PERFORMANCE OF TWENTY VARIETIES OF GRAPE (Vitis vinifera L.) AND THE RESPONSE OF TWO VARIETIES TO THE APPLICATION OF FARM YARD MANURE, FERTILIZERS, TRAINING SYSTEMS AND PRUNING DATES

BY

ISHAYA S. MAJANBU

A dissertation submitted to the Post-graduate School,

Ahmadu Bello University in Partial fulfilment

of the Requirements for the Degree of

Doctor of Philosophy in Agronomy

Department of Agronomy,

Faculty of Agriculture,

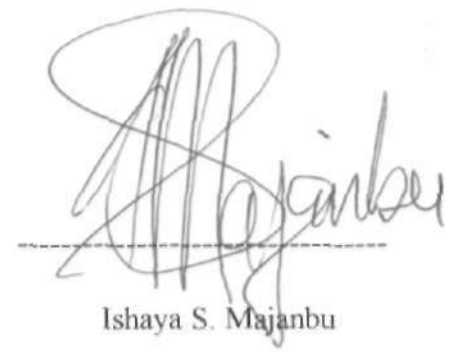
Ahmadu Bello University,

Zaria, Nigeria

MARCH 1996

DECLARATION

I hereby declare that this dissertation has been written by me and that it is a record of my own research work. It has not been presented before in any previous application for a higher degree.



Ishaya S. Majanbu

(Student)

The above declaration is confirmed.



Prof. M. K. Ahmed

(Chairman, Supervisory Committee)

Date: 28-3-1996

CERTIFICATION

This dissertation titled "Performance of Twenty Varieties of Grape (Vitis vinifera L.) and the Response of Two Varieties to the Application of Farm Yard Manure, Fertilizers, Training Systems and Pruning Dates" by Ishaya S. Majanbu meets the regulation governing the degree of Doctor of Philosophy (Agronomy) of Ahmadu Bello University and is approved for its contribution to scientific knowledge and literary presentation.

Prof. M. K. Ahmed
(Chairman, Supervisory Committee)

Prof. I. D. Erinle
(Member, Supervisory Committee)

26/7/95

(Dean, Postgraduate School)

Date: .....

Ahmadu Bello University,

Zaria, Nigeria.

DEDICATION

To

my Late father, Mallam Samaila Kasuwa Bissalla Majanbu

for his foresight in sending me to school,

my mother, Mrs. Gbafu Samaila

for her concern about me

and

all the grape growers for advancing grape production in Nigeria.

ACKNOWLEDGMENTS

Prof. M. K. Ahmed, my major supervisor has given me tremendous support and encouragement in the course of this study. He did not only give the academic training, but also offered his time and means to support me both on the field work and presentation of this thesis. He is to me a father, who is very patient and immensely delighted in seeing to the success of his son. I owe him thanks for ever. I wish to refer him as the father of grapes in Nigeria.

Prof. I. D. Erinle, a member of my supervisory committee, was very supportive. He made available to me materials from the Horticultural Crop Research Programme's office of the Institute for Agricultural Research (IAR), in carrying out the field experiments. I cherished the academic guidance he gave me. I remained grateful to him as well.

The completion of this programme would hardly have been possible if not for the encouragement I received from many people. Moreso since I had to combine the demanded assignment in the Niger State Government with this study. To them all I expressed my sincerely gratitude and in particular Prof. Joseph Y. Yayock, Dr. Tunji Arokoyo the Deputy Director, National Agricutural Extension and Research Liaison Services (NAERLS), Prof. V. B. Ogunlela, Prof. S. T. O. Lagoke and Dr. V. O. Chude.

The research work was made possible with grants from the University Board of Research and NAERLS research grant. I am therefore grateful to the Vice-Chancellor of the University and the Director of NAERLS, Alhaji M. B. Zaria, for the opportunity I was offered to contribute scientific knowledge to the academic and farming communities.

I also want to acknowledge the assistance I received from Mr. Okutu, an IAR technical staff and Mallam Hamidu Kano of the same Institute during the field

experimentation. Messr Johnson Onyibe, Zaki Ahmed and staff of IAR Data Processing Unit deserved my appreciation. The assistance I got from staff of the Ministry of Agriculture and Natural Resources, Niger State is acknowledged.

I wish to thank most sincerely the efforts of Mrs Bassey Basseda and Miss Esther Gambo Sati for their typing work. To the several other people who have contributed to the success of this work and whose names have not been mentioned I ask for God's blessings to them all.

I wish to express my profound appreciation to my wife, Naomi I. Majanbu, for her understanding, care and love and to our children, Dauda, Varashi and Unei'keshile for bearing my inabilities when they needed me. Finally, whatever achievements I have made as a result of this work, I owe it all to God and my Lord Jesus Christ and thanked Him for his loving kindness towards me.

ABSTRACT

Three field experiments were conducted at the Ahmadu Bello University farm, Samaru from 1986 to 1993 to investigate the performance of twenty varieties of grape (Vitis vinifera L.) and response of two varieties to farm yard manure (FYM), fertilizers, training systems and pruning dates.

Of the twenty varieties (namely Anab-e-shahi, Anab-e-shahi x American seedling, Bangalore blue, Black hamburg, Black rose, Black verico, Cardinal, Catawba, Concord, Gross coleman, Israel blue, Monaca sabo, Ex-Zaria black, Ex-Horticulture Samaru, Ex-Hospital, MKM-7, Ex-Maiduguri, Queen golden, Regina and Thompson Seedless), five varieties (namely Queen golden, Concord, MKM-7, Ex-Horticulture Samaru and Ex-Zaria black) have shown outstanding vegetative and reproductive characters. Queen golden, the highest yielder had very fast growing stems, long shoots, very high number of canes per vine, very high number of bunches per vine, very heavy bunch and a very high number of berries per bunch. Of the five varieties which gave the outstanding vegetative and reproductive characters, Concord and Ex-Horticulture Samaru may be suitably grown in the southern parts of Nigeria being also found to be resistant to both anthracnose and downy mildew.

All the varieties gave a significant positive and negative correlation between yield and stem diameter, yield and fruit sugar percent, respectively. A significant positive correlation was also found between yield and shoot length, yield and weight of October pruned material

(summer pruned material), yield and number of canes per vine, yield and number of bunches per vine, yield and bunch weight and, yield and number of berries per bunch. Path co-efficient

study of the vegetative and reproductive characters revealed direct contribution to fruit yield by number of canes per vine, shoot length, number of bunches per vine and bunch weight as 17.1%, 22%, 76.8% and 33.2%, respectively.

The two varieties (Ex-Horticulture Samaru and Ex-Zaria black) studied for their response to application of FYM (10, 20 and 30 t/ha) and fertilizer (50:40:50, 150:80:100 and 250:120:150 of NPK kg/ha) revealed differential response on shoot length, berry size, fruit sugar percent and juice pH. Ex-Zaria black's longer shoot length was not due to FYM or fertilizer treatments. Stem diameter, number of canes per vine, number of bunches per vine and bunch weight were significantly influenced by FYM and fertilizer application. Number of berries per bunch was not greatly influenced by nutrition and its direct contribution to yield was assessed to be 8%. Although, application of FYM and fertilizers increased fruit yield significantly in both varieties, the yield of Ex-Zaria black was superior. In both varieties, the interaction study revealed that FYM at 30 t/ha and fertilizer treatment at 250:120:150 NPK kg/ha gave the highest fruit yield in this study.

The results of the combined analysis irrespective of the years revealed that pruning dates did not affect shoot length, berry size and fruit sugar content. The weight of summer pruned material was higher in September 26 and October 17 pruning dates. The loss in weight of the summer pruned material for November 7 pruning date was attributed to loss of leaves due to defoliation. The study showed that the September 26 pruning date was the best as it gives a higher yield and other yield components. The variety Bangalore blue produced longer shoots, weight of October and April pruned materials, number of bunches and sugar

content than Ex-Zaria black. The interaction between variety x training system was significant with Ex-Zaria black producing higher yield under the Overhead training system.

The two training systems (Kniffen and Overhead trellis) used did not affect shoot length, weight of April pruned material, number of bunches, number of berries, bunch weight, sugar content and fruit pH. A higher number of canes was recorded in the Kniffen training system.

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ABBREVIATIONS AND SYMBOLS

g	Gram
hl	Hecto litre
kg	Kilogram
mg	Milligram
ml	Millilitre
l	*Litre*
Meq	Milliequivalent
M	Meter
m2	Meter squared
Cm	Centimeter squared
mm	Millimeter
ha	hectare
%	Percentage
C.E.C	Cation Exchange capacity
N	Nitrogen
P	Phosphorous
K	Potassium
Ca	Calcium
Mg	Megnesium
H	Hydrogen
Al	Aluminium
Na	Sodium

Am	ante meridian (beforenoon)
Pm	Post meridian (afternoon)
Min.	Minimum
Max.	Maximum
NS	Non significant
*	Significant difference at 5% level
**	Significant difference at 1% level
°C	Degree centigrade
Lat.	Latitude
/	per
SE	Standard error

CHAPTER ONE

INTRODUCTION

Grape (Vitis vinifera L.) is an ancient crop, the cultivation of which dates back to as early as the history of mankind. It originated from temperate and sub-tropical regions. It could, however, be grown successfully in the tropics through agronomic manipulations by way of pruning.

Grape is one of the most nutritious, delicious and refreshing fruits which occupies more than half of the world total fruit production area and ranks first in the global tonnage of fruit production . World production of grapes is put at 59.5 million mt with the continents' production decreasing in the order of Europe (53.2%), Asia (15.8%), North America (10.4%), U.S.S.R. (former, 7.4%), South America (6.9%), Africa (4.6%) and Australia (1.8%). The major grape growing countries are Italy (15.6%), France (14.3%), U.S.A. (9.4%), Spain (9.3%), former U.S.S.R. (7.4%), Turkey (5.9%), Argentina (3.1%), Iran (2.8%), South Africa (2.5%),Germany (2.4%), Greece (2.4%), Portugal (2.2%) and China (2.1%) (Anon., 1994). Over 8,000 varieties of grape have been reported (Khanduja, 1972) . The varieties are classified according to their intended use, such as table varieties and those for wine, raisin, juice, jam, jelly, etc. Some varieties are multi-purpose utilization. The varieties differ in their content and quality when grown in different regions.

Grape being a temperate crop requires a cool period or winter to undergo rest and summer to flower and fruit. Therefore, in the tropics the vine grows as an evergreen without producing any bunches due to warm climatic condition. In temperate regions, grapevine is pruned once after the harvest of fruit and the winter kills the tender green shoots thereby

removing the apical dominance. In the tropics however, unless the vine is pruned a second time for fruiting, it will not produce any satisfactory yield.

Grape is an important industrial raw material for the production of wine, raisin, jam, jelly and juice. A global survey indicate Italy as the leading wine producer followed by France, Greece and Spain. Italy is also a major exporter of fruits while France is a major importer. Greece heads the list of raisin exporters and United Kingdom (U.K.) is the largest importer of raisin. Other important countries are USSR and U.S.A.

The crop was introduced to Nigeria in 1965 and was established at Maigana, Daura, Gembu, Biu, Riyom and Panyam by the United States Agency for International Development (USAID). In 1963, the Hon. Premier of northern Nigeria visited Morocco and Libya where he found grape and apple being grown on similar soils and climatic conditions as some part of northern Nigeria. He therefore arranged to introduce grape in 1965 through USAID (Tappan, 1966). The vines established but produced very little or no fruit due to lack of technical know-how of production of grapes in the tropics. Some of these introductions remained in the gardens of emirs and missionaries. Ahmed et al. (1982) observed that there were some varieties being grown around Zaria which failed to fruit due to lack of knowledge to make these varieties produce under tropical conditions. The crop was re-introduced in 1975, initially with Anab-e-shahi from Hyderabad, India followed by 11 more varieties.

Training is directing the growth of vines to assume a specific shape in relation to the supporting structures. Some variety lend themselves better than others for a specific training system. Also some training systems are more popular than others in a particular region.

Pruning is the most important single factor which determine as whether the vine would bear fruits or not, the fruit load and quality.

Manuring and fertilizer application is a key operation for successful production of grape. Grapevine is a voracious feeder and removes a considerable quantity of nutrients from the soil and such removals must be replenished by large amount of organic manures and fertilizers

Nitrogen is believed to improve the yield and quality of fruit. Phosphorous application enhances ripening of bunches, yield and quality of grape. It also helps in the establishment by having active root system. Potassium fertilizer is necessary to improve the yield and quality of fruit and also gives better resistance against the diseases.

Although there is accumulated information on grape production elsewhere, its direct local application by extrapolating to Nigerian conditions may not be of much use. Investigations were therefore planned to have the relevant information emanating from local research for use of Nigerian growers. The objectives of this study were:

- to examine the growth, yield and quality of fruit of twenty varieties and suggest their possible uses.
- to determine the optimum requirement of farm yard manure (FYM) and fertilizer to produce maximum fruit yield.
- to study the response of vines to pruning dates and training systems for maximum fruit yield and quality.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 Varietal Performance

Eight selections of Sultana (Thompson seedless) were assessed over three seasons for their suitability for table grape production by using special cultural techniques to enhance the berry size. Moss Sultana consistently produced highest berry weight and on an average, the berries were 27 percent heavier than those of H5, a commercially popular selection; their mean weight were 6.1g and 6.8g respectively. Moss Sultana had the lowest sugar levels and the highest pruning weights in all the three seasons. There was no significant difference between selection for marketable yield, bunch number per vine, bunch weight, acidity and brix: acid ratio (Deer and Whiting, 1989).

Bhujbal and Phadnis (1972) described the development Anab-e-Shahi variety. According to them, the floral primordia of this variety was formed 45 days after pruning and the auxillary buds developed 60 days after pruning. The inflorescence primordium developed numerous growing points 100 days after pruning and further development of bud ceases by 180 days which approximately coincides with the date of pruning. The differentiation of buds into flowers occurs 2-4 days after bud burst. Muthukrishnan (1968) observed that the period of initiation was 35 days after pruning in Bangalore blue. In the same variety the period initiation of and differentiation into floral parts varied from 60-85 days in different years depending upon the growth of the variety. The berry of Bangalore

blue has a sub-acid taste unless fully ripe. Based upon the experiment for nodal number which bears the bunch, Majanbu (1991) observed that fifth bud from the base is the nodal bud for bunch production in Ex-Zaria black. Therefore for maximum fruiting during October pruning, 3-5 buds should be left on the cane. Cook (1966) studied the fruiting behaviour in grapes. In many varieties it was only the central shoot which isfruitful. In the case of Thompson seedless and its similar clones, the secondary and the tertiary buds were also found to be fruitful and produce fruit if the main shoot is damaged. Nir (1993) reported that the main problem of Thompson seedless grown in warm area is its fruit quality especially in relation to its berry size due to insufficient bunch thinning. The vines with high fruit load have 40 percent more berries per bunch than vines with lower fruit load according to the report, and fruit quality was poorest on weak and over loaded vine.

Result of 8-year trial with White Burgundy showed that for grapevine to produce good yield, the soil water supply should be 60 per cent above the soil moisture capacity during the berry enlargement and softening stage. Irrigation increased yield up to 20 percent and had only negligible effect on sugar content. The general plant vigour and number and weight of clusters were also increased (Roth, 1986). Thompson seedless was found to be more susceptible to alkalinity than Perlette (Samra, 1986). A new Bulgarian variety was bred from a cross between Pamid x Cabernet Sauvignon. The bunches were large (mean weight 260 g) with large dark blue berries and thick skin. The vine had a vigorous growth and good fruit quality production. It yielded 6.5 kg per vine (18 t/ha).

Sugar content of the berry was 21.4 percent. It is suitable for making dry, well coloured wine (Zankov et. al. 1986). The pistillate muscandine grape cultivar Hunt and male plant planted as every third plant in a row and every third row gave statistically better yield. The vine yard was harvested and yield recorded over an experimental period of 40 years. The yield per plant increased from 1946-49. The position effect of the male plant on yield was found to be significant in 6 out of 40 years (Austin and Boudari, 1989). Nauriyal et. al. (1967) concluded that out of 90 varieties grown at Abohar, Thompson seedless and Anab-e-Shahi were among 12 top yielding varieties. Thompson seedless is late maturing, prolific bearer and has a high quality fruit. The above stated characters, growing Thompson seedless may prove to be a better proposition than Anab-e-Shahi. According to (Singh, 1963), Gross coleman variety is good for juice and wine making. Kashap et. al. (1967) reported that out of 6 varieties tried, Bangalore blue was not the outstanding variety in terms of quality for table purpose.

Eight (8) varieties were tested from 1982-84 in Turkey, the early native varieties exceeded the exotic varieties in shoot production and shoot growth per year but exotic varieties like Parle de csaba, Cardinal, Muscat and Reine and Pause Precoce were earlier, more productive and had a stronger berry attachment. Muscat Reine and Parle de csaba were characterized by pleasant muscat flavour. The local variety Adama black, had the smallest cluster and Muscat Reine the largest and the rest did not differ in cluster size (Erzenoglu, 1988). The concentration of acid other than malic and lactic, showed to be related

more to the area of production rather than the grape variety. Shikimic and galacturonic acids were helpful for classifying the grape varieties (Etievant et. al., 1989).

The production economics of 533 farms in five major vine producing zones of Cyprus revealed that grapevine was the most important crop in terms of area and income. The mountain zones were least productive, less than 2.5 t/ha, while the Paphos was the most productive area with 9 t/ha (Papachristodoulou and Papayiannis, 1988). Aromat and Ozana are early varieties for table use and production of superior white wine and Arcas is good for red wine. It was resistance to frost and give high yield of 19t/ha (Danulescu et. al., 1986). The ratio of grape to vine will largely depend on the varieties and wine making process, for example in Turkey, 1 hl of wine per hectare is produced whereas in Japan 130 hl of wine per hectare is attainable. The rate of transformation from grape to wine also vary in different countries; for example, in USSR, it is 46 per cent and Chile, it is 92 per cent (Calo, 1988). The variety Regina accounted for 55 per cent of the production in Italy up to 1970 and thereafter its hectarage fell considerably and the variety Italia occupied 45 percent followed by Cardinal. Fifty per cent of the production of Italia are sold as table and the remainder are used in the manufacture of processed food stuff including sugar (Fregoni, 1989).

2.2 Farm Yard Manure (FYM) and Fertilizer Levels

The use of organic matter either as FYM, green manure or green leaf manure has been encouraged as a means of improving soil productivity. Tropical

soils are low in organic matter content, therefore are less capable of withstanding high inputs of inorganic fertilizers without destroying their nutrient balance status (Tomlinson, 1962; Jones, 1973).

Organic matter application has been recommended as soil management practice to maintain soil productivity (Jacob and Uexkull, 1958; Jones, 1971; Brady, 1974). The value of organic matter in improving the soil structure and soil capacity to retain moisture and nutrient beside providing to plants its available nutrients after decomposition has been well noted (Anonymous, 1964; Kononova, 1966). Organic matter may be added to the soil in the form of FYM, green manure, green leaf manure or compost. A study by Kr 'stevakoslova and Mikhailova (1987) on the effect of green manure in grapevine cultivation showed that green manure use increased the fruit yield by 20 percent. Application of organic matter in the form of compost to grapevine has varied from 25 - 80 t/ha (Nauriyal et al., 1967; Temurev and Ahmedov, 1968; Anonymous, 1984; Ahmed, 1985). Ahmed et al., (1987) advised on the application of FYM at the rate of 6 kg/m^2 on the basis of individual vine grown in the Guinea savanna soil of Nigeria. Chadha (1965) cautioned that excessive use of manure may reduce yield of grape.

A perusal of various recommended manurial rate revealed that of the total nitrogen supplied to the plant, over 70 per cent of this nutrient is through organic manure. Raw and composted poultry manure at the rate or 4.5 and 9 t/ha in the vineyard on Ramona sandy loam were studied from 1984-86. It was applied on both side of the row and incorporated in the top 10 cm of the soil in November

each year. Fruit yield and quality increased over the unmanured control. The response of 4.5 and 9 t/ha rate was similar. Berry size, cluster number per vine and cluster weight increased with the rate of application of manure, raisin quality improved linearly with manure rate. Soil available P, exchangeable K and nitrate nitrogen, water infiltration rate and organic matter content increased with manure application. There was no significant difference between the raw and composted manure (Bhangoo et al., 1988). Ahmed (1995) suggested that grapevine is a voracious feeder and needs large quantities of manures and fertilizers like FYM, compost, green leaf manure at the rate of 20-30 t/ha, in addition 300-400 kg of superphosphate, 200-300 kg of calcium ammonium nitrate and 100-150 kg of muriate of potash per hectare applied in two equal split doses at the time of pruning.

2.3 Effect of Pruning Dates and Training Systems

Fruits in grapevine are borne on shoots growing from buds on canes of about six months old. The central point in the compound bud is responsible for producing fruits. Some times the lateral buds bear fruits if the central bud is damaged (Shalitin, 1973; Edmond et al., 19750. In the Sultanina variety and its similar clones, the secondary and tertiary shoots were also found to be fruitful (Cook, 1966). The fruitfulness is determined by how many of the tendrils are differentiated into flower clusters. The primordia of leaves, inflorescence, tendrils are formed before the cane matures (Bhujbal and Phadnis, 1972). The new primordia were formed about 45 days after pruning in Anab-e-shahi. The auxiliary

buds develop into axils of the previously formed promordia by 60th day. The buds are either narrow and pointed or blunt and obviate. The former are usually the vegetative and the latter are fruiting buds. Such differentiation is evident when a bud attains a 5-nodal stage in its development. The inflorescence primordium developed numerous growing points by 100th day and further development of bud ceases by 180th day which approximately co-incides with the time of pruning. After pruning the bud swelled in size considerably but the differentiation of bud into flowers occurs 2 - 4 days after bud burst. The time of initiation and differentiation vary among varieties and even within a variety between seasons. In Bangalore blue, Black Prince and Kishimishi varieties was found to be 25, 30 and 35 days after pruning. In Bangalore blue, further development was completed from 60 - 85 days at different years (Muthukrishman, 1968).

Training is directing the growth of a vine to assume a specific shape which suits the support provided. Thus, it is a process of disposition of trunk, secondaries and tertiaries in relation to the supporting structure for easy pruning, crop protection and cultural operations. In some training systems as in mechanized orchards or on hilly lands no supporting structure are provided and the vines are trained as low growing stocky bushes. The process of training starts soon after transplanting by allowing a single stem (which later becomes a trunk) trail vertically along a support by retaining a single vigorous shoot. There are about a dozen different types of training. The Overhead bower training system is suited to vigorous varieties and is commonly adopted under home gardens (Venkatratmam, 1968). The Kniffen system of training was described in detail by Bakashi and

Kanwar (1970a). Weaver (1976) reported that there are 3 main training systems used in California namely head trained/spur pruned, cordon trained/spur pruned and head trained cane pruned. In India, the common training system used on a field scale are single stake, trellis of Kniffen system and overhead trellis or telephone trained system (Ahmed, 1994). A number of modification have been suggested to the above stated basic training systems.

Viticulture is an expensive enterprise involving supporting structures, irrigation system, large quantities of inputs and labour for training, pruning, etc. (Carbonneau and Huglin. 1980). It can therefore be profitable if the yield and price of grape is high. The yield of a grape cultivar depends on its training and growing conditions (Smart, 1985), fruit distribution and light penetration (Koblet, 1987 and May 1965). The level of production therefore has to be controlled specifically according to vine development, method of cultivation and training and the environment (Jackson et al., 1984; Kliewer and Bledsoe, 1987). The variety Concord produced higher yield under Geneva double cordon training system by promoting more fruitful nodes than single cordon or umbrella Kniffen trained vines which produced higher vegetative growth (Morris and Cawthon, 1980). Bindra and Brar (1979) found that the bower system was most suitable for Beauty seedless variety. In another study Bindra and Brar (1981), compared cultivar Himrod under different training systems. They recorded the highest yield under bower system followed by Kniffen bilateral and lowest yield under head trained system. Muscat hamburg also yielded higher under bower system. The yield was about 5 fold when compared with unilateral telephone, bilateral telephone and

bilateral Kniffen systems. Deidda and Milella (1979) observed that training systems affected the growth and yield of grapevine. Alberello training system gave maximum trunk growth, pruned material and cane to node ratio, whereas Sylvozo-wing system gave the highest cluster to node ratio, cluster weight and number of reproductive buds/ha. Although the overhead bower system gives the highest yield, it needs a large capital outlay to establish and for pruning operations (Gopalakrishna, 1968; Anon, 1984, Ratnam and Majanbu 1985). In another study by Bindra and Brar (1978) found the relative sequence of training system in descending order as overhead bower, bilateral Kniffen, Unilateral Kniffen, Overhead bilateral trellis, overhead unilateral trellis and head pruning. Their yield were 16.2, 10.5,5.5, 9.6, 7.6 and 5.7 t/ha, respectively. In terms of cost, head pruning was cheapest followed by Kniffen, overhead trellis and bower system.

In temperate regions pruning is done only once after the harvest. The apical dominance is removed by the winter killing the tender top shoot. As it result in Spring, the lateral buds on the mature cane burst and produce fruits. In the tropics pruning twice a year is necessary to force the vine to produce fruit. In April fruited cane is cut to a single basal bud by removing all found vegetative growth on the vine. This also enables vine to undergo some rest during hot summer. The purpose of this pruning is to get a new vegetative growth from April to October when the canes are pruned a second time for fruiting. However, if the canes are pruned in April leaving 3 - 12 buds, such canes produce fruits which mature during the rainy season. Both the yield and quality of such fruits will be poor and they are subjected to diseases and pest due to high humidities and high

temperatures. Producing fruits both in the rainy and dry seasons not only affect the yield and quality but it also affect the longevity of the vine. Therefore two crops a year is discouraged under a prudent commercial venture (Ahmed, 1994). Turkinton, et. al., (1980) also observed that over cropping is not only detrimental for a long time vine development but also to the current crop quality. The second pruning is done in the month of October for fruiting leaving 3 - 12 buds depending upon the variety. This pruning is necessary to remove apical dominance without which the vine will not produce economic crop (Ahmed, 1994). Grapevine grown in a glasshouse in the temperate regions are also pruned twice a year for vegetative growth and fruiting as the conditions for growth in the glasshouse are similar to those of the tropics (Verhej, 1968). Shukla (1965) also recommended pruning vines twice a year in the tropics according to the growth cycle of the variety. Pruning also help to get a uniform distribution of fruiting buds over the entire vine in order to get a good crop and maintain the productivity of the vine for a longer period. The date of pruning was found to affect the vine growth and fruit yield (Patil, 1975b). Shrivastav et. al. (1970) found that 31 December pruning date produced maximum number of total sprouts, which was closely followed by 21 January and 21 December. The percentage of fruitful sprouts was greater on 11 January pruning date closely followed by 31 and 21 December but the fruit yield was higher in 31 December pruning date. Patil (1975b) used seven dates of pruning starting from 1 September to 1 November with 10 days interval on Anab-e-Shahi. The pruning dates 21 September, 1 October, 11 October and 21 October was found to be better than 1st of 11th September and 1st November.

Percentage of bud burst was significantly higher in vines pruned on 1st November but resulted in poor sprout. The growing bud sprout was also significantly affected by pruning date. The sprouts of 1st October and 11 October were found to be vigorous and length of shoot was more than for 1st November. He concluded that grape pruned on 1st October gave maximum yield. When the temperature was lower than 30°C bud burst, growth and yield were adversely affected. The result corroborated with those of Aubert (1972) who noted that for satisfactory bud burst to take place, the temperature should be between 30 - 35°C. The total soluble solids and acidity were not significantly affected by different pruning dates. Bakshi and Kanwa (1970b) found that pruning dates during dormant period of vine should not produce significant effect on the vine performance. When pruning is delayed to a point when sap is active there will be a heavy "bleeding" of vine which may predispose the vine to diseases and flower drop. In tropical regions it is necessary to prune to allow sufficient time for berry ripening before onset of rains (Singh and Chadha, 1965; Nauriyal et al., 1967).

Pruning is the highest labour consuming and most expensive operation in countries where labour is expensive. In such countries, it is now done mechanically. Peterson et al. (1973) observed that mechanical pruning for cordon trained vines is being developed in Australia. Cargnello (1980) suggested that a high grave yield with premium fruits quality is difficult to achieve by mechanical pruning. Trellising system of pruning which needed skilled labour is expensive. Mechanization of pruning is complex and demand long term development of machines. Freeman (1980) described the various approaches to mechanical

pruning of vine. In mechanical pruning, the vines are planted close (2 - 3 m x 1 - 1.5 m) and hand pruned for the two initial years after which they are hedge pruned mechanically (Lavee et al., 1993). In another study, Lavee and Haskal (1993) planted four varieties in densities 2000 to 8000 plants/ha. The vines are trained on standard cordon 'Y' shape and "W" shape and pergola trellis system. Densely planted head pruned vines on a 'Y' trellis produced a higher yield of 60 t/ha as against standard plots of 25 t/ha.

In regions of dry summer irrigation is a must for grape production as flowering and fruiting takes place during the dry season. Irrigation in combination with high levels of manures and fertilizers result in rank growth of high vigour and result in rich vegetation. The excess vegetative growth reduces the fruit production and therefore need to be pruned (Jensen, et. al., 1980). Severe pruning produces higher number of bunches in Anab-e-Shahi (Chadha and Mand, 1969) and fruit of better quality (Kimball and Shaulis, 1958). Another way to control the excess vegetative growth was by the use of growth regulators (Lavee, 1987). Such excessive growth could be successfully controlled by the use of ethylene releasing substances (Hirschfeld and Lavee, 1980). Schulman et al. (1980) found that 2-chloroethyl phosphoric acid controlled the growth of vine satisfactorily.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Experimental Site

Three experiments were conducted at the Ahmadu Bello University Farm, Zaria ($11^{0}11'$ N,$07^{0}38'$ E) situated at an altitude of 686 m above the sea level. It is located in the Northern Guinea Savanna zone of Kaduna State, Nigeria.

3.2 Climate

The annual rainfall range is from 800 to 1300 mm and the long term average from 1928 to 1995 is 1063 mm. (The rainy season starts in June and ends at the end of September, during which period the relative humidity is very high (70 - 84%).) Being located close to the equator and within the region of tropic of cancer, it has a very high solar radiation which results in high mean temperatures ranging between 21 - 30^{0}C. A high humidity in combination with the high temperature during the rainy season predispose the grape vine to fungal diseases. Therefore, rainy season is not conducive for flowering and fruiting of grapes as a commercial venture. The period of October to May is usually a rain free period, with very low humidity (12 - 25%) and comparatively lower temperature especially during the "Harmattan" period (November - February). This period is ideally suited for flowering and fruiting of grapes provided there is an assured source of irrigation: The mean climatological factors during the period of experimentation from 1988 - 93 are given in Appendices 1 (a-c).

3.3 Soil

The soils of the region are broadly classified as well drained, ferruginous (Tomlinson, 1969) and often leached (Klinkenberg and Higgins, 1968). As regards specific soil characteristics of the experimental site, it is deep, acidic in nature, low in nitrogen, organic matter and calcium and exchangeable ions. Texturally, the soil is classified as a clay loam. The field was fallow for the past several years. The site was selected for these experiments due to its proximity to the irrigation source and depth of the soil.

3.4 Planting Material, Planting and Nursery Management

Stem cuttings 0.7 - 0.8 cm in diameter and 15 - 20 cm in length containing 3 - 4 buds from a matured cane of medium growth of twenty varieties were planted in polybags (6 x 25 cm) containing equal parts of top soil, sand and well decomposed farm yard manure (FYM). Adequate space was left at the top of the polybag for watering. The lower cut was made close to the node and straight whereas the cut at the upper end of the cutting was made slanting and about 2 cm away from the bud. Polybags were watered 2 hours before planting, a hole was made in the centre of each with a stick and the cutting was placed in the hole with two nodes above the soil surface. The soil around the cutting was pressed. The polybags were watered immediately.

The polybags were watered twice a day until sprouts were formed and thereafter they were watered on alternate days throughout the dry season. Only one shoot was allowed to grow per cutting and any sprout from the auxilary bud was nipped off as too many growing points results in stunted growth. The cuttings

were watched for pests and diseases and appropriate control measures were taken.

3.5 Land Preparation and Transplanting

Land of the experimental field was ploughed twice, followed by a single harrowing. A composite soil sample was derived from 4 depths (0-15, 15-30, 30-45 and 45-60 cm) to study the physical and chemical properties of the soil (Appendix 2). Also samples were collected to determine the nematode population as grape is a perennial crop, irrigated during dry weather which allows nematode population to multiply very fast.

Pits of the size 60 x 60 cm and 75 cm deep were dug at a spacing of 2.5 m within and 3.5 m between the rows in June Each pit was filled back with top soil, 20 kg well rotted FYM, and 2 kg each of single superphosphate (18% P_2O_5) and 15:15:15 compound fertilizer in the month of July. Soil from the centre of the pit was scooped out, the polybag was torn and the rooted cutting was planted in the hole as per the layout plan in each experiment. The soil around the plant was pressed and the plants were irrigated immediately.

3.6 Irrigation

To ensure an assured source of irrigation water, an open well of 3 x 3 m was dug near the lake. The plots were irrigated by a 3-inch (7.5cm) Honda pump as and when necessary. Irrigation water was carried to the field through 3-inch galvanised pipe. Water hydrants were erected at 14 m gaps internal throughout the field and irrigation was carried out to the basin through a plastic pipe. The size of the basins for the experiments were 1.75 x 2.5 m around each plant. Irrigation

was applied at weekly interval during early stage of establishment of the vines, whereas it was irrigated at an interval of 12 and/or to 15 days during fruiting and growth period, respectively. Irrigation was stopped two weeks before harvest for uniform maturity but was resumed after pruning and manuring.

3.7 Manuring

The grape vine need lots of manure and fertilizer. During establishment of the orchard and early stage of production, the manure and fertilizer schedule in Table 1 was followed except in the fertilizer experiment wherein fertilizer schedule was adopted after three years.

Table 1: Manure and Fertilizer Schedule during Establishment and Early Production of Orchard

	Age of Vines (Years)				
Manure/Fertilizer	1	2	3	4	5 and above
FYM (kG/M^2)	2	3	4.5	6.0	7.0
$N(g/m^2)$	5.0	8.0	15.0	18.0	20.0
$P_2O5(g/m^2)$	5.0	5.0	7.5	9.0	10.0
$K_2O(g/m^2)$	3.0	3.0	7.5	9.0	10.0

3.8 Experiment No. 1: Performance of Grapevine varieties at Ahmadu Bello University Farm

3.8.1 Treatments and Experimental Design.

Twenty varieties namely Anab-e-Shahi, Anab-e-Shahi x American seedling, Bangalore blue, Black hamburg, Black rose, Black verico, Cardinal, Catawba, Concord, Gross coleman, Israel blue, Monaca sabo, Ex-Zaria black, Ex-Hort-Samaru, Ex-Hospital., MKM-7, Ex-Maiduguri, Queen golden, Regina and Thompson seedless were evaluated. As regards their source, a majority of

them (12 varieties) were brought from Hyderabad-India, 4 within Nigeria, 3 from Greece and 1 from Eqypt (Appendix3). The experiment was conducted in a randomised complete block design replicated 3 times. The vines were trained in a double cordon Kniffen system. A detailed layout plan is given in Appendix 4.

3.8.2 Spacing

Pits of the size 60 x 60cm and 75 cm deep were dug at a spacing of 2.5 m within and 3.5 m between the rows in June. Each pit was filled back with top soil, 20kg well rotted FYM, and 2 kg each of single superphosphate (18% P_2O_5) and 15:15:15 compound fertilizer in the month of July.

3.8.3 Transplanting

Healthy and vigorous cuttings were planted 17-10-1987. Soil from the centre of the pit was scooped, polybag was torn and the rooted cuttings were planted as per the layout plan of the experiment. The soil around the plant was pressed and the plants were irrigated immediately.

3.8.4 Training

The vine were trained on the Kniffen system. In the Kniffen system of training, any axially bud that develops from the main stem was pinched except those which were trained along the 3 wires stretched on posts in a double cordon. The height of the lowest cordon was 60 cm from the ground and thereafter 45 cm each. In the Kniffen system, the secondaries trained along the cordon, formed the permanent structures on which pruning was done twice a year. The system were selected for an easy pruning and spraying in a standing position.

3.8.5 Pruning

The pruning operation consists of removal of excessive growth either by leaving a single bud, for production of shoot in April, of which 3 - 12 buds were intended to bear fruit after the rainy season as the shoots will be green and buds will be immature during the rainy season. The other purpose of pruning was to get a uniform distribution of fruiting buds on the entire vine in order to get a good crop and maintain the vine's productiveness for along time.

3.8.6 Manuring

Manure and Fertilizer Schedule for this experiment is as given on Table 1.

3.9 Experiment No. 2 Response of two grape varieties to FYM and fertilizer application

3.9.1 Treatments and experimental design

Two varieties (Ex-Horticulture Samaru and Ex-Zaria black) were grown at 3 levels of fertilizer (50:40:50, 150:80:100 and 250:120:150 kg of NPK./ha, respectively) each at 3 levels of FYM (10, 20 and 30 t/ha) applied in two equal splits after April and October pruning. In addition to the above 18 treatments, one in each of the variety with no manure and fertilizer application formed a control (Appendix 5). Thus, in all, there were 20 treatments replicated 3 times in a randomized complete lock design with factorial arrangement. A single vine constituted a replication.

3.9.2 Spacing

As in item 3.8.2

3.9.3 Transplanting

As in item 3.8.3

3.9.4 Training

As in item 3.8.4

3.9..5 Pruning

As in item 3.8..5

3.9.6 Manuring

The first 3-year manure and fertilizer schedule as given in Table 1 were applied to all vines and thereafter the manure and fertilizer treatments in item 3.9.1 were imposed

3.10 Experiment No. 3: Effect of pruning date on growth and yield of two varieties of grape trained under two training systems.

3.10.1 Treatments and experimental design

The experiment was conducted in a split-plot design with two varieties (Bangalore blue and Ex-Zaria black) pruned on 3 dates, 26th September (early pruning), 17th October (normal pruning) and 7th November (late pruning), under two training systems (Overhead trellis and Kniffen). The training systems were treated as the main plot treatments and varieties x pruning date as subplot treatments. The layout of the experiment is given in Appendix 6.

3.10.2 Spacing

As in item 3.8.2

3.10.3 Transplanting

Healthy and vigorous rooted cuttings were planted on 19-10-86. Other operations were as described in item 3.8.3

3.10.4 Training

Two training systems used in this experiment were Overhead trellis system and Kniffen system of training. The Kniffen system has been described in item 3.8.4. In the Overhead trellis system, any axially bud that sprouts on the main stem will be pinched until the mainstem reaches the height of an overhead trellis (1.35 m). The main stem was topped and the two secondaries were allowed to develop and trained across the trellis. On these secondary branches tertiaries were allowed to develop at a distance of 0.5 m and to a length of 1.25 m along with trellis wires. Such tertiary structures formed the basic frames which are pruned twice a year in April for vegetative growth (leaving the basal bud of the cane) and in October for fruiting 3 - 12 buds were left depending upon the fruiting behavior of a variety).

3.10.5 Pruning

As in item 3.8..5

3.10.6 Manuring

As in item 3.8.6

3.11 Data Collected and Analyses

3.11.1 Varietal description

The 20 varieties used in this study were described as per the various characteristics given in Appendix 7.

3.11.2 Vegetative characters

1. Stem diameter

The girth of the main stem was recorded in cm, periodically at 30 cm above the ground level with a measuring tape. The diameter was calculated therefrom. This measurement shall indicate the growth and vigour of the vine as described by Chohan et al. 1979 and Peterace, 1976.

2. Shoot length Ten randomly tagged shoots were measured (in cm) at bi-weekly intervals beginning from sprouting until the pruning time. Only the finals length of shoot was subjected to statistical analysis

3. Weight of October pruned material (summer pruning)

The weight of pruned material was recorded in kg/vine immediately after pruning and was analysed to determine its influence on fruiting of the vines.

4. Number of canes/vine (after October pruning)

The number of canes per vine were counted after October pruning to study the number of bunches and yield in relation to the number of canes per vine.

5. Weight of April pruned material

The weight of pruned material was recorded in kg per vine. Statistical analysis of data is done on weight of total pruned material.

3.11.3 Reproductive Characters

1. Number of bunches per vine

The number of bunches of each vine was recorded and was subjected to statistical analysis

2. Fruit yield

The bunches were harvested with a secateur when they were fully ripe. Ripeness in grapes is judged by combination of factors like the waxy bloom on the fruits, characteristic colour of the berries, slight thickening of juice, easy detachment of berries, a free separation of seeds from pulp and sweetness of berries. The bunches were weighed and the yield was recorded as kg/vine.

3. Weight of bunches Five bunches which were typical of a variety were taken at random to study the bunch berry and juice characteristics. These bunches were weighed and the mean was arrived at.

4. Number of berries per bunch

Berries from two bunches were carefully detached and counted to determine the mean number of berries /bunch.

5. Berry size

The counted berries were placed in a measuring cylinder with a known volume of water. The volume of berries was recorded in ml by the difference in the initial and final volume. The mean volume of berry was worked out.

3.11.4 Juice Characters

1. Sugar content

Fresh juice was extracted and the sugar content was recorded by use of hand refractometer which was calibrated to read the sugar content of fruits.

2. pH of juice

The juice was squeezed into a beaker and the pH was recorded with the aid of a pH meter. The beakers were very well washed and cleaned before they were used for another set of observations to avoid any " carry over".

3.12 Varietal Classification:

The procedure of normal deviate to place each 25 percent of the population under low, medium, high and very high magnitude of any parameter was used to classify the varieties.. This classification was based on mean $\pm$ 0.6744δ. Thus, the group with values up to mean -.6744δ was taken as low magnitude group, from this point up to mean as moderate group, mean +0.6744δ a high group and any value beyond this point as a very high magnitude for a character. The ordinate at these points will be having a population of 25 percent in each group theoretically.

3.13 Statistical Analysis

The data for the different characters was collected and were subjected to analysis of variance using the 'F' test of significance as described by Snedecor and Cochran (1967). The treatment means were compared using Duncan's Multiple Range test (Carmer and Swanson, 1973). The total and partial correlation coefficients were determined and path coefficients were worked out to establish the relative contribution of each factor directly and indirectly (Dewey and Lu, 1959).

CHAPTER FOUR

RESULTS

4.1 Experiment No. 1 Performance of twenty varieties grape (Vitis vinifera L.)

4.1.1. Stem diameter

The mean stem diameter during 1990 to 1993 and the varietal significance in individual years and in the combined analysis is shown in Table 2. The Hybrid Anab-e-Shahi x American seedling (Anab. x Amer. seedling) and Black hamburg have produced the highest stem diameter both in individual years and in combined analysis. The variety Ex-Hospital was found to be lowest in all the four years.

The data of the stem diameter was put on a normal distribution with 25 percent of the varieties placing in each group of slow, moderate, vigorous and very vigorous varieties in items of stem growth, it was observed that Bangalore blue, Ex-Hort Samaru, Thompson seedless, Cardinal, Gross Coleman, ex-Hospital were found to be slow growing. All of them except Ex-Hospital come under the same significance group in the combined analysis. The varieties Black verico, Ex-Maiduguri, Monaca sabo and Concord were found to be moderate in their main stem growth. The differences among their means were not statistically significant. The varieties Black rose, Regina, Anab-e-Shahi, Catawba, Ex-Zaria black were found to be vigorous varieties with their mean differences statistically insignificant. The most vigorous varieties in the collection were Anab. x Amer. seedling, Black

Table 2: Vine Stem Diameter (cm) of twenty varieties of grape during 1990 -93 at Samaru.

S/No.	Variety	Year				Combined
		1990	1991	1992	1993	
1.	Anab-e-Shahi	4.87a-d[1/]	6.93a-c	8.83a-d	12.33a-e	8.33b-d
2.	Anab.x Amer. seedling	6.50a	9.23a	11.33a	15.57ab	10.66a
3.	Bangalore blue	3.17d-f	5.70b-d	7.67b-d	9.23d-f	6.44e-g
4.	Black hamburg	6.27ab	9.13a	11.50a	15.00ac	10.48a
5.	Black rose	4.20c-e	6.97a-c	10.67a	12.47a-d	8.57b-d
6.	Black verico	3.53c-e	5.77b-d	9.33a-c	11.00b-f	7.41d-f
7.	Cardinal	3.13d-f	5.63b-d	6.50cd	9.07d-f	6.08fg
8.	Catawba	4.63a-d	8.00a-c	7.67b-d	10.90b-f	7.80c-e
9.	Concord	3.50c-e	7.17a-c	6.83cd	9.03d-f	6.63e-g
10	Cross coleman	2.53d-f	6.57a-c	6.03d	6.83fg	5.49g
11	Israel blue	5.13a-d	8.43ab	9.33a-c	13.50ac	9.10a-c
12	Monaca sabo	4.17c-e	6.10a-d	7.50b-d	10.83c-f	7.15d-g
13	Ex-Zaria black	4.33b-e	6.97a-c	7.83b-d	11.83b-e	7.74c-f
14	Ex-Hort. Samaru	3.87c-e	5.73b-d	7.80b-d	7.83e-g	6.31e-g
15	Ex-Hosp.	1.40f	2.93d	3.33e	3.87g	2.88h
16	MKM-7	5.37a-c	8.43ab	10.33ab	13.37a-d	9.38a-c
17	Ex-Maiduguri	4.40b-e	6.47a-c	7.50b-d	10.37c-f	7.18d-f
18	Queen golden	5.13a-d	8.57ab	11.17a	14.47ac	9.83ab
19	Regina	4.97a-d	7.33a-c	8.67a-d	12.90a-d	8.47b-d
20	Thompson seedless	3.53c-e	5.13cd	7.83b-d	8.75e-g	6.31e-g
	SE ±	0.61	0.95	0.84	1.39	0.49
	Significance	**	**	**	**	**
	Year Mean SE± 0.15	4.25d	6.86c	8.38ab	10.96a	**

[1/] *Varietal means followed by the same letter(s) within a column or year means (within a row) are not statistically significant using DMRT 0.05.*

** = *Significant at 1 percent level.*

hamburg, Queen golden, MKM-7 and Isreal blue. When their means in the combined analysis are compared they all fell under the same group of significance.

4.1.2. Shoot length

When the shoot length of different varieties was compared (Table 3), the varieties Black hamburg and Ex-Hospital were found to produce the longest and shortest shoots respectively, in 3 out of 4 years. Converting the mean of 4 years data into a normal distribution, majority (40%) of them fall into short shoot length group. They include MKM-7, Gross Coleman, Thompson seedless, Ex-Zaria black, Ex-hort. Samaru, Black verico, Cardinal and Ex-Hospital. All the varieties except Ex-Hospital constituted the same group of significance. The varieties Isreal blue and Black rose fell into medium length shoot and were similar statistically. The varieties Queen golden, Monaca sabo, Anab-e-Shahi and Ex-Maiduguri, are placed in long shoot length group. The varieties with extra long shoot included Black hamburg, Catawba, Anab.x Amer. Seedling, Bangalore blue, Concord, Regina. Within this group, Black hamburg produced longer shoots than Bangalore blue, Concord and Regina. The varieties Catawba and Anab.x Amer. Seedling also produced longer shoots than Regina.

4.1.3. Weight of October pruned material (summer pruning)

The data on weight of October pruned material for the four years of experimentation is given in Table 4. The varieties Anab.x Amer. Seedling and Catawba produced the highest weight of October pruned material in 2 out of 4 experiments. The variety Ex-Hospital produced the lowest October pruned

Table 3: Length of Shoot (cm) of twenty varieties of grape during 1990 - 93 at Samaru.

S/No.	Variety	Year				Combined
		1990	1991	1992	1993	
1.	Anab-e-Shahi	33.3bc[1/]	40.9a-f	121.1a-d	95.6a-c	72.7d
2.	Anab.x Amer. seedling	63.2a-c	64.5a-d	164.4ab	153.6ab	111.4ab
3.	Bangalore blue	55.3a-c	74.1ab	151.1a-c	147.6ab	107.0bc
4.	Black hamburg	93.9a	58.0a-e	180.3a	165.3a	124.4a
5.	Black rose	30.7bc	32.9b-f	81.8a-d	90.0a-c	58.8d-f
6.	Black verico	18.1c	17.6d-f	53.4b-d	57.8a-c	36.7g
7.	Cardinal	21.7c	22.1c-f	44.6cd	45.0bc	33.3gh
8.	Catawba	64.0a-c	83.8a	156.2a-c	142.1ab	111.5ab
9.	Concord	54.8a-c	66.2a-c	131.7a-c	152.8ab	101.4bc
10	Cross coleman	25.2bc	24.6c-f	67.0a-d	65.1a-c	45.5fg
11	Isreal blue	31.1bc	38.8a-f	94.7a-d	87.9a-c	63.1de
12	Monaca sabo	53.2a-c	47.5a-f	97.1a-d	97.9a-c	73.9d
13	Ex-Zaria black	27.2bc	28.9b-f	55.5b-d	57.4a-c	42.3g
14	Ex-Hort. Samaru	22.0c	14.9ef	62.2b-d	50.6bc	37.4g
15	Ex-Hosp.	18.8c	7.7f	24.7d	24.3c	18.9h
16	MKM-7	38.8bc	21.0c-f	68.3a-d	62.9a-c	47.7e-g
17	Ex-Maiduguri	45.8bc	41.6a-f	92.0a-d	96.7a-c	69.0d
18	Queen golden	47.0a-c	54.4a-f	105.9a-d	88.7a-c	74.0d
19	Regina	72.7ab	65.5a-d	115.2a-d	118.8a-c	93.0c
20	Thompson seedless	15.1c	13.4ef	74.6a-d	65.9a-c	42.3g
	SE ±	9.62	7.54	12.71	10.67	5.15
	Significance	**	**	**	**	**
	Year Mean SE± 1.49	41.6b	40.9b	97.1a	93.3a	**

[1/] *Varietal means followed by the same letter(s) within a column or year means (within a row) are not statistically significant using DMRT 0.05.*

** = *Significant at 1 percent level.*

Table 4: Weight of October pruned material (kg/vine) of twenty varieties of grape during 1990-93 at Samaru

S/No.	Variety	Year				Combined
		1990	1991	1992	1993	
1.	Anab-e-Shahi	0.967a-e[1/]	1.227d-f	2.30b-e	1.333f-i	1.47ef
2.	Anab. x Amer. seedling	0.600c-e	4.60a	4.03a	5.700a	3.73a
3.	Bangalore blue	2.100ab	3.07bc	2.60b-d	2.169c-g	2.48cd
4.	Black hamburg	1.067a-e	3.47a-c	4.27a	3.133b-d	2.98bc
5.	Black rose	1.133a-e	1.27d-f	1.53c-g	1.500e-i	1.36f
6.	Black verico	1.267a-e	1.03e-f	0.83e-g	0.733hi	0.97f
7.	Cardinal	1.300a-e	1.07e-f	1.00d-g	0.467hi	0.96f
8.	Catawba	2.367a	4.57a	3.17ab	4.200b	3.58ab
9.	Concord	2.367a	2.73b-d	4.03a	2.667c-k	2.95bc
10	Gross coleman	0.800b-e	0.80ef	0.97e-g	1.000g-i	0.89f
11	Israel blue	1.767a-d	2.70b-d	2.70bc	1.667e-h	2.21d
12	Monaca sabo	0.467de	1.07ef	2.30b-e	1.833d-h	1.42ef
13	Ex-Zaria Black	1.033a-e	0.87ef	0.90e-g	0.933g-i	0.93f
14	Ex-Hort. Samaru	1.233a-e	0.70ef	0.63fg	0.567hi	0.78fg
15	Ex-Hosp.	0.133e	0.10f	0.10g	0.300i	0.16g
16	MKM-7	0.633c-e	1.20e-f	1.87b-f	2.167c-g	1.47ef
17	Ex-Maiduguri	2.033a-c	2.03b-e	3.40ab	2.767c-e	2.56cd
18	Queen golden	2.033a-c	2.90bc	1.87b-f	1.500e-i	2.08de
19	Regina	2.167ab	3.57ab	3.13ab	3.400bc	3.07a-c
20	Thompson seedless	0.433de	0.50ef	0.67fg	0.867hi	0.62g
	SE ±	0.42	0.46	0.48	0.42	0.22
	Significance	**	**	**	**	**
	Year mean SE ± 0.067	1.295b	1.975a	2.115a	1.945a	**

[1/] *Varietal means followed by the same letter(s) within a column and year means (within a row) are not statistically significant using DMRT 0.05.*

** = *Significant at 1 percent level.*

material in all the 4 experiments. When the combined data was transformed to normal distribution the varieties Black verico, Cardinal, Ex-Zaria Black, Gross Coleman, Ex-hort. Samaru, Thompson seedless and Ex-Hospital produced a low October pruned material. The first four varieties within this group produced significantly higher October pruned material than Thompson seedless and Ex-Hospital. The varieties MKM-7, Anab-e-Shahi, Monaca Sabo and Black rose produced moderate weight of October pruned material and were under the same significance group. Isreal blue and Queen golden fall under the same significance group and produced more October pruned material. The highest weight of October pruned material was produced by the varieties Anab.x Amer. Seedling, Catawba, Regina, Black hamburg, Concord, Bangalore blue, and Ex-Maiduguri. Within the group, Anab.x Amer. Seedling produced a higher October pruned material than all others except Catawba and Regina which also produced a higher October pruned material than Bangalore blue and Ex-Maiduguri.

4.1.4 Number of canes per vine

The means of 4 experiments and the combined analysis is shown in Table 5. The highest number of canes was produced by Queen golden in two out of four experiments. The lowest number of canes was produced by Thompson seedless in 2 seasons and Ex-Hospital in the other two experiments. When the combined data was classified, it was noted that the varieties Concord, Thompson seedless and Ex-Hospital produced a low number of canes per vine. The differences in means within this group were not significant. The varieties which constituted a moderate number of canes per vine include Ex-hort. Samaru, Monaca sabo, Anab.x Amer.

Table 5: Number of Canes per Vine of twenty varieties of grape during 1990 - 93 at Samaru

S/No.	Variety	Year 1990	1991	1992	1993	Combined
1.	Anab-e-Shahi	24.7a-d[1/]	43.3a-c	48.0a-e	82.0b-f	49.5b-f
2.	Anab.x Amer. seedling	24.7a-d	57.7a-d	60.3a-c	29.0ef	42.9c-f
3.	Bangalore blue	14.0b-d	45.7a-e	35.0c-e	62.3b-f	39.3d-g
4.	Black hamburg	28.0a-c	45.0a-e	60.7a-c	34.33ef	42.0d-f
5.	Black rose	19.0a-d	31.7de	43.3a-e	159.3a	63.3a-c
6.	Black verico	18.3a-d	43.7a-e	35.0c-e	134.7a-c	57.4a-e
7.	Cardinal	31.7a	48.0a-d	39.0b-e	118.3a-d	59.3a-d
8.	Catawba	15.0a-d	47.0a-d	52.3a-d	49.3d-f	40.9d-g
9.	Concord	15.7a-d	49.7a-d	39.0b-e	43.3d-f	36.9e-g
10	Cross coleman	10.7cd	31.3de	27.3d-f	82.7b-f	38.0d-g
11	Isreal blue	28.0a-c	66.0ab	61.0a-c	138.3ab	73.3a
12	Monaca sabo	11.7cd	42.3b-e	52.7a-d	66.7b-f	43.3c-f
13	Ex-Zaria black	11.7cd	34.0c-e	36.0c-e	78.7b-f	40.1d-g
14	Ex-Hort. Samaru	24.0a-d	31.7de	21.3ef	100.7a-f	44.4c-f
15	Ex-Hosp.	12.3cd	39.0b-e	3.3f	26.0f	20.2g
16	MKM-7	11.0cd	43.0a-e	36.3c-e	58.0c-f	37.1d-g
17	Ex-Maiduguri	14.7a-d	42.7a-e	43.0a-e	99.7a-f	50.7b-f
18	Queen golden	27.0a-d	72.0a	70.7a	105.7a-e	68.8ab
19	Regina	30.7ab	62.0a-c	65.0ab	99.0a-f	64.2ab
20	Thompson seedless	10.0d	16.7e	19.7ef	81.7b-f	32.0e-g
	SE ±	5.17	8.68	8.33	22.54	6.51
	Significance	*	*	**	**	**
	Year Mean SE± 1.25	19.1c	44.6b	42.4b	82.4a	**

[1/] *Varietal means followed by the same letter(s) within a column and year means (within a row) are not significantly different.*

* *and* ** = *Significant at 5 and 1 percent levels, respectively.*

Seedling, Black hamburg, Catawba, Ex-Zaria black, Bangalore blue, Gross Coleman and MKM-7. The differences among their means were not statistically significant and they fall within the same significance group. The varieties Cardinal, Black verico, Ex-Maiduguri and Anab-e-Shahi produced a high number of canes per vine and they all fall within the same significance group. The highest number of canes per vine were produced by the group of varieties which include Isreal blue, Queen golden, Regina and Black rose. They all fall under the same group of significance

4.1.5. Weight of April pruned material

The means of 4 experiments and the combined analysis for weight of April pruned material are shown in Table 6. Regina occupied the first position in 3 and second position in the fourth experiment for weight of April pruned material. Ex-Hospital recorded the lowest weight of April pruned material in 2 and Thompson seedless in one experiment. When the combined data was transformed to a normal distribution to classify the varieties into different groups, it was noted that Ex-Zaria black, Thompson seedless and Ex-Hospital recorded the lowest weight of April pruned material and they belong to the same significance group. A moderate weight of April pruned material was recorded by Bangalore blue, Anab-e-Shahi, Black verico, real blue, MKM-7, Gross Coleman and Ex-hort. Samaru. All these varieties were within the same significance group. The weight of pruned material was high in varieties Ex-Maiduguri, Monaca sabo, Queen golden, Anab.x Amer. Seedling, Catawba, Black hamburg, Concord, Black rose

Table 6: Weight of April Pruned Material (kg/vine) of twenty varieties of grape during 1990 - 93 Samaru.

S/No.	Variety	Year				Combined
		1990	1991	1992	1993	
1.	Anab-e-Shahi	5.87a-d[1/]	3.57b-c	1.68d-g	2.67d-g	3.45c-g
2.	Anab.x Amer. seedling	1.83de	3.53b-e	5.27b	7.83a	4.62a-c
3.	Bangalore blue	4.40b-e	3.10c-e	2.43c-f	4.00b-f	3.48b-g
4.	Black hamburg	1.63de	4.83bc	3.90bc	5.67a-c	4.01b-e
5.	Black rose	4.97b-e	3.67b-e	2.93c-e	2.67d-g	3.56b-g
6.	Black verico	3.83b-e	3.70b-e	2.87c-e	1.90fg	3.07d-g
7.	Cardinal	6.37a-d	3.80b-e	1.83d-g	1.00g	3.52b-g
8.	Catawba	5.33b-d	3.67b-e	2.67c-e	5.67a-c	4.33b-d
9.	Concord	4.50b-e	2.93c-e	2.33c-f	4.83b-d	3.65b-f
10	Cross coleman	1.97de	2.50c-e	1.40e-g	1.97e.g	1.96f-i
11	Israel blue	4.43b-e	1.63c-e	2.40c-f	2.77d-g	2.81d-g
12	Monaca sabo	8.80ab	4.50b-d	3.50b-d	3.47c-g	5.07a-c
13	Ex-Zaria black	3.20c-e	0.80de	0.73fg	1.67fg	1.60hi
14	Ex-Hort. Samaru	3.17c-e	1.50c-e	1.17e-g	1.77fg	1.90g-i
15	Ex-Hosp.	0.43e	0.17e	0.17g	2.77d-g	0.88i
16	MKM-7	3.03c-e	2.33c-e	1.57e-g	3.33c-g	2.57e-g
17	Ex-Maiduguri	5.70b-d	6.83ab	3.87bc	4.50b-e	5.22ab
18	Queen golden	7.43a-c	5.07bc	4.10bc	3.00d-g	4.90a-c
19	Regina	10.93a	8.47a	7.37a	6.00ab	8.19a
20	Thompson seedless	3.07c-e	0.13e	0.67fg	2.47d-g	1.58hi
	SE ±	1.58	1.1	0.56	0.76	0.54
	Significance	**	**	**	**	**
	Year Mean SE± 0.33	4.55a	3.34bc	2.64c	3.50ab	*

[1/] *Varietal means followed by the same letter(s) within a column and year means (within a row) are not significantly different using DMRT 0.05.*

* *and* ** = *Significant at 5 and 1 percent levels, respectively.*

and Cardinal. They all have constituted the same significance group. A higher weight of April pruned material was recorded by the variety Regina.

4.1.6. Number of bunches

The data on the number of bunches during 4 seasons and of combined analysis is shown in Table 7. The variety Bangalore blue recorded a highest number of bunches in all the four experiments. The lowest number of bunches was recorded by Thompson seedless in all the four experiments. Classification of combined data into different groups confirmed that Thompson seedless recorded the low number of bunches per vine. A moderate number of bunches per vine was born by the varieties Israel Blue, Ex-Hospital, Catawba, Black rose, Black verico, Ex-Maiduguri, Ex-Zaria black, Anab.x Amer. seedling, Cardinal, Monaca sabo, Gross coleman and Anab-e-Shahi. They all are included within the same significant group, a high number of bunches was produced by varieties Concord, Regina, Ex-hort. Samaru and MKM-7 the yields of which are statistically the same. The highest number of bunches per vine was produced by Bangalore blue which were significantly higher than Queen golden and Black hamburg within this group.

4.1.7. Fruit yield per vine

The mean yield per vine during 1990-93 and of the combined data is given in Table 8. The varieties MKM-7 and Queen golden produced the highest yields in two of the 4 experiments.. It was followed by the variety Concord in 3 out of 4 experiments. The lowest yielding varieties were Thompson seedless and Gross Coleman in all the four years of experimentation. Based on the combined analysis

Table 7: Number of Bunches per Vine of twenty varieties of grape during 1990 - 93 at Samaru.

S/No.	Variety	Year				Combined
		1990	1991	1992	1993	
1.	Anab-e-Shahi	1.67e[1/]	2.3cd	4.00de	3.3c	2.8ef
2.	Anab.x Amer. seedling	3.00c	4.3cd	6.67de	7.3c	5.3d-f
3.	Barngalore blue	24.67a	44.3a	52.33a	93.0a	53.6a
4.	Black hamburg	16.67ab	33.0a	29.33b	47.7a-c	31.7b
5.	Black rose	4.67c	9.7b-d	8.00de	12.3c	8.7d-f
6.	Black verico	6.33c	10.0b-d	6.00de	8.7c	7.7d-f
7.	Cardinal	3.00c	5.0cd	3.67de	7.3c	4.8d-f
8.	Catawba	4.33c	6.3cd	11.33c-e	16.3c	9.6c-f
9.	Concord	6.67c	17.0b	29.00b	57.0a-c	27.4c
10	Cross coleman	3.33c	3.0cd	3.00de	4.7c	3.5d-f
11	Israel blue	4.33c	6.0cd	11.67c-d	19.0c	10.3c-f
12	Monaca sabo	3.33c	5.7cd	2.33de	4.7c	4.0d-f
13	Ex-Zaria black	5.67c	10.0b-d	5.33de	11.7c	8.2d-f
14	Ex-Hort. Samaru	1.33c	3.3cd	23.00bc	43.3a-c	17.8c-e
15	Ex-Hosp.	7.33bc	12.0bc	8.00de	13.0e	10.1c-f
16	MKM-7	11.33bc	17.0b	13.33de	27.0c	17.2c-e
17	Ex-Maiduguri	2.00c	3.0cd	8.33de	13.3c	6.7d-f
18	Queen golden	5.00c	34.3a	32.67b	84.7ab	39.2b
19	Regina	10.00bc	19.7b	15.00cd	31.3bc	19.0cd
20	Thompson seedless	1.33c	1.7d	1.33e	2.0c	1.6f
	SE ±	2.98	7.47	3.86	16.96	4.79
	Significance	**	**	**	**	**
	Year Mean	6.3c	12.4c	13.7b	25.4a	**
	SE ± 0.82					

[1/] *Varietal means followed by the same letter(s) within a column are not statistically significant using DMRT 0.05.*

** *Significant at 1 percent ,.*

Table 8: Fruit Yield of Grapes (kg/vine) of twenty varieties of grape during 1990 - 93 at Samaru.

S/No.	Variety	Year				Combined
		1990	1991	1992	1993	
1.	Anab-e-Shahi	0.30f	0.40bc	0.73ef	1.17bc	0.65b
2.	Anab.x Amer. seedling	0.17f	0.23bc	0.37f	0.43c	0.30b
3.	Bangalore blue	0.97b-d	1.67a	1.97c-e	3.43bc	2.01b
4.	Black hamburg	0.47c-f	0.93bc	0.90ef	1.57bc	0.97b
5.	Black rose	0.30f	0.53bc	0.47ef	0.70c	0.50b
6.	Black verico	0.53c-f	0.80bc	0.50ef	0.90c	0.68b
7.	Cardinal	0.30f	0.50bc	0.37f	0.77c	0.48b
8.	Catawba	0.33f	0.53bc	0.97d-f	1.50bc	0.83b
9.	Concord	1.10b	1.77a	3.57b	6.57ab	3.25ab
10	Cross coleman	0.13f	0.17bc	0.17f	0.30c	0.19b
11	Israel blue	0.27f	0.40bc	0.79ef	1.17bc	0.65b
12	Monaca sabo	0.47c-f	0.70bc	0.30f	0.50c	0.49b
13	Ex-Zaria black	0.93b-e	1.60a	1.13c-e	2.10bc	1.44b
14	Ex-Hort. Samaru	1.13b	0.37bc	2.60bc	4.20bc	2.07b
15	Ex-Hosp.	0.40ef	0.60bc	0.40ef	0.63c	0.51b
16	MKM-7	1.83a	2.90a	2.43b-d	4.33bc	2.88ab
17	Ex-Maiduguri	0.20f	0.47bc	1.00d-f	1.53bc	0.80b
18	Queen golden	1.00bc	1.53ab	6.63a	11.40a	5.14a
19	Regina	0.43d-f	0.90bc	0.83ef	1.40bc	0.89b
20	Thompson seedless	0.10f	0.13c	0.13f	0.20c	0.14b
	SE ±	0.17	0.47	0.47	1.66	0.45
	Significance	**	*	**	**	**
	Year Mean SE ± 0.58	0.57c	0.86c	1.31b	2.24a	**

[1/] *Varietal means followed by the same letter(s) within a column or year means (within a row) are not statistically significant using DMRT 0.05.*

* *and* ** = *Significant at 5 and 1 percent levels respectively.*

the variety Queen golden yielded significantly higher than all other varieties except Concord and MKM-7. All varieties except Queen golden were found to be within the same significance group. When the yield data was converted to normal distribution in the combined analysis it was observed that the varieties Anab. x Amer. seedling, Regina and Thompson seedless were placed under low yielding group. The moderate yielding group of varieties consists of Black hamburg, Regina, Catawba, Ex-Maiduguri, Black verico, Isreal blue, Anab-e-Shahi, Ex-Hospital, Black rose, Monaca sabo and Concord. They all fall under the same significance group. The group of high yielding varieties include Ex-hort. Samaru, Bangalore blue, Ex-Zaria black which are placed under the same bar of significance. The highest yields per vine in the experiments were recorded by Queen golden, Concord and MKM-7 which are statistically similar.

4.1.8. Bunch weight

The mean bunch weight of varieties is given in Table 9. The variety of Anab-e-Shahi ranked as first in 3 out of 4 years followed by Queen golden. The varieties Bangalore blue and Black hamburg were found to bear the smallest bunches in all the four years of experimentation. When the combined data was transformed to normal distribution the lowest bunch weights were found in the varietal group of Isreal blue, Black rose, Anab. x Amer. Seedling, Ex-Hospital, Regina, Bangalore blue and Black hamburg. In terms of significance within this group Isreal blue produced heavier bunches than Ex-Hospital, Regina, Bangalore blue and Black hamburg. The bunches of Black rose were heavier than Bangalore blue and Black Hamburg. The bunch weight was moderate in varieties Ex-hort.

Table 9: Bunch Weight (g/bunch) of twenty varieties of grape during 1990 - 93 at Samaru.

S/No.	Variety	Year 1990	1991	1992	1993	Combined
1.	Anab-e-Shahi	124.3a[1/]	192.0a	283.3a	373.7a	243.3a
2.	Anab. x Amer. seedling	44.7de	64.0ef	98.7e-h	160.7e-g	92.0fg
3.	Bangalore blue	27.7e	34.3f	55.3h	92.7g	52.5h
4.	Black hamburg	28.7e	31.0f	50.0h	79.3g	47.3h
5.	Black rose	43.3de	66.0ef	104.3e-h	163.0e-g	94.2fg
6.	Black verico	66..3c-e	100.0d-f	156.3d-g	210.7c-f	133.3c-e
7.	Cardinal	72.0b-e	110.0c-e	166.0c-f	262.7b-d	152.7b-d
8.	Catawba	67.0c-e	99.7d-f	157.3d-g	223.0c-f	136.8c-e
9.	Concord	78.7b-d	119.0b-e	185.7b-e	266.0b-d	162.3bc
10	Gross coleman	53.3c-e	83.0d-f	127.7e-h	215.7c-f	119.9d-f
11	Israel blue	46.3d-c	146.0a-d	200.3a-d	270.7c-f	100.3ef
12	Monaca sabo	192.3a-c	140.0a-d	220.3a-d	270.7b-d	180.6b
13	Ex-Zaria black	112.0ab	178.0ab	271.0ab	378.7a	234.9a
14	Ex-Hort. Samaru	62.3c-e	97.0d-f	149.3d-g	250.0b-e	139.7cd
15	Ex-Hosp.	36.3de	53.0ef	83.7f-h	142.3fg	78.8gh
16	MKM-7	115.3ab	175.0a-c	251.3a-c	394.7a	234.1a
17	Ex-Maiduguri	76.0c-d	119.3b-e	186.7b-e	283.3bc	166.3bcc
18	Queen golden	119.7a	189.0ab	276.3a	334.7ab	229.9a
19	Regina	30.0e	45.0f	72.0gh	118.3g	66.3gh
20	Thompson seedless	64.0c-e	100.0d-f	152.0d-g	263.7b-d	144.9b-d
SE ±		13.29	20.52	27.41	28.09	11.56
Significant		**	**	**	**	**
Year Mean SE ± 6.64		68.0d	103.2c	157.8b	233.1a	**

[1/] *Varietal means followed by the same letter(s) within a column and year means (within a row) are not statistically significant using DMRT 0.05.*

** = *Significant at 1 percent level.*

Samaru, Catawba, Black verico, Gross Coleman. They all are included under the same bar of significance. The group of varieties with high bunch weight included Monaca sabo, Ex-Maiduguri, Concord, Cardinal and Thompson seedless. They all constituted the same group of significance. The varieties with the largest bunches were Anab-e-Shahi, Ex-Zaria black, MKM-7 and Queen golden which constituted a single group of significance.

4.1.9 Berries per bunch

The data on the number of berries is shown in Table 10. The varieties Queen golden and Ex-Maiduguri occupied first and second positions in the first two experiments for the number of berries per bunch. The variety Anab-e-Shahi was in the first and second positions in 1992 and 1993 seasons, respectively. Likewise, the variety MKM-7 occupied first and second positions in 1993 and 1992, respectively. The variety Cardinal was found to have the last position in 3 out of 4 experiments for number of berries per bunch. When the combined data was placed on a normal distribution, the varieties Monaca sabo and Cardinal were found to have a small number of berries and were in the same significant group. One half of the varieties including Anab. x Amer. Seedling, Ex-Zaria black, Bangalore blue, Gross Coleman, Ex-Hort. Samaru, Isreal blue, Ex-Hospital, Black verico, Black rose and Concord were found to have a moderate number of berries per bunch. They all belong to the same significance group. The varieties Black hamburg, Ex-Maiduguri, Catawba and Regina have a large number of berries per bunch and are placed under the same significance group. A very large number of

Table 10: Number of Berries per Bunch of twenty varieties of grape during 1990-93 at Samaru

S/No.	Variety	Year				Combined
		1990	1991	1992	1993	
1.	Anab-e-Shahi	9.70cd	9.4d	103.7a	121.5b	61.1ab
2.	Anab. x Amer. seedling	12.97cd	13.2cd	57.8a-d	59.5e-g	35.9d-g
3.	Bangalore blue	13.80a-c	15.6bd	47.5a-d	53.0f-h	32.5d-h
4.	Black hamburg	10.33cd	11.4cd	74.4a-d	72.5de	42.2cd
5.	Black rose	8.53cd	9.3d	31.8cd	42.7g-i	23.1g-i
6.	Black verico	9.03cd	7.9d	34.2cd	44.4g-i	23.9f-i
7.	Cardinal	4.53d	4.6d	18.1d	36.3hi	15.9hi
8.	Catawba	13.03cd	13.5cd	71.9a-d	64.2d-f	40.7c-e
9.	Concord	11.67cd	10.3cd	29.0cd	39.6hi	22.7g-i
10	Gross coleman	9.23cd	10.7cd	52.3a-d	51.if-h	30.8d-h
11	Israel blue	13.17cd	15.3bd	31.1cd	44.0g-i	25.9f-i
12	Monaca sabo	10.63cd	12.7cd	23.5d	31.6i	19.6hi
13	Ex-Zaria black	13.10cd	16.0bd	47.0b-d	57.5e-g	33.4d-h
14	Ex-Hort. Samaru	10.79cd	12.9cd	39.0cd	45.8g-i	27.1e-i
15	Ex-Hosp.	6.70d	7.2d	51.5a-d	33.3i	24.5f-i
16	MKM-7	20.30a-c	25.9a-c	99.4ab	139.8a	71.3a
17	Ex-Maiduguri	24.13ab	29.7ab	66.1a-d	43.3g-i	40.8c-e
18	Queen golden	29.87a	34.0a	85.4a-c	78.1cd	56.8b
19	Regina	7.77d	10.2cd	45.2b-d	90.4c	38.4d-f
20	Thompson seedless	11.67cd	16.9bd	70.1a-d	115.2b	53.5bc
	SE ±	3.49	4.71	16.57	5.13	4.57
	Significance	**	**	*	**	**
	Year mean ± 2.7	12.5c	14.3c	53.9b	63.2a	**

[1/] *Varietal means followed by the same letter(s) within a column and year means (within a row) are not statistically significant using DMRT 0.05.*

**, * = *Significant at 5 and 1 percent levels, respectively.*

berries were found in variety MKM-7, Anab-e-Shahi, Queen golden and Thompson seedless. The variety MKM-7 has a higher number of berries per bunch than Queen golden and Thompson seedless within this group.

4.1.10. Berry size

The data of berry size for individual experiments and combined analysis and their significance are shown in Table 11. Anab-e-Shahi, Black rose and Queen golden ranked first, second and third for berry size in all the four years as well as in the combined analysis. On the other end Regina, Black verico and Thompson seedless recorded the smallest berry size in all the experiments. When the combined data was converted into a normal distribution, the varieties Black hamburg, Anab. x Amer. seedling, Regina, Black verico and Thompson seedless fell in the first quarter of the small sized berries. Within the group, Black hamburg and Anab. x Amer. seedling were found to be larger than Black verico and Thompson seedless. The next group of medium sized berry includes Ex-Maiduguri, Concord, Gross Coleman, Isreal blue, Bangalore blue, Ex-Hospital, Ex-hort. Samaru. All of them fell into the same group of significance. Medium to large berry size varieties include Ex-Zaria black, Cardinal, Catawba and MKM-7 which come under the same significance group. The large berry sized varieties include Monaca sabo, Queen golden, Black rose and Anab-e-Shahi. Within this group the variety Anab-e-Shahi berry was larger than the other 3 varieties followed by Black rose and Queen golden which were also larger than Monaca sabo.

Table 11: Berry Size (volume of 5 berries in ml) of twenty varieties of grape during 1990-93 at Samaru.

S/No.	Variety	Year				Combined
		1990	1991	1992	1993	
1.	Anab-e-Shahi	4.100a[1/]	4.169a	4.467a	4.233a	4.24a
2.	Anab. x Amer. seedling	1.900d-g	2.067gh	1.767d-g	2.169d-f	1.98i
3.	Bangalore blue	2.100d-f	2.233f-h	1.700d-g	2.567c-e	2.15gh
4.	Black hamburg	1.767e-g	2.100gh	1.933d-g	2.267c-f	2.02hi
5.	Black rose	3.233b	4.00ab	4.00b	4.033ab	3.82b
6.	Black verico	1.567f-g	1.567ij	1.233fg	1.633ef	1.50jk
7.	Cardinal	2.100d-f	3.600bc	2.600cd	3.067a-d	2.82c-e
8.	Catawba	2.267de	3.200cd	2.200de	2.900b-d	2.64c-f
9.	Concord	2.267de	2.500f-g	2.200de	2.567c-e	2.38f-h
10	Gross coleman	2.100d-f	2.300f-h	2.300c-e	2.833c-e	2.38f-h
11	Israel blue	1.967d-f	2.300f-h	2.067d-f	2.833c-e	2.29f-h
12	Monaca Sabo	3.000b	3.033de	3.100bc	2.769c-e	2.98c
13	Ex-Zaria black	2.933bc	3.200cd	2.467cd	2.900b-d	2.88cd
14	Ex-Hort. Samaru	1.900d-g	2.133f-h	1.433e-g	2.800c-e	2.07g-i
15	Ex-Hosp.	1.733e-g	2.500fg	2.033d-g	2.300c-f	2.14gh
16	MKM-7	2.433cd	3.100de	2.100d-f	2.633c-e	2.57d-f
17	Ex-Maiduguri	2.400cd	2.633ef	2.533cd	2.200a-f	2.44e-g
18	Queen golden	3.233b	3.933ab	3.667ab	3.467a-c	3.58b
19	Regina	1.700e-g	1.867hi	1.400e-g	1.933e-f	1.73ij
20	Thompson seedless	1.133g	1.200j	1.133g	1.267f	1.18k
	SE ±	0.18	0.16	1.27	0.37	0.13
	Significance	**	**	**	**	**
	Year mean ± SE ± 0.69	2.29	2.68	2.32	2.66	**

[1/] *Varietal means followed by the same letter(s) within a column and year means (within a row) are not statistically significant.*

** = *Significant at 1 percent level.*

4.1.11. Sugar content of berries

The data of sugar content of varieties for the four seasons and the combined analysis is given in Table 12. The highest sugar content was recorded for Thompson seedless in 3 out of 4 years. When the varieties were classified into 4 groups on a normal distribution, the varieties Ex-Zaria black and Monaca sabo were found to be low in sweetness and fall in the same significance group. The varieties with moderate sugar content include Black hamburg, Gross Coleman, MKM-7, Bangalore blue, Ex-Maduguri, Ex-Hospital, Anab.x Amer. seedling, Regina, Concord, Catawba and Queen golden. All the eleven varieties fall in the same group of significance. The next group of sweet varieties included Ex-hort. Samaru, Isreal blue, Cardinal, Anab-e-Shahi and Black rose which are included under the same significance group. The sweetest varieties included Thompson seedless and Black verico which were similar statistically.

4.1.12. Juice pH

The data on juice pH for each experiment and the combined analysis are shown in Table 13. The variety Thompson seedless and Ex-hort. Samaru were found to have the highest pH in two out of 4 experiments each. The variety Ex-Zaria black recorded the lowest pH in two out of the years. When the data was converted to a normal distribution the varieties Ex-Zaria black and Ex-Maiduguri were found to have the lowest pH and were placed in the same significance group.

Table 12: Sugar Content (%) in Juice of twenty varieties of grape during 1990-93 at Samaru

S/No.	Variety	Year 1990	1991	1992	1993	Combined
1.	Anab-e-Shahi	16.37bc[1/]	16.43a-d	14.67a-c	12.83c-g	15.07c
2.	Anab. x Amer. seedling	12.27e	13.93d-f	12.83b-d	13.00c-g	13.01d-f
3.	Bangalore blue	13.63de	14.03d-f	13.67b-d	13.33c-f	13.67b-e
4.	Black hamburg	14.13c-e	14.10c-f	13.67b-d	13.67c-f	13.89c-e
5.	Black rose	14.90cd	14.33b-e	14.67a-c	14.67b-e	14.64b-d
6.	Black verico	17.10b	16.57a-c	17.07ab	20.67a	17.85a
7.	Cardinal	14.50c-e	13.60ef	13.73b-d	18.83ab	15.17bc
8.	Catawba	13.03de	12.80ef	13.27b-d	11.83e-g	12.73d-f
9.	Concord	13.50de	13.17ef	13.17b-d	11.50e-g	12.83d-f
10	Gross coleman	13.43de	13.57ef	11.70cd	16.83a-d	13.88c-e
11	Israel blue	14.57c-e	14.63b-e	11.90cd	20.83a	15.48bc
12	Monaca sabo	17.67b	10.99f	10.00cd	9.50fg	10.78g
13	Ex-Zaria black	12.37e	10.93f	11.83cd	10.33e-g	11.37fg
14	Ex-Hort. Samaru	16.47bc	16.67ab	16.87ab	13.00c-g	15.75b
15	Ex-Hosp.	13.90de	12.53ef	12.37cd	13.33c-f	13.03d-f
16	MKM-7	14.43c-e	14.00d-f	13.73b-d	12.00d-g	13.54c-e
17	Ex-Maiduguri	15.07cd	14.87b-e	14.17a-d	8.33g	13.11d-f
18	Queen golden	12.07e	11.40f	12.20cd	12.50d-g	12.04e-g
19	Regina	13.37de	13.13ef	13.23b-d	12.17d-g	12.98d-f
20	Thompson seedless	20.10a	19.37a	18.17a	17.67a-c	18.83a
	SE ±	0.76	0.98	1.25	1.45	0.57
	Significance	**	**	**	**	**
	Year mean SE ± 0.18	14.39	14.05	13.65	13.84	NS

[1/] *Varietal means followed by the same letter(s) within a column and year means (within a row) are not statistically significant using DMRT 0.05.*

***and NS = Significant at 1 percent level and not significant, respectively.*

Table 13: *pH of juice of twenty varieities of grape during 1990-93 at Samaru*

S/No.	Variety	Year				Combined
		1990	1991	1992	1993	
1.	Anab-e-Shahi	6.00e-g	6.07bc	6.10g	6.03ab	6.05fg
2.	Anab. x Amer. seedling	6.07d-g	6.27a-c	6.40ef	6.37ab	6.28d-f
3.	Bangalore blue	6.13c-g	6.43a-c	6.63de	6.20ab	6.35c-f
4.	Black hamburg	6.80a-c	6.80a-c	6.83bc	6.63ab	6.77ab
5.	Black rose	6.83a-c	6.63a-c	6.77b-d	6.77ab	6.75a-c
6.	Black verico	6.73a-d	6.77a-c	6.63de	6.83a	6.77ab
7.	Cardinal	6.37a-g	6.43a-c	6.43ef	6.70ab	6.48b-d
8.	Catawba	6.03d-g	6.37a-c	6.50ef	6.50ab	6.35c-f
9.	Cocord	6.60a-e	6.60a-c	6.87bc	6.40ab	6.62b-d
10.	Gross coleman	5.87f-g	5.97c	6.07g	6.27ab	6.04fg
11.	Israel blue	6.23b-g	6.63a-c	6.73b-d	6.70ab	6.58b-d
12.	Monaca sabo	6.40a-g	6.50a-c	6.47ef	6.47ab	6.46b-e
13.	Ex-Zaria black	5.73g	6.03bc	6.17fg	5.63b	5.89g
14.	Ex-Hort. Samaru	6.87ab	7.00a	7.20a	7.10a	7.04a
15.	Ex-Hosp.	6.70a-e	6.87ab	6.97ab	6.93a	6.87ab
16.	MKM-7	6.20b-g	6.20a-c	6.43ef	6.40ab	6.31d-f
17.	Ex-Maiduguri	5.87f-g	6.03bc	5.93fg	6.07ab	5.98fg
18.	Queen golden	6.20b-g	6.23ac	6.27fg	6.37ab	6.27d-f
19.	Regina	6.57a-f	6.03bc	5.93g	6.67ab	6.30d-f
20.	Thompson seedless	6.97a	6.77ac	6.80b-d	6.67ab	6.80ab
	SE ±	0.21	0.24	0.22	0.34	0.13
	Significance	**	NS	**	NS	**
	Year mean	6.36	6.43	6.51	6.49	NS
	SE ± 0.07					

[1/] *Varietal means followed by the same letter(s) within a column and year means (within a row) are not statistically significant using DMRT 0.05.*

***and NS = Significant at 1 percent level and not significant, respectively.*

The varieties with moderate pH group included Catawba, Bangalore blue, MKM-7, Regina, Anab. x Amer. seedling, Queen golden, Gross Coleman. The varieties of next pH group included Ex-Hospital, Thompson seedless, Black hamburg, Black verico, Black rose, Concord, Isreal blue, Cardinal and Monaca sabo. The differences among their means were statistically not significant. The variety Ex-hort Samaru was the only variety with a pH of above 7.0.

4.1.13 Varietal Description

The 20 varieties investigated above were described based on the various attributes of their vegetative and reproductive characters and are given in Appendix 8.

4.2 Experiment No.2: Response to farm yard manure (FYM) and fertilizer to two grape (Vitis vinifera L) varieties

4.2.1 Stem Diameter

The growth of varieties as measured in terms of stem diameter for 4 years of experimentation and the combined analysis is given in Table 14. The differences in the means of stem diameters were significant in 3 out of 4 experiments. In 1990 the stem growth of Ex-hort. Samaru was higher than Ex-Zaria black; whereas in 1992 and 1993 the significance order was reverse. The differences among the means of FYM levels were not significant in the initial 3 years, but significant in 1993, the highest level of 30t/ha of FYM resulted in a higher stem growth than all other levels except 20t/ha. In the combined analysis both 20 and 30t/ha of FYM gave a significantly higher stem growth than the other two levels. The differences in the fertilizer level means were not significant during the 4 years of experiments.

Table 14: Stem Diameter (cm) as affected by Variety, FYM and Fertilizer Levels during 1990-93 at Samaru.

	Year				
Treatment	1990	1991	1992	1993	Combined
Variety (V)					
Ex-Hort. Samaru	2.87a[1/]	4.25	6.52b	7.37b	5.25
Ex-Zaria black	2.41b	4.07	7.26a	8.40a	5.54
SE ±	0.14	0.15	0.16	0.23	0.12
Significance	*	NS	**	**	NS
FYM (M) (t/ha)					
Control	2.6	3.72	6.4	7.05b	5.10b
10	2.61	3.86	6.63	7.38b	5.12b
20	2.66	4.33	7.08	7.78ab	5.46a
30	2.66	4.3	6.96	8.45a	5.60a
SE ±	0.17	0.18	0.19	0.28	0.1
Significance	NS	NS	NS	*	**
Fertilizer (F) NPK (kg/ha)					
Control	2.6	3.73	6.4	7.05	5.10b
50:40:50	2.62	4.13	6.67	7.35	5.19b
150:80:100	2.67	4.24	6.98	8.15	5.51a
250:120:150	2.63	4.12	7.03	8.11	5.47a
SE ±	0.17	0.18	0.19	0.28	0.1
Significance	NS	NS	NS	NS	*
Significance of Interaction					
V x M	NS	*	**	*	**
V x F	NS	NS	NS	NS	NS
M x F	NS	NS	*	NS	**

[1/] Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

*, ** and NS = Significant and highly significant at 5, and 1 percent levels not significant, respectively

However, such differences were significant in combined analysis wherein, medium and high levels of fertilizer means did not differ significantly, but their stem diameter were significantly higher than control and low fertilizer level. None of the first order of interaction in 1990 was statistically significant. The interaction between variety x FYM were significant in 1991 and 1993 and highly significant in 1992 and in the combined analysis (Table 15). Both in 1991 and 1992 seasons and in the combined analysis increasing FYM levels up to 30t/ha did not increase the stem diameter significantly in the variety Ex-hort. Samaru. In the case of Ex-Zaria black, increasing FYM from 10t to 20t/ha increased the growth of stem, a further increase in FYM level from 20 to 30t/ha, however, did not increase the stem growth significantly. When the two varieties were examined at the same FYM levels, 20 t/ha of FYM was found to increase stem growth in all experiments and combined analysis in the case of Ex-Zaria black. The interaction between variety x fertilizer was not significant in all the 4 experiments and combined analysis. The interaction between FYM x fertilizer levels were significant in the 1992 and the combined analysis. Ten tons (10t) of FYM and 50:40:50 kg NPK/ha resulted in significantly lower stem growth than all other FYM x fertilizer level combination. When the stem growth in different years was combined, there was a significant increase in the stem growth with each year increase in age.

4.2.2 Shoot Length

The differences in shoot length of the varieties were significant (5% level) in 1993 and highly significant (1% level) in 1992 and in the combined analysis (Table 16). In all cases Ex-Zaria block produced longer shoots than Ex-hort.

Table 15: Interaction between Variety x FYM (1991), Fertilizer x FYM (1992) variety x FYM (1993), Variety by FYM (combined) and Fertilizer x FYM (combined) for stem diameter (cm) in Grape

		FYM (t/ha)		
	Year	10	20	30
Variety	1991			
Ex-Hort. Samaru		4.33a[1/]	4.19a	4.42a
Ex-Zaria black		4.23a	3.39b	4.41a
SE ±			0.25	
Variety				
Ex-Hort Samaru	6.84b	6.21b	6.51b	
Zaria black	6.42b	7.96a	7.41a	
SE±		0.27		
Fertilizer	1992			
NPK (kg/ha)				
50:40:50		5.72b	6.90a	7.38a
150:80:100		7.13a	7.08a	6.73a
250:120:150	7.05a	7.27a	6.77a	
SE ±			0.33	
Variety	1993			
Ex-Hort. Samaru		7.36cd	6.58d	8.08ac
Ex-Zaria black		7.40cd	8.98a	8.82ab
SE ±			0.25	
Variety	Combined			
Ex-Hort. Samaru		5.39bc	4.96cd	5.39bc
Ex-Zaria black		4.85d	5.97a	5.79ab
SE ±			0.24	
Fertilizer				
NPK (t/ha)				
50:40:50		4.46b	5.40a	5.71a
150:80:100		5.58a	5.41a	5.55a
250:120:150		5.32a	5.58a	5.52a
SE ±			0.18	

1/ Means followed by the same letter within a column or row are not 999significant statistically using DMRT.05.

Table 16: *Shoot length (cm) of twenty varieties of grape, FYM and Fertilizer levels during 1990-93 at Samaru.*

Treatment	1990	1991	1992	1993	Combined
Variety (V)					
Ex-Hort. Samaru	31.7	20.2	48.5b[1/]	53.7b	38.5b
Ex-Zaria black	35.8	20.6	61.4a	61.4a	44.8a
SE ±	0.31	0.98	2.26	2.56	0.6
Significance	NS	NS	**	*	**
FYM (M) (t/ha)					
Control	30.5	19.6	54.7	51.4	38.9
10	31.4	20.8	54.6	51.4	40.2
20	35.3	19.7	58.1	60.1	43.3
30	34.6	20.8	52.1	58.4	41.5
SE ±	3.66	1.2	2.89	3.14	1.38
Significance	NS	NS	NS	NS	NS
Fertilizer (F) NPK (kg/ha)					
Control	30.5	19.6	54.2	51.4	38.9
50:40:50	32.9	19.68	55.6	58.3	41.6
150:80:100	33.8	21.34	59.4	58.9	43.3
250:120:150	34.6	30.32	49.9	55.4	40.1
SE ±	3.66	1.2	2.9	3.14	1.72
Significance	NS	NS	NS	NS	NS
Significance of Interaction					
V x M	NS	NS	NS	NS	NS
V x F	NS	NS	NS	NS	NS
M x F	NS	NS	NS	*	NS

[1/] Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

*, ** and NS = Significant and highly significant at 5, and 1 percent levels and not significant, respectively.

Samaru. The differences due to different levels of FYM were not statistically significant in all the 4 years of experimentation and in the combined analysis. Similarly, the four fertilizer levels also did not affect the shoot length significantly during the period of experimentation and in combined analysis. None of the first order of interaction in any of the experiments or in the combined analysis were found to be significant except FYM x fertilizer in 1993 (Table 17). When 10 and 20 t/ha FYM levels were examined at varying fertilizer levels, shoot length decreased significantly at the highest fertilizer level. The fertilizer level 50:40:50 NPK kg/ha at 20 t/ha of FYM produced longest shoots.. The shoot length was longer with the age of the crop.

4.2.3 Weight of October pruned material

The differences in the means of the varieties were not significant in any of the experiments or in the combined analysis except in 1993 (Table 18). The variety Ex-Zaria black produced a heavier pruned material during October than Ex-hort. Samaru. The differences due to FYM levels were found to be significant in 1991 and in the combined analysis and highly significant in 1993. In the 1991 season, the difference between the control and 10t FYM/ha was not significant, however, an increase of FYM to 20t/ha significantly increased the October pruned material. A further increase in FYM to 30t/ha significantly depressed the October pruned material. In 1993, each increase in the FYM significantly increased the October pruned material. In the combined analysis of data also each increase in the level of FYM increased the October pruned material up to 20t/ha and a further increase in the FYM to 30t/ha did not increase the October pruned material significantly. The

Table 17: Interaction between FYM x Fertilizer during 1993 for shoot length (cm) in Grape.

Fertilizer NPK (kg/ha)		FYM (t/ha) 10	20	30
50:40:50		53.00b[1/]	70.30a	51.70c
150:80:100		60.30b	61.30ac	55.10ab
250:120:150	49.00c	48.6c	68.5ab	
SE ± 5.44				

1/ Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

Table 18: Weight of October pruned material (kg/vine) of twenty varieties of grape and Fertilizer levels during 1990-93 at Samaru.

Treatment	1990	1991	1992	1993	Combined
Variety (V)					
Ex-Hort. Samaru	0.89	0.78	0.75	0.72b[1/]	0.79
Ex-Zaria black	0.93	0.8	0.89	0.82a	0.86
SE ±	0.08	0.06	0.07	0.02	0.03
Significance	NS	NS	NS	**	NS
FYM (M) (t/ha)					
Control	0.66	0.71b	0.55	0.39d	0.58c
10	0.82	0.70b	0.84	0.58bc	0.74b
20	0.87	0.96a	0.85	0.75b	0.86a
30	1.04	0.72b	0.78	0.98a	0.88a
SE ±	0.09	0.08	0.08	0.02	0.04
Significance	NS	*	NS	**	*
Fertilizer (F) NPK (kg/ha)					
Control	0.66	0.71	0.55b	0.39d	0.58
50:40:50	0.99	0.73	0.71b	0.64c	0.78
150:80:100	0.9	0.8	1.05a	0.70b	0.86
250:120:150	0.84	0.84	0.71b	0.97a	0.84
SE ±	0.09	0.08	0.08	0.02	0.03
Significance	NS	NS	**	**	NS
Significance of Interaction					
V x M	NS	NS	*	NS	**
V x F	NS	NS	NS	**	NS
M x F	NS	NS	NS	**	NS

1/ Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

*, ** and NS = Significant and highly significant at 5, and 1 percent levels and not significant, respectively

means of fertilizer levels were highly significant in 1992 and 1993 experiments. In 1992 the difference between the control and first level of fertilizer was not statistically significant but these two were significantly lower than 150:80:100 kg NPK/ha level and a further increase in fertilizer level depressed significantly the weight of October pruned material. In 1993, each increase in the fertilizer level significantly increased the weight of October pruned material.

All the first order of interaction were found to be non significant in the 1990 and 1991 experiments. The interaction between variety x FYM was significant in 1992 and highly significant in the combined analysis (Table 19). The interaction between variety x fertilizer and FYM x fertilizer alone were highly significant in the 1993 experiment. In variety x FYM interaction, there was no significant difference for Ex-hort. Samaru both in 1992 and in the combined analysis for the different FYM levels. Similarly, different levels of FYM did not affect the October pruned material in 1992. However, in combined analysis the variety Ex-Zaria black at 10t/ha produced significantly lower October pruned material. As regards variety x fertilizer interaction in 1993 the variety produced a higher pruned material in the month of October at the highest level of fertilizer, whereas, in the case of Ex-Zaria black each increase in the fertilizer level significantly increased the October pruned material. When the interaction between FYM x fertilizer was examined in 1993, there was an increase in October pruned material with each increase in FYM level at the same fertilizer level. When the same FYM level was considered at varying fertilizer levels at 10 and 20t/ha of FYM there was no

Table 19: Interaction between Variety x FYM during 1992, FYM x Fertilizer and Variety x Fertilizer during 1993 and Varieties x FYM in Combined Data analysis for October pruned material in Grape.

	Year	FYM (t/ha)			Variety	
		10	20	30	Ex-Hort.	Ex-Zaria
Variety	1992					
Ex-Hort. Samaru		0.93ab[1/]	0.62b	0.71b		
Ex-Zaria black		0.76ab	1.07a	0.84ab		
SE ±		0.11				
Fertilizer NPK (kg/ha)	1993					
50:40:50		0.48f	0.64de	0.81c	0.64c	0.64c
150:80:100		0.56ef	0.68d	0.86b	0.58c	0.82b
250:120:150		0.72d	0.92b	1.27a	0.93a	1.00a
SE ±		0.03			0.03	
Variety	Combined					
Ex-Hort. Samaru		0.79b-d	0.72cd	0.85a-c		
Ex-Zaria black		0.69d	0.99a	0.90ab		
SE ±		0.11				

[1/] Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

increase with the first two fertilizer levels, but at the highest fertilizer level the October pruned material increased with each increase in the fertilizer level.

4.2.4 Number of canes per vine

The result of number of canes per vine as affected by varieties, FYM and fertilizer levels are given in Table 20. The differences in the varietal means were highly significant in 1990 and significant in 1993. The variety Ex-hort. Samaru produced a higher number of canes per vine than Ex-Zaria black in both years. The differences due to FYM levels were highly significant in the 4 years of experiments and in the combined analysis. In all the years except in 1992 each increase in FYM level significantly increased the number of canes per vine. In 1992 experiment, however, the differences between the control and 10t FYM/ha and between 10 and 20t/ha were not significant and 30t/ha resulted in significantly higher number of canes than all other levels. The differences due to fertilizer levels were significant during the 1990 season only. All fertilizer levels produced more canes per vine. Within the fertilizer levels 150:80:100 kg of NPK/ha resulted in lower canes per vine. No interaction of first order was found during 1991 and 1992 experiments. The interaction between variety x fertilizer was significant in 1990, variety x fertilizer and FYM x fertilizer was highly significant in 1993 and variety x FYM in the combined analysis (Table 21). There was a differential response of the two varieties to fertilizer levels. Ex-hort. Samaru produced fewer canes at the highest fertilizer level whereas Ex-Zaria black produced the highest number of canes at this level. When the interaction of variety x FYM in combined analysis was critically examined variety Ex-hort. Samaru responded only at the

Table 20: Number of Canes per vine of twenty grape Varieties, Fertilizer levels during 1990-93 at Samaru.

Treatment	1990	1991	1992	1993	Combined
Variety (V)					
Ex-Hort. Samaru	14.78a[1/]	34.81	27.41	38.07a	28.77
Ex-Zaria black	12.11b	33.89	28	33.78b	27.44
SE ±	0.54	1.18	1.36	0.75	0.72
Significance	**	NS	NS	*	NS
FYM (M) (t/ha)					
Control	7.21d	19.15d	17.15c	20.30d	15.95d
10	9.28c	25.50c	20.06bc	25.06c	19.97c
20	12.17b	34.61b	24.17b	37.61b	27.14b
30	18.89a	42.94a	38.89a	48.11a	37.21a
SE ±	0.66	1.45	1.67	0.92	0.52
Significance	**	**	**	**	**
Fertilizer (F) NPK (kg/ha)					
Control	7.21c	19.15	17.15	20.3	15.95
50:40:50	14.56a	35.72	28.83	37.61	29.18
150:80:100	11.89b	33.94	27.94	37.67	27.86
250:120:150	13.89a	33.39	26.33	35.5	22.28
SE ±	0.66	1.45	1.67	0.92	0.8
Significance	*	NS	NS	NS	NS
Significance of Interaction					
V x M	NS	NS	NS	NS	*
V x F	*	NS	NS	**	**
M x F	NS	NS	NS	**	NS

[1/] Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

*, ** and NS = Significant and highly significant at 5, and 1 percent levels and not significant, respectively.

Table 21: Interaction between Variety x Fertilizer during 1990, FYM x Fertilizer and Variety x Fertilizer during 1993, FYM x Variety and Fertilizer x Variety in combined data analysis on number of canes/vine in a Grape.

	Year	FYM (t/ha)			Variety	
		10	20	30	Ex-Hort	Ex-Zaria
Fertilizer NPK (kg/ha)	1990					
50:40:50					17.22a[1/]	11.89c
150:80:100					12.11c	11.67c
250:120:150					15.00ab	12.78ba
SE ±					0.93	
Fertilizer NPK (kg/ha)	1993					
50:40:50		28.17d	38.67c	46.00b	41.00a	34.22b
150:80:100		26.17d	39.17c	47.67ab	41.56a	33.78b
250:120:150		20.83e	35.00c	50.67a	31.67b	39.33a
SE ±			1.60		1.31	

Variety	Combined				Fertilizer NPK (kg/ha) 50:40:50	150:80:100	250:120:150
Ex-Hort Samaru		20.61e	28.75b	36.94a	31.39a	29.36ab	25.56c
Ex-Zaria black		19.33e	25.53d	37.47a	26.97bc	26.36bc	29.00a
SE ±		0.94			1.17		

[1/] Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

highest FYM level whereas Ex-Zaria black produced higher canes with each increase in the FYM level. The FYM x fertilizer interaction in 1993 revealed that the cane number increased with increasing levels of FYM at all fertilizer levels. When the same manure level was examined at varying fertilizer levels, it was observed that at 10 t/ha, the cane number decreased at highest fertilizer level. There was no difference in cane number at varying fertilizer levels at 20 tons of FYM/ha and at 30 tons FYM/ha. There was an increase in number of canes with each increase in FYM level.

4.2.5 Weight of April pruned material

The weight of April pruned material as affected by variety, FYM and fertilizer levels is shown in Table 22. Analysis of results revealed that differences in the varietal means were highly significant in all the 4 years of experiments and the combined analysis. The variety Ex-hort. Samaru produced more April pruned material than Ex-Zaria black in all the cases. The differences in means of FYM levels as well as fertilizer levels were not significant in all the 4 years of the experiments and in the combined analysis. None of the first order of interaction in 1990, 1991 and 1993 were found to be significant. The interaction between variety x FYM and FYM x fertilizer were found to be significant in 1992 season and the combined analysis (Table 23), respectively. The variety Ex-hort Samaru produced a higher April pruned material than Ex-Zaria black at 10 and 30 t/ha of FYM. When each variety was examined at varying FYM levels, the variety Ex-hort. Samaru produced the same weight of April pruned material at all FYM levels. The variety Ex-Zaria black produced lower April pruned material at 10

Table 22: April pruned material (kg/vine) of twenty grape varieties, FYM and fertilizer levels during 1990-93 at Samaru

Treatment	1990	1991	1992	1993	Combi
Variety (V)					
Ex-Hort. Samaru	2.79a[1/]	1.98a	1.22a	1.93a	1.98a
Ex-Zaria black	1.38b	1.28b	0.82b	1.46b	1.23b
SE ±	0.27	0.14	0.05	0.12	0.05
Significance	**	**	**	**	**
FYM (M) (t/ha)					
Control	1.58	1.13	0.75	1.6	
10	1.69	1.42	0.99	1.66	1.44
20	2.22	1.76	1.02	1.81	1.7
30	2.34	1.72	1.05	1.61	1.68
SE ±	0.33	0.17	0.06	0.15	0.1
Significance	NS	NS	NS	NS	NS
Fertilizer (F) NPK (kg/ha)					
Control	1.58	1.63	0.75	1.6	1.27
50:40:50	2.29	1.62	1.02	0.91	1.71
150:80:100	1.91	1.73	1.03	1.57	1.56
250:120:150	2.05	1.55	1.01	1.58	1.55
SE ±	0.33	0.17	0.06	0.15	0.11
Significance	NS	NS	NS	NS	NS
Significance of Interaction					
V x M	NS	NS	*	NS	NS
V x F	NS	NS	NS	NS	NS
M x F	NS	NS	NS	NS	*

1/ Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

*, ** and NS = Significant and highly significant at 5, and 1 percent levels and not significant, respectively.

Table 23: Interaction between variety x FYM during 1992 and FYM x fertilizer in combined data analysis for April pruned material in Grape

	Year	FYM (t/ha)		
		10	20	30
Variety				
Ex-Hort. Samaru	1992	1.28ab[1/]	1.10a-c	1.29a
Ex-Zaria black		0.69e	0.95cd	0.81de
SE ±			0.09	
Fertilizer NPK (kg/ha)				
50:40:50	Combined	1.40b	1.78a	1.95a
150:80:100		1.71a	1.43b	1.54ab
250:120:150		1.21b	1.89a	1.55ab
SE ±			0.18	

1/ Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

tons FYM/ha than the other 2 levels. When the fertilizer x FYM interaction was considered, the April pruned material increased was significant at 50:40:50 NPK/ha level when the FYM was increased from 10 to 20 t/ha. A further increase in either the FYM or fertilizer level did not increase the April pruned material significantly.

4.2.6 Number of bunches per vine

The data on number of bunches per vine is shown in Table 24. The difference in the means of the two varieties was significant in 1991, 1992 and highly significant in 1990, 1993 and the combined analysis. In all cases Ex-hort. Samaru produced a higher number of bunches than Ex-Zaria black. The differences in the means of FYM levels were found to be highly significant in all the experiments and combined analysis. In all the seasons and the combined data the difference between control and 10 t/ha FYM was not significant. When the FYM level was increased to 20 t/ha, there was a significant increase in the number of bunches per vine. A further increase of 30 t/ha of FYM however did not increase the number of bunches significantly. In 1993 and in combined analysis, control and 10 t/ha resulted in similar yields. An increase in FYM to 20 and 30 t/ha, yields were increased significantly with each increase in FYM. When the fertilizer levels were considered, the differences in means were highly significant from 1990 to 1992 and significant in 1993 and in combined analysis. Except in 1993, the fertilizer treatments constituted 2 non-significant groups of control - 50:40:50 and 150:80:100 - 250:120:150 kg NPK/ha. The differences within the group were not significant, however, the higher fertilizer treatment

Table 24: Number of bunches per vine as affected by variety, FYM and fertilizer levels during 1990-93 at Samaru

Treatment	1990	1991	1992	1993	Combin
Variety (V)					
Ex-Hort. Samaru	3.74a[1/]	11.00a	25.70a	64.70a	26.28a
Ex-Zaria black	2.81b	8.48b	18.70b	31.9b	15.49b
SE ±	0.2	0.73	0.18	2.65	0.05
Significance	**	*	*	**	**
FYM (M) (t/ha)					
Control	2.15b	6.15b	14.70b	32.70c	13.92c
10	2.50b	7.22b	16.60b	33.1c	14.86c
20	3.44a	10.22a	23.30a	49.10b	21.51b
30	3.89a	11.78a	26.70a	62.70a	26.28a
SE ±	0.25	0.9	2.21	3.24	0.98
Significance	**	**	**	**	**
Fertilizer (F) NPK (kg/ha)					
Control	2.15b	6.15b	14.70b	32.70c	13.92b
50:40:50	2.50b	6.78b	15.90b	54.80a	20.01a
150:80:100	3.56a	10.67a	24.70a	40.50bc	19.86a
250:120:150	3.78a	11.78a	25.90a	49.6ab	22.78a
SE ±	0.25	0.9	2.21	3.24	1.17
Significance	**	**	**	*	*
Significance of Interaction					
V x M	**	**	*	*	**
V x F	**	**	**	**	**
M x F	*	*	*	NS	**

1/ Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

*, ** and NS = Significant and highly significant at 5, and 1 percent levels and not significant, respectively .

produced more number of bunches than the other group. In 1993, there was a progressive increase in the number of bunches with

increasing levels of fertilizer. They fell into 3 non-significant groups. The highest fertilizer level produced higher number of bunches than low fertilizer level and control and the medium fertilizer level also produced a higher number of bunches than control. The interactions between variety x FYM were highly significant in 1990, 1991 and combined analysis and significant in 1992 and 1993 (Tables 25 and 26). Ex-hort. Samaru produced a higher number of bunches with each increase in the FYM level in 1990 and in combined analysis whereas in the other experiment there was no increase in number of bunches with increasing FYM levels. Ex-Zaria black produced a higher number of bunches when the FYM level was increased from 10 to 20 t/h. When the number of bunches of the 2 varieties were examined at the same FYM level Ex-hort. Samaru produced a higher number of bunches than Ex-Zaria black at all levels in 1993 and combined analysis. In other experiments it produced higher number of bunches only at 10t/ha. When the variety x fertilizer interaction was considered it was found to be highly significant in all the experiments and combined analysis. Increasing fertilizer level from low to medium increased the number of bunches in Ex-hort. Samaru in all experiments except in combined analysis. An increase in fertilizer level from medium to high did not increase the number of bunches. In the case of Ex-Zaria black the difference between low and medium fertilizer level was not significant, however the highest fertilizer level produced significantly higher number of bunches. The interactions between FYM x fertilizer were highly significant for

Table 25: Interaction between FYM x fertilizer, Variety x Fertilizer, FYM x Variety during 1990, 1991 and 1992 for number of bunches/vine in Grape

	Year	FYM (t/ha)			Variety	
		10	20	30	Ex-Hort.	Ex-Zaria
Fertilizer NPK (kg/ha)	1990					
50:40:50		2.50de[1/]	2.33de	2.67de	3.44b	1.56d
150:80:100		3.00c-e	2.50b-d	4.17a-c	5.00a	2.11cd
250:120:150		2.00e	4.50ab	4.83a	2.78bc	4.78a
SE ±			0.35			0.35
Variety						
Ex-Hort. Samaru		3.89a	3.44a	3.89a		
Ex-Zaria black		1.11b	3.44a	3.89a		
SE ±			0.43			
Fertilizer NPK (kg/ha)	1991					
50:40:50		7.83bc	5.83c	6.67c	9.22b	4.33c
150:80:100		7.50bc	12.00ab	12.50a	14.78a	6.56bc
250:120:150		6.63c	12.83a	16.17a	9.00b	14.56a
SE ±			1.56			1.27
Variety						
Ex-Hort. Samaru		11.11a	10.33a	11.5ba		
Ex-Zaria black		3.33b	10.11a	12.00a		
SE +			1.27			
Fertilizer NPK (kg/ha)	1992					
50:40:50		18.50bc	13.30c	16.00c	21.90bc	10.00d
150:80:100		16.50c	28.30a	29.30ab	34.00a	15.40cd
250:120:150		14.80c	28.20a	34.80a	21.10c	30.80ab
SE ±			3.82			3.12
Variety						
Ex-Hort. Samaru		25.60a	24.00a	27.40a		
Ex-Zaria black		7.70b	22.60a	26.00a		
SE ±			3.12			

[1/] Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

Table 26: Interaction between Variety x Fertilizer and FYM x Variety during 1993 and combined analysis for number of bunches/vine in Grape

	Year	FYM (t/ha)			Variety	
		10	20	30	Ex-Hort.	Ex-Zaria
Fertilizer	1993					
NPK (kg/ha)						
50:40:50					79.9a	29.8cd
150:80:100					57.1b	23.9d
250:120:150					57.1b	42.1c
SE ±					4.58	
Variety						
Ex-Hort. Samaru		45.0c	63.3b	85.8a		
Ex-Zaria black		21.2e	34.9d	39.7d		
SE ±			4.58			
Fertilizer	Combined					
NPK (kg/ha)						
50:40:50		18.54cd	16.71de	24.79b	28.61a	11.42c
150:80:100		13.25e	23.17bc	23.17bc	27.72a	12.00c
250:120:150		12.79c	24.67b	30.88a	22.50b	23.06b
SE ±			3.39			4.11
Variety						
Ex-Hort. Samaru		21.39c	25.28b	32.17a		
Ex-Zaria black		8.33e	17.75d	20.39d		
SE ±			4.11			

1/ Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

1990 and combined analysis, significant in 1991 and 1992 and not significant in 1993 (Tables 25 and 26). When each FYM level was examined at varying fertilizer level of 10 tons FYM/ha, increasing fertilizer dose did not increase the number of bunches except the combined analysis in which lower fertilizer produced more bunches. At 20 tons FYM/ha, medium and higher fertilizer dose produce more between except in 1991 where lower and medium fertilizer levels were similar. A similar response was observed at 30 t/ha from 1990 - 1992, but in the combined analysis the difference between low and medium fertilizer was not significant. When the same fertilizer level was examined for various FYM levels, the difference at low fertilizer level was not significant except in combined analysis. At medium fertilizer levels 20 and 30 tons FYM produced a higher number of bunches than 10t FYM except in 1990. The response at high fertilizer level was also similar except in combined analysis where an increase in each FYM level significantly increased the number of bunches.

4.2.7 Fruit yield per vine

The fruit yield (kg/vine) as affected by variety, FYM and fertilizer levels is given in Table 27. The mean differences in the varieties were highly significant in all experiments and the combined analysis except in 1993. The variety Ex-Zaria black yielded higher than Ex-Hort-Samaru in the 3 experiments and the combined analysis. In 1990 each increase in the level of FYM significantly increased the fruit yield. In 1991, 1992 and 1993 seasons the differences between the control and 10 t/ha were not significant, but a further increase in FYM to either 20 or 30 t/ha significantly increased the yield at each level. The differences in means of fertilizer

Table 27: Fruit yield (kg/vine) as affected by Variety, FYM and Fertilizer levels during 1990-93 at Samaru.

Treatment	1990	1991	1992	1993	Combin
Variety (V)					
Ex-Hort. Samaru	0.20b[1/]	0.62b	1.43b	3.57	1.45b
Ex-Zaria black	0.35a	1.10a	2.46a	4.11	2.01a
SE ±	0.02	0.05	0.12	0.25	0.04
Significance	**	**	**	NS	**
FYM (M) (t/ha)					
Control	0.10d	0.31c	0.84c	1.83c	0.77b
10	0.15c	0.48c	1.12c	2.35c	1.02b
20	0.31b	0.95b	2.14b	4.00b	1.85b
30	0.36a	1.16a	2.67a	5.18a	2.32a
SE ±	0.01	0.06	0.15	0.31	0.09
Significance	**	**	**	**	**
Fertilizer (F) NPK (kg/ha)					
Control	0.10d	0.33c	0.84c	1.83c	0.77c
50:40:50	0.16c	0.49c	1.14c	3.81ab	1.40b
150:80:100	0.27c	0.85b	1.94b	3.08b	1.53b
250:120:150	0.4	1.25a	4.64a	4.64a	2.26a
SE ±	0.02	0.06	0.15	0.31	0.09
Significance	**	**	**	**	**
Significance of Interaction					
V x M	**	**	**	NS	**
V x F	**	**	**	*	**
M x F	**	**	**	NS	**

[1/] Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

*, ** and NS = Significant and highly significant at 5, and 1 percent levels and not significant, respectively.

levels were highly significant in all experiments and combined analysis. In 1990 each increase in the fertilizer level significantly increased the yield. In 1991 and 1992 seasons, the difference between the yield of control and the first level of fertilizers was not significant, but application of either medium or high fertilizer dose significantly increased the yield at each level. In 1993 season, the control treatment recorded significantly lower yield than all fertilizer levels. The highest dose of 250:120:150 kg NPK/ha gave significantly higher yield than 150:80:100 level. In the case of combined analysis, the control yielded significantly lower than all other fertilizer levels. The difference between the low and medium levels of fertilizer was not significant. The highest dose of fertilizer yielded significantly higher than all other fertilizer levels.

Except in 1993, the interaction between variety x FYM were highly significant. In 1990 to 1992 seasons increasing FYM levels from 10 to 30 t/ha did not increase the yield significantly, but in combined analysis each increase in the FYM level significantly increased the yield (Table 28). In the case of Ex-Zaria black increasing FYM level from 10 to 20 t/ha significantly increased the yield. Increasing FYM level from 20 to 30 t/ha did not significantly increased the yield in 1990 and 1992 season. In 1991 and combined analysis each increment in the FYM level significantly increased the yield. The interaction between variety x fertilizer was significant in 1993 and highly significant in all other experiments and the combined analysis (Table 29). In Ex-hort. Samaru increasing fertilizer level from low to medium level significantly increased the yield in 1990, 1991 and 1992 but a further increase in the fertilizer level depressed the yield. In 1993 and

Table 28: Interaction between FYM x Fertilizer, Vareity x Fertilizer and FYM x Variety during 1990, 1991 and 1992 for fruit yield (kg/vine) in Grape

	Year	FYM (t/ha)			Variety	
		10	20	30	Ex-Hort.	Ex-Zaria
Fertilizer NPK (kg/ha)	1990					
50:40:50		0.14f[1/]	0.15ef	0.18e	0.16c	0.15c
150:80:100		0.19e	0.28d	0.33c	0.27b	0.25b
250:120:150		0.13f	0.50b	0.57a	0.17c	0.63a
SE ±			0.03			0.02
Variety						
Ex-Hort. Samaru		0.19c	0.19c	0.22c		
Ex-Zaria black		0.11d	0.43a	0.50a		
SE ±			0.02			
Fertilizer NPK (kg/ha)	1991					
50:40:50		0.49d	0.41d	0.56d	0.45c	0.52c
150:80:100		0.49d	0.99c	1.10c	0.84b	0.85b
250:120:150		0.46d	1.44b	1.87a	0.57c	1.94a
SE ±			0.03			0.02
Variety						
Ex-Hort. Samaru		0.58c	0.59c	0.68c		
Ex-Zaria black		0.37d	1.30b	1.64a		
SE ±			0.02			
Fertilizer NPK (kg/ha)	1992					
50:40:50		1.14e	0.94c	1.34c	1.05c	1.23c
150:80:100		1.13c	2.24b	2.44b	1.92b	1.96b
250:120:150		1.08c	3.23a	3.93a	1.31c	4.19a
SE ±			0.12			0.09
Variety						
Ex-Hort. Samaru		1.34cd	1.33cd	1.60c		
Ex-Zaria black		0.89d	2.95a	3.54a		
SE ±			0.09			

[1/] Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

Table 29: Interaction between Variety x Fertilizer during 1993, FYM x Variety and Fertilizer x Variety in combined data analysis for fruit yield (kg/vine) in Grape

	Year	FYM (t/ha)			Variety	
		10	20	30	Ex-Hort.	Ex-Zaria
Fertilizer NPK (kg/ha)	1993					
50:40:50					3.89b[1/]	3.73b
150:80:100					3.19b	2.97b
250:120:150					3.63b	5.64a
SE ±					0.44	

Variety	Combined				Fertilizer (NPK kg/ha)		
					50:40:50	150:80:100	250:120:150
Ex-Hort. Samaru		1.08e	1.40d	1.88c	1.39b	1.55b	1.42b
Ex-Zaria black		0.97e	2.30b	2.76a	1.41b	1.51b	3.10a
SE ±			0.11			0.11	

Fertilizer NPK (kg/ha)				
50:40:50	1.08d	1.14d	1.97c	
150:80:100	0.94d	1.78c	1.88c	
250:120:150	1.05d	2.63b	3.10a	
SE ±		0.14		

[1/] Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

combined analysis these was no significant difference in fruit yield of Ex-hort Samaru due to increase in fertilizer levels. The variety Ex-Zaria black produced higher yields with each increase in fertilizer level in 1990, 1991 and 1992 seasons. In 1993 and in combined analysis the difference between low and medium fertilizer was not significant, but the highest fertilizer level of 250:120:150 kg of NPK/ha increased the fruit yield significantly. The interaction between FYM x fertilizer level was not significant in 1993, was significant at 5 percent level in 1990 and highly significant in other cases. When each fertilizer level was examined at varying FYM levels no significant difference was observed in 1991 and 1992. The treatment 30 t/ha of FYM yielded higher than 10 tons in 1990 and the same treatment yielded higher than 10 and 20 t/ha in combined analysis at low fertilizer level. In the case of medium level of fertilizer, 10 and 20 t/ha FYM resulted in a higher yield than 10 t/ha FYM in 1991, 1992 and in combined analysis. In 1990, however, each increase in FYM level increased the fruit yield significantly. At the highest fertilizer level, each increase in the FYM level increased the yield significantly in 1990, 1991 and in combined analysis. In 1992, the FYM at 20 and 30 t/ha yielded higher than 10 tons. When the same FYM level was looked at varying fertilizer levels, no difference was found in 1991, 1992 and the combined analysis for 10 t/ha of FYM. In 1990, however, the medium fertilizer level yielded higher than the other two levels. At 20 and 30 t/ha of FYM, an increase in each fertilizer level increased the yield significantly in 1990, 1991 and 1992 seasons. In the case of combined analysis the highest fertilizer dose yielded significantly higher than the other two fertilizer levels.

4.2.8 Weight of bunch

Weight of bunch (g) as affected by variety, FYM and fertilizer levels is given in Table 30 for the 4 years of experimentation and the combined analysis. The differences in the varietal means were highly significant in all the 4 seasons and combined analysis. Ex-Zaria black bunch was heavier than Ex-hort. Samaru in all experiments and combined analysis. The differences due to FYM levels were also highly significant. Each increase in the FYM level significantly increased the bunch weight. Similarly, differences in the means of fertilizer levels were also highly significant. When the fertilizer level was increased bunch weight also increased significantly at each level of the fertilizer under trial. The interaction between variety x FYM were highly significant in 1990, 1992, 1993 and in the combined analysis and significant in 1991 (Tables 31 and 32). The difference in the mean bunch weight of 10 and 20 t/ha FYM was not significant in Ex-Hort. Samaru in all the 4 seasons, however, such difference was significant in the combined analysis. In Ex-Zaria black, however each increase in the FYM level significantly increased the bunch weight. The interaction between variety x fertilizer were not significant in 1990 and 1992 and highly significant in 1991, 1993 and in combined analysis in which each increase in the fertilizer level significantly increased the bunch weight of both varieties. Also the bunch weight of Ex-Zaria black was higher than Ex-hort. Samaru of all levels of fertilizer stated above.

The interaction between fertilizer x FYM was significant only in combined analysis (Table 32). At the same fertilizer level, increasing FYM level increased

Table 30: Bunch weight (g) as affected by Variety, FYM and Fertilizer levels during 1990-93 at Samaru

Treatment	1990	1991	1992	1993	Combined
Variety (V)					
Ex-Hort. Samaru	54.3b[1/]	54.41b	54.37b	54.43b	54.38b
Ex-Zaria black	125.5a	126.070a	125.98a	126.26a	125.90a
SE ±	0.68	0.55	0.68	0.57	0.31
Significance	**	**	**	**	**
FYM (M) (t/ha)					
Control	69.50d	65.05d	65.55d	73.50d	68.40d
10	83.70c	83.78c	84.17c	83.94c	83.89c
20	90.40b	90.89b	90.83b	90.72b	90.71b
30	95.70a	96.06a	95.72a	96.33a	95.82a
SE ±	0.83	0.68	0.83	0.7	0.39
Significance	**	**	**	**	**
Fertilizer (F) NPK (kg/ha)					
Control	69.50d	65.05d	65.55d	73.50d	68.40d
50:40:50	82.90c	83.11c	82.56c	83.33c	82.99c
150:80:100	89.40b	89.89b	90.11b	89.85b	89.81b
250:120:150	97.40a	97.72a	97.56a	97.83a	97.63a
SE ±	0.08	0.68	0.83	0.7	0.35
Significance	**	**	**	**	**
Significance of Interaction					
V x M	**	*	**	**	**
V x F	NS	*	NS	**	**
M x F	NS	NS	NS	NS	**

1/ Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

*, ** and NS = Significant and highly significant at 5, and 1 percent levels and not significant, respectively.

Table 31: Interaction between FYM x Variety during 1990, Variety x Fertilizer and FYM x Variety during 1991, FYM x Variety during 1992, Variety x Fertilizer and FYM x Variety during 1993 for bunch weight (gm) in Grape.

	Year	FYM (t/ha)			Variety	
		10	20	30	Ex-Hort.	Ex-Zaria
Variety	1990					
Ex-Hort. Samaru		15.56e[1/]	53.67e	57.78d		
Ex-Zaria black		115.75c	127.11b	133.56a		
SE ±			1.17			
Fertilizer NPK (kg/ha)	1991					
50:40:50					45.56f	120.67c
150:80:100					55.33e	124.44b
250:120:150					62.33d	133.11a
SE ±						1.17
Variety						
Ex-Hort. Samaru		51.56e	53.67e	58.00d		
Ex-Zaria black		116.00c	128.11b	134.11a		
SE ±			0.96			
Variety	1992					
Ex-Hort. Samaru		52.33e	53.44e	57.33d		
Ex-Zaria black		116.00c	128.22b	133.11a		
SE ±			1.17			
Fertilizer NPK (kg/ha)	1993					
50:40:50					45.44f	121.22c
150:80:100					55.33e	124.33b
250:120:150					62.44d	133.22a
SE ±						0.99
Variety						
Ex-Hort. Samaru		51.56e	54.30e	57.67d		
Ex-Zaria black		116.33c	127.44b	135.00a		
SE ±			0.99			

1/ Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

Table 32: Interaction between FYM x Variety, Fertilizer x Variety and FYM x Fertilizer in Combined data analysis for bunch weight (gm) in grape

	FYM (t/ha)			Fertilizer (NPK kg/ha)		
	10	20	30	50:40:10	150:80:100	250:120:150
Variety						
Ex-Hort. Samaru	51.75f[1/]	53.69e	57.69d	45.58f	55.06e	62.50d
Ex-Zaria black	116.03c	127.72b	133.94a	120.39c	124.56b	132.75a
SE ±		0.55			0.51	
Fertilizer NPK (kg/ha)						
50:40:50	77.00g	82.21f	90.75d			
150:80:100	84.46e	91.17d	93.79c			
250:120:150	91.21d	98.75b	102.92a			
SE ±		0.65				

[1/] Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

the bunch weight. The greatest bunch weight was produced at the highest levels of fertilizer and FYM application.

4.2.9 Number of berries per bunch

The data on number of berries per bunch as affected by variety, FYM and fertilizers is given in Table 33. Statistical analysis of the data revealed that the difference between the varieties was highly significant in all the experiment as well as in the combined analysis. In 1990 Ex-Zaria black produced a higher number of berries per bunch, but in the rest of the experiments and in combined analysis Ex-hort. Samaru gave a higher number of berries per bunch than Ex-Zaria black. The differences in the mean due to FYM levels were highly significant in all the experiments as well as in a combined analysis. Each additional level of FYM significantly increased the number of berries per bunch. Similarly, the differences in means due to fertilizer levels were highly significant in all the seasons and in a combined analysis. Each increase in fertilizer level significantly increased the number of berries per bunch.

The interaction between variety x FYM were neither significant in individual experiments nor in the combined analysis. The interaction between variety x fertilizer were highly significant in all the experiments and in the combined analysis (Table 34). The number of berries per bunch significantly increased with an increase in the fertilizer level on each variety. When each fertilizer level was examined for different varieties, it was observed that Ex-hort. Samaru resulted in a higher number of berries than Ex-Zaria black at all fertilizer levels. The

Table 33: Number of berries per bunch of twenty varieties of grape, FYM and Fertilizer levels during 1990-93 at Samaru.

Treatment	1990	1991	1992	1993	Combin
Variety (V)					
Ex-Hort. Samaru	43.74b[1/]	62.00a	62.33a	62.48a	62.31a
Ex-Zaria black	62.41a	43.93b	43.89b	44.11b	43.92b
SE ±	0.66	0.56	0.63	0.68	0.35
Significance	**	**	**	**	**
FYM (M) (t/ha)					
Control	29.70d	30.15d	31.23d	30.61d	30.42dd
10	47.70c	47.50c	47.72c	48.33c	47.82c
20	51.90b	51.72b	51.94b	52.06b	51.92b
30	59.60a	59.67a	59.67a	59.50a	59.60a
SE ±	0.79	0.69	0.77	0.83	0.39
Significance	**	**	**	**	**
Fertilizer (F) NPK (kg/ha)					
Control	29.70d	30.15d	31.23d	30.61d	30.42d
50:40:50	35.30c	35.17c	35.28c	35.44c	35.29c
150:80:100	54.10b	54.50b	54.39b	54.11b	54.28b
250:120:150	69.89a	69.22a	69.67a	70.33a	69.76a
	0.79	0.69	0.77	0.83	0.35
SE ±					
Significance	**	**	**	**	0.5
Significance of Interaction					
V x M	NS	NS	NS	NS	NS
V x F	**	**	**	**	**
M x F	**	**	*	**	**

[1/] Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

*, ** and NS = Significant and highly significant at 5, and 1 percent levels and not significant, respectively .

Table 34: Interaction between FYM x Fertilizer, Variety x Fertilizer during 1990, 1991, 1992, 1993 and in combined data analysis respectively, for number of bunches/vine in Grape

	Year	FYM (t/ha)			Variety	
		10	20	30	Ex-Hort.	Ex-Zari
Fertilizer NPK (kg/ha)	1990					
50:40:50		31.50g[1/]	36.17f	38.17f	38.33e	32.22f
150:80:100		46.67e	52.17d	63.50c	65.00b	43.22d
250:120:150		65.00bc	67.50b	77.00a	83.89a	55.78c
SE ±			1.37			0.12
Fertilizer NPK (kg/ha)	1991					
50:40:50		31.83f	35.67e	38.00e	37.67e	32.67f
150:80:100		46.83d	53.00c	63.67b	65.22b	43.78d
250:120:150		63.83b	66.50b	77.33a	83.11a	55.33c
SE ±			0.19			0.98
Fertilizer NPK (kg/ha)	1992					
50:40:50		32.00f	35.83e	38.00e	38.00e	32.56f
150:80:100		46.83d	52.83c	63.50b	65.33b	43.44d
250:120:150		64.33b	67.17b	77.50a	83.67a	55.67c
SE ±			1.34			1.09
Fertilizer NPK (kg/ha)	1993					
50:40:50		31.12f	35.67f	37.50f	39.00e	31.89f
150:80:100		46.67e	52.00d	63.67c	64.89b	43.33d
250:120:150		65.17b	68.50b	77.33a	83.56a	57.11c
SE ±			1.44			1.18
Fertilizer NPK (kg/ha)	Combined					
50:40:50		32.12h	35.83g	37.92f	38.25e	32.33f
150:80:100		46.75e	52.50d	63.58c	65.11b	43.44d
250:120:150		62.58c	67.42b	77.29a	83.56a	55.97c
SE ±			0.66			0.54

[1/] Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

interactions between FYM x fertilizer were highly significant in all experiments and combined analysis (Table 34) except in 1992 in which year it was significant. In the case of low fertilizer and at varying FYM levels increasing FYM level from 10 to 20t/ha significantly increased the number of berries per bunch but a further increase in FYM level to 30t/ha did not increase the number of berries per bunch in all experiments. There was an increase in the number of berries per bunch with each increase in FYM at medium fertilizer level in all experiments. At high fertilizer level the difference between 10 and 20 t/ha of FYM was not significant, except in the combined analysis. There was a significant increase in the number of berries per bunch in all experiments when FYM was increased to 30 t/ha. In combined analysis an increase in either FYM level or fertilizer level significantly increased the number of berries per bunch.. The variety Ex-Hort. Samaru had a significantly higher number of berries than Ex-Zaria black.

4.2.10. Berry size

The berry size as affected by variety, FYM and fertilizer levels is shown in Table 35 for the 4 years of experimentation and combined analysis. Analysis of data revealed that varietal differences were not significant statistically in all the 4 years of experiments and in combined analysis. The differences due to FYM levels were highly significant in 1990 and combined analysis, significant in 1991 and not significant in 1992 and 1993. Increasing FYM level from control to either 10 or 20 t/ha did not significantly increase the berry size. A further increase in FYM level to 30 t/ha however increased the berry size significantly in 1990, 1991 and in combined analysis. The differences in the means of fertilizer levels were significant

Table 35: Berry size (volume of 5 berries in ml) as affected by Variety, FYM and Fertilizer levels during 1990-93 at Samaru

Treatment	1990	1991	1992	1993	Combined
Variety (V)					
Ex-Hort. Samaru	2.41[1/]	2.43	2.02	2.88	2.44
Ex-Zaria black	2.51	2.39	2.09	2.9	2.47
SE ±	0.07	0.05	0.11	0.13	0.03
Significance	NS	NS	NS	NS	NS
FYM (M) (t/ha)					
Control	2.10b	2.15b	2.13	2.63	2.25b
10	2.33b	2.45a	2.1	2.74	2.41b
20	2.32b	2.25b	2.01	2.83	2.35b
30	2.73a	2.53a	2.04	3.1	2.60a
SE ±	0.09	0.06	0.13	0.16	0.06
Significance	**	*	NS	NS	**
Fertilizer (F) NPK (kg/ha)					
Control	2.1	2.15b	2.13	2.63	2.31
50:40:50	2.3	2.26b	2.14	2.75b	2.36
150:80:100	2.49	2.53a	2.67	2.98	2.52
250:120:150	2.6	2.44a	1.94	2.93	2.48
SE ±	0.09	0.06	0.13	0.16	0.07
Significance	NS	*	NS	NS	NS
Significance of Interaction					
V x M	NS	NS	NS	NS	NS
V x F	NS	NS	NS	NS	NS
M x F	**	**	NS	NS	NS

1/ Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

*, ** and NS = Significant and highly significant at 5, and 1 percent levels and not significant, respectively.

in 1991 only. The difference in the means of control and low fertilizer level was not significant. Similarly, the difference between the medium and high fertilizer level was not significant, but these two levels resulted in a larger berry size than control and low fertilizer levels. None of the interactions between variety x FYM and Variety x Fertilizer were found to be significant. The FYM x Fertilizer interactions were found to be highly significant in 1990 and 1991 seasons (Table 36) respectively. In 1990 when each fertilizer level was examined at varying FYM levels no significant difference was found at low or medium fertilizer level. However, at a high fertilizer level increasing FYM level from 10 to 20t/ha did not affect the berry size but with the highest FYM of 30 t/ha significantly large sized berries were produced. In 1991 low fertilizer level at 20t/ha produced smaller berries than all other fertilizer x FYM combination treatments.

4.2.11. Sugar content of fruits (%)

The berry sugar content as affected by variety, FYM and fertilizer levels is shown in Table 37. The differences due to varieties were highly significant in 4 years of experimentation and in combined analysis. In all analyses Ex-hort. Samaru fruits were found to have a higher sugar content than Ex-Zaria black berries. The differences due to FYM levels were highly significant in 1990 and 1991 seasons only. In 1990 control treatment resulted in lower sugar content than all other applied levels of FYM. Applying 10 or 20 t/ha of FYM did not affect the sugar content of grapes but a further increase in FYM to 30 t/ha significantly increased the sugar content. In the 1991 season, sugar content of control & 20 t/ha and 10 & 30 t/ha constituted the same sugar content group and the former was found to

Table 36: Interaction between FYM x Fertilizer during 1990 and 1991 for berry size (volume of 5 berries in ml) in Grape

	Year	FYM (t/ha)		
		10	20	30
Fertilizer NPK (kg/ha)	1990			
50:40:50		2.33bc[1/]	2.07c	2.50bc
150:80:100		2.58b	2.42bc	2.47bc
250:120:150		2.08c	2.48bc	3.23a
SE ±			0.16	
Fertilizer NPK (kg/ha)	1991			
50:40:50		2.47a	1.77b	2.53a
150:80:100		2.55a	2.47a	2.57a
250:120:150		2.33a	2.52a	2.48a
SE ±			0.11	

[1/] Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

Table 37: Sugar content of fruits (%) of twenty varieties of grape, FYM and Fertilizer during 1990-93 at Samaru

Treatment	1990	1991	1992	1993	Combined
Variety (V)					
Ex-Hort. Samaru	12.87a[1/]	13.46a	12.31a	17.51a	14.04a
Ex-Zaria black	11.74b	11.99b	10.94b	12.63b	11.83b
SE ±	0.15	0.18	0.22	0.63	0.15
Significance	**	**	**	**	**
FYM (M) (t/ha)					
Control	11.30c	12.53b	11.49	15.09	12.6
10	11.80b	12.65a	11.68	15.71	12.96
20	11.90b	12.47b	11.25	15.72	12.71
30	13.2a	13.26a	11.94	14.28	13.12
SE ±	0.19	0.22	0.27	0.78	0.21
Significance	**	**	NS	NS	NS
Fertilizer (F) NPK (kg/ha)					
Control	11.30c	12.53	11.49ab	15.09	12.60b
50:40:50	12.50b	12.74	11.61ab	15.56	13.09b
150:80:100	11.50c	11.78	10.92b	13.58	11.94c
250:120:150	13.00c	13.66	12.34a	16.07	13.76a
SE +	0.19	0.22	0.27	0.08	0.24
Significance	**	NS	**	NS	**
Significance of Interaction					
V x M	NS	NS	*	NS	NS
V x F	**	NS	NS	NS	NS
M x F	*	*	**	NS	**

1/ Means followed by the same letter(s) within columns and treatment set are *not significant using DMRT.05*

*, ** and NS = Significant and highly significant at 5, and 1 percent levels and not significant, respectively .

be less sweet than the latter. The differences due to fertilizer were highly significant in 1990, 1992 and in combined analysis. In 1990 the highest level of fertilizer produced sweeter berries than all other fertilizer levels. It was followed by low level fertilizer which was also sweeter than the control and the medium fertilizer level. In 1992 the highest fertilizer level produced sweeter berries than medium fertilizer level. In the combined analysis the highest fertilizer level followed by control and low fertilizer level which were also higher than the medium fertilizer level.

The interaction between variety x FYM was significant in 1992 only (Table 38). Increasing FYM levels up to 30t/ha did not affect the sugar content of berries in Ex-hort. Samaru but the sugar content at 10t/ha FYM was superior. In Ex-Zaria black however, increasing FYM level from 10 to 20 t/ha did not increase the sugar content. An increase of FYM from 20 to 30 t/ha significantly increased the sugar content of the fruits. The differences in the means of fertilizer application were highly significant in 1991, 1992 and in combined analysis and significant in 1990 season (Table 38). When the same fertilizer level was examined at varying FYM levels, sugar content of fruits was at low fertilizer level in 1990. Sugar content increased in medium and high fertilizer level at 30 t/ha of FYM. In 1991 and 1992 seasons sugar content was not affected by increasing FYM levels at low and medium fertilizer level. At the highest fertilizer level, 30 t/ha FYM produced a higher sugar content. In the combined analysis 30 t/ha produced lower sugar in low fertilizer level and a high sugar content at the highest fertilizer level.

Table 38: Interaction between FYM x Fertilizer, Variety x Fertilizer during 1990, FYM x Fertilizer during 1991, 1992 and in combined, and FYM x Variety during 1992 for sugar content (%) in Grape

	Year	FYM (t/ha)			Variety	
		10	20	30	Ex-Hort.	Ex-Zari
Fertilizer NPK (kg/ha)	1990					
50:40:50		12.12b[1/]	12.52b	12.75b	12.64bc	12.28c
150:80:100		11.12c	10.98c	12.30b	12.69bc	10.24d
250:120:150		12.22b	12.23b	14.56a	13.28a	12.71b
SE ±			0.33			0.27
Fertilizer NPK (kg/ha)	1991					
50:40:50		13.65b	12.68bc	11.90cd		
150:80:100		11.53d	11.52d	12.28cd		
250:120:150		12.77bc	13.20b	15.00a		
SE ±			0.37			
Fertilizer NPK (kg/ha)	1992					
50:40:50		12.07b	12.00b	10.77bc		
150:80:100		11.00bc	10.52c	11.23bc		
250:120:150		11.97b	11.23bc	13.82a		
SE ±			0.47			
Variety						
Ex-Hort. Samaru		12.57a	12.29ab	12.07ab		
Ex-Zaria black		10.79b	10.21b	11.81b		
SE ±			0.39			
Fertilizer NPK (kg/ha)	Combined					
50:40:50		13.77b	13.45bc	12.06de		
150:80:100		12.02de	11.40e	12.39c-e		
250:120:150		13.10b-d	13.29bc	14.90a		
SE ±			0.39			

[1/] Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

4.2.12. Juice pH

The difference in varietal mean was found to be significant in 1992 and highly significant in combined analysis (Table 39). The variety Ex-hort. Samaru had a higher pH than Ex-Zaria black. The differences in the means of FYM was significant in 1992 and 1993 but fertilizer levels were not significant. The interaction between variety x FYM, variety x fertilizer and FYM x fertilizer were found to be insignificant.

4.3 Experiment No. 3. Response of two grape (Vitis vinifera L) varieties to pruning dates and training systems

4.3.1. Shoot length (cm)

The shoot length as affected by pruning date, training systems and variety of grape during 1989 - 92 and the combined analysis of four years are shown in Table 40. The date of pruning did not affect the shoot length significantly, although a tendency of longer shoot-length in early pruning was displayed in the combined analysis. The variety Bangalore blue produced longer shoot than Ex-Zaria black in 3 out of 4 years and in combined analysis. Training system did not affect shoot-length in 1989, 1991 and in combined analysis. The differences in shoot length were significant at 5 percent in 1990 and 1 percent in 1992. Overhead trellis system produced longer shoots in 1990 which were reversed in 1992.

Interaction between Variety x Training system (hitherto referred to as system) was highly significant at 5% percent level (during 1989 and 1992. (Table 41). In the combined analysis interaction between date x system, variety x system,

Table 39: Grape juice pH of twenty varieties of grape, FYM and Fertilizer levels during 1992-93 at Samaru

Treatment	1992	1993	Combined
Variety (V)			
Ex-Hort. Samaru	6.55a[1/]	6.63	6.59a
Ex-Zaria black	6.41b	6.43	6.12b
SE ±	0.05	0.08	0.05
Significance	*	NS	**
FYM (M) (t/ha)			
Control	6.47ab	6.72a	6.6
10	6.38b	6.74a	6.56
20	6.47ab	6.35b	6.41
30	6.59a	6.50ab	6.55
SE ±	0.06	0.1	0.67
Significance	*	*	NS
Fertilizer (F) NPK (kg/ha)			
Control	6.47	6.72	6.6
50:40:50	6.47	6.66	6.61
150:80:100	6.46	6.51	6.49
250:120:150	6.41	6.42	6.41
SE ±	0.06	0.1	0.07
Significance	NS	NS	NS
Significance of Interaction			
V x M	NS	NS	NS
V x F	NS	NS	NS
M x F	NS	NS	NS

1/ Means followed by the same letter(s) within columns and treatment set are not significant using DMRT.05

*, ** and NS = Significant and highly significant at 5, and 1 percent levels and not significant, respectively.

Table 40: Shoot Length (cm) as affected by pruning date, Training System and Variety of Grape during 1989 - 92 at Samaru.

Treatment	1989	1990	1991	1992	Combined
Date of Pruning (D)					
September 26	44.0	48.1	28.2	34.3	38.6
October 17	45.7	35.8	32.5	23.6	34.4
November 7	27.1	37.5	33.9	26.2	31.2
SE ±	5.88	6.05	1.96	2.20	2.23
Significance	NS	NS	NS	NS	NS
Variety (V)					
Bangalore blue	44.9	53.0a[1/]	41.0a	40.9a	44.9a
Ex-Zaria black	33.0	27.9b	22.1b	15.2b	24.5b
SE ±	4.80	4.94	1.60	1.80	2.46
Significance	NS	**	**	**	**
Training System (S)					
Overhead Trellis	38.9	48.1a	32.3	23.0b	35.6
Kniffen	39.0	32.7b	30.8	33.0a	33.9
SE ±	4.80	4.94	1.60	1.80	2.46
Significance	NS	*	NS	**	NS
Sign. of Interaction					
D x V	NS	NS	NS	NS	NS
D x S	NS	NS	NS	NS	**
V x S	**	NS	NS	**	**
Y x D	-	-	-	-	*
Y x V	-	-	-	-	NS
Y x S	-	-	-	-	**
Year (Y) Mean	38.9a	40.4a	31.5b	28.0b	*
SE ± 1.79					

1/ Means followed by the same letter within a treatment of a column and within the year means are not significant statistically using DMRT 0.05.

*, ** and NS = Significant at 5 and 1 Percent Levels and not significant, respevtively.

Table 41: Interaction between Variety x Training System during 1989 and 1992, and Training System x Training Date, Training System x Variety, Training System x Year, Pruning Date x Year in combined data analysis for shoot length (cm) in grape

	1989		1992	
Variety	Overhead trellis	Kniffen	Overhead trellis	Kniffen
Bangalore blue	33.1b[1/]	56.7a	31.6b	50.1a
Ex-Zaria black	44.7ab	21.4c	14.4c	15.9c
SE ±	6.79		2.54	

	Combined 1989-92				
	Pruning Date			Variety	
Training System	29/9	17/10	7/11	Bangalore blue	Ex-Zaria black
Overhead trellis	42.1a	35.8ab	28.9b	40.8b	49.0a
Kniffen	35.2ab	33.0b	33.5ab	30.3c	18.8d
SE ±	3.16			2.58	

	Year			
Training System	1989	1990	1991	1992
Overhead trellis	38.9b	48.1a	32.3b	23.0c
Kniffen	39.0b	32.7b	30.8c	33.0b
SE ±	2.87			
Pruning Date				
29/9	44.0a	48.1a	28.2b	34.3ab
17/10	45.7a	35.8ab	32.5ab	23.6b
7/11	27.1b	37.5ab	33.9a	26.22b
SE ±	6.31			

[1/] Means followed by the same letter(s) within an interaction means are not significant using DMRT0.05

and year x system were highly significant (1% level) and between year x date was significant (Table 41). In 1989, Kniffen system of training was found to be suitable for Bangalore blue and overhead trellis for Ex-Zaria black. The variety Bangalore blue yielded higher than Ex-Zaria black under Kniffen training systems in 1989.. Kniffen system was found to be better than over head trellis for Bangalore blue and such difference was insignificant in Ex-Zaria black in 1992 (Table 41).

In the combined analysis, the interaction between pruning date x training system (Table 41) revealed that the shoot length decreased as the pruning date was delayed in both varieties. The training system however, had no effect on shoot length in all the 3 dates of pruning. The interaction between variety x training system (Table 41) indicated that Ex-Zaria black had longer shoots than in Bangalore blue on overhead trellis system, When the training systems were considered, overhead trellis system produced longer shoots than Kniffen system. The year x training system interaction (Table 41) show that shoot length in overhead trellis system was longer than Kniffen system in 1990 and 1991, it was reverse in 1992 and no difference in 1989.

For the interaction between year x pruning date it was observed that late September pruning produced longer shoots in 1990 than 1991, mid October pruning of 1989 was better than 1992 and early November pruning produced longer shoots than those produced in 1989 and 1992. When the 3 pruning dates were compared within a year, September and October pruning produced longer shoots than November pruning in 1989 and November pruning was better than

September pruning in 1991. The differences in the year means were also significant. Shoot length in 1989 and 1990 was longer than in 1991 and 1992.

4.3.2. Weight of October pruned material

The data of October pruned material as affected by pruning date, training system and variety during 1989 - 92 and combined analysis is shown in Table 42.

Pruning date did not affect the weight of October pruned material in any of the four years of experimentation. However, such differences of the combined analysis were significant at 5 percent level. The difference between the means of early September and mid-October was not significant and these two treatments produced higher pruned material than early November. The difference in the varietal means was highly significant in combined analysis and all years except in 1990 in which year such difference was significant at 5 percent level. In all years and combined analysis, Bangalore blue produced higher October pruned material than Ex-Zaria Black variety. The October pruned material of the two training systems were highly significant in 1989 and the combined analysis of data and significant in 1990. In all the 3 analyses, overhead training system produced higher October pruned material than Kniffen system. Such differences in 1991 and 1992 were not statistically significant.

None of the first order of interactions were significant in individual years, however, in the combined analyses interactions between date x variety, were highly significant (Table 43, a-d). When the individual dates are examined for the two varieties, Bangalore blue produced higher October pruned material than that of

TABLE 42: October Pruned Material (kg/vine) as affected by Pruning Date, Training System and Variety of Grape During 1989 - 92 at Samaru.

Treatment	1989	1990	1991	1992	Combined
Pruning Date (D)					
September 26	5.73	2.55	2.15	2.39	3.20a[1/]
October 17	5.62	3.60	2.16	1.90	3.32a
November 7	4.67	2.05	1.74	1.47	2.49b
SE ±	0.66	0.43	0.27	0.40	0.23
Significance	NS	NS	NS	NS	*
Variety (V)					
Bangalore blue	6.98a	3.33a	2.46a	3.19a	3.99a
Ex-Zaria black	3.71b	2.13b	1.57b	0.65b	2.01b
SE ±	0.54	0.35	0.22	0.33	0.19
Significance	**	*	**	**	**
Training System (S)					
Overhead trellis	6.79a	3.33a	2.15	1.78	3.51a
Kniffen	3.90b	2.14b	1.88	2.06	2.50b
SE ±	0.54	0.35	0.22	0.33	0.19
Significance	**	*	NS	NS	**
Sign of Interaction					
D x V	NS	NS	NS	NS	**
D x S	NS	NS	NS	NS	NS
V x S	NS	NS	NS	NS	**
Y x D	-	-	-	-	**
Y x V	-	-	-	-	**
Y x S	-	-	-	-	NS
Year (Y) Mean	5.34a	2.73b	2.02c	1.92c	**
SE ± 0.24					

1/ *Means following by the same letter within a treatment of a column and within the year means are not statistically* using DMRT0.05.

*, ** and NS = Significant at 5 and 1 percent levels, and not significant,.respectively

Table 43: Interaction between (a) Pruning Variety x Date
(b) Training Variety x System (c) Pruning Year x Date and
(d) Year x Variety for October pruned material (kg/vine) in
combined data analysis from 1989 - 92.

Variety	(a) Pruning Date			(b) Training System	
	26/9	17/10	7/11	Overhead trellis	Kniffen
Bangalore blue	4.82a[1/]	4.18a	2.98b	4.69a	3.30b
Ex-Zaria black	1.59c	2.46bc	1.99c	2.33c	1.70c
SE ±		0.33			0.54
	(c) Pruning Date			(d) Variety	
Year	26/9	17/10	7/11	Bangalore blue	Ex-Zaria black
1989	5.73a	5.63a	4.67a	6.98a	3.71b
1990	2.55bc	3.69b	2.05c	3.33b	2.13cd
1991	2.15c	2.16c	1.74c	2.46c	1.57d
1992	2.39c	1.90c	1.48c	3.19b	0.65c
SE ±		0.82			0.31

[1/] Means followed by the same letter(s) within an interaction means are not significant statistically using DMRT0.05

Ex-Zaria Black in all the 3 pruning dates. When the individual variety was examined across the 3 pruning dates, the weight of September and October pruning were higher than November in the case of Bangalore blue. Such differences for Ex-Zaria Black however, were not significant. In the variety x training system interaction, Bangalore blue produced higher October pruned material than Ex-Zaria black under both systems of training. Also overhead training system recorded higher October pruned material than Kniffen system for Bangalore blue and such difference was insignificant for Ex-Zaria black. In the pruning date x year interaction, it was observed that within a year, there were no significant differences for the pruning dates, however, when the same pruning date was seen across the different years, the year 1989 produced a higher October pruned materials than the other 3 years. The variety x year interaction revealed that Bangalore blue produced higher pruned material than Ex-Zaria black in all the four years. Within the same variety, October pruned material decreased from 1989 - 91. The differences in the year mean were also highly significant. October pruned material significantly decreased from 1989 - 91, there was no significant decrease in 1992.

4.3.3. Number of canes per vine

Number of canes per vine as affected by pruning date, training system and variety of grape during 1989 - 92 and the combined data analysis is shown in Table 44. The differences in means due to pruning dates were highly significant in 1989, 1990 and in combined data analysis. The number of canes produced due to late September or mid-October pruning were statistically similarly. However, if the

Table 44: Number of Canes per Vine as Affected by Pruning Date, Training System and Variety of Grape During 1989 - 92 at Samaru.

Treatment	1989	1990	1991	1992	Combined
Pruning Date (D)					
September 26	43.6a[1/]	57.7a	37.4	36.4	43.8b
October 17	51.8a	73.8a	48.8	32.9	51.9a
November 7	33.1b	36.8b	43.6	25.3	34.7b
SE ±	3.92	5.81	4.55	3.88	2.31
Significance	**	**	NS	NS	**
Variety (V)					
Bangalore blue	41.4	46.7b	37.2b	22.6b	41.1b
Ex-Zaria black	44.3	65.5a	49.4a	40.5a	45.4a
SE ±	3.20	4.74	3.71	3.17	1.88
Significance	NS	*	*	**	*
Training System (S)					
Overhead trellis	39.2	57.6	37.3b	25.3b	39.8b
Kniffen	46.5	54.6	49.3a	37.8a	47.1a
SE ±	3.20	4.74	3.71	3.17	1.88
Significance	NS	NS	*	*	**
Significance of Interaction					
D x V	NS	NS	NS	NS	**
D x S	NS	NS	NS	NS	NS
V x S	NS	NS	*	NS	**
Y x D	-	-	-	-	**
Y x V	-	-	-	-	**
Y x V	-	-	-	-	NS
Y x S	-	-	-	-	NS
Year (V) Mean	42.8b	56.1a	43.3b	31.5c	**
SE ± 2.08					

1/ Means followed by the same letter within a treatment of a column and within the year means are not significant statistically using DMRT 0.05

*, ** and NS = Significant at 5, and 1 percent levels, and not significant, respectively.

pruning is delayed to early November, there was a significant decrease in the number of canes per vine. The differences in the varietal means were not significant in 1989, significant in 1990, 1991 and combined data analysis and highly significant in 1992. In all the significant cases, Ex-Zaria Black produced higher number of canes per vine than Bangalore Blue. The differences of means of training systems were not significant in 1989 and 1990, was significant in 1991 and 1992 and highly significant in the combined analysis of data. In all the significant cases, the Kniffen system of training resulted in higher number of canes per vine.

None of the first order of interactions except variety x training system (Table 45) was found to be significant. In the combined data analysis date x variety were found to be highly significant (Table 45, a-d). Bangalore blue produced more canes under Kniffen system of training, whereas, Ex-Zaria black produced the same number of canes under the two training systems. In the combined data analysis, pruning date x variety interaction revealed that the highest number of canes per vine was produced by October pruning of Ex-Zaria black. The same date of pruning also produced similar number of canes as September pruning which were significantly higher than November pruning in Bangalore blue. When each date of pruning was examined across the varieties, there was a significant difference in October pruning only in which Ex-Zaria black which produced higher number of canes than Bangalore blue. In an interaction between training system x variety (Table 45, b), Bangalore blue under overhead trellis system produced lower number of canes than all other variety x training system combinations which were statistically the same. Although, the interaction between

Table 45: Interaction between Variety x Training System during 1991 and Variety x Pruning Date, Variety x Training System, Year x Pruning Date and Year x Variety in combined data analysis for number of canes per grapevine

1991

Variety	Training System	
	Overhead	Kniffen
Bangalore blue	25.3b[1/]	49.0a
Ex-Zaria black	49.1a	49.7a
SE ±	5.15	

Combined - 1989-92

Variety	(a) Pruning Date			(b) Training System	
	29/9	17/10	7/11	Overhead Trellis	Kniffen
Bangalore blue	47.6b	43.0b	33.6c	34.1b	48.8a
Ex-Zaria black	39.9bc	60.7a	35.7c	45.5a	45.3a
SE ±		3.2b		2.6b	

Year	(c) Pruning Date			(d) Variety	
	29/9	17/10	7/11	Bangalore blue	Ex-Zaria black
1989	43.6c-e	51.8bc	33.1ef	41.4bc	44.3bc
1990	57.7b	73.8a	36.8d-f	41.7bc	65.5a
1991	37.4ef	48.8b-d	43.6c-e	37.2c	49.4b
1992	36.4ef	32.9ef	25.3f	40.5b	22.6d
SE ±		3.26		4.30	

[1/] *Means followed by the same letter(s) within an interaction means are not significant statistically* using DMRT0.05.

the pruning date x year was significant, yet no definite trend could be deduced by the data. In general it may be observed that the October pruning date produced a higher number of canes than both the September and November pruning dates in most of the years. Similarly no definite trend was observed in variety x year interaction. Ex-Zaria black produced a higher number of canes in 2 out of 4 years, in 1989 number of canes produced by the two varieties was similar and in 1992 Bangalore blue produced a higher number of canes than Ex-Zaria black. The number of canes produced was higher in 1990 when compared with 1989 and 1991 which were also significantly higher than 1992.

4.3.4. Weight of April pruned material

The results of weight of April pruned material (kg/vine) is shown in Table 46 and the significant interaction of combined analysis are given in Table 47. The differences in the April pruned material did not attain the level of significance, although there was a decreasing trend with a delay in pruning in the individual seasons from 1989 - 92. However, the combined analysis of variance indicated that each delay of 3 weeks in pruning significantly reduced the weight of April pruned material. April pruned material of the varietal means were significantly affected in all years and combined analyses except in 1990. In all cases Bangalore blue produced higher April pruned material than Ex-Zaria black. Training system means were not significantly different in individual years as well as in the combined analysis.

Table 46: April Pruned Material (kg/vine) as affected by Pruning Date, Training System and Variety of Grape during 1989 - 92 at Samar

Treatment	1989	1990	1991	1992	Combined
Pruning Date (D)					
September 26	5.07	4.11	2.74	5.09	4.25a[1/]
October 17	3.96	4.49	2.05	4.32	3.71b
November 7	3.95	2.97	1.42	3.63	3.00c
SE ±	0.59	0.64	0.46	0.59	0.21
Significance	NS	NS	NS	NS	*
Variety (V)					
Bangalore blue	5.47a	4.38	3.39a	5.52a	4.69a
Ex-Zaria black	3.18b	3.34	0.76b	3.18b	2.62b
SE ±	0.448	0.52	0.37	0.48	0.23
Significance	**	NS	**	**	**
Training System (S)					
Overhead trellis	4.74	4.03	1.88	4.79	3.86
Kniffen	3.91	3.68	2.27	3.91	3.44
SE ±	0.48	0.52	0.37	0.48	0.23
Significance	NS	NS	NS	NS	NS
Significance of Interaction					
D x V	NS	NS	NS	NS	**
D x S	NS	NS	NS	NS	*
V x S	NS	NS	NS	NS	NS
Y x D	-	-	-	-	NS
Y x V	-	-	-	-	NS
Y x S	-	-	-	-	NS
Year (Y)	4.32a	3.86a	2.07b	4.35a	**
SE + 0.21					

[1/] Means followed by the same letter within a treatment of a column and within the year means are not significant statisticall using DMRT0.05.

*, ** and NS = Significant at 5, and 1 percent levels, and not significant, respectively

Table 47: Interaction between (a) Pruning Date x Variety and (b) Pruning Date x Training System for April Pruned Material (kg/vine) for the April Pruned Material (kg/vine) for the Combined Data Analysis from 1989 - 92.

	(a) Variety		(b) Training System	
Pruning Date	Bangalore blue	Ex-Zaria black	Overhead trellis	Kniffen
29/9	6.05a[1/]	2.46c	3.81ab	4.70a
17/10	4.18b	3.24bc	4.21ab	3.20bc
7/11	3.84b	2.15c	3.57ab	2.42c
SE ±	0.40		0.40	

[1/] *Means followed by the same letter(s) within an interaction means are not significant statistically* using DMRT0.05.

None of the first order of interactions in the individual years were found to be significant. However, interaction between date x varieties and date x systems were found to be highly significant and significant, respectively (Table 47, a and b). Bangalore blue produced higher April pruned material when pruned in September when compared with October and November pruning dates. Such differences in Ex-Zaria black were insignificant. When the two varieties were examined at the same date of pruning, Bangalore blue April pruned material was higher than Ex-Zaria black in September and November. The interaction between training system x pruning date indicated that April pruned material was lower only in November pruning. Within a training system, September pruning in Kniffen System resulted in a higher April pruned material than the other two dates. The differences in the year means were also found to be highly significant. April pruned material in 1991 was found to be lower than the other years.

4.3.5 Number of bunches per vine

The data of number of bunches per vine for individual year and combined analysis is presented in Table 48, and the first order of interaction of individual year and combined analysis is depicted in Table 49. The results revealed that the differences in the mean of the pruning date were highly significant in all the years as well as in combined analyses. A delay of 3 weeks in pruning significantly decreased the number of bunches per vine in all the cases from September 26th to November 7th. The varietal differences were significant in 1989 and highly significant in 1992 and combined analysis. Bangalore blue produced higher number

Table 48: Number of Bunches per Vine as affected by Pruning Date, Training System and Variety of Grape During 1989 - 92 at Samaru.

Treatment	1989	1990	1991	1992	Combined
Pruning Date (D)					
September 26	111.8a[1/]	121.2a	22.9a	70.2a	81.5a
October 17	63.8b	61.4b	9.3b	37.3b	43.0b
November 7	41.4c	28.1c	8.7c	9.6c	21.9c
SE ±	7.07	10.72	2.00	9.45	4.48
Significance	**	**	**	**	**
Variety (V)					
Bangalore blue	86.7a	76.5	16.7	70.0a	62.5a
Ex-Zaria black	58.0b	63.9	10.6	8.1b	35.1b
SE ±	7.24	9.69	2.38	7.92	3.66
Significance	**	NS	NS	**	**
Training System (S)					
Overhead trellis	69.4	77.1	16.8	34.9	49.6
Kniffen	75.3	63.3	10.4	43.1	48.0
SE ±	7.24	9.69	2.38	7.92	3.66
Significance	NS	NS	NS	NS	NS
Significance of Interaction					
D x V	NS	NS	NS	**	*
D x S	NS	NS	NS	NS	NS
V x S	**	NS	NS	NS	**
Y x D	-	-	-	-	**
Y x V	-	-	-	-	**
Y x S	-	-	-	-	NS
Year (Y) Mean	72.3	70.2a	13.3b	39.0b	**
SE ± 8.09					

1/ Means followed by the same letter within a treatment of column and within the year means are not significant statistically using DMRT0.05.

*, ** and NS = Significant at 5 and 1 percent levels, respectively and not significant

Table 49: Interaction between Variety x Training System during 1989, Variety x Pruning Date during 1992 and Variety x Pruning Date, Variety x Training System, Year x Pruning Date Year x Variety in combined data analysis for number of bunches per vine in Grape.

	1989		1992		
	Training System		Pruning Date		
Variety	Overhead trellis	Kniffen	29/9	17/10	7/11
Bangalore blue	66.4b[1/]	106.9a	123.5a	70.7b	15.8c
Ex-Zaria black	72.3b	43.7b	16.8c	4.0c	3.3c
SE ±	10.25		13.71		

	Combined - 1989-92				
	(a) Pruning Date			(b) Training System	
Variety	29/9	17/10	7/11	Overhead trillis	Kniffen
Bangalore blue	101.3a	60.7b	25.4c	54.8b	70.2a
Ex-Zaria black	61.7b	25.3c	18.5c	44.4b	25.9c
SE ±	6.33			5.17	

	(c) Pruning Date			(d) Variety	
Year	29/9	17/10	7/11	Bangalore blue	Ex-Zaria black
1989	111.8a	63.8c	41.4cd	86.7a	58.0a
1990	121.2a	61.4c	28.1de	76.5a	63.9a
1991	22.9d	9.3e	8.7e	16.7b	10.6b
1992	70.2c	37.3de	9.6e	70.0a	9.1b
SE ±	6.33			9.6	

1/ Means followed by the same letter(s) within an interaction means are not significant statistically using DMRT0.05.

of bunches than Ex-Zaria black in all cases. Neither the differences of training systems due to years nor the combined analysis were significantly different.

The interaction between variety x system in 1989 and date x variety in 1992 were found to be highly significant (Table 49, a-d). In combined analysis interaction between date x variety was significant and variety x system, year x date and year x variety were highly significant (Table 49). In 1989, the variety Bangalore blue produced more than all other treatment combinations. The training system did not affect number of bunches in Ex-Zaria black. The interaction between variety x pruning date in 1992 revealed that each delay in pruning date significantly decreased the number of bunches. No such decrease was observed in Ex-Zaria black. Within each pruning date Bangalore blue produced a higher number of bunches than Ex-Zaria black except in November pruning. In the combined analysis also each delay in pruning significantly decreased the number of bunches as in 1992. Ex-Zaria black produced lower number of bunches when the pruning was delayed from 29th September to 17th October. A further delay in pruning to 7th November however did not reduce the number of bunches significantly. The interaction between variety x training system (Table 49, b) indicated a differential response of varieties to training system. The variety Bangalore blue produced higher number of bunches under Kniffen system whereas Ex-Zaria black produced higher number of bunches in overhead trellis system. Within the same training system Bangalore blue produced a higher number of bunches under both training systems. The pruning date x year interaction has shown that the number of bunches decreased when the pruning was delayed from

September to October in all the years (Table 49, c). A further delay in pruning date to early November decreased the number of bunches in 1990 only. The years did not affect the number of bunches except in 1992 (Table 49, d) when Bangalore blue produced a higher number of bunches than Ex-Zaria black. The differences in the year means were also highly significant. In 1989 the number of bunches was the same as in 1990 and these two were significantly higher than 1991 and 1992 years which were similar statistically in Ex-Zaria black. In the case of Bangalore blue however, the numbers of bunches in 1991 were significantly lower than other years.

4.3.6. Fruit yield (kg/vine)

The data on fruit yield per vine as affected by pruning date, training systems, and varieties is given in Table 50. Pruning date significantly affected the yield in all the four years of experimentation as well as in the combined analysis. In all the years except in 1991 and in the combined analysis, each delay in the pruning date significantly reduced the yield. In 1991, a delay in pruning date from September to October reduced the yield significantly. However, a further delay in pruning from October to November did not reduce the yield significantly. The difference in yield of varieties were highly significant in 1989 and 1992 and significant in combined analysis. In 1989, 1992 and combined analysis, Ex-Zaria black yielded significantly higher than Bangalore blue. The differences in the means of training systems were highly significant in 1991 and significant in combined analysis. In both cases, the overhead trellis system gave a higher yield than Kniffen.

Table 50: Fruit yield (kg/vine) as affected by Pruning Date, Training System and Varieties of Grape During 1989 - 92 at Samaru.

Treatment	1989	1990	1991	1992	Combined
Pruning Date (D)					
September 26	10.96a[1/]	9.97a	3.77a	2.36a	6.76a
October 17	6.08b	4.63b	1.66b	1.21b	3.39b
November 7	4.08c	2.43c	1.53b	0.35c	2.10c
SE ±	0.67	0.74	0.42	0.30	0.37
Significance	**	**	**	**	**
Variety (V)					
Bangalore blue	4.77b	4.94	2.24	0.44b	3.10b
Ex-Zaria black	9.31a	6.41	2.39	2.17a	5.07a
SE ±	0.86	0.74	0.35	0.26	0.30
Significance	**	NS	NS	**	*
Training System (S)					
Overhead trellis	7.61	6.49	3.11a	1.14	4.59a
Kniffen	6.47	4.86	1.53b	1.47	3.58b
SE ±	0.86	0.74	0.35	0.26	0.30
Significance	NS	NS	**	NS	*
Significance of Interaction					
D x V	NS	NS	NS	*	NS
D x S	NS	NS	NS	NS	*
V x S	*	*	*	NS	**
Y x D	-	-	-	-	**
Y x V	-	-	-	-	**
Y x S	-	-	-	-	NS
Year (Y) Mean	7.04a	5.68a	2.32b	1.31b	**
SE ± 0.61					

1/ Means followed by the same letter within a treatment of a column and within the year means are not significant statistically using DMRT0.05.

*, ** and NS = Significant at 5,and 1 percent levels and not significant, respectively.

Interaction between pruning date x varieties in 1992 and variety x systems in 1989, 1990 and 1991 were found to be significant at 5 percent level (Table 51). Similar interaction were found in 1989 and 1990. Ex-Zaria black under overhead trellis system yielded higher than all other variety x training combinations. In 1991, the variety of Ex-Zaria black produced higher yield under. Overhead trellis system when compared with the Kniffen system. Such difference was however not significant in the case of Bangalore blue. When the varieties are examined within this same training system, Bangalore blue yielded significantly higher than Ex-Zaria black under Kniffen system. In case of pruning date x variety interaction in 1992, the fruit yield significantly decreased with every delay of 3 weeks in pruning date in the case of Bangalore blue. No such decrease was observed in Ex-Zaria black. Except in November pruning the yield of Bangalore blue was higher than Ex-Zaria black within each date of pruning.

Interactions of combined data analysis are shown in Table 52. In the pruning date x training system interaction (Table 52, a) fruit yield decreased with every delay in pruning under overhead training system. In Kniffen training system the yield decrease from September to October pruning and there was no further decrease from October to November pruning. In the variety x training system interaction (Table 52, b) Ex-Zaria black under overhead trellis system produced higher yield than all other combinations. The interaction between pruning date x year (Table 52, c) revealed that from 1989 - 91 the yield decreased when the pruning was delayed from 26/9 to 17/10, a further delay in pruning to 7/11, however, did not significantly affect the yield. For the variety x year interaction

Table 51: Interaction between (a) Variety x Training System in 1989, (b) Variety x Training System in 1990, (c) Variety x Training System in 1991 and (d) Variety x Pruning Date in 1992 for Fruit Yield (kg/vine).

	(a) Training System 1989		(b) Training System 1990	
Variety	Overhead trellis	Kniffen	Overhead Trellis	Kniffen
Bangalore blue	3.67b[1/]	5.87b	4.57b	5.32b
Ex-Zaria black	11.54a	7.07b	8.42a	4.40b
SE ±	1.22		1.04	

	(c) Training System 1991		(d) Pruning Dates 1992		
Variety	Overhead trellis	Kniffen	29/9	17/10	7/11
Bangalore blue	2.43ab	2.06b	3.77a	2.22b	0.52c
Ex-Zaria black	3.78a	1.01c	0.95bc	0.20c	0.18c
SE ±	0.45		0.45		

[1/] Means followed by the same letter(s) within an interaction means are not significant statistically using DMRT0.05.

Table 52: Interaction between (a) Training System x Pruning Dates (b)Training System x Variety (c) years x Pruning Date and Year x Varieties for Fruit Yield (kg/vine) in Combined Data Analysis from 1989 - 92.

	(a) Pruning Date			(b) Variety	
Training System	29/9	17/10	7/11	Bangalore blue	Ex-Zaria black
Overhead trellis	8.06a[1/]	3.77c	1.93d	3.15b	6.02a
Kniffen	5.46b	3.02cd	2.26d	3.91b	3.26b
SE ±		0.52		0.43	

	(c) Pruning Date			(d) Varieties	
Year	29/9	17/10	7/11	Bangalore blue	Ex-Zaria black
1989	10.96a	6.07b	4.07bc	4.77b	9.31a
1990	9.97a	4.63bc	2.43cd	4.94b	6.41b
1991	3.77bc	1.66d	1.53d	2.24c	2.39c
1992	2.36cd	1.21d	0.35d	2.17c	0.44c
SE ±		0.86		0.74	

1/ Means followed by the same letter(s) within an interaction means are not significant statistically using DMRT0.05.

(Table 52, d) Ex-Zaria black yielded higher than Bangalore blue in 1989 only. Within a variety, yield of 1989 and 1990 were higher than the other two years in Bangalore blue. In the case of Ex-Zaria black, 1989 yields were higher than 1990 which was also higher than 1991 and 1992.

4.3.7. Bunch weight

The result of bunch weight as influenced by pruning date, training system and variety of grape for individual year and combined analysis is presented in Table 53. Bunch weight was significantly affected by pruning date in 1989 and 1992 and significant in 1991. The combined analysis result also revealed a highly significant effect of pruning date on bunch weight.

In all the individual years' and combined analysis results, Ex-Zaria black variety produced significantly larger bunch size. Training system had no effect on bunch size.

Although the interaction of pruning date x variety, pruning date x training system and variety x training system was not significant in the individual year, the combined analysis result of the data gave a significant interaction on variety x training system. In variety x training system interaction (Table 54 (a), the Kniffen system enhanced larger size of bunch in the two varieties but the increase was greater on the Ex-Zaria black. In the year x training system interaction, bunch size was not to be different in 1989, 1991 and 1992 (Table 54 (b) but bunch size was larger in the overhead trellis in 1990 than in Kniffen system. Within training system, the 1991 bunch size was greater in both systems with the bunch size

Table 53: Bunch Weight (g/bunch) as affected by Pruning Date, Training System and Variety of Grape During 1989 - 92 at Samaru.

Treatment	1989	1990	1991	1992	Combined
Puning Date (D)					
Sept. 26	121.8a[1/]	105.0	210.5a	53.8a	122.6a
Oct. 17	106.0b	97	155.7b	40.8b	99.9b
Nov. 7	87.8c	81	156.4b	38.8b	91.0b
SE ±	5.37	17.82	14.58	2.45	5.94
Significance	**	NS	*	**	**
Variety (V)					
Bangalore blue	50.0b	63.0b	119.3b	31.8b	66.0b
Ex-Zaria black	160.4a	126.0a	229.1a	57.1a	143.0a
SE ±	4.39	14.5	11.91	2.OO	4.85
Significance	**	**	**	**	**
Training System (S)					
Overhead trellis	109.9	111.O	162.8	42.4	106.4
Kniffen	100.4	78.O	185.6	46.4	102.6
SE ±	4.39	14.5O	11.91	2.OO	4.85
Significance	NS	NS	NS	NS	NS
Significance of Interaction					
D x V	NS	NS	NS	NS	NS
D x S	NS	NS	NS	NS	NS
V x S	NS	NS	NS	NS	*
Y x D	-	-	-	-	NS
Y x V	-	-	-	-	**
Y x S	-		-	-	*
Year (Y) Mean	105.2b	94.2b	174.2a	44.2c	**
SE ± 6.03					

[1/] Means followed by the same letter within a treatment of a column and within the year means are not significant statistically using DMRT0.05.

*, ** and NS = Significant at 5, and 1 percent levels and not significant, respectively.

Table 54: Interaction between (a) Variety x Training System, (b) Year x Training System and (c) Year x Variety for Bunch Weight (g/bunch) in the Combined Data Analysis from 1989 - 92.

Variety	(a) Training System	
	Overhead Trellis	Kniffen
Bangalore blue	59.4d[1/]	132.7b
Ex-Zaria black	72.5b	153.4a
SE ±	6.86	

	(b) Training System	
Year	Overhead Trellis	Kniffen
1989	109.9b	100.4bc
1990	110.6b	77.8c
1991	162.8a	185.6a
1992	42.4d	46.4d
SE ±	9.14	

Year	(c) Variety	
	Bangalore blue	Ex-Zaria black
1989	50.0de	160.4b
1990	62.8de	125.6c
1991	119.3c	229.1a
1992	31.8e	57.1de
SE ±	9.14	

[1/] *Means followed by the same letter(s) within an interaction means are not significant statistically* using DMRT0.05.

slightly larger in the Kniffen system. A closer observation of the interaction between year x variety revealed Ex-Zaria black bunch size greater in 1989, 1990 and 1991 than for Bangalore blue. The Bangalore blue variety bunch size was largest in 1991. Similarly bunch size was greatest in 1991 in Ex-Zaria black than other years of the study. The large bunch size of Ex-Zaria black produced in 1991 was closely followed by the sizes in 1990, the 1989 and 1992 were statistically the same in the interaction of year x variety analysis

4.3.8. Number of berries per bunch

In Table 55 is presented the number of berries per bunch as affected by pruning date, variety and training system from 1989 to 1992. The interaction between the above treatments on number of berries per bunch and the number of berries per bunch are given in Table 56.

The effect of pruning date on number of berries per bunch was highly significant in 1989, 1991 and 1992. In combined analysis, the effect of pruning date on number of berries per bunch was significant at 5%. In any of the year that pruning date caused the highly significant effect on number of berries per bunch, the October pruning date produced the maximum number of berries per bunch as was also the case in the combined analysed result. The effect of variety on number of berries per bunch was highly significant at 1% in 1990 and 1992 and also in the combined analysis. The effect of variety on number of berries per bunch was significant at 5% in 1989 with Ex-Zaria black having its maximum number of

Table 55: Number of Berries per Bunch as affected by Pruning Date, Training System and Variety of Grape During 1989 - 92 at Samaru.

Treatment	1989	1990	1991	1992	Combined
Pruning Date (D)					
Sept. 26	99.4b[1/]	37.5	20.3b	24.5b	45.4b
Oct. 17	106.5 a	43.5	25.7a	33.6a	52.3a
Nov. 7	99.7b	50.1	17.1b	30.9b	49.56
SE ±	2.19	5.88	1.41	0.9	4.19
Significance	**	NS	**	**	*
Variety (V)					
Bangalore blue	75.1b	32.9b	20.2	23.3b	37.9b
Ex-Zaria black	128.6a	54.5a	21.8	36.0a	60.2a
SE ±	6.41	4.8	1.15	1.1O	1.67
Significance	*	**	NS	**	**
Training System (S)					
Overhead trellis	110.O	41.6	20.7	30.3	50.7
Kniffen	93.4	45.8	21.3	29.1	47.4
SE ±	6.41	4.8	1.15	1.1O	1.67
Significance	NS	NS	NS	NS	NS
Significance of Interaction					
D x V	NS	NS	NS	NS	**
D x S	NS	NS	NS	NS	NS
V x S	NS	NS	NS	NS	NS
Y x D	-	-	-	-	**
Y x V	-	-	-	-	*
Y x S	-	-	-	-	NS
Year (Y) Mean	80.2a	43.7b	21.0d	29.7c	**
SE ± 1.92					

1/ Means followed by the same letter within a treatment of a column and within the year means are not significant statistically using DMRT0.05.

*, ** and NS = Significant at 5, and 1 percent levels and not significant, respectively .

Table 56: Interaction between (a) Pruning Date x Variety, (b) Year x Variety and (c) Year x Pruning date for Number of Berries per Bunch in Combined Data Analysis from 1989 - 92.

	(a)	Variety	
Pruning Date		Bangalore blue	Ex-Zaria black
26/9		40.3cd[1/]	42.4bc
17/10		33.5d	49.8ab
7/11		38.3cd	57.6a
SE ±		2.89	

	(b)	Variety	
Year		Bangalore blue	Ex-Zaria black
1989		72.9b	87.4a
1990		32.9d	54.5c
1991		20.2e	21.8e
1992		23.3e	36.0d
SE ±		3.04	

	(c)	Pruning Date	
Year	29/9	17/10	7/11
1989	83.0a	63.8b	93.7a
1990	37.5d-f	43.5cd	50.1c
1991	20.3g	25.7fg	17.1g
1992	24.5fg	33.6ef	30.9ef
SE ±		3.85	

[1/] *Means followed by the same letter(s) within an interaction means are not significant statistically* using DMRT0.05.

berries per bunch throughout the experimental period. Training system did not give significant increase on number of berries per bunch.

No interaction of any treatment was statistically significant in any individual year but in the combined analysis pruning date x variety resulted in highly significant effect on number of berries per bunch. Also in the combined analysis, interaction between year x variety a significant result was obtained on number of berries per bunch. The interaction between pruning date x variety (Table 56, a) showed that the October and November pruning dates resulted in greater influence on Ex-Zaria black than Bangalore blue. In the Ex-Zaria black variety, while the November pruning date gave the maximum number of berries per bunch, this was statistically different with the October pruning date and the October pruning also produced statistically same number of berries per bunch with the September pruning date. In the year x variety interaction (Table 56, b) on number of berries per bunch, Bangalore blue variety had statistically lower number of berries per bunch than Ex-Zaria black in 1989, 1990 and 1992. The result of the interaction between year x variety also showed a superior value of the number of berries per bunch in 1989 in both varieties. The year x pruning date interaction (Table 56, c) revealed that the superior value of number of berries per bunch observed in 1989 was significant in the September and November pruning dates. In 1990, it was the November pruning that gave higher number of berries per bunch than the September pruning date. In subsequent years, the interaction between year x pruning date did not result in superior number of berries per bunch as a result of staggering the pruning date.

4.3.9. Berry size

The volume of 100 (in ml) berries as affected by pruning date, training system and variety during 1989 - 92 and the combined data analysis is shown in Table 57. The differences in the pruning dates were not significant both in individual years and combined analysis. The differences in the mean of varieties were highly significant. Ex-Zaria black produced larger berries than Bangalore blue in all the years and combined analyses. The differences in the training system were highly significant in 1989, 1990 and combined analysis in which overhead trellis system produced larger berries than Kniffen system.

Interaction between date x variety in 1989, variety x training system in 1989 and 1991, variety x training system in 1989 and 1991 were found to be significant at 5 percent level (Table 58). Within a pruning date Ex-Zaria black produced larger berries than Bangalore blue. When the berry size was studied within a variety at different pruning date it was not affected in Ex-Zaria black, but in the case of Bangalore blue the berry size increased in the pruning date of 7/11 when compared with 17/10. In the variety x training system interaction, it was observed that Ex-Zaria black produced larger berries than Bangalore blue under both system of training. Also Ex-Zaria black produced larger berries under Overhead trellis system. There was no such difference in Bangalore blue.

Interaction in combined analysis is shown in Table 59. In the interaction between variety x pruning date Ex-Zaria black produced large sized berries than

Table 57: Berry Size (Volume of 100 berries in ml) as affected by Pruning Date, Training Systems and Variety of Grape During 1989 - 92 at Samaru.

Treatment	1989	1990	1991	1992	Combined
Pruning Date (D)					
September 26	298.3	207.6	192.1	226.2	231.0
October 17	299.1	236.7	205.7	235.8	244.3
November 7	319.3	236.7	203.5	234.0	248.4
SE ±	12.64	13.36	8.63	10.08	5.67
Significance	NS	NS	NS	NS	NS
Variety (V)					
Bangalore blue	225.3b[1/]	193.9b	181.6b	204.4b	201.3b
Ex-Zaria black	285.8a	260.0a	219.3a	259.5a	281.1a
SE ±	10.32	10.91	7.04	8.23	4.63
Significance	**	**	**	**	**
Training System (S)					
Overhead trellis	330.0a	253.9a	194.2	234.8	253.2a
Kniffen	281.1b	200.0b	206.7	229.1	229.2b
Se ±	10.32	10.91	7.04	8.23	4.63
Significance	**	**	NS	NS	**
Significance of Interaction					
D x V	*	NS	NS	NS	*
D x S	NS	NS	NS	NS	NS
V x S	*	NS	*	NS	NS
Y x D	-	-	-	-	NS
Y x V	-	-	-	-	**
Y x S	-	-	-	-	**
Year (Y) Mean	305.5a	227.0b	200.4b	232.0b	**
SE ±	11.08				

1/ Means followed by the same letter within a treatment of a column and within the year means are not significant statistically using DMRT0.05.

*, ** and NS = Significant at 5, and 1 percent levels and not significant, respectively.

Table 58: Interaction between (a) Variety x Pruning Date and (b) Variety x Training System in 1989, Variety x Training System in 1989, Variety x Training System in 1991 for Berry Size (Volume of 100 Berries in ml) of Grape.

	(a) Pruning Date			(b) Training System 1989	
Varieties	29/9	17/10	7/11	Overhead trellis	Kniffen
Bangalore blue	194.3c[1/]	214.8c	266.7b	232.9c	217.7e
Ex-Zaria black	402.2a	383.3a	371.8a	427.1a	334.4b
SE ±	17.86			14.59	

	(c) Training System 1991	
Variety	Overhead trellis	Kniffen
Bangalore blue	189.1c	174.0d
Ex-Zaria black	199.2b	239.3a
SE ±	9.96	

1/ Means followed by the same letter(s within an interaction means are not significant statistically using DMRT0.05.

Table 59: Interaction between (a) Pruning Date x Variety, (b) year x Variety and (c) year x Pruning System for Berry Size (Volume of 100 Berries in ml) of Grape in Combined Data Analysis During 1989 - 92.

Pruning Date	(a) Variety	
	Bangalore blue	Ex-Zaria black
26/9	183.6c[1/]	278.5a
17/10	198.2c	290.4a
7/11	222.2b	274.5a
SE ±	8.02	

Year	(b) Variety	
	Bangalore blue	Ex-Zaria black
1989	225.3bc	385.8a
1990	193.9cd	260.0b
1991	181.6d	219.3c
1992	204.4cd	259.5b
SE ±	12.87	

Year	(c) Pruning System	
	Overhead trellis	Kniffen
1989	330.0a	281.1b
1990	254.9c	200.0f
1991	194.2f	206.7f
1992	234.8d	229.1e
SE ±	6.55	

[1/] Means followed by the same letter(s) within an interaction means are not significant statistically using DMRT0.05.

Bangalore blue on all pruning dates. When the berry size of a variety was looked at different dates Bangalore blue produced larger berries at 7/11 pruning date when compared with the other two dates. The variety x year interaction revealed that there was a progressive decrease in the berry size of Ex-Zaria black from 1989 - 91. A similar trend was observed in Bangalore blue although the differences were not significant. In an interaction between pruning system x year, Kniffen system produced smaller berries in all years except in 1991.

4.3.10. Sugar content of fruit (%)

The effect of pruning date, training system and variety on sugar content of grape (fruit) is shown in Table 60. There was a significant effect on sugar content of fruit due to pruning date only in 1990. The September pruning date resulted in higher sugar content of fruit than the latter dates of pruning which were statistically similar. The sugar content of fruit due to variety was highly significant in 1989, 1991 and in the combined data analysis with Bangalore blue variety having the greater sugar content in its fruits. Neither individual year nor the combined data analysis indicated any statistically significant difference in sugar content due to training system. No significant interaction was found in the individual years except in the combined analysis where the year x pruning date and year x variety interactions were found to be highly significant. Sugar content (%) year mean was significant at 1% with the value higher in 1990 but significant similar values obtained in 1989 and 1992. The lowest sugar content of fruit was observed in 1991 but statistically similar with the figures obtained in 1989 and 1992.

Interaction between year x pruning date for sugar content (%) (Table 61, a) was superior in fruits pruned in September in 1990 but the sugar content (%) of fruits of the September 1990 pruning was statistically the same with September pruning in 1989, October and November pruning in 1992. Grapes pruned in October in 1991 produced lowest fruit sugar although this was statistically similar to sugar content (%) of fruit found in September 1991 and 1992 and November 1989, 1990 and 1991 pruned grapes.

In Table 61 (b) is presented the year x variety interaction and clearly showed the superior sugar content in Bangalore blue in 1989. Sugar content was relatively low in Ex-Zaria black and lowest in 1990 and 1991. The sugar content was however higher in 1990 than 1992.

4.3.11. Juice pH

Juice pH as influenced by pruning date, training system and variety of grape is presented in Table 62. The effect of pruning date was significant in 1991 and highly significant in 1990, 1992 and the combined data analysis. In 1990, it was the November pruning date that produced significant higher pH while the September and October pruning gave statistically similar fruit pH value. In 1992, the September and November pruning produced fruits which were more acidic than the October pruning date. There was a significant decrease in fruit juice pH with each delayed pruning in the combined analysis result.

The effect of variety on juice pH was highly significant in 1992 individual result and combined data analysis. The Ex-Zaria black variety had fruit juice pH

Table 61: Interaction between (a) Year and Pruning Date and (b) Year and Variety for Sugar Content (%), of Grape in combined Data Analysis from 1989 - 92.

(a)	Pruning Date		
Year	26/9	17/10	7/11
1989	12.31a-c[1/]	11.32b-d	10.80cd
1990	14.08a	12.21a-c	11.81b-d
1991	11.4b-d	10.27d	10.99cd
1992	9.79d	13.22ab	12.60a-c
SE ±		0.78	

(b)	Variety	
Year	Bangalore blue	Ex-Zaria black
1989	14.22a	8.74e
1990	13.29b	12.11c
1991	12.97b	8.80e
1992	12.91b	10.83d
SE ±	0.63	

[1/] *Means followed by the same letter(s) within an interaction means are not significant statisticall* using DMRT0.05.

Table 62: Juice pH as affected by Pruning Date, Training System and Variety of Grape During 1989 - 92 at Samaru.

Treatment	1989	1990	1991	1992	Combined
Pruning Date (D)					
Sept. 26	3.17	3.22b[1/]	3.34a	2.75b	3.12c
Oct. 17	3.23	3.28b	3.24b	3.02a	3.19b
Nov. 7	3.63	3.84a	3.49a	2.57b	3.38a
SE ±	0.15	0.14	0.06	0.05	0.05
Significance	NS	**	*	**	**
Variety (V)					
Bangalore blue	3.39	3.38	3.28	2.46b	3.13b
Ex-Zaria black	3.29	3.51	3.43	3.09a	3.33a
SE ±	0.12	0.11	0.05	0.04	0.04
Significance	NS	NS	NS	**	**
Training System (S)					
Overhead trellis	3.35	3.47	3.35	2.88a	3.26
Kniffen	3.33	3.43	3.37	2.68b	3.2
SE ±	0.12	0.11	0.05	0.04	0.04
Significance	NS	NS	NS	**	NS
Significance of Interaction					
D x V	NS	NS	*	**	**
D x S	NS	NS	NS	NS	NS
V x S	NS	NS	*	*	NS
Y x D	-	-	-	-	**
Y x V	-	-	-	-	**
Y x S	-	-	-	-	NS
Year (Y) Mean	3.34a	3.35a	3.36a	2.78b	**
SE ± 0.07					

1/ Means followed by the same letter with a treatment of a column and within the year means are not significant statistically using DMRT0.05.

*, ** and NS = Significant at 5, and 1 percent levels and not significant, respectively .

significantly higher than the Bangalore variety. There was also a highly significant effect on juice pH as a result of the training system in 1992. The Kniffen system produced fruits that were highly acidic.

Interaction between pruning date x variety and variety x training system were significant in 1991 (Table 63). A highly significant interaction also emerged between pruning date x variety in 1992 (Table 63) and combined data analysis (Table 64). The interaction between year x pruning date and year x variety was highly significant in the combined data analysis. The significant interaction shown in Table 63 (a) indicated that the Ex-Zaria black had lower acidity from November pruning date. The interaction between training system x variety showed that both variety produced fruits of similar acidity in the overhead trellis system. The juice pH of Bangalore blue was more acidic in the Kniffen system. The juice pH was significantly different with each pruning date in the interaction between pruning date x variety (Table 63,c) in the Bangalore blue variety but pruning date failed to produce any significant interaction between pruning date x variety of Ex-Zaria black. The acidity of the fruit was, however higher in Bangalore blue in each of the significant interaction between pruning date x variety except the October pruning date where the acidity was similar in the two varieties. Interaction between training system x variety in Table 63 (d) revealed no significant difference in Bangalore blue due to training system adopted but the Ex-Zaria black produced significantly higher juice pH in each of the two system and was less acidic than the Bangalore blue. The combined data analysis which produced significant interaction between pruning date x year is shown in Table 64(b). In 1989, juice pH was lower

Table 63: Interaction between (a) Variety x Pruning Date, (b) Variety x Training System in 1991, (c) Variety x Pruning Date and (d) Variety x Training System for Grape Juice pH.

(a)	Pruning Date 1991			(b)	Training System 1991	
Variety	26/9	17/10	7/11		Overhead trellis	Kniffen
Bangalore blue	3.33b[1/]	3.25b	3.28b		3.37a	3.20b
Ex-Zaria black	3.35b	3.23b	3.72a		3.33a	3.53a
SE ±		0.09			0.07	

(c)	Pruning Date 1992			(d)	Training System 1992	
Variety	26/9	17/10	7/11		Overhead trellis	Kniffen
Bangalore blue	2.43b[1/]	2.98a	1.97c		2.50c	2.42c
Ex-Zaria black	3.07a	3.05a	3.17a		3.26a	2.93b
SE ±		0.07			0.06	

1/ Means followed by the same letter(s) within an interaction means are not significant statistically using DMRT0.05.

Table 64: Interaction between (a) Variety x Pruning Date, (b) Year x Pruning Date and (c) Variety x Year for Juice pH in Grape in Combined Data Analysis from 1989 - 92.

(a)	Pruning Date		
Variety	26/9	17/10	7/11
Bangalore blue	3.10b	3.22b	3.07b
Ex-Zaria black	3.13b	3.17b	3.70a
SE ±		0.08	

(b)	Pruning Date		
Year	26/9	17/10	7/11
1989	3.17d	3.23cd	3.63ab
1990	3.22cd	3.28cd	3.84a
1991	3.34b	3.24cd	3.49bc
1992	2.75e	3.02d	2.57e
SE ±		0.11	

(c)	Year			
Variety	1989	1990	1991	1992
Bangalore blue	3.39a	3.38a	3.28ab	2.46c
Ex-Zaria black	3.29ab	3.51a	3.43a	3.09b
SE ±			0.09	

[1/] *Means followed by the same letter(s) within an interaction means are not significant statistically* using DMRT0.05.

in September and October than November pruning. The 1990 result was similar to that of 1989. Juice pH was higher in September and November pruning in 1991 but the November pruning was similar to the October pruning date. The October pruning in 1992 gave less acidic fruit than the early and latter pruning. The juice pH in the year means revealed lower acidity in 1989, 1990 and 1991 compared to 1992.

The year x variety interaction shown in Table 64(c) gave more acidity to fruits of Bangalore blue pruned in 1992 but in the same year, fruit of Ex-Zaria black was significantly less acidic than the Bangalore blue. The result of these interactions showed that fruits of both variety were more acidic in 1992 thereby confirming the influence of year on fruit juice pH of grape.

4.4 Correlation Studies and Path Coefficients

4.4.1 Varietal performance

In table 65 is given the simple correlation of coefficients between characters in the varietal experiment. Among the vegetative characters studied, a positive and highly significant correlation was obtained between stem diameter with shoot length and weight of October pruned material, shoot length with October pruned material, number of canes per vine and weight of April pruned material, weight of October pruned material with number of canes per vine and weight of April pruned material. A significant correlation was however revealed between stem diameter with number of canes per vine. A highly significant correlation also existed between some vegetative and reproductive characters, namely stem

Table 65: Simple Correlation of Coefficients between different characters in Varietal Experiment

	1	2	3	4	5	6	7	8	9	10	11	12
1	1											
2	.202**	1										
3	.433**	.642**	1									
4	.417*	.266**	.167**	1								
5	.117	.237**	.440**	-0.02	1							
6	.179**	.352**	.217**	.237**	0.08	1						
7	.147*	.201**	0.08	.244**	0.02	.791**	1					
8	.169**	.183**	-0.05	.394**	-.167*	0.11	.392**	1				
9	.140*	.475**	.188**	.336**	-0.08	.204**	.277**	.562**	1			
10	.227**	0.01	0.01	.212**	0.04	0.02	0.12	.328**	0.09	1		
11	-.047	-.214**	-.218**	0.08	-.152*	-.161*	-.197**	-.156*	-0.08	-.176**	1	
12	-.012	-0.01	-0.06	0.06	-.150*	0.07	-0.02	-0.14	-0.04	-.175**	.229**	1

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(1) Stem diameter (2) Shoot length (3) Weight of Oct. Pruned material
(4) Number of canes/vine (5) Weight of April pruned material (6) Number of bunches/vine
(7) Yield per vine (8) Bunch weight (9) Berries/bunch (10) Berry size (11) Sugar percent **(12) Juice pH.**

diameter with number of bunches per vine, bunch weight, and berry size, shoot length with all the reproductive character, weight of October pruned material with number of bunches per vine and berries per bunch and number of canes per vine with all the reproductive characters studied. The association among the reproductive characters however revealed a highly significant correlation between number of bunches per vine with yield and number of berries per bunch, yield with bunch weight and number of berries per bunch and bunch weight with number of berries per bunch. The correlation coefficient between sugar content with all the characters was negative and highly significant with shoot length, weight of October pruned material, yield per vine and berry size and significant with weight of April pruned material, number of bunches per vine and bunch weight, sugar content with juice pH was positively and highly correlated, but negative and highly significant correlation was observed between juice pH with berry size and significant only with weight of April pruned material.

The direct and indirect effect of vegetative and reproductive characters on fruit yield of grapes in varietal experiment are presented in Tables 66 & 67, respectively. The path coefficient between yield and vegetative characters in the varietal experiment (Figures 1 & 2) revealed that number of canes/vine directly contributed 17.1% to the yield . Indirectly canes/vine contributed via shoot length 5.9%. The contribution of canes/vine via October pruned material is small and negative (-2.1%). Indirect effect via stem diameter was found to be 3.6%. Thus the total effect was found to be 24.4%. When the contribution of shoot length was examined for yield, the direct effect was found to be 22%. Indirect effect via

Table 66: Direct and Indirect effect of Vegetative Parameters on Fruit Yield of Grapes in Varietal Experiment

(a)	Number of Canes/Vine (X_1) and fruit yield (X_5)	
	Direct effect (P_{15})	.171
	Indirect effect via Shoot length ($r_{12} P_{25}$)	.059
	Indirect effect via October pruned material ($r_{13} P_{35}$)	-.021
	Indirect effect via stem diameter ($r_{14} P_{45}$)	.036
	Total effect (Direct + Indirect effect)	.244
(b)	Shoot length (X_2) and fruit yield (x_5)	
	Direct effect (P_{25})	.220
	Indirect effect via canes/vine ($r_{12} P_{15}$)	.045
	Indirect effect via October pruned material ($r_{23} P_{35}$)	-.082
	Indirect effect via stem diameter ($r_{24} P_{45}$)	.017
	Total effect (Direct + Indirect effect)	.200
(c)	October pruned material (x_3) and fruit yield (x_5)	
	Direct effect (P_{35})	-.127
	Indirect effect via shoot length ($r_{23} P_{25}$)	.141
	Indirect effect via stem diameter ($r_{34} P_{45}$)	.037
	Indirect effect via canes/vine ($r_{13} P_{15}$)	.029
	Total effect (Direct + Indirect effect)	.080
(d)	Stem diameter (X_4) and Yield (X_5)	
	Direct effect (P_{45})	.086
	Indirect effect via shoot length ($r_{24} P_{25}$)	.044
	Indirect effect via October pruned material ($r_{34} P_{35}$)	-.055
	Indirect effect via canes/vine ($r_{14} P_{15}$)	.071
	Total effect (Direct + Indirect effect)	.146

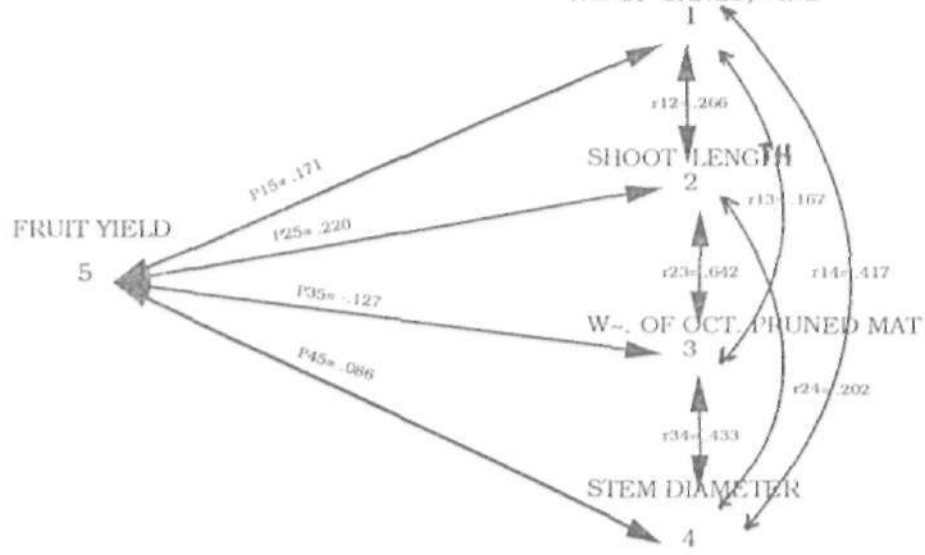


Fig.1 Path diagram and coefficient of Vegetative Characters affecting fruit yield in grapes

Table 67: Direct and Indirect effect of Reproductive Parameters on Fruit Yield of Grapes in Varietal Experiment

(a)	Number of bunches/Vine (X_1) and fruit yield (X_5)	
	Direct effect (P_{15})	0 .768
	Indirect effect via Bunch weight ($r_{12} P_{25}$)	0 .036
	Indirect effect via Berries/bunch ($r_{13} P_{35}$)	- 0.015
	Indirect effect via Berry size ($r_{14} P_{45}$)	+0.001
	Total effect (Direct + Indirect effect)	0.790
(b)	Bunch Weight (X_2) and Fruit Yield (X_5)	
	Direct effect (P_{25})	0 .332
	Indirect effect via Bunches/vine ($r_{12} P_{15}$)	0.084
	Indirect effect via Berries/bunch ($r_{23} P_{35}$)	-0.040
	Indirect effect via Berry size ($r_{24} P_{45}$)	+0.016
	Total effect (Direct + Indirect effect)	0.392
(c)	Berries/bunch (X_3) and Fruit Yield (X_5)	
	Direct effect (P_{35})	-0.071
	Indirect effect via Bunches/vine ($r_{13} P_{15}$)	0.157
	Indirect effect via Bunch weight ($r_{23} P_{25}$)	0.187
	Indirect effect via Berry size ($r_{34} P_{45}$)	0.004
	Total effect (Direct + Indirect effect)	.277
(d)	Berry size (X_4) and Fruit yield (X_5)	
	Direct effect (P_{45})	0.048
	Indirect effect via Bunches/Vine ($r_{14} P_{15}$)	0.015
	Indirect effect via Bunch weight ($r_{24} P_{25}$)	0.109
	Indirect effect via Berries/bunch ($r_{34} P_{35}$)	-0.006
	Total effect (Direct + Indirect effect)	0.166

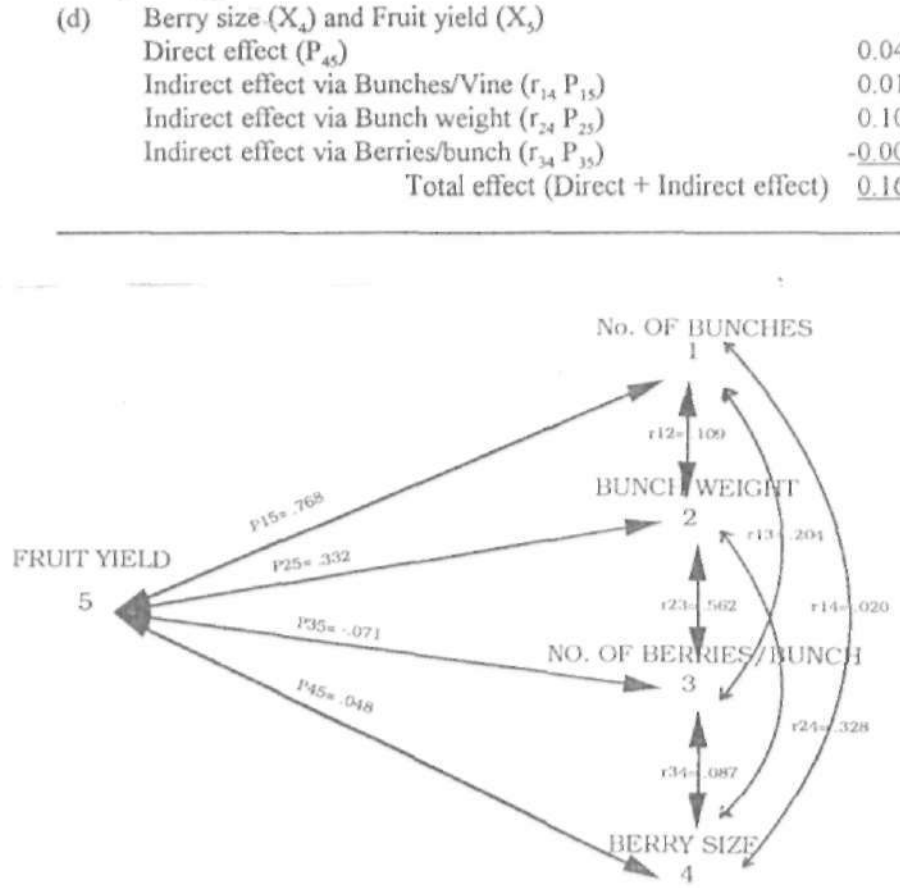


Fig.2 Path diagram and coefficient of reproductive characters affecting fruit yield

canes/vine and stem diameter was found to be 4.5% and 1.7%, respectively. The contribution of short length via October pruned material was negative and -8.2%. Thus the total effect of shoot length (direct and indirect) was found to be 20%.

When the October pruned material was investigated for its contribution to the yield, a direct effect was found to be negative and to the tune of -12.7%. Indirectly October pruned material contributed via shoot length, stem diameter and canes/vine to the tune of 14.1%, 3.7% and 2.9%. thus, the total direct and indirect effect of October pruned material towards yield was found to be 8%. When the contribution of stem diameter and yield was examined, it contributed directly 8.6% to the yield. Its indirect effect via shoot length and canes/vine was found to be 4.4% and 7.1%, respectively. The contribution of stem diameter via October pruned material was negative and 5.5%, thus, the total effect of the stem diameter on yield was found to be 14.6%.

The Path coefficient between yield and reproductive characters in the varietal experiment has revealed a 76.8% direct contribution by number of bunches/vine on yield. A 3.6% and 1% indirect contribution was observed by number of bunches vine via bunch weight and berry size, respectively. A negative contribution of -1.5% by number of bunches/vine via number of berries/bunch on yield was observed. Thus the total contribution of number of bunches/vine (including both direct and indirect effect) on yield was found to be 79.

The contribution of bunch weight on fruit yield was found to be 33.2% directly and indirectly via bunches/vine and berry size was found to be 8.4% and

1.6%, respectively. The contribution of bunch weight via berries/bunch was negative and -4%. Thus the total contribution of bunch weight both directly and indirectly was 39.2%.

The direct and indirect contribution of berries/bunch on yield revealed that its direct effect was negative and -7.1%. Berries/bunch indirectly via bunches/vine, bunch weight and berry size, contributed 15.7%, 18.7% and 0.4%, respectively. thus the total contribution of berries/bunch was found to be 27.7%. The contribution of berry size on yield was only 4.8% directly and indirectly via bunches/vine and bunch weight was 1.5% and 10.9%, respectively. The indirect effect of berry size via berries/bunch was negative and only -0.6%.

4.4.2 Response to FYM and Fertilizer

The simple correlation coefficients among the vegetative and reproductive characters studied in grape response to FYM and fertilizer application are presented in Table 68. A positive and highly significant correlation was revealed between stem diameter with shoot length and shoot length with October pruned material only. The correlation relationship was significant between stem diameter with April pruned material and October pruned material with April pruned material. The relationship among the vegetative and reproductive characters is positive and highly significant between stem diameter with number of bunches per vine, and fruit yield and canes per vine with bunches per vine and fruit yield. Among the reproductive characters themselves, the relation was negative and highly significant between bunch weight with number of bunches per vine, and

Table 68: Simple correlation of coefficient between different characters in Fertilizer experiment

	1	2	3	4	5	6	7	8	9	10	11	12
1	1											
2	.636**	1										
3	.063	.200**	1									
4	.482*	0.12	-0.04	1								
5	-.124	-0.12	.158*	-0.06	1							
6	.594**	.441**	-0O3	.555**	0.O8	1						
7	.669**	.499**	.O78	.564**	-.1O7	.834**	1					
8	.093	.154*	.145*	.O14	-.363**	-.189**	.218**	1				
9	.026	-.O96	.O13	.1O5	0.12	.175**	0.11	-.310**	1			
10	.091	.O90	-.O21	.208**	.O50	.223**	.234**	.O53	.O69	1		
11	.147*	.O67	-.O70	.232**	.203**	.440**	.237**	-.372**	.295**	.221**	1	
12	.049	-.O32	.O80	-.O60	-.O67	.O48	.183**	.162*	.743**	.O77	.O98	1

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(1) Stem diameter (2) Shoot length (3) October pruned materials (4) Number of canes/vine
(5) April pruned materials (6) Bunches per vine (7) Fruit yield (8) Bunch weight (9) Berries per bunch
(10) Berry size (11) sugar percent (12) Juice pH.

positive and highly significant between the bunch weight with fruit yield. Sugar content was positive and highly significantly correlated with number of bunches per vine, April pruned material, bunches per vine, fruit yield, berries per bunch and berry size. The relationship between sugar content with bunch weight was negative and highly significant.

The direct and indirect effects of vegetative and reproductive characters on fruit yield of grapes in the fertilizer experiment are shown in Tables 69 & 70, respectively. The path diagram and coefficients of vegetative and reproductive characters affecting fruit yield in grape is presented in Figures 3 & 4 .

Direct and indirect contribution of vegetative parameters in the fertilizer experiment revealed that number of canes/vine directly contributed to yield 37.4%. Indirectly it contributed via shoot length and stem diameter 2.8% and 16.3%, respectively. Number of canes/vine via October pruned material was very small and negative (-.1%). The contribution of shoot length and fruit yield was found to be 23.4% directly. Indirectly, via canes/vine, October pruned material and stem diameter, it was 4.5%, 0.5% and 21.6%, respectively. Thus, shoot length contributed both directly and indirectly 50% to the yield. October pruned material contributed to fruit yield directly 2.5% only. Its effect via canes/vine was negative and -1.5%. October pruned material indirectly contributed via shoot length and stem diameter 4.7% and 2.1%, respectively. Thus its total contribution to yield was found to be 7.8%. The direct contribution of stem diameter on fruit yield was found to be 33.9%. Its indirect effect via canes/vine, via shoot length, via October

Table 69: Direct and Indirect Effect of Vegetative Characters on Fruit Yield of Grapes in Fertilizer Experiment

(a) Number of Canes/Vine (X_1) and Fruit yield (X_5)	
Direct effect (P_{15})	0.374
Indirect effect via shoot length ($r_{12} P_{25}$)	0.028
Indirect effect via October pruned material ($r_{13} P_{35}$)	-0.001
Indirect effect via stem diameter ($r_{14} P_{45}$)	0.163
Total effect (Direct + Indirect)	.564
(b) Shoot length (X_2) and Fruit yield (X_5)	
Direct effect (P_{25})	0.234
Indirect effect via canes/vine ($r_{12} P_{15}$)	0.045
Indirect effect via October pruned material ($r_{23} P_{35}$)	0.005
Indirect effect via stem diameter ($r_{24} P_{45}$)	0.216
Total effect (Direct + Indirect)	0.500
(c) October pruned material (X_3) and Fruit Yield (X_5)	
Direct effect (P_{35})	0.025
Indirect effect via canes/vine ($r_{13} P_{15}$)	-0.015
Indirect effect via shoot length ($r_{23} P_{25}$)	0.047
Indirect effect via stem diameter ($r_{34} P_{45}$)	0.021
Total effect (Direct + Indirect)	0.078
(d) Stem diamter (X_4) and Fruit Yield (X_5)	
Direct effect (P_{45})	0.339
Indirect effect via canes/vine ($r_{14} P_{15}$)	0.180
Indirect effect via shoot length ($r_{24} P_{25}$)	0.149
Indirect effect via October pruned material ($r_{34} P_{35}$)	0.002
Total effect (Direct + Indirect)	0.67

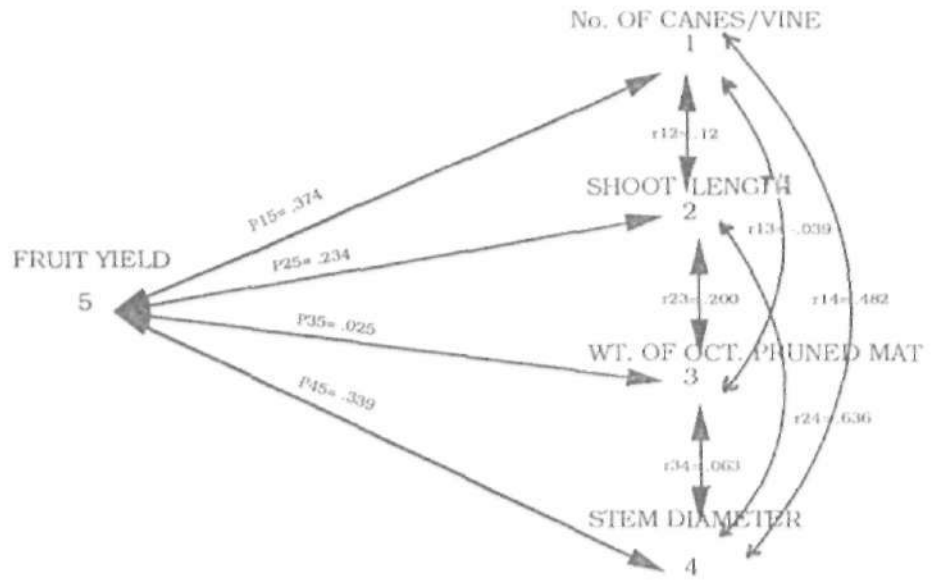


Fig.3 Path diagram and coefficient of vegetative characters affecting fruit yield in grapes

Table 70: Direct and Indirect Effect of Reproductive Parameters on Fruit Yield of Grapes in Fertilizer Experiment

(a) Number of Bunches/vine (X_1) and Fruit yield (X_5)	
Direct effect (P_{15})	0.896
Indirect effect via Bunch weight ($r_{12} P_{25}$)	-0.078
Indirect effect via Berries/bunch ($r_{13} P_{35}$)	-0.014
Indirect effect via Berry size ($r_{14} P_{45}$)	0.002
Total effect (Direct + Indirect)	0.834
(b) Bunch weight (X_2) and Fruit yield (X_5)	
Direct effect (P_{25})	0.412
Indirect effect via bunches/vine ($r_{12} P_{15}$)	-0.169
Indirect effect via berries/bunch ($r_{23} P_{35}$)	-0.025
Indirect effect via berry size ($r_{24} P_{45}$)	0.004
Total effect (Direct + Indirect)	0.218
(c) Berries/bunch (X_3) and Fruit Yield (X_5)	
Direct effect (P_{35})	0.080
Indirect effect via bunches/vine ($r_{13} P_{15}$)	-0.157
Indirect effect via bunch weight ($r_{23} P_{25}$)	-0.128
Indirect effect via berry size ($r_{34} P_{45}$)	0.001
Total effect (Direct + Indirect)	0.110
(d) Berry size (X_4) and Fruit Yield (X_5)	
Direct effect (P_{45})	0.007
Indirect effect via bunches/vine ($r_{14} P_{15}$)	0.200
Indirect effect via bunch weight ($r_{24} P_{25}$)	0.022
Indirect effect via berries/bunch ($r_{34} P_{35}$)	0.006
Total effect (Direct + Indirect)	0.235

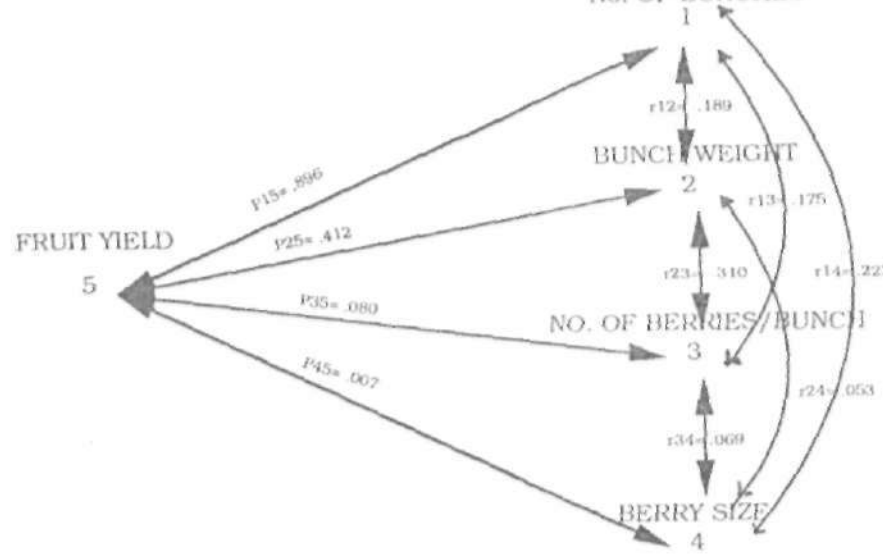


Fig.4 Path diagram and coefficient of reproductive characters affecting fruit yield in grapes.

pruned material was found to be 18%, 14.9%, 0.2% respectively. Thus the total contribution of stem diameter was found to be 67%.

The direct and indirect effect of reproduction parameters on fruit yield in fertilizer experiments indicated that the number of bunches/vine contributed directly 89.6% to the yield. Its indirect effect via bunch weight was negative and -7.8%. The number of bunches/vine indirectly via berries/bunch and berry size contributed 1.4 and 0.2%, respectively. Thus the total contribution of number of bunches/vine on yield was found to be 83.4%. Bunch weight directly contributed to the yield 41.2%. Its indirect effect via bunches/vine and berries/bunch was negative and to the tune of -16.9% and 2.5%, respectively. Bunch weight via berry size contributed 0.04% only, thus the total contribution was found to be 21.8%. The direct effect of berries/vine on fruit yield was observed to be 8.0%. Its indirect effect via bunches/vine and berry size were 15.7% and 0.1%, respectively. The indirect effect of berries/bunch via bunch weight was found to be negative and -12.8%. Thus the total effect was 11.0%. The berry size contributed directly to yield 0.7% while indirectly it contributed via bunches/vine, bunch weight and berries/bunch 20%, 2.2% and 0.6%, respectively. Thus the total contribution of berry size was found to be 23.5%

4.4.3 Response to pruning dates

Among the vegetative parameters positive and highly significant correlation coefficients were found between yield and fruiting canes per vine, shoot length, October pruned material and total canes per vine (Table 71) of which path

Table 71: Correction of Co-Efficients among Vegetative and Reproductive Parameters in Grape Fruit from 1989-1992 in Pruning Date and Variety Experiment

	1	2	3	4	5	6	7	8	9	10	11
1	1										
2	.362**	1									
3	.295**	.362**	1								
4	.432**	.432**	.280**	1							
5	.464**	.455**	.280**	.424**	1						
6	.287**	.274**	.252**	0.11	.770**	1					
7	.180**	.177*	.167*	-.356**	-.O82	.307**	1				
8	-.086	.332**	.O40	0.12	.204*	.318**	.O41	1			
9	-.110	.O36	.O10	-.099	-.O15	.300**	.215**	.535**	1		
10	.255**	.181*	-.OO9	.230**	.293**	.O44	-.405**	-0.13	-.321**	1	
11	-.O66	.O65	.O48	-.169*	-.077*	0.01	.274**	.315**	.O71	-.O71	1

** and ** = Significant at 5 and 1 percent levels, respectively. DF = 142*

(1) Shoot (2) Oct. pruned material (3) Canes/vine (4) April pruned material (5) Bunch/vine (6) Fruit yield
(7) Bunch weight (8) Berries/bunch (9) Berry size (10) Sugar content (11) Juice pH

coefficients were determined to study the direct and indirect contribution of each of these parameters (Tables 72 and 73). The fruit yield was not found to be significantly correlated with April pruned material. When the coefficients of correlation were examined between yield and reproductive parameters, it was also found to be highly significant with number of bunches per vine, bunch weight, number of berries per bunch and berry size. The correlation coefficient between the yield with sugar content (.044) and Juice pH (0.01) was very insignificant. A positive and highly significant correlation was found within the vegetative parameters themselves in all possible combinations. When the correlation of coefficients within the reproductive parameters was examined, it was observed that the number of bunches per vine was negatively correlated with bunch weight and berry size and it was significantly correlated with number of berries per bunch. There was no significant association between bunch weight and number of berries per bunch (.041). The associations between berry size with bunch weight and number of berries per bunch were positive and highly significant.

The direct and indirect effects of vegetative parameters with fruit yield (Table 72 and Figure 5) revealed that about 77 percent of the fruit yield was contributed by the number of fruiting canes per vine. Indirectly it contributed about 2.9 percent to fruit yield via total number of canes per vine. The indirect contribution of fruiting canes via shoot length and October pruned material was negative and 1.4 and 8.1 percent, respectively. The direct effect of shoot length with fruit yield was negative (-3.1%). Shoot length indirectly contributed 33.6 percent via number of fruiting canes/vine and 3.8 percent total number of canes per

Table 72: Direct and Indirect Effects of Vegetative Characters on fruit yield - (in agrapevine in Pruning Date x Training system and Variety—Experiment)

1.	Number of Fruiting Canes/Vine and fruit yield (x_1)	
	(a) Direct effect (P_{15})	.768
	(b) Indirect effect via shoot length ($P_{25}.r_{12}$)	-.014
	(c) Indirect effect via Oct. Pruned material ($P_{35}.r_{13}$)	-.081
	(d) Indirect effect via canes/vine ($P_{45}.r_{14}$)	.029
	Total effect (Direct + Indirect) =	0.702
2.	Shoot Length (x_2) and fruit yield (x_5)	
	(a) Direct effect (P_{25})	-.031
	(b) Indirect effect via fruiting cane vine ($p_{15}.r_{12}$)	.336
	(c) Indirect effect via Dict. pruned material ($P_{35}.r_{23}$)	-.056
	(d) Indirect effect via total canes/vine ($P_{45}.r_{24}$)	-.038
	Total effect (Direct + Indirect) =	0.287
3.	Weight of Oct. pruned material (x_3) and Fruit Yield (x_5)	
	(a) Direct effect (P_{35})	-.154
	(b) Indirect effect via Frt. canes/vine ($P_{15}.r_{13}$)	.404
	(c) Indirect effect via shoot length ($P_{25}.r_{23}$)	-.011
	(d) Indirect effect via total canes/vine ($P_{45}.r_{34}$)	.035
	Total effect (Direct + Indirect) =	.274
4.	Total canes/vine (x_4) and fruit yield (x_5)	
	(a) Direct effect (P_{45})	.129
	(b) Indirect effect via fruit canes/vine ($P_{15}.r_{14}$)	-.174
	(c) Indirect effect via shoot length ($P_{35}.r_{34}$)	-.009
	(d) Indirect effect via weight of Oct. pruned material ($P_{35}.r_{34}$)	-.042
	Total effect (Direct + Indirect) =	.252

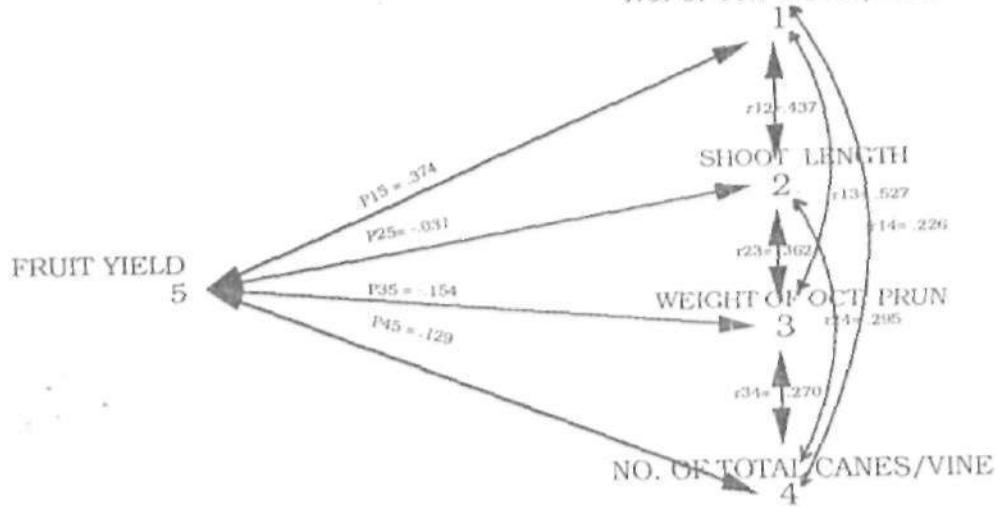


Fig. 5 Path diagram and coefficient of vegetative characters affecting fruit yield in grapevine

Table 73: Direct and Indirect Effects of Reproductive Characters on Yield (n Grapevine in Pruning Date, Training System and Variety Experiment)

1.	Bunches/Vine (x_1) and Fruit Yield (x_5)		
	(a) Direct effect (P_{15})		.799
	(b) Indirect effect via berries/bunch ($P_{25}.r_{12}$)		.001
	(c) Indirect effect via berry size ($P_{35}.r_{13}$)		-.004
	(d) Indirect effect via bunch weight ($P_{45}.r_{14}$)		-.026
	Total (Direct + Indirect)	=	.770
2.	Berries/Bunch (x_2) and Fruit Yield (x_5)		
	(a) Direct effect (P_{25})		.006
	(b) Indirect effect via bunches/vine ($P_{15}.r_{12}$)		.163
	(c) Indirect effect via Berry size ($P_{35}.r_{23}$)		.133
	(d) Indirect effect via bunch weight ($P_{45}.r_{24}$)		.013
	Total (Direct + Indirect)	=	.315
3.	Berry Size (x_3) and Fruit Yield (x_5)		
	(a) Direct effect (P_{35})		.248
	(b) Indirect effect via bunches/vine ($P_{15}.r_{13}$)		-.012
	(c) Indirect effect via berries/bunch ($P_{25}.r_{23}$)		.003
	(d) Indirect effect via bunch weight ($P_{45}.r_{34}$)		.069
	Total (Direct + Indirect)	=	.308
4.	Bunch Weight (x_4) Fruit Yield (x_5)		
	(a) Direct effect (P_{45})		.319
	(b) Indirect effect via bunches/vine ($P_{15}.r_{14}$)		-.066
	(c) Indirect effect via berries/bunch ($P_{25}.r_{24}$)		.022
	(d) Indirect effect via berry size ($P_{35}.r_{34}$)		.053
	Total (Direct + Indirect)	=	.306

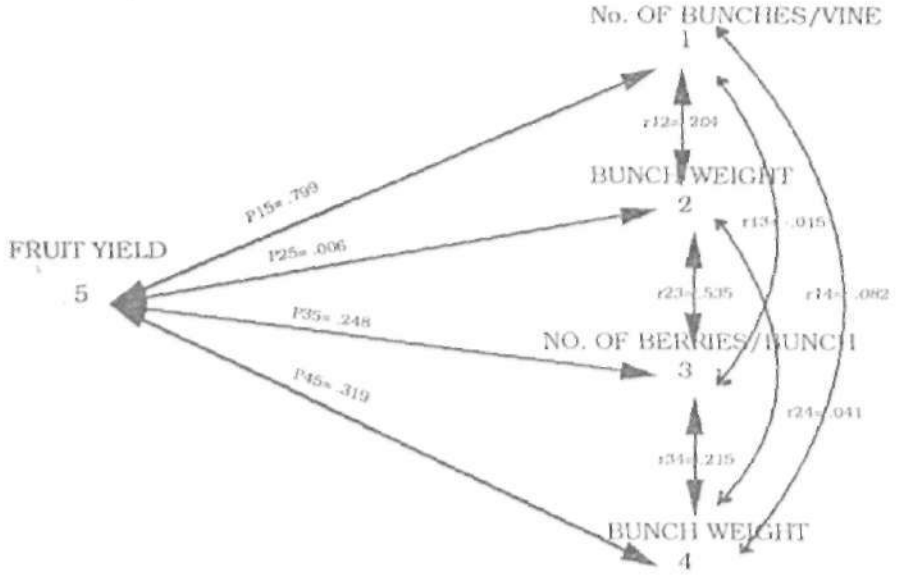


Fig. 6 Path diagram and coefficient of reproductive characters affecting fruit yield

vine. The indirect contribution of shoot length via October pruned material was negative and 5.6 percent on yield. The direct effect of October pruned material on fruit yield was -15.4 percent. Indirectly it contributed 4.04 and 3.5 percent via fruiting and total canes per vine, respectively. The indirect effect of October pruned material via shoot length was negative and very small (-1.1%). The direct effect of total canes per vine on fruit yield was 12.9 percent and indirect effect via fruiting canes per vine was 17.4 percent. The indirect effect of total canes per vine via October pruned material and shoot length were negative and -4.2 and -.09 percent.

The direct and indirect contribution of reproductive characters on yield is shown in Table 73 and Figure 6. The bunches per vine contributed to fruit yield 79.9 percent and indirectly it contributed via berries per bunch 0.1 percent. The contribution of bunches per vine via berry size and bunch weight was negative to the tune of 0.4 and 2.6 percent, respectively. The total direct and indirect effect of bunches per vine on fruit yield was found to be 77 percent. Out of the total contribution of 31.5 percent of berries per bunch on fruit yield, the direct effect was very small (0.6%) but indirectly it contributed 16.3, 13.3 and 1.3 via bunches per vine, berry size and bunch weight respectively. Most of the effect of berry size on yield was direct (24.8%) followed by via bunch weight (6.9%) and via berries per bunch (0.3%). The effect of berry size via bunches per vine was also small and negative (-1.2%). The bunch weight directly contributed to yield about 31.9 percent followed by via berry size and berries per bunch 5.3 and 2.2% respectively.

The indirect effect of bunch weight via bunches per vine was found to be negative (-6.6%).

CHAPTER FIVE

DISCUSSIONS

5.1. Varietal Performance

A study profile of vegetative and reproductive characters of high and very high yielding varieties has revealed that the highest yielding variety Queen golden had very fast growing stem, long shoots and very high number of canes per vine. Among the reproductive parameters, it has a very high number of bunches per vine, very heavy bunch weight and a very high number of berries per bunch. It is moderately resistant to both anthracnose and downy mildew. It is a very good table variety. It was followed by Concord which has a moderate growth of stem, very long shoot length and low number of canes per vine. In the reproductive characters it has a high number of heavy bunches with moderate number of berries. The variety is good for both table and wine making and is found to be resistant to both anthracnose and downy mildew. This variety may be grown in the southern parts of Nigeria. Another very high yielding variety is MKM-7. It has a very fast growing stem with short shoot length and moderate number of canes per vine. As regards the reproductive parameters, it has a very high number of bunches per vine with very heavy bunches and a very large number of berries. It is susceptible to anthracnose and moderately resistant to downy mildew. The next high yielding variety is Ex-hort Samaru which has slow growing stem, very long shoot length and very high number of canes per vine. It bears a very high number of bunches per vine which are small in size but have moderate number of berries per bunch. It is resistant to both anthracnose and downy mildew and could be grown in the

southern parts of the country. It is a good variety for making wine. The last high yielding variety is Ex-Zaria black which has a fast growing stem with short shoot length and moderate number of canes per vine. It bears a moderate number of bunches per vine which are very heavy and have a moderate number of large berries. Berries often split. It is good for table. The variety is moderately resistant to both anthracnose and downy mildew.

The highly talked about variety Anab-e-Shahi has not featured in the list of high and very high yielding variety as it responds to a very intensive culture on a home garden scale. It is extremely susceptible to both anthracnose and downy mildew and needs lots of plant protection measures to produce it satisfactorily.

Yield of the varieties are low in general as the vines are at their initial stage of growth that is the first 4 years. Also, these vines are grown on a field scale, under Kniffen system of training and field management condition which have all contributed to the low yields.

5.2. Response to Application of FYM and Fertilizers

Stem diameter differences were not significant in the initial one to two experiments for both FYM and fertilizer levels. As these are the growth parameters and growth being exponential in nature, its growth rate is too slow in the beginning to attain the level of significance. In the combined analysis, however, difference due to FYM and fertilizer levels were found to be significant due to a higher error DF and fertilizer and FYM levels differences were significant in third and fourth year.

The differences in the shoot length were not significant in all the 4 years of experimentation and in the combined analysis for both FYM and fertilizer levels. The non significant result is attributed to the controlled regulation of growth initially as part of the training system i.e. any unwanted growth is nipped off regularly and finally by pruning twice, in April to a single bud for a vegetative growth and in October from 3-5 buds. Thus the growth is regulated every season. The varieties, however, showed a differential response in the last 2 years and in the combined analysis. The local and adapted variety Ex-Zaria black was found to produce longer shoots than variety Ex-hort Samaru. The cases of October and April pruned material were also similar to the above situation as they are also growth parameters. But the varietal differences were significant in all the 4 experiments and in combined analysis for April pruning. The variety Ex-hort. Samaru produced a higher pruned material than Ex-Zaria black in all the experiments and combined analysis due to its vigorous growth and a higher number of canes than Ex-Zaria black.

The number of canes produced was significantly influenced at all the FYM levels in all the 4 years of experiments and in combined analysis. This emphasized the need of organic manure in grape production. Although their nutritional value is not as much, but its effect on soil and water holding capacity of the soil make the conditions very conducive for grape production. These results also confirm those reported by Anonymous (1964), Kononova (1966) and Bhangoo et. al.(1988).

The fertilizer levels were not significantly affected in 3 out of 4 experiments and in combined analysis. This further supports the point discussed above on the importance of organic manure to grape production. The difference due to varieties was significant in two out of 4 experiments. Variety Ex-hort. Samaru produced higher number of canes than Ex-Zaria black.

The number of bunches was significantly affected both by FYM and fertilizer levels. It is clear from the interaction of the combined analysis that the highest number of bunches were produced at the highest level of manure and fertilizer and the lowest number of bunch at the highest fertilizer level and lowest FYM level indicating the need for organic manure for yield of grapes. The variety Ex-hort. Samaru produced a higher number of bunches which is a genetic character than Ex-Zaria black.

Path coefficient analysis indicated that among the vegetative parameters, number of canes directly contributed to yield about 37 percent. When the data on the number of canes per vine was examined in the light of this the effect of FYM was highly significant in all the experiments and in combined analysis as against fertilizer levels significantly influenced the number of canes only in one season out of five analyses. This clearly shows that organic manure has a very important role to play in yield determination by increasing the number of canes per vine. The other vegetative parameters for yield were shoot length and stem diameter which directly contributed 23 and 34 percent, respectively. It is for these reasons that adequate nitrogenous fertilizers are added after each pruning for satisfactory shoot

growth. Also, it is recommended that the vine should not be allowed to fruit unless it has a stem girth of at least the size a wrist for the longevity of its production. A study of path coefficient of reproductive parameters indicated that the number of bunches contributed 89.6 percent to yield followed by bunch weight (41%) and berries per bunch (8%). The number of bunches is a function of number of canes and bud burst. Therefore for high yield a high number of canes and bud burst by appropriate manure and fertilizer application and adequate irrigation should be aimed at.

Weight of bunch is a result of berry development. Irrigation is most crucial at the time of berry development in addition to nutrition. Therefore some growers apply a regular amount of nutrients during the phase of berry development.

The number of berries per bunch is basically a genetic factor and is not much influenced by the management and nutrition. Its direct contribution to the yield is very small (8%). The berry size is purely a genetic factor and it does not contribute to yield of fruits.No definite trend was found in the application of FYM and fertilizer for the sugar content but the variety seemed to be the chief factor for the sugar content. No definite trend was observed by application of FYM or fertilizers on pH of juice, varieties however seemed to have the greatest influence on the pH. The concentration of acid in grape has been reported to be influenced more by area of production (Etievant et. al., 1989).

5.3 Response to Pruning Dates and training system

The shoot length was not significantly affected by the pruning dates either in the individual season or in the combined analysis. A nonsignificant difference is explained due to a uniform single bud pruning in middle April which shall allow a minimum of $5^{1}/_{2}$ months during which the sprouts shall grow to a maximum length. The variety Bangalore blue produced longer shoots than Ex-Zaria black, in 3 out of 4 experiments and also in the combined analysis. This indicates that the variety Bangalore blue is more vigorous than Ex-Zaria black as its mean shoot length was longer than Ex-Zaria black. A significant interaction between variety x system in two seasons and combined analysis revealed a differential response of varieties to training system. Kniffen system of training was found to be more suitable for a vigorous variety like Bangalore blue. Similarly, interaction between years x pruning dates and training systems indicated that the response of pruning date or training system varied from one year to another due to the factors that influence growth like temperature which affect the number of sprout and shoot growth, nutrient and soil moisture. Muthukrishnan (1968) also found that the time of initiation, differentiation and growth of sprout varied from one variety to another and even within the same variety it varied from season to season.

The differences in the weight of October pruned material due to different pruning dates during the 4 season did not attain the level of significance. However, such difference was found to be significant in combined analysis due to a higher sensitivity of the combined analysis. The lower temperature after November reduced the rate of growth and consequently November pruning date recorded

significantly lower weight than October pruned material. The results are in conformity with those of Patil (1975) who also observed that pruning date significantly affected the growth. The variety Bangalore blue produced significantly higher October pruned material than Ex-Zaria black in all the 4 seasons and combined analysis clearly indicating it is a more vigorous variety. The overhead trellis training system produced a higher October pruned material than Kniffen system in two seasons and in the combined analysis. The horizontal disposition of leaves in Overhead trellis system exposed them better to light than Kniffen system, consequently more photosynthates were produced and a higher growth. Interaction between year x variety in the combined analysis also clearly indicated the vigorous variety Bangalore blue produced a higher October pruned material in all the 4 seasons than Ex-Zaria black.

Number of canes per vine is a function of number of sprouts. The number of sprouts depends upon the exposure of vine to the lower temperatures for the chemical changes for the bud burst followed by optimum temperature of 30 - 35^{0} C after pruning for satisfactory sprouts. Significant differences in the number of sprouts and consequently the canes during 1989 and 1990 were due to a lower temperature during March of these years when compared with March temperatures in 1991 and 1992. The variety Ex-Zaria black produced a higher number of canes the vigorous variety Bangalore blue in 3 out of 4 experiments and in the combined analysis. Kniffen system of training produced more canes than Overhead trellis system as such canes are produced on secondaries compared with the Overhead trellis system in which they are produced on tertiaries. Also, the distance

between the trailing wires is wider in Kniffen system when compared with that in the Overhead trellis system. Interaction between pruning dates x years indicated October pruning resulted in higher number of canes than the other two pruning dates in all experiments except in 1992.

The weight of April pruned material was not affected by pruning dates. It is due to the fact that in October pruning more or less the same length of basal cane was left and the rest is pruned for fruiting. Such differences were however, found to be significant in the combined analysis due to a higher degree of freedom for error wherein each delay in pruning resulted in significantly lower April pruned material. The vigorous variety Bangalore blue produced higher April pruned material than Ex-Zaria black in all the four experiments as well as in the combined analysis. The difference in the training systems for April pruned material is not significant in all the 4 experiments and in combined analysis.

The number of bunches progressively decreased as the pruning date was delayed. Apparently, this seemed to be associated with the minimum temperature which markedly decreased from September to November. The bud burst and sprouting was affected by temperatures. Aubert (1972) and Patil (1975) reported that in tropical regions for a satisfactory bud burst and sprouting the temperature should be between 30 - 35^{0}C. There is decline in temperature from September to November in all the experimental years which resulted in a decrease of bud burst and lower number of bunches per vine. The variety Bangalore blue produced a higher number of bunches in 2 out of 4 experiments and in the combined analysis.

It could be explained on the basis of fruiting habit of the two varieties. The variety Bangalore blue bears 3 - 5 bunches in a series on a fruiting shoot unlike Ex-Zaria black which bears only 1 - 2 bunch on fruiting shoot. The training system did not affect the number of bunches per vine.

As in the case of number of bunches per vine, there was a progressive decrease in the fruit yield as pruning was delayed from September to November except in 1991 in which the difference between October and November pruning was not significant. When it was examined in relation to the rainfall in September 1991 it was observed that it was only 51 mm as against 118 - 229 mm in the other years of experimentation. Although, the grape crop is irrigated, which starts in late October after pruning, it has reduced the yield of October pruned vine to the level of November pruned vines in 1991. The variety Ex-Zaria black produced higher yield than Bangalore blue in 2 seasons and in combined analysis. Although, Bangalore blue produced higher number of bunches, yet the weight of bunch in Ex-Zaria black was much higher than Bangalore blue. The variety Ex-Zaria black also produced a higher number of fruiting canes per vine, but due to a smaller number of bunches per shoot it did not exceed in number of bunches per vine. Overhead trellis system produced a higher yield only in 1 out of 4 experiments and in combined analysis.

The pruning date x variety interaction was found to be significant in 1992 in which the yield was significantly lower with each delay in the pruning date. There was no such difference in Ex-Zaria black indicating a differential response of

varieties to pruning date in this experiment. The pruning dates x training systems did not reach the level of significance in the individual experiments, but in the combined analysis, it revealed that the earlier the pruning, the higher are the yields. Also Overhead training system produced higher yield only in September pruning. The interaction between variety x training system was found to be significant in 3 years and in combined analyses. In all cases, Ex-Zaria black yielded higher under Overhead training system. A number of researchers also found a particular variety suited for a specific training system (Gopalakrishna, 1968; Diedda and Milella, 1979; Bindra and Brar 1980 and 1981; Morris and Cawthon, 1980; Anon., 1984; Ratnam and Majanbu 1985). The interaction between years x pruning date was found to be significant. In general, higher yields are obtained by early pruning in all the years. Yield within a year is a function of temperatures before and after pruning, fertilization and berry and bunch development and factors influencing them. In the present investigations the earlier 2 year yield was significantly higher than the last 2 years because of incidence and severity of fungal diseases. Both the pathogen build up and severity were on an increase. It is for this reason that Ex-Zaria black yielded higher than Bangalore blue only in 1989. The other years yield differences were not statistically significant. The path coefficients revealed that among the vegetative parameters, total number of canes and fruiting canes contributed 12.9 and 76.8 percent for yield. In the reproductive character bunches per vine, bunch weight and berry size contributed to 79.9, 31 9 and 24.8 percent, respectively.

Bunch weight is an important fruit yield contributing factor and was significantly affected by pruning date in 3 out of 4 years and in the combined analysis. September pruning produced heavier bunches as a result of longer growth and development period of suitable temperatures. Ex-Zaria black produced heavier bunches than Bangalore blue in all the four experiments and in the combined analysis which is attributed to its genetic nature. The bunches of Ex-Zaria black are larger than Bangalore blue. Bunch weight was not affected by the training systems both in 4 years of experimentation as well as in combined analysis. In the combined analysis Ex-Zaria black produced heavier bunches under overhead training system. No such difference was observed in Bangalore blue indicating a differential response of varieties for bunch weight under different training systems. Similar results of different bunch weight with different training systems were recorded by Deidda and Milella (1979), Bindra and Brar (1981) and Jackson et al. (1984). The interaction between year x variety and year x training system were also significant. Ex-Zaria black produced higher bunch weight than Bangalore blue in all the 4 years. The bunch weight varied from year to year within a training system.

Number of berries per bunch was significantly affected in 3 out of 4 seasons and in the combined analysis. October pruning date resulted in a higher number of berries than the other two pruning dates. The inflorescence primordia is formed about 30 - 40 days after pruning which developed into numerous growing points in another 4 - 5 weeks thereafter. This results in a higher number of berries per bunch in October pruned canes. The variety Ex-Zaria black had a higher number of

berries which is a genetic character, than Bangalore blue . Training systems did not affect the number of berries per bunch.

The berry size (volume) was not affected by pruning dates in all the 4 experiments and in the combined analysis. The berries of Zaria black are larger than Bangalore blue which is a genetic character. Overhead trellis system produced larger berries in two years and in combined analysis. It is due to this fact that the conditions for growth and development of berries is more conducive under a canopy of leaves in Overhead trellis system when compared with Kniffen system. Berry size of Ex-Zaria black was not affected by pruning date, but in the case of Bangalore blue November pruning date produced larger berries due to smaller number of berries per bunch. The system of training affected the berry size of Ex-Zaria black and not of Bangalore blue indicating a differential response of varieties to training system for berry size. The size of variety was also affected in different years.

Fruit sugar content was affected by the pruning dates in 1990. Early pruning in September produced sweater fruits than the other dates because it was able to produce more photosynthates due to longer growing period and accumulated more sugars. The small fruited variety Bangalore blue was found to be sweeter than Ex-Zaria in 2 years and in combined analysis. The training systems did not affect the fruit sugar content in all the 4 years and in the combined analysis. Sugar content of berries was found to change from one year to another,

but within a variety it was found to be consistent indicating it is a varietal character.

Juice pH was significantly affected by pruning dates in 3 seasons and combined analysis. In the combined analysis, it was clearly indicated that the earlier the pruning, the lower is the pH of the fruits. Among varieties Bangalore blue was found to be more acidic than Ex-Zaria black in 1992. In the same year, Kniffen system of training was found to give more acidic fruits than Overhead trellis system.

CHAPTER SIX

SUMMARY AND CONCLUSIONS

It has been established that grapes could be very successfully grown at Zaria. Infact, it could be the most remunerative crop. So far, the demand for table grapes is high. In future it could become a raw material for industries making wine, raisin, jam, jelly, etc. With the present investigation, five high and very high yielding varieties have been identified, 2 - 3 of which may have the potential to grow even in the southern parts of the country.

In all the years and in combined analysis, the highest yield was obtained with 30 t/ha of FYM and 250:120:150 kg of NPK/ha. The yield contributing factors such as the number of bunches, bunch weight and number of berries are also highest at the above fertilizer rate. Therefore the above fertilizer rate is recommended.

A four-year field experiment was conducted at the Ahmadu Bello University Farm, Samaru during 1989 - 92 to investigate the effect of 3 pruning dates (September 26, October 17 and November 7) under 2 training systems (Overhead trellis and Kniffen) on 2 varieties (Bangalore blue and Ex-Zaria black) of grapes. The results of the combined analysis irrespective of the years revealed that pruning dates did not affect shoot length, berry size and fruit sugar content. The weight of October pruned material was higher in September 26 and October 17 pruning dates. The number of fruiting canes and berries per bunch was higher in October 17 when compared with the other two pruning dates. The weight of

April pruned material, number of bunches and fruit yield per vine decreased with each delay in pruning date from September to November. The bunch weight was also higher in September pruning when compared with the other two pruning dates. The juice pH was highest in November pruning followed by October and September pruning date.

The variety Bangalore blue produced longer shoots, weight of October and April pruned material, number of bunches and sugar content than Ex-Zaria black. Number of fruiting canes, fruit yield, bunch weight, number of berries per bunch, berry size and juice pH were higher in Ex-Zaria black when compared with Bangalore blue variety.

The two training systems used did not affect shoot length, weight of April pruned material, number of bunches and berries, bunch weight, sugar content and fruit pH. The Overhead training system produced higher weight of October pruned material, fruit yield and berry size. A higher number of canes was recorded in Kniffen training system.

In conclusion September 26 pruning date was the best as it gave a higher yield and other yield components. However, there is a risk associated with this pruning date. Often the late September/early October rains in combination with high temperatures and high humidities have proved to be disastrous in terms of fungal disease which are more severe on tender leaves, shoots and inflorescence. It is therefore advisable to prune the vines in middle of October. The variety Ex-Zaria black yield higher than Bangalore blue. Often the berries split especially

under condition of excess irrigation and high humidity. But in terms of quality of fruit with its crisp pulp and large sized berries it is found to be better than Bangalore blue for fresh fruits. The variety Bangalore blue was more adapted to Kniffen system of training.

SUGGESTIONS FOR FUTURE RESEARCH ON GRAPES

1. Addition to Gene Pool: It has been observed that grapes can produce very good yields in Zaria. Attempts should be made to add more varieties to the collections made under varietal improvement project.
2. Regional trials should be established to select promising varieties from my collection.
3. By studying fruiting behaviour of promising varieties their yield should be improved by additional agronomic manipulations like pruning and manuring, irrigation, training, etc.
4. The disease incidence is on an increase because they are not controlled effectively. Research should be conducted on more efficient use of available fungicides and a search for cheaper alternatives.

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APPENDIX 1 (a): Meteorological Data During 1988 - 1993.

Month	Rainfall (mm)	Relative Humidity (%)		Air Temperature °C		Sunshine (Hours)
		a.m.	p.m.	Min.	Max.	
1988						
January	0.0	22.1	18.1	13.5	28.9	6.5
February	3.5	17.8	14.4	15.7	31.9	8.3
March	0.0	21.5	14.8	20.9	35.9	7.0
April	34.6	47.6	28.1	22.2	36.1	7.9
May	94.4	60.7	38.3	22.5	34.8	8.0
June	138.2	75.4	60.1	20.1	30.7	7.3
July	181.5	83.1	67.4	19.5	28.1	5.4
August	401.5	83.3	74.6	19.4	27.4	5.6
September	192.3	76.9	66.7	19.3	29.3	6.5
October	114.7	47.8	35.7	15.7	31.0	9.4
November	0.0	23.4	20.5	12.0	31.7	10.1
December	0.0	24.7	21.5	11.8	28.2	7.3
1989						
January	0.0	25.6	17.7	10.1	25.2	10.1
February	0.0	17.5	14.2	13.4	28.0	6.2
March	0.0	15.5	12.4	17.5	34.7	8.7
April	15.0	37.0	20.0	20.0	36.8	9.2
May	113.0	61.8	43.8	20.4	33.1	7.7
June	124.4	72.3	58.0	20.0	30.7	7.3
July	154.6	78.9	63.2	19.6	29.4	6.7
August	170.4	81.7	71.0	19.3	28.0	53.7
September	118.3	78.4	66.9	19.2	29.8	6.5
October	52.9	51.9	42.4	16.5	30.6	8.5
November	0.0	19.3	18.5	12.7	31.1	9.3
December	0.0	19.3	17.4	12.9	28.6	8.0

Source: Meteorological data at Institute for Agricultural Research, Samaru, Zaria.

APPENDIX 1 (b)

Month	Rainfall (mm)	Relative Humidity (%)		Air Temperature °C		Sunshine (hours)
		a.m.	p.m.	Min.	Max.	
1990						
January	0.0	17.9	13.6	12.6	31.1	7.8
February	0.0	13.1	10.1	15.2	30.1	7.7
March	0.0	9.1	9.0	18.5	33.1	7.8
April	0.0	45.9	23.0	23.0	37.2	8.4
May	123.3	68.5	50.5	21.7	32.7	7.5
June	155.7	75.8	60.7	20.6	31.2	7.3
July	221.9	80.4	65.5	19.6	28.7	6.4
August	255.3	81.4	66.6	19.5	28.9	26.0
September	131.5	75.9	62.2	19.6	30.0	6.7
October	0.0	58.8	46.8	18.5	32.8	8.4
November	0.0	31.0	26.4	15.5	33.7	9.3
December	5.0	26.2	20.5	14.8	33.0	8.8
1991						
January	0.0	21.5	17.4	14.3	29.6	8.4
February	0.0	20.4	22.9	17.5	35.4	8.6
March	44.7	27.4	17.7	20.6	35.2	7.6
April	47.8	54.3	33.4	22.8	35.4	8.2
May	243.0	76.8	60.5	21.3	30.8	6.4
June	87.0	78.4	64.3	20.7	30.1	6.9
July	189.6	80.3	69.9	20.0	28.1	5.7
August	329.0	84.0	72.5	19.7	27.9	5.0
September	51.2	72.8	58.8	20.0	31.3	8.1
October	28.7	66.0	40.0	18.3	32.0	8.5
November	0.0	20.8	17.3	12.9	31.6	8.9
December	0.0	21.1	16.3	12.6	28.6	7.7

Source: Meteorological data at Institute for Agricultural Research, Samaru, Zaria.

APPENDIX 1 (c) Meteorological Data During 1988 - 1993

Month	Rainfall (mm)	Relative Humidity (%)		Air Temperature °C		Mean	Sunshine (hours)
		a.m.	p.m.	Min.	Max.		
1992							
January	0.0	21.5	14.6	12.3	26.7	19.5	5.3
February	0.0	12.6	9.1	15.0	30.0	22.5	7.9
March	0.0	23.4	16.6	19.5	35.0	27.2	5.9
April	32.3	41.3	29.9	22.4	35.4	28.9	7.4
May	73.1	66.4	49.7	22.1	33.0	27.5	7.4
June	112.4	71.3	57.9	19.7	29.6	24.6	6.2
July	243.6	82.6	68.1	19.8	28.4	24.1	6.2
August	287.3	83.0	74.8	20.0	29.5	24.7	4.9
September	229.7	78.6	65.1	20.2	29.5	24.8	4.6
October	39.9	61.1	35.2	17.7	31.5	24.6	8.9
November	2.6	32.4	35.0	15.1	29.7	22.4	6.9
December	0.0	25.1	24.6	12.3	29.6	20.9	7.9
1993							
January	0.0	23.6	19.2	11.6	26.3	19.0	4.0
February	0.0	19.5	23.3	14.6	31.8	23.2	-
March	0.0	31.5	29.7	18.2	34.4	26.3	-
April	8.3	42.7	33.8	23.5	36.5	30.0	-
May	113.6	62.9	46.8	22.0	37.8	29.9	8.2
June	155.8	72.7	51.8	20.9	31.7	26.3	7.6
July	269.0	78.4	56.7	20.2	29.5	24.9	6.6
August	300.8	81.8	62.1	19.5	28.4	24.0	5.0
September	181.8	76.7	58.2	19.3	30.2	24.8	7.0
October	32.4	63.1	54.0	18.7	34.1	26.4	8.4
November	00.0	24.5	23.5	14.1	33.6	23.9	8.6
December	0.0	31.3	25.5	14.1	29.1	21.6	6.2

Source: Meteorological data at Institute for Agricultural Research, Samaru, Zaria.

Appendix 2: Physical and chemical properties of the soil experimental field at different depths

	Soil Depth (cm)			
	0-15	15-30	30-45	45-60
Particle size distribution (%)				
Clay	42	40	36	34
Silt	37	35	36	35
Sand	21	25	28	31
pH				
H_2O	6.3	6.6	6.8	6.5
KCl	5.70	5.75	5.65	5.30
Organic Carbon (%)	1.20	1.03	0.40	0.53
Total Nitrogen (%)	0.08	0.08	0.07	0.06
Available P (ppm)	31.5	29.4	6.6	3.9
Exchangeable bases (meg/100g soil)				
Ca	2.25	2.31	1.87	1.75
Mg	1.09	1.15	1.16	1.16
K	0.30	0.24	0.24	0.23
Na	0.13	0.10	0.14	0.11
CEC	3.97	4.00	3.62	3.40
Exchangeable Acidity (meg/100g soil)				
H + AL	0.20	0.20	0.20	0.15

Appendix 3: List of varieties used in Experiment No. 1 and the sources of the introduction.

S/No.	Variety	Source
1.	Anab-e-Shahi	India
2.	Anab-e-Shahi x American seedling	India
3.	Bangalore blue	India
4.	Black hamburg	India
5.	Black rose	Greece
6.	Black verico	Greece
7.	Cardinal	India
8.	Catawba	India
9.	Concord	India
10	Gross coleman	Greece
11	Israel blue	Nigeria
12	Monaca sabo	India
13	Ex-Zaria black	Nigeria
14	Ex-Hort. Samaru	Egypt
15	Ex-Hosp.	Nigeria
16	MKM-7	India
17	Ex-Maiduguri	Nigeria
18	Queen golden	India
19	Regina	India
20	Thompson seedless	India

Appendix 4: Field Layout - Varietal Trial
(Experiment No. I)

S/No.	Variety	Rep.I	Rep.II	Rep.III
1.	Anab-e-Shahi	J_{12}	G_{15}	H_{19}
2.	Anab-e-Shahi x American Seedling	J_{13}	K_{14}	I_{17}
3.	Bangalore blue	J_{11}	F_{16}	I_{19}
4.	Black Hamburg	H_{12}	H_{16}	I_{17}
5.	Black rose	L_{13}	I_{15}	K_{19}
6.	Black Verico	L_{11}	K_{16}	I_{17}
7.	Cardinal	F_{12}	L_{16}	I_{19}
8.	Catawba	L_{12}	J_{14}	I_{18}
9.	Concord	F_{11}	H_{14}	I_{19}
10.	Gross Coleman	G_{12}	F_{14}	I_{18}
11.	Isreal blue	G_{11}	L_{15}	I_{17}
12.	Monaca sabo	F_{13}	J_{15}	G_{17}
13.	Ex-Zaria black	I_{13}	J_{15}	L_{18}
14.	Ex-Hort. Samaru	K_{13}	G_{14}	K_{18}
15.	Ex-Hosp	H_{11}	G_{16}	G_{18}
16.	MK 7	I_{12}	I_{14}	H_{17}
17.	Ex-Maiduguri	K_{12}	J_{16}	F_{18}
18.	Queen golden	I_{11}	L_{14}	H_{18}
19.	Regina	F_{15}	H_{15}	I_{19}
20.	Thompson Seedless	K_{11}	I_{16}	K_{17}

Appendix 5: Field Layout Variety x Fertilizer x Farm Yard Manure Trial (Experiment No. 2)

S/No.	Variety	Fertilizer (kg/ha)			FYM			
		N	P	K	(t/h/ha)	Rep.I	Rep.II	Re III
1.	Ex-Hort. (Control)	0	0	0	0	I_3	L_7	L_9
2.	"	50	40	50	10	C_4	G_7	H_8
3.	"	50	40	50	20	H_4	J_5	K_{10}
4.	"	50	40	50	30	L_3	J_7	F_8
5.	"	150	80	100	10	L_3	F_6	J_8
6.	"	150	80	100	20	F_2	G_5	J_{10}
7.	"	150	80	100	30	J_7	K_6	G_9
8.	"	250	120	150	10	H_2	H_6	G_{80}
9.	"	250	120	150	20	F_3	L_6	G_{10}
10	"	250	120	150	30	I_3	F_5	H_{10}
11	Ex-Zaria (Control)	0	0	0	0	K_3	I_5	I_{10}
12	"	50	40	50	10	G_3	L_5	L_8
13	"	50	40	50	20	K_4	I_7	G_9
14	"	50	40	50	30	G_3	J_6	F_{10}
15	"	150	80	100	10	J_2	H_7	K_9
16	"	150	80	100	20	J_4	I_6	H_9
17	"	150	80	100	30	H_3	F_7	I_8
18	"	250	120	150	10	K_3	H_5	L_{10}
19	"	250	120	150	20	F_4	G_6	I_9
20	"	250	120	150	90	I_4	K_5	F_9

Initial N.P. and K was supplied through N:P:K. compound fertilizer 15:15:15. Additional N. and P. were supplied thorugh calcium ammonium nitrate (26%N) and single super phosphate (19%P_2O_5)

Appendix 6: Field Layout - Date of Pruning x Variety Trial (Experiment No.3)

Treatment			Training System					
			Rep.I		Rep.II		Rep.III	
S/No.	Variety	Pruning Date	Over-head *trellis*	Kniffen	Over-head *trellis*	Kniffen	Over-head *trellis*	Kniffen
1.	Bangalore blue	26/9	B18	B25	C18	C24	D16	D23
2.	"	17/10	B14	B26	C17	C27	D18	D22
3.	"	7/11	B19	B22	C16	C22	D14	D24
4.	Ex-Zaria black	26/9	B17	B23	C14	C23	D15	D27
5.	"	17/10	B15	B27	C19	C25	D19	D25
6.	"	7/11	B16	B24	C15	C26	D17	D26

APPENDIX 7: Vegetation and Reproductive Parts of Grapevine used in Characterizing Vines Grown at the University Farm, Zaria

FIELD NO.	CHARACTERISTICS OF GRAPE VARIETIES
I VINE	1/2 Plant No. ( ) Variety ( ) S/Date ( ) 1. Vigour Low/Med./High 2. Growth-Dense/Sketchy 3. Trunk Int. Nodes L/M/S 4. Bark - Loose/Tight Shreddy/Hard
II LEAF	1. Peduncles - Green/Pigmented; Small/Med./Large 2. Blade Colour Upper ( ) Lower ( ) Soft/Rough; Hairy/Smooth 3 Size-S/M/L 4 Margins-Serrated/Smooth 5. Lobes S/M/L 6. No. of Lobes.
III GROWING	Sheet 1 Colour/Appearance 2. Tendril-Simple/Birfurcated: S/M/L: Thick/thin; Smooth/Rough; Wooly/non-wooly.
IV MATURED CANE	1. Colour/Appearance ( ) 2. Thick/Medium/Thin 3. Straight/Curved 4. Nodes-Round/Angular; Distinct/Insignificant 5. Internodes - S/M/L; Think/thin; Round/Flatten.
V FLOWER	1. Colour ( ) 2. Size S/N/L. 3. Unisexual/Hermaphrodite Stamens - Upright/Insignificant 5. ovary - S/M/L 6. Flowering - Early/Med./Late.
VI BUNCH	1. Colour initial ( ) at Ripening ( ) 2.Size S/M/L 4 Shape - Conical/Irregular/Others. Bunch Filling - Compact/Lax 6. Bunch Branches - Few/Many 7. Peduncle - S/M/L. Thick/Thin
VII BERRY	1. Colour initial ( ) at Ripening ( ) Ripening - Un-even/simultaneous 2. Shape - Round/Oval/Cylindrical. 3. size S/M/L 4. Adherence to Bunch - Weak/Int./Strong 5. Bloom - Low/Med./Thick. 6. Skin - Thin/Med./Thick 7. Pulp Adherence Weak/Int/Strong. 8. Pulp - Crispy/Non-Crispy
VIII SEED	1. Size - S/M/L 2. Colour ( ) 3. Body - S/M/L 4. Beak - straight/curved 5. Chalaza - S/M/L Mean 100-Berry data.

Appendix 8. Description of twenty varieties of grape used in the study.

1. Anab-e-Shahi

Source: The variety was introduced from Grape Research Station, Andhra Pradesh Agric. University, Hyderabad, India in 1975.

Stem: Stem is fast growing. The growth of the stem is sketchy, internodes medium in length and the bark is loose and shredy.

Petiole: The petiole is green, small to medium in size some times slightly pigmented.

Leaf: Upper surface of the black is light green and the lower surface dark green. the leaves are medium in size, margin serrated with 3-5 medium sized lobes. The texture of leaf is soft and smooth.

Growing Shoot: It is long, pale green in colour. Tendril is simple, thin, small to medium in size and non woolly.

Matured Cane: Greenish brown to light brown in colour, medium in thickness, straight in structure. Node is round and insignificant. Internode small to medium, thin and round.

Bunch: Medium in size, conical in shape, initially green which turns to light green in colour on ripening. Bunch is compact with many branches. Peduncle is medium and thick.

Berry: Berry ripens simultaneously. They are oval in shape, very large in size and strongly adhere to the bunch. Berry has no bloom. Skin is thin, pulp crispy, 15.1 percent sugar. Volume of 5 berries, 4.3 cc^3.

Seed: Seed is medium in size, brown in colour. Beak is straight and chalaza small.

Remarks: Anab-e-shahi is a medium yielding variety with excellent table quality fruit. It can also be used for making white or dessert wine. It is susceptible to anthracnose and moderately resistant to downy mildew.

2 .Anab-e-Shahi x American Seedling

Source: The hybrid was introduced from Grape Research Station Andhra Pradesh Agric. University in 1986.

Stem: The growth of stem is very vigorous and dense. Internodes low to medium in growth with loose and shreddy bark.

Petiole: Petiole is green, medium to large in size.

Leaf: Small to medium in size with upper surface of blade as light green and lower surface dark green. The leaf margin is serrated with 3-4 medium sized lobes.

Growing shoot: The young shoot is very long and green. It has simple, medium sized, thick smooth non-woolly tendrils.

Matured cane: Matured cane is brown in colour, medium in growth and slightly curved. The node is round and distinct. Internode is thick and flattened..

Bunch: It is small in size, irregular in shape, initially green which latter turns to dark purple on ripening. The bunch is compact in nature with a few branches. Penducle is small and thick.

Berry: Small round slightly bloomed berries with slightly staggered ripening. Adherence to bunch is moderate. Skin thin to medium, pulp slightly crispy with 13.0 percent sugar. Volume of 5 berries 1.98 cc^3.

Seed: Seeds are medium, light brown in colour. Beak slightly curved and chalaza medium.

Remarks: Anab-e-Shahi x American seedling is a low yielding and highly vigorous variety which is suitable for table and wine making. It is susceptible to anthracnose and moderately resistant to downy mildew.

3. Bangalore blue

Source: The variety is introduced from Regional Grape Research Station, University of Agric. Sciences, Bangalore, India in 1987.

Stem: The growth of stem is vigorous and stocky with medium sized internodes. The bark is loose and shreddy.

Petiole: The length of petiole is medium to large. Usually green at times slightly pigmented.

Leaf: The leaves are medium to large with upper surface dark green and the lower surface whitish green. The leaf margin serrated and medium to low lobed with 3-4 lobes. The texture of leaf slightly rough.

Growing shoot: It has very long shoot, is pale green to green with small to medium, simple, thin, smooth and non-woolly tendrils.

Matured cane: It is brown to dark brown in colour, thin to medium in thickness and straight. Node round and distinct. Internodes medium, thin and round.

Bunch: Bunch is green initially but turn to very dark purple on ripening. Small in size and cylindrical. The bunch filling is compact with a few branches. Penduncle is very small and thin. There are 3-5 bunches per cane.

Berry: Ripening is slightly uneven. Berries are medium, round in shape and their adherence to bunch is very weak. Berries are covered with thick bloom. Skin thick, pulp is non-crispy sweet. If not fully ripe tastes acidic. Quality of berries medium. Sugar content 13.6 percent. They have sherry aroma.

Seed: Large in size, dark brown, beak straight with large chalaza.

Remarks: Bangalore blue is a high yielding and highly vigorous variety which is more suitable for wine making. The variety is resistant to both anthracnose and downy mildew.

4. Black Hamburg

Source: It was introduced from Grape Research Station, Andhra Pradesh Agric. University, Hyderabad, India in 1986.

Stem: Stem has small to medium internodes with loose shreddy bark.

Petiole: Small to medium petiole, often green in colour but sometimes pinkish.

Leaf: Leaves are small to medium in size. The upper surface of leaf is dark green and lower surface green, margins serrated with 3 lobes. The texture of leaves is soft and smooth.

Growing point: The growing tip is green with simple or bifurcated small thin tendrils which are smooth and non-woolly.

Matured cane: It is dark brown in colour, medium to thick straight with round and distinct buds. Internodes are thin and round.

Bunch: Bunch is small and irregularly conical in shape, initially green which turn to dark purple at ripening. Bunch filling is semi-lax with few branches. Peduncle is thick and medium in size.

Berry: It is medium in size and ripens evenly. It is slightly oval in shape and strongly adhere to bunch with very light bloom. Skin is thin and the pulp is sweet and crispy. Sugar 13.9 percent.

Seed: Seeds are medium in size, dark brown in colour, with slightly curved beak and small chalaza.

Remarks: It is highly a vigorous variety. Berries are used both as a dessert and currant. Yield of variety is medium to high. It is susceptible to anthracnose and moderately resistant to downy mildew.

5.. Black Rose

Source: It was introduced from Greece in 1984.

Stem: The stem is not vigorous with medium internodes. The bark is loose and shreddy.

Petiole: Small to medium petiole, pigmented.

Leaf: Leaves are medium in size with both upper and lower sides dark green in colour. The leaf margin is serrated with 3-4 small to medium lobes. They are smooth and soft in texture.

Growing Shoot: The growing shoot is green with simple or up to trifurcated, medium, smooth thin tendrils.

Matured cane: Light brown in colour with medium thickness. The nodes are round and insignificant. Internodes medium to thick and flat.

Bunch: It is green initially which turns black to purple on ripening. Bunch branches only few. Peduncle small and thick.

Berry: Large sized berries which ripen unevenly, slightly oval in shape. They adhere to bunch strongly. There is a little bloom on the berries. Skin medium in thickness, pulp crispy and sweet sugar content 14.6 percent.

Seed: Seeds are medium light brown in colour with slightly curved beak. Chalaza medium.

Remarks: It is a vigorous variety used as fresh fruit and wine making. Yields are moderate. The variety is susceptible to anthracnose and downy mildew.

6. Black verico

Source: It was introduced from Greece in 1984 by the Nigerian Bottling Company.

Stem: Trunk internodes are small. Bark loose and shreddy.

Petiole: Medium to large in size. Mostly green, near the blade slightly pigmented.

Leaf: Small to medium in size, both upper and lower leaf surface dark green. Leaf margins serrated with 3 small to medium lobes. the blade texture is soft and smooth.

Growing Shoot: It is green with bifurcated tendrils which are thin, smooth and nonwoolly.

Matured cane: Matured canes are thick, brown and straight. Nodes are round and insignificant. Internodes small, thin and round.

Bunch: Initially green which turn to dark purple at ripening. The size of bunch is medium and cylindrical in shape. It is well filled with few branches.

Berry: Berry is small, round and ripen simultaneously. Berry attachment is strong. Bloom low, skin thin pulp crispy and sweet. Sugar content 17.9 percent. Peduncle medium.

Seeds: Seed medium in size, brown in colour, beak slightly curved and chalaza medium in size.

Remarks: The vigour and yield of the variety are moderate. It is used as dessert, currant and for wine making. It is susceptible to anthracnose and moderately resistant to downy mildew.

7. Cardinal

Source: The variety was introduced from Regional Grape Research Station, Bangalore, India in 1987.

Stem: It is sketchy with small to medium stem internodes. The bark is loose and shreddy.

Petiole: It is small and slightly pigmented.

Leaf: Small to medium leaf. Blade is green on both sides with 3-4 small to medium sized lobes which are soft and smooth.

Growing Shoot: Light green in colour which bears simple and sometimes bifurcated small thin smooth tendrils which are non woolly.

Matured cane: It is medium in thickness, light brown in colour and curved. Nodes are angular and insignificant. Internodes small, thick and round.

Bunch: It is green initially which turns to dark purple at ripening. Bunch is medium in size, irregular in shape with lax bunch filling. Bunch branches are few, with medium peduncle.

Berry: Small berries which are slightly cylindrical. Adhereence to bunch strong. They have low bloom. Skin is thin, pulp crispy and sweet. Sugar content 15.2 percent.

Remarks: It is a moderately vigorous variety, very good for both dessert and wine making. The yields are moderate. Fregoni (1989). reported that Cardinal is an important variety in Italy. The variety is moderately resistant to both anthracnose and downy mildew.

8. Catawba

Source: It was obtained from Regional Grape Research Station, Bangalore, India in 1987.

Stem: Stem internodes are medium, bark is loose and shreddy.

Petiole: The petiole is medium to large and pigmented.

Leaf: It has small leaves with both sides dark green. Leaf margin serrated with 3 small lobes. The leaves are soft in texture and smooth on surface.

Growing Shoot: It is green in colour, straight in its growth which often bears simple to trifurcated small, thin, smooth and non woolly tendrils.

Matured cane: It is brown in colour, medium in thickness with round and distinct nodes. Internodes medium to thick and round.

Bunch: Initially green in colour and deep purple on maturity. They are medium in size and each cane bears 3-5 bunches in a series. The shape is slightly irregular with semi - compact filling. Bunch branches few with medium sized peduncle.

Berry: Berry is medium in size, slightly oval in shape with strong attachment with the bunch. Bloom medium, berry skin is thin with sweet crispy pulp. Adherence to bunch is strong. Sugar content 12.7 percent.

Seed: They are medium, light brown, with straight beak and small chalaza.

Remarks: It is a highly vigorous variety used for table and wine making. The yields are moderate to high. Catawba matures 2 weeks later than Concord. It is primarily used for wine making but also used as dessert and for juice. It is resistant to both anthracnose and downy mildew.

9. Concord

Source: The variety was introduced from Regional Grape Research Station, Bangalore, India in 1987.

Stem: Trunk growth is dense with small to medium internodes. Bark is loose and shreddy.

Petiole: It is medium to large in size, slightly pigmented.

Leaf: Leaves are small in size, dark green at the upper and light green at the lower side of the blade. Margins are serrated with 3 small lobes which are soft and smooth.

Growing Shoot: It is light green in colour which bears simple to trifoliate, small thick, smooth tendrils.

Matured cane: It is thick, brown and curved. Nodes are round and distinct with medium round and thick internodes.

Bunch: It is medium sized, well filled, cylindrical and compact with few branches. Initially green which turns to deep purple on maturity. Peduncle small. Ripening very slightly uneven. Some 3-4 bunches are borned in series on same cane.

Berry: They are round, medium sized with medium bloom and adhere to bunch strongly. Skin is thin with sweet and crispy pulp. Sugar percentage 12.8.

Seed: Dark brown in colour, medium in size, with slightly curved beak and medium chalaza.

Remarks: Highly vigorous variety used as fresh fruit, currant and wine making. It is a very high yielding variety. It is resistant to anthracnose and downy mildew.

10. Gross Coleman

Source: The variety was introduced in 1984 from Greece.

Stem: Medium trunk internode with dense growth. The bark is loose and shreddy.

Petiole: It is small to medium in size and slightly pigmented.

Leaf: Leaves are medium to large, light green on both sides. Leaf margin serrated with 3 small to medium lobes and soft and smooth in texture.

Growing Shoot: It grows straight and green in colour. The tendrils are small, thin, smooth, simple to trifurcated and non woolly.

Matured cane: It is medium, brown. The nodes are angular and distinct. The internodes are medium, thick and round.

Bunch : The variety has medium sized bunch which is green initially and turns to deep purple on maturity. The bunch filling is lax and many branched. The shape of the bunch is irregular. Peduncle is medium sized.

Berry: Deep purple in colour, oblong in shape and ripen simultaneously. Skin thin, pulp sweet and crispy. Sugar content 13.9 percent. Berry adherence to bunch is strong.

Seed: Medium sized, greenish brown in colour, beak slightly curved and chalaza small.

Remarks :Moderately vigorous and low yielding variety. It is susceptible to anthracnose and moderately resistant to downy mildew.

11. Israel blue

Source: Collected from Talata Mafara, Sokoto state in 1986.

Stem: Trunk internodes medium in size. Bark loose and shreddy

Petiole: Medium in size and pigmented.

Leaf: Medium sized leaves, green on both sides serrated with 3 Medium sized lobes and soft in texture and smooth surface.

Growing Shoot: Green in colour, with small, simple, thin and smooth tendrils.

Matured cane: Dark brown and medium in thickness. It grows straight. Nodes are round and insignificant. Internode small, thin and round.

Bunch: Small to medium in size, initially green which turns to dark purple on maturity. Shape irregular with few medium size branches. Peduncle medium.

Berry: Medium sized, dark purple in colour and round. They are slightly bloomed and strongly adhered to bunch. Skin thin to medium pulp sweet and has 15.5 percent sugar.

Seed: Brown medium sized seeds with straight beak and small chalaza.

Remarks: A vigorous variety used as a fresh fruit. The yields are moderate. It is moderately resistant to both anthracnose and downy mildew.

12. Monaca Sabo

Source: Introduced from Grape Research Station Andhra Pradesh Agric. University, Hyderabad, India in 1986.

Stem: Small to medium internodes with loose and shreddy bark.

Petiole: Small to medium petiole, green in colour.

Leaf: Small to medium in size, the upper surface of the leaf is darker green than the lower surface. The margins are serrated with 3 medium sized lobes which are soft and smooth.

Growing Shoot: Light green and straight. They have thick, medium sized tendrils which are simple or bifurcated. The tendrils are smooth and non-woolly.

Matured cane: The matured cane is light brown to brown in colour, straight and are thin to medium. Nodes are round and insignificant. Internodes are small, thin and round.

Bunch: Initially green and turn to purple on maturity. They are medium in size and irregular in shape. Bunch filling is lax with few branches and medium peduncle.

Berry: Deep purple medium to large size, oblong berries with slight bloom. Adherence to bunch is strong. Skin thin, pulp crispy and sweet. Sugar content 10.8 percent.

Remarks: It is a vigorous variety, very good for table purpose. The yields are moderate. It is susceptible to both anthracnose and downy mildew.

13. Ex-Zaria black

Source: The variety was found growing at some backyard gardens in and around Zaria, although its potential was not exploited.

Stem: Trunk internodes small to medium, with loose shreddy bark.

Petiole: Small to medium petiole, slightly tinted.

Leaf: Medium size leaves which are green on both surfaces. Leaf margin serrated with 3 medium sized lobes which are soft and smooth.

Growing Shoot: It is green in colour and straight. The tendrils are small, thick, smooth and from simple to trifurcated.

Matured cane: Medium in size and brown in colour. Nodes round and distinct. Internodes thin, small, and round.

Bunch: Initially green which turn to dark purple on maturity, conical in shape and large in size. Bunch filling is compact with many bunch branches. Peduncle small.

Berry: Medium sized, round berries which ripen simultaneously. The berries often split. Attachment to bunch is intermediate and they have thick bloom. Pulp crispy and sweet. Sugar content 11.4 percent. Skin medium.

Remarks: A moderately vigorous variety suitable for juice and wine making. Its yields are moderate to high.
It is moderately resistant to both anthracnose and downy mildew.

14. Ex-Hort. Samaru

Source: Botany Garden, IAR (abandoned grape orchard). It seemed to be one of those introduced in mid 1960.

Stem: It has medium to small internodes with tight and hard bark.

Petiole/leaf: Petioles are small and green in colour. Leaves small to medium in size, upper surface light green when compared with lower surface. Margins serrated with 3 small lobes which are soft and smooth.

Growing Shoot: It is green, growing straight with simple small, thin tendrils which are smooth.

Matured cane: Greenish brown in colour. Thin to medium in thickness. The nodes are angular and distinct with thin, small round internodes.

Bunch: Medium sized bunch, initially green which turns to deep purple on maturity. Bunch filling lax with many bunch branches. Peduncle large and thin.

Berry: Berry ripen simultaneously, small to medium in size and slightly oblong in shape. Adherence to bunch is very strong. Berries have slight bloom. Skin thin, pulp sweet and crispy, with 15.8 percent sugar. They have sherry aroma.

Seed: Small seeds with greenish brown colour, with straight beak and medium chalaza.

Remarks: A very good variety for table and wine making. The vine is moderately vigorous but the yield is high.
It is moderately resistant to both anthracnose and downy mildew.

15. Ex-Hospital

Source: Collected from Ahmadu Bello University Teaching Hospital , Tudun Wada - Zaria.

Stem: Small to medium internodes, trunk stocky with loose and shreddy bark.

Petiole/Leaf: Petiole small and tinted, leaves small and dark green on both sides. Leaf margin serrated with 3 small lobes which are soft and smooth.

Growing Shoot: It is light green with small, thin, smooth, simple or bifurcated tendrils.

Matured cane: They are thin to medium in thickness with angular and insignificant nodes. Internodes thin, small and round.

Bunch: Initial colour green and dark purple on maturity. Bunch is small, filling compact and irregular in shape. There are a few bunch branches with small peduncle.

Berry: Small round berries which ripen simultaneously. Berry attachment to bunch is intermediate. The berries have medium bloom. Skin medium, pulp slightly crispy and sweet. Sugar content 13.0 percent.

Seed: Brown and medium sized with slightly curved beak and large chalaza.

Remark: It is a low quality table fruit. The growth of vine is moderately vigorous. The variety yields are moderate.
It is susceptible to both anthracnose and downy mildew diseases.

16. MKM-7

Source: It was introduced from Grape Research Station, Andhra Pradesh Agric. University, Hyderabad, India in 1986.

Stem: It has small to medium internodes with loose and shreddy bark.

Petiole/Leaf: Petiole is small to medium, pigmented with medium sized leaves which are green on both sides. Leaves margins serrated with 3 small to medium sized lobes which are soft and smooth.

Growing Shoot: It is green and straight and bears thin, small, simple and smooth tendrils.

Matured cane: It is thin, brown in colour, with angular and insignificant buds. Internodes are medium in length, thick and round.

Bunch: The variety has a large size bunch, which is irregular in shape initially green but deep purple on maturity. Bunch branches are many and bunch filling is semi compact. Peduncle is medium.

Berry: The berries ripen simultaneously. They are round in shape small in size, and adhere to bunch strongly. They have a thin

skin, slightly bloomed and sweet and crispy pulp. The sugar percentage is 13.5.

Seed: Seeds are medium, brown in colour with straight beak and medium chalaza.

Remarks: It is a very high yielding good table variety. The vine is vigorous. It is susceptible to anthracnose and moderately resistant to downy mildew.

17. Ex-Maiduguri

Source: The variety was obtained from a private home garden at Maiduguri in 1986.

Stem: Trunk internodes are medium with loose and shreddy bark.

Petiole/Leaf: Small medium sized pigmented petiole. Leaves are small to medium in size. Leaf blade green on both sides. Leaf margin serrated with 3-4 small to medium lobes which are soft and smooth.

Growing Shoot: Green in colour, which bears small, thin, smooth, simple tendrils.

Matured cane: It is brown in colour, thin to medium in thickness. The nodes are round and insignificant. Internodes thin, small and round.

Bunch: Initially green, medium sized bunches which turn to light green on maturity. The bunch shape is conical and bunch filling is compact. The number of branches are few and peduncle small.

Berry: Berries are round, medium sized berries which mature simultaneously. Berry adherence to bunch is strong. Skin thin, pulp crispy and sweet. Sugar content 13.1 percent.

Seed: Medium sized brown seed with slightly curved beak and medium sized chalaza.

Remarks: It is a good variety for fresh fruit. The growth of vine is vigorous. The yield is moderate to high.
It is susceptible to both anthracnose and downy mildew.

18. Queen golden

Source: It was obtained from Grape Research Station, Andhra Pradesh Agric. University, Hyderabad, India in 1986.

Stem: Small trunk internodes. Bark is loose and shreddy.

Petiole/Leaf: Petiole medium in size and slightly pigmented. Leaves also medium in size and green on both sides. Leaf margin serrated, with 3 medium size lobes which are soft and smooth.

Growing shoot: It is green with medium sized simple, smooth and thick tendrils.

Matured cane: It is medium in thickness, brown with round and distinct nodes. Internodes are medium in length, thick and round.

Bunch: Medium to large bunches, irregular in shape, initially green but turn to deep purple on maturity. Bunch filling compact, bunch branches few. Peduncle medium.

Berry: Berries are large with slight bloom. They are round and mature simultaneously. Skin thin, pulp crispy and sweet with sugar content 12.1 percent. It has sherry aroma.
Seed: Seeds are brown in colour and medium in size. Beak straight and chalaza medium.
Remarks: It is a vigorous variety and a very high yielder. Good for table and wine making. It is moderately resistant to both anthracnose and downy mildew.

19. Regina
Source: The variety was introduced from Grape Research Station, Andhra Pradesh Agric. University, Hyderabad, India in 1986.
Stem: The trunk internode small to medium with loose and shreddy bark.
Petiole/Leaf: Medium to large petiole, green in colour. Leaves green on both sides and medium in size. Leaf margin serrated with 3 medium sized lobes, soft and smooth.
Growing Shoot: Light green in colour which bears simple or bifurcated small, thin and smooth tendrils.
Matured canes: Matured cane is thick and dark brown. The nodes are angular and distinct. Internodes medium in length, thick and round.
Bunch: Initially green which turn to deep purple on maturity. The bunch is small and irregular in shape. Bunch filling is compact with few branches. Peduncle small.
Berry: The berries are small and round and ripen simultaneously. They contain small amount of bloom and adhere to bunch strongly. Pulp crispy and sweet with 13 percent sugar.
Seed: Seeds are small, medium with straight beak and medium chalaza.
Remarks: It is a highly vigorous variety. Very good for dessert and wine making. The yields are moderate to high. It is moderately resistant to both anthracnose and downy mildew.

20. Thompson seedless
Source: It was obtained from Grape Research Station, Andhra Pradesh Agric. University, Hyderabad, India in 1986.
Stem: Trunk internodes medium with loose and shreddy bark.
Petiole/Leaf: Petiole is small and pigmented. Leaf small to medium in size, light green on both sides, margins serrated with 3 small to medium size lobes which are soft and smooth.
Growing Shoot: It is green with small, simple, thin and smooth tendrils.
Matured cane: It is thin and brown. The nodes are round and insignificant and small, thin, round internodes.
Bunch: Initially green which turn to yellowish green on maturity. It is conical in shape with many branches. Bunch filling is compact and peduncle is small.

Berry: It is round and ripens simultaneously. Berries are small and adherence to bunch is intermediate. Skin thin, pulp is very crispy and very sweet. Sugar content 18.8 percent.

Seed: Seeds are absent or very rudimentary. Immediately after fertilization the seed abort and remain as rudimentary greenish material.

Remarks: It is a moderately vigorous variety. It is an excellent raisin and table variety. It is also used for making wine. It is a low yielding variety. It is susceptible to anthracnose and moderately resistant to downy mildew.

BIOGRAPHY

Name:	Ishaya Samaila Majanbu
Date of birth	28th August, 1956
Business Addess:	NAERLS, ABU, Zaria
Home Address	UMCA Church, Agwara
State:	Niger State
Previous Qualifications:	B.Sc. (Agric); M.Sc. (Agronomy).

Institutions attended	Period	Certificate
L.E.A. Primary School, Agwara Niger State.	1963-1969	First School Leaving Certificate
Awgu County High School, Nenwe, Enugu State.	1971	-
Borgu Secondary School, New Bussa, Niger State	1972-1975	West African School Certificate
Ahmadu Bello University, Zaria		
School of Basic Studies	1975/76 session	I.J.M.B. (A.B.U.)
Faculty of Agriculture	1976-1979	B.Sc. (Agriculture)
Department of Agronomy	1981-1984	M.Sc. (Agronomy)

Posts held since the award of first Degree

Organization	Period	Position
National Youth Service Corps	1979/80 Session	Agriculture Extension Worker
National Agricultural Extension and Research Liaison Services	1980-Sept.1981	Graduate Assistant
Ahmadu Bello University, Zaria	Oct,1981-Sept,1984	Assistant Extension Specialist
	Oct,1984-Sept,1987	Extension Specialist II
	Oct.1987-Sept,1990	Extension Specialist I
	Oct,1990 - To-date	Senior Extension Specialist
Niger State Government	Jan,1992-Jan,1994	Director General (General Services/ Agriculture)
	Jan,1994-Nov,1995	Honourable Commissioner (Agriculture)

Year of Admission into Post-graduate School: 1985

Admission Number: Ph. D/AGRIC/10768/85-86