THE EFFECT OF NITROGEN AND PHOSPHORUS FERTILIZERS AND FARMYARD MANURE ON GROWTH AND YIELD OF LOCAL GARDEN EGG (*Solanum qilo*) VARIETY SAMARU STRIPED

BY

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A thesis submitted to the Postgraduate School,
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DEPARTMENT OF AGRONOMY
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DECLARATION

I hereby declare that this thesis 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.

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CERTIFICATION

This thesis entitled THE EFFECT OF NITROGEN AND PHOSPHORUS FERTILIZERS AND FARMYARD MANURE ON GROWTH AND YIELD OF LOCAL GARDEN EGG (*Solanum gilo*) VARIETY 'SAMARU STRIPED', by Clement Okoye EZEAKUNNE meets the regulations governing the degree of Master of Science of Ahmadu Bello University, Zaria, and is approved for its contribution to scientific knowledge and literary presentation.

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ABSTRACT

An experiment on the effect of nitrogen and phosphorus fertilizers and farmyard manure on growth and yield of a local garden egg (Solanum qilo) variety 'Samaru Striped', was conducted under rainfed conditions in 1983/84 at the Horticultural Unit of Ahmadu Bello University, Samaru, Zaria.

Three levels of each of the nutrients (Nitrogen - 0, 75 and 150 kg/ha; Phosphorus - 0, 30 and 60 kg/ha and Farmyard manure - 0, 10 and 20 t/ha) were applied. The investigation revealed that each of the nutrients improved both the vegetative growth and fruit yield. Nitrogen application remarkably increased plant height, number of branches, number of leaves, leaf area index, total dry matter production and number of fruits per plant,, Total yield per hectare increased significantly with each increased application of nitrogen up to 150 kg/ha, at which 39.44 t of fruits were producedo However, the optimum level of nitrogen application for optimum yield was 143 kg/ha.

Only application of up to 60 kg P2O5_/ha significantly increased yield. This produced about 35.22 t/ha of fruitS. A positive linear response between yield and farmyard manure application was shown. Each level significantly increased fruit yield; 20 t/ha produced 35.95 t of fruits.

The interdependency of the nutrients in improving yield was quite evident. The highest fruit yield was obtained by a combination of the highest levels of N, P and Farmyard manure. Neither the nutrients, nor their interactions significantly influenced the crude protein content of the fruits.

A highly significant positive correlation was found between yield and vegetative growth characters. The number of days to flowering was, however, not significantly correlated with yield..

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Chapter 1

INTRODUCTION

1.1 Botany, Origin and Classification

Garden egg, also known as eggplant, belongs to the family Solanaceae which includes several other economic crops such as tomato (Lycopersicon esculentum), the chilli and bell peppers (Capsicum spp.), tobacco (Nicotiana tabacum) and a number of ornamental plants. It is a perennial shrub usually grown as annual. According to Norman (1974) garden egg is bushy and grows to a height of 120 cm long and alternately arranged on the stems. Garden egg is a much branched plant with a strong tap root and a deep, extensively branched but not widely spread root system. It is self-compatible and highly fertile. The flowers are solitary or in clusters of two or more opposite the leaves. The fruit is a berry differing in size and form. It is variously coloured and could be green, dark purple, red, white or yellow (Grubben, 1977).

Various views have been expressed about the origin of garden egg. Vavilov (1926) opined that its centre of origin was Indo-Burma where large number of genetic varieties were found. However, Bhaduri (1951) and Omidiji (1976) suggested that Solanum melongena possibly evolved independently in different parts of the world.

1.2 Production and Uses

The total world production of eggplant in 1980 was 4.5

million tonnes, produced on 323,000 hectares of land (F.A.O., 1980) giving an average yield of 13.9 t/ha. In Africa, Ghana, Egypt and Ivory Coast are listed as producers but production in these countries is very low. For example, production in Ghana is of the order of 25,000 t/year on an estimated 10,000 hectares giving a yield of 2.9 t/ha. There are no production figures for eggplant in Nigeria and this supports the fact that production may be minimal in terms of trade statistics. However, it is estimated that production is of the order of one tonne per hectare (Annon, 1976), with large quantity being used for home consumption and local markets.

Eggplant is widely used as a vegetable throughout the warmer regions of the world (Choudhury, 1976). According to Oyenuga (1960) and Oyenuga and Fetuga (1975), it supplements starchy foods in addition to being a cheap source of protein, minerals and vitamins. Kogbe (1981) reported a number of species such as S. indicum, S. nigrum and S. aethiopicum, which are grown to a limited extent for their leaves. Some other species for example S. ferox in South-east Asia, and S. torum and S. gilo in Africa are cultivated to a large extent for their immature fruits which are chewed raw, cooked as vegetables and also for seasoning other foods (Purseglove, 1969; Tologbonshe, 1984). There are other species of Solanum which are used for native medicine throughout the tropics. The alkaloid 'solanine' extracted from the roots, leaves and fruits, is well known for its therapeutic value (Choudhuri, 1984). S. aviculare and

S. Khasianum have also gained importance as source of solasidine used for synthesis of steroid hormone. Among these, S. gilo appears to be more widely grown by peasant farmers in Nigeria both for consumption and for market probably because of its prolific fruit production and its ability to transport and store well.

1.3 Agronomy/Cultural Practices

Agronomically, garden egg requires a well drained fertile sandy loam soil with a high organic matter content. Soils low in humus should be supplied with farmyard manure at the rate of 20 to 30 t/ha. Nothmann and Koller (1975) reported that eggplant thrives better in tropical and sub-tropical weather condition. It is susceptible to low temperature but requires an optimum day temperature range of 25 to 35^{0}C.

Garden egg can be cultivated directly by seeding but preferably raised in a nursery and later transplanted to the field. Seeds are sown in seedboxes or in nursery bed. These germinate in 7 to 10 days and are transplanted 4 - 6 weeks later at a spacing of 75 cm square.

Fruits are ready for harvesting about 7 weeks after transplanting and continue up to about 10 weeks after transplanting. Regular harvesting at weekly interval is essential to encourage further fruiting and to avoid overmaturity. The size and number of fruit yield progressively declines after the second and third harvests (Neowah, 1969).

1.4 Problems of Low Yield

Factors responsible for low yields of garden egg, include adapted varieties, and inadequate management practices. For example, it is generally agreed that most producers of eggplants do not care for fertilizer and plant protection measures.

Sampson (1971) stressed the importance of fertilizer application for eggplant production. Ware and McCollum (1975) have indicated that eggplant is a very heavy factor and, therefore, requires adequate fertilizer nutrition for improved productivity. Apart from breeding work that has been carried out recently (Omidiji, 1975 and 1976), much is yet to be done to determine the responses of garden egg to different plant nutrient sources in Nigeria.

Since farmyard manure and compost could be readily available in northern part of the country and has merits for improving fertility and soil structure, its incorporation with artificial fertilizers would be an added advantage. This investigation was, therefore, undertaken with the following objectives:-

1. To study the effect of levels of applied nitrogen, phosphorus and farmyard manure on the growth, yield and yield components of eggplant.

2. To assess the effect of these treatments on the crude protein content of the fruits.

Chapter 2

REVIEW OF LITERATURE

2.1 Yield and Yield Contributing Factors of Garden Egg

The number of fruits produced per plant greatly influences yield of garden egg. Shrivastrova and Sachan (1973), Singh and Khanna (1970) and Vijay et al. (1978), reported that fruit number per plant is a major yield component in eggplant and should be given more weightage in the selection of better yielding variety.

Fruit size is inversely related to fruit number but linearly correlated to fruit weight (Vijay et al., 1978; Siddiqui and Khan, 1979). As such eggplants bearing large-sized fruits are not expected to produce large number of fruits or vice versa. Other growth character associated with yield include plant height (Mestia and Chauhan, 1978); plant spread (Addae-Kegya and Norman, 1977), and number of branches per plant (Singh and Khanna, 1970).

2.2 Mineral Nutrition in Garden Egg Production

Garden egg requires nutrient elements for proper growth and development. This is especially true when it is realised that garden egg plant is a long-seasoned crop often perennial in nature, and, therefore, should be furnished with all the

nutrients required during its period of growth.

Organic matter in the form of farmyard manure and compost was the most popular source of mineral nutrients used for vegetable growing in Ghana (Sinnandurai, 1973). It is, however, lower in nutrient concentration than the inorganic fertilizers (Dennison, 1961; Kagbe, 1976) and is more difficult to procure in a large quantity capable of furnishing the high nutrient demand of eggplant. Because of this, inorganic fertilizers especially nitrogen and phosphorus are used either solely or in combination with organic manure to provide the mineral requirement of eggplant (Petrov and Doikova, 1975).

Adequate mineral nutrition is crucial in sustaining high yields of eggplant especially in intensively cultivated land because of the important role it plays during various phases of the plant growth (Gutschick, 1977). According to Rajput and Singh (1962), and Sauchelli (1970) during the early period of growth, adequate nutrition, especially nitrogen supply is important in sustaining an abundant and persistent vegetative cover necessary for vital photosynthetic activities. At the later stage, when the flowers are initiated and fruits formed, optimum mineral nutrition is also required for effective flower formation, fruit set and mobilization of synthesised plant food to storage organs.

2.3 Effect of Nitrogen on Garden Egg

Nitrogen application promotes vegetative growth by enhancing cell division and elongation. As an essential unit of chlorophyll it indirectly determines the amount of photosynthetic activity of eggplant.

According to Singh and Sandhu (1970), Choudhury et al. (1902), optimum nitrogen application encourages eggplant growth by stimulating long and large fuliage. When applied in deficient amount, it causes reduction of growth. The number and size of leaves become reduced, roots become thin and fibrous. On the other hand, it has been reported that excess nitrogen encourages luxurient, thick and succulent growth of leaves accompanied by reduced flower and fruit formation (Verma et al., 1970; Addae-Kagya and Norman, 1977).

2.3.1 Effect of nitrogen on garden egg growth and development

Various researchers including Eguchi et al. (1950); Mertia and Chauhan (1970); Addae-Kagya and Norman (1977); Gupta et al. (1970) and Kogbe (1902) have reported significant increase in eggplant growth due to nitrogen fertilization. This is due to the fact that nitrogen is an essential constituent of eggplant metabolites and chlorophyll necessary for promoting aerial vegetative growth increasing the top-to-root ratio and essential for fruit and seed formation (Olson et al., 1971).

Singh and Sandhu (1970) observed that leaf area index, plant height and stem girth were all affected by soil and foliar application of nitrogen. The leaf area was increased with high dose of nitrogen irrespective of the method of application. The largest leaves were obtained in plots fertilized with 75 kg/ha of nitrogen. Plant height also progressively increased with increasing levels of nitrogen. Tallest plants were obtained with 100 kg N/ha. There was, however, no significant response by stem thickness to nitrogen application, though increased doses of nitrogen promoted increased stem girth non-significantly than the control. The thickest stem was obtained with 100 kg N/ha. Similar observations have been made on tomatoes (Montelaro et al., 1952; Bajpai and Bajpai, 1963) and pepper (Olarewaju, 1977) both of which belong to the same family as eggplant.

A linear relationship was observed between the dry matter production and increase in nitrogen application by Seth and Dhauder (1970), Doikova (1977) and Kogbe (1982). Number of branches per plant is also reported to increase by nitrogen application (Singh and Sandhu, 1970; and Gill et al. 1974).

The influence of nitrogen on flower development in eggplant has also been reported. Eguchi et al. (1950), Iwata et al. (1960), and Aliev (1972) found that nitrogen applied alone, delayed flower initiation and led to differentiation of flower buds at higher nodes, and that flower differentiation

occurred early in plots receiving N P K and N P. Eguchi et al. (1950) however cautioned that flower initiation is multi-factor controlled character, and so should not always or entirely be attributed to nitrogen effect. In many crops, it is induced by low temperature, in others it is controlled by day-length, while in some it is essentially effected by nitrogen.

In contrast, Singh and Sandhu (1970), and Verma et al. (1970) observed that earliness in flowering was encouraged with increase in the level of nitrogen from 25 to 50 kg N/ha and that further application beyond 50 kg N/ha delayed flowering.

2.3.2 Effect of nitrogen on fruit yield, yield components and attributes

Experiments conducted by Singh and Sandhu (1970) showed that increase in number of fruits formed occur with increased level of nitrogen. The highest number of fruits per plant was, however, obtained by application of 100 kg N/ha. Similar observations were made by Mertia and Chauhan (1970).

Changes in fruit size have been attributed to the concentration and rate of supply of available nutrients to plants. Gupta et al. (1970) while working on response of eggplant to nitrogen, phosphorus and potassium fertilization with different spacings observed a significant difference between 75 kg N and no nitrogen control, although no such difference occurred between 75 and 150 kg N/ha treatments. Similar results have

been obtained by Uzo (1971), Lal and Pundrik (1971), Ludilov and Ludilova (1975), Gupta and Shukla (1977) and Hari et al. (1978) in related crops. However, Addae-Kagya and Norman (1977) observed that nitrogen fertilization did not have significant effect on fruit size of local Ghanaian eggplant, Solanum integrifolium.

Malyshkina (1975), Sulikeri (1977), Gupta et al. (1979), and Kogbe (1982) observed that yield of eggplant increased significantly with increase in nitrogen up to 100 kg/ha but 150 kg N/ha depressed yield. This was probably caused by a shift in carbohydrate-nitrogen ratio due to excess nitrogen application which eventually favoured vegetative growth at the expense of fruit development. However, Gupta et al. (1978) did not observe such decrease in yield with application of 150 kg N/ha.

2.4 Effect of Phosphorus on Garden Egg

2.4.1 Effect of phosphorus on garden egg growth and development

The effect of phosphorus on crop growth is manifested in earliness of crop maturity and enhanced root system covering a wider area of the soil. Deficiency of phosphorus causes stunted growth, reduced yield and leads to inefficient and limited utilization of soil nitrogen (Hari et al., 1978; Balasubramanian et al., 1979; and Negi et al., 1982).

Phosphorus application promotes crop root growth and

consequently enhances nutrient uptake for a greater vegetative and fruit development. Aliev (1972) noted that its application, immediately after emergence of eggplant, stimulated growth until flowering but declined later. It also advanced flowering when applied alone or in combination with nitrogen and potassium. Mertia and Chauhan (1970), and Petrov and Doikova (1975) further reported that even though nitrogen advanced plant growth, a greater growth occurred while in combination with phosphorus.

Similar findings have been made on other solanaceous crops. In sweet pepper, for example, a high dose of phosphorus application (250 P_2O_5/ha) resulted in a considerable reduction in number of days to flowering (Gill et al., 1974). Doikova (1977) also observed a progressive increase in dry matter yield with increase in rate of phosphorus application up to 120 kg P_2O_5/ha. In culture solution, the influence of phosphorus on growth of tomato was also demonstrated when phosphorus application was withheld for 10 days after seedling had produced 8 or 9 leaf primodia. It markedly reduced flower number on fruit truss, and the time to anthesis was lengthened by seven days (Menary and Staden, 1976).

The effect of phosphorus on garden egg branching, however, has been inconsistent. While non-significant response was observed by Sharma and Mann (1972) and Ghatnagar and Pandit (1979), Gill et al. (1974) reported significant increase in number of branches per plant.

2.4.2 Effect of phosphorus on yield, yield components and attributes

Conflicting results on the effect of phosphorus on eggplant has been reported. Seth and Dhauder (1970), studied the effect of fertilizer and spacing on eggplant and observed that the levels of phosphorus - 30 and 60 kg P_2O_5/ha - had no significant effect on fruit yield though fruit quality in fertilized plots were slightly better than in control. On the other hand, Gupta et al. (1970) observed that phosphorus fertilization have significant effect on fruit yield. They noted that yield was highest at 60 kg P_2O_5/ha and was significantly higher than yield at 30 kg P_2O_5/ha and the control. In another year of study, yield at 60 kg P_2O_5/ha was at par with that of 30 kg P_2O_5/ha but significantly higher than the control. Similarly, Mertia and Chauhan (1970), and Aliev (1972) reported significant increases in eggplant yield with increasing levels of phosphorus, up to 120 kg P_2O_5/ha.

Gupta et al. (1970) observed that phosphorus fertilization significantly reduced the number of fruits although fruit number at 60 kg P/ha was significantly higher than at 30 kg P/ha. Similar results have been reported by Gupta and Shukla (1977), Sobulo et al. (1974) in tomato, and Gill et al. (1974) in Sweet pepper. Olarewaju (1977) and Sagiv and Kafkafi (1976) on the other hand found that application of phosphorus at rate of up to 363 kg P/ha had no significant effect on the total number of

fruits per plant in chilli pepper.

Increase in fruit size of eggplant due to increased level of phosphorus application was reported by Gupta et al. (1970). They found that fruit size at 60 kg P/ha was significantly higher than at 30 kg P/ha. Similarly, in tomato, Gupta and Shukla (1977) observed that phosphorus at 30kg P/ha and 60 kg P/ha fertilization resulted in higher fruit sizes than no phosphorus. Inyang (1966) also recorded significant increase in tomato fruit size after application of 50 kg P/ha although higher rates of fertilizer were significantly better than lower ones.

2.5 Effect of Farmyard Manure on Garden Egg

2.5.1 General effect of farmyard manure on garden egg

The use of organic manure in form of farmyard manure, compost and green manure is widely recognised. (Sinnendurai, 1973). It has been in use for a long time and it is still preferred in many communities to mineral or inorganic fertilizers. This is no doubt due to difficulties encountered in procurement and delivery of inorganic fertilizers (Robinson and Falusi, 1974). Preference to organic manure is also due to its other advantages, such as improved retention of plant food nutrients and moisture in the soil, improved plant-soil-water relationship, slow release of nitrogen and improved

structure and porosity of soil (Bunting, 1963; Ajakaiye, 1971).

Eggplant is an exhaustive crop capable of remaining productive for more than one growing season depending on the availability of plant food nutrients and moisture (Ware and McCollum, 1975). In view of this, it requires constant nutrient supply to sustain it for the prolonged life. Farmyard manure seems best suited for supply of the required nutrients because of its ability to release nutrients gradually for a long time.

Doikova (1979) reported that application of 20 tonnes of farmyard manure per hectare to eggplant promoted growth and increased yield significantly above the control and that a greater yield was achieved when 20 tonnes of farmyard manure per hectare in combination with 420 kg N plus 120 kg P_2O_5 and 240 K_2O/ha was applied. Also yield increase of 200% over the control has been reported when N P K plus farmyard manure were applied (Aliev, 1972). Such combinations appreciably advanced flowering when compared with other treatments. Omori et al. (1972). Petrov and Doikova (1975), Doikova (1976), and Sulikeri (1977) also found that application of farmyard manure up to 20 tonnes/ha increased eggplant yield significantly above the control.

2.5.2 Farmyard manure effect on growth and development

The ability of farmyard manure in influencing crop

growth and development has been attributed to its nutrient composition as well as its effect on physical and biological properties of the soil. In the savanna areas of Nigeria, farmyard manure is valued mainly because of its phosphorus content as most savanna soils are deficient of phosphorus (Balasubramanian et al., 1979; Mokwunye, 1981). Thus the remarkable crop returns obtained from small dressings of farmyard manure (Abdulahi and Lombin, 1978) may be attributed largely to its nutrient content, especially phosphorus, micronutrients and to a lesser extent nitrogen and potassium (Djokoto and Stephens, 1961; Peat and Brown, 1962; Heathcote, 1970; Hartley, 1973), and its soil improvement characteristics (Bache and Heathcote, 1969; Heathcote, 1970).

Aliev (1972) in a trial involving N P K and farmyard manure on eggplant, observed that farmyard manure at the rate of 20 t/ha significantly increased the fruit dry matter, sugar and vitamin C content. In another experiment in which N P K and farmyard manure were used, Doikova (1977) found that total dry matter content increased with increasing rate of the manure up to 40 t/ha though manure alone proved less effective than mineral fertilizer.

Other solanaceous crops have also been reported to show positive response to farmyard manure application. For example, Kirti et al. (1973) observed that nitrogen fertilizer progressively increased growth of potato plant but a combination

of poultry manure at the rate of 15 t/ha and nitrogen fertilizer at rate of 160 kg N/ha produced the maximum yield. Also Feigin (1960) compared the effect of farmyard manure, single superphosphate and ammonium sulphate and reported a significant response to all the three sources of plant nutrient but obtained the highest yield by application of 4 tonnes of farmyard manure/1000 m^2 without additional fertilizer. In pepper, however, Sagiv and Kafkafi (1976) observed that application of 12.5 tonnes of farmyard manure per hectare did not significantly affect fruit yield.

2.5.3 Farmyard manure effect on total fruit yield/ha

Farmyard manure essentially contains phosphorus, nitrogen, potassium and micronutrients. Its ability to increase fruit yield is mainly due to the activities of phosphorus and nitrogen. In a 24 years of cropping experiment at Samaru to determine the effect of farmyard manure and N P K fertilizers on crop yield and soil residual phosphorus, Mokwunye (1977) reported that farmyard manure was a major source of nitrogen and phosphorus. He observed that annual application of 5 tonnes/ha of farmyard manure throughout the period of the experiment, contributes 29.5 kg P_2O_5 per hectare to the residual phosphorus, and that this amount was enough for the highest crop yield obtained.

Kogbe (1976) studied the nutrient requirements of Nigerian local leaf vegetables and reported that both marketable and

edible yields increased with increase in rate of poultry manure applied. The highest marketable and edible yields were obtained at the highest rate of manure (40 t/ha) applied. Inyang (1967) suggested the use of 25 t/ha of farmyard manure with nitrogen fertilizer as basal dressing for tomato production in both wet and dry season in northern Nigeria. Yayock and Awoniyi (1974) also compared the effects of different animal manures including those of poultry, cow, pig and horse with inorganic fertilizers on maize and sorghum and found that poultry, pig and inorganic fertilizers persistently gave the highest yield of stalk and seed.

Similarly, experiments to determine the effect of farmyard manure on eggplant indicate that increased yield is often associated with application of farmyard manure. Aliev (1972), Omori (1972), and Doikova (1979) reported significant increases in eggplant yield when farmyard manure was applied in combination with inorganic fertilizers.

2.6 Interaction Effects

Soil nutrients are often complementary in their effect on plant growth so that a nutrient would require the presence of another before it can exhibit a maximum effect in promoting crop growth and development. The interaction effect of one nutrient on the other can significantly influence yield depending on the strength of the interacting nutrients and factors affecting their availability. Significant interaction

effect may not always be observed especially when the soil contains an adequate amount of any of the nutrients involved.

2.6.1 Nitrogen and phosphorus interaction

Nitrogen is directly involved in phosphorus metabolism and the amount of nitrogen required by a plant depends to some extent on the level of available phosphorus (Gunes, 1959). Interaction between nitrogen and phosphorus occurs in different ways. According to Balasubramanian et al. (1979) phosphorus deficiency retards nitrification in soil and as such leads to low efficiency of applied ammonium nitrogen fertilizers. Also different nitrogenous fertilizers are capable of influencing soil pH levels and, therefore, bound to affect phosphorus availability. Furthermore, nitrogen and phosphorus are both essential for plant growth and deficiency of either will limit crop growth. Results obtained by Nye (1952) and Stephens (1960) under comparable conditions in northern Ghana suggests that the interactions between nitrogen and phosphorus would be high and positive where the effect of individual elements themselves were high.

There was much delay in flower differentiation in eggplant (Eguchi et al., 1950) and in tomato (Uzo, 1971) supplied with only nitrogen but occurred earlier in plots which received combined N P or N P K. In other words an adequate supply of phosphorus nutrient tended to counteract the delay in maturity caused by excess nitrogen application. Experiments by Mertia and Chauhan (1970), Ludilov and

Ludilova (1975), Gupta et al.,(1970), and Mangual (1901) revealed that application of both nitrogenous and phosphatic fertilizers, combined, resulted in a greater yield response in eggplant when compared to the effect of either of the two fertilizers applied singly.

While Gill et al. (1974), Gupta and Shukla (1977), and Gupta et al. (1970) observed significant increase in yield of solanaceous crops due to nitrogen and phosphorus interaction, Verma et al. (1970), and Umrani and Khot (1973) reported no significant increase in yield due to nitrogen and phosphorus interaction.

2.6.2 Nitrogen and farmyard manure interaction

Farmyard manure is generally beneficial to plant growth. Though it cannot replace mineral fertilizers, its use would help to increase the efficiency of mineral fertilizers by improving the physical properties of the soil such as water holding capacity, aeration and soil structure (Ajakaiye, 1971). According to Dennison (1961), the full benefits of humus appear only when it is used in combination with suitable inorganic fertilizer. Analytical experiments by Hemingway (1961) revealed that nitrogen is not a major component of farmyard manure and as such its influence on crop growth is not always very evident except when applied in a very large amount. Moreover, the small quantity present is usually tied up in unavailable form so that less than 30 per

cent of the total nitrogen in farmyard manure is utilized in the first year of plant growth. Probably interaction between nitrogen and farmyard manure may not always increase yield significantly except if the available phosphorus content of the soil is very low.

2.6.3 Phosphorus and farmyard manure interaction

Phosphorus is the second most important nutrient necessary for plant growth but it is not easily available to plants because of fixation. Farmyard manure however has been suggested to be able to increase phosphorus availability (Brady, 1974). Ortlepp et al. (1964) examined the effect of farmyard manure on the use of phosphorus by plant and observed that utilization of phosphorus in superphosphate and farmyard manure mixture was increased by 32 per cent. This resulted in a considerable higher crop yield than separate application of manure or single superphosphate. Mokwunye (1981) obtained similar results when he observed spectacular maize response to application of 5 tonnes per hectare of farmyard manure on phosphorus fertilized plots.

Sagiv and Kafkafi (1976) however could not observe any significant difference in yield when farmyard manure and phosphorus fertilizer applications were combined.

2.6.4 Nitrogen, phosphorus and farmyard manure interactions

When applied alone, nitrogen or phosphorus often

increases yield. This, however, does not apply to every level of application. At higher rate of application, yield increase may not correspond to increasing level of fertilizer application or yield may even decrease.

Combined application of these fertilizers especially with farmyard manure has been known to increase their utilization at higher levels of application (Dennison, 1961; Martin and Chauhan, 1970; Aliev, 1972).

Petrov and Doikova (1975), and Doikova (1976 and 1979) observed that nitrogen and phosphorus increased yield when applied together to eggplant. However, a greater yield occurred when combined with farmyard manure, and that plots receiving 20 tonnes farmyard manure plus 240 kg N and 120 kg P_2O_5 were the first to produce fruits and also produced the highest yield. Similar observations were made on tomato by Spasov and Rankov (1971).

Fox and Komproth (1971) suggested that the greater increase in yield shown when farmyard manure is applied in combination with mineral fertilizers could be due to micronutrients supplied by farmyard manure, and its ability to improve the physical properties of the soil.

2.7 Fertility Status of Savanna Soils

2.7.1 Nitrogen status of savanna soils

The chemical status of savanna soils is very poor

(Jones, 1973b, 1974; Mokwunye, 1977). Over half of the soils are ferrugineous tropical soils which are generally low in native fertility. In particular, is the low status of nitrogen level. Among the 295 samples of well drained top soils from all over the region examined by Jones (1973b) values for nitrogen levels ranged from 0.0000 to 0.250 per cent with a mean of 0.051 per cent. Consequently, savanna soils often respond to nitrogen fertilizer application (Goldsworthy, 1967; Jones 1973b; Ologunde and Egharevba, 1901).

In many soils, peak availability of native nitrogen occurs shortly after the start of the rains due to relatively high concentration of nitrate nitrogen in the surface soil and thereafter declines as a result of leaching and immobilization (Jones, 1974).

The low level of nitrogen in savanna soils has been attributed to several factors such as the low native organic matter content. Soil mineral nitrogen is obtained as a result of decomposition of soil organic matter. Thus, savanna soils which are low in organic matter (Ahn 1970; Jones, 1973a) are equally poor in mineral nitrogen. Another cause of the low nitrogen content of the savanna soils is the seasonal bush burning. This not only destroys the organic matter cover but decomposes soil nutrients into gaseous forms unavailable to plants. Nye and Greenland (1950) estimated that about 20 kg/ha/annum of nitrogen is

lost in this way from savanna soils. Losses through denitrification and volatilization can also occur. In the tropics, nitrogen losses are intensified by high temperature which acts indirectly by accelerating microbial activities through which nitrogen is assimilated, and directly by increasing volatilization (Odu, 1967).

Savanna soil nitrogen content is however built up in other ways. Evidence exists that mineral nitrogen can be increased in savanna soils as a result of rain and thunderstorm. Jones and Bromfied (1970) reported that as much as 4 - 5 kg/ha/annum of nitrogen can be contributed in this manner at Samaru. Atmospheric nitrogen can also be fixed in the soil by symbiotic fixation and non-symbiotic fixation. While the contribution of the later is negligible, Nye and Greenland (1960) estimated that as much as 30 kg/ha/annum of nitrogen is fixed symbiotically.

2.7.2 Phosphorus status of savanna soils

Phosphorus is the main nutrient deficient in savanna soils (Nye, 1954; Uyovbisere, 1979; Ologunde and Eghareva, 1981). According to Jones (1974), the soil total phosphate content is generally very low. Phosphate deficiency is wide-spread and occurs in nearly all crops in most parts of the savanna. This is because the amount of phosphorus mineralised annually from savanna soils is often below the requirement for a good crop yield. The above problem is

compounded in derived savanna crops where Nye and Bertheux (1957) observed that if such area is subjected to long period of intermitent cropping and bush fallow, the surface soils are likely to be low in their capacity to supply available phosphorus.

In his study of savanna soils of Nigeria, Uyovbisere (1979) concluded that the total phosphorus content of the soils were generally low with average values of 147.0 and 97.7 ppm in the surface and sub-surface soils, respectively. He attributed the low phosphorus content of the savanna soils to the low apatite content of the soil minerals. Their parent rocks consist mainly of schists, granitic, gneiss and sandstone all of which have low apatite content.

The low value of phosphorus content of Nigerian savanna soils was also reported by Jones and Wild (1975). They recorded a mean value of 143 ppm phosphorus after analysing 334 topsoil samples for their phosphorus content.

2.7.3 Organic matter status of savanna soils

Most savanna soils are inherently low in organic matter and, therefore, incapable of sustaining good crop growth for even one growing season (Ologunde, 1981). According to Ahn (1970) the long severe dry season of the savanna region aggravated by annual grass burning, causes a general decrease in vegetation which results in low organic matter content of the soil. Most of the vegetation of the

savanna may be eaten by grazing animals or burnt off by bush fire and consequently do not decompose to humus. The humus in the savanna soils is mainly that derived from the decay of grass roots which have escaped combustion. It is, therefore, usually much less than in a forest soil, and its distribution is also somewhat different with a greater proportion of the total humus in the savanna soil being below the top soil (Ahn, 1970).

Beside being a source of nutrients, particularly nitrogen, the organic matter in savanna soils is important in maintaining soil structure. It also improves the water holding capacity, the cation exchange capacity of the soil, and prevents or controls soil erosion.

The amount of organic matter in a soil is a product of a number of diverse factors acting over a period of time. According to Jones (1973a) the two most important factors which govern the organic matter content of West African savanna soils are their clay content and annual rainfall. The amount and distribution of rainfall will determine the nature of vegetation, the duration and its sustenance. Small and short duration rainfall sustains little vegetation for a very short time. Clay soils accumulate water and, therefore, hold enough for longer time to enable good vegetation growth.

Other factors such as cultivation, bush fire, temperature and altitude also play their part in determining the extent of organic matter of the soil.

Chapter 3

MATERIALS AND METHODS

3.1 Location of Experiment

Field experiments were conducted at the Horticultural Garden of the Institute for Agricultural Research, Ahmadu Bello University, Samaru, Zaria, under rainfed condition in 1983. Samaru, which is 605 metres above sea level, is within the Northern Guinea Savanna ecological zone of Nigeria and situated at 11^{0} 10'N, 07^{0} 38'E.

The soil of the experimental site was sandy loam of ferruginous tropical soil, low in cation exchange capacity and organic carbon (Klinkenberg and Higgins, 1960). Details of the physico-chemical analysis is presented in Table 1. Rainfall at Samaru during the period of the experiment is tabulated in Appendix 1.

3.2 Treatments and Experimental Design

The treatments were made up of three levels of nitrogen (0, 75 and 150 kg N/ha), three levels of phosphorus (0, 30 and 60 kg P_2O_5/ha) and three levels of farmyard manure (0, 10 and 20 t/ha) in all possible factorial combinations. This gave a total of 27 treatments which were replicated four times in a factorial randomised complete block design.

The nitrogen and phosphorus were supplied as calcium

Table 1. Physical and Chemical Properties of the Farmyard Manure used and Soil taken at two depths from the experimental site at Samaru.

Soil and farmyard manure characteristics	FYM	Soil Depths (cm) 0-15	15-30
pH in water (1:1) ratio	8.5	5.5	5.3
pH in water (1:2.5 ratio)	8.4	6.3	6.0
Organic Carbon (%)	9.4	0.6	0.25
Total Nitrogen (%)	0.5	0.03	0.01
Available phosphorus (ppm)	-	7.92	4.7
Total phosphorus (ppm)	234.3	-	-
Exchangeable:-			
K (m. eq/100g)	23.02	0.12	0.11
Ca "	9.40	1.31	2.03
Mg "	23.04	0.41	0.00
CEC "	84.6	17.0	21.4
Particle Size:-			
Clay (%)	-	12	22
Silt (%)	-	30	30
Sand (%)	-	58	48

ammonium nitrate (26% N) and single superphosphate (18.5% P_2O_5), respectively. The farmyard manure was supplied in the form of cow dung which had been well rotted. The physico-chemical analysis of the farmyard manure is shown in Table 1.

3.3 Nursery Management

The nursery plot was thoroughly tilled on 29/ 1903 and /May a bed measuring 1.3 x 6 metres prepared. Healthy seeds of Solanum gilo var. 'Samaru striped' were drilled on the bed at rows 15 cm. apart. These were later mulched and heavily watered by the use of fine nozzled watering can.

After germination, the mulch was removed and placed in between the rows of growing seedlings. The seedlings were watered as the need be, and also kept weed free until 5 weeks after sowing when they were transplanted to the field.

3.4 Preparation of Experimental Site

The experimental site was ploughed, harrowed and then built into raised flat beds of sizes 2.5 x 6 m to represent a plot. Twenty-seven of such plots, each representing a treatment, made up a replicate.

3.5 Transplanting

Seedlings were transplanted from the nursery bed to the field beds on 2 July, 1903. Nursery bed was heavily watered and left for about 2 hours before seedlings were transplanted, by the aid of hand trowel. Only healthy and uniform sized seedlings were transplanted. Selected seedlings were spaced 75 cm between rows and 50 cm within rows giving a population of 40 plants per plot.

3.6 Fertilizer Application

Farmyard manure was applied in one single dose two weeks before transplanting by broadcasting and mixing with the top soil of the seed bed. Phosphate fertilizer was applied in a single dose, in grooves 5 cm deep and 5 cm away from each plant, soon after transplanting. Nitrogen fertilizer was applied in two equal split doses at 2 and 6 weeks after transplanting. A basal application of 40 kg K_2O/ha as muriate of potash was made before preparation of beds.

3.7 Weeding

Hoe weeding was adopted to control weeds. This started 2 weeks after transplanting and continued till eight weeks after transplanting when the foliage cover of the crop was dense enough to smother away competing weeds.

3.8 Insect Control

A biweekly application of 'Ambush 25' (250g permethrin per litre formulated as emulsifiable concentrate) at the rate of 12ml in 20 litres of water was carried out against insects. This was conducted up to 8 weeks after transplanting.

3.9 Harvesting

Mature fruits were manually harvested by plucking with hand at biweekly interval. Ten plants were randomly selected from the inner rows and tagged for easy identification.

Harvested fruits from these were used in determining the average fruit yield.

3.10 Growth Characteristics

Assessment of growth rate characteristics was started 3 weeks after transplanting. Ten plants were randomly selected from each plot and tagged for the purpose of measuring growth changes. All growth characteristics observations were taken fortnightly. Number of leaves per p plant were recorded by counting all leaves on each of the tagged plants. The number of branches per plant was measured by counting the main and primary branches produced by each of the tagged plants. Plant height was recorded by measuring the height of each of the tagged plants from ground level to the tip of the terminal bud. Stem diameter was measured with calipers at the ground level. Plant leaf-spread was determined by measuring the distance between the distal ends of opened foliage of the plant when a ruler has been laid across.

The Leaf Area Index (LAI) was also determined by the method of Watson (1958). Two plants were randomly selected from the outer rows. Their leaves were detached and placed one on top of the other. A cork borer having a circumference of 2.5 cm was passed through the heap of leaves so that leaf discs were formed. The number of complete leaf discs was noted, labelled and together with the remaining leaf samples were oven dried to constant weight at 70^{0}C.

A separate weight of leaf discs was taken and the weight of the remaining leaf sample also noted. The mean of leaf disc weight was found by dividing the total leaf disc weight by the number of leaf discs. Leaf Area (L.A.) of the sample was then calculated with the following equation:-

$$LA = \frac{a + b}{c} \times d \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where a = weight of the leaf disc in grams.

b = weight of the remaining leaves in the sample in grams.

c = mean disc weight in grams.

d = disc area in cm^2

This was then used to determine the Leaf Area Index (LAI) as follows:-

$$LAI = \frac{LA}{S} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where S = appropriate area in cm^2.

The Leaf Area Index was then calculated as in equation 2 above and was transformed using square root transformation before statistical analysis was done.

3.11 Yield and Yield-related Characteristics

The number of days to 50% flowering was recorded by determining when 50% of the total number of plants in a plot have reached anthesis. The number of fruits per plant was determined by finding the average number of fruits harvested biweekly from the tagged, ten randomly selected plants used

in measuring growth characters. The fruit yield weight per plant was also determined by recording the weight of the whole fruits harvested from the ten tagged plants and finding the average weight per plant. Fruit size in a plot was determined by dividing the fruit yield weight per plant by the number of fruits harvested per plant in that same plot. Fruit diameter was determined by measuring the diameter of fruits of a plot with calipers half way the length of the fruit. The shoot dry matter was determined by harvesting four plants at random from the discard of each plot every forthnight. These were separated into stem and leaves and bagged before being dried to constant weight at 70°C. Weight of these oven-dry samples were later determined.

3.12 Fruit Total Nitrogen Analysis

Fruits were randomly selected from each plot. The samples were oven-dried to a constant weight at 70°C and then ground in a mill. Total nitrogen content of the samples were estimated using semi-micro Kjeldahl method.

3.13 Statistical Analysis

Data collected were subjected to statistical analysis to test treatment effects for significance using F test as described by Snedecor and Cockran (1967). Means of effects of nitrogen, phosphorus and farmyard manure and their interactions were compared using Duncan's Multiple Range Test (Duncan, 1955).

Chapter 4

RESULTS

4.1 Effect of Nitrogen, Phosphorus and Farmyard Manure on the Growth Parameters of Garden Egg

4.1.1 Plant height

Both nitrogen and phosphorus significantly affected plant height from 5 to 11 weeks after transplanting while the effect of farmyard manure was significant at 7 to 11 weeks after transplanting (Table 2).

Nitrogen application enhanced plant height significantly over no nitrogen at 5, 7, 9 and 11 weeks after transplanting. There was no significant difference between 75 and 150 kg N/ha. The percentage increases in height due to the application of 75 kg N/ha compared with no nitrogen were 31, 47, 46 and 47 at 5, 7, 9 and 11 weeks after transplanting, respectively.

Plant height increased with phosphorus level at 5 and 7 weeks after transplanting, while only 60 kg P/ha increased heights compared with no phosphorus control at 9 and 11 weeks after transplanting.

Both levels of farmyard manure (10 and 20 t/ha). similarly significantly increased plant height only at 7, 9, and 11 weeks after transplanting.

Table 2. Height of eggplant (cm) as influenced by nitrogen phosphorus and farmyard manure application.

Treatment	Weeks After Transplanting				
	3	5	7	9	11
N (kg/ha)					
0	7.94 a	23.79 a	45.60 a	53.70 a	60.00 a
75	0.00 a	31.34 b	67.40 b	70.60 b	89.60 b
150	0.47 a	29.66 b	65.40 b	77.70 b	89.10 b
SE ±	0.50	1.59	2.60	3.00	3.10
P (kg/ha)					
0	0.04 a	24.62 a	54.10 a	64.10 a	76.50 a
30	0.27 a	27.00 b	59.20 b	70.20ab	78.40 a
60	0.98 a	32.37 c	65.10 c	75.20 b	84.50 b
SE ±	0.50	1.59	2.60	3.00	3.10
FYM (t/ha)					
0	0.64 a	27.40 a	55.10 a	64.10 a	73.00 a
10	0.62 a	20.15 a	61.00 b	71.60 b	81.90 b
20	0.03 a	29.17 a	62.20 b	74.30 b	84.50 b
SE ±	0.50	1.59	2.60	3.00	3.10

Means followed by unlike letter(s) within a treatment group are significantly different at 5% level of significance.

None of the interactions between the fertilizers on plant height was significant.

4.1.2 Number of branches per plant

The data for number of branches per plant, recorded at 3, 5, 7 and 9 weeks after transplanting are shown in Table 3. Branching increased with age under applied nutrients.

Application of nitrogen at 75 and 150 kg N/ha similarly significantly increased the number of branches per plant above the control at 3, 5, 7 and 9 weeks after transplanting.

The effect of phosphorus on number of branches per plant was significant at 3, 5 and 9 weeks after transplanting. At 3 and 9 weeks after transplanting only 60 kg P/ha resulted in significant increase in the number of branches compared with 30 kg P/ha and the control. However, both rates produced higher number of branches than the control at 5 weeks after transplanting.

Farmyard manure only increased number of branches per plant significantly at a later stage (that is 7 and 9 weeks after transplanting). At 7 weeks after transplanting only 20 t FYM/ha resulted in higher number of branches than the control while at 9 weeks after transplanting both rates similarly increased the number significantly.

None of the fertilizer treatments had significant interactions on the number of branches produced per plant.

Table 3. Number of branches per eggplant as influenced by nitrogen, phosphorus and farmyard manure application.

Treatment	Weeks After Transplanting			
	3	5	7	9
N (kg/ha)				
0	1.54 a	3.91 a	7.33 a	10.09 a
75	2.20 b	5.36 b	13.41 b	17.07 b
150	2.10 b	4.00 b	12.54 b	16.37 b
SE ±	0.20	0.29	0.77	0.09
P (kg/ha)				
0	1.63 a	4.05 a	10.23 a	13.02 a
30	1.90 a	4.79 b	11.17 a	14.02 a
60	2.31 b	5.31 b	11.07 a	16.49 b
SE ±	0.20	0.29	0.77	0.09
FYM (t/ha)				
0	1.00 a	4.47 a	10.01 a	13.39 a
10	1.95 a	4.00 a	11.17ab	15.40 b
20	2.00 a	4.00 a	12.09 b	15.54 b
SE ±	0.20	0.29	0.77	0.09

Means followed by unlike letter(s) within a treatment group are significantly different at 5% level of significant.

4.1.3 Number of leaves per plant

The data on number of leaves produced per plant were recorded on 3, 5, 7 and 9 weeks after transplanting and are presented on Table 4. Both nitrogen and phosphorus had significant effect on number of leaves produced per plant at all the stages of crop growth; while the effect of farmyard manure was significant only at 7 and 9 weeks after transplanting.

Application of 75 kg N/ha during all the periods of sampling produced significantly more leaves than the control. With further increase in nitrogen to 150 kg N/ha, significant increase was found only at 3 weeks after transplanting.

Application of 60 kg P/ha consistently produced significantly higher number of leaves over the control (Table 4). 30 kg P/ha was found to be significantly superior to the control only at 5 weeks after transplanting. At 3 and 5 weeks after transplanting the two levels of phosphorus did not differ significantly among themselves but 60 kg P/ha produced more leaves than 30 kg P/ha at 7 and 9 weeks after transplanting.

All the levels of farmyard manure had no significant effect on the number of leaves produced during the 3 and 5 weeks after transplanting. At 7 weeks after transplanting farmyard manure at 10 and 20 t/ha similarly caused significant increase in number of leaves when compared with

Table 4. Number of leaves produced per eggplant as influenced by nitrogen, phosphorus and farmyard manure application.

Treatment	Weeks After Transplanting			
	3	5	7	9
N (kg/ha)				
0	8.42. a	23.22 a	51.90 a	60.2 a
75	9.96 b	30.23 b	82.00 b	90.6 b
150	10.00 c	27.68 b	82.20 b	92.5 b
SE ±	0.42	1.611	4.00	4.10
P (kg/ha)				
0	9.04 a	23.06 a	64.70 a	74.00 a
30	9.07ab	27.11 b	80.00 a	70.30 a
60	10.35 b	30.16 b	82.50 b	90.10 b
SE ±	0.42	1.61	4.00	4.10
FYM (t/ha)				
0	9.01 a	26.54 a	63.90 a	71.7 a
10	9.61 a	26.71 a	74.40 b	81.6 b
20	9.04 a	27.00 a	77.70 b	90.10 c
SE ±	0.42	1.61	4.00	4.10

Means followed by unlike letter(s) within a treatment group are significantly different at 5% level of significance.

the control. However, at 9 weeks after transplanting leaf number increased significantly with the rates of applied farmyard manure.

The interaction between phosphorus and farmyard manure on number of leaves per eggplant was significant at 7 weeks after transplanting (Table 5). Application of either phosphorus or farmyard manure in absence of the other had no marked effect on the number of leaves produced per plant. At 30 kg P/ha, 20 t FYM/ha resulted in higher leaf number than the control, while at 60 kg P/ha the 10 t FYM/ha produced higher leaf number than the control and 20 t FYM/ha. Although no significant difference between phosphorus levels was observed when 0 and 20 t FYM/ha were applied, 60 kg P/ha resulted in higher leaf number than 0 and 30 kg P/ha in plots with 10 t FYM/ha.

4.1.4 Plant leaf spread

The data for plant leaf spread measured at 11 weeks after transplanting are shown in Table 6. Both nitrogen and farmyard manure had significant effect on leaf spread.

Garden egg responded significantly in terms of the leaf spread to application of 75 kg N/ha. The treatment produced 29 per cent increase in plant leaf spread over the control. Increasing the level of nitrogen fertilizer to 150 kg N/ha did not result in further increase in leaf spread.

Application of farmyard manure at 10 t/ha significantly

Table 5. Number of leaves produced per eggplant at 7 weeks after transplanting as influenced by phosphorus x farmyard manure interactions.

Treatment FYM (t/ha)	0	10	20
P (kg/ha)			
0	61.4 c	60.3 c	72.4bc
30	50.3 c	67.3bc	80.7 b
60	72.1bc	95.5 a	80.1 b

S.E Farmyard manure x phosphorus interaction = ± 7.0

Means followed by unlike letter(s) within an interaction group are significantly different at 5 per cent level of significance.

increased the plant leaf spread but application of 20 t/ha did not cause further increase in the spread.

The interaction between the nutrients had no significant effect.

4.1.5 Leaf area index (LAI)

Leaf area index was measured at six weeks after transplanting when 50 per cent of the plants had flowered and the data as affected by nitrogen, phosphorus and farmyard manure are shown in Table 7.

Table 6. Plant leaf spread of eggplant at 11 weeks after transplanting as influenced by nitrogen, phosphorus and farmyard manure application.

Treatment	Plant leaf spread (cm)
N (kg/ha)	
0	55.92 a
75	72.39 b
150	74.66 b
SE ±	2.20
P (kg/ha)	
0	67.96 a
30	66.91 a
60	71.11 a
SE ±	2.20
FYM (t/ha)	
0	62.30 a
10	70.41 b
20	73.19 b
SE ±	2.20

Means followed by unlike letter(s) with a treatment group are significantly different at 5 per cent level of significance.

Table 7. Leaf area index of eggplant at 50 per cent flowering (6 weeks after transplanting) as influenced by nitrogen, phosphorus and farmyard manure application.

Treatment	Leaf Area Index
N (kg/ha)	
0	0.53 a
75	1.24 b
150	1.26 b
SE ±	0.071
P (kg/ha)	
0	0.93 a
30	0.99 ab
60	1.11 b
SE ±	0.071
FYM (t/ha)	
0	0.92 a
10	1.00 ab
20	1.11 b
SE ±	0.071

Means followed by unlike letter(s) within a treatment group are significantly different at 5% level of significance.

Nitrogen fertilizer at 75 and 150 kg/ha produced significantly higher leaf area index than the control plot but the two rates were not statistically different from the other.

Application of 60 kg P/ha resulted in significantly higher leaf area index than the control.

Although similar to 10 t FYM/ha, only 20 t FYM/ha produced higher leaf area index than the control.

4.1.6 Main stem diameter

The effects of nitrogen, phosphorus and farmyard manure on main stem diameter are shown in Table 8. Both nitrogen and farmyard manure had significant effect on main stem diameter whereas phosphorus had no such effect.

Stem diameters at 75 and 150 kg N/ha were both significantly higher than that of the control plot but at par with one another.

Farmyard manure at rates of 10 and 20 t/ha similarly, significantly increased stem diameter above the control.

4.1.7 Stem dry weight

The data on Table 9 shows the effect of nitrogen, phosphorus and farmyard manure on the stem dry weight at different sampling dates of 6, 8, 10 and 12 weeks after transplanting.

Nitrogen fertilizer increased stem dry weight per plant

Table 8. Main stem diameter of eggplant (mm) at 6 weeks after transplanting as influenced by nitrogen phosphorus and farmyard manure application.

Treatment	Main stem diameter (mm)
N (kg/ha)	
0	309.0 a
75	391.5 b
150	379.1 b
SE ±	11.40
P (kg/ha)	
0	350.40 a
30	358.10 a
60	371.10 a
SE ±	11.40
FYM (t/ha)	
0	342.5 a
10	367.6 b
20	369.4 b
SE ±	11.40

Means followed by unlike letter(s) within a treatment group are significantly different at 5% level of significance.

Table 9. Stem dry weight (g) per eggplant at different sampling dates as influenced by nitrogen, phosphorus and farmyard manure application.

Treatment	Weeks After Transplanting			
	6	8	10	12
N (kg/ha)				
0	9.37 a	14.71 a	19.35 a	23.90 a
75	20.07 b	29.36 b	34.97 b	41.80 b
150	20.71 b	32.25 b	40.19 c	47.60 c
SE ±	1.37	1.57	2.16	2.40
P (kg/ha)				
0	14.27 a	22.25 a	29.03 a	34.90 a
30	16.53 a	26.20 b	31.75 ab	37.80 ab
60	20.14 b	27.07 b	33.75 b	40.60 b
S.E	1.37	1.57	2.16	2.40
FYM (t/ha)				
0	14.17 a	23.86 a	20.34 a	34.10 a
10	17.74 b	26.22 a	32.74 b	39.70 b
20	10.51 b	26.24 a	33.44 b	39.50 b
S.E	1.37	1.57	2.16	2.40

Means followed by unlike letter(s) within a treatment group are significantly different at 5% level of significance.

significantly at all the four sampling dates. Application of 75 and 150 kg N/ha similarly, significantly increased the stem dry weight per plant above the control at 6 and 8 weeks after transplanting. However, at 10 and 12 weeks after transplanting stem dry weight per plant specifically increased with the levels of nitrogen fertilizer applied.

The stem dry matter was significantly increased by 60 kg P/ha compared with the control at all the four sampling dates while 30 kg P/ha only increased the dry matter at 8 weeks after transplanting.

Increases in stem dry weight due to application of farmyard manure occurred in all the weeks of sampling with the exception of 8 weeks after transplanting. Farmyard manure at both 10 and 20 t/ha similarly significantly increased stem dry weight per plant at 6, 10 and 12 weeks after transplanting.

4.1.8 Leaf dry weight

The data on leaf dry weight as influenced by nitrogen, phosphorus and farmyard manure at 6, 8, 10 and 12 weeks after transplanting are presented on Table 10. All the treatments except phosphorus at 12 weeks after transplanting, significantly influenced leaf dry weight. The interactions were not significant.

At all the sampling, application of nitrogen remarkably increased leaf dry weight above the control. Higher level of

Table 10. Leaf dry weight (g) per eggplant at different sampling dates as affected by nitrogen, phosphorus and farmyard manure application.

Treatment	Weeks After Transplanting			
	6	8	10	12
N (kg/ha)				
0	9.96 a	22.00 a	24.3 a	26.7 a
75	23.11 b	56.70 b	66.3 b	70.0b
150	24.97 b	64.70 c	01.5 c	06.3 b
SE ±	1.54	3.90	4.70	6.20
P (kg/ha)				
0	16.42 a	43.50 a	51.10 a	50.10 a
30	19.33 ab	45.90 a	56.60 ab	62.90 a
60	22.23 b	54.00 b	64.40 b	69.90 a
SE ±	1.54	3.90	4.70	6.20
FYM (t/ha)				
0	16.69 a	30.30 a	47.30 a	40.10 a
10	20.09 b	50.50 b	50.30 b	66.70 b
20	21.25 b	54.50 b	66.40 b	76.20 b
SE ±	1.54	3.90	4.70	6.20

Means followed by unlike letter(s) within a treatment group are significantly different at 5% level of significance.

nitrogen (150 kg N/ha) did not increase leaf dry weight significantly above that of 75 kg N/ha level at 6 and 12 weeks after transplanting but did so at 0 and 10 weeks after transplanting.

30 kg P/ha had no significant effect above the control at all the periods of sampling. Doubling the level to 60 kg P/ha, however, increased the leaf dry weight significantly above the control at 3 to 9 weeks after transplanting.

Both levels of farmyard manure (10 and 20 t/ha) similarly significantly increased leaf dry weight when compared to the control in all the samplings.

4.2 Effect of Nitrogen, Phosphorus and Farmyard Manure on Fruit Yield

4.2.1 Fruit fresh weight per plant

Results of the effect of nitrogen phosphorus and farmyard manure on fresh fruit weight per plant at 8, 10, 12 and 14 weeks after transplanting are shown in Tables 11 to 14.

The effect of nitrogen on fresh fruit weight per plant was significant in all the periods of study. At 8 weeks after transplanting, both rates of nitrogen similarly resulted in higher fresh fruit weight than the control, while at 10, 12 and 14 weeks after transplanting fruit weight increased with nitrogen levels.

30 kg P/ha significantly improved fresh fruit weight over

Table 11. Fresh fruit weight (g) per eggplant as influenced by nitrogen, phosphorus and farmyard manure application.

Treatment	Weeks After Transplanting			
	8	10	12	14
N (kg/ha)				
0	210.70 a	341.70 a	190.90 a	70.7 a
75	312.20 b	634.50 b	311.40 b	142.3 b
150	302.00 b	731.90 c	350.50 c	159.5 c
SE ±	17.96	22.94	15.79	7.0
P (kg/ha)				
0	239.10 a	553.10 a	296.20 a	112.9 a
30	202.10 b	516.90 a	285.50 a	120.8 a
60	312.50 b	630.10 b	279.20 a	130.0 b
SE ±	17.96	22.94	15.79	7.0
FYM (t/ha)				
0	264.00a	475.00a	229.30 a	100.2 a
10	271.70 a	591.00 a	302.20 b	125.1 b
20	297.20 a	639.40 b	329.40 b	146.1 c
SE ±	17.96	22.94	15.99	7.0

Means followed by unlike letter(s) within a treatment group are significantly different at 5% level of significance.

the control, and no further increase occurred with the application of 60 kg P/ha at 8 weeks after transplanting. At 10 and 14 weeks after transplanting, only the high level of 60 kg P/ha significantly increased fresh fruit weight more than the control. However at 12 weeks after transplanting, phosphorus had no significant effect on fresh fruit weight.

Farmyard manure had no significant effect on fresh fruit weight at 8 weeks after transplanting, but at 14 weeks after transplanting every increase in rate of of farmyard manure application caused significant increase in fresh fruit weight produced per plant.

The interactions of N and P, N and P and FYM, N and FYM, P and FYM were significant on fresh fruit yield at different weeks of sampling (Tables 12 to 18). Nitrogen x phosphorus interaction was significant on fresh fruit weight per plant at 10 weeks after transplanting (Table 12). In the absence of nitrogen, phosphorus application had no significant effect on fresh fruit weight per plant compared with the control. Also in the absence of phosphorus, increasing nitrogen fertilization from 75 to 150 kg N/ha produced no significant effect on fresh fruit weight. The highest weight of fresh fruits 853.40g was produced as a result of combination of the highest levels of phusphorus and nitrogen.

Nitrogen x phosphorus x farmyard manure interaction was significant on fresh fruit weight per plant at 10 weeks after

Table 12. The interaction of nitrogen and phosphorus on weight of fruits (g) per eggplant at 10 weeks after transplanting.

Treatment			
P (kg/ha)	0	30	60
N (kg/ha)			
0	352.00 d	295.30 d	376.00 d
75	664.40 b	555.10 c	604.00 b
150	642.00 b	700.30 b	853.40 a

SE Nitrogen x Phosphorus interaction = +39.73

Means followed by unlike letter(s) within an interaction group are significantly different at 5% level of significance.

transplanting (Table 13). Application of either of the nutrients in absence of the others greatly limited the utilization of the applied nutrient. The highest yields of fresh fruit per plant were produced by combination of the different levels of nitrogen, phosphorus and farmyard manure.

Table 14 shows that significant responses were observed on fresh fruit weight harvested per plant as a result of nitrogen x farmyard manure interactions at 12 weeks after transplanting. Increasing the level of either of the nutrients in absence of the other resulted in no remarkable effect on fresh fruit weight per plant.

Table 13. The interaction of nitrogen, phosphorus and farmyard manure on weight of fruits (g) per eggplant at 10 weeks after transplanting.

Treatment									
P (kg/ha)	0	0	0	30	30	30	60	60	60
FYM (t/ha)	0	10	20	0	10	20	0	10	20
N (kg/ha)									
0	196.1i	354.2gh	510.1ef	223.0hi	245.0hi	417.2gh	266.0hi	553.4def	3109ghi
75	603.2cde	796.0ab	994.0cde	427.9fg	544.5def	692.0bcde	551.4def	696.6bcd	804.1ab
150	603.0cde	809.7cde	713.1bc	536.6ef	754.4ab	810.0ab	886.2a	771.9ab	982.0a

SE Nitrogenx phosphorus x farmyard manure interactions = ±60.0

Means followed by unlike letter(s) within an interaction group are signficantly different at 5% level of significance.

Table 14. The interaction of nitrogen and farmyard manure on weight of fruit (g) per eggplant

12 weeks after transplanting.

Treatment			
FYM (t/ha)	0	10	20
0	194.10 cd	107.00 d	215.50 cd
75	251.10 bc	299.50 b	303.70 a
150	242.70 cd	420.00 a	300.90 a

SE Nitrogen x farmyard manure interaction = ±27.34.

Means followed by unlike letter(s) within an interaction group are significantly different at 5% level of significance.

Nitrogen x phosphorus interaction effect on fresh fruit yield at 14 weeks after transplanting is shown on Table 16. Phosphorus fertilizer applied at rate of 30 kg P/ha in the absence of nitrogen fertilizer depressed fresh fruit weight significantly below the control. On the other hand, every increase in level of nitrogen applied in absence of phosphorus significantly increased fresh fruit weight per plant.

At 14 weeks after transplanting, nitrogen x farmyard manure interaction on fresh fruit weight was significant (Table 17). Whilst the application of farmyard manure without nitrogen increased yield when the level of farmyard manure was 20 t/ha, nitrogen fertilizer at 75 kg N/ha without

Table 15. The interaction of phosphorus and farmyard manure on weight of fruits (g) per eggplant at 12 weeks after transplanting.

Treatment			
FYM (t/ha)	0	10	20
P (kg/ha)			
0	221.00 c	296.10 bcd	371.50 a
30	224.50 c	337.40 ab	294.60 bcd
60	242.50 de	273.10 cde	322.00 abc

SE Phosphorus x farmyard manure interaction = ±27.34.

Means followed by unlike letter(s) within an interaction group are significantly different at 5% level of significance.

Table 16. The interaction of nitrogen and phosphorus on weight of fruits (g) per eggplant at 14 weeks after transplanting.

Treatment			
P (kg/ha)	0	30	60
N (kg/ha)			
0	52.50c	36.40 d	49.70 c
75	63.10 b	64.50 b	56.20 bc
150	76.30 a	55.10 bc	50.90 bc

SE Nitrogen x phosphorus interaction = +4.69

Means followed by unlike letter(s) within an interaction group are significantly different at 5% level of significance.

Table 17. The interaction of nitrogen and farmyard manure on weight of fruits (g) per eggplant at 14 weeks after transplanting.

Treatment			
FYM (t/ha)	0	10	20
N (kg/ha)			
0	33.6 e	41.4 de	63.6 b
75	53.3 c	51.4 c	79.1 a
150	49.2 cd	69.6 ab	71.5 ab

SE Nitrogen x farmyard manure interaction = ±4.7

Means followed by unlike letter(s) within ar, interaction group are significantly different at 5% level of significance.

farmyard manure significantly increased fresh fruit weight.

Table 18 shows the effect of phosphorus x farmyard manure interaction on fresh fruit weight per plant at 14 weeks after transplanting. Whereas every level of farmyard manure applied in absence of phosphorus, significantly increased fruit weight, no significant effect was observed for all the levels of phosphorus applied in absence of farmyard manure. The highest weight of fresh fruits per plant was obtained by application of only 20 t FYM/ha.

4.2.2. Fruit dry weight per plant

The effect of nitrogen, phosphorus and farmyard manure

Table 10. The interaction of phosphorus and farmyard manure on weight of fruits (g) per eggplant at 14 weeks after transplanting.

Treatment			
FYM (t/ha)	0	10	20
P (kg/ha)			
0	47.1e	62.0 c	02.9 a
30	44.0 e	52.0 de	59.4 cd
60	44.3 e	40.5 e	72.0 b

SE Phosphorus x farmyard manure interaction = ±4.7.

Means followed by unlike letter(s) within an interaction group are significantly different at 5% level of significan

application on fruit dry weight per plant at 8, 10, 12 and 14 weeks after transplanting is shown in Table 19.

Fruit dry weight per plant increased significantly wit application of nitrogen fertilizer. At 8, 10 and 14 weeks after transplanting, 150 kg N/ha did not differ significant from 75 kg N/ha but at 12 weeks after transplanting it significantly increased fruit weight over 75 kg N/ha level.

Application of 60 kg P/ha significantly increased frui dry weight over the control at all the sampling dates and over 30 kg P/ha at 10 and 12 weeks after transplanting.

At 8 and 10 weeks after transplanting 10 and 20 t FYM/ rates similarly significantly increased fresh fruit weight

Table 19. Fruit dry weight (g) per eggplant at different sampling dates as influenced by nitrogen, phosphorus and farmyard manure application.

Treatment	Weeks After Transplanting			
	8	10	12	14
N (kg/ha)				
0	23.2 a	54.4 a	65.2 a	46.20 a
75	34.9 b	106.0 b	134.3 b	61.30 b
150	34.0 b	112.4 b	152.4 c	63.40 b
SE ±	3.1	6.3	7.0	2.71
P (kg/ha)				
0	25.5 a	80.7 a	106.1 a	64.00 a
30	30.0 ab	87.6 a	114.4 a	52.00 b
60	35.7 b	105.3 b	131.3 b	54.90 b
SE ±	3.1	6.3	7.0	2.71
FYM (kg/ha)				
0	25.7 a	76.1 a	95.2 a	45.40a
10	32.0 b	95.3 b	121.6 b	54.10 b
20	33.5 b	102.3 b	135.0 c	71.40 c
SE ±	3.1	6.3	7.0	2.71

Means followed by unlike letter(s) within a treatment group significantly different at 5% level of significance.

more than the control. However, during the 12 and 14 weeks after transplanting fresh fruit weight per plant increased with increasing farmyard manure rates.

4.2.3 Total fruit yield at end of harvest

The effects of nitrogen, phosphorus and farmyard manure on total fresh fruit yield in tonnes per hectare at the end of harvest are shown on Table 20. All the treatments had significant effect on the total fruit yield. The interactions of N x P, P x FYM, and N x P x FYM were also significant (Tables 21 to 23).

Fruit yield per hectare increased significantly with increasing levels of nitrogen. Nitrogen dose of 75 kg N/ha resulted in 35.81 tonnes of fresh fruits/ha which was 66 per cent more than that of the control. A further increase in nitrogen level up to 150 kg/ha raised the total fruit yield significantly more than that of 75 kg N per hectare and resulted in 34.44 tonnes of fresh fruit yield/ha which was 83 per cent above the control.

Significant effect of phosphorus fertilizer was observed when the level of application was raised to 60 kg P/ha.

Total fruit yield of gardenegg increased with increasing levels of farmyard manure.

Table 21 shows the interaction of nitrogen and phosphorus on total fruit yield in tonnes/ha. Only high level of

Table 20. Total fruit yield of eggplant (tonnes/ha) at the end of harvest (14 weeks after transplanting) as influenced by nitrogen, phosphorus and farmyard manure.

Treatment	Yield Tonnes/ha
N (kg/ha)	
0	21.46 c
75	35.01 b
150	39.44 a
SE ±	0.97
P (kg/ha)	
0	30.74 b
30	30.72 b
60	35.22 a
SE ±	0.97
FYM (t/ha)	
0	27.52 c
10	33.20 b
20	35.97 a
SE ±	0.97

Means followed by unlike letter(s) within a treatment group are significantly different at 5% level of significance.

phosphorus application (60 kg P/ha) in absence of nitrogen significantly increased total fruit yield. On the other hand, it was only the lower level of nitrogen fertilizer which had significant effect on fruit yield in absence of

Table 21. Total fruit yield of eggplant (tonnes/ha) as influenced by nitrogen x phosphorus interaction at the end of harvest (14 weeks after transplanting).

Treatment			
P (kg/ha)	0	30	60
N (kg/ha)			
0	21.04 f	19.97 f	23.30 e
75	36.05 bcd	34.40 d	36.96 bc
150	35.17 cd	37.01 b	45.30 a

SE Nitrogen x phosphorus interaction = ±1.60.

Means followed by unlike letter(s) within an interaction group are significantly different at 5% level of significance.

phosphorus. The highest total fruit yield (45.30 tonnes/ha) was achieved by the interaction of 60 kg P/ha and 150 kg N/ha. This gave 126 per cent increase more than the control.

The interaction of phosphorus x farmyard manure on total fruit yield per hectare is shown on Table 22. Application of farmyard manure in absence of phosphorus significantly raised the total fruit yield as rates of farmyard manure increased.

Table 23 shows how the interaction of nitrogen, phosphorus and farmyard manure affects the total fruit yield per hectare. In the absence of farmyard manure and phosphorus, 75 and 150 kg N/ha being at par, significantly increased fruit yield

Table 22. Total fruit yield of eggplant (tonnes/ha) as influenced by phosphorus x farmyard interaction at the end of harvest (14 weeks after transplanting).

Treatment			
FYM (t/ha)	0	10	20
P (kg/ha)			
0	25.04 c	30.98 b	35.41 a
30	24.77 c	31.09 b	36.29 a
60	31.97 b	37.49 a	36.21 a

SE Phosphorus x farmyard manure interaction = ±0.97.

Means followed by unlike letter(s) within an interaction group are significantly different at 5% level of significance.

above the control. In absence of nitrogen and phosphorus farmyard manure only at 20 t/ha significantly increased the fruit yield. Phosphorus application in the absence of nitrogen and farmyard manure had no significant effect on total fruit yield.

4.2.4 Total dry matter production

Data on the effect for nitrogen phosphorus and farmyard manure application on total dry matter production at 6, 8, 10, 12 and 14 weeks after transplanting are presented in Table 24.

Nitrogen at both 75 and 150 kg N/ha significantly

Teble 23. The interaction of nitrogen and phosphorus and farmyard manure on total fruit yield (tonnes/ha) of eggplant at the end of harvest (14 weeks after transplanting).

Treatment									
P (kg/ha)	0	0	0	30	30	30	60	60	60
FYM (t/ha)	0	10	20	0	10	20	0	10	20
N (kg/ha)									
0	14.56 i	20.50 hi	20.02 fg	18.34 hi	17.20 i	24.37 gh	20.10 hi	30.10 efg	19.84 hi
75	31.84 def	38.10 bcd	38.21 bcd	18.10 fg	33.70 def	41.25 abc	32.72 def	35.97 cde	42.24 ab
150	31.17 ef	34.34 def	40.00 be	27.01 fg	42.32abc	43.30 ab	43.06 ab	46.20 a	46.50 a

SE Nitrogen x phosphorus x farmyard manure interaction = ±2.93.

Means followed by unlike (letter(s) within an interaction group are significantly different at 5% level of significance.

Table 24. Total dry matter production (g) per eggplant as influenced by nitrogen, phosphorus and farmyard manure application.

Treatment	Weeks After Transplanting				
	6	8	10	12	14
N (kg/ha)					
0	20.6 a	59.1 c	97.5 a	122.5 a	122.5 a
75	44.1 b	121.0 b	210.75 b	256.7 b	266.3 b
150	45.7 b	132.4 b	230.0 b	204.0 c	297.3 c
SE ±	2.6	6.5	10.5	12.1	12.1
P (kg/ha)					
0	30.1 a	90.7 a	161.6 a	203.4 a	209.9 a
30	37.2 b	103.5 b	176.4 a	210.2 ab	224.9 a
60	43.2 c	118.3 c	200.2 b	242.5 b	251.0 b
SE ±	2.6	6.5	10.5	12.1	12.1
FYM (t/ha)					
0	33.3 a	87.3 a	146.1 a	176.5 a	183.7 a
10	37.7 ab	110.0 b	189.6 b	232.1 b	235.0 b
20	39.5 b	115.2 c	202.5 b	255.5 b	266.3 c
SE ±	2.6	6.5	10.5	12.1	12.1

Means followed by like letter(s) within a treatment group are significantly different at 5% level of significance.

increased the shoot dry matter production in all the periods of study compared with the control. 150 kg N/ha, however, resulted in higher total dry matter production at 12 and 14 weeks after transplanting.

Total dry matter production increased with the level of phosphorus applied at 6 and 8 weeks after transplanting while at 10, 12 and 14 weeks after transplanting only 60 kg P/ha increased total dry matter production over the control.

Total dry matter production increased with the level of applied farmyard manure at 8 and 14 weeks after transplanting while at 10 and 12 weeks after transplanting both rates similarly increased total dry matter. At 6 weeks after transplanting only 20 t FYM/ha resulted in higher total dry matter than the control.

The interactions between nutrients had no significant effect.

4.3 Effect of Nitrogen, Phosphorus and Farmyard Manure on Yield Attributes

4.3.1 Number of fruits produced per plant

Table 25 shows the influence of nitrogen, phosphorus and farmyard manure on the total number of fruits produced per plant at the end of harvest. All the nutrients significantly increased the number of fruits.

Fruit number increased with nitrogen levels. 60 kg P/ha

Table 25. Total number of fruits produced at the end of harvest per plant as influenced by nitrogen, phosphorus and farmyard manure application.

Treatment	Total No. of fruits at the end of harvest
N (kg/ha)	
0	70.0 a
75	153.4 b
150	170.5 c
SE ±	7.4
P (kg/ha)	
0	129.0 a
30	120.5 a
60	144.5 b
SE ±	7.4
FYM (t/ha)	
0	113.2 a
10	130.0 b
20	151.5 b
SE ±	7.4

Means followed by unlike letter(s) within a treatment group are significantly different at 5% level of significance.

significantly increased the total number of fruits produced per plant compared with the control.

Application of 10 t FYM/ha significantly increased the number of fruits produced more than the control. Increasing the rate of farmyard manure to 20 t/ha did not cause any further increase in fruit number.

4.3.2 Fruit diameter

Table 26 shows the effect of nitrogen, phosphorus and farmyard manure on the size of fruits sampled at 8, 10, 12 and 14 weeks after transplanting.

Nitrogen fertilizer significantly increased fruit diameter over the control at all the periods of sampling. At 8 and 10 weeks after transplanting, nitrogen application beyond 75 kg/ha had no significant effect but at 12 and 14 weeks after transplanting it increased fruit diameter.

Both 30 and 60 kg P/ha at 12 weeks after transplanting and 60 kg P/ha at 8 weeks after transplanting produced fruits of significantly large diameter than the control.

Farmyard manure had no significant effect on fruit diameter except at 12 weeks after transplanting. At this stage both rates of farmyard manure (10 and 20 t/ha) were found to be equally good over the control in increasing fruit diameter.

Table 26. Fruit diameter (mm) of eggplant as effected by nitrogen phosphorus and farmyard manure.

Treatment	Weeks After Transplanting			
	0	10	12	14
N (kg/ha)				
0	26.53 a	25.34 a	20.79 a	19.30 a
75	28.66 b	28.03 b	23.29 b	20.19 b
150	28.77 b	27.05 b	24.75 c	21.33 c
SE ±	0.36	0.39	0.52	0.42
P (kg/ha)				
0	27.52 a	26.63 a	22.24 a	19.03 a
30	27.95 ab	27.07 a	23.45 b	20.47 a
60	28.49 b	27.52 a	23.14 b	20.60 a
SE ±	0.36	0.39	0.52	0.40
FYM (t/ha)				
0	27.92 a	26.69 a	22.19 a	20.05 a
10	28.06 a	26.95 a	23.26 b	20.30 a
20	27.98 a	27.50 a	23.30 b	20.56 a
SE ±	0.36	0.39	0.52	0.42

Means followed by like letter(s) within a treatment group are significantly different at 5% level of significance.

The interactions of nitrogen and phosphorus was significant on fruit diameter at 10 weeks after transplanting (Table 27). Although phosphorus did not significantly affect fruit diameter under 0 and 75 kg N/ha, with the application of 150 kg N/ha both 30 and 60 kg P/ha produced large fruits than no phosphorus treatment.

4.3.3 Average weight per fruit

The data on the influence of nitrogen, phosphorus and farmyard manure on average fruit weight as measured at 8, 10, 12 and 14 weeks after transplanting are shown on Table 28. A gradual reduction of fruit size occurred with the age of the crop.

Nitrogen fertilizer had no significant effect on average fruit weight at 8, 10 and 12 weeks after transplanting. At 14 weeks after transplanting both levels of nitrogen similarly significantly reduced the average fruit weight of garden egg.

Application of phosphorus generally had no significant effect on average fruit weight at all the periods of sampling.

During the early periods of sampling (8 and 10 weeks after transplanting) farmyard manure had no significant effect over the control. At 12 weeks after transplanting both levels of farmyard manure similarly resulted in bigger fruits than the control. However, at 14 weeks after transplanting, fruit size increased with the level of farmyard

Table 27. The interaction of nitrogen and phosphorus on fruit diameter of eggplant (mm) at 10 weeks after transplanting.

Treatment P (kg/ha)	Weeks After Transplanting		
	0	30	60
N (kg/ha)			
0	25.00 b	24.93 b	25.21 b
75	27.73 a	27.73	20.64 a
150	16.26 b	20.56 a	20.71 a

SE Nitrogen x Phosphorus interaction = ±0.68

Means followed by unlike letter(s) within an interaction group are significantly different at 5 per cent level of significance.

manure applied.

4.3.4 Number of days to 50 per cent flowering

The effects of nitrogen, phosphorus and farmyard manure on the number of days to 50 per cent flowering are shown in Table 29. Each of the nutrients significantly influenced the number of days taken for the plant to flower. Nitrogen x Phosphorus interaction on number of days to flowering was also significant (Table 30).

Nitrogen at 150 kg N/ha increased the number of days to flowering compared with the control while it decreased

Table 20. Average fruit weight of eggplant (g) at different sampling dates as influenced by nitrogen, phosphorus and farmyard manure application.

Treatment	Weeks after transplanting			
	8	10	12	14
N (kg/ha)				
0	10.49 a	9.09 a	7.04 a	5.13 a
75	11.33 a	10.82 a	7.04 a	4.63 b
150	11.60 a	11.46 a	6.93 a	4.74 b
SE ±	0.73	0.73	0.10	0.10
P (kg/ha)				
0	10.20 a	10.46	6.92 a	4.00 a
30	11.30 a	10.20 a	7.14 a	4.00 a
60	11.04 a	11.43 a	6.95 a	4.03 a
SE ±	0.73	0.73	0.10	0.10
FYM (t/ha)				
0	11.23 a	10.09 a	6.66 a	4.41 a
10	11.42 a	10.60 a	7.10 b	4.03 b
20	10.05 a	10.69 a	7.10 b	5.26 c
SE ±	0.73	0.73	0.10	0.10

Means followed by unlike letter(s) within a treatment group are significantly different at 5% level of significance.

Table 29. Number of days taken by eggplant from transplanting to 50 per cent flowering as affected by application of nitrogen, phosphorus and farmyard manure.

Treatment	Number of days taken to flowering
N (kg/ha)	
0	20.50 a
75	20.25 a
150	31.00 b
SE ±	0.37
P (kg/ha)	
0	30.53 a
30	29.50 b
60	27.81 c
SE ±	0.37
FYM (t/ha)	
0	29.81 a
10	29.17 ab
20	28.06 b
SE ±	0.37

Means followed by unlike letter(s) within a treatment group are significantly different at 5% level of significance.

Table 30. The interaction of nitrogen and phosphorus on number of days taken by eggplant from transplanting to 50 per cent flowering.

Treatment			
P (kg/ha)	0	30	60
N (kg/ha)			
0	29.03 bc	29.50 c	26.00 e
75	29.00 cd	27.92 d	27.03 d
150	32.75 a	31.00 b	29.50 c

SE Nitrogen x phosphorus interaction = $\pm$1.11

Means followed by unlike letter(s) within an interaction group are significantly different at 5% level of significance.

with increase in phosphorus level.

Farmyard manure application at the rate of 10 tonnes/ha had no significant effect on number of days to flowering but 20 t FYM/ha encouraged earliness of flowering.

The interaction of nitrogen and phosphorus on the number of days required to flower is shown on Table 30. When applied alone, none of the interacting nutrients at the low levels significantly influenced the number of days to flowering, but when applied in combination with one another they induced earliness to flowering.

4.4 Crude Proten Content of Fruits

The data in Table 31 and 32 show the effect of nitrogen, phosphorus and farmyard manure application on crude protein content of the fruits at the final harvest.

None of the treatments had any significant effect on crude protein content of the fruits. No significant interaction between the treatments was observed on the crude protein content of the fruits.

4.5 Correlation Analysis

The relationship between fruit yield and yield-related characters were determined by simple correlation coefficient analyses between varying growth characters, yield components and yield (detail are given in Table 33). Correlation coefficient analyses were also done between yield, plant height, number of leaves and number of branches.

All simple correlation coefficients were positive and and significant at 1% probability level except simple correlation between fruit yield and number of days to flowering. Also all partial correlation coefficients were positive and significant at 1% level except partial correlation between fruit yield and number of branches when plant height and number of leaves are constant; and partial correlation between fruit yield and number of branches when only the number of leaves is constant. The analysis revealed that there was high positive correlation between fruit yield

Table 31. Percentage crude protein content of eggplant fruits as influenced by application of nitrogen, phosphorus and farmyard manure.

Treatment	Crude protein content (%)
N (kg/ha)	
0	14.09 a
75	14.02 a
150	15.13 a
SE ±	0.56
P (kg/ha)	
0	14.55 a
30	14.28 a
60	14.41 a
SE ±	0.56
FYM (t/ha)	
0	14.45 a
10	14.57 a
20	14.22 a
SE ±	0.56

Means followed by unlike letter(s) within a treatment group are significantly different at 5% level of significance.

Table 32. The interaction of nitrogen and phosphorus on percentage crude protein content of eggplant fruits.

Treatment			
P (kg/ha)	0	30	60
N (kg/ha)			
0	13.90a	14.73 a	14.36 a
75	14.54 a	13.46 a	14.06 a
150	15.91 a	14.67 a	14.01 a

SE Nitrogen x phosphorus interaction = ±0.90

Means followed by unlike letter(s) within an interaction group are significantly different at 5% level of significance.

and number of fruits per plant (0.070), between fruit yield and shoot dry matter yield (0.039), between fruit yield and fruit dry matter weight (0.010). The correlations between fruit yield and plant height (0.741); between fruit yield and number of leaves per plant (0.744), between fruit and Leaf Area Index (0.744), between fruit yield and plant leaf spread (0.711) and between fruit yield and number of branches (0.600) were all highly positive and significant. Plant height was also highly correlated to number of leaves (0.710), and number of branches (0.783). The analysis also showed that partial correlation between fruit yield and plant height

Table 33. Simple and Partial Correlation Coefficients between plot means for fruit yield and yield-related characters of eggplant grown at Samaru, 1983.

Variable Correlated	'r' Value
Simple Correlation	
Fruit yield Vs plant height	0.741 **
Fruit yield Vs number of leaves per plant	0.744 **
Fruit yield Vs Leaf Area Index	0.744 **
Fruit yield Vs number of fruits per plant	0.070 **
Fruit yield Vs plant leaf spread	0.711 **
Fruit yield Vs Number of branches	0.600 **
Fruit yield Vs shoot dry matter yield	0.039 **
Fruit yield Vs Number of days to flowering	0.031 N.S
Plant height Vs number of leaves	0.710 **
Plant height Vs number of branches	0.703 **
Fruit yield Vs stem dry weight	0.723 **
Fruit yield Vs leaf dry weight	0.722 **
Fruit yield Vs fruit dry weight	0.010 **
Partial Correlation	
Fruit yield Vs plant height when number of leaves is constant	0.452 **
Fruit yield Vs number of leaves when plant height is constant	0.462 **
Fruit yield Vs number of branches when plant height and number of leaves are constant	0.006 NS
Fruit yield Vs number of branches when number of leaves is constant	0.236 NS

** = Significant at 1% probability level.

NS = Not significant at 5% probability.

with number of leaves constant, was positive and significant (0.452). Non-significant correlation was however observed between fruit yield and number of days to flowering (0.031); between fruit yield and number of branches when plant height and number of leaves are constant (0.236); and between fruit yield and number of branches when number of leaves is constant (0.236).

Chapter 5

DISCUSSION

5.1 Effect of Nitrogen on Vegetative Growth of Eggplant

There was significant increase in plant height, number of branches, number of leaves and stem diameter with increased nitrogen application. This might be attributed to the fact that vegetative growth is generally influenced by the application of nitrogen, and that relatively large amount of this will promote vigorous plant growth. Patnaik and Farooqui (1964) observed stunted growth of brinjal plants when nitrogen was deficient.

Nitrogen application increased plant height significantly above the control in all the weeks of sampling except in the early stage of plant growth (three weeks after transplanting), when probably the plants have not developed enough roots for nutrient absorption. The failure of 150 kg N/ha to increase plant height was probably because the optimum nitrogen requirement of the plant might have been met at a lower level, and nitrogen application above this optimum probably created an inbalance in other nutrients which resulted in no increase in height. These results are in agreement with observations of Sharma and Mann (1972) who reported that nitrogen application of up to 100 kg N/ha generally produced no increase in plant height.

Generally, nitrogen application resulted in more number of branches per plant as the number of weeks after transplanting increased. The highest number of branches were recorded at the last week of observation (nine weeks after transplanting) and this gave a 7.7 fold increase of the number of branches at a corresponding level of applied fertilizer at 3 weeks after transplanting. The increase may be due to the property of nitrogen fertilizers to enhance vegetative growth since it is an important constituent of chlorophyll, amino acid and nucleic acid (Sauchelli, 1978; Bhatnagar and Pandita, 1979). The ineffectiveness of 150 kg N/ha to increase number of branches more than 75 kg N/ha might be due to the limited capacity of the plant to utilize greater amount of nitrogen beyond a certain optimum.

The number of leaves produced per plant was also increased by increase in the levels of nitrogen. This enhanced photosynthetic capacity and probably increased fruit yield of the plant. These findings are in agreement with the findings of Singh and Sandhu (1970) and Choudhury et al. (1982). Eggplant also showed the greatest response of increased leaf number to nitrogen fertilizer at the early and middle stages (3 to 7 weeks after transplanting) of growth. During the late phase of growth (7 to 9 weeks after transplanting) the number of leaves produced was greatly reduced due to preference of floral growth to vegetative growth. Also at this period, maturity and senescence was about setting in.

The ability of nitrogen fertilizer to induce increased stem girth is in accordance with observations made by Chonkar and Singh (1963), and Singh and Sandhu (1970), who observed that application of nitrogen up to 100 kg/ha resulted in increase in girth. The significant effect observed by application of 75 kg N/ha in this experiment might be due to lower nitrogen status (0.03%) of the soil of the experimental site.

5.2 Effect of Phosphorus in Vegetative Growth of Eggplant

The general improvement of vegetative growth characters by application of phosphatic fertilizer was no doubt due to its ability to promote crop root growth and development, and consequently enhanced nutrient uptake for a greater vegetative growth (Hari et al., 1978; Negi et al., 1982). Response of eggplants vegetative characters were observed to be more pronounced at the early stages of growth than the late stages. The unpronounced effect during the later period of growth was attributed to lack of available phosphate all of which might have been utilized in the initial phase of growth.

Phosphorus application had no significant effect on plant height at 3 weeks after transplanting, because the plants were still at their early stage of growth and might not have fully recovered from transplanting shock. At 5 - 7 weeks after transplanting the differences between the various levels of phosphorus were significant. Phosphorus enhanced the intial root development necessary for establishment of the seedlings,

thereby increasing nutrient absorption and consequently resulted in taller plants. Similar observations were made by Aliev (1972), Doikova (1977), and Amans (1982).

The ability of phosphorus to significantly increase the number of branches per plant at the early and late stages of growth is due to its enhancement of the rate of nitrogen translocation for the growth of vegetative parts of the plant. During the period of maximum flower and fruit production (7 weeks after transplanting), phosphorus had no significant effect on number of branches per plant, probably because the nutrient was diverted for flower and fruit formation. These changes in the pattern of response of eggplant to phosphorus is contrary to Sharma and Mann (1972) but agrees with the observation made by Eguchi et al. (1958).

Except at five weeks after transplanting, only the highest level of phosphorus application (60kg P_2O_5/ha) produced significant increase in number of leaves. Phosphorus, however, did not produce any significant increase in stem diameter. All these go to point out that the effect of phosphorus on vegetative growth was not as remarkable as that of nitrogen where low levels of applied fertilizer (75 kg N/ha) produced significant increases.

5.3 Effect of Farmyard Manure on Vegetative Growth

Farmyard manure did not result in significant increase in plant height during the early period (3 to 5 weeks after transplanting) but from 7 to 11 weeks after transplanting,

10 t FYM/ha application significantly increased plant height. Due to the slow releasing power of nutrients in farmyard manure, even the highest level of farmyard manure could not significantly increase height at 3 to 5 weeks after transplanting. At this period, enough nutrients have not been mineralised to produce significant effect on plant height. Hemingway (1961), and Bunting (1963) found that less than 40 per cent of total nitrogen in a feed lot manure was released during the first year after application. At 7 to 11 weeks after transplanting, enough nutrients had been mineralized to produce significant effect.

Increasing the rate of farmyard manure also resulted in higher number of branches per plant. As in the case of plant height, significant increases were not recorded during the initial stage of growth, but more pronounced effect leading to significant differences occurred during the latter stage. Application of 10 t FYM/ha produced significantly more branches than the control. Increasing the rate to 20 t/ha produced no further significant increase.

The effect of farmyard manure on number of leaves per plant followed the same pattern as those of height and number of branches. A more pronounced effect was however recorded at the sampling (9 weeks after transplanting) in which each of the two levels of farmyard manure applied (10 and 20 t/ha) produced significant increase in number of leaves. Main stem diameter at 6 weeks after transplanting also

increased due to the effect of the farmyard manure.

Since eggplant requires constant nutrient to sustain its growth for long petiod, farmyard manure seems best suited for this purpose because of its ability to act as nutrient source for a long time.

5.4 Effect of the Various Nutrient Interactions on Vegetative Growth of Eggplant

The general inability of nitrogen, phosphorus and farmyard manure interactions to produce significant effect on the vegetative growth characters of plant height, number of branches and stem girth may probably be due to the masked effect of secondary elements on the way plants utilize the major nutrients. This is in conformity with reports of York et al. (1953).

However, phosphorus x farmyard manure interaction significantly increased the number of leaves per plant at 7 weeks after transplanting. The importance of combined application of phosphorus and farmyard manure was manifested since neither the main effect of phosphorus nor that of farmyard had significant influence on the number of leaves per plant. The increase in number of leaves per plant due to phosphorus and farmyard manure interaction agreed with the reports of Mertia and Chauhan (1970) and Aliev (1972) who reported that combined application of phosphorus fertilizer with farmyard manure increase their utilization at higher levels.

5.5 Effect of Nitrogen on Yield-related Characters of Eggplant

Nitrogen fertilizer significantly increased the number of fruits. The highest dose of nitrogen applied (150 kg N/ha) produced the highest number of fruits per plant. The increase in number of fruits over control could be due to the activity of nitrogen in promoting foliage growth which also enhanced photosynthate production for development of more fruits. Singh and Sandhu (1970), Mertia and Chauhan (1970) and Kamruddin et al. (1970) also reported that nitrogen application increased the number of fruits per plant.

Low rate of nitrogen fertilizer (75 kg N/ha) had no effect on earliness in flowering, whilst the highest level of 150 kg N/ha delayed the number of days to flowering. The delay in flowering was probably due to Carbon-Nitrogen ratio balance. Excess nitrogen caused a shift in Carbon-Nitrogen ratio which probably favoured vegetative growth at the expense of flower development. This is confirmed by the observations of Lambeth (1948), Mentelaro et al. (1952), Bajpoi and Bajpoi (1963), Singh and Sandhu (1970) and Olareweju (1977) that high levels of nitrogen fertilizer delay flower development.

Plant leaf spread and leaf area index were also greatly increased by nitrogen fertilizer. Because these parameters were correlated to fruit yield, increasing any of them to an optimum level also increased fruit yield.

Application of 75 kg N/ha significantly increased fruit

diameter. Since fruit size depends upon vegetative activities of plant, it appears that nitrogen treatment leading to increased leaf growth ultimately favoured synthesis of more food material. Translocation of this final material into fruit led to an increase in fruit size. This supports the finding of Gupta and Shukla (1977) and Gupta et al. (1978) who reported that nitrogen fertilizer application significantly increased fruit size.

5.6 Effect of Phosphorus on Yield-related Characters

The increased number of fruits per plant due to phosphorus application as observed in this study, contradicts the findings of Gupta et al. (1978) who reported that number of fruits per plant decreased when phosphorus fertilizer is increased. The observed increase in number of fruits resulting from phosphorus application could be explained on the basis of the positive influence of this nutrient in encouraging flower formation (Gill et al., 1974 and Bhatnagar and Pandita, 1979). These flowers later developed to fruits early before the onset of drought.

While phosphorus application had no significant effect on plant leaf spread, it significantly increased the leaf area index. The lack of marked effect on the plant leaf spread could be due to the fact that plant leaf spread is not a very accurate method of measuring foliage growth.

Phosphorus fertilizer induced early flowering more

effectively than nitrogen. This confirmed the reports made by Lombert (1948) that high phosphorus/nitrogen ratio enhanced flowering while high nitrogen/phosphorus ratio delayed it.

Fruit diameter as affected by phosphorus decreased with age. The decrease was as a result of decreasing influence of applied nutrient with time. Whereas fruit diameter was significantly increased by applied phosphorus at 8 and 12 weeks after transplanting, no such significant differences were observed at 10 and 14 weeks after transplanting. These differences could be associated with fluctuations in the rainfall pattern which affected the availability of applied phosphorus.

5.7 Effect of Farmyard Manure on Yield-related Characters

Application of 10 t/ha farmyard manure significantly increased the number of fruits per plant but increasing the rate to 20 t/ha resulted in no further increase. The influence of farmyard manure in increasing fruit number may be due to its nitrogen and phosphorus contents as reported by Okokoto and Stephen (1961), and its ability to improve soil chemical and physical properties (Bache and Heathcote, 1969; Heathcote, 1970).

The most probable reason why high level of farmyard manure application decreased the number of days to flowering is due to its phosphorus content, and its ability to increase soil phosphorus availability. Plant leaf spread as well as

leaf area index were greatly improved by application of farmyard manure.

The ability of farmyard manure in increasing fruit diameter decreased with age. The diameter was greater at first sampling (8 weeks after transplanting) and progressively decreased up to the last sampling (14 weeks after transplanting). This decrease was probably as a result of progressive reduction in amount of available nutrient and increasing difficulty of mineralization of the farmyard manure.

5.8 Effect of Various Nutrient Interaction on Yield-related Characters

Yield related characters such as number of fruits, leaf spread and leaf area index were not significantly influenced by various nutrient interactions. This indicated that the nutrients reacted independently.

Nitrogen x phosphorus interaction significantly increased earliness to flowering. The higher doses of nitrogen alone were responsible for delay in flowering, but nitrogen in combination with phosphorus was able to maintain intermediate response towards flowering. Phosphorus alone tended to reduce the days to flowering. This result confirms with the findings of Lambeth (1948) and Eguchi *et al.* (1958) who reported that high nitrogen/phosphorus ratio delayed flowering, while high phosphorus/nitrogen ratio enhanced flowering.

5.9 Effect of Nitrogen on Yield

Total fruit yield of S. gilo increased remarkably by nitrogen. Similar results were recorded for S. melongena (Gupta et al., 1970), S. aethiopicum and S. macrocapon (Taylor, 1979; and Kogbe, 1982). In the present study, application of 75 kg N/ha produced 35.81 t/ha fruit yield which was 66 per cent more than the yield of the control. Though increasing the rate of fertilizer up to 150 kg N/ha increased yield further, it was done at a diminishing rate. From a regression analysis, the most optimum level of nitrogen fertilizer application for increased fruit yield lies at about 143 kg N/ha (Fig. 1). This increase in yield may be due to an increase in number of leaves, leaf area index and number of fruits. A direct relationship between the number of leaves, leaf area index, fruit number and yield has been established. Number of leaves, leaf area index, fruit number and yield, all showed diminishing effect at 150 kg N/ha level. Thus, it appears that at optimum level of nitrogen, enough leaves might have been produced and this in turn resulted to more photosynthetic activity which lead to production of more larger-sized fruits and, therefore, greater fruit yield. Sharma and Singh (1963) had similar results.

Yield distribution showed that fruit production generally decreased towards the end of crop growth when leaves started to die as a result of senescence. Consequently, fruit yield sharply dropped due to reduction in the number and size of

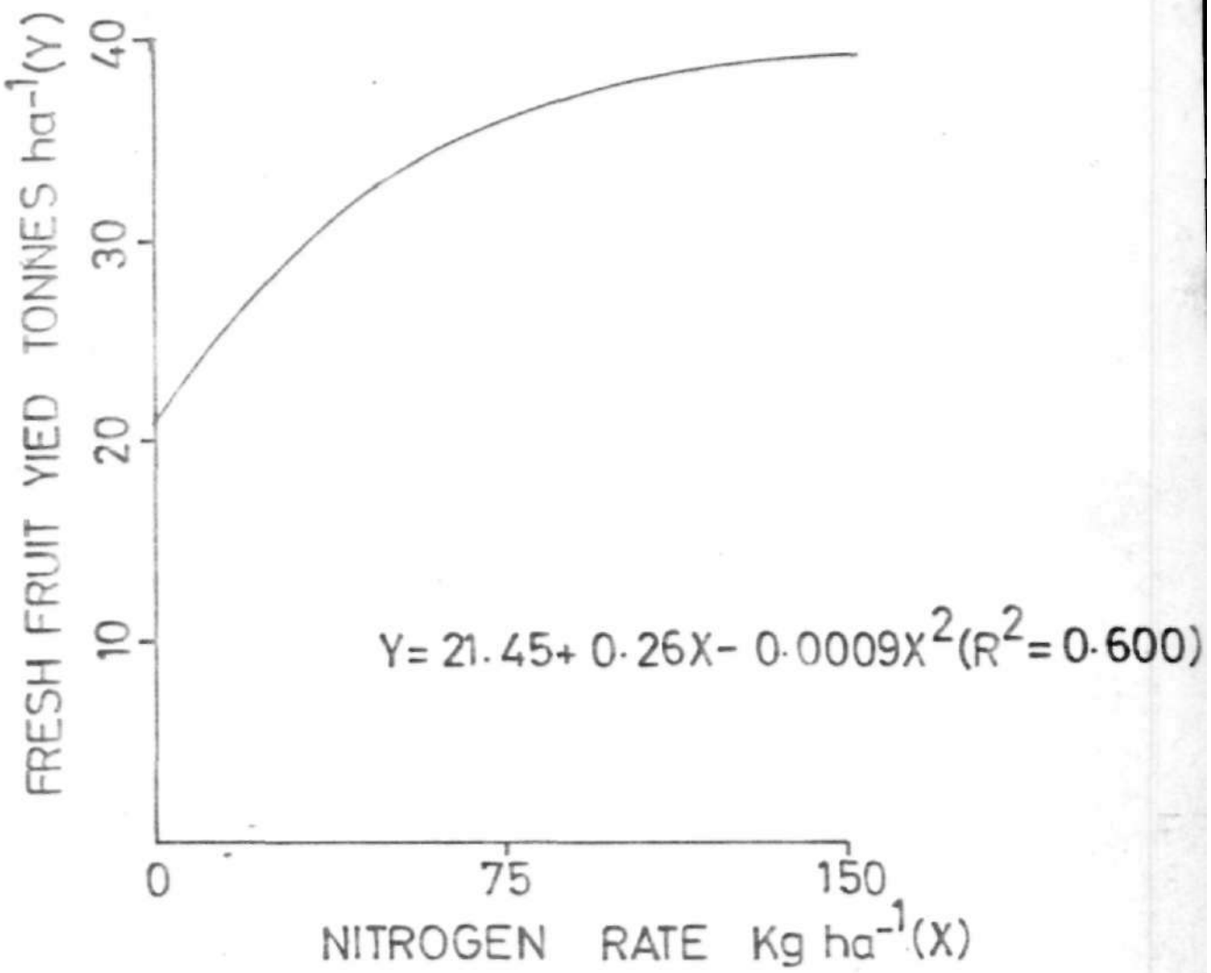


FIG. 1: RESPONSE OF EGGPLANT YIELD TO NITROGEN APPLICATION

photosynthetic apparatus. The highest fruit production occurred at 10 weeks after transplanting when over 50 per cent of the total fruit yield occurred probably due to the attainment of optimum leaf area index.

Nitrogen also progressively advanced the dry weights of stem, fruit and leaf and consequently the shoot dry matter yield in all the periods of study. Application of 75 kg N/ha produced more shoot dry matter yield than the control. Application of 150 kg N/ha resulted in a statistically higher shoot dry matter yield than 75 kg N/ha only at the last periods of sampling. This was probably due to prolonged activity of higher dose of nitrogen fertilizer. Shoot dry matter yield increased with increase in number of weeks after transplanting. A greater increase in shoot dry matter yield however occurred between 6 and 10 weeks after transplanting due to differences in fruit yield at that later period of growth.

5.10 Effect of Phosphorus on Yield

Phosphate fertilizer increased yield but the magnetitude of response was not as much as in the case of nitrogen. This low positive yield response revealed the extent to which phosphorus was available in the soil. Low level of 30 kg P_2O_5/ha had no significant effect on yield, but increasing the 60 kg P_2O_5/ha produced 35 t/ha of fruits which was significantly higher than the control and plots receiving 30 kg P_2O_5/ha. Positive yield response to phosphorus has been reported by

Shukla (1977). Gupta et al. (1978), and Bhatnagar and Pandita (1979). Application of phosphorus fertilizer stimulated root development which not only increased the vegetative portion by enhancing nutrient absorption but also increased fruit yield.

5.11 Effect of Farmyard Manure on Yield

All the levels of farmyard manure applied significantly increased the fruit yield. However, the marginal increase in yield diminished with increasing rate. Application of 10 t/ha increased yield by about 21% over the control, while application of 20 t/ha resulted in only 8 per cent increase above that of 10t. A regression analysis of yield over farmyard manure applied showed that a positive linear curve best described the yield response (Fig. 2). This points to the poor content of organic matter in the soil for satisfactory yield. Similar increases in fruit yield due to farmyard manure application has been reported by Inyang (1967), Kogbe (1976), Mokwunye (1978) and Doikova (1979). Many factors are responsible for the increase in yield often associated with farmyard manure. The ability to retain plant nutrient and moisture in the soil for a longer time, and also the nutrients contributed, are some of the factors.

5.12 Effect of Nitrogen, Phosphorus and Farmyard Manure Interactions on Yield

The effect of the nutrients in increasing fruit yield was relatively higher when used in association with one

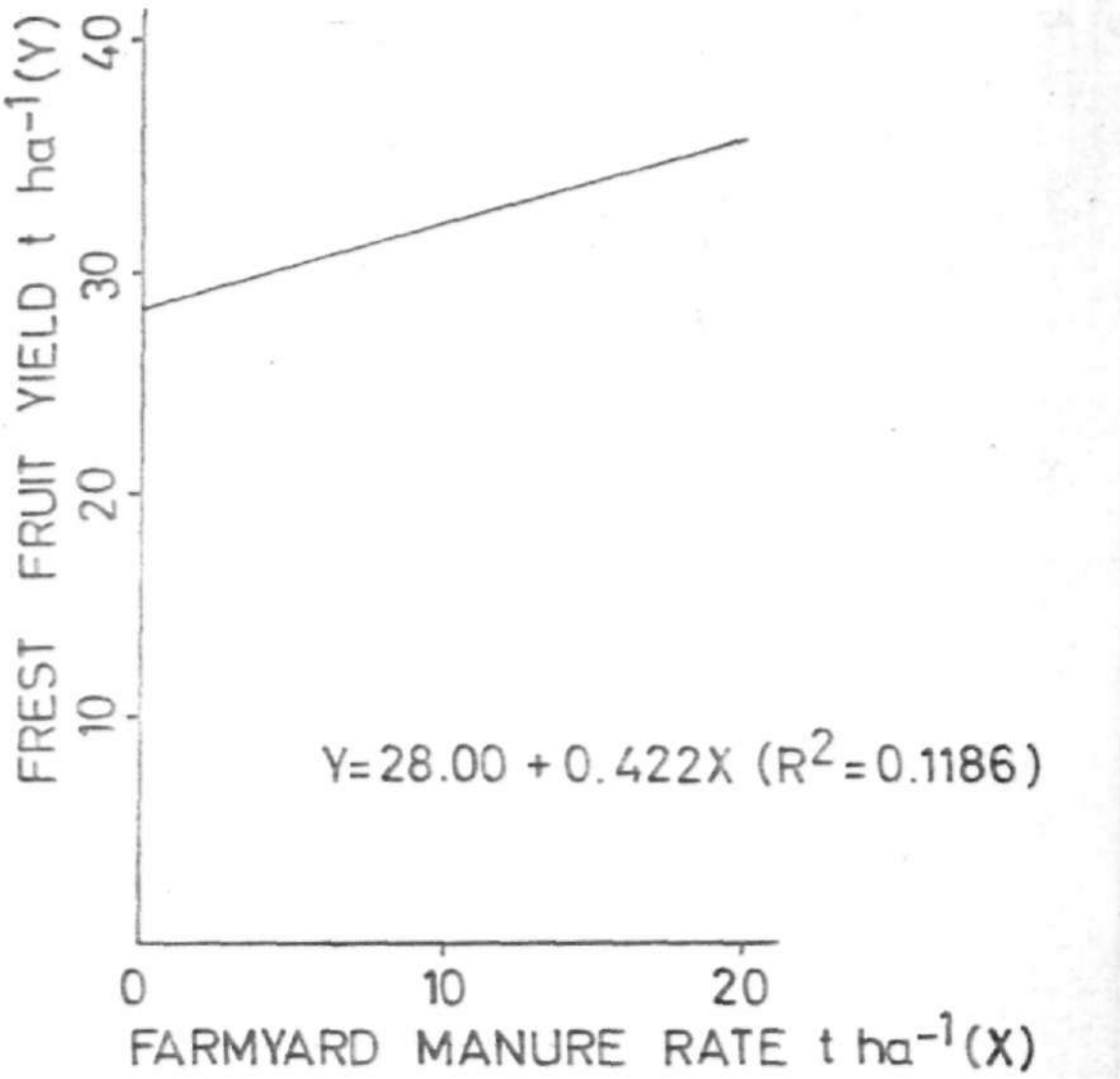


FIG.2 RESPONSE OF EGGPLANT YIELD TO FARMYARD MANURE APPLICATION

another. Good vegetative development under the combination of nitrogen and phosphorus enabled the plant to photosynthesize and store for fruit development and increased yield. The inefficiency of 150 kg N/ha in absence of phosphorus to increase fruit yield is attributed to limited use of applied nitrogen. This is in conformity with observations made by Gunes (1959), Martia and Chauhan (1970) that the amount of nitrogen required by a plant depends to some extent on the level of available phosphorus. This was probably why the highest fruit yield came as a result of combination of the highest level of nitrogen with the highest level of phosphorus. On the other hand, limited application of phosphorus in the absence of nitrogen had no significant effect until the level was raised to 60 kg P_2O_5/ha.

In phosphorus x farmyard manure interaction, the significant effect on fruit yield observed for every level of farmyard manure that went into combination with 30 kg P_2O_5/ha was due to the ability of farmyard manure to enhance the availability of phosphorus. Farmyard manure increases phosphorus availability by discouraging its fixation (Brady, 1974). This however may not continue for every quantity of phosphorus added, and probably accounted for inability of increasing levels of farmyard manure to increase availability of phosphorus at 60 kg/ha level.

The interdependence of nitrogen x phosphorus x farmyard manure in affecting yield was quite evident. The highest fruit yield was as a result of combination of the highest levels of

nitrogen, phosphorus and farmyard manure. This is in agreement with results of Petrov and Doikova (1975), Doikova (1976 and 1979) and Spasov and Rankov (1971).

5.13 Crude Protein Content of Fruits

No significant increase in crude protein content of fruit was observed by application of nitrogen. This is probably due to the fact that nitrogen is required for synthesis of nitrogen compounds of the plant. Since protein in relatively small amount (less than 1%) in eggplant (Plot, 1962; Rangil et al., 1974) little of the nitrogen applied is converted into crude protein. The application of phosphorus also had no significant effect on fruit crude protein content.

The non-directional trend in the effect of farmyard manure application on crude protein content may be due to the low concentration of nitrogen and phosphorus in farmyard manure as reported by Dennison (1961). This had no observable effect on crude protein content.

5.14 Correlations

The positive and significant correlations observed between yield and such characters as number of leaves, leaf area index, leaf spread, number of branches and shoot dry matter production was due to the fact that these vegetative characters directly determine the amount of photosynthate available for plant growth and fruit formation. Increased

vegetative growth greatly enhanced the activities of the photosynthetic apparatus. The resulting photosynthetic food material are readily translocated to the storage sinks for fruit development and increased yield. A major reason why plant height is significantly correlated to fruit yield is probably because increased plant height exposes the crop to higher photosynthetic source. Also, higher plant possesses more vegetative matter and, therefore, can produce more flowers. This increased number of flowers lead to more fruits which result in increased yield. Singh and Khanna (1978), also observed that plant height was highly corealated to fruit yield.

Number of days to flowering had no significant correlation to fruit yield because it is negatively related to fruit number per plant (Vijay et al., 1978).

Number of fruits per plant was highly and significantly correlated to fruit yield. This is in conformity with observation made by other researchers that fruit number is a major component of yield and, therefore, highly correlated to fruit yield (Nsowah, 1970; Shrivastava and Sachan, 1973; Vijay and Prem, 1978; Singh and Khanna, 1978).

Chapter 6

SUMMARY AND CONCLUSIONS

A field experiment was conducted at the horticultural garden of Ahmadu Bello University, Zaria, during the 1983 rainy season. The aim of the experiment was to determine the effect of nitrogen, and phosphorus fertilizer and farmyard manure on growth and yield of local eggplant Solanum gilo, variety 'Samaru striped'. Three levels of each of the nutrients (N-0, 75 and 150 kg/ha; P_2O_5-0, 30 and 60 kg/ha; FYM-0, 10 and 20 t/ha) were applied. A randomised complete bolck design was adopted. There were 27 fertilizer and farmyard manure treatment combinations, which were replicated four times.

Application of nitrogen fertilizer affected the growth. It remarkably increased vegetative growth characters of plant height, number of branches, number of leaves, main stem diameter, leaf spread, leaf area index, shoot dry matter yield, number of fruit, number of days to flowering and the total fruit yield.

The fruit yield per hectare increased significantly with increasing levels of nitrogen application up to 150kg. Application of 75kg N resulted in 35.81 t/ha fresh fruit weight which was 66 per cent increase in yield over the control. However, the marginal increase in yield decreased with nitrogen application up to 150 kg/ha so that only 17 per cent significant increase occurred. A regression analysis

showed that an optimum level of nitrogen application for increased yield is about 143kg N/ha. The sharp decline in yield at 12 and 14 weeks after transplanting inspite of the fact that eggplant is a perennial crop indicates the importance of split application of nitrogen fertilizer. Two split applications was used in this experiment to sustain greater yield over a longer time.

The number of fruits produced increased significantly with increasing levels of nitrogen but the marginal increase decreased with higher doses. Low level of nitrogen applied (75kg N/ha) had no effect on days to flowering but higher dose at (150kg N/ha) significantly increased the number of days to flowering.

The response to phosphorus was modest and less remarkable than nitrogen. Like nitrogen, application of phosphatic fertilizer increased vegetative growth characters except leaf spread and stem diameter. Lower level of phosphorus (30kg P_2O_5/ha) had no significant effect on fruit yield but increasing the level to 60kg P_2O_5/ha significantly increased yield, producing 35.22 t/ha. Phosphorus application also profoundly increased the earliness to flowering. Each increase in level of phosphorus significantly reduced the days to flowering.

Farmyard manure application was not as effective as nitrogenous fertilizer. It significantly increased plant height, number of branches, number of leaves, plant leaf

spread, leaf area index and stem diameter. It also significantly increased the fruit yield as the rate of application increased. Application of 20 t/ha farmyard manure produced 35.95 t/ha of fruits.

The interaction of nitrogen, phosphorus and farmyard manure was significant on fruit yield. The interdependency of these nutrients in effecting yield was, therefore, quite evident. When applied alone, each of these nutrients increased yield but much greater yield occurred as a result of combination of these nutrients. The highest fruit yield was obtained as a result of combined application of the highest levels of nitrogen, phosphorus and farmyard manure. This produced about 46 t/ha of fruits which was over 300 per cent increase over the control.

The correlation between yield and plant height, number of branches, number of leaves, leaf area index, shoot dry matter and fruit number were highly significant. The number of days to flowering however did not correlate with fruit yield.

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Appendix I: Rainfall distribution (mm) at Samaru during the 1983 Cropping Season.

	Period	Rainfall (mm)
April	1 - 10	0.0
	11 - 20	0.0
	21 - 30	0.0
May	1 - 10	0.0
	11 - 20	54.1
	21 - 31	19.2
June	1 - 10	14.0
	11 - 20	14.0
	21 - 30	46.3
July	1 - 10	46.7
	11 - 20	8.3
	21 - 31	52.5
August	1 - 10	98.1
	11 - 20	84.0
	21 - 31	76.9
September	1 - 10	51.7
	11 - 20	38.2
	21 - 30	3.5
October	1 - 10	8.0
	11 - 20	0.0
	21 - 31	0.0
		608.5 mm

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