PERFORMANCE OF SWEET PEPPER (*Capsicum annuum* L.) VARIETIES AS INFLUENCED BY NITROGEN AND POULTRY MANURE FERTILIZATION IN THE SUDAN SAVANNA.

BY

KAUTHAR, KABIR

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A THESIS SUBMITTED TO SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE IN AGRONOMY.

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DECLARATION

I hereby declare that the work in this thesis titled "PERFORMANCE OF SWEET PEPPER (*Capsicum annuum* l.) VARIETIES AS INFLUENCED BY NITROGEN AND POULTRY MANURE FERTILIZATION IN THE SUDAN SAVANNA" was performed by me in the Department of Agronomy under the supervision of Dr. R.A Yahaya, Professor L. Aliyu and Dr. B. A. Babaji, The information derived from literature have been duly acknowledged in the text and a list of references provided. No part of this work has been presented for another degree or diploma at any institution.

Kabir Kauthar	Signature	Date

The above declaration is confirmed by;

Dr. R.A. Yahaya	Signature	Date

(Chairman, Supervisory Committee)

CERTIFICATION

This thesis titled" PERFORMANCE OF SWEET PEPPER (*Capsicum annuum* l.) VARIETIES AS INFLUENCED BY NITROGEN AND POULTRY MANURE FERTILIZATION IN THE SUDAN SAVANNA" meets the regulations governing the award of the degree of Master of Science Agronomy of the Ahmadu Bello University, and is approved for its contribution to knowledge and literacy presentation.

Dr. R. A. Yahaya Chairman, Supervisory Committee	_____ Signature	_____ Date
Dr. B. A. Babaji Member, Supervisory Committee	_____ Signature	_____ Date
Professor L. Aliyu Member, Supervisory Committee	_____ Signature	_____ Date
Dr. B.A. Babaji Head of Department	_____ Signature	_____ Date
Professor Adebayo Joshua Dean, School of Postgraduate Studies	_____ Signature	_____ Date

DEDICATION

This Research work is dedicated to the Almighty Allah and to my parents, siblings and husband for their support, guidance and love.

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I want to express my profound gratitude to all those who contributed to the realization of this consolidating step in my academic pursuit. My sincere gratitude goes to my supportive supervisors, Dr. R. A. Yahaya, Professor L. Aliyu and Dr. B. A. Babaji who in spite of their tight schedules gave me the necessary assistance needed to complete this project. To my lovely parents, husband and siblings, I will forever remain indebted to you for your love, support and encouragement. I also wish to express my gratitude to my colleagues and staff of Agronomy Department who assisted and guided me through this project.

ABSTRACT

Two field experiments were conducted during the 2011/2012 dry season at the Irrigation Research Station (IRS) of the Institute for Agricultural Research (IAR), Kadawa and Kadawa Village, Kano State. Treatment evaluated consisted of two varieties of sweet pepper (California Wonder and Tattasai Dan-Garko), three nitrogen rates (50, 75 and 100 kg N ha^{-1}) and three poultry manure rates (0, 3 and 6 t ha^{-1}) which were factorially combined and laid in a randomized complete block design (RCBD), replicated three times. It was observed that California Wonder had higher leaf area index (3.03) fruit diameter (5.00, 4.70 cm) and fresh fruit weight (8307.60 kg ha^{-1}) than Tattasai Dan-Garko (2.14), (4.13, 4.20) and (6380.8 kg ha^{-1}). Growth and yield characters such as crop growth rate (8.30 and 8.01g/week) in both sites, plant height (17.70 cm) and fresh fruit weight (7535.70, 7544.1 kg ha^{-1}) in Kadawa Village and combined, while number of fruits per plant (10.00) in Kadawa Station were significantly influenced by application of 75 kg N ha^{-1}. Fruit length, number of branches and leaves, number of days to 50% flowering and net assimilatory rate were not significantly influenced by varying nitrogen rates. Three tons per hectare of poultry manure had a significant effect on pepper fruit length (6.64 cm) and other growth characters such as leaf area index (4.81, 5.34) in both location, plant height (24.31 cm) and crop growth rate (8.90 g/week) in Kadawa Village. Interactions between nitrogen and variety, poultry manure and variety gave taller plants (26.11 cm) at 8 WAT at Kadawa Station and application of 3 t ha^{-1} of poultry manure gave higher yield of pepper (8395.15 and 7436.79 kg ha^{-1}) combined data at Kadawa Village. Regression analysis showed that the optimum rates of nitrogen for sweet pepper were (78.90 and 88.49 kg N ha^{-1}) and yield (7930.60 and 9601.02 kg ha^{-1}) for California Wonder variety in both sites. While for Tattasai Dan-Garko the optimum nitrogen rates were (78.04 kg N ha^{-1} and 92.32 kg N ha^{-1}) in the two locations. Poultry manure when regressed against pepper yield gave an optimum of (4.33, 4.00 t ha^{-1}) and yield (9848.43, 7928.8 kg ha^{-1}) with California Wonder variety. For Tattasai Dan-Garko optimum poultry manure of (3.04, 4.0 t ha^{-1}) gave a yield of (8384.66, 7397.4 kg ha^{-1}) at both sites. From the study, it could be suggested that a farmer may use California Wonder variety with application of 78.90 kg N ha^{-1} and 4.00 t ha^{-1} poultry manure rates in Sudan savannah ecological zone.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Origin and Distribution

Peppers are vegetable crops belonging to the family *Solanaceae* and the genus *Capsicum*. They are indigenous to Central and South America. Columbus found them growing in West Indies but were introduced into Europe in the 16th century. (Agricultural Alternative, 2000). Gibbon and Pain (1985) also reported that all *Capsicums* are of American origin, but they are now widely spread throughout the tropical and subtropical regions of the world. *Capsicum* consists of approximately twenty two wild species and five domesticated species. The five domesticated specie include, *C. annum L., C. baccatum L., C. chinensis L., C. pubescens L., and C. frutescens L.,* (Bosland and Votava, 2000). On the hand, Capsicum can be divided into several groups based on fruit/pod characteristics ranging in pungency, color, shape, intended use, flavor and size. Despite their vast trait differences most cultivars of pepper commercially cultivated in the world belongs to the species *C. annum L*. (Smith *et al.,*1987). It is one of the most important vegetables grown in Nigeria and other parts of sub humid and semi arid tropics (Aliyu, 2000). Although the crop is widely cultivated in Nigeria, yield obtained by peasant farmers are often very low due to various production constraints such as lack of information on fertilizer application and non availability of fertilizers. As a result low yield are obtained leading to exorbitant prices per unit weight (Uzo, 1984).

The crop can be grown on many kinds of soils ranging from fine sands through many loams, clay loams and silt loams but sandy loams and loams are preferred (Jaliya and Sani, 2010). Peppers were classified as day neutral plants (Eguchi, 1958). Optimum growth temperature ranges from 21 °C to 25 °C (Grubben, 1977). Low to moderate rainfall of 635 – 1200mm per annum is adequate for the crop.

Jaliya and Sani (2010) reported that peppers require more heat and are more sensitive to cold than most common garden crops grown in Nigeria. The crop will fail to thrive during cool periods when temperatures are between 4.4 °C to 15.6 °C.

The plant is grown as an annual, but in home garden sometimes as a short term perennial, (Pickergill, 1989). Erect herb, up to 2.5 m tall, much branched, tap root strong, lateral root are numerous and stem irregularly angular up to 1cm in diameter. Leaves are alternate, simple, variable, and flowers solitary, white pending. The fruit is a berry, with either three or four lobes fruit. The fruit usually range in size from 5-13 cm in diameter and 5-15 cm in length. Inside the thick flesh is an inner cavity with edible bitter seeds and a white spongy core (Wolf-Garten *et al*., 1977). Both yellow and green immature and red, yellow and brown mature fruits are common. They include mild non pungent (sweet) varieties which are longer and have thicker flesh than the pungent ones (Aliyu *et al.;*1996). Nigeria is known to be one of the major producers of pepper in the world accounting for about 50% of the African production (Idowu-Agida *et al.*2010). World production statistics in 2006 showed that Nigeria's pepper production of about 204,200 metric tons. While the dry fruit production figures for Nigeria in 2007 was 49,500 metric tons out of Africa's totals of 457,650 metric tons (Yahaya, *et al;*2010).

The crop responds to both organic and inorganic fertilizers and has been shown to respond positively to nitrogen and phosphorus fertilizers (Wien *et al*.1989, Aliyu, 2002). The savannah region of Nigeria where most of the pepper production takes place is reported to be poor in native nitrogen and phosphorus supply. It is therefore very important to supplement these soils with mineral fertilizers and manures (Jones and Wild, 1975), Organic manures especially. Poultry manure has high concentrations of nutrients like nitrogen, phosphorus, calcium and magnesium than other forms of organic manure (Aliyu, 2000). Despite ability to tolerate drought, yield in sweet pepper had been reported to increase with increase in moisture supply.

1.2 Economic Importance of Sweet Pepper

Pepper like other vegetable crops contributes nutritionally to the human diet. It is rich in nutrient that may be lacking in other food materials thereby making it more palatable and hence improves food intake and digestion. Sweet pepper also known as bell pepper can be cooked or eaten as raw salad. The leaves are also consumed as salad in soup or eaten with rice. It was also discovered to be a good source of medicinal preparation for black vomit, gout and paralysis (Khan *et al.*, 2010). Sweet pepper has low calorie value but the nutritive value is especially high for vitamins A and C. Peppers are also used in pickles of various kinds consisting of pungent fruits preserved

in brine or strong vinegar. Peppers are used for flavoring, sauces and in canned products. They are also used for other confectionary products like bread, meat pie, and burger.

Pepper is widely used in pharmaceutical industries as a powerful stimulant and carminative and externally as counter irritant due to the capsaicin in the placenta tissue and septa of the fruit (Thompson, 1939; Yamaguchi, 1983). Sweet Pepper contains a recessive gene that eliminates capsaicin, the compound responsible for the hotness found in other peppers (Wolf Garten et al. 1977).

1.3 Justification and Objective of the Study

The use of organic and inorganic fertilizers has amassed a great significance in recent years in vegetable production for two reasons. Firstly, the need for enhanced sustainable increase in production; and per hectare yield of vegetables requires an increased amount of nutrients. Secondly, the results of a large number of experiments on organic and inorganic fertilizers conducted in several countries reveal that inorganic fertilizer alone cannot sustain productivity of soils under highly intensive cropping system (Khan *et al*.2010). Arising from the need for increased production of this crop, especially under irrigated cropping condition for all year round supply of the commodity thereby enhancing food security, necessitates this work. There is also the need for use of high yielding, disease and pest resistant varieties for increase in the crop yield. In order to obtain high yield of sweet pepper, there is the need to augment the nutrient status of the soil to meet the crop requirement and maintain the fertility status of the soil. One of the ways of increasing the nutrient content is by boosting the nutrient content with organic materials such as poultry manure, with or without inorganic fertilizers (Dauda *e t al.*2008). Poultry manure is relatively resistant to microbial degradation (Dauda e t al.2005). However, it is essential for establishing and maintaining the optimum soil physical condition for plant growth. Savannah soils of Nigeria have also been found to be inherently low in plant available nitrogen, this has made nitrogen an important nutrient in crop production (Jones and wild, 1975).

In view of the need to update available literature on growth and yield of sweet pepper in response to poultry manure and nitrogen fertilization under irrigation, the proposed study was carried out:

1. To determine the effect of different poultry manure rates on growth and yield of two sweet pepper varieties under irrigated condition.
2. To determine the response of sweet pepper to nitrogen fertilization under irrigation.
3. To evaluate the performance of sweet pepper varieties to the combined effects of nitrogen and poultry manure and recommend to the farmer the optimum level.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Effect of Nitrogen Fertilizer on Growth and Yield of Pepper

Fertilizer is one of the major factors of crop production and nitrogen is a nutrient essential for good growth and development of plants (Khan *et al.*, 2010). Nitrogen metabolism in plants results in synthesis of soluble N-compounds, proteins, alkaloids, chlorophyll and other complex substances which are necessary for promoting growth. It increases the tap root ratio and fruit and seed formation (Olson *et al.*, 1971). Pepper has been known to respond well to nitrogen fertilizer. Frank (1965) reported a general increase in vegetative growth with increase in nitrogen rate. Khan *et al.*(2010) reported that optimum dose of N fertilizer increases proper growth and development and maximizes the yield of sweet pepper. Fertilizer also influences quantity and quality of *capsaicin* content and colour of powdered pepper, (Khan *et al.,*2010). Sharma *et al.* (1996) also reported that plant height, fruit number per plant, fruit weight and yield of Chilli increased significantly with 150:75:75 kg NPK ha^{-1}. Cochran, (1938) opined that a pepper plant which received relatively high nitrogen rate (180 kg N ha^{-l}) produced significantly more blossom than the plants receiving low N rate (50 kg N ha^{-1}). However, high rate of N is often associated with increased vegetative growth at the expense of fruiting. Aliyu *et al.,*(1996) observed that high rate of nitrogen application has been found to reduce significantly the yield of pepper.

Excessive application of nitrogen has been found to delay flowering in pepper (Frank, 1965). There were no significant differences in fruit yield, fruit diameter and number of fruits per plant when nitrogen rate was increased from 120 kg N $ha^{-1}$to 180 kg N ha^{-1} (Aliyu *et al.*, 1991).The response of pepper to nitrogen had been reported by several workers that includes (Batal and Smittle, 1981). Hartz et al. 1993. Aliyu, 2001, 2002, 2000). The substantial differences in nitrogen response from 0 kg N ha^{-1} to 240 kg N ha^{-1} was attributed to type and variety of pepper, regional, seasonal and environmental differences and cultural practices which affect plant vigor and nitrogen availability and uptake efficiency. Khan *et al*. (2010) reported that plant height at first flowering and first harvest, final number of branches per plant at first flowering stage, at first harvest and at final harvest and number of fruits per plant increased with increase in the

level of nitrogen from 0 to 150 kg N ha^{-1}. Aliyu, (2002) reported higher yield of sweet pepper with application of 240 kg N ha^{-1}. Ekwu and Okporie (2000) observed increased plant height, number of branches, number and diameter of fruits as nitrogen rates increased from 0 kg N $ha^{-1}$to 150 kg N ha^{-1}.

Ekwu and Okporie (2000) explained that the increase in vegetative growth as the nitrogen rate increased could be attributed to an increase in cell division in the plant tissues, leading to the production of more photosynthetic surface and subsequent accumulation of photosynthates for more vegetative growth. The number and diameter of fruits increased as the nitrogen rate increased from 0 kg N ha^{-1} to 150 kg N ha^{-1}. This could be attributed to a higher number of fruiting buds which may have resulted to increased fruit production at the higher nitrogen rates. In another study on effect of nitrogen fertilization, uptake and composition of pepper Aliyu, (2003) observed that uptake of nitrogen was enhanced with successive increment up to 160kg N ha^{-} , while concentration of nitrogen in fruits increased significantly with levels up to 240 kg N ha^{-1}. Furthermore, fruit length, fruit diameter and yield were significantly increased with additional nitrogen. Application of nitrogen up to 134 kg N ha^{-1} improved pepper fruit weight and yield.

2.2 Effect of Poultry Manure on the Growth and Yield of Pepper

In crop production, organic materials such as poultry manures are used to supplement chemical fertilizers. (Anon, 1980). Poultry manure like other manure is known to improve the soil by enhancing both its physical and chemical properties. For manure to be effective, large amounts of up to 10 t ha^{-1} is needed for application depending on the nutrient, competition and concentration. (Anon, 1980).

There is variability in the nutrient composition of manures and this depends on the type of animal, its age, the feed supplied, bedding material used, storage and handling of manure (Anon, 1980, Aliyu, 2002), hence the reason for the differential response of crops to different manures. Poultry manure contains high amounts of nitrogen, phosphorus, calcium, magnesium and potassium than other forms of organic manures (Aliyu, 2002). Poultry manure increases water holding capacity and plant nutrient in the soil when properly decomposed. Poultry manures have the ability to release nutrients gradually and therefore can support crops for a long time (Ware

and Mc Collin, 1975). In another experiment in which NPK and poultry manure were used, Doikova, (1977) found out that total dry matter content increases with an increasing rate of poultry manure up to 4 t ha^{-1}though manure alone proved less effective than mineral fertilizer. Other Solanaceous crops have also been reported to show positive responses to manure application.

Addition of poultry manure to the soil resulted in long term nutrient availability to *Capsicum* (Omori *et al.*, 1977). Whereas Cerna, (1981) found that application of N and K in the absence of poultry manure retarded the formation of vegetative organs in *Capsicum*, while poultry manure promoted vegetative mass, dry weight, plant height, rate of dry matter increment per leaf unit area, photosynthetic potential and consequently the yield of Capsicum cultivar zlaten-7 was obtained with poultry manure rate of 29 t ha^{-1} (Yacheva, 1981).

Alabi (2006) also found that application of organic waste, poultry droppings increases growth and yield component of Capsicum significantly more than inorganic fertilizers. A similar result was observed by Anonymous (1991) where poultry manure significantly increased fresh fruit weight of chilli pepper, *Capsicum annum* variety Tattasai at a rate of 2% by volume in combination with 60 kg N ha^{-1}. Aliyu and Kuchinda (2002) working with different organic manure at Samaru, to determine their effect on yield and composition of pepper reported that yield of pepper increased with increase in the rate of manure. However, poultry manure and guano to produce more fruit yield than farm yard manure.

2.3 Effect of Nitrogen and Poultry Manure Rates on Sweet Pepper Varieties

Aliyu (2000) reported that application of poultry manure at 5 t $ha^{-1}$and farm yard manure at 5-10 t ha^{-1}supplemented with 50 kg N ha^{-1} resulted in adequate crop growth and maximum fruit yield of sweet pepper. Similarly Aliev (1972) observed that poultry manure plus NPK on fruit yield of pepper, increased yield by 200% over the control. The combination apparently advanced flowering when compared to the other treatments. Nair and Peter (1990) reported that combined application of organic manure (poultry droppings) of up to 5 t ha^{-1} and 50% recommended nitrogen fertilizer increased fruit number, fruit weight, plant and fruit yield of chilli compared with either poultry droppings or nitrogen fertilizer applied alone. Shehata *et al.*(2004) observed treatments that received NPK plus poultry manure at the rate of (1/3+1/3)

increased plant height, number of leaves, weight of fruit, length, total yield, fruit thickness and increased concentration of NPK in leaves and stems of sweet pepper plant. Sharu and Meerabi, (2001) found that the higher chilli fruit yield was obtained with 50% poultry manure and 50% inorganic nitrogen.

2.4 Variation among Sweet Pepper Varieties

A wide range of sweet pepper varieties are grown for both fresh market and processing. These include varieties with the traditional blocky 3 or 4 lobe shape as well as longer more pointed varieties known as Europe and Lamuyo types (Bosland, 1992). Lemma *et al.* (2008) reported that each variety of pepper has its own significant effect on yield and yield components, and each variety has its own traits that are part and parcel as quality parameter of the crop (shape, size and color, taste and pungency). The most important trait among others include, number of branches per plant, plant height, number of fruit per plant, days to maturity, fruit yield per plant and fruit length.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Experimental Site

The field experiments were conducted during the dry season of 2011/2012 at Kadawa. The first experiment was conducted at the Irrigation Research Station farm of the Institute for Agricultural Research , Ahmadu Bello University located at Kadawa and the second site was at a private farm at Kadawa village ($11^{o}39^{'}$ N, $08^{o'}$ 02 E, 500 m above sea level). Both sites are located in the Sudan savanna agro ecological zone.

3.2 Treatments, Experimental Design and Plot Size

The treatments consisted of two sweet pepper varieties (Tattasai Dan-Garko and California Wonder), three nitrogen levels (50, 75 and 100 kg N ha^{-1}) and three manure rates (0, 3 and 6 t ha^{-1}). Treatment combinations were factorially arranged in a Randomized Complete Block Design (RCBD) and replicated three times. The gross plot was 4.5 x 3 m ($13.5m^2$) while the net plot size of 3 x 3 m^2 (9 m^2) and intra-row and inter-row spacing of 30 cm and 75 cm respectively were adopted.

3.3 Seed Source and Description of Variety

The improved seed (California Wonder) was sourced from Premier Seeds Nigeria limited, while the local (Tattasai Dan-Garko) was obtained from Yankaba market, Hadejia road, Kano. California Wonder is blocky shaped and has a primary color that is usually green, but may be yellow or purple. The secondary mature color is usually red, with 75 to 80 days from transplanting to maturity. It is a very hardy strong and vigorous plant with short nodes. The variety has a yield potential of up to 3 t ha^{-1}. Tattasai Dan-Garko is a long shaped pepper. It is hardy and vigorous bushy plant, with semi determinant growth habit. The variety takes longer days to mature (75 -85 days), and has a yield potential of up to 2 t ha^{-1}.

3.4 Cultural Practices

3.4.1 Nursery preparation and management

The seeds were sown in well prepared nursery beds of 2 m x 1 m. Seeds were drilled in rows 15 cm apart. These were covered with thin layer of soil and polythene mulch and then watered regularly until the seedlings emerged. The mulch material was removed and spread between the emerged seedlings. The seedlings were watered and weeded regularly until the time of transplanting at 5 WAS.

3.4.2 Soil and manure analysis

Soil samples were randomly collected from depth of 0 -30 cm across the experimental site during 2011 dry season prior to transplanting. The soil samples were thoroughly mixed, air dried, and sieved using 2 mm mesh sieve and later analyzed for physicochemical properties. The soil particle size analysis was determined by a hydrometer method (Day, 1965) and the textural class determined using textural triangle (USDA, 1960). Soil pH was determined using pH meter (Black, 1965). Total nitrogen was determined by macro Kjeldahl digestion (Bremner, 1965). Organic carbon was analyzed by Walkley and Black (1934). Available P was extracted by Bray No. 1 method (Bray and Kurtz, 1945). Exchangeable bases were determined in neutral NH_4OAC extract (Black, 1968) by atomic adsorption for calcium and potassium and CEC was estimated by summation. Manure samples were taken before applying to the soil and analyzed for NPK and 3 other elements Na, Mg and Ca (Table 1).

3.4.3 Land preparation and fertilizer application

The experimental sites were harrowed and later ridged 75 cm between rows. Manure was incorporated as per treatment after land preparation two weeks to transplanting by splitting the ridge and the manure applied and thereafter buried. Nitrogen fertilizer was applied at two equal split doses, first at transplanting and the second at 6 WAT as per treatment.

3.4.4 Weed control

Weeds were controlled by manual hoe weeding at 3 and 6 WAT, which kept the plots clean

3.4.5 Irrigation

The experimental field was irrigated by furrow irrigation system, to supply adequate moisture for the crop at weekly interval.

3.4.6 Harvesting

The green glossy matured fruits were harvested during the cool hours of the day by hand picking. Care was taken not to damage or severe the fruiting branches in the course of the harvest. The fruits were also placed directly into well labeled field baskets before weighing. Harvest was done three times at weekly interval.

3.5 Data Collection

3.5.1 Meteorological data

Data on temperature, relative humidity and sunshine hours were obtained from the meteorological Station at Kadawa (Appendix I)

3.5.2 Growth parameters

Growth parameters were assessed through random sampling of five plants from each net plot that were later tagged. Observation and measurement of growth characters were done at intervals of three weeks beginning from 4 WAT and terminated at 12 WAT. Parameters measured include;

3.5.2.1 Plant height (cm)

Heights of five randomly tagged plants per plot were determined by measuring the height from the ground level to the main shoot apex of the plant using a meter rule, and the average thereafter recorded.

3.5.2.2 Number of branches per plant

The number of primary and secondary branches per plant were carefully counted from the five tagged plants and the average was determined and recorded per plant.

3.5.2.3 Number of leaves per plant

The number of leaves was counted per plant from the five tagged plants and the average per plot was determined and recorded.

3.5.2.4 Leaf area index (LAI)

Leaf area index was derived from the result of the leaf area and calculated as shown below

$$LAI = \frac{\text{Total leaf area per plant}}{\text{Area of ground covered}}$$

3.5.2.5 Number of days to 50% flowering:

The number of days it takes 50% of the plant to start flowering were observed and recorded from transplanting, on per plant basis.

3.5.2.6 Total dry matter production

The dry matter produced per plant was determined by uprooting plants and thereafter oven dried to a constant weight at 70^{o} C. The weights of the dried samples were then taken using an electric weighing scale, determined and recorded as per treatment.

3.5.2.7 Net assimilation rate (NAR)

This represents the photosynthetic efficiency of assimilatory surfaces. It was computed using the following formula given by Radford (1967) and recorded on per plot basis.

$$NAR = \frac{W_2 - W_1}{A_2 - A_1} \quad \frac{\log_e A_2 - \log_e A_1}{t_2 - t_1} \quad (g\ cm^{-2}\ wk^{-1})$$

Where W_2 and W_1 represent the total dry matter of the plant when corresponding leaf area was A_2 and A_1 at times t_2 and t_1 respectively.

3.5.2.8 Relative growth rate (RGR)

The cumulative dry matter increment per unit time was computed as described by Radford, (1967) as follows:

$$RGR = \frac{\log_e W_2 - \log_e W_1}{t_2 - t_1} \qquad (g\ g\ wk^{-1})$$

Where W_2 and W_1 represent total dry weights at time t_2 and t_1 respectively.

3.5.2.9 Crop growth rate (CGR)

The crop growth rate expresses the dry matter increment of plant material per unit area of ground per unit time. It was computed as suggested by Watson (1958) and recorded on per plant basis.

$$CGR = \frac{W_2 - W_1}{t_2 - t_1} \qquad (g\ wk^{-1})$$

Where W_2 and W_1 represent total dry weights at time t_2 and t_1 respectively.

3.5.3 Yield parameters

3.5.3.1 Number of fruits per plant

The number of harvested fruits were counted at each sampling period and recorded. The total number of harvested fruits per plant thereafter was recorded.

3.5.3.2 Fruit diameter

This was determined by measuring the diameter at the top broad end of five randomly selected fruits using a Vanier caliper and the average was recorded on per plot basis.

3.5.3.3 Fruit length

This was determined by measuring the length of five randomly selected fruits from the proximal to the distal ends and the average was recorded as per treatment.

3.5.3.4 Fresh fruit yield (kg ha^{-1})

This was determined by weighing freshly harvested fruits from the net plots with a balance scale. The fresh fruit weights per net plot were added and taken as yield per plot and the yield ha^{-1} computed thereafter was recorded.

3.6 Data Analysis

The data collected were subjected to analysis of variance (ANOVA) using F test described by Snedecor and Cochran (1967). The treatment means were compared using Duncan's New Multiple Range Test (Duncan, 1955). Regression analysis was done to find out the optimum nitrogen and poultry manure rates for maximum yield as suggested by Garg and Bansal (1972) and Reddy *et al*. (1975).

CHAPTER FOUR

4.0 RESULTS

4.1 Soil Physical and Chemical Properties of the Experimental Site and Nutrient Content of Poultry Manure used for the Trial.

The soils of the two experimental sites (Kadawa station and Kadawa village) were sandy clay loam and sandy loam respectively (Table 1). The soil has low levels of nitrogen, organic carbon, high level of available phosphorus and the pH was slightly acidic. Poultry manure analysis indicated high levels of nitrogen (Table 2).

4.2 Plant Height

Table 3 shows plant height of the two sweet pepper varieties as influenced by nitrogen and poultry manure during 2011/2012 dry season at the two sites. The two varieties produced statistically similar plant heights at both sites throughout the sampling period. Nitrogen showed significant effect on pepper plant height only at 4 WAT at Kadawa village. Application of 75 kg N ha^{-1} resulted in taller plants (17.70 cm) than those at 50 kg N ha^{-1} in both sites. Beyond 75 kg N ha^{-1} there was no significant increased in plant height of pepper. Likewise application of poultry manure significantly influenced plant height at 8 WAT in Kadawa village, where application of 6 t ha^{-1} produced taller plants (36.75 cm) than the least.

The first order interaction was not significant at all the sampling periods except at 8WAT (Table 4). A significant interaction was observed between variety and nitrogen on plant height at 8 WAT. Varying the N rates did not influence plant height of Tattasai Dan-Garko; the use of 50 and 75 kg N ha^{-1} has taller plants than for 100 kg N ha^{-1}. At each level of the applied N, the height of the two varieties did not differ significantly, except at 100 kg N ha^{-1} when Tattasai Dan-Garko produced taller plants than California Wonder.

Table 1: Soil physical and chemical properties of the experimental sites (2011/2012 dry season)

Physical Properties	Kadawa station	Kadawa village
% Clay	20	18
% Silt	8	12
% Sand	72	70
Textural Class	sandy clay loam	sandy loam
Chemical Properties		
pH (H_2O) 1:2:50	7.50	7.30
pH 0.1M$CaCl_2$	6.30	6.20
% Total Nitrogen	0.04	0.05
Available P (ppm)	7.40	7.56
% Organic Carbon	0.12	0.30
Calcium Cmol/kg	4.20	5.40
Magnesium Cmol/kg	0.63	0.56
Potassium Cmol/kg	0.43	0.34
Sodium Cmol/kg	1.34	1.62
CEC Cmol/kg	6.90	8.30
H+Al	0.10	0.10

Table 2: Nutrient content of the poultry manure used in the experiments (2011 /2012 dry season)

Nutrient Content	Value (Amount %)
Total Nitrogen	2.80
Total P	0.70
Potassium	1.50
Sodium	0.40
Calcium	0.30
Magnesium	0.10

Table 3: Plant height of two sweet pepper varieties as influenced by nitrogen fertilizer and poultry manure at Irrigation Research Station Kadawa and Kadawa village during 2011/2012 dry season.

	Kadawa station			Kadawa village		
Treatment	4WAT	8WAT	12WAT	4WAT	8WAT	12WAT
Variety (v)						
Tattasai Dan-Garko	14.74	24.60	68.52	16.94	24.10	34.99
California Wonder	14.73	24.60	71.90	17.23	24.80	33.80
SE±	0.440	0.470	3.990	0.440	0.730	1.140
Nitrogen (kg ha^{-1})						
50	14.21	24.20	70.40	15.90b	24.43	33.50
75	15.60	24.94	68.83	17.70a	24.62	35.64
100	14.44	24.60	71.40	17.70a	24.24	34.02
SE±	0.540	0.580	4.880	0.540	0.650	1.390
Poultry manure (t ha^{-1})						
0	14.70	23.80	66.00	16.30	23.30b	32.71
3	15.09	24.93	74.22	17.51	24.31ab	33.70
6	14.50	24.98	70.40	17.22	25.90a	36.80
SE±	0.540	0.580	4.880	0.540	0.650	1.390
Interaction						
N*V	NS	*	NS	NS	NS	NS
M*V	NS	NS	NS	NS	NS	NS
M*N	NS	NS	NS	NS	NS	NS
M*N*V	NS	NS	NS	NS	NS	NS

Means followed by different letter(s) are significantly different at 5% level using DMRT. * = Significant at 5%, NS = Not significant.

Table 4: Interaction of variety and nitrogen fertilizer on plant height of sweet pepper at 8WAT, 2011/2012 dry season at Kadawa station.

	Variety	
Treatment	Tattasai Dangarko	California Wonder
Nitrogen (kg ha^{-1})		
50	24.40a	23.94a
75	23.80ab	26.11a
100	25.53a	23.60b
SE±	0.820	

Means followed by different letter(s) are significantly different at 5% level using DMRT.

4.3 Number of Branches

Table 5 shows number of branches of two sweet pepper varieties as influenced by rates of nitrogen and poultry manure fertilizers during 2011/2012 dry season at Kadawa station and Kadawa village. The two varieties produced statistically similar number of branches at both sites throughout the period of study. Nitrogen and poultry manure fertilization had no significant effect on number of branches of pepper at both sites. Similarly poultry manure rates did not significantly influence number of branches of pepper, at all the sampling periods. Significant interaction was recorded between poultry manure rates and variety at 4 WAT at Kadawa village.

Table 6 shows interaction between variety and poultry manure rates on number of branches. It was observed that application of 3 t ha^{-1} to Tattasai Dan-Garko resulted in production of more branches compared with other levels which were the same. However California Wonder recorded statistically similar and higher number of branches at 3 and 6 t ha^{-1} than the control. Whereas, when the two varieties were compared at the same level of Poultry manure, California Wonder produced significantly more branches than Tattasai Dan-Garko.This was however, only for treatment without Poultry manure (control). At other levels of Poultry manure, the two varieties were significantly differing in the number of branches produced.

Table 5: Number of branches per plant of two sweet pepper varieties as influenced by nitrogen fertilizer and poultry manure at Kadawa station and Kadawa village during 2011/2012 dry season.

	Kadawa station			Kadawa village		
Treatment	4WAT	8WAT	12WAT	4WAT	8WAT	12WAT
Variety (v)						
Tattasai Dan-Garko	2.74	9.30	14.80	1.93	7.90	14.30
California Wonder	2.22	9.04	13.90	2.00	8.70	16.04
SE±	0.180	0.280	0.700	0.140	0.320	0.980
Nitrogen (kg ha^{-1})						
50	2.06	8.94	13.60	1.78	7.94	14.11
75	1.80	8.94	14.22	1.94	8.30	15.17
100	2.11	9.60	15.22	2.20	8.70	16.22
SE±	0.230	0.340	0.860	0.170	0.390	1.200
Poultry manure (t ha^{-1})						
0	1.94	8.44	13.00	1.70	7.83	14.50
3	1.90	9.50	14.50	1.94	8.40	14.72
6	2.11	9.50	15.50	2.28	8.67	16.28
SE±	0.230	0.340	0.860	0.170	0.390	1.200
Interaction						
N*V	NS	NS	NS	NS	NS	NS
M*V	NS	NS	NS	*	NS	NS
M*N	NS	NS	NS	NS	NS	NS
M*N*V	NS	NS	NS	NS	NS	NS

Means followed by different letter(s) are significantly different at 5% level using DMRT. * = Significant at 5%, NS = Not significant.

Table 6: Interaction between variety and poultry manure on number of branches of pepper at 4WAT at Kadawa village.

	Variety	
Treatment	Tattasai Dan-Garko	California Wonder
Poultry manure (t ha^{-1})		
0	1.89b	1.33b
3	2.00a	2.67a
6	1.89b	2.00a
SE±	0.244	

Means followed by different letter(s) are significantly different at 5% level using DMRT

4.4 Number of Leaves per Plant

The response of number of leaves of two sweet pepper varieties to nitrogen kg ha^{-1} and poultry manure (t $ha^{-1)}$ fertilization at Kadawa station and Kadawa village during 2011/2012 dry season is presented in Table 7. There was no significant difference in number of leaves produced by the two varieties. Nitrogen had significant effect on number of leaves at 4 and 12 WAT at Kadawa village, where application of 100 kg N ha^{-1} resulted in more number of leaves than 50 kg N ha^{-1}. It was observed that nitrogen did not significantly influence pepper number of leaves at Kadawa station and at 8 WAT in Kadawa village.

Likewise poultry manure rate had no significant effect on number of leaves of pepper throughout the sampling periods. Only the interaction between poultry manure and variety on number of leaves per plant at 4 and 8 WAT was significant.

The interaction between variety and poultry manure rate on pepper number of leaves at 4 and 8 WAT is shown on Table 8. At 4 and 8 WAT, application of poultry manure at 3 t ha^{-1} resulted in significant increase in number of leaves of both pepper varieties. Further increase in poultry manure to 6 t ha^{-1} did not significantly affect the parameter. Comparing the performance of the two peppers varieties at each poultry manure rate, revealed that at 4WAT and when 6 t ha^{-1} poultry manure was used, California Wonder had higher number of leaves than Tattasai Dan-Garko.

Table 7: Number of leaves per plant of two sweet pepper varieties as influenced by nitrogen and poultry manure at Kadawa station and Kadawa village during 2011/2012 dry season

	Kadawa station			Kadawa village		
Treatment	4WAT	8WAT	12WAT	4WAT	8WAT	12WAT
Variety (v)						
Tattasai Dan-Garko	9.90	77.90	68.30	18.63	62.80	74.41
California Wonder	10.07	79.00	71.90	20.44	68.70	76.41
SE±	0.330	2.700	3.980	0.950	2.400	3.300
Nitrogen (kg ha^{-1})						
50	9.80	24.94	68.40	19.30ab	63.90	69.10b
75	10.44	78.00	70.40	17.10b	64.10	75.90ab
100	15.60	80.80	71.40	22.30a	69.30	81.30a
SE±	0.400	3.300	4.880	1.160	2.920	3.980
Poultry manure (t ha^{-1})						
0	9.94	43.83	66.00	17.70	61.60	73.30
3	9.94	79.44	70.40	20.44	67.00	73.70
6	10.50	81.00	74.22	20.50	68.70	79.30
SE±	0.400	3.300	4.880	1.160	2.920	3.980
Interaction						
N*V	NS	NS	NS	NS	NS	NS
M*V	NS	NS	NS	*	*	NS
M*N	NS	NS	NS	NS	NS	NS
M*N*V	NS	NS	NS	NS	NS	NS

Means followed by different letter(s) are significantly different at 5% level using DMRT. * = Significant at 5%, NS = Not significant.

Table 8: Interaction between variety and poultry manure on number of leaves of pepper per plant at 4 WAT and 8 WAT at Kadawa village.

	Variety		Variety	
Treatment	Tattasai Dan-Garko	California Wonder	Tattasai Dan-Garko	California Wonder
Poultry manure(t ha^{-1})				
0	17.44c	15.80c	53.33b	57.44b
3	19.60ab	23.60a	65.70a	75.70a
6	18.90b	22.00a	64.33a	73.00a
SE±	1.642		4.123	

Means followed by different letter(s) are significantly different at 5% level using DMRT.

4.5 Leaf Area Index

The effect of nitrogen and poultry manure application on leaf area index of two sweet pepper varieties during the 2011/2012 dry season at Kadawa station and Kadawa village is presented in Table 9. The two varieties did not significantly differ in their leaf area index at all stages of growth except at 8 WAT in Kadawa village, where California Wonder variety recorded larger leaf area index than Tattasai Dan-Garko. Also nitrogen significantly influenced leaf area index of pepper only at 4 WAT in Kadawa village. Application of 100 kg N ha^{-1} resulted in larger leaf area index than other rates. Likewise, poultry manure significantly influenced leaf area index of pepper at 12 WAT in both locations and at 8 WAT in Kadawa village. It was observed that 3 and 6 t ha^{-1} of poultry manure had leaf area index that were statistically similar with the control. All the first order interaction were not significant, except poultry manure and variety at 4 WAT in Kadawa station.

Table 10 presents interaction between variety and poultry manure (4WAT) on leaf area index at Kadawa station. It was observed that application of 3 and 6 t ha^{-1} of poultry manure to Tattasai Dan-Garko resulted in larger leaf area index than the control. A similar trend was also observed with the California Wonder variety.

Table 9: Leaf area index of two sweet pepper varieties as influenced by nitrogen and poultry manure at Kadawa station and Kadawa village during 2011/2012 dry season

	Kadawa station			Kadawa village		
Treatment	4WAT	8WAT	12WAT	4WAT	8WAT	12WAT
Variety (v)						
Tattasai Dan-Garko	0.10	3.30	3.80	0.20	2.14b	4.63
California Wonder	0.10	3.90	4.40	0.23	3.03a	4.70
SE±	0.001	0.060	0.090	0.001	0.040	0.060
Nitrogen (kg ha^{-1})						
50	0.16	3.40	3.50	0.20b	2.43	4.70
75	0.10	3.33	4.15	0.20b	2.40	4.17
100	0.10	4.00	4.53	0.29a	2.92	5.10
SE±	0.001	0.080	0.130	0.001	0.080	0.090
Poultry manure (t ha^{-1})						
0	0.04	3.23	3.07b	0.16	2.19b	3.91b
3	0.10	3.33	4.81a	0.23	3.06a	5.34a
6	0.10	4.00	4.30ab	0.24	2.50ab	4.74ab
SE±	0.001	0.084	0.130	0.001	0.080	0.090
Interaction						
N*V	NS	NS	NS	NS	NS	NS
M*V	*	NS	NS	NS	NS	NS
M*N	NS	NS	NS	NS	NS	NS
M*N*V	NS	NS	NS	NS	NS	NS

Means followed by different letter(s) are significantly different at 5% level using DMRT. * = Significant at 5%, NS = Not significant.

Table 10: Interaction between variety and poultry manure on leaf area index of two sweet pepper varieties at 4WAT, 2011/2012 dry season at Kadawa station.

	Variety	
Treatment	Tattasai Dan-Garko	California Wonder
Poultry manure (t ha^{-1})		
0	0.04b	0.04b
3	0.20a	0.20a
6	0.20a	0.20a
SE±	0.010	

Means followed by different letter(s) are significantly different at 5% level using DMRT.

4.6 Number of Days to 50% Flowering

Number of days to 50% flowering of two sweet pepper varieties as influenced by nitrogen (kg ha^{-1}) and poultry manure (t ha^{-1}) application during 2011/2012 season is presented on Table 11. There was no significant difference in days to 50% flowering among the two varieties of pepper. Also nitrogen did not significantly affect number of days to 50% flowering. Application of poultry manure significantiy influence days to 50% flowering at Kadawa station where the control delayed recorded flowering than the 6 t ha^{-1}. There was a significant interaction between poultry manure rates and variety as well as the interaction of nitrogen and variety on days to 50% flowering (Table 12 and 13). The lower rates of 0 and 3t ha^{-1} poultry manure had resulted in delayed flowering for the two varieties when compared to 6t ha^{-1} that resulted in early flowering. The differences in days to 50% flowering for California Wonder between 0 and 3t ha^{-1} or between 3 and 6t ha^{-1} poultry manure was not significant. Non application of poultry manure had resulted in the longest days to 50% flowering while application of 6t ha^{-1} had shortest days to 50% flowering for each of the variety.

The interaction of nitrogen and variety on days to 50% flowering is presented on Table 13. Application of 50 or 75 kg N ha^{-1} to Tattasai Dan-Garko and 50 kg N ha^{-1} to California Wonderkdelayed number of days to 50% flowering. When compared to other N rate California Wonder had early flowering only when 75 kg N ha^{-1} was used. 0 t $ha^{-1}$was higher than Tattasai Dan-Garko in terms of number of days to 50% flowering. At other nitrogen rates, the two pepper varieties did not differ in days to 50% flowering.

Table 11: Days to 50% flowering of two sweet pepper varieties as influenced by nitrogen and poultry manure fertilization at Kadawa station and Kadawa village during 2011/2012 dry season

Treatment	Kadawa station	Kadawa village
Variety (v)		
Tattasai Dan-Garko	52.7	59.5
California Wonder	52.6	58.7
SE±	0.52	0.64
Nitrogen (kg ha^{-1})		
50	53.3	61.6
75	52.6	59.6
100	52.0	56.2
SE±	0.64	0.78
Poultry manure (t ha^{-1})		
0	54.0ab	59.4
3	53.1a	59.2
6	51.4b	58.0
SE±	0.64	0.78
Interaction		
N*V	*	NS
M*V	**	NS
M*N	NS	NS

Means followed by different letter(s) are significantly different at 5% level using DMRT. * = Significant at 5%, ** = Highly significant at 1%, NS = Not significant.

Table 12: Interaction between variety and poultry manure on number of days to 50% flowering of two sweet pepper varieties during 2011/2012 dry season at Kadawa station.

	Variety	
Treatment	Tattasai Dan-Garko	California Wonder
Poultry manure (t ha^{-1})		
0	54.3a	55.0a
3	52.8a	52.7ab
6	50.9b	50.0b
SE±	0.90	

Means followed by different letter(s) are significantly different at 5% level using DMRT.

Table 13: Interaction between variety and nitrogen on number of days to 50% flowering of two sweet pepper varieties during 2011/2012 dry season at Kadawa station.

	Variety	
Treatment	Tattasai Dan-Garko	California Wonder
Nitrogen (kg ha^{-1})		
50	53.1a	54.6a
75	52.9a	52.1b
100	52.0b	51.1b
SE±	0.90	

Means followed by different letter(s) are significantly different at 5% level using DMRT.

4.7 Net Assimilation Rate (NAR)

Table 14 presents net assimilation rate of sweet pepper as affected by nitrogen kg $ha^{-1}$and poultry manure t ha^{-1} during the 2011/2012 dry season at Kadawa station and Village. There was no significant difference among the two varieties. Also nitrogen did not significantly affect net assimilation rate of sweet pepper. Likewise, poultry manure rates had no significant effect throughout the period of study. There was no significant interaction between the three factors on net assimilation of pepper.

4.8 Relative Growth Rate (RGR)

Table 15 shows relative growth rates of two sweet pepper variety as affected by application of poultry manure and nitrogen fertilizer during 2011/2012 dry season. The two varieties did not differ significantly in their RGR except at 8 WAT at Kadawa village, where California Wonder variety had higher RGR than Tattasai Dan-Garko. Also nitrogen significantly influenced relative growth rate of pepper only at 12 WAT at Kadawa village, where application 75 kg N ha^{-1} resulted in higher RGR where statistically similar with 100 kg N ha^{-1} and lower rate noted when 50 kg N ha^{-1} was applied. The effect of Poultry manure on RGR was significant only at 12 WAT in Kadawa village in which application of 3 and 6 t ha^{-1} recorded statistically similar but lower RGR than the control. Factor interaction on RGR was not significant.

Table 14: Net assimilation rate of two sweet pepper varieties as influenced by nitrogen and poultry manure at Kadawa station and Kadawa village during 2011/2012 dry season

	Kadawa station		Kadawa village	
Treatment	8WAT	12WAT	8WAT	12WAT
Variety (v)				
Tattasai Dan-Garko	0.03	0.02	0.02	0.10
California Wonder	0.03	0.01	0.02	0.10
SE±	0.001	0.001	0.001	0.010
Nitrogen (kg ha^{-1})				
50	0.03	0.01	0.01	0.10
75	0.02	0.03	0.02	0.10
100	0.03	0.10	0.02	0.12
SE±	0.001	0.010	0.001	0.070
Poultry manure (t ha^{-1})				
0	0.02	0.02	0.02	0.02
3	0.03	0.02	0.02	0.10
6	0.03	0.10	0.02	0.14
SE±	0.001	0.010	0.001	0.070
Interaction				
N*V	NS	NS	NS	NS
M*V	NS	NS	NS	NS
M*N	NS	NS	NS	NS
M*N*V	NS	NS	NS	NS

Means followed by different letter(s) are significantly different at 5% level using DMRT. NS = Not significant.

Table 15: Relative growth rate of two sweet pepper varieties as influenced by nitrogen and poultry manure fertilization at Kadawa station and Kadawa village during 2011/2012 dry season

	Kadawa station		Kadawa village	
Treatment	8WAT	12WAT	8WAT	12WAT
Variety (v)				
Tattasai Dan-Garko	0.13	0.04	0.10b	0.04
California Wonder	0.12	0.05	0.12a	0.04
SE±	0.004	0.001	0.004	0.001
Nitrogen (kg ha^{-1})				
50	0.12	0.05	0.11	0.04b
75	0.12	0.05	0.10	0.05a
100	0.12	0.04	0.12	0.04ab
SE±	0.005	0.002	0.005	0.004
Poultry manure (t ha^{-1})				
0	0.11	0.05	0.12	0.05a
3	0.13	0.05	0.11	0.04b
6	0.12	0.05	0.11	0.04b
SE±	0.005	0.002	0.005	0.004
Interaction				
N*V	NS	NS	NS	NS
M*V	NS	NS	NS	NS
M*N	NS	NS	NS	NS
M*N*V	NS	NS	NS	NS

Means followed by different letter(s) are significantly different at 5% level using DMRT. NS =Not significant.

4.9 Crop Growth Rate (CGR)

Table 16 presents crop growth rate for two sweet pepper varieties as affected by nitrogen and poultry manure fertilization at Kadawa station and Kadawa village. The two varieties recorded similar CGR throughout the period of the study. Nitrogen significantly influenced crop growth rate of sweet pepper except at 12 WAT at Kadawa station. Application of 100 kg N ha^{-1} at (8 and 12 WAT) at both sites, resulted in higher CGR which were at par with 75 kg N ha^{-1}, and lower rate noted when 50 kg N ha was applied. At Kadawa village (4WAT), 100 kg N ha-1 had higher CGR than other levels of applied nitrogen. Poultry manure did not significantly affect crop growth rate of pepper except at 8 WAT in Kadawa village. It was observed that application of 3 and 6 t ha-1 of poultry manure had statistically similar but higher CGR than the control.

All the interactions on CGR were not significant except at 8 WAT at Kadawa village. Table 17 showed the significant interaction between poultry manure and variety on CGR. Application of poultry manure to each of the varieties significantly increased CGR. Further increase to 6 t ha^{-1} of poultry manure did not significantly affect the parameter. At each of the poultry manure rate the variety did not show any significant variation. The applied poultry manure rates resulted in the highest CGR while pepper that received no poultry manure had the least CGR.

Table 16: Crop growth rate of two sweet pepper varieties as influenced by nitrogen and poultry manure at Kadawa station and Kadawa village 2011/2012 dry season.

	Kadawa station		Kadawa village	
Treatment	8 WAT	12 WAT	8 WAT	12 WAT
Variety (v)				
Tattasai Dan-Garko	8.31	6.30	8.60	6.44
California Wonder	8.21	6.42	8.50	6.14
SE±	0.530	0.350	0.420	0.310
Nitrogen kg ha^{-1}				
50	7.24 b	5.92	7.99 b	5.80b
75	8.30 ab	6.28	8.01 b	6.50ab
100	9.30 a	6.81	9.70 a	7.09a
SE±	0.610	0.430	0.520	0.380
Poultry Manure (t ha^{-1})				
0	7.63	6.13	7.30 b	5.95
3	8.50	6.30	8.90 a	6.63
6	8.70	6.60	9.50a	6.74
SE±	0.610	0.430	0.520	0.380
Interaction				
N*V	N.S	N.S	N.S	N.S
N*M	N.S	N.S	N.S	N.S
M*V	N.S	N.S	*	N.S
M*N*V	N.S	N.S	N.S	N.S

Means followed by different letter(s) are significantly different at 5% using DMRT. *=significant at 5%, NS= Not Significant.

Table 17: Interaction between variety and poultry manure on crop growth rate of two sweet pepper varieties between 4 WAT and 8 WAT during 2011/2012 dry season at Kadawa village.

	Variety	
Treatment	Tattasai Dan-Garko	California Wonder
Poultry manure (t ha^{-1})		
0	7.70b	6.90b
3	8.80a	9.01a
6	9.34a	10.00a
SE±	0.730	

Means followed by different letter(s) are significantly different at 5% using DMRT.

4.10 Number of Fruits per Plant

Table 18 shows number of fruit/plant for two sweet pepper varieties as influenced by nitrogen and poultry manure rates at Kadawa station and Kadawa village during 2011/2012 dry season. The two varieties did not statistically differ in their number of fruits/plant throughout the sampling period. Nitrogen significantly influenced number of fruits of pepper at Kadawa station only, where application of 75 and 100 kg N ha^{-1} had higher number of fruits (10.63, 10.00) than 50 kg N ha^{-1}. At Kadawa village, application of nitrogen did not affect pepper number of fruit. Also, application of poultry manure rates did not significantly affect number of fruits per plant in both sites.

The interaction of nitrogen and variety at both sites, nitrogen and poultry manure at Kadawa village and poultry manure and variety at both sites on number of fruits per plant were significant (Table 19). Application of 75 kg N ha^{-1} significantly increased number of fruits (12.22, 11.73) of pepper for both varieties at Kadawa village and only that of California Wonder (12.98) at Kadawa station. Further increase to 100 kg N ha^{-1} increased number of fruits (13.40) for Tattasai Dan-Garko at Kadawa station, while that of California Wonder decreased at both sites. Whereas, when the two varieties were compared, Tattasai Dan-Garko had higher number of fruits per plant (8.46) than California Wonder only when 50 kg N ha^{-1} was used at Kadawa station and 75 kg N ha^{-1} was used at both site. When 75 kg N ha^{-1} was used, California Wonder produced more fruit than Tattasai Dan-Garko at Kadawa station, while the difference was statistically not significant in Kadawa village.

The interaction of poultry manure and variety on number of fruit is presented on Table 20. When the response of each variety to varying manure rates was studied, it was observed at Kadawa station that, applying 3 and 6 t ha^{-1} poultry manure to Tattasai Dan-Garko variety resulted in statistically similar and higher number of fruit than the control. On the other hand, application of 3 t ha^{-1} to California Wonder variety produced more number of fruits than for 6 t ha^{-1}. At 0 and 6 t ha^{-1} poultry manure, California Wonder had higher and lower fruit number than Tattasai Dan-Garko respectively. At Kadawa village, application of 3 t ha^{-1} poultry manure significantly increased fruit production for both varieties. Further increase to 6 t ha^{-1} poultry manure increased

the number of fruit of Tattasai Dan-Garko, while that of California Wonder remained significantly unaffected.

Table 21 shows the interaction of nitrogen and poultry manure fertilization on number of fruit per plant. Increasing nitrogen rate from 50 to 75 kg N ha^{-1} increased fruits (7.31, 9.73) production only when no poultry manure was applied, while the parameter remained statistically the same when 3 and 6 t ha^{-1} poultry manure were applied. Further increase to 100 kg N ha^{-1} increased number of fruit at the levels of 0 and 3 t ha^{-1} poultry manure.

Table 18: Number of fruits per plant of sweet pepper variety as influenced by nitrogen and poultry manure at Kadawa station and Kadawa village 2011/2012 dry season.

Treatment	Kadawa station	Kadawa village
Variety (v)		
Tattasai Dan-Garko	9.50	10.13
California Wonder	8.80	9.20
SE±	0.520	0.200
Nitrogen kg ha^{-1}		
50	6.94 b	9.02
75	10.00a	9.91
100	10.63a	10.04
SE±	0.410	0.250
Poultry Manure (t ha^{-1})		
0	8.34	9.10
3	9.32	9.50
6	9.71	10.43
SE±	0.410	0.250
Interaction		
N*V	**	**
N*M	N.S	**
M*V	*	**
M*N*V	N.S	N.S

Means followed by different letter(s) are significantly different at 5% using DMRT. * = significant at 5%, ** =highly significant at 1%, NS= Not Significant.

Table 19: Interaction between variety and nitrogen on number of fruits of two sweet pepper varieties at Kadawa station and Kadawa village during 2011/2012 dry season.

	Variety		Variety	
Treatment	Tattasai Dan-Garko	California Wonder	Tattasai Dan-Garko	California Wonder
	Kadawa station		Kadawa village	
Nitrogen (kg ha^{-1})				
50	8.50b	5.43c	7.60c	6.32c
75	6.60c	12.98a	11.73a	12.22a
100	13.40a	7.87c	11.10ab	9.02b
SE±	0.903		0.500	

Means followed by different letter(s) are significantly different at 5% level using DMRT.

Table 20: Interaction between variety and poultry manure on number of fruits of two sweet pepper varieties at Kadawa station and Kadawa village during 2011/2012 dry season.

	Variety		Variety	
Treatment	Tattasai Dan-Garko	California Wonder	Tattasai Dan-Garko	California Wonder
	Kadawa station		Kadawa village	
Poultry manure(t ha^{-1})				
0	6.71c	7.84b	8.04c	7.98c
3	10.80a	9.96ab	9.50b	8.70b
6	10.96a	8.50c	12.90a	10.90a
SE±	0.903		0.500	

Means followed by different letter(s) are significantly different at 5% level using DMRT.

Table 21: Interaction between nitrogen and poultry manure on fruit of two sweet pepper varieties at Kadawa village during 2011/2012 dry season.

Treatment	**Nitrogen (kg ha^{-1})**		
Poultry manure (t ha^{-1})	50	75	100
0	7.31b	9.73a	9.00b
3	7.90b	9.63b	11.40a
6	11.90a	10.40a	9.80a
SE±		0.870	

Means followed by different letter(s) are significantly different at 5% level using DMRT.

4.11 Fruit Diameter (cm)

Fruit diameter of sweet pepper as affected by nitrogen and poultry manure during 2011/2012 dry season at Kadawa station and Village is presented on Table 22. The two varieties were significant in fruit diameter in both sites, where California Wonder variety produced larger fruits than Tattasai Dan-Garko. Neither the application of nitrogen or poultry manure had significant effect on pepper fruit diameter in the two sites.

Only interactions of nitrogen and variety and poultry manure and variety on fruit diameter were significant at both sites.

Table 23 shows the interaction between variety and nitrogen on fruit diameter at both sites. Increasing nitrogen rates from 50 to75 kg N ha^{-1} increased fruit diameter for both varieties. Further increase in nitrogen to 100 kg N ha^{-1} did not affect the fruit size of California Wonder but reduced that of the other variety. California Wonder had larger fruit size than Tattasai Dan-Garko when 50 kg N ha^{-1}at Kadawa station or 100 kg N ha^{-1} at both sites were used. The fruit sizes for both varieties were statistically at par at other instances.

The interaction between variety and poultry manure rate on fruit diameter of two sweet pepper varieties in both sites is presented on Table 24, application of 3 t ha^{-1} of poultry manure to California Wonder in Kadawa station resulted in larger fruit diameter than treatment without poultry manure (0 t ha^{-1}). The latter was statistically at par with the former rate in the case of Tattasai Dan-Garko at Kadawa station. Further increase in Poultry manure to 6 t ha^{-1} resulted in significant reduction in fruit diameter of Tattasai Dan-Garko at the Kadawa village site, while the parameter remained statistically the same at other instances. 0 t ha^{-1} had the least values for fruit diameter for both varieties, while 3 t ha^{-1} poultry manure had the highest values for fruit diameter.

Table 22: Fruit diameter of two sweet pepper varieties as influenced by nitrogen and poultry manure at Kadawa station and Kadawa village 2011/2012 dry season.

Treatment	Kadawa station	Kadawa village
Variety (v)		
Tattasai Dan-Garko	4.13b	4.20b
California Wonder	5.00a	4.70a
SE±	0.050	0.090
Nitrogen kg ha^{-1}		
50	4..30	4..40
75	4.40	4.50
100	4.42	4.50
SE±	0.060	0.120
Poultry Manure		
0	4.30.	4.34.
3	4.40	4.50
6	4.40	4.52
SE±	0.060	0.120
Interaction		
N*V	**	**
N*M	N.S	N.S
M*V	**	**
M*N*V	N.S	N.S

Means followed by different letter(s) are significantly different at 5% using DMRT. **=highly significant at 1%, NS= Not Significant

Table 23: Interaction between variety and nitrogen on fruit diameter of two sweet pepper varieties at Kadawa station and Kadawa village during 2011/2012 dry season.

	Variety		Variety	
Treatment	Tattasai Dan-Garko	California Wonder	Tattasai Dan-Garko	California Wonder
	Kadawa station		Kadawa village	
Nitrogen (kg ha^{-1})				
50	3.70c	4.00b	4.00b	4.00b
75	5.00a	5.10a	4.80a	5.02a
100	3.80bc	5.10a	4.00b	5.10a
SE±	0.090		1.170	

Means followed by different letter(s) are significantly different at 5% level using DMRT.

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Table 24: Interaction between variety and poultry manure on fruit diameter of two sweet pepper varieties Kadawa station and Kadawa village during 2011/2012 dry season.

	Variety		Variety	
Treatment	Tattasai Dan-Garko	California Wonder	Tattasai Dan-Garko	California Wonder
	Kadawa station		Kadawa village	
Poultry manure(t ha^{-1})				
0	3.64b	3.60b	3.50b	4.00b
3	5.02ab	5.12a	5.20a	5.20a
6	3.71b	5.14a	4.00b	5.10a
SE±	0.090		0.170	

Means followed by different letter(s) are significantly different at 5% level using DMRT.

4.12 Fruit Length

Table 25 shows fruit length (cm) of pepper for two pepper varieties as affected by nitrogen fertilizer and poultry manure during 2011/2012 the dry season at Kadawa station and Kadawa village. The two varieties produced statistically similar fruit length at both sites. Application of nitrogen fertilizer had no significant effect on pepper fruit length, though the highest N rate produced the longest fruit. Fruit length was significantly influenced by application of poultry manure at Kadawa station. Application of 0 and 3 t ha^{-1} at Kadawa station recorded longer pepper fruit than for treatment with 6 t ha^{-1}. The result from Kadawa village showed that poultry manure did not significantly affect pepper fruit length. Only the interaction of poultry manure fertilization and variety on fruit length at Kadawa station was significant.

The interaction between variety and poultry manure rate on length of fruit of pepper is shown in Table 26. Application of 3 and 6 t ha^{-1} to either of the two varieties produced statistically similar and longer fruit than the control. At each of the poultry manure rates, the two pepper varieties recorded statistically similar fruit length, with the highest value (6.83) recorded from 3 t ha^{-1} applied to California Wonder variety.

Table 25: Fruit length of two sweet pepper varieties as influenced by nitrogen and poultry manure Kadawa station and Kadawa village during 2011/2012 dry season.

Treatment	Kadawa station	Kadawa village
Variety (v)		
Tattasai Dan-Garko	6.34	6.60
California Wonder	6.44	6.90
SE±	0.100	0.160
Nitrogen kg ha^{-1}		
R		
50	6.32	6.63
75	6.31	6.62
100	7.00	6.99
SE±	0.130	0.210
Poultry Manure (t ha^{-1})		
R		
0	6.50a	6.50
3	6.64a	6.72
6	6.06b	7.10
SE±	0.130	0.210
Interaction		
N*V	N.S	N.S
N*M	N.S	N.S
M*V	*	N.S
M*N*V	N.S	N.S

Means followed by different letter(s) are significantly different at 5% using DMRT. * = significant at 5%, NS= Not Significant.

Table 26: Interaction between variety and poultry manure on fruit length of pepper at Kadawa station during 2011/2012 dry season.

	Variety	
Treatment	Tattasai Dan-Garko	California Wonder
Poultry manure (t ha^{-1})		
0	5.80b	6.14b
3	6.81a	6.83a
6	6.50a	6.40ab
SE±	0.200	

Means followed by different letter(s) are significantly different at 5% level using DMRT.

4.13 Fresh Fruit Yield (kg ha^{-1})

Fresh fruit yield of two sweet pepper varieties as affected by poultry manure and nitrogen fertilization during 2011/2012 dry season at Kadawa station and Kadawa village and the combined effect is presented in Table 27. The two varieties were significant at Kadawa village and combined. However, California Wonder variety had higher fresh fruit yield than Tattasai Dan-Garko. Nitrogen significantly influenced pepper fresh fruit yield at Kadawa village and Combined. Increasing N rate from 50 to 75 kg significantly increased fresh fruit yield of pepper. Beyond 75 kg N ha^{-1}, no significant increase in fresh fruit yield was observed. It was observed that nitrogen did not significantly affect pepper fresh fruit yield at Kadawa station.

The use of different rate of poultry manure did not significantly influence pepper fresh fruit weight at both sites and combined, however, highest pepper fresh fruit weight was recorded at 6 t ha^{-1} than either at 0 or 3 t ha^{-1}.

The interaction of nitrogen rates and variety on fresh fruit yield ha^{-1} was observed at Kadawa village, while that of poultry manure rates and variety on fresh fruit yield ha^{-1} was observed at Kadawa village and combined. Table 28 shows an interaction between nitrogen and variety on fresh fruit yield ha^{-1}. Application of 100kg N ha^{-1} resulted in higher fresh fruit weight of Tattasai Dan-Garko (7473.40 kg ha^{-1}) only than (5650.20 kg ha^{-1}) at 50 kg N ha^{-1}. The difference in the yield of Tattasai Dan-Garko at 75 and 100 kg N ha^{-1} or at 50 and 75 kg N ha^{-1} were not significant. In the case of California Wonder, 75 and 100 kg N ha^{-1} resulted in statistically similar and higher fruit yield than 50 kg N ha^{-1}. California Wonder out yielded Tattasai Dan-Garko when each was supplied with 50,75 and 100 kg ha^{-1}.The highest (9421.20 kg ha^{-1}) and the least (5650.20 kg ha^{-1}) values for fruit yield was by the respective combination of California Wonder and 75 kg N ha^{-1} and Tattasai Dan-Garko and 50 kg N ha^{-1}.

The interaction of variety and poultry manure on pepper fruit yield is shown on Table 29. Application of 3 t ha^{-1} poultry manure significantly increased fresh fruit yield of both varieties. Further increase to 6 t ha^{-1} significantly increased yield of Tattasai Dan-Garko while that of California Wonder remained statistically same. The two varieties did not differ in their yield when 0 or 6 t ha^{-1} was applied, but at 3 t ha^{-1} California Wonder out yielded Tattasai Dan-Garko. The highest fruit yield was recorded when either 3 or 6 t ha^{-1} was applied to California Wonder

and when 6 t $ha^{-1}$was applied to Tattasai Dan-Garko, while the least (5185.70 kg ha^{-1}) fruit yield was recorded when no manure was applied.

Table 30 shows the interaction between poultry manure rates and variety on pepper fresh fruit yield (kg ha^{-1}) for the combined effect in the sudan savanna.The application of 3t ha^{-1} to both varieties resulted in the highest fresh fruit yield of (8495.20, 7436.80 kg ha^{-1}). Further increase in poultry manure to 6 t ha^{-1} decreased fruit yield of Tattasai Dan-Garko, while that of California Wonder was not significantly affected. The two pepper varieties showed significant variation in fruit yield only when 6 t ha^{-1} poultry manure was applied, where California Wonder had significantly higher fruit yield. California Wonder plus 3 t ha^{-1} poultry manure had the highest (8395.20 kg ha^{-1}) values for fruit yield, while Tattasai Dan-Garko plus 0 t ha^{-1} poultry manure had the least (5866.30 kg ha^{-1}).

Table 27: Fresh fruit yield of two sweet pepper varieties as influenced by nitrogen and poultry manure Kadawa station and Kadawa village 2011/2012 dry season.

Treatment	Kadawa station	Kadawa village	Combined
Variety (v)			
Tattasai Dan-Garko	5884.4	6380.8b	6453.8b
California Wonder	6104.4	8307.6a	7508.49a
SE±	336.20	292.30	227.80
Nitrogen kg ha^{-1}			
50	5923.5	6137.4b	6378.7b
75	5969.9	7535.7a	7544.1a
100	6093.7	8359.5a	7020.49a
SE±	463.00	358.00	279.00
Poultry Manure (t ha^{-1})			
0	5536.5	7279.6	6680.2
3	6139.8	7349.0	7131.4
6	6300.8	7404.0	7131.6
SE±	463.00	358.00	279.00
Interaction			
N*V	N.S	**	NS
N*M	N.S	N.S	NS
M*V	N.S	**	**
M*N*V	N.S	N.S	NS

Means followed by different letter(s) are significantly different at 5% using DMRT. ** = highly significant at 1%, NS= Not Significant.

Table 28: Interaction between variety and poultry manure on fresh fruit yield at Kadawa village during 2011/2012 dry season.

	Variety	
Treatment	Tattasai Dan-Garko	California Wonder
Nitrogen (kg ha^{-1})		
50	5650.2c	6256.0b
75	6018.7bc	9421.2a
100	7473.4b	9245.6a
SE±	506.30	

Means followed by different letter(s) are significantly different at 5% level using DMRT.

Table 29: Interaction between variety and poultry manure on fresh fruit yield at Kadawa village during 2011/2012 dry season.

	Variety	
Treatment	Tattasai Dan-Garko	California Wonder
Poultry manure (t ha^{-1})		
0	5185.7c	5536.8bc
3	6139.5b	9271.1a
6	8419.8a	9512.3a
SE±	506.30	

Means followed by different letter(s) are significantly different at 5% level using DMRT.

Table 30 Interaction between poultry manure rate and variety on fresh fruit yield during 2011/2012 dry season, combined data.

Treatment	Variety	
	Tattasai Dan-Garko	California Wonder
Poultry manure (t ha^{-1})		
0	5866.7b	5923.7b
3	7436.8a	8395.2a
6	6057.8b	8205.4a
SE±	394.53	

Means followed by different letter(s) are significantly different at 5% using DMRT.

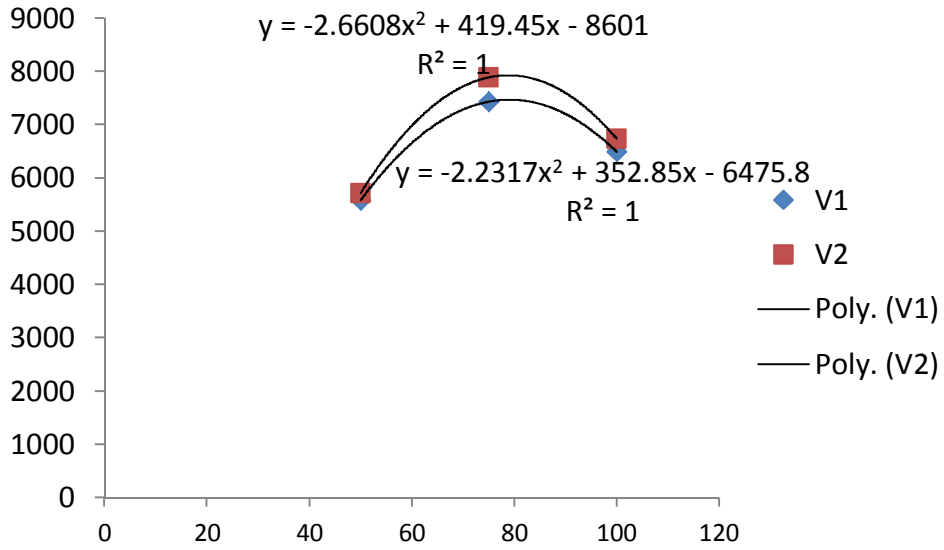
4.14 Regression

4.14.1 Regression analysis on fresh fruit yield and nitrogen rate

The regression analysis between sweet pepper fresh fruit yield against nitrogen and poultry manure rates at irrigation research Station Kadawa and Kadawa village are shown in Fig 1, 2, 3 and 4 respectively. The regression equations for nitrogen rates against yield kg ha^{-1} were both quadratic, such that the optimum yield of California Wonder variety were 7930.60 kg ha^{-1} at 78.90 kg N ha^{-1} in Kadawa station and 9691.02 kg ha^{-1} at 88.49 kg N ha^{-1} in Kadawa village respectively. For Tattasai Dan-Garko variety, the optimum sweet pepper yield were 7471.54 ha^{-1} at 78.40 kg N ha^{-1} in Kadawa station and 6945.11 kg ha^{-1} at 96.32 kg N ha^{-1}in Kadawa village.

4.14.2 Regression analysis on fresh fruit yield and poultry manure rate

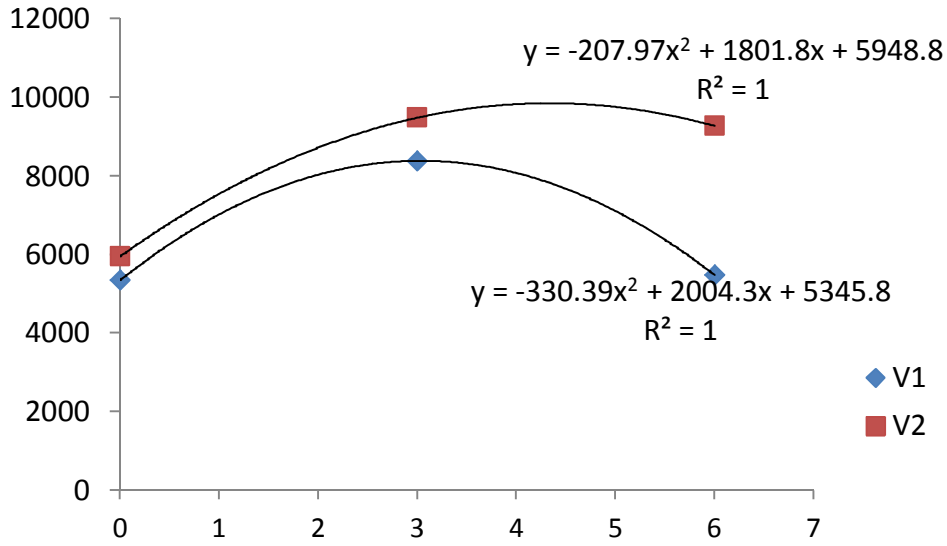
Similarly, the regression analysis between pepper fresh fruit yield kg ha^{-1} against poultry manure rates were also quadratic in both sites. For California Wonder variety optimum yield were 9848.43 kg ha^{-1} at 4.33 t ha^{-1} in Kadawa station and 7628.80 kg ha^{-1} at 4.0 t ha^{-1} in Kadawa village. Optimum yield for Tattasai Dan-Garko variety were 8384.66 kg ha^{-1} at 3.04 t ha^{-1} in Kadawa station and 7397.4 kg ha^{-1} at 4.0 t ha^{-1} in Kadawa village.



V1- Tattasai Dan-Garko

V2- California Wonder

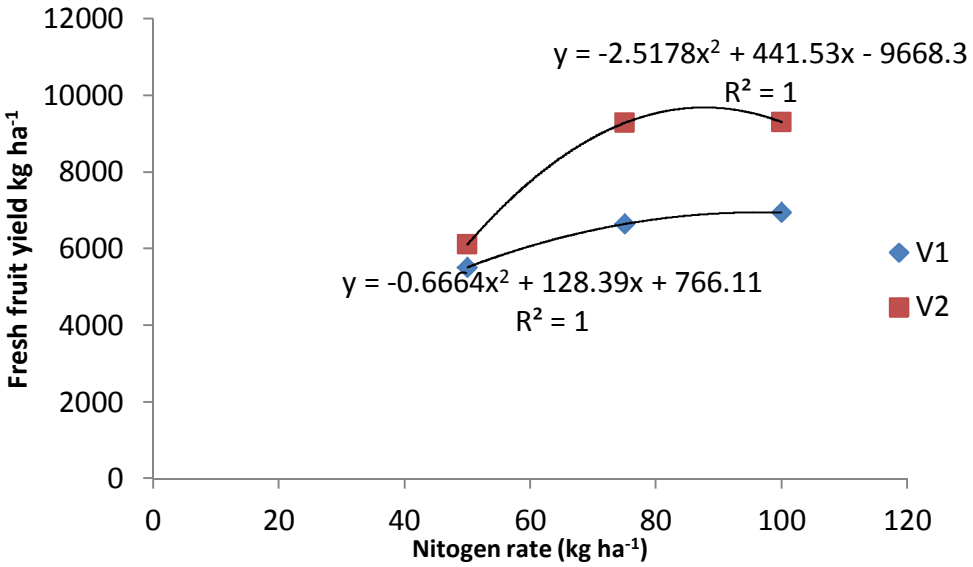
Fig 1 Regression of fresh fruit yield kg ha^{-1} against nitrogen at Kadawa station.



V1- Tattasai Dan-Garko

V2- California Wonder

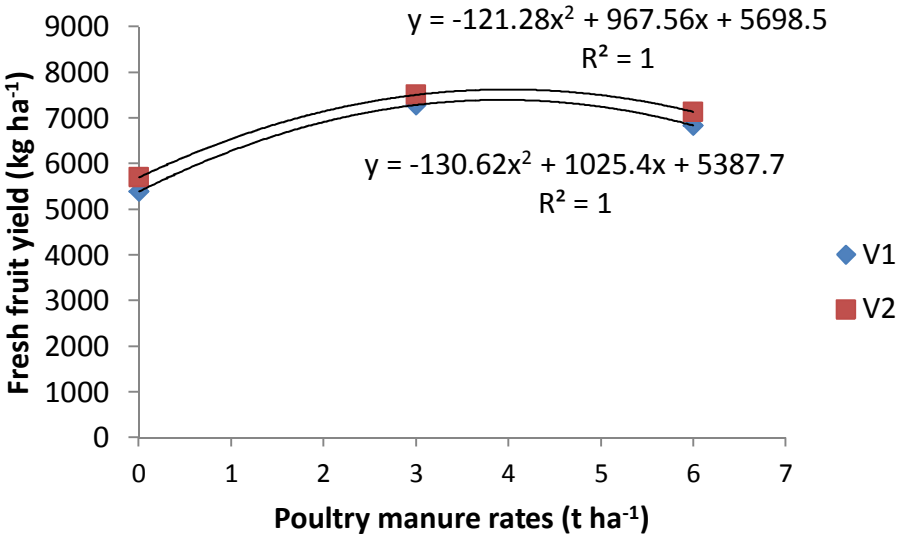
Fig 2 Regression of poultry manure rates on fresh fruit yield at Kadawa station



V1- Tattasai Dan-Garko

V2- California Wonder

Fig 3 Regression of fresh fruit yield against nitrogen at Kadawa village



V1- Tattasai Dan-Garko

V2- California Wonder

Fig 4 Regression of poultry manure on fresh fruit yield at Kadawa village

CHAPTER FIVE

5.0 DISCUSSION

5.1 Varietal Response.

From the investigation, varieties had a considerable influence on growth and yield of pepper. The two varieties showed significant varietal difference on growth and yield component at both locations. The California Wonder variety had larger leaf area index (8 WAT), higher relative growth rate (8 WAT), larger fruit diameter and higher yield compared to Tattasai Dan-Garko. This could be due to the fact that California Wonder had better Canopy developed to intercept solar radiation, hence more photosynthates were produced that enhance source and sink relationship which translates to higher yield. Similar results with respect to high yield of California Wonder were reported by Backer (1989), Sharma *et al.*(2004) and Appireddy *et al.* (2008). The low yield of Tattasai Dan-Garko might also have been as a result of less adaptability and low genetic performance of the variety to local environmental condition. The difference in yield between the two locations could be attributed to the low nutrient status of the soil (Appendix I) as soils with low fertility reduce the potential yield of a crop. This has been reported by Jones and Wild (1975).

5.2 Response to Nitrogen Fertilization

The significant response of growth components such as leaf area index (4 WAT) at Kadawa station, plant height (4 and 12 WAT), relative growth rate (12 WAT) at Kadawa village and crop growth rate at both locations could be attributed to the fact that among various nutrients, nitrogen is very important for sweet pepper growth and reproduction (Khan *et al.,* 2010). In addition, the significant response of nitrogen fertilization in vegetative growth may be due to the role of nitrogen on synthesis of chlorophyll, enzymes and protein which increases the vegetative growth. Plant height and number of leaves increased as the nitrogen increased from 50 to 75 kg N ha^{-1}, whereas leaf area index increased with increase in N from 50 to 100 kg N ha^{-1}. This could be attributed to an increase in nitrogen that affects the leaf area index and with increasing leaf area index, more solar radiation is intercepted by the plant and used for photosynthesis. Similar result with respect to leaf area index was reported by Lawlor *et al.* (2001) and Carlyle 1998.

The lack of response of most of the growth parameters to the application of N beyond 75 kg N ha^{-1} indicates that the crop requirement for nitrogen has been satisfied at this rate. Therefore further addition of nitrogen can only promote luxury consumption. Nitrogen is an important component of chlorophyll which enhances photosynthesis and promotes vegetative growth thereby increasing production of assimilates which translate into yield. The results from the soil samples analyzed (Appendix I) showed that the soil from the two locations were low in nitrogen, thus the positive responses to nitrogen observed. This is in agreement with Lombin (1987) who reported that Savannah soils are poor in inherent fertility and are easily leached, have low organic matter content, low Cation Exchange Capacity and poor buffering capacity.

The yield components such as number of fruits per plant and fruit fresh yield responded to application of nitrogen fertilizer up to 75 kg ha^{-1}. The increase recorded on number of fruits per stand and fruit fresh yield might be as a result of increased flowering process which leads to greater fruit formation. Also the increase recorded in yield might be due to cumulative stimulating effect of nitrogen on vegetative growth characters which form the base for flowering and fruiting and translocated assismilates from source to sink (Dass *et al.*, 2008). In other words, the assimilates produced might have been fully translocated to the sink leading to the production of heavier fruits.

5.3 Response to Poultry Manure Rate

The growth components such as plant height (8 WAT), leaf area index (8 and 12 WAT), number of days to 50% flowering, relative growth rate (12 WAT), crop growth rate (8 WAT) were significantly affected by poultry manure fertilization. The significant response to poultry manure by these parameters to applied poultry manure at 3 and 6 t ha^{-1} might be as a result of improved nutrient supply, as well as positive manipulation of soil physical properties such as moisture retention, soil structure and aeration. Moreover, poultry manure contains essential nutrient element associated with high photosynthetic activities and thus promoted root and vegetative growth (John *et. al.,* 2004). Similar result with respect to increase in vegetative growth in treatment that receives high poultry manure rates was reported by Frank (1965). Significant increase in leaf area index due to applied poultry manure might be due to positive role in leaf area development and expansion, which means more assimilates were made available in such plants. This is in conformity with the report that although an individual leaf exports only

limited portion of its photosynthates, the portion that is exported will be shared equally with the rest of the plant parts, Khan and Assign (1981). Studies have shown that application of poultry manure to pepper leads to an increase in plant height, leaf area index and number of branches. Olson *et al.* (1971). The significant response in number of days to 50% flowering to poultry manure application of 6t ha^{-1} led to early flowering compared with the control, and this could be attributed to rich nutrient composition in manure that led to rapid growth and development and consequently the attainment of early flowering. The earliness in attaining 50% flowering in sweet pepper by manure application is in conformity with the findings of Eguchi *et al.* (1958) that there was a delay in flower initiation in plots with nitrogen deficiency. The significant increase in fruit length at Kadawa station could be as a result of adequate supply of nutrient by the poultry droppings to the plant. Tisdale and Nelson (1975) noted that crop response to poultry manure application is affected by nutrient reserve in the soil and that crop response to fertilizer application in soil with low nutrient content than soils with high nutrient reserves. Dauda *et al,* (2008) reported that poultry manure promotes vigorous growth, increases meristematic and physiological activities in plant due to supply of plant nutrients and improvement in soil properties. This often results in synthesis of more photosynthates which are used in producing fruits. The response of poultry manure to growth and yield components such as number of leaves and branches, number of fruits per plant, fruit diameter , fresh fruit yield in both locations could be attributed to the ability of poultry manure to supply N and K and gradually these nutrients slowly leading to longer period of supply, that induced sustained luxuriant growth. Better storage of large reserve of assimilate produced was enhanced. Also the ability of manure to improve the physical and chemical properties of the soil ensures stress free crop development hence high yields were recorded. This observation agrees with the findings of Aliyu and Kuchinda (2002), Aliyu (2002), Dauda et al. (2005) and Anon (2007) who reported that nutrients in manures most especially nitrogen and other nutrients become available more slowly and a considerable amount is still available towards the latter part of the growing season.

5.4 Regression

The regression analysis showed a quadratic response on pepper fresh fruit yield against nitrogen and poultry manure rates in both sites which indicate that the optimum nitrogen and manure rates requirement for the crop were attained. Neetson and Wadman (1987) reported that quadratic response predicts economic optimum application rate of fertilizers i.e. the minimum amount of fertilizer needed for maximum profit. He also stated that recommendations was not based on prediction of the optimum rate of fertilizer, but separately on the recommended amount of fertilizer and the yield obtained.

CHAPTER SIX

6.0 Summary and Conclusion

Field experiments were conducted to determine the performance of sweet pepper varieties as influenced by nitrogen and poultry manure fertilization. The experiments were carried out during the 2011/2012 dry season at the Institute for Agricultural Research Farm, Kadawa, and Kadawa village, Kano State. The treatments evaluated were two varieties of sweet pepper (California Wonder and Tattasai Dan-Garko), three Nitrogen rates (50, 75 and 100 kg N ha^{-1}) and three poultry manure rates (0, 3 and 6 t ha^{-1}) which were factorially combined and laid in a Randomized Complete Block Design (RCBD), replicated three times. Parameters measured were, plant height, number of leaves, number of branches, leaf area index, crop growth rate, relative growth rate, net assimilatory rate, number of days to 50% flowering, number of fruits per plant, fruit diameter, fruit length and fresh fruit yield kg ha^{-1}. California Wonder had higher leaf area index (3.03), relative growth rate (0.12g/gwk^{-1}), fruit diameter (5.00, 4.70cm) and fresh fruit yield (8307.60 kg ha^{-1}) than Tattasai Dan-Garko (2.14) (0.10g/gwk^{-1}) (4.13, 4.20cm) and (6380.80 kg ha^{-1}) respectively. Number of leaves (22.28), leaf area index (1.50), relative growth rate (0.043) in Kadawa village, crop growth rate (9.30, 9.66, 7.09) at both sites showed significant response to nitrogen fertilizer with 100 kg N ha^{-1} producing higher values. While number of fruits per plant (10.00) in Kadawa station and fresh fruit yield (7535.70, 7544.10 kg ha^{-1} in Kadawa village and combined were significantly increased by application of 75 kg N ha^{-1}. Growth characters of sweet pepper were significantly improved by application of poultry manure at 3t ha^{-1}. Regression analysis showed the optimum rates of nitrogen and poultry manure for sweet pepper yield were (78.90 and 88.49 kg N ha^{-1}) and yield of (7930.30, 9691.02 kg ha^{-1}) for California Wonder variety at both sites. While Tattasai Dan-Garko has optimum nitrogen as (78.40 and 92.32 kg N ha^{-1}) and gave yield of (7471.54, 6945.11 kg ha^{-1}) in the two locations respectively. Poultry manure when regressed against pepper yield showed an optimum of (4.33, 4.00 t ha^{-1}), yielded (9848.43, 7628.80 kg ha^{-1}) with California Wonder variety. An optimum of 3.04 and 4.00 t ha^{-1}, and yield of (8384.66, 7397.40 kg ha^{-1}) for Tattasai Dan-Garko in both locations were recorded. In conclusion, it could be suggested that California Wonder (78.90 kg ha^{-1}) and (4.00 t ha^{-1}) poultry manure could be used by farmers in Kadawa station and Kadawa village respectively.

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Appendix I: Kadawa Meteorogical Observation 2011/2012

Month	Max Temp°C	Min Temp°C	RH Dry %(10am)	RH Wet %(10am)	RH Dry %(4pm)	RH Wet %(4pm)	Sunshine Hours
November	28.9	26.1	23.0	22.2	21.6	18.1	9.8
December	28.7	21.9	24.4	18.9	20.0	15.6	9.2
January	27.7	23.6	21.3	15.2	20.3	14.8	8.9
February	37.5	29.9	28.0	15.9	24.7	14.5	9.1
March	29.9	20.7	20.4	17.4	26.5	19.8	8.6
April	33.2	22.9	25.4	19.3	24.3	19.8	8.4
May	34.2	24.1	25.9	21.1	24.8	22.1	8.8

Source: Kadawa Meteorogical Unit, Kano.