GROWTH AND YIELD ATTRIBUTES OF TOMATO *(*lycopersicon lycopersicum MILL) AS INFLUENCED BY POULTRY MANURE, SPACING AND PRUNING

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Abstract

Field experiment was conducted during the 2012/2013 and 2013/2014 dry seasons under irrigation at the farm of the Federal College of Horticulture, Dadin-kowa (Latitude 11^0 30N, Longitude 10^0 20E and 240 M above sea level) located in the Sudan Savanna agro-ecological zone of Nigeria, to determine the influence of poultry manure, spacing and pruning on the growth and yield of tomato. The treatments consisted of three rates of poultry manure (0.0, 2.0 and 4.0t/ha), three intra-row spacings (No-spacing, 30.0 and 60/cm) and three levels of pruning (unprunned, two-stem and four-stem) which were laid out in a split plot design with three replications.Application of poultry manure at all rates significantly (P≤0.01) increased plant height in the two seasons, number of leaves in 2012/2013 only, number of fruit per plant, fruit weight per plant, fruit length, girth, fruit weight per plot and fruit yield per hectare in the 2012/2013 and 2013/2014 dry seasons. However, 4.0/$^{tha-1}$ of poultry manure consistently produced highest value in these parameters.Spacing at all level significantly (P≤0.01) influenced plant height, number of leaves, weight of fruit per plant, fruit length,girth, fruit weight per plot and fruit yield per hectare in both seasons.The 60/cm spacing significantly produced highest value in these parameters.Pruning at all level significantly (P≤0.01) increased plant height and number of leaves in 2014, number of fruit per plant, weight of fruit per plant, fruit length, girth , fruit weight per plot and fruit yield per hectare in all dry seasons. Unprunned treatment significantly (P≤0.01) produced highest number of fruit per plant and weight of fruit per plant in the two seasons, while four-stem pruning significantly produced highest plant weight, number of leaves, fruit length,girths, fruit weight per plant and fruit yield per hectare in the two seasons. It could therefore, be concluded that 4.0/tha^{-1} of cured poultry manure, 60/cm spacing and four-stem pruning could be recommended for optimum tomato production in the study area.

Keywords: Growth,Irrigation, Poultry manure, Pruning,Spacing, Tomato, Yield

Introduction

Tomato (Lycopersicon Lycopersicum MILL) is an annual crop and belongs to the solanaceae family group of fruit vegetables and genus Lycopersicon (Tindal, 1996). Tomato originated in the Peruvian and Mexican regions and was introduced into other regions of the world by the Spanish explorers and European migrants (Myanmar, 1999). It is a reliable source of vitamins and minerals (Fayemi, 1999).The fruit is eatened raw, grind into paste to make

soup or sliced, dried and grind into powder or grind to produced tomato juice (Musa *et al.,* 2007). World production of the crop in 2013 was estimated to be 70 million tons per hectare from 2.7million hectare (FAO 2013).

In Nigeria, there is a continuous decline in the cultivation of the crop by most farmers due to poor yields per hectare obtained. This situation may be attributed to the continuous decline in the fertility of the savanna soils (where the crop is predominantly being produced) due to low organic matter, poor nitrogen availability coupled with the adoption of inappropriate and inferior cultural practices. For sustainable production of tomato, farmers should focus their strategy on increasing fertility to the soils through the use of organic manure, Considering the fact that there is an increasing demand and preference for organically produced fruit and vegetables that are good in appearance and taste hence given high premium in the global market (Adams, 1991).

Poultry manure, if properly handled is the most valuable of all manure produced by livestock and has historically been used as a source of plant nutrient and for soil amendment (Ja'afar, 1997).It is one of the best forms of organic fertilizers for vegetable production (Hegmehg *et al.,* 1993). The use of animal manure in vegetable production has long been realized but recorded information on crop response has been scanty (Anonymous, 2007). Tomato yield could be substantially increased through the used of improved cultural practices. Some of the practices that may increased tomato yield are spacing and pruning (Rafi, 1996), Chen and Lal (1999) and Myanmar (1999). For example it was reported that wider spacing increased tomato fruit size, fruit weight and fruit weight per plant while closer spacing increased fruit number per plant and fruit yield per hectare (Rawshan,(1996 and Zhang,1999). Appropriate pruning produced larger, early and good yield compared to un-prunned tomato of same cultivar (Sarkawal *et al.,* 2008).

This study was carried out to investigate the effect of varying rates of poultry manure,intra row spacing and pruning on growth and yield attributes of tomato.

Materials and Methods

Field experiment was conducted under irrigation at Teaching and Research Farm of Federal College of Horticulture, Dadin-Kowa (Latitude 11^0 30N, Longitude 10^0 10E and 240 m above sea level) located in the Sudan Savanna agro-ecological zone of Nigeria (Kowal and Knabe, 1972). The average monthly temperature during the experimental period was 27^0C in 2012/2013 and 26^0C in 2013/2014, respectively. Maize and okra were grown on the experimental field for the past two years, physico-chemical properties of the soil of the experimental site revealed that the soil was sandy loam with P^H of 5.3 in 2013 and 5.9 in 2014, 3.6/gkg^{-1} organic matter content, 0.1/gkg^{-1} total N, 14mg/kg^{-1} available phosphorus and exchangeable cations status for calcium, magnesium, potassium and sodium were 2.6, 0.8, 1.1 and 0.2cm mol.kg^{-1}, respectively. Chemical composition of the poultry manure used in the two experiment was 10.13(mg/kg^{-1}) organic carbon, 1.53 (g/kg^{-1}) total nitrogen, 0.197 (g/kg^{-1}) available phosphorus, 0.181 (g/kg^{-1}) potassium, 2580 calcium (ppm), 4210 magnesium (ppm), 883 Iron (ppm), 238 Zinc (ppm) and 9.41 Copper (ppm).

The treatments were three levels of cured poultry manure (0, 2.0 and 4.0/tha^{-1}), three levels of intra-row spacing (No-spacing,30.0 and 60/cm) and three pruning levels (unprunned, two-stem and four-stem) arranged in a split plot design and replicated three times. The poultry manure and spacing were assigned to the main plot, and pruning in the sub-sub plot. The experimental site was ploughed and harrowed using a tractor in order to obtain a fine tilth. Sunken beds of 8m^2 and 4.5m^2 individual gross and net plot sizes were prepared in a way that irrigation water will be retain for gradual percolation. Plots were spaced 1m and 0.5m between and within each replication and treatment. All plots received single dose of cured poultry manure incorporated into the sunken bed via sprading with hand in the morning on 28th October of 2012/2013 according to the treatment and irrigated instantly to further stimulate its biodegradation. Tomato seed variety Roma VFN was obtained from Gombe State Agricultural Development Programme (GSADP), Gombe.

The tomato seeds were raised in the nursery for a period of 4 weeks before it was transplanted to the field at 3 – 5 leaf stage. Seedlings were transplanted at intra-row spacing of 0.0, 30.0 and 60.0cm on 8th November of 2012/2013 and 2013/2014 seasons, respectively. Pruning (the removal of the side shoots and lower shoots) was carried out by grasping the shoots (at about 10/cm) with thumb and forefinger and pulling outward and downward. For the two-stem pruning, the immediate shoot (sucker) below the first truss was allowed to grow as the second stem while the rest was completely removed. For the four-stem, three immediate suckers below the first truss were allowed to grow as second, third and fourth shoots. The pruning exercise were carried out four times at two-weeks interval, starting from 4 week after transplanting (WAT). Irrigation was given at three days interval up to the period when the tomato plant senescence.Weeding was carried out manually using hoe and hand pulling were necessary and helicoverpa armigera hubner fruit worm was control using crushed neem seed powder. Data were collected at 4,6,8,10th weeks after transplanting on plant height (cm), number leaves per plant, number of fruit per plant, weight of fruit per plant (kg), fruit length (cm), fruit girth (cm), fruit weight per plot (kg) and fruit yield per hectare.

All the data collected were statistical analyzed using F test as described by Steel and Torrrie (1981),Duncan multiple range tests (DMRT) was used to separate significantly different means using Minitab Computer Software.

Results and Discussion

Table 1 shows the effect of poultry manure levels, spacing and pruning on tomato plant height, number of leaves, number of fruit per plant, and fruit weight per plant during the 2012/2013 and 2013/2014 dry seasons, respectively. The plant height were found to be influenced significantly ($P \leq 0.01$) by poultry manure levels during the period of the experiment. Application of 4.0/tha^{-1} of poultry manure significantly produced the tallest plants in the two seasons compared to other levels and the control. It was noted that plant height increased with increase in poultry manure application in both seasons, and this might be due to availability of nutrients released by the poultry manure as it contains both micro and macro nutrient elements in moderately sufficient amount to support crop growth (Maqsood *et al.,* 1999).

Spacing significantly (P≤0.01) increased tomato plant height in 2012/2013 dry season only (Table 1). Intra-row spacing of 60/cm significantly produced the tallest plants in the season compared to the other spacing and control (Table 1),this could be due to adequate space which allows for wider photosyntate assimilation by tomato leave. These findings concur well with that of Rafi (1996), Rawshan (1996) and Myanmar (1999). The effect of pruning on tomato plant height was significant (P≤0.01) in 2012/2013 and 2013/2014dry seasons (Tables 1 and 2). However, in 2012/2013 season the effect of spacing on plant height was found to be significant (Table 1). Four-stem pruning consistently and significantly produced the tallest plants compared to other pruning levels and control. This could be as a result of diversion of nutrients and assimilate pertitioning to the blower dusters and fruit on the stem as reported by Chen and Lal (1999).

Application of poultry manure rates significantly (P≤0.05) influence number of leaves of tomato during the 2012/2013 season only (Table 1). Application of 4.0/tha^{-1} of poultry manure significantly produced the highest number of leaves in this season (Table 1). The positive response of tomato plant to the different levels of poultry manure application could be due role of N in the tomato plant growth and development as trigger by the availability of N because of poultry manure application and the initial low fertility status of the soil of the experimental site. It might also be due to high decomposition of poultry manure as observed by Salim *et al.* (1997).

Table 1 further showed that the influenced of spacing on tomato number of leaves during the two dry seasons were significant (P≤0.01).Number of tomato leaves significantly increased with increase in spacing up to 60/cm. Highest number of leaves were obtained at 60/cm spacing during the two years of study, perhaps due to more spacing which increases the rate of assimilation. This result corroborates the findings of Ayigbede *et al.* (2005), Ushaima and Rafi (2008) and Ali and Kabir (2008). The data in Table 1 also revealed that pruning significantly (P≤0.01) increase number of tomato leaves in 2013/2014. However, the effect of pruning on tomato number of leaves was significant in 2012/2013 season (Table 1). Highest number of leaves per plant were obtained with four-stem pruning due to less intra plant competition and more vigorous growth. Number of leaves per plant is the most important component which increases biomass production (Chilching *et al.,* 2007), Johnson and Ramo (2008) and Kirwanshoy *et al.* (2008) reported similar findings.

Table 1 also showed that number of fruit and fruit weight per plant were significantly (P≤0.01) increase by poultry manure application such that application of 4.0/tha^{-1} of poultry manure produced the highest value than other levels and control during the two seasons, Spacing significantly increased number of fruit per plant in the two seasons. However, weight of fruit per plant were significantly (P≤0.01) influenced by spacing in the two seasons (Table 1). Highest fruit weight per plant was obtained in No-spacing treatment followed by 30cm and the least with 60/cm spacing. This findings is in line with that of Zhang (1999) and Shuangxi (1985) who reported that spacing had no significant effect on number of tomato fruit per plant. Pruning significantly (P≤0.01) increased number of fruit per plant and weight of fruit per plant in the two dry seasons (Table 1). Unprunned plants significantly produced the highest number of fruits per plant and weight of fruits per plant more than four-stem and two-stem prunings in this study. This may not be unconnected with the

availability of more undisturbed fruit producing shoots in the former than the later. Similar trend was reported by Myanmar (1999) and Zhang (1999).

Table 2 showed the effect of poultry manure levels, spacing and pruning on tomato fruit length, girth, weight per plot and yield per hectare in 2012/2013 and 2013/2014 dry seasons, respectively. Poultry manure significantly ($P \leq 0.01$) increased fruit length and fruit girth during the two years of study.The application of 4.0/tha^{-1} of poultry manure significantly produced the longest fruits and largest fruits compared to the other levels and the control, This could be attributed to higher nutrients availability which resulted in increased growth of the tomato plant. Akoun (2004) reported that poultry manure increases nutrients status of soil which in turn leads to improved growth and development in plants.

Spacing significantly ($P \leq 0.05$) increased tomato fruit length and girth in the two seasons (Table 2).The use of 60/cm of spacing significantly produced largest fruit and widest fruit during the period of study compared to other levels and control. This result is in agreement with the finding of Ahmad and singh (2004) who reported that wider spacing minimizes competition for nutrients, water and sunlight radiation. The effect of pruning were found to be significant ($P \leq 0.05$) on fruit length and girth in the two seasons (Table 2). Longest fruit and larger fruits were obtained in four stem followed by two stem and the least by the control probably due to the residual effect of last season cropping activity. This result concur well with findings of Myanmar (1999),Zhang (1999) and Hernandez and Sanchez (1992).

Poultry manure levels significantly ($P \leq 0.01$) increased tomato fruit weight and tomato fruit yield per hectare during the 2012/2013 and 2013/2014 dry seasons (Table 2).The application of 4.0/tha^{-1} of poultry manure significantly produced the heavest fruits per plot and highest fruit yield per hectare in the two seasons compared to other levels and control. This result is similar to the earlier result obtained by Odeleye *et al.*(2008), Blum *et al*. (2004) and Adams (1991) who resported that the application of 4.O/tha^{-1} of poultry manure significantly increased the growth of fruiting and yield of cucumber.

The effect of spacing was significant ($P \leq 0.05$) on tomato fruit weight and yield per hectare during the two dry seasons (table 2).The 60/cm spacing significantly produced heaevest fruits followed by 30/cm and the least by the control. Seasons. This could be due to minimal competition between plants for nutrients, water and sunlight as reported by Kulkani *et al*. (2007) and Shengfu tsu *et al.* (2009) However,No-spacing significantly produced the highest fruit per hectare in 2012/2013 and 2013/2014 compared other levels in the two seasons (Table 2). This may be attributed to high number of fruit per plot as a result of higher population density in No-spacing treatment, because at closer spacing, adequate plant density is obtained which is a predetermining factor for unit area return as reported by Kamal and Shaktur (2006), Zakhar (2008) and Johnson *et al*. (2009).

The influence of pruning was observed to be significant ($P \leq 0.05$) on tomato fruit yield per hectare in the two seasons (Table 2) The four-stem pruning significant produced the highest fruit weight and fruit yield per hectare during the two dry seasons compare to other levels of pruning and control. Reasons for higher fruit weight per plot and fruit yield per hectare obtained in the two seasons might be due the fact that the pruned plants had less

photosynthate demanding shoots which resulted to more dry matter partitioning to its fruit as reported by (Rafi 1996), Zhang (1999), Myanmar (1999) and Aliyu (2007).

Conclusion

It could be concluded from this study that poultry manure at 4.0/tha^{-1}, 60/cm and pruning at four-stem significantly produced the highest value in all the characters recorded during the two dry seasons (plant height, number of leaves,number of fruits per plant, fruits weight per plot,girth and fruits yield per hectare).

Recommendation

Based on the main effect of the applied treatments,the application of poultry manure at 4.0/tha^{-1}, spacing at 60/cm and four-stem pruning is recommended for the cultivation of tomato variety Roma VFN in the Sudan Savanna agro-ecological zone of Nigeria.

Table 1: Effect of poultry manure, intra-row spacing and pruning on some agronomic parameters of tomato during the 2012/2013 and 2013/2014 dry Seasons

Treatments	Plant height (cm)		Number of Leaves per plant		Number of fruit per plant		Fruit weight per plant (kg)	
	2012/2013	2013/2014	2012/2013	2013/2014	2012/2013	2013/2014	2012/2013	2013/2014
Poultry manure (tha^{-1})								
0.0	36.21[c]	32.00[c]	30.21[b]	31.66	17.00[c]	18.00c	0.83[c]	0.85[c]
2.0	60.51[b]	61.73[b]	7.41c	40.00	24.00[b]	23.00b	1.57[b]	1.60[b]
4.0	70.82[a]	69.48[a]	44.86[a]	47.51	39.00[a]	38.00a	2.08[a]	2.09[a]
LS	**	**	*	NS	**	**	**	**
S.E ±	2.15	3.31	2.99	2.51	0.86	0.42	0.06	0.05
Intra-row spacing(cm)								
No-spacing	40.21[C]	34.33[b]	35.03[C]	38.20[C]	12.00[c]	11.00c	2.73[a]	2.75[a]
30.0	47.56[b]	53.81[a]	42.32[b]	43.51[b]	22.00[b]	25.00b	1.42[b]	1.53[b]
60	59.46[a]	60.62[a]	53.39[a]	51.68[a]	35.00[a]	40.00a	0.81[c]	0.85[c]
LS	**	**	**	**	**	**	**	**
SE ±	3.48	2.76	3.43	3.66	0.39	0.71		

0.04	0.08						
Pruning							
Un-pruned		39.40^{C}	37.66^{C}	33.61^{b}	34.33^{b}	29.00^{a}	33.00a
2.06^{a}	2.08^{a}						
Two-stem		61.39^{b}	64.42^{b}	45.81^{a}	44.62^{a}	16.00^{c}	17.00^{b}
0.86^{c}	0.88^{c}						
Four-stem		71.42^{a}	70.21^{a}	47.73^{a}	45.76^{a}	22.00b	1.27^{b}
1.27^{b}	1.21^{b}						
LS		**	**	**	**	**	**
**	**						
SE ±		4.02	3.15	2.83	3.81	0.34	0.40
0.02	0.07						

NS=Not significant,* and **=significant at 5% and 1% levels of probability,respectively. Means followed by the same letter(s) within a set of treatment column are not significantly different at 5% level of probability using Duncan multiple range test (DMRT).

Table 2: Effect of poultry manure, intra-row spacing and pruning on some yield parameters of tomato during the 2012/2013 and 2013/2014 dry Seasons

Treatments	Fruit Length (cm)		Girth (cm)		Fruit weight per plot(cm)		Fruit yield(kgha^{-1})	
	2012/2013	2013/2014	2012/2013	2013/2014	2012/2013	2013/2014	2012/2013	2013/2014
Poultry manure (tha^{-1})								
0.0	3 .56^{c}	3.41^{c}	2.00^{b}	2.08^{c}	36.41^{c}	37.59^{c}	40.51^{c}	41.66^{c}
2.0	4.50^{b}	4.71^{b}	3.21^{a}	3.51^{b}	47.54^{b}	46.81^{b}	57.62^{b}	58.91^{b}
4.0	5.49^{a}	6.01^{a}	3.21^{a}	4.00^{a}	54.50^{a}	55.06^{a}	61.50^{a}	62.72^{a}
LS	**	**	**	**	**	**	**	**
S.E ±	0.06	0.09	0.07	0.10	0.68	1.04	1.63	1.51
Intra-row spacing (cm)								
0.0	3.61^{c}	3.00^{c}	3.00^{b}	3.02^{b}	40.00^{b}	39.69^{b}	59.21^{a}	54.32^{a}
30.0	5.00^{b}	4.61^{b}	3.43^{a}	3.21^{b}	50.49^{b}	49.88^{b}	52.67^{b}	54.33^{a}
60.0	6.08^{a}	5.52^{a}	3.63^{a}	3.79^{a}	51.03^{a}	50.73^{a}	50.51^{c}	52.56^{b}
LS	*	*	*	*	*	*	*	*
S.E ±	0.05	0.04	0.05	0.08	0.79	0.71	1.03	1.08
Pruning								
Un-pruned	5.00^{b}	4.00^{c}	2.96^{c}	2.33^{c}	40.75^{c}	41.35^{c}	50.88^{c}	50.0^{c}

Two-stem	5.66[b]	5.92[a]	3.51[b]	3.00[b]	45.61[b]	48.32[b]	51.54[b]	52.47[b]				
Four-stem	5.73[a]	5.56[b]	4.31[a]	3.79[a]	52.00[a]	50.55[a]	57.49[a]	58.53[a]				
LS	*	*	*	*	*	*	*	*				
S.E ±	0.08	0.07	0.10	0.07	0.35	0.48	1.44	1.06				

NS = Not significant,* and ** = Significant at 5% and 1% levels ofprobability,respectively.Means followed by the same letter(s) within a set of treatment column are not significantly different at 5% level of probability using Duncan multiple range test (DMRT).

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