Optimization of plant population density and chicken manure rates in enhancing sweet corn yield (*Zea mays* saccharata L.)

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Abstract

Maize production has increasingly become strategic in Nigeria, facing food security challenges presently. Moving from net importer to sufficiency, creates need for urgent production expansion. A two year field experiment evaluated spatial dimensions and manuring rates effects on performance of sweet maize in the early cropping seasons of 2019 and 2020, at the Teaching and Research Farm of the University of Calabar, Nigeria, using a randomized complete block design (RCBD) with nine treatment combinations as follows: 40 cm x 25 cm + 0 t ha^{-1} CM, 40 cm x 25 cm + 10 t ha^{-1} CM, 40 cm x 25 cm + 20 t ha^{-1} CM, 50 cm x 25 cm + 0 t ha^{-1} CM, 50 cm x 25 cm + 10 t ha^{-1} CM, 50 cm x 25 cm + 20 t ha^{-1} CM, 60 cm x 25 cm + 0 t ha^{-1} CM, 60 cm x 25 cm + 10 t ha^{-1} CM and 60 cm x 25cm +20 t ha^{-1} CM, replicated three times. From results, sweet maize(Zea mays saccharata L.) spaced at 40 cm x 25 cm with 20 t ha^{-1} of chicken manure had better performance which resulted in the highest ($p \le 0.05$) leaf area index (2.82 and 4.19), stem girth (3.51 and 3.51) and grain yield(2.36 and 2.41 t ha^{-1}) in both years of the study. In conclusion, sweet maize production can be profitable using the optimum spacing and chicken manure combinations articulated in this study.

Keywords: grain yield, humid, land degradation,manuring rates, spatial dimensions

Introduction

Sweet maize production requires adequate supply of nutrients for optimum growth and yield performance. Nitrogen is associated with high photosynthetic activity, vigorous vegetative growth and dark green pigmentation of leaves (Dauda *et al*., (2005), Jahn *et al*., (2005). Inadequate supply of nitrogen is a limiting factor in maize production (Akintoye *et al*., 1997). Efforts aimed at obtaining high yield of maize necessitate the elevation of the nutrient status of the soil through fertilization, to meet the crop's requirements for optimum productivity and maintain soil fertility (Stephen *et al*., 2014). Inorganic fertilizers alone have not been completely helpful under intensive agriculture because of aggravation of soil degradation (Belay, 2015). Organic fertilizers are important for maintaining sustainable soil fertility, are slow releasing and environmentally friendly (Sharma and Mittra, 1991). Chicken manure is a good organic source of plant nutrients, and can be incorporated in to most fertilizer programs (Boateng *et al*., 2006).

Chicken manure increases the nutrient level of soil, improves structure and microbial activities/processes and enhances water/nutrient holding capacity as well as chemical properties of the soil system (Tasneem *et al*., 2004). According to Ibeawuchi *et al*. (2006), chicken manure application increased the residual soil N, K, Ca,Mg and organic matter. Rasool *et al*. (2008) reported higher grain yield and NPK uptake by maize was achieved with the application of chicken manure. Thus, using chicken manure in crop production could bring more benefit for farmers by reducing both the use and cost of chemical fertilizers (Uko *et al*., 2009). Pote *et al*. (2003) showed that chicken house litter improved soil properties compared to chemical fertilizers. According to Arshad *et al*. (2017), chicken manure at the rate of 50 t/ha was statistically superior to the control (0 t/ha) treatment and 25 t/ha in both growth and yield of sweet corn. Similarly, Enujeke (2013) recommended 30 t ha^{1} of poultry manure to farmers as most appropriate rate of application to enhance growth and yield of maize in Asaba area of Delta State of Nigeria

The above statements are synchronous with Adekiya and Agbede (2009) and Agbede *et al*. (2013) assertions that chicken manure application improved soil fertility and crop yield. The positive response to chicken manure treatment is attributed to increased nitrogen availability as indicated by increase in N concentrations within plant tissues (Opara and Asiegbu, 1996). The use of chicken manure as an amendment for soil, to sustain crop performance and produce adequate yields has been found effective for many crops in south western Nigeria (Adeleye *et al*., 2010). Adoption of chicken manure for crop production is a substitute of chemical fertilizer (Sanchez-Monedero, 2004) in moving into organic farming. Over time, application of chicken manure increases nutrient uptake, growth and yield besides ensuring the stability of soil structure by reduction of bulk density (Rasool *et al*., 2008). This implies that soil health has been boosted by the improvement in nutrient profile, increasing root exploratory capacity of plants through improvement of soil physical properties and making nutrients more easily accessible to plants. Chicken manure generally has higher N concentration and lower C: N ratio resulting in quick release of N to plants (Parnes, 1990). Approximately 30 – 50 % of N becomes available to plants following application (Hue and Sobieszczyk, 1999).

Maize production is greatly affected by varying population density as influenced by the planting distance, low tillering capacity to fill the gap among plants (Azam *et al*., 2012). Spacing requirement for maize is an important consideration both for home gardens and large-scale industrial crop production (Ali *et al*., 2017). Spatial orientation gives the crop a dual advantage; by providing an available surrounding soil volume for effective rooting, exploration and nutrient exploitation. Under wide spacing and reduced plant density, plants face less inter specific competition due to availability of plant growth resources (Tanimu *et al*., 1991). Under crowded conditions, however, the effects of higher population density and overcrowding could result in compensatory etiolation, where plants struggle to reach incident radiation at the upper canopy, as a result of interspecific plant competition (Birch *et al*., 2008). Intra-row spacing influences plant density per unit area and their interactions within the system. Each maize production system has an optimum population that maximizes utilization of available resources to enhance attainment of maximum grain yield in that environment (Sangoi, 2000). These in turn affects the availability of nutrients for plants, and the exploitation of available resources.

Typical inter-row width spacing employed by corn producers vary from 50-75 cm with intra-row widths of 20-25 cm, while 75 x 25 cm for sole maize crop at one plant per hill seems to be the standard practice in Nigeria and other maize producing locations worldwide (Birch *et al*., (2008); Eskandarnejad *et al*., (2013) and Uwah *et al*., (2014). According to Eskandarnejad *et al*. (2013), the highest average grain yield of 15.03 t/ha was recorded at row spacing of 55 cm for sweet corn. Also, Getaneh *et al*. (2016) reported that spacing combinations of 65 cm x 25 cm responded favorably in attaining higher grain yield of maize in Ethiopia. However, Kebede (2019) maintained that 75 x 25 cm spacing gave the best maize yields in Ethiopia, while Uwah *et al*. (2014) reported highest yields of sweet corn at 60 cminter-row and 30 cm intra-row spacing in South Eastern Nigeria. According to Tahmasbi and Rashed-Mohasel (2009), increased plant density resulted in increased yield; with the highest grain yield of 11.13 t ha^{-1} occurring at 85,000 plants ha^{-1} in maize.

Sole reliance on mineral fertilizers is fraught with several problems for soil and the environment (Stephen *et al.*, 2014). Organic fertilizers however, have the potential to correct most of these negative impacts. They are effective in maintaining adequate supply of organic matter to soils, with attendant improvement in soil physical and chemical conditions as well as enhanced crop performance, besides guaranteeing environmental friendliness and sustainability of soil natural resources (Ikpe and Powel, (2003); Ano and Agwu (2005). Enormous volumes of organic wastes from plants and animals as well as household refuse could be used as effective nutrient sources for crop production (Moyin-Jesu, 2008). This study was embarked on to optimize spatial orientations and chicken manure rates effect on agronomic performance of sweet corn on humid Ultisol in Calabar, South-Eastern Nigeria.

Materials and Methods

Field experiment was conducted in 2019 and 2020 at the Teaching and Research Farm of the

University of Calabar, Nigeria (Latitude 4.5 - 5.2^0 N and longitude of 8.0 - 8.3^0 E), about 39 m above sea level. This area is characterized by a bimodal rainfall pattern that ranges from 3,000 – 3,500 mm, mean annual temperature range of 27^0 C to 35^0 C and relative humidity between 75 - 85% (NIMET, 2010). Chicken manure (CM) was sourced from battery cage units in the University of Calabar Research Farm. The manure was cured by spreading out in shade for fifteen days until totally dry and crumbly. This crumbly mass was then applied to the plots and incorporated during tilling, three weeks before planting. Seeds of sweet corn variety TZISWEETCY (Lowland sweet corn) were obtained from Seed bank of the International Institute for Tropical Agriculture, Ibadan, Nigeria. Twelve random soil samples were collected from the experimental site at 0-30 cm depth prior to application of treatments and planting. Samples were air-dried, bulked and a composite sample analyzed for physico-chemical properties using suitable methods.

Experimental design was randomized complete block design (RCBD) having nine treatment combinations expressed as follows: 40 cm x 25 cm + 0 t ha^{-1} CM, 40 cm x 25 cm + 10 t ha^{-1} CM, 40 cm x 25 cm + 20 t ha^{-1} CM, 50 cm x 25 cm + 0 t ha^{-1} CM, 50 cm x 25 cm + 10 t ha^{-1} CM, 50 cm x 25 cm + 20 t ha^{-1} CM, 60 cm x 25 cm + 0 t ha^{-1} CM, 60 cm x 25 cm + 10 t ha^{-1} CM and 60 cm x 25cm +20 t ha^{-1} CM. These were replicated three times giving a total of 27 experimental plots.

Two seeds of maize were planted per stand at a spacing of 40 x 25 cm, 50 x 25 cm and 60 x 25 cm into a previously ploughed and harrowed field. They were later thinned to one per stand giving respective plant population densities of 100,000; 80,000 and 66,666 plants ha-^{1}, equivalent to 40, 32 and 26 sweet corn stands per plot, on experimental plots that measured 2.0 m x 2.0 m (4.00 m^2) with a net plot size of 1.5 m x 1.5 m (2.25 m^2) respectively. Plants were sampled every two weeks starting from 3 - 11 weeks after planting (WAP). Data were collected on growth variables such as plant height, number of leaves, leaf area index, dry matter (g), stem girth (cm), days to 50 % silking; yield and yield contributing factors as length of cobs, cob girth (cm), number of grains cob^{-1}, weight of cobs, green cob yield t ha^{-1} and grain yield t ha^{-1}. Data collected were subjected to a two –way analysis of variance (ANOVA) at 5% level of significance following procedures outlined by (Gomez and Gomez, 1984). Significant means were compared using the Duncan Multiple Range Test (DMRT) at 0.05 probability level.

Results and discussion

The results of analysis of soil on Table 1 show that soil at the experimental site was made up of sandy clay loam texture. The pH of manure was 7.75 while organic manure (OM) was 43.01 %. The effects of chicken manure and inter-row spacing on vegetative attributes of sweet maize presented in Tables 2 and 3 indicated positive effects $p \leq 0.05$on plant height, number of leaves, leaf area index, dry matter, stem girth but not number of days to 50 % silking. The tallest sweet corn plants occurred when sweet corn was spaced at 40 cm x 25 cm and fertilized with 10 t/ha CM (229.1 cm), which was statistically similar ($P>0.05$) to height of corn spaced at 40 – 50 cm and treated either with 10 or 20 t/ha of chicken manure, and significantly taller than SC spaced at 50 cm x 25 cm that was treated with 20 t/ha CM (125.1 cm) in 2019. In 2020, the tallest maize plants (235.3 cm) were observed in the treatment combination of 40 x 25 cm spacing and 20 t/ha CM, statistically similar ($P>0.05$) to height of sweet corn at 40 x 25 cm + 10 t/ha CM, 50 x 25 cm and 0 – 10 t/ha CM and 60 x 25 cm + 20 t/ha CM respectively ($P>0.05$). These were in turn significantly taller than sweet corn from combinations of 40 x 25 cm + 0 t/ha, 50 – 60 x 25 cm spacing and treated with either 0-20 t/ha CM ($p \leq 0.05$) respectively with the height of corn from 50 x 25 cm and 20 t/ha CM (143.1 cm) being the shortest.

The number of leaves in 2019 was highest among plots of sweet corn spaced at 40 x 25 cm and fertilized with CM at 10 t/ha (11.75) which was similar to number of leaves from other treatments ($P>0.05$), and significantly higher ($p<0.05$) than the number of leaves in sweet corn spaced at 40 x 25 cm + 0 t/ha CM, 50 x 25 cm + 20 t/ha CM and 60 x 25 cm + 0 t/ha CM respectively. In 2020, sweet corn from plots treated with 40 x 25 and 60 x 25 cm + 20 t/ha CM were the same (10.92), statistically similar to number of leaves from 40 – 50 cm + 10 t/ha CM respectively ($P>0.05$). These were all significantly higher than the number of leaves (Table 2) arising from other treatment combinations with the treatment of 60 x 25 cm + 0 t/ha CM bringing up the lowest number of leaves (7.63) ($p \leq 0.05$). The leaf area index in both years was highest ($p \leq 0.05$) in the plots of treatment combination 40 x 25 cm + 0 – 20 t/ha CM and lowest from plots with the combination of 60 x 25 cm + 0 t/ha CM in both years (Table 2).

Results of effects of inter-row spacing and chicken manure rates on dry matter of sweet corn (Table 3) showed that dry matter increased progressively with increase in spacing intervals from 40 – 60 cm at different manure rates. Dry matter at 60 x 25 cm + 10-20 t/ha CM was statistically at par ($P>0.05$) in both years, significantly higher ($p \leq 0.05$). Cob girth and number of grains were not significant ($p>0.05$) in the two years of the study (Table 4). However, the length of cobs was significantly higher in both years when 20 t ha^{-1} of chicken manure was applied to sweet corn spaced at 50 x 25 cm in both years. The effects of CM and IRS on weight of cobs and the grain yield (t/ha) alone were significant (Table 5). From results, the weight of cobs for sweet corn grown at 40 x 25 cm – 50 x 25 cm + 10 – 20 t/ha CM and 60 x 25 cm + 20 t/ha CM were statistically similar (*P*>0.05) to other treatments and only significantly higher than cob weight from the 60 x 25 cm + 0 t/ha CM treatment plots in 2019. During the 2020 planting season, the highest cob weight (204.2 g) was reported for plots that obtained treatment 40 x 25 cm + 20 t/ha CM, significantly higher than cob weight of plants from plots at 60 x 25 cm + 10 t/ha CM (140.3 g) but statistically at par (*P*>0.05) with cob weight from all other treatment combinations (Table 5). The green cob yield was not significant (*P*>0.05) in both seasons. Grain yield was highest at 40 x 25 cm + 20 t/ha CM (2.41 t/ha) in 2020, statistically similar (*P*>0.05) to grain yield at 50 x 25 cm + 0-20 t/ha respectively and significantly higher (p≤0.05) than grain yield at 40 x 25 cm + 0 – 10 t/ha CM. In 2019 however, all treatments from 50 x 25 cm to 60 x 25 cm + 0 – 20 t/ha CM were statistically at par in grain yield (*P*>0.05) which was significantly higher (p≤0.05) than grain yield at 40 x 25 cm + 10 t/ha with the control having the least yield values of grain yield.

With wide spacing and low plant density, plants experience reduced interspecific competition due to availability of resources for growth (Tanimu *et al*., 1991). Under conditions of low spacing, however, the effects of higher population density apply, and resultant overcrowding could result in considerable mutual shading and a situation where plants struggle to reach incident radiation at the upper canopy, as a result of inter plant competition (Kebede, 2019)**.** Intra-row spacing influences plant density per unit area and their interactions within the system. The maximum yield of a particular crop can be obtained at spacing where competition among the plants is minimal. Spacing is vital in crop production systems due to its influence on competition for plant growth resources. When plants are well spaced, they utilize soil moisture and nutrients more effectively as well as avoid excessive competition among the plants. Population of plants per square meter affects root spread as well as effective rooting area and available aerial space to each stand for mining and exploitation of available growth resources. Taller plants will produce a higher number of leaves arising from a larger number of internodes on the stem.

According to Sangoi (2000), plant density is influenced by inter and intra-row dimensions, which in turn influences the mobilization of plant growth resources. Consequently, taller plants with abundant leafiness translated to higher leaf area index values due to sufficient ground to leaf cover ratio enhance interception of photosynthetically active radiation within the plant system. This is in turn translated to photoassimilate production and partitioning for maximum yield. Studies by Eskandarnejad *et al*. (2013) reported the highest grain yield of sweet corn at 55 cm inter row spacing which is in consonance with results in this study and well supported by Raja (2001) report that raising of corn plant population from 53,333 to 88,888 plants per hectare significantly increased the fresh ear yield. One of the benefits of chicken manure is the improvement of soil fertility and crop yield, as alluded to by Agbede *et al*. (2013). According to Zamir *et al*. (2011), corn kernel yield was enhanced from 10.1 t ha^{-1} to 10.8 t ha^{-1} as population increased from 59,000 to 89,000 plants ha^{-1}. Higher grain yield occurring in the 40 cm x 25 cm spacing + 20 t/ha chicken manure indicates the efficacy of nitrogen in increasing plant yields (Opara and Asiegbu, 1996).

From the findings of Ali *et al*. (2017), in increasing plant density, yield per plant decreases while grain yield per unit area increases. Leaf area index was significantly higher ($p \leq 0.05$) among the 40 x 25 cm spaced plants. Lush growth contributed to dry matter accumulation as a result of spacing and adequate manure application, which also resulted in stout stalks useful for sustaining yields while preventing lodging. Unlike field corn, sweet corn has smaller status plants with lower leaf expansion, hence a higher leaf area index is attained at closer spacing and higher density. The higher number of plants for the partition of photo-assimilates could have resulted in lower seed weight, but the sheer number of plants at that population contributed more to the cob yield basis. This may have been as a result of higher exploitation of available plant growth resources to increase maximum yield.

Conclusion

The application of 20 t ha^{-1} of chicken manure significantly ($p \leq 0.05$) increased the growth and performance of sweet corn above other rates. The highest ($p \leq 0.05$) agronomic performance occurred at 40 cm x 25 cm spacing with chicken manure rates of 20 t ha^{-1} which resulted in the best grain yield of sweet corn (2.41 t ha^{-1}) in the study. It is therefore recommended that for sweet corn production within the study area, farmers should adopt the optimum rates of chicken manure and spacing for sweet corn 40 cm x 25 cm and 20 t ha^{-1} of chicken manure as demonstrated in this experiment.

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Table 1: Physical and chemical properties of the soil from 0-20cm at the experimental sites during 2019 - 2020 and chemical composition of chicken manure

Soil analysis	2019	2020	Manure Analysis	
Physical Composition				
Particle size analysis				
Sand (%)	85.6	85.70		
Silt "	7.3	8.00		
Clay "	7.1	6.30		
Soil textural class	Loamy sand	Loamy sand		
Chemical composition				
pH	5.00	6.30		7.75
EC dsm^{-1}	0.065	-		3.369
Organic matter (g/kg)	1.03	1.04	Organic C	43.01 %
Total Nitrogen (g/kg)	0.10	0.12	N	1.82 %
Available P (mg/kg)	18.55	33.6	P (mg/kg)	1.42 %
Exchangeable bases (cmol/kg)			C/N ratio	23.14
Na	0.09	0.10	Na	0.42 %
K	0.12	0.17	K	3.8 %
Ca	2.2	4.20	Ca	0.70 %
Mg	2.4	3.00	Mg	0.30 %
H^+	0.86	0.52	Mn	0.34 %
Al^{3+}	1.08	0.60	Fe	0.91 %
ECEC	6.75	8.59		
Base Saturation (%)	71.2	86.9		

Table 2: Effects of inter row spacing and chicken manure on growth attributes of sweet maize

Treatment	Plant height		Number of leaves		Leaf area index	
40 cm x 25 cm + 0 t ha^{-1} CM	170.3bcd	162.7b	9.29bc	8.46bc	2.37ab	3.61a
40 cm x 25 cm + 10 t ha^{-1} CM	229.1a	215.3a	11.75a	10.83a	2.56ab	3.70a
40 cm x 25 cm + 20 t ha^{-1} CM	226.2a	235.3a	10.96ab	10.92a	2.82a	4.19a
50 cm x 25 cm + 0 t ha^{-1} CM	216.7ab	212.0a	10.84ab	9.84ab	2.06b	2.78b
50 cm x 25 cm + 10 t ha^{-1} CM	219.0ab	218.4a	11.13ab	10.63a	2.30ab	2.57b
50 cm x 25 cm + 20 t ha^{-1} CM	125.1d	143.1b	7.25c	9.54abc	2.07b	3.19bc
60 cm x 25 cm + 0 t ha^{-1} CM	154.7cd	166.5b	7.63c	7.67c	1.47c	1.87c
60 cm x 25 cm + 10 t ha^{-1} CM	168.6bcd	188.7ab	10.13	9.34ab	2.19b	2.62b
60 cm x 25cm +20 t ha^{-1} CM	194.2abc	213.7a	11.04ab	10.92a	2.08b	2.78b
SED	22.51	20.17	0.93	0.85	0.25	0.28

Means with the same letters in a column are not significant at 0.05 % probability level. CM – chicken manure, SED – Standard Error of Difference

Table 3: Effects of inter row spacing and chicken manure on phenology of sweet maize

Treatment	**Dry matter (g)**		**Stem girth (cm)**		**Days to 50 % silking**	
40 cm x 25 cm + 0 t ha^{-1} CM	45.6d	47.4d	2.60bcd	2.83b	41.33a	39.67a
40 cm x 25 cm + 10 t ha^{-1} CM	79.0c	82.0c	3.31ab	3.41ab	41. 00a	39.33a
40 cm x 25 cm + 20 t ha^{-1} CM	97.2bc	98.7bc	3.51a	3.51a	39.33a	39.00a
50 cm x 25 cm + 0 t ha^{-1} CM	96.8bc	100.6bc	3.49ab	3.33ab	38.00a	38.00a
50 cm x 25 cm + 10 t ha^{-1} CM	94.5c	84.9c	3.76a	3.53a	38.00a	37.67a
50 cm x 25 cm + 20 t ha^{-1} CM	107.3bc	104.8bc	2.24cd	2.89b	36.67a	40.00a
60 cm x 25 cm + 0 t ha^{-1} CM	130.8b	129.7b	2.10d	2.72b	36.33a	37.00a
60 cm x 25 cm + 10 t ha^{-1} CM	166.4a	173.3a	3.14abc	3.15ab	36.00a	36.33a
60 cm x 25cm +20 t ha^{-1} CM	169.3a	173.1a	3.59ab	3.30ab	36.00a	36..00a
SED	15.16	15.11	0.42	0.31	2.65	2.99

Means with the same letters in a column are not significant at 0.05 % probability level. CM – chicken manure, SED – Standard Error of Difference.

Table 4: Effects of inter row spacing and chicken manure on length of cobs, cob girth and number of grains per cob

Treatment	Length of cobs		Cob girth cm		Number of grains cob^{-1}	
40 cm x 25 cm + 0 t ha^{-1} CM	24.02b	24.09b	10.81a	11.66a	260.1a	286.2a
40 cm x 25 cm + 10 t ha^{-1} CM	25.74ab	28.70ab	11.86a	12.50a	267.3a	263.4a
40 cm x 25 cm + 20 t ha^{-1} CM	26.38ab	28.75ab	12.51a	11.16a	257.0a	265.2a
50 cm x 25 cm + 0 t ha^{-1} CM	25.74ab	26.42ab	12.24a	12.31a	262.8a	253.5a
50 cm x 25 cm + 10 t ha^{-1} CM	26.45ab	28.84ab	11.68a	10.87a	245.6a	268.0a
50 cm x 25 cm + 20 t ha^{-1} CM	29.25a	29.66a	10.90a	10.96a	254.4a	247.9a
60 cm x 25 cm + 0 t ha^{-1} CM	28.07ab	24.02b	11.30a	12.18a	271.3a	251.1a
60 cm x 25 cm + 10 t ha^{-1} CM	29.39a	28.13ab	11.56a	11.88a	255.5a	269.6a
60 cm x 25cm +20 t ha^{-1} CM	28.93a	25.65ab	11.61a	10.96a	267.0a	264.4a
SED	1.90	4.72	0.93	1.03	15.18	16.78

Means with the same letters in a column are not significant at 0.05 % probability level. CM – chicken manure, SED – Standard Error of Difference.

Table 5: Effects of inter row spacing and chicken manure on weight of cobs, green cob yield and grain yield

Treatment	Weight of cobs		Green cob yield t ha^{-1}		Grain yield t ha^{-1}	
40 cm x 25 cm + 0 t ha^{-1} CM	158.8ab	172.1ab	10.43a	8.62a	1.74c	1.93b
40 cm x 25 cm + 10 t ha^{-1} CM	186.8a	175.0ab	12.52a	8.33a	1.84c	1.87b
40 cm x 25 cm + 20 t ha^{-1} CM	192.6a	204.2a	8.68a	10.42a	2.36a	2.41a
50 cm x 25 cm + 0 t ha^{-1} CM	184.5a	184.7ab	9.60a	10.20a	1.88c	1.87b
50 cm x 25 cm + 10 t ha^{-1} CM	192.7a	190.5ab	11.24a	10.52a	2.35a	2.40a
50 cm x 25 cm + 20 t ha^{-1} CM	185.5a	152.4ab	9.32a	9.97a	2.22a	2.30a
60 cm x 25 cm + 0 t ha^{-1} CM	178.9ab	177.4ab	11.95a	9.79a	2.00bc	2.28ab
60 cm x 25 cm + 10 t ha^{-1} CM	141.7b	140.3b	11.12a	11.94a	2.20a	2.39a
60 cm x 25cm + 20 t ha^{-1} CM	188.9a	187.5ab	8.98a	9.33a	2.32a	2.41a
SED	17.11	22.34	1.96	1.73	0.12	0.19

Means with the same letters in a column are not significant at 0.05 % probability level. CM – chicken manure, SED – Standard Error of Difference.