DOI: 10.1515/cerce-2017-0035 **Original Article**
Available online: www.uaiasi.ro/CERCET_AGROMOLD/
Print ISSN 0379-5837; Electronic ISSN 2067-1865

Cercetări Agronomice în Moldova
Vol. L , No. 4 (172) / 2017: 51-64

IMPROVEMENT OF GROWTH AND YIELD OF MAIZE (*ZEA MAYS* L.) BY POULTRY MANURE, MAIZE VARIETY AND PLANT POPULATION

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Received July 24, 2017. Revised: Oct. 24, 2017. Accepted: Nov. 10, 2017. Published online: Dec. 27, 2017

ABSTRACT. Soils of the savannah zones of Nigeria are low in plant nutrients and peasant farmers; therefore, rely on external inputs in the form of organic and inorganic manure for sustainable yield. They also sow their seeds at suboptimal plant population density, thereby providing opportunity for weeds to thrive. Moreover, farmers use saved seeds from the previous cropping season for planting, which often results in low yield**.** A study was conducted to assess the growth and yield of two maize cultivars under the influence of organic fertilizer and plant population density. Treatments used were factorial combinations of three levels of poultry manure (0, 2.5, 5.0 t/ha), two population densities (95,556 and 53,333 plants/ha) and two maize varieties (DMR-ESR-Y and Suwan-1-SR). Data were collected on number of leaves, plant height, leaf area, stem girth, root and shoot dry weight, total dry weight, days to tasseling, days to silk appearance, grain yield per hectare, number of seeds per cob, seed rows per cob, weight of 100 seeds and shelling percentage. The results revealed significant improvement ($p \leq 0.05$) in all parameters examined, when 5 t/ha poultry manure was applied to Suwan-1-SR at density 53,333 plants/ha. However, there was marginal difference between 5 and 2.5 t/ha in grain production. Therefore, application of 2.5 t/ha poultry manure for production of Suwan-1-SR maize variety at plant density 53,333 plants/ha could be used for getting optimum yield, that can feed the growing population of maize consumers coupled with better straw production for animal feed.

Keywords: organic manure; plant density; growth, yield.

INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal crop after

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sorghum (*Sorghum bicolor*) and millet (*Pennisetum glaucum*) in Nigeria and it is a major staple food to large number of human population in the world (Farhad *et al.*, 2009). It is also as fodder and industrial material and its production is at both subsistence and commercial levels in Nigeria (Eleweanya *et al.*, 2005). The use of inorganic fertilizer in the savannah zones of Nigeria is a *sine qua non* and continuous use of inorganic fertilizer leads to environmental pollution (Oad *et al.*, 2004), organic farming thus becomes imperative for safe production, without endangering the environment (Prabu *et al.*, 2003). Organic farming involves the use of organic fertilizer of which poultry manure is a part and it is used to amend soils whose physical properties has been degraded (Mitchell, 2005); it is also rich in plant nutrients, which are useful to crops (Warren *et al.*, 2006). Unlike chemical fertilizers, poultry manure improves the organic matter content, soil structure, nutrient retention, aeration, soil moisture holding capacity and water infiltration (Farhad *et al.*, 2009). Moreover, poultry manure can increase the dry grain yield of maize (Ayoola & Makinde, 2006). Ali *et al.* (2003) had reported that the use of poultry manure increased the height of maize because of the presence of macro and micronutrients than other organic manure sources. Thus, it is adjudged as the most valuable of all forms of livestock manure (Omosore *et al.,* 2009). For poultry manure to be beneficial to crops, optimum plant population is important.

Plant spacing is an agronomic management strategy used by farmers to optimize the husbandry of plant ecosystem from sowing to harvest with the goal of boosting the production of crops and determining plant population density (Sharratt & McWilliams, 2005). Plant population density is one of the important yield determinants of crops and it is an efficient management tool for maximizing grain yield. This yield maximization can be achieved by increasing canopy capture of solar radiation through optimum plant population. Maximum economic yield that could be gained in crop species and specific production environment (Bruns & Abbas, 2005). Because high population density heightens intra-specific competition among the plants, each production system should have a population density that maximizes the utilization of available resources and allows expression of maximum attainable grain yield in that environment (Sangoi *et al.,* 2000). Among grass family, maize is most sensitive to plant population density (Vega *et al.,* 2001). Furthermore, it differs in its responses to plant density (Luque *et al.,* 2006). Therefore, its production requires optimum plant population density that could guarantee better growth and higher yield under optimal climatic and improved management conditions. Achievement of better growth and improved yield through manure application and suitable population density require a rightful crop variety.

Varietal differences are the primary sources of yield variation in maize because of variation in genome. Based on this fact, maize varieties have different growth characteristics and differ in yield and yield components (Odeleye & Odeleye, 2001). Therefore, the quest for improved high yielding and disease or pest resistant maize varieties now becomes imperative for profitable maize production. However, most of maize producers in Nigeria still adopt local varieties, despite their inherent low yield potentials. This is the reason behind low yield in maize production of the country. It has been established that maize production in the sub-Saharan Africa has an annual increase range of 2 to 3% (Boxall, 2000). With this trend, its production may not meet the demands of the ever increasing human population in Nigeria. Hence, intensive effort to improve and increase maize yield becomes imperative. To accomplish this objective, this study was conducted to investigate the effects of poultry manure and plant population density on growth and yield performance of two maize cultivars.

MATERIALS AND METHODS

Experimental site.

The experiment was conducted at the University of Ilorin Teaching and Research Farm. The University is located on Lat. 8^{o}29'N and 8^{o}30'N, Long. 4^{o}30'E and 4^{o}32'E. The location is about 307 m above sea level in the southern Guinea savannah ecological zone of Nigeria. It has average temperature of 26.7^{o} and average annual precipitation of 1186 mm.

Land preparation and soil analysis

The experimental field was ploughed twice and then harrowed to break the clods and make a good till for plant survival. The field was then divided into 36 plots of area of 9 m^2 each (3 x 3 m). After that, representative soil samples (0-15 cm) were collected using systemic sampling method. These soil samples were bulked together to have a composite sample. The composite sample was then air-dried at room temperature and sieved with a 2 mm sieve for determination of some physical and chemical properties of the soil. Particle size distribution was determined using Bouyoucos hydrometer method (Landor, 1991). Soil pH in water was determined by the use of glass electrode pH-meter (McLean, 1965). The method of Walkley and Black (Walkley, 1934) was used for organic carbon determination. Modified KJeldahl distillation method (Landon, 1991) was used to determine soil total nitrogen. Determination of available phosphorus was achieved with Bray No.1 method (Landon, 1991). Exchangeable bases were determined with the method of Brady and Weils (Brady & Weils, 1999), while exchangeable acidity was determined by the method of Juo (Juo, 1981) and then expressed in Cmol/kg of soil. Effective cation exchange capacity (ECEC) was calculated as the sum of exchangeable bases (Ca^{++}, Mg^{++}, K^+ and Na^+) and exchangeable acidity ($A1^{3+}$ and H^+), expressed in cmo1/kg of soil. The cation exchange capacity (CEC) was determined using the procedure of Anderson and Ingram (Anderson & Ingram, 1996). The results of these analyses are presented in *Table 1*.

Table 1 - Physico-chemical composition of the soil before and after cropping

	Soil pH	Org. C %	Org. matter %	Total N mg/kg	Avail P mg/kg	K mg/kg	Ca cmol/kg	Mg cmol/kg
Before	6.5	1.07	1.86	0.03	10.2	0.04	1.2	0.8
After	5.8	0.32	0.55	0.01	5.79	0.02	0.8	0.4

Table 2 - List of treatments used

Treatment	Composition
T1	Zero poultry manure+ 95,556 plants/ha+ DMR-ESR-Y
T2	2.5 t/ha dry poultry manure+ 95,556 plants/ha+DMR-ESR-Y
T3	5.0 t/ha poultry manure+ 95,556 plants/ha+ DMR-ESR-Y
T4	Zero poultry manure+53,333 plants/ha+Suwan-1-SR
T5	2.5 t/ha dry poultry manure+ 53,333 plants/ha+Suwan-1-SR
T6	5.0 t/ha poultry manure+ 53,333 plants/ha +Suwan-1-SR
T7	Zero poultry manure+95,556 plants/ha+ Suwan-1-SR
T8	2.5 t/ha dry poultry manure+ 95,556 plants/ha+ Suwan-1-SR
T9	5.0 t/ha poultry manure+ 95,556 plants/ha+ Suwan-1-SR
T10	Zero poultry manure+53,333 plants/ha+ DMR-S-RY
T11	2.5 t/ha dry poultry manure+ 53,333 plants/ha+ DMR-S-RY
T12	5.0 t/ha poultry manure+ 53,333 plants/ha+ DMR-S-R

Treatments and experimental design

Three levels of poultry manure (0, 2.5 and 5.0 t/ha), two population densities (95,556 and 53,333 plants/ha) and two maize varieties (DMR-ESR-Y and Suwan-1-SR) were used as the main factors. These factors were combined in a 3×2×2 factorial to have a total of twelve treatments (*Table 2*). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Poultry manure collected from the university farm was incorporated into the soil two weeks before planting. Apron Plus treated seeds were then planted at a depth of 2.5 cm. Two weeks after planting, the resulting seedlings were thinned to two per hill. Manual weeding with hoe was done at three and six weeks after planting, while scare crow and bobby traps were used to control birds. Morphological data were collected from 4th to 12th weeks after planting at two weeks interval, while data on dry matter, grain yield and yield components were taken at harvest. Morphological parameters taken were plant height, number of leaves per plant, leaf area and stem girth, while days to tassel and silk appearance were counted and recorded. Data on yield included grain yield per net plot, number of cobs per row, number of seeds per cob, weight of 100 seeds and shelling percentage, total plant dry weight, root and shoot dry weight were also taken. Correlations between yield and leaf area, number of grains per row, number of seeds per cob and weight of 100 seeds were subsequently determined. Data collected were analyzed using analysis of variance (ANOVA) with Genstat 5.2 package software, while significant means were separated using least significant difference (LSD) at 5% probability level (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

Effects of poultry manure, variety and population density on leaf production at different ages

In leaf production there was no interaction among the tested factors at all the growth stages, except at four weeks after planting. At that stage, all the interactions were significant, except interaction between variety and population density. The most efficient treatment combination for higher leaf yield was T3 (5.0 t/ha poultry manure + 95556 plants/ha + DMR-ESR-Y) (*Table 3*). This implies that effectiveness of manure application in increasing the leaf yield at 4WAP changed with cultivars and densities. So, each of the treatment components depended upon the other components for significant influence on leaf production because of the interaction that existed among them. In this study, the increase in the number of leaves above the control was not significant at $p \leq 0.05$. The use of inorganic fertilizer could produce plants with luxuriant growth, accompanied by excessive leaves (Stefano *et al.,*2004). This could have been so because of inorganic fertilizer that was applied, which, normally, releases its nutrients quickly as against poultry manure, which does that slowly because it takes longer time for mineralization to occur. Higher number of leaves on fertilizer treated plants contributes to production of better canopy and efficient suppression of weeds.

Table 3 - Effects of poultry manure, variety and population density on maize leaf production at different ages

Treatments	Weeks after planting				
	4	6	8	10	12
Manure (t/ha)					
0	4	7	8	9	9
2.5	5	7	8	9	9
5	5	8	8	10	10
LSD (0.05)	ns	ns	ns	Ns	ns
Variety					
DMR-ESR-Y	5	7	8	9	10
Suwan-1-SR	5	7	9	9	10
LSD (0.05)	ns	ns	ns	ns	ns
Density (plants/ha)					
95,556	5	8	9	9	10
53,333	5	7	8	9	9
LSD (0.05)	ns	ns	ns	ns	ns

ns = not significant

Effects of poultry manure, variety and population density on maize plant height at different ages

The interaction among poultry manure, variety and plant density was significant ($p \leq 0.05$) at 4, 6, and 12 WAP. This implies that the treatment components were interdependent for the significant enhancement of plant height. Therefore, treatment T9 (5.0 t/ha poultry manure + 95,556 plants/ha + DMR-ESR-Y), that produced the tallest plants at the end of the growth period was the best treatment combination for plant height (*Table 4*).

Table 4 - Effects of poultry manure, variety and population density on maize plant height of maize at different ages

Treatments	Weeks after planting				
	4	6	8	10	12
Manure (t/ha)					
0	69.5	79	91.9	95.6	99.3
2.5	76.7	87.3	105.6	105.8	109.1
5	83.6	95.2	110.7	113.4	116.9
LSD(0.05)	ns	11.65	13.13	13.77	ns
Variety					
DMR-ESR-Y	82.9	93.1	111.6	113.3	116.5
Suwan-1-SR	70.3	81.2	93.9	96.7	100.3
LSD (0.05)	9.42	9.51	10.72	ns	ns
Density (plants/ha)					
95,556	81.3	2.1	106.9	110.5	114
53,333	51.9	82.2	98.7	99.4	102.8
LSD(0.05)	9.42	9.51	10.72	ns	ns

ns = not significant

Application of poultry had an influence in plant height. Mitchell & Tu (2000) and Dauda *et al.* (2008) found enhancement of plant height through application of poultry manure. This increase in plant height could be associated with continuous supply of nutrients by poultry manure (Farhad *et al.,* 2009). Furthermore, enhancement of shoot apical meristem might be the reason behind achievement of better height. It seemed that application of 5 t/ha of poultry manure enhanced the activities of apical meristem, which, in turn led, to increase in height. Furthermore, genetic constituent of DMR-ESR-Y maize could have paved way for its having better height than Suwan-1-SR. In this study it was observed that higher density did not have adverse effect on plant height. This might be because increase in height takes place at the apical parts of the plants and such did not require competition for space. Appreciable height in plants enhances better interception of solar energy, which will eventually aid photosynthesis. However, this interception depends on the exposed parts of the leaves, because mutual shading can decrease available leaf area for solar interception. In this study, appreciable height gain did not contribute to the overall grain yield of the tested crop.

Effect of poultry manure, variety and population density on maize stem girth at different ages

At four weeks after planting, the girth of the plants was enhanced by the combination of poultry manure, plant density and variety because M x V x D were significant at $p \leq 0.05$. With the exception of observation at four weeks after planting, manure in combination with variety determined the girth size because there was significant interaction between the two factors at $p \leq 0.05$. This implied that none of the main factors singly influenced stem girth. However, plant density was significant ($p \leq 0.05$) at 6,10 and 12 weeks after planting, without interacting with other factors. It could be said that plant density also influenced the plant girth whenever its effect was significant. This is because higher plant density led to higher intra-specific competition and vice versa. This phenomenon has direct effect on the plant size. Finally, the best treatment combination in this study was T6 (5.0 t/ha poultry manure + 53,333 plants/ha + Suwan-1-SR) (*Table5*).

Table 5 - Effects of poultry manure, variety and population density on maize stem girth at different ages

Treatments	Weeks after planting				
	4	6	8	10	12
Manure (t/ha)					
0	1.77	3.39	4.75	4.99	5.43
2.5	1.84	3.56	5.02	5.26	5.46
5	2.05	4.88	6.28	6.53	6.72
LSD (0.05)	ns	0.378	0.392	0.384	0.38
Variety					
DMR-ESR-Y	1.81	3.67	5.66	5.3	5.54
Suwan-1-SR	1.97	4.21	5.64	5.88	6.08
LSD (0.05)	ns	0.31	ns	0.314	0.31
Density(Plants/ha)					
95,556	1.84	3.81	5.17	5.43	5.65
53,333	1.93	4.07	5.52	5.76	5.95
LSD (0.05)	ns	ns	0.32	0.314	0.31

ns = not significant

The increase in the girth was not a product of secondary thickening because the plant is a monocot. Rather, it might have stemmed out of increase mitotic cell division in the stem as well as cell enlargement which then created a big sink in the stem for photo-assimilate storage. It could be said that mitotic cell division has been enhanced by better supply of nutrients through the application of poultry manure. When the enlarged cells were filled after cell division and enlargement, expansion of stem girth resulted. Since higher nutrient is needed for this process, low plant density became the choice for the achievement of this goal. This increase in stem girth enhanced production of higher straw yield. It is also advantageous if the targets of the production are hay and silage. Finally, better stem girth strengthens and protects plants against lodging.

Effect of poultry manure, variety and population density on maize leaf area at different ages

Leaf area was significantly increased by additive effects of poultry manure, plant density and variety at four weeks after planting and their interaction was significant at $p \leq 0.05$. However, at other stages of observation no significant interaction was observed. But manure application alone produced significant effect at $p \leq 0.05$. Despite this, the best treatment combination was T6 (5.0 t/ha poultry manure + 53,333 plants/ha + Suwan-1-SR) (*Table 6*).

Table 6 - Effects of poultry manure, variety and population density on maize leaf area (cm^2) at different ages

Treatments	Weeks after planting				
	4	6	8	10	12
Manure (t/ha)					
0	447	347	352	357	361
2.5	475	492	497	498	507
5	429	551	558	559	595
LSD (0.05)	ns	63	63.1	62.4	64.5
Variety					
DMR-ESR-Y	432	451	456	462	472
Suwan-1-SR	468	476	482	481	503
LSD (0.05)	ns	ns	ns	ns	ns
Density (plants/ha)					
95,556	442	449	445	458	477
53,333	460	478	483	485	498
LSD (0.05)	ns	ns	ns	ns	ns

ns = not significant

The leaf area determines the level at which solar radiation could be captured. This has consequential effects on net photosynthesis and the final assimilate production because they are interrelated. The enhanced leaf area in this work might be the manifestation of better supply of nutrients by poultry manure, which led to higher cell division in the leaves, followed by enlargement and maturation. With low plant population density, adequate nutrients could be mobilized, absorbed and utilized by the leaves to grant them expanded leaf area. Leaf area expansion enhanced photosynthetic activities for better photo-assimilate production, which finally resulted in better grain yield and straw production. This is because the leaf area determines the amount of solar energy that could be intercepted for photo-assimilate production, as stated earlier. As observed in this study, reduction in plant density enhanced higher leaf area per plants. This might be because of reduction in intraspecific competition and availability of enabling wide area for better leaf expansion.

Effects of poultry manure, variety and population density on days to tasseling (DTT) and silk production (DTS)

Reduction in days to tassel and silk appearance was significantly enhanced by balanced combination of the three main factors (poultry manure, variety and population density). So, none of these factors had significant influence both days to tasseling and silk production. The best treatment combination for achievement of reduced number of days to tassel appearance was T7. For the shortest number of days to silk appearance, the best treatment combinations were T1 and T7 (*Table 7*). Tassel production determined silk appearance silk. Therefore, if tassel appears early, silk will also be produced early and *vice versa*.

Table 7 - Effects of poultry manure, variety and population density on days to tasseling (DTT) and days to silking (DTS)

Manure	Density	Variety	DTT	DTS
0	95,556	DMR-ESR-Y	57	61
0.25			58	63
5			74	80
0	53,333	DMR-ESR-Y	57	60
0.25			59	64
5			75	81
0	95,556	Suwan-1-SR	56	60
0.25			58	62
5			74	80
0	53,333	Suwan-1-SR	58	61
0.25			60	63
5			72	78
LSD (0.05)			21.81	12.4

Poultry manure has high amount of nitrogen (Dauda *et al.,* 2008). So, the more the poultry manure applied the higher the nitrogen available to the plants which aids luxuriant vegetative growth of plants, which if not checked results in delay in attainment of reproductive stage (Akongwubel *et al.,* 2012). As it was observed in this experiment, the shortest number of days to silk and tassel production was through the control application of manure. Therefore, higher plant density enhanced earlier attainment of reproductive stage because the plants were deprived of the opportunity of getting more than enough nitrogen, that would have led to unnecessary luxuriant growth, that could have resulted if the plant density was less.

Effects of poultry manure, variety and population density on dry weight of maize plant parts

All forms of dry weight measured were significantly influenced by the combination of poultry manure, variety and population density at $p\leq 0.05$. Thus, the main factors could not singly influence dry matter production because of the interaction that existed among all the component factors used. T6 (5.0 t/ha poultry manure + 53,333 plants/ha + Suwan-1-SR) enhanced root, stem and total dry weight (*Table 8*).

Table 8 - Effects of poultry manure, variety and population density on dry weight of plant parts

Treatments	RDW(g)	SDW(g)	TDW(g)
Manure (t/ha)			
0	2.79	3.99	8.33
0.5	3.5	4.47	10.74
5	4.19	5.74	13.75
LSD(0.05)	0.029	0.028	0.318
Variety			
DMR-ESR-Y	3.39	4.41	10.25
Suwan-1-SR	3.6	5.05	11.63
LSD(0.05)	0.024	0.023	0.26
Density (plants/ha)			
95,556	3.49	4.66	10.76
53,333	3.49	4.8	11.12
LSD(0.05)	0.024	0.023	0.26

RDW = root dry weight; SDW = stem dry weight; TDW = total dry weight.

Application of high levels of poultry manure could increase plant height, its dry shoot and root weight (Hossain *et al.,* 2012). This dry matter production in plant is used to determine photo-assimilate production and efficiency of photosynthesis. So, increase in dry matter production as a result of application of higher rate of poultry manure in this work pointed out the fact that higher levels of nutrient (nitrogen), that was supplied to the plants, resulted in better vegetative production. This is because poultry manure has long been recognized as the most desirable organic fertilizer because it improves soil fertility by adding essential nutrients, as well as soil organic matter, which improves soil moisture and nutrient retention (Farhad *et al.*, 2009). Soil fertility improvement, coupled with reduction of keen intra-specific competition through lower plant population density, resulted in better dry matter yield. As stated earlier, leaf area determines the amount of solar radiation that will be intercepted. Therefore, improved leaf area recorded in this study led to production of higher straw yield. However, straw production could be at the detriment of grain yield. This is because the total amount of assimilate produced will be partitioned into both economic and non-economic yield. Therefore, if more is mobilized to the non-economic parts, it will be detrimental to the economic yield. Consequently, the ratio of economic yield to the biological yield will be low, showing ineffectiveness in assimilate partitioning.

Effects of poultry manure, variety and population density on yield and its components

Yield per unit area, number of kernels per cob, number of kernel rows per cob, weight of 100 seeds and shelling percentage were all significantly improved by combination of 5.0 t/ha poultry manure, 53,333 plants/ha and Suwan-1-SR (T6) at $p \leq 0.05$. However, the yield difference between application of 2.5 and 5 t/ha poultry manure was marginal and also not significant. Therefore, the economic choice will be 2.5 t/ha for saving resources, reducing cost of production and labour. So, the best combination was 2.5 t/ha poultry manure + 53,333 plants/ha + Suwan-1-SR (T5) (*Table 9*).

Better grain yield in maize could be achieved with application of poultry manure (Sharma *et al.,* 1987). However, higher population density may be detrimental to crop yield improvement because it stimulates apical dominance and decrease in the number of ears produced per plant and kernel set per ear. Based on this, lower plant density (53,333 plants/ha) resulted in higher yield in this work because the problem encountered by using higher plant density was absent. Furthermore, the yield increase observed in this study could be as a result of better supply of the needed nutrients for growth and development of the plant, which, in turn, led to production of higher assimilate, that was judiciously partitioned into the economic parts of the crop (Udom & Bello, 2009). The existence of marginal difference between application of 2.5 and 5 t/ha could be attributed to luxury consumption after 2.5 t/ha application. Therefore, application of poultry manure beyond that level was neither economical nor profitable. However, yield component, such as weight of 100 seeds, could not be used as a yardstick for determination of the final grain yield.

Table 9 - Effects of poultry manure, variety and population density on yield and its components

Treatments	Y/P(kg)	Y/ha(kg)	NKR	100SW(g)	SP(%)	NKC
Manure (t/ha)						
0	1.2	2132	17.1	23.89	32.3	0.767
2.5	2.33	2580	17.21	24.36	36.8	0.965
5	2.37	2644	19.11	25.6	37.6	1.349
LSD (0.05)	0.105	116.6	0.79	0.809	8.1	0.141
Variety						
DMR-ESR-Y	2.139	2410	17.1	0.848	30.8	24.55
Suwan-1-SR	2.246	2594	17.21	1.206	40.3	24.68
LSD (0.05)	0.135	95.2	0.65	0.115	6.61	0.661
Density(plants/ha)						
95,556	2.184	2427	17.1	1.01	27.5	23.67
53,333	3.201	2478	18.31	1.15	43.6	25.57
LSD(0.05)	0.135	95.2	0.65	0.115	6.61	0.66

Y/P = yield per plot; Y/ha = yield per hectare; NKC = number of kernels per cob; NKR = number of kernel row; 100SW = 100 grain weight; SP = shelling percentage.

Table 10 - Relationship between grain yield, leaf area, kernel per row and kernel rows per cob

Grain yield	R
Vs	
Leaf area	0.581**
Number of kernels per row	0.875**
Number of kernels row per cob	0.838**

* Denotes correlation significance at 5% probability level;
** Denotes correlation significance at 0.1% probability level.

Relationships between yield, leaf area, kernel per row and kernel rows per cob

There was strong and significant relationship between the final yield and growth parameters, like leaf area, kernels per row and kernel rows per cob ($p \leq 0.05$). The correlation coefficients of the yield components were higher than that of leaf area. These coefficients denote the effect of each component on one another (*Table 10*). Therefore, we can say that there is positive relationship between leaf area and grain yield. This might be because the leaf area (photosynthetic area) determines the level of assimilate production. In the same vein, when the number of kernels per row and the number of kernels per cob increased, the final grain yield will increase and *vice versa*.

CONCLUSION

Application rate of poultry droppings, variety and population density had influence on morphology, yield and yield components of the maize varieties tested in this study. The yield difference between application of 2.5 and 5 t/ha poultry manure was marginal. Therefore, to reduce production cost, application of 2.5 t/ha poultry manure is recommended for production of Suwan-1-SR maize variety at plant density 53,333 plants/ha for higher grain yield and better biomass production.

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