Original Research Article

INFLUENCE OF SOIL AMENDMENTS ON GROWTH PARAMETERS AND ECONOMICS IN MAIZE (*Zea mays* L).

ABSTRACT:

Aim: To evaluate the efficacy of different soil amendments on plant growth parameters and economics in maize (*Zea mays* L).

Place and Duration of Study : Maize variety 900-M-GOLD was cultivated during rabi 2014-15 at College Farm, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, Telangana state, India.

Methodology: The Experiment was laid out in Randomised Block Design (RBD) with 6 treatments replicated four times. Treatments consist of T1- vermicompost @ 5 t ha^{-1} ,T2-FYM @ 10 t ha^{-1} , T3-tanksilt @ 50 t ha^{-1} , T4- biochar @10 t ha^{-1} ,T5- control (without any fertilizer),T6- RDF (NPK-200, 60, 50 kg ha^{-1}). Recommended Dose of Fertilizers was commonly applied from treatment T1 to T4.

Results: There is no significant difference in plant population with the application of all the treatments. At harvest, significantly higher leaf area index recorded with application of tanksilt (1.67) which was on par with vermicompost (1.66), biochar (1.65), FYM (1.65), RDF (1.51) and significantly higher than control (0.80). Maximum gross returns (INR 131283 ha^{-1}), net returns (INR 85533 ha^{-1}) and BC ratio (2.87) were recorded with the application of tanksilt and minimum gross returns (INR51431 ha^{-1}), net returns (INR 24781 ha^{-1}) and BC ratio (1.93) were recorded in the control.

Conclusion: It was determined that growth parameter viz., leaf area, leaf area index recorded significantly higher with tanksilt application which is on par with the application of vermicompost, biochar, FYM. The application of all the treatments increased net returns compared to control.

Key words: Benefit, cost, leaf area index, maize, plant height and tanksilt.

1. INTRODUCTION:

Maize (*Zea mays* L.) is an important food and feed crop among cereals which occupies third rank after wheat and rice in the world. Because of its expanded use in the agro-industries, it is recognized as a leading commercial crop of agro economic value. In India, maize (*Zea mays* L.) is the third most important cereal crop that provides food, feed, fodder and serves as a source of raw material for developing hundreds of industrial products viz., starch, protein, oil, alcoholic beverages, food sweetners, pharma, cosmetics and bio-fuel etc. Potential yield of maize is higher than that of either wheat or rice and we can expect maize to play a proportionally larger and more important role in world food security. Hence, it is called as the "Queen of cereals" [1]. Maize, a crop of worldwide economic importance together with rice and wheat provides approximately more than 30% of the food calories to more than 4.5 billion people. In India, maize is considered as third most important crop among the cereals and used as staple food in many developing countries [2]. Worldwide, maize is grown in an area of 197.20 m ha with production of 1148.49 Mt and productivity of 5824 kg ha^{-1} while 9.56 m ha with 28.77 Mt production and 3006 kg ha^{-1} productivity in our country [3]. In Telangana, maize occupies an area of 0.56 m ha with production and productivity of 2.99 Mt and 5347 kg ha^{-1} respectively [4]. Maize yields in India need to be increased significantly so as to meet food, feed and industrial needs. Maize yield and yield components showed positive response when biochar was used as soil amendment because it improves the field-saturated hydraulic conductivity of the sandy soil, as a result net WUE also increased and more moisture and nutrients were available to the crop throughout the growing season [5]. Biochar amended soils resulted in better crop establishment and positively increased crop growth rate and net assimilation rate which resulted in higher corn productivity [6]. The nutrient needs of crop production systems can be met through integrated nutrient management and sustainable crop productivity in maize based cropping systems [7].

Keeping in view the importance of soil amendments and integrated nutrient management, the present study was therefore conducted to compare different levels of synthetic fertilizer with soil amendments and investigate best possible combinations of organic and inorganic fertilizers.

2. MATERIAL AND METHODS:

A field experiment was carried out at College Farm, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, Telangana state, India. Maize variety 900-M-GOLD was cultivated during *rabi* 2014-15 in Randomised Block Design (RBD) with 6 treatments replicated four times. Treatments consist of T1- vermicompost @ 5 t ha^{-1} ,T2-FYM @ 10 t ha^{-1} , T3-tanksilt @ 50 t ha^{-1} , T4- biochar @10 t ha^{-1} ,T5- control (without any fertilizer),T6- RDF (NPK-200, 60, 50 kg ha^{-1}). Recommended Dose of Fertilizers was commonly applied from treatment T1 to T4. Plant number was counted in six rows of 3.5 m length and converted to hectare. The final plant population at harvest stage were recorded from each experimental plot and expressed in thousands per hectare. Plant height (cm) was measured from the base of the plant to the tip of the top most leaf before tasseling and to the tip of the tassel after tasseling of every tagged plant. Mean of five selected plants was reported as plant height at 30, 60, 90 days after sowing and at harvest expressed in cm. Leaf area was estimated on three plants in each plot at 30, 60, 90 DAS and harvesting stages. The area of total leaves was measured with digital leaf area meter (LI-3100) and expressed in cm^2. Leaf area index was calculated by using the formula [8].

$$LAI = \frac{\text{Leaf area } (cm^2)}{\text{Unit ground area } (cm^2)}$$

Cost of cultivation (INR ha^{-1}): The market price of the inputs that were prevailing during the period of experiment and produce were considered for working out the cost of cultivation.

Gross returns (INR ha^{-1}): Gross returns (GMR) were calculated by multiplying the grain and stover yield with their respective prevailing market price

Net returns (INR ha^{-1}): Net returns were calculated by subtracting the cost of cultivation from gross returns for each treatment.

Benefit cost ratio (BC ratio): Benefit cost ratio was calculated by dividing gross returns with cost of cultivation for each treatment.

$$\text{Benefit: Cost} = \frac{\text{Gross returns (INR } ha^{--1})}{\text{Cost of cultivation (INR } ha^{-1})}$$

Statistically significance was tested by F-value at 5 % level of probability and critical difference was worked out where ever the effect were significant.

3. RESULTS AND DISCUSSION:

3.1 Plant population:

Data in regard with plant population per plot was recorded at the time of crop harvest are depicted in table 1 showed non significant variation in plant population within all the treatments. Maximum number of plants ha^{-1} (63,333) was recorded with tanksilt and minimum (63295) in control. These findings are related to the findings of Mishra *et al.* [9].

3.2 Plant height:

The plant height of maize in response to different integrated nutrient management treatments was furnished in the table 1. No significant difference was observed with plant height due to different treatments at 30 days after sowing. At 60 DAS, there was significant difference observed among the treatments in terms of plant height. Application of tanksilt (195.10 cm) recorded significantly higher plant height which was on par with vermicompost (190.80 cm), biochar (188.60 cm), FYM (180.50 cm) and significantly higher than the RDF (176.50 cm) and control (120.10 cm). At 90 DAS, there was significant difference observed among the treatments in terms of plant height. Application of tanksilt (241.20 cm) recorded significantly higher plant height which was on par with vermicompost (238.20 cm), biochar (237.10 cm), FYM (235.10 cm), RDF (230.30 cm) and significantly higher than the and control (140.10 cm). At harvest there was significant difference observed among the treatments in terms of plant height. Application of tanksilt (249.80 cm) recorded significantly higher plant height which was on par with vermicompost (246.10 cm), biochar (245.20 cm), FYM (243.30 cm), RDF (238.90 cm) and significantly higher than the and control (148.10 cm). The effect of tanksilt, vermicompost, FYM, biochar and chemical fertilizer in combination was more pronounced with the advancement of crop growth indicating better effect on plant height of maize. It is due to the improved fertility status of the soil through microbial and better utilization of plant nutrients by maize. Organic manures especially vermicompost supply nutrients to plant roots in balanced amount and stimulate growth, increased organic matter content of the soil including the “humic substances” that affect nutrient production and promote root growth which lead to better growth of maize plants resulting in taller plants. Similar findings were also reported by Biswasi *et al*. [10] and Naveen *et al*. [11].

3.3 Leaf area:

Leaf area computed at 30, 60, 90 days after sowing and at harvest differed significantly by the application of different soil amendments (Table 2). The leaf area tends to increase up to 90 DAS, beyond which, it tends to decline towards harvest. Leaf area was not significantly differed with different treatments at 30 days after sowing. At 60 DAS, significantly higher leaf area recorded with application of tanksilt (5012 cm^2) which was on par with vermicompost (4990 cm^2), biochar (4982 cm^2), FYM (4960 cm^2) and significantly higher than the RDF (4610 cm^2) and control (2000 cm^2). Application of all treatments significantly increased the leaf area compared to control. Application of tanksilt and vermicompost significantly increased leaf area compared to RDF and control. At 90 DAS, significantly higher leaf area recorded with application of tanksilt (5522 cm^2) which was on par with vermicompost (5501 cm^2), biochar (5491 cm^2), FYM (5483 cm^2) and significantly higher than the RDF (5010 cm^2) and control (2400 cm^2). Application of all the amendments significantly increased the leaf area compared to RDF and control. At harvest, significantly higher leaf area recorded with application of tanksilt (2500) which was on par with vermicompost (2492 cm^2), biochar (2480 cm^2), FYM (2471 cm^2), RDF (2262 cm^2) and significantly higher than control (1200 cm^2). Application of all the amendments significantly increased the leaf area compared to control. The increased leaf area under combined application of organic and inorganic nutrients might be attributed to better absorption of nutrients, imparted by sufficient air and moisture in the *rhizosphere* which helped in increasing expansion of leaf lamina. This corroborates the findings of Manjhi *et al.* [12] and Iniya Ponmozhi *et al.* [13].

3.4 Leaf Area Index (LAI):

Leaf area index computed at 30, 60, 90 days after sowing and at harvest differed significantly by the application of different soil amendments (Table 2). The leaf area index tends to increase up to 90 DAS, beyond which, it tends to decline towards harvest. Leaf area index was not significantly differed with different treatments at 30 days after sowing. At 60 DAS, significantly higher leaf area index recorded with application of tanksilt (3.34) which was on par with vermicompost (3.33), biochar (3.32), FYM (3.31) and significantly higher than the RDF (3.07) and control (1.33). Application of all the amendments significantly increased the LAI compared to RDF and control. At 90 DAS, significantly higher leaf area index recorded with application of tanksilt (3.68) which was on par with vermicompost (3.67), biochar (3.66), FYM

(3.66) and significantly higher than the RDF (3.34) and control (1.60). Application of all the amendments significantly increased the LAI compared to RDF and control. At harvest, significantly higher leaf area index recorded with application of tanksilt (1.67) which was on par with vermicompost (1.66), biochar (1.65), FYM (1.65), RDF (1.51) and significantly higher than control (0.80). Application of all the amendments significantly increased the LAI compared to control.

Leaf area index is principal important growth parameter in all crops, since the optimum leaf area is required for a maximum light interception, which results in higher photosynthesis [14]. The significant response to vermicompost or FYM application on leaf area index of maize might be due to addition of manures likely to increase the respiration rate, metabolism and growth of plants [15]. Further, the beneficial effect of organic manures on leaf area index might be due to synthesis of certain phytohormones and vitamins and more interception of solar radiation and synthesis of more chlorophyll, more photosynthetic rate and accumulation of more assimilates which resulted in higher leaf area index in maize [16].

3.5 Test weight:

The application of different amendments resulted increase in test weight than RDF applied plots and control (Table 3). The test weight of maize grain ranged from 18.41 g (control) to 30.78 g (tanksilt). The lowest test weight was produced from control plot where fertilizer was not applied. Among the various amendments, the test weight of maize followed the order of tanksilt > vermicompost > biochar > FYM. All the amendment application resulted in significant increase in test weight over the control but it was on par with the RDF applied plots. Application of amendments resulted in more availability of nutrients and causes the increased test weight of the grains. Results were in line with the findings of Adeyemo and Agele [17].

3.6 Yield:

The application of different amendments resulted increases in grain yield than RDF applied plots and control (Table 3). The grain yield of maize ranged from 3547 kg ha^{-1} (control) to 9054 kg ha^{-1} (tanksilt). The lowest yield was produced from control plot where fertilizer was not applied. In RDF applied plots 5750 kg ha^{-1} of maize grain yield was recorded. Among the various amendments, the grain yield of maize followed the order of tanksilt > vermicompost >

biochar > FYM. All the amendment application resulted in significant increase in grain yield over the RDF applied plots but the application of FYM was on par with the RDF applied plots. The increase in grain yield was 33.14, 30.38, 15.94 and 10 % in tanksilt, vermicompost, biochar and FYM applied plots respectively over RDF applied plots (5750 kg ha^{-1}). Application of amendments resulted in better soil physical environment as discussed earlier and also increased availability of nutrients by improving biological activity and also supplied nutrients directly which was resulted in more plant growth and biomass production which inturn reflected in grain yield of maize.

An increase in grain yield in biochar amendments plots include the effect of biochar on soil physio-chemical properties like enhance water holding capacity, increased cation exchange capacity (CEC) and providing a medium for adsorption of plant nutrients and improved conditions for soil micro-organisms [18]. The better growth in terms of leaf area index, dry matter accumulation and more cobs/plant could be the reason for increased grain yield [19]. Results were in line with the findings of Jayaprakash *et al* [20].

3.7 Economics:

Data pertaining to economics of maize analyzed statistically and was significantly differed due to application of different type of organic amendments and shown in Table 4. Highest cost of cultivation was observed in the application of vermicompost (INR 49250 ha^{-1}) and lowest cost of cultivation in control (INR 26650 ha^{-1}). Maximum gross returns (INR 131283 ha^{-1}), net returns (INR 85533 ha^{-1}) and BC ratio (2.87) were recorded with the application of tanksilt and minimum gross returns (INR 51431 ha^{-1}), net returns (INR 24781 ha^{-1}) and BC ratio (1.93) were recorded in the control. Application of all the treatments increased net returns compared to control. Application of soil amendments with chemical fertilizer shown the increased grain yield and ultimately resulted in high BC ratio. Results were in line with the findings of Tetarwal *et al.* [21] and Lone *et al.* [22].

4. CONCLUSION: Application of tanksilt produced taller plants at all stages. The growth parameter viz., leaf area, leaf area index recorded significantly higher with tanksilt application which is on par with the application of vermicompost, biochar, FYM. Growth parameters *viz.*, plant population, plant height, leaf area, LAI were not significantly influenced by application of soil amendments at 30 days after sowing. Among the various amendments, the grain yield of maize followed the order of tanksilt > vermicompost > biochar > FYM. Application of all the treatments increased net returns compared to control.

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Table 1. Plant population (ha^{-1}) and Plant height (cm) at different growth stages of maize crop as influenced by different treatments.

Treatments	Plant population (per ha)	Plant height (cm)			
		30 DAS	60 DAS	90 DAS	At harvest
T_1 : Vermicompost	63325	55.50	190.80	238.20	246.10
T_2 : FYM	63305	54.80	180.50	235.10	243.30
T_3 : Tanksilt	63333	56.10	195.10	241.20	249.80
T_4 : Biochar	63310	55.20	188.60	237.10	245.20
T_5 : Control	63295	53.10	120.10	140.10	148.10
T_6 : RDF	63300	54.00	176.50	230.30	238.90
SEm±	166.67	1.22	5.33	5.73	6.56
CD (P = 0.05)	NS	NS	16.08	17.27	19.76

Table 2. Leaf area (cm^2) and Leaf area index at different growth stages of maize crop as influenced by different treatments

Treatments	Leaf area (cm^2)				Leaf area Index			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1 : Vermicompost	1340	4990	5501	2492	0.89	3.33	3.67	1.66
T_2 : FYM	1320	4960	5483	2471	0.88	3.31	3.66	1.65
T_3 : Tanksilt	1350	5012	5522	2500	0.90	3.34	3.68	1.67

T_4 : Biochar	1333	4982	5491	2480	0.89	3.32	3.66	1.65
T_5 : Control	1280	2000	2400	1200	0.85	1.33	1.60	0.80
T_6 : RDF	1307	4610	5010	2262	0.87	3.07	3.34	1.51
SEm±	44.93	116.55	122.93	92.80	0.04	0.08	0.09	0.05
CD (P = 0.05)	NS	351.31	370.54	279.72	NS	0.23	0.27	0.15

Table 3. Test weight (g) and yield (kg ha^{-1}) of maize as influenced by different treatments

Treatments	Test weight (g)	Yield (kg ha^{-1})
T_1 : Vermicompost	30.71	7497
T_2 : FYM	30.43	6325
T_3 : Tanksilt	30.78	9054
T_4 : Biochar	30.55	6667
T_5 : Control	18.41	3547
T_6 : RDF	28.84	5750
SEm±	0.83	246
CD (P = 0.05)	2.51	741

Table 4. Economics (₹ ha^{-1}) of maize as influenced by different treatments

Treatments	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	BC ratio
T_1 : Vermicompost	49250	108706	59456	2.21
T_2 : FYM	45750	91712	45962	2.00
T_3 : Tanksilt	45750	131283	85533	2.87
T_4 : Biochar	44570	96671	52101	2.17
T_5 : Control	26650	51431	24781	1.93

T_6 : RDF	33760	83375	49615	2.47
SEm±	--	3340.82	3340.82	---
CD (P = 0.05)	--	10070.33	10070.33	--