

Yield and Yield Components of Maize Response Tocompost and Fertilizer-Nitrogen

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Abstract
An experiment on yield and yield components of maize response to compost and fertilizer nitrogen rate as well as timing of application was conducted at New Developmental Farm Khyber Pakhtunkhwa Agricultural University Peshawar during Kharif 2011. The experiment was carried out in Randomized Complete Block Design with split plot arrangement. Compost (0) and 5 kg ha^{-1}) and nitrogen (65 and 130 tons ha^{-1})were allotted to main plots while Methods (M) of nitrogen application(full at sowing, full at knee stage, and half at sowing and half at knee stages) to sub-plots. Plants at harvest, number of ears per plant, number of grains per row, no. of rows per earwere studied. Higher number of plants at harvest (62102), ear per plant(1.50), grains per row(31), grains per ear (436), rows per ear(13) were produced by compost when applied at the rate of 5 ton ha^{-1} compared to control plots. Higher no. of plant at harvest(62913), grains per row (31),grains per ear(425),rows per ear(13) were produced by 130 kg N ha^{-1} compared to 65 kg N ha^{-1}. Higher number of plants at harvest (61599) ,grains per row (31), grains per ear (432), rows per ear (13), were produced when nitrogen was applied as 1/2 at sowing and half 1/2 at knee stage compared to N application as full dose either at sowing or knee stage. So it is concluded from the experiment that compost at the rate of 5 tons per ha^{-1} along with 130 kg N ha^{-1} applied as nitrogen at the rate 130 kg per ha^{-1} and methods of nitrogen application 1/2 at sowing and 1/2 at knee stage improved yield and yield component of maize and is therefore recommended for general cultivation in agro-climatic condition of Peshawar.
Keywords: Maize, Compost, Nitrogen, Method of Nitrogen Application

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops of the world and is extensively grown both in irrigated as well as rainfed areas (Irshad*et al*., 2002). It is grown on an area of 1052.1 thousand hectares with a total production of 3593.0 thousand tones and average grain yield of 3415 kg ha^{-1}in Pakistan.In Khyber Pakhtunkhwa its average yield during the same year was 1880 kg ha^{-1}(MINFA, 2009).Maize is multipurpose crop and provides food for human beings, fodder for live stock and feed for poultry. It has great nutritional value as it contain about 66.70% starch, 10% protein, 4.8% oil, 8.5% fiber, 3% sugar and 7% ash (Chaudhry, 1983). Maize yield in our province is very low as compared with other province of Pakistan and is mainly due to low soil fertility and less use of organic fertilizer in addition to the other factor of crop production.

The cultivated soils of Pakistan are deficient in organic matter and in major plant nutrients such as nitrogen (N) and phosphorus (P). Low crop productivity is the common feature of agriculture in Pakistan because of very low organic matter content, poor soil physical condition, wide spread nutrient deficiencies (Rashid, 1994), unbalanced use of fertilizers and low nutrient-use-efficiency (Anon.2006). Cahill *et al*., (2007) studied the slow release nitrogenous fertilizers which have potential to improve yield and nitrogen use efficiency (NUE) in maize.

Composting is one of the biological processes for recycling of organic waste and can be defined as a method of biological decomposition, where organic material decomposed to a stage that can be handled, stored and applied to land without any environmental impact (Rynk, 1992; Millner*et al*., 1998; Eghball*et al*., 2004). During composting, organic residues are decomposed under controlled conditions (temperature, moisture and aeration). In addition, extensive microbiological and chemical transformations are involved in the composting process. Composted organic material can be used as a source of important nutrients for sustainable crop productivity. The composted organic wastes not only act as supplement to chemical fertilizers but may also improve the organic matter status and physico-chemical properties of soil (Harmsen*et al*., 1994).It is highly likely that the use of composted organic materials along with chemical fertilizers may be an effective alternate approach for further improving levels of the crop yields. Composting reduces the N availability of the end-use product, so N fertilizer value may be only 30 to 50% of fresh solid manure (Castellanos and Pratt 1981; Brinton 1985). On the other hand, compost P availability may be equivalent to that of inorganic fertilizers in alkaline sandy soils (Elias-Azar*et al*. 1980).

Nitrogen is one of the most abundant elements on earth but still its deficiency is probably the most common nutritional problem affecting plants worldwide. Healthy plants often contain 3-4% nitrogen in their aboveground tissues. Nitrogen is an important component of many important structural, genetic and metabolic compounds in plant cells. Nitrogen is a component of energy-transfer compounds, such as ATP (adenosine tri phosphate) which allow cells to conserve and use the energy released in metabolism. For sufficient food production to sustain the huge population, cropping practices often call for large applications of nitrogen fertilizer to maximize yields. However, the N applied is not all taken by crop; the efficiencies of N fertilizer use are very low, approximately 32-35%. Thus the addition of both chemical and organic fertilizer was hypothesis to improve crop productivity. Keeping in view the importance of organic and inorganic fertilizer a research planned to study the effect of N-fertilizers and composting on maize plant yield and yield components.

MATERIALS AND METHODS

Field experiment was conducted at the new developmental farm of Khyber Pakhtunkhwa Agricultural University Peshawar. The date of sowing was 11th July of summer 2011.The following factors and their levels were studied during the experiment.

Factor A. Compost (C)

C1 = Non compost
C2 = compost(5 t ha^{-1})

Factor B. Nitrogen (N)

N 1 = 65 kg ha^{-1}
N 2 = 130 kg ha^{-1}

Factor C. Method of Nitrogen application (M)

M 1 = N application at sowing (full doze)
M 2 = N application at knee stage (full doze)
M 3 = N application of ½ at sowing and ½ N at knee stage.

The experiment was laid out in randomized complete block design with split plot arrangement using four replications. Both compost and N rate were applied to main plots, whereas methods of N application to subplots. Sub-plot was 17.5cm^2 (5 × 3.5m) having 5 rows, 75 cm apart and 5 meter long. Azam variety was used six irrigation was used source of N was urea. Compost was applied on soil surface. Seed rate was applied at the rate of 28 kg/ha while herbicide was applied for weed management.The data was recorded on the following parameter.

1. Number of plants at harvest
2. Number of ears plant^{-1}
3. Number of grains row^{-1}
4. Number of rows per ear^{-1}
5. Grains ear^{-1}

Plants at harvest ha^{-1}

Plant population was recorded at harvesting by counting number of plants in four central rows and then was converted into ha^{-1}using the following formula:

$$Plant\,at\,harvest\,ha^{-1} = \frac{No.\ of\ plants\,counted\,in\ four\,central\,rows}{No.of\ rows\,x\,row\,length\ \ x\,R-R}\,x\,10000$$

Number of ears per plant

Ten plants in each subplot were randomly selected; their ears were counted and averaged to record number of ears per plant.

Number of grains row^{-1}

Number of grains per row was recorded from five ears randomly selected in each subplot and average was worked out.

Number of rows ear^{-1}

Five randomly selected ears were harvested in each sub plots, and numbers of rows per each ear was counted and were averaged.

Grains ear^{-1}

Grains ear^{-1}was recorded by counting maize grains in randomly selected five ears in each plot.

Statistical analysis

The data recorded on different parameters was analyzed statistically according to the procedure relevant to randomized complete block design as described by little and Hills, (1978). Least significant difference (LSD) tests were used for mean separation when the F test was significant.

EXPERIMENTAL RESULTS

Number of plants at harvest

Data regarding number of plants at harvest was affected by compost (c), nitrogen (n) and application method of nitrogen is presented in Table 1. Statistical analysis of the data revealed that C, and had significantly affected number of plants at harvest whereas application methods had no effect number of plants at harvest. The interactive responses among M X N and C X N X M were observed significant whereas C x N interaction was non significant. Application of compost at the rate of 5 tons ha^{-1} has 24 % higher number of plants at harvest than no application of compost. Similarly nitrogen at the rate of 130 kg ha^{-1} has higher number of plants at harvest (62913 kg ha^{-1}) than 60 kg ha^{-1} application of nitrogen. The interactions between M X N showed that when nitrogen was applied at sowing and increase number of plants at harvest increased. In case of C X N X M interaction showed that at sowing stage increasing nitrogen and compost rate had increased the number of plants at harvest significantly. Similarly, the increasing rate of nitrogen had increased the number of plants at harvest irrespective of compost application.

Number of ear plant^{-1}

Data regarding number of ears plant^{-1} as affected by C, N and application method of nitrogen are presented in Table 2. Statistical analysis of the data revealed that N and application had no significant effects on number of ears plant^{-1}, whereas C had significant effect. The interactive responses among all the treatment were observed non significant for number of ears plant^{-1}.Application of compost at the rate of 5 tons ha^{-1} has 20% higher number of ears plant^{-1} than no application of compost.

Table 1. Number of plants at harvest of maize as affected by compost, N levels and their methods.

Nitrogen (Kg ha^{-1})	Compost (tons ha^{-1})	Nitrogen applied at			Mean
		Sowing (S)	Knee stage (K)	1/2 S + 1/2 K	
65	0	60958.50	58729	56777	58821
130	0	60499	62295	64326	62373
65	5	61020	60237	60998	60752
130	5	63919	62247	64191	63452
	0	60728	60512	60551	60597
	5	62469	61242	62595	62102
65		60989	59483	58887	59786
130		62209	62271	64259	62913
Means		61599 a	60877 a	61573 a	

LSD at P≤ LSD at P≤ 0.05 for method of N application = 1506,Means followed by different letter (s) within each category are significantly different using LSD test at P≤ 0.05.

Table 2. Number of ear plant^{-1} of maize as affected by compost, N levels and their methods

Nitrogen (Kg ha^{-1})	Compost (tons ha^{-1})	Nitrogen applied at			Mean
		Sowing	Knee stage	1/2 S + 1/2 K	
65	0	1.00	1.50	1.00	1.17
130	0	1.50	1.25	1.50	1.42
65	5	1.50	1.50	1.75	1.58
130	5				
		1.00	1.50	1.00	1.17
	0	1.50	1.38	1.63	1.50
	5				
65		1.50	1.25	1.50	1.42
130		1.25	1.50	1.38	1.38
Mean		1.33 a	1.42 a	1.42 a	

LSD at P≤ 0.05 for method of N application = .3699,Means followed by different letter (s) within each category are significantly different using LSD test at P≤ 0.05.

Numbers of grains row^{-1}

Data regarding number of grains row^{-1} as affected by C, N and application method of nitrogen are presented in Table 3. Statistical analysis of the data revealed that N and M had significantly affected number of grains row^{-1} while C had non significant effect on number of grains row^{-1}. The interactive responses among all the treatment were observed non significant except C X N X M which were significant for numbers of grain per row.Application of nitrogen at the rate of 130 kg ha^{-1} has 5.6 higher number of grain row^{-1} than 60 kg ha^{-1} application of nitrogen. In case of application method half at sowing and half at knee time has higher number of grains row^{-1} of (31.25 kg ha^{-1}) than the application of full N either at sowing or knee stage.The interaction among C X N X M showed that when nitrogen was applied half at sowing and half at knee time and increased from 65 to 130 kg ha^{-1}, as well as increasing compost from 0 to 5 tons ha^{-1}, number of grains r ow^{-1} significantly increased.

Number of grains ear^{-1}

Data regarding number of grains ear^{-1} as affected by C, N and M are presented in Table 4. Statistical analysis of the data revealed that all the three factors including C, N and M had significantly affected number of grains ear^{-1}. The interactive responses among all the treatment were observed non significant. Application of compost at the rate of 5 tons ha^{-1} has 24 % higher number of grains ear^{-1} than no application of compost. Similarly nitrogen the rate of 130 kg ha^{-1} has (425.2) higher number of grains ear^{-1} than 60 kg ha^{-1} application of nitrogen. Similary, N applied as split dose half at sowing and half at knee stage had significantly higher grain per ear than full application of N either at sowing or knee stages.

Table 3. Number of grains row^{-1} of maize as affected by compost,N levels and their methods.

Nitrogen (Kg ha^{-1})	Compost (tons ha^{-1})	Nitrogen applied at			Mean
		Sowing	Knee stage	1/2 S + 1/2 K	
65	0	26	29.25	28	28
130	0	30	29	30	30
65	5	29	29	33	30
130	5	31	32	33	32
	0	28	29	29	29
	5	30	30	33	31
65		28.	29	30	29
130		31	30	31	31
Means		29.56 b	30.19 b	31.25 a	

Table 4. Number of grains ear^{-1} of maize as affected by compost, N levels and their methods.

Nitrogen (Kg ha^{-1})	Compost (tons ha^{-1})	Nitrogen applied at			Mean
		Sowing	Knee stage	1/2 S + 1/2 K	
65	0	322	358.25	368	349
130	0	374	379	415	389
65	5	383	388	462	411
130	5	440	456	486	461
	0	348	368	391	369
	5	412	422	474	436
65		352	373	415	380
130		407	417	450	425
Means		380 b	395 b	432 a	

Number of rows ear^{-1}

Data regarding number of row ear^{-1} as affected by C, N and M are presented in Table 5. Statistical analysis of the data revealed that compost, nitrogen as well as method of N application had significantly affected number of row ear^{-1}. The interactive responses among all the treatment were observed non significant. Application of compost at the rate of 130 kg ha^{-1} has 12.83 % higher number of row ear^{-1} than no application of compost. Similarly nitrogen at the rate of 130 kg ha^{-1} has higher number of row ear^{-1}(13.6) than 60 kg ha^{-1} application of nitrogen. In case of application method half at sowing and half at knee time has higher number of row ear^{-1}(13.81)than N been applied as a single dose either at swinger knee stage.

Table 5. Number of rows ear^{-1} of maize as affected by compost, N levels and their methods.

Nitrogen (Kg ha^{-1})	Compost (tons ha^{-1})	Nitrogen applied at			Mean
		Sowing	Knee stage	1/2 S + 1/2 K	
65	0	12	12	12	12
130	0	12	12	13	12
65	5	13	13	14	13
130	5	14	14	14	14
	0	12	12	13	12
	5	13	13	14	13
65		12	12	13	12
130		13	13	14	13
	Means	12 b	13 b	13 a	

LSD at P≤ .05 for method of N application = .6684,Means followed by different letter (s) within each category are significantly different using LSD test at P≤ 0.05.

DISCUSSION

The results outlined in the preceding chapters are discussed here in the light of literature for comparisons and clarification.

Plants at harvest were higher in plots receiving higher N dose when compared to lower rate of N. The higher plants at harvest due to higher dose of N could be associated with the ample supply of N for plant growth and development and thus might have increased the plants at harvest. The results are in line with that of Bakht et al (2006) who also founded higher plant at harvest with higher dose of nitrogen application. Similarly, increasing compost from 0 to 5 tons ha^{-1} had increased plants at harvest. This increases in plants at harvest due to compost application could be related to improved soil fertility, which in turn had increased the nutrients availability for improved plant growth and might be positive correlated with vigorous plant growth thus might have increased the plants at harvest.

Number of ears plant^{-1} were higher in plots receiving compost from 0 to 5 tons ha^{-1} had increased number of ear plant^{-1}. The application of compost to the crop contains a considerable amount of macro and micro nutrient. This increases in number of ears plant^{-1}due to compost application could be related to improved soil fertility, which in turn had increased the nutrients availability for improved plant growth and might be positive correlated with vigorous plant growth thus might have increased the number of ears plant^{-1}

Numbers of grains ear^{-1} were higher in plots receiving higher N dose when compared to lower rate of N. The higher plants at harvest due to higher dose of N could be associated with the ample supply of N for plant growth and development and thus might have increased the number of grains ear^{-1}. The result agrees with those reported by Mehmood et al (2001). Similarly, increasing compost from 0 to 5 tons ha^{-1} had increased number of grains ear^{-1}. This increases in plants at harvest due to compost application could be related to improved soil fertility, which in turn had increased the nutrients availability for improved plant growth and might be positive correlated with vigorous plant growth thus might have increased the number of grains ear^{-1}. The might be due the split application of nitrogen to reduce nitrogen losses through leeching and volatilization.

Numbers of rows ear^{-1} were higher in plots receiving higher N dose when compared to lower rate of N. The higher Numbers of rows ear^{-1} due to higher dose of N could be associated with the ample supply of N for plant growth and development and thus might have increased the number of rows ear^{-1}. The result agrees with those reported by Mehmood et al (2001). Similarly, increasing compost from 0 to 5 tons ha^{-1} had increased number of rows ear^{-1}. In case of application method half at sowing and half at knee time has higher number of rows ear$^{-1.}$

CONCLUSION AND RECOMMENDATIONS

- It is concluded that compost at the rate 5 ton ha^{-1} increased crop productivity in term of yield and yield component of maize.
- In case of nitrogen when applied at the rate of 130 kg ha^{-1}improved yield and yield component than application of 65 kg N ha^{-1}.
- Similarly when N was applied half at the time of sowing and half at knee stage increased maize productivity.
- Thus application of compost at the rate of 5 tons ha^{-1} and nitrogen at the rate of 130 kg N ha^{-1},½ at sowing and ½ at knee stage is suitable for general cultivation of maize in agro-climatic condition of

Peshawar.

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