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# Maize Response to Compost, Nitrogen and its Method of Application at Peshawar, Pakistan

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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. Biological yield,1000 grain weight, grain yield, shelling percentage, and harvest index(%) were studied. Higher biological yield(9832 kg ha-1), 1000 grain weight(251gm), grain yield (3449 kg ha-1) and shelling (55%),were produced by compost when applied at the rate of 5 ton ha-1 compared to control plots. Higher biological yield(9707 kg ha-1), 1000 grain weight (249g), grain yield (3391 kg ha-1), and shelling (54%) were produced by 130 kg N ha-1 compared to 65 kg N ha-1. Higher biological yield (9180 kg ha-1) and 1000 grain weight (244g) were produced when nitrogen was applied as 1/2 at sowing and half 1/2 at knee stage compared toan 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 hectare 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 (Irshadet 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-1in 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; Millneret al., 1998; Eghballet 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 (Harmsenet 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-Azaret 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 17.5cm2 (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. Biological yield (kg ha-1)
2. 1000 grain weight (g)
3. Grain yield (kg ha-1)
4. Shelling %
5. Harvest index (%)

Biological yield (kg ha-1)

Biological yield data were recorded by harvesting four central rows from each plot. The harvested material was sun dried, weighed and was converted into kg ha-1 using the formula:

$$Bio\log ical\ yield\ (kg\ ha^{-1}) = \frac{bio\log ical\ yield\ of\ \ four\ central\ rows}{No.of\ \ rows\ x\ row\ length\ \ x\ R-R} x\,10000$$

1000 grain weight (g)

Thousand grains weight was recorded on sensitive electronic balance after counting thousand grains with seed counter for the seed lot of each sub-plot.

Grain yield (kg ha-1)

The harvested material for biological yield was threshed using a mini thresher, cleaned and were weighed using sensitive electronic balance, and were converted to kg ha-1) using the following formula;

$$Grain\ yield\ (kg\ ha^{-1}) = \frac{Grain\ yield\ \ four\ central\ rows}{No.of\ \ rows\ x\ row\ length\ x\ \ R-R} x\,10000$$

Harvest index (%)

Harvest index was calculated by using the following formula:

$$Harvest index(\%) = \frac{Grain\, yield}{Biological\, yield} x100$$

Shelling (%)

Shelling percentage was recorded with the following formula:

$$Shelling(\%) = \frac{Grain\, weight - Cob\, weight}{Grain + Cob} x100$$

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**

Table 1.Biological yield 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 | 6174 | 8221 | 6666 | 7020 |
| 130 | 0 | 7999 | 8777 | 9499 | 8758 |
| 65 | 5 | 8944 | 9110 | 8972 | 9008 |
| 130 | 5 | 10082 | 10302 | 11585 | 10656 |
| | 0 | 7087 | 8499 | 8082 | 7889 |
| | 5 | 9513 | 9706 | 10278 | 9832 |
| 65 | | 7559 | 8666 | 7819 | 8014 |
| 130 | | 9041 | 9539 | 10542 | 9707 |
| Means | | 8300 b | 9102 a | 9180a | |

LSD at P≤ 0.05 for method of N application =703.1

Means followed by different letter (s) within each category are significantly different using LSD test at P≤ 0.05

Thousand grain weight

Data regarding thousand grain weight as affected by compost, nitrogen and application method of nitrogen are presented in Table 7. Statistical analysis of the data revealed that C, N and M had significantly affected thousand grain weight. The interactive response among C X N X M was observed significant while the remaining interactions were non-significant. Application of compost at the rate of 5 tons ha-1 has 11.5 % higher thousand grain weight than no application of compost. Similarly nitrogen at rate of 130 kg ha-1 hashigher thousand grain weight (249 kg ha-1) than 60 kg ha-1 application of nitrogen. In case of application method half at sowing and half at knee time has higher thousand grain weight (244.94 kg ha-1) than the rest of the application methods. The interactions among C X N X M showed that when nitrogen was applied half at sowing and half at knee time and increasing the rate of nitrogen as well as compost had increased thousand grain weight. At all application stages increasing nitrogen and compost rate had increased the thousand grain weight irrespective of method of N application.

Grain yield

Data regarding grain yield as affected by compost, nitrogen and application method of nitrogen are presented in Table 8. Statistical analysis of the data revealed that compost, nitrogen and application method had significantly affected grain yield. The interactive responses among all the treatment were observed significant. Application of compost at the rate of 5 tons ha-1 has 14 % higher grain yield than no application of compost. Similarly nitrogen at the rate of 130 kg ha-1 has higher grain yield (3391.5 kg ha-1)than 60 kg ha-1 application of nitrogen. In case of application method full application of N at sowing time has higher grain yield of (3259.9 kg ha-1) than the full application at knee stage or half at sowing and half at knee stages. The interactions among the treatment showed that when nitrogen was applied at sowing and increasing the rate of nitrogen as well as compost had increased grain yield.Increase of split application of nitrogen, half at sowing and half at knee stage.The increasing N rate had increases the grain yield respective of compost application.

Table 2. Thousand grain weight 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 | |
| Nitrogen Kg ha-1 | Compost tons ha-1 | Sowing | Knee stage | 1/2 S + 1/2 K | Mean |
| 65 | 0 | 194 | 225 | 230 | 216 |
| 130 | 0 | 240 | 230 | 230 | 233 |
| 65 | 5 | 240 | 239 | 235 | 238 |
| 130 | 5 | 242 | 266 | 284 | 264 |
| | 0 | 217 | 227 | 230 | 225 |
| | 5 | 241 | 253 | 259 | 251 |
| 65 | | 217 | 232 | 232 | 227 |
| 130 | | 241 | 248 | 257 | 249 |
| | Means | 229 b | 240 a | 244 a | |

LSD at P≤ 0.05 for method of N application =8.907
Means followed by different letter (s) within each category are significantly different using LSD test at P≤ 0.05

Table 3.Grain yield (kg ha-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 | 3144 | 2552 | 2319 | 2671 |
| 130 | 0 | 2960 | 3197 | 2883 | 3013 |
| 65 | 5 | 3111 | 3281 | 2999 | 3130 |
| 130 | 5 | 3824 | 3666 | 3817 | 3769 |
| | 0 | 3052 | 2875 | 2601 | 2842 |
| | 5 | 3467 | 3473 | 3408 | 3449 |
| 65 | | 3127 | 2916 | 2659 | 2901 |
| 130 | | 3392 | 3432 | 3350 | 3391 |
| | Means | 3259 | 3174 b | 3004 c | |

LSD at P≤ 0.05 for method of N application =50.16
Means followed by different letter (s) within each category are significantly different using LSD test at P≤ 0.05

Harvest index (%)

Data regarding harvest as affected by compost , nitrogen and application method of nitrogen are presented in Table. Statistical analysis of the data revealed that nitrogen and application method had significantly affected harvest index while compost had no significant effect on maize harvest index. The interactive responses among all the treatment were observed non significant except N X C which was observed significant.Application of nitrogen at the rate of 130 kg ha-1 has higher harvest index(34.6) than 60 kg ha-1 application of nitrogen. In case of application method full application of N at sowing time has significantly higher harvest index (39.57) than the rest of application methods. The interactions N X C showed that when compost was applied at sowing and increased from 0 to 5 tons ha-1, a corresponding increase in harvest index was observed coupled with increasing rate of N.

Shelling (%)

Data regarding grain yield as affected by compost, nitrogen and application method of nitrogen are presented in Table10. Statistical analysis of the data revealed that compost and nitrogen had significantly affected shelling percentage while application method had non significantly affected shelling % of maize. The interactive responses of M X C and M X C X N were observed significant while the C x N and M x N interactions was non significant for shelling % of maize. Application of compost at the rate of 5 tons ha-1 has 54.5 % higher shelling percentage than no application of compost. Similarly nitrogen the rate of 130 kg ha-1 has higher shelling percentage than 60 kg ha-1 application of nitrogen. The interaction among M X C showed that regardless of method of N application, the increase in rate of compost had increased harvest index. Similarly the interactions among M X C X N showed that when increasing the rate of nitrogen as well as compost had irrespective of method of N application, a corresponding increase in shelling percentage was observed.

Table 4. Harvest index (%) of maize as affected by compost, N levels and theirmethods.

| Nitrogen (Kg ha-1) | Compost (tons ha-1) | Nitrogen applied at | | | Mean |
|---|---|---|---|---|---|
| | | Sowing | Knee stage | 1/2 S + 1/2 K | |
| 65 | 0 | 30 | 33 | 36 | 40 |
| 130 | 0 | 36 | 37 | 30 | 34 |
| 65 | 5 | 35 | 35 | 33 | 34 |
| 130 | 5 | 36 | 34 | 33 | 34 |
| | 0 | 43 | 35 | 33 | 37 |
| | 5 | 35 | 35 | 33 | 34 |
| 65 | | 43 | 34 | 35 | 37 |
| 130 | | 3 | 35 | 31 | 34 |
| Means | | 39.57 a | 35.19 b | 33.45 c | |

LSD at P⩽ 0.05 for method of N application =1.330

Means followed by different letter (s) within each category are significantly different using LSD test at P⩽ 0.05

Table 5.Shelling percentage (%) 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 | 46 | 1 | 40 | 45 |
| 130 | 0 | 55 | 45 | 49 | 50 |
| 65 | 5 | 50 | 53 | 54 | 53 |
| 130 | 5 | 54 | 59 | 59 | 58 |
| | 5 | 52 | 56 | 57 | 55 |
| 65 | | 48 | 50 | 47 | 49 |
| 130 | | 55 | 52 | 54 | 54 |
| Means | | 51.90 | 51.55 | 51.25 | |

LSD at P≤ 0.05 for method of N application = 3.82

Meansfollowed 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. Biological yield were higher in plots receiving higher N dose when compared to lower rate of N. The higher biological yield 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 biological yield. The results are in line with that of Bakht et al (2006) who also founded higher biological yield with higher dose of nitrogen application. Similarly, increasing compost from 0 to 5 tons ha-1 had increased biological yield. This increase in plants at harvest due to compost application could be related to improved soil fertility. The result are in agreement with that of Ahmad et al (2007), 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 biological yield. In case of application method half at sowing and half at knee time has higher biological yield. The might be due the split application of nitrogen to reduce nitrogen losses through leeching and volatilization.

Higher weight of 1000-grains was observed in response to application of enriched compost and chemical fertilizer. Thousand grain weight were higher in plots receiving higher N dose when compared to lower rate of N. The higher thousand grain weight 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 thousand grain weight. The results are in line with that of Bakht et al (2006) who also founded higher biological yield with higher dose of nitrogen application. Similarly, increasing compost from 0 to 5 tons ha-1 had increased thousand grain weight. The result are in agreement with that of Ahmad et al (2007). 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 thousand grain weight. In case of application method half at sowing and half at knee time has higher thousand grain weight.

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Harvest index were higher in plots receiving higher N dose when compared to lower rate of N. The higher harvest index 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 harvest index. The results are in line with that of Bakht et al (2006) who also founded higher grain yield with higher dose of nitrogen application. In case of application method half at sowing and half at knee time has higher harvest index.

Shelling (%) was higher in plots receiving higher N dose when compared to lower rate of N. The higher shelling (%) 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 shelling (%). The results are in line with that of Bakht et al (2006) who also founded higher grain yield with higher dose of nitrogen application. Similarly, increasing compost from 0 to 5 tons ha-1 had increased shelling (%). This increases in harvest index 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 shelling (%). In case of application method half at sowing and half at knee time has higher shelling (%).

## 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-1improved 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-1½ at sowing and ½ at knee stage is suitable for general cultivation of maize in agro-climatic condition of Peshawar.

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