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RESPONSE OF MAIZE TO PLANTING METHODS AND FERTILIZER N

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ABSTRACT

A field experiment was conducted at Malakandher Research Farm, NWFP Agricultural University, Peshawar, Pakistan to study the response of maize to planting methods and fertilizer N levels during spring 2004. Two planting methods (ridge and flat) and five levels of nitrogen (0, 80, 120, 160, and 200kg N ha^{-1}) were applied. The experiment was laid out in well prepared field using RCBD design with split arrangement having four replications. Sowing methods were allotted to main plots while nitrogen levels were allotted to split-plots. Days to 50% tasseling and silking were significantly affected by planting methods and nitrogen levels. Maximum days to 50 % tasseling and 50 % silking were recorded in the treatment of 200kg N ha^{-1} when compared with other treatments. Maximum number of leaves $plant^{-1}$, number of cobs $plant^{-1}$, number of grains $cobs^{-1}$, taller plants, grain and biological yield was recorded in ridge planting and application of 200kg N ha^{-1} when compared with other treatments. It can be concluded from these results that ridge planting method and fertilizer N at the rate of 200kg ha^{-1} produced economical crop of maize under climatic conditions of Peshawar valley.

Keywords: maize, planting, methods, nitrogen, ridge, flat, yield.

INTRODUCTION

Maize require abundant of readily available plant nutrients and soil reaction between 5.5 and 8.0 pH for best production. Although soil and climatic condition of Pakistan are highly favorable and high yielding varieties are available. Yet the yield of maize at farmer's field is very low as compared to other maize producing countries such as U.S.A, Canada, Egypt etc. To boost up maize production, adoption of modern agro-management practices seems imperative and one of the major techniques is the proper method of seeding. For raising the crop yield fertilizer impact is one of the major factors and it contributes about 50% to yield performance. Many farmers in our country do not apply fertilizer in proper quantity and proper method of fertilizer application. Hence the efficiency of fertilizer may effect badly.

Shaikh *et al*. (1994), Majid *et al*. (1986) while studying the effects of different sowing methods concluded that plant height, total dry matter production, 100 grain weight and grain yield was highest with ridge sowing and decreased days to tasseling, silking and maturity. Nunes *et al.* (1996) reported that biomass and grain yields of maize crop increased with increasing N rate. Sanjeev *et al.* (1997) and Fedotkin and Kravtsov (2001) reported that grain and stover yield increased significantly up to 240kg N ha^{-1}. Number of grains ear^{-1}, 100-seed weight and grain $weight^{-1}$ increased significantly up to 180kg N ha^{-1} and grain yield $plant^{-1}$ up to 240kg N ha^{-1}. Shivay and Singh (2000) reported that highest plant height, LAI and dry matter accumulation were recorded with 120kg N ha^{-1}. Increased application of N reduced barrenness and increased the shelling percentage. Gokmen *et al*. (2001) studied that plant height, 1000 grain weight and grain weight ear^{-1} increased significantly with 100kg N ha^{-1} while tasseling period generally decreased with increasing N rate. Application of nitrogen had a significant effect on plant height, number of grains cob^{-1}, 1000 grain weight and harvest index (Mahmood *et al*., 2001). Ali *et al.* (2002) concluded that nitrogen and phosphorous had a significant effect on grain yield, nitrogen uptake at tasselling, maturity and in grain while non-significant effect of nitrogen and phosphorus was recorded for harvest index. Plots treated with NP combination of 150:90 kg ha^{-1} produced maximum grain yield. Keeping in view the importance of sowing methods and N management in the production of maize crop, the present experiment was conducted to determine the effect of various planting technique with different levels of nitrogen fertilizer on the performance of maize plant.

MATERIALS AND METHODS

In order to study the "Response of maize to planting methods and fertilizer N" an experiment was conducted at Malakandher Research Farm, NWFP Agricultural University Peshawar, Pakistan during spring 2004. The experiment was laid out in Randomized Complete Block Design (RCBD) with split-plot arrangements, having four replications with two planting methods (Ridge and Flat) and five levels of nitrogen (0, 80, 120, 160 and 200kg N ha^{-1}). Planting methods were allotted to the main plots and fertilizer N was allotted to the sub-plot. The area of sub plot was 3 x 4 m which was composed of five rows, 75cm apart. All standard agronomic practices were followed during the course of experiment. The following parameters were studied during the course of the experiment:

- Days to 50% tasseling
- Days to 50% silking
- Number of leaves $plant^{-1}$
- Number of cobs $plant^{-1}$
- Number of grain cob^{-1}

- Plant height (cm)
- Number of harvested plants ha^{-1}
- Hundred grain weight (g)
- Grain yield (kg ha^{-1})
- Biological yield (kg ha^{-1})
- Harvest index (%)
- Stover yield (kg ha^{-1})

Days to 50% tasseling and siliking were recorded from the date of sowing till when 50% plants in each sub plot produced tassels and silk. Leaves in six plants were randomly selected from the two central row of each sub plot and were counted and their average was then worked out. Plant height was recorded by measuring the height of six randomly selected plants from the two central rows of each sub plot and then averaged. Cobs in six plant randomly selected from the two central row of each sub plot were counted and their average was calculated to record data regarding cobs plant^{-1}. Similarly, number of grains cob^{-1} was calculated by counting the number of grain in five cobs of the two central rows of each subplot and then their average was calculated. Hundred grain weights were counted from the cobs of the two central rows of each sub plot and their weight was recorded with the help of electronic balance. Grain was obtained from each subplot after husking and cleaning and their weight was recorded and then converted into grain yield (kg ha^{-1}). Biological yield was recorded in each subplot after adequate sun drying and was converted into kg ha^{-1}. Stover yield was recorded from each subplot when grains were separated from the cobs of each plant. This was converted later on into kg ha^{-1} Number of harvested plants were counted at harvesting time in each subplot which was converted in to number of harvested plant ha^{-1}.

Harvest index was calculated according to the following formula:

$$\text{H.I (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \text{x}\,100$$

The data recorded was analyzed statistically by using analysis of variance technique appropriate to Randomized Complete Block Design, with split plot arrangement and upon obtaining significant differences, Least Significant Difference (LSD) test was used for comparing the treatment means (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Growth and development:

Statistical analysis of the data indicated that various levels of nitrogen and planting methods had significantly ($p \leq 0.05$) affected days to 50% tasseling and silking while interaction between nitrogen levels and planting methods was non significant (Table-1 and 2).

Table-1. Days to 50% tasseling of maize as affected by different planting methods and nitrogen levels.

Nitrogen levels (kg ha^{-1})	**Planting methods**		**Mean**
	Flat planting	**Ridge planting**	
0	51.25	56.75	54.00 e
80	54.75	60.00	57.37 d
120	61.50	65.50	63.50 c
160	66.25	68.25	67.25 b
200	68.25	70.00	69.12 a
Mean	**60.40 b**	**64.10 a**	

LSD value at 0.05% for planting methods = 1.810
LSD value at 0.05% for nitrogen levels = 1.657

Table-2. Days to 50% silking of maize as affected by different planting methods and nitrogen levels.

Nitrogen levels (kg ha^{-1})	**Planting methods**		**Mean**
	Flat planting	**Ridge planting**	
0	61.25	67.25	64.25 d
80	66.00	69.50	67.75 c
120	70.75	71.25	71.00 b
160	73.00	76.25	74.62 a
200	74.50	78.00	76.25 a
Mean	**69.10 b**	**72.45 a**	

LSD value at 0.05% for planting methods = 2.470
LSD value at 0.05% for nitrogen levels = 2.138
Mean followed by different letters are significantly different at $p < 0.05$ level of probability using least significant difference (LSD) test.

It is clear from the mean values of the data that maximum number of 69.12 days to 50% tasseling was recorded in treatments having nitrogen dose of 200kg ha^{-1} when compared with other treatments including control. Similarly, maximum number of 64.10 days to 50% tasseling was recorded in plots having ridge planting while minimum number of 60.40 days to 50% tasseling was recorded in flat planting method. It can be seen from the data that maximum number of 76.25 days to 50% silking was recorded in those plots which were fertilized with 200kg N ha^{-1} whereas minimum number of 64.25 days to 50% silking was recorded in control treatment. These results agree with those reported by Chaudry, 1964. Similarly, ridge sown plots took maximum number of 72.45 days to 50% silking when compared with other treatments.

The impact of planting methods and nitrogen levels on number of leaves $plant^{-1}$ is presented in Table-3.

Table-3. Number of leaves $plant^{-1}$ of maize as affected by different planting methods and nitrogen levels.

Nitrogen levels (kg ha^{-1})	**Planting methods**		**Mean**
	Flat planting	**Ridge planting**	
0	9.16	10.87	10.02 d
80	11.34	12.00	11.67 c
120	12.00	12.88	12.44 b
160	12.71	13.28	12.99 b
200	13.42	14.05	13.74 a
Mean	**11.73 b**	**12.62 a**	

LSD value at 0.05% for planting methods = 0.5885
LSD value at 0.05% for nitrogen levels = 0.5810

Statistical analysis of the data showed that various levels of nitrogen had significantly ($p < 0.05$) affected the number of leaves $plant^{-1}$. Interaction between nitrogen levels and planting methods was non-significant. Maximum number of 13.74 leaves $plant^{-1}$ was recorded in case of those treatments which were treated with 200kg N ha^{-1}, whereas minimum number of 10.02 leaves $plant^{-1}$ was recorded in control treatments. These results are in conformity with those reported by Shivay and Singh (2000). Highest number of 12.62 leaves $plant^{-1}$ was recorded from the treatment of ridge planting methods.

The effect of planting methods and nitrogen levels on plant height (cm) is presented in Table-4.

Table-4. Plant height (cm) of maize as affected by different planting methods and nitrogen levels.

Nitrogen levels (kg ha^{-1})	**Planting methods**		**Mean**
	Flat planting	**Ridge planting**	
0	135.47	145.75	140.61 e
80	153.45	156.53	154.99 d
120	157.42	162.32	159.87 c
160	164.14	167.20	165.67 b
200	170.16	172.72	171.44 a
Mean	**156.13 b**	**160.91 a**	

LSD value at 0.05% for planting methods = 3.401
LSD value at 0.05% for nitrogen levels = 4.538
Mean followed by different letters are significantly different at $p < 0.05$ level of probability using least significant difference (LSD) test.

Statistical analysis of the data showed that various levels of nitrogen and planting methods had significantly ($p < 0.05$) affected plant height. Interaction between nitrogen levels and planting methods was non-significant. Mean values of the data suggested that taller plants (171.44cm) were attained in plots treated with nitrogen dose of 200kg ha^{-1} whereas shorter plants (140.61cm) were observed in control. These results are in conformity with those reported by Shaikh *et al.* (1994), Majid *et al*. (1986) and Shivay and Singh. (2000). Maize when sown on ridges produced taller plants (160.91cm) when compared with other sowing methods. Majid *et al*. (1986) and Gokmen *et al*. (2001) reported that taller plants were attained by maize when sown on ridges. Statistical analysis of the data showed that various levels of nitrogen had significantly ($p < 0.05$) affected number of harvested plants ha^{-1} whereas

the effect of planting methods and interaction between plating methods and nitrogen levels was non-significant (Table-5). Maximum number of 41638 harvested plants ha^{-1} was recorded in plots fertilized with 200kg N ha^{-1} while control plots produced minimum number of harvested plants (31083 ha^{-1}). Similarly, maximum number of harvested plants (36098 ha^{-1}) was observed in treatments of ridge planting when compared with other sowing methods.

Table-5. Number of harvested plants ha^{-1} of maize as affected by different planting methods and nitrogen levels.

Nitrogen levels (kg ha^{-1})	**Planting methods**		**Mean**
	Flat planting	**Ridge planting**	
0	30346	31819	31083 d
80	31788	32792	32290 cd
120	33146	34662	33904 c
160	36021	37939	36980 b
200	39999	43277	41638 a
Mean	**34260**	**36098**	

LSD value at 0.05% for nitrogen levels = 2789

Yield and yield components:

Data regarding number of cobs plant^{-1} is shown in Table-6. Statistical analysis of the data indicated that various levels of nitrogen had significantly ($p < 0.05$) affected on the number of cobs plant^{-1}.The effect of planting methods and interaction between nitrogen and planting methods was non-significant. Highest number of 1.15 cobs plant^{-1} was produced by plots treated with highest dose of N (200kg ha^{-1}) while cobs plant^{-1} were minimum in control treatments. When the effect of sowing methods on cobs plant^{-1} was taken into account, the data revealed that maximum number of 1.07 cobs plant^{-1} was recorded in plots having ridge planting method. Minimum number of 1.05 cobs plant^{-1} was recorded in flat planting method.

Table-6. Number of cobs plant^{-1} of maize as affected by different planting methods and nitrogen levels.

Nitrogen levels (kg ha^{-1})	**Planting methods**		**Mean**
	Flat planting	**Ridge planting**	
0	1.00	1.00	1.00 d
80	1.00	1.02	1.01 cd
120	1.05	1.07	1.06 bc
160	1.10	1.10	1.10 ab
200	1.12	1.17	1.15 a
Mean	**1.05**	**1.07**	

LSD value at 0.05% for nitrogen levels = 0.05652
Mean followed by different letters are significantly different at $p < 0.05$ level of probability using least significant difference (LSD) test.

Analysis of the data also revealed that various levels of nitrogen and different planting methods had significantly ($p < 0.05$) affected the number of grains cobs^{-1} (Table-7) whereas the effect of their interaction was non-significant. Maximum number of 585 grains cobs^{-1} was produced from the treatment applied with 200kg N ha^{-1}. Minimum number of 425.0 grains cobs^{-1} was recorded in control treatment. These results agree with those reported by Mahmood *et al*. (2001), Nunes *et al*. (1996), Shaikh *et al*. (1994) and Majid *et al.* (1986). Highest number of 527.20 grains cobs^{-1} was recorded in those treatments which were planted on ridge. Table-8 shows the data of hundred grain weight as affected by different planting methods and nitrogen levels. Statistical analysis of the data indicated that various levels of nitrogen had a significant ($p < 0.05$) effect on hundred grains weight. The effect of planting methods and interaction between nitrogen and planting methods was non-significant. Mean values of the data indicated that heavier grains (30.19g 100^{-1} grains) were produced by those plots which received N fertilizer at the rate of 200kg ha^{-1} whereas lighter grains were observed in control treatment. Similar results were also reported by Krishnasamy and Kamaswamy. (1986). Similarly, ridge sown maize produced maximum hundred grains weight (27.96g) while minimum hundred grains weight (26.84g) in flat planting method.

Table-7. Number of grains cob^{-1} of maize as affected by different planting methods and nitrogen levels.

Nitrogen levels (kg ha^{-1})	**Planting methods**		**Mean**
	Flat planting	**Ridge planting**	
0	395.75	454.25	425.00 d
80	480.50	492.75	486.62 c
120	503.00	533.25	518.12 b
160	515.50	562.00	538.75 b
200	576.25	593.75	585.00 a
Mean	**494.20 b**	**527.20 a**	

LSD value at 0.05% for planting methods = 8.55
LSD value at 0.05% for nitrogen levels = 25.46

Table-8. Hundred grain weight (g) of maize as affected by different planting methods and nitrogen levels.

Nitrogen levels (kg ha^{-1})	**Planting methods**		**Mean**
	Flat planting	**Ridge planting**	
0	24.46	25.23	24.84 e
80	25.67	26.81	26.24 d
120	26.88	27.67	27.27 c
160	27.81	29.06	28.44 b
200	29.37	31.01	30.19 a
Mean	**26.84**	**27.96**	

LSD value at 0.05% for nitrogen levels = 0.8859
Mean followed by different letters are significantly different at $p < 0.05$ level of probability using least significant difference (LSD) test.

It can be seen from the mean values of the data shown in Table-9 that various levels of nitrogen and planting methods had significantly ($p \leq 0.05$) affected grain yield while their interaction was non-significant. Highest grain yield of 4083.3kg ha^{-1} was recorded in plots treated with nitrogen dose of 200kg ha^{-1} when compared with other N levels. These results agree with those reported by Fedotkin and Kravtsov (2001). Likely, maximum grain yield of 3494kg ha^{-1} was recorded in ridge planted plots while minimum grain yield of 3183.2kg ha^{-1} was harvested from plots sown with flat planting methods. Shaikh *et al*. (1994), Majid *et al*. (1986) reported that grain yield was significantly affected by different panting methods.

Table-9. Grain yield (kg ha^{-1}) of maize as affected by different planting methods and nitrogen levels.

Nitrogen levels (kg ha^{-1})	**Planting methods**		**Mean**
	Flat planting	**Ridge planting**	
0	2305.3	2416.6	2360.9 d
80	2722.1	3277.7	2999.9 c
120	3333.3	3583.2	3458.2 b
160	3611.0	3972.1	3791.6 ab
200	3944.4	4222.2	4083.3 a
Mean	**3183.2 b**	**3494.4 a**	

LSD value at 0.05% for planting methods = 284.4
LSD value at 0.05% for nitrogen levels = 340.7

Statistical analysis of the data showed that various levels of nitrogen and planting methods had significantly ($p \leq 0.05$) affected biological yield. Interaction between nitrogen levels and planting methods was non-significant (Table-10). Maximum biological yield of 14472.1kg ha^{-1} was recorded in the treatment of 200kg N ha^{-1} while minimum biological yield of 9035kg ha^{-1} was recorded in control treatments. Powal (1998), Shaikh *et al.* (1994) and

Majid *et al*. (1986) reported that biomass was increased with each incremental dose of nitrogen. Highest biological yield of 12861kg ha^{-1} was recorded in the treatment of ridge planting. Shaikh *et al*. (1994) also reported that total dry matter production was highest with ridge sowing. Lowest biological yield of 11581kg ha^{-1} was recorded in the treatment of flat planting.

Table 10. Biological yield (kg ha^{-1}) of maize as affected by different planting methods and nitrogen levels.

Nitrogen levels (kg ha^{-1})	**Planting methods**		**Mean**
	Flat planting	**Ridge planting**	
0	8627.7	9444.2	9035.9 d
80	9999.9	11999.9	10999.9 c
120	12333.3	13694.4	13013.8 b
160	13111.0	14055.5	13583.2 b
200	13833.3	15111.0	14472.1 a
Mean	**11581.0 b**	**12861.0 a**	

LSD value at 0.05% for planting methods = 72.78
LSD value at 0.05% for nitrogen levels = 762.5
Mean followed by different letters are significantly different at $p < 0.05$ level of probability using least significant difference (LSD) test.

Statistical analysis of the data revealed that various levels of nitrogen and planting method had significantly ($p \leq 0.05$) affected stover yield while their interaction was non –significant (Table-11). Maximum stover yield of 9085.2kg ha^{-1} was recorded in the treatment of 200kg N ha^{-1} when compared with other levels of nitrogen. Sanjeev *et al*. (1997) reported that grain and stover yield increased significantly due to nitrogen application. Similarly, ridge sown crop produced highest stover yield of 7144.4kg ha^{-1} when compared with other sowing methods. These results agree with those reported by Gupta *et al*. (1979).

Table-11. Stover yield (kg ha^{-1}) of maize as affected by different planting methods and nitrogen levels.

Nitrogen levels (kg ha^{-1})	**Planting methods**		**Mean**
	Flat planting	**Ridge planting**	
0	5277.7	5444.4	5361.0 d
80	5944.2	6277.7	6111.0 c
120	6333.3	6666.6	6499.9 c
160	6944.4	7944.4	7444.4 b
200	8777.7	9388.8	9085.2 a
Mean	**6655.4 b**	**7144.4 a**	

LSD value at 0.05% for planting methods = 350.0
LSD value at 0.05% for nitrogen levels = 668.9

It can be inferred from the mean values of the data that harvest index was affected non-significantly by various levels of nitrogen, planting methods and their interaction (Table-12). However, maximum harvest index of 28.24% was recorded from plots treated with 200kg ha^{-1} and flat sowing. These results agree with those reported by Ali *et al*. (2002).

Table-12. Harvest index (%) of maize as affected by different planting methods and nitrogen levels.

Nitrogen levels (kg ha^{-1})	**Planting methods**		**Mean**
	Flat planting	**Ridge planting**	
0	26.85	25.74	26.30
80	27.31	27.43	27.37
120	27.11	26.15	26.63
160	27.53	28.35	27.94
200	28.55	27.94	28.24
Mean	**27.47**	**27.12**	

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