

EFFECT OF GENOTYPES AND NITROGEN LEVELS ON PRODUCTION POTENTIAL OF MAIZE (*ZEA MAYS* L.) UNDER INDO-GANGATIC PLAIN ZONE OF WESTERN U.P.

PRADEEP SINGH, N. S. RANA,¹ U. N. SHUKLA, SMITA SINGH RAKESH KUMAR² AND KAUSHAL KUMAR*

Department of Agronomy, S.V.P. U.A and T, Meerut - 250 110, INDIA

¹Department of Agronomy, S.V.P.U.A. and T., Meerut (U. P) - 250 110 INDIA

²Department of Agronomy, Institute of Agricultural Sciences, BHU, Varanasi - 221 005

e-mail: singhkaushalbhu@gmail.com

KEYWORDS

Genotypes
Maize
Nitrogen levels
Yield

Received on :
21.03.2012

Accepted on :
07.07.2012

*Corresponding
author

ABSTRACT

Among genotypes, Dekalb 900 M Gold had significantly higher yield attributes viz. cobs/plant, cob length (cm), grains/row, grains/cob, 1000 grain weight, ten cobs weight, grain weight/ten cobs, shelling percentage, grain yield (6340 kg/ha), stover yield (8550 kg/ha), benefit: cost ratio (2.0), crop profitability (329.47 ₹/ha/day) and crop productivity (62.35 kg/ha/day). Crop fertilized with 160 kg N/ha registered significantly higher yield attributes viz. cob length, cob girth, grain rows/cob, grains/row, grains/cob, 1000 grain weight, ten cobs weight, grain weight/ten cobs, shelling percentage, grain yield (6240 kg/ha) and stover yield over 40 kg N/ha, but it was at par with 120 N kg/ha. However, the highest benefit: cost ratio (2.0), crop profitability (322.42/ha/day) and crop productivity (61.76 kg/ha/day) with the application of 120 kg N/ha closely followed by 160 kg N/ha. Harvest index, grain rows/cobs and cobs girth did not influenced by any of the genotypes and N levels.

INTRODUCTION

Maize, being a C₄ plant, has yield potential far higher than any other cereals and that's why sometimes referred to as the miracle crop or 'Queen of Cereals'. Like other cereals, it has multiple uses. Over 35% of maize produced in the country is consumed as human food, 25% as poultry feed, 25% as cattle feed and 15% undergoes food processing (corn flakes, popcorns etc). The green cobs harvested at the milk stage are ground to make "chapattis" or local bread. It is also used to brew local liquor either solely or in combination with millet. "Sattu" or "champa" prepared by grinding maize to powder form alone or with wheat or barley is consumed along with tea (Narang and Gill, 2004). Nitrogen is a component of protein and nucleic acids and when nitrogen is sub-optimal, growth is reduced. Its availability in sufficient quantity throughout the growing season is essential for optimum maize growth. It is also characteristic constituent element of proteins and also an integral component of many other compounds essential for plant growth processes including chlorophyll and many enzymes. It also mediates the utilization of phosphorus, potassium and other elements in plants. An adequate supply of N is associated with dark green colour, high photosynthetic activity and vigorous growth. An excess of N can delay the crop maturity and the optimum use of maize crop when N supply is insufficient, carbohydrate will be deposited in vegetative cells, causes them to thicken (Rasheed *et al.*, 2004). When N supply is adequate, the conditions are favorable for

growth, proteins are formed from manufactured carbohydrates ultimately higher crop yield (Sabha Jeet *et al.*, 2012). An experiment was conducted with five N levels (0, 40, 80, 120 and 160 kg/ha) and found that the increased growth attributes with increasing N levels while highest plant diameter, LAI and DM production up to 160 kg/ha (Rasheed *et al.*, 2004). Crop produced significantly maximum plant height, stem girth, number of leaves and dry weight/plant (87.42g) was recorded at 120 kg N + 20 kg P/ha while the lowest was recorded in the control by Onasanya *et al.* (2009). Khan *et al.*, (2005) tested four N levels (0, 60, 120 and 180 kg/ha) and recorded maximum cobs/plant (1.5), 1000-grain weight (254.4g) and number of grains/cob (342.5) with 120kg N/ha. The increase of nitrogen consumption caused an increase in grain/cobs and 1000-seed weight was also reported by Sabha Jeet *et al.* (2012) and Lack *et al.* (2008).

Projections by National Centre for Agricultural Economics and Policy Research (NCAP) has shown that by the end of 11th five year plan (2011- 12) the total demand for maize in India will be 22.73 million tonnes (3.07 million tonnes for food and 19.66 million tonnes for other purposes) requiring an annual growth rate of 5.91 per cent. Hybrid vigour is very well documented in a number of crops including maize. Maize hybrids, besides having high yield potential, are well recognized for better nutritive value in terms of protein content and oil than normal field maize (Pal and Bhatnagar, 2009; Thomson *et al.*, 2004). Realization of yield potential, in a given environment, is considerably governed by crop

management including various monetary and non-monetary inputs. Among them fertilizer is one of the costliest and perhaps the most crucial input limiting cereal yields. Among the essential nutrient, response to nitrogen application is by and large obtained in Indian soils, low in nitrogen. Even under the best of prevailing situations in Indian soil, utilization efficiency of nitrogen ranges from 30-35 per cent, and has never exceeded 50 per cent (Prasad and Prasad, 1988). Nitrogen is most important in yield and quality formation in crops through manifestation of growth and development. Its role in photosynthesis, protein synthesis, cell division and other plant metabolic activities are well documented. Increase nitrogen supply in continuous manner to the crop results in greater cell size and leaf area and thus greater photosynthetic activity. Therefore, under such circumstances only two ways are there which can increase the productivity per unit area and quality, firstly by the adoption of hybrid varieties and secondly with improved agronomic practices (Kumar *et al.*, 2002; Muhammad *et al.*, 2004, Pal and Bhatnagar, 2009). It is also important to study the interaction of appropriate fertility levels with judicious selection of hybrids under Indo-gangatic plain zone. The present study was, for such motives, undertaken with the objective to find out and determine the effect of nitrogen application on growth and yield of maize hybrids.

MATERIALS AND METHODS

Experimental site and meteorological information

A field experiment was conducted at Crop Research Center, Sardar Vallabhbhai Patel University of Agriculture and Technology, Modipuram, Meerut (Uttar Pradesh) during 2008-09. Geographically, Meerut is located in semi-arid and sub-tropical region at 29°05' 19" North latitude, 77°41' 50" East longitude. The meteorological trends during crop period were depicted in Fig. 1. The soil of experimental plot was sandy-loamy textural class (42% sand, 38% silt and 20% clay) with low in organic carbon (0.46%), available N (190.4 kg/ha) and K₂O (178.0 kg/ha), but medium in P₂O₅ (12.0 kg/ha). The pH and EC (ds/m) of soil was 7.4 and 0.351, respectively. Alkaline permanganate method (Subbiah and Asija, 1956), Olsen's method (Watanabe and Olsen, 1965), Neutral normal Ammonium Acetate extract using flame photometer (Hanway and Heidel, 1952) and Walkely and Black method (Jackson, 1967) for the determination of available nitrogen (N), phosphorus (P₂O₅) potassium (K₂O) and organic carbon, respectively. The pH and EC of experimental site was determined through 1:2.5 soil and water suspension method (Jackson, 1967).

Technical programme

The experiment was laid out in Factorial RBD design with three replications. On succeeding maize crop, 25 treatment combinations comprising of five genotype (V₁- Dekalb-Hishell, V₂-Dekalb-Double, V₃-Dekalb-900M-Gold, V₄-Dekalb-DKC-7074 and V₅-Mahyco 3838) and five nitrogen levels (N₀, N₄₀, N₈₀, N₁₂₀ and N₁₆₀) were imposed. The crop was fertilized with nitrogen as per the treatment (0, 40, 80, 120 and 160 N kg/ha) and uniformly with 60-40-20 P₂O₅, K₂O and ZnSO₄ kg/ha.

Experimental materials used and cultural operations

Table 1: Yield attributes and yield as influenced by different genotypes and nitrogen levels

Treatments	Cobs/ plant	Cobs/ length (cm)	Cobs girth (cm)	Grain rows/ cob	Grains/ row	Grains/ cob	1000 grain weight (g)	10 cobs weight (g)	Grain weight /10 cobs (g)	Shelling (%)	Grain yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)
Genotypes													
V ₁ -Dekalb Hishell	1.2	21.6	13.6	14.6	32.3	471	226	1825	1510	82.3	5150	6900	43.0
V ₂ -Dekalb Double	1.3	21.9	13.3	14.3	32.1	466	230	1829	1514	82.6	5750	8000	41.8
V ₃ -Dekalb 900M Gold	1.5	23.3	15.6	15.9	36.6	586	239	1886	1571	83.3	6360	8550	42.9
V ₄ -Dekalb DKC 7074	1.3	23.0	13.3	14.5	35.6	515	236	1873	1558	83.1	6080	8050	43.3
V ₅ -Mahyco 3838	1.0	22.3	13.5	14.0	32.2	449	228	1505	1190	78.8	4830	6830	41.5
SEM±	0.04	0.17	0.62	0.6	0.67	22.5	3.3	26.2	26.2	0.3	24.1	42.0	0.6
CD (P = 0.05)	0.11	0.48	NS	NS	1.91	64.0	9.5	74.5	74.5	0.9	69.2	120.0	NS
Nitrogen levels (kg/ha)													
N ₀	1.2	20.7	12.8	13.3	29.8	397	222	1708	1393	81.3	4740	6120	43.7
N ₄₀	1.2	21.8	13.3	14.1	32.2	457	229	1736	1421	81.5	5180	7220	41.9
N ₈₀	1.3	23.0	13.4	14.9	34.5	514	232	1785	1470	82.0	5700	7600	40.2
N ₁₂₀	1.3	23.7	14.8	15.4	35.8	554	236	1802	1487	82.3	6300	8780	41.6
N ₁₆₀	1.4	23.9	15.0	15.5	36.4	565	240	1886	1571	83.1	6240	8630	42.4
SEM±	0.04	0.17	0.62	0.6	0.67	22.5	3.3	26.2	26.2	0.3	24.1	42.0	0.3
CD (P = 0.05)	NS	0.48	1.79	1.6	1.91	64.0	9.5	74.5	74.5	0.9	69.2	120.0	NS

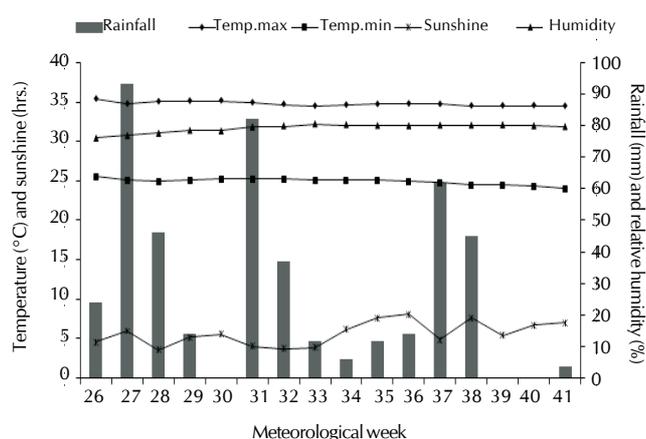
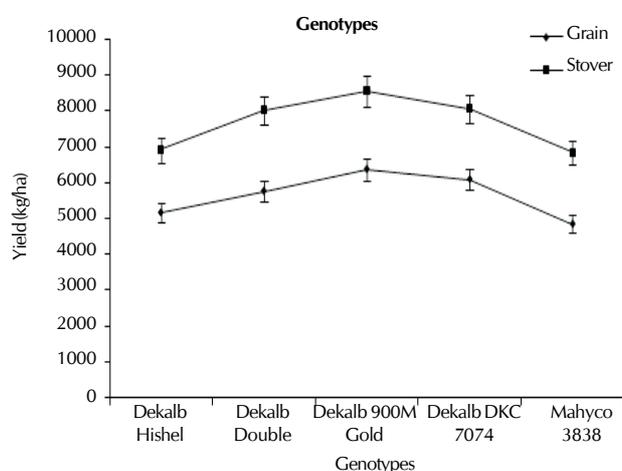


Figure 1: Meteorological trends during maize growing period



The sources of nitrogen, phosphorus and potassium were urea, single super phosphate and murate of potash, respectively. Full dose of phosphorus and potash were applied as basal, while zinc sulphate was added at the time of last harrowing during field preparation. Nitrogen was applied in three equal splits as basal, knee-height and tasseling stages. Basal application of fertilizers was made at 8-10cm depth in furrows opened 2-3cm to the side of seed furrow. The seeds were placed manually in the furrows at a spacing of 60 x 20cm using the with recommended seed rate (20 kg/ha) on 29th June, 2008. Excess plants were thinned out at 21 days after sowing of the crop as to ensure intra-row spacing of 20cm. Weeding and irrigation were done as per crop requirements.

Experimental design, data collection and analysis

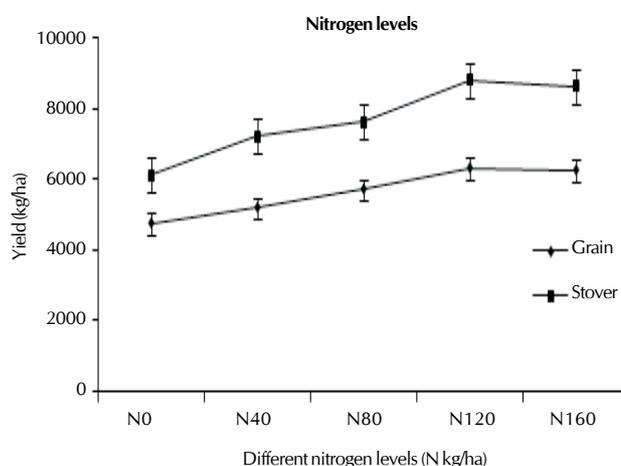


Figure 2. Effect of genotypes and nitrogen levels on grain and stover yield of Maize (standard error bars indicates the CD Values)

Table 2: Cost of cultivation, B: C ratio, crop profitability and crop productivity as influenced by different genotypes and nitrogen levels

Treatments	Cost of cultivation (₹/ha)	B:C ratio	Crop profitability(/ha/day)	Crop productivity (kg/ha/day)
Genotypes				
V ₁ -Dekalb Hishell	32148	1.7	206.63	50.49
V ₂ -DeKalb Double	32148	1.9	270.41	56.37
V ₃ -Dekalb 900M Gold	32148	2.0	329.47	62.35
V ₄ -Dekalb DKC 7074	32148	1.9	299.92	59.61
V ₅ -Mahyco 3838	32148	1.6	177.69	47.35
SEm ±	-	0.08	6.2	0.7
CD (P=0.05)	-	0.23	17.6	0.20
Nitrogen levels (kg/ha)				
N ₀	31542	1.5	169.21	46.47
N ₄₀	31649	1.7	217.15	50.78
N ₈₀	32083	1.8	263.13	55.88
N ₁₂₀	32517	2.0	322.42	61.76
N ₁₆₀	32951	1.9	312.22	61.18
SEm ±	-	0.08	6.2	0.7
CD (P=0.05)	-	0.23	17.6	0.20

Various yield attributes and yield data on maize were recorded at harvest stages and B: C ratio worked out accordingly. Observations were recorded and analyzed as per standard statistical procedure (FRBD) suggested by Gomez and Gomez (1984). The estimates of correlation coefficients were worked out using the Mini-Tab programme based on concept developed by Dewey and Lu (1959). The correlation and

regression studies were done to established cause and effect relationship among yield attributes and yield.

RESULTS AND DISCUSSION

Dekalb 900M Gold had significantly superior yield attributes viz. cobs/plant (1.5), cob length (23.3cm), grains/row (36.6),

grains/cob (586), 1000 grain weight (239g), ten cobs weight (1886g), grain weight/ten cobs (1571g), shelling percentage (83.3%), grain yield (6340 kg/ha) and stover yield (8550 kg/ha) over other genotypes (Table 1). Harvest index, grain rows/cobs and cobs girth did not influenced by none of the genotypes, but highest values were recorded by Dekalb 900M Gold. Dekalb 900M Gold yielded 31.6%, 23.5%, 10.6% and 4.6% higher grain yield than Mahyco 3838, Dekalb Hishell, Dekalb Double and Dekalb DKC 7074, respectively. This might be due to higher leaf area index of genotype Dekalb 900 M Gold resulted in more photosynthesis and produce more photosynthate for sink and gave batter yield attributes. Similar finding were also reported by Kumar *et al.* (2002) Muhammad *et al.* (2004) and Pal and Bhatnagar (2009). Effect of genotypes and nitrogen levels on grain and stover yield of maize (standard error bars indicates the CD values) were depicted in Fig. 2. Significantly higher benefit: cost ratio (2.0), crop profitability (329.47 ₹/ha/day) and crop productivity (62.35 kg/ha/day) were fetched with the genotype Dekalb 900 M Gold. However, significantly lowest benefit: cost ratio (1.6) were obtained under Mahyco 3838 (Table 2). This might be due to Dekalb 900 M Gold have great potential to produced more grain and stover yield that may leads more B: C ratio and crop productivity than others hybrids (Sabh Jeet *et al.*, 2012).

CD values

Crop fertilized with 160 kg N/ha registered significantly higher yield attributes *viz.* cob length (23.9cm), cob girth (15.0cm), grain rows/cob (15.5), grains/row(36.4), grains/cob (565), 1000 grain weight (240g), ten cobs weight (1886 g), grain weight/ten cobs (1571), shelling percentage (83.1%), grain yield (6240 kg/ha) and stover yield (8630 kg/ha) than those given 40 kg N/ha or no nitrogen (Table 1). The crop fertilized with 120kg N/ha remaining at par yield attributes with those given 80 and 160kg N/ha and proved superior over no nitrogen and 40kg N/ha in terms of yield and yield attributes. Cobs/plant and harvest index did not influenced by different nitrogen levels, The sink capacity of the plant is depends mainly on vegetative growth of the plants and vigorous vegetative growth increased leaf area index with the application of higher dose of nitrogen, consequently supply of photosynthates for the formation of yield components was also enhanced. The results are in close conformity with the findings of Sabh Jeet *et al.* (2012), Raja (2000) and Sharma *et al.* (2000). The significantly higher B: C ratio, crop profitability and crop productivity at the slightly higher levels of nitrogen (120 kg N/ha) than lower levels (Table 2). The application of 120 kg N/ha gave the highest benefit: cost ratio (2.0), crop profitability (322.42/ha/day) and crop productivity (61.76 kg/ha/day) closely followed by 160 kg N/ha (Sabh Jeet *et al.*, 2012, Pal and Bhatnagar, 2009 and Sharma *et al.*, 2000). Crop productivity and crop profitability was positively correlated with correlation co-efficient of 0.998 (R²). This was further supported by the regression analysis (equation 1). Thus, unit increase in crop profitability caused increase in crop productivity by 29.44 kg/ha/day (Fig. 3). The increase in crop profitability with increase in crop productivity was also reported by Chaudhary *et al.* (2002).

$Y = 0.100x + 29.44$

(R² = 0.998).....1

Table 3: Correlation coefficient study among yield attributes, yield and economics

	Grain yield (kg/ha)	Stover Yield (kg/ha)	Net return (₹/ha)	Cobs /plant	Cobs length (cm)	Cobs girth (cm)	Grain rows /cob	Grains /row	Grains/ cob	1000 grain weight (g)
Grain yield(kg/ha)	1.000**									
Stover Yield (kg/ha)	0.972**	1.000**								
Net return (/ha)	0.999**	0.973**	1.000**							
Cob /plant	0.846**	0.749**	0.848**	1.000**						
Cobs length (cm)	0.865**	0.891**	0.857**	0.572**	1.000**					
Cobs girth (cm)	0.749**	0.772**	0.744**	0.681**	0.767**	1.000**				
Grain rows/cob	0.873**	0.870**	0.867**	0.763**	0.914**	0.914**	1.000**			
Grains/row	0.921**	0.898**	0.914**	0.713**	0.958**	0.799**	0.916**	1.000**		
Grains/cob	0.929**	0.915**	0.924**	0.777**	0.930**	0.884**	0.978**	0.977**	1.000**	
1000 grain weight(g)	0.937**	0.938**	0.933**	0.742**	0.944**	0.804**	0.881**	0.971**	0.953**	1.000**

Note: Correlation coefficient is significant at *P=0.05 and **P=0.01 level of significance.

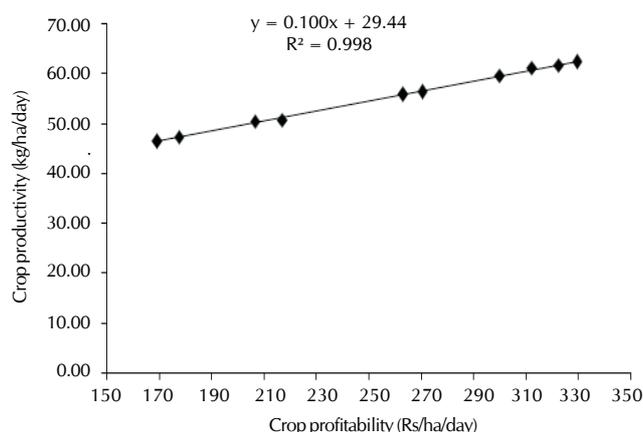


Figure 3: Regression between crop productivity and crop profitability

Association among traits measured by correlation coefficient revealed a significant and positive correlation (Table 3). The grain yield of maize was significant and positively correlated stover yield ($r = 0.972$), net return ($r = 0.999$), cobs/plant ($r = 0.846$), cobs length ($r = 0.865$), cobs girth ($r = 0.749$) grain rows/cobs ($r = 0.873$), grain/rows ($r = 0.921$), grain/cobs ($r = 0.929$) and 1000 grain weight ($r = 0.937$). Test weight (1000 grain weight) which was yield determined attributes also significant and positively correlated with other yield attributing characters viz. stover yield ($r = 0.0938$), net return ($r = 0.933$), cobs/plant ($r = 0.742$), cobs length ($r = 0.944$), cobs girth ($r = 0.804$) grain rows/cobs ($r = 0.881$), grain/rows ($r = 0.971$), grain/cobs ($r = 0.953$).

The present investigation confirmed that maize genotype well performed and produced higher yield attributes to the added nitrogen. It was found that genotype Dekalb 900 M Gold produced higher yield attributes that resulted in more grain yield under 160 kg N/ha closely followed by 120 kg N/ha. Correlation matrix among traits (yield attribute and yield) showed significantly and positively associated with each other. This was further supported by the curve fitted regression analysis. However, application of 120kg N/ha caused higher benefit: cost ratio and crop productivity closely followed by 160 kg N/ha. Hence, from the above discussion, it may conclude that genotype Dekalb 900 M Gold well responds to the each unit added nitrogen i.e. 120kg N/ha and saved 40kg N/ha to achieved comparable yield attributes and yield of maize in respect of economics and ecological concern.

REFERENCES

- Choudhary, R. S., Rana, K. S. and Kantwa, S. R. 2002. Effect of cropping system and nitrogen on growth and yield of maize (*Zea mays* L.). *Ann. Agril. Res.* **23**(3): 461-464.
- Kumar, A., Thakur, K. S. and Manuja, S. 2002. Effect of fertility levels of promising hybrids maize (*Zea mays*, L) under rainfed conditions of

Himachal Pardesh. *Indian J. Agronomy.* **47**(4): 526-530.

Muhammad, S., Abdul, A., Muhammad, I. and Abdul, A. 2004. Performance of maize hybrids under different NPK regime. *Sarhad J. Agric.* **20**(1): 93-97.

Pal, M. S. and Bhatnagar, A. 2009. Production potential and economics of winter maize (*Zea mays* L.) cultivars in Tarai belt of Uttarakhand. *Current Adv. Agril. Sciences* **1**(1): 14-16.

Prasad, U. K. and Parsad, T. N. 1988. Production potential of intercrops with winter maize. *Indian Farming.* **38**(7): 9-10.

Raja, A. 2000. Effect of nitrogen and plant population on yield and quality of super sweet corn (*Zea mays* L.). *Indian J. Agronomy.* **46**(2): 246-249.

Sharma, N. N., Paul, S. R. and Sarma, D. 2000. Response of maize (*Zea mays* L.) to nitrogen and phosphorus under rainfed conditions of the hills zone of Assam. *Indian J. Agronomy.* **45**(1): 126-131.

Thomson P. R., Geyer A. B., Bishop B. L., Yong J. R. and Lentz, E. 2004. Nitrogen fertility effects on grain yield, protein and oil of corn hybrids with enhanced grain quality traits. *Crop Management.* pp. 1-7.

Dewey, D. R. and Lu, K. H. 1959. A correlation and path coefficient analysis of components of crested wheat grass and seed production. *Agron. J.* **51**: 515-518.

Gomez, K. A. and Gomez, J. H. 1984. Statistical Procedures for Agricultural Research. *J. Wiley and Sons.*

Hanway, J. J. and Heidel, H. 1952. Soil analysis, as used in Iowa State. College of Soil Testing Laboratory, Iowa, Agriculture. **57**: 1-31.

Watanabe, F. S. and Olsen, S. R. 1965. Test of an ascorbic acid method for determining phosphorus in water and NaHCO_3 extracts. *Soil Sci. Soc. Amr. Proc.* **29**: 677-678.

Subbiah, B. V. and Asija, E. L. 1956. A rapid procedure for estimation of available nitrogen in soil. *Current Sci.* **25**(8): 259-260.

Sabha Jeet, Singh, J. P., Rakesh, K., Prasad, R. K., Pramod, K., Anupma, K. and Prakash, P. 2012. Effect of nitrogen and sulphur levels on yield, economics and quality of QPM hybrids under dryland condition of Eastern Uttar Pradesh, India. *J. Agric. Sci.* **4**(9): 31-38.

Narang and Gill. 2004. A text book of field crops. pp. 89-120.

Rasheed, M., Ali, H. and Tariq, M. 2004. Impact of nitrogen and sulfur application on growth and yield of maize (*Zea mays* L.). *J. Crop Res.* **15**(2): 153-157.

Onasanya, R. O., Aiyelari, O. P., Onasanya, A., Oikeh, S., Nwilene, F. E. N. and Oyelakin, O. O. 2009. Growth and Yield Response of Maize (*Zea mays* L.) to Different Rates of Nitrogen and Phosphorus Fertilizers in Southern Nigeria. *World J. Agric. Sci.* **5**(4): 400-407, 2009.

Khan, A., Jan, A., Bashir, S. and Mammona N. 2005. Effect of nitrogen and seed size on maize crop. *J. Agric. Social Sci.* **1** (4): 380-381.

Lack, S., Naderi, A., Siadat, S. A., Ayenehband, A., Nour-Mohammadi, G. and Moosavi, S. H. 2008. The effects of different levels of irrigation, nitrogen and plant population on yield, yield components and dry matter remobilization of corn at climatical conditions of Khuzestan. *J. Sci. Tech. Agric. Nat. Res.* **11**(42A): 1-15.

Jackson, M. L. 1967. Soil chemical analysis, Prentice Hall of Inc. New York, USA.

