EXCELLENT PUBLISHERS

International Journal of Current Trends in
Pharmacobiology and Medical Sciences

Volume 1 • Number 3 (August-2016) • ISSN: 2456-2432

Journal homepage: www.ijctpms.com

Original Research Article

Effect of Nitrogen Level and Source Management on Grain Yield and Yield Attributes of Maize Genotypes

Gul Roz Khan[1]*, Inamullah[1], Habib Ullah[2], Nawab Ali[1] and Muhammad Mehran Anjum[1]

[1]*Department of Agronomy, University of Agriculture, Peshawar, Pakistan*
[2]*Department of Agric. Chemistry, University of Agriculture, Peshawar, Pakistan*

***Corresponding author.**

Abstract

Effect of nitrogen level and source management on grain yield and yield attributes of maize genotypes was studied at Agronomy Research Farm, The University of Agriculture Peshawar Khyber Pakhtunkhwa Pakistan. Main objective of the study was to find out the effect of various N levels (0, 80, 120, 160 and 200 kg ha^{-1}) obtained from various chemical nitrogenous fertilizers (Urea and Calcium Ammonium Nitrate) on the agronomic performance of various maize genotypes (Jalal, Azam, Iqbal and Kiramat). The experiment was laid out in RCB design with split plot arrangement using three replications. Sub plot size of 4.2m × 3m (12.6m^2), having 6 rows, 3m long and 70cm apart were used. Combinations of different N levels and N sources were allotted to main plots while genotypes were assigned to subplots. Uniform basal dose of 60 kg ha^{-1} SSP and SOP each were applied to the soil at sowing. Nitrogen was applied in three splits i.e. 1/3 rd each at sowing, 1st irrigation after emergence and at knee height stage of the plants. Significant differences were observed among various genotypes and various N levels, however, N sources were found not significantly different from each other in various agronomic parameters. Data on various parameters were recorded using standard procedures. Results obtained showed that higher levels of N application increased yield and yield components of maize genotypes. It was observed that higher nitrogen levels of 160 and 200 kg N ha^{-1} increased grains row^{-1} (30 grains), thousand grains weight (279 g), grain yield (4039 kg ha^{-1}) and biological yield (11043 kg ha^{-1}). Among the genotype hybrid Kiramat produced maximum grain yield (3865 kg ha^{-1}). It produced higher and at par values for grains row^{-1} (29 and 28), thousand grain weight (278 and275g) and biological yield (10697 and 10307 kg ha^{-1}) with Jalal. On the basis of this experiment, it was concluded that hybrid Kiramat produced significantly higher grain yield at N level of 160 kg ha^{-1}.

Article Info

Accepted: 23 July2016
Available Online: 25 August 2016

Keywords

Maize
Nitrogen levels
Yield components
Zea mays L.

Introduction

Nitrogen plays a very important role in crop productivity (Zapata and Cleenput, 1986) and its deficiency is one of the major yield limiting factors for cereal production (Shah et al. 2003). To maintain soil fertility and to realize our food requirement, the increase of fertilizer input should not be avoided (Nisar, 2002). Maize yield is most sensitive to nitrogen application (Mohamed, 1993). Improper nitrogen management is a major factor contributing to low yield. Plant absorbs most of its nitrogen in the NH_4^+ and NO_3^- forms. Nitrate (NO_3^-) is often the dominant source of nitrogen since it generally occurs in higher concentration than NH_4^+ (Tisdale et al., 1985). The rate of NO_3^- uptake is usually high and it occurs by active absorption. NO_3^- uptake is favored by low pH conditions. NH_4^+, ideally, is the preferred nitrogen source since energy is saved when it is used instead of NO_3^- for synthesis of protein. NO_3^- must be reduced before it can be incorporated into protein. Also, NH_4^+ is less subject to losses from soil by leaching and denitrification. Plant uptake of NH_4^+ proceeds best at natural pH values and is depressed by increasing acidity (Tisdale et al., 1985).

A comparison of apparent crop recovery of applied N indicated that calcium ammonium nitrate $Ca(NH_4)_2NO_3$ generally referred to as CAN, was a more effective N source than urea under sub humid conditions but urea $[CO(NH_2)_2]$ was more effective under humid conditions (Arora et al., 1986). However, compared with other N fertilizers the efficiency of urea is relatively low because of potential losses due to ammonia volatilization and nitrogen leaching (Rochette et al., 2009). Increase in the amount of urea application than recommended doses increases the nitrogen losses through volatilization and this loss was observed at the rate of 0.11 % in the silty loam having organic matter of 0.3% (Fu et al., 2010).

Nitrogen (N) is lost from the field through three principal pathways: denitrification, leaching and surface volatilization. The nitrate ($NO3^-$) nitrogen is available immediately after its application. It is immediately absorbed in water and is taken up directly by the plant and nutrient losses are almost eliminated. CAN is a hygroscopic product and needs very low moisture to be absorbed by the plants. It is equally effective in water stressed areas where soil has low moisture. Furthermore, Calcium available in CAN is also helpful in soil reclamation (Tisdale et al., 1985).

Studies on the effect of proper combination of N sources and N levels on maize genotypes in the agro-ecological climatic conditions of Peshawar valley of KP are limited. The present research work was therefore conducted to investigate the effects of proper combinations of various N sources and N levels on the agronomic performance of popular maize genotypes including a local maize hybrid and three synthetic varieties in the agro-climatic conditions of Peshawar valley.

Materials and methods

Effect of various nitrogen levels and sources on grain yield and yield components of various maize (*Zea mays* L.) genotypes was studied in a field experiment conducted at Agronomy Research Farm, The University of Agriculture Peshawar Khyber Pakhtunkhwa Pakistan during summer 2009. During the experiment the effects of various nitrogen levels obtained from different nitrogen sources on growth and yield of maize synthetic varieties (Jalal, Azam and Iqbal) and a hybrid (Kiramat) were studied. Sowing was done on July 10, 2009. Five N levels including control i.e. 0, 80, 120, 160 and 200 kg ha^{-1} obtained from two commercial nitrogenous fertilizer sources i.e. Urea $[CO(NH_2)_2]$ having 46% nitrogen and Calcium Ammonium Nitrate $Ca(NH_4)_2NO_3$ having 26% nitrogen were used. The experiment was conducted in RCB design with split plot arrangement using three replications. Combinations of nitrogen levels and sources were allotted to main plots while maize genotypes were assigned to sub plots. A sub plot size of 4.2m x 3m ($12.6m^2$), having 6 rows, 3m long and 70cm apart was used. A uniform basal dose of 60 kg ha^{-1} P_2O_5 as SSP (18% P_2O_5) and 60 kg ha^{-1} K_2O as SOP (50% K_2O) were applied and mixed with the soil during seed bed preparation. Nitrogen was applied in three splits i.e. 1/3 rd each at sowing, 1st irrigation after emergence and at knee height stage of the crop. All other agronomic practices like hoeing, irrigation and insecticide application were carried out uniformly. The experiment was harvested on October 22, 2009.

Data were recorded on the following parameters: Ears $plant^{-1}$ were counted in ten plants randomly selected in central four rows in each subplot and then average ears $plant^{-1}$ was worked out. For grain rows ear^{-1}, five randomly selected ears were taken from each subplot. Number of grain rows were counted on each ear and then averaged to record rows ear^{-1}data. Number of grains row^{-1} was recorded by counting the number of grains in all rows of the five selected ears from each subplot and then their average was calculated. Data on thousand grain weight were recorded by taking thousand grains randomly from the shelled grains in each subplot and were weighed through electronic balance in grams. For grain yield (kg ha^{-1}), grains obtained after shelling of ears of all the plants harvested from the central four rows in each subplot were weighed after drying. Grain yield thus obtained was converted into grain yield (kg ha^{-1}) using the following formula:

$$\text{Grain yield (kg ha}^{-1}\text{)} = \{\text{Grain yield (kg)} / 8.4\text{m}^2\} \times 10000$$

Biological yield was recorded by weighing all the plants harvested from central four rows in each subplot and then converted into kg ha^{-1} using the formula:

$$\text{Biological yield (kg ha}^{-1}\text{)} = \{\text{Biological yield (kg)}/ 8.4\text{m}^2\} \times 10000$$

The data were analyzed statistically according to RCB design with split arrangement (Jan et al, 2009). Least significant difference (LSD) test was employed upon obtaining significant differences among various levels of the treatments and treatment interactions (Steel and Torrie, 1980).

Results and discussion

Ears plant^{-1}

Statistical analysis of the data showed that neither N levels and sources nor genotypes showed any significant difference among themselves for ears plant^{-1}. The interaction among genotypes, nitrogen levels and N sources also showed a non-significant impact on ears plant^{-1} of maize (Table 1; Fig.1). Ears plant^{-1} is a factor which is mostly genetically controlled. Our results were not in accordance to the findings of Ali (1994) who reported that ears plant^{-1} was affected by environmental factors and soil fertility levels.

Grain rows ear^{-1}

Statistical analysis of the data showed that neither N levels and source nor genotypes showed any significant difference among themselves for grain rows ear^{-1}. The interactions also showed a non-significant impact on grain rows ear^{-1} (Table 1; Fig.1). This might be due to the fact that rows ear^{-1} was genetically controlled character and among these tested genotypes no significant difference was observed in rows ear^{-1}. Our results are in disagreement to those reported by Turi et al. (2007). It was observed that grains row^{-1} in maize increased with increase in nitrogen level.

Number of grains row^{-1}

Statistical analysis of the data showed that maize genotypes were significantly different from each other in number of grains row^{-1} at $p \leq 0.01$. Various N levels $p \leq 0.01$ and the interaction of N×G also affected number of grains row^{-1} significantly ($p \leq 0.05$). However, the effects of N sources and the interactions of N × S, S × G and N × S × G on number of grains row^{-1} was found non significant (Table 2; Fig. 2).

Maximum number of grains row^{-1} (29) was produced by the hybrid Kiramat followed by varieties Jalal and Iqbal with at par number of 28 grains while the minimum number of 27 grains row^{-1} was produced by variety Azam. It was also observed that maximum number of grains row^{-1} (30 grains) row^{-1} was recorded in plots fertilized with 200 kg ha^{-1} N, while minimum number of 26 grains row^{-1} was observed where 80 kg ha^{-1} N was applied. These finding are in according to the findings of Gokmen et al. (2001). They reported increase in grains row^{-1} with increase in nitrogen concentration. It was observed that the hybrid Kiramat and variety Jalal produced more grains row^{-1} as compared with other genotypes. It might be the genetic characteristic of Kiramat and Jalal to produce more grains row^{-1}. Similar results were also mentioned by Turi et al. (2007). Similarly significant differences were also observed in grains row^{-1} of various maize genotypes in interaction with nitrogen. Hybrid Kiramat and variety Jalal showed significantly higher number of grains row^{-1} in plots which received 160 and 200 kg ha^{-1} nitrogen.

Table 1. Ears plant^{-1} and Grain rows ear^{-1} of various maize genotypes as affected by various nitrogen levels and sources.

Treatment		**Ears plant^{-1}**	**Grain rows ear^{-1}**
Control vs rest	Control	1	12
	Rest	1	12
Nitrogen levels (N) (kg ha^{-1})	80	1	12
	120	1	12
	160	1	12
	200	1	12
LSD (0.05)		ns	ns
N Sources (S)	Urea	1	12
	CAN	1	12
LSD (0.05)		ns	ns
Genotypes (G)	Jalal	1	13
	Azam	1	13
	Kiramat	1	13
	Iqbal	1	12
LSD (0.05)		ns	ns
Interactions	N × S	ns	ns
	N × G	ns	ns
	S × G	ns	ns
	N × S × G	ns	ns

Mean values in the same category followed by different letters are significantly different from one another at 5 % level of probability; ns = non significant.

Table 2. Grains row^{-1} and 1000 grain weight (g) of various maize genotypes as affected by various nitrogen levels and sources.

Treatment		Grains row^{-1}	1000 grain weight (g)
Control vs rest	Control	22 b	228 b
	Rest	28 a	268 a
Nitrogen levels	80	26 b	253 b
(N) (kg ha^{-1})	120	27 b	263 b
	160	29 a	278 a
	200	30 a	279 a
LSD (0.05)		1.567	12.33
N Sources (S)	Urea	28	271
	CAN	28	266
LSD (0.05)		ns	ns
Genotypes (G)	Jalal	28 ab	275 a
	Azam	27 b	266 b
	Kiramat	29 a	278 a
	Iqbal	28 ab	255 c
LSD (0.05)		1.214	6.466
Interactions	N × S	ns	ns
	N × G	* (Fig.1)	ns
	S × G	ns	ns
	N × S × G	ns	* (Fig. 2)

Mean values in the same category followed by different letters are significantly different from one another at 5% level of probability; * = significant at 5% level of probability, ns = non significant.

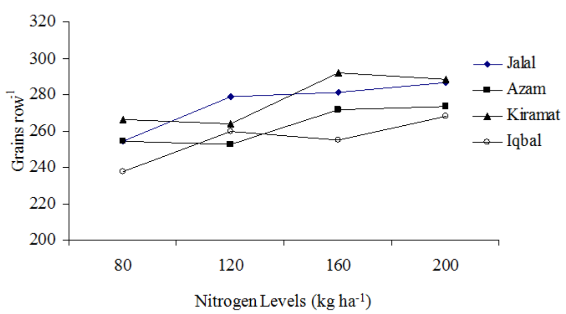

Fig. 1: Interaction of N×G for number grains row^{-1} of various maize genotypes as affected by different nitrogen levels.

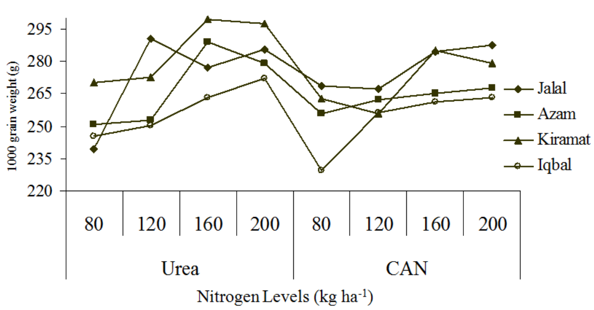

Fig. 2: Interaction of N×S×G for thousand grain weight (g) of various maize genotypes as affected by different nitrogen levels and sources.

Thousand grain weight (g)

Statistical analysis of the data showed that maize genotypes were significantly different ($p\leq0.01$) from each other in thousand grain weight. The effect of N levels ($p\leq0.01$) and the interaction of N×S×G also affected thousand grain weight significantly ($p\leq0.05$). However, the effects of N sources and the interactions of N×S, N×G and G×S on thousand grain weight was found non significant (Table 2). Maximum and at par thousand grain weight of 278 and 275 g was recorded for Kiramat and Jalal respectively It was observed that the highest and at par thousand grain weight (278 and 279 g) was produced in plots fertilized with 160 and 200 kg ha^{-1} N while the lowest and at par thousand grain weight (253 and 263 g) was produced in plots where 80 and 120 kg ha^{-1} N was applied, respectively. This might be due to the reason that nitrogen is a key factor in increasing vegetative growth which later on results in increased photosynthates production and thus heavier grains are produced. Our results were in accordance to those reported by Masood et al. (2003) and Shah et al. (2009). Significant differences were observed for thousand grains weight of various maize genotypes. Hybrid Kiramat and variety Jalal showed maximum and at par thousand grains weight as compared with Azam and Iqbal. Shah et al. (2009) reported that increase in thousand grain weight of certain genotypes is the genetic characteristic as well as it is affected by the availability of nutrients. Significant differences were also observed for thousand grains weight of various maize genotypes in interaction with nitrogen levels and sources. Hybrid Kiramat produced maximum thousand grain weight when 160 and 200 kg ha^{-1} N was applied from either N source Urea or CAN.

Grain yield (kg ha^{-1})

Statistical analysis of the data showed that maize genotypes were significantly different from each other ($p\leq0.01$) in grain yield. The effect of N levels and the interaction of N×G also affected grain yield of maize genotypes significantly ($p\leq0.01$). However, the effects of N sources and the interactions of N × S, S × G and N × S × G on grain yield was found non significant (Table 3; Fig. 3). Maximum grain yield of 3865 kg ha^{-1} was recorded by the hybrid Kiramat followed by Jalal with 3643 kg ha^{-1} grain yield. The highest amount of 4039 kg ha^{-1} grain yield was produced in plots fertilized with 200 kg ha^{-1} N, followed by plots fertilized with 160 kg ha^{-1} N which produced 3879 kg ha^{-1} grain yield while the smallest amount of 2764 kg ha^{-1} grain yield was produced in plots where 80 kg ha^{-1} N was applied. This might be due to the reason that for higher grain yield, higher production of photosynthates is required which is provided by the plant in the presence of optimum nutrients. Nitrogen acts as a major constituent for increasing the photosynthates production which ultimately results in higher grain yield. Significant differences were observed for grain yield of various maize genotypes in interaction with nitrogen. Kiramat produced maximum grain yield in plots fertilized with 160 to 200 kg ha^{-1} N. This might be due to the genetic characteristic of Kiramat to produce higher grain yield at higher N levels. Similar results were reported by Bakht et al. (2004).

Table 3. Grain yield (kg ha^{-1}) and biological yield (kg ha^{-1}) of various maize genotypes as affected by various nitrogen levels and sources.

Treatment		**Grain yield (kg ha^{-1})**	**Biological yield (kg ha^{-1})**
Control vs	Control	1440 b	5382 b
rest	Rest	3463 a	9521 a
Nitrogen	80	2764 d	8055 d
levels (N)	120	3231 c	8987 c
(kg ha^{-1})	160	3879 b	10159 b
	200	4039 a	11043 a
LSD (0.05)		119.7	327.5
N Sources	Urea	3488	9557
(S)	CAN	3437	9485
LSD (0.05)		ns	ns
Genotypes	Jalal	3643 b	10307 a
(G)	Azam	3372 c	9090 b
	Kiramat	3865 a	10697 a
	Iqbal	3032 d	8150 c
LSD (0.05)		125	404.2
Interactions	N × S	ns	ns
	N × G	** (Fig. 3)	* (Fig 4)
	S × G	ns	ns
	N × S × G	ns	ns

Mean values in the same category followed by different letters are significantly different from one another at 5% level of probability; * = significant at 5% level of probability, ns = non significant; ** = significant at 1% level of probability.

Biological yield (kg ha^{-1})

Statistical analysis of the data showed that maize genotypes were significantly different from each other ($p \leq 0.01$) in biological yield. The effect of N levels and the interaction of N×G also affected biological yield significantly ($p \leq 0.01$). However, the effects of N sources and the interactions of N × S, G × S and N × S × G on biological yield was found non significant (Table 3; Fig. 4). Maximum and at par biological yields of 10697 and 10307 kg ha^{-1} were recorded by the Kiramat and Jalal while minimum biological yield (8150 kg ha^{-1}) was recorded by Iqbal. The highest biological yield of 11043 kg ha^{-1} was produced in plots applied with 200 kg ha^{-1} N while the lowest biological yield of 8055 kg ha^{-1} yield was produced in plots where 80 kg ha^{-1} N was applied. Maximum biological yield was recorded in plots fertilized with 160 and 200 kg N ha^{-1} while minimum biological yield was recorded in plots which were fertilized with low level of nitrogen. Similarly maximum and at par harvest indices were calculated for plots applied with 160 and 200 kg N ha^{-1}. Our results are supported by Gokmen et al. (2001), who reported increase in both biological yield and harvest index with increase in nitrogen application. It was also observed that the hybrid Kiramat and variety Jalal produced maximum and at par biological yields as compared with other genotypes. It might be the genetic characteristic of hybrid Kiramat and variety Jalal to produce higher biological yield.

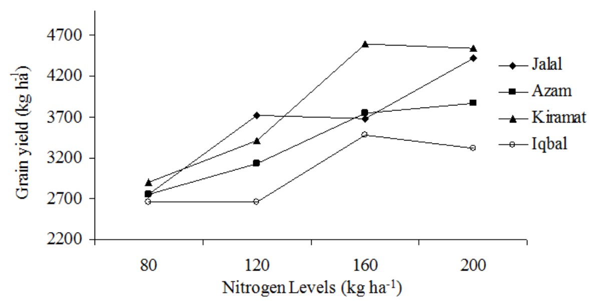

Fig. 3: Interaction of N×G for grain yield (kg ha^{-1}) of various maize genotypes as affected by different nitrogen levels.

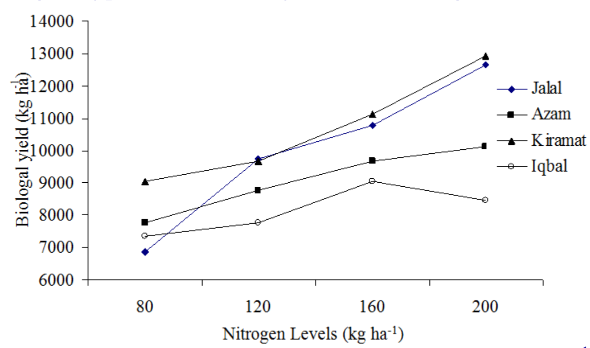

Fig. 4: Interaction of N×G for biological yield (kg ha^{-1}) of various maize genotypes as affected by different nitrogen levels.

Biological yield (kg ha^{-1})

Statistical analysis of the data showed that maize genotypes were significantly different from each other

($p \leq 0.01$) in biological yield. The effect of N levels and the interaction of N×G also affected biological yield significantly ($p \leq 0.01$). However, the effects of N sources and the interactions of N × S, G × S and N × S × G on biological yield was found non significant (Table 3; Fig. 4). Maximum and at par biological yields of 10697 and 10307 kg ha^{-1} were recorded by the Kiramat and Jalal while minimum biological yield (8150 kg ha^{-1}) was recorded by Iqbal. The highest biological yield of 11043 kg ha^{-1} was produced in plots applied with 200 kg ha^{-1} N while the lowest biological yield of 8055 kg ha^{-1} yield was produced in plots where 80 kg ha^{-1} N was applied. Maximum biological yield was recorded in plots fertilized with 160 and 200 kg N ha^{-1} while minimum biological yield was recorded in plots which were fertilized with low level of nitrogen. Similarly maximum and at par harvest indices were calculated for plots applied with 160 and 200 kg N ha^{-1}. Our results are supported by Gokmen et al. (2001), who reported increase in both biological yield and harvest index with increase in nitrogen application. It was also observed that the hybrid Kiramat and variety Jalal produced maximum and at par biological yields as compared with other genotypes. It might be the genetic characteristic of hybrid Kiramat and variety Jalal to produce higher biological yield.

Conflict of interest statement

Authors declare that they have no conflict of interest.

References

Akbar Ali, Z., 1994. Studies on comparative economic returns of different maize genotypes. M.Sc. Thesis, Deptt. Agronomy, University of Agriculture, Faisalabad, Pakistan.

Arora, Y., Nnadi, L.A., Juo, A.S.R., 1986. Nitrogen efficiency of urea and calcium ammonium nitrate for maize (*Zea mays* L.) in humid and sub-humid regions of Nigeria. J. Agric. Sci. 109, 47-51.

Bakht, J., Ahmad, S., Tariq, M., Akbar, H., Shafi, M., 2006. Response of maize to planting methods and fertilizer. Niger. J. Agric. Biosci. 1(3), 814-846.

Fu, X., Shao, M., Wei, X., Horton, R., 2010. Potential urea-derived nitrogen losses caused by ammonia volatilization and nitrogen leaching in a rain-fed semiarid region. J. Soil Plant Sci. 60, 560-568.

Gokmen, S., Sencar, O., Sakin, M.A., 2001. Response of popcorn (*Zea mays* everta) to nitrogen and plant densities. Turk. J. Agric. Forest. 25, 15-23.

Jan, M.T., Shah, P., Hollington, P.A., Khan, M.J., Sohail, Q., 2009. Agriculture Research: Design and Analysis. A Monograph. Department of Agronomy, NWFP Agriculture, University, Peshawar, Pakistan.

Masood, M., Shamsi, I.H., Hussain, N., Shah, W.A., 2003. Performance of various maize varieties as affected by different NP levels. Asian J. Plant Sci. 2(7), 535-538.

Mohamed, A.A., 1993. Effect of nitrogen fertilization levels on the performance and combining ability of maize hybrids (*Zea mays* L.). Ann. Agric. Sci. 38(2), 531-549.

Nisar, A., 2002. Soil fertility management: Key to food security and poverty alleviation. 9th Int. Cong. Soil Sci., March 2002, Faisalabad, Pakistan.

Rochette, P., Angers, D.A., Chantigny, M.H., Macdonald, J.D., Bissonnette, N., Bertrand, N., 2009. Ammonia volatilization following surface application of urea to tilled and no-till soils. J. Soil Till. Res. 103(2), 310-315.

Shah, S.T.H., Zamir, M.S.I., Waseem, M., Ali, A., Tahir, M., Khalid, W.B., 2009. Growth and yield response of maize (*Zea mays* L.) to organic and inorganic sources of nitrogen. Pak. J. Life Soc. Sci. 7(2), 108-111.

Shah, Z., Shah, S.H., Peoples, M.B., Herriedge, G.D., 2003. Crop residue and fertilizer N effect on nitrogen fixation and yields of legume-cereal rotation and soil organic fertility. Field Crops Res. 83, 1-11.

Steel, R.G.D., Torrie, J.H., 1980. Principles and Procedures of Statistics. A Biological Approach. 2nd Edn. McGraw Hill Inc., New York.

Tisdale, S.L., Nelson, W.L., Beaton, J.D., 1985. Soil Fertility and Fertilizer. Collier Macmillan Inc., Canada. 120p.

Turi, N.A., Shah, S.S., Ali, S., Rahman, H., Ali, T., Sajjad, M., 2007. Genetic variability for yield parameters in maize (*Zea mays* L.) genotypes. J. Agric. Bio. Sci. 2, 4-5.

Zapata, F., Cleenput, O.V., 1986. Recovery of N^{15} labelled fertilizer by sugar beet, spring wheat and winter sugar beet cropping sequences. J. Fertil. Res. 8, 269-178.

How to cite this article:
Khan, G. R., Inamullah, Ullah, H., Ali1, N., Anjum, M. M., 2016. Effect of nitrogen level and source management on grain yield and yield attributes of maize genotypes. Int. J. Curr. Trend. Pharmacobiol. Med. Sci. 1(3), 65-70.