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Effect of various levels of NP fertilizers on maize (*Zea mays* L.) under different moisture conditions

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Abstract

The present study was conducted in the University of Agriculture, Peshawar, Pakistan research farm to investigate the effectiveness of various levels of nitrogen (N), phosphorus (P) fertilizers and irrigation (I) on growth and yield components of maize crop (*Zea mays* L.) as well as total P and N. The experiment was laid out in Split block design replicated three times. The experiment comprised of two main plots where two levels of irrigations were applied i.e. irrigation at the same day of sowing field capacity (FC) 50-60 % (I_1) and irrigations after five days of sowing (FC) 20- 30 % (I_2). While in the subplots Nitrogen (N) using urea and Phosphorus (P_2O_5) using single super phosphate were applied in the following combination i.e. 0:0, 50:0, 50:60, 50:90, 100:0, 100:60, 100:90, 150:0, 150:60, 150:90. The results showed that the treatments combinations N_3P_3, I_1N_3 and I_1P_3 yielded maximum plant height, weight of grains ear^{-1}, and grain yield. The total P and N concentration in plant leaves were also highest at the interactions N_3P_3, I_1N_3, and I_1P_3. It is concluded that application of irrigation on same day after NP fertilizers 150 and 90 kg ha^{-1} is much better than other treatments. These results suggest that irrigation move added urea and SSP from the surface layer to sub soil layers where it is likely to make good contact with plant roots.

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Introduction

Maize (*Zea mays* L.) is a member of family Gramineae, and its rank third position after wheat and rice throughout the world. It is widely sown in tropical subtropical and temperate areas. Maize is cultivated extensively in various countries of the world. United States, France, Brazil, India and Italy are the countries which produce maize in greater amount. Starch, glucose and corn oil are produced by maize; in addition to this bio fuel such as ethanol is also produced in the world (Ahmad *et al.,* 2007). Throughout Pakistan maize is grown over an area of 939 thousands hectares and its annual production is 3341 thousands tones with average yield of 3264 kg ha^{-1} (Government of Pakistan, 2011). Maize production is not good despite of having large land areas. Some of the major causes for low maize production are less fertile soils and improper use of fertilizers which results in depletion of elements from soil (Buresh *et al.,* 1997). It is necessary to supply adequate nutrients mainly nitrogen (N) and phosphorus (P) to achieve good growth and high yield.

Among the essential plant nutrients N plays a vital role in plant growth and development since N is a primary part of chlorophyll (Schrader, 1984, Marschner, 1986). Moreover N is element of many molecules in plants like amines, amides and nucleotides as a result sufficient N is needed for better crop yield (Abid *et al.,* 2005), stated that N is a crucial element for obtaining highest production of maize. Besides nitrogen phosphorus is another important element which increases maize production (Chen *et al.,* 1994). P plays role in reproductive system in plants and in majority of soils it is the second most crop-limiting element (Wojnowska *et al.,* 1995). After nitrogen it is the second one which is mostly used in fertilizers. Appliance of P effects performance of plant growth (Kaya *et al.,* 2001; Gill *et al.*, 1995). P is mobile element in plants which quickly transfers from older tissues to younger ones as a result root, leaves and stem growth occurs (Ali *et al.,* 2002). Vegetative growth of plants increase besides this plant growth and maturity rapidly occurs by the supply of sufficient P. In Pakistani soils P deficiently is greatly found. About 90 % soils are recorded as P deficient so to overcome this problem and to achieve high yield phosphatic fertilizers are vitally necessary (Rashid and Memon, 2001).

In addition to this maize performs well too many management operations such as irrigation, N and P fertilization. Irrigation timing is most important for efficient use of water which results in maximum maize yield. Nutrients availability and soil moisture have an important relationship. Moreover fertilizers can be use in an efficient manner under the proper irrigation conditions. Restrictions in plant growth can be reduced through adequate nutrients as well as good moisture conditions which increased nutrients consumption (Michael, 1981). In maize crop days to emergence and number of leaves are not significantly affected by moisture stress however moisture support tasseling initiation and emergence of silking besides it decreased vegetative reproduction and plant height (Khaliq *et al.,* 2008; Chandrashekra *et al.,* 2000). The principal aim of the present study was to find out the optimal nitrogen and phosphorus requirement of maize for improving yield and effect of different timing of irrigation on nitrogen and phosphorus fertilizers and crop yield.

Materials and methods

The present experiment was carried out at The University of Agriculture Peshawar, in new developmental farm during summer season. The test was set in split plot design replicated thrice. Two levels of irrigation was applied in main plots i.e. irrigation at the same of sowing field capacity (FC) 50-60 % (I_1) and irrigation after five days of sowing FC 20-30 % (I_2), whereas in the subplots Nitrogen (N) using urea and Phosphorus (P_2O_5) using single super phosphate were applied in the following combinations i.e. 0:0, 50:0, 50:60, 50:90, 100:0, 100:60, 100:90, 150:0, 150:60, 150:90. Plot size was kept 10.5 m^2 and maize variety AZAM was sown. In the all plots a basal dose of K_2O at the rate 60 kg ha^{-1} was applied. Management practices like weeding, hoeing and irrigation fulfill uniformly in all the experimental units. The various physico-chemical characteristics of the soil were analyzed and samples were obtained from the field at 0-10 cm depth as shown in (Table 1). The soil was sieved at 2 mm, air dried then at room temperature. The soil was silt loam low in Organic matter 0.9 %, sand 41.4 %, silt 7.2 %, clay 51.4 %, $pH_{(1:5)}$ 7.95, Electrical $conductivity_{(1:5)}$ 1.12 dSm^{-1}, total N 0.1 %, extractable P 2.14 mg kg^{-1}. The experimental site is located at 34.01° N latitude, 71.35° E longitude and at altitude of 350 m above sea level. The majority of soils in KPK are calcareous in nature which contain high amount of calcium carbonate and belongs to Pedocals soil series having dry soils. The average annual rainfall ranges between 300 and 500 mm per year and the climatic conditions in this region are semi arid (Amanullah *et al.,* 2009b).

Table 1. Physico-chemical characteristics of soil under investigations.

Soil properties	Unit	Values
Sand	%	41.4
Clay	%	51.4
Silt	%	7.2
Soil texture	-	Silt loam
$pH_{(1:5)}$	-	7.95
$EC_{(1:5)}$	d Sm^{-1}	1.12
Lime	%	15.3
Organic matter	%	0. 9
Total nitrogen content	%	0.1
Bulk density	gm cm^{-3}	1.35
AB-DTPA extractable P	mg kg^{-1}	2.14

Collection of plant and soil samples

The various parameters recorded during developmental and growth at distinct phases of crop were Number of leaves, Plant height, Weight of grains ear-1 and Grain yield.

Plant height (cm)

Inch tap was used to record plant height in centimeter.

Grain yield (kg ha^{-1})

To record grain yield the middle two lines were harvested from each plot through sickle. Ears of harvested plants were detached, after sun drying threshed with a small sheller. With the help of an electronic balance the grains obtained from ears of the each plot were weighted. The data was then converted into kg ha^{-1} by the following formula;

$$\text{Grain yield (kg per hectare)} = \frac{\text{Grain yield per plot} \quad \text{x 10,000}}{\text{R} - \text{R distance (m) x Row length (m) x No. of Rows}}$$

Soil analysis

Before sowing four composite soil samples, comprising 10 randomly collected soil cores (0–10 cm) each collected and passed through a 2 mm sieve to remove visible plant litter and roots. Sieved soil samples were analyzed for soil physical and chemical properties such as, soil texture, electrical conductivity (EC), pH, total nitrogen (N), organic matter (OM), cation exchange capacity (CEC), and AB-DTPA extractable Phosphorus (P). Soil moisture and temperature at 0-10 cm soil depth was monitor.

Determination of total P in plant samples

P concentration in plant sample was determined by spectrophotometer. In this method 0.5 g plant sample was digested by adding 10 ml concentrated HNO_3 and left overnight. The next day sample was taken into hard plates and 4 ml $HClO_4$ was added. The samples were digested till whites fumes produced then left for cooling. The volume was made by adding 50 ml distilled water and samples were taken into plastic bottles. One ml sample was taken from each sample then 5 ml of ascorbic acid was added and made the volume up to 25 ml. Samples were placed for 15 minutes for colour development. Then P was determined by spectrophotometer (Lambda-35), at 880 nm after proper colour development.

Determination of total N in plant samples

Total N in plant samples was determined by the Kjekdhal method. In this method, 0.2 g of finely ground samples of dry materials was digested with 3 ml of concentrated H_2SO_4 in the presence of 1.1 g digestion mixture containing $CuSO_4$, K_2SO_4 and Se on a heating mantle for about 1 hour. The digest was transferred quantitatively to the distillation flask and distilled in the presence of 4ml of 40 % NaOH. The distillate was collected in 5 ml boric acid mixed indicator solution and then titrates against 0.01 M HCl.

The total nitrogen in plant was calculated as follow:

$$\text{Total nitrogen (\%)} = \frac{\text{(Sample-Blank)*0.005*0.014*100*100}}{\text{Wt. of sample}}$$

Statistical analysis

The data recorded was analyzed using formulas in MS excel sheet suitable for Split plot design. Comparisons of means were done by utilizing LSD test at 5 % level of probability.

Results

Number of leaves

The interaction of irrigation, nitrogen and phosphorus for number of leaves found to be non-significantly affected at $P < 0.05$ (Table 2). The numbers of leaves among different treatment combination of nitrogen and phosphorus were non-significantly different at $P < 0.05$. Maximum number of leaves were recorded from interaction effect of N_3P_2 (11.50), followed by N_2P_3 (11.33), and N_3P_1 (11.17) while minimum number of leaves were recorded from N_1P_1 (9.83) and control which is (9.50). Means value for number of leaves plant^{-1} affected by the different combination of irrigation and nitrogen were found to be non- significantly different at $P < 0.05$. Maximum number of leaves plant^{-1} was recorded from treatment combination of I_1N_3 (12.44) while minimum number of leaves plant^{-1} was recorded from control where it value was (9.50) which were lowest as compared to other treatments. Means value for number of leaves plant^{-1} affected by the different combination of irrigation and phosphorus were significantly different. Maximum number of leaves plant^{-1} was recorded in interaction I_1P_3 (11.89) whereas minimum numbers of leaves plant^{-1} were observed in the treatment combination I_2P_3 (10.33) and I_2P_1 (10.33).

Table 2. Effect of different levels of irrigation, nitrogen and phosphorus on number of leaves of maize.

		Irrigations		
Nitrogen (N)	Phosphorus (P)	I 1	I 2	N × P
1	1	10.00 fg	9.67 g	9.83 b
1	2	10.67 ef	11.33 cde	11.00 a
1	3	11.33 cde	10.67 ef	11.00 a
2	1	10.33 f	11.33 cde	10.83 ab
2	2	11.00 d	10.67 ef	10.83 ab
2	3	11.67 bcd	11.00 de	11.33 a
3	1	12.33 ab	10.00 fg	11.17 a
3	2	12.33 ab	10.67 ef	11.50 a
3	3	12.67 a	9.33 g	11.00 a
	1	10.89 ab	10.33 b	10.61 a
	2	11.33 a	10.89 ab	11.11 a
	3	11.89 a	10.33 b	11.11 a
1		10.67 ab	10.56 ab	10.61 a
2		11.00 ab	11.00 ab	11.00 a
3		12.44 a	10.00 b	11.22 a
		11.37 a	10.52 b	
	Planned Mean comparison			
	Control	9.50		
	Rest	10.94		

Means followed by different letters are significantly different from one another at 5% level of probability.

Plant height (cm)

The interaction of irrigation, nitrogen and phosphorus interactions for plant height was highly significantly different at $P < 0.05$ (Table 3). Data regarding plant height indicates that the interaction of nitrogen and phosphorus were non-significantly differences at $P < 0.05$. The mean values shows that maximum plant height was recorded from combination of N_2P_2 (201.37 cm) followed by N_3P_2 (197.70 cm), and N_3P_3 (196.03 cm). While plant height was minimum at N_1P_1 (171.67 cm) and control which was (162.66 cm). The interaction of irrigation and nitrogen showed significant difference. Means values indicated that plant height was maximum at treatment combination I_1N_3 (202.93 cm) whereas minimum plant height was recorded from I_1N_1

(182.43 cm). The combination of irrigation and phosphorus were significantly different. Maximum plant height was measured at the interaction effect I_1P_3 (200.27 cm) followed by I_1P_2 (201.39 cm), I_2P_2 (194. 72 cm), I_2P_1 (191.06 cm) and I_2P_3 (188.63 cm) whereas minimum plant height was recorded from the interaction effect I_1P_1 (182.83 cm).

Table 3. Effect of different levels of irrigation, nitrogen and phosphorus on plant height (cm) of maize.

		Irrigations		
Nitrogen (N)	Phosphorus (P)	I 1	I 2	N × P
1	1	155.33 e	188.00 cd	171.67 c
1	2	197.33 b	192.87 c	195.10 b
1	3	194.63 bc	190.53 c	192.58 b
2	1	197.77 b	190.43 c	194.10 b
2	2	201.63 ab	201.10 ab	201.37 a
2	3	197.97 b	191.50 c	194.73 b
3	1	195.40 bc	194.73 bc	195.07 b
3	2	205.20 ab	190.20 c	197.70 ab
3	3	208.20 a	183.87 d	196.03 ab
	1	182.83 c	191.06 b	186.94 c
	2	201.39 a	194.72 b	198.06 a
	3	200.27 a	188.63 bc	194.45 b
1		182.43 d	190.47bc	186.45 b
2		199.12 a	194.34 b	196.73 a
3		202.93 a	189.60 c	196.27 a
		194.83 a	191.47 b	
		Planned comparison	Mean	
	Control	162.22		
	Rest	193.15		

Means followed by different letters are significantly different from one another at 5% level of probability.

Weight of grains ear^{-1} (g)

The mean values for weights of grains ear^{-1} showed that the interaction of irrigation, nitrogen and phosphorus were significantly different from each other at $P < 0.05$ (Table 4). The combination of nitrogen and phosphorus were non- significantly affected at $P < 0.05$. Results showed that the interaction N_3P_3 (386.51 g) gave maximum weights of grains ear^{-1} while minimum was recorded from the control (207.10 g). The weight of grains ear^{-1} was highly significantly affected by interaction of irrigation and nitrogen. Maximum weight of grains ear^{-1} was measured from combination of I_1N_3 (415.90 g) followed by I_1N_2 (376.96 g) and I_1N_3 (337.99 g) while treatment combination I_1N_1 (252.56 g) gave minimum weight of grains ear^{-1}. The combination of irrigation and nitrogen were also affected significantly. Treatment combination I_1P_2 gave maximum weight of grains ear^{-1} (373. 79 g) and I_1P_3 (362.11 g) and minimum weight of grains ear^{-1} was observed in I_1P_1 (309.52 g).

Table 4. Effect of different levels of irrigation, nitrogen and phosphorus on weight of grains ear^{-1} (g) of maize.

		Irrigations		
Nitrogen (N)	Phosphorus (P)	I 1	I 2	N × P
1	1	187.67 f	318.68 cd	253.18 d
1	2	272.20 de	321.55 cd	296.87 c
1	3	297.82 cde	382.46 b	340.14 b
2	1	345.94 c	374.85 bc	360.40 a
2	2	415.17 ab	348.40 c	381.79 a
2	3	369.75 bc	350.15c	359.95 a
3	1	394.94 ab	338.31 cd	366.63 a
3	2	433.99 a	321.41 cd	377.70 a
3	3	418.76 ab	354.25 c	386.51 a
	1	309.52 c	343.95 ab	326.73 b
	2	373.79 a	330.46 bc	352.12 a
	3	362.11 ab	362.29 ab	362.20 a
1		252.56 d	340.90 c	296.73 b
2		376.96 b	357.80 bc	367.38 a
3		415.90 a	337.99 c	376.95 a
		348.47 a	345.56 a	
		Planned Mean comparison		
	Control	207.10		
	Rest	347.02		

Means followed by different letters are significantly different from one another at 5% level of probability.

Grains Yield (kg ha^{-1})

Data regarding grains yield showed that the interaction of irrigation, nitrogen and phosphorus were affected non-significantly at $P < 0.05$. Grains yield means among different combination of nitrogen and phosphorus were found to be highly significant at $P < 0.05$ (Table 5). Maximum grain yield was observed in interaction N_3P_3 (5977.23 kg ha^{-1}) while minimum grain yield was obtained in control (3412.69kg ha^{-1}) then at N_1P_1 (4327.95 kg ha^{-1}) which showed that the combination N_1P_1 as well as control is a level which was not enhancing yield. Grains yield was significantly affected by the interaction of irrigation and nitrogen. Maximum grains yield were recorded from the interaction I_1N_3 (5979.00 kg ha^{-1}) followed by I_1N_2 (5659.78 kg ha^{-1}) and I_2N_3 (5425.39 kg ha^{-1}) while minimum from I_1N_1 (4664.10 kg ha^{-1}). Grain yield at different treatment combinations of irrigation and phosphorus was highly significantly different. Maximum grains yield were obtained from the combination I_1P_3 (6039.85 kg ha^{-1}) followed by I_2P_3 (5569.94 kg ha^{-1}), I_1P_2 (5393.73 kg ha^{-1}), I_2P_2 (5222.38 kg ha^{-1}) and I_2P_1 (5113.87 kg ha^{-1}) while minimum grain yield was recorded from I_1P_1 (4869.31 kg ha^{-1}).

Table 5. Effect of different levels of irrigation, nitrogen and phosphorus on grain yield (kg ha^{-1}) of maize.

		Irrigations		
Nitrogen (N)	Phosphorus (P)	I 1	I 2	N × P
1	1	3647.61	5008.28 f	4327.95 f
1	2	4620.88	5108.43 ef	4864.66 e
1	3	5723.81 bc	5552.38 cd	5638.09 bc
2	1	5225.39	5119.05 ef	5172.22 d
2	2	5714.28 bc	5095.23 ef	5404.76 cd
2	3	6039.68 ab	5559.02 cd	5799.35 ab
3	1	5734.92 bc	5214.28 def	5474.60 cd
3	2	5846.03 bc	5463.49 cde	5654.76 bc
3	3	6356.06 a	5598.41 cd	5977.23 a
	1	4869.31 e	5113.87 d	4991.59 c
	2	5393.73 bc	5222.38 cd	5308.06 b
	3	6039.85 a	5569.94 b	5804.89 a
1		4664.10 d	5223.03 c	4943.56 c
2		5659.78 b	5257.77 c	5458.78 b
3		5979.00 a	5425.39 bc	5702.20 a
		5434.30 a	5302.06 a	
	Planned Mean comparison			
	Control	3412.69		
	Rest	5368.18		

Means followed by different letters are significantly different from one another at 5% level of probability.

Total P concentration of maize leaves

Data regarding total P showed effect of different combinations of irrigation, nitrogen and phosphorus application were non-significant on total P concentration of maize leaves at P < 0.05 (Table 6). The interaction of nitrogen and phosphorus significantly affected on total P. Maximum total P was recorded at interaction N_3P_3 (3.29 µ g^{-1}) followed by N_3P_2 (3.19 µ g^{-1}), N_2P_3 (2.95 µ g^{-1}), N_3P_1 (2.94 µ g^{-1}), and N_2P_2 (2.40 µ g^{-1}) whereas minimum total P was measured from N_1P_1 and control with values (1.22 µ g^{-1}) and (1.11 µ g^{-1}) respectively. The mean values for total P indicate that different combinations of irrigation and nitrogen were significantly different at P < 0.05. Maximum total P was measured at interaction effect I_1N_3 (3. 39 µ g^{-1}) followed by the interaction effect I_2N_3 (2.88 µ g^{-1}), I_1N_2 (2.84 µ g^{-1}), I_2N_2 (2.14 µ g^{-1}), I_1N_1 (1.40 µ g^{-1}) and minimum total P was calculated from I_2N_1 (1.26 µ g^{-1}). Total P among various interactions of irrigation and phosphorus were also significantly different at P < 0.05. Maximum total P was recorded in combination I_1P_3 (2. 86 µ g^{-1}) followed by I_1P_1 (2.39 µ g^{-1}), I_1P_2 (2.38 µ g^{-1}), I_2P_3 (2.27 µ g^{-1}) and I_2P_2 (2.23 µ g^{-1}) while minimum total P was noted in I_2P_1 (1.79 µ g^{-1}).

Table 6. Effect of different levels of irrigation, nitrogen and phosphorus on total P (µ g-1) concentration of maize leaves.

		Irrigations		
Nitrogen (N)	Phosphorus (P)	I 1	I 2	N × P
1	1	1.33 f	1.10 g	1.22 f
1	2	1.31 f	1.33 f	1.32 ef
1	3	1.56ef	1.35 f	1.46 e
2	1	2.40 d	1.83 e	2.12 d
2	2	2.54 d	2.26 d	2.40 c
2	3	3.56 a	2.33 d	2.95 b
3	1	3.44 ab	2.44 d	2.94 b
3	2	3.28 abc	3.09 c	3.19 a
3	3	3.46 a	3.13 bc	3.29 a
	1	2.39 b	1.79 c	2.09 c
	2	2.38 b	2.23 b	2.30 b
	3	2.86 a	2.27 b	2.57 a
1		1.40 d	1.26 d	1.33 c
2		2.84 b	2.14 c	2.49 b
3		3.39 a	2.88 b	3.14 a
		2.54 a	2.10 a	
	Planned Mean comparison			
	Control	1.11		
	Rest	2.32		

Means followed by different letters are significantly different from one another at 5% level of probability.

Total N concentration of maize leaves

Data regarding total N showed that the interaction of irrigation, nitrogen and phosphorus were non-significant for total N on maize leaves at P < 0.05. Total N was significantly affected by the combination of nitrogen and phosphorus (Table 7). Maximum total N was measured from combination N_3P_3 (0.39 µ g^{-1})

followed by N_3P_2 (0.37 μ g^{-1}), N_2P_2 (0.33 μ g^{-1}), N_2P_3 (0.32 μ g^{-1}) and N_3P_1 (0.31 μ g^{-1}) whereas minimum total N was obtained from control (0.15 μ g^{-1}) and N_1P_1 (0.16 μ g^{-1}). The combination of irrigation and nitrogen were significantly different for total N. Maximum total N was obtained from interaction I_1N_3 (0.41 μ g^{-1}) followed by I_1N_2 (0.32 μ g^{-1}), I_2N_3 (0.30 μ g^{-1}), I_2N_2 (0.30 μ g^{-1}), I_1N_1 (0.25 μ g^{-1}) and minimum total N was calculated at the interaction effect of I_2N_1 (0.20 μ g^{-1}). Total N in various combinations of irrigation and nitrogen were also significantly different. Maximum total N was recorded from the interaction effect of I_1P_3 with the value of (0.36 μ g^{-1}) followed by I_1P_2 (0.34 μ g^{-1}), I_2P_3 (0.32 μ g^{-1}), I_1P_1 (0.28 μ g^{-1}) and I_2P_2 (0.27 μ g^{-1}) whereas minimum was total N was recorded from interaction I_2P_1 (0.22 μ g^{-1}).

Table 7. Effect of different levels of irrigation, nitrogen and phosphorus on total N (μ g^{-1}) concentration of maize leaves.

		Irrigations		
Nitrogen (N)	Phosphorus (P)	I 1	I 2	N × P
1	1	0.17 de	0.15 e	0.16 e
1	2	0.23 d	0.18 de	0.21 d
1	3	0.34 bc	0.28 cd	0.31 c
2	1	0.30 bc	0.25 d	0.28 c
2	2	0.35 b	0.31 bc	0.33 bc
2	3	0.30 bc	0.34 bc	0.32 bc
3	1	0.36 ab	0.27 cd	0.31 c
3	2	0.43 a	0.31 bc	0.37 ab
3	3	0.45 a	0.33 bc	0.39 a
	1	0.28 b	0.22 c	0.25 c
	2	0.34 a	0.27 b	0.30 b
	3	0.36 a	0.32 ab	0.34 a
1		0.25 c	0.20 d	0.23 c
2		0.32 b	0.30 b	0.31 b
3		0.41 a	0.30 ab	0.36 a
		0.33 a	0.27 b	
		Planned Mean comparison		
	Control	0.15		
	Rest	0.30		

Means followed by different letters are significantly different from one another at 5% level of probability.

Discussion

Effect of nitrogen and phosphorus on growth and yield components

The number of leaves plant^{-1} was not significantly affected by the application of nitrogen and by the nitrogen and phosphorus interaction which are similar with the results of (Karasu *et al.,* 2009; Aslam *et al.,* 2011) who observed no significant connectedness between nitrogen and leaves plant^{-1}. On the other hand Nadeem *et al.* (2009), Onasanya *et al.* (2009), Saeed *et al.* (2001) noticed that the numbers of leaves plant^{-1} were increased by nitrogen and by combination of nitrogen and phosphorus. The maximum (11.50) and minimum (9.50) number of leaves plant^{-1} was observed in interaction N_3P_2 and control respectively (Table 2). Same results were reported by Chaudhry and Khade (1991), Cheema (2000), Saeed *et al.* (2001) and Onasanya *et al.* (2009). They noted that with increased level of phosphorus the numbers of leaves were increased.

The maximum plant height (201.37 cm) and (197.70 cm) was noticed in interaction N_2P_2 and N_3P_3 respectively (Table 4). While minimum was recorded from control (97.33 cm). These consequences are similar with the findings of Agha *et al.* (1981), Saeed *et al.* (2001), Keskin *et al.* (2005), Karasu *et al.* (2009), Nadeem *et al.* (2009), Onsanya *et al.* (2009), Aslam *et al.* (2011) who noticed that plant height was enhanced due to increased rates of nitrogen. These results are also resemblance with Karadag and Buyukburc (2001), Masood *et al.* (2011), Rashid and Iqbal (2012) who found that phosphorus affected plant height in a significant manner. Plant height enhanced in a linear manner with nitrogen and phosphorus application, since nitrogen in assemblage with phosphorus has greatly affected vegetative growth as well as plant height. So plant height and weight of grains were enhanced regarding increased level of nitrogen and phosphorus. Same consequences was accounted by Maqsood *et al.* (2001), Ayub *et al.* (2002), Sharar *et al.* (2003) that increasing level of nitrogen and phosphorus application enhanced growth and yield parameters in maize.

Weight of grains and grains yield were significantly affected by interaction of nitrogen and phosphorus. These consequences are resemblance with the findings of (Magboul *et al.,* 1999) who reported that increased levels of nitrogen and phosphorus fertilizers enhanced yield and yield component of maize. The maximum weight of grains ear^{-1} (385.51 g) and grains yield (5977.23 kg ha^{-1}) was obtained with the interaction of N_3P_3. Regarding this, similar results were found by (Nour and Lazin, 2000) who reported that the combination of nitrogen and phosphorus affected in a significant manner on weight of grains and grains yield. These results are also confirmed by (Abdel malik *et al.,* 1976) who accounted that grain yield increased significantly with the interaction of nitrogen and phosphorus. Singh and Dubey (1991) also reported that the combination of nitrogen and phosphorus fertilizers maximize weight of grains ear^{-1}.

Effect of irrigation, nitrogen and phosphorus on growth and yield components

These findings are similar with (Hammad *et al.,* 2012) who reported that irrigation and nitrogen treatments affected significantly on vegetative growth parameters. This may be due to fact that when irrigation was applied at the same day after sowing it dissolved nitrogen fertilizer and becomes available to maize crop. These results are related with (Khatun *et al.,* 2012) who observed that with increased moisture and nitrogen level maximum plant height, weight of grains and grain yield obtained. These results are also in accord with (Singh, 2001; Gheysari *et al.,* 2009);; Ebelhar, 2010; who noticed that irrigation and nitrogen in maximum quantity facilitate to uptake of nitrogen which increase grain yield and all growth parameters in maize.

These results are in accordance with (Amanullah *et al.,* 2010b) who found that increased in grain yield might be due to increased in yield and yield components of maize by increased level of P. Ibrikci *et al.* (2005) observed that the deficiency of P is a common factor for limiting growth and yield, particularly in high calcium carbonate soils, which cut back solubility of P. these consequences are also confirmed by (Hussain and Haq, 2000) who proposed that the KPK soils have high fixation capacity with higher demand of P. These findings were confirmed by (Singaram and Kothandaraman, 1994) who observed that P applied 90 kg ha^{-1} increased yield of maize crop. These results are similar with (Arya and Singh, 2001) who observed increased in growth and vegetative parameters in maize by increased irrigation and phosphorus.

Effect of nitrogen and phosphorus on total P and N of maize leaves

Plants leaves analysis has been done to show the deficiency or adequacy status of various nutrient elements in a soil plant system. The nitrogen and phosphorus interaction for total P and total N concentration was found significant at $P < (0.05)$ in maize plant (Table 6 and 7). The highest concentration of total P (3.29 µ g^{-1}) and total N (0.39 µ g^{-1}) was found in interaction effect of N_3P_3 while lowest was found in control. These results are in accordance with (Hussaini *et al.,* 2008) who reported that nitrogen and phosphorus interactions were significantly affected P and N concentrations in maize leaves and grains. They further elaborated that with increasing N and P level nutrients concentration either increased or decreased. However nutrients accumulation in the grains and stover was significantly enhanced by the increasing level of N and P. (Hussaini *et al.,* 2002) also stated that fairly maximum amount of grain yield resulted principally by using N then by P.

There is a degree of synergism between nitrogen and phosphorus in certain field crops. Some scientist have described that the nitrogen addition has affected uptake of soil and fertilizer sources of phosphorus. This phenomenon might be explained by the statement that nitrogen application increased production of small roots and roots hairs, which successively increased absorbing capacity per unit of dry weight. These reasons are confirmed by (Hussaini *et al.,* 2001) who observed that N and P uptake accumulation in maize stover was actually an interconnection to N and P application. These findings are also resemblance with (Barber and Olson, 1968) who described that the application of nitrogenous fertilizers enhanced yield nitrogen percent and uptake of other nutrients. This could be ascribed to the mobilization of large proportions of nitrogen and phosphorus.

Effect of irrigation, nitrogen and phosphorus on total P and N of maize leaves

Regarding impact of irrigation and phosphorus on total P the results of present study are similar with (Reddy *et al.,* 1992) who observed that the P percentage in the crop was maximum when moisture accessibility was optimum as compared to less moisture level. This might be occurred due to irrigation at the same in the present experimental site where P fixation decreased and its availability becomes enhanced to plants which may be possible cause for increased in total P. These reasons are also in accordance with (Yash *et al.,* 1992) who noted that the soil with high moisture increased availability of P. These results are also confirmed by (Griffith, 1983) who accounted that the P availability in soil increased with more time of contact between soluble P and soil particles which is a appropriate reason for increased in total P in our treatments. This may be due the increased phosphorus availability because of irrigation at the same day after sowing that prepared phosphorus available to maize plants by dissolving it.

Concerning effect of irrigation and nitrogen on total N the present results support the idea that urea use efficiency may be improved through reduced gaseous losses of NH_3 if urea is moved into the soil with maximum amounts of irrigation as a result nitrogen is taken up by plants (Black *et al.,* 1987). Irrigation facilitates the convey of added urea into the root-zone of sub-surface soil layers, dilutes surface NH^{4+} concentration, reduces NH_3 partial pressure and thereby minimizes NH_3 losses possibly due to low soil pH in sub-surface soil (Whitehead and Raistrick, 1993). The distribution and movement of applied N during an irrigation event will depend on N form (urea versus NH^{4+}). The source of NH_3 is mainly the exchangeable NH^{4+} present in the soil. We suggest that, although soil colloids adsorb NH^{4+} ions, applying irrigation after urea application could reduce the higher concentration of NH^{4+}-N in the surface soil layer, thereby resulting in its even distribution down the soil profile and laterally away from the application point.

Conclusion

The present study concluded that grain yield, and weight of grains ear^{-1} was significantly affected by NP combination and irrigation. These results suggest that applied irrigation drifted urea and SSP from the surface layer to sub soil layers where it is likely to make good contact with plant roots. Moreover distribution of urea in the rooting zone has the potential to enhance N use efficiency and minimize N losses through ammonia volatilization. By keeping in mind the data on yield, it can be concluded that application of irrigation at the same day after NP fertilizers 150 kg N ha^{-1} and 90 kg P ha^{-1} is much better than other treatments.

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