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Uptake Nitrogen as Affected by Various Combinations of Nitrogen and Phosphorus

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Abstract: An experiment to study the uptake of nitrogen by maize as affected by various combinations of nitrogen and phosphorus was conducted at Malakandher Research Farms, NWFP. Agricultural University Peshawar, Pakistan during 1997. Nitrogen and phosphorus had a significant effect on grain yield, nitrogen uptake at tasseling, maturity and in grain while non-significant effect of N and P was recorded for harvest index. Plots treated with NP combination of 150:90 kg ha^{-1} produced maximum grain yield while fertilizer combination of 150:120 NP kg ha^{-1} resulted in maximum nitrogen uptake at tesseling, maturity and in grain.

Key words: Uptake, nitrogen phosphorous, maize

Introduction

Being an exhaustive crop, maize need a balanced application of macro and micro- nutrients especially nitrogen and phosphorous. Nitrogen is needed for good growth, as it is an important constituent of protein, RNA, DNA and chlorophyll. Phosphorus is also necessary for the production of healthy plant as it encourages the growth of root system which helps in the absorption of nutrients especially nitrogen. Though our soils are not as deficient in phosphorus as nitrogen but due to the unavailable nature of phosphorus in our soils, it becomes imperative to apply it along with nitrogen because it has been postulated that phosphorous application enhances the uptake of nitrogen. Therefore, the present experiment was carried out to investigate the effect of N and P on the uptake of nitrogen by maize crop. Dahiya *et al*. (1991) reported that applied nitrogen increased the uptake of N and P. Alfoldi *et al*. (1994) investigated that concentration in the mature grains of maize were higher at high doses of nitrogen. N and P fertilizers at higher rate and especially in combination with lime markedly increased maize yield and NPK and Ca uptake. (Invoilove *et al*. 1990). Kostic *et al*. (1991) reported that as compared to nitrogen alone, phosphorous increased average gain yield of maize by 11.5% at a lower and 14.2% at higher nitrogen rate. Singh and Duby (1991) concluded that grain yield and net returns increased with increase in nitrogen and phosphorous rates. Similarly, Thiraporn *et al*. (1992) reported that grain and biomass yield increased up to 80 kg N. ha^{-1} , higher application did not increase biomass.

Materials and Methods

An experiment titles was conducted at Malakandher Research Farms NWFP, Agricultural University, Peshawar, Pakistan during 1997. The experiment was laid out in randomized complete block (RCB) design haring three replications. Before sowing a composite soil sample was taken for the determination of various physiochemical properties of the soil (Table 1). Different levels of nitrogen (0, 90 and 150 kg ha^{-1}) and phosphorus (0, 60, 90 and 120 kg ha^{-1}) were applied in the form of urea and triple super phosphate. All phosphorus and half of the nitrogen was applied at the time of sowing while the remaining half of nitrogen was used at second irrigation. Recommended cultural practices were followed through out the growing season.

Data was recorded on the following parameters:

Grain yield, biomass yield, tissue analysis (whole plant) for nitrogen at tasseling stage, tissue analysis for nitrogen uptake in stalk at maturity, tissue analysis for nitrogen uptake in grain, unutilized nitrogen from various doses, cost-benefit ratio of various levels of N and P (VCR).

Data regarding gain yield was determined after harvest of four central rows in each sub-plot and then converted into economic yield.

$$\text{Grain yield (kg ha}^{-1}) = \frac{\text{Grain yield unit area}^{-1}}{\text{Unit area}} \times 10000$$

Biomass yield was calculated from the four central rows of each treatment and then converted into biomass yield in kg ha^{-1}.

$$\text{Biomass} = \frac{\text{Biomass unit area}^{-1}}{\text{Unit area}} \times 10000$$

Table 1: Physiochemical properties of the soil

Properties	Value
Clay (%)	36.0
Sand (%)	18.0
Silt (%)	46.0
Texture	Silty clay loam
Lime (%)	23.88
pH	07.0
E.C. (dSm^{-1})	00.54
Organic matter (%)	00.72
Total nitrogen (before sowing) (mg kg^{-1})	210
Total nitrogen (after sowing) (mg kg^{-1})	3-5
Available phosphorus (mg kg^{-1})	11

Tissue analysis for nitrogen at different stages was determine by Kjeldahl method. Unutilized nitrogen from different doses of nitrogen and phosphorus was recorded.

Unutilized N = (Total N in the soil + N applied) – (N uptake by plant + N remaining in the Soil)

Results and Discussion

Grain yield: Statistical analysis of the data (Table 2) showed that various levels of nitrogen, phosphorus and their interaction had a signification ($P \leq 0.05$) effect on grain yield. Mean values of the data revealed that grain yield was maximum (3033.23 kg ha^{-1}) in those plots, which were treated with 60 kg P_2O_5 ha^{-1} when compared with other treatments. Similarly, a positive correlation was also observed between various doses of nitrogen and grain yield; maximum (3424.95 kg ha^{-1}) grain yield was obtained in 150 kg N ha^{-1} treated plots. It can also be seen from the data presented in Table 2 that NP when applied at the rate of 150:90 kg ha^{-1} resulted in maximum (3841.35 kg ha^{-1}) grain yield which was at par with NP combination of 150:60 kg ha^{-1} but was significantly different from NP combination of 150:120 kg ha^{-1}. Similar results were also reported by Ram *et al*. (1993), Sharma and Sharma (1991), Negrila and Negrila (1994) and Brar *et al*. (1989).

Biomass yield: Various levels of N had a significant ($P \leq 0.05$) effect on biomass yield while P and their interaction with N had a non-significant effect (Table 3). It can be inferred from the mean values of the data that increasing levels of nitrogen had significantly increased biomass and was maximum (10795.85 kg ha^{-1}) in plots treated with 150 kg N ha^{-1}, while minimum biomass was recorded in check plots (control). Though the effect of various levels of P

Table 2: Grain yield (kg ha^{-1}) in maize as affected by various levels of nitrogen phosphorus

Nitrogen levels (kg ha^{-1})	Phosphorus (kg ha^{-1})				
	0	60	90	120	Mean
0	1615.12h	2022.80g	1963.28g	2025.01g	1906.55c
90	2132.34f	3237.75c	2591.38ef	2847.20d	2702.17b
150	2654.01e	3839.13a	3841.35a	3365.39b	3424.95a
Mean	2133.82c	3033.23a	2798.67b	2745.83b	

LSD value for nitrogen at p ≤ 0.05 = 52.36 LSD value for phosphorus at p ≤ 0.05 = 60.46
LSD value for interaction at p ≤ 0.05 = 104.70
Means of the same category followed by different letters are significantly different from one another at p ≤ 0.05

Table 3: Biomass yield (kg ha^{-1}) in maize as affected by various levels of nitrogen phosphorus

Nitrogen levels (kg ha^{-1})	Phosphorus (kg ha^{-1})				
	0	60	90	120	Mean
0	6049.48	6964.14	06466.28	04992.84	06118.19c
90	8647.23	8883.47	07618.44	09282.40	08607.88b
150	9754.83	11929.90	11312.05	10186.62	10795.85a
Mean	8150.51	9259.17	08465.59	08153.95	

LSD value for nitrogen at p ≤ 0.05 = 1019.00
Means of the same category followed by different letters are significantly different from one another at p ≤ 0.05

Table 4: Tissue analysis for nitrogen (kg ha^{-1}) at tasseling stage in maize as affected by various levels of nitrogen and phosphorus

Nitrogen levels (kg ha^{-1})	Phosphorus (kg ha^{-1})				
	0	60	90	120	Mean
0	28.01g	30.36g	034.94g	033.38g	031.67c
90	46.05f	66.03e	094.48e	116.29c	080.71b
150	59.26e	164.66b	177.5a	181.49a	145.60a
Mean	44.44d	86.91c	102.30b	110.40a	

LSD value for nitrogen at p ≤ 0.05 = 3.60 LSD value for phosphorus at p ≤ 0.05 = 4.16
LSD value for interaction at p ≤ 0.05 = 7.21
Means of the same category followed by different letters are significantly different from one another at p ≤ 0.05

Table 5: Tissue analysis for nitrogen (kg ha^{-1}) at maturity in maize as affected by various levels of nitrogen and phosphorus

Nitrogen levels (kg ha^{-1})	Phosphorus (kg ha^{-1})				
	0	60	90	120	Mean
0	25.01i	27.23hi	029.15hi	031.03h	28.10c
90	38.10g	59.16e	068.10d	088.28c	63.44b
150	51.11f	98.62b	103.0b	109.2a	90.50a
Mean	38.11d	61.67c	066.76b	076.17a	

LSD value for nitrogen at p ≤ 0.05 = 3.76 LSD value for phosphorus at p ≤ 0.05 = 3.19
LSD value for interaction at p ≤ 0.05 = 5.52
Means of the same category followed by different letters are significantly different from one another at p ≤ 0.05

Table 6: Tissue analysis for nitrogen (kg ha^{-1}) in maize grain as affected by various levels of nitrogen and phosphorus

Nitrogen levels (kg ha^{-1})	Phosphorus (kg ha^{-1})				
	0	60	90	120	Mean
0	10.98j	14.15ij	016.29hi	018.02h	14.86c
90	26.16g	57.63e	066.08d	076.58c	56.61b
150	42.08f	105.95b	109.09b	119.13a	94.06a
Mean	26.41d	59.24c	063.82b	071.27a	

LSD value for nitrogen at p ≤ 0.05 = 1.91 LSD value for phosphorus at p ≤ 0.05 = 2.20
LSD value for interaction at p ≤ 0.05 = 3.82
Means of the same category followed by different letters are significantly different from one another at p ≤ 0.05.

Table 7: Unutilized nitrogen (kg ha^{-1}) in maize grain as affected by various levels of nitrogen and phosphorus

Nitrogen levels (kg ha^{-1})	Phosphorus (kg ha^{-1})				
	0	60	90	120	Mean
0	079.01d	73.62de	69.56e	65.95ef	72.05b
90	140.61b	88.21c	70.91de	40.19h	84.98a
150	171.81a	60.43fg	52.87g	36.64h	81.02a
Mean	130.50a	74.08b	64.47d	47.59c	

LSD value for nitrogen at p ≤ 0.05 = 4.56 LSD value for phosphorus at p ≤ 0.05 = 5.27
LSD value for interaction at p ≤ 0.05 = 9.12
Means of the same category followed by different letters are significantly different from one another at p ≤ 0.05

and their interaction with N showed a non significant effect but still it can be seen from the mean values of the data (Table 3) that biomass yield was maximum 99259.17 kg ha^{-1}) in plots treated with P at the rate of 60 kg ha^{-1}. Similarly, when NP was applied at the rate of 150:90 kg ha^{-1} produced maximum biomass.

Nitrogen uptake at tasseling stage: Statistical analysis of the data revealed that different levels of NP and their interaction had a significant ($P \leq 0.05$) effect on nitrogen uptake at tasseling stage (Table 4). Men values of the data suggested that various doses of phosphorus had a positive correlation with the uptake of nitrogen at tasseling stage. Nitrogen uptake was increased with increasing levels of phosphorus, maximum uptake (110.40 kg N ha^{-1}) being observed at phosphorus level of 120 kg ha^{-1}. A similar positive correlation was also observed between various levels of nitrogen and their uptake at tassling stage. It can be inferred from the data indicated in Table 4 that nitrogen uptake was maximum (145.60 kg ha^{-1}) in those plots which received the highest dose of nitrogen (i.e., 150 kg ha^{-1}) while those plots which received no nitrogen (control) resulted in minimum uptake. It can be concluded from these results that application of nitrogen had increased the availability of nitrogen and thus more concentration of nitrogen in plant was observed at tasseling stage. Mean values of the data also suggested that various combinations of N and P had significantly ($P \leq 0.05$) increased the uptake of nitrogen when compared with control. It is clear from the data shown in Table 4 that maximum (181.49 kg ha^{-1}) uptake of nitrogen was observed in those plots which received NP combination of 150:120 kg ha^{-1} which was at par with NP level of 150:90 kg ha^{-1} but significantly different from other treatments. The possible justification could be due to sufficient phosphorus which had improved nitrogen availability and had thus resulted in maximum nitrogen uptake. Similar results are also reported by Myuller (1991), Tveintnes and McPhillips (1989) and Invoilove *et al.* (1990).

Nitrogen uptake at maturity: Statistical analysis of the data (Table 5) revealed that various levels of N, P and their interactions had a significant ($P \leq 0.05$) effect on nitrogen uptake at maturity. Mean values of the data suggested that phosphorus when applied at the rate of 120 kg ha^{-1} resulting in maximum uptake of nitrogen (76.17 kg ha^{-1}) at maturity while plots which received no phosphorus (control) noted minimum nitrogen uptake. A similar positive trend was observed between various doses of nitrogen and their uptake at maturity. When maximum uptake of nitrogen (90.50 kg ha^{-1}) was noted in those plots, where highest dose of nitrogen was used while minimum uptake being recorded in control plots. When interaction between various combination of nitrogen and phosphorus was taken into an account, it was noted that maximum uptake (109.21 N kg ha^{-1}) was observed in plots treated with NP combination of 150:120 kg ha^{-1} followed by plots receiving NP at the rate of 150:90 kg ha^{-1} which was at par with NP level of 150:60 kg ha^{-1} but significantly different from control plots. These results are in line with those reported by Dahiya *et al.* (1991), Saragoni and Poss (1992) and Patel and Patil (1990).

Nitrogen uptake by grains: Statistical analysis of the data (Table 6) revealed that nitrogen uptake by grain was significantly ($P \leq 0.05$) affected by N, P and their interactions. A positive correlation between nitrogen uptake by grains and various levels of phosphorus. It is clear from the mean values of the data that increasing levels of phosphorus had increased the uptake of N by grain, maximum uptake (71.27 kg ha^{-1}) being noticed in grains of those treatments which received phosphorus at the rate of 120 kg ha^{-1}. Similarly, maximum uptake of 94.0 6 N kg ha^{-1} was noted in plots, which were treated with 150 kg N ha^{-1} when compared with the other treatments. Analysis of the data revealed that NP at the rate of 150:120 kg ha^{-1} resulted in more nitrogen uptake (119.13 kg ha^{-1}) by grains followed by plots treated with NP at the rate of 150:90 kg ha^{-1}, which was at par with NP combination of 150:60 kg ha^{-1}. These results agree with those reported by Barsukov and Vasheprudov (1991). Thiraporn *et al.* (1992). Singh *et al.* (1992) and Invoilov *et al.* (1990).

Unutilized nitrogen from various levels of N and P: Analysis of the data (Table 7) reveled that unutilized nitrogen was significantly ($P \leq 0.05$) affected by various levels of N, P and their interactions. A negative correlation was noted between various levels of phosphorus and unutilized nitrogen (Table 7). Mean values of the data indicated that highest unutilized nitrogen of 130.50 kg ha^{-1} was recorded in control plots while lowest unutilized nitrogen was observed in plots treated with P at the rate of 120 kg ha^{-1}. Similarly, maximum unutilized nitrogen of 84.98 and 81.02 kg ha^{-1} was noted at nitrogen levels of 90 and 150 kg ha^{-1} respectively. When interactions between N and P was taken into consideration, maximum unutilized (171.81 kg ha^{-1}) was observed at NP combination of 150:0 kg ha^{-1}.

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