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Effects of Nitrogen and Phosphorus on the Growth Performance of Maize (*Zea mays*) in Selected Soils of Shahdol (M.P.) Vindhyan Regions

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Abstract – The study was carried out in Shahdol (M.P.). Soil samples were collected from six locations within Shahdol (M.P.) namely Burhar, Jaitpur, Shahdol, Gohparu, Jaisinghnagar and Beohari. Surface soils (0-15 cm) and sub-surface soils (15-30 cm) depth. These were analyzed for their physical and chemical properties. In one of the locations (Burhar) found to be deficient in nitrogen (N) and phosphorus (P) field trials on the effects of these nutrients on the performance of maize (Zea mays) were carried out. The variety HQPM 1 was used. The design was a 4 × 4 factorial scheme fitted into a randomized complete block design given sixteen treatments combinations with three replicates. The following treatments combinations were applied N0P20kg/ha, N0P40kg/ha, N0P60kg/ha, N20P0kg/ha, N20P20kg/ha, N20P40kg/ha, N20P60kg/ha, N40P0kg/ha, N40P20kg/ ha, N40P40kg/ha, N40P60kg/ha, N60P0kg/ha, N60P20kg/ha, N60P40kg/ha, and N60P60kg/ha. The parameter measured were plant height and leaf number at 3, 6 and 9 weeks after planting (WAP), respectively. Combined application of 40 kgN/ha+40 kgP/ha significantly increased maize plant height and leaf number among all the treatments. Therefore combined application of 40 kgN/ha+40 kgP/ha is recommended for optimum growth of maize in the study area.
Keywords - Nitrogen; Phosphorus; Growth performance; Maize; Shahdol, Vindhyan region.

I. INTRODUCTION

Maize (***Zea mays* L**) is a cereal crop which belongs to the family poaceae (Downswell, *et al.* 1996)[1]. It is an important food crop in Tribal areas. It forms a major part of cereal crops consumed by man (Onwueme and Sinha, 1991)[2] and serve as a source of dietary carbohydrates (Wudiri and Fatobi, 1992)[3]. It is used for livestock feed and it is the cheapest and palatable livestock feed for animals such as cattle, sheep, and poultry (Ekpeyong, 1985[4]. It is also a source of raw materials for the production of corn sugar, corn starch, corn syrub and corn oil (Anochili, 1984)[5].

Nitrogen is a vital plant nutrient and a major yield determining factor for maize production (Shanti, *et al.* 1997)[6]. Its availability in sufficient quantity throughout the growing season is essential for optimum growth of maize. Most farmers in developing countries usually rely on natural soil fertility for crop production.

An application of urea and triple superphosphate (TSP) fertilizers in combination with farmyard manure was found to enhance the effectiveness of N and P fertilizers (Duncan, 2002)[7]. Opening up of a long fallow land may provide adequate nutrients to crops; however, cropping such land is only successful within a few years after its opening. Thereafter, subsequent cropping requires fertilizer input most importantly nitrogen to maintain good yields. Studies conducted by Stewart *et al.*,2005[8] and Niehues *et al.* 2004[9] revealed that starter nitrogen was able to stimulate the early growth and yield of maize.

Phosphorus is closely concerned with many growth processes in crop plants. It is involved in many biochemical reactions and concerned with the metabolism of carbohydrates, fats and protein and play roles in the breakdown of carbohydrates; phosphorus (P) is another limiting nutrient in maize production. According to Rehman *et al.* 2011[10] nutrient P affects leaf growth and senescence dynamics in maize. Various factors could be responsible for P availability to crop plants. These include the form of native soil P, the type of P applied to the soil and reaction.

Some of the problems associated with the soil for cultivation of maize in Shahdol (M.P.) Vindhyan region are deficiencies of Nitrogen and Phosphorus, leaching, continuous cropping, oil spillage and exploration (Corliss, 1991)[11]. For maize to reach full production capacity there is need to address nutrient deficiency and response to N and P fertilization in Shahdol (M.P.). Thus the objective was to determine the effect of N and P on maize plant height and leave number

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II. MATERIAL AND METHODS

The study was carried out in the agriculture farm of Shahdol. The soils have loose brownish top soil over a great depth of large differentiated, non-molten, non gravelly, porous sub soil with coarse sand ass the predominant fraction and clay content is up to 35%. There are three distinct seasons usually the dry, rainy and winter season. Temperature is high during summer (Iloje, 2003)[12].

The samples were collected from six locations within a month. These were chosen to reflect the differences in soil and vegetation characteristics. Surface soils (0-15 cm) and sub surface soils (15-30 cm) were sampled with a tabular sampling augur. Representative soil samples were taken and then bulked for each depth and location.

Based on the analysis, soil obtained (0-15 cm) from Burhar was found to be deficient in Nitrogen and Phosphorus against the established critical values. Consequently, the field trial was established in this location.

The design was a 4 × 4 factorial scheme fitted into a randomized complete block design giving sixteen treatment combinations with three replicates. The following treatment combinations were applied N0P20kg/ ha, N_0P_{40}kg/ha, N_0P_{60}kg/ha, $N_{20}P_0$kg/ha, $N_{20}P_{20}$kg/ha, $N_{20}P_{40}$kg/ha, $N_{20}P_{60}$kg/ha, $N_{40}P_0$kg/ha, $N_{40}P_{20}$kg/ha, $N_{40}P_{40}$kg/ha, $N_{40}P_{60}$kg/ha, $N_{60}P_0$kg/ ha, $N_{60}P_{20}$kg/ha, $N_{60}P_{40}$kg/ha, and $N_{60}P_{60}$kg/ha. Each plot measured 2.1 × 1 m2 with alley of 1 m between plot and replicates. There were a total of 48 plots (16 × 3). The experimental area used was 329.6 m^2.

Maize seeds (HQPM 1) obtained from JNKVV Jabalpur (M.P.) were sown on the 13th of April 2014 at 2 seeds per hole and later thinned to one plant per stand. The spacing was 70 cm × 25 cm giving a plant population of 20 plants per plot. Reading was done at interval 3, 4 and 10 weeks after planting (WAP) respectively.

Plant height readings were taken at 3, 6 and 9 weeks after planting, a tape rule was used to measure the height of the plant from the soil surface to the apex. The mean value was recorded in centimeters. Number of leaves were counted per plant, per plot at 3, 6 and 9 weeks and recorded respectively.

Plant height and number of leaves determined were subjected to appropriate statistical analysis; ANOVA and correlation coefficient.

III. RESULTS AND DISCUSSION

A. *Plant height*

Mean plant height at 3 weeks after planting (WAP) ranged from 11.60-12.90 cm and 10.60 cm-13.60 cm when treated only to Nitrogen and Phosphorus fertilizers respectively (**Table 1**). The mean plant height value was highest when 40 kg/N/ha and 40 kg P/ha were applied and lowest in the control treatment. Application of fertilizer had no significant effect on plant height.

Table 1 : Effect of Nitrogen and Phosphorus fertilizer on mean plant height of maize.

Treatment	Phosphorus				Mean
Nitrogen (kg/ha)	0	20	40	60	
3 Week					
0	9.83	11.42	13.00	13.88	12.0a
20	9.37	12.50	13.17	11.50	11.6a
40	12.48	10.78	15.27	12.87	12.9a
60	10.7	11.12	12.82	14.75	12.4a
Mean	10.6a	11.5a	13.6a	13.3a	
6 Week					
0	56.50	59.50	68.50	67.83	63.1b
20	61.83	70.33	69.00	65.83	66.7b
40	69.17	65.50	78.50	73.33	71.6b
60	61.33	72.67	81.33	87.00	75.8ab
Mean	62.2b	67.0ab	74.3a	73.5a	
9 weeks					
0	120.5	122.0	143.7	140.3	151.6b
20	156.7	167.0	156.0	151.3	157.8a
40	162.2	166.3	184.5	179.2	173.1a
60	154.7	167.2	167.0	192.3	170.3a
Mean	148.5a	155.6a	162.8a	165.8a	

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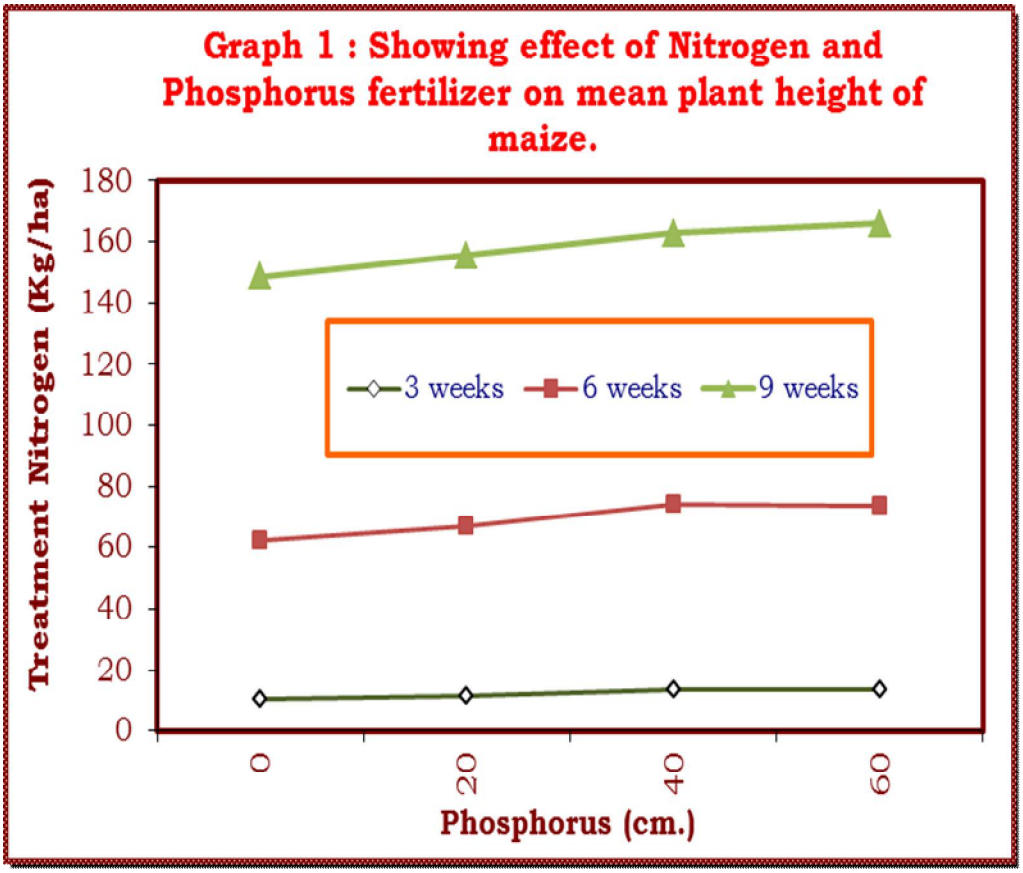
Table 2 : Effect of Nitrogen and Phosphorus fertilizer on the number of leaves.

Treatment	Phosphorus				Mean
Nitrogen (kg/ha)	0	20	40	60	
3 Week					
0	6.17	6.33	6.00	6.00	6.1a
20	6.00	6.17	6.17	6.00	6.1a
40	6.17	6.00	6.83	6.33	6.3a
60	6.33	6.00	6.50	6.67	6.4a
Mean	6.2a	6.1a	6.4a	6.3a	
6 Week					
0	10.0	10.2	11.0	11.3	10.63b
20	11.7	12.2	11.8	10.3	11.50a
40	12.0	11.7	13.5	13.0	12.55a
60	11.5	11.5	12.2	13.3	12.13a
Mean	11.30a	11.40a	12.13a	11.98a	
9 weeks					
0	14.8	14.3	15.3	14.3	14.68b
20	16.5	16.3	16.0	16.0	16.20a
40	14.8	15.3	15.8	15.7	15.28b
60	16.7	15.8	15.8	17.2	16.38a
Mean	15.7a	15.4a	15.6a	15.8a	



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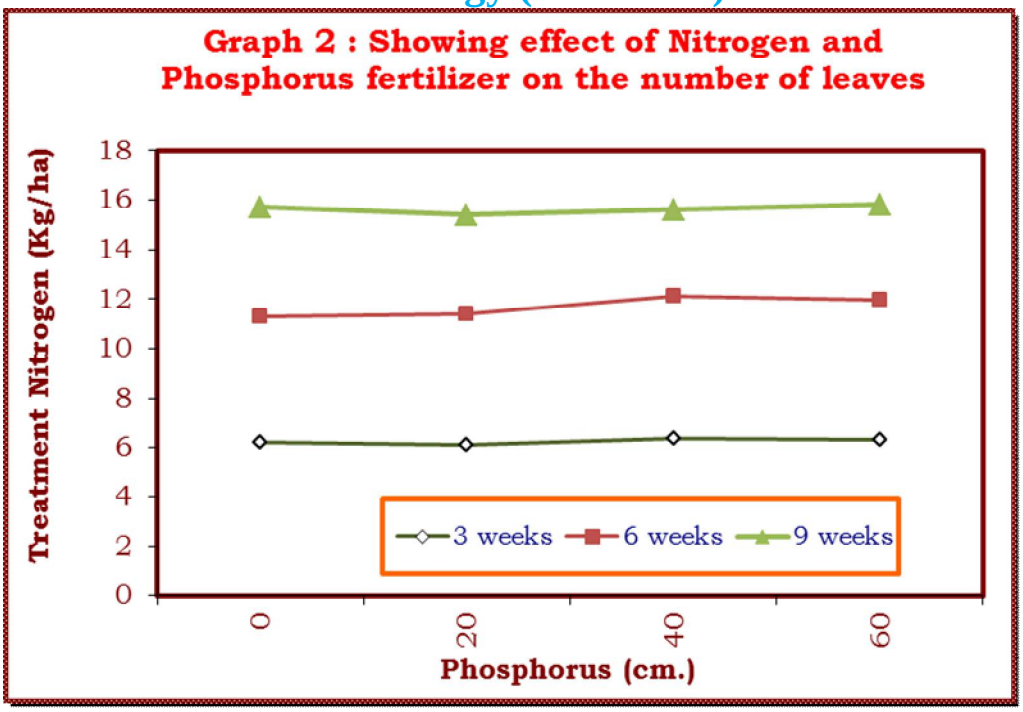

At 6 WAP, the mean plant height ranged from 63.1 to 75.8 and 62.2 to 74.3 cm when treated with Nitrogen and phosphorus fertilizer respectively. The application of P at 40 kg/ha significantly increased plant in comparison to the control but was not significantly different from other rates. The highest height was obtained at 40 kg/N/ha and 40 kg P/ha combined at three weeks after planting and 60 kgP and 40 kgN at six weeks after planting.

At 9 WAP, plant height was not significantly improved by phosphorus fertilization but was with nitrogen fertilizer. Mean plant height ranged from 148.5 to 165.8 cm and 131.6 to 173.1 cm when treated with phosphorus and nitrogen fertilizers respectively. Mean plant height increased with increasing levels of application of phosphorus and nitrogen fertilizers which is in line with studies conducted by Stewart *et al.*, 2005[8] and Niehues *et al.* 2004 [9] revealed that starter nitrogen was able to stimulate the early growth and yield of maize.

B. Number of Leaves

The mean number of leaves at 3WAP ranged from 6.1 to 6.4 when treated with phosphorus and nitrogen fertilizers respectively **(**Table 2**).** The mean values were not significantly different for both fertilizers rates of application.

At 6 WAP, mean number of leaves ranged from 11.30 to 12.13 and 10.63 to 12.55 when treated with phosphorus and nitrogen fertilizers respectively. The values obtained from treatments which received fertilizers were higher than the control.

At 9 WAP, mean number of leaves varied from 14.68 to 16.38 and 15.4 to 15.8 as a result of phosphorus and nitrogen fertilization. The values did not follow definite pattern with increasing fertilizer rates. Nitrogen fertilizer significantly increased mean number of leaves. The rates of 20 kgN/ha and 60 kgN/ha were significantly different from control which is in agreement with Rehman *et al.* 2011[10] Who stated that nutrient P affects leaf growth and senescence dynamics in maize (Duncan, 2002)[7] who reported that an application of urea and triple superphosphate (TSP) fertilizers in combination with farmyard manure was found to enhance the effectiveness of N and P fertilizers in maize production.

IV. CONCLUSION

Nitrogen and phosphorus fertilization are important in the management of soil of the study area due to deficiency of both nutrients. The study revealed that maize growth was significantly enhanced by the application of Nitrogen fertilizer at the rate of 40 to 60 kg/ha compared to other rates of application. Maize response to applied phosphorus was not significantly different. However, the combined application of 40 kgN/ha plus 40 kgP/ha performed better in enhancing growth of maize. It is therefore recommended that the application of 40 kgN/ha plus 40 kgP/ha will effectively enhance maize growth since nitrogen has been reported to favour

vegetative growth especially at the initial stage of growth (Udoh, *et al.* 2005)[13].

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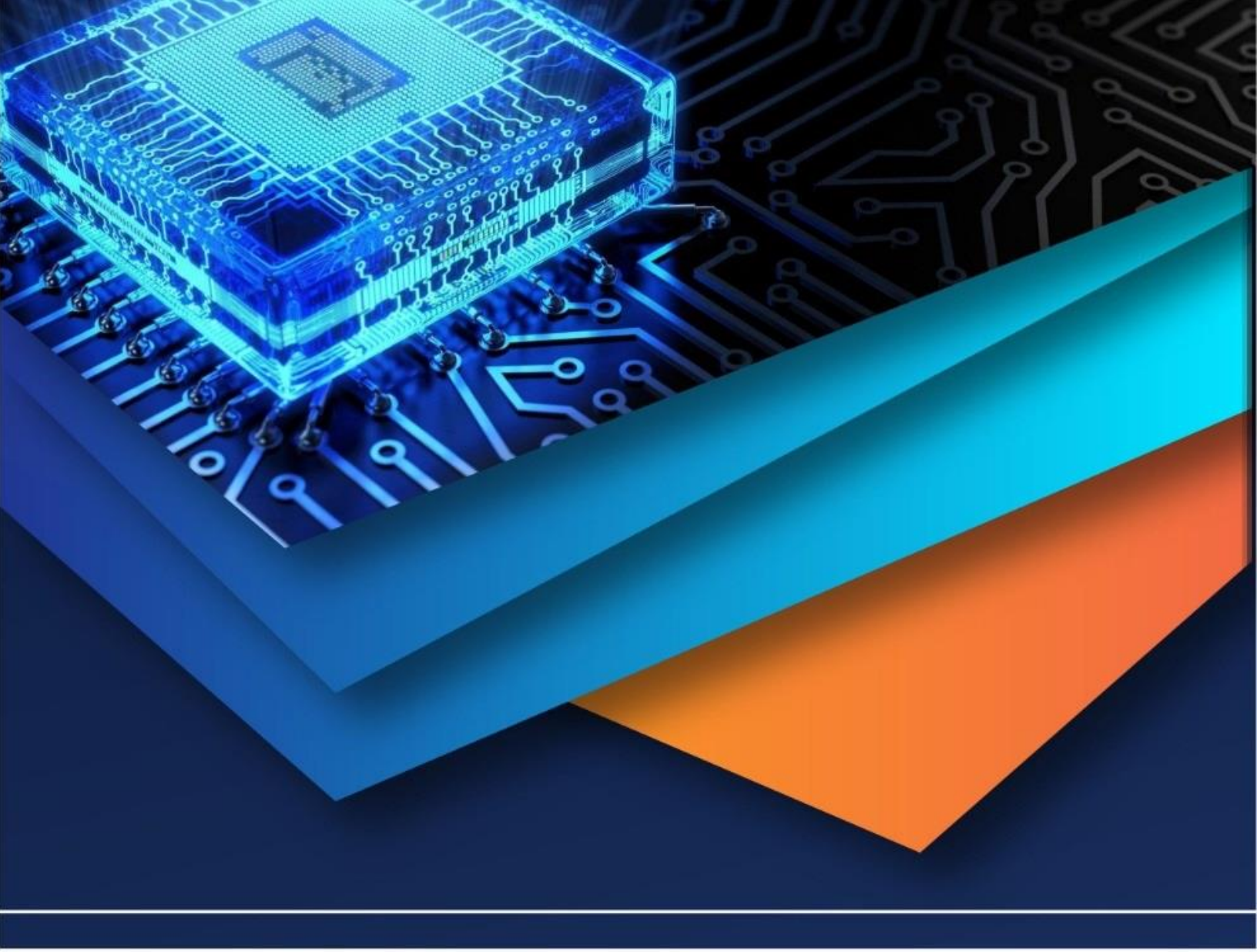

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