

Differential Genotypic Response to Phosphorus Application in Lentil (*Lens culinaris Medic*)

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ABSTRACT

A field study to evaluate the effect of phosphorus application on different agronomic traits of three lentil cultivars viz. Masoor-local, Masoor-85 and Masoor-93 was conducted on a sandy-clay loam soil for two years. The phosphorus levels comprised of 0, 25, 50 and 75 kg ha⁻¹. Among the cultivars, Masoor-93 because of higher fruiting potential and 1000-seed weight gave the highest seed yield of 1163 kg ha⁻¹ against the minimum of 773 kg ha⁻¹ in Masoor-local. Phosphorus application @ 75 kg ha⁻¹ produced significantly the maximum seed yield of 1019 kg ha⁻¹ which was 25.37% higher than control (813 kg ha⁻¹).

Key Words: Genotypic response; Phosphorus; Lentil

INTRODUCTION

Pulses are important world food crops contributing about 20% of the world human food and providing 2.2 to 3.5 times more protein than cereals. Among the pulse crops, lentil is of special interest in Pakistan as it contains 23.7% protein, a level about double than that of cereals and slightly higher than that of meat, egg and fish (Pellet & Shadarevian, 1970). Besides, lentil seed contains considerable amounts of phosphorus (350-370 mg), potassium (790-801 mg), calcium (68-79 mg) and magnesium (80 mg) per 100 g of seed (Watt & Merrill, 1963) with energy content level of 357 Kcal/100 g of seed (Manan *et al.*, 1985). Lentil can fix 83-114 kg N ha⁻¹ (Nutman, 1976) and under good symbiotic association with lentil more than 85% of the total nitrogen need of the crop may be fulfilled by biological nitrogen fixation under good symbiotic association (Rizk, 1966).

In Pakistan, lentil is cultivated on an area of 54887 hectares with total annual production of 35459 tonnes resulting in an average yield of 646 kg ha⁻¹ which is much lower than world average lentil production of 928 kg ha⁻¹ (FAO, 2000). The average lentil yield in Pakistan is low due to continuous cultivation of conventional low yield potential cultivars having excessive vegetative growth with poor response to inputs and improved agro-management practices, narrow adaptability, low stability of yield and susceptibility to stress. Second main reason for low yield of lentil is the insufficient application of essential plant nutrients. So, the only way to increase unit area production is the judicious use of the nutrients and selection of high yielding and fertilizer responsive genotypes with wider adaptability. Among the nutrients phosphorus plays a special role in many physiological functions of crop plants and thereby improving the overall morpho-qualitative development. The present study was, therefore, designed to determine the effect of different phosphorus levels on the

agronomic traits of three cultivars of lentil under irrigated conditions of Faisalabad.

MATERIALS AND METHODS

The study was conducted on a sandy-clay loam soil at the Agronomic Research Area, University of Agriculture, Faisalabad for two years (1997-98 and 1998-99). The soil was analysed for physico-chemical characters before sowing the crop. Three lentil cultivars (Masoor-local, Masoor-85 and Masoor-93) were tested at 0, 25, 50 and 75 kg P ha⁻¹ with a uniform basal dose of 50-50 NK kg ha⁻¹.

The experiment was laid out in a randomized complete block design with split arrangement keeping the cultivars in the main plots and phosphorus levels in sub-plots. The crop was sown during the second week of November in 25 cm apart rows with a single row hand drill using a recommended seed rate of 20 kg ha⁻¹ for Masoor-local and Masoor-85 and 25 kg ha⁻¹ for Masoor-93 in order to maintain uniform number of seeds per unit area in all the cultivars. The net plot size measured was 1 m x 2 m. All the fertilizers were well mixed into the soil at seed bed preparation before sowing the crop. The crop was kept weed free throughout the growing season. Two irrigations each of 7.5 cm were given to mature the crop in addition to seed bed preparation irrigation of 10 cm. The crop was harvested at its full maturity during the 2nd week of April every year, dried and then threshed manually. Observations on desired agronomic parameters were recorded using standard procedures. The harvest index was computed by using the following formula:

$$\text{H.I.} = \frac{\text{Seed yield ha}^{-1}}{\text{Total biomass yield ha}^{-1}} \times 100$$

The data collected were subjected to Fisher's Analysis of Variance Technique and Least Significant Difference

(LSD) test at 0.05 P was used to compare the treatment means.

RESULTS AND DISCUSSION

The data pertaining to different agronomic parameters of three lentil cultivars as affected by phosphorus application are presented in Table I.

Stand density at harvest (m^{-2}). The data on stand density m^{-2} revealed non-significant differences among the cultivars as well as among different phosphorus levels. However, the stand density on an average varied from 88.47 to 89.35 m^{-2} among the cultivars and from 88.81 to 89.18 m^{-2} among the different phosphorus treatments. Uniform plant density at harvest in all the experimental treatments was attributed to almost the same number of seedlings emerged m^{-2} as a result of uniform number of seeds sown per unit area in all the experimental units. These results are in agreement with those of Maqsood *et al.* (1991).

Plant height (cm). Plant height varied significantly among the cultivars. More plant height was recorded in Masoor-93 (36.24 cm) than Masoor-85 and Masoor-local which also differed significantly from each other showing a plant height of 33.29 and 30.90 cm, respectively. Variation in plant height among the cultivars might be ascribed to their variable inherent growth potential and environmental adaptability. Similar results were reported by Gray *et al.* (1996) and Sadiq *et al.* (1998).

There were also significant differences among the different phosphorus levels in lentil cultivars. The plant height increased linearly with each successive increase in phosphorus dose from 25 to 75 $kg\ ha^{-1}$ with significantly the maximum at 75 $kg\ P\ ha^{-1}$ (36.26 cm) against the minimum at 30.45 cm in control. Increase in plant height with phosphorus application has also been reported by Kumar *et al.* (1993).

Number of branches $plant^{-1}$. There was significant variation among the cultivars. Masoor-93 although produced significantly more number of branches $plant^{-1}$ (5.25) than

Masoor-local (4.63) but did not differ significantly from Masoor-85, which produced on an average 5.10 branches $plant^{-1}$. This variation was also attributed to their inherent variable growth pattern and response to environment. These results are in line with those of Salam and Islam (1994) and Khan *et al.* (1998) who reported significant variation among the different lentil genotypes in respect of growth pattern.

Phosphorus application also affected the number of branches $plant^{-1}$ significantly. Although phosphorus applied @ 50 $kg\ ha^{-1}$ increased significantly the number of branches $plant^{-1}$ (5.10) over control (4.63) but was on a par with 75 $kg\ P\ ha^{-1}$ (5.25). However, the difference between 25 $kg\ P\ ha^{-1}$ and control was non-significant. These results are in consonance with those of Kumar *et al.* (1993).

Number of pods $plant^{-1}$. There were significant differences among the cultivars. Masoor-93 and Masoor-85 being at par with each other produced significantly more number of pods $plant^{-1}$ than Masoor-local showing the corresponding values of 39.81, 39.89 and 37.98 number of pods $plant^{-1}$, respectively. Variation in fruiting among the cultivars might be attributed to their variable inherent fruiting potential and response to environments. Similar results have been reported by Salam and Islam (1994) and Rahman and Sarkar (1997).

Phosphorus application also affected the fruiting behavior of lentil to a significant level. Although all the phosphorus levels increased the number of pods $plant^{-1}$ over control significantly but the difference between 50 and 75 $kg\ P\ ha^{-1}$ treatments was non-significant which produced on an average 40.40 and 40.13 pods $plant^{-1}$, respectively, against the minimum of 36.64 in control. Improvement in fruiting potential of lentil with the application of phosphorus has also been reported by Kumar *et al.* (1993) and Shivakumar *et al.* (1995).

Number of seeds pod^{-1} . All the cultivars under study differed significantly from one another with regard to seeds pod^{-1} . Masoor-93 and Masoor-85 being equal to each other produced significantly more seeds pod^{-1} than Masoor-local with the corresponding values of 1.74, 1.72 and 1.55 seeds pod^{-1} , respectively. These results coincide with those of

Table I. Agronomic traits of lentil as affected by different cultivars and phosphorus levels (2-year average data)

Cultivars	Stand density (m^{-2})	Plant height (cm)	Number of branches $plant^{-1}$	Number of pods $plant^{-1}$	Number seeds pod^{-1}	1000-seed weight (g)	Seed yield ($kg\ ha^{-1}$)	Harvest index (%)
C ₁ = Masoor-local	88.47 ^{NS}	30.90 c	4.63 b	37.98 b	1.55 b	17.04 c	773 c	39.57 b
C ₂ = Masoor-85	89.35	33.29 b	5.10 a	39.89 a	1.72 a	17.93 b	856 b	41.59a
C ₃ = Masoor-93	89.13	36.24 a	5.25 a	39.31 a	1.74 a	24.21 a	1163 a	42.45a
LSD (0.05 P)	NS	2.309	0.3115	0.7253	0.02983	0.2405	0.5447	1.461
Phosphorus levels ($kg\ ha^{-1}$)								
P ₀ = 0	88.88 ^{NS}	30.45d	4.65 b	36.64 c	1.58 d	19.24 c	812 d	38.99 c
P ₁ = 25	88.81	32.72 c	4.95 ab	38.73 b	1.66 c	19.60 b	906 c	40.82 b
P ₂ = 50	89.18	34.48 b	5.10 a	40.40 a	1.70 b	19.96 a	986 b	42.15 a
P ₃ = 75	89.06	36.26 a	5.28 a	41.13 a	1.74 a	20.10 a	1018 a	42.85 a
LSD (0.05 P)	NS	1.688	0.3360	0.7812	0.03170	0.2549	0.2588	1.270

Entries in a column not sharing a letter differ significantly at 0.05 P; NS=Non-significant

Maqsood *et al.* (1991), Bakhtiar *et al.* (1992) and Rahman and Sarkar (1997).

Seeds pod⁻¹ were affected significantly by phosphorus application as compared to control. There was a linear increase in the number of seeds pod⁻¹ with each increment of phosphorus from 25 to 75 kg ha⁻¹ showing a range of 1.66 to 1.74 seeds pod⁻¹. The results are supported by the findings of Maqsood *et al.* (1991), Bakhtiar *et al.* (1992) and Rahman and Sarkar (1997).

1000-seed weight (g). Seed test weight varied significantly among the three cultivars with the maximum (24.21 g) in Masoor-93 and the minimum of 17.04 g in Masoor-local while Masoor-85 intermediated, recording 1000-seed weight of 17.93 g. This much variation among the cultivars might be due to their variable sink capacity and ability to convert dry matter into seed development. These results are corroborated with those of Salam and Islam (1994), Tufail *et al.* (1995), Gray *et al.* (1996), Rahman and Sarkar (1997) and Sadiq *et al.* (1998).

Among phosphorus levels, although phosphorus application increased the seed weight significantly over control but the difference between 50 and 75 kg P ha⁻¹ treatment was non-significant giving on an average 19.96 and 20.10 g, respectively against the minimum of 19.24 g seed weight in control. The results clearly indicate the role of phosphorus in the development of lentil seed. These findings are in line with those of Kumar *et al.* (1993).

Seed yield (kg ha⁻¹). The final yield of a crop is a function of the combined effect of their yield components. The data on seed yield ha⁻¹ indicated significant differences among the three cultivars with significantly the maximum (1163 kg ha⁻¹) in Masoor-93 because of its higher number of pods plant⁻¹ and 1000-seed weight and was followed by Masoor-85 (856 kg ha⁻¹) against the minimum of 773 kg ha⁻¹ in Masoor-local. Variable yield potential of different lentil genotypes has also been reported by Tufail *et al.* (1995), Gray *et al.* (1996), Rahman and Sarkar (1997) and Sadiq *et al.* (1998).

The different phosphorus levels also had significant effect on seed yield of lentil. The seed yield increased linearly with each successive increment of phosphorus from 25 to 75 kg ha⁻¹ over control showing a range of 813 to 1019 kg ha⁻¹. The results clearly showed the potential role of phosphorus application in improving the yield potential of lentil. These results are supported by the findings of Maqsood *et al.* (1991).

Harvest index (%). Harvest index is an indication of the physiological ability of a cultivar to convert the dry matter into economic yield. Harvest index varied significantly

among the cultivars. Masoor-93 and Masoor-85 being at par with each other gave significantly higher harvest index than Masoor-local showing a range of 39.57 to 42.45%. Similar results have been reported by Salam and Islam (1994) and Sadiq *et al.* (1998).

Phosphorus application also increased the harvest index significantly over control. However, the difference between 50 and 75 kg ha⁻¹ treatments was observed to be non-significant giving a harvest index of 42.15 and 42.85%, respectively. These results are in conformity with those of Kumar *et al.* (1993).

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