*Indian J. Agron.* **40** (1) : 77–81 (March 1995)

# Effect of soil-moisture regime, kaolin spray and phosphorus fertilizer on growth, yield and economics of lentil (*Lens culinaris*)

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Received: November 1993

ABSTRACT

A field experiment was conducted during the winter season of 1987–88 and 1988–89 at New Delhi, to study the effect of soil-moisture regime, kaolin spray and phosphorus fertilizer on growth, yield and economics of lentil (*Lens culinaris* Medikus). Two irrigations applied 45 and 80 days after sowing recorded the maximum increase in various growth and yield attributes compared with no irrigation in both the years. This treatment also recorded maximum grain (15.7 q/ha) and straw yields (29.2 q/ha) as well as the highest net return/rupee (Rs 3.37). P application improved the growth and yield attributes and grain and straw yields with no difference between 40 and 80 kg $P_2O_5$/ha. Economic optimum dose of P was 62.8 kg $P_2O_5$/ha, which gave a response of 8.5 kg grain/kg $P_2O_5$/ha. Net return/ha was the highest with 80 kg $P_2O_5$/ha (Rs 7,240), but net return/rupee invested was the highest with 40 kg $P_2O_5$/ha (Rs 3.20).

Lentil (*Lens culinaris* Medikus) responds favourably to irrigations (Rizk, 1979), kaolin spray (Murari and Pandey, 1984) and also to fertilization especially phosphorus (Watt and Singh, 1992). Since an information regarding the response of lentil to irrigation and kaolin spray under varying levels of phosphorus is meagre, the present study was undertaken.

## MATERIALS AND METHODS

A field experiment was conducted during the winter season of 1987–88 and 1988–89 on sandy-loam soil at New Delhi. The soil had 0.34–0.35% organic carbon, 0.031–0.33% total N, 12.6–13.5 kg/ha available phosphorus and 170–178 kg/ha available potassium, with pH 8.2. The field capacity and permanent wilting point of 0–30 cm soil layer were 17.32 and 5.72 respectively, with bulk density of 1.47 g/cm.$^3$ The treatments comprised 7 soil-moisture regimes and kaolin spray as main plots and 3 P levels as subplots (Table 1), replicated thrice in split-plot design. Lentil 'Pusa 4' was sown at a 30 cm row spacing on 22 and 15 November in 1987–88 and 1988–89 respectively. A uniform basal dose of 20 kg N/ha (as urea) and P fertilizer (as single superphosphate) as per treatments was applied at sowing. Each irrigation treatment consisted of 60 mm water. The water-table depth was below 2 m throughout the cropping season. Hence the ground-water contribution was considered negligible. The total rainfall during the crop season was 81.6 mm in 1987–88 and 95.0 mm in 1988–89.

The net returns per hectare and per rupee were estimated on the basis of prevailing market rates during the respective years.

The optimum economic dose of phosphorus was worked out by the following formula:

$$X = \frac{1}{2c} \left( \frac{q}{p} - b \right)$$

where X is the optimum dose of P (kg/ha), b and c are the constants of quadratic equation, p is the price of unit produce (Rs 585/q grain) and q is cost of unit input (Rs 5.98/ha of phosphorus).

## RESULTS AND DISCUSSION

*Effect of soil-moisture regime and kaolin spray*

Irrigation either alone or coupled with kaolin spray at 45 or 80 days stage or at both the stages improved plant growth (plant height and dry matter/plant and yield attributes, viz. branches and pods/plant and 1,000-grain weight) compared with no irrigation (Table 1). The crop irrigated twice at 45 and 80 days after sowing, however, recorded highest values of all these growth and yield attributes in both years. Though kaolin spray twice at 45 and 80 days after sowing did not improve plant height and dry matter/plant, it remarkably improved 1,000-grain weight. The improvement in 1,000-grain weight due to kaolin spray could be attributed to reduced transpiration, resulting in higher leaf-water status consequently favouring greater photosynthesis and translocation of photosynthates towards grain. Murari (1982) also reported similar results.

Irrigation and kaolin spray markedly increased grain and straw yields compared with no irrigation in both years (Table 2). During 1987–88 the highest grain and straw yields were recorded with 2 irrigations applied 45 and 80 days after sowing and during 1988–89 these both were highest with kaolin spray at 45 days + 1 irrigation applied at 80 days. Two irrigations applied 45 and 80 days, however, maintained its superiority when the data of the 2 years were pooled. Though it was at par with kaolin spray at 45 days + 1 irrigation at 80 days, 1 irrigation alone at 80 days and 1 irrigation at 45 days + kaolin spray at 80 days for grain yield and it outyielded all the other treatments significantly for straw yield. The increase in grain and straw yields by irrigation and kaolin spray may be attributed to better development of growth and yield attributes. Murari and Pandey (1984) also reported similar results. The effect of 1 irrigation alone at 45 days during 1988–89 was not appreciable because the winter rains were of considerable magnitue at this stage. Saxena *et al.* (1973) also observed that yield of lentil increases due to irrigation only in the absence of winter rains. Similarly, kaolin spray twice at 45 and 80 days did not improve the straw yield in individual years as well as in their pooled analysis. This was apparently due its ineffectiveness on the growth of the crop.

Net return/ha (Rs 6,905) and net return/rupee invested (Rs 4.04) were the highest with 2 irrigations at 45 and 80 days in 1987–88. In 1988–89 highest values in respect of net return/ha (Rs 8,898) and net return/rupee invested (Rs 3.82) were associated with kaolin spray at 45 days + 1 irrigation at 80 days.

*Effect of P*

Application of P showed a positive effect on growth and yield attributes except seeds/pod in both years (Table 1). There was no difference between 40 and 80 kg $P_2O_5$/ha. Application of P in legumes enhances the activity of *Rhizobia* which ultimately results in accelerated root development, increased nitrogen fixation in the root nodules and

**Table 1.** Growth and yield attributes of lentil as affected by soil-moisture regime, kaolin spray and P application

| Treatment | Plant height (cm) | | Branches/ plant | | Dry matter/ plant (g) | | Pods/ plant | | Seeds/ pod | | 1,000-seed weight (g) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ |
| *Soil-moisture regime and kaolin spray* | | | | | | | | | | | | |
| $M_0$ | 31.1 | 35.8 | 8.1 | 10.6 | 2.90 | 3.20 | 48.5 | 62.5 | 1.48 | 1.48 | 14.1 | 15.2 |
| $M_1$ | 37.5 | 37.2 | 10.7 | 11.3 | 3.80 | 3.42 | 57.8 | 671.7 | 1.51 | 1.50 | 16.3 | 15.7 |
| $M_2$ | 34.3 | 40.6 | 9.9 | 12.5 | 3.40 | 4.10 | 54.1 | 79.4 | 1.51 | 1.52 | 16.1 | 16.8 |
| $M_3$ | 38.1 | 42.2 | 11.0 | 13.7 | 3.95 | 4.20 | 60.2 | 82.1 | 1.53 | 1.55 | 16.5 | 17.0 |
| $M_4$ | 30.9 | 35.2 | 8.6 | 11.8 | 2.75 | 3.21 | 50.3 | 70.9 | 1.51 | 1.49 | 15.4 | 16.4 |
| $M_5$ | 36.4 | 38.9 | 10.6 | 11.9 | 3.86 | 3.70 | 58.1 | 73.6 | 1.50 | 1.50 | 16.5 | 16.5 |
| $M_6$ | 34.6 | 41.6 | 10.2 | 12.5 | 3.42 | 4.02 | 55.6 | 80.8 | 1.50 | 1.51 | 16.2 | 16.9 |
| CD (P = 0.05) | 2.9 | 2.9 | 0.8 | 0.9 | 0.40 | 0.43 | 6.5 | 7.5 | NS | NS | 1.1 | 1.1 |
| *$P_2O_5$ (kg/ha)* | | | | | | | | | | | | |
| 0 | 32.5 | 36.2 | 9.0 | 10.9 | 3.10 | 3.30 | 47.3 | 65.4 | 1.49 | 1.50 | 14.8 | 15.2 |
| 40 | 36.1 | 39.3 | 10.4 | 12.5 | 3.60 | 3.81 | 57.9 | 77.8 | 1.50 | 1.52 | 16.5 | 16.7 |
| 80 | 35.5 | 40.0 | 10.3 | 12.7 | 3.65 | 3.94 | 59.6 | 79.4 | 1.52 | 1.50 | 16.3 | 17.2 |
| CD (P = 0.05) | 2.4 | 2.1 | 0.7 | 0.6 | 0.30 | 0.30 | 4.7 | 5.1 | NS | NS | 0.9 | 0.7 |

$Y_1$, 1987–88; $Y_2$, 1988–89

$M_0$, No irrigation; $M_1$, 1 irrigation 45 days after sowing (DAS); $M_2$, 1 irrigation at 80 DAS; $M_3$, 2 irrigations, 1 at 45 DAS and other at 80 DAS; $M_4$, kaolin spray twice, 1 at 45 DAS and other at 80 DAS; $M_5$, 1 irrigation at 45 DAS + kaolin spray at 80 DAS; $M_6$, kaolin spray at 45 DAS + 1 irrigation at 80 DAS

**Table 2.** Grain and straw yields and economics of lentil as affected by soil-moisture regime, kaolin spray and P application

| Treatment | Grain yield (q/ha) | | | Straw yield (q/ha) | | | Net return (Rs/ha) | | Net return/rupee invested (Rs/ha) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $Y_1$ | $Y_2$ | Pooled | $Y_1$ | $Y_2$ | Pooled | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ |
| *Soil-moisture regime and kaolin spray* | | | | | | | | | | |
| $M_0$ | 7.5 | 12.4 | 10.0 | 17.0 | 25.6 | 21.3 | 2,759 | 5,817 | 1.33 | 2.79 |
| $M_1$ | 13.2 | 13.7 | 13.5 | 26.3 | 26.7 | 26.5 | 6,233 | 6,495 | 2.85 | 2.99 |
| $M_2$ | 12.5 | 17.5 | 15.0 | 21.5 | 29.3 | 25.4 | 5,675 | 8,811 | 2.61 | 4.05 |
| $M_3$ | 14.5 | 17.0 | 15.7 | 28.4 | 29.9 | 29.2 | 6,905 | 8,406 | 3.04 | 3.70 |
| $M_4$ | 11.2 | 13.8 | 12.5 | 18.7 | 24.9 | 21.8 | 4,666 | 6,346 | 1.96 | 2.66 |
| $M_5$ | 14.2 | 14.2 | 14.2 | 26.1 | 26.3 | 26.2 | 6,662 | 6,655 | 2.86 | 2.86 |
| $M_6$ | 13.3 | 17.9 | 15.6 | 22.6 | 30.4 | 26.5 | 6,013 | 8,898 | 2.58 | 3.82 |
| CD (P = 0.05) | 1.9 | 1.4 | 1.6 | 2.5 | 2.3 | 2.3 | | | | |
| *$P_2O_5$ (kg/ha)* | | | | | | | | | | |
| 0 | 9.7 | 11.8 | 10.7 | 21.1 | 26.3 | 23.7 | 4,217 | 5,569 | 2.13 | 2.81 |
| 40 | 13.4 | 16.8 | 15.1 | 23.6 | 28.0 | 25.8 | 6,160 | 8,296 | 2.73 | 3.67 |
| 80 | 14.0 | 17.0 | 15.5 | 24.1 | 28.4 | 26.2 | 6,306 | 8,174 | 2.51 | 3.25 |
| CD (P = 0.05) | 0.7 | 1.0 | 0.8 | 1.6 | 1.5 | 1.4 | | | | |

$Y_1$, 1987–88; $Y_2$ 1988–89

Details of moisture regimes and kaolin spray treatments are given in Table 1

thereby an improvment in plant growth and development (Chowdhury *et al.*, 1974, Watt and Singh, 1992).

The P fertilization significantly increased the grain and straw yields with no marked difference between 40 and 80 kg $P_2O_5$/ha in individual years as well as in pooled data (Table 2). The improvement in the growth and yield attributes with P was responsible for greater yields. Venkateswarlu and Ahlawat (1993) also reported similar results.

The relationship between grain yield and P application indicated quadratic response during both years as well as in pooled data. The economic optimum dose of $P_2O_5$ during 1987–88 and 1988–89 and on an average was 66.6, 59.0 and 61.8 kg/ha respectively, which showed a response of 7.0, 10.0 and 8.4 kg grain/kg $P_2O_5$/ha and a return of Rs 6.86, 9.80 and 8.25/ rupee spent on P.

During 1987–88 net return/ha was maximum at 80 kg $P_2O_5$/ha (Rs 6,306) but during 1988–89 it was the highest at 40 kg $P_2O_5$/ha (Rs 8,296). Net return/rupee was the highest with 40 kg $P_2O_5$/ha in both years, being Rs 2.73 and 3.67 during 1987–88 and 1988–89 respectively.

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