IJPS INTERNATIONAL JOURNAL OF PLANT SCIENCES
e ISSN-0976-593X Volume **13** | Issue 1 | January, 2018 | 102-107

DOI: 10.15740/HAS/IJPS/13.1/102-107
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RESEARCH ARTICLE

Studies on phosphorus requirement of lentil and french bean intercropping with Indian mustard

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SUMMARY

The study was laidout during *Rabi* season of 1994-95 and 1995-96 at Student's Instructional Farm, C.S. Azad University of Agriculture and Technology, Kanpur. The soil of experimental field was sandy loam, having low fertility status. Five cropping systems *i.e.*, Indian mustard sole, Indian mustard + lentil, Indian mustard without lentil at same distance, Indian mustard + French bean and Indian mustard without French bean at same distance were tested under three levels of phosphorus (control, 30 kg P_2O_5/ha and 60 kg P_2O_5/ha). The highest yield of Indian mustard by 24.04 q/ha was harvested under treatment of Indian mustard sole. In associated cropping system of lentil and French bean, Indian mustard yielded by 11.72 q/ha and 15.52 q/ha seed yield, respectively. The yield of Indian mustard was obtained 16.95 q/ha at 30 kg P_2O_5/ha closely followed by 60 kg P_2O_5/ha (16.45 q/ha). The growth and yield traits of Indian mustard were concordant to the yields obtained from Indian mustard under different cropping systems and levels of phosphorus. The yield of intercropped lentil and French bean were harvested by 6.69 q/ha and 12.02 q/ha, respectively. Both inter crops provided more grain yield upto highest tested dose of 60 kg P_2O_5/ha closely followed by 80 kg P_2O_5/ha. The growth and yield attributes of both crops were commensurable to the yields obtained from lentil and French bean under cropping systems with Indian mustard and levels of phosphorus application.

Key Words : Associated cropping, Commensurable, Concordant, French bean, Inter cropping

How to cite this article : Singh, R.K., Chaudhary, V.R., Prakash, Ram and Singh, M.K. (2018). Studies on phosphorus requirement of lentil and french bean intercropping with Indian mustard. *Internat. J. Plant Sci.*, **13** (1): 102-107, **DOI: 10.15740/HAS/IJPS/13.1/102-107**.

Article chronicle : Received : 28.10.2017; **Revised :** 23.11.2017; **Accepted :** 07.12.2017

Intercropping is not a new concept but at in one way or other is in practice since a quite long time in developing countries including India. Its importance was highlighted 68 years ago in a very comprehensive review given by Aiyer (1949). In Indian agriculture intercropping has been traditionally practiced at low level technology for reduction of risk but later it has been recognized as potentially beneficial system of crop production. The evidences suggested that intercropping can provide substantial yield advantage as compared to sole cropping (Willey, 1979). Intercropping is a key element of traditional farming system largely for risk aversion. It has been suggested that intercropping alters

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rooting pattern so that a greater volume of soil is exploited than in a monoculture (Waghmare and Singh, 1984).

Pulses and oilseeds are the backbone of India's crop production but the production of pulses in the three decades is almost stagnating except increase in production due to increase in area rather than productivity. As a results of poor productivity and inceasing population, the availability of pulses per capita per day has come down significantly. In India oilseeds occupy good area but contribute in term of production, oilseeds form the second largest agricultural commodity after cereals in India. Among all the *Rabi* oil seeds, Indian mustard occupies good area. In U.P. Indian mustard occupies 6.26 lakh ha area and production 4.86 lakh mt with a productivity of 777 kg/ha (Anonymous, 2016).

Among *Rabi* pulses, lentil has been reported as better a intercrop because it appears to be more tolerant to shade and competition than other pulse crops. Kushwaha (1985); Mandal *et al*. (1991); Asaduzzaman and Islam (1993) and Kushwaha (1992) reported the yield and monetary advantage of lentil grown in association with Indian mustard. Intercropping of French bean with vegetable crops, Indian mustard and wheat has been suggested by Ali and Singh (1988); Kadalli *et al.* (1988); Poniedzialek *et al*. (1989); Ramasinghe and Mayhead (1990); Arias *et al*. (1991) and Dahatonde *et al*. (1992).

Soils of pulses growing area are generally low in native fertility particularly in nitrogen and phosphorus. Since pulse crops are endowed with capability of meeting out larger part of their N requirement through biological N_2 fixation. The deficiency of phosphorus, therefore, becomes most limiting factors in the yield exploitation of pulse crops.

Phosphorus requirement of crops in an intercropping system may not be the same as that of sole cropping. It is, therefore, essential to determine the optimum dose in intercrop combination because P is likely to interact with higher plant density. Keeping the above point in to the consideration, the present field experiment was planned and conducted with the main objective to find out the optimum dose of phosphorus for components crops.

MATERIAL AND METHODS

The present study was carried out during winter season of 1994-95 and 1995-96 at Student's Instructional Farm, C.S. Azad University of Agriculture and Technology, Kanpur. The soil of experiment was sandy loam, having pH 7.8, organic carbon 0.46%, available N 237 kg/ha, available phosphorus 12.75 kg/ha and available potash 153.75 kg/ha, therefore, the fertility status was poor. The pH was determined by Electrometric glass electrode method (Piper, 1950), while organic carbon was determined by Colorimetric method (Datta *et al.*, 1962). Available nitrogen was analysed by Kjendahl's method as discussed by Piper (1950). The available phosphorus and potassium were determined by Olsen's method (Olsen *et al.*, 1954) and Flame photometric method (Singh, 1971), respectively. The five cropping system *i.e.*, Indian mustard sole (C_1), Indian mustard + lentil (1:5-C_2), Indian mustard without lentil at same distance (C_3), Indian mustard + French bean (2:6-C_4) and Indian mustard without French bean at same distance (C_5) were tested with three levels of phosphorus (control-P_0, 30 kg P_2O_5/ha-P_1 and 60 kg P_2O_5/ha P_2). Therefore, fifteen treatment combinations were tested in Split Plot Design with four replications. The Indian mustard variety Varuna, lentil cultivar K-75 and French bean variety PDR-14 were planted in pure and intercropping system.

The experimental crops were sown 7th and 11th November in 1994 and 1995, respectively. The crops were harvested on 24.03.95 and 25.03.95 in first year and 28.03.96 and 29.03.96 in second years. The other recommended agronomical practices were also followed in tested crops. The pooled data of two years were statistically analysed with the standard method as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The pooled results obtained from the experiment are reported and discussed on mean value of two years.

Effect of cropping systems and phosphorus levels on Indian mustard :

(A_1) Effect on growth parameters:

The plant was significantly taller in Indian mustard sole than all the remaining systems. The difference in plant height under inter cropping systems was not more marked (Table 1). Application of phosphorus @ 30 kg/ha increased the plant height significantly. Further increase in phosphorus level reduced the plant height significantly.

The functioning leaves/plant recorded in intercropped Indian mustard were significantly higher than sole Indian mustard sown at regular spacing of 45 cm. Not much variation was noted under intercropping systems. There was significant increase in functioning

leaves by first level of 30 kg P_2O_5/ha over control but further increase in the dose of P_2O_5 was responsible for significant decrease.

Quite wide variation due to cropping systems was marked in the total branches/plant. All the cropping systems produced significantly more total number of branches than sole Indian mustard. The Indian mustard sown without intercrops made improvement in the branches than Indian mustard of intercropping. The increase in total number of branches was significant only by 30 kg P_2O_5/ha over control and 60 kg P_2O_5/ha.

The number of siliqua/plant was counted higher in intercropping system than sole planting systems. Number of siliqua recorded at the 30 kg P_2O_5/ha showed significant response. The further installment of P_2O_5 stagnated the production of siliqua/plant.

The lentil and French bean showed the positive effective on almost all growth parameters of Indian mustard. The positive effect of lentil on growth parameters has been reported by Gangasaran and Giri (1985); Kunshwaha (1985); Mandal *et al.* (1991); Kushwaha (1992) and Singh *et al.* (1998). Similarly positive effect of French bean on Indian mustard has been reported by Singh and Ali (1987). Ali and Singh (1988); Khola and Singh (1996) and Ahlawat (1998).

The difference in growth parameters among the 30 kg P_2O_5/ha and 60 kg P_2O_5/ha not due to treatment effect but only due to physiological nature of attributes. A number of workers have reported the above response to phosphorus (Singh and Kamath, 1991; Singh *et al.*, 1998; Tomar *et al.*, 1997; Patel and Shelke, 1998 and Thakur *et al.*, 1999).

(A_2) Effect on yield traits:

The different cropping systems were failed to show significant response on seeds/siliqua. The effect of phosphorus was found significant upto 30 kg P_2O_5/ha. The further installment of P_2O_5 was showed at par number of seeds/siliqua to 30 kg P_2O_5/ha.

The sole mustard was observed inferior than remaining cropping systems. Lentil and French bean slightly decreased and increased the seed weight/plant, respectively. Insignificant response was recorded in different levels of phosphorus. The cropping systems had no significant effect on 1000-seed weight, while the response of phosphorus has gone upto highest tested dose of phosphorus in comparison to control.

These results confirm the findings of Gangasaran and Giri (1985), Kushwaha (1985), Mandal *et al.* (1991), Kushwaha (1992) and Singh *et al.* (1998) in the study of intercropping of Indian mustard and lentil. Similar studies have also been reported by Ali and Singh (1988), Khola and Singh (1996) and Ahlawat (1998) in the intercropping of Indian mustard and French bean.

Table 1 : Growth, yield traits and yield of Indian mustard under the influence of inter cropping systems and level of phosphorus (pooled data of two years)

Treatments	Plant height (cm)	Functioning leaves/plant	Branches/ plant	Siliqua/ plant	Pods/ siliqua	Seed weight/ plant (g)	1000-seed weight (g)	Seed yield (q/ha)	Harvest index
Cropping system									
Indian mustard sole (C_1)	161.10	74.10	30.20	372.40	11.76	25.79	5.55	24.04	28.17
Indian mustard + lentil (C_2)	146.30	96.30	48.17	591.20	11.94	36.51	5.43	11.72	26.34
Indian mustard without lentil at same distance (C_3)	156.50	88.94	52.58	567.20	12.38	40.09	5.49	15.52	25.46
Indian mustard + French bean (C_4)	159.00	99.88	58.49	604.30	12.33	38.75	5.43	15.28	33.38
Indian mustard without French bean at same distance (C_5)	158.10	101.62	59.33	544.30	12.10	38.17	5.66	14.34	31.63
S.E. ±	2.90	6.25	2.45	3150	0.22	2.39	0.11	0.68	2.17
C.D. (P=0.05)	6.00	12.89	5.06	65.00	NS	5.21	NS	1.41	4.73
Phosphorus level									
Control (P_0)	151.00	80.21	40.95	493.50	11.58	34.04	5.34	15.17	29.52
30 kg/ha (P_1)	161.10	103.20	52.62	568.00	12.38	36.58	5.67	16.95	28.88
60 kg/ha (P_2)	156.70	93.08	48.54	546.00	12.35	36.97	5.51	16.45	28.58
S.E. ±	0.60	2.10	1.60	22.20	0.10	1.81	0.03	0.37	0.67
C.D. (P=0.05)	1.20	4.19	3.20	44.40	0.19	NS	0.06	0.75	NS

NS=Non-significant

(A_3) Effect on seed yield (q/ha):

The seed yield of Indian mustard in all the four cropping systems was low than Indian mustard sole. It is apparent from data presented in Table 1 that the lentil induced significant reduction, while the effect of French bean was numerically positive. On the basis of pooled seed yield, the crop response to phosphorus was noted upto 30 kg P_2O_5/ha, while highest dose of 60 kg P_2O_5/ha showed slightly reduction in comparison to 30 kg P_2O_5/ha.

The yields of Indian mustard were low with lentil and French bean intercropping systems due to lesser plant stand. The work of Gangasaran and Giri (1985), Mandal *et al.* (1991), Kushwaha (1992) and Singh (1996) is in the support of these findings.

The difference in the yield of Indian mustard under different levels of phosphorus was due to physiological factor. These findings confirm the results of Singh and Kamath (1991); Singh (1996); Tomar *et al.* (1997); Patel and Shelke (1998) and Thakur *et al.* (1999).

(A_4) Harvest index:

The erratic trend in harvest index was observed under different cropping systems. The insignificant response of different levels of phosphorus was also noted.

Effects of cropping systems and phosphorus levels on intercrops :

(B_1) Effect on growth parameters:

The lentil plants remained significantly taller than French bean in intercropping systems with Indian mustard. The linear increase in plant height was noted upto 60 kg P_2O_5/ha.

The lentil had more number of functioning leaves/plant than French bean. The linear increase in functioning leaves per plant was also recorded upto application of 60 kg P_2O_5/ha.

(B_2) Effect on yield traits:

It is clear from the data available in Table 2 that the lentil developed more pods than French bean. There was increase in number of pods upto 60 kg P_2O_5/ha but use of 30 kg P_2O_5/ha produced at par number of pods/plant to 60 kg P_2O_5/ha.

The grains per pod of French bean were significantly more than the lentil. Application of 60 kg P_2O_5/ha increased the grains/pod significantly over the control but this increase was at par with 30 kg P_2O_5/ha.

Per plant grains of lentil were more than French bean. A dose of 30 kg P_2O_5/ha followed by 60 kg P_2O_5/ha was superior to the control. The grain weight/plant of French bean was higher than lentil in pooled results of two years. There was increase in grain weight upto 60 kg P_2O_5/ha. The grain weight recorded at 30 kg P_2O_5/ha was statistically at par to the 60 kg P_2O_5/ha. The seeds of French bean were much bolder (52.29 g/100-seed) over the lentil (2.50 g/100-seed). Applied phosphorus increased the 100-seed weight upto highest tested dose of 60 kg P_2O_5/ha.

(B_2) Effect on seed yield (q/ha):

French bean yielded higher grain yield by 12.02 q/

Table 2 : Growth, yield traits and yield of lentil and french bean under the influence of inter cropping systems with Indian mustard and level of phosphorus (pooled data of two years)

Treatments	Plant height (cm)	Functioning leaves/plant	Branches/ plant	Pods/ plant	Grains/ pod	Grains/ plant	Grain weight/ plant (g)	100-seed weight (g)	Grain yield (q/ha)	Harvest index (%)
Intercropping										
Indian mustard + lentil (C_2)	56.81	82.17	10.04	27.17	1.15	31.00	0.78	2.50	6.69	19.34
Indian mustard + French bean (C_4)	42.55	57.87	18.81	11.25	2.02	23.79	9.35	52.29	12.02	43.99
S.E. ±	1.07	4.71	0.83	1.30	0.07	2.04	0.65	0.51	0.38	2.07
C.D. (P=0.05)	3.42	15.07	2.03	4.16	0.22	5.00	2.08	1.65	0.79	6.64
Phosphorus level										
Control (P_0)	44.58	56.04	12.12	15.53	1.51	21.05	4.21	25.98	8.60	32.02
30 kg/ha (P_1)	51.71	76.60	15.18	21.21	1.62	31.06	7.34	27.60	9.49	31.14
60 kg/ha (P_2)	52.75	77.44	15.98	21.42	1.64	30.08	7.63	28.60	9.98	31.85
S.E. ±	0.65	2.18	0.48	0.60	0.03	0.66	0.34	0.19	0.25	0.77
C.D. (P=0.05)	2.08	4.73	1.00	1.31	0.06	1.36	0.74	0.39	0.58	NS

NS=Non-significant

ha over lentil (6.69 q/ha). Response of phosphorus on grain yield was noted upto 60 kg P_2O_5/ha (9.98 q/ha) followed by 30 kg P_2O_5/ha (9.49 q/ha).

The grain yield of French bean was recorded better than lentil due to differential nature of crop plants. No past research evidence is available to justify these findings. Response of phosphorus application on seed yield (q/ha) was recorded upto 60 kg P_2O_5/ha followed by 30 kg P_2O_5/ha. Khare *et al.* (1988); Azad and Gill (1989); Azad *et al.* (1991); Chandra (1991); Singh and Singh (1991); Banwarilal *et al.* (1995) and Purushottam *et al.* (1995) have given the same recommendation.

(B4) harvest index:

The harvest index of French bean was higher than the lentil in pooled results of two years. Effect of phosphorus on harvest index was computed non significant.

Conclusion :

On the basis of experimental finding, the intercropping of French bean was found much suitable with Indian mustard at 60 kg P_2O_5/ha and its effect on Indian mustard was slightly positive. Intercropping of lentil was also given better performance at 60 kg P_2O_5/ ha but its effect on Indian mustard was recorded adverse. However, both the intercropping systems may be recommended to the farm families for increasing the production of pulses and oil.

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