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Effect of row ratio and phosphorus level on performance of chickpea (*Cicer arietinum*)–Indian mustard (*Brassica juncea*) intercropping

AVANESH KUMAR AND B.P. SINGH

Department of Agronomy, Raja Balwant Singh College, Bichpuri, Agra, Uttar Pradesh 283 105

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ABSTRACT

A field experiment was conducted during winter seasons (*rabi*) of 2000–01 and 2001–02 at Agricultural Research Farm to find out the effect of row ratios (4:2, 6:2 and 8:2) and phosphorus levels (30, 60 and 90 kg P_2O_5/ha) on chickpea or gram (*Cicer arietinum* L.) + Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson] intercropping on growth, yield attributes, yield, yield assessment and monetary returns as well as P uptake under dryland conditions in semi-arid region of central Uttar Pradesh. The highest land-equivalent ratio (LER), area × time equivalency ratio (ATER), effective yield total (EYT), net return and benefit : cost ratio were obtained at 6:2 row-ratio. Among the phosphorus levels tried, 60 kg P_2O_5/ha was found most economic. P uptake was significantly higher at 60 kg P_2O_5/ha in comparison with 30 kg P_2O_5/ha. Net return was also highest, i.e. Rs 22,042.90 and 20,182.04/ha at 6:2 row ratio and 60 kg P_2O_5/ha respectively.

Key words : Intercropping, Chickpea, Indian mustard, Phosphorus level

Cultivation of Indian mustard (*Brassica juncea*) as an intercrop in chickpea (*Cicer arietinum*) is common in India under rainfed condition. Scientific approach of intercropping of these two crops increases the productivity per unit area per unit time (Ali, 1988) under a situation where two crops are grown in intercropping at a certain proportion and row ratio. Intercropping increases the cropping intensity, productivity and profitability, under optimum utilization of soil, water, nutrients and sunlight in time and space. Chickpea intercropped with lentil at row ratio of 6:2 gave higher monetary return in comparison with that at 2:1 and 4:2 row ratios (Mishra *et al.,* 2001).

Phosphorus fertilization is important for grain legumes, having very specific key-role in atmospheric nitrogen fixation. It improves root development, nodulation and seed quality. Although information is available on the phosphorus level in chickpea and Indian mustard grown as sole crops, its effect on their intercropping system has not been thoroughly investigated. Hence the present study was undertaken.

MATERIALS AND METHOD

The experiment was conducted during the winter seasons (*rabi*) 2000–01 and 2001–02 at Agricultural Research Farm of R.B.S. College, Bichpuri (Agra). The soil was sandy loam, having pH 8.10, electrical conductivity (EC) 1.55 dS/m, organic carbon 0.29%, and the available N, P_2O_5 and K_2O 190.75, 28.25 and 294.50 kg/ha respectively. The treatments consisted of three row ratios (chickpea + mustard 4:2, 6:2 and 8:2) and sole crops of chickpea and mustard to compare the intercropping, and three levels of phosphorus (30, 60 and 90 kg P_2O_5/ha). The experiment was conducted in randomized block design. The cultivars used were 'Awarodhi' chickpea and 'Rohini' Indian mustard at 30 cm row spacing. Indian mustard and chickpea were sown on 24 and 16 October, and harvested on 21 and 14 March and 4 and 2 April during 2000–01 and 2001–02 respectively. A basal dose of nitrogen for chickpea and Indian mustard @ 20 and 60 kg/ha respectively was given, and phosphorus as per treatment and potassium (30 kg K_2O/ha) were applied as per recommendation. P was applied through trisodium phosphate, N through urea and K through muriate of potash, at the time of sowing.

RESULTS AND DISCUSSION

Chickpea

Grain and straw yields of chickpea were significantly lower at 4 : 2 row ratio than at 6:2 and 8:2 row ratios and sole crop. The highest yield attributes, and the grain and straw yields were obtained with sole crop of chickpea, which was statistically on a par with that at 6:2 and 8:2 row ratios. Mishra *et al.* (2001) also obtained similar results. The reduction in yield attributes and yield was due to the shading effect of Indian mustard on chickpea. Chickpea in intercropping recorded 70.13% (4:2), 92.06%

Table 1. Effect of row ratios and P levels on growth, yield attributes and yield of chickpea and Indian mustard intercropping (pooled data of 2 seasons)

Treatment	Plant height of chickpea (cm)	Plant height of mustard (cm)	No. of pods/ plant	No. of siliquae/ plant	Weight of pods/ plant (g)	Weight of siliquae/ plant (g)	No. of grains/ pod	No. of seeds/ siliqua	Grain yield (q/ha)	Seed yield (q/ha)	Straw yield (q/ha)	Straw or stalk yield (q/ha)
Sole crop												
Chickpea	57.6		34.0		8.85		1.80		19.15		22.92	
Mustard		130.2		227.17		24.24		12.95		14.22		34.47
Chickpea + mustard (row ratio)												
4:2	64.3	148.2	29.39	245.78	7.56	30.93	1.74	13.82	13.43	7.35	17.91	18.26
6:2	62.8	154.2	32.61	299.11	8.60	35.58	17.9	15.06	17.62	5.77	21.16	14.14
8:2	59.7	152.7	33.61	290.39	8.82	35.14	1.76	14.67	18.23	4.47	21.21	10.83
CD (P=0.05)	3.3	5.0	2.88	19.14	0.76	2.68	NS	1.24	1.63	0.92	1.92	1.83
P (P_2O_5/ha)												
30	58.9	142.5	30.00	249.92	7.93	29.37	1.35	13.21	15.38	6.93	19.25	17.75
60	61.8	147.7	33.00	168.09	8.65	31.85	1.96	14.30	18.28	8.80	21.71	20.49
90	62.6	148.8	34.21	279.19	8.80	33.18	1.99	14.92	17.67	8.13	21.06	20.03
CD (P=0.05)	2.9	4.4	2.57	16.73	0.23	2.31	0.11	1.12	1.41	0.81	1.66	1.60

(6:2) and 95.19% (8:2) yield of the sole crop.

Phosphorus greatly influenced the yield attributes, grain yield and P uptake up to 60 kg P_2O_5/ha. These were highest at 90 kg P_2O_5/ha, which was statistically at par with that of 60 kg P_2O_5/ha and significantly superior to that of 30 kg P_2O_5/ha. Application of 60 and 90 kg P_2O_5/ha improved the seed yield by 18.86 and 14.86% respectively compared with that of 30 kg P_2O_5/ha. These findings are in close conformity with those of Patel *et al.* (2002).

Indian mustard

The plant height and yield attributes (Table 1), number of siliquae, and weight of siliquae were significantly higher when Indian mustard was grown in intercropping system than as sole crop. Yield attributes were the highest at 6:2 row ratio, which was statistically superior to sole crop and 4:2 row ratio, but statistically on a par with that at 8:2 row ratio. However, sole crop of Indian mustard recorded significantly higher seed yield than intercropping. In intercropping it decreased due to less plant population per unit area with different row ratios of chickpea-mustard intercropping. Mishra *et al.* (2001) also reported similar results.

Phosphorus application up to 60 kg P_2O_5/ha significantly increased the plant height and yield-contributing characters such as number of siliquae and weight of siliquae/plant, number of seeds/siliqua, and seed and straw or stalk yields as well as P uptake. The difference in these characters at 60 and 90 kg P_2O_5/ha was non-significant. These doses improved the seed yield by 26.98 and 17.32% respectively compared with that of 30 kg P_2O_5/ha (Table 1). Sharma and Jalali (2001) too reported such beneficial effects.

Intercropping of chickpea and Indian mustard increased the total productivity and net returns significantly compared with their sole crops. This was due to the increase in yield of component crops in the intercropping system and beneficial effect of widening of row ratio. The highest land-equivalent ratio (LER), area × time equivalency ratio (ATER) and effective yield total (EYT) were obtained at 6:2 row ratio. Mishra *et al.* (2001) also reported similar findings. This row ratio also gave the highest net returns and benefit : cost ratio, confirming the results of Singh *et al.* (2000).

Phosphorus also increased the total productivity, P uptake as well as quality. The highest improvement was observed at the highest level (90 kg P_2O_5/ha), which was statistically on a par with that at 60 kg P_2O_5/ha. However, 60 kg P_2O_5/ha gave the highest land-equivalent ratio, area × time equivalency ratio and effective yield total with higher net returns/ha and benefit :cost ratio compared with 30 kg and 90 kg P_2O_5/ha. Siag (1995) reported similar results.

Table 2. Effect of row ratios and P levels on quality, P uptake, yield assessment and benefit : cost ratio of chickpea and Indian mustard (pooled data of 2 seasons)

Treatment	Protein (%)		Oil content (%) in mustard	Test weight (g)		P uptake (kg/ha)		LER	EYT (q/ha)	ATER	Net return	Benefit: cost ratio
	Chickpea	Mustard		Chickpea	Mustard	Chickpea	Mustard					
Sole crop												
Chickpea	19.66			119.73		36.26		1.00	19.15	1.0	15,252	1.52
Mustard		14.77	38.27		5.56		34.97	1.00	19.05	1.0	12,108	1.34
Chickpea + mustard (row ratio)												
4 : 2	20.22	17.25	39.67	117.17	5.60	38.67	35.20	1.22	23.33	1.12	19,070	1.96
6 : 2	20.46	17.45	39.81	118.95	5.75	39.02	35.37	1.33	25.41	1.24	22,042	2.25
8 : 2	20.62	17.54	39.71	119.17	5.58	38.90	35.42	1.26	24.26	1.20	20,853	2.12
CD (P=0.05)	NS	0.61	NS	NS	NS	5.2	6.0					
P (P_2O_5/ha)												
30	19.54	16.22	37.81	111.21	5.22	39.75	35.90	1.17	20.21	1.16	15,441	1.69
60	20.46	16.87	39.98	119.34	5.73	47.32	40.75	1.22	25.03	1.21	20,182	2.10
90	20.72	17.16	40.31	125.71	6.02	49.15	41.20	1.21	23.87	1.20	17,974	1.73
CD (P=0.05)	0.85	0.60	1.51	7.02	0.32	6.20	4.35					

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