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Response of chickpea (*Cicer arietinum*) to seeding time and phosphorus and their after-effects on succeeding baby corn (*Zea mays*)

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ABSTRACT

A field study conducted during 2005-07 on chickpea (*Cicer arietinum* L.)–baby corn (*Zea mays* L.) cropping system on sandy loam soil at New Delhi revealed that chickpea cv 'ICCV 96029' produced higher mean green-seed (*chholia*) yield (1.20 t/ha) than 'ICCV 96030' (0.93 t/ha). The maximum *chholia* production was recorded when the crop was sown on 7 October (1.31 t/ha), and the least (0.82 t/ha) when it was sown on 15 October. Application of 26.4 kg P/ha recorded significantly more *chholia* production (1.15 t/ha) than 13.2 kg P/ha (1.09 t/ha) and unfertilized crop (0.94 t/ha). The performance of the succeeding baby corn was not influenced by chickpea cultivars. Baby corn raised after chickpea sown on 15 October recorded higher yield than that after chickpea grown after two other dates of seeding. Baby corn after chickpea fertilized with 26.4 kg P/ha produced the highest yield. The chickpea–baby corn cropping system on an average removed 16.47 kg P/ha, whereas the cropping system received 39.6 kg P/ha, resulting in build-up of available soil P by 0.73 kg/ha. The net returns followed the trend of *chholia* production. Thus sowing chickpea cv 'ICCV 96029' on 7 October with 13.2 kg/ha for *chholia* with the succeeding baby corn receiving the recommended dose of fertilizers is best for productivity and returns of chickpea-baby corn cropping system.

Key words: Baby corn, *Chholia*, Chickpea, Phosphorus, Seeding time

Crop diversification with vegetables is being increasingly adopted by the farmers to improve farm profitability. *Chholia* (immature green seeds of chickpea) and baby corn are the important short-duration vegetable crops receiving attention in recent times. These can be grown in rotation after rainy season (*kharif*) crops (rice, blackgram, and soybean) in early winter (*rabi*) - spring seasons for intensive land use and remuneration. In north India especially in Punjab, Haryana, Delhi and western Uttar Pradesh, *chholia* is consumed, with its peak demand during December to middle of February. Owing to severe winters, the crop in this region comes to market from the end of February and is available up to the end of March. It is therefore procured from far-off places of south India, where the crop comes to market from December onwards due to mild winters. The high overhead cost (transport) leads to low farmer's share (<60%) in the consumers price (Rs 50/kg). This study is an effort to produce *chholia* not only to increase the farmer's income but also to diversify the fatigued rice-wheat, rice/cotton-fallow systems. The early chickpea cultivars have been found best for *chholia* production, when sown on 30 September at Ludhiana (Sandhu *et al.,* 2002). The performance of crop cultivars is always variable depending upon the climatic conditions prevailing during the various growth phases. Further, there is also not much information on P needs for *chholia* production, and also when grown in sequence with baby corn. The present study was therefore conducted to evaluate two early chickpea cultivars under different seeding dates and rates of P fertilization, and also to assess their residual effect on baby corn.

MATERIALS AND METHODS

A field experiment was conducted during 2005-07 at New Delhi. The experimental soil was sandy loam with pH 7.75, analysing low in organic C (0.37%), medium in available P (14.6 kg/ha) and low in available K (177 kg/ha). The experiment was laid out in split plot design with three replications having 18 treatment combinations involving three dates of seeding (30 September, 7 October and 15 October) as main plots, along with two cultivars of chickpea ('ICCV 96029' and 'ICCV 96030') and three levels of P (0, 13.2 and 26.4 kg/ha) as subplots. The respective mean maximum and minimum temperatures at the time of seeding were 32.9 and 22.6°C in 2005 and 34.9

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and 22.0°C in 2006 for the crop sown on 30 September; 34.5 and 19.7°C in 2005 and 37.1 and 20.4 °C in 2006 for the crop sown on 7 October; and 33.1 and 17.4 °C in 2005 and 35.4 and 19.6°C in 2006 for the crop sown on 15 October. Assuming the base temperature as 0°C for chickpea (Ellis *et al.*, 1986), it received 2,428, 2,240 and 2,055 thermal degree-days in 2005-06, and 2526, 2,331, 2,133 thermal degree-days in 2006-07 from their respective dates of sowing to harvest (15 February).

The succeeding baby corn as a general crop was grown with recommended dose of N (100 kg/ha), P (26.4 kg/ha) and K (50 kg/ha). *Chholia* was given the entire P as per the treatments through single superphosphate along with a uniform dose of 20 kg N/ha at the time of sowing. Besides a pre-sowing irrigation, chickpea also received two irrigations at 35 and 80 days after sowing (DAS). Two weeks before harvest of *chholia* (end of January), irrigation was given for facilitating the land preparation for succeeding baby corn and also to reduce the turn-around period of the crops. Recommended integrated pest management (IPM) practices were adopted to protect the chickpea. *Chholia* were harvested in all the dates of sowing on 15 February at the peak price period of the market. The baby corn cv 'PEMH 2' (Pusa early maize hybrid) was sown at 40 cm x 20 cm spacing, with half the dose of N and full amount of P and K as basal. The remaining N was top-dressed 30 DAS following irrigation. The crop received four irrigations at 15-day intervals, beginning at 15 DAS. Young cobs were harvested within 2-4 days after silk emergence on alternate days during 50-70 days of crop growth and the remaining stalks were harvested for green fodder. A rainfall of 124.1 mm in 2005-06 and 28.8 mm in 2006-07 was received, of which 33.7 and 3.2 mm was received during chickpea-growing season (October-mid February).

RESULTS AND DISCUSSION

Chholia

Results revealed that the 2 chickpea cultivars differed in growth, yield attributes and *chholia* production (Table 1). The biological yield of chickpea was significantly higher in 'ICCV 96029', being 29.4 % more than that of 'ICCV 96030'. Taller plants with profused branching (data not reported), more pods/plant (9.5) and 1,000-green seed weight (39.0 g) in 'ICCV 96029' contributed to greater biomass production as well as *chholia* compared with those in 'ICCV 96030'. Over the seasons, 'ICCV 96029' produced 28.5% higher *chholia* yield than 'ICCV 96030'. Sandhu *et al.* (2002) also reported similar differences in biomass production of these short-duration cultivars at Ludhiana.

Among seeding dates, chickpea raised for *chholia* showed better performance in terms of yield attributes and yield when sown on 7 October (Table 1). The crop sown on 7 October also produced higher biomass than that sown on other two dates of sowing. Further, the chickpea sown on 30 September also recorded higher biological yield than that sown on 15 October sown in 2006-07, but both these treatments were at par in 2005-06. The crop sown on 7 October gave 15.3 and 22.6% higher mean biological yield than that sown on 30 September and 15 October respectively. The higher biomass production in 30 September and 7 October sowings could be attributed to the cumulative effect of taller plants and associated canopy growth. The effect of date of seeding on yield attributes was noticed on seeds/pod only, which were significantly higher in the crop sown on 7 October than in that sown on 15 October. The crop sown on 30 September, however, recorded more seeds/pod than that sown on 15 October in 2006-07 only. The cumulative effect of higher values of yield attributes (pods/plant, seeds/pod, and test weight of seeds) in the crop sown on 7 October finally resulted in higher *chholia* production than in those sown on 30 September and 15 October. The differential sowing times resulted in exposure of crop to variable thermal degree days (2477, 2286 and 2096 in 30 September, and 7 and 15 October respectively) with optimum thermal time in 7 October sowing. The high thermal degree-days in the crop sown on 30 September and 7 October during 2006-07 caused 45 and 46.7% reduction in *chholia* production compared with that sown during 2005-06. The extent of reduction in production in 15 October sowing was 16% only.

The increasing rates of P up to 26.4 kg/ha markedly increased the biological yield. Application of 13.2 kg P/ha increased the biomass yield by 10.9% over the control, whereas further addition of 13.2 kg P/ha gave an increase of 4.3% only over that of 13.2 kg P/ha. The increase in biological yield by P application could be ascribed to the cumulative effective of increased plant growth and yield attributes. Better root growth and its nodulation with P fertilization might have favoured N fixation, which in turn promoted the plant growth, and development, finally leading to greater biomass production. Srinivasarao *et al.* (2007) also reported similar increase biomass production with P fertilization in chickpea.

The mean seeds/pod increased significantly with 13.2 kg P/ha (1.30) over the control (1.22), but further increase in P dose to 26.4 kg/ha gave no additional increase in seeds/pod. The test weight of *chholia* increased significantly in 2005-06 with only 26.4 kg P/ha over the control.

The improvement in yield attributes with P fertilization was reflected on *chholia* production. P fertilization improved the *chholia* production up to 26.4 and 13.2 kg

P/ha in 2005-06 and 2006-07 respectively. The mean *chholia* yield increased by 0.15 and 0.21 t/ha with 13.2 and 26.4 kg P/ha respectively over the control. The differential response of P in the two seasons could be attributed to relatively higher values of pods/plant and test weight with 26.4 kg P/ha over that of 13.2 kg P/ha in 2005-06. These results corroborate the findings of Sharma and Abrol (2007).

The interaction effects of sowing date x variety and sowing date x P fertilization in 2005-06 revealed that 'ICCV 96030', though recorded higher *chholia* yield over that of 'ICCV 96030' in all the dates of sowing, the magnitude of increase was relatively greater in 7 October seeding (Figure1). This indicated wider adaptability of 'ICCV 96030' to temperature. The interaction effect of P fertilization and dates of sowing indicated that the crop sown on 30 September with 26.4 kg/ha P fertilization gave yield on a par with that of unfertilized crop sown on 7 October (Figure 2). The crop sown later on 15 October showed response to P fertilization at higher rate (26.4 kg/ ha) only.

Baby corn

Chickpea cultivars failed to influence the growth and yields attributes, and yield of the succeeding baby corn (Table 2). The effects of sowing date of the preceding chickpea on baby corn yield was marked in 2005-06 only, where baby corn planted after chickpea sown on 15 October, being on a par with that sown on 7 October, recorded higher baby corn yield compared with that planted after chickpea sown on 30 September. However, fodder yield was the maximum when maize was sown after chickpea planted on 15 October. The higher baby corn and fodder yields in 15 October sowing might be ascribed to cumulative effect of higher values of yield attributes (cobs/plant and cob weight) and plant height respectively. The better

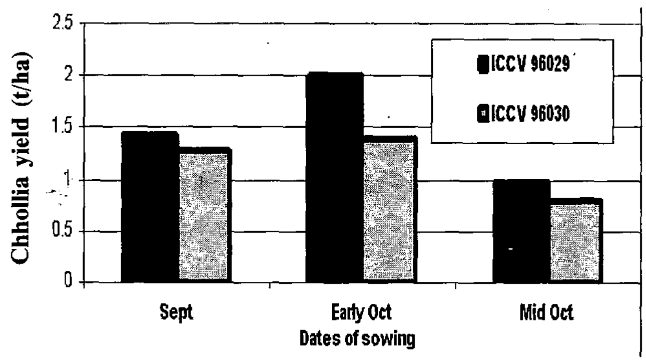

Figure. 1. Interaction effect of dates of sowing x chickpea cultivars on *chholia* production during 2005-06

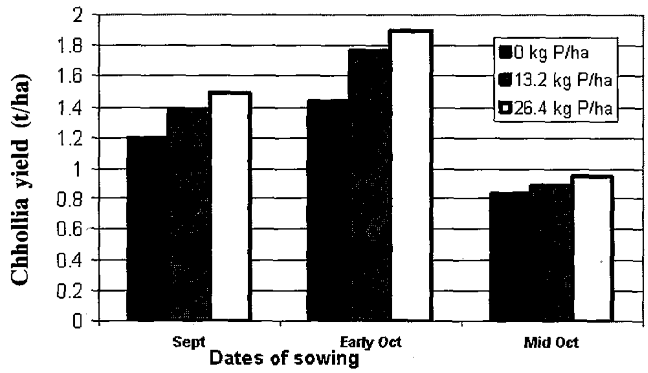

Figure 2. Interaction effect of dates of sowing x P fertilization on *chholia* production during 2005-06

Table 1. Effect of date of sowing and phosphorus fertilization on performance of two early chickpea varieties for *chholia* production

Treatment	Plant height (cm)		Pods/plant		Seeds/pod		Test weight (g)		Yield (t/ha)			
									Biological		*Chholia*	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Date of sowing												
30 Sep	54	49	45	34	1.32	1.31	246.0	247.8	7.49	8.03	1.36	0.75
7 Oct	51	48	50	38	1.33	1.36	249.3	250.8	9.15	8.75	1.70	0.92
15 Oct	44	43	40	35	1.21	1.22	247.0	247.8	7.51	7.09	0.89	0.75
SEm±	5	4	13	10	0.03	0.03	18.0	30.0	0.06	0.17	0.04	0.03
CD (P=0.05)	NS	NS	NS	NS	0.08	0.10	NS	NS	0.25	0.70	0.16	0.13
Variety												
'ICCV 96029'	54	51	50	40	1.30	1.30	250.0	268.0	9.15	8.90	1.47	0.92
'ICCV 96030'	45	44	40	31	1.27	1.29	210.0	229.0	6.95	7.00	1.16	0.70
SEm±	1	1	3	2	0.01	0.01	4.0	7.5	0.02	0.04	0.01	0.02
CD (P=0.05)	4	3	8	6	NS	NS	10.5	18.0	0.05	0.15	0.04	0.05
P level (kg/ha)												
0	45	44	41	32	1.21	1.24	232.0	239.0	7.22	7.48	1.16	0.72
13.2	49	48	46	35	1.31	1.30	252.2	252.5	8.28	8.03	1.35	0.83
26.4	53	48	48	36	1.34	1.33	258.0	254.5	8.64	8.37	1.44	0.86
SEm±	3	2	7	5	0.01	0.02	10.0	14.8	0.04	0.12	0.02	0.03
CD (P=0.05)	NS	NS	NS	NS	0.04	0.05	25.0	NS	0.10	0.30	0.07	0.10

performance of maize grown after chickpea seeded on 15 October might be attributed to less removal of P and other nutrients in these plots owing to poor production of chickpea.

There was marked residual effect of P applied to chickpea on growth, yield attributes (except cob weight) and yield of the succeeding maize. The improved soil-P status following chickpea crop fertilized with 26.4 kg P/ha resulted in increased plant height, cobs/plant and cob length of the succeeding maize over no P fertilization. The increase in these parameters consequently led to higher baby corn and fodder yields. The improved performance of baby corn following chickpea with 26.4 kg P/ha might be due to greater biological N fixation and other positive

Table 2. Effect of date of sowing and phosphorus fertilization of preceding chickpea varieties on performance of succeeding baby corn

Treatment	Plant height (cm)		Cobs/plant		Corn length (cm)		Corn weight (g)		Yield (t/ha)			
									Baby corn*		Green fodder	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Date of sowing												
30 Sep	140.0	132.0	1.98	1.95	8.4	8.3	9.25	9.23	1.53	1.42	22.94	31.70
7 Oct	143.0	136.0	2.00	1.99	8.5	8.4	9.30	9.26	1.65	1.57	24.72	33.60
15 Oct	148.0	139.0	2.10	2.02	8.4	8.5	9.35	9.31	1.89	1.63	30.91	33.40
SEm±	3.6	3.8	0.09	0.10	0.2	0.2	0.21	0.23	0.07	0.10	0.95	1.40
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	0.26	NS	3.73	NS
Variety												
'ICCV 96029'	144.0	135.5	2.03	2.00	8.5	8.4	9.35	9.28	1.71	1.59	26.80	32.30
'ICCV 96030'	145.3	138.0	2.02	1.95	8.5	8.3	9.28	9.19	1.67	1.45	25.57	33.40
SEm±	1.5	1.5	0.02	0.02	0.08	0.07	0.06	0.07	0.03	0.06	0.68	1.00
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
P level (kg/ha)												
0	138.0	128.0	1.94	1.92	8.2	8.1	9.20	9.20	1.53	1.30	22.94	30.60
13.2	142.0	137.0	2.05	2.00	8.3	8.2	9.30	9.25	1.65	1.53	24.72	33.60
26.4	145.8	142.0	2.10	2.06	8.6	8.5	9.40	9.33	1.89	1.73	30.91	34.50
SEm±	1.9	2.0	0.03	0.04	0.1	0.1	0.10	0.10	0.04	0.07	0.67	0.98
CD (P=0.05)	7.2	7.4	0.10	0.12	0.3	0.3	NS	NS	0.15	0.25	1.97	3.00

*Baby corn yield without husk

Table 3. Effect of date of sowing and phosphorus fertilization of *chholia* varieties on economics, P uptake and soil P balance of chickpea-baby corn cropping system

Treatment	Net returns (x 10^3 Rs/ha)		Total P uptake (kg/ha)						Available P in soil after *chholia* (maize)	
	2005-06	2006-07	*Chholia*		Baby corn		System			
			2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Date of sowing										
30 Sep	26.75	17.80	5.10	5.00	10.29	11.44	15.39	15.44	14.5 (15.1)	14.8 (15.5)
7 Oct	42.32	29.20	5.96	5.72	10.48	11.72	16.44	17.44	14.1 (15.0)	14.6 (15.5)
15 Oct	20.23	14.00	5.18	4.70	11.54	11.64	16.72	16.34	14.5 (15.0)	14.9 (15.6)
SEm±			0.15	0.16	0.26	0.30	0.65	0.61		
CD (P=0.05)			0.62	0.67	NS	NS	NS	NS		
Variety										
'ICCV 96029'	32.96	21.60	5.89	5.63	10.75	11.48	16.64	17.11	14.3 (15.1)	14.7 (15.5)
'ICCV 96030'	26.51	17.40	4.93	4.65	10.80	11.72	15.73	16.37	14.4 (15.1)	14.8 (15.6)
SEm±			0.03	0.03	0.08	0.09	0.18	0.16		
CD (P=0.05)			0.10	0.11	NS	NS	0.73	0.66		
P level (kg/ha)										
0	25.01	16.53	3.45	3.64	10.04	10.93	13.49	14.57	14.1 (14.4)	14.5 (14.6)
13.2	30.40	22.05	5.90	5.73	10.53	11.54	16.44	17.27	14.4 (15.0)	14.7 (15.5)
26.4	25.79	12.42	6.87	6.61	11.74	12.33	18.61	18.94	14.6 (15.7)	15.1 (16.6)
SEm±			0.05	0.05	0.16	0.18	0.40	0.37		
CD (P=0.05)			0.21	0.23	0.86	0.75	1.45	1.35		

Price *chholia*/baby corn: Rs 20,000/t, maize fodder: Rs 500/t; P: Rs 61 Rs/kg
Figures in parentheses refer to data after baby corn

benefits of inclusion of legume in the cropping system, besides better P availability. Pypers *et al.* (2007) also reported. improved performance of maize following legume.

P uptake, use efficiency and balance

The total P uptake of *chholia* followed the trend of biological and seed yield. Among the cultivars, P uptake was higher in 'ICCV 96029' than in 'ICCV 96030'. Similarly, chickpea sown on 7 October recorded higher P uptake than other two dates of sowing. The P uptake in chickpea increased with increase in P rate up to 26.4 kg/ha. The available P of the soil after *chholia* was more or less similar to the initial status after different cultivars and seeding dates. The available soil P status, however, gradually increased with increase in P rate up to 26.4 kg/ha. This could be attributed to the addition of P through fertilizers more than its depletion by the crop. The balance was negative in the control (no P fertilizer) in both the years (Table 3).

Maize grown after different cultivars and dates of seeding of chickpea failed to affect the P uptake by baby corn. However, 26.4 kg P/ha to the preceding chickpea recorded markedly higher P uptake by baby corn compared with the control and 13.2 kg P/ha.

The agronomic P-use efficiency was the highest (14.39 and 8.33 kg grain/kg P applied in 2005-06 and 2006-07 respectively) with 13.2 kg P/ha, which decreased with increase in P dose to 26.4 kg/ha (10.61 and 5.30). This decrease was owing to less incremental increase in yield with successive increase of P fertilization. The physiological use efficiency (kg grain/kg P uptake) of P was, however, increased with increase in P fertilization from 13.2 (77.55) to 26.4 kg/ha (81.87) in 2005-06. But in 2006-07 it decreased with increase in P from 13.2 (52.63) to 26.4 kg/ha (47.13). Such a behaviour could be ascribed to less incremental increase in yield with increase in P uptake.

The available soil P after the cropping system receiving P at 0, 13.2 and 26.4 kg/ha in chickpea plus 26.4 kg/ha in baby corn as uniform dose declined on an average by -0.10 and increased by 0.75, and 1.55 kg/ha, respectively.

Economics

The mean net returns of the *chholia*-baby corn system were the highest with 'ICCV 96029' (Rs 27,280/ha) (Table 3). It gave Rs 5,320/ha more returns than 'ICCV 96030'. Sowing of chickpea on 7 October resulted in the highest net income from the system (Rs 35,760/ha), being Rs 13,485 and Rs 18,645/ha higher than the 30 September and 15 October sowings respectively. The highest mean net return of Rs 17,115/ha was accrued from the cropping system where chickpea received 13.2 kg P/ha. Higher net returns in 2005-06 could be ascribed to higher *chholia* production.

It is concluded that higher productivity and monetary gains in chickpea-baby corn cropping system could be achieved by sowing chickpea cv 'ICCV 96029' on 7 October with 13.2 kg/ha.

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