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Nutrient uptake by chickpea + mustard intercropping system as influenced by weed management

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ABSTRACT

A field experiment was consisted of four intercropping systems, *viz*. sole chickpea, sole mustard, chickpea + mustard (additive series) and chickpea + mustard (replacement series) and six weed management practices *viz*. weedy check, weed free, pendimethalin 1 kg/ha as pre-emergence (PE), fluchloralin 1 kg/ha as pre-plant incorporation (PPI), isoproturon 0.75 kg/ha as post-emergence (POE) and quizalofop-ethyl 50 ml/ha as post-emergence. These treatments were evaluated under split plot design with three replications. Results revealed that sole stands of chickpea and mustard removed highest amount of N, P and K which were followed by additive series and replacement series whereas among the weed management practices, highest amount of N, P and K was removed by weed free treatment followed by pendimethalim 1kg/ha and fluchloralin 1 kg/ha while the lowest N, P and K was removed by isoproturon 0.75 kg/ha followed by quizalofop-ethyl 50 ml/ha. Among the different intercropping treatments, weeds removed significantly highest N, P and K from sole mustard followed by sole chickpea, replacement series and additive series. Among weed management practices, the uptake of N, P and K in weeds was found to be significantly less in all the weed management practices as compared to weedy check treatment.

Key words: Chickpea, Mustard Intercropping, Weed management

Weed infestation is one of the major limiting factors in the productivity of the crops both under rainfed and irrigated situations. Weeds always pose a serious threat to the stability of crop yields. However, yield loss by weeds in different crops varies from situation to situation. On an average, the reduction in crop yield to the tune of 20-40% has been reported in weed infested crops which calls for effective weed control measures. Initial slow growth of crops and adequate soil moisture provide conducive conditions for profuse growth of weeds relatively in wide spaced crops. Control of weeds is vitally important not only to check the losses, caused by them but also to increase the fertilizer use efficiency. The present study was, therefore, undertaken to assess the losses of nutrients caused by weeds in chickpea + mustard intercropping and to minimise these losses by controlling them.

MATERIALS AND METHODS

A field experiment was conducted at the Research Farm, Main Campus, Chatha of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (J&K) during *Rabi* season of 2009-10 and 2010-11 under split plot design with three replications. The treatment consisted of four intercropping systems, *viz*. sole chickpea (30 cm), sole mustard (30 cm), chickpea + mustard in additive series (an additional row was opened in between two rows of chickpea for sowing of mustard in additive series) and chickpea + mustard in replacement series (one row of chickpea was replaced with one row of mustard) and six weed management practices, *viz*. weedy check, weed free, pendimethalin 1 kg/ha as pre-emergence (PE), fluchloralin 1 kg/ha as pre plant incorporation (PPI), isoproturon 0.75 kg/ha as post-emergence (POE) and quizalofop-ethyl 50 ml/ha as post-emergence. The experiment soil was sandy loam in texture (sand 66.2%, silt 18.5% and clay 15.5%), slightly alkaline in reaction (pH 7.27), medium in organic carbon (0.53%) and available N (252.5 kg/ha), P (13.7 kg/ha) and K (162.9 kg/ha). Full dose of DAP as recommended for chickpea was applied as basal at the time of sowing.

Furrows were opened manually with the help of liners at a specified row to row distance of 30 cm. Chickpea *GNG-469* and mustard *RSPR-01* was sown on 5 November, 2010 and 31 October, 2011. A seed rate of 70 kg and 5 kg/ha for chickpea and mustard was used in their sole plots and additive series, respectively. Whereas the seed rate for replacement series was used as 50% less as compared to seed rate used in the sole and additive series. The seeds of chickpea and mustard were sown in

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furrows by *Kera* method in sole stand treatments whereas an additional row was opened in between two rows of chickpea for sowing of mustard in additive series treatments and in replacement series treatments where sowing of chickpea and mustard were done in alternate rows. All the herbicides were applied through knapsack sprayer using flat-fan nozzle as per treatment. Weedy plots remained infested with natural population of weeds till the harvesting of crops with root elongation. The mustard was harvested on 28 March, and chickpea on 30 April, 2010 whereas, mustard on 25 March and chickpea on 28 April, 2011. Weed population and weeds dry weight was recorded at 30 days interval and at harvest. The weed dry weight was taken with the help of iron frame of one meter square from each plot. The total N, P and K content in crops and weeds (at harvest of crops) was determined by Kjeldhal method. The uptake of N, P and K by crops was calculated by multiplying with yield of crops while uptake of nutrients by weeds was calculated by multiplying with the dry matter accumulation of weeds at harvest by the respective percentage composition of N, P and K.

RESULTS AND DISCUSSION

Weed

The experimental field was mainly infested with broad-leaved weeds in the decreasing order of their occurrence including *Medicago sativa, Anagallis arvensis, Trachyspermum* spp., Similarly, grassy weeds included *Cynodon dactylon* and *Poa annua* and the prominent weed amongst sedges was found to be *Cyperus rotundus* during both the years. Among the intercropping systems, at harvest, the minimum weed density and weed dry weight of 8.78 and 7.59/m^2 and 8.48 and 6.56 g/m^2 were recorded in additive treatment followed by replacement treatment during 2009-10 and 2010-11, respectively (Table 1) which might be due to the lesser space available to the weeds due to intercrops and ultimately lesser availability of resources to the weeds. Highest population of weeds was observed in weedy check over weed free treatment. Application of pendimethalin 1 kg/ha was highly effective in controlling the weeds especially *Medicago sativa* and *Anagallis arvensis*. Weed management practices had statistically significant effect on weed population during both the years. The lowest weed population of all the species was registered under application of pendimethalin 1kg/ha in comparison to other treatments during both the years. Arya (2004) reported similar results in favour of pendimethalin. Singh and Singh (1998) reported that preplant incorporation of fluchloralin 1.5 kg/ha significantly reduced the density and biomass of weeds (*Cyperus rotundus* and *Anagallis arvensis*) by 38.6 and 46.1%, respectively compared to unweeded control.

Productivity

Chickpea: In respect of intercropping systems, chickpea in sole stand recorded significantly higher grain and

Table 1. Influence of weed management practices on weed growth and grain/seed yield, stover yield of chickpea and mustard

Treatment	Weed density/m^2 (at harvest)		Weeds dry weight (g/m^2)		Grain/seed yield (t/ha) Chickpea		Grain/seed yield (t/ha) Mustard		Stover yield (t/ha) Chickpea		Stover yield (t/ha) Mustard	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
Intercropping												
Sole chickpea	10.11(140.6)	9.58(128.9)	8.87(96.1)	7.54(72.8)	0.86	0.94	-	-	2.12	2.17	-	-
Sole mustard	-	-	-	-			1.10	1.20	-	-	3.28	3.38
Chickpea + mustard aditive series	8.78(106.3)	7.59(100.3)	8.48(93.2)	6.56(53.8)	0.63	0.73	0.93	1.03	1.93	1.97	3.13	3.24
Chickpea + mustard replacement series)	9.86(135.3)	8.08(93.8)	8.72(77.3)	7.36(69.8)	0.50	0.60	0.71	0.82	1.71	1.85	2.97	3.02
LSD (P= 0.05)	0.09	0.08	0.06	0.1	0.92	1.02	0.94	1.20	1.62	0.96	1.49	1.04
Weed management												
Fluchloralin 1 kg/ha (PPI)	8.41(70.0)	6.37(41.7)	8.24(62.8)	6.27(34.5)	0.70	0.81	0.96	1.12	1.98	2.06	3.20	3.31
Pendimethalin 1 kg/ha (PE)	7.77(59.7)	5.33(29.3)	7.88(56.7)	5.74(28.2)	0.77	0.87	1.03	1.17	2.07	2.12	3.27	3.38
Isoproturon 0.75 kg/ha (POE)	9.65(92.3)	8.74(76.0)	9.1(77.8)	7.37(49.2)	0.62	0.75	0.87	1.02	1.88	1.99	3.10	3.21
Quizalofop-ethyl 50 ml/ha (POE)	9.35(87.0)	8.38(70.7)	8.77(72.9)	7.04(44.9)	0.68	0.78	0.94	1.08	1.98	2.02	3.16	3.26
Weedy check	21.33(455.4)	20.7(428.4)	16.31(264.5)	15.5(236.1)	0.38	0.37	0.57	0.42	1.47	1.62	2.71	2.62
Weed free	1(0)	1(0)	1(0)	1(0)	0.83	0.94	1.11	1.28	2.13	2.17	3.34	3.48
LSD (P= 0.05)	0.07	0.08	0.07	0.11	0.89	0.91	0.89	1.14	1.08	0.97	1.02	1.04

stover yield and was followed by additive and replacement series which was probably because of less competition for sunlight, space, water and nutrients for sole crop as compared to intercropping treatments wherein the competition of crop plants might have curtailed efficient utilization of natural resources and restricted growth of chickpea from initial stages to harvest resulting in yield competition for main and intercrops. However, between additive and replacement treatments, significantly higher grain and stover yield of chickpea under additive series mainly might have happened due to significantly higher plant population as compared to replacement series (Table 1). These results of yield attributes are in conformity with the results of Tripathi *et al.* (2005) and Kumar and Singh (2006).

Higher grain and stover yield of chickpea were recorded where weed free environment was provided to the crop throughout its crop growing period. The grain and stover yield of chickpea as recorded with the application of pendimethalin 1 kg/ha was found to be statistically at par with weed free treatment and fluchloralin 1 kg/ha might be due to effective control of weeds with the application of pendimethalin as a result of which there was poor growth and population of the weeds. Further, under this treatment weeds were unable to compete with the crop plants and resulted in better expression of yield attributing characters and thus gave higher yield. Among the other herbicidal treatments, the lowest grain yield of chickpea was recorded with isoproturon 0.75 kg/ha which in turn was observed to be statistically at par with quizalofop-ethyl 50 ml/ha and fluchloralin applied at 1 kg/ha. This confirms the findings of Yadav *et al.* (1983) and Singh *et al.* (1986). The lowest grain and stover yield of chickpea was noticed in weedy check as a consequence of stiff competition imposed by weeds resulting in poor source and sink development with poor yield contributing characters and higher weed index. The above results could be corroborated with the findings of Rout and Satapathy (1996), Sinha *et al.* (2000) and Kolage *et al.* (2004).

Mustard: Chickpea and mustard in sole stand also recorded significantly higher values of grain and stover yields and was followed by additive and replacement series. The optimum space as available for mustard plants under sole stand reduced the competition for moisture, nutrients and light among the mustard plants than other intercropping combinations which might be responsible for the production of higher yield attributes of sole crop of mustard (Table 1). These results were in agreement with the findings of Prasad (1996) and Singh *et al.* (2008). The possible reason for higher yield of mustard in additive treatment rather than the replacement treatment might have been achieved due to the fact besides the single plant yield remaining inferior in additive treatment the overall yield per unit area improved due to cumulative effect of higher plant populations in additive treatment during first and second years of cropping.

Among the weed management practices, higher grain and stover yields of mustard were recorded where weed free environment was provided to the crop throughout its crop growing period. The grain and stover yields of mustard as recorded with the application of pendimethalin 1 kg/ha followed by fluchloralin 1 kg/ha, however, found to be statistically at par to that of weed free treatment and fluchloralin 1 kg/ha, also might be due to reduced crop-weed competition and enhancement in most of the crop-growth parameters under the favourable environmental situation. These results are in conformity with the findings of Sinha *et al.* (1999). Under this treatment, weeds were unable to compete with the crop plants which resulted in better expression of yield attributing characters and thus gave higher yield. Among the other herbicidal treatments, the lowest grain and stover yields of mustard was recorded with isoproturon 0.75 kg/ha which in turn was observed to be statistically at par with quizalofop-ethyl 50 ml/ha and fluchloralin applied 1 kg/ha.

Nutrient removal by crops

Chickpea : Irrespective of the treatments, highest N, P and K removal from grain of chickpea was recorded with sole stand followed by additive series and replacement series during both the cropping seasons of *Rabi* 2009-10 and 2010-11, respectively (Table 2). The higher removal of these nutrients by sole chickpea as compared to intercropping treatments probably happened due to vigorous growth and better root system under optimum spacing which had helped in adequate supply of these nutrients resulting in higher biological yield coupled with their effective transfer to the ultimate sink *i.e.* the grains thus leading to numerically higher chickpea grain nutrient contents of N, P and K. Obviously, this was due to lesser competition from weeds and ultimately better growth of crop. Among weed management practices, highest N, P and K removal from grain and stover of chickpea was removed from weed free treatment during 2009-10 and 2010-11, respectively. The greater nutrient removal by crop could be attributed to poor competition of weeds with chickpea. The nutrient removal by crop was significantly increased due to application of herbicides and hand weeding as compared to weedy control. Hand weeding and use of herbi-

Table 2. Influence of weed management treatments on the uptake of N, P and K (kg/ha) of chickpea

Treatment	N				P				K			
	Grain		Stover		Grain		Stover		Grain		Stover	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
Intercropping												
Sole chickpea	65.0	70.1	40.4	41.1	9.62	11.19	15.7	17.39	27.8	30.2	48.6	50.5
Sole mustard	-	-	-	-	-	-	-	-	-	-	-	-
Chickpea + mustard (additive series)	63.0	67.6	38.3	39.7	7.65	9.64	14.62	16.53	25.6	27.9	47.0	49.4
Chickpea + mustard (replacement series)	60.8	66.9	36.2	37.5	5.91	7.74	13.31	15.27	23.5	25.0	45.7	48.2
LSD=P(0.05)	2.9	2.4	NS	NS	2.16	2.25	NS	NS	2.6	3.5	NS	NS
Weed management												
Weedy check	45.9	44.3	31.7	33.7	3.61	4.47	8.29	10.17	16.3	13.6	41.3	44.9
Weed free	68.3	74.9	41.5	42.9	10.75	12.03	17.47	20.14	29.3	32.4	49.5	51.6
Fluchloralin 1kg/ha (PPI)	66.3	73.3	39.6	40.3	8.35	10.53	15.5	17.21	27.4	30.1	48.4	50.6
Pendimethalin 1kg/ha (PE)	67.3	74.3	40.8	41.8	9.46	11.17	16.61	18.95	28.7	31.4	49.3	51.2
Isoproturon 0.75kg/ha (POE)	64.4	70.9	37.4	38.6	6.71	9.39	14.61	15.32	25.6	29.1	46.9	48.4
Quizalofop-ethyl 0.50 kg/ha (POE)	65.5	71.5	38.6	39.4	7.49	9.56	14.8	16.58	26.5	29.7	47.2	49.4
LSD=P(0.05)	5.6	5.4	4.4	4.7	1.7	1.18	1.5	2.34	3.1	2.91	4.6	3.3

PPI : Pre plant incorporation; PE- Pre-emergance; POE- Post-emergence

cides effectively controlled the weeds and consequently made more nutrients available to the crop thereby higher removal of nutrients by crop. Similar results were also reported by Singh and Malik (1992). Among the herbicides, highest N, P and K from grain and stover of chickpea was removed from pendimethalin 1 kg/ha and was found to be statistically at par with isoproturon 0.75 kg/ha and quizalofop-ethyl 50ml/ha and fluchloralin 1kg/ha during both the seasons respectively. This could possibly be attributed to higher weed-control efficiency resulting in more favourable environment for growth and development of crop plants apparently due to the lesser weed competition. The results conformed with the findings of Angiras and Singh (1989), Sreenivas and Satyanarayana (1996) and Mundra *et al.* (2002).

Mustard (grain and stover): N removal by mustard grain was observed under sole stand of mustard, additive series and replacement series which were seen not to be significantly influenced by intercropping systems whereas numerically highest N and significantly higher P and K uptake in mustard stover was recorded with sole stand followed by additive series and replacement series which in turn where P and K found significantly different to one another during 2009-10 and 2010-11, respectively (Table 3). These results were in accordance with those of Singh *et al.* (1997), Kawtra and Mishra (1999), Singh (2005), Singh and Rana (2006) and Singh *et al.* (2008). Similar to intercropping systems, weed management practices also failed to show any influence on the N and K removal by mustard grains whereas highest P in mustard grains and N, P and K removal by mustard stover was recorded where weed free environment was provided to the crop during crop growing season followed by pendimethalin 1 kg/ha and fluchloralin and both were found to be statistically similar to weed free treatment during both the seasons, respectively. Similar results were also reported by Singh and Malik (1992).

NPK uptake by weeds: At harvest significantly higher N, P and K was removed by sole cropping of mustard followed by sole cropping of chickpea, replacement and additive series though being at par with one other during 2009-10 and 2010-11, respectively. This might have happened due to growing of intercrop in spaced chickpea rows which while utilizing the space efficiently reduced the intensity and dry matter of weeds leading to lower NPK uptake by weeds. The removal of N, P and K by weeds were reduced significantly by various herbicidal and manual weeding treatments and it almost nil under weed free treatment whereas the significantly highest N, P and K uptake by weeds were recorded in the weedy check treatment (Table 4). These results confirm the findings of Sreenivas and Satyanarayana (1996) and Mundra *et al.* (2002). Among the herbicides, significantly higher value of NPK uptake was recorded in the treatment isoproturon 0.75

Table 3. Influence of weed management treatments on the uptake of N, P and K (kg/ha) of mustard

Treatment	N				P				K			
	Grain		Stover		Grain		Stover		Grain		Stover	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
Intercropping												
Sole chickpea	-	-	-	-	-	-	-	-	-	-	-	-
Sole mustard	67.1	74.2	38.1	38.7	8.26	9.84	2.96	3.35	99.5	112.5	29.2	29.9
Chickpea + mustard (additive series)	65.0	73.2	36.2	37.0	7.07	8.79	2.56	2.69	97.6	111.5	27.6	28.7
Chickpea + mustard (replacement series)	63.2	72.1	34.3	34.8	5.58	8.24	2.14	2.14	95.8	110.4	25.9	26.9
LSD (P=0.05)	NS	NS	2.4	2.2	1.94	1.19	0.35	0.46	NS	NS	1.0	1.0
Weed management												
Fluchloralin 1kg/ha (PPI)	66.4	74.3	36.4	38.1	7.65	9.45	2.86	2.75	98.2	111.3	28.1	29.2
Pendimethalin1kg/ha (PE)	67.4	75.7	38.2	39.1	8.35	10.33	3.24	3.2	99.3	112.2	29.5	30.7
Isoproturon 0.75kg/ha (POE)	64.8	72.2	35.1	35.5	6.46	8.56	2.41	2.41	96.3	109.4	26.7	27.7
Quizalofop-ethyl 50 ml/ha (POE)	65.5	73.2	35.4	37.3	6.94	8.98	2.46	2.48	97.4	110.3	27.4	28.8
Weedy check	58.2	67.2	33.3	29.6	3.37	5.17	0.85	1.87	93.9	112.0	22.9	22.0
Weed free	68.4	76.4	38.7	41.6	9.05	11.26	3.49	3.62	100.4	113.6	30.8	32.6
LSD (P=0.05)	NS	NS	2.8	3.5	1.38	0.96	0.49	0.47	NS	NS	2.0	1.9

Table 4. Influence of weed management treatments on the uptake of N, P and K (kg/ha) of weeds and economics of the system

Treatment	N		P		K		Net returns ($x10^3$ `/ha)		B:C ratio	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
Intercropping										
Sole chickpea	26.4	20.4	8.08	3.75	29.9	28.0	10.32	12.10	0.72	0.86
Sole mustard	27.4	24.0	8.21	4.32	31.5	33.4	12.06	12.98	1.14	1.21
Chickpea + mustard (additive series)	21.2	14.9	6.37	2.67	24.1	20.4	2.27	2.61	1.5	1.75
Chickpea + mustard (replacement series)	25.3	19.3	7.63	3.45	28.9	26.6	16.65	20.51	1.34	1.65
LSD (P=0.05)	0.8	0.9	0.13	0.12	1.1	0.9	_	_	_	_
Weed management										
Fluchloralin 1kg/ha (PPI)	25.3	17.0	6.72	3.06	32.9	23.8	15.83	2.22	1.55	1.88
Pendimethalin 1kg/ha (PE)	22.8	15.1	5.93	2.51	30.2	21.4	17.30	23.44	1.57	1.85
Isoproturon 0.75kg/ha (POE)	28.8	22.2	8.84	4.57	38.2	31.5	12.90	19.78	1.36	1.73
Quizalofop-ethyl 50 ml/ha (POE)	26.1	19.9	8.25	4.15	35.0	29.2	14.07	19.95	1.3	1.56
Weedy check	43.6	43.7	15.7	7.01	35.3	56.7	4.18	13.22	0.56	0.29
Weed free	0	0	0	0	0	0	12.12	18.85	0.73	0.92
LSD (P=0.05)	3.9	2.9	0.45	0.36	1.9	1.5	_	_	_	_

kg/ha followed by quizalofop ethyl 50 ml/ha and were found statistically at par with each other during both the seasons of *Rabi* 2009-10 and 2010-11, respectively. The removal of N, P, K by weeds was reduced significantly by various herbicidal and manual weeding treatments and it was minimum under weed free treatment. However, they were at par in respect of NPK removal/ha by the weeds. These observations are in agreement with those of Thakur (1988) and Dashora *et al.* (1990).

Economics

The results showed that the maximum values of net returns *i.e*, ` 22,729 and ` 26,101/ha and B:C ratio of 1.50 and 1.75 were recorded in chickpea + mustard (additive series) intercropping treatment during both the years of study. This might be due the additional benefit of component crop of mustard along with the main crop of chickpea. The results are in line with Singh *et al.* (2003). Maximum net returns (` 17,307/ha) and benefit:cost ratio (1.57) were recorded with the application of pendimethalin 1 kg/ha in chickpea and mustard intercropping system during the years of 2009-10 whereas in second year highest B:C ratio was obtained with the application of fluchloralin 1 kg/ha. However, minimum net returns and B:C ratio were recorded in weedy check in chickpea + mustard intercropping system.

Results of present investigation suggest that, among the intercropping systems, chickpea + mustard (additive series) found to be best in terms of chickpea yield and sole mustard in terms of chickpea yield. The application of pendimethalin 1 kg/ha resulted in significantly higher grain yield of chickpea and mustard. The highest uptake by crops and lowest removal of nutrients by weeds was also with the application of pendimethalin 1 kg/ha.

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