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Response of Pre and Post Emergence Herbicides on Nutrient uptake by Chickpea and Weeds

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ABSTRACT: Generally, rabi pulses grown in marginal crop land under minimal management. Initial slow vegetative phase provides more scope to weed growth. Corp weed competition leads to distribution of resources which cause huge losses to the crop yield. To understand resources distribution in chickpea a field experiment was laid out at BAU research farm, Sabour during rabi of 2019-20 to assess the effect of various pre and post-emergence herbicides in chickpea. The experiment consisted of 13 treatments i.e. pendimethalin @ 1000 g a.i. ha^{-1} PE fb 1 HW, oxyfluorfen @ 100 g a.i.ha^{-1} PE fb 1 HW, imazethapyr @ 40 g a.i. ha^{-1} PoE, quizalofop-ethyl @ 50 g a.i. ha^{-1} PoE, topramezone @20 g a.i. ha^{-1} PoE, topramezone @ 25 g a.i. ha^{-1} PoE, clodinafop-propargyl + Na-acifluorfen @ 500 g a.i. ha^{-1} PoE, pendimethalin @ 1000 g a.i. ha^{-1} PE fb imazethapyr @ 40 g a.i. ha^{-1} PoE, pendimethalin @ 1000 g a.i. ha^{-1} PE fb quizalofop-ethyl @ 50 g a.i. ha^{-1} PoE, oxyfluorfen @ 100 g a.i. ha^{-1} PE fb imazethapyr @ 40 g a.i. ha^{-1} PoE, oxyfluorfen @ 100 g a.i. ha^{-1} PE fb quizalofop-ethyl @ 50 g a.i. ha^{-1} PoE apart from weedy check and weed free in RBD replicated thrice. In this experiment, effect of all the treatments on nutrient (N, P and K) uptake was found highest under weed free treatment and lowest was recorded under weedy check. Among herbicides, pendimethalin @ 1000 g a.i. ha^{-1} PE fb 1 HW was found significantly higher nutrient (N, P and K) uptake which was statistically at par to oxyfluorfen @ 100 g a.i. ha^{-1} fb 1 HW, topramezone @ 25 g a.i. ha^{-1} and topramezone @ 20 g a.i. ha^{-1}. In case of weeds, significantly lower nutrient uptake by weeds were observed in weed free treatments and significantly higher nutrient uptake by weeds were observed in weedy check. Under herbicidal application, the minimum nutrient uptake by weeds were recorded with pendimethalin @ 1000 g a.i. ha^{-1} fb 1 HW. However, it was considerably similar to oxyfluorfen @ 100 g a.i. ha^{-1} fb 1 HW, topramezone @ 25 g a.i. ha^{-1} and topramezone @ 20 g a.i. ha^{-1} and was significantly lower over rest of the treatments.

Keywords: Chickpea, weed management, topramezone, nutrient uptake, herbicide.

INTRODUCTION

Chickpea is one of the oldest known cultivated legumes, dating back at least 7,000 years to the start of agriculture. It is assumed that the crop originated in southeast Turkey and expanded west and south along the Silkroad. Weeds are naturally efficient and vigorous in their use of resources–nutrients and moisture–and can compete with crops, resulting in economic loss. Chickpea appears to be a poor weed competitor among rabi pulses, with yield losses ranging from 40% to 87% due to its initial lag in growth rate and number of leaf (Poonia and Pithia, 2013). Chaudhary *et al.,* (2005) also found losses up to 75% due to temporal mismatch. A thorough understanding of crop–weed competition is required before developing an effective weed management approach. Although, it was found that crop weed competition was not at very early stage (Barker, 2017) but weeds establish themselves which compete later. Singh *et al.,* (2000) stated that in chickpea, first 60 days are found to be crucial for competition between crop and weed. Weeds needs to be properly managed not only for enhancing yield but also for improving fertilizer use efficiency by use of growth promoting rhizobacteria (PGPR) and Mesorhizobium through nodulation improvement (Verma *et al*., 2009). Present techniques for the management of chickpea weed comprises of crop rotations, mechanical methods, hand weeding and often pre-emergence herbicide application, out of which farmers typically goes for manual weeding. The shortage of manpower and the prices involved, however, make them look for other cheaper solutions to control weed. Unfavourable environmental conditions often disrupt weeding operations. Weed management with the use of herbicides is considered the most efficient approach in closer-row sown crops such as chickpea. For the management of the mixed weed population, appropriate herbicides are necessary in order to promote the farmers' acceptance of this crop. Application of herbicides help the pulses to manage a large range of pulse weeds at a profitable cost. Several new generation post emergence herbicides like quizalofop-ethyl, topramezone, imazethapyr, clodinafop-propargyl +Na acifluorfen (ready-mix) have been effectively used in several crops (Solh and Pala 1990). Keeping these information into consideration, the current investigation was intended to be carried out to determine the effect of pre and post emergence herbicides on nutrient uptake by chickpea and weeds.

METHOD AND MATERIALS

A field experiment was undertaken at the Bihar Agricultural University Sabour research farm in Bhagalpur, Bihar, during the rabi season of 2020-2021, to test the effectiveness of different pre and post-emergence herbicides in chickpea. Chickpea cv. GCP-105 was sown on November, 9, 2020, at a seed rate of 80 kg ha^{-1} and spacing of 30cm × 10 cm. The experiment followed a randomized block design with three replications. The experiment comprised of 13 treatments given in Table 1 designed in RBD replicated thrice. The crop was fertilized evenly with 20:40:00 kg N: P_2O_5: K_2O ha^{-1}, with the whole N and P_2O_5 dose administered as a basal. By following standard methods, the dry matter of weed and seed samples obtained at harvest was cleaned, crushed, and tested for total nitrogen, phosphorus, and potassium. In the context of crop, the nutrient content of haulm and seeds were determined separately. The nutrient uptake was estimated by multiplying the nutrient content (%) of both haulm and seeds with their corresponding plot yields and summing the results. For weeds, nutrient content (%) was multiplied to their corresponding total dry weights (kg ha^{-1}) at harvest and nutrient uptake of weeds was represented as kg ha^{-1}.

RESULTS AND DISCUSSION

A. Nutrient content in seed and stover (%)

Table displays information on the nitrogen content of chickpea seed and stover. There was not any significant difference between the various weed control measures on nutrient content in seed as well as haulm. However, highest nitrogen content was observed in weed free treatment while lowest was observed in weedy check.

Among herbicidal treatment highest nitrogen content in seed as well as haulm was found in pendimethalin @ 1000 g a.i. ha^{-1} fb 1 HW and clodinafop-propargyl + Na-acifluorfen @ 500 g a.i. ha^{-1} and lowest was observed under application of imazethapyr @ 40 g a.i. ha^{-1}. Similarly in case of phosphorus weed free treatment showed highest phosphorus content while lowest phosphorus content was shown by weedy check in seeds as well as haulm. Among herbicides highest phosphorus content in seeds as well as haulm was observed in pendimethalin @ 1000 g a.i. ha^{-1} fb 1 HW and lowest was observed in imazethapyr @ 40 g a.i. ha^{-1}. Similar trend was observed in case of potassium content in seeds and haulm among several weed control measures.

Table 1: Treatment details of the experiment for weed management in chickpea.

Sr. No.	Treatments
T_1	Weedy check
T_2	Weed free (up to 60 DAS)
T_3	Pendimethalin @ 1000 g a.i. ha^{-1} at 1DAS fb 1 HW at 30 DAS
T_4	Oxyfluorfen @ 100 g a.i. ha^{-1} at 1DAS fb 1 HW at 30 DAS
T_5	Imazethapyr @ 40 g a.i. ha^{-1} at 25DAS
T_6	Quizalofop-ethyl @ 50 g a.i. ha^{-1} at 25DAS
T_7	Topramezone @ 20 g a.i. ha^{-1} at 25DAS
T_8	Topramezone @ 25 g a.i. ha^{-1} at 25DAS
T_9	Clodinafop-propargyl + Na-acifluorfen @ 500 g a.i. ha^{-1} at 25DAS
T_{10}	Pendimethalin @ 1000 g a.i. ha^{-1} at 1DAS fb Imazethapyr @ 40 g a.i. ha^{-1} at 25DAS
T_{11}	Pendimethalin @ 1000 g a.i. ha^{-1} at 1DAS fb quizalofop-ethyl @ 50 g a.i. ha^{-1} at 25DAS
T_{12}	Oxyfluorfen @ 100 g a.i. ha^{-1} at 1DAS fb Imazethapyr @ 40 g a.i. ha^{-1} at 25DAS
T_{13}	Oxyfluorfen @ 100 g a.i. ha^{-1} at 1DAS fb quizalofop-ethyl @ 50 g a.i. ha^{-1} at 25DAS

B. Nutrient uptake by seed and stover (kg ha^{-1})

Table 2, 3 and 4 shows the influence of several treatments on nutrient uptake by chickpea seed and haulm. Nutrient uptake by chickpea seeds and haulm were measured at harvest which was significantly affected by several treatments.

Significantly highest nitrogen (Table 2, Fig. 1) uptake by seeds as well as haulm was recorded in weed free treatment (68.64 kg/ha) which was statistically comparable to pendimethalin @ 1000 g a.i. ha^{-1} fb 1 HW (65.18 kg/ha), topramezone @ 25 g a.i. ha^{-1} (64.31 kg/ha), oxyfluorfen @ 100 g a.i. ha^{-1} fb 1 HW (62.91 kg/ha) and topramezone @ 20 g a.i. ha^{-1} (61.91 kg/ha). Weedy check (T_1) had lowest nitrogen uptake (33.13 kg/ha). Similar results were observed in chickpea by Singh *et al.*, (2014).

In case of phosphorus (Table 3, Fig. 1), the weed-free treatment had the highest phosphorus uptake (20.86 kg/ha), while the weedy check had the lowest (9.83 kg/ha). Among herbicidal treatment maximum phosphorus uptake was recorded under pendimethalin @ 1000 g a.i. ha^{-1} fb 1 HW (20.05 kg/ha) which was at par to oxyfluorfen @ 100 g a.i. ha^{-1} fb 1 HW (19.14 kg/ha) and topramezone @ 25 g a.i. ha^{-1} (19.04 kg/ha), significantly outperformed the rest of herbicidal treatments.

In case of potassium (Table 4, Fig. 1), weed free had maximum potassium uptake (51.48 kg/ha) and it was statistically on par to pendimethalin @ 1000 g a.i. ha^{-1} fb 1 HW (48.53 kg/ha), oxyfluorfen @ 100 g a.i. ha^{-1} fb 1 HW (46.41 kg/ha) and topramezone @ 25 g a.i. ha^{-1} (45.40 kg/ha). The lowest potassium uptake (22.19 kg/ha) was found under weedy check (22.19) followed by imazethapyr @ 40 g a.i. ha^{-1} (31.03 kg/ha). It was mainly because weed free treatment reduces weed density and crop weed competition, resulting in less nutrient loss by weeds. Similar findings were also concluded by Singh *et al.*, (2004); Nath *et al.* (2017); Jangade *et al.*, (2019); Mahaveer and Rakesh (2020).

Table 2: Effect of different herbicidal treatments on nitrogen concentration and nitrogen uptake of chickpea crop in grain and haulm.

Sr. No.	N content (%)		N uptake (kg/ha)		
	Grain	Haulm	Grain	Haulm	Total
T_1	2.38	0.73	23.09	10.04	33.13
T_2	2.71	0.88	48.87	19.78	68.64
T_3	2.69	0.84	46.39	18.79	65.18
T_4	2.68	0.82	44.66	18.25	62.91
T_5	2.44	0.76	31.98	14.22	46.20
T_6	2.45	0.76	32.77	14.60	47.37
T_7	2.67	0.81	44.37	17.54	61.91
T_8	2.68	0.81	46.63	17.67	64.31
T_9	2.69	0.84	32.78	13.61	46.40
T_{10}	2.62	0.76	36.85	15.16	52.01
T_{11}	2.63	0.80	41.64	17.27	58.91
T_{12}	2.55	0.77	37.11	15.60	52.70
T_{13}	2.53	0.80	37.86	16.59	54.45
SEm±	**0.09**	**0.03**	**2.4**	**1.07**	**3.17**
CD (P=0.05)	**-**	**-**	**7.27**	**3.13**	**9.25**

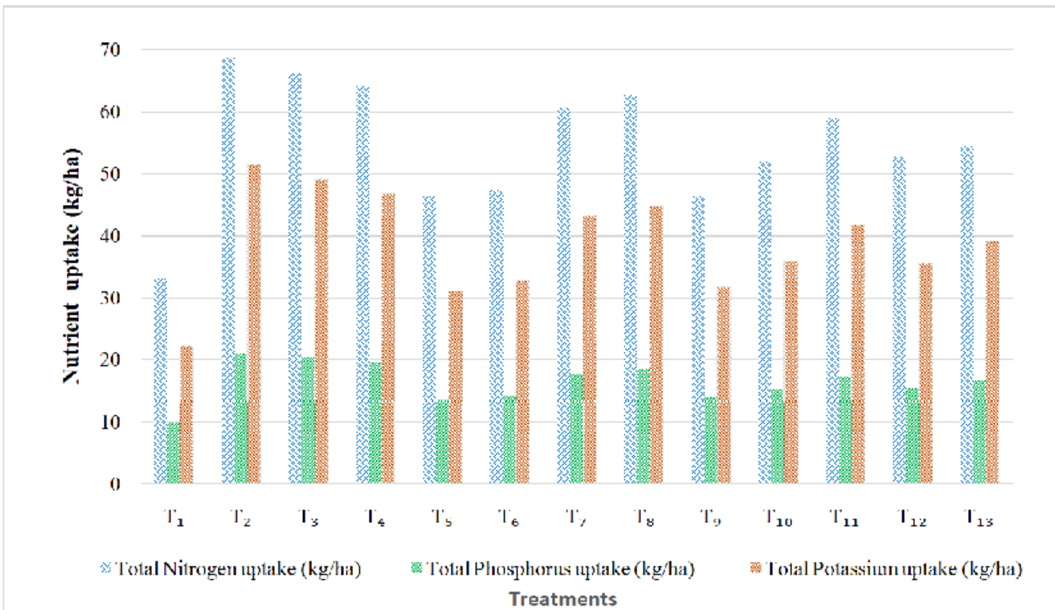

Fig. 1. Total nutrients (N, P_2O_5 and K_2O) uptake (kg ha^{-1}) by chickpea crop as influenced by different herbicide treatments.

Table 3: Effect of different herbicidal treatments on phosphorous concentration and phosphorous uptake of chickpea crop in grain and haulm.

Sr. No.	Phosphorus content (%)		Phosphorus uptake (kg/ha)		
	Grain	Haulm	Grain	Haulm	Total
T_1	0.72	0.21	7.00	2.83	9.83
T_2	0.87	0.24	15.58	5.28	20.86
T_3	0.86	0.23	14.83	5.22	20.05
T_4	0.84	0.23	14.04	5.10	19.14
T_5	0.74	0.21	9.64	4.00	13.65
T_6	0.75	0.22	9.93	4.20	14.13
T_7	0.80	0.23	13.25	4.85	18.10
T_8	0.81	0.23	14.02	5.02	19.04
T_9	0.84	0.22	10.25	3.63	13.87
T_{10}	0.76	0.22	10.76	4.41	15.17
T_{11}	0.79	0.22	12.43	4.83	17.26
T_{12}	0.76	0.22	11.01	4.43	15.44
T_{13}	0.80	0.22	12.01	4.60	16.62
SEm±	**0.03**	**0.01**	**0.77**	**0.22**	**0.86**
CD (P=0.05)	**-**	**-**	**2.24**	**0.65**	**2.51**

Table 4: Effect of different herbicidal treatments on potassium concentration and potassium uptake of chickpea crop in grain and haulm.

Sr. No.	K content (%)		K uptake (kg/ha)		
	Grain	Haulm	Grain	Haulm	Total
T_1	0.89	1.00	8.65	13.54	22.19
T_2	1.16	1.37	20.89	30.59	51.48
T_3	1.12	1.31	19.31	29.22	48.53
T_4	1.08	1.28	18.00	28.41	46.41
T_5	0.92	1.02	11.98	19.05	31.03
T_6	0.97	1.04	12.93	19.85	32.78
T_7	1.04	1.22	17.26	26.41	43.67
T_8	1.04	1.25	18.12	27.29	45.40
T_9	1.00	1.22	12.30	19.41	31.72
T_{10}	0.98	1.10	13.89	22.05	35.94
T_{11}	1.02	1.19	16.10	25.60	41.71
T_{12}	0.98	1.06	14.04	21.43	35.47
T_{13}	1.01	1.16	15.15	23.89	39.04
SEm±	**0.05**	**0.08**	**1.09**	**1.70**	**2.36**
CD (P=0.05)	**-**	**-**	**3.19**	**4.98**	**6.90**

C. Nutrient content in weeds (%)

Nutrient content in weeds were not significantly influenced by several weed control treatments (Table 5). However, highest nitrogen content was observed in weedy check while lowest was recorded under weed free treatment. Among herbicides pendimethalin @ 1000 g a.i. ha^{-1} fb 1 HW and oxyfluorfen @ 100 g a.i. ha^{-1} fb 1 HW recorded lowest nitrogen content. Similar results were also recorded in case of phosphorus content in weeds. In case of potassium highest content was recorded in weedy check and lowest in weed free while among herbicidal application lowest K content was observed in pendimethalin @ 1000 g a.i. ha^{-1} fb 1 HW.

Table 5: Uptake of nutrients (N, P and K) by weeds (kg ha^{-1}) as influenced by different weed control treatments.

Sr. No.	Uptake of nutrients (N, P and K) by weeds					
	Concentration (%)			Nutrient uptake (kg ha^{-1})		
	N	P	K	N	P	K
T_1	1.76	0.29	1.60	34.75	5.80	31.57
T_2	1.52	0.24	1.38	0.91	0.14	0.83
T_3	1.58	0.25	1.45	5.85	0.93	5.38
T_4	1.58	0.25	1.47	6.07	0.95	5.67
T_5	1.75	0.28	1.58	16.92	2.73	15.23
T_6	1.74	0.28	1.57	18.82	3.01	16.97
T_7	1.63	0.26	1.48	6.74	1.08	6.14
T_8	1.63	0.26	1.48	6.43	1.03	5.81
T_9	1.76	0.28	1.48	16.46	2.58	13.87
T_{10}	1.73	0.27	1.53	11.06	1.74	9.78
T_{11}	1.68	0.26	1.50	11.46	1.76	10.27
T_{12}	1.70	0.27	1.52	9.80	1.56	8.75
T_{13}	1.68	0.27	1.52	12.58	2.00	11.42
SEm±	0.06	0.01	0.08	0.47	0.09	0.59
CD (P=0.05)	-	-	-	1.36	0.26	1.72

D. Nutrient uptake by Weeds

Weed nitrogen uptake recorded as minimum and maximum with weed free and weedy check, respectively (Table 5, Fig. 2). Under herbicidal application, the minimum uptake (5.85 kg ha^{-1}) was recorded with pendimethalin @ 1000 g a.i. ha^{-1} fb 1 HW. However, it was considerably similar to oxyfluorfen @ 100 g a.i. ha^{-1} fb 1 HW, topramezone @ 20 g a.i. ha^{-1} and topramezone @ 25 g a.i. ha^{-1} and was significantly lower over rest of the treatments. Similar trend was followed in phosphorus as well as potassium uptake by weeds as influenced by several weed control treatments. The results shows that NPK content and their uptake by weeds were lowest in treatments weed free, pendimethalin @ 1000 g a.i. ha^{-1} fb 1 HW oxyfluorfen @ 100 g a.i. ha^{-1} fb 1 HW, topramezone @ 20 g a.i. ha^{-1} and topramezone @ 25 g a.i. ha^{-1} whereas, it was highest in weedy check due to more weed competition and higher weed dry matter, more nutrients were uptake by the weed in weedy check. These findings corroborate the reports of Mani *et al.*, (1973); Patel *et al*., (2006); Goud *et al.*, (2013).

E. Correlation between crop and weed nutrient uptake

Total crop nitrogen, phosphorus and potash uptake were significantly correlated to each other (Table 6) while Weed nitrogen uptake was highly correlated with phosphorus and potash. Meanwhile, nitrogen and potash uptake by weeds was perfectly correlated. This shows the uptake of primary nutrients are correlated, it was also observed by Kumar *et al*., (2020). While, crop and weed nutrient uptake was highly negatively correlated to each other. It might be due to competition for the nutrient because both crop and weeds lies in close proximity and have overlapping encroachment area.

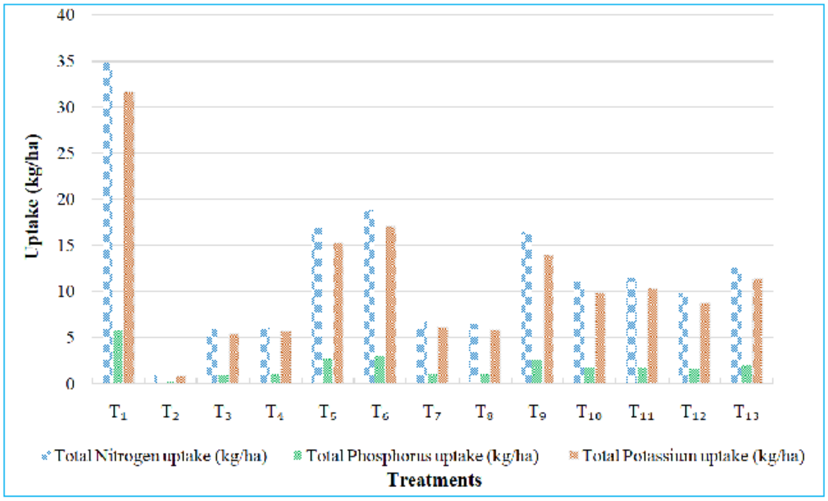

Fig. 2. Nutrients (N, P_2O_5, and K_2O) uptake (kg ha^{-1}) by weeds as influenced by different herbicide treatments.

Table 6: Correlation analysis of crop and weed nutrient uptake which were influenced by different weed control herbicide treatments.

		Crop uptake			Weed uptake		
		N	P	K	N	P	K
Crop uptake	N	1					
	P	0.995**	1				
	K	0.993**	0.998**	1			
Weed uptake	N	-0.953**	-0.940**	-0.928**	1		
	P	-0.947**	-0.934**	-0.921**	0.999**	1	
	K	-0.945**	-0.932**	-0.919**	0.999**	1.00**	1

CONCLUSION

On the basis of field trial findings, it can be concluded that application of herbicides like pendimethalin @ 1000 g a.i. ha^{-1} PE fb 1 HW, oxyfluorfen @ 100 g a.i. ha^{-1} fb 1 HW, topramezone @ 25 g a.i. ha^{-1} and topramezone @ 20 g a.i. ha^{-1} results in significantly higher nutrient (N, P and K) uptake and in case of weeds, these herbicidal application results in the minimum nutrient (N, P and K) uptake by weeds. Such herbicides were successful in controlling weeds resulting in lower crop weed competition ultimately leading to higher nutrient uptake by chickpea and lowering down the nutrient uptake by weeds.

FUTURE SCOPE

Long term trail must be conducted for new herbicides and its impact on the crop ecology very closely.

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Conflict of Interest. Nil.

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