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Effect of chickpea (*Cicer arietinum* L.) weed management practices on quality parameters, nutrient content and uptake by crop and weed

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Abstract
Field experiment was conducted during *rabi* 2017-2018 at Instructional Agronomy Farm of Rajasthan College of Agriculture, MPUAT, Udaipur. The experiment consisted of twelve treatments (Pendimethalin 750 g ha^{-1} PE; Pendimethalin 1000 g ha^{-1} PE; Metribuzin 150 g ha^{-1} PE; Metribuzin 200 g ha^{-1} PE; Imazethapyr 50 g ha^{-1} PoE at 20 DAS; Imazethapyr 75 g ha^{-1} PoE at 20 DAS**;** Quizalofop-ethyl 40 g ha^{-1} PoE at 20 DAS**;** Quizalofop- ethyl 50 g ha^{-1} PoE at 20 DAS**;** Imazethpyr + Imazamox (RM) 15+15 g ha^{-1} PoE at 20 DAS; Imazethpyr + Imazamox (RM) 15+15 g ha^{-1} PoE at 20 DAS**;** Handweeding at 30 and 60 DAS; Weedy check). Pendimethalin and metribuzin were applied as pre-emergence while all other herbicides were applied as post-emergence at 20 days after sowing and handweeding at 30 and 60 DAS. The twelve treatments were replicated thrice in Randomize Block Design.
The result showed that two hand weeding 30 and 60 DAS followed by pendimethalin 1000 g ha^{-1} PE and pendimethalin 750 g ha^{-1} PE significantly reduced weed density and dry weight, thereby attaining the highest seed yield. Net reurn and B C ratio was also the highest in pre-emergence application of pendimethalin 1000 g ha^{-1} PE and pendimethalin 750 g ha^{-1} PE.

Keywords: Chickpea, economics, herbicides, weed density, weed dry weight, WCE, yield

Introduction
Chickpea is one of the most important *rabi* season pulse crop grown in India for their economic importance and besides maintaining soil fertility. Chickpea is the most important pulse crop of India, which account for 43.5 per cent of total pulse production from 33 per cent of total pulse area. The major chickpea growing states are M.P., Karnataka, Rajasthan, Maharashtra and Andhra Pradesh, which together contribute 86.8 per cent area and 86.4 per cent production in the country. In India, the area under chickpea during 2016-17 was 8.35 million hectare with a production 7.17 million tonnes having average productivity 859 kg per hectare (Goverrnment of India, 2017) [4]. Rajasthan as the third major chickpea producing state contributes to around 12 per cent to the country's total production. In the state, area covered under chickpea cultivation is nearly 7 per cent of the state's net sown area. In the state, the area, production and productivity were very low up to the year 1980 (4.29 lakh ha, 1.50 lakh tone and 3.50 q ha^{-1}, respectively). However, it has increased up to 9.42 lakh hectare area having 8.03 lakh tonnes production with average productivity 852 kg per hectare during the year 2016-17 (Goverrnment of Rajasthan, 2017). Kacchhadia. (2009) [5, 6] reported that crop yield losses in gram due to weeds have been estimated to range from 30 to 50 percent. Due to unrestricted weed growth growth 31.33 percent yield reduction was observed. Weed infestation in *rabi* pulses has been reported to offer serious competition and cause yield reduction to the extent of 75 percent in chickpea. Its being slow in its early growth and short saturated plant a highly susceptible to weed competition and often considerable loss may occur if weeds are not controlled at proper time (Chaudhary *et al.*, 2005) [2]. Therefore, there is a need to identify effective herbicides and also to integrate various methods of weed control for effective and economical weed management in this crop.

Materials and Methods

A field experiment was conducted during *Rabi* 2017-18, at Instructional Farm of Agronomy, Rajasthan college of Agriculture, Udaipur. The experiment was laid out at the Instructional Agronomy Farm, Rajasthan College of Agriculture, Udaipur, which is situated at 24^0 35'N latitude and $74^0$42'E longitude and at an altitude of 582.17 meters above the mean sea level. The region falls under Agro-climatic zone iva *i.e.* Sub Humid Southern Plain and Aravali Hills of the Rajasthan. The topography of the experimental field was fairly uniform and leveled. The agro-climatic zone Sub Humid Southern Plain and Aravali Hills possesses typical sub-tropical climatic conditions characterized by mild winters and moderate summers associated with high relative humidity during the months of July to September. The mean annual rainfall of this region is 637 mm, most of which contributed by south-west monsoon from July to September. The soil of experimental site was clay loam in texture, non saline and slightly alkaline in reaction. The soil was low in available nitrogen, medium in organic carbon and phosphorus and high in available potassium. The experiment was laid out in Randomize Block Design with 12 treatments replicated three times. The treatments were : Pendimethalin 750 g ha^{-1} PE; Pendimethalin 1000 g ha^{-1} PE; Metribuzin 150 g ha^{-1} PE; Metribuzin 200 g ha^{-1} PE; Imazethapyr 50 g ha^{-1} PoE at 20 DAS; Imazethapyr 75 g ha^{-1} PoE at 20 DAS**;** Quizalofop-ethyl 40 g ha^{-1} PoE at 20 DAS**;** Quizalofop- ethyl 50 g ha^{-1} PoE at 20 DAS**;** Imazethpyr + Imazamox (RM) 15+15 g ha^{-1} PoE at 20 DAS; Imazethpyr + Imazamox (RM) 15+15 g ha^{-1} PoE at 20 DAS**;** Handweeding at 30 and 60 DAS; Weedy check. Herbicides were applied as pre and post emergence application as per requirement of the treatments. The herbicides were sprayed with Knapsack sprayer fitted with flat fan nozzle using 500 liters of water per hectare. In the plots involving hand weeding treatment, the weeds were removed manually on scheduled dates as per treatment. Sowing of chickpea variety Pratap chana-1 was done manually on 7th November 2017, in row spacing of 30 cm. A seed rate of 80 kg ha^{-1} was used during both the years. The seed was treated with fungicides carbendazim at 2.0 g kg^{-1} seed to protect it from fungal diseases and then chlorpyrifos at 4 ml kg^{-1} seed to protect the seed from termites. Thereafter, it was inoculated with *Rhizobium culture.* Crop was raised by applying 20 kg N ha^{-1} and 40 kg P_2O_5. The crop was harvested manually. The data on yield attributes and seed yield were recorded and analyzed statistically. In each plot, 2 spots were randomly selected for recording the data on weed density and dry matter accumulation 30,60 DAS and at harvest, using quadrate measuring 0.25 m^2. The weeds were counted and removed for recording their biomass. Weed samples were initially sun-dried and then dried in an oven at temperature of 60 ^oC until constant weight was attained. The data on weeds were subjected to square-root transformation before statistical analysis. The weed control efficiency (WCE) was calculated as:

$$WCE = \frac{X-Y}{X} X\ 100$$

Where, WCE= Weed control efficiency, X= Weed dry matter in weedy check and Y= Weed dry matter in treated plot. The benefit:cost ratio (B:C) was calculated by dividing gross returns with cost of cultivation.

Results and Discussion

The experimental field was infested by predominant weeds *viz.*, *Chenopodium album* L. (22.68%), *Chenopodium murale* L. (19.22%), *Convolvulus arvensis L.* (13.01%), *Cyperus rotundus* (6.27%), *Phalaris minor* Retz. (7.78), *Melilotus indica* (L.) (13.30%) and *Malva parviflora* L. were predominantly present in unweeded control plot during the course of experimentation. The results (Table 1) revealed that various weed management practices significantly influence the protein content of chickpea seed. The higher protein content was noted under treatment two hand weeding at 30 and 60 DAS (21.44 per cent) and all the weed control treatments were found at par except quizalofop-ethyl 40 g ha^{-1} PoE at 20 DAS (19.52 per cent). While significantly the lowest protein content was observed in weedy check. The increase in protein content with these treatments might be due to better nourishment reputed from effective reduction in competition reflected in higher protein content in seed and their yield under respective weed management treatments. These results are in line with those reported by Singh *et al.* (2004) [7], Bhutada *et al.* (2014) [1] and Chauhan (2000) [3].

Two hand weeding at 30 and 60 DAS () recorded significantly the highest content and uptake of major nutrients *i.e.* N, P and K but it remained at par with all the treatments except that of quizalofop-ethyl 40 g ha^{-1} PoE at 20 DAS (0.68%) and quizalofop-ethyl 50 g ha^{-1} PoE at 20 DAS (0.72%) in nitrogen, phosphorus and potassium content and nitrogen uptake by seed and haulm. This might be due to better development of crop and lesser crop weed competition. Further, the higher dry matter production (seed and haulm) of crop under these treatments boosted the nutrient content and uptake. Similar results were also reported by Singh *et al.* (2004) [7] and Nath *et al.* (2012).

Significantly the highest removal of major nutrients by weeds were registered under weedy check (Table 2 and 3), whereas significantly the lowest nutrient depletion was noted under treatment two hand weeding at 30 and 60 DAS in content and uptake of major nutrients *i.e.* N, P and K. This might be due to reduced crop weed competition under these treatments which resulted in lesser dry matter production by weeds and ultimately nutrient content and uptake.

The results clearly indicated that effective weed management under $T_{12,}$ T_1 and T_2 resulted in minimum depletion of nutrients by weeds and maximum content and uptake by chickpea crop which reflected in better growth and development ultimately higher seed and haulm yield of chickpea crop.

Table 1: Protein content in seed (%), seed yield (kg ha^{-1}) and dry weight of weeds as influenced by various treatments in chickpea

Treatments	Protein content in seed (%)	Seed yield (kg ha^{-1})	Weed dry weight at harvest (kg ha^{-1})		
			Grassy weeds	Broadleaf weeds	Total weeds
Pendimethalin 750 g ha^{-1} PE	21.13	1688	16.34	25.83	41.17
Pendimethalin 1000 g ha^{-1} PE	21.27	1722	14.72	18.83	33.55
Metribuzin 150 g ha^{-1} PE	20.58	1592	112.56	126.07	238.63
Metribuzin 200 g ha^{-1} PE	20.04	1505	73.91	86.63	160.54
Imazethapyr 50 g ha^{-1} PoE at 20 DAS	21.00	1639	24.53	38.71	63.24
Imazethapyr 75 g ha^{-1} PoE at 20 DAS	20.88	1606	21.34	32.04	53.38
Quizalofop - ethyl 40 g ha^{-1} PoE at 20 DAS	19.52	1485	14.46	208.75	223.21
Quizalofop - ethyl 50 g ha^{-1} PoE at 20 DAS	19.85	1502	12.25	210.67	222.92
Imazethapyr + Imazamox (RM) 15+15 g ha^{-1} PoE at 20DAS	20.38	1568	94.20	116.90	211.11
Imazethapyr + Imazamox (RM) 20+20 g ha^{-1} PoE at 20 DAS	20.23	1550	90.95	103.38	194.32
Hand weeding at 30 and 60 DAS	21.44	1748	11.98	16.20	28.18
Weedy check	18.21	767	161.34	213.45	374.78
SEm ±	0.58	42	4.15	5.63	7.25
CD (P=0.05)	1.70	122	12.16	16.52	21.27

Table 2: N, P and K content (%) by seed and haulm of chickpea and weeds as influenced by various treatments

Treatments	Chickpea seed			Chickpea haulm			Weeds		
	N	P	K	N	P	K	N	P	K
Pendimethalin 750 g ha^{-1} PE	3.38	0.37	0.83	0.84	0.23	1.59	1.33	0.21	1.34
Pendimethalin 1000 g ha^{-1} PE	3.40	0.38	0.84	0.85	0.25	1.61	1.27	0.18	1.30
Metribuzin 150 g ha^{-1} PE	3.29	0.32	0.74	0.79	0.23	1.52	1.46	0.31	1.45
Metribuzin 200 g ha^{-1} PE	3.21	0.27	0.69	0.74	0.20	1.43	1.57	0.38	1.54
Imazethapyr 50 g ha^{-1} PoE at 20 DAS	3.36	0.36	0.81	0.82	0.23	1.56	1.35	0.24	1.36
Imazethapyr 75 g ha^{-1} PoE at 20 DAS	3.34	0.34	0.75	0.81	0.20	1.55	1.43	0.27	1.43
Quizalofop - ethyl 40 g ha^{-1} PoE at 20 DAS	3.12	0.28	0.70	0.68	0.21	1.38	1.74	0.41	1.63
Quizalofop - ethyl 50 g ha^{-1} PoE at 20 DAS	3.18	0.27	0.69	0.72	0.23	1.40	1.63	0.39	1.57
Imazethapyr + Imazamox (RM) 15+15 g ha^{-1} PoE at 20DAS	3.26	0.31	0.69	0.78	0.21	1.50	1.50	0.34	1.48
Imazethapyr + Imazamox (RM) 20+20 g ha^{-1} PoE at 20 DAS	3.24	0.30	0.66	0.76	0.21	1.48	1.55	0.36	1.51
Hand weeding at 30 and 60 DAS	3.43	0.39	0.88	0.87	0.26	1.63	0.84	0.16	1.26
Weedy check	3.10	0.27	0.69	0.66	0.18	1.35	1.83	0.45	1.74
SEm ±	0.04	0.01	0.03	0.02	0.01	0.04	0.041	0.009	0.042
CD(P=0.05)	0.13	0.03	0.08	0.07	0.02	0.13	0.12	0.03	0.12

Table 3: N, P and K uptake by seed and haulm of chickpea and weeds as influenced by various treatments

Treatments	Chickpea seed			Chickpea haulm			Weeds		
	N	P	K	N	P	K	N	P	K
Pendimethalin 750 g ha^{-1} PE	57.05	6.18	14.05	32.61	8.95	61.76	5.63	0.88	5.67
Pendimethalin 1000 g ha^{-1} PE	58.60	6.48	14.47	33.70	9.91	63.94	4.27	0.60	4.37
Metribuzin 150 g ha^{-1} PE	52.45	5.12	11.77	29.40	8.54	56.57	34.91	7.33	34.75
Metribuzin 200 g ha^{-1} PE	48.26	4.09	10.44	24.98	6.75	48.42	25.20	6.05	24.72
Imazethapyr 50 g ha^{-1} PoE at 20 DAS	55.11	5.82	13.19	31.42	8.77	59.67	8.55	1.54	8.57
Imazethapyr 75 g ha^{-1} PoE at 20 DAS	53.68	5.44	12.09	30.38	7.52	58.12	7.62	1.42	7.64
Quizalofop - ethyl 40 g ha^{-1} PoE at 20 DAS	46.42	4.15	10.35	21.44	6.58	43.22	38.92	9.08	36.39
Quizalofop - ethyl 50 g ha^{-1} PoE at 20 DAS	47.73	4.06	10.40	23.42	7.52	45.83	36.40	8.69	34.99
Imazethapyr + Imazamox (RM) 15+15 g ha^{-1} PoE at 20DAS	51.15	4.85	10.88	26.95	7.27	51.89	31.59	7.18	31.16
Imazethapyr + Imazamox (RM) 20+20 g ha^{-1} PoE at 20 DAS	50.19	4.57	10.22	26.10	7.23	50.80	30.09	6.91	29.18
Hand weeding at 30 and 60 DAS	59.96	6.84	15.35	35.48	10.63	66.69	2.36	0.45	3.54
Weedy check	23.77	2.05	5.26	7.52	2.04	15.24	68.47	16.71	65.10
SEm ±	1.83	0.19	0.49	2.19	0.62	4.23	1.22	0.27	1.91
CD(P=0.05)	5.38	0.56	1.43	6.42	1.83	12.42	3.58	0.80	3.49

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