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Effect of post-emergence herbicides in chickpea

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ABSTRACT

A field experiment was conducted during two consecutive (*Rabi*) winter seasons (2018-19 and 2019-20) at Agricultural Research Station, Navgaon (Alwar), S.K.N. Agriculture University, Jobner, Jaipur (Rajasthan), India, to study the effect of weed management practices in chickpea. The experiment was laid out in a randomized block design with eight treatments and replicated thrice. The crop was sown as per the package of practices recommended for zone IIIB of Rajasthan. Treatments included application of pendimethalin 30% EC 1.0 kg/ha as pre-emergence, and quizalofop-p-ethyl 10% SL at 50g/ha, fenoxaprop p-butyl 10% EC at 100 g/ha, imazethapyr 10% EC at 75 g/ha, imazethapyr (35%) + imazamox (35%) at 100 g/ha, imazethapyr (2%) + pendimethalin (30%) at 2.5 litre/ha as post-emergence along with weedy and weed free checks. Among the different herbicidal treatments, imazethapyr (35%) + imazamox (35%) at 100 g/ha recorded significantly higher seed yield 2.22 t/ha in 2018-19 and 2.28 t/ha in 2019-20 with higher weed control efficiency and the lowest weed index. However, it remained at par with imazethapyr 10% EC 75 g/ha and, imazethapyr (2%) + pendimethalin (30%) at 1.0 kg/ha.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is one of the most important *Rabi* pulse crops of India and occupies first position among the pulses. It was grown in an area of 8.4 million ha and producing 10.13 million tonnes with productivity of 1.07 t/ha during 2019-20 in India (Anonymous 2019). In Rajasthan, chickpea is successfully cultivated in arid and semi-arid districts and occupied second rank in respect of area (1.26 mha) with low productivity (725 kg/ha) (Anonymous 2018). Poor weed management is one of the most important yield limiting factors in chickpea. Being slow in its early growth and short statured plant, chickpea is highly susceptible to weed competition and weeds causes up to 75% yield loss (Chaudhary *et al.* 2005). Excessive weed competition may adversely affect seed size which is an important quality parameter in chickpea. Initial 60 days is the period considered as too critical for weed crop competition in chickpea (Singh and Singh 2000). Manual weed control is labour intensive and therefore limits the production area (Dubey 2014). Suitable herbicide (s) for effective control of mixed weed flora in chickpea is required application of pendimethalin at 1.0 kg/ha (Singh and Jain 2017) and oxyfluorfen (80 g/ha) as pre-emergence (Patel *et al.* 2006) provided effective control of annual broad-leaved and grassy weeds in chickpea field at early stages. However, later flushes of weeds can only be control by application of imazethapyr as post-emergence (Rathod *et al.* 2017). The use of post-emergence herbicides for season-long weed control is thus, preferred over pre-plant incorporation (fluchloralin and trifluralin) and pre-mergence (pendimethalin) herbicides. Keeping in view above facts, the present study was undertaken to evaluate the performance of post-emergence herbicides in chickpea.

MATERIALS AND METHODS

The field experiment was conducted during *Rabi* season in year 2018-19 and 2019-20 at Agricultural Research Station, Navgaon (Alwar), S.K.N Agriculture University, Jobner, Jaipur (Rajasthan), India, to study the effect of different herbicides in chickpea**.** The soil of experimental field

was sandy loam in texture, low in organic carbon and available nitrogen, and medium in phosphorus and potassium with alkaline in pH. The experiment was laid out in a randomized block design with eight treatments including pendimethalin 30% EC 1.0 kg/ha as pre-emergence, and quizalofop-p-ethyl 10% SL50 g/ha, fenoxaprop-p-butyl 10% EC 100 g/ha, imazethapyr 10% EC 75 g/ha, imazethapyr (35%) + imazamox (35%)100g/ha, imazethapyr (2%) + pendimethalin (30%) at 1.0 kg/ha as post-emergencealong with weedy and weed free checks with three replications. Chickpea, *cv. RSG-974* was sown at the end of the October. The fertilizer dose 20:40:00 kg/ha of N, P and K was applied as basal and thoroughly mixed with the soil. The seeds were inoculated with selected *Rhizobium* culture and sown at 80 kg/ha in furrows by keeping 30 x 15 cm spacing at a depth of 5 cm. Foliar herbicides spray was done with knap-sack sprayer using flat-fan nozzle in 600 L of water/ha.

Weed density (no./m^2) was recorded species-wise just before the execution of first-hand weeding or before the application of post-emergence herbicides during both the years by using a quadrate of 0.5 x 0.5 m (0.25 m^2) size. Weed count was expressed as number per meter square. Weed dry matter of all the weed species (grasses, broad-leaved weeds and sedges) was recorded just before the execution of first-hand weeding and before application of post-emergence herbicides within an area of quadrate (0.25 m^2) by cutting them close to ground surface, separating species-wise and sun-drying for first 4-5 days and thereafter by keeping into an oven at 70$\pm$1^{O}C temperature till a constant weight was obtained. The dry weight of weeds was expressed as g/m^2.

RESULTS AND DISCUSSION

Weed flora

The weed flora in the experimental field consisted of grasses like *Cynodon dactylon, Asphodelus tenuifolius*, *Phalaris minor*, *Spergula arvensis;* sedges like *Cyperus rotundus* and broad-leaved weeds like *Chenopodium murale, Chenopodium album*, *Melilotus indica*, *Anagallis arvensis*, *Pluchea lanceolata*, *Convolvulus arvensis*, *Phyllanthus niruri*, *Cirsium arvense*, *Launaea asplenifolia*, *Coronopus didymus*, *Rumex dentatus etc*. The weed flora was more pronounced during second year of investigation due to enough soil moisture.

The lowest total weed density (no./m^2) was recorded with imazethapyr 10% EC at 75 g/ha as PoE (148) closely followed by imazethapyr (2%) + pendimethalin (30%) at 1.0 kg/ha (147), imazethapyr (35%) + imazamox (35%) at 100 g/ha PoE (156) and pendimethalin 30% EC at 1.0 kg/ha as PE (163) during 2018-19 (**Table 1**). The corresponding values were 144, 145, 162 and 163, respectively during 2019-20. After application of imazethapyr (35%) + imazamox (35%) 100 g/ha PoE significantly lower weed density (5.67 in 2018-19 and 4.67 in 2019-20) was recorded.

Among herbicidal treatments, weed dry weight (g/m^2) was significantly lower in imazethapyr (2%) + pendimethalin (30%) at 1.0 kg/ha (65.4) closely

Table 1. Effect of weed management practices on weed density and dry matter in standing chickpea crop

Treatment	Weed density (no./m^2)						Weed dry matter (g/m^2)					
	Before spray			After spray			Before spray			After spray		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
Pendimethalin 1.0 kg/ha as PE	12.87 (165.3)	12.74 (162.0)	12.81 (163.7)	9.82 (96.0)	9.43 (88.7)	9.63 (92.3)	8.64 (74.4)	8.52 (72.4)	8.58 (73.4)	7.86 (61.5)	7.74 (59.6)	7.80 (60.6)
Quizalofop-p-ethyl 50 g/ha as PoE	13.30 (176.7)	13.18 (173.3)	13.24 (175.0)	9.42 (88.3)	9.13 (83.0)	9.28 (85.7)	8.77 (76.6)	8.61 (73.9)	8.69 (75.2)	7.56 (57.1)	7.38 (54.4)	7.47 (55.7)
Fenoxaprop-p-butyl 100 g/ha as PoE	13.49 (181.7)	13.25 (175.3)	13.37 (178.5)	8.90 (78.7)	8.71 (75.3)	8.80 (77.0)	9.08 (82.1)	8.95 (79.8)	9.02 (81.0)	6.99 (48.7)	6.78 (45.8)	6.88 (47.2)
Imazethapyr 75 g/ha as PoE	12.13 (148.0)	11.97 (144.3)	12.05 (146.2)	4.60 (20.7)	4.33 (18.3)	4.47 (19.5)	8.33 (69.3)	8.06 (64.8)	8.20 (67.1)	3.37 (11.2)	3.13 (9.6)	3.25 (10.4)
Imazethapyr + imazamox 100 g/ha PoE	12.46 (156.3)	12.74 (163.0)	12.60 (159.7)	2.47 (5.7)	2.26 (4.7)	2.36 (5.7)	8.53 (72.4)	8.28 (68.4)	8.41 (70.4)	1.98 (3.5)	1.85 (3.0)	1.92 (3.2)
Imazethapyr + pendimethalin 1.0 kg/ha	12.14 (147.0)	12.04 (144.7)	12.09 (145.8)	3.89 (14.7)	3.53 (12.0)	3.71 (13.3)	8.09 (65.4)	7.74 (59.8)	7.92 (62.7)	2.88 (7.9)	2.62 (6.4)	2.75 (7.2)
Weed free	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)
Weedy check	14.06 (197.3)	13.70 (187.3)	13.88 (192.3)	13.79 (189.7)	13.42 (179.7)	13.60 (184.7)	9.82 (96.2)	9.47 (89.5)	9.65 (92.9)	9.57 (91.2)	9.24 (85.0)	9.40 (88.1)
LSD (p=0.05)	1.06	1.07	1.03	0.36	0.43	0.28	0.80	0.69	0.61	0.58	0.74	0.52

Original values given in parentheses was subjected to square root ($\sqrt{x+1}$) transformation before analysis

followed by imazethapyr 10% EC at 75 g/ha as PoE (69.3), imazethapyr (35%) + imazamox (35%) at 100 g/ha PoE (72.4), pendimethalin 30% EC at 1.0 kg/ha as PE (74.5) and quizalofop-p-ethyl 10% SL at 50 g/ha as PoE (76.6).

The highest weed control efficiency (97%) was attained with the application of post-emergence herbicide imazethapyr (35%) + imazamox (35%) at 100 g/ha closely followed by imazethapyr (2%) + pendimethalin (30%) at 1.0 kg/ha and imazethapyr 10% EC 75 g/ha at harvest stage (**Table 2**). However, the lowest weed control efficiency was recorded in post-emergence application fenoxaprop-p-butyl 10% EC at 100 g/ha. Broad-spectrum nature of pendimethalin which killed weed by inhibiting cell division and elongation thereafter coincides with imazethapyr which acted as inhibitor of three branched-chain amino-acids and thus, resulted in lesser weed counts and ultimately produced lower weed dry weight. Imazethapyr emerged as promising one in averting both density and dry matter accumulation in weeds (Das 2015). Similar results were also reported by Kalyani (2011) and (Yadav *et al.* 2018)

Weed index indicates the loss of yield caused by weeds under particular treatment as compared to weed free plot (**Table 2**). Efficacy of different treatments under weed management varied due to their mode and extent of weed control. However, minimum losses in yield *i.e.* weed index was associated with post-emergence herbicides *i.e.* imazethapyr (35%) + imazamox (35%) at 100 g/ha (2.65 and 0.58 during first year and second year, respectively) followed by imazethapyr (2%) + pendimethalin (30%) at 1.0 kg/ha and imazethapyr 10% EC 75 g/ha compared to weed free plot. The loss of yield as measured in terms of weed index was recorded maximum under weedy check due to heavy infestation of weeds, while application of pendimethalin, quizalofop-p-ethyl and fenoxaprop-p-butyl also recorded reduction in yield due to lesser efficacy against weed control as compared to other post-emergence herbicides. These results were parallel with the findings of Singh *et al.* (2014), Chandrakar *et al.* (2015), and Yadav *et al.* (2018)

Growth, yield and yield attributes

Plant height indicates the important growth variation caused by weeds under particular treatment as compared to weed free plot (**Table 2**). At 30, 60, 90, 120 DAS and at harvest, the maximum plant height was recorded in weed free, but it was at par with imazethapyr 10% EC 75 g/ha as PoE, imazethapyr (35%) + imazamox (35%) at 100g/ha PoE and imazethapyr (2%) + pendimethalin (30%) 1.0 kg/ha (**Table 2)**. Minimum plant height was recorded under unweeded control. These findings were in agreement with those of Singh *et al.* (2003), Kachhadia *et al.* (2009), Poonia *et al.* (2013) and Rupareliya *et al.* (2017).

Imazethapyr (35%) + imazamox (35%) at 100 g/ha PoE produced maximum number of pods per plant which were significantly higher than other weed management practices. However, seeds per pod of chickpea were not significantly affected by different weed management practices (**Table 4)**. Significantly higher seed yield of 2.22, 2.18 and 2.11 t/ha in 2018-19 and 2.28, 2.23 and 2.19 kg/ha, respectively in 2019-20 (**Table 3**). Significantly the highest harvest index was recorded with pendimethalin 30% EC 1.0 kg/ha as PE treatment (25.3%) during 2018-19 and quizalofop-p-ethyl 10% SL 50 g/ha as PoE treatment (25.2%) during 2019-20. Similar trend was also found with respect to the stover yield. Correlation between seed yield and weed density (**Figure 1**) were fond perfectly negative (r=0.977). It might be due to lesser infestation of weeds that encourage proper translocation of photosynthesis from source to sink. Such condition may increase the seed production

Table 2. Effect of weed management practices on weed index, weed control efficiency and plant height in standing chickpea crop

Treatment	Weed index		Weed control efficiency				Plant height at harvest		
			Before spray		After spray				
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	Pooled
Pendimethalin 1.0 kg/haas PE	20.98	20.07	16.21	13.52	49.39	50.65	34.0	34.8	34.4
Quizalofop-p-ethyl 50 g/ha as PoE	18.93	19.30	10.47	7.47	53.43	53.80	35.0	35.3	35.1
Fenoxaprop-p-butyl 100 g/ha as PoE	17.07	16.38	7.94	6.40	58.52	58.07	35.5	35.8	35.7
Imazethapyr 75 g/ha as PoE	7.50	4.52	25.00	22.95	89.10	89.80	36.0	36.1	36.0
Imazethapyr + imazamox 100 g/ha PoE	2.65	0.58	20.78	12.99	97.01	97.40	37.3	37.7	37.5
Imazethapyr + pendimethalin 1.0 kg/ha	4.81	2.75	25.51	22.77	92.27	93.32	37.1	37.4	37.2
Weed free	0.00	0.00	100.00	100.00	100.00	100.00	40.5	40.8	40.7
Weedy check	39.63	35.46	0.00	0.00	0.00	0.00	32.0	32.5	32.3
LSD (p=0.05)							2.25	4.16	2.46

Table 3. Effects of weed management practices on growth, yield attributes and yield in standing chickpea crop

Treatment	Pods/plant (no.)			Seeds/pod (no.)			100 Seed wt.(g)			Seed yield (t/ha)			Stover yield (t/ha)			Harvest index (%)		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
Pendimethalin 1.0 kg/ha as PE	29.7	30.3	30.0	1.50	1.60	1.55	12.2	11.4	11.8	1.81	1.83	1.82	5.41	5.44	5.43	25.1	25.2	25.2
Quizalofop-p-ethyl 50 g/ha as PoE	30.7	31.0	30.8	1.42	1.50	1.46	12.8	12.0	12.4	1.85	1.84	1.85	5.48	5.43	5.45	25.3	24.9	25.1
Fenoxaprop-p-butyl 100 g/ha as PoE	31.3	31.7	31.5	1.50	1.50	1.50	12.0	12.1	12.0	1.90	1.92	1.91	5.68	5.75	5.71	25.0	25.1	25.0
Imazethapyr 75 g/ha as PoE	30.3	30.7	30.5	1.58	1.60	1.59	13.3	13.4	13.3	2.11	2.19	2.15	6.57	6.59	6.58	24.4	25.0	24.7
Imazethapyr + imazamox 100 g/ha PoE	35.0	35.3	35.2	1.50	1.60	1.55	12.8	12.1	12.5	2.22	2.28	2.25	6.80	6.84	6.82	24.6	25.1	24.8
Imazethapyr + pendimethalin 1.0 kg/ha	33.0	33.7	33.3	1.50	1.60	1.55	13.2	12.4	12.8	2.18	2.23	2.20	6.75	6.81	6.78	24.4	24.7	24.5
Weed free	34.0	34.3	34.2	1.58	1.67	1.63	12.7	12.0	12.3	2.29	2.27	2.28	6.97	6.91	6.94	24.7	24.5	24.6
Weedy check	27.3	27.7	27.5	1.42	1.48	1.45	10.7	10.9	10.8	1.38	1.49	1.43	4.21	4.53	4.37	24.6	24.9	24.7
LSD (p=0.05)	2.72	2.55	1.55	NS	NS	NS	0.87	0.99	0.71	0.36	0.50	0.24	0.48	0.56	0.51	3.48	5.52	3.14

Table 4. Effect of weed management practices on economics

Treatment	Cost of cultivation (x10^3 `/ha)		Gross returns (x10^3 `/ha)			Net returns (x10^3 `/ha)			BC ratio		
	2018-19	2019-20	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
Pendimethalin 1.0 kg/ha as PE	32.73	32.95	83.46	89.41	86.44	50.73	56.47	53.60	2.55	2.71	2.63
Quizalofop-p-ethyl 50 g/ha as PoE	32.36	32.58	85.62	89.60	87.61	53.26	57.01	55.14	2.65	2.75	2.70
Fenoxaprop-p-butyl 100 g/ha as PoE	32.64	32.86	87.59	93.69	90.64	54.95	60.83	57.89	2.68	2.85	2.77
Imazethapyr 75 g/ha as PoE	32.67	32.89	97.69	106.94	102.32	65.02	74.05	69.54	2.99	3.25	3.12
Imazethapyr + imazamox 100 g/ha PoE	34.00	34.22	102.82	111.41	107.11	68.82	77.20	73.01	3.02	3.26	3.14
Imazethapyr + pendimethalin 1.0 kg/ha	36.90	37.12	100.53	108.91	104.72	63.63	71.80	67.71	2.72	2.93	2.83
Weed free	36.95	37.46	105.60	110.62	108.11	68.65	73.16	70.90	2.86	2.95	2.91
Weedy check	31.84	32.06	63.76	72.49	68.12	31.92	40.43	36.18	2.00	2.26	2.13
LSD (p=0.05)	0.00	0.00	16.46	24.32	11.76	16.46	24.32	11.76	0.50	0.70	0.35

ratio in total produce. The results generated gains support from the other report by Dubey *et al.* (2018).

Economics

The lowest cost of cultivation was in weedy check treatment (₹ 31838/ha during 2018-19 and ₹ 32058/ha during 2019-20) due to no use of any herbicide or other means, whereas, it was more in weed free treatment. Weed free treatment recorded higher gross returns (₹ 105597/ha) during 2018-19 and imazethapyr (35%) + imazamox (35%) at 100 g/ha PoE (₹ 111411/ha) during 2019-20 as compared to other treatments. Imazethapyr (35%) + imazamox (35%) at 100 g/ha PoE resulted in higher net returns (₹ 68822/ha during 2018-19 and ₹ 77196/ha during 2019-20) compared to other treatments. The highest B:C was recorded with imazethapyr (35%) + imazamox (35%) 100 g/ha PoE treatment (3.02 during 2018-19 and 3.26 during 2019-20) compared to rest of the treatments (**Table 4**). Therefore, from the study it was found that the application imazethapyr (35%) + imazamox (35%) at 100 g/ha proved superior in chickpea in the agro climatic zone IIIB of Rajasthan.

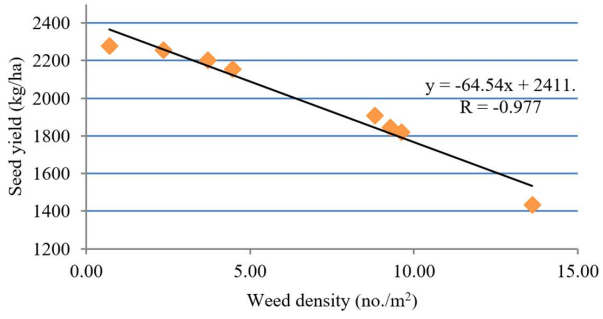

Figure 1. Correlation between seed density and seed yield of chickpea crop

REFERENCES

Ahmed A, Thakral SK, Yadav A and Balyan RS. 2010. Grain yield of wheat as affected by different tillage practices varieties and weed control methods. p. 19. In: *National Symposium on Integrated Weed Management in the Era of Climate Change*, held at NAAS, New Delhi on 21-22 August.

Anonymous 2018. *Agricultural Statistics at a Glance 2018*. Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Govt. of India, New Delhi.

Anonymous. 2019. *3rd Advanced Estimates*. Ministry of Agriculture and Farmers Welfare, Govt. of India.

Chandrakar S, Sharma A and Thakur DK. 2015. Effect of chickpea (*Cicer arietinum* L.) varieties and weed management practices on quality parameters, nutrient content and uptake by crop and weed. *International Journal of Agricultural Sciences* **11**: 217–220.

Chaudhary BM, Patel JJ and Delvadia DR. 2005. Effect of weed management practices and seed rates on weeds and yield of chickpea. *Indian Journal of Weed Sciences* **37**: 271–272.

Das TK. 2015. *Weed Science: Basic and Applications*. Jain Brothers, New Delhi, India.

Dubey RP. 2014. Integrated weed management- an approach. pp. 19-21. In: *Training Manual Advance Training in Weed Management*, held at DWSR, Jabalpur, India on 14-23 January.

Dubey SK, Kumar A, Singh D, Pratap T and Chaurasiya A. 2018. Effect of different weed control measures on performance of chickpea under irrigated condition. *International Journal of Current Microbiology and Applied Science* **7**: 3103–3111.

Kachhadia SP, Savaliya JJ, Bhalu VB, Pansuriya AG and Savalia SG. 2009. Evaluation of new herbicides for weed management in chickpea (Cicer arietinum L.). *Legume Research* **32**(4): 293–297.

Kalyani D. 2011. *Integrated Weed Management in Chickpea (Cicer arietinum L.)*. M.Sc. submitted to ANGRAU, Rajendranagar, Hyderabad.

Mani VS, Malla MC, Gautam KC and Bhagwant's. 1973. Weed killing chemicals in potato cultivars. *Indian Farming* **32**: 17–18.

Patel BD, Patel VJ, Patel JB and Patel RB. 2006. Effect of fertilizers and weed management practices on weed control in chickpea (*Cicer arietinum* L.) under middle Gujrat conditions. *Indian Journal of Crop Science*s **1**: 180–183.

Poonia TC and Pithia MS. 2013. Pre- and post-emergence herbicides for weed management in chickpea. *Indian Journal of Weed Science* **45**(3): 223–225.

Rathod PS, Patil DH and Dodamani BM 2017. Evaluation of time and dose of imazethapyr in controlling weeds of chickpea (*Cicer arietinum* L.). *Legume Research* **40**: 906–910.

Rupareliya VV, Chovatia PK, Vekariya SJ and Javiya PP. 2017. Effects of different pre- and post emergences herbicide on growth, yield attributes, yield and quality of chickpea (*Cicer arietinum* L.). *International Journal of Science, Environment and Technology* **6**(4): 2587–2593

Ryan MR, Smith RG and Mortensen DA. 2009. Weed: crop competition relationships differ between organic and conventional cropping systems. *Weed Research* **49**: 572–580.

Singh A and Jain N. 2017. Integrated weed management in chickpea. *Indian Journal of Weed Science* **49**: 93–94.

Singh RP, Verma SK, Singh RK and Idnani LK. 2014. Influence of sowing dates and weed management on weed growth and nutrients depletion by weeds and uptake by chickpea (*Cicer arietinum*) under rainfed condition. *Indian Journal of Agricultural Sciences* **84**: 468–472.

Singh RV, Sharma AK and Tomar RK 2003. Weed control in chickpea (*Cicer arietinum* L.) under late-sown condition. *Indian Journal of Agronomy* **48**(2):114–116.

Singh S and Singh AN. 2000. Crop-weed competition in chickpea: Challenges and strategies for the New Millenium. p. 199. In: *National Symposium on Agronomy*. 15-18 November 2000. GAU Campus, Junagarh.

Verma SK. 2014. Enhancing sustainability in wheat production though irrigation regimes and weed management practices in eastern Uttar Pradesh. *The Ecoscane* **6**: 115–119.

Yadav VL, Shukla UN, Raiger PR and Mandiwal M. 2018. Efficacy of pre- and post-emergence herbicides on weed control in chickpea (*Cicer arietinum* L.) *Indian Journal of Agricultural Research* **53**(1): 112–115.