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Short communication

Pre- and post-emergence herbicides for weed management in chickpea

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Chickpea (*Cicer arietinum* L.) is one of the important grain legume of the world which is grown in 44 countries across five continents. India is the largest producer of chickpea accounting to 75% of the world production. The major chickpea growing states in India are Maharashtra, Andhra Pradesh, Bihar, Karnataka, Madhya Pradesh, Rajasthan, Uttar Pradesh and Gujarat. It grows on a very light sandy loam to heavy textured clay soils. Chickpea can fix up to 140 kg N/ha in a growing period. Potential yield losses in chickpea due to weeds range from 22 - 100%. Bhalla *et al.* (1998) reported that herbicide treatment gave 50 - 64% weed control with an increase in yield. Weed growth was significantly reduced by the use of herbicides and resulted in 50% increase in yield over untreated fields (Hosseini *et al*. 1997). But after emergence of weeds, suitable post-emergence (POE) herbicide are not available. Keeping in view, the present experiment was designed to investigate the efficacy of different per-and post-emergence herbicides for broad-spectrum weed management and their effects on the growth and yield of the chickpea crop. Parasitic weed, *Cuscuta* was also becoming a problem in some parts of the country. There is urgent need to identify more effective herbicides with broad-spectrum of weed control and wider adaptability in chickpea (Singh and Sharma 2013).

An experiment was carried out at research farm of Junagarh Agricultural University, Junagadh located in south Saurashtra region of Gujarat during *Rabi* season 2012-13. This region receives an average rainfall of 680 mm with a variability of 61%. The average monthly temperature during the growing period in the experimental year was 33.0 °C, lower than climatic data of long-term period (33.5 °C). The soil was medium black clay having 252 kg/ha N, 97.3 kg/ha P, 319 kg/ha K, and 0.87% organic carbon. The experiment was laid out with nine treatment combinations in randomized block design with three replications (Table 1). Crop was grown in *Rabi* 2012-13 at 45×10 cm spacing having six rows of five meter row length. The net plot size was 4.0×1.8 m (7.2 m^2) at harvest time. Each plot had two rows at the beginning and at the end of the plot for protection which were removed before harvest.

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The dominant weed flora of the experimental field comprised of *Cyperus rotundus*, *Elurops vellosus*, *Eleusine indica*, *Dactyloctenium aegyptium* and *Asphodelus tenuifolius* among monocots. Among dicot, *Chenopodium album*, *Chenopodium murale*, *Melilotus indica*, *Boerhavia diffusa*, *Portulaca oleracia*, *Euphorbia hirta* and *Digera arvensis* were found dominant weeds.

Unweeded check plot produced significantly maximum weed density at all the stages except at 30 DAS (Table 1). At 30 days crop growth, application of pendimethalin (1.0 kg/ha) PE + HW at 25-30 DAS produced significantly maximum weed density (3.46 weeds/m^2) but remained at par with fenoxaprop-ethyl (60 g/ha) POE at 25-30 DAS (3.16 weeds/m^2) and unweeded check (3.07 weeds/m^2). Application of pendimethalin + imazethapyr 1.0 kg/ha PE recorded significantly lower weed density at 30 DAS (1.65 weeds/m^2), 60 DAS (1.44 weeds/m^2), 90 DAS (1.63 weeds/m^2) and at harvest (1.49 weeds/m^2). At 60 DAS, the same treatment was found significantly superior over all herbicide applications and one hand weeding in production of minimum weed density. However, one hand weeding was found inadequate for reducing the weed density. Application of pendimethalin + imazethapyr 1.0 kg/ha + one hand weeding at 30-35 DAS significantly produced minimum weed dry weight (38.0 kg/ha) which remained at par with fenoxaprop-ethyl (60 g/ha) as post-emergence at 25-30 DAS and pendimethalin + imazethapyr 2% 1.0 kg/ha P as PE at 30 days crop growth. At 60 days crop growth, the same treatment produced minimum weed dry weight (48.3 kg/ha). At harvest the minimum weed dry weight (50.3 kg/ha) was produced by one hand weeding which remained at par with application of oxyfluorfen 23.5% EC (0.25 kg/ha) as PE at 20 DAS + hoeing at 30-35 DAS, fenoxaprop-ethyl 10% EC (60 g/ha) as POE at 25-30 DAS, pendimethalin 30% EC + imazethapyr 2% 1.0 kg/ha as PE + hand weeding. Significantly the maximum weed dry

Table 1. Effect of weed management practices on density and dry weight of weeds

Treatment	Weed count* (m^2)				Weed dry weight (kg/ha)			
	30	60	90	Harvest	30	60	90	Harvest
Pendimethalin 30% EC (1.0 kg/ha) PE + HW at 25-30 DAS	2.55 (6.56)	1.93 (3.81)	1.60 (2.60)	1.70 (2.93)	98.1	94.0	73.3	91.7
Pendimethalin 38.7% CS (1.0 kg/ha) PE	2.60 (6.78)	2.05 (4.22)	1.76 (3.17)	1.90 (3.60)	113.7	106.0	100.7	104.0
Pendimethalin 38.7% CS (1.0 kg/ha) PE+ hoeing at 30-35 DAS	3.46 (12.04)	1.64 (2.71)	1.56 (2.43)	1.50 (2.27)	106.3	79.3	81.7	84.0
Oxyfluorfen 23.5% EC (0.25 kg/ha) PE at 20 DAS + hoeing at 30-35 DAS	2.40 (5.81)	1.92 (3.76)	1.94 (3.83)	1.77 (3.17)	89.3	55.3	61.7	67.7
Fenoxaprop-ethyl 10% EC (60 g/ha) POE at 25-30 DAS	3.16 (10.05)	2.20 (4.91)	1.84 (3.40)	2.07 (4.33)	42.8	46.2	54.7	63.7
Pendimethalin 30% EC + imazethapyr 2% (1.0 kg/ha) PE	1.65 (2.80)	1.44 (2.18)	1.63 (2.70)	1.49 (2.23)	44.7	61.0	47.3	55.0
Pendimethalin 30% EC + imazethapyr 2% (1.0 kg/ha) PE + hoeing at 30-35 DAS	1.97 (3.94)	1.94 (3.75)	1.80 (3.30)	1.76 (3.13)	38.0	48.3	51.7	55.7
One hand weeding at 30-35 DAS	2.38 (5.75)	1.95 (3.84)	1.82 (3.33)	2.00 (4.03)	74.0	62.0	47.7	50.3
Unweeded control	3.07 (9.50)	3.26 (10.66)	2.99 (8.92)	3.13 (9.84)	119.1	121.3	114.3	133.0
LSD (P=0.05)	0.52	0.46	0.40	0.33	35.0	24.2	31.1	26.8

***** Figures given in the parentheses are original means

weight was produced under unweeded control plot (133.0 kg/ha). Application of pendimethalin 30% EC + imazethapyr 2% 1.0 kg/ha with or without hand weeding gave good results on parameters of weed density and dry weight of weeds but found phytotoxic on chickpea.

At Ludhiana (north-west plain zone) and Kota (central zone) both fenoxaprop-ethyl and oxyfluorfen herbicides gave poor control of weeds and their application showed phytotoxic effect on germination of the chickpea crop (Anon. 2013) but at Junagadh both were found safer for chickpea. Application of pendimethalin 38.7% CS formulation was found at par with pendimethalin 30% EC formulation but slightly better over EC formulation at harvest in production of weed density and dry weight of weeds. This may be due to the longer herbicidal activity with CS formulated chemicals which control newly emerged weeds upto longer period. Singh and Sharma (2013) reported that pendimethalin is an effective pre-emergence herbicide (0.50-0.75 kg/ha) for control of annual broad-leaved and grassy weeds in chickpea. They also reported that application of oxyfluorfen (0.25 kg/ha) as pre-emergence is effective for managing broad-leaved weeds especially for *Medicago hispida* in central India.

The maximum herbicidal efficiency index (Table 2) was achieved under pendimethalin 38.7% CS (1.0 kg/ha) PE + hoeing at 30-35 DAS (100.9%) followed by pendimethalin 30% EC (1.0 kg/ha) as PE + HW at 25-30 DAS (96.5%) and oxyfluorfen 23.5% EC (0.25 kg/ha) as PE at 20 DAS + hoeing at 30-35 DAS. Pendimethalin 38.7% CS formulation when applied with one HW was found better compared to its EC formulation with one hoeing in herbicide efficiency index.

Application of different dosage of pre-and-post emergence herbicides influenced significant effect on number of branches/plant and pods/plant while on plant population and plant height, it was found non-significant (Table 2). Significantly maximum number of pods/plant (37.3) was produced with application of pendimethalin 30% EC (1.0 kg/ha) PE + HW at 25-30 DAS over unweeded control plot (24.3) and remained at par with all the treatments except application of fenoxaprop-ethyl 10% EC (60 g/ha) as POE at 25-30 DAS. Weeds in unweeded check reduced chickpea seed yield by 101.3% over the best treatment pendimethalin 38.7% CS as PE + hoeing at 30-35 DAS. Significantly maximum seed yield (1387 kg/ha) was recorded with application of pendimethalin 38.7% CS (1.0 kg/ha) PE + hoeing at 30-35 DAS over unweeded check (689 kg/ha) and remained at par with pendimethalin 30% EC (1.0 kg/ha) PE + HW at 25-30 DAS and oxyfluorfen 23.5% EC (0.25 kg/ha) PE at 20 DAS + hoeing at 30-35 DAS by producing 1356 and 1207 kg/ha seed yield of chickpea, respectively. The maximum straw yield (1511 kg/ha) was produced with application of pendimethalin 38.7% CS (1.0 kg/ha) PE + hoeing at 30-35 DAS and

Table 2. Effect of broad spectrum weed management practices on growth and yield of chickpea

Treatment	Plant stand ($x10^5$/ha)	Plant height (cm)	Branches/ plant	Pods/ plant	Seed yield (t/ha)	Straw yield (t/ha)	Herbicide efficiency index (HEI)
Pendimethalin 30% EC (1.0 kg/ha) PE + HW at 25-30 DAS	2.38	38.6	4.13	37.3	1.36	1.51	96.5
Pendimethalin 38.7% CS (1.0 kg/ha) PE	2.43	34.1	4.73	29.1	1.18	1.35	71.7
Pendimethalin 38.7% CS (1.0 kg/ha) PE+ hoeing at 30-35 DAS	2.42	38.5	4.20	33.7	1.39	1.45	100.9
Oxyfluorfen 23.5% EC (0.25 kg/ha) PE at 20 DAS + hoeing at 30-35 DAS	2.38	38.1	4.53	31.8	1.21	1.41	74.8
Fenoxaprop-ethyl 10% EC (60 g/ha) POE at 25-30 DAS	2.39	35.2	4.00	27.5	1.10	1.20	59.6
Pendimethalin 30% EC + imazethapyr 2% (1.0 kg/ha) PE	2.39	36.5	5.93	31.5	0.85	0.99	23.0
Pendimethalin 30% EC + imazethapyr 2% (1.0 kg/ha) PE + hoeing at 30-35 DAS	2.39	32.7	7.07	29.4	0.93	1.01	35.4
One hand weeding at 30-35 DAS	2.37	37.2	4.73	41.2	1.07	1.26	54.5
Unweeded control	2.40	32.6	3.80	24.2	0.69	0.82	-
LSD (P=0.05)	NS	NS	1.8	9.2	0.20	0.27	-

minimum with unweeded check (817 kg/ha). However, due to its phytotoxic effect on chickpea, application of pendimethalin + imazethapyr 1.0 kg/ha as PE without hand weeding reduced the straw yield significantly when compared with unweeded check.

Higher seed yield of chickpea under pendimethalin 38.7% CS (1.0 kg/ha) PE + hoeing at 30-35 DAS was due to better herbicidal efficiency index (100.9%) and less weed count throughout the growing season. Application of pendimethalin + imazethapyr1.0 kg/ha as PE proved phytotoxic with poor chickpea seed yield but results in enhanced branching in chickpea. However, results showed that one hand weeding gave more yield over unweeded control plot but was found inadequate for getting higher seed yield. Application pendimethalin 30% EC (1.0 kg/ha) PE + HW at 25-30 DAS and pendimethalin 38.7% CS (1.0 kg/ha) PE + hoeing at 30-35 DAS were found superior over one hand weeding during the investigation. Weedy situation prevailing throughout the crop period caused 54.7% reduction in yield of chickpea over one hand weeding. Hence, one hand weeding was found inadequate for getting higher chickpea seed yield under irrigated conditions of south Gujarat.

Pendimethalin 38.7% CS (1.0 kg/ha as PE) + 1 hoeing at 30-35 DAS was found best weed management practice and may be recommended for irrigated conditions for south Gujarat, however, application enhanced branching significantly but found phytotoxic in the chickpea.

SUMMARY

A field experiment was conducted at Junagadh during 2012-13 to evaluate bio-efficacy of pre-and post-emergence herbicides under irrigated conditions of south Gujarat (India). Significantly higher chickpea seed yield (1.39 g/ha) was recorded with application of pendimethalin 38.7% CS at 1.0 kg/ha as pre-emergence (PE) + 1 hoeing at 30-35 DAS and remained at par with pendimethalin (1.0 kg/ha) as PE + 1 HW at 25-30 DAS (1.36 g/ha) and oxyfluorfen 23.5% EC (0.25 kg/ha) as PE at 20 DAS + hoeing at 30-35 DAS (1.21 g/ha). Pre-application of pendimethalin 30% EC + imazethapyr 2% (Velor 32 at 1.0 kg/ha) significantly enhanced branching in chickpea but proved phytotoxic under south Gujarat conditions. One hand weeding was found inadequate for getting higher chickpea seed yield as weedy situation prevailing throughout the crop period caused 54.7% reduction in seed yield of chickpea.

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