Indian J. Agric. Res., 53(1) 2019: 112-115
Print ISSN:0367-8245 / Online ISSN:0976-058X

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
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Efficacy of pre and post-emergence herbicides on weed control in chickpea (*Cicer arietinum* L.)

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Received: 03-08-2018 Accepted: 29-10-2018 DOI: 10.18805/IJARe.A-5102

ABSTRACT

The study was conducted at Agricultural Research Station, Mandor, Jodhpur during 2016-17 (*rabi*). The experiment was laid out in randomized block design (RBD) with 16 treatments and replicated thrice. The treatments were two doses of each herbicides *i.e.* pendimethalin (0.40 and 0.60 kg *a.i.*/ha), oxyfluorfen (100 and 200 g *a.i.*/ha) and imazethapyr (40 and 60 g *a.i.*/ha) with their combinations as pre and post-emergence including weedy check and weed free. Among the herbicidal treatments, sequential application of pre and post-emergence herbicides *i.e.* pendimethalin @ 0.60 kg *a.i.*/ha (PE) + imazethapyr @ 60 g *a.i.*/ha at 20 DAS (W_{12}) recorded significantly higher seed yield with higher weed control efficiency and weed index and established its superiority over other weed management treatments. However, it remained at par with pre and post-emergence herbicides *i.e.* pendimethalin @ 0.60 kg *a.i.*/ha (PE) + imazethapyr @ 40 g *a.i.*/ha at 20 DAS (W_{11}) at all growth stages of crop. Although, weed free recorded higher seed yield and showed significant superiority over rest of the weed management treatments, but it was statistically at par with W_{12} and W_{11}.

Key words: Chickpea, Herbicide, Weed control efficiency, Weed index, Yield.

INTRODUCTION

Chickpea is one of the most important *rabi* pulse crop of India and occupies first position among the pulses. It is grown in an area 84 million ha and producing 8.32 million tonnes with productivity of 942 kg/ha during 2016-17 in India. In Rajasthan, chickpea is successfully cultivated in arid and semi-arid districts and occupied at second rank in respect of area (1.26 m_ha) with low productivity (725 kg/ha) (Anonymous, 2016). The productivity of chickpea has fallen due to various constraints such as biotic and abiotic factors. Poor weed management is one of the most important yield limiting factors in chickpea. Weeds can removes plant nutrients from soil more efficiently than crops. 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). Initial 60 days is the period considered too critical for weed crop competition in chickpea (Singh and Singh, 2000), but continuous facing scarcity of labour and increase in labour cost, manual weed control has become a difficult task. Suitable herbicide for effective control of mixed weed flora is required for better adoption in chickpea. Many research workers from the various parts of the country have reported that the application of pendimethalin as pre-emergence at 1.0 kg/ha (Singh and Jain, 2017) and oxyfluorfen (80 g/ha) as weed control treatment (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). Keeping in view these facts, the present study was undertaken to test the performance of pre and post-emergence herbicides either alone or combination with other weed management practices for providing effective weed control in chickpea.

MATERIALS AND METHODS

Climate and weather: The climate of Jodhpur is typically arid with hot dry summers. The average annual rainfall is about 367 mm (CV 52%) and bulk of it (85 to 90%) is received from June to September (*kharif* season) through the southwest monsoon. The normal time of onset of monsoon is last week of June to first week of July, but weather aberrations are quite common with respect to late arrival and early withdrawal of monsoon that results dry spells and high temperature during *kharif* season. The other distinct climatic features of this region are low relative humidity (15 to 30%) with high wind velocity (30 to 40 km/hr), solar incidence (520 cal/cm), potential evapotranspiration (1843 mm/year) and wide range of maximum (24.6°C in January to 41.6°C in May) and minimum (9.6 in January to 27.7°C in June) temperatures.

The periodical mean weekly weather parameters for the period of the experimentation recorded from the meteorological observatory of ICAR-Central Arid Zone Research Institute, Jodhpur, are depicted in Fig.1. The mean daily maximum and minimum temperature fluctuated

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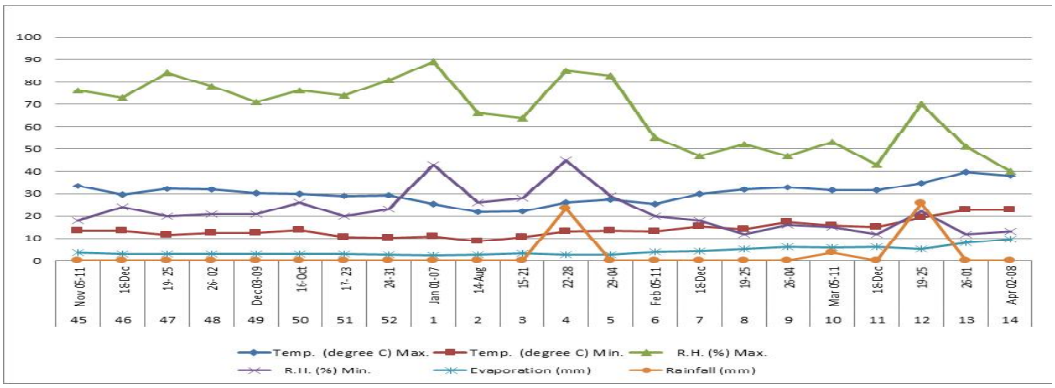

Fig 1: Meteorological data recorded at CAZRI, Jodhpur during crop season (*rabi*, 2016-17).

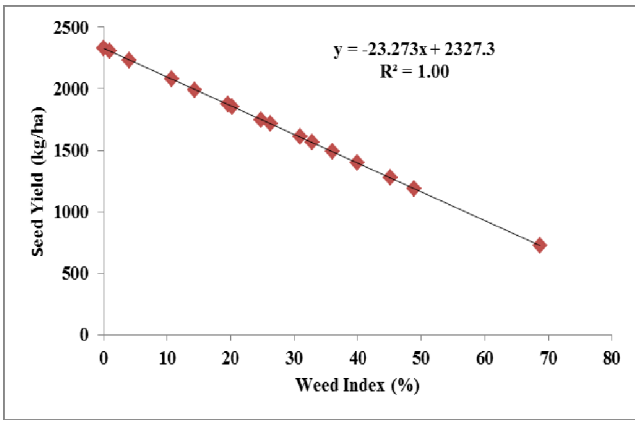

Fig 2: Regression analysis between seed yield (kg/ha) and weed index of chickpea.

between 21.8 to 39.8°C and 8.8 to 22.9°C, respectively during the crop growing season. Approximately 52.7 mm total rainfall was received with three rainy days in growing season (45th MW, 2016 to 14th MW). The good growth of crop favoured by rainfall occurred in 4th MW (22 to 28th January). Later on, the subsequent rainfall also occurred in the month of March (10th and 12th MW), but due to efficient drainage facilities available at farm the crop did not affected. The mean daily evaporation ranged from 2.1 to 9.7 mm/day and the average daily relative humidity fluctuated between 12 to 89 % during the experimental season.

Experimental site and treatments: Field experiment was conducted during *rabi* season 2016-17 at Agricultural Research Station, Mandor, Jodhpur. The soil was loamy sand in texture, slightly alkaline in reaction (pH 8.2), low in organic carbon (0.13%) and available nitrogen (174 kg/ha), whereas medium in phosphorus (22.2 kg P_2O_5/ha) and available potassium (325 kg K_2O/ha). The experiment was laid out in randomized block design (RBD) comprising sixteen treatment combinations *viz.*, W_1-Weedy Check, W_2-Weed free, W_3-Pendimethalin @ 0.40 kg *a.i.*/ha (PE), W_4-Pendimethalin @ 0.60 kg *a.i.*/ha (PE), W_5- Oxyfluorfen @ 100 g *a.i.*/ha (PE), W_6-Oxyfluorfen @ 200 g *a.i.*/ha (PE), W_7-Imazethapyr @ 40 g *a.i.*/ha at 20 DAS, W_8-Imazethapyr @ 60 g *a.i.*/ha at 20 DAS, W_9-Pendimethalin @ 0.40 kg *a.i.*/ha (PE) + imazethapyr @ 40 g *a.i.*/ha at 20 DAS, W_{10}-Pendimethalin @ 0.40 kg *a.i.*/ha (PE) + imazethapyr @ 60 g *a.i.*/ha at 20 DAS, W_{11}-Pendimethalin @ 0.60 kg *a.i.*/ha (PE) + imazethapyr @ 40 g *a.i.*/ha at 20 DAS, W_{12}-Pendimethalin @ 0.60 kg *a.i.*/ha (PE) + imazethapyr @ 60 g *a.i.*/ha at 20 DAS, W_{13}-Oxyfluorfen @ 100 g *a.i.*/ha (PE + imazethapyr @ 40 g *a.i.*/ha at 20 DAS, W_{14}-Oxyfluorfen @ 100 g *a.i.*/ha (PE) + imazethapyr @ 60 g *a.i.*/ha at 20 DAS, W_{15}-Oxyfluorfen @ 200 g *a.i.*/ha (PE) + imazethapyr @ 40 g *a.i.*/ha at 20 DAS and W_{16}-Oxyfluorfen @ 200 g *a.i.*/ha (PE) + imazethapyr @ 60 g *a.i.*/ha at 20 DAS with three replications. Among different doses of herbicides, pendimethalin and oxyfluorfen were applied as pre-mergence (within 3 DAS), while imazethapyr was applied as post-emergence (20 DAS). The chickpea cv. *Gangour* (GNG-1581) was sown manually keeping the row distance of 30 cm at 60 kg seed/ha. Entire quantity of nitrogen (20 kg/ha) and phosphorous (40 kg/ha) was given uniformly through urea and DAP, respectively and were applied at the time of field preparation. The herbicides were applied using knapsack sprayer fitted with flat fan nozzle as per treatment. The other package of practices was adopted to raise the crop as per the recommendations. Immediately after sowing, a light irrigation was given to the crop for uniform germination and next day the pre-emergence herbicides were applied. The observations on number of weeds and dry matter of weeds were taken randomly by using 0.50 m^2 quadrate from net plot area. Weed control efficiency was calculated on the basis of standard formula suggested by Mani *et al.* (1973). The seed and stalk yield was harvested from the net plot area and converted into hectare for comparison.

RESULTS AND DISCUSSION

Effect of pre and post-emergence herbicides on weed control efficiency: The weed control efficiency showed the efficacy of herbicides with respect to controlling weeds over weedy check. Data (Table 1) revealed that higher weed control efficiency brought up by the sequential application of pre and post-emergence herbicides *i.e.* pendimethalin @

0.60 kg *a.i.*/ha (PE) + imazethapyr @ 60 g *a.i.*/ha at 20 DAS (W_{12}) followed by pendimethalin @ 0.60 kg *a.i.*/ha (PE) + imazethapyr @ 40 g *a.i.*/ha at 20 DAS (W_{11}) at all growth stages of crop and attained highest efficacy *viz.*, 95.33 and 94.41% at 90 DAS, respectively. However, the lowest weed control efficiency was recorded under pre-emergence application of oxyfluorfen @ 100 g *a.i.*/ha. Similar results were also reported by Kalyani (2011). This was might be due to 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-acid 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).

Effect of pre and post-emergence herbicides on weed index: Weed index is the measure of crop yield reduction due to weed competition in comparison to weed free. 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 nature and mode of weed control. However, minimum losses in yield *i.e.* weed index was associated with combined application of pre and post-emergence herbicides *i.e.* pendimethalin @ 0.60 kg *a.i.*/ha (PE) + imazethapyr @ 60 g *a.i.*/ha at 20 DAS (W_{12}) followed by pendimethalin @ 0.60 kg *a.i.*/ha (PE) + imazethapyr @ 40 g *a.i.*/ha at 20 DAS (W_{11}) in respect to weed free plot. The loss of yield as measured in terms of weed index was recorded maximum under weedy check (W_1) due to heavy

Table 1: Weed control efficiency as influenced by various weed management treatment.

		WCI (%)			
	Treatments	**30 DAS**	**60 DAS**	**90 DAS**	**At harvest**
W_1	Weedy	0.0	0.00	0.00	0.00
W_2	Weed free (Season long)	100.00	100.00	100.00	100.00
W_3	Pendimethalin @ 0.40 kg *a.i.*/ha (PE)	61.90	66.97	78.15	63.50
W_4	Pendimethalin @ 0.60 kg *a.i.*/ha (PE)	69.05	70.18	79.52	65.35
W_5	Oxyflourfen @100 g *a.i.*/ha (PE)	50.00	47.90	48.68	38.82
W_6	Oxyflourfen @ 200 g *a.i.*/ha (PE)	54.76	51.31	50.73	42.36
W_7	Imazethapyr @ 40 g *a.i.*/ha at 20 DAS	64.29	59.53	71.79	59.16
W_8	Imazethapyr @ 60 g *a.i.*/ha at 20 DAS	71.43	61.40	73.24	58.60
W_9	Pendimethalin @ 0.40 kg *a.i.*/ha (PE) + Imazethapyr @ 40 g *a.i.*/ha at 20 DAS	78.57	85.92	91.07	89.18
W_{10}	Pendimethalin @ 0.40 kg *a.i.*/ha (PE) + Imazethapyr @ 60 g *a.i.*/ha at 20 DAS	83.33	87.80	91.94	90.61
W_{11}	Pendimethalin @ 0.60 kg *a.i.*/ha (PE) + Imazethapyr @ 40 g *a.i.*/ha at 20 DAS	85.71	90.72	94.41	93.11
W_{12}	Pendimethalin @ 0.60 kg *a.i.*/ha (PE) + Imazethapyr @ 60 g *a.i.*/ha at 20 DAS	90.48	92.57	95.33	94.21
W_{13}	Oxyflourfen @100 g *a.i.*/ha (PE) + Imazethapyr @ 40 g *a.i.*/ha at 20 DAS	73.81	77.48	85.19	80.34
W_{14}	Oxyflourfen @100 g *a.i.*/ha (PE) + Imazethapyr @ 60 g *a.i.*/ha at 20 DAS	76.19	78.41	86.98	81.85
W_{15}	Oxyflourfen @ 200 g *a.i.*/ha (PE) + Imazethapyr @ 40 g *a.i.*/ha at 20 DAS	78.57	81.80	88.66	84.44
W_{16}	Oxyflourfen @ 200 g *a.i.*/ha (PE) + Imazethapyr @ 60 g *a.i.*/ha at 20 DAS	80.95	83.14	89.24	85.02

Table 2: Seed yield of chickpea and weed index as influenced by various weed management treatments.

	Treatments	**Seed yield(kg ha^{-1})**	**Weed index (%)**
W_1	Weedy	728.33	68.71
W_2	Weed free (Season long)	2327.33	0.00
W_3	Pendimethalin @ 0.40 kg *a.i.*/ha (PE)	1561.33	32.91
W_4	Pendimethalin @ 0.60 kg *a.i.*/ha (PE)	1607.33	30.94
W_5	Oxyflourfen @100 g *a.i.*/ha (PE)	1189.00	48.91
W_6	Oxyflourfen @ 200 g *a.i.*/ha (PE)	1274.67	45.23
W_7	Imazethapyr @ 40 g *a.i.*/ha at 20 DAS	1398.67	39.90
W_8	Imazethapyr @ 60 g *a.i.*/ha at 20 DAS	1489.00	36.02
W_9	Pendimethalin @ 0.40 kg *a.i.*/ha (PE) + Imazethapyr @ 40 g *a.i.*/ha at 20 DAS	1991.33	14.44
W_{10}	Pendimethalin @ 0.40 kg *a.i.*/ha (PE) + Imazethapyr @ 60 g *a.i.*/ha at 20 DAS	2077.67	10.73
W_{11}	Pendimethalin @ 0.60 kg *a.i.*/ha (PE) + Imazethapyr @ 40 g *a.i.*/ha at 20 DAS	2231.33	4.12
W_{12}	Pendimethalin @ 0.60 kg *a.i.*/ha (PE) + Imazethapyr @ 60 g *a.i.*/ha at 20 DAS	2303.33	1.03
W_{13}	Oxyflourfen @100 g *a.i.*/ha (PE) + Imazethapyr @ 40 g *a.i.*/ha at 20 DAS	1715.33	26.30
W_{14}	Oxyflourfen @100 g *a.i.*/ha (PE) + Imazethapyr @ 60 g *a.i.*/ha at 20 DAS	1749.67	24.82
W_{15}	Oxyflourfen @ 200 g *a.i.*/ha (PE) + Imazethapyr @ 40 g *a.i.*/ha at 20 DAS	1855.33	20.28
W_{16}	Oxyflourfen @ 200 g *a.i.*/ha (PE) + Imazethapyr @ 60 g *a.i.*/ha at 20 DAS	1872.67	19.54
SEm±		36.91	-
CD (*P*=0.05)		104.23	-

infestation of weeds, while alone application of pendimethalin, oxyfluorfen and imazethapyr also recorded reduction in yield due to lesser efficacy against weed control as compared to its combined application as pre and post-emergence herbicides. Similarly, these finding were parallel with the findings of Chandrakar *et al.* (2015) and Singh *et al*. (2014).

Effect of pre and post-emergence herbicides on yield: Seed yield is an important parameter which decides the efficiency and superiority of a particular treatment over other treatments (Table 2). Sequential application of pre and post-emergence herbicide *i.e*. pendimethalin @ 0.60 kg *a.i.*/ha (PE) + imazethapyr @ 60 g *a.i.*/ha at 20 DAS (W_{12}) and pendimethalin @ 0.60 kg *a.i.*/ha (PE) + imazethapyr @ 40 g *a.i.*/ha at 20 DAS (W_{11}) were recorded significantly higher seed yield (2303.33 and 2231.33 kg ha^{-1}), respectively over other weed management treatments, but these were at par with each other and also were equally effective as weed free treatment (W_2). While lesser difference of increments between W_2, W_{12} andW_{11} treatments were noticed due to similar weed control across the crop growth period. 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 ratio in total produce. The results generated gains support from the other report by Dubay *et al.,* (2018). The seed yield and weed index was negatively correlated with correlation co-efficient of 1.00. This was further supported by the regression analysis, which revealed that as the density and dry weight of weeds increased, the seed yield of chickpea was decreased by 23.273 kg/ha (Fig. 2) in terms of weed index.

CONCLUSION

It is concluded that combined application of pre and post-emergence herbicides *i.e*. pendimethalin @ 0.60 kg *a.i.*/ha (PE) + imazethapyr @ 60 g *a.i.*/ha at 20 DAS recorded higher weed control efficiency, weed index and recorded maximum grain yield of chickpea. However, it showed equal effectiveness as was observed in treatment combined with pendimethalin @ 0.60 kg *a.i.* ha^{-1} (PE) + imazethapyr @ 40 g *a.i.* ha^{-1} at 20 DAS (W_{11}) as pre and post-emergence herbicide. The above findings are based on one year experimentation, which needs to be validated through further experimentation to formulate a recommendation.

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