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MB Landge
College of Agriculture, Dhule, Maharashtra, India

PP Pawar
College of Agriculture, Dhule, Maharashtra, India

AS Tandale
College of Agriculture, Dhule, Maharashtra, India

GL Thakare
College of Agriculture, Dhule, Maharashtra, India

Correspondence
MB Landge
College of Agriculture, Dhule, Maharashtra, India

Integrated weed management in rainfed pigeonpea (*Cajanus cajan* (L.) Millsp.)

MB Landge, PP Pawar, AS Tandale and GL Thakare

Abstract
A field experiment was conducted during kharif, 2016 at Agronomy Farm, College of Agriculture, Dhule. To evaluate the optimum doses and efficacy of new molecules of herbicides used alone or in combination with cultural methods for better management of weeds in pigeonpea. Ten treatment were replicated thrice in Randomized Block Design (RBD). Significantly higher seed and straw yield of pigeonpea was recorded in the integrated weed management treatment which received application of pendimethalin @ 1.0 kg ha -1 as PE + imazethapyr 35 EC + imazamox 35 EC @ 0.075 kg ha -1 (20 DAS)fb HW at 40DAS (2215 and 5610 kg ha -1, respectively). Growth parameters viz., plant height (215.12 cm), number of primary branches (19.10), total dry matter (203.14 g plant -1) and yield parameters like number of pods plant -1 (160 plant-1) and 100 seed weight (9.99 g) of pigeonpea were also increased significantly with pendimethalin @ 1.0 kg ha -1 as PE + imazethapyr 35 EC imazamox 35 EC @ 0.075 kg ha -1 (20DAS) fb HW at 40DAS as compared to weedy check. Combination of pre and post emergence herbicides along with manual method of weed control has resulted in significant increase in growth and yield of pigeonpea.

Keywords: grain yield, straw yield, pigeonpea, weed control efficiency, weed index

Introduction
Pigeonpea (*Cajanus cajan* (L.) Millsp.) being a widely spaced and slow growing crop during early stage, provides ample opportunity for weed growth. In *kharif* season there is high and continuous rainfall which does not permit hand weeding operation timely. This resulted in yield loss up to 32-65 percent (Vaishya and Khan 1989, Kundra and Brar 1990) [9, 4]. A singal factor weed, if left uncontrolled, mitigates the benefits obtainable fom different agricultural inputs. The effective and economical weed control may be possible through manual means due to unavailability of human labour at critical period of competition and its high cost coupled with heavy and continuous rainfall in *kharif* make the use of herbicides an alternative method to manage weed in this situation. Herbicide and its integration with manual and mechanical methods can prove more effective and economical. Use of integrated weed management methods would make weed control more acceptable to farmers and control of weeds using herbicides was a cheaper proposition than with manual methods. Cost of weed control using herbicides was lower than total cost under manual weeding (Sukhadia *et al.* 2000) [8]. Therefore an experiment was planned with an objective to find out suitable and economical weed control method for enhancing productivity and profitability of pigeonpea.

Methodology
A field experimental was undertaken during *kharif* season of 2016 at Agronomy Farm, College of Agriculture, Dhule. The soil was black cotton soil having pH 7.5 and organic carbon 0.70 per cent. The available nitrogen, phosphorus and potassium contents were 163.97, 11.52 and 351.45 kg ha^{-1}, respectively. The experiment with ten treatment combinations were laid out in randomized block design in three replications with gross and net plot size of 6.00 x 5.40 m^2 and 5.20 x 3.60 m^2, respectively. The ten treatment consisted of weed free, weedy check, pendimethalin @ 1.0 kg ha^{-1} as PE *fb* HW at 40 DAS, pendimethalin @ 1.0 kg ha^{-1} as PE *fb* HW at 20 and 40 DAS, imazethapyr 35 EC + imazamox 35 EC @ 0.075 kg ha^{-1} at 20 DAS *fb* HW at 40 DAS, quizalofop ethyl 100 g ha^{-1} (20 DAS) *fb* HW at 40 DAS, pendimethalin @ 1.0 kg ha^{-1} (3 DAS) + quizalofop ethyl @ 100 g ha^{-1} (20 DAS) *fb* HW at 40 DAS, pendimethalin1.0 kgha^{-1}(3 DAS) + quizalofop ethyl @ 100 g ha^{-1} (20 DAS), pendimethalin @ 1.0 kg ha^{-1}as PE + imazethapyr 35 EC + imazamox 35 EC @ 0.075 kg ha^{-1} (20 DAS) *fb* HW at

40DAS and pendimethalin @ 1.0 kg ha^{-1} as PE + imazethapyr 35 EC + imazamox 35 EC @ 0.075 kg ha^{-1} (20 DAS). Pigeonpea variety 'Vipula' was sown at 90 x 20 cm were sown on 04th July 2016. Harvesting of Pigeonpea on 15th December 2016. At the time of sowing of pigeonpea 25:50:00 N:P_2O_5:K_2O kg ha^{-1} were applied through urea and singal super phosphate (SSP).

Results

Weed control treatments recorded significantly lower weed count and dry biomass than weedy check. Among the integrated weed management treatments, application of pendimethalin @ 1.0 kg ha^{-1}as PE + imazethapyr 35 EC + imazamox 35 EC @ 0.075 kg ha^{-1} (20 DAS) *fb* HW at 40DAS (T_9) recorded highest weed control efficiency and lower the weed index and this treatment found at par with application of pendimethalin @ 1.0 kg ha^{-1} as PE *fb* HW at 20 and 40 DAS. Maximum weed index and lowest weed control efficiency were recorded in weedy check treatment. These results are in agreement with the results reported by Padmaja (2015) [5], Pandey (2015) [6] and Reddy *et al.* (2016).

Weed free treatment (T_1) recorded significantly the higher grain and straw yield of pigeon pea (2400 and 6000 kg ha^{-1}) but it was found statistically at par with treatments pendimethalin @ 1.0 kg ha^{-1}as PE + imazethapyr 35 EC + imazamox 35 EC @ 0.075 kg ha^{-1} (20 DAS) *fb* HW at 40DAS (2215 and 5610 kg ha^{-1}) (T_9) and pendimethalin @ 1.0 kg ha^{-1} as PE *fb* HW at 20 and 40 DAS (2173 and 5560 kg ha^{-1}) (T_4). Significantly the lowest grain and straw yield of pigeonpea (890 and 1513 kg ha^{-1}) was observed under treatment weedy check (T_2) due to appearance of weeds since beginning of crop emergence and.

Table 1: Effect of different weed management practices on weeds, grain and straw yield and economics of pigeonpea

Treatment	WCE (%)	WI (%)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
T_1 : Weed free	100	-	2400	6000	117700	2.51
T_2 : Weedy check	-	62.91	890	1513	25608	1.55
T_3 : Pendimethalin @ 1.0 kg ha^{-1} as PE *fb* HW at 40 DAS	64.04	40.00	1440	3024	60364	2.06
T_4 : Pendimethalin @ 1.0 kg ha^{-1} as PE *fb* HW at 20 and 40 DAS	93.62	9.45	2173	5560	112926	2.75
T_5 : Imazethapyr 35 EC + Imazamox35 EC 0.075 kg ha^{-1} at 20 DAS *fb* HW at 40 DAS	83.02	27.70	1735	3817	83278	2.44
T_6 : Quizalofop ethyl 100 g ha^{-1} (20 DAS) *fb* HW at 40 DAS	64.88	43.33	1360	2856	53412	1.93
T_7 : Pendimethalin @ 1.0 kg ha^{1}(3DAS)+ Quizalofop ethyl @ 100 g ha^{-1} (20 DAS) *fb* HW at 40 DAS	83.87	24.75	1806	3974	88213	2.50
T_8 : Pendimethalin 1.0 kg ha^{-1} (3DAS) + Quizalofop ethyl @ 100 g ha^{-1} (20 DAS)	64.51	42.08	1390	2919	61900	2.21
T_9 :Pendimethalin @ 1.0 kg ha^{-1} as PE + Imazethapyr 35 EC + Imazamox 35 EC @ 0.075 kg ha^{-1} (20 DAS) *fb* HW at 40DAS.	94.57	7.70	2215	5610	121204	3.04
T_{10} :Pendimethalin @ 1.0 kg ha^{-1} as PE + Imazethapyr 35 EC + Imazamox 35 EC @ 0.075 kg ha^{-1} (20 DAS).	64.77	39.16	1460	3066	66878	2.29
S.E.(m) ±	0.85	-	80	160	-	-
C.D. at 5 %	2.53	-	238	476	-	-
General mean	71.33	-	1687	3834	-	-

* DAS= Days After Sowing, PE= Pre-emergence, POE= Post emergence, *fb*=followed by, WCE= Weed control efficiency, WI= Weed index

resulted in great competition with crop plants for nutrients, moisture and sunlight. Among integrated weed management treatments, sequential application of pendimethalin @ 1.0 kg ha^{-1}as PE + imazethapyr 35 EC + imazamox 35 EC @ 0.075 kg ha^{-1} (20 DAS) *fb* HW at 40DAS (T_9) produce better grain and straw yield of pigeonpea as compared to other methods of weed control. This might be due to application of pre-emergence herbicide control the weeds in early growth stage of crop and followed by application of post emergence herbicide + hand weeding at 40 DAS efficiently controlled post emergent weeds in later stages and it has created a congenial conditions for crop to come up well under weed free situation and resulted in higher yield. This result corroborates the finding of Pandey (2015) [6], Venkata Rao *et. al.* (2015) [10], Jadhav (2016) [1] and Vinutha and Patil (2016) [11].

The highest net returns of (₹ 130150 ha^{-1}) was observed under weed free treatment (T_1). Among integrated weed management treatment application of pendimethalin @ 1.0 kg ha^{-1}as PE + imazethapyr 35 EC + imazamox 35 EC @ 0.075 kg ha^{-1} (20 DAS) *fb* HW at 40DAS (T_9), pendimethalin @ 1.0 kg ha^{-1} as PE *fb* HW at 20 and 40 DAS (T_4) recorded higher net returns (₹ 126082 and 121766 net ha^{-1}, respectively). Whereas, least net returns of ₹ 28873 ha^{-1} was recorded with weedy check (T_2).

The benefit cost ratio was maximum in application of pendimethalin @ 1.0 kg ha^{-1} as PE + imazethapyr 35 EC + imazamox 35 EC @ 0.075 kg ha^{-1} (20 DAS) *fb* HW at 40DAS (T_9) (3.31) followed by pendimethalin @ 1.0 kg ha^{-1} as PE *fb* HW at 20 and 40 DAS (T_4) (3.19) and Weed free (T_1) (2.98). The sequential application of pre and post-emergence herbicides flowed by one hand weeding recorded maximum gross returns, net returns and benefit cost ratio in rainfed pigeonpea as compared to other integrated weed control treatments. These results corroborate with the findings of Sharma *et. al.* (2014), Padmaja (2015) [5], Komal and Yadav (2015) [3], Pandey (2015) [6] and Khawale (2015) [2].

Conclusion

It was concluded that among the integrated weed management treatments application of pre and post-emergence herbicides followed by one hand weeding i.e. pendimethalin @ 1. 0 kg ha^{-1} as PE + imazethapyr 35 EC + imazamox 35 EC @ 0.075 kg ha^{-1} (20 DAS) *fb* HW at 40 DAS was most effective for controlling weeds, improving grain and straw yield and profitability of pigeonpea.

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