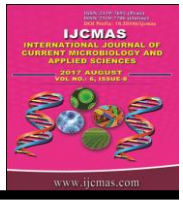
Int.J.Curr.Microbiol.App.Sci (2017) *6*(8): 810-817

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 8 (2017) pp. 810-817**
Journal homepage: http://www.ijcmas.com



Original Research Article https://doi.org/10.20546/ijcmas.2017.608.102

Productivity and Weed Dynamics of Integrated Weed Management Practices in Soybean + Pigeonpea Intercropping System

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Keywords

Dicot, Intercropping, Monocot, Pigeonpea, Soybean, SEY, Weed.

Article Info

Accepted:
14 June 2017
Available Online:
10 August 2017

A B S T R A C T

A field experiment was conducted during 2015-16 at Experimental Farm, Department of Agronomy, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani to study the effect of integrated weed management practices on crop and weed parameters. The soil of the experimental site was clayey in texture. pH was 8.0, low in available Nitrogen (160.7 kg/ha), medium in Phosphorus (11.7 kg/ha) and high in potassium (489.61 kg/ha). The experiment was laid out in randomized block design with three replications and ten different treatments. Results revealed that the minimum weed growth rate, density and dry matter production of weeds and the higher weed control efficiency were recorded with pre emergence application of Pendimethalin 30% EC @ 0.75 kg a.i./ha *fb* tank mix *POE* - Imazethapyr 10% SL @ 0.100 kg a.i./ha + Quizalofop ethyl 10 EC @ 0.075 kg a.i./ha supplemented with 1 Hoeing (40-50 DAS). The highest Soybean Equivalent Yield were obtained with the application of *PE*– Pendimethalin 30% EC @ 0.75 kg a.i./ha +1 Hoeing (30-40 DAS) + 1 Hand Weeding (40-50 DAS). The highest weed index was recorded under weedy check.

Introduction

Soybean (*Glycine max* (L.) Merrill) is a leguminous crop and belongs to family leguminoaceae with sub family papillionaceae Soybean (*Glycine max* L.) is the only major crop that has witnessed an impressive expansion in acreage and production at the global level. Major soybean growing states in India are Madhya Pradesh, Uttar Pradesh, Maharashtra, Gujarat, Rajasthan, Karnataka and Andhra Pradesh. Pigeonpea (*Cajanus cajan* (L.) Mill sp) is the fifth prominent legume crop in the world and ranked second after chickpea in India in terms of area and production. When pigeonpea is grown as a sole crop, it is relatively inefficient because of its slow initial growth rate and low harvest index (Willey, 1979); therefore it is grown as intercrop, which helps in efficient utilization of available resources for enhancing the productivity and profitability.

Weed flush come at same time in almost all the *Kharif* crops, which also restrict the availability of manpower for weeding operation in these crops. The untimely and poor weed management adversely affects

proper growth and yield of soybean and pigeonpea. Weed management through the herbicidal application remains the only viable option under these situations. Application of herbicides as pre-emergence for effective weed control in soybean + pigeonpea are required to be used within very short period (2-3 DAS) of time after sowing. In monsoon season, if rains captures this critical period of application then pre emergence herbicide cannot be used effectively to control the weeds.

Integration of weed control methods are effective and workable practices that may be used ecologically and economically viable to the farmers. Unavailability of adequate labour during peak period of weeding and difficulty in use of mechanical weeding in heavy rains create problem for effective weed management in crops (Nainwal *et al.*, 2010). Under such condition, mulching, hand hoeing and weed control through herbicides remains the choice for controlling the weeds. Therefore integrated approach of mechanical cultural and chemical control may be more feasible. Till now no systematic work has been made on integrated weed management in soybean + pigeonpea intercropping system under Vertisols in Marathwada region of Maharashtra. In present investigation an attempt has been made to determine the integrated approaches for the management of weed in soybean + pigeonpea intercropping system.

Materials and Methods

The present investigation was carried out during *Kharif* 2015 at the Experimental Farm, Department of Agronomy, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani to study the effect of integrated weed management practices on crop and weed parameters. The soil of the experimental site was clayey in texture. pH was 8.0, low in available Nitrogen (160.7 kg/ha), medium in Phosphorus (11.7 kg/ha) and high in potassium (489.61 kg/ha). The experiment was laid out in randomized block design and replicated thrice. The treatments consisted of ten weed management practices *viz.*, T_1- *PE*- Pendimethalin 30% EC @ 1.0 kg a.i./ha, T_2- *PE*–Pendimethalin 30% EC @ 0.75 kg a.i./ha +1 Hoeing (30-40 DAS) + 1 Hand Weeding (40-50 DAS), T_3- *PE*- Pendimethalin 30% EC @ 0.75 kg a.i./ha +*POE* – Imazethapyr 35% + Imazamox 35% WG @ 0.01 kg a.i /ha + 1 Hoeing (40-50 DAS), T_4- *PE* - Pendimethalin 30% EC @ 0.75 kg a.i./ha + *POE* - Imazethapyr 10% SL @ 0.100 kg a.i./ha + Quizalofop ethyl 10 EC @ 0.075 kg a.i./ha + 1 Hoeing (40-50 DAS), T_5- Stale seed bed technique + 1 Hoeing (25-30 DAS) + mulching (30 DAS), T_6 - Stale seed bed technique + 1 Hoeing (25-30 DAS) + 1 Hand Weeding (40-50 DAS), T_7- Stale seed bed technique + *POE*-Imazethapyr35% + Imazamox 35% WG @ 0.01 kg a.i./ha, T_8- Stale seed bed technique + *POE*-Imazethapyr 10% SL @ 0.100 kg a.i./ha + Quizalofop ethyl 10 EC @ 0.075 kg a.i. /ha, T_9 - Weed free, T_{10} – Weedy check. The recorded agronomic practices were followed for both crops. Weed management practices were adopted as per the treatments. In weedy check plot weeds were permitted to grow without any control measures throughout the crop growing period. Mulching in inter row space was done by soybean straw at 30 DAS as per treatment of weed management. Herbicides were applied with the help of Knapsack sprayer fitted with flat fan nozzle.

Weed density were recorded at 30, 60, 90 DAS and at harvest stage by quadrate randomly placed in each plot to count the weed species in each plot. The weed biomass from different plots under all the treatments was recorded at 30, 60, 90 DAS and at harvest. The weeds were first sun dried and thereafter kept in paper bags and dried in

oven at 60oC for 48 hours and dry weight was recorded till constant weight was achieved. The weed control efficiency was calculated on the basis of reduction in dry matter production of weeds in treated plot in comparison with weedy check and expressed in percentage as suggested by Mani *et al.*, (1973).

$$\text{WCE} \quad (\%) \quad = \frac{\text{DWC} \quad - \text{DWT}}{\text{DWC}} \text{ x } 100$$

Whereas,

WCE = Weed control efficiency in percent,
DWC = Weed dry weight in control plot,
DWT = Weed dry weight in treated plot.

The data obtained on various observations were tabulated and subjected to their analysis by using analysis of variance and the treatments were tested by F test (Panse and Sukhatme, 1964). The soil samples taken for analysis from 0-15 cm soil layer were analyzed in the laboratory using standard procedures. Available N, P and K were determined by the methods described by Dalal *et al.,* (1984); Subbiah and Asija (1956); Olsen *et al.,* (1954), respectively.

Results and Discussion

Weed density

Integrated weed management practices had a remarkable effect on weed density (Table 1). Maximum density of weeds was observed throughout the investigation period under weedy check. Whereas minimum density is observed under weed free treatment. At 30 DAS, minimum density of weeds was observed with application of *PE* - Pendimethalin 30% EC @ 0.75 kg a.i./ha + *POE* - Imazethapyr 10% SL @ 0.100 kg a.i./ha + Quizalofop ethyl 10 EC @ 0.075 kg a.i./ha + 1 Hoeing (40-50 DAS) and which was closely followed by the application of *PE*- Pendimethalin 30% EC @ 0.75 kg a.i./ha +*POE* – Imazethapyr 35% + Imazamox 35% WG @ 0.01 kg a.i /ha + 1 Hoeing (40-50 DAS). It was observed that the application of pre emergence herbicides effectively controlled both monocot and dicot weeds whereas, application of post emergence was found mainly effective to control the grassy weeds (Jadon *et al.,* 2017). Similar results were also reported by Nepalia *et al.,* (2017).

Weed dry matter production

Weed dry matter production is presented in table 2 at different time interval. The significant highest weed dry matter production was recorded in weedy check plot at all the stages of observation, which was closely followed with the application of *PE*- Pendimethalin 30% EC @ 1.0 kg a.i./ha. The treatments involving the integrated application of herbicides and cultural practices (T_4, T_3) recorded significantly less weed dry matter production compared to other treatments. Similar results were also reported by Rai *et al.,* (2016).

Weed control efficiency

The highest weed control efficiency was witnessed under weed free treatment which remained statistically at par with *PE* - Pendimethalin 30% EC @ 0.75 kg a.i./ha + *POE* - Imazethapyr 10% SL @ 0.100 kg a.i./ha + Quizalofop ethyl 10 EC @ 0.075 kg a.i./ha + 1 Hoeing (40-50 DAS) and these was closely followed by the application of *PE*- Pendimethalin 30% EC @ 0.75 kg a.i./ha +*POE* – Imazethapyr 35% + Imazamox 35% WG @ 0.01 kg a.i /ha + 1 Hoeing (40-50 DAS).

This is due to less dry matter production and density of weeds which reduced by successful checking the weed growth in the above treatments. Similar results were also reported by Reddy *et al.,* (2016).

Table.1 Weed density at different time interval as affected by integrated weed management practices in soybean + pigeonpea

Tr. No.	Treatments	Monocots				Dicots			
		30 DAS	60 DAS	90 DAS	At Harvest	30 DAS	60 DAS	90 DAS	At Harvest
T_1	*PE*- Pendimethalin 30% EC @ 1.0 kg a.i./ha	17.78	40.18	50.37	58.11	13.39	21.25	26.50	28.77
T_2	*PE*–Pendimethalin 30% EC @ 0.75 kg a.i./ha + 1 Hoeing (30-40 DAS) +1 Hand Weeding (40-50 DAS)	10.43	16.11	23.57	27.68	6.36	10.84	14.79	18.74
T_3	*PE*- Pendimethalin 30% EC @ 0.75 kg a.i./ha +*POE* - Imazethapyr 35% + Imazamox 35% WG @ 0.01 kg a.i /ha + 1 Hoeing (40-50 DAS)	7.69	14.05	20.41	24.17	4.50	8.42	11.28	16.02
T_4	*PE* - Pendimethalin 30% EC @ 0.75 kg a.i./ha + *POE* - Imazethapyr 10% SL@ 0.100 kg a.i./ha + Quizalofop ethyl 10 EC @ 0.075 kg a.i. /ha + 1 Hoeing (40-50 DAS)	5.24	12.95	18.27	22.31	3.51	7.63	10.02	15.47
T_5	Stale seed bed technique + 1 Hoeing (25-30 DAS) + Mulching (30 DAS)	15.06	27.74	38.24	43.37	11.74	16.29	22.48	24.41
T_6	Stale seed bed technique + 1 Hoeing (25-30 DAS) +1 Hand Weeding (40-50 DAS)	14.57	25.66	35.08	40.48	10.83	14.90	20.85	23.11
T_7	Stale seed bed technique + *POE*-Imazethapyr35% + Imazamox 35% WG @ 0.01 kg a.i./ha	12.22	18.19	26.66	30.33	8.56	12.88	16.74	20.81
T_8	Stale seed bed technique + *POE*-Imazethapyr 10% SL @ 0.100 kg a.i./ha + Quizalofop ethyl 10 EC @ 0.075 kg a.i./ha	11.50	17.26	25.47	28.39	7.14	11.27	15.97	19.77
T_9	Weed free	0.00	6.22	12.72	18.57	0.11	4.20	7.51	11.07
T_{10}	Weedy check	21.26	46.83	61.63	71.78	16.78	24.56	33.47	37.11
SE $\pm$		0.43	0.91	1.14	1.46	0.37	0.58	0.82	0.93
C.D. at 5%		1.27	2.71	3.39	4.34	1.08	1.74	2.43	2.77
General mean		**11.58**	**22.52**	**31.24**	**36.51**	**8.29**	**13.22**	**17.96**	**21.53**

Table.2 Weed dry matter (g) at different time interval as affected by integrated weed management practices in soybean + pigeonpea

Tr. No.	Treatments	Monocots				Dicots			
		30 DAS	60 DAS	90 DAS	At Harvest	30 DAS	60 DAS	90 DAS	At Harvest
T_1	*PE*- Pendimethalin 30% EC @ 1.0 kg a.i./ha	9.1	20.73	28.38	33.71	6.38	11.38	18.11	23.38
T_2	*PE*–Pendimethalin 30% EC @ 0.75 kg a.i./ha + 1 Hoeing (30-40 DAS) +1 Hand Weeding (40-50 DAS)	4.59	10.02	13.31	19.11	3.10	5.18	8.10	11.72
T_3	*PE*- Pendimethalin 30% EC @ 0.75 kg a.i./ha +*POE* - Imazethapyr 35% + Imazamox 35% WG @ 0.01 kg a.i /ha + 1 Hoeing (40-50 DAS)	2.38	8.92	11.91	16.72	2.37	4.11	7.36	9.16
T_4	*PE* - Pendimethalin 30% EC @ 0.75 kg a.i./ha + *POE* - Imazethapyr 10% SL@ 0.100 kg a.i./ha + Quizalofop ethyl 10 EC @ 0.075 kg a.i. /ha + 1 Hoeing (40-50 DAS)	1.20	7.72	10.57	15.32	1.32	3.89	6.75	8.83
T_5	Stale seed bed technique + 1 Hoeing (25-30 DAS) + Mulching (30 DAS)	7.29	16.10	20.43	29.18	4.98	8.27	12.88	17.77
T_6	Stale seed bed technique + 1 Hoeing (25-30 DAS) +1 Hand Weeding (40-50 DAS)	6.96	14.65	18.30	26.22	4.86	7.87	11.33	16.18
T_7	Stale seed bed technique + *POE*-Imazethapyr35% + Imazamox 35% WG @ 0.01 kg a.i./ha	5.39	11.37	15.27	22.16	3.98	6.28	9.29	13.11
T_8	Stale seed bed technique + *POE*-Imazethapyr 10% SL @ 0.100 kg a.i./ha + Quizalofop ethyl 10 EC @ 0.075 kg a.i./ha	4.77	10.98	14.43	20.10	3.42	5.95	8.35	12.38
T_9	Weed free	0.00	2.76	6.81	11.77	0.00	1.73	4.52	6.32
T_{10}	Weedy check	11.93	23.44	40.24	55.79	9.50	14.61	24.27	28.11
SE $\pm$		0.29	0.55	0.91	1.10	0.21	0.27	0.55	0.73
C.D. at 5%		0.86	1.63	2.71	3.25	0.63	0.81	1.63	2.17
General mean		**5.36**	**12.67**	**17.97**	**25.01**	**3.99**	**6.93**	**11.10**	**14.70**

Table.3 Weed control efficiency (WCE %), weed index (%), Seed, Straw and Soybean Equivalent Yield (SEY) (kg ha^{-1}) as affected by integrated weed management practices in soybean + pigeonpea

Tr. No.	Treatments	WCE (%)	Weed Index (%)	Soybean Yield (kg ha^{-1})		Pigeonpea Yield (kg ha^{-1})		SEY (kg ha^{-1})
				Seed	Straw	Seed	Straw	
T_1	*PE*- Pendimethalin 30% EC @ 1.0 kg a.i./ha	31.95	52.06	583	983	391	1126	1279
T_2	*PE*–Pendimethalin 30% EC @ 0.75 kg a.i./ha + 1 Hoeing (30-40 DAS) +1 Hand Weeding (40-50 DAS)	63.25	13.64	1178	1704	633	1689	2304
T_3	*PE*- Pendimethalin 30% EC @ 0.75 kg a.i./ha +*POE* - Imazethapyr 35% + Imazamox 35% WG @ 0.01 kg a.i /ha + 1 Hoeing (40-50 DAS)	69.15	26.87	740	1186	681	1791	1951
T_4	*PE* - Pendimethalin 30% EC @ 0.75 kg a.i./ha + *POE* - Imazethapyr 10% SL@ 0.100 kg a.i./ha + Quizalofop ethyl 10 EC @ 0.075 kg a.i. /ha + 1 Hoeing (40-50 DAS)	71.22	21.55	781	1211	738	1904	2093
T_5	Stale seed bed technique + 1 Hoeing (25-30 DAS) + Mulching (30 DAS)	44.04	38.76	832	1286	451	1273	1634
T_6	Stale seed bed technique + 1 Hoeing (25-30 DAS) +1 Hand Weeding (40-50 DAS)	49.46	44.79	612	1016	484	1348	1473
T_7	Stale seed bed technique + *POE*-Imazethapyr35% + Imazamox 35% WG @ 0.01 kg a.i./ha	57.96	25.49	967	1473	574	1582	1988
T_8	Stale seed bed technique + *POE*-Imazethapyr 10% SL @ 0.100 kg a.i./ha + Quizalofop ethyl 10 EC @ 0.075 kg a.i./ha	61.29	21.74	1030	1546	595	1632	2088
T_9	Weed free	78.44	--	1272	1781	785	2019	2668
T_{10}	Weedy check	--	64.02	433	780	294	921	960
SE $\pm$		--	--	39	51	24	56	94
C.D. at 5%		--	--	115	151	72	166	278
General mean		**58.53**	**34.32**	**843**	**1297**	**563**	**1529**	**1844**

Weed index

The data revealed that there was much variation in weed index. The maximum seed yield reduction (Table 3) was found under weedy check followed by *PE*- Pendimethalin 30% EC @ 1.0 kg a.i./ha due to the fact there was minimum seed yield. Whereas, the minimum reduction were registered with T_2 PE–Pendimethalin 30% EC @ 0.75 kg a.i./ha + 1 Hoeing (30-40 DAS) +1 Hand Weeding (40-50 DAS). Similar results were also reported by Pria *et al.,* (2009).

Seed and straw yield

In soybean under different weed management practices weed free treatment recorded highest seed and straw yield. But among weed management application of PE–Pendimethalin 30% EC @ 0.75 kg a.i./ha +1 Hoeing (30-40 DAS) + 1 Hand Weeding (40-50 DAS) recorded significantly highest yield than other treatments (Table 3). On the other hand, the minimum seed yield was recorded under weedy check. Kamble *et al.,* (2017) reported similar kind of findings. The capacity of plants to produce seed yield depends not only the size of photosynthetic systems, it's efficiently and length of time for which it is active but also on translocation of dry matter into economic sink. The final buildup of yield is cumulative function of yield components. Lower weed population and higher weed control efficiency also resulted in higher seed yield (Habimana *et al.,* 2013).

In pigeonpea, the highest seed and straw yield was recorded in weed free treatment but it was numerically at par with *PE* - Pendimethalin 30% EC @ 0.75 kg a.i./ha + *POE* - Imazethapyr 10% SL @ 0.100 kg a.i./ha + Quizalofop ethyl 10 EC @ 0.075 kg a.i./ha + 1 Hoeing (40-50 DAS). The minimum seed and straw yield was recorded in unweeded check plots. The minimum yield of seed and straw was due to the less dry matter accumulation, less LAI, less CGR, high weed infestation and high competition during the critical periods, which does not allow the crop to grow their potential and vice versa. Similar results were also reported by Dhaker *et al.,* (2016).

As far as Soybean Equivalent yield (SEY) is concerned it was highest with the weed free treatment. However, it was at par with PE–Pendimethalin 30% EC @ 0.75 kg a.i./ha +1 Hoeing (30-40 DAS) + 1 Hand Weeding (40-50 DAS) and rest of the treatments shows significant differences.

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How to cite this article:

Khazi, G.S., A.S. Karle and Narkhede, W.N. 2017. Productivity and Weed Dynamics of Integrated Weed Management Practices in Soybean + Pigeonpea Intercropping System. *Int.J.Curr.Microbiol.App.Sci.* 6(8): 810-817. doi: https://doi.org/10.20546/ijcmas.2017.608.102