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Integrated Weed Management in Soybean (*Glycine max L.)*

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ABSTRACT

Soybean is a rainy season crop and intense weed competition during the active phase of growth is one of the constraints in realizing higher soybean productivity. Yield reduction in soybean due to poor weeds management ranges from 12 to 85 per cent depending on weed flora and their density. Present study was conducted during kharif season of 2014, 2015, 2016 in Nashik Dist., to study the effect of different weed management practices on growth and yield of soybean, to test the efficacy of promising weed control practices in soybean, to study the weed dynamics in soybean. Growth contributing characters viz. plant height spread, number of branches and dry matter and yield contributing characters like number of seeds pod-1, number of pods plant-1, weight of pods plant-1, 1000 grain weight, grain and straw yield were found significantly superior in weed free check followed by pendimethalin @ 1kg a.i. ha-1 fb one hoeing at 30 DAS. The treatment weed free check recorded significantly highest grain and straw yield followed by pendimethalin @ 1kg a.i. ha-1 fb one hoeing at 30 DAS as compared to weedy check. As regards the economics of different weed treatments pendimethalin @ 1kg a.i. ha-1 fb one hoeing at 30 DAS recorded highest net monetary returns and benefit : cost ratio followed by Imazethapyr@ 0.15kg a.i. ha-1 (POE) at 15 DAS fb hoeing at 30 DAS and Thus, in integrated weed control method, chemical plus mechanical methods like pendimethalin plus hoeing in combination were found economical in controlling weeds in kharif soybean.

Keywords : Weed Control Efficiency, Pendimethalin, Imazethapyr.

I. INTRODUCTION

Weeds pose problems during the entire crop period but the first 30-45 days of the crop is the most critical. Recent studies in many crops indicated sequential application of herbicides (pre followed by post) or integration of herbicides with hand weeding will provide more consistent weed control than single application.

Soybean suffers from heavy weed competition especially in the early growth stages hence early herbicidal control seems to be a must in this crop for harvesting acceptable yields. Unavailability of adequate laborers at peak period of weeding and unpredictability of rains along with non workable soil conditions; weed management in soybean is really a challenging task. Manual weeding is effective but it is cumbersome, time consuming and uneconomical while mechanical means generally leads to root injury. Under such situation weed management through the herbicidal application remains the only viable option. Spraying of pre-emergence herbicides helps to minimize the crop weed competition during such critical growth stages resulting in higher crop yields. In soybean there are few pre-emergence herbicides which are well adopted by farmers like pendimethalin. In cases where application of pre-emergence herbicides is not possible due to frequent rains, work load of farmer or unavailability of labour and increasing labour cost. Therefore, farmers are facing problems in controlling weeds in soybean.

II. METHODS AND MATERIAL

The present investigation was conducted during kharif season of 2014, 2015, 2016 at Nashik Dist.. The experiment was laid out in Randomized Block Design with three replications and eight treatments. The treatments comprise of one hoeing at 20 DAS and one HW at 40 DAS, Pendimethalin@ 1kg a.i. ha-1 (PE) fb Imazethapyr@0.15 kg a.i.ha-1 at 25 DAS, Oxyflurofen@ 0.15kg a.i. ha-1(PE) fb hand weeding at 30 DAS, Pendimethalin @ 1kg a.i. ha-1 (PE) fb hoeing at 30 DAS, Imazethapyr@ 0.15kg a.i. ha-1 (POE) at 15 DAS fb hoeing at 30 DAS, Oxyflurofen @ 0.15 kg a.i.

ha-1 (PE) fb Imezethapyr @ 0.15 kg a.i ha-1 at 25 DAS, weedy check, weed free check.

The gross plot size was 4.50 m x 3.60 m and net plot size 3.50 m x 2.70 m. The experimental field was leveled and well drained, loam in texture, alkaline in reaction, low in available nitrogen, medium in phosphorus and highin potassium.

Variety used for experimental study was DS - 228, sowing was done by line sowing with 45 cm x 5 cm spacing. Full dose of nitrogen and phosphorus at the rate of 50:75 kg ha-1 were applied in the form of urea and single super phosphate as basal dose. The seeds were inoculated with Rhizobium culture @ 25 g per kg of seeds.

III. RESULTS AND DISCUSSION

Effect on growth contributing characters:

The maximum plant height , plant spread and number of branches were recorded in weed free treatment which was found significantly superior over Imazethapyr @ 0.15kg a.i. ha^{-1} (POE) at 15 DAS *fb* hoeing at 30 DAS , Oxyflurofen @ 0.15kg a.i. ha^{-1}(PE) *fb* hand weeding at 30 DAS, One hoeing at 20 DAS and one HW at 40 DAS, Pendimethalin @1kg a.i. ha^{-1} (PE) *fb* Imazethapyr @0.15 Kg a.i ha^{-1} at 25 DAS , Oxyflurofen @ 0.15kg a.i. ha^{-1} (PE) *fb* Imezethapyr @ 0.15kg a.i ha^{-1} at 25 DAS. The weedy check recorded significantly lowest heightand it was followed by pre emergence application of Pendimethalin @ 1kg a.i. ha^{-1} (PE) *fb* hoeing at 30 DAS. These results are in conformity with Prabha *et al.,* (2007), Habimana *et al.,* (2013) and Smita *et al*., (2014).

Dry matter production is largely a function of photosynthetic surface which has also influenced more in weed management treatments resulting in higher dry matter accumulation in weed free treatment due to minimum competition, height of plants, number of plants and leaves which resulted in higher dry matter production. Whereas, significantly less dry matter accumulation was in weedy check indicating its inability in controlling weeds which affected dry matter production. The maximum plant dry matter was recorded with weed free treatment which was significantly superior over Imazethapyr @ 0.15kg a.i. ha^{-1} (POE) at 15 DAS *fb* hoeing at 30 DAS, Oxyflurofen @ 0.15kg a.i. ha^{-1}(PE) *fb* hand weeding at 30 DAS),One hoeing at 20 DAS and one HW at 40 DAS, Pendimethalin @1kg a.i. ha^{-1} (PE) *fb* Imazethapyr @0.15 Kg a.i ha^{-1} at 25 DAS , Oxyflurofen @ 0.15kg a.i. ha^{-1} (PE) *fb* Imezethapyr @ 0.15kg a.i ha^{-1} at 25 DAS , weedy check and it was at par with pre emergence application of Pendimethalin @ 1kg a.i. ha^{-1} (PE) *fb* hoeing at 30 DAS .These results are in conformity with Patel *et al.,* (2011), Sangeetha *et al.,* (2012) and Smita *et al.,* (2014).

Effect on yield attributes and yield:

All weed control treatments recorded significantly more number of pods $plant^{-1}$ over weedy check . The maximum pods $plant^{-1}$ was recorded with weed free treatment which was significantly superior over Imazethapyr @ 0.15kg a.i. ha^{-1} (POE) at 15 DAS *fb* hoeing at 30 DAS , Oxyflurofen @ 0.15kg a.i. ha^{-1}(PE) *fb* hand weeding at 30 DAS One hoeing at 20 DAS and one HW at 40 DAS , Pendimethalin @1kg a.i. ha^{-1} (PE) *fb* Imazethapyr @0.15 Kg a.i ha^{-1} at 25 DAS , Oxyflurofen @ 0.15kg a.i. ha^{-1} (PE) *fb* Imezethapyr @ 0.15kg a.i ha^{-1} at 25 DAS weedy check and it was at par with pre emergence application of Pendimethalin @ 1kg a.i. ha^{-1} (PE) *fb* hoeing at 30 DAS .

The maximum seeds pod^{-1} was recorded with weed free treatment which was found significantly superior over all treatments under study *viz.*, Pendimethalin @ 1kg a.i. ha^{-1} (PE) *fb* hoeing at 30 DAS , Imazethapyr @ 0.15kg a.i. ha^{-1} (POE) at 15 DAS *fb* hoeing at 30 DAS, Oxyflurofen @ 0.15kg a.i. ha^{-1}(PE) *fb* hand weeding at 30 DAS , One hoeing at 20 DAS and one HW at 40 DAS , Pendimethalin @1kg a.i. ha^{-1} (PE) *fb* Imazethapyr @0.15 Kg a.i ha^{-1} at 25 DAS , Oxyflurofen @ 0.15kg a.i. ha^{-1} (PE) *fb* Imezethapyr @ 0.15 kg a.i ha^{-1} at 25 DAS ,weedy check.

The significantly highest weight of pods $plant^{-1}$ was recorded in weed free check which was significantly superior over Imazethapyr @ 0.15kg a.i. ha^{-1} (POE) at 15 DAS *fb* hoeing at 30 DAS, Oxyflurofen @ 0.15kg a.i. ha^{-1} (PE) *fb* hand weeding at 30 DAS , One hoeing at 20 DAS and one HW at 40 DAS , Pendimethalin @1kg a.i. ha^{-1} (PE) *fb* Imazethapyr @0.15 Kg a.i ha^{-1} at 25 DAS ,

Oxyflurofen @ 0.15kg a.i. ha^{-1} (PE) *fb* Imezethapyr @ 0.15kg a.i ha^{-1} at 25 DAS ,weedy check and it was at par with Pendimethalin @ 1kg a.i. ha^{-1} (PE) *fb* hoeing at 30 DAS . Significantly maximum 1000 seed weight was recorded under weed free check which was significantly superior over Imazethapyr @ 0.15kg a.i. ha^{-1} (POE) at 15 DAS *fb* hoeing at 30 DAS , Oxyflurofen @ 0.15kg a.i. ha^{-1}(PE) *fb* hand weeding at 30 DAS , One hoeing at 20 DAS and one HW at 40 DAS , Pendimethalin @1kg a.i. ha^{-1} (PE) *fb* Imazethapyr @0.15 Kg a.i ha^{-1} at 25 DAS , Oxyflurofen @ 0.15kg a.i. ha^{-1} (PE) *fb* Imezethapyr @ 0.15kg a.i ha^{-1} at 25 DAS ,weedy check and it was at par with Pendimethalin @ 1kg a.i. ha^{-1} (PE) *fb* hoeing at 30 DAS .

The Maximum seed yield was recorded under weed free check which was significantly superior over Imazethapyr @ 0.15kg a.i. ha^{-1} (POE) at 15 DAS *fb* hoeing at 30 DAS , Oxyflurofen @ 0.15kg a.i. ha^{-1}(PE) *fb* hand weeding at 30 DAS (26.78 q ha^{-1}), One hoeing at 20 DAS and one HW at 40 DAS , Pendimethalin @1kg a.i. ha^{-1} (PE) *fb* Imazethapyr @0.15 Kg a.i ha^{-1} at 25 DAS , Oxyflurofen @ 0.15kg a.i. ha^{-1} (PE) *fb* Imezethapyr @ 0.15kg a.i ha^{-1} at 25 DAS ,weedy check and it was at par with Pendimethalin @ 1kg a.i. ha^{-1} (PE) *fb* hoeing at 30 DAS . These results are in conformity with Sangeetha *et al.,* (2012), Habimana *et al.,* (2013), Jadhav *et al.,* (2013) and Panda *et al* .,(2015) .

The highest straw yield was recorded under weed free check which was found significantly superior over Imazethapyr @ 0.15kg a.i. ha^{-1} (POE) at 15 DAS *fb* hoeing at 30 DAS , Oxyflurofen @ 0.15kg a.i. ha^{-1}(PE) *fb* hand weeding at 30 DAS , Pendimethalin @1kg a.i. ha^{-1} (PE) *fb* Imazethapyr @0.15 Kg a.i ha^{-1} at 25 DAS , One hoeing at 20 DAS and one HW at 40 DAS , Oxyflurofen @ 0.15kg a.i. ha^{-1} (PE) *fb* Imezethapyr @ 0.15kg a.i ha^{-1} at 25 DAS , weedy check and it was at par with Pendimethalin @ 1kg a.i. ha^{-1} (PE) *fb* hoeing at 30 DAS

Weed Study :

Weed free check recorded significantly lowest weed intensity. Among integrated weed management treatment monocoat as well as dicoat weeds were controlled by pendimethalin @1.0 kg a.i. ha^{-1} as PE *fb* one hoeing at 30 DAS followed by imazethapyr 0.1 kg a.i. ha^{-1} as

POE at 15 DAS *fb* one hoeing at 30 DAS very effectively. In case dicoat weeds Imazethapyr 0.1 kg a.i. ha^{-1} as POE at 15 DAS *fb* one hoeing at 30 DAS followed by pendimethalin @1.0 kg a.i. ha^{-1} as PE *fb* one hoeing at 30 DAS, Oxyflurofen@ 0.15kg a.i. ha^{-1}(PE) *fb* hand weeding at 30 DAS .Weedy check recorded highest number of both monocot and dicot weeds.

Throughout the crop growth period lowest weed intensity was observed in weed free check treatment. Because of its lowest weed intensity, lowest weed crop competition creats favorable environmental condition for crop growth resulted in to higher yield . In weedy check recorded highest weed intensity resulted in high weed crop competition for nutrient, sunlight, space carbon dioxide and water which hampered crop growth resulted in low yield. These results are in conformity with finding of Thakur *et al*., (2008).

The dry matter of weeds at harvest was significantly influenced by different treatments. However, weedy check recorded highest weed dry matter over all weed management treatments. Significantly lowest dry matter of weeds was recorded in weed free check and it was followed by of pendimethalin@1kg a.i(PE) + hoeing at 30 DAS , Imazethapyr @ 0.15kg a.i. ha^{-1} (POE) at 15 DAS *fb* hoeing at 30 DAS , Oxyflurofen @ 0.15kg a.i. ha^{-1}(PE) *fb* hand weeding at 30 DAS ,One hoeing at 20 DAS and one HW at 40 DAS , Pendimethalin @ 1kg a.i. ha^{-1} (PE) *fb* Imazethapyr @0.15 Kg a.iha^{-1} at 25 DAS , Oxyflurofen @ 0.15kg a.i. ha^{-1} (PE) *fb* Imezethapyr @0.15kg a.i ha^{-1} at 25 DAS, respectively over weedy check.

At harvest highest weed control efficiency was recorded in weed free check treatment it was followed by pendimethalin@1kg a.i (PE) + hoeing at 30 DAS , Imazethapyr @ 0.15kg a.i. ha^{-1} (POE) at 15 DAS *fb* hoeing at 30 DAS, Oxyflurofen @ 0.15kg a.i. ha^{-1}(PE) *fb* hand weeding at 30 DAS ,One hoeing at 20 DAS and one HW at 40 DAS Pendimethalin @ 1kg a.i. ha^{-1} (PE) *fb* Imazethapyr @0.15 Kg a.i ha^{-1} at 25 DAS ,Oxyflurofen @ 0.15kg a.i. ha^{-1} (PE) *fb* Imezethapyr @0.15kg a.i ha^{-1} at 25 DAS , respectively over weedy

check. This is due to lower weed population and reduced dry matter production of weeds due to initial stage and effective weed control of later emerged weeds through hand weeding which ultimately provided weed free environment to the crop.

At harvest highest weed index was recorded in weedy check treatment followed by One hoeing at 20 DAS and one HW at40 DAS ,Oxyflurofen @ 0.15kg a.i. ha^{-1} (PE) *fb* Imezethapyr @0.15kh a.i ha $^{-1}$ at 25 DAS ,Oxyflurofen @ 0.15kg a.i. ha^{-1} (PE) *fb* hand weeding at 30 DAS ,Pendimethalin @ 1kg a.i. ha^{-1} (PE) *fb* Imazethapyr @0.15 Kg a.iha^{-1} at 25 DAS, Imazethapyr @ 0.15kg a.i. ha^{-1} (POE) at 15 DAS *fb* hoeing at 30 DAS , pendimethalin@1kg a.i (PE) along with hoeing at 30 DAS .

Economic study:

Gross monetary returns were significantly influenced by various treatments. Maximum gross monetary returns were observed in weed free check treatment which was at par with pendimethalin@1kg a.i (PE) + hoeing at 30 DAS. While lowest gross monetary returns were observed in weedy check. Due to effective weed control in weed free check, it reduced the weed crop competition as a result vigorous crop growth was obtained which resulted in to higher yield as well as gross monetary returns.

Highest cost of cultivation was observed in weed free check treatment followed by Oxyflurofen @ 0.15kg a.i. ha^{-1}(PE) *fb* hand weeding at 30 DAS . However the lowest cost of cultivation was observed in weedy check. The highest cost of cultivation was in weed free check treatment due to high cost of labours and additional requirement of hand weeding.

The net monetary returns were significantly influenced by different weed management treatments. Significantly highest net monetary returns were observed in pendimethalin@1kg a.i (PE) + hoeing at 30 DAS. However the lowest net monetary returns were observed in weedy check.

Benefit: cost ratio was influenced by various treatments. The highest benefit cost ratio was observed in pendimethalin@1kg a.i (PE) + hoeing at 30 DAS followed by Imazethapyr @ 0.15kg a.i. ha^{-1} (POE) at 15 DAS *fb* hoeing at 30 DAS. However the lowest benefit cost ratio was observed in weedy check.

Among the integrated weed management practices, the highest crop growth, yield and yield attributing characters, weed control efficiency, lowest intensity of weed flora, weed dry matter and gross and net returns were recorded in application of pendimetalin @ 1kg a.i. ha^{-1} as pre-emergence *fb* one hoeing at 30 DAS this can be compared with application of Imazethapyr @ 0.15kg a.i. ha^{-1} (POE) at 15 DAS *fb* hoeing at 30 DAS.

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Table 1. Soybean growth, yield contributing characters and yield influenced by weed management practices (Pooled data of 3years)

Treatments	Plant height (cm)	Plant spread (cm)	No. of branches	Dry matter/plant (g)	No. of pods plant^{-1}	Test weight	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1. One hoeing at 20 DAS and one HW at40 DAS	58.12	43.10	4.14	28.1	47.44	109.6	24.57	30.98
T_2. Pendimethalin@ 1kg a.i. ha^{-1} (PE) *fb* Imazethapyr @ 0.15 Kg a.iha^{-1} at 25 DAS	56.25	40.93	4.24	27.19	46.69	106.74	24.26	31.03
T3 Oxyflurofen@ 0.15kg a.i. ha^{-1}(PE) *fb* and weeding at 30 DAS	60.55	43.89	4.35	30.33	48.43	109.8	25.18	31.15
T4 Pendimethalin @ 1kg a.i. ha^{-1} (PE) *fb* Hoeing at 30 DAS	63.02	47.93	4.88	32.16	52.99	113.1	27.9	33.12
T_5 Imazethapyr@ 0.15kg a.i. ha^{-1} (POE) at 15 DAS *fb* hoeing at 30 DAS	60.92	44.76	4.71	31.17	49.98	111.0	26.48	31.58
T_6 Oxyflurofen @ 0.15kg a.i. ha^{-1} (PE) *fb* Imezethapyr @ 0.15kh a.i ha $^{-1}$ at 25 DAS	53.02	40.93	4.08	26.83	45.04	106.26	23.59	30.37
T_7. Weedy check	34.98	35.6	3.78	21.19	21.73	103.6	14.07	18.32
T_8. Weed free check (HW at 15,30 and 45 DAS)	66.53	49.76	5.18	34.83	59.74	116.6	29.59	34.10
S.E.±	1.69	1.28	0.16	0.95	1.72	1.17	0.90	1.01
C.D.at 5%	5.07	3.85	0.49	2.86	5.17	3.55	2.71	3.05

Table2. Weed studies and economics of soybean as influenced by different weed management practices (Pooled data of 3years)

Treatments	Weed dry matter	Weed control efficiency	Weed index	Gross monetary returns (Rs/ha^{-1})	Cost of cultivation (Rs/ha^{1})	Net monetary returns (Rs/ha^{1})	B:C Ratio
T1. One hoeing at 20 DAS and one HW at40 DAS	12.81	71.68	19.23	83,644	42,298	41,346	1.97
T_2. Pendimethalin@ 1kg a.i. ha^{-1} (PE) *fb* Imazethapyr @ 0.15 Kg a.iha^{-1} at 25 DAS	13.41	70.43	14.31	82,652	40,440	43,212	2.04
T_3 Oxyflurofen@ 0.15kg a.i. ha^{-1}(PE) *fb* and weeding at 30 DAS	11.81	73.76	16.09	85,617	43,254	42,363	1.98
T_4 Pendimethalin @ 1kg a.i. ha^{-1} (PE) *fb* Hoeing at 30 DAS	10.0	77.52	5.40	94,300	40,478	53,822	2.33
T_5 Imazethapyr@ 0.15kg a.i. ha^{-1} (POE) at 15 DAS *fb* hoeing at 30 DAS	11.11	75.21	9.97	89,756	40,363	49,393	2.22
T_6 Oxyflurofen @ 0.15kg a.i. ha^{-1} (PE) *fb* Imezethapyr @	13.94	69.33	17.08	80,530	40,368	40,162	1.99

0.15kh a.i ha $^{-1}$ at 25 DAS							
T_7. Weedy check	47.26	_	49.75	50,044	36,598	13,446	1.37
T_8. Weed free check (HW at 15,30 and 45 DAS)	4.4	89.18	-	99,708	53,698	46,010	1.85
S.E.±	0.80	-	-	2780.85	-	2780.85	-
C.D.at 5%	2.42	-	-	8346.50	-	8346.50	-