

Effect of Different Herbicides on Weed Management, Crop Growth and Yield of Soybean

ABSTRACT

To assess the performance of several PPI combination herbicides during the 2019 *Kharif* season, a field experiment was carried out at the Product Testing Unit, Department of Agronomy, JNKVV, Jabalpur (M.P.). Proper contact of herbicide with weeds is very difficult in case of post emergence application in soybean due to quick cover of ground and attaining the proper height. Post-emergence herbicides like chlorimuron, and phenoxaprop-p-ethyl are being used by the farmers from quite long time. Herbicides combinations are more effective weapons in talking weed menace and thereby nutrient depletion by them than a single herbicide approach. The use of herbicides, particularly as pre plant-incorporation may check the emergence of weeds in early stage and create weed free environment. Three replications of the field studies using the Randomized Block Design (RBD) with eleven treatments were conducted. The results showed that applying Diclosulam 0.9% + Pendimethalin 35% SE 22.5 + 875 g ha⁻¹ as PPI significantly surpassed other herbicide mixtures in terms of weed index (12%), WCE (77.69%), except for T₄ (81.00%), growth and yield attributes such as number of branches plant⁻¹ (4.07), root nodules plant⁻¹ (69.00), pods plant⁻¹ (50.33), seeds pod⁻¹ (2.67) as well as seed index (10.03). Whereas, highest seed as well as stover yield was found superior under Diclosulam 0.9% + Pendimethalin 35% SE 22.5 + 875 g ha⁻¹.

Keywords: Diclosulam + Pendimethalin, hand weeding, pre plant incorporation (PPI), root nodules soybean, , seed yield, seed index.

1. INTRODUCTION

Soybean (*Glycine max*(L.) *merrill*) is a significant leguminous oilseed crop, accounting for more than 50% of oilseeds and around 30% of the supply of all vegetable oils in the nation [1]. The crop's unique property is its ability to increase soil fertility in a cropping system through biological nitrogen fixation. Tropical and subtropical climates are favorable for the crop's growth. Because of its exceptional resilience and ability to thrive in harsh water stress circumstances, soybeans may produce lucrative

returns with the least amount of agricultural inputs and management techniques. Typically, it grows in a rainfed climate. In India, Madhya Pradesh, Maharashtra, Rajasthan, Andhra Pradesh, and Karnataka account for the majority of the cultivation [2]. The "Miracle Crop" or "Wonder Crop" or "Golden Bean" of the twenty-first century is soybean. It originated in China and was brought to India in 1968 by the USA. It has become a significant commercial crop in several nations. The top soybean-producing

nations are China (4%), Brazil (30%), Argentina (18%), the United States (34%), and India, which contributes 3.95 percent to global production [3]. 11.48 million tones of soybeans are produced in India on an area of 10.84 million hectares. With 5.4 million hectares under cultivation and a total production of 5.9 million tones (SOPA 2018), Madhya Pradesh is one of the top states in India for soybean production. As a result, Madhya Pradesh is referred to as the soybean state in the nation. Nevertheless, soybean productivity is only 1094 kg ha⁻¹, which is far less than its yield potential of 2500 kg ha⁻¹ [4]. Gidesa and Kebede (2018) recorded highest grain yield reduction (78.50%) in soybean due to weed competition [5]. According to Kunduet *al.*, (2011) Since weeds contributed to a 43% decrease in soybean output, it is clear that weed control is essential to maximizing soybean yield potential [6]. Proper contact of herbicide with weeds is very difficult in case of post emergence application in soybean due to quick cover of ground

2. MATERIALS AND METHOD

field experiment was carried out at the Product Testing Unit, Department of Agronomy, JNKVV, Jabalpur (M.P.) in 2019 *Kharif* season, Three replications of the field studies using the Randomized Block Design (RBD) with eleven treatments were conducted. The mixture Diclosulam 0.9% + Pendimethalin 35% SE (18 + 700, 20.25 + 787.5, 22.5 + 875, and 45 + 1750 g ha⁻¹), applications of Diclosulam 84% WG (20.25 + 22.50 g ha⁻¹), and Pendimethalin 30% EC (787.50 + 875 g ha⁻¹), combined the information shows that the soil in the experimental field had

and attaining the proper height. A considerable amount of study has been done on the management of weeds by pre-plant herbicide inclusion in soybean. Even there is a need to identify new molecules for selective management of weeds and to overcome the problem of resistance in certain weeds against recommended herbicides. The use of herbicides, particularly as pre-plant incorporation may check the emergence of weeds in early stage and create weed free environment. To effectively manage weeds in soybean, pre-emergence herbicide applications must be performed within a relatively small window of time, typically 2-3 DAS. If rain falls during this crucial application window during monsoon season, pre-emergence herbicide cannot be utilised to successfully control weeds in soybean. This circumstance has made looking for pre-plant herbicide integration necessary for the efficient and cost-effective management of weeds in soybeans. New molecules must be found in order to manage weeds selectively and to solve the issue.

a sandy clay loam texture and was neutral in reaction (7.1), Medium levels of organic carbon (0.65%), nitrogen (360 kg/ha), phosphorus (16 kg/ha), and potassium (311 kg/ha) are present. Depending on the season, the growth of the crop, and the management techniques used throughout the study, the soil of the experimental field can be infested with many kinds of weeds.

3. RESULTS AND DISCUSSION

3.1 Effect on Weed Control Efficiency and Weed Index (%)

Results of one year study revealed that the different herbicidal mixture had significant effect on WCE and WI. The data in relation to WCE and WI are presented in Table 1. , The maximum WCE (81.00%) was recorded combined application of Diclosulam 0.9% + Pendimethalin 35% SE 45 + 1750 g ha⁻¹ followed by Diclosulam 0.9% + Pendimethalin 35% SE at 22.5 + 875 g ha⁻¹ (77.69%). However, the WCE was found highest (95.69%) under hand weeding twice at 20 and 40 DAS. The lowest weed index was recorded the application of Diclosulam 0.9% + Pendimethalin 35% SE at 22.5 + 875 g ha⁻¹ (12.00%) under the herbicidal

treatment and followed by Diclosulam 0.9% + Pendimethalin 35% SE at 45 + 1750 g ha⁻¹ (21.72%). It is clear from the data that highest reduction in yield (55.91%) occurred in control plots. But reduction in yield was found zero under hand weeding plots this might be due to the crop under hand weeded plots attained lush growth due to elimination of weeds from inter and intra row spaces which resulted better aeration owing to manipulation of surface soil and thus, more space, water, light and nutrients were available for the better growth and development resulting lower weed population [7, 8 & 9].

Table 1. Weed control efficiency and weed index as influenced by different weed control treatments

Treatment		Dose g/ha	Weed control efficiency (%)	Weed index (%)
T ₁	Diclosulam 0.9% + Pendimethalin 35% SE	18 + 700	71.85	33.95
T ₂	Diclosulam 0.9% + Pendimethalin 35% SE	20.25 + 787.5	74.79	31.97
T ₃	Diclosulam 0.9% + Pendimethalin 35% SE	22.5 + 875	77.69	12.00
T ₄	Diclosulam 0.9% + Pendimethalin 35% SE	45 + 1750	81.00	21.72
T ₅	Diclosulam 84 % WG	20.25	70.51	34.31
T ₆	Diclosulam 84 % WG	22.50	69.87	33.86
T ₇	Pendimethalin 30 % EC	787.5	69.33	33.68
T ₈	Pendimethalin 30 % EC	875	70.26	33.50
T ₉	Pendimethalin 30 % EC + Imazethapyr 2 % EC	900 + 60	68.48	36.11
T ₁₀	Hand weeding	20 & 40 DAS	95.69	0.00
T ₁₁	Control	-	0.00	55.91
	SEm±	-	-	0.74
	CD (p= 0.05)	-	-	2.21

3.2 Effect on Crop Growth Parameters 3.3 Branches and Root Nodules plant⁻¹

Results of one year study revealed that the different herbicidal mixture had significant effect on branches and root nodules. In Table 2, data on

branches/plants at various growth stages under various weed management measures are shown. The number of branches per plant in soybeans was lowest at the 30day stage, produced with time to reach its peak at 90 DAS,

and remained unchanged at harvest for all treatments. The statistics clearly show that applications of weed control have a noticeable impact on the plant's branches at 30, 60, and harvest. When the crop was harvested, it had reached its highest value under all of the treatments, and it grew as the crop grew. This might be due to higher crop growth and lower weed crop competition at this stage would have facilitated better growth and development ultimately a greater number of branches per plant. At 60 DAS, weedy check plots (T_{11}) had the lowest number of branches per plant (2.07) while weed control treatment plots had significantly more branches per plant. The application of Diclosulam 0.9% + Pendimethalin 35% SE 22.5 + 875 g ha⁻¹ registered highest value of branches plant⁻¹ (3.87) followed by Diclosulam 0.9% + Pendimethalin 35% SE 20.25 + 787.5 g ha⁻¹ of (3.33) and Diclosulam 0.9% + Pendimethalin 35% SE 18 + 700 g ha⁻¹ of (3.25). But none of the herbicidal methods outperformed hand weeding twice, which had the most branches per plant (4.00). These results are in collaboration with the findings [7 & 8]. On the other hand, Table 3 lists the effective

nodules per plant for soybean at 30 and 45 DAS. It is evident from the above result shown in Table 3 that at 30 DAS, there were no appreciable differences in the number of nodules per plant under various treatments. Under weedy check plots, the lowest number (31.07) of nodules per plant was observed among the various herbicidal treatments. When weed management strategies were implemented in soybean, the nodulation activity increased noticeably. The highest number of root nodules (46.33) per plant enhanced slightly with PPI application of Diclosulam 0.9% + Pendimethalin 35% SE @ 22.5 + 875 g ha⁻¹. Among the herbicidal treatment and highest dose of Diclosulam 0.9% + Pendimethalin 35% SE 45 + 1750 g ha⁻¹ was recorded lower number (43.67) of nodules this might be due to some phytotoxic effect on plant. Diclosulam 0.9% + Pendimethalin 35% SE 20.25 + 787.5 g ha⁻¹ at par with the Diclosulam 0.9% + Pendimethalin 35% SE 18 + 700. Similar results were also recorded at harvest. The maximum root nodules (50.00 and 80.00) was observed under hand weeding at 30 and 45 DAS, respectively [10 & 11].

Table 2. Influence of weed control treatments on branches and root nodules plant⁻¹

Treatments	Dose g/ha	Branches plant ⁻¹			Nodules plant ⁻¹	
		30 DAS	60 DAS	At harvest	30 DAS	45 DAS
T ₁ Diclosulam 0.9% + Pendimethalin 35% SE	18 + 700	2.27	3.25	3.36	43.90	63.33
T ₂ Diclosulam 0.9% + Pendimethalin 35% SE	20.25 + 787.5	2.33	3.33	3.47	44.70	64.19
T ₃ Diclosulam 0.9% + Pendimethalin 35% SE	22.5 + 875	2.47	3.87	4.07	46.33	69.00
T ₄ Diclosulam 0.9% + Pendimethalin 35% SE	45 + 1750	2.11	3.07	3.13	43.67	60.33
T ₅ Diclosulam 84 % WG	20.25	2.20	3.17	3.23	44.10	62.90
T ₆ Diclosulam 84 % WG	22.50	2.23	3.22	3.26	44.07	64.00
T ₇ Pendimethalin 30 % EC	787.5	2.17	3.14	3.20	44.00	63.67
T ₈ Pendimethalin 30 % EC	875	2.16	3.15	3.17	44.00	62.67
T ₉ Pendimethalin 30 % EC + Imazethapyr 2 % EC	900 + 60	2.13	3.11	3.18	44.03	63.00

T ₁₀	Hand weeding	20 & 40 DAS	2.57	4.07	4.10	50.00	80.00
T ₁₁	Control	-	1.10	2.07	2.00	31.07	50.00
		SEm±	0.06	0.06	0.07	0.87	1.91
		CD (p= 0.05)	0.18	0.19	0.21	2.57	5.67

3.5 Effect on Yield Attributing Characters

Table 3 presents data on how various weed control methods affected the number of pods plant⁻¹, seeds pod⁻¹, and seed index. Data showed that number of pods plant⁻¹, seeds pod⁻¹ and seed index varied vitally due to different weed control treatments. Under control plot (T₁₁), the lowest numbers of pods plant⁻¹, seeds pod⁻¹, and seed index were observed across all treatments (27.08, 2.00, and 9.33, respectively), but these numbers dramatically rose when weed management techniques were implemented. Application of Diclosulam 0.9% + Pendimethalin 35% SE as pre plant incorporation at the rate of 18 + 700 and 20.25 + 787.5g ha⁻¹ enhanced the number of pods plant⁻¹, seeds pod⁻¹ and seed

index in soybean plant. The maximum number of pods plant⁻¹, seeds pod⁻¹ as well as seed index was noted under the application of Diclosulam 0.9% + Pendimethalin 35% SE applied at 22.5 + 875 g ha⁻¹ (50.33), (2.67) and (10.03) respectively. This was followed by Diclosulam 0.9% + Pendimethalin 35% SE as pre plant incorporation at the rate of 20.25 + 787.5 g ha⁻¹. However, none of the herbicidal treatments were significantly better than manual weeding twice (20 and 40 DAS), which outperformed the other treatments (56.73), (2.80), and (10.23) in terms of number of pods plant⁻¹, seeds pod⁻¹ as well as seed index respectively [12 & 13].

Table 3. Influence of weed control treatments on pods plant⁻¹, seeds pod⁻¹ and seed index

Treatments		Dose g ha ⁻¹	pods plant ⁻¹	seeds pod ⁻¹	Seed index (g)
T ₁	Diclosulam 0.9% + Pendimethalin 35% SE	18 + 700	40.03	2.27	9.70
T ₂	Diclosulam 0.9% + Pendimethalin 35% SE	20.25 + 787.5	46.07	2.34	9.77
T ₃	Diclosulam 0.9% + Pendimethalin 35% SE	22.5 + 875	50.33	2.67	10.03
T ₄	Diclosulam 0.9% + Pendimethalin 35% SE	45 + 1750	38.00	2.20	9.43
T ₅	Diclosulam 84 % WG	20.25	39.07	2.23	9.70
T ₆	Diclosulam 84 % WG	22.50	41.33	2.27	9.80
T ₇	Pendimethalin 30 % EC	787.5	39.03	2.23	9.80
T ₈	Pendimethalin 30 % EC	875	39.11	2.27	9.47
T ₉	Pendimethalin 30%EC +Imazethapyr 2 % EC	900 + 60	38.03	2.17	9.44
T ₁₀	Hand weeding	20 & 40 DAS	56.73	2.80	10.23
T ₁₁	Control	-	27.08	2.00	9.33
		SEm±	0.86	0.08	0.16
		CD (P= 0.05)	2.57	0.23	0.48

3.6 Effect on Yields of Soybean

The data presented in Table 4 relates to soybean seed and stover yield (kg ha⁻¹) under various treatments. The data shows that the various weed control methods resulted in considerable variations in seed and stover yield. The control plot (907.41 and 2283.33 kg ha⁻¹, respectively) found the lowest seed and stover yields among all the treatments. However, the seed and stover yield were increased when Diclosulam 0.9% + Pendimethalin 35% SE was applied at lower doses 18 + 700 to 22.5 + 875 g ha⁻¹ which was superior over check herbicides. In contrast, Diclosulam 0.9% + Pendimethalin 35% SE was applied at 22.5 + 875 g ha⁻¹ found significantly highest seed as well as

stover yield (1811.11 and 3207.41 kg ha⁻¹ respectively) compared to other herbicidal treatments. However, manual weeding twice was shown to be significantly better than all the herbicidal treatments and the highest seed and stover yield was recorded (2058.02 and 3237.04 kg ha⁻¹, respectively). In contrast to other treatments that had severe crop weed competition starting at early growth stages and ultimately produced the most inferior yield attributes. , and weeding of soybean plants resulted in excellent growth and development of the plants. This may be due to the favorable environment during the critical period of crop growth [14 & 15].

Table 4. Influence of weed control treatments on seed and stover yield (kg ha⁻¹) of soybean

Treatment		Dose (g ha ⁻¹)	Seed yield	Stover yield
T ₁	Diclosulam 0.9% + Pendimethalin 35% SE	18 + 700	1359.26	2627.78
T ₂	Diclosulam 0.9% + Pendimethalin 35% SE	20.25 + 787.5	1400.00	2790.74
T ₃	Diclosulam 0.9% + Pendimethalin 35% SE	22.5 + 875	1811.11	3207.41
T ₄	Diclosulam 0.9% + Pendimethalin 35% SE	45 + 1750	1611.11	3079.63
T ₅	Diclosulam 84 % WG	20.25	1351.85	2590.74
T ₆	Diclosulam 84 % WG	22.50	1361.11	2853.70
T ₇	Pendimethalin 30 % EC	787.5	1364.81	2775.93
T ₈	Pendimethalin 30 % EC	875	1368.52	2705.56
T ₉	Pendimethalin 30% EC + Imazethapyr 2 % EC	900 + 60	1314.81	2777.78
T ₁₀	Hand weeding	20 & 40 DAS	2058.00	3237.04
T ₁₁	Control	-	907.41	2283.33
		SEm±	38.28	71.09
		CD (P= 0.05)	113.73	211.20

4. CONCLUSION

1. The results of the study showed that application of Diclosulam 0.9% + Pendimethalin 35% SE at 22.5 + 875 g ha⁻¹ was found suitable for effective

control of weeds in soybean which attained significantly higher values of growth parameters, yield attributing traits and yield without any phytotoxicity on soybean plant.

except hand weeding plots because there is no herbicides treatment beat hand weeding twice. The herbicides tested in present investigation must be evaluated alone or in combination at different doses in order to get cost effective weed control.

REFERENCES

1. Tiwari SP. 2006. Plant introduction in soybean- achievements and opportunities. Indian Journal of Plant Genetic Resources 19: 353–65.
2. Tiwari SP. 2001. Sharering the production constraints in soybean based cropping system. JNKVV Research Journal, 35 (1&2): 1-7.
3. USDA. 2018. World Agricultural Production. U.S. Department of Agriculture, International Production Assessment Division (IPAD), Washington. URL: <http://www.fas.usda.gov>
4. SOPA 2018. The Soybean Processors Association of India e-mail: sopa@sopa.org, URL: www.sopa.org.
5. Gidesa A and Kebede M. 2018. Integration effects of herbicide and hand weeding on grain yield of soybean [*Glycine max (L.) Merrill*] in Assossa, Western Ethopia. Advances in Crop Science and Technology. Vol 6(5):400
6. Kundu R, Brahmachari K, Bera PS, Kundu CK and Roy CS. 2011. Bio-efficacy of imazethapyr on the predominant weeds in soybean. Journal of Crop and Weed 7(2): 173-178.
7. Singh SP, Pratap V, Nainwal RC, Tripathi N and Kumar A. 2009. Efficacy of diclosulam on weeds and yield of soybean. Indian Journal of Weed Science. 41(3&4): 170-173.
8. Jha AK and Soni M. 2013. Weed management by sowing methods and herbicides in soybean. Indian Journal of Weed Science 45(4):250-252.
9. Raskar BS and Bhoi PG. 2002. Bio-efficiency and phytotoxicity of herbicides against weeds in soybean. Indian Journal of Weed Science. 34(1/2):218-220.
10. Amaregouda A, Jadhav J, Chetti MB and Nawalagatti. 2013. Effect of Weedicides on Physiological parameters, Growth, Yield and Yield components of Soybean (*Glycine max. L*) and Weed Growth. Journal of Agriculture and Allied sciences RRJAAS | Volume 2| Issue 4 | 12-15.
11. Habimana S, Kalyana Murthy KN, Shankaralingappa BC, Sanjay MT and Ramachandra C, 2013. a. Effect of pre and post-emergence herbicides on weed dynamics, growth and yield of soybean (*Glycine max. L. Merrill*). Advances in Applied Science Research, 4(4):72-75.
12. Singh SP, Pratap V, Nainwal RC, Tripathi N and Kumar A. 2009. Efficacy of diclosulam on weeds and yield of soybean. Indian Journal of Weed Science. 41(3&4): 170-173.
13. Kushwaha SS and Vyas MD. 2005. Herbicidal weed control in soybean. Indian Journal of Agronomy 50(3): 225-227.
14. Kamble AB, Nagre BS and Dhonde MB. 2017. Effect of crop geometry and weed management practices on weed dynamics and yield of soybean. In: Proceedings of Biennial Conference on “Doubling Farmers’ Income by 2022: The Role of Weed Science”, 1-3 March, 2017, Udaipur. Indian Society of Weed Science, Jabalpur, India pp:127.
15. Khedkar HP, Patel BD and Patel RB. 2009. Effect of post emergence herbicides on yield and economics of *kharif* soybean. Indian Journal Weed Science. 41(3&4): 204-206.

UNDER PEER REVIEW