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RESEARCH NOTE

Efficacy of a few new generation herbicides in managing weeds and improving soybean productivity and profitability

N. Sravya*, Sreedhar Chauhan, K. Bhanu Rekha and A. Krishna Chaitanya

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ABSTRACT

The experiment was conducted at the Agricultural Research Station, Adilabad, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Telangana during *Kharif*, 2022 to assess the efficacy of weed management treatments on weed control, soybean productivity and profitability and identify effective and economical option. A randomized block design with 11 treatments replicated thrice was used. Among herbicidal treatments, pre-emergence application (PE) diclosulam 26 g/ha followed by (*fb*) post-emergence application (PoE) of fluazifop-p-butyl + fomesafen 250 g/ha recorded highest soybean seed yield, gross returns and net returns which was comparable with imazethapyr +pendimethalin 960 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE.

Keywords: Soybean, Diclosulam, Fluazifop-p-butyl + fomesafen and Imazethapyr + pendimethalin, Intercultivation

Soybean (*Glycine max* L.) is a vital oilseed crop that has gained popularity worldwide due to its adaptability to diverse agro-climatic conditions, unique chemical composition and multiple uses. It is utilized in feed production, as a food source and in several non-edible industries. Soybean enriches soil fertility by fixing atmospheric nitrogen symbiotically through root nodules and contributes about 25 per cent of the fixed nitrogen to the succeeding crop

The major soybean-growing states in India are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, and Telangana. In Telangana, soyabean was cultivated in 2,01,066 hectares with a production of 3,24,556 tons and productivity of 1.63 t/ha during 2022-2023 (DES 2025). In Adilabad district, Telangana, soybean is the second major crop, after cotton, predominantly grown in black cotton soils. The sowing window of soybean in the rainy season is very short and farmers prioritize timely sowing. Among several constraints in soybean production, weed infestation is one of the major constraints limiting the higher productivity of soybean (Deshmukh *et al*. 2025). Being a rainy season crop, soybean faces severe weed competition during its early growth stages, which reduces yield potential depending on weed type, intensity, and environmental factors (Jadhav and Kashid 2019). Weeds compete with crop for light, moisture and nutrients (Rao 2022).

Professor Jayashankar Telangana Agricultural University, Hyderabad, Telangana 500030, India

* Corresponding author email: sravyanettikopula@gmail.com

Due to intermittent rainfall and limited labour availability during rainy season, manual weeding at critical stage is often difficult, tedious and costly. Farmers, therefore, are increasingly adopting herbicide-based weed management. However, a single application of herbicide is not effective against complex weed flora throughout the crop-growing season. Sole herbicide use may not effectively control grasses, sedges, and broad-leaved weeds. Therefore, identifying herbicide mixtures with a broad-spectrum activity and residual effect is essential for achieving higher soybean productivity.

New-generation herbicides, effective even at very low application rates, offer lower mammalian toxicity and minimize the risk of environmental pollution. Their use, either alone or in conjunction with manual or chemical weeding, has been shown to effectively suppress weed growth (Deshmukh *et al*. 2025). However, the effectiveness of new-generation herbicides in soybean has not yet been thoroughly evaluated. Their crop selectivity and economic viability must be assessed to design a cost-effective herbicide-based weed management strategy. In this context, the present study was undertaken to identify a suitable herbicide-based weed management approach for soybean by evaluation efficacy of different weed management treatments.

The field experiment was conducted during *Kharif*, 2022 at Agricultural Research Station, Adilabad, Telangana on black soil, neutral in nature, low in available nitrogen, medium in P and high in potassium. The study was laid out in a randomized block design with 11 treatments replicated thrice. The treatments comprised various pre-emergence herbicides in combination with post-emergence herbicides or intercultivation (using hand hoe). The new low dose herbicides used were diclosulam, imazethapyr + pendimethalin, pyroxasulfone for pre-emergence application (PE) and fluazifop-p-butyl + fomesafen, sodium-acifluorfen + clodinafop propargyl for post-emergence application (PoE). The treatments comprised of imazethapyr + pendimethalin 960 g/ha PE followed by (*fb*) intercultivation at 20-25 days after seeding (DAS), pyroxasulfone 127.5 g/ha PE *fb* intercultivation at 20-25 DAS, diclosulam 26 g/ha PE *fb* intercultivation at 20-25 DAS, diclosulam 26 g/ha PE *fb* post-emergence application (PoE) of sodium- acifluorfen + clodinafop-propargyl 250 g/ha, diclosulam 26 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE, imazethapyr + pendimethalin 960 g/ha PE *fb* sodium-acifluorfen + clodinafop propargyl 250 g/ha PoE, imazethapyr + pendimethalin 960 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE, pyroxasulfone 127.5 g/ha PE *fb* sodium-acifluorfen + clodinafop propargyl 250 g/ha PoE , pyroxasulfone 127.5 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE, intercultivation at 20-25 DAS *fb* hand weeding at 40 DAS and unweeded control. Soybean variety JS-335 was sown at a seed rate of 65 kg/ha, with 45 × 10 cm spacing. The crop was fertilized with 50:60:20 kg/ha Nitrogen, Phosphorous and Potassium, respectively in the form of urea DAP, MOP. Seed were inoculated with Brady Rhizobium culture 200 g/8 kg of seed. Pre-emergent herbicides were applied at 2 days after seeding (DAS) while post-emergent herbicides were sprayed at 20 DAS using 500 L of water/ha with a flat fan nozzle fitted knapsack sprayer. The observations on weed density (no/m^2) and weed dry weight (biomass) (g/m^2) were recorded at 15, 30 and 45 DAS using a 0.25 square meter (0.5 x 0.5 m) quadrat, using standard recommended procedures Weed control efficiency (%) was calculated using standard procedure.

Effect on weeds

Grasses and broad-leaved weeds (BLW) were the major weeds in the experimental site. The grasses were: *Cynodon dactylon, Echinichloa colonum, Dactyloctenium aegyptium* and *Digitaria sanguinalis*. The broad-leaved weeds were: *Commelina benghalensis, Amaranthus viridis, Digera arvensis, Parthenium hysterophorus* and *Euphorbia hirta*.

The intercultivation at 20-25 DAS *fb* hand weeding at 40 DAS resulted in the lowest weed density of all weed categories, and it was followed by diclosulam 26 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE , and it was on comparable with imazethapyr + pendimethalin 960 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE, diclosulam 26 g/ha PE *fb* intercultivation 20-25 DAS, diclosulam 26 g/ha PE *fb* sodium- acifluorfen + clodinafop-propargyl 250 g/ha PoE and imazethapyr + pendimethalin 960 g/ha PE *fb* sodium-acifluorfen + clodinafop- propargyl 250 g/ha PoE , which were found to be promising broad-spectrum herbicides for weed control in soybean (**Table 1**). Diclosulam is a soil-applied acetolactate synthase (ALS) inhibiting herbicide which results in a blockage of the synthesis of branched-chain amino acids (valine, leucine, and isoleucine). The deficiency of these amino acids, leading to a decrease in DNA and protein synthesis, which adversely affects cellular division and photosynthate translocation to growing points of

Table 1. Weed density and biomass and weed control efficiency at 45 DAS as influenced by weed management treatments in soybean

Treatment	Weed density (no./m^2)			Weed biomass (g/ m^2)	Weed control efficiency (%)
	Grasses	Broad leaved weeds	Sedges		
Imazethapyr + pendimethalin 960 g/ha PE *fb* intercultivation 20-25 DAS	3.40 (11.0)	3.67 (13.0)	2.37 (5.1)	5.47 (29.5)	71.23
Pyroxasulfone 127.5 g/ha PE *fb* intercultivation 20-25 DAS	4.20 (17.1)	4.01 (15.6)	2.51 (5.8)	5.39 (28.5)	72.14
Diclosulam 26 g/ha PE *fb* intercultivation 20-25 DAS	3.01 (8.6)	3.24 (10.0)	2.01 (3.5)	4.23 (17.4)	82.95
Diclosulam 26 g/ha PE *fb* sodium- acifluorfen + clodinafop-propargyl 250 g/ha PoE	3.19 (9.7)	3.29 (10.3)	2.10 (3.9)	4.38 (18.7)	81.70
Diclosulam 26 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE	2.75 (7.1)	3.06 (8.9)	2.01 (3.5)	3.92 (14.8)	85.51
Imazethapyr + pendimethalin 960 g/ha PE *fb* sodium-acifluorfen + clodinafop- propargyl 250 g/ha PoE	3.29 (11.0)	3.49 (11.7)	2.34 (5.0)	4.61 (20.8)	79.66
Imazethapyr + pendimethalin 960 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE	2.98 (8.4)	3.13 (9.3)	2.04 (3.7)	4.17 (16.9)	83.50
Pyroxasulfone 127.5 g/ha PE *fb* sodium-acifluorfen + clodinafop propargyl 250 g/ha PoE	3.65 (12.8)	4.85 (23.0)	2.73 (7.0)	5.59 (30.7)	70.00
Pyroxasulfone 127.5 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE	3.40 (11.1)	3.53 (12.0)	2.57 (6.1)	5.39 (28.6)	72.07
Intercultivation (20-25 DAS) *fb* hand weeding (40 DAS)	1.61 (2.1)	3.01 (18.6)	1.13 (0.8)	3.12 (9.2)	90.95
Unweeded control	7.27 (52.3)	8.05 (64.3)	3.85 (14.3)	10.1 (102.5)	-
LSD (p=0.05)	0.56	0.45	0.35	0.71	

Note: Figures in parenthesis are the original values; square root transformation ($\sqrt{x+0.5}$) used for statistical analysis. *fb* = followed by; PE = pre-emergence application; PoE = post-emergence application

Table 2. Seed yield, weed index, gross return, net return & B: C ratio as influenced by weed management treatments in soybean

Treatment	Seed yield (kg/ha)	Weed index (%)	Cost of cultivation	Gross returns	Net returns	B:C ratio
Imazethapyr + pendimethalin 960 g/ha PE *fb* intercultivation 20-25 DAS	1545	40.7	52095	66421	14325	1.28
Pyroxasulfone 127.5 g/ha PE *fb* intercultivation 20-25 DAS	1384	47.7	52483	59498	7015	1.13
Diclosulam 26 g/ha PE *fb* intercultivation 20-25 DAS	1954	26.1	51570	84008	32438	1.63
Diclosulam 26 g/ha PE *fb* sodium- acifluorfen + clodinafop-propargyl 250 g/ha PoE	1886	28.4	49883	81084	31201	1.63
Diclosulam 26 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE	2280	14.2	50095	98040	47945	1.96
Imazethapyr + pendimethalin 960 g/ha PE *fb* sodium-acifluorfen + clodinafop-propargyl 250 g/ha PoE	1654	37	50408	71136	20728	1.41
Imazethapyr + pendimethalin 960 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE	2089	21.5	50620	89813	39193	1.77
Pyroxasulfone 127.5 g/ha PE *fb* sodium-acifluorfen + clodinafop propargyl 250 g/ha PoE	1443	45.8	50795	62049	11254	1.22
Pyroxasulfone 127.5 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE	1548	41.7	51008	66564	15556	1.31
Intercultivation (20-25 DAS) *fb* hand weeding (40 DAS)	2662	-	55170	114466	59296	2.08
Unweeded control	1152	56.3	44920	49550	4630	1.10
LSD (p=0.05)	318			13709		

fb = followed by; PE = pre-emergence application; PoE = post-emergence application

weeds. Further, Kadam *et al*. (2018) reported that fluazifop-p-butyl + fomesafen 250 g/ha PoE effectively reduced total weed density due to its dual mode of action. Fomesafen inhibits lipid synthesis and also fatty acid elongation. Fluazifop-p-butyl inhibits acetyl CoA carboxylase. This combination provides broad-spectrum and prolonged weed control by preventing weed emergence during the early crop growth period.

The percentage reduction in weed biomass over unweeded control ranged from 70 to 90.95 % at 45 DAS (**Table 1**). Maximum weed control efficiency was recorded with intercultivation (20-25 DAS) *fb* hand weeding (40 DAS) followed by diclosulam 26 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE and imazethapyr + pendimethalin 960 g/ha PE fb sodium-acifluorfen + clodinafop-propargyl 250 g/ha PoE. The effective pre- and post-emergence application of herbicides effectively managed weed growth, shifted crop–weed competition in favour of soybean.

Effect on soybean seed yield, weed index and economics

Significantly higher seed yield of soybean was obtained with intercultivation at 20-25 DAS *fb* hand weeding at 40 DAS and it was followed by diclosulam 26 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE which was comparable with imazethapyr + pendimethalin 960 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE. The yield advantage in these treatments was due to reduced weed density and biomass, and higher weed control efficiency.

Weed competition throughout the crop season resulted in a yield loss of 56.3% in unweeded control. The percentage reduction in yield due to weed infestation was denoted by weed index. Amongst the treatments, the lowest weed index was recorded with diclosulam 26 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE which was followed by imazethapyr + pendimethalin 960 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE.

It is essential for farmers to adopt economically viable weed management practices that can lower input costs without compromising yields. Among herbicidal treatments diclosulam 26 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE and imazethapyr + pendimethalin 960 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE gave significantly higher gross returns, net returns and benefit-cost ratio. These findings are in agreement with Aher *et al.* (2023).

Conclusion

It can be concluded that diclosulam 26 g/ha PE *fb* fluazifop-p-butyl + fomesafen 250 g/ha PoE is an effective and economically viable option for weed management in soybean

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