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Short Communication

Evaluation of herbicide combinations for effective weed management in soybean {*Glycine max* (L.) Merrill}

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Abstract

A field experiment for evaluating the herbicide combinations for weed management and profitability of soybean {*Glycine max* (L.) Merrill} was conducted at Research Farm of Department of Agronomy, College of Agriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur during the *kharif* season of 2023. The experiment was conducted in Randomized Block Design with three replications. The dominant weeds present in the field were *Polygonum* spp., *Echinochloa colona, Digitaria sanguinalis, Panicum dichotomiflorum, Cyperus difformis*, *Bidens Pilosa, Commelina benghalensis* and *Ageratum conyzoides*. Results indicated that among herbicide treatments, pre-emergence application of sulfentrazone + clomazone (725 g/ha) remaining statistically at par with pendimethalin + imazethapyr (800 g/ha) and hand weeding twice, significantly reduced total weed count and weed dry weight. Due to effective control of weeds, these said treatments performed in a similar way for recording significantly higher crop dry weight and contributing to significantly higher seed and straw yield.

Keywords: Sulfentrazone + clomazone, soybean, total weed count, weed dry weight, yield

Soybean {*Glycine max* (L.) Merrill}, the most important oilseed crop grown during rainy season globally for its oilseed and rich protein content and other versatile use in food, oil, fuel and industrial products is also known as the "Golden Bean" or "Miracle Crop". It plays a key role in combating malnutrition, especially in developing countries like India, where it is called the "Poor Man's Meat" due to its affordability and high nutritional value. Soybean contains 40-45% protein and 18-22% oil and contributes to soil fertility through nitrogen fixation (Shah and Kataria 2019).

In 2023, global soybean production reached 391.17 million tonnes from 135.5 million hectares, with Brazil leading production at 152 million tonnes, followed by the USA, Argentina and China. India ranks fourth in area (12.92 million hectares) and fifth in production (12.6 million tonnes), with a productivity rate of 976 kg/ha (Anonymous 2023). In Himachal Pradesh (H.P.), 520 hectares are devoted to soybean cultivation, yielding 410 tonnes with a productivity rate of 799 kg/ha (Anonymous 2023a). Despite advances in cultivation, soybean productivity remains constrained by severe weed infestations, leading to yield losses of 20-77% depending on soil, season, and weed density (Kurchania *et al.* 2001, Peer *et al.* 2013 and Khan *et al.* 2021). Weeds compete with soybean for nutrients, moisture and light, and can disrupt operations and harbour pests. Unchecked weed growth can also deplete significant nutrients, such as 33.53 kg N, 15.78 kg P and 72.19 kg K per hectare (Gaikwad and Pawar 2003).

Weed competition is most critical during the first 15-45 days after sowing (Prachand *et al.* 2015). Integrated weed management (IWM) strategies combining cultural, mechanical, biological and chemical methods are essential. However, mechanical and hand weeding, though effective, are labour-intensive and time-consuming. Therefore, herbicides have become a key method for cost-effective and efficient weed control (Rana *et al*. 2004 a & b). Herbicides should have a fate in the soil that effectively

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suppresses weeds for a long enough time to provide crops a competitive edge, but also fade from the soil before the crop season is over to allow for the safe planting of succeeding crops (Thakur *et al.* 2023). Pre emergence herbicides are commonly used, but their limited scope necessitates the development of new pre and post emergence herbicides with broader activity. These herbicides need further evaluation in Indian conditions to ensure effective weed management across diverse locations.

A field experiment was conducted during the *kharif* season of 2023 at the Experimental Farm of the Department of Agronomy, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur, located in the North-Western Himalayas at 32°6' N latitude, 76°3' E longitude and an elevation of 1290.8 meters above mean sea level, within the Palam Valley of Himachal Pradesh. The area falls under the mid-hills sub-humid zone and experiences a wet temperate climate. The soil of the experimental field was silty clay loam, acidic in nature (pH 5.6), with low available nitrogen (278.6 kg/ha), medium available phosphorus (24.6 kg/ha) and potassium (236.5 kg/ha).

The soybean variety '*Harit Soya*' was sown on June 21, 2023, and harvested on October 24, 2023. Fertilizer application included 20 kg N, 60 kg P_2O_5 and 40 kg K_2 O per hectare, provided through urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2 O), respectively. The experiment comprised of ten treatments: diclosulam, pendimethalin + imazethapyr, sulfentrazone + clomazone, diclosulam + pendimethalin, fluazifop-p-butyl + fomesafen, bentazone, sodium acifluorfen + clodinafop propargyl and imazethapyr + propaquizafop, alongside two hand weedings at 20 & 40 DAS treatments and a weedy check.

All post-emergence herbicides were applied 20 DAS using a knapsack sprayer fitted with a flat fan nozzle, utilizing a spray volume of 750 litres per hectare. Weed count and weed dry weight data were collected from two randomly selected spots using a 0.25 m x 0.25 m quadrat and were expressed as number/m² and g/m², respectively. Due to wide variability in weed count and dry weight data, square root transformation ($\sqrt{x+1}$) was applied for statistical analysis (Gomez and Gomez 1984).

The field was predominantly infested with a diverse range of weed species, including grasses, sedges and broadleaf weeds. Among the most prevalent were *Polygonum* spp., *Echinochloa colona*, *Digitaria sanguinalis* and *Panicum dichotomiflorum*, all of which are aggressive annual grasses. Additionally, sedge species like *Cyperus difformis* was widely present. Broadleaf weeds such as *Bidens pilosa*, *Commelina benghalensis* and *Ageratum conyzoides* also posed a major challenge. Singh *et al.* (2014) also reported similar kind of weed flora Pantnagar.

The herbicide treatments had a significant effect on total weed count and dry weight at all stages of observation (Tables 1 & 2). The data clearly indicate that the weedy check exhibited the highest weed count and dry weight throughout the experiment, highlighting the impact of unchecked weed growth.

Among the herbicide treatments, sulfentrazone + clomazone (725 g/ha) was statistically similar to pendimethalin + imazethapyr (800 g/ha) and hand weeding, significantly reducing both weed count and dry weight compared to other treatments. In contrast, diclosulam *(*26 g/ha) was the least effective among the herbicide treatments, showing significantly higher weed count and dry weight. This demonstrates its comparatively lower efficacy in controlling weed populations. However, among all the treatments hand weeding twice, consistently resulted in the significantly lowest weed count and dry weight, effectively minimizing weed competition and maximum weed count and dry weight being recorded from weedy check.

The seed yield of soybean was significantly influenced by different treatments and all the treatments were significantly superior to the weedy check (Table 3). Among different herbicide treatments pre-emergence application of sulfentrazone + clomazone 725 g/ha, behaving statistically similar with pendimethalin + imazethapyr 800 g/ha and hand weeding twice, recorded significantly maximum seed yield of 1430.00 kg/ha. Significantly lowest seed yield in herbicide treatment was recorded with diclosulam 26 g/ha (900.33 kg/ha). The higher values of seed yield with these treatments may be ascribed to marked decrease in weed population and weed dry weight and there by better and increased the seed yield attributes.

Hand weeding twice recorded highest seed yield

Table 1. Effect of weed management treatments on total weed count (Number/m^2) at different stages of observation

Treatment	Dose	20 DAS	40 DAS	60 DAS	80 DAS	100 DAS	At harvest
Diclosulam	26 g/ha	8.50	10.68	12.15	13.73	13.05	12.08
		(72.00)	(113.33)	(146.67)	(188.00)	(169.33)	(145.33)
Pendimethalin + imazethapyr (RM)	800 g/ha	2.19	3.00	4.43	5.50	4.95	3.56
		(6.67)	(10.67)	(18.67)	(29.33)	(26.67)	(25.33)
Sulfentrazone + clomazone (RM)	725 g/ha	1.00	2.28	3.87	4.54	3.67	2.61
		(0.00)	(5.33)	(14.67)	(20.00)	(25.33)	(8.00)
Diclosulam + pendimethalin (TM)	25.2+750 g/ha	6.19	7.36	8.54	10.10	9.50	8.34
		(38.67)	(54.67)	(72.00)	(101.33)	(90.67)	(69.33)
Fluazifop-p-butyl + Fomesafen (RM)	250 g/ha	11.52	9.63	11.16	12.98	12.36	11.29
		(132.00)	(92.00)	(124.00)	(168.00)	(152.00)	(126.67)
Bentazone	960 g/ha	11.42	8.28	9.84	11.11	10.55	9.46
		(130.67)	(68.00)	(96.00)	(122.67)	(110.67)	(89.33)
Sodium acifluorfen +	245 g/ha	10.80	7.74	9.21	10.49	9.89	8.72
clodinafoppropargyl (RM)		(116.00)	(60.00)	(84.00)	(109.33)	(97.33)	(76.00)
Imazethapyr + propaquizafop (RM)	125 g/ha	10.74	4.66	5.74	7.08	7.04	5.89
		(114.67)	(22.67)	(32.00)	(50.67)	(49.33)	(34.67)
2 HW at 20 & 40 DAS	-	1.00	1.67	2.75	4.60	2.86	1.87
		(0.00)	(5.33)	(9.33)	(24.00)	(9.33)	(4.00)
Weedy check	-	11.59	13.9	15.77	17.76	17.05	16.05
		(133.33)	(194.67)	(248.00)	(314.67)	(290.67)	(257.33)
SE(m) ±		0.44	0.57	0.49	0.54	0.71	0.68
CD (P=0.05)		1.32	1.70	1.47	1.59	2.12	2.01

DAS: Days after sowing, TM: Tank Mix, RM: Ready Mix, HW: Hand Weeding
Values given in parentheses are the mean of original values, Data subjected to transformation

Table 2. Effect of weed management treatments on total weed dry weight (g/m^2) at different stages of observation

Treatment	20 DAS	40 DAS	60 DAS	80 DAS	100 DAS	At harvest
Diclosulam	4.22	4.95	5.51	6.36	6.02	5.55
	(16.85)	(23.63)	(29.33)	(40.48)	(36.53)	(29.87)
Pendimethalin + imazethapyr (RM)	1.32	1.56	2.08	2.71	2.33	1.83
	(0.96)	(1.65)	(3.36)	(6.45)	(4.91)	(2.99)
Sulfentrazone + clomazone (RM)	1.00	1.29	1.66	2.12	1.74	1.33
	(0.00)	(0.75)	(1.97)	(3.52)	(2.61)	(0.91)
Diclosulam + pendimethalin (TM)	2.97	3.47	3.89	4.67	4.34	3.92
	(8.16)	(11.31)	(14.19)	(20.85)	(17.81)	(14.40)
Fluazifop-p-butyl + Fomesafen(RM)	5.85	4.38	5.03	5.96	5.70	5.16
	(33.23)	(18.24)	(24.48)	(34.56)	(31.47)	(25.65)
Bentazone	5.70	3.75	4.43	5.25	4.92	4.38
	(31.73)	(13.07)	(18.61)	(26.67)	(23.20)	(18.29)
Sodium acifluorfen + clodinafop propargyl (RM)	5.55	3.48	4.11	4.86	4.48	3.95
	(29.81)	(11.20)	(15.95)	(22.61)	(19.09)	(14.77)
Imazethapyr + propaquizafop (RM)	5.29	2.43	2.90	3.53	3.16	2.77
	(27.15)	(5.44)	(7.52)	(11.47)	(9.23)	(6.83)
2 HW at 20 & 40 DAS	1.00a	1.13	1.42	1.97	1.48	1.13
	(0.00)	(0.32)	(1.17)	(3.04)	(1.33)	(0.32)
Weedy check	5.42d	6.47	7.16	7.98	7.61	7.31
	(28.43)	(41.01)	(51.47)	(63.41)	(58.03)	(53.39)
SE(m±)	0.18	0.29	0.33	0.32	0.31	0.30
CD (P=0.05)	0.54	0.87	0.97	0.94	0.93	0.88

DAS: Days after sowing, TM: Tank Mix, RM: Ready Mix, HW: Hand Weeding
Values given in parentheses are the mean of original values, Data subjected to transformation

Table 3. Effect of different herbicide treatments on yield (grain & straw) and economics of soybean

Particulars	Grain yield (kg/ha)	Straw yield (kg/ha)	Cost of cultivation	Gross returns	Net returns	Net return per rupee invested
Diclosulam	900.33	1700.33	40430	81030	40600	1.00
Pendimethalin + imazethapyr (RM)	1385.33	2450.33	41530	124680	83150	2.00
Sulfentrazone + clomazone (RM)	1430.00	2564.33	42530	128700	86170	2.03
Diclosulam + pendimethalin (TM)	1200.00	2103.33	41634	108000	66365	1.59
Fluazifop-p-butyl + fomesafen (RM)	968.67	1804.00	40877	87180	46303	1.13
Bentazone	1035.33	1903.33	40940	93180	52240	1.28
Sodium acifluorfen + clodinafop propargyl (RM)	1104.33	2000.00	40630	99390	58760	1.45
Imazethapyr + propaquizafop (RM)	1318.00	2233.33	41555	118620	77065	1.85
2HW at 20 and 40 DAS	1529.67	2719.33	52130	137670	85540	1.64
Weedy check	835.00	1566.33	38130	75150	37020	0.97

DAS: Days after sowing, TM: Tank Mix, RM: Ready Mix, HW: Hand Weeding

(1529.67 kg/ha) among all other treatments and significantly lowest seed yield was obtained under weedy check treatment (835.00 kg/ha). These higher yields of soybean with hand weeding could be due to elimination or partial reduction in competition by weeds and subsequent increase in yield attributes and results are in confirmatory with the findings of Manjunath and Hosmath (2016) and Kamble *et al.* (2017). The percent increase with hand weeding twice and pre-emergence application of sulfentrazone + clomazone 725 g/ha over weedy check was 83.4 and 71.21%, respectively. Similar beneficial effects of weed control treatments with herbicide on seed yield of soybean have been also reported by Kadam *et al.* (2018) and Parita *et.al* (2022).

The straw yield (kg/ha) also followed the similar trend as that of seed yield of soybean (Table 3) as all herbicide treatments significantly influenced the straw yield of soybean over weedy check. Being statistically equivalent to hand weeding twice (2719.33 kg/ha), the herbicide treatments of sulfentrazone + clomazone 725 g/ha (2564.33 kg/ha) and pendimethalin + imazethapyr800 g/ha (2450.33 kg/ha) had recorded significantly higher straw yield of soybean over rest of treatments. Significantly, lowest straw yield was recorded under diclosulam 26 g/ha (1700.33 kg/ha) among herbicide treatments and weedy check overall (1566.33 kg/ha). Decreased crop-weed competition for resources (sunlight, nutrients and space) resulted in significant improvement in growth in terms of more dry weight in plant which ultimately contributed to higher straw yield in soybean. Saharan *et al.* (2016) have also observed similar trends for seed and straw yields of soybean.

The highest net returns (Rs. 86170/ha) were recorded with the pre-emergence application of sulfentrazone + clomazone 725 g/ha (Table 3) followed by handweeding twice (Rs. 85540/ha) and pendimethalin + imazethapyr 800 g/ha (Rs. 83150/ha). Highest net return per rupee invested (2.03) was recorded with the pre-emergence application of sulfentrazone + clomazone 725 g/ha followed by application of pendimethalin + imazethapyr 800 g/ha (2.00) and imazethapyr + propaquizafop 125 g/ha (1.85). Weedy check resulted in lowest net return per rupee invested. The monetary benefits with application of herbicides over weedy check have also been reported by Singh *et al.* (2015) in garden pea.

Conclusion

Sulfentrazone + clomazone (725 g/ha) is effective herbicide for the control of different weeds in soybean. Hand weeding was not economical due to the higher cost of cultivation.

Conflict of interest: The authors declare that there is no conflict of interest among the authors in this research paper.

References

Anonymous. 2023. World Agricultural Production. United States Department of Agriculture.

Anonymous. 2023a. Agriculture Statistics at a Glance. Department of Agriculture and Farmers Welfare, New Delhi.

Gaikwad RP and Pawar VS. 2003. Effect of herbicides on

soybean crop and weeds. Indian Journal of Weed Science **35**(1&2): 145-147.

Gomez GA and Gomez AA. 1984. Statistical procedure for agricultural research (2nd Ed.). John Wiley and sons, New York p 680.

Kadam SP, Gokhale DN, Pawar SU and Chavan RM. 2018. Efficacy of post emergence herbicides in soybean (*Glycine max* (L.) Merrill). Journal of Pharmacognosy and Phytochemistry **7**(6): 456-458.

Kamble AB, Nagre BS and Dhonde MB. 2017. Crop geometry and weed management effect on weed dynamics in 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.

Khan S, Tufail M, Khan MT, Khan ZA and Anwar S. 2021. Deep learning-based identification system of weeds and crops in strawberry and pea fields for a precision agriculture sprayer. Precision Agriculture **22**(6): 1711-1727.

Kurchania SP, Rathi GS, Bhalla CS and Mathew R. 2001. Bioefficacy of post-emergent herbicides for weed control in soybean [*Glycine max* (L.) Merr.]. Indian Journal of Weed Science **33**(1&2): 34-37.

Manjunath NC and Hosmath JA. 2016. Effect of sequential application of herbicides on weed dynamics and yield of soybean [*Glycine max* (L.) Merrill]. Journal of Farm Sciences **29**(2): 187-189.

Parita, Kumar S, Rana S, Sharma N and Manuja S. 2022. Effect of Ethalfluralin 36% EC on weeds, yield attributes and their correlation with yield of soybean. Himachal Journal of Agricultural Research **48**(1): 44-47.

Peer FA, Hassan B, Lone BA, Qayoom S, Ahmad L, Khanday BA and Singh G. 2013. Effect of weed control methods on yield and yield attributes of soybean. African Journal of Agricultural Research **8**(48): 6135-6141.

Prachand S, Kalhapure A and Kubde KJ. 2015. Weed management in soybean with pre and post emergence herbicides. Indian Journal of Weed Science **47**(2): 163-165.

Rana MC, Rana RS, Sharma A and Rana SS. 2004(a). Management of complex weed flora in seed potato with herbicidal mixture under dry temperate high hills of Himachal Pradesh. Indian Journal of Weed Science **36** (3&4): 231-235.

Rana MC, Sharma GD, Sharma A and Rana SS. 2004 (b). Management of complex weed flora in pea with herbicidal mixture under Lahaul valley conditions of Himachal Pradesh. Indian Journal of Weed Science **36**(1&2): 68-72.

Saharan B, Jha G, Jha AK and Sanodiya P. 2016. Efficacy of chlorimuron for controlling weeds in soybean. Indian Journal of Weed Science **48**(1): 86-89.

Shah A and Kataria RK. 2019. Effect of integrated nutrient management on seed yield and quality of soybean (*Glycine max* (L.) Merrill) under mid hill conditions of Himachal Pradesh. Himachal Journal of Agricultural Research **45**(1&2): 76-79.

Singh D, Mir NH, Singh N, and Kumar J. 2014. Promising early postemergence herbicides for effective weed management in soybean. Indian Journal of Weed Science **46**(2): 135-137.

Singh J, Chaudhary D R, and Kumar S. (2015). Effect of post-emergence herbicides on productivity and profitability of garden pea (*Pisum sativum* L.) in Lahaul Valley of Himachal Pradesh. Himachal Journal of Agricultural Research **41**(2): 172-176.

Thakur S, Kumar S, Manuja S, Shukla S. 2023. Bioassay for herbicide residues applied to control weeds in grassland. Himachal Journal of Agricultural Research **49**(1): 124-127.