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Effect of weed management practices on growth, yield and economics of soybean [*Glycine max* (L.) Merrill]

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Abstract

Experiments were conducted during *kharif* season of 2019 at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya Raipur (C.G.). The soil of the experimental field was 'Vertisols' locally known as 'Kanhar' with sandy clay loam in texture and pH 7.10. It was low in available nitrogen (220 kg ha⁻¹), medium in available phosphorus (12.54 kg ha⁻¹), and high in potassium (288 kg ha⁻¹). The experiment was laid out in Randomized block design (RBD) with 7 treatments and 3 replications. The result of present experiment conclude that growth attributes *viz*, plant height, number of branch, dry matter accumulation as well as yield attributes *viz*, number of pod plant⁻¹, number of seed pod⁻¹, Seed index (100 seed), seed yield, stover yield, harvest index were found maximum under Sodium Acifluorfan (16.5%) + Clodinafoppropargyl (8% EC) @ 1000 MI/ha + MACARENA @ 625 ml/ha which was at par with Propaquizafop 2.5% EC + Imazethapyr 3.7% ME @ 2000 ml/ha + MACARENA @ 625 ml/ha.

Keywords: Growth attributes, Seed yield, Stover yield, harvest index

Introduction

Soybean [*Glycine max* (L.) Merrill] is one of the most important oilseed crop in the world and it is also known as wonder crop of the 20th century. It is a cheapest source of vegetable oil and protein. It contains about 40 percent protein, well balanced in essential amino acids, 18-20 per cent oil rich with poly unsaturated fatty acids specially Omega 6 and Omega 3 fatty acids, 6-7 percent total mineral, 5-6 percent crude fiber and 17-19 percent carbohydrates. It is able to leave residual nitrogen effect for succeeding crop equivalent to 35-40 kg N ha⁻¹. Soybean can tolerate mild drought as well as floods. This characteristic has made soybean to fit well in sustainable agriculture. Soybean due to its various uses is rightly called "Golden Gift" of nature to mankind.

Globally soybean is cultivated over an area of 118.3 million hectares with a production of 318.25 million metric tonnes and having a productivity of 2.69 metric tones ha⁻¹ (Anonymous, 2015) [2]. In Chhattisgarh, during 2015-16, soybean occupies an area of 137.53 thousand hectares with productivity of 995 kg ha⁻¹ (Anonymous, 2017) [3]. In Chhattisgarh, major soybean growing districts are Rajnandgaon, Durg, Mungeli, Bemetara and Kabirdham. In chhattisgarh most prominent weeds observed in soybean are *Echinochloa*, *Cyperus rotundus*, *Euphorbia spp.*, *Commelina benghalensis*, *Phyllanthus niruri*, (Kolhe *et al.*, 1998) [7]. In soybean the weed flora as observed from the unweeded control plots consist of 58 per cent sedges, 32 per cent broad-leaved weeds and 10 per cent grasses. Among the sedges, *Cyperus rotundus*, the broad-leaved weeds like *Trianthema portulacastrum*, *Digera arvensis*, *Amaranthus viridis* and *Phyllanthus niruri* and the grasses like *Acrachne racemosa*, *Dactyloctenium aegyptium*, *Digitaria sanguinalis*, *Eragrostis pilosa* and *Commelina benghalensis* were mostly found in soybean (Kumar and Das, 2008) [8].

Alleviating weed competition through weed management practices especially. Involving new herbicides have been found to be effective in enhancing crop yield of soybean. The use of selective herbicide in soybean seems to be effective and economical. Although several post and pre-emergence herbicides have been used by the farmers of the state to maximize the crop-weed competition, but there is always scope to work on newer herbicides for effective, timely and economical control of weeds for efficient utilization of applied inputs. Therefore, it is of paramount importance to evaluate new herbicides for controlling weeds in agro-ecological situation of Chhattisgarh plains.

Materials and Methods

The experiment was carried out at Instructional cum Research Farm of IGKV, Raipur situated at latitude of 21°4' N, longitude of 81°35' E and altitude of 290.2 m above mean sea level. The climate of Raipur region is sub-humid to semi arid. The source of rainfall is south-west monsoon. The average annual rainfall is 1326 mm (based on 80 years mean), of which mostly concentrated during the period from June to September and very little during October to February. May is the hottest and December is the coolest month of the year. Temperature controls seed germination, tillering, and other plant practices. Through experiments, the weekly mean maximum and minimum temperature varied from 28.01 to 35.67 and 15.23 to 26.22 during the experiments, respectively. The maximum temperature recorded was 35.67 on 02 to 05 July whereas the minimum temperature was 15.23 °C from 20 to 22 October. During the soybean-growing season, the weekly average relative humidity varied from 6 to 10% and the total relative humidity ranged from 82.71 to 92.57%.

Soybean variety 'JS 97-52' (Jawahar Soybean 97-52) was grown as a test crop. It is released from JNKVV, Jabalpur. This variety has potential to provide high yield in varied eco-edaphic situation. It is multiple resistant against major diseases including yellow mosaic virus and root rot, moderately resistant to stem borer and defoliator and tolerant to excessive moisture stress. plant spacing 30 × 10 cm and seed rate of 75 kg ha⁻¹. Recommended dose of nutrients was used 20:60:40 kg ha⁻¹ N: P₂O₅: K₂O applied through Urea, Single Super Phosphate and Muriate of potash. The treatments comprised of seven weed management practices viz, Sodium Acifluarfan (16.5%) + Clodinafoppropargyl (8% EC) @ 1000 ml/ha + MACARENA @ 625 ml/ha (T₁), Imazethapyr 10 SL@ 1000 ml/ha + MACARENA @ 625 ml/ha (T₂), Fluazifop-p-butyl 13.4 EC @ 2000 ml/ha + MACARENA @ 625 ml/ha (T₃), Propaquizafop 2.5% EC + Imazethapyr 3.7% ME @ 2000 ml/ha + MACARENA @ 625 ml/ha (T₄), MACARENA @ 625 ml/ha (T₅), Two hand weeding at 20 and 40 DAS (T₆) and Weedy check (T₇).

Results and Discussion

Plant height

At 30 DAS, there was no significant effect of herbicides on the height of crop growth. At 60 DAS T₁- Sodium Acifluarfan (16.5%) + Clodinafop propargyl (8% EC) @ 1000ml/ha + MACARENA @ 625ml/ha produced significantly taller plants than rest of the treatment, but it was *at par* with T₄- Propaquizafop 2.5% EC + Imazethapyr 3.7% ME @ 2000ml/ha + MACARENA @ 625ml/ha and T₆- Two hand weeding at 20 and 40DAS. At harvest same trend was obtained with two *at par* i.e. T₁- Sodium Acifluarfan (16.5%) + Clodinafop propargyl (8% EC) @ 1000ml/ha + MACARENA @ 625ml/ha and T₄-Propaquizafop 2.5% EC + Imazethapyr 3.7% ME @ 2000ml/ha + MACARENA @ 625ml/ha. The maximum plant height in above treatments might be due to the favorable growing conditions in view of low crop-weed competition and weed free environment height under untreated control could be due to the competitive stress for available resources shared by the weeds (Singh *et al.*, 2005) [12].

Number of branches (plant⁻¹)

The data on number of branches of soybean recorded at 30, 60 DAS and at harvest as affected by application of herbicides

are presented in Table 1. Different treatment of herbicides showed significant impact on number of branches at all the stages of soybean.

The result revealed that at 30 DAS there was no significant effect of treatment on soybean. While at 60 DAS treatment T₁-Sodium Acifluarfan (16.5%) + Clodinafop propargyl (8% EC) @ 1000ml/ha + MACARENA @ 625ml/ha gave significantly higher number of branches than others at 30, 60 DAS and at harvest. However, it was *on par* to treatment T₇-weedy check and at harvest same trend was observed.

The highest number of branches plant⁻¹ was observed under T₁- Sodium Acifluarfan (16.5%) + Clodinafop propargyl (8% EC) @ 1000 ml/ha + MACARENA @ 625ml/h at 60 DAS and at harvest and in comparable to treatments might be due to the reduction in crowding effect or weed population among the crop plants, which facilitate more space, nutrients, light, and moisture and reduces the competition ultimately resulting in more number of branches plant⁻¹. These results are conformlty with those reported by Vyas and Jain (2003) [16], Kushwah and Vyas (2005).

Dry matter accumulation (g plant⁻¹)

The data on dry matter accumulation of soybean recorded at 30,60 DAS and at harvest are presented in Table 1.0, In general, dry matter increased up to at harvest.

The dry matter accumulation under T₁- Sodium Acifluarfan (16.5%) + Clodinafop propargyl (8% EC) @ 1000ml/ha + MACARENA @ 625ml/ha found highest which was *at par* with T₄- Propaquizafop 2.5% EC + Imazethapyr 3.7% ME @ 2000ml/ha + MACARENA @ 625ml/ha and T₆- Two hand weeding at 20 and 40 DAS at 30 DAS. However, at 60 DAS and at harvest, maximum dry matter accumulation was recorded under T₄- Propaquizafop 2.5% EC + Imazethapyr 3.7% ME @ 2000ml/ha + MACARENA @ 625ml/ha followed by T₆- Two hand weeding at 20 and 40 DAS and T₁- Sodium Acifluarfan (16.5%) + Clodinafop propargyl (8% EC) @ 1000ml/ha + MACARENA @ 625ml/ha and lowest dry matter accumulation was recorded under T₇- weedy check. The higher dry matter accumulation plant⁻¹ in above treatments might be due to lesser population of weeds which facilitate better utilization of resources and reduces the competition ultimately resulting in more dry matter accumulation plant⁻¹.

Similar results have been reported by Mandloi *et al.* (2000) [10], Tiwari *et al.* (2006) [13, 14] and Deore *et al.* (2008) [4]. The lowest dry matter accumulation was recorded under untreated control at all the time intervals of observations. It might be due to adverse effect of excessive crop-weed competition as evident from maximum dry matter production of weeds which resulted in reduction of nutrient uptake and dry matter accumulation by crop. Similar results have been reported by Deore *et al.* (2008) [4].

Number of pods plant⁻¹

The data on number of pods plant⁻¹ of soybean as affected by application of new herbicides are presented in Table 2.0 significant result was observed for number pods plant⁻¹.

The maximum number of pods plant⁻¹ was recorded in T₁- Sodium Acifluarfan (16.5%) + Clodinafop propargyl (8% EC) @ 1000ml/ha + MACARENA @ 625ml/ha which was *at par* with T₂- Imazethapyr 10 SL@ 1000ml/ha + MACARENA @ 625ml/ha, T₄- Propaquizafop 2.5% EC + Imazethapyr 3.7% ME @ 2000ml/ha + MACARENA @ 625ml/ha and T₆- Two hand weeding at 20 and 40 DAS. This was followed by T₃-

Fluazifop-p-butyl 13.4 EC @ 2000ml/ha + MACARENA @ 625ml/ha and T₅- MACARENA @ 625ml/ha. The minimum number of pods plant⁻¹ was recorded in T₇- weedy check.

Number of seeds pod⁻¹

The data on number of seeds pod⁻¹ of soybean as affected by application of herbicides are presented in Table 2.0. There was significant result was observed for number seeds pod⁻¹. The maximum number of seeds pods⁻¹ was noted in treatment T₁- Sodium Acifluarfan (16.5%) + Clodinafop propargyl (8% EC) @ 1000ml/ha + MACARENA @ 625ml/ha which was statistically comparable to T₄- Propaquizafop 2.5% EC + Imazethapyr 3.7% ME @ 2000ml/ha + MACARENA @ 625ml/ha. This was followed by T₆- Two hand weeding at 20 and 40 DAS and T₂- Imazethapyr 10 SL@ 1000ml/+ MACARENA @ 625ml/ha. However, the minimum number of seeds pod⁻¹ was recorded in T₇- weedy check.

100- Seed weight (g)

Data on 100- seed weight are presented in Table 2.0 Test weight of soybean seeds was influenced due to different herbicides. Data showed that maximum seed index was recorded on T₁- Sodium Acifluarfan (16.5%) + Clodinafop propargyl (8% EC) @ 1000ml/ha + MACARENA @ 625ml/ha which was at par with T₄- Propaquizafop 2.5% EC + Imazethapyr 3.7% ME @ 2000ml/ha + MACARENA @ 625ml/ha, T₆- Two hand weeding at 20 and 40DAS, T₂- Imazethapyr 10 SL@ 1000ml/+ MACARENA @ 625ml/ha and T₃- Fluazifop-p-butyl 13.4 EC @ 2000ml/ha + MACARENA @ 625ml/ha. This was followed by T₅- MACARENA @ 625ml/ha and minimum was recorded under T₇- weedy check.

Seed yield (kg ha⁻¹)

The data on seed yield influenced by different new herbicides are presented in Table 2.0 Date revealed that there is considerable effect on seed yield of soybean due to new herbicide application. Data showed that treatment T₁- Sodium Acifluarfan (16.5%) + Clodinafop propargyl (8% EC) @ 1000ml/ha + MACARENA @ 625ml/ha which is at par with T₄- Propaquizafop 2.5% EC + Imazethapyr 3.7% ME @ 2000ml/ha + MACARENA @ 625ml/ha. This is followed by T₆- Two hand weeding at 20 and 40DAS and T₂- Imazethapyr 10 SL@ 1000ml/+ MACARENA @ 625ml/ha. The lowest seed yield was recorded in T₇- weedy check.

Similar findings were also reported by Dubey *et al.* (2000) [6], Mandloi *et al.* (2000) [10], Kumar *et al.* (2001) [9], Gaikward

and Powar (2002), Raskar and Bhoi (2002) [11], Tiwari *et al.* (2006) [13, 14], Dhane *et al.* (2009) [5] and Yadav *et al.* (2009) [17].

Stover yield (kg ha⁻¹)

The data on stover yield are presented in Table 2.0 With different new herbicides application, there was significant result was recorded for stover yield. The maximum stover yield was recorded in T₁- Sodium Acifluarfan (16.5%) + Clodinafop propargyl (8% EC) @ 1000ml/ha + MACARENA @ 625ml/ha and T₄- Propaquizafop 2.5% EC + Imazethapyr 3.7% ME @ 2000ml/ha + MACARENA @ 625ml/ha. Both the treatment are at par, which was followed by T₂- Imazethapyr 10 SL@ 1000ml/+ MACARENA @ 625ml/ha and T₃- Fluazifop-p-butyl 13.4 EC @ 2000ml/ha + MACARENA @ 625ml/ha. The lowest stover yield was recorded in T₇- weedy check.

The higher stover yield in above treatments might be due to lesser weeds during early crop growth period and give higher yield attributes and pod yield which leads to higher stover yield. While, in weedy check reverse trend was observed and therefore, the lowest stover yield was noted under this treatment. Similar findings were reported by Dhane *et al.* (2009) [5].

Harvest index (%)

The data on harvest index are presented in Table 2.0 Non-significant variation was observed in harvest index due to application of different herbicides.

Economics

The data on the economics viz, cost of cultivation, gross return, net return, and benefit: cost ratio presented in table 2.0. The cost of cultivation varied according to different herbicide combination and their combinations. Different herbicide combination, hectare⁻¹ cost of cultivation, was minimum with the application of along weedy check (T₇) (12,685 Rs/ha⁻¹) and increased with increase in the level of herbicide combinations (17,785 Rs/ha⁻¹) under two hand weeding at 20 and 40 DAS (T₆). Gross return increased significantly with each increment in herbicide combination and level. However, further, increase herbicide combination. Maximum gross return (88195 Rs/ha⁻¹) was recorded with the application of Sodium Acifluarfan (16.5%) + Clodinafop propargyl (8% EC) @ 1000ml/ha + MACARENA @ 625ml/ha and maximum net return (71410 Rs/ ha⁻¹) with maximum B:C ratio (5.2).

Table 1: Evaluation of bio-efficacy of MACARENA (bio-stimulant) along with herbicides on plant height, Number of branches plant⁻¹ and Dry matter accumulation of soybean

Treatment	Plant height (cm)			Number of branches plant ⁻¹			Dry matter accumulation (g plant ⁻¹)		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
T ₁ -Sodium Acifluarfan (16.5%) + Clodinafop propargyl (8% EC) @ 1000ml/ha + MACARENA @ 625ml/ha	48.27	72.27	81.53	1.00	1.80	3.33	2.38	22.75	32.23
T ₂ -Imazethapyr 10 SL@ 1000ml/+ MACARENA @ 625ml/ha	36.27	61.13	73.13	1.00	1.73	3.27	1.41	18.21	25.35
T ₃ -Fluazifop-p-butyl 13.4 EC @ 2000ml/ha + MACARENA @ 625ml/ha	35.93	60.00	73.13	1.00	1.67	3.20	0.98	18.12	23.87
T ₄ -Propaquizafop 2.5% EC + Imazethapyr 3.7% ME @ 2000ml/ha + MACARENA @ 625ml/ha	36.60	71.00	79.07	1.00	1.73	3.33	1.59	21.08	31.14
T ₅ - MACARENA @ 625ml/ha	35.93	59.87	72.93	1.00	1.67	2.93	0.60	17.64	23.62
T ₆ - Two hand weeding at 20 and 40 DAS	36.47	62.27	73.40	1.00	1.73	3.27	1.42	20.62	28.08

T7- Weedy check	35.60	58.07	72.27	1.00	1.57	2.67	1.12	14.71	19.53
S.Em±	2.39	3.40	1.78	00	0.07	0.19	0.26	0.47	0.66
CD(P=0.05)	NS	10.10	5.28	NS	0.22	0.58	NS	1.42	1.97

Table 2: Evaluation of bio-efficacy of MACARENA (bio-stimulant) along with herbicides on number of Pods plant⁻¹, number of seed pod⁻¹, Seed index, Seed and Stover yield, Harvest index (%), Gross and net return (Rs\h) and B:C ratio

Treatment	Pods plant ⁻¹ (No.)	Seed pod ⁻¹ (No.)	Seed index 100 seeds (g)	Seed yield (kg ha ⁻¹)	Stover yield (kg ha ⁻¹)	Harvest index (%)	Gross return (Rs/ha)	Net returns (Rs/h)	B:C ratio
T ₁ -Sodium Acifluorfan (16.5%) + Clodinafop propargyl (8% EC) @ 1000ml/ha + MACARENA @ 625ml/ha	53.80	2.77	12.15	1930	3870	33.28	88195	71410	5.2
T ₂ -Imazethapyr 10 SL@ 1000ml/+ MACARENA @ 625ml/ha	49.53	2.33	11.23	1600	3560	31.01	75485	59200	4.6
T ₃ -Fluazifop-p-butyl 13.4 EC @ 2000ml/ha + MACARENA @ 625ml/ha	47.13	2.32	11.13	1470	3410	30.12	70275	54390	4.4
T ₄ -Propaquizafop 2.5% EC + Imazethapyr 3.7% ME @ 2000ml/ha + MACARENA @ 625ml/ha	50.20	2.63	11.53	1830	3860	32.16	84495	67710	5.0
T ₅ - MACARENA @ 625ml/ha	46.00	2.27	10.20	1350	2920	31.62	65235	49950	4.2
T ₆ - Two hand weeding at 20 and 40 DAS	49.60	2.57	11.44	1650	3280	33.47	78835	61050	4.4
T ₇ - Weedy check	45.80	2.23	9.98	411	804	33.83	27892	15207	2.1
S.Em±	1.65	0.06	0.37	43	89	-	-	-	-
CD(P=0.05)	4.91	0.19	1.08	124	262	-	-	-	-

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