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RESEARCH PAPER

Effect of early post emergence herbicides application on growth, yield and economics of soybean

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Abstract: Soybean is also known as "Miracle crop" of the 21st century because of its multiple utilization. It has the highest protein content (40-42%), 20 per cent oil and other vitamins. The crop has very high yielding capacity but its productivity in India and Karnataka are significantly lower when compared with world. One of the major reasons for the poor performance of soybean is inadequate and timely weed control. Hence an experiment was conducted at Agricultural Research Station, Hukkeri, Belagavi, Karnataka during *kharif/rabi* 2022-23 to evaluate the efficacy of early post emergence herbicides on growth and yield of soybean. The experiment was laid out in a randomised complete block design by having 9 treatments of different early post emergence herbicide combinations which were replicated thrice. Results revealed that application of Fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @1000 g ha^{-1} as Early post emergence herbicides recorded significantly higher growth parameters *viz.,* higher number of branches (6.8 $plant^{-1}$), higher total dry matter production of soybean at harvest (27.6 g $plant^{-1}$) and leaf area index at 60 DAS and yield and yield attributes *viz.,* seed yield $plant^{-1}$ (9.34 g), seed yield (2392 kg ha^{-1}) and haulm yield (2800 kg ha^{-1}) as compared to other treatments. Similarly, same treatment also recorded significantly higher gross (₹ 132556 ha^{-1}) and net return (₹ 89828 ha^{-1}) as compared to rest of the treatments. However, most of the parameters were remained statistically similar with Sodium aceflourofen16.5% + clodinafop propargyl 8% ECRM @ 1000 ml ha^{-1} and Imazethapyr 35% + Imazamox 35% WG RM @ 100 g ha^{-1} as Early post emergence herbicides.

Key words: Aceflourofen 16.5% + clodinafop propargyl 8% EC, Early post emergence herbicide, Fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w, Leaf area index, Sodium, Soybean, Yield, Yield attributes

Introduction

Soybean [*Glycine max* (L.) Merrill] is an important oilseed crop introduced and cultivated in India. The crop is also known as "Golden Bean" or "Miracle crop" of the 21st century because of its multiple utilization. It has the highest protein content (40-42%), 20 per cent oil, rich in the lysine (6%) and vitamins A, B and D and also contains minerals and essential amino acids. It has high potential among various legumes for warning acute malnutrition. The major significance of the crop is that it improves soil fertility by leaving the residual nitrogen (30-40 kg ha^{-1}) through atmospheric fixation. Soybean is a major oil seed crop of world. It is grown over an area of 121.1 million hectare with 385.8 million tonnes production and productivity of 1,960 kg ha^{-1} (Anon., 2022). Around the world, it is largely cultivated in countries like USA, China, Brazil, Argentina and India. In India it is extensively grown over an area of 10.02 million hectare with production of 114.9 million tonnes and productivity of 1,146 kg ha^{-1} (Anon., 2022). The Predominant soybean growing states in India are Madhya Pradesh, Maharashtra, Gujarat, Andhra Pradesh, Karnataka and Rajasthan. Soybean occupies an area of 0.32 million hectare with production of 0.30 million tonnes and productivity of 937 kg ha^{-1} in Karnataka (Anon., 2022).

The crop has very high yielding capacity but its productivity in India (1,146 kg ha^{-1}) and Karnataka (937 kg ha^{-1}) are significantly lower when compared with world (1,960 kg ha^{-1}). One of the major reasons for the poor performance of soybean is inadequate and timely weed control. Weed infestation is becoming one of the major constraints in achieving the potential yield. The crop is mainly cultivated during *kharif* season and is infested with varied grassy, sedge and broad-leaved weeds which emerge simultaneously with the crop plant and competes for the essential nutrients, space and moisture causing substantial loss in yield (30-77%) depending upon the nature, intensity and duration of infestation of weed flora and weed density (Kuruchania *et al.,* 2001). Therefore, it is important to keep the soybean crop weed free as far as possible, so as to get higher seed yield. Now a days pre-emergence herbicides are not very popular among the farmers due to short time span for sowing during *kharif* season. Therefore, farmers are using post-emergence herbicides for control of weeds in soybean. Broad spectrum early post emergence usage proved effective in controlling weeds in crop like soybean (Sangeetha *et al.,* 2012). Hand weeding is the most efficient means to control weeds in soybean, but it is time consuming and difficult due to unavailability of labourers during peak period of demand. Hence, the use of suitable herbicide appears to be an alternative option to minimize the weed problem. Hence an experiment was conducted to evaluate the bioefficacy of early post emergence herbicides on growth and yield of soybean.

Material and methods

A field experiment was conducted at Agricultural Research Station, Hukkeri, Belagavi, Karnataka during *kharif/rabi* 2022-23 to evaluate the bioefficacy of early post emergence herbicides

on growth and yield of soybean. The experimental site is situated in the Northern Transition Zone (Zone 8) at a latitude of 16^0 13` 48.00" North, longitude 74^0 35' 59.99" East and at an altitude of 631 m above mean sea level (MSL). The soil of the experimental site is clay in texture having high in organic carbon, neutral to slightly alkaline in pH (7.1), normal in EC (0.32 dS m^{-1}), low in available nitrogen (252.0 kg ha^{-1}), medium in available phosphorus (32.5 kg ha^{-1}) and available potassium (492.8 kg ha^{-1}). The experiment was laid out in a randomised complete block design by having 9 treatments which were replicated thrice. Treatments details are T_1- Imazethapyr 35% + Imazamox 35% WG ready mix (RM) @100 g ha^{-1} as Early post emergence herbicides (When weeds are @ 2-3 leaf stage); T_2- Propaquizafop 2.5%+ Imazethapyr 3.75% W/W ME RM @ 2000 g ha^{-1} as Early post emergence herbicides; T_3- Sodium aceflourofen 16.5% + Clodinafop Propargyl 8% EC RM @1000 ml ha^{-1} as Early post emergence herbicides; T_4- Fluazifop-p-butyl 11.1% w/w + Fomesafen 11.1% w/w SL RM @1000 g ha^{-1} as Early post emergence herbicides; T_5- Fomesafen 175+ Clethodium 120 EC RM @1500 g ha^{-1} as Early post emergence herbicides; T_6- Chlorimuron ethyl 25% WP @36 g ha^{-1} as Early post emergence herbicides (RPP); T_7- Diclosulam 84% WDG @ 31 g ha^{-1} as PE (RPP); T_8- Weed free check; and T_9- Weedy check. Data on species wise weed density at 30 days after herbicide application (DAHA) was recorded using a quadrant of 1m × 1m from three random spots per plot and was reported as weed density (m^{-2}). The weeds were oven dried and total weed dry weight was recorded at 30 DAHA and expressed as (g m^{-2}). Data of both weed density and total weed dry weight was analyzed statistically using suitable square root transformation. Weed control efficiency measures the efficiency of any weed control treatment in comparison to weedy treatment. To adjudge the efficiency of weed control treatments, weed control efficiency (WCE) was calculated as follows:

$$WCE(\%)=\frac{DWC-DWT}{DWC} \times 100$$

(Where, WCE = Weed control efficiency in percent, DWC = Dry weight of weeds in control plot and DWT = Dry weight of weeds in treated plot)

Weed index is defined as the per cent reduction in the seed yield under a particular treatment due to the presence of weeds in comparison to the seed yield obtained in weed free plot as suggested by. It is expressed in percentage and was determined with the help of following formula

$$\text{Weed index (\%)} = \frac{X-Y}{X}$$

(Where, X = yield from weed free plot and Y = yield from treated plot)

The data on growth and yield parameters of soybean collected at the time of harvest were subjected to statistical analysis as suggested by Gomez and Gomez (1983).

Results and discussion

Effect on weeds

Data pertaining to effect of weeds in soybean are presented in Table 1. Among the different herbicide treatments, early post-emergence application of fluazifop-p-butyl + fomesafen @ 250 g *a.i.* ha^{-1} was found efficient in controlling the sedges in soybean. Weedy check recorded significantly higher sedges population (20.20 m^{-2}) as compared to other weed controlling treatments at 30 days after herbicide application. These results were in conformity with the findings of Singh *et al.* (2014) who reported significantly lower weed density of grasses and non-grassy weeds with application of post-emergence herbicide

Table 1. Effect of weed control treatments on weed density, total weed dry weight, weed control efficiency and weed index in soybean at 30 DAHA

Treatment	Weed density (m^{-2})			Total weed dry weight (g m^{-2})	WCE (%)	Weed index (%)
	Broad-leaved weeds	Grasses	Sedges			
T_1 - Imazethapyr 35% + Imazamox 35% WG (70 g *a.i.* ha^{-1}) ready mix RM @100 g ha^{-1} as EPoE	2.96(8.32)	2.37(5.17)	2.82(7.50)	3.46(11.51)	8119.8	
T_2 - Propaquizafop 2.5 % + Imazethapyr 3.75% W/W ME (50+75 g *a.i.* ha^{-1}) RM @ 2000 g ha^{-1} as EPoE	3.20(9.98)	2.39(5.22)	2.91(8.01)	3.80(13.99)	76.8	22.4
T_3 - Sodium aceflourofen 16.5% + clodinafop propargy l8% EC (80+165 g *a.i.* ha^{-1}) RM @1000 ml ha^{-1} as EPoE	2.60(6.80)	2.3(5.20)	2.64(6.94)	3.18(9.62)	84	18.9
T_4 - Fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL (250 g *a.i.* ha^{-1}) RM @ 1000 *g* ha^{-1} as EPoE	2.40(5.95)	2.34(5.00)	2.43(5.42)	3.00(8.52)	84.2	8.2
T_5 - Fomesafen 17.5% + clethodium 12% EC (442.5 g *a.i.* ha^{-1}) RM @1500 g ha^{-1} as EPoE	3.57(12.3)	2.57(6.15)	2.94(8.20)	4.12(16.51)	72	23.3
T_6 - Chlorimuron Ethyl 25%WP (9 g *a.i.* ha^{-1}) @ 36 g ha^{-1} as EPoE (RPP)	4.77(22.3)	2.92(7.83)	3.03(8.73)	5.32(27.90)	53.8	32.6
T_7 - Diclosulam 84% WDG (26 g *a.i.* ha^{-1}) @ 31 g ha^{-1} as PE (RPP)	4.53(20.1)	2.74(7.22)	2.96(8.29)	5.19(26.50)	56.1	26.5
T_8 - Weed free check	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	100	-
T_9 - Weedy check	6.82(46.10)	4.50(19.72)	4.54(20.20)	7.8(60.46)	-	53.5
S.Em ±	1.55	0.44	0.34	0.95	2.48	0.8

Mean followed by the same alphabet (s) within a coloumn don't significantly differ by DMRT (P=0.05)

WG-Wettable granule, RM- Ready mix, EPoE- Early post emergence, ME- Microemulsions, EC- Emulsifiable concentrate, SL- Suspension liquid, WP- Wettable powder, WDG-Water dispersible granules, PE- Pre emergence, RPP- Recommended package of practice

fluazifop-p-butyl + fomesafen. Early post-emergence application of fluazifop-p-butyl + fomesafen @ 250 g *a.i.* ha^{-1} found to be significantly superior over rest of the herbicide treatments in controlling the weeds and recorded least total dry weight of weeds (8.52 g m^{-2}) at 30 days after herbicide application. Further, weedy check recorded significantly higher total dry weight of weeds (60.46 g m^{-2}) as compared to other weed control treatments. Among the different herbicide treatments, application of fluazifop-p-butyl + fomesafen @ 250 g *a.i.* ha^{-1} as post-emergence recorded highest weed control efficiency (84.2%) at 30 days after herbicide application. These results were in conformity with the findings of Singh *et al.* (2014) and Thakare *et al.* (2015).

Weed index indicates the reduction in yield due to weed competition as compared to the maximum attained seed yield. Lowest weed index (8.20%) was recorded with post-emergence application Fluazifop-p-butyl + Fomesafen @ 250 g *a.i.* ha^{-1} . The maximum weed index (53.50%) was recorded under weedy check where no weed management practices were applied ultimately caused reduction in seed yield. Similar results were also reported by Kushwah and Vyas (2005) and Jha *et al.* (2014) [6].

Growth parameters

Data pertaining to growth parameters of soybean are presented in Table 2 and 3. Data revealed that plant height of soybean significantly influenced by early post emergence herbicides. Application of fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @1000 g ha^{-1} as Early post emergence herbicides recorded significantly higher plant height (76.6 cm) and higher number of branches (6.8 plant^{-1}) as compared to other treatments. However, it was followed by application of sodium aceflourofen16.5% + clodinafop propargyl 8% ECRM @ 1000 ml ha^{-1} (73.9 cm and 6.6 plant^{-1}, respectively) and Imazethapyr 35% + Imazamox 35% WG RM @ 100 g ha^{-1} as Early post emergence herbicides (73.7 cm and 6.4 plant^{-1}, respectively). This might be due to the application of early post emergence herbicide at early growth stages of crop helps in reducing the weed population thereby reducing the crop weed competition at critical stage of crop growth and created favourable conditions for growth, which led to the higher growth attributes *viz.,* plant height and number of branchers per plant.

Among the different herbicide treatments, application of fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL RM @1000 g ha^{-1} as Early post emergence herbicides recorded the significantly higher total dry matter production of soybean at harvest (27.6 g plant^{-1}) as compared to other treatments. It was followed by application of sodium aceflourofen 16.5% + clodinafop propargyl 8% EC RM @ 1000 ml ha^{-1} and Imazethapyr 35% + Imazamox 35% WG RM @ (26.6 and 26.13 g plant $^{-1}$, respectively). This might be due to the efficient control of weeds by the application of early post emergence herbicide reduced the competition for sunlight and nutrient which might have resulted in enhanced uptake of nutrients which increased the accumulation of photosynthates in leaves and adequate partitioning of photosynthates towards reproductive parts resulting in higher total dry matter accumulation at harvest. At 60 DAS, among different herbicide treatments application of fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @1000 g ha^{-1} as Early post emergence herbicides recorded significantly higher number of leaves plant^{-1} (31.3), higher leaf area (9.8 dm^2 plant^{-1}) and leaf area index (3.6) as compared to other treatments. However, it was on par with sodium aceflourofen 16.5% + clodinafop propargyl 8% EC @1000 ml ha^{-1} as EPoE. Different weed management methods led to a higher variation in the soybean leaf area and leaf area index. The function of the decrease in weed spread brought on by these treatments appears to be the leaf area index. This might have given the plants more room to spread their foliage and branches, producing more leaves per unit of land.

Table 2. Growth parameters of soybean at harvest as influenced by early post emergence herbicides herbicides

Treatment	Plant height (cm)	Number of branches plant^{-1}	Total dry matter production (g plant^{-1})
T_1 - Imazethapyr 35% + Imazamox 35% WG ready mix RM @ 100 g ha^{-1} as Early post emergence herbicides	73.7^{bc}	6.4^{ab}	26.13 $^{b-d}$
T_2 - Propaquizafop 2.5% + Imazethapyr 3.75% W/W ME (50+75 g *a.i.* ha^{-1}) RM @ 2000 g ha^{-1} as Early post emergence herbicides	71.2^{cd}	5.5^{bc}	24.5 ^{d}
T_3 - Sodium aceflourofen 16.5% + clodinafop propargyl 8% EC (80+165 g *a.i.* ha^{-1}) RM @1000 ml ha^{-1} as Early post emergence herbicides	73.9^{bc}	6.6^{ab}	26.6 ^{bc}
T_4 - Fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL RM @ 1000 g ha^{-1} as Early post emergence herbicides	76.6^{a}	6.8^{ab}	27.6^{a}
T_5 - Fomesafen 17.5% + clethodium 12% EC (442.5 g *a.i.* ha^{-1}) RM @1500 g ha^{-1} as Early post emergence herbicides	70.3^{cd}	6.2^{a-c}	23.5^{cd}
T_6 - Chlorimuron ethyl 25%WP (9 g *a.i.* ha^{-1}) @ 36 g ha^{-1} as Early post emergence herbicides (RPP)	68.3^{d}	5.8^{a-c}	22.3^{d}
T_7 - Diclosulam 84% WDG (26 g *a.i.* ha^{-1}) @ 31 g ha^{-1} as PE (RPP)	69.3^{cd}	6.1^{a-c}	23.1^{cd}
T_8 - Weed free check	71.1^{a}	7.6^{a}	28.6^{a}
T_9 - Weedy check	66.4^{d}	4.3^{c}	18.6^{e}
S.Em ±	2.09	0.21	0.82

Mean followed by the same alphabet (s) within a coloumn don't significantly differ by DMRT (P=0.05)WG- Wettable granule, RM- Ready mix, Early post emergence herbicides- Early post emergence, ME- Microemulsions, EC- Emulsifiable concentrate, SL- Suspension liquid, WP- Wettable powder, WDG-Water dispersible granules, PE-Pre emergence, RPP- Recommended package of practice, DAS- Days after sowing

Table 3. Leaf parameters of soybean at 60 DAS as influenced by different early post emergence herbicides

Treatment	Number of leaves plant^{-1}	Leaf area (dm^2 plant^{-1})	Leaf area index
T_1 - Imazethapyr 35% + Imazamox 35% WG ready mix RM @ 100 g ha^{-1} as Early post emergence herbicides	28.8^{bc}	9.6^{bc}	3.1^{bc}
T_2 - Propaquizafop 2.5 % + Imazethapyr 3.75% W/W ME (50+75 g *a.i.* ha^{-1}) RM @ 2000 g ha^{-1} as Early post emergence herbicides	24.4^{c}	9.0^{bc}	3.0^{bc}
T_3 - Sodium aceflourofen 16.5% + clodinafop propargyl 8% EC (80+165 g *a.i.* ha^{-1}) RM @1000 ml ha^{-1} as Early post emergence herbicides	29.9^{a-c}	9.7^{b}	3.1^{bc}
T_4 - Fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL RM @ 1000 g ha^{-1} as Early post emergence herbicides	31.3^{a}	9.8^{a}	3.6^{a}
T_5 - Fomesafen 17.5% + clethodium 12% EC (442.5 g *a.i.* ha^{-1}) RM @ 1500 g ha^{-1} as Early post emergence herbicides	28.0^{cd}	9.3^{bc}	3.0^{c}
T_6 - Chlorimuron ethyl 25%WP (9 g *a.i.* ha^{-1}) @ 36 g ha^{-1} as Early post emergence herbicides (RPP)	25.1^{de}	8.8^{c}	2.9^{c}
T_7 - Diclosulam 84% WDG (26 g *a.i.* ha^{-1}) @ 31 g ha^{-1} as PE (RPP)	27.6^{cd}	9.2^{bc}	3.0^{c}
T_8 - Weed free check	32.0^{a}	10.1^{a}	3.7^{a}
T_9 - Weedy check	17.9^{f}	6.9^{d}	2.2^{d}
S.Em ±	0.93	0.29	0.10

Mean followed by the same alphabet (s) within a coloumn don't significantly differ by DMRT (P=0.05)WG- Wettable granule, RM- Ready mix, Early post emergence herbicides- Early post emergence, ME- Microemulsions, EC- Emulsifiable concentrate, SL- Suspension liquid, WP- Wettable powder, WDG-Water dispersible granules, PE-Pre emergence, RPP- Recommended package of practice, DAS- Days after sowing

Table 4. Yield and yield components of soybean as influenced by Early post emergence herbicides herbicides

Treatment	Number of pods plant^{-1}	Seed yield (g plant^{-1})	100 seed weight (g)	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index (%)
T_1 - Imazethapyr 35% + Imazamox 35% WG ready mix RM @ 100 g ha^{-1} as Early post emergence herbicides	46.80^{b}	8.33^{c}	12.10^{ab}	2061^{c}	2480^{cd}	49.31^{a}
T_2 - Propaquizafop 2.5 % + Imazethapyr 3.75% W/W ME (50+75 g *a.i.* ha^{-1}) RM @ 2000 g ha^{-1} as Early post emergence herbicides	46.30^{bc}	8.00^{cd}	11.80^{a-c}	2023^{c}	2210^{cd}	49.22^{a}
T_3 - Sodium aceflourofen 16.5% + clodinafop propargyl 8% EC (80+165 g *a.i.* ha^{-1}) RM @1000 ml ha^{-1} as Early post emergence herbicides	48.20^{ab}	9.17^{b}	12.50^{ab}	2254^{b}	2650^{b}	49.80^{a}
T_4 - Fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL RM @ 1000 *g* ha^{-1} as Early post emergence herbicides	49.30^{a}	9.34^{ab}	12.90^{a}	2392^{ab}	2800^{ab}	49.83^{a}
T_5 - Fomesafen 17.5% + clethodium 12% EC (442.5 g *a.i.* ha^{-1}) RM @1500 g ha^{-1} as Early post emergence herbicides	45.60^{bc}	7.20^{de}	11.60^{a-c}	1998^{c}	2065^{cd}	49.15^{a}
T_6 - Chlorimuron ethyl 25%WP (9 g *a.i.* ha^{-1}) @ 36 g ha^{-1} as Early post emergence herbicides (RPP)	42.10^{cd}	6.01^{fg}	10.90^{bc}	1756^{d}	1750^{d}	46.83^{ab}
T_7 - Diclosulam 84% WDG (26 g *a.i.* ha^{-1}) @ 31 g ha^{-1} as PE (RPP)	44.19^{bc}	6.60^{ef}	11.20^{bc}	1916^{cd}	1896^{cd}	49.17^{a}
T_8 - Weed free check	50.12^{a}	10.05^{a}	13.20^{a}	2507^{a}	2925^{a}	49.89^{a}
T_9 - Weedy check	38.23^{d}	5.40^{g}	10.20^{c}	1210^{e}	1550^{e}	42.46^{b}
S.Em ±	1.51	0.24	0.40	0.69	0.39	1.61

Mean followed by the same alphabet (s) within a coloumn don't significantly differ by DMRT (P=0.05) WG- Wettable granule, RM- Ready mix, Early post emergence herbicides- Early post emergence, ME- Microemulsions, EC- Emulsifiable concentrate, SL- Suspension liquid, WP- Wettable powder, WDG-Water dispersible granules, PE-Pre emergence, RPP- Recommended package of practice

Yield components

Significantly higher number of pods plant^{-1} (49.3), seed yield plant^{-1} (9.34 g) and test weight (27.6 g) were recorded with the application of different Early post emergence herbicides herbicides fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 1000 g ha^{-1} as Early post emergence herbicides and was followed by application of Sodium aceflourofen 16.5% + clodinafop propargyl 8% EC @ 1000 ml ha^{-1}. This outcome may be attributable to less competition during critical growth stages and better weed suppression, which allowed the crop to reach its full potential by absorbing enough nutrients, light, moisture, and space, which facilitates more translocation of photosynthates towards the reproductive parts, as a result of the removal of weeds, led to more number of pods plant^{-1}, test weight and finally seed yield per plant. Similar findings have also been reported by Kothawade *et al.* (2006), Vyas and Jain (2003), and Kumar *et al.* (2001).

Among different herbicide treatments, significantly higher seed yield (2392 kg ha^{-1}) and haulm yield (2800 kg ha^{-1}) was recorded with the application of fluazifop-p-butyl 11.1% w/w +

Table 5. Economics of soybean cultivation as influenced by early post emergence herbicides

Treatment		Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B: C ratio
T_1 -	Imazethapyr 35% + Imazamox 35% WG ready mix RM @ 100g ha^{-1} as Early post emergence herbicides	119125^{b}	74702^{c}	2.60^{cde}
T_2 -	Propaquizafop 2.5 % + Imazethapyr 3.75% W/W ME (50+75 g *a.i.* ha^{-1}) RM @ 2000g ha^{-1} as Early post emergence herbicides	116848^{b}	74288^{c}	2.71^{de}
T_3 -	Sodium aceflourofen 16.5% + clodinafop propargyl 8% EC (80+165 g *a.i.* ha^{-1}) RM @1000 ml ha^{-1} as Early post emergence herbicides	128210^{b}	85220^{b}	2.98^{c}
T_4 -	Fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL RM @ 1000 *g* ha^{-1} as Early post emergence herbicides	132556^{a}	89828^{ab}	3.10^{b}
T_5 -	Fomesafen 17.5% + clethodium 12% EC (442.5 g *a.i.* ha^{-1}) RM @1500 g ha^{-1} as Early post emergence herbicides	102147^{c}	58637^{d}	2.39^{e}
T_6 -	Chlorimuron ethyl 25%WP (9 g *a.i.* ha^{-1}) @ 36 g ha^{-1} as Early post emergence herbicides (RPP)	116620^{b}	74003^{c}	2.70^{cd}
T_7 -	Diclosulam 84% WDG (26 g *a.i.* ha^{-1}) @ 31 g ha^{-1} as PE (RPP)	115853^{b}	74617^{c}	2.80^{c}
T_8 -	Weed free check	140639^{a}	93889^{a}	3.20^{a}
T_9 -	Weedy check	74159^{d}	35703^{e}	1.89^{f}
S.Em. ±		3985.75	2248.15	0.10

Mean followed by the same alphabet (s) within a coloumn don't significantly differ by DMRT (P=0.05) WG- Wettable granule, RM- Ready mix, Early post emergence herbicides- Early post emergence, ME- Microemulsions, EC- Emulsifiable concentrate, SL- Suspension liquid, WP- Wettable powder, WDG-Water dispersible granules, PE- Pre emergence, RPP- Recommended package of practice B:C ratio: Benefit cost ratio

fomesafen 11.1% w/w SL RM @ 1000 g ha^{-1} as Early post emergence herbicides as compared to other treatments. However, it was on par with Sodium aceflourofen16.5% + clodinafop propargyl 8% ECRM @ 1000 ml ha^{-1}. This may be attributable to the absence of weeds during the crop-weed competition period, favouring vigorous crop growth due to superior assimilate partitioning and relative accumulation, which ultimately leads to higher yield attributes finally the yield. These outcomes were in agreement with the findings made by Sandii *et al.* (2015), Thakare *et al.* (2015) and Andhale *et al.* (2019).

Economics of soybean

Higher gross return (₹ 140639 ha^{-1}) and net return (₹ 93889 ha^{-1}) obtained in Weed free check. Among herbicide treatments, higher gross (₹ 132556 ha^{-1}) and net return (₹ 89828 ha^{-1}) recorded with application of fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL RM @1000 g ha^{-1} as Early post emergence herbicides as compared to other treatments. Benefit cost ratio (3.1) was recorded maximum with the fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL RM @ 1000 g ha^{-1} as Early post emergence herbicides. With respect to marginal benefits of net return observed in weed free check, it is quite evident to note that the keeping of land free from weeds throughout the crop growth period is hardly impossible for the farmers since it involves higher cost on labour. The use of herbicides had resulted in greater net return, primarily because they increased production that was comparable to weed-free output and decreased cultivation costs while also controlling monocot and dicot weeds. The results are in conformity with the results of Upadhyay *et al.,* (2012) Mishra *et al.,* (2013), and Moghal *et al.,* (2014).

Conclusion

According to the findings of present investigation, weeds could be managed efficiently by using early post emergence herbicides without affecting the crop growth and productivity. Present investigation revealed that application of Early post emergence herbicides fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL RM @1000 g ha^{-1} as is the best weed management practice in soybean to get the greater yield and economic returns.

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