International Journal of Forestry and Crop Improvement
Volume **3** | Issue 2 | December, 2012 | 127-133

Research Article

Effect of integrated weed management practices on growth and productivity of soybean [*Glycine max* (L.) Merrill]

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ABSTRACT : A field experiment was conducted at the Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during *Kharif* season of 2010 to find out the appropriate integrated weed management practices for growth and productivity of soybean. Results revealed that significantly higher growth character *viz.*, number of branches, dry matter accumulation, number of leaves, leaf area, crop growth rate and relative growth rate were obtained under hand weeding twice at 20 DAS and 40 DAS (T_{12}), as compared to others. This was followed by hoeing twice (by wheel hoe) at 15 DAS and 35 DAS (T_{11}), imazethapyr 10 SL @ 100 g ha^{-1} fb hoeing (by wheel hoe) at 35 DAS (T_{10}), imazethapyr 10 SL @ 100 g ha^{-1} fb HW at 35 DAS (T_9) and quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + chlorimuron ethyl 25 WP @ 9 g ha^{-1} + surfactant @ 0.2 per cent fb HW at 35 DAS (T_6). However, the plant height was obtained significantly higher under weedy check (T_{13}), as compared to others.

KEY WORDS : Integrated weed management, Growth, Productivity, Quizalofop ethyl 10EC, Imazethapyr 10SL, Chlorimuron ethyl 25WP

How to cite this Article : Toppo, Anuj Roshan, Dewangan, D.K. and Lakpale, R. (2012).Effect of integrated weed management practices on growth and productivity of soybean [*Glycine max* (L.) Merrill], *Internat. J. Forestry & Crop Improv.*, **3** (2) : 127-133.

Article Chronical : Received : *10.08.2012;* Revised : *05.10.2012;* Accepted : *01.11.2012*

INTRODUCTION

It is two dimensional crop as it contains about 40-42 per cent high quality protein and 20-22 per cent oil. In India, soybean occupies an area of 9.67 m ha, with production potential of 10.22 MT and average productivity of 1124 kg ha^{-1}. The productivity of soybean in India is less as compared to world average 1.8 t ha^{-1} and Asia 1.3 t ha^{-1}. In Chhattisgarh, soybean occupies 0.13 m ha with production of 0.12 MT and average productivity of 925 kg ha^{-1} (Anonymous, 2010).

The soybean grown in rainy season faces severe weed competition. Weed competition in soybean at early stage of crop growth is critical, as it causes yield losses up to 35 to 50 per cent (Tiwari and Kurchania, 1990). Losses by weeds can be alleviated by effective integrated weed management practices. Integrated weed management is an integration of effective and workable weed management practices that can be used ecologically and economically by the farmers. Therefore, integrated approach of chemical and cultural control may be more feasible and practicable (Sharma *et al.*, 2009).

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EXPERIMENTAL METHODS

The present investigation was carried out during *Kharif* season of 2010 at the Research cum Instructional Farm, Indira Gandhi Krishi Vishwa Vidyalaya, Raipur (C.G.), to find out the appropriate integrated weed management practices for growth and productivity of soybean. The experimental site is located at latitude of $21^0$4' North, a longitude of $81^0$35' East with an altitude of 290.20 m above the mean sea level. The soil of experimental field was cyaley in texture, low in nitrogen, medium in phosphorus and high in potassium contents with neutral in

pH. The experiment was laid in randomized block design with three replications. Soybean variety 'JS-335' (Jawahar Soybean-335) was grown as a test crop. The crop was fertilized with 20:60:30 kg N:P_2O_5:K2O ha^{-1}, respectively, was applied through urea, single super phosphate (SSP) and muriate of potash (MOP) as basal in rows uniformly to each plot. The treatment comprised of thirteen integrated weed management practices, *viz*., T_1- Quizalofop ethyl 10 EC @ 37.5 g ha^{-1}, T_2- Chlorimuron ethyl 25 WP @ 9 g ha^{-1}, T_3- Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + surfactant @ 0.2 per cent, T_4- Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1}, T_5- Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + surfactant @ 0.2 per cent, T_6- Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + Surfactant @ 0.2 per cent fb HW at 35 DAS, T_7- Imazethapyr 10 SL @ 100 g ha^{-1}, T_8- Imazethapyr 10 SL @ 100 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1}, T_9- Imazethapyr 10 SL @ 100 g ha^{-1} fb HW at 35 DAS, T_{10}- Imazethapyr 10 SL @ 100 g ha^{-1} fb hoeing (by wheel hoe) at 35 DAS, T_{11}- hoeing twice (by wheel hoe) at 15 DAS and 35 DAS, T_{12}- farmer's practice (hand weeding twice) at 20 DAS and 40 DAS, T_{13}- control (weedy check). Soybean variety 'JS-335' was sown as a test crop on July 06th, 2010. Sowing was done with a seed-rate of 75 kg ha^{-1} at a spacing of 30 x 10 cm, the crop was harvested on October 27th, 2010.

EXPERIMENTAL RESULTS AND ANALYSIS

The results obtained from the present study have been discussed in detail under following heads :

Growth studies of soybean:

Plant height of soybean was observed at 30, 60, 90 DAS and at harvest and data are presented in Table 1. Data indicate that at 30 DAS, significantly maximum plant height was observed in weedy check (T_{13}), however, it was at par with treatment farmer's practices (hand weeding twice) at 20 DAS and 40 DAS (T_{12}) and hoeing twice (by wheel hoe) at 15 DAS and 35 DAS (T_{11}). At 60 DAS, significantly maximum plant height was observed under weedy check (T_{13}) which was comparable with treatment two hand weeding at 20 DAS and 40 DAS (T_{12}), hoeing twice (by wheel hoe) at 15 DAS and 35 DAS (T_{11}), Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + Surfactant @ 0.2 per cent fb HW at 35 DAS (T_6), Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + Surfactant @ 0.2 per cent (T_5), Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1}(T_4) and Quizalofop ethyl 10 EC @ 37.5 g ha^{-1}(T_1). At 90 DAS, significantly maximum plant height was observed under weedy check (T_{13}), which, was comparable with treatment Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + surfactant @ 0.2 per cent fb HW at 35 DAS (T_6), Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + chlorimuron ethyl 25 WP @ 9 g ha^{-1} + Surfactant @ 0.2 per cent (T_5), Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} (T_4), and Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} (T_1). At harvest, significantly maximum plant height was recorded in weedy check (T_{13}) however it was at par with treatment Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + surfactant @ 0.2 per cent fb HW at 35 DAS (T_6), Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron

Table 1 : Plant height of soybean as affected by integrated weed management practices

	Integrated weed management practices	Dose (a.i.ha^{-1})	Time of application	Plant height (cm)			
				30 DAS	60 DAS	90 DAS	At harvest
T_1	Quizalofop ethyl 10 EC	37.5g	15 DAS	18.24	42.23	53.58	58.56
T_2	Chlorimuron ethyl 25 WP	9g	15 DAS	18.43	40.56	51.67	57.84
T_3	Chlorimuron ethyl 25 WP + Surfactant	9g + 0.2%	15 DAS	18.42	38.88	51.90	56.32
T_4	Quizalofop ethyl 10 EC + Chlorimuron ethyl 25 WP	37.5g + 9g	15 DAS	18.22	43.84	54.97	58.18
T_5	Quizalofop ethyl 10 EC + Chlorimuron ethyl 25 WP + Surfactant	37.5g + 9g + 0.2%	15 DAS	18.26	43.13	55.73	57.82
T_6	Quizalofop ethyl 10 EC + Chlorimuron ethyl 25 WP + Surfactant fb HW	37.5g + 9g + 0.2%	15 DAS fb 35 DAS	18.34	40.47	52.81	56.22
T_7	Imazethapyr 10 SL	100g	15 DAS	18.52	35.11	44.87	47.67
T_8	Imazethapyr 10 SL + Chlorimuron ethyl 25 WP	100g + 9g	15 DAS	18.21	32.56	44.53	47.36
T_9	Imazethapyr 10 SL fb HW	100g	15 DAS fb 35 DAS	18.62	37.10	48.34	54.35
T_{10}	Imazethapyr 10 SL fb Hoeing (by wheel hoe)	100g	15 DAS fb 35 DAS	18.66	39.25	48.44	53.47
T_{11}	Hoeing (by wheel hoe)	-	15 DAS and 35 DAS	20.78	42.79	50.93	54.44
T_{12}	Farmer's practice (hand weeding twice)	-	20 DAS and 40 DAS	20.93	42.87	51.72	55.52
T_{13}	Control (Weedy check)	-	-	21.79	44.48	57.87	60.67
S.E.±				0.90	1.40	1.84	1.73
C.D. (P=0.05)				2.62	4.08	5.38	5.05

ethyl 25 WP @ 9 g ha^{-1} + Surfactant @ 0.2 per cent (T_5), Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 per cent WP @ 9 g ha^{-1} (T_4), Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + surfactant @ 0.2 per cent (T_3), Chlorimuron ethyl 25 WP @ 9 g ha^{-1} (T_2) and Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} (T_1). The significantly shortest plant height was observed in treatment Imazethapyr 10 SL @ 100 g ha^{-1} (T_8) at all the period of observations. This was might be due to herbicidal effects.

The maximum plant height in above treatments might be due to crop-weed competition for light and space. Similar results have been reported by Kothawade *et al.* (2006) and Tiwari *et al.* (2006).

Number of branches $plant^{-1}$:

Number of branches $plant^{-1}$ of soybean was observed at 30, 60, 90 DAS and at harvest (Table 2) Data show that at 30 DAS, significantly highest number of branches $plant^{-1}$ was observed in farmer's practice (hand weeding twice) at 20 DAS and 40 DAS (T_{12}), however, it was at par with hoeing twice (by wheel hoe) at 15 DAS and 35 DAS (T_{11}), Imazethapyr 10 SL @ 100 g ha^{-1} fb hoeing (by wheel hoe) at 35 DAS (T_{10}), Imazethapyr 10 SL @ 100 g ha^{-1} fb HW at 35 DAS (T_9), Imazethapyr 10 SL @ 100 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} (T_8) and Imazethapyr 10 SL @ 100 g ha^{-1} (T_7). At 60 DAS, significantly highest number of branches $plant^{-1}$ was observed under treatment farmer's practice (hand weeding twice) at 20 DAS and 40 DAS (T_{12}), however it was at par with hoeing twice (by wheel hoe) at 15 DAS and 35 DAS (T_{11}), Imazethapyr 10 SL @ 100 g ha^{-1} fb hoeing (by wheel hoe) at 35 DAS (T_{10}), Imazethapyr 10 SL @ 100 g ha^{-1} fb HW at 35 DAS (T_9), Imazethapyr 10 SL @ 100 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} (T_8), Imazethapyr 10 SL @ 100 g ha^{-1} (T_7) and Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + Surfactant @ 0.2 per cent fb HW at 35 DAS (T_6). At 90 DAS and at harvest, significantly maximum number of branches $plant^{-1}$ was observed under treatment farmer's practice (hand weeding twice) at 20 DAS and 40 DAS (T_{12}), however it was at par to treatment hoeing twice (by wheel hoe) at 15 DAS and 35 DAS (T_{11}), Imazethapyr 10 SL @ 100 g ha^{-1} fb hoeing (by wheel hoe) at 35 DAS (T_{10}), Imazethapyr 10 SL @ 100 g ha^{-1} fb HW at 35 DAS (T_9), Imazethapyr 10 SL @ 100 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} (T_8), Imazethapyr 10 SL @ 100 g ha^{-1} (T_7), quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + Surfactant @ 0.2 per cent fb HW at 35 DAS (T_6) and Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + Surfactant @ 0.2 per cent (T_5). The significantly lowest number of branches $plant^{-1}$ was observed under weedy check (T_{13}) at all the period of investigations.

The highest number of branches $plant^{-1}$ observed under treatment farmer's practice (hand weeding twice) at 20 DAS and 40 DAS (T_{12}) and in comparable 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 in conformity with those reported by Vyas and Jain (2003), Kushwah and Vyas (2005) and Vyas and Kushwah (2008).

Dry matter accumulation (g $plant^{-1}$):

Dry matter accumulation $plant^{-1}$ of soybean was observed

Table 2 : Number of branches of soybean as affected by integrated weed management practices

	Integrated weed management practices	Dose ($a.i.ha^{-1}$)	Time of application	No. of branches $plant^{-1}$			
				30 DAS	60 DAS	90 DAS	At harvest
T_1	Quizalofop ethyl 10 EC	37.5g	15 DAS	0.76	2.11	2.34	2.37
T_2	Chlorimuron ethyl 25 WP	9g	15 DAS	0.69	1.89	2.20	2.22
T_3	Chlorimuron ethyl 25 WP + Surfactant	9g + 0.2%	15 DAS	0.77	1.68	2.13	2.16
T_4	Quizalofop ethyl 10 EC + Chlorimuron ethyl 25 WP	37.5g + 9g	15 DAS	1.00	2.28	2.91	2.99
T_5	Quizalofop ethyl 10 EC + Chlorimuron ethyl 25 WP + Surfactant	37.5g + 9g + 0.2%	15 DAS	1.11	2.73	3.40	3.47
T_6	Quizalofop ethyl 10 EC + Chlorimuron ethyl 25 WP + Surfactant fb HW	37.5g + 9g + 0.2%	15 DAS fb 35 DAS	1.20	2.86	3.51	3.62
T_7	Imazethapyr 10 SL	100g	15 DAS	1.24	2.87	3.57	3.65
T_8	Imazethapyr 10 SL + Chlorimuron ethyl 25 WP	100g + 9g	15 DAS	1.30	2.89	3.62	3.66
T_9	Imazethapyr 10 SL fb HW	100g	15 DAS fb 35 DAS	1.29	3.23	3.68	3.79
T_{10}	Imazethapyr 10 SL fb Hoeing (by wheel hoe)	100g	15 DAS fb 35 DAS	1.35	3.19	3.77	3.73
T_{11}	Hoeing (by wheel hoe)	-	15 DAS and 35 DAS	1.33	3.22	3.82	3.84
T_{12}	Farmer's practice (hand weeding twice)	-	20 DAS and 40 DAS	1.43	3.33	3.84	3.85
T_{13}	Control (Weedy check)	-	-	0.89	1.00	1.10	1.14
S.E.±				0.08	0.20	0.22	0.21
C.D. (P=0.05)				0.22	0.58	0.65	0.61

at 30, 60, 90 DAS and at harvest and data presented in Table 3. Data indicate that at 30 DAS, significantly maximum dry matter accumulation plant^{-1} was observed in treatment farmer's practice (hand weeding twice) at 20 DAS and 40 DAS (T_{12}), however, it was at par with, hoeing twice (by wheel hoe) at 15 DAS and 35 DAS (T_{11}), Imazethapyr 10 SL @ 100 g ha^{-1} fb hoeing (by wheel hoe) at 35 DAS (T_{10}), Imazethapyr 10 SL @ 100 g ha^{-1} fb HW at 35 DAS (T_9), Imazethapyr 10 SL @ 100 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} (T_8), Imazethapyr 10 SL @ 100 g ha^{-1} (T_7), Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + Surfactant @ 0.2 per cent fb HW at 35 DAS (T_6), Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + Surfactant @ 0.2 per cent (T_5) and Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} (T_4). At 60 DAS, significantly maximum dry matter accumulation plant^{-1} was observed in treatment farmer's practice (hand weeding twice) at 20 DAS and 40 DAS (T_{12}), however, it was at par with, hoeing twice (by wheel hoe) at 15 DAS and 35 DAS (T_{11}) and Imazethapyr 10 SL @ 100 g ha^{-1} fb HW at 35 DAS (T_9). At 90 DAS and at harvest, significantly maximum dry matter accumulation plant^{-1} was observed under treatment farmer's practice (hand weeding twice) at 20 DAS and 40 DAS (T_{12}), however, it was at par with, hoeing twice (by wheel hoe) at 15 DAS and 35 DAS (T_{11}), whereas significantly minimum dry matter accumulation plant^{-1} was observed under weedy check (T_{13}) at all the time intervals of observation.

The higher dry matter accumulation plant^{-1} in above treatments might be due to lesser population 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), Tiwari *et al.* (2006) and Deore *et al*. (2008). The lowest dry matter accumulation was recorded under weedy check 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).

Number of leaves plant^{-1}:

Number of leaves plant^{-1} of soybean was observed at 30, 60 and 90 DAS (Table 3). At 30 DAS, data indicate that number of leaves plant^{-1} was not influenced due to integrated weed management practices, however, maximum number of leaves

Table 3 : Dry matter accumulation and no. of leaves plant^{-1} of soybean as affected by integrated weed management practices

	Integrated weed management practices	Dose (a.i.ha^{-1})	Time of application	Dry matter accumulation (g plant^{-1})				No. of leaves plant^{-1}		
				30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS
T_1	Quizalofop ethyl 10 EC	37.5g	15 DAS	2.28	7.76	14.77	19.83	14.74	60.65	57.66
T_2	Chlorimuron ethyl 25 WP	9g	15 DAS	2.20	6.37	12.22	16.30	14.43	57.86	51.85
T_3	Chlorimuron ethyl 25 WP + Surfactant	9g + 0.2%	15 DAS	2.24	6.80	12.86	16.96	14.67	58.83	54.84
T_4	Quizalofop ethyl 10 EC + Chlorimuron ethyl 25 WP	37.5g + 9g	15 DAS	2.31	8.19	15.67	21.00	14.32	62.25	54.24
T_5	Quizalofop ethyl 10 EC + Chlorimuron ethyl 25 WP + Surfactant	37.5g + 9g + 0.2%	15 DAS	2.30	9.33	17.12	22.84	14.83	66.82	60.83
T_6	Quizalofop ethyl 10 EC + Chlorimuron ethyl 25 WP + Surfactant fb HW	37.5g + 9g + 0.2%	15 DAS fb 35 DAS	2.33	12	23.10	30.44	14.38	72.46	69.63
T_7	Imazethapyr 10 SL	100g	15 DAS	2.48	11.43	21.80	27.84	14.65	66.48	62.47
T_8	Imazethapyr 10 SL + Chlorimuron ethyl 25 WP	100g + 9g	15 DAS	2.67	11.64	22.00	28.23	14.82	68.66	63.56
T_9	Imazethapyr 10 SL fb HW	100g	15 DAS fb 35 DAS	2.66	12.73	24.00	31.49	14.69	75.82	69.81
T_{10}	Imazethapyr 10 SL fb Hoeing (by wheel hoe)	100g	15 DAS fb 35 DAS	2.65	12.18	22.83	30.00	14.46	75.65	66.47
T_{11}	Hoeing (by wheel hoe)	-	15 DAS and 35 DAS	2.68	13.54	26.55	35.65	15.26	73.84	67.84
T_{12}	Farmer's practice (hand weeding twice)	-	20 DAS and 40 DAS	2.77	14.00	28.20	38.88	15.38	78.65	72.66
T_{13}	Control (Weedy check)	-	-	1.85	6.47	11.67	14.22	14.28	45.83	42.84
S.E.±				0.16	0.51	1.40	1.64	0.70	3.24	3.20
C.D. (P=0.05)				0.48	1.48	4.09	4.79	NS	9.28	9.03

NS=Non-significant

plant^{-1} and minimum number of leaves plant^{-1} were observed under farmer's practice (two hand weeding) at 20 DAS and 40 DAS (T_{12}) and weedy check (T_{13}), respectively. At 60 and 90 DAS, significantly maximum number of leaves plant^{-1} was observed under treatment farmer's practice (hand weeding twice) at 20 DAS and 40 DAS (T_{12}), however, it was at par with hoeing twice (by wheel hoe) at 15 DAS and 35 DAS (T_{11}), Imazethapyr 10 SL @ 100 g ha^{-1} fb hoeing (by wheel hoe) at 35 DAS (T_{10}), Imazethapyr 10 SL @ 100 g ha^{-1} fb HW at 35 DAS (T_9) and Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + Surfactant @ 0.2 per cent fb HW at 35 DAS (T_6), whereas significantly minimum number of leaves plant^{-1} was observed under weedy check (T_{13}) at all period of investigations.

The higher number of leaves plant^{-1} was observed in above treatments owing to better utilization of available nutrient. Similar results have been reported by Deore *et al*. (2008).

Leaf area (cm plant^{-1}):

Leaf area plant^{-1} of soybean was observed at 30, 60 and 90 DAS and data are presented in Table 4. Data reveal that at 30 DAS, significantly maximum leaf area plant^{-1} was observed in treatment farmer's practice (hand weeding twice) at 20 DAS and 40 DAS (T_{12}) however, it was at par with treatment hoeing twice (by wheel hoe) at 15 DAS and 35 DAS (T_{11}), Imazethapyr 10 SL @ 100 g ha^{-1} fb hoeing (by wheel hoe) at 35 DAS (T_{10}), Imazethapyr 10 SL @ 100 g ha^{-1} fb HW at 35 DAS (T_9), Imazethapyr 10 SL @ 100 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} (T_8), Imazethapyr 10 SL @ 100 g ha^{-1} (T_7), Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + Surfactant @ 0.2 per cent fb HW at 35 DAS (T_6), Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + Surfactant @ 0.2 per cent (T_5) and Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} (T_4). At 60 and 90 DAS, significantly maximum leaf area plant^{-1} was observed under treatment farmer's practice (hand weeding twice) at 20 DAS and 40 DAS (T_{12}), which was found comparable with treatment hoeing twice (by wheel hoe) at 15 DAS and 35 DAS (T_{11}), Imazethapyr 10 SL @ 100 g ha^{-1} fb hoeing (by wheel hoe) at 35 DAS (T_{10}), Imazethapyr 10 SL @ 100 g ha^{-1} fb HW at 35 DAS (T_9) and Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + Surfactant @ 0.2 per cent fb HW at 35 DAS (T_6), whereas significantly minimum leaf area plant^{-1} was observed under weedy check (T_{13}) at all time of observations. Similar results have been reported by Deore *et al.* (2008).

The higher leaf area plant^{-1} in above treatments might be due to more number and diameter of leaves plant^{-1}.

Crop growth rate (g plant^{-1} day^{-1}):

Crop growth rate of soybean was observed at 0-30, 30-60, 60-90 DAS and 90 DAS-at harvest. Crop growth rate of soybean

Table 4 : Leaf area, seed yield and stover yield of soybean as affected by integrated weed management practices

	Integrated weed management practices	Dose (a.i. ha^{-1})	Time of application	Leaf area (cm plant^{-1})			Seed yield (q ha^{-1})	Stover yield (q ha^{-1})
				30 DAS	60 DAS	90 DAS		
T_1	Quizalofop ethyl 10 EC	37.5g	15 DAS	167.54	1370.27	1297.55	14.40	40.42
T_2	Chlorimuron ethyl 25 WP	9g	15 DAS	166.32	1309.72	1163.53	10.30	37.40
T_3	Chlorimuron ethyl 25 WP + Surfactant	9g + 0.2%	15 DAS	165.69	1334.55	1237.01	10.53	37.39
T_4	Quizalofop ethyl 10 EC + Chlorimuron ethyl 25 WP	37.5g + 9g	15 DAS	182.68	1419.22	1223.98	15.25	40.91
T_5	Quizalofop ethyl 10 EC + Chlorimuron ethyl 25 WP + Surfactant	37.5g + 9g + 0.2%	15 DAS	183.61	1530.75	1384.32	15.42	40.84
T_6	Quizalofop ethyl 10 EC + Chlorimuron ethyl 25 WP + Surfactant fb HW	37.5g + 9g + 0.2%	15 DAS fb 35 DAS	184.74	1775.06	1602.54	17.66	42.72
T_7	Imazethapyr 10 SL	100g	15 DAS	189.17	1512.96	1415.91	16.56	42.86
T_8	Imazethapyr 10 SL + Chlorimuron ethyl 25 WP	100g + 9g	15 DAS	197.66	1588.69	1442.24	16.76	42.99
T_9	Imazethapyr 10 SL fb HW	100g	15 DAS fb 35 DAS	199.64	1790.45	1626.34	19.88	44.11
T_{10}	Imazethapyr 10 SL fb Hoeing (by wheel hoe)	100g	15 DAS fb 35 DAS	184.65	1685.15	1537.33	19.56	43.16
T_{11}	Hoeing (by wheel hoe)	-	15 DAS and 35 DAS	196.25	1800.41	1636.83	20.81	44.57
T_{12}	Farmer's practice (hand weeding twice)	-	20 DAS and 40 DAS	210.97	1925.36	1770.85	21.13	44.90
T_{13}	Control (Weedy check)	-	-	129.31	1077.04	1006.53	9.15	34.45
S.E.±				10.17	86.66	83.72	1.28	2.16
C.D. (P=0.05)				29.67	252.95	244.35	3.74	6.30

showed increasing trend up to 90 DAS and declined there after till harvest. The numerically maximum crop growth rate was observed under treatment farmer's practice (hand weeding twice) at 20 DAS and 40 DAS (T_{12}) fallowed by hoeing twice (by wheel hoe) at 15 DAS and 35 DAS (T_{11}), Imazethapyr 10 SL @ 100 g ha^{-1} fb hoeing (by wheel hoe) at 35 DAS (T_{10}), Imazethapyr 10 SL @ 100 g ha^{-1} fb HW at 35 DAS (T_9) and Quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + Chlorimuron ethyl 25 WP @ 9 g ha^{-1} + Surfactant @ 0.2 per cent fb HW at 35 DAS (T_6). Minimum crop growth rate was observed under weedy check (T_{13}), at all the period of investigations.

Decline crop growth rate was caused by senescence of leaves probably owing to competition from weeds for solar radiation and also due to density of weeds higher in these periods.

Relative growth rate (g g^{-1} $plant^{-1}$ day^{-1}):

Relative growth rate of soybean was observed at 0-30, 30-60, 60-90 DAS and 90 DAS-at harvest and data are presented in Fig. 1. Relative growth rate of soybean showed increasing trend upto 60 DAS and declined there after till harvest. The numerically maximum relative growth rate was observed under treatment farmer's practice (hand weeding twice) at 20 DAS and 40 DAS (T_{12}) fallowed by hoeing twice (by wheel hoe) at 15 DAS and 35 DAS (T_{11}), imazethapyr 10 SL @ 100 g ha^{-1} fb hoeing (by wheel hoe) at 35 DAS (T_{10}), imazethapyr 10 SL @ 100 g ha^{-1} fb HW at 35 DAS (T_9) and quizalofop ethyl 10 EC @ 37.5 g ha^{-1} + chlorimuron ethyl 25 WP @ 9 g ha^{-1} + surfactant @ 0.2 per cent fb HW at 35 DAS (T_6). Minimum relative growth rate was observed under weedy check (T_{13}), at all the intervals of observations.

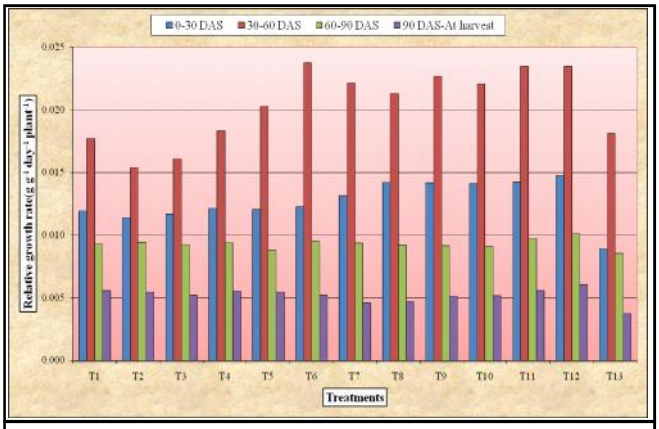

Fig. 1 : Relative growth rate (g g^{-1} day^{-1} $plant^{-1}$) of soybean as affected by integrated weed management practices

Relative growth rate of soybean in above treatments was higher because of comparatively less crop-weed competition, which allowed more utilization of light, water and nutrient as well as more number of leaves available for photosynthesis, which resulted into more carbohydrate production. The increased sink size, stored the photosynthates very effectively and ultimately transformed in the shape of more dry matter accumulation which resulted in higher relative growth rate.

Seed yield (q ha^{-1}):

The capacity of plants to produce seed yield depends not only the size of photosynthetic systems, it's efficiently and length of time for which it is active but also on translocation of dry matter into economic sink. The final build up of yield is cumulative function of yield components. The data presented in the Table 4 clearly indicated that the significantly maximum seed yield of soybean was found under the treatment farmer's practice (hand weeding twice) at 20 DAS and 40 DAS (T_{12}), which was found comparable with treatment hoeing twice (by wheel hoe) at 15 DAS and 35 DAS (T_{11}), imazethapyr 10 SL @ 100 g ha^{-1} fb hoeing (by wheel hoe) at 35 DAS (T_{10}) and imazethapyr 10 SL @ 100 g ha^{-1} fb HW at 35 DAS (T_9), where as significantly minimum seed yield observed under weedy check (T_{13}). Similar findings were also reported by Dubey *et al.* (2000), Mandloi *et al.* (2000), Kumar *et al.* (2001), Gaikward and Powar (2002).

The possible reason for higher seed yield in these treatments was due to the weed managed at critical period and early crop growth, higher dry matter production, which resulted in higher production of photosynthesis, which acts as a source and greater translocation of food materials to the reproductive parts resulted in superiority of yield attributing characters and ultimately high yield. The lower seed yield under weedy check may be due to the high weed interference.

Stover yield (q ha^{-1}):

Significantly maximum stover yield of soybean was observed under treatment farmer's practice (hand weeding twice) at 20 DAS and 40 DAS (T_{12}) which was found comparable with treatments hoeing twice (by wheel hoe) at 15 DAS and 35 DAS (T_{11}), imazethapyr 10 SL @ 100 g ha^{-1} fb hoeing (by wheel hoe) at 35 DAS (T_{10})and imazethapyr 10 SL @ 100 g ha^{-1} fb HW at 35 DAS (T_9), whereas significantly minimum stover yield observed under weedy check (T_{13}) (Table 4). The higher stover yield in above treatments might be due to lesser weeds during early crop growth period and get higher yield attributes and pod yield which leads to higher stover yield. Similar findings were reported by Dhane *et al.* (2009)

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