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Effect of Integrated weed management on yield and yield attributes of soybean (*Glycine max*. (L.) Merrill)

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Abstract
A field experiment was carried out at experimental farm of Agronomy section, College of Agriculture, Latur during *Kharif* 2017. As the title indicates, the current work aims to identify the effect of integrated weed management on yield and yield attributes of soybean (*Glycine max*. (L.) Merrill). The experiment was laid out in a Randomized Block Design with eight treatments and replicated thrice.
The work revealed that, seed yield and yield components were found significantly superior with treatment (T_8) i.e. weed free, which recorded highest seed yield (2009 kg ha^{-1}) as compared to all other treatments. Treatment (T_4) i.e. Pendimethalin 30% EC @ 1kg a.i./ha (PE) + Imazethapyr 10% SL @ 100g a.i./ha (PoE) ranked second in case of seed yield and lowest seed yield was recorded with treatment (T_7) i.e. Weedy check (1266 kg ha^{-1}) as compared to all other treatments.
Study revealed the superiority of treatment weed free (T_8) for majority of yield attributes in addition to the seed yield and suggesting the positive benefits of weed management on yield and yield attributing characters of soybean.

Keywords: Weed management, weeds, herbicides, soybean, yield, yield attributes

1. Introduction
Soybean (*Glycine max* (L.) Merill) is a leguminous crop and belongs to family leguminoceae with sub family papilionaceae. It is originated in China and it was introduced in India in recent years. Soybean (*Glycine max*) is important oil yielding rainy season crop having multiple uses. Soybean which is also known as soya beans are species of legume that have become one of the most widely consumed foods in the world. They are extremely useful for human health, and they are easy to cultivate as well.
Soybean is an important crop in human and animal nutrition, because it is a major source of edible vegetable oil and high protein feed as well as food in the world. The protein content of soybean ranges from 36 to 56 percent of dry weight (Atli Arnarson 2015) [1].
During *kharif* 2016, all India estimated area, production and productivity of soybean was 109.716 lakh ha, 114.907 lakh MT and 1047 kg ha^{-1} respectively (Anonymous 2016) [2]. Major soybean growing states in India are Madhya Pradesh (58%), Maharashtra (30%), Rajasthan (6%), Karnataka, Uttar Pradesh, Andhra Pradesh, Chhattisgarh and Gujarat. During the year 2017-2018 world's soybean production was 346.919 lakh MT and India 9.500 lakh MT (Anonymous 2017) [3].
Among the major constraints, initial heavy infestation of weeds is one of the important factors, which hinders its overall growth and productivity (Malik and Malik, 1994) [4]. It is an established fact that weeds, due to their competition for water, light and nutrients reduce crop yields, but little is known about the physiological interaction between crop plants and weeds that brings about the reduction in growth which indirectly results in yield reduction (Aspinall and Milthorpe, 1959) [5].
Weed management is one of the most important factors impacting agricultural productivity. Weeds directly compete with crops for limited resources which reduce crop yield and increase the cost of production. Weeds also impede the efficiency of crop harvest and harbour insects and diseases that can be harmful to crops. There are three goals of any weed management system: reduce weed density, reduce the amount of damage that a given density of weeds inflicts on an associated crop, and alter the composition of weed communities towards less aggressive and easier-to-manage species.
Among the various weed management options herbicide use is not only efficient method but it is cost effective also. On the other hand, physical weed control measure *viz.* hand weeding are safe but labour intensive.

Keeping this view the present study was carried out to study the effect of integrated weed management on yield and yield attributes of soybean (*Glycine max*. (L.) Merrill).

2. Materials and Methods

A field experiment was conducted during *kharif* season of 2017-18 at Experimental Farm, Agronomy Section, College of Agriculture, Latur. The experimental site was low in available nitrogen (108.00 kg ha^{-1}), low in available phosphorus (8.18kg ha^{-1}), high in available potassium (430.00 kg ha^{-1}) and alkaline (p^H 7.45) in reaction. The soil was clayey in texture with moderate moisture holding capacity which was good for normal growth. Mechanical analysis of soil was done by International Pipette Method (Piper, 1966) [6], Available nitrogen by alkaline potassium permanganate method (Subbiah and Asija, 1956) [7], available phosphorous by Olsen method (Olsen *et al.*, 1954) [8] and available potassium by Flame emission method (Jackson, 1967) [9].

The experiment was laid out in a Randomized Block Design with eight treatments and replicated thrice. The treatments were (T_1) Pendimethalin 30% EC @ 1 kg a. i./ha (P. E.) + Hoeing at 25-30 DAS, (T_2) Quizalofop-ethyl 5% EC @ 0.05 kg a. i./ha (PoE), (T_3) Imazethapyr 10% SL @ 100 g a.i./ha (PoE), (T_4) Pendimethalin 30% EC @ 1 kg a.i./ha (PE) + Imazethapyr10% SL @ 100 g a.i/ha (PoE), (T_5) Pendimethalin 30% EC @ 1 kg a. i. /ha (PE) + Quizalofop-ethyl 5% EC @ 0.05 kg a.i/ha.(PoE), (T_6) Haloxyfop – ethoxyethyl 10.8 EC @ 0.05 kg a.i./ha.(PoE), (T_7) Weedy check and (T_8) Weed free check.

Gross and net sizes of plots were 5.4 m × 3.9m and 4.5m × 2.9 m respectively. Sowing was done by dibbling method on 28 June 2017 with spacing 45cm × 05 cm. Fertilizers were applied to respective plots as per the recommended dose of fertilizer i.e. 30:60:30 NPK kg ha^{-1} by using the urea (46% N), 10:26:26 and murate of potash (60% K2O). The recommended cultural practices and plant protection measures were taken. The crop was harvested on 11 Oct. 2017.

3. Yield and yield attributes were worked out as follows,

3.1 Number of pods plant^{-1}

The number of pods plant^{-1} were counted and recorded periodically on plant basis.

3.2 Pod yield plant^{-1} (g)

The pods obtained from each plant were dried and weighed in gram.

3.3 Seed yield plant^{-1} (g)

Weight of seed plant^{-1} was recorded after harvest. The samples constituted of five randomly selected plants from each net plot were cleaned and mean weight was recorded in gram.

3.4 Number of seeds pod^{-1}

Total number of seeds pod^{-1} from observational plant was counted.

3.5 Test weight (g)

One thousand representative seeds counted from the produce of net plot and their weight was recorded in grams as test weight.

3.6 Yield

3.6.1 Seed yield (kg ha^{-1})

The plants from each net plot were threshed and seeds were cleaned. The cleaned seeds obtained from each net plot were weighted in kg which was then converted into seed yield (kg ha^{-1}) by multiplying with hectare factor.

3.6.2 Straw yield (kg ha^{-1})

After separation of seeds from biological yield, remaining material (stem+ bhoosa) was considered as straw yield and its final weights were recorded in kg per net plot, which was then converted into straw yield (kg ha^{-1}) by multiplying with hectare factor.

3.6.3 Biological yield (kg ha^{-1})

The biological yield was recorded by the following formula.

Biological yield= Seed yield + Straw yield.

3.6.4 Harvest index (%)

Harvest index indicates the efficiency of plant material to convert the photosynthate into the economic yield and it was worked out as

$$\text{Harvest index (\%)} = \frac{\text{Seed yield (kg ha}^{-1})}{\text{Total biological yield (kgha}^{-1})} \text{ X } 100$$

Biological yield = Seed yield + Straw weight + Pod husk
Where, straw yield = Stalks + leaves

3.7 Statistical analysis and interpretation of data

Data obtained on various variables were analyzed by "analysis of variance method" (Panse and Sukhatme, 1967) [10]. The total variance (S^2) and d. f. (n-1) divided into different possible sources. The variance due to replication and treatment effects were calculated and compared with error variance for finding out "F" values and ultimately for testing the significance at P = 0.05 wherever the results were found significant. Critical difference was calculated for comparison of treatment mean at 5% level of significance where results are significant.

The total precipitation received during crop period was only 626 mm with 27 rainy days.

4. Results and Discussion

Almost all the yield and yield attributing characters *viz*., mean number of pods plant^{-1}, pod yield plant^{-1}, seed yield plant^{-1} number of seeds pod^{-1}, test weight, seed yield (kg ha^{-1}), straw yield (kg ha^{-1}), biological yield (kg ha^{-1}) and harvest index (%) were significantly influenced by various treatments.

4.1 Mean number of pods plant^{-1}

The highest mean number of pods plant^{-1} at harvest were recorded by weed free plot (T_8). It was found significantly superior over rest of the treatments. Treatment (T_7) weedy check recorded lowest pod plant^{-1}. This might be happened due to effective weed control, which reduced the crop-weed competition for resources. Similar result reported by Kulal *et al*. (2016) [11].

4.2 Pod yield plant^{-1} (g)

Significant differences were observed in respect of pod yield plant^{-1} due to different weed control treatments. The treatment (T_8) weed free plot recorded highest pod yield plant^{-1}. It was found at par with T_1 and T_4 and significantly superior over rest of the treatments. It might be due to no competition for resources between crop plants and weeds due to effective weed control. Similar results were reported by Kulal *et al.* (2016) [11].

4.3 Seed yield plant^{-1}(g)

The seed yield plant^{-1} was significantly influenced by different weed control treatments. The treatment (T_8) weed free plot recorded highest seed yield plant^{-1} which was found significantly superior over (T_7) treatment. It might be due to effective control of weeds, which indirectly enhanced the crop seed yield. These results are in conformation with Kulal *et al.* (2016) [11].

4.4 Number of seeds plant^{-1}

The number of seeds plant^{-1} was influenced significantly due to different weed control treatments. The maximum number of seeds plant^{-1} was observed in weed free plot (T_8) which was at par with T_1, T_2, T_3 and T_4 and significantly superior over rest of the treatments. It might be due to effective control of weeds.

4.5 Test weight (g)

The maximum test weight (115.10 g) was obtained with the weed free plot (T_8) which was closely followed by (T_4) treatment i.e. Pendimethalin 30% EC @ 1 kg a.i./ha (PE) + Imazethapyr 10%SL @ 100 g a.i./ha. The test weight did not significantly influenced due to different weed control treatments.

4.6 Seed yield, straw yield, biological yield and harvest Index

The mean seed yield (1507 kg ha^{-1}), straw yield (2393 kg ha^{-1}), biological yield (3896 kg ha^{-1}) and harvest index (38.04%) were recorded at harvest. The seed yield, straw yield and biological yield were influenced significantly by different treatments.

4.6.1 Seed yield (kg ha^{-1})

Weed control treatments differed significantly with each other in respect of seed yield kg ha^{-1}. The treatments weed free plot (T_8) recorded highest seed yield (2009 kg ha^{-1}) which was found significantly superior over all other treatments. Treatment (T_4) Pendimethalin 30% EC @ 1kg a.i./ha (PE) + Imazethapyr 10% SL @ 100g a.i./ha (PoE) ranked second and treatment weed check recorded lowest seed yield ha^{-1}. It might be due to effective control of weeds, which indirectly enhanced the seed yield potential of the crop. These results are in conformation with Kulal *et al.* (2016) [11].

4.6.2 Straw yield (kg ha^{-1})

The straw yield was varied materially due to weed control treatments. Straw yield was augmenting effect increased vegetative growth through plant height, number of branches and number of pods plant^{-1}. The treatment (T_8) weed free plot produced highest straw yield ha^{-1} and weedy check (T_7) recorded lowest straw yield ha^{-1}. It might be due to effective control of weeds. This result is in close conformity with Smita Prachand *et al.* (2012) [12], Kulal *et al*. (2016) [11] and Jain *et al.* (1985) [13].

4.6.3 Biological yield (kg ha^{-1})

Data on biological yield as affected by different weed control treatments revealed that treatments differed significantly in respect to biological yield (Table 2). The treatment weed free plot (T_8) produced higher biological yield which was significantly superior over all other treatments. The treatment T_2 ranked second and found at par with all other treatments except T_8. It might be due to effective control of weeds, which indirectly helped the plant to grow with its full yield potential. Similar results were reported by Raghuwanshi *et al*. (2005) [14].

4.6.4 Harvest index (%)

In case of harvest index treatment weed free plot (T_8) recorded highest harvest index (41.85%) followed by (T4) Pendimethalin 30% EC @ 1kg a.i./ha (PE) + Imazethapyr 10% SL @ 100g a.i./ha (PoE). The mean harvest index of soybean was 38.04 per cent.

Table 1: Yield attributes of soybean influenced by different treatments.

Treatments	Mean No. of Pods plant^{-1}	Pod yield plant^{-1} (g)	Seed yield plant^{-1} (g)	No of seeds plant^{-1}	Test weight (g)
T1 - Pendimethalin 30% EC @ 1 kg a. i./ha (P. E.) + Hoeing at 25-30 DAS	27.44	7.48	5.42	43.25	112.90
T2 - Quizalofop-ethyl 5% EC @ 0.05 kg a. i./ha (PoE)	26.39	7.04	5.31	40.13	111.03
T3 – Imazethapyr 10% SL @ 100 g a.i./ha (PoE)	26.72	7.08	5.56	40.91	111.07
T4 - Pendimethalin 30% EC @ 1 kg a.i./ha (PE) + Imazethapyr10% SL @ 100 g a.i/ha (PoE)	34.14	7.90	5.79	46.51	114.47
T5 – Pendimethalin 30% EC @ 1 kg a. i. /ha (PE) + Quizalofop-ethyl 5% EC @ 0.05 kg a.i/ha.(PoE)	25.41	6.84	5.22	39.49	109.83
T6 - Haloxyfop – ethoxyethyl 10.8 EC @ 0.05 kg a.i./ha.(PoE)	23.42	6.75	5.11	38.64	112.13
T7 - Weedy check	21.46	5.35	4.04	30.61	109.73
T8 - Weed free check.	42.30	8.12	6.13	46.91	115.10
S.E.±	1.6	0.36	0.33	2.31	2.41
CD at 5%	5.0	1.0	1.02	7.0	NS
General Mean	28.41	7.07	5.32	40.81	112.03

Table 2: Seed yield, straw yield, biological yield (kg ha^{-1}) and harvest index (HI%) of soybean as influenced by different treatments.

Treatments	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	HI (%)
T1 - Pendimethalin 30% EC @ 1 kg a. i./ha (P. E.) + Hoeing at 25-30 DAS	1523	2310	3833	39.73
T2 - Quizalofop-ethyl 5% EC @ 0.05 kg a. i./ha (PoE)	1481	2419	3900	37.97
T3 – Imazethapyr 10% SL @ 100 g a.i./ha (PoE)	1508	2325	3833	39.34
T4 - Pendimethalin 30% EC @ 1 kg a.i./ha (PE) + Imazethapyr10% SL @ 100 g a.i/ha (PoE)	1539	2328	3867	39.80
T5 – Pendimethalin 30% EC @ 1 kg a. i. /ha (PE) + Quizalofop-ethyl 5% EC @ 0.05 kg a.i/ha.(PoE)	1424	2409	3833	37.15
T6 - Haloxyfop – ethoxyethyl 10.8 EC @ 0.05 kg a.i./ha.(PoE)	1304	2236	3567	36.58
T7 - Weedy check	1266	2267	3533	35.83

T8 - Weed free check.	2009	2791	4800	41.85
S.E.±	98	96	187	-
CD at 5%	297	297	566	-
General Mean	1507	2393	3896	38.04

5. Conclusion

On the basis of above findings it may be inferred that for achieving higher seed yield (kg ha^{-1}), harvest index (%) and yield attributes *viz*., seed yield $plant^{-1}$(g), mean number of pods $plant^{-1}$ and pod yield $plant^{-1}$ (g), treatment weed free (T_8) was found effective.

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