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Subhash Bhanwar
M.Sc.(Ag) Agronomy, Dr. B.R. Ambedkar University of Social Sciences, Mhow, Madhya Pradesh, India

Gabu Singh Gathiye
Scientist (Agronomy), RVSKVV-Krishi Vigyan Kendra, Dhar, Madhya Pradesh, India

Vishal Verma
JRF, Division of Genetics and Plant propagation, TFRI, Jabalpur, Madhya Pradesh, India

Corresponding Author:
Subhash Bhanwar
M.Sc.(Ag) Agronomy, Dr. B.R. Ambedkar University of Social Sciences, Mhow, Madhya Pradesh, India

To study the effect of chemical weed control on growth and yield of soybean (*Glycine max* L.)

Subhash Bhanwar, Gabu Singh Gathiye and Vishal Verma

Abstract
An experiment entitled "To study the effect of Chemical Weed Control on Growth and Yield of Soybean (*Glycine max* L.)" was conducted in *Kharif* season at student research field, College of Agriculture, Indore (M.P.). The soil of the experimental field was medium black in texture, neutral in reaction (pH 7.60) with normal EC (0.45 dS/m) and medium organic carbon contents (0.72%) and analysing low in available N (270 kg/ha), medium in available P (6.9 kg/ha) and high in available K (382 kg/ha) contents. Due to dominance of montmorillonite clay content it has high capacity to swell and shrink and high CEC. A field experiment was consisted of 9 treatments replicated four times in randomized block design (RBD). As per treatment, the seed of soybean *cv.* JS 335 was sown in all the treatments consisting with pre and post emergence herbicides. The maximum numbers of branches/plant (3.38) was recorded in the treatment T_9 (weed free plot) followed by T_4-fenoxaprop-ethyl 9% EC (3.12), which was applied as post-emergence herbicide at 20 DAS at all the stages of crop growth. The maximum number of pods per plant (30.90), number of seeds per pod (2.30) and number of seeds per plant (58.00) was recorded under treatment T_9 (weed free plot) while minimum number of pods (20.00) and seeds (46.0) per plant was recorded under treatment T_5. The highest grain (1433 kg/ha) and stover yield (1552 kg/ha) was recorded under treatment T_9 -weed free plot followed by 1400 kg/ha (grain) and 1473 kg/ha (stover) under treatment T_4-fenoxaprop-p-ethyl 9% EC while the lowest grain yield (914 kg/ha) and stover yield (1138 kg/ha) was obtained under treatment T_8 (control).

Keywords: Soybean, Pre and post emergence herbicide, growth and yield parameters

Introduction
Soybean (*Glycine max* (L) Merrill) is established as one of the major *kharif* season field crops in Madhya Pradesh particularly in Malwa plateau. It has resulted economical crop because of comparatively good economic return/unit area obtained by the farmers from its improvement in the living condition of farmers. Indian soybean holds on an average 37-41% protein, 17-21% oil, 25-30% carbohydrate, 4-5% ash, 4-5% crude fibre and 2% phospholipids, that is why, it is called 'meat of the field'. It has recorded biological value of 2.5 and 3.5 PER (protein efficiency ratio) when it is used as raw and processed respectively. However, its productivity in the State is 1102 kg/ha which is very low as compared to the global productivity of 2206 kg/ha (Anonymous, 2014) [1].

Among the causes of low productivity, weeds are the major problems causing about 37% yield reduction (Arya *et al.,* 1994). Weed control is indispensable in modern crop management because weeds cause competition stresses for light, moisture, space, nutrients and may have some allelopathic as well, resulting in poor crop growth especially during the 40 days after sowing and thereby yields are reduced markedly (Tiwari *et al.,* 1997) [14]. Complete mechanical and/or manual weeding may not be possible and cost effective during the critical period of crop weed competition for obvious reasons.

Herbicides are considered almost synonymous with modern weed science technology, as they gave a new direction to the formers to realize the maximum yield potential of the crop at lower production. Areas where farmers are progressive and have greater managerial ability, with scarcity of labour, chemical weed control has emerged out as one of the important factors in increasing the yield of crop. The medium to deep *Vertisol* soils in Malwa plateau in *kharif* season at times lose their workability due to rains and mechanical weeding in standing crop becomes almost impossible. Under such situations, the chemical weed control seems to be the best option to overcome the weed competition.

Material and Methods
The experiment was conducted on the Research Farm of BRAUSS Mhow in Rehati Hoshangabad, (M.P.). The topography of the experimental area are fairly leveled and proper drainage was provided.

Plots were protected as not to allow the free flowing of surface runoff water, affecting the individual plot treatments. The meteorological data showed that the total rainfall received during the crop growth period was 588 mm. The maximum temperature varied from 25.7-38.6^{o}c and the minimum temperature varied from 14.1-23.2^{o}c. The total number of rainy days was 48.

The soil of the experimental field has been grouped under medium black (*Vertisols*) belonging to fine montmorillonite hypertharmic family predominantly clay textural class. For fertility status of the experimental area, the soil samples were collected randomly with the help of soil augar before sowing from the experimental field and representative composite sample was made for the mechanical and chemical analysis. The soil of the experimental field was medium black in texture, neutral in reaction (pH 7.60) with normal EC (0.45 dS/m) and medium organic carbon contents (0.72%) and analysing low in available N (270 kg/ha), medium in available P (6.9 kg/ha) and high in available K (382 kg/ha) contents.

The experiment consisting of nine treatments and four replications with randomized block design was laid out in the experiment. Alachlor, Pendimetholin are the herbicides, which were used as pre emergence. These were sprayed immediately after the sowing of soybean crop. Chlorimuron ethyl, fenoxoprop ethyl. Chlorimuron ethyl + fenoxoprop ethyl, quizaifop ethyl, and imazethapyr were used as post emergence herbicide. These were sprayed at 15-25 days after planting as per herbicide. The herbicides spray mixture was added with 1 ml per litre of gum as stickers. The following pre and post harvest observations were taken during the study:

Pre harvest observation

Pre-harvest observations on soybean crop were recorded on various growth parameters to study the influence of different treatments at various stages during crop growth period.

Plant population

Initial and final plant population of crop of crop was counted at 20 days after sowing and just before harvesting respectively in one m row length at three random places in three different rows in each net plot and mean was worked out.

Height of the plant

Plant height is an index of growth, which is influenced by different weed management treatments. Five plants per plot were selected randomly and tagged for taking the periodic observations on height. The height was measured on the main shoot from the ground surface to the tip. These observations were taken at 15 days interval in all the treatments *i.e.* at 30, 45, 60, 75 DAS and at maturity.

Number of leaves per plant

The number of leaves was counted on the 5-tagged plants plants per plot and mean was calculated. These observations were taken at 30, 45, 60, 75 DAS in all the treatments.

Number of branches per plant

The primary branches were counted on five tagged plants at 30, 45, 60, 75 DAS and at harvesting of crop in all the plots.

Post harvest observations

Number of pods per plant

The increase in grain yield of soybean crop is determined by the bearing of number of pods. The number of pods per plant directly affects the number of grains per plant and ultimately the final grain yield of the crop. Number of pods counted on 10 already tagged sample plants per plot and mean was calculated,

Number of grains per pod

Random samples of 20 pods were drawn from each plot to work out the mean number of grains per pod.

Seed yield (kg/ha)

The seed yield per net plot was recorded after drying the seed it is also known as economical yield. The plot yield was later on converted in to kg per hectare by multiplying it by conversion factor.

Stover yield (kg/ha)

The stover yield per plot was obtained by subtracting grain yield (economical yield) from biological yield (bundle weight) in each plot. This was later on converted in to kg/ha.

Results and Discussion

Pre harvest studies

Plant population (per m row length)

The data showed that plant population affected significantly by various weed management treatments, which comprised of different chemical herbicides, It was also noted that the plant population was fairly uniform and there was no mortality at any stage of crop growth till maturity of the crop.

Table 1: Plant population of soybean as affected by different treatments

Tr. No	Treatments	Plant population/ running meter	
		20 DAS	At harvest
T_1	Alachlor 50 EC, 2.0 kg/ha (Pre.eme.)	16.40	16.10
T_2	Pendimethalin 30 EC, 750 g/ha (Pre.eme.)	16.20	16.10
T_3	Chlorimuron-ethyl 25% WP, 9.37 g/ha, post eme. (20 DAS)	16.30	16.40
T_4	Fenoxaprop-p-ethyl 9% EC, 67.5 g/ha post eme.(20 DAS)	16.10	16.50
T_5	Chlorimuron ethyl + Fenoxaprop-ethyl, 9.37 g/ha + 67.5 g/ha, post eme.	16.30	16.10
T_6	Quizalafop-p-ethyl 5% EC, 50 g/ha, post eme. (15 DAS)	16.50	16.10
T_7	Imazethapyr 5% EC, 50 g/ha, post eme. (25 DAS)	16.50	15.10
T_8	Control (unweeded)	15.30	15.80
T_9	Weed free	16.40	17.00
	SEm	1.30	1.35
	CD at 5%	NS	NS

Plant height (cm)

Data revealed that average plant height increased progressively with increase in the age of the crop till 75 DAS. The plant gained height at increased rate between 30 to 45 DAS and relatively slower rate between 60 and 75 DAS. Maximum plant height of 57.90 cm at harvest was recorded in treatment of weed free condition (T_9) and closely followed by treatments T_3 (Chlorimuron-ethyl), T_4 (Fenoxaprop-p-ethyl) and T_5 (Chlorimuron-ethyl + Fenoxaprop-p-ethyl) suggesting that these chemicals could be used for weed control in soybean.

Table 2: Plant height as influenced by different treatments at successive stages of growth

Tr. No	Treatments	Plant height (cm)				
		30 DAS	45 DAS	60 DAS	75 DAS	At harvest
T_1	Alachlor 50 EC, 2.0 kg/ha (Pre.eme.)	11.80	37.50	53.30	53.10	52.50
T_2	Pendimethalin 30 EC, 750 g/ha (Pre.eme.)	11.90	37.30	52.70	53.20	53.10
T_3	Chlorimuron-ethyl 25% WP, 9.37 g/ha, post eme. (20 DAS)	15.00	37.70	56.60	57.40	56.10
T_4	Fenoxaprop-p-ethyl 9% EC, 67.5 g/ha post eme.(20 DAS)	15.60	39.20	58.70	59.00	56.40
T_5	Chlorimuron ethyl + Fenoxaprop-ethyl, 9.37 g/ha + 67.5 g/ha, post eme.	15.60	38.10	58.50	58.17	56.20
T_6	Quizalafop-p-ethyl 5% EC, 50 g/ha, post eme. (15 DAS)	11.40	36.80	49.30	49.30	51.20
T_7	Imazethapyr 5% EC, 50 g/ha, post eme. (25 DAS)	11.20	36.00	48.30	48.60	52.10
T_8	Control (unweeded)	9.06	32.30	46.10	46.60	49.60
T_9	Weed free	16.10	41.50	59.80	60.10	57.40
	SEm	1.00	1.17	2.17	1.89	1.12
	CD at 5%	2.93	3.44	6.35	5.53	3.27

Number of leaves/plant

Data indicated that the number of trifoliate leaves/plant progressively increased with increase in the age of the crop 60 DAS. The rate of increase in number of trifoliate leaves per plant was maximum between 45 and 60 DAS. Number of trifoliate leaves/plant at maturity was reduced. Data revealed that treatment T_9 (weed free plot) proved significantly superior to all the treatments except T_4 (Fenoxaprop-p-ethyl) at harvest stage (21.60) while the minimum number of leaves at harvest was recorded in T_7 -Imazethapyr 5% SL (14.60). The treatment T_4 (fenoxaprop-p-ethyl) gave 20.20 number of leaves/plant at harvest, which was almost at par with T_9 -weed free plot (21.60).

Table 3: Average number of trifoliate leaves/plant at successive stages of plant growth

Tr. No	Treatments	Average number of trifoliate leaves/plant				
		30 DAS	45 DAS	60 DAS	75 DAS	At harvest
T_1	Alachlor 50 EC, 2.0 kg/ha (Pre.eme.)	7.61	14.60	22.40	20.20	15.70
T_2	Pendimethalin 30 EC, 750 g/ha (Pre.eme.)	7.89	14.40	21.60	19.40	14.90
T_3	Chlorimuron-ethyl 25% WP, 9.37 g/ha, post eme. (20 DAS)	8.80	15.90	23.90	22.60	17.10
T_4	Fenoxaprop-p-ethyl 9% EC, 67.5 g/ha post eme.(20 DAS)	9.19	16.60	26.40	24.20	20.20
T_5	Chlorimuron ethyl + Fenoxaprop-ethyl, 9.37 g/ha + 67.5 g/ha, post eme.	9.10	16.00	24.40	21.10	17.50
T_6	Quizalafop-p-ethyl 5% EC, 50 g/ha, post eme. (15 DAS)	7.69	14.30	21.00	18.80	16.70
T_7	Imazethapyr 5% EC, 50 g/ha, post eme. (25 DAS)	7.58	14.20	21.10	18.10	14.60
T_8	Control (unweeded)	6.15	11.10	19.30	17.30	15.65
T_9	Weed free	9.58	17.10	27.40	25.50	21.60
	SEm	0..47	0.79	1.09	1.15	1.26
	CD at 5%	1.39	2.32	3.20	3.36	3.69

Number of branches per plant

The average number of branches/plant increased with the increase in the age of the crop. The maximum number of branches/plant were recorded in the treatment T_9 (weed free plot) at all the stages of crop growth followed by T_4 - fenoxaprop-ethyl 9% EC, which was applied as post-emergence herbicide at 20 DAS. It was significant to record that the values of number of branches/plant (3.38 and 3.12) were almost same at 75 DAS and at harvest, since no branching function took place after 75 DAS. T_6 (quizalofop-p-ethyl 5% EC) and T_7 (Imazethapyr 5% SL) were almost similar in influencing the number of branches/plant at all stages of plant growth.

Table 4: Effect of different treatments on average number of branches per plant

Tr. No	Treatments	Average number of branches/plant				
		30 DAS	45 DAS	60 DAS	75 DAS	At harvest
T_1	Alachlor 50 EC, 2.0 kg/ha (Pre. eme.)	0.70	1.60	2.25	2.28	2.24
T_2	Pendimethalin 30 EC, 750 g/ha (Pre. eme.)	0.73	1.48	2.10	2.10	2.03
T_3	Chlorimuron-ethyl 25% WP, 9.37 g/ha, post eme. (20 DAS)	0.90	1.69	2.80	2.80	2.78
T_4	Fenoxaprop-p-ethyl 9% EC, 67.5 g/ha post eme.(20 DAS)	1.01	2.04	3.10	3.13	3.12
T_5	Chlorimuron ethyl + Fenoxaprop-ethyl, 9.37 g/ha + 67.5 g/ha, post eme.	1.01	1.80	2.91	2.93	2.90
T_6	Quizalafop-p-ethyl 5% EC, 50 g/ha, post eme. (15 DAS)	0.41	1.29	1.87	1.87	1.88
T_7	Imazethapyr 5% EC, 50 g/ha, post eme. (25 DAS)	0.37	1.15	1.72	1.72	1.72
T_8	Control (unweeded)	0.33	0.91	1.31	1.33	1.34
T_9	Weed free	1.21	2.11	3.28	3.38	3.38
	SEm	0.14	0.11	0.18	0.21	0.20
	CD at 5%	0.42	0.34	0.54	0.62	0.58

Post harvest studies

Number of pods/plant

The highest number of pods (30.90) per plant was recorded under treatment T_9 (weed free plot) followed by 27.60 pods per plant in the treatment T4, fenoxaprop-p-ethyl 9% EC applied as post-emergence treatment at 20 DAS. The treatment of imazethapyr recorded least number of pods (20.00) per plant among chemical herbicides.

Number of seeds/pod

The highest (2.30) number of seeds per pod was recorded under treatment T_9- weed free plot followed by treatment T_4, fenoxaprop-p-ethyl (2.13) and treatment T_1, alachlor (2.02). All the treatments were found superior over control. However, the differences among the treatments were found non-significant.

Number of seeds/plant

The highest number of seeds (58.00) was observed in T_9 - weed free condition plot followed by treatment T_4, fenoxaprop-p-ethyl 9% EC (56.90) while the lowest number of seeds/plant (46.00) was recorded under treatment T_5.

Table 5: Number of pods/plant, seeds/pod and seeds/plant as influenced by different treatments

Tr. No	Treatments	Pods/ plant	seeds/pod	seeds/ plant
T_1	Alachlor 50 EC, 2.0 kg/ha (Pre.eme.)	24.80	2.02	55.50
T_2	Pendimethalin 30 EC, 750 g/ha (Pre.eme.)	24.80	1.79	53.60
T_3	Chlorimuron-ethyl 25% WP, 9.37 g/ha, post eme. (20 DAS)	26.60	1.97	55.10
T_4	Fenoxaprop-p-ethyl 9% EC, 67.5 g/ha post eme.(20 DAS)	27.60	2.13	56.90
T_5	Chlorimuron ethyl + Fenoxaprop-ethyl, 9.37 g/ha + 67.5 g/ha, post eme.	27.70	1.96	55.40
T_6	Quizalafop-p-ethyl 5% EC, 50 g/ha, post eme. (15 DAS)	22.90	1.46	48.50
T_7	Imazethapyr 5% EC, 50 g/ha, post eme.(25 DAS)	20.00	1.37	48.50
T_8	Control (unweeded)	17.40	1.25	46.00
T_9	Weed free	30.90	2.30	58.00
	SEm	1.53	0.24	1.14
	CD at 5%	4.48	NS	3.34

Grain yield (kg/ha)

The highest grain yield of 1433 kg/ha was recorded under treatment T_9 -weed free plot followed by 1400 kg/ha under treatment T_4-fenoxaprop-p-ethyl 9% EC while the lowest grain yield (914 kg/ha) was obtained under treatment T_8 (control). Treatment T_3 and T_5 with grain yield of 1334 and 1362 kg per hectare were recorded at par while treatment T_2 and T_6 both with grain yield of 1286 kg/ha were found exactly at par with each other.

Stover yield (kg/ha)

The highest amount of stover yield (1552 kg/ha) was recorded under T_9 -weed free plot followed by 1473 kg/ha under treatment T_4. Higher quantity of stover production naturally resulted in lower grain yield of 914 kg/ha due to weedy condition of this treatment while lowest stover yield (1138 kg/ha) was recorded under T_8 -weed check.

Table 6: Mean grain yield and stover yield (kg/ha) and harvest indeed as influenced by different treatments

Tr. No.	Treatments	Yield (kg/ha)	
		Grain	Stover
T_1	Alachlor 50 EC, 2.0 kg/ha (Pre.eme.)	1314	1405
T_2	Pendimethalin 30 EC, 750 g/ha (Pre.eme.)	1286	1416
T_3	Chlorimuron-ethyl 25% WP, 9.37 g/ha, post eme. (20DAS)	1334	1395
T_4	Fenoxaprop-p-ethyl 9% EC,67.5 g/ha post eme.(20DAS)	1400	1473
T_5	Chlorimuron ethyl + Fenoxaprop-ethyl, 9.37 g/ha + 67.5 g/ha, post eme.	1362	1365
T_6	Quizalafop-p-ethyl 5% EC, 50 g/ha, post eme. (15 DAS)	1286	1458
T_7	Imazethapyr 5% EC, 50 g/ha, post eme. (25 DAS)	1238	1391
T_8	Control (unweeded)	914	1138
T_9	Weed free	1433	1552
	SEm	49.77	56.83
	CD at 5%	145.28	165.88

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