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Production potential of [*Glycine max* (L.) Merrill] under different weed management practices

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ABSTRACT : The results of experiment reveal that pre-emergence application of pendimethalin 0.75kg ha^{-1} + hand weeding 30DAS resulted the lowest density of monocot (3.41m^{-2}), dicot (3.15m^{-2}) and total weeds (4.59m^{-2}) 50DAS compared to weedy check (6.80, 6.01 and 9.05m^{-2}), respectively. Integration of pre-emergence herbicides with hand weeding or their sequential use with post-emergence herbicides was found significantly superior in controlling the weed density 50DAS compared to their corresponding application alone. All the weed control treatments were also found significantly superior in reducing dry matter of monocot; dicot and total weeds compared to weedy check 75DAS. Minimum total weed dry matter 75DAS was observed under weed free (146kg ha^{-1}) closely followed by pre-emergence application of pendimethalin 0.75kg ha^{-1} + hand weeding 30DAS (431.7kg ha^{-1}) compared to weedy check (1884.5kg ha^{-1}). Weed control efficiency 75DAS observed maximum under weed free treatment in which crop was kept weed free upto 50 days (92.18%) which is closely followed by pre-emergence application of pendimethalin 0.75kg ha^{-1} + hand weeding 30DAS (76.96%) and weed index was also recorded the lowest under pre-emergence application of pendimethalin 0.75kg ha^{-1} + hand weeding 30DAS (3.17%). Uptake of N and P by weeds at harvest was found significantly lower with all the weed control treatments compared to weedy check. The minimum uptake of N (2.78kg ha^{-1}) and P (0.40kg ha^{-1}) was recorded with weed free treatment closely followed by pre-emergence application of pendimethalin 0.75kg ha^{-1} + hand weeding 30DAS with the respective uptake values as 8.17 and 1.18kg ha^{-1}. All the weed control treatments significantly tended to increase plant height, dry matter accumulation, branches plant^{-1} and leaf area of soybean over weedy check. Weed free treatment recorded the highest plant dry matter (32.20g plant^{-1}) at harvest closely followed by pre-emergence application of pendimethalin 0.75kg ha^{-1} + hand weeding 30DAS (31.05g plant^{-1}) and two hand weeding (30.65g plant^{-1}). Weed free treatment recorded maximum number of branch plant^{-1}, number of pods plant^{-1}, pod length and seed index which was closely followed by pre-emergence application of pendimethalin 0.75kg ha^{-1} + hand weeding 30DAS and these treatments were found statistically at par to each other in this regard. Weed free upto 50 days treatment resulted in maximum seed yield (1421kg ha^{-1}) which was statistically at par with pre-emergence application of pendimethalin 0.75kg ha^{-1} + hand weeding 30 DAS (1376kg ha^{-1}) and two hand weeding 15 and 30DAS (1321kg ha^{-1}). A like seed yield, haulm yield (3100kg ha^{-1}), biological yield (4521kg ha^{-1}) and harvest index (31.43%) were also recorded maximum under weed free treatment which were closely followed by pendimethalin 0.75kg ha^{-1} PE + hand weeding 30DAS. The maximum uptake of total nitrogen (143.78kg ha^{-1}) and phosphorus (15.63kg ha^{-1}) by the crop was significantly more in weed free check closely followed by pre-emergence application of pendimethalin 0.75kg ha^{-1} + hand weeding 30DAS and these treatments were found statistically at par to each other in this regard and the minimum being recorded under weedy check with the respective value of 52.32 and

5.64kg ha^{-1}. Both net return (Rs.29508 ha^{-1}) and benefit cost ratio (2.38) were also obtained maximum under pre-emergent pendimethalin 0.75kg ha^{-1}+ hand weeding 30DAS closely followed by two hand weeding 15 and 30DAS with the respective net return and BC ratio of Rs. 27244 and 2.26.

KEY WORDS : CGR, RGR, LAI, NAR, DAS

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Soybean is a miracle " golden bean" of 21st century because it contains 38-42 per cent good quality protein and 18-20 per cent oil, which is rich in polyunsaturated fatty acids (Linoleic and oleic acid) along with good amount of minerals (Ca, P, Mg, Fe and K) and vitamins specially B- complex and teco-pherols. Additionally, it provides phyto-chemicals in high amounts. It also contains good quality dietary fibre, which enables the human body to fight against diabetes. It has a very high potential among the grain legumes for combating acute malnutrition. The quality of soybean protein is equivalent to animal protein and it is also a good source of dietary fibre, calcium, magnesium, phosphate, thiamine, riboflavin, niacin etc. It has also been reported for its medicinal properties in combating diabetes, cancer, heart disease etc. Another significance of this crop is its ability to fix atmospheric nitrogen (Priya *et al.,* 2009). Soybean can be utilized for food as well as non-food purposes. Food products like oil, soy flour, soymilk, soy paneer, soy nuts, candy sauce, extruded products, fortified traditional products etc. are made from it. For non-food purposes, it is utilized for manufacturing ink, cosmetics, bio-diesel, textiles, fibre glass etc. One kg of soybean may yield five to six kg soymilk after processing. Approximate 85 per cent soybean is utilized for oil extraction, 10 per cent for seed and 5 per cent for food. It plays a pivotal role in meeting the continuously increasing demand of the edible oil across the world. Globally, the crop contributes about 25 per cent to the total edible oil production. The estimates of world soybean area, production and productivity for 2012-13 were 103.29 million ha, 257.00 million tones and 2.43 tones ha^{-1}, respectively. India is the fourth and fifth largest country in the world with respect to its area and production, respectively. In the recent years it has emerged as an important oilseed crop in India and stood first among the oilseed crops followed by rapeseed and mustard and groundnut. On the national basis, during the year 2014-15, soybean occupied an area of 10.83 million ha with production and productivity of 10.43 million tones and 959 kg ha^{-1}, respectively. Madhya Pradesh is the largest soybean producing state of India which contributes 57.72 per cent of total production followed by Maharashtra (29.43 %). Rajasthan occupies an area of 0.68 million hectare with the production of 0.56 million tons during *Kharif* 2014 (SOPA, 2014). There is a big gap between the present productivity (827kg ha^{-1}) and genetic potential of the crop due to number of reasons including poor crop establishment, higher infestation of weeds, insects and diseases etc. Soybean is a rainy season crop and intense weed competition during the active phase of growth is one of the constraints in realizing its higher productivity. In soybean grassy and broad leaf weeds emerge simultaneously with the crop plants and rob it of essential nutrients, space and moisture, causing substantial loss in yield (33-55%) depending on weed flora and their density. Yield reductions in soybean due to poor weed management ranges from 12 to 85 per cent depending on weed flora and their density. Although weeds pose problems during the entire crop period but the first 30-45 days of the crop is the most critical. Unavailability of adequate laborers at peak periods of weeding, unpredictability of rains as well as non-workable soil conditions; weed management in soybean is really a challenging task. Manual weeding is effective but, it is cumbersome, time consuming and uneconomical while mechanical means generally leads to root injury. Under such situation weed management through the herbicidal application remains the only viable option. Use of herbicide not only improve crop yield but also makes available significant laborers for other productive activities. Various pre emergence herbicides have been tested and recommended for control of weeds in this crop in the zone and most of which have a narrow spectrum weed control. The biology of some weeds that occur in soybean makes it difficult

to achieve effective weed control with single application either pre or post-emergence herbicide. Recent studies in many crops indicated that sequential application of herbicides (pre followed by post) or integration of herbicides with hand weeding will provide more consistent weed control than single application. A single application of any herbicide has not been effective in curbing the weed menace with diversified weed flora. Hence, it is worthwhile to use different herbicides at varying doses in conjunction with hand weeding as well as their sequential application for effective control of wide varieties of weeds (i) To study the effect of weed management practices on the weed dynamics, (ii) To assess the performance of weed management practices on productivity of soybean and (iii) To evaluate the economic feasibility of weed management practices.

RESEARCH METHODS

The details of experimental techniques, materials used and criteria adopted for treatment evaluation during the course of investigation are presented in this chapter.

Seed treatments:

Seed was treated with thiram @ 2g kg^{-1} seed to prevent seed borne disease. Then it was inoculated with efficient Rhizobium japonicum and PSB strain procured from Department of Agricultural Chemistry and Soil Science (Microbiology unit), Rajasthan College of Agriculture, Udaipur as per recommended procedure.

Fertilizer application:

A uniform dose of 20kg N and 40kg P_2O_5 ha^{-1} was given through urea and DAP after adjusting the quantity of nitrogen supplied through DAP. The required quantities of fertilizers were drilled manually below the seed.

Seed and sowing:

Soybean variety JS-9560 was used as a test crop. Furrow were opened at a spacing of 30cm and after 15 DAS of sowing plant to plant distance was maintained about 10cm and seeds were placed at a depth of 2-3cm.

Weed management:

As per treatment, pendimethalin and metribuzin were applied one day after the sowing of crop while imazethapyr and fenoxaprop-p-ethyl were applied twenty days after sowing. These herbicides were sprayed with knapsack sprayer fitted with flat fen nozzle using 500 litres of water per hectare. Hand weeding operations were performed with hand hoe.

Plant protection:

During the crop growth period the crop remained unaffected with any of the insect and pest. Therefore, neither the fungicide nor insecticide was used as a plant protection measures.

Table A : Physico-chemical characteristics of the soil of experimental field

Characteristics	Content	Method of analysis	Reference
Mechanical analysis			
Sand (%)	38.30	Hydrometer method	(Bouyoucos, 1962)
Silt (%)	28.40		
Clay (%)	33.30		
Textural classes	Clay loam	Triangular diagram	(Brady, 1983)
Physical analysis			
Bulk density (Mg m^{-3})	1.35	Core sampler method	(Piper, 1950)
Particle density (Mg m^{-3})	2.75		(Black, 1965)
Porosity (%)	49.28		
Chemical analysis			
Organic carbon (%)	0.84	Rapid titration method	(Walkley and Black, 1947)
Available N (kg ha^{-1})	275.00	Modified Kjeldal's method	(Jackson, 1967)
Available P (kg ha^{-1})	16.42	Olsen's method	(Olsen *et al.,* 1954)
Available K (kg ha^{-1})	275.90	Flame photometer	(Jackson, 1967)
Electrical conductivity (d Sm^{-1} at 25^0C)	0.88	Solubridge	(Richards, 1968)
pH (1:2.5 soil water suspension)	7.8	pH meter	(Richards, 1968)

Table B : Schedule of operations during crop period

Operations	Date
Field preparation	14.07.2016
Layout and bunding	15.07.2016
Opening of furrows and fertilizer placement	15.07.2016
Sowing	16.07.2016
Metribuzin (PE)	17.07.2016
Pendimethalin (PE)	17.07.2016
Thinning	31.07.2016
One hand weeding (20DAS)	06.08.2016
Imazethapyr and Fenoxaprop-p-ethyl application	06.08.2016
Two hand weeding (15 and 30DAS)	01.08.2016 and 16.08.2016
Harvesting	20.10.2016
Threshing and winnowing	02.11.2016

Harvesting and threshing :

The crop was harvested at physiological maturity when plants turned golden yellow. The plants from border areas were harvested first and collected, thereafter, and removed from each plot. After this, crop of net plot area was harvested, bundled and tagged separately. These bundles were brought to the threshing floor and left for sun drying for a period of 13 days. The dried bundles were weighed to record biological yield. After threshing, winnowing and cleaning was done and seeds were weighed separately to record seed yield kg ha^{-1}. The composite seed and haulm samples from each experimental unit were collected for laboratory studies.

Table C : Details of herbicides used

Common name	Trade name	Chemical name
Pendimethalin	Stomp	N-(1-ethylproyl)-3, 4-dimethyl-2, 6- dinitro benzenamine
Metribuzin	Sencor	4-amino-6-(1,1 –dimethylethal)-3-(methylthio)-1,2,4-triazin
Fenoxaprop-p-ethyl	Whip super	2-[4-(6-chloro-benzoxazoly) oxy) phenoxy] propionate
Imazethapyr	Pursuit	2[4, (5-dihydro-4-methyl-4(1-methylethyl)-5-oxo-1,H-imidazol-2-yl]-5-ethyl-3-pyrine carboxylic acid

Treatment evaluation:

In order to evaluate effect of treatments on growth, yield components, yield, nutrient content and their uptake observations were recorded for each parameter as per methodology.

Weed studies:

Weed density m^{-2} 25DAS and 50DAS :

List of dominant weed species observed during the course of investigation is presented in Table D. In each plot, categories wise (monocot and dicot) weeds were counted from two randomly selected area of 0.25 m^2 using 0.5 m x 0.5 m quadrate at 25 and 50DAS and their average was multiplied by four to obtain density in one square meter area. The mean data were subjected to square root transformation $(x + 0.5)^{1/2}$ to normalize their distribution.

Table D: Weed flora of experimental site

Botanical name	English name	Growth habit
Amarathus viridis L.	Slender amaranthus	ADRs
Commelina benghalensis L.	Day flower	ADRs
Parthenium hysterophorus L.	Carrot grass	ADRs
Trianthima portulcastrum L.	Carpet weed	ADRs
Cynodon dactylon (L.) Pers.	Bermuda grass	PMRsRv
Cyperus rotundus L.	Purple nutsedge	PMRsRv
Echinochloa colona (L.) Link.	Jungle rice	AMRs
Digera arvensis Forsk.	Digera	AMRs

Dry matter accumulation 75DAS (*g m^{-2}*):

The weeds under 0.25m^2 area were removed at harvest and classified as monocot and dicot. These were dried at 70°C temperature till a constant weight was observed and converted into kg ha^{-1}.

Crop studies:

Plant population:

The numbers of plants were counted in five randomly selected spots in one-meter row length in each experimental unit at 25, 50DAS and at harvest. These were averaged and numbers of plants ha^{-1} was worked out and expressed in lac ha^{-1}.

Growth parameters:

Plant height :

Height of five randomly selected plants from each plot was measured at 25, 50, 75DAS and at harvest from the base of the plant to fully open leaf tip and the average plant height was worked out and expressed in cm.

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

The number of branches from five randomly

selected plants from each plot was recorded at 75DAS and average was worked out.

Dry matter accumulation plant^{-1}:

The periodic changes in dry matter accumulation plant^{-1} were recorded at 25, 50, 75DAS and at harvest by uprooting five randomly selected plants from each plot. These samples were chopped and placed in perforated paper bags; sun dried for two days and finally kept in oven at 70°C till a constant weight was noted. Dry matter accumulation plant^{-1} was computed for each treatment at each stage and it was expressed as g plant^{-1}.

Leaf area:

Leaf area was calculated by randomly selecting five plants, detaching leaves and categorizing them according to their size *i.e.* length and width (small, medium and large). The number of leaves in each category was counted. The average area of three representative leaves was estimated through plan meter from each category. This average leaf area was used to compute total leaf area in each category by multiplying area of representative leaf and number of leaves in the same category. The leaf area of all three categories was summed upto find out the leaf area of five plants and then average leaf area plant^{-1} was obtained dividing it through five. Leaf area (m^{-2}) was calculated using formula: Plant population running metre^{-1} x 3.33 x leaf area plant^{-1} (m^2).

Leaf area index:

Mean leaf area plant^{-1} was used to work out leaf area index using equation given by (Watson, 1947) as under.

$$\text{Leaf area index (LAI)} = \frac{\text{Leaf area plant}^{-1}\ (\text{m}^2)}{\text{Ground area occupied by the plant}^{-1}\ (\text{m}^2)}$$

Growth analysis:

The crop growth rate, relative growth rate and net assimilation rate were computed empirically by using formula proposed by Redford in 1967.

Crop growth rate (*CGR*):

Crop growth rate is the gain in dry matter production on a unit of land in a unit of time. The efficiency parameter CGR between 25-50 and 50-75DAS was computed on the basis of dry matter accumulation plant^{-1} using following formula given and expressed in g m^{-2} day^{-1}.

$$\text{CGR (g m}^{-2}\text{day}^{-1}) = \frac{W_2 - W_1}{t_2 - t_1}$$

where, W_1 and W_2 are dry matter production at time t_1 and t_2, respectively.

Net assimilation rate (*NAR*):

NAR directly indicates the rate of net photosynthesis. It is expressed as g of dry matter production m^{-2} of leaf area in a day. For calculating NAR, leaf area of individual plant was used. It was estimated between 25-50 and 50-75DAS.

$$\text{NAR (g m}^{-2}\text{ day}^{-1}) = \frac{(W_2 - W_1)(\text{Log}_e L_2 - \text{Log}_e L_1)}{(t_2 - t_1)(L_2 - L_1)}$$

where, Log_e = Natural log, W_1 = Total dry matter at time t_1, W_2, = Total dry matter at time t_2, t_1 = Time of first observation, t_2 = Time of second observation, L_1 = Leaf area at time t_1, L_1 = Leaf area at time t_2.

Yield attributes:

Pods plant^{-1}:

Fully matured and developed pods from randomly selected five plants from each plot were plucked and counted. The average pods plant^{-1} was worked out.

Number of seeds pod^{-1}:

Pods collected from ten randomly selected plants were threshed, cleaned and total number of seeds was counted and the average number of seed pod^{-1} was estimated by dividing the number of pods.

Length of pods:

Length of pods was estimated by randomly selecting 20 pods selected from soybean plants from each experimental plot was measured from the base to the tip using a scale. Mean pods length (cm) was determined by summing up the length of all 20 pods and divided by 20.

Hundred seed weight:

Seed sample was drawn after weighing of produce from each net plot yield. From these, 100 seeds were counted and weighed and expressed in gram.

Yield and harvest index:

Seed yield (*kg ha^{-1}*):

After threshing and winnowing seed yield of net

plot was recorded and used to compute seed yield kg ha^{-1}.

Haulm yield (*kg* ha^{-1}):

The haulm yield was computed by subtracting the corresponding seed yield from biological yield and expressed in kg ha^{-1}.

Biological yield (*kg* ha^{-1}):

The produce (seed + haulm) from each net plot area after complete sun drying was weighed for recording biological yield and expressed as kg ha^{-1}.

Harvest index (*%*):

It is ratio of economic yield (seed yield) to the biological yield, which was worked out by following formula and expressed in per cent.

$$\text{Harvest index (\%)} = \frac{\text{Seed yield (kg ha}^{-1})}{\text{Biological yield (kg ha}^{-1})} \text{ x 100}$$

Biochemical studies:

Oil content in seeds (*%*):

Oil percentage in seeds from each net plot sample was determined by soxhlet ether extraction method and expressed as per cent oil content in seed.

Protein content in seeds (*%*):

The protein content of seed was estimated by multiplying nitrogen content of seed with conversion factor of 6.25.

Chlorophyll content (*mg* g^{-1}):

Chlorophyll content of fresh leaf samples from each experimental plot was estimated at 50 and 75DAS following the procedure lay down by Aron in 1949 using 80 per cent acetone. Total chlorophyll was computed using following formula.

$$\text{Total chlorophyll content} = \frac{20.2\ A_{645} + 8.02\ A_{663}}{(\text{Mg g}^{-1})\text{a x 1000 x W}}$$

where, a = Length of light path in the cell (usually 1 cm), W = Fresh weight of the leaf sample (g), V= Volume of extract (ml).

Chemical studies:

Nutrient content:

Seed and haulm samples collected at harvest from each experimental unit were oven dried at 70°C till a constant weight and grounded in laboratory mill. These samples were subjected to chemical analysis for determining N and P contents. The following standard methods for analysis were adopted (i) Nitrogen-Nessler's reagent colorimetric method and (ii) Phosphorus-ammonium vanadomolybdate yellow colour method.

Nutrient uptake :

Uptake of N and P by seed and haulm were estimated by using following formula:

$$\text{Nutrient uptake} = \frac{\text{Nutrient content in seed (\%)x Seed yield (kg ha}^{-1})}{\text{By seed (kg ha}^{-1})\ 100}$$

$$\text{Nutrient uptake} = \frac{\text{Nutrient content in haulm (\%)x Haulm yield (kg ha}^{-1})}{\text{By haulms (kg ha}^{-1})\ 100}$$

Total uptake of nutrients was computed by summing up the uptake by seed and haulm.

RESEARCH FINDINGS AND DISCUSSION

The result of the experiment on production potential of [*Glycine max* (L.) Merrill] under weed management practices" conducted during *Kharif*, 2016 are being presented in this chapter.

Weed density:

It is pertinent to point out here that since, at 25DAS hand weeding twice treatment as well as hand weeding 30DAS in combination with pre-emergence herbicidal treatments were partially performed. As such the effects of these treatments in the following text will construed to mean only one and not to separate treatment. It is also felt necessary to mention that crop was kept weed free upto 50 days stage and after 50 days stage some of the late emerging weed flush appeared in the field which constitute negligible weed dry matter in the observations of weeds taken after this stage of crop.

25DAS:

An examination of data Table 1 reveals that all the weed control treatments significantly reduced density of monocot, dicot and total weeds over weedy check. Data clearly indicate that at this stage of observation weed free treatments recorded the lowest density of all sort of weeds compared to rest of the weed control treatments. After weed free treatment the next best treatment in this regard was one hand weeding performed 20DAS followed by two hand weeding

treatment in which only one weeding was done 15DAS. At this stage of observation hand weeding in combination with pre-emergence application of herbicides could not be performed, therefore, pre-emergence application of pendimethalin 750g ha^{-1} and its combination with one hand weeding as well as pre-emergence application of metribuzin 350g ha^{-1} and its integration with one hand weeding 30DAS are almost identical to their corrosponding applicaton alone with respect to control of weed density.

Table 1 : Effect of weed management treatments on density of weeds at 25 and 50 DAS (No. m^{-2})

Treatments	Weed density					
	25 DAS			50 DAS		
	Monocots	Dicots	Total	Monocots	Dicots	Total
Weedy check	5.96* (35)	5.48 (29.50)	8.06 (64.5)	6.80 (45.84)	6.01 (35.68)	9.05 (81.52)
Pendimethalin 750 g ha^{-1} PE	4.29 (17.94)	4.12 (16.50)	5.91 (34.44)	4.80 (22.59)	4.34 (18.36)	6.44 (40.95)
Metribuzin 350 g ha^{-1} PE	3.94 (15.02)	3.88 (14.59)	5.48 (29.61)	4.53 (20.02)	4.37 (18.58)	6.25 (38.60)
Fenoxaprop-p-ethyl 75 g ha^{-1} POE	4.17 (16.95)	3.94 (15.03)	5.70 (31.98)	4.62 (20.86)	4.19 (17.10)	6.20 (37.96)
Imazethapyr 100 g ha^{-1} POE	4.10 (16.32)	3.83 (14.21)	5.57 (30.53)	4.55 (20.18)	4.18 (17.03)	6.14 (37.21)
Pendimethalin PE + HW 30 DAS	4.18 (17.15)	4.01 (15.56)	5.76 (32.71)	3.41 (11.15)	3.15 (9.44)	4.59 (20.59)
Metribuzin PE + HW 30 DAS	3.90 (14.71)	3.73 (13.60)	5.36 (28.31)	3.83 (14.16)	3.36 (10.77)	5.04 (24.93)
Pendimethalin PE + Fenoxaprop-p-ethyl POE	3.55 (12.1)	3.33 (10.60)	4.82 (22.7)	4.11 (16.45)	3.58 (12.31)	5.40 (28.76)
Pendimethalin PE + Imazethapyr POE	3.43 (11.28)	3.20 (9.71)	4.64 (20.99)	4.03 (15.75)	3.49 (11.71)	5.29 (27.46)
Metribuzin PE + Fenoxaprop-p-ethyl POE	3.54 (12.06)	3.34 (10.64)	4.82 (22.7)	4.07 (16.10)	3.52 (11.93)	5.34 (28.03)
Metribuzin PE + Imazethapyr POE	3.49 (11.71)	3.28 (10.25)	4.74 (21.96)	4.01 (15.60)	3.51 (11.85)	5.28 (27.45)
One hand weeding at 20 DAS	3.26 (10.1)	3.11 (9.18)	4.45 (19.28)	4.19 (17.07	4.01 (15.57)	5.76 (32.64)
Two hand weeding 15 and 30 DAS	3.37 (10.83)	3.17 (9.53)	4.57 (20.36)	3.75 (13.68)	3.27 (10.19)	4.92 (23.87)
Weed free upto 50 days	0.71 (0)	0.71(0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)
S.E.±	0.10	0.09	0.11	0.12	0.09	0.15
C.D. (P=0.05)	0.28	0.27	0.31	0.34	0.27	0.43

Table 2 : Effect of weed management treatments on dry matter of weeds at 75 DAS

Treatments	Weed dry matter (kg ha^{-1})		
	Monocot	Dicot	Total
Weedy check	890.0	994.5	1884.5
Pendimethalin 750 g ha^{-1} PE	321.5	480.3	800.8
Metribuzin 350 g ha^{-1} PE	329.8	451.2	781.0
Fenoxaprop-p-ethyl 75 g ha^{-1} POE	334.4	425.5	759.9
Imazethapyr 100 g ha^{-1} POE	365.0	355.0	720.0
Pendimethalin PE + HW 30 DAS	225.7	206.0	431.7
Metribuzin PE + HW 30 DAS	268.4	275.2	543.6
Pendimethalin PE + Fenoxaprop-p-ethyl POE	280.0	289.0	569.0
Pendimethalin PE + Imazethapyr POE	272.8	260.9	533.7
Metribuzin PE + Fenoxaprop-p-ethyl POE	265.8	298.8	564.6
Metribuzin PE + Imazethapyr POE	284.0	281.5	565.5
One hand weeding at 20 DAS	308.0	320.0	628.0
Two hand weeding 15 and 30 DAS	255.0	220.6	475.6
Weed free upto 50 days	80.5	65.5	146.0
S.E.±	18.4	20.5	38.8
C.D. (P=0.05)	53.4	59.7	112.9

50DAS:

A perusal of data Table 1 indicates that all the weed control practices significantly reduced density of monocot, dicot and total weed over weedy check. At this stage of observation pre-emergence application of pendimethalin 750g ha^{-1} + one hand weeding 30DAS recorded the lowest density of monocot, dicot and total weeds compared to rest of the weed control treatments which was closely followed by two hand weeding and both of these treatments were found statistically at par to each other in reducing weed density.

Weed dry weight at 75DAS:

Data in Table 2 reveal that all the weed control treatments significantly reduced dry matter accumulation of monocot, dicot and total weeds over weedy check. After weed free treatment minimum dry matter of monocot, dicot and total weeds was recorded under pre-emergence application of pendimethalin 750g ha^{-1} + one hand weeding 30DAS and the respective values for these parameters under unweeded treatment were 890, 994.5 and 1884.5kg ha^{-1}, respectively. Amongst sequential application of herbicides pre-emergence application of pendimethalin followed by imazethapyr 20DAS recorded the lowest dry matter of monocot, dicot and total weeds to the tune of 272.8, 260.9 and 533.7kg ha^{-1}, respectively and these sequential treatments were found statistically at par to other treatments of sequential application. Data further reported that integration of pre-emergence herbicide with hand weeding 30DAS or their sequential application were found significantly superior to over their counter parts.

Weed control efficiency :

A reference to data presented in Table 3 explicit that weed control efficiency at 75DAS based on weed dry weight fluctuated to a great extent under the influence of various weed control treatments. Data clearly indicate that in general all weed control treatments efficiently controlled monocots, dicot as well as total weeds.

Weed index:

A perusal of data in Table 3 shows that all weed control treatments substantially reduced weed index compared to un weeded control and it ranged from minimum of 3.17 per cent in pre emergence application of pendimethalin 750g ha^{-1} + one hand weeding 30DAS to maximum of 63.34 per cent under weedy check thus, indicating a great variation under different weed control treatments. The next best treatment in this regard was two hands weeding 15 and 30DAS with weed index value of 7.04 per cent and it is followed by sequential application of pendimethalin and post-emergence application of imazethapyr with weed index value of 13.30 per cent.

Table 3 : Effect of weed management treatments on weed control efficiency at 75 DAS and weed index at harvest

Treatments	Weed control efficiency (%)			Weed index (%)
	Monocot	Dicot	Total	
Weedy check	-	-	-	63.34
Pendimethalin 750 g ha^{-1} PE	63.88	51.70	57.79	35.61
Metribuzin 350 g ha^{-1} PE	62.94	54.63	58.79	41.24
Fenoxaprop-p-ethyl 75 g ha^{-1} POE	62.43	57.21	59.82	29.28
Imazethapyr 100 g ha^{-1} POE	58.99	64.30	61.65	26.46
Pendimethalin PE + HW 30 DAS	74.64	79.29	76.96	3.17
Metribuzin PE + HW 30 DAS	69.84	72.33	71.09	20.41
Pendimethalin PE + Fenoxaprop-p-ethyl POE	68.54	70.94	69.74	16.68
Pendimethalin PE+ Imazethapyr POE	69.35	73.77	71.56	13.30
Metribuzin PE + Fenoxaprop-p-ethyl POE	70.13	69.95	70.04	20.48
Metribuzin PE + Imazethapyr POE	68.09	71.69	69.89	16.61
One hand weeding at 20 DAS	65.39	67.82	66.61	21.46
Two hand weeding 15 and 30 DAS	71.35	77.82	74.58	7.04
Weed free upto 50 days	90.96	93.41	92.18	-
S.E.±	-	-	-	-
C.D. (P=0.05)	-	-	-	-

Nutrient content in weeds:

Nitrogen content:

Data reveal that nitrogen content in monocot and dicot weeds at 75DAS under the influence of all weed control treatments did not vary significantly however, it ranged between 1.56 to 1.71 and 2.01 to 2.15 under monocot and dicot weeds, respectively (Table 4).

Phosphorus content:

An assessment of data indicates that alike nitrogen content in weeds, phosphorus content in monocots and dicot weeds also did not significantly affect under the influence of all weed control treatments and it ranged from 0.24 to 0.25 in monocots and 0.28 to 0.30 in dicots under different treatments (Table 5).

Table 4 : Effect of weed management treatments on nitrogen and phosphorus content of weeds

Treatments	N content (%)		P content (%)	
	Monocot	Dicot	Monocot	Dicot
Weedy check	1.56	2.01	0.24	0.28
Pendimethalin 750 g ha^{-1} PE	1.65	2.10	0.25	0.29
Metribuzin 350 g ha^{-1}PE	1.66	2.12	0.25	0.29
Fenoxaprop-p-ethyl 75 g ha^{-1} POE	1.70	2.10	0.25	0.30
Imazethapyr 100 g ha^{-1} POE	1.70	2.14	0.25	0.30
Pendimethalin PE + HW 30 DAS	1.69	2.11	0.25	0.30
Metribuzin PE + HW 30 DAS	1.70	2.10	0.25	0.29
Pendimethalin PE + fenoxaprop-p-ethyl POE	1.69	2.11	0.25	0.30
Pendimethalin PE + Imazethapyr POE	1.69	2.12	0.25	0.30
Metribuzin PE + fenoxaprop-p-ethyl POE	1.70	2.12	0.24	0.30
Metribuzin PE + Imazethapyr POE	1.70	2.13	0.24	0.30
One hand weeding at 20 DAS	1.70	2.15	0.25	0.30
2 hand weeding 15 and 30 DAS	1.70	2.14	0.25	0.29
Weed free upto 50 days	1.71	2.14	0.25	0.30
S.E.±	0.04	0.02	0.00	0.00
C.D. (P=0.05)	NS	NS	NS	NS

NS= Non-significant

Table 5 : Effect of weed management treatments on nitrogen and phosphorus uptake by weeds

Treatments	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})		
	Monocot	Dicot	Total	Monocot	Dicot	Total
Weedy check	13.90	20.00	33.91	2.11	2.78	4.88
Pendimethalin 750 g ha^{-1} PE	5.29	10.10	15.39	0.79	1.41	2.20
Metribuzin 350 g ha^{-1} PE	5.51	9.57	15.08	0.81	1.32	2.14
Fenoxaprop-p-ethyl 75 g ha^{-1} POE	5.68	8.94	14.61	0.82	1.26	2.08
Imazethapyr 100 g ha^{-1} POE	6.20	7.59	13.79	0.91	1.05	1.96
Pendimethalin PE + HW 30 DAS	3.81	4.36	8.17	0.56	0.62	1.18
Metribuzin PE + HW 30 DAS	4.56	5.78	10.34	0.67	0.79	1.47
Pendimethalin PE + Fenoxaprop-p-ethyl POE	4.73	6.11	10.84	0.70	0.85	1.55
Pendimethalin PE + Imazethapyr POE	4.61	5.54	10.14	0.67	0.77	1.44
Metribuzin PE + Fenoxaprop-p-ethyl POE	4.50	6.33	10.84	0.64	0.89	1.53
Metribuzin PE + Imazethapyr POE	4.83	6.00	10.83	0.69	0.84	1.53
One hand weeding at 20 DAS	5.24	6.88	12.12	0.76	0.96	1.71
Two hand weeding 15 and 30 DAS	4.32	4.73	9.04	0.64	0.64	1.28
Weed free upto 50 days	1.38	1.40	2.78	0.20	0.20	0.40
S.E.±	0.35	0.41	0.75	0.04	0.07	0.11
C.D. (P=0.05)	1.02	1.18	2.18	0.12	0.19	0.31

Nutrient uptake by weeds:

Nitrogen uptake:

An appraisal of data in Table 5 reveals that all weed control treatments significantly reduced nitrogen uptake by monocots and dicot weeds as well as total uptake by the weeds compared to weedy check. Data further reveal that uptake of N by monocot dicot and total weeds was observed minimum under pre-emergence application of pendimethalin 750g ha^{-1} + one hand weeding 30DAS. Here it is felt necessary to discuss that crop was kept weed free upto 50 days stage of crops, hence, a very limited number of weeds appeared after 50DAS, therefore, N uptake by weeds in this treatments was the least among all the weed control treatments. It is also noticed that integration of pre-emergence herbicide with hand weeding or post-emergence herbicide was found significantly superior in reducing N uptake by monocots, dicot and total uptake by weeds compared to their application alone likewise in sequential application of herbicides N uptake by the weeds was significantly reduced compare to their single application and these sequential treatments were found stastically at par to each other.

Phosphorus uptake :

Data pertaining to phosphorus uptake by weeds presented in Table 5 show that all the weed control treatments significantly reduced uptake of phosphorus by monocots and dicot weeds as well as total uptake by the weeds compared to weedy check. Data clearly indicate that amongst weed control treatments, pre-emergence application of pendimethalin 750g ha^{-1} + one hand weeding at 30DAS recorded the lowest uptake of phosphorus by monocot, dicot and total uptake which was very closly followed by two hand weeding 15 and 30DAS with the corrosponding P uptake by monocot, dicot and total weeds as 0.64, 0.64 and 1.28kg ha^{-1}, respectively and both of these treatments were statistically at par to each other.

Studies on soybean:

Plant stand:

Here it is necessary to mention that plant population at different stages of crop growth was inadequate because of the fact that the trial was located at isolate place and in spite of continuous watching it was severely damaged by birds and squirrels. Data on number of plants ha^{-1} under the influence of treatments are presented in Table 6 reveal that all weed control treatments failed to record significant influence on plant stand ha^{-1} recorded at 25, 50DAS and at harvest. It is also observed that at subsequent stage there is a decline in plant stand due to

Table 6 : Effect of weed management treatments on plant population (lakh ha^{-1})

Treatments	Plant population (lakh ha^{-1})		
	25 DAS	50 DAS	At harvest
Weedy check	2.90	2.60	2.53
Pendimethalin 750 g ha^{-1} PE	3.01	2.89	2.75
Metribuzin 350 g ha^{-1} PE	2.95	2.85	2.68
Fenoxaprop-p-ethyl 75 g ha^{-1} POE	3.04	2.92	2.73
Imazethapyr 100 g ha^{-1} POE	3.10	2.96	2.75
Pendimethalin + HW 30 DAS	3.15	3.04	2.90
Metribuzin 350 g ha^{-1} + HW 30 DAS	3.11	3.00	2.84
Pendimethalin 750 g ha^{-1}+ Fenoxaprop-p-ethyl POE	3.12	3.02	2.87
Pendimethalin 750 g ha^{-1}+ Imazethapyr at POE	3.13	3.03	2.87
Metribuzin 350 g ha^{-1} + Fenoxaprop-p-ethyl POE	3.12	2.99	2.84
Metribuzin 350 g ha^{-1} + Imazethapyr POE	3.10	2.98	2.86
One hand weeding at 20 DAS	3.09	2.95	2.84
Two hand weeding 15 and 30 DAS	3.15	3.03	2.88
Weed free	3.18	3.10	2.95
S.E.±	0.14	0.13	0.14
C.D. (P=0.05)	NS	NS	NS

NS= Non-significant

so many reasons.

Growth:

Data pertaining to growth parameters are summarized and presented in Table 7 to 10.

Plant height:

25DAS :

A critical examination of data in Table 7 shows that all the weed control treatments significantly affected plant height as compared to weedy check. Data further show that single application of pre or post-emergence herbicide were found at par to each other in this regard while all treatments comprising of sequential application of herbicide were significantly superior over pre or post-emergence application herbicide alone. The maximum plant height of 15.4cm was recorded with weed free treatment which was followed by hand weeding treatments with plant height of. At this stage of observation, hand weeding in combination with pre-emergence application of herbicides could not be performed, therefore, pre-emergence application of pendimethalin 750g ha^{-1} and metribuzin 350g ha^{-1} along with hand weeding are almost identical to their individual application.

50DAS :

An assessment of data shows that all the weed control treatments significantly affected plant height 50DAS compared to weedy check. The maximum plant height was recorded with weed free which was closely followed by pre-emergence application of pendimethalin 0.750kg ha^{-1} + hand weeding 30DAS with a plant height of 41.1cm. Data further reported that integration of pre-emergence herbicides with hand weeding or their sequential application found significantly superior over their counter parts. Among the pre- emergence herbicides either with hand weeding or with post-emergence herbicide, the highest plant height of 41.1, 39.5 and 39.3cm was recorded with pre-emergence application of pendimethalin 750g ha^{-1} + hand weeding 30 DAS, pre-emergence application of metribuzin 350g ha^{-1} + hand weeding 30DAS and pre-emergence application of pendimethalin 750g ha^{-1} fb post-emergence application of imazethapyr 100g ha^{-1}, respectively.

75DAS :

A critical examination of data indicates that all weed control treatments significantly increased plant height 75DAS compared to weedy check except sole application of either pre or post-emergence herbicides. The maximum plant height was recorded under weed free while the minimum was recorded under weedy check. Amongst remaining weed control treatments pre-emergence application of pendimethalin 750g ha^{-1} + hand weeding 30DAS was found significantly superior over

Table 7 : Effect of weed management treatments on plant height and number of branches plant $^{-1}$ of soybean

Treatments	Plant height (cm)				Branches plant^{-1}
	25 DAS	50 DAS	75 DAS	At harvest	75 DAS
Weedy check	11.3	28.4	37.6	38.3	3.39
Pendimethalin 750 g ha^{-1} PE	13.1	31.0	44.1	46.3	4.29
Metribuzin 350 g ha^{-1} PE	13.3	29.9	43.7	44.7	4.08
Fenoxaprop-p-ethyl 75 g ha^{-1} POE	13.6	31.3	42.8	43.8	4.11
Imazethapyr 100 g ha^{-1} POE	13.7	31.5	43.9	46.9	4.20
Pendimethalin + HW 30 DAS	13.5	41.1	55.3	58.0	5.99
Metribuzin 350 g ha^{-1} + HW 30 DAS	13.4	39.5	52.9	56.3	4.93
Pendimethalin 750 g ha^{-1}+ Fenoxaprop-p-ethyl POE	14.9	38.5	51.6	53.5	4.79
Pendimethalin 750 g ha^{-1}+ Imazethapyr POE	15.1	39.3	52.5	55.2	4.83
Metribuzin 350 g ha^{-1} + Fenoxaprop-p-ethyl POE	14.8	38.3	50.4	54.4	4.80
Metribuzin 350 g ha^{-1} + Imazethapyr POE	15.0	38.4	52.2	54.9	4.93
One hand weeding at 20 DAS	14.9	36.1	46.2	49.1	4.72
Two hand weeding 15 and 30 DAS	14.9	39.7	53.6	56.5	5.32
Weed free	15.4	42.3	57.2	59.7	6.33
S.E.±	0.4	2.0	3.0	3.0	0.15
C.D. (P=0.05)	1.1	5.7	7.0	8.6	0.4

one hand weeding, all pre/post-emergence herbicides applied alone and found statistically at par with two hand weeding as well as all treatments of sequential application of herbicides.

At harvest :

Data presented in indicate that all the weed management practices significantly increased plant height at harvest compared to weedy check except all pre/post-emergence herbicides applied alone. At this stage of observation after weed free, pre-emergence application of pendimethalin 750g ha^{-1} + hand weeding 30DAS recorded maximum plant height (58 cm) which was closly followed by two hand weeding 15 and 30DAS with the value of 56.5cm. Data further reported that integration of pre-emergence herbicide with hand weeding 30DAS or their sequential application were found significantly superior over their counter parts and all of these treatments were found stastistically at par in this regard.

Dry matter accumulation:

25DAS:

A persual of data indicates that all the weed management treatments significantly increased dry matter accumulation in plant of soybean as compared to weedy check. Data clearly indicate that the maximum plant dry matter accumulation was recorded under weed free treatment which was closely followed by pre-emergence application of pendimethalin 750g ha^{-1} fb. post- emergence application of imazethapyr 100g ha^{-1} in this regard. At this stage of observation, hand weeding with pre-emergence application of herbicides could not performed, therefore, pre-emergence application of pendimethalin 750g ha^{-1} and metribuzin 350g ha^{-1} along with hand weeding treatments are statistically identical to their single application.

50DAS:

A critical examination of data indicates that all weed control treatments significantly increased dry matter accumulation per plant of soybean 50DAS compared to weedy check. The highest dry matter accumulation of 13.60g $plant^{-1}$ was recorded under weed free check followed by pre-emergence application of pendimethalin 750g ha^{-1} + hand weeding 30DAS and two hand weeding and these treatments were found statistically at par to each other. In all sequential treatments pre-emergence application of pendimethalin followed by imazethapyr 20DAS recorded the highest dry matter accumulation but all of these treatments were found statistically at par to each other but significantly superior over their counter part.

75DAS:

It is evienced from the data presented in Table 8 that all the weed management treatments with variyng

Table 8 : Effect of weed management treatments on dry matter accumulation per plant of soybean

Treatments	Dry matter accumulation (g $plant^{-1}$)			
	25 DAS	50 DAS	75 DAS	At harvest
Weedy check	1.90	5.85	12.76	15.65
Pendimethalin 750 g ha^{-1} PE	2.35	7.98	18.13	22.31
Metribuzin 350 g ha^{-1} PE	2.52	7.95	17.47	21.47
Fenoxaprop-p-ethyl 75 g ha^{-1} POE	2.58	8.05	18.66	24.65
Imazethapyr 100 g ha^{-1} POE	2.60	8.00	18.75	23.87
Pendimethalin + HW 30 DAS	2.52	11.31	24.89	31.05
Metribuzin 350 g ha^{-1} + HW 30 DAS	2.69	9.86	22.01	29.20
Pendimethalin 750 g ha^{-1}+ Fenoxaprop-p-ethyl POE	3.14	9.84	21.62	27.40
Pendimethalin 750 g ha^{-1}+ Imazethapyr POE	3.23	9.95	22.20	29.88
Metribuzin 350 g ha^{-1} + Fenoxaprop-p-ethyl POE	3.00	9.70	21.40	28.00
Metribuzin 350 g ha^{-1} + Imazethapyr POE	3.10	9.75	22.00	28.44
One hand weeding at 20 DAS	2.85	9.15	20.11	25.40
Two hand weeding 15 and 30 DAS	3.00	11.26	23.65	30.65
Weed free	3.25	13.60	27.20	32.20
S.E.±	0.13	0.38	0.86	1.20
C.D. (P=0.05)	0.37	1.10	2.50	3.50

magnitude significantly affected dry matter accumulation of soybean at 75DAS compared to weedy check. Data clearly indicate that after weed free treatments pre-emergence application of pendimethalin 750g ha^{-1} + hand weeding 30DAS and two hand weeding were found significantly superior over all the treatments except all the sequential application of herbicides and these treatments are statistically at par to each other in this regard.

At harvest:

A critical examination of data in Table 8 reveals that all the weed control treatments significantly increased dry matter accumulation per plant of soybean compared to weedy check. Data also show that the highest plant dry matter was recorded with weed free which is closly followed by pre emergence application of pendimethalin 750g ha^{-1} + hand weeding 30DAS and two hand weeding. It is also observed that either of the pre-emergence herbicides in combinations with hand weeding 30DAS or their conjugation with post-emergence herbicides were found significantly superior in enhanceing dry matter accumulation in plant as compared to their corresponding application alone and these treatments were found statistically at par to each other.

Branches plant^{-1}:

An examination of data indicates that all weed control treatments significantly increased number of branches plant^{-1} at 75DAS over weedy check. Weed free treatment recorded maximum number of branches plant^{-1} which was found at par with pre-emergence application of pendimethalin 750g ha^{-1} +hand weeding 30DAS and both of these treatments were found significantly superior over all other weed management treatments, however, these treatments were found statistically at par to each other.

Leaf area index :

25DAS :

A persual of data Table 9 indicates that all the weed control treatments significantly affected leaf area index of soybean compared to weedy check. Maximum leaf area index was recorded under weed free treatment which was followed by hand weeding 15DAS in two hand weeding treatment. At this stage of observation hand weeding with pre-emergence application of herbicide could not be performed, therefore, pre-emergence application of pendimethalin 750g ha^{-1} as well as pre- emergence application of metribuzin along with hand weeding were found statistically at par with their corrosponding counter parts. Amongst all sequential

Table 9 : Effect of weed management treatments on leaf area index of soybean at different growth stages

Treatments	Leaf area index		
	25 DAS	50 DAS	75 DAS
Weedy check	0.95	2.11	3.84
Pendimethalin 750 g ha^{-1} PE	1.26	2.68	4.75
Metribuzin 350 g ha^{-1} PE	1.22	2.60	4.67
Fenoxaprop-p-ethyl 75 g ha^{-1} POE	1.15	2.53	4.53
Imazethapyr 100 g ha^{-1} POE	1.26	2.75	4.82
Pendimethalin + HW 30 DAS	1.20	3.91	6.17
Metribuzin 350 g ha^{-1} + HW 30 DAS	1.18	3.65	5.84
Pendimethalin 750 g ha^{-1}+ Fenoxaprop-p-ethyl POE	1.51	3.33	5.67
Pendimethalin 750 g ha^{-1}+ Imazethapyr POE	1.58	3.49	5.80
Metribuzin 350 g ha^{-1} + Fenoxaprop-p-ethyl POE	1.48	3.43	5.66
Metribuzin 350 g ha^{-1} + Imazethapyr POE	1.50	3.31	5.41
One hand weeding at 20 DAS	1.39	3.00	4.97
Two hand weeding 15 and 30 DAS	1.72	3.78	6.04
Weed free	1.85	4.06	6.78
S.E.±	0.03	0.07	0.12
C.D. (P=0.05)	0.09	0.21	0.34

application of herbicides, pre-emergence application of pendimethalin followed by imazethapyr 20DAS recorded the maximum LAI but all these treatment were found stastically at par to each other in this regard.

50DAS :

It is evienced from the data that all the weed control treatments significantly increased leaf area index of soybean 50DAS compared to weedy check. The highest leaf area index of 4.06 was recorded under weed free check which was closely followed by pre-emergence application of pendimethalin 750g ha^{-1} + hand weeding 30DAS and these treatments were found significantly superior over all other weed control treatments but pre-emergence application of pendimethalin 750g ha^{-1} + hand weeding 30DAS found statistically at par with two hand weeding. Critical analysis of data further show that integration of the pre-emergence herbicide with hand weeding 30 DAS or sequential application of herbicides were found significantly superior over their counter parts and amongst sequential treatments pre-emergence application of pendimethalin 750g ha^{-1} fb post-emergence application of imazethapyr 100g ha^{-1} recorded maximum LAI over rest of the treatments.

75DAS:

An assessment of data shows that all the weed control treatments significantly affected leaf area index at 75DAS compared to weedy check. The maximum leaf area index was recorded with weed free which was closely followed by pre-emergence application of pendimethalin 0.750kg ha^{-1} + hand weeding 30DAS and two hand wedding. Both these treatments were significantly superior over all other weed control treatments except pre-emergence application of metribuzin along with hand weeding 30DAS and pre-emergence application of pendimethalin followed by imazethapyr 20DAS. Amongst sequential application of herbicides, pre- emergence application of pendimethalin 750g ha^{-1} fb post-emergence application of imazethapyr 100g ha^{-1} recorded the maximum LAI and all these treatments were found statistically at par to each other and were found significantly superior over their corrosponding counter parts.

Crop growth rate:

CGR between 25 and 50DAS:

An assessment of data shows that all the weed control treatments significantly affected the crop growth rate between 25 and 50DAS as compared to weedy check. Amongst all weed control treatment, weed free recorded the highest crop growth rate closely followed by pre-emergence application of pendimethalin 750g ha^{-1} + HW 30DAS and two hand weeding treatment

Table 10 : Effect of weed management treatments on CGR, RGR and NAR of soybean at different growth periods

Treatments	CGR (g m^{-2} day^{-1})		RGR (g g^{-1} day^{-1})		NAR (g m^{-2} day^{-1})	
	25-50 DAS	50-75 DAS	25-50 DAS	50-75 DAS	25-50 DAS	50-75 DAS
Weedy check	5.27	9.21	0.0448	0.0313	4.18	8.42
Pendimethalin 750 g ha^{-1} PE	7.51	13.53	0.0489	0.0328	6.18	14.61
Metribuzin 350 g ha^{-1} PE	7.24	12.69	0.0459	0.0315	5.90	13.73
Fenoxaprop-p-ethyl 75 g ha^{-1} POE	7.29	14.15	0.0455	0.0348	6.05	14.79
Imazethapyr 100 g ha^{-1} POE	7.20	14.33	0.0450	0.0327	6.17	15.54
Pendimethalin + HW 30 DAS	11.73	18.10	0.0602	0.0316	15.19	20.95
Metribuzin 350 g ha^{-1} + HW 30 DAS	9.56	16.20	0.0521	0.0321	11.73	19.01
Pendimethalin 750 g ha^{-1}+ Fenoxaprop-p-ethyl POE	8.93	15.71	0.0457	0.0315	8.72	19.17
Pendimethalin 750 g ha^{-1}+ Imazethapyr POE	8.95	16.34	0.0450	0.0320	9.05	19.92
Metribuzin 350 g ha^{-1} + Fenoxaprop-p-ethyl POE	8.94	15.60	0.0469	0.0317	9.21	18.39
Metribuzin 350 g ha^{-1} + Imazethapyr POE	8.87	16.33	0.0458	0.0326	8.64	18.29
One hand weeding at 20 DAS	8.40	14.61	0.0467	0.0315	7.51	15.27
Two hand weeding 15 and 30 DAS	11.00	16.52	0.0529	0.0297	11.74	20.84
Weed free	13.80	18.13	0.0573	0.0277	15.49	25.37
S.E.±	0.45	0.85	0.0043	0.0012	0.46	1.09
C.D. (P=0.05)	1.29	2.48	NS	NS	1.35	3.17

NS= Non-significant

and these treatments were found statistically at par to each other. Data further indicate that integration of pre-emergence herbicides with one hand weeding 30DAS or sequential application of herbicides were found significantly superior over their respective counter parts and amongst sequential application of herbicide pre-emergence application of pendimethalin followed by imazethapyr recorded the maximum crop growth rate and these treatments were found statistically at par to each other.

CGR between 50 and 75 DAS :

An appraisal of data shows that all the weed control treatments significantly affected the crop growth rate between 50 and 75DAS as compared to weedy check. Amongst weed control treatments, weed free treatment recorded the highest crop growth rate which was closely followed by pre-emergence application of pendimethalin 750g ha^{-1} + one hand weeding 30DAS and two hand weeding 15 and 30DAS and these treatments were found statistically at par to each other. Data also clearly indicate that integration of pre-emergence herbicide with hand weeding 30DAS or sequential application of herbicides were found significantly superior over their respective counter parts. Amongst sequential herbicidal treatments pre-emergence application of pendimethalin + Imazethapyr 20DAS reported the maximum CGR 16.34g m^{-2} day^{-1} but these treatments were found statistically at par to each other.

Relative growth rate:

RGR between 25 and 50DAS:

An examination of data reveals that all the weed control treatments failed to record significantly influence on relative growth rate between 25-50DAS however, the maximum RGR between 25-50DAS was reported as 0.0602g g^{-1} day^{-1} in pendimethalin + hand weeding treatment which was closely followed by weed free.

RGR between 50 and 75DAS:

A perusal of data reveals that all weed control treatments failed to record significant influence on relative growth rate between 50 to 75DAS over weedy check. However, the maximum relative growth rate was recorded under post-emergence application of imazethapyr 100g ha^{-1} which was closely followed by post-emergence application of fenoxaprop-p-ethyl 75g ha^{-1}, as well as pre-emergence application of metribuzin 350g ha^{-1} followed by post-emergence application of imazethapyr 100g ha^{-1}.

Net assimilation rate:

NAR between 25 and 50DAS:

It is evienced from the data presented in Table 10 that all weed control treatments significantly increased net assimilation rate of soybean between 25 to 50DAS compared to weedy check. The highest net assimilation rate of 15.49g m^{-2} day^{-1} was recorded under weed free treatment which was closely followed by pre emergence application of pendimethalin 750g ha^{-1} + hand weeding 30DAS and two hand weeding. Data further reported that integration of pre emergence herbicides with hand weeding 30DAS or sequential application of herbicides were found significantly superior over their counter parts and all sequential application of herbicides were found statistically at par to each other in this regard.

NAR between 50 and 75 DAS:

An assessment of data shows that all the weed control treatments significantly affected net assimilation rate of soybean between 25 and 50DAS compared to weedy check. Amongst all weed control treatment, weed free treatment recorded the highest net assimilation rate which was closely followed by pre-emergence application of pendimethalin 750g ha^{-1} + one hand weeding at 30DAS and two hand weeding 15 and 30DAS and both of these treatments were found statistically at par to each other. Data also show that integration of pre-emergence herbicide with hand weeding 30DAS or sequential application of herbicides were found significantly superior over their corresponding counter parts and these treatments were statistically at par to each other in this regards.

Yield attributes :

Data on yield attributes under the influence of various treatments are presented in Table 11.

Pods $plant^{-1}$:

An appraisal of data shows that all the weed control treatments significantly increased number of pods $plant^{-1}$ over weedy check. Although weed free check treatment reported the highest number of pods $plant^{-1}$ but it was found statistically at par with pre-emergence application of pendimethalin 750g ha^{-1} + hand weeding 30DAS and two hand weeding. Data further reported that integration of pre-emergence applied herbicide along

with hand weeding or post-emergence herbicides were found significantly superior over their individual application and amongst these treatments pre-emergence application of pendimethalin 750g ha^{-1} + hand weeding 30DAS was found significantly superior over rest of the treatments but these treatments were found statistically at par to each other in this regard.

Number of seeds pod^{-1}:

A critical examination of data reveals that all the weed control treatments had a significantly effect on the number of seeds pod^{-1} over weedy check. The highest number of seeds pod^{-1} was recorded under weed free check which was found significantly superior over all weed control treatments except pre-emergence

Table 11 : Effect of weed management treatments on yield attributes of soybean

Treatments	Pods plant^{-1}	Seeds pod^{-1}	Pod length (cm)	Seed index (g)
Weedy check	17.95	2.16	4.12	10.56
Pendimethalin 750 g ha^{-1} PE	23.68	2.75	4.53	11.95
Metribuzin 350 g ha^{-1} PE	24.37	2.61	4.59	11.20
Fenoxaprop-p-ethyl 75 g ha^{-1} POE	24.72	2.70	4.72	11.50
Imazethapyr 100 g ha^{-1} POE	25.65	2.76	4.75	11.84
Pendimethalin + HW 30 DAS	32.30	3.29	5.00	12.94
Metribuzin 350 g ha^{-1} + HW 30 DAS	27.76	3.00	4.92	12.50
Pendimethalin 750 g ha^{-1}+ Fenoxaprop-p-ethyl POE	26.33	2.92	4.86	12.15
Pendimethalin 750 g ha^{-1}+ Imazethapyr POE	29.06	3.06	4.92	12.87
Metribuzin 350 g ha^{-1} + Fenoxaprop-p-ethyl POE	28.89	2.91	4.89	12.60
Metribuzin 350 g ha^{-1} + Imazethapyr POE	29.23	2.98	4.85	12.05
One hand weeding at 20 DAS	28.81	2.81	4.83	12.35
Two hand weeding 15 and 30 DAS	31.74	3.10	4.95	12.90
Weed free	33.00	3.40	5.05	13.65
S.E.±	0.62	0.07	0.10	0.27
C.D. (P=0.05)	1.80	0.20	0.30	0.79

Table 12 : Effect of weed management treatments on seed, haulm, biological yield and harvest index of soybean

Treatments	Yield (kg ha^{-1})			Harvest index (%)
	Seed	Haulm	Biological	
Weedy check	521	1359	1880	27.73
Pendimethalin 750 g ha^{-1} PE	915	2084	2999	30.51
Metribuzin 350 g ha^{-1} PE	835	1904	2739	30.49
Fenoxaprop-p-ethyl 75 g ha^{-1} POE	1005	2287	3292	30.54
Imazethapyr 100 g ha^{-1} POE	1045	2377	3422	30.54
Pendimethalin + HW 30 DAS	1376	3043	4419	31.13
Metribuzin 350 g ha^{-1} + HW 30 DAS	1131	2571	3702	30.55
Pendimethalin 750 g ha^{-1}+ Fenoxaprop-p-ethyl POE	1184	2689	3873	30.57
Pendimethalin 750 g ha^{-1}+ Imazethapyr POE	1232	2793	4025	30.60
Metribuzin 350 g ha^{-1} + Fenoxaprop-p-ethyl POE	1130	2568	3698	30.56
Metribuzin 350 g ha^{-1} + Imazethapyr POE	1185	2710	3895	30.42
One hand weeding at 20 DAS	1116	2536	3652	30.55
Two hand weeding 15 and 30 DAS	1321	2898	4219	31.31
Weed free	1421	3100	4521	31.43
S.E.±	71	138	164	1.53
C.D. (P=0.05)	207	402	477	NS

NS= Non-significant

application of pendimethalin 750g ha^{-1} + hand weeding 30DAS. Data further indicate that after weed free treatment, pre-emergence application of pendimethalin along with hand weeding 30DAS was found significantly superior over one hand weeding, all pre/post-emergence herbicides applied alone as well as their sequential application in this regard and these treatments were found statistically at par with two hand weeding treatment.

Pod length:

Data in Table 11 reveal that all the weed control treatments significantly increased pod length of soybean over weedy check. Weed free treatment recorded the maximum pod length of 5.05cm which was closely followed by pre-emergence application of pendimethalin 750g ha^{-1} + one hand weeding 30DAS and the values for these parameters under unweeded treatment was 4.12cm. Data further indicate that integration of pre-emergence herbicide with hand weeding or sequential application of herbicide were found significantly superior over their counter parts and these treatments were found statistically at par to each other in this regard. The per cent increase in pod length due to weed free, pre-emergence application of pendimethalin 750g ha^{-1} + one hand weeding 30DAS, two hand weeding 15 and 30DAS and pre-emergence application of pendimethalin 750g ha^{-1} followed by imazethapyr 100g ha^{-1} 20DAS was 22.57, 21.36, 20.15 and 19.42, respectively compared to weedy check.

Hundred seed weight:

All weed control treatments significantly increased 100 seed weight of soybean over weedy check. Maximum 100 seedweight was recorded under weed free check which was statistically at par with pre-emergence application of pendimethalin + hand weeding as well as two hand weeding treatment. Data further indicate that integration of pre-emergence herbicide with hand weeding or sequential application of herbicides were found significantly superior over their corresponding application alone and these treatments were found statistically at par to each other.

Yield and harvest index :

Data on crop productivity in terms of seed, haulm and biological yield and crop efficiency *i.e.* harvest index under the influence of treatments are presented in Table 12.

Seed yield:

Data present in indicate that all the weed management practices significantly affected seed yield of soybean over weedy check. Critical analysis of data

Table 13 : Effect of weed management treatments on biochemical parameters of soybean

Treatments	Seed oil content (%)	Seed protein content (%)	Chlorophyll content (mg g^{-1} fresh weight)	
			50 DAS	75 DAS
Weedy check	19.54	37.84	2.20	1.70
Pendimethalin 750 g ha^{-1} PE	19.84	38.38	2.45	1.88
Metribuzin 350 g ha^{-1} PE	19.85	38.53	2.43	1.89
Fenoxaprop-p-ethyl 75 g ha^{-1} POE	19.95	38.59	2.50	1.94
Imazethapyr 100 g ha^{-1} POE	19.95	38.74	2.55	1.95
Pendimethalin + HW 30 DAS	20.86	40.44	2.80	2.22
Metribuzin 350 g ha^{-1} + HW 30 DAS	20.45	40.14	2.76	2.15
Pendimethalin 750 g ha^{-1}+ Fenoxaprop-p-ethyl POE	20.34	39.81	2.70	2.12
Pendimethalin 750 g ha^{-1}+ Imazethapyr POE	20.34	40.06	2.75	2.20
Metribuzin 350 g ha^{-1} + Fenoxaprop-p-ethyl POE	20.26	39.97	2.71	2.15
Metribuzin 350 g ha^{-1} + Imazethapyr POE	20.22	40.00	2.73	2.18
One hand weeding at 20 DAS	20.15	39.50	2.65	2.05
Two hand weeding 15 and 30 DAS	20.75	40.31	2.78	2.17
Weed free	20.88	40.63	2.91	2.29
S.E.±	0.66	0.66	0.06	0.06
C.D. (P=0.05)	NS	NS	0.17	0.14

NS= Non-significant

further show that integration of the pre-emergence herbicide with hand weeding 30 DAS or sequential application of herbicides were found significantly superior over their counter parts applied alone. Weed free check recorded maximum seed yield of 1421 kg ha^{-1} as against 521 kg ha^{-1} under unweeded control. Data further indicate that after weed free treatment, pre-emergence application of pendimethalin along with hand weeding 30DAS was found significantly superior over one hand weeding, all pre/post-emergence herbicides applied alone. Sequential application of herbicides was found significantly superior over their counter parts and these treatments were found statistically at par to each other in this regard.

Haulm yield:

Critical examination of data reveal that all weed control treatments significantly increased haulm yield of soybean over unweeded control with the maximum haulm yield of 3100kg ha^{-1} recorded under weed free treatment closely followed by pre-emergence application of pendimethalin in combination with hand weeding with the haulm yield of 3043kg ha^{-1}. Data clearely indicate that integration of pre-emergence herbicide with hand weeding or sequential application of herbicides were found significantly superior over their corresponding application alone and these treatments were found statistically at par to each other except pre-emergence application of metribuzin along with hand weeding and pre-emergence application of metribuzin followed by fenoxaprop-p-ethyl 20DAS. Amongest all weed control treatments pre-emergence application of pendimethalin in combination with hand weeding was found significantly superior over one hand weeding, all pre/post-emergence herbicides applied alone as well as their sequential application.

Biological yield :

All weed control treatments significantly increased biological yield of soybean over weedy check. Data reveal that the weed free check gave the highest biological yield of 4521kg ha^{-1} closely followed by pre-emergence application of pendimethalin 750g ha^{-1} + hand weeding 30DAS and two hand weeding 15 and 30DAS. Data further reported that integration of pre-emergence herbicide with hand weeding 30DAS or sequential application of herbicides were found significantly superior over their corresponding application alone.

Harvest index :

It is revealed from data that all weed control treatments failed to record significant influence on harvest index of crop and it varied from 27.33 to 31.43 per cent under different treatments.

Table 14 : Effect of weed management treatments on nitrogen and phosphorus content of soybean

Treatments	N content (%)		P content (%)	
	Seed	Haulm	Seed	Haulm
Weedy check	6.054	1.520	0.602	0.184
Pendimethalin 750 g ha^{-1} PE	6.140	1.537	0.630	0.187
Metribuzin 350 g ha^{-1} PE	6.165	1.531	0.625	0.189
Fenoxaprop-p-ethyl 75 g ha^{-1} POE	6.174	1.547	0.631	0.188
Imazethapyr 100 g ha^{-1} POE	6.198	1.540	0.636	0.185
Pendimethalin + HW 30 DAS	6.470	1.615	0.661	0.196
Metribuzin 350 g ha^{-1} + HW 30 DAS	6.423	1.598	0.662	0.193
Pendimethalin 750 g ha^{-1}+ Fenoxaprop-p-ethyl POE	6.370	1.572	0.643	0.190
Pendimethalin 750 g ha^{-1}+ Imazethapyr POE	6.410	1.588	0.655	0.192
Metribuzin 350 g ha^{-1} + Fenoxaprop-p-ethyl POE	6.395	1.577	0.649	0.189
Metribuzin 350 g ha^{-1} + Imazethapyr at POE	6.400	1.565	0.652	0.188
One hand weeding at 20 DAS	6.320	1.498	0.648	0.187
Two hand weeding 15 and 30 DAS	6.450	1.600	0.665	0.195
Weed free	6.500	1.650	0.669	0.197
S.E.±	0.106	0.039	0.014	0.005
C.D. (P=0.05)	NS	NS	NS	NS

NS= Non-significant

Biochemical parameters:

Protein content in seed:

A critical examination of data show that all weed control treatments failed to record significant influence on protein content of soybean. However, maximum protein content was recorded under weed free check which was followed by pre-emergence application of pendimethalin along with hand weeding 30DAS and two hands weeding 15 and 30DAS.

Oil content in seed :

A persual of data reveals that application of different weed control treatments had no significant influence on oil content of soybean seeds and it ranged from 19.54 to 20.88 under different treatments.

Nutrient content in crop :

Nitrogen content :

A persual of data reveal that nitrogen content in seed and haulm of soybean under the influence of weed control treatments did not vary significantly and varies from 6.054 to 6.500 per cent in seeds and 1.520 to 1.650 per cent in haulm.

Phosphorus content:

An assessment of data indicates that alike N content P content in seed and haulm also not affected significantly under weed control treatment and it varies from 0.602 to 0.669 and 0.184 to 0.197 per cent in seed and haulm, respectively.

Nutrient uptake by crop:

Nitrogen:

An appraisal of data presented in shows that weed control treatments significantly increased nitrogen uptake by seeds, haulm as well as total nitrogen uptake by the crop compared to weedy check. Data further indicate that weed free treatment recorded maximum N uptake by seeds, haulm as well as total uptake and their respective uptake values under this treatment was 92.63, 51.15 and 143.78kg ha^{-1} which is closely followed by pre-emergence application of pendimethalin 0.750kg ha^{-1} + hand weeding 30DAS.

Phosphorus uptake :

An assessment of data Table 15 explicits that all the weed control treatments significantly enhanced P uptake by seeds, haulm as well as total uptake by the crops compared to weedy check. After weed free treatment, pre-emergence application of pendimethalin in combination with hand weeding recorded the highest P uptake by seeds, haulm and total uptake by crops compared to all other weed control treatments and closely followed by two hand weeding treatment. Integration of

Table 15 : Effect of weed management treatments on nitrogen and phosphorus uptake by soybean

Treatments	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})		
	Seed	Haulm	Total	Seed	Haulm	Total
Weedy check	31.61	20.71	52.32	3.14	2.50	5.64
Pendimethalin 750 g ha^{-1}PE	56.21	32.02	88.23	5.77	3.90	9.66
Metribuzin 350 g ha^{-1} PE	51.52	29.19	80.70	5.22	3.60	8.83
Fenoxaprop-p-ethyl 75 g ha^{-1} POE	62.10	35.33	97.43	6.33	4.29	10.62
Imazethapyr 100 g ha^{-1} POE	64.75	37.00	101.75	6.64	4.40	11.05
Pendimethalin + HW 30 DAS	88.79	49.14	137.93	9.07	5.96	15.03
Metribuzin 350 g ha^{-1} + HW 30 DAS	72.70	41.17	113.88	7.50	4.97	12.47
Pendimethalin 750 g ha^{-1}+ Fenoxaprop-p-ethyl POE	75.43	42.27	117.70	7.61	5.11	12.72
Pendimethalin 750 g ha^{-1}+ Imazethapyr POE	78.95	44.38	123.33	8.07	5.37	13.44
Metribuzin 350 g ha^{-1} + Fenoxaprop-p-ethyl POE	72.46	40.45	112.92	7.35	4.85	12.20
Metribuzin 350 g ha^{-1} + Imazethapyr at POE	76.03	42.49	118.52	7.72	5.09	12.82
One hand weeding at 20 DAS	70.57	37.95	108.52	7.24	4.74	11.97
Two hand weeding 15 and 30 DAS	85.54	46.37	131.91	8.82	5.67	14.49
Weed free	92.63	51.15	143.78	9.52	6.11	15.63
S.E.±	5.33	2.63	6.30	0.52	0.32	0.73
C.D. (P=0.05)	15.49	7.65	18.31	1.52	0.93	2.12

pre-emergence herbicide with post-emergence herbicides 20DAS recorded a significant increase in P uptake by seeds, haulm as well as total uptake by the crop compared to their individual application alone and these treatments were found statistically at par to each other.

Chlorophyll content:

Chlorophyll content 50DAS:

An assessment of data shows that all the weed control treatments were found significant in affecting total chlorophyll content 50DAS compared to weedy check. The maximum chlorophyll was recorded with weed free which was closely followed by pre-emergence application of pendimethalin 0.750kg ha^{-1} + hand weeding 30DAS. Amongst sequential application of herbicides, pre-emergence application of pendimethalin 750g ha^{-1} fb post-emergence application of imazethapyr 100g ha^{-1} recorded the maximum total chlorophyll content and all these sequential application of herbicide treatment were found statistically at par to each other but these treatment are significantly superior over their corrosponding counter parts.

Chlorophyll content 75DAS:

Data presented in Table 13 reveal that all weed control treatments significantly increased total chlorophyll content of soybean over weedy check. Amongst all weed management treatments weed free treatments recorded maximum total chlorophyll content in leaves 75DAS which was significantly at par with pre-emergence application of pendimethalin along with hand weeding combination as well as two hand weeding treatment. Data further indicate that pre-emergence application of pendimethalin along with hand weeding 30DAS was found significantly superior over one hand weeding; all pre/post-emergence herbicides applied alone and statistically at par with sequential herbicides treatments. Similar work related to the present investigation was also carried out by Angiras *et al*. (2008); Dhaker *et al*. (2010); Jha and Soni (2013); Meena and Jadon (2009); Meena *et al*. (2011); Priya *et al*. (2009); Singh *et al*. (2006) and Vyas and Kushwah (2008).

Economics:

Economics evaluation of different weed management treatments in soybean presented in Table 16 indicate that maximum net returns of Rs.29508 ha^{-1} was obtained with pre-emergence application of pendimethalin 0.750kg ha^{-1} along with hand weeding 30DAS which was closely followed by two hand weeding. As far as BC ratio is concerned, the maximum BC also follows the same trend as that of net returns in

Table 16 : Effect of weed management treatments on net returns and B-C ratio of soybean

Treatments	Net returns (Rs. ha^{-1})	B-C ratio
Weedy check	2344	1.13
Pendimethalin 750 g ha^{-1} POE	15113	1.80
Metribuzin 350 g ha^{-1} POE	12518	1.68
Fenoxaprop-p-ethyl 75 g ha^{-1} POE	18078	1.94
Imazethapyr 100 g ha^{-1} POE	19265	1.98
Pendimethalin + HW 30 DAS	29508	2.38
Metribuzin 350 g ha^{-1} + HW 30 DAS	21019	2.00
Pendimethalin 750 g ha^{-1}+ Fenoxaprop-p-ethyl POE	23267	2.12
Pendimethalin 750 g ha^{-1}+ Imazethapyr POE	24705	2.17
Metribuzin 350 g ha^{-1} + Fenoxaprop-p-ethyl POE	21638	2.06
Metribuzin 350 g ha^{-1} + Imazethapyr POE	23426	2.13
One hand weeding at 20 DAS	21507	2.08
Two hand weeding 15 and 30 DAS	27244	2.26
Weed free	26749	2.04

both of these treatments with a BC ratio of 2.38 and 2.26 under pre-emergence application of pendimethalin 0.750kg ha^{-1} along with hand weeding 30DAS and two hands weeding, respectively. Amongst weed control treatments the lowest net returns and BC ratio were obtained under pre-emergence application of metribuzin 0.350kg ha^{-1} (Kumar and Das, 2008 and Singh and Kumar, 2008).

Conclusion :

On the basis of results and economics evaluation of treatments of the field experiment on production potential of soybean [*Glycine max* (L.) Merrill] under weed management practices, it is concluded that pre-emergence application of pendimethalin 0.750 kg ha^{-1} along with hand weeding 30DAS recorded the seed yield of 1376kg ha^{-1} at par with two hand weeding (1321kg ha^{-1}) as well as weed free treatment (1421kg ha^{-1}). This treatment also recorded the maximum net return (Rs.29508) as well as BC ratio (2.38) compared to rest of the treatments. The second best alternative effective treatment with respect to net return (Rs.27244) and BC ratio (2.26) is two hand weeding 15 and 30DAS.

REFERENCES

Angiras, N.N. Rana, S.S. and Thakur, A.S. (2008). Evaluation of dose of some herbicides to manage weeds in soybean [*Glycine max* (L.) Merrill]. *Indian J. Weed Sci.,* **40** : 56-61.

Aron, D. (1949). Copper enzymes isolated chloroplasts, polyphenoloxidase in Beta vulgaris. *Plant Physiol.,* **24**: 1-15.

Black, C.A. (1965). *Methods of soil analysis,* Part II, American Soci. of Agroninc. Pub. No: 9 Madison WI. USA.

Bouyoucos, G.J. (1962). Hydrometer method improved for making particle size analysis of soils. *Agron. J.,* **54** : 464- 465. http://dx.doi.org/10.2134/agronj1962.00021962005400050028x.

Brady, M. (1983). *Criteria for representations of shape*. In: Beck, J., Hope, B. and Kosenfeld, A. (Ed.) IIuman and Machine Vision New York: Academic Press, 39-84 pp.

Dhaker, S.C., Mundra, S.L. and Nepalia, V. (2010). Effect of weed management and sulphur nutrition on productivity of soybean. *Indian J. Weed Sci.,* **42**: 232-234.

Jackson, M.L. (1967). *Soil chemical analysis*. Prentice Hall of India, Pvt. Ltd., New Delhi, India, 498p.

Jha, A.K. and Soni, M. (2013). Weed management by sowing methods and herbicide in soybean. *Indian J. Weed Sci.,* **45**: 250 - 252.

Kumar, M. and Das, T.K. (2008). Integrated weed management for system productivity and economics in soybean (*Glycine max*)-wheat (*Teiticum aestivum*) cropping system. *Indian J. Agron.,* **36** : 189-194.

Meena, D.S. and Jadon, Chaman (2009). Effect of integrated weed management on growth and yield of soybean (*Glycine max*). *Curr. Adv. Agric. Sci.,* **1**: 50-51.

Meena, D.S., Ram, Beldev, Jadon, Chaman and Tetarwal, J.P. (2011). Efficacy of imazethaypr on weed management in soybean. *Indian J. Weed Sci.,* **43**: 169-171.

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. (1954). Estimation of available P in soil by extraction with sodium bicarbonate. *Circ. Irs Dep.Agric.,* 939.

Piper, C. S. (1950). *Soil and plant analysis*, The University of Adelaide Press, Adelaide, Australia, 368p.

Priya, G., Thomas, Rajkannan, G. B. and Jayakumar, R. (2009). Efficacy of weeds control practices in soybean crop production. *Indian J. Weed Sci.,* **41**: 58-64.

Redford, P.J. (1967). Growth analysis formulae their use and abuse. *Crop Sci.,* **7**: 171.

Richards, L.A. (1968). *Diagnosis and improvement of saline and alkaline soils*. Hand Book No. 60, USDA, Washington, D.C., USA.

Singh, P., Nepalia, V. and Tomar, S.S. (2006). Effect of weed control and nutrient management on soybean (*Glycine max*) productivity. *Indian J. Agron.,* **51**: 314-317.

Singh P. and Kumar, R. (2008). Agro-economics feasibility of weed management in soybean grown in vertisols of south-eastern Rajasthan. *Indian J. Weed Sci.,* **40** : 62-64.

Vyas, M.D. and Kushwah, S.S. (2008). Effect of cultural and chemical methods on growth and yield of soybean in Vindhynagar plateau of Madhya Pradesh. *Indian J. Weed Sci.,* **40** : 92-94.

Walkley, A. and Black, Z.A. (1947). Rapid titration method for organic carbon of soils. *Soil Sci.,* **37** : 29-32.

Watson D.J. (1947). Comparative physiological studies in the growth of field crops. I. Variation in net assimilation rate and leaf area between species and varieties, and within and between years. *Annl. Botany,* **11**: 41–76.