

COMPARATIVE STUDY OF HERBICIDES AND CULTURAL METHODS
OF WEED CONTROL ON THE GROWTH AND YIELD OF SOYBEAN
[GLYCINE MAX (L)] IN MALWA REGION OF M P.

THESIS

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C E R T I F I C A T E - I

This is to certify that the thesis entitled "COMPARATIVE STUDY OF HERBICIDES AND CULTURAL METHODS OF WEED CONTROL ON THE GROWTH AND YIELD OF SOYBEAN (GLYCINE MAX. L) IN MALWA REGION OF M.P." submitted in partial fulfilment of the requirements for the degree of Master of Science in Agriculture of the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, is a record of the bonafide research work carried out by Shri D. Venkata Narayana Raju I.D. No. AP/ID/5073/72 under my guidance and supervision. The subject of the thesis has been approved by the students advisory committee and the Director of Post Graduate Studies.

No part of the thesis has been submitted for any other degree or diploma. All the assistance and help received during the course of the investigations have been duly acknowledged by him.

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C E R T I F I C A T E - I I

This is to certify that the thesis entitled "COMPARATIVE STUDY OF HERBICIDES AND CULTURAL METHODS OF WEED CONTROL ON THE GROWTH AND YIELD OF SOYBEAN (Glycine Max (L)) IN MALWA REGION OF MADHYA PRADESH" submitted by Shri D.Venkata Narayana Raju I.D.No. AP/ID 5073/72 to Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur in partial fulfilment of the requirements of the degree of M.Sc. (Ag.) in the department of Agronomy has been approved by the students advisory committee and external examiner after an oral examination of the same.


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A C K N O W L E D G E M E N T

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INTRODUCTION
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INTRODUCTION

Weeds, the frail innocent looking plants have the dubious and richly deserved distinction of being the greatest enemy to the farmers. Weed control is one of the arduous arts of agriculture practised from stone-age and has developed into a science of complexity. Weed infestation is one of the limiting factors in crop production. The current energy crisis all over the world is posing a serious fertilizer shortage resulting in reduced food production, demanding a complete reorientation of agricultural production strategy by conserving available quantity of fertilizers. There is little advantage in using fertilizers, if the weeds are not controlled properly. It is estimated that if 1200 tones of weed killers costing Rs. two crores is used, it will compensate 30 per cent of the fertilizer need of the crops, thus saving a foreign exchange of Rs.10 crores every year in India.

The yield losses from 35 to 50 per cent in soybean have been reported by Bhan and Singh (1972) depending upon the type of weeds, time of occurrence and their intensity of infestation. These losses are due to severe crop-weed competition for soil-moisture, nutrients, space and light. Such losses can considerably be reduced by the use of herbicides and other prevalent mechanical and cultural methods.

Weeding by manual labour, hoeing implements and interculture are the physical methods still in vogue in many parts of India. Hand weeding undoubtedly is the most efficient method of elimination of weed growth. Moreover, the colossal amount of physical energy, continuous rains in the kharif season and upward spiraling labour costs preclude its timely adoption on a large scale. Barring this aspect, chemical method of weed control appears to have an edge over the physical methods. In this age of mechanisation hand weeding is expensive and wasteful of human effort. Roger P. Humbest (1970) reported that "A man with a Knapsac on his back and proper herbicide in his tank can be much more effective against weeds than the same man with a hoe in his hand".

Weed control with chemicals is a part of modern crop production technology and one of the most outstanding discovery of twentieth century. Used correctly, the chemicals are a boon to crop production. Under the prevailing situations chemical weed control by the use of suitable herbicides appears to hold promise in modern agriculture with the development of intensive and multiple system of cropping.

Soybean, being a protein and oil rich crop, holds an important place in a protein and fat deficit country like India. Containing 40 per cent protein and 20 per cent oil it is one of the most nutritive food crops. Protein from soybean is approximately twice that of meat, four times that of egg, wheat

and other pulses, five times that of bread and twelve times that of milk. In India, where bulk of the population is vegetarian, the protein rich soybean is found to play a vital role to supply protenaceous food to the growing population.

In India the importance of soybean cultivation has recently been realised and has extended over large areas in every year. Crop production technology like the use of improved varieties, good manurial schedule, plant protection measures and suitable herbicides to kill the growing weeds is of prime importance in drawing the correct agronomy of soybean cultivation for maximising its yield potential.

Soybean, being mainly a kharif crop, enormous weeds constantly pose a serious threat to its successful cultivation; more so in its early stages of crop growth. Therefore the crop should be kept weed-free during first 15-30 days after planting.

Keeping in view the period of weed-free condition required for soybean crop, the pre-emergence application of herbicides is more effective in controlling weeds, because weeds are more sensitive to herbicides when they are young and tender. More over, the greater advantage in using pre-emergence herbicides is that, they are relatively cheaper, easy to apply and kill the weeds well in time.

Use of proper herbicide is essential to keep the field weed-free during critical stages of crop growth. Various

herbicides are in use in different kharif crops e.g. Propanile (Stam F.34), Melinate, Nitrofen (TOK) and MCPA in Rice crop; Triazine compounds like Atrazine, Simazine and Propazine in Sorghum and Maize crops; Diuron, Alachlor (Lasso), Chloroprotham in cotton crop; Alachlor, Nitrofen, B.V.201 and M.C.P.B. in Groundnuts; Similarly Triflan, Vernam, Eptam, Amiben, Alachlor, Nitrofen, B.V.201, Tenoran, Meloram and Preforan are found effective to control weeds in soybean crop in different parts of India.

No single method or combination of weed control methods can be universally applied with success. Careful testing and evolution of weed control techniques in individual crops under specific soil-climate and economic conditions in relation to the existing cultural practises is necessary to pinpoint the optimal method. Very little work has been done to evaluate such methods of weed control for Soybean crop in Malwa tract of Madhya Pradesh, hence the need of present investigation.

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REVIEW OF LITERATURE
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REVIEW OF LITERATURE

Soybean, being a rainy season crop, the fields are heavily infested with grassy and broad-leaf weeds. Most of these weeds appear and grow along with the germinating crop resulting in heavy crop-weed competition for soil-moisture, nutrients, sunlight and space thereby reducing the yields considerably. To harvest a good yield, weed control at an early stage of crop is very essential.

Mammal weeding, undoubtedly is the most efficient method of controlling weeds, but continuous rains in the kharif season, upward labour costs preclude its timely adoption on a large scale. This necessitates the use of herbicides which can also perform the same job very effectively.

1. EFFECT OF CROP-WEED COMPETITION

Crop and weed compete with each other and also within themselves for soil-moisture, nutrients, sunlight and space. This competition is more severe if monocot and dicot crops are infested with grassy and broad-leaf weeds respectively. Crop-weed competition varies with the geographic to area, nature of crop growth and type of weeds. Uncontrolled weed growth within two or three weeks of emergence usually affect the yield of many crops and this may be the critical period of competition.

a) Soil-Moisture depletion by weeds :-

In India more than 70 per cent of the cultivated area is under rain-fed conditions making the soil-moisture limiting for good crop growth. In such areas soil-moisture conservation is very essential for successful crop production by attaining weed control.

Nijhawan (1944) stated that if one acre of land is kept weed free it was possible to save 300 to 500 tonnes of water.

Robbins et al. (1952) found that water requirement for Ambrosia sp is about three times that of Millets and chenopodium album and four times that of oat plants.

Pathak (1958) observed that moisture lost by evapo-transpiration through weeds is much greater than that lost of evaporation, surface run-off or deep seepage.

Arakeri et al. (1959) stated that crop yields could be increased from 10 to 25 per cent by keeping the field weed-free throughout the crop period by avoiding water losses by weeds through transpiration.

Bodade (1965) reported that every tonne of weeds removed 3 inches of rainfall.

b) Nutrient depletion by weeds :-

Weeds have a persistent and extensive root system, grow

faster than the crop, depleting the available nutrients from the soil there by limiting crop production.

Asana (1951) reported that unchecked weed growth removed 17 lbs of N per acre from wheat fields.

Robbins et al. (1952) observed that one plant of yellow mustard (Brassica Capiestrius) removed twice as much nitrogen, twice as much phosphorus and four times that of potash as by an oat plant.

Divekar (1965) noted that weeds removed 63, 11 and 87 kg. of nitrogen, phosphorus and potash per hectare in potato crop under Delhi conditions.

Hosamani, (1966) found that unchecked weed growth for three months onion crop removed 57 kg. N; 19 kg. P₂O₅ and 77 kg. K₂O per hectare.

Mani (1971) indicated that the unchecked weed growth removed 46.1; 18.3 and 47.7 kgs of N; P₂O₅ and K₂O per hectare respectively in Sorghum crop at 35 days of crop growth.

Kirti Singh et al. (1973) reported that unchecked weed growth removed 212.23 kgs N; 24.3 kgs P₂O₅ and 109.06 kgs K₂O per hectare in Peas.

2. EFFECT OF WEEDS ON SOYBEAN YIELD

Staniforth et al. (1950) found that weeds growing in

soyabean crop cause a reduction of 17 per cent in the yield. On an average yield reduction of 8 to 10 bushels per hectare was observed due to crop-weed competition in soybean.

Verma and Bharadwaja (1963) indicated that loss in different crops ranges from 5 to 50 per cent due to weeds alone. All these losses are mostly due to the depletion of soil-moisture and plant nutrients by weeds.

Staniforth et al. (1963) reported from ten year experiments on soybean crop, an average yield reduction of 3.8 bushels per acre due to weed infestation.

Burnside and Colville (1964) found that for each 86 lbs. weight of weeds, there was an average yield reduction of one bushel of soybean yield.

Moolani et al. (1964) noted that the heaviest crop-weed competition of smooth pig weed (Amaranthus hybridus) reduced the soybean yield by 55 per cent. They also observed that there was a decrease in soybean yield and pods per plant when the intensity of the same weed was more.

Burnside (1967) observed at Nebraska farm that each 50 lbs of dry matter produced by weeds is equivalent to one bushel of grain.

Hari (1968) estimated that, in wheat crop alone the losses due to weeds amounted to 8 lakh tonnes of produce.

valued at Rs.25 crores per year in India.

Wax and McWhorter (1968) observed that uncontrolled weeds reduced the soybean yields from 15 to 30 per cent, but in some cases much higher losses have been observed. The presence of weed seed reduced the quality of soybean.

Bhan and Singh (1970) found that weed control at early stages of crop growth increased the soybean yields. But at later stages of weed control i.e. 30 days after sowing reduced the soybean yields by 50 per cent.

Nave and Wax (1971) ^{reported that} one specimen of smooth pig weed (Amaranthus hybridus) per foot reduced the soybean yield of 25 to 30 per cent. Setaria fabri at the same density reduced the soybean yield by 13 per cent. The same scientists also reported that Setaria glauca; polygonum pennsylvanicum and Abutilon theophrastimedie reduced soybean yields by 5 to 10 per cent. At Illinois studies Smooth pig weed (Amaranthus hybridus) reduced the soybean yield upto 5.5 per cent.

Bhan and Megh Singh (1972) yield reduction in soybean infested with weeds may vary from 35 to 50 per cent depending on the type of weeds, time of occurrence and their intensity. Under pantnagar conditions the weeds reduced soybean yields from 20 to 40 per cent in various years.

Joshi (1973) reported that the losses caused by weeds is as high as 70 to 80 per cent insome cases in India. Even if

we consider 10 per cent loss of the total agricultural produce, the amount for this country would be Rs.4,200 millions for principle cereals, pulses, oilseeds, cotton, sugar cane and chillies.

Malik and Lal (1973) noted that weeds cause tremendous reduction in yield especially in kharif crops. Yield losses are as much as the combined losses caused by insects and diseases.

Nalewaja (1973) reported that one wild mustard plant (Brassica pinnatifida) per foot of row reduced the soybean yield by 35 per cent and 16 plants/foot of row reduced the yield by 60 per cent. He also pointed that that, if the weeds emerges before the crop, the yield loss is much greater than when the crop emerges first.

3. EFFECT OF CULTURAL METHODS ON WEEDS :-

Cultural methods of weed control have been practised by cultivators ever since man first realised that weeds reduced the yield of crop. These methods such as tillage, hoeing implements, weeding by manual labour, inter culturing, mowing and flooding etc. are ten physical methods of weed control frequently employed to getrid of weeds. These methods not only help to controll weeds, but also to conserve soil moisture.

> Burnside (1962) mentioned that soybean yields were increased by reducing the row space from 40 inches to 10 and

Amibèn application. Amibèn application increased the soybean yields, but crop injury was observed. Tillage treatments markedly increased soybean yields whereas other weed control measures were ineffective.

> Evans (1967) reviewed that even though the herbicides are used by more and more farmers through out the world, sound agricultural practises can still do much to eliminate weeds. The agricultural practises have the added advantage of being much less expensive than chemicals.

Wax and Mc.Whorter (1968) stated that good cultural practises and seed bed preparation combined with timely mechanical cultivation often provide an effective grass control programme in soybean crop.

Earl leng (1969) from his trails in India on soybean crop stated that perennial grasses and sedges are the most serious weed competitors for soybeans. Persistant herbicides like triflan have their own limitations in the control of sedges. Less persistant herbicides are usually leached out or broken down due to heavy rains. Hence clean cultivation during the early stages, especially by hand weeding has given the highest yields in soybean.

> Schweizer et al. (1971) indicated that intigrated method of control is necessary to eradicate some of the perennial weeds like field bind weed (convolvulus arvensis).

Herbicides combined with tillage and crop competition suppressed the weed growth by 31 to 55 per cent.

Humbest (1970) mentioned that controlling annual and biennial weeds with cultivation is relatively easy, but controlling of perennial weeds with persistent root system is more difficult. To prevent weeds from seeding mechanical cultivation should be done before weeds reaching seeding stage and shallow tillage to kill the young weeds.

4. EFFECT OF CHEMICAL METHODS ON WEEDS

= Ennis Jr. et al. (1965) reviewed that development of improved methods of weed control greatly enhance the practicability of minimum tillage.

Hari (1968) chemical weed control is one of the most outstanding discovery of the 20th century. The chance discovery of copper sulphate in 1896 in France killed yellow lock (Sinapis arvensis) without injury to oats led to the development of this revolutionary method of weed control.

= Cadwaladr (1968) reported that the chance discovery of 2,4-D and MCPA in the early 1940s and their subsequent release for farmer use proved to be the beginning of a new era in chemical weed control.

Megh Singh (1969) pointed out that there are several cultural as well as mechanical methods for controlling weeds in

soybean crop. But these methods are laborious and costly. Due to weather abnormalities, unavailability of human labour, the control of weeds at proper stage becomes difficult. In this situation chemical method of weed control remains the only effective method.

Mani et al. (1970) stated that chemical weed control is very effective in controlling weeds in modern agriculture with the development of intensive and multiple system of cropping where time and labour is very important factor. The advantage in using chemicals is timely control of weeds on a large scale at a reasonable cost.

Humbest (1970) expressed his view about the chemical weed control. In this age of mechanisation hand weeding is expensive and it is wasteful of human effort. He also expressed that if a farmer having proper herbicide, it is very easy to control weeds effectively than hand weeding or hoeing by man.

Kurdikeri et al. (1971) the use of herbicides coupled with minimum tillage has a great advantage by improved soil structure, increase moisture penetration, reduce water run-off and soil losses by water and wind. In fallow years of crop rotation, minimum tillage by the use of herbicides has a great advantage.

Bhan and Megh Singh (1972) reported that the weeds can be eradicated manually but manual weeding is costly, laborious

intensive and also time consuming. Some times, timely control of weeds is not possible because of continuous rains in the kharif season. Hence chemical method of weed control has an advantage over others and it is also economic and efficient method of controlling weeds.

5. EFFECT OF HERBICIDES ON WEEDS; CROP GROWTH AND YIELD OF SOYBEAN

Burnside et al. (1962) reported that Amiben application at 1, 2, 4 lbs/acre was effective in controlling annual weeds in soybean however slight soybean injury was observed at 4 lbs per acre. 25 to 75 per cent of weeds were controlled at various doses of amiben application.

Burnside (1967) from his green house and field studies indicated that Trifluralin gave better control of wild cane (Sorghum bicolor) when incorporated in the soil above rather than below the wild cane seed in soybean crop.

Johnson (1969) in his experiment on soybean reported that amiben ester + Dinoseb and Trifluralin reduced the growth of soybean seedlings, but no difference in plant height was observed at the time of crop maturity. Seedling vigor was also affected by the above herbicides. Soybean yields were reduced when the crop was treated with chloroxuron; chloropropham + Dinoseb.

2 Krust et al. (1971) have studied the effect of

Trifluralin rate and placement in the soil on the growth and anatomy of soybean plants. They observed that starch accumulation in nodules and in xylem when the rate of trifluralin was increased from 0.36 to 1.1 kg per hectare. Plant top growth was reduced more when Trifluralin was incorporated below 10 cms in the soil, but root growth inhibition was not affected by its placement.

Johnson (1971) reported that vernolate injected at 2.24 kg per hectare controlled grasses and broad leaf weeds very effectively than vernolate incorporated in the soil at the same rate. Pre-emergence application of vernolate gave good weed control, but it was not effective in controlling weeds throughout the crop season. 93 to 100 per cent broad leaved weeds were controlled when linuron or prometryne was applied as a post emergence alone or the plots previously treated with vernolate.

Johnson (1972) observed that repeated post-emergence application of chloroxuron, linuron, dinoseb were effectively controlled weeds in soybean crop without any crop injury, however repeated application of prometryne resulted in more foliar injury in early stages of crop growth. Seed quality was best in dinoseb and poorest in prometryne.

Johnson (1971) reported that vernolate applied as pre-plant followed by prometryne as pre-E. controlled an average of 87 per cent of broad-leaf weeds. Vernolate + chloramben or

linuron controlled an average of 79 and 83 per cent of weeds respectively. Plant height is more when soybean treated with prometryne than linuron or chloramben.

(a) Lasso :-

Bhan and Megh Singh (1972) reported that Lasso is a selective pre-emergence herbicide. This herbicide has been found to provide an effective control of annual grasses as well as broad leaf annual weeds.

Chandrasingh et al. (1972) found that Lasso controls a broad spectrum of both monocot and dicot weeds, but perennial weeds like nut grass (Cyperus rotundus) was found to be tolerant to this herbicide. At higher doses moderate control of this weed was observed.

Chandrasingh et al. (1972) from an experiment on groundnut found that among all other herbicides Lasso controlled the weeds very effectively. About 80 to 95 per cent of monocot and dicot weed control was achieved throughout the crop period.

Jain et al. (1972) reported that among the five herbicides used at different concentrations to control weeds in soybean, lasso at 2 and 3 lit. a.i/ha. produced 1039, 851 and 1918 kg dry weight of weeds per hectare as compared to no weeding control respectively. The pod number and test weight of soybean were closely related to the intensity of weed control. The highest yield of 18.41 q/ha. was obtained in the lasso applied at the rate of 1.0 kg/ha.

Bajpai et al. (1972) observed that among the herbicide, eptam 6 kg/ha. followed by Lasso at 1 kg/ha. gave the highest yield of soybean 16.06 and 14.97 q/ha. respectively. Lasso at 1.0; 3.0 lit. ai/ha. produced 34; 23 and 22 q/ha. of fresh weight of weeds respectively over 42 q/ha. by weedy control.

Johnson (1972) indicated that highest control of broad-leaved weeds was obtained from alachlor (Lasso) applied with prometryne or chloropropham in sunflower. Control of 90 to 92 per cent of broad leaf weeds ^{at} normal planting by the above herbicides was noted.

- Karve et al. (1972) pointed out that Lasso at 2.5 kg/ha. gave very satisfactory weed control in cotton, lasso caused no visible injury to cotton, while the supression of weeds too was quiet satisfactory.

Malik and Lal (1973) from their two year experiment on soybean reported that soybean yields were reduced to 41.4 and 31.4 percent in 1970 and 71 respectively due to weed infestation. Among the herbicides Lasso and Tok E-25 proved very effective in controlling weeds in soybean. Lasso at 1.0 and 2.0 kg/ha. produced 24.5 and 6.2 number of weeds as against 198.2 weeds by weedy control at 30 days of planting.

(b) Tenoran :-

Gautam et al. (1966) reported that Tenoran effectively

controlled some of the weeds like Chinopodium album, Anagalis arvensis; Amaranthus sp; portulaca sp in carrots. Early application of Tenoran killed most of the weeds very effectively.

Hosamani (1968) reported that, Tenoran was significantly reduced annual dicot weeds but the kill is greater when applied in early stages. Tenoran at 5.0 kg/ha. has a toxic effect on onions, but the same dose applied later was harmless. Pre and post-Emergence application of tenoran had no adverse effects on crop growth.

Kasasian and Seeyave (1968) reported that Tenoran applied beyond 1.5 kg/ha. had a toxic effect on soybean crop.

Bajpai et al. (1972) in their experiment on soybean observed that Tenoran at 2, 4, 6 kg/ha. produced 24, 16 and 6 q/ha. fresh weight of weeds respectively over 42 q/ha. in no weeding control. Effective weed control was obtained with Tenoran at 4 and 6 kg/ha. but crop suffered from its injurious effects resulting in decreased yield.

Experiments conducted by Kuldip singh et al. (1972) on groundnuts reported that Tenoran increased the pod yield of 17.2 per cent over unweeded control. Tenoran at 2.0 kg/ha. produced 100 kg/ha. dry weight of weeds as against 223 kg/ha. in weedy control.

Malik and Lal (1973) indicated that Tenoran at 1.0 and

2.0 kg/ha. reduced the weed population in soybean as compared to unweeded control. Tenoran at the same rates produced the number of weeds as 98.2 and 88.2 as against 198.2 in weedy control per M² at 30 days of crop growth.

(c) Sirmate :-

Sirmate is highly selective pre-emergence herbicide used for controlling certain perennial grasses like Eleusine indica; Schinochloa colonum; Digetaria sanguinalis, Andropogon repens etc, but sirmate is not controlled some weed species like xanthium sp, cyperus sp sirmate is not effective against established perennial weeds.

Little work has been done regarding the effect of this herbicide in soyabean crop hence needs further investigation.

Chandra Singh et al. (1972) data collected from exploratory trail on ground nut showed that sirmate applied at 4.48 kg/ha. was the best for controlling weeds in groundnut. Sirmate produced 1827 and 1383 kg pods/ha. against 543 kg in weedy control.

Saraswat and Roy (1973) tested sirmate along with other herbicides in jute and noted that it gave promising control of grasses but was in effective against nut-sedge (cyperus rotundus) when applied as pre-emergence at 2 kg/ha.

(d) TokE-25 :-

Balanarasalah et al. (1969) reported satisfactory weed

control in groundnut with Tok E 25. Tok at 4.0 kg/ha. reduced the weed growth by about 64.5 and 89.2 and 89.2 per cent over no weeding control in 1967 and 68. The herbicide showed longer residual activity and weed free condition in early stages of crop growth. Highest pod yields of 643 kg/ha. or 67 per cent increase over no weeding was observed in Tok E-25 at 4.0 lit/ha.

Jain and Choubey (1969) reported that Tok E-25 at 2.0 kg/ha. kills the weeds like Echinochloa coloum; Phyllanthus miruri; Gyperus rotundus in soybean crop. Among the various herbicides used Tok E-25 was significantly superior in controlling weeds followed by Triflan over weedy control. Tok E-25 at 1.5 and 2.0 kg/ha. produced 23.8 and 23.19 Q/ha. pods in Groundnut against 20.17 q/ha. in no weeding control.

Saxena (1971) while working on herbicides in soybean at Pantnagar noted that the use of higher dose of Tok E-25 beyond 1.0 kg/ha. has an effective killing of weeds.

Bajpai et al. (1972) reported that Tok at lower doses was ineffective in controlling weeds in soybean. Tok at 0.5, 0.75 and 1.0 lit/ha. produced 35, 31 and 30 q/ha. fresh weight of weeds and 106, 110 and 82 number of weeds per M² over 42q/ha. and 209 weeds per M² respectively in weedy control. Lower dose of Tok is inefficient to control weeds as compared to Lasso, Tenoran and Treflan on soybean crop.

Bhan and Megh Singh (1972) reported that Tok E-25 is

the most effective herbicide on actively growing weed seedlings at the true leaf stage. The efficacy of the herbicide declines rapidly as the weeds increase in size and age.

Mukhopadhyay (1972) reported that Tok is a pre-emergence herbicide, toxic to number of broad leaf and grassy weeds, but its activity is rapidly lost if incorporated in the soil.

Malik and Lal (1973) reported that pre-emergence application of Tok in the inter-row spaces of soybean either singly or in combination with hand weeding did an efficient job of weed control. Tok at 1.0 and 2.0 kg/ha. produced 24.2 and 12.0 weeds/M² over 192 in weedy control at 30 days in soybean. After Lasso, Tok E-25 produced more grain yield of 27.88 and 31.72 q/ha. at the same doses over 24.11 q/ha. by weedy control.

(e) Meloran (C 6313)

Meloran (C6313) is a new selective herbicide hence very little work has been done in India. Few scientists have conducted experiments on different crops like Groundnut, peas and Potato.

Yield trail in Trinidad on Beans showed that C6313 at 1 lb/acre gave better weed control. C6313 at 2.0 lbs/acre caused physiological injury to the beans was reported by university of West Indies (1966-67).

Kirti Singh and Khurana (1972) reported that C6313 at 2.5

and 3.75 kg/ha. controlled most of the dicot weeds like Chinopodium album; Convolvulus arvensis; Amaranthus sp, Euphorbia sp, and monocot weeds like Rumex acutus ; Cyperus rotundus; Cynodon dactylon and Eleusineaegypticum in Potato crop. C.6313 at 3.75 kg/ha. plus earthing produced the highest tuber yield of 310 q/ha.

Saimbhi et al. (1970) reported that there was absolutely no weeds in the plots treated with C6313 and the plots appeared like that of hand weeded plots. The fresh weight of both Kharif and Rabi weeds was 61.07 and 127.73 q/ha. at 1.0 and 2.0 kg/ha. and 2.59; 3.96 q/ha. respectively over 86.97 and 100.33 q/ha. in weedy control in peas. Lower yields were obtained when C6313 applied at 2.0 kg/ha.

- Kirti Singh et al. (1973) reported effective control of weeds with C6313 at 2.0 kg/ha. applied as a pre-emergence to the vegetable crops but the yields were low due to crop injury in initial stages of crop growth in peas. C6313 at 1.0 and 2.0 kg/ha. produced 50.65 and 58.37 q/ha. of grain yield over 12.6 q/ha. in weedy control.

(f) Preforan (C6989)

Preforan (C6989) is a new herbicide suitable for use in Rice crop as pre or post-emergence and pre-emergence in cotton, soybean, Groundnuts etc.

Preliminary trials in Trinidad in onion crop indicated

that C6989 at 1 and 2 lbs/ha. increased the bulb yield in onion crop. (Annual report West Indies, 1968)

Ebner, et al. (1968) reported in proceedings 9th British weed control conference that C6989 controlled a wide range of broad-leaf weeds and grany weeds including Echinochloa crusgalli; Scirpus sp; Eleusine sp and Setaria sp and gave an acceptable supression of cyperus sp. The resitant weed in the treated plots was Ipomea sp. Same authors reported that out of 30 samples trials conducted and reported that in soybean using C6989 at the rates 2, 3, 4, 6 lbs/acres controlled 85, 88, 86 and 90 per cent of grasses and 68, 78 and 79 per cent of broad leaved weeds respectively at 8 weeks stage. C6989 at the same rates produced a grain yield of 23.6, 34.7, 37.0 and 32.8 bushels/acres over 20.5, 31.1, 28.0 and 29.3 bu/ac. in no weeding treatments respectively.

Ebner et al. (1968) conducted field trails in Rice, infested with Paspalum sp, Cyperus rotundus, Echinochloa Crasgalli weeds and obtained the control tothe extent of 90, 85 and 96 per cent at 2, 3 and 4 kg/ha. respectively with C6989.

Saimbhi (1970) reported that C6989 at 2.0 and 3.0 kg/ha. produced 57.33 and 46.27 q/ha of fresh weeds in kharif season as against 86.97 q/ha. in unweeded check. C6989 also reduced the Rabi weeds incomparision to the unweeded check. Highest grain yield of 17.49 q/ha. was obtained in plots treated with C6989 at 3.0 kg/ha. in Peas, and it was found superior to handweed plot.

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* METHOD AND MATERIALS *
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MATERIAL AND METHODS

The present investigation was carried out during the kharif season of 1973-74 at the farm of Jawaharlal Nehru Krishi Vishwa Vidyalaya, College of Agriculture Campus, Indore, to study the effect of different herbicides to control weeds and their influence on the growth and yield of 'Bragg' variety of Soybean. Effect of herbicides was compared with the cultural practices under soil and climatic conditions of Indore.

CLIMATE

Indore is situated at 567 meters above mean sea level with latitude of 22 - 43° north and longitude of 75 - 56° east. According to the climatological data recorded by the Madhya Pradesh soil testing laboratory. The average annual rainfall for the past ten years is 97.7 cms. In 1973-74 Indore received a maximum rainfall of 191.44 cms. The weather conditions prevailing during the kharif season of 1973-74 are given below:

TABLE - 1

CLIMATOLOGICAL DATA DURING KHARIF SEASON OF 1973-74

Month	Monthly rainfall in cms.	Monthly average temperature in °c.		Relative humidity in %	Number of rainy days
		Maximum	Minimum		
June	4.27	35.6	24.3	74.2	6
July	79.02	27.1	22.0	94.6	27
August	60.05	27.1	21.7	95.1	21
September	50.00	27.1	21.0	93.6	18
October	5.20	29.7	17.0	67.5	5
November	Nil	27.3	10.9	50.3	Nil

SOIL:-

The soil of the experimental field was a typical medium black cotton soil of Malwa tract having an average fertility level. The topography of the field was uniform with gentle slope and natural drainage. In order to findout the initial fertility of the soil composit soil sample was taken from 6" depth. The collected soil sample was analysed for constituents. The results are given as under:

RAINFALL DURING 1973-74
RAINFALL DURING LAST 10 YEARS

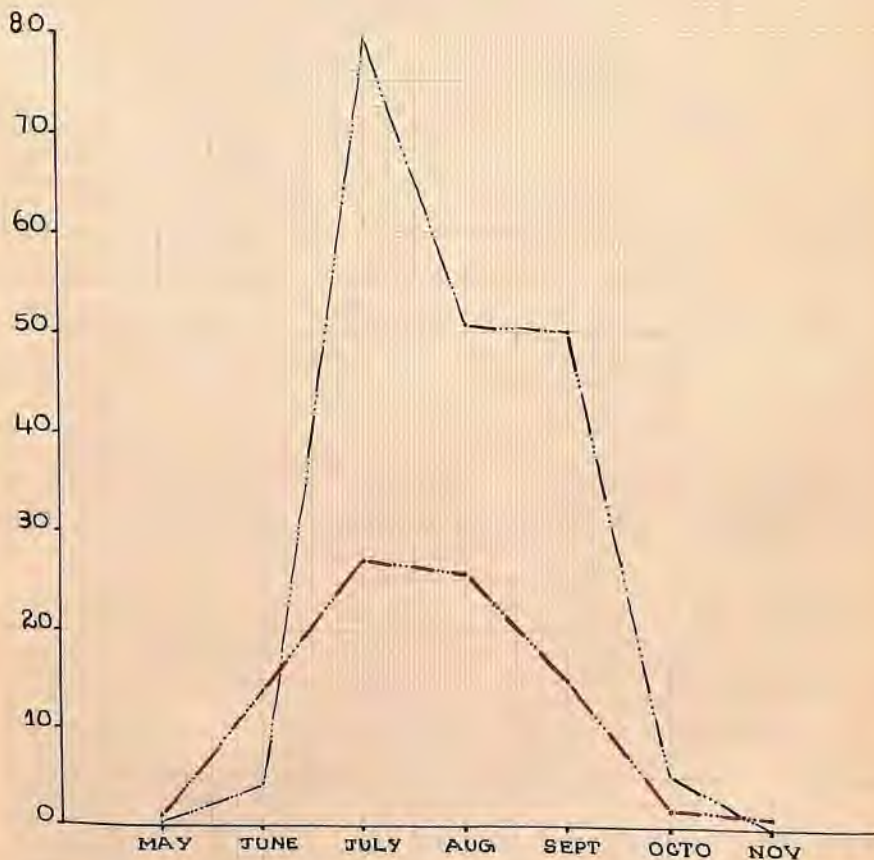


FIG 1 MONTHLY RAINFALL IN 'CM'

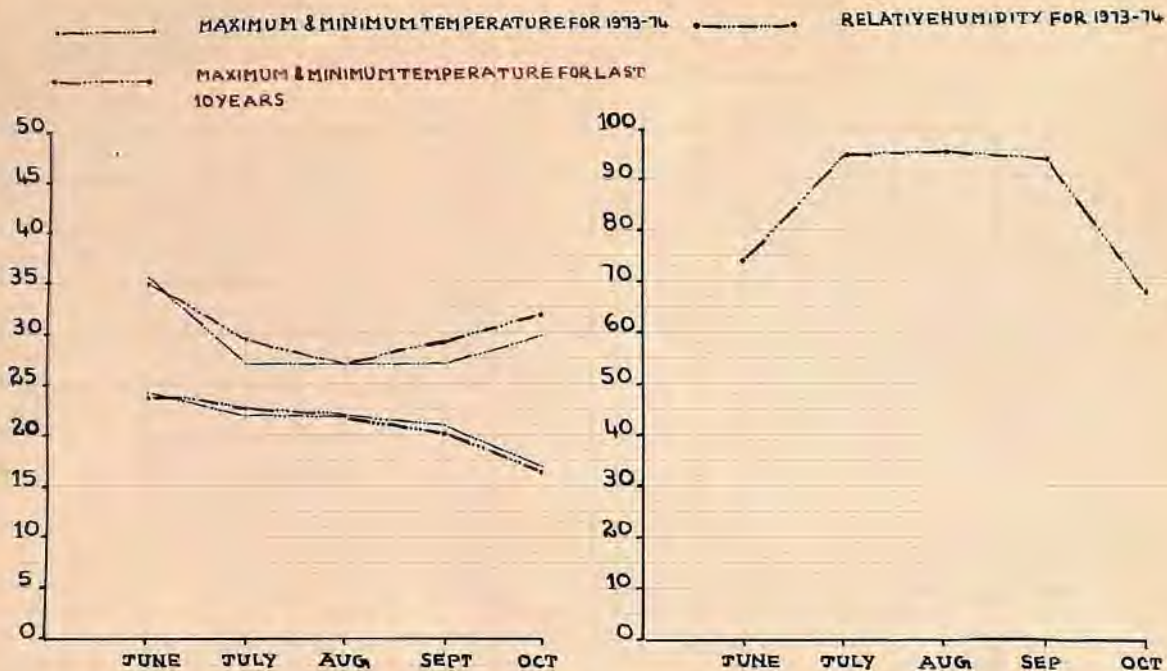


FIG. :- 2 MAXIMUM AND MINIMUM TEMPERATURE IN °C AND RELATIVE HUMIDITY IN %

TABLE - 2CHEMICAL ANALYSIS OF THE SOIL

1.	Available Nitrogen	...	138 kg per hectare.
2.	Available phosphorus	...	38 kg per hectare
3.	Available potash	...	750 kg per hectare
4.	Soil p ^H	...	8.3
5.	Conductivity	...	0.58

TABLE - 3MECHANICAL ANALYSIS OF THE SOIL(PERCENTAGE)

1.	Sand	13.3
2.	Silt	26.9
3.	Clay	59.8

TABLE - 4PREVIOUS HISTORY OF THE FIELD

S.No.	Year	Crops in	
		Kharif	Rabi
1.	1970-71	Jowar	Wheat
2.	1971-72	Jowar	Wheat
3.	1972-73	Soybean	Wheat
4.	1973-74	Soybean	Wheat

TABLE - 5
EXPERIMENTAL DETAILS

1.	Design	...	Simple randomised block design
2.	Number of Replications	...	4
3.	Number of Treatments	...	16
4.	Total number of plots	...	64
5.	Gross plot size	...	6 x 2.7 = 16.2 M ²
6.	Net plot size	...	5 x 1.8 = 9.0 M ²
7.	Replication border	...	1.0 meter
8.	Plot border	...	0.5 meter
9.	Total experimental area.	...	1331.2 M ²
10.	Net sown area	...	1036.8 M ²
11.	Number of rows in each plot	...	6

TABLE - 6

DETAILS OF TREATMENTS WITH SYMBOLS MENTIONED BELOW.

S.No.	Treatments	A.E.	Quantity/ ha.	Quantity/ plot.	Symbols.
1.	LASSO	50%	1 Lit.	3.24 cc	T ₁
2.	LASSO	50%	2 Lit.	6.48 cc	T ₂
3.	TENORAN	50%	1 kg.	3.24 gm	T ₃
4.	TENORAN	50%	2 kg.	6.48 gm	T ₄
5.	SIRMATE	80%	2 Lit.	4.05 cc	T ₅

contd...

contd....

S.No.	Treatments	A.E.	Quantity/ ha.	Quantity/ plot.	Symbols.
6.	SIRMATE	80%	4 Lit.	8.10 cc	T ₆
7.	TOK E-25	25%	1 Lit.	6.48 cc	T ₇
8.	TOK E-25	25%	2 Lit.	12.96 cc	T ₈
9.	MELORAN (C.6313)	50%	2 kg.	6.48 gm	T ₉
10.	MELORAN (C.6313)	50%	4 kg	12.96 gm	T ₁₀
11.	PREFORAN (C.6989)	30%	2 Lit.	10.69 cc	T ₁₁
12.	PREFORAN (C.6989)	30%	4 Lit.	21.38 cc	T ₁₂
13.	HANDWEEDING	(20 days after sowing)			T ₁₃
14.	HAND WEEDING	(30 days after sowing)			T ₁₄
15.	CLEAN CULTIVATION	(4 Hoelings)			T ₁₅
16.	CONTROL	(No weeding, No chemical)			T ₁₆

CULTURAL OPERATIONS BEFORE SOWING:-

The field was ploughed in summer with tractor after the harvest of the previous crop of wheat. Two cross bukharing were given after the onset of monsoon rains. Finally the planker was worked to level the field and drainage channels were drawn in between the plots.

FERTILIZER APPLICATION :-

A fertilizer dose @ 20 kg. nitrogen, 80 kg. phosphoric acid and 60 kg. potash per/ha. in the form of urea, single

LAY OUT PLAN OF THE EXPERIMENTAL FIELD

RANDOMIZED BLOCK DESIGN

R ₁	R ₂
R ₃	R ₄

PLOT SIZE
 LENGTH 6 mt.
 BREADTH 2.7 mt.

SCALE
 1 cm. - 2 mt.



superphosphate and Muriate of potash respectively was applied as a basal dressing with the help of a drill, at 6 cms, deep in the soil along the rows.

SEED AND SEED TREATMENT:-

A high yielding soybean variety 'Bragg' with high germinating percentage was selected for this experiment. The seeds were treated with fungicide 'Thiram' as 5 gm per 1 kg. seed before sowing against soil borne diseases. A seed rate 120 Rg. per hectare was used.

INOCULATION OF SEED:-

Soybean seeds were inoculated just before sowing with commercial Rhizobium culture (Nitragen) a) 5 gm per 1 kg. seed with 10 per cent jaggary solution to ensure effective nodulation.

SOWING :-

The inoculated soybean seeds were sown by dibbling at 45 cms. inter row spacing and 4 cms. intra row spacing at 4 cms. depth in the soil. Sowing was done on 4th July, 1973.

HERBICIDES APPLICATION :-

The herbicides were applied in ^{aqueous} aqueous solutions made carefully at the rate of 800 lit. per heatare. The amount of different herbicides was calculated on the basis of a.i; dose and the plot size. The solution was stirred from time to time

during the spraying. The herbicides were sprayed with a high volume - low pressure sprayer on the next day of sowing as a pre - emergence spray. The drift of the spray to the adjoining plots was avoided by using a wind screen.

PROPERTIES OF HERBICIDES :-

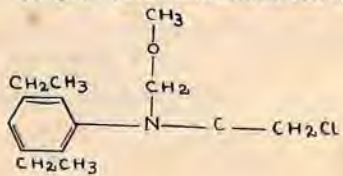
The herbicides included in the experiment are classified as under :-

- | | | | |
|----|---------------------|-----|-------------------|
| 1. | LASSO (ALACHLOR) | ... | Amides |
| 2. | TENORAM | ... | Substituted ureas |
| 3. | MELORAN (C. 6313) | ... | Substituted ureas |
| 4. | SIRMATE | ... | Carbamates |
| 5. | TOK E-25 (NITROFEN) | ... | Phenols |
| 6. | PREFORAN (C.6989) | ... | Phenols |

I. LASSO

Group	...	Acetanilide
Common name	...	Alachlor
Chemical name	...	2 - Chloro - 2', 6' - diethyl - N (Methoxymethyl) acetanilide.
Active ingredient	...	50 per cent Emulsifiable concentrate

Structural formula



EFFECTIVENESS IN CROP:-

Lasso is a selective, pre-emergence herbicide which effectively controls most grasses and broad leaf weeds except perennials in crops like Ground nut, Soybean, Maize, Cotton, Potato and sugar cane. Normally Lasso is applied under sufficient moisture in the upper surface of soil, at the rate of 2 to 4 Lit. a.i per hectare. Lasso normally degrades in the soil in 45 to 50 days after application, so that, there is no danger of residual toxicity to the next crop.

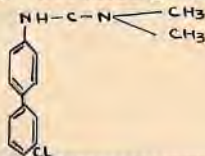
MODE OF ACTION :-

Most of the amides acts on cells of susceptible plants by contact action and also by absorption and translocation into active growing points. These compounds inhibit the hill reaction and acts primarily the path way of oxidation of water (H₂O to O₂).

II - TENORAN

Group	...	Substituted ureas
Common name	...	Chloroxuron
Chemical name	...	N'-4- (4-Chlorophenoxy) phenyl-N-N-dimethyl urea.
Active ingredient	...	50% wettable powder

Structural formula



EFFECTIVENESS IN CROP :-

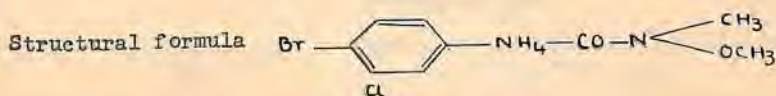
Tenoran is a selective, soil herbicide. It is highly effective against freshly germinated weeds, just after the cotyledons are opened above the soil. The top layer of soil must be left undisturbed and no soil cultivation should be taken during 3 to 4 weeks after application for effective killing of weeds. Tenoran is recommended at the rate of 3 to 4.5 kg. a.i per hectare in various crops like Ground nut, Soybean, Maize, Carrots, Peas and Onion crops. The effect of Tenoran lasts for 6 to 9 weeks. No harmful residues will accumulate to the subsequent crop.

MODE OF ACTION :-

Substituted urea herbicides kill plants by root absorption and they are translocated upward in the transpiration stream. Root injury was observed by Ashton (1965) when the plants were treated with urea herbicides. These herbicides act through inhibition of photolysis (Hill reaction) of water leading to oxidation of chlorophyll apparatus. The major cause of the toxicity is the inhibition of photosynthesis (Van O Orshot and Belksma 1961). Hassal (1961) considered the physical poison nature of the phenyl urea herbicides causing disruption of cellular structures for destruction of plants.

III- MELORAN

Group	...	Substituted ureas
Common name	...	-
Chemical name	...	N - (4-bromo-3-Chlorophenyl) - N-Methoxy - N - Methyl urea.
Active ingredient	...	50% wettable powder.

EFFECTIVENESS IN CROP :-

Meloran C. 6313 is a selective pre or post emergence herbicide and it is highly effective in controlling broad-leaf weeds. Meloran is recommended at the rates of 2 to 6.0 kg. per hectare to various crops like Potato, Peas, Ground nuts, Paddy, Soybean etc.

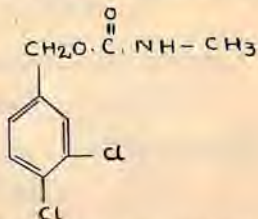
MODE OF ACTION :-

Substituted urea herbicides altered the sugar content of plants and low concentration of this compound inhibit the Hill reaction. Some ureas like Monuron and Diuron inhibit the electron transport, oxygen evolution and phospho relation processes.

IV - SIRMATE

Group	...	Carbamate
Common name	...	
Chemical name	...	An isomeric mixture containing 3, 4 - dichlorobenzene methyl carbamate 80% 2,3, - dichlorobenzyl methyl carbamate 20%.
Active ingredient	...	80% E.C. and granular formulations

Structural formula ..



vs
EFFECTIVENESS IN CROP :-

Sirmate is a highly selective pre-emergence and selective post - emergence herbicide for control of certain perennial weeds and a wide spectrum of annual broad-leaf weeds and grasses. It is not effective against established perennial weeds. Sirmate is recommended at the rate of 4 to 8 kg. a.i per hectare on all types of soils to various crops like Peas, Potato, Ground nut, Soybean and other vegetable crops. It is not readily leached from the soil surface. Weed control may be obtained from 4 to 12 weeks depending upon soil type, rate and climatic conditions.

MODE OF ACTION :-

Sirmate kills young weed seedlings after germination

but does not suppress seed germination itself. Kill probably comes from lack of carbohydrate availability, resulting from inhibition of chlorophyll synthesis. It is most effectively absorbed through nodes and internodes of young weed seedlings near the soil surface. Foliar application may result in foliage burn. Carbamate herbicides inhibit the Hill reaction by hydrogen bonding of carboxyl oxygen (Moreland and Hill 1959 and Vanover Veek 1964).

V - NITROFEN

Group	...	Substituted phenol
Common name	...	Tok- <i>Nitrofen</i>
Chemical name	...	2,4 - dichlorophenyl 4-Nitrophenyl ether.
Active ingredient	...	25% E.C.

Structural formula



EFFECTIVENESS IN CROP :-

Tok E - 25 is a selective pre-emergence and early post-emergence herbicide. It is most effective on actively growing weed seedlings at the first true leaf stage. It has been found to control annual grasses and broad leaf weeds.

Tok E - 25 is recommended for various crops like cotton, ground - nut, Peas, Soybean, Sugarbeets and onions at the rate of 2 to

5 lit. a.i per hectare. Adequate surface soil moisture is necessary to activate its herbicidal properties. Prolonged effect can be reduced by soil incorporation.

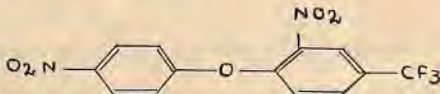
MODE OF ACTION :-

Substituted phenols are organic compounds of relatively low polarity. Compatible with Cuticle, they enter into plant cells rapidly. Phenols are less translocated. They act almost completely as contact action. Phenols stimulate respiration in low concentration and actively inhibit respiration at higher concentrations. Some phenols inhibits the coupling during phosphorelation and oxydation of pyruvate. Besides causing the respiratory response, they acts as coagulants.

VI - PREFORAN (C.6989)

Group	...	Substituted phenols
Common Name	...	Fluorodifen (Proposed)
Chemical name	...	2,4 - dinitro - 4 - trifluoromethyl diphenyl ether.
Active ingredient	...	30% E.C.

Structural formula



EFFECTIVENESS IN CROP :-

Preforan is a selective soil and contact herbicide of medium residual action for Rice as a pre or post - emergence or post - transplanting and pre-emergence in cotton, Soybean, Ground nut, Maize and other large seeded legumes. It is persistent and active for upto 8 to 12 weeks and is active even in dry soils.

MODE OF ACTION :-

The mode of action of preforan appears to be largely by contact, as translocation is relatively slow and weak. Phenol herbicides are rapidly absorbed by the cell walls. Phenols raises the temperature and stimulate respiration in the plants.

Trials on Soybeans have shown that C.6989 applied to the cotyledons has a contact burning effect at the point of application, but there is no visible evidence of Translocation. When applied to young or older leaves in Soybean causes a clearing of veins.

CROP CARE :-

Constant watch was kept to the field against bird damage in the early hours of morning and evening until the seedlings established well in the field. Plant population at 20 plants per meter row length was maintained after 15 days of sowing by thinning the seedlings in each plot.

PLANT PROTECTION :-

The following plant protection measures were taken from time to time.

(a) After Planting :-

Dialdrin 18 E.C. at 0.05% (25 c.c. of diadrin in 10 litres of water) at the rate of 80 gallons of solution per hectare was sprayed on the crop to control soil insects. The same spray was repeated again after the emergence of seedlings.

(b) At 4 weeks :-

1 : 1 mixture of Diazinon 20 E.C. at 0.2% and Rogar 30 E.C. at 0.03% (1:1 c.c. in 1 lit. of water) at the rate of 100 gallons of solution per hectare was sprayed to control leaf caterpillars, stem fly and petiole borers. The same spray was repeated at 50 days of sowing.

HARVESTING, THRESHING AND WINNOWER :

Crop was harvested on November 6th when the pods had dried and the seeds had attained yellow colour. To eliminate the border effect, firstly 50 cms. on both the sides length wise and one row on both sides width wise in each plot was harvested seperately. The net plot (5.0 M x 1.8 M) was harvested by cutting the plants with sickles closer to the ground. The dried crop from each plot was tied into bundles tagged with treatment

labels and taken to the threshing floor.

Individual plot produce was threshed with wooden sticks and then winnowed carefully. The grain yield obtained from each plot was weighed in kg. per plot and recorded.

EXPERIMENTAL OBSERVATIONS:-

(1) Plant Population Studies :-

Initial and final plant population of Soybean crop was taken at 15 days of sowing and just before harvest of the crop respectively. Plant population was counted by using meter scale along the row randomly fixed at five places in each plot and mean was taken.

(2) Weed Control Studies :-

Mortality of weeds was observed by recording the weed population, green weight and dry weight of weeds due to different treatments, at monthly intervals. The observation was taken by placing a quadrant (30x30 cms) at five places randomly in each plot, and number of growing weeds inside the quadrant was counted. The green weight of the same number of weeds was immediately recorded in grams. The dry weight of the weeds in grams was taken by drying the weeds in the oven for twelve hours at 105^oc temperature.

(3) Crop Growth Studies :-

(a) Plant height:- Crop growth studies were made by taking

plant height in cms. at monthly intervals. Eight plants two in each row were tagged randomly in each plot. The height of the crop was measured from the base of the stem to the tip of the leaf.

(4) Post Harvesting Studies :-

Yield contributing characters like number of branches, number of pods per plant, per plant yield in grams per plant and test weight in grams of individual treatments were recorded.

(a) Number of branches per plant :-

Number of branches per plant was counted from the eight tagged plants and mean was calculated.

(b) Number of pods per plant :-

Number of pods were counted from the eight tagged plants and mean was calculated as number of pods per plant.

(c) Per plant yield :-

The eight tagged plants from each plot were threshed and winnowed seperately. The grain from the eight tagged plants weighed in grams and mean was calculated as per plant yield.

(d) Test Weight :-

From a composite sample produce, thousand seeds were counted for each plot and weighed in a physical balance and the

weight was recorded in grams.

(5) Yield :-

After threshing and winnowing, the produce obtained from net was weighed separately in kg. per plot and converted into q/ha.

(6) Chemical analysis studies :-

(a) Oil and protein percentage :-

A composite grain sample of each treatment from all the four replications was analysed for oil and protein content in soybean seed.

Oil in the soybean seed was estimated by extracting the oil with ether by 'Soxhlet' extraction method.

Protein content in the soybean seed was calculated by estimating the nitrogen in the seed by 'Kjeldahl Method' and multiplying the reading by 6.25. (Protein = $N \times 6.25$).

(b) Nutrient uptake studies by the crop and weeds:-

A composite sample of two plants of each treatment from the four replications was taken and the stem, leaf and pods were dried separately for estimating Nitrogen, Phosphorus and Potash uptake by the crop.

The dry matter of weeds collected at the time of crop harvest was taken for Nitrogen, Phosphorus and Potash uptake by the weeds.

Nitrogen :-

Nitrogen content both in plant and weed samples was estimated by 'Kjeldahl method' and nitrogen uptake by the soybean plants and weeds was converted into Kgs. per hectare, according to dry weight basis.

Phosphorus :-

Wet digestion of the samples was done by triacid mixture. One gram of sample was digested, filtered and volume made upto 100.

A suitable aliquot of the above solution was taken and colour was developed by using ammonium Meta Vanadate and ammonium Molybdate. Phosphorus was determined calorimetrically. Phosphorus uptake by Soyabean plants and weeds was converted into kgs/ha. according to dry weight basis.

Potash :-

Suitable aliquot of the same solution was taken and diluted to suitable extent. Potash was determined by flame photometer. Potash uptake by the soybean plants and weeds are converted into kgs/ha. according to dry weight basis.

Weed spectrum :-

Weed species observed in the experimental plot during the crop growth was given as under:

1. Family : Gramineae

Cynodon dactylon, Pers., Dinebra arabica, Lona.,
Elucine indica, Gaertn., Paspalum sangunali, Lamx.,
Panicum javanicum, Poir., Saccharum spontaneum, L.,

2. Family : Cyperaceae

Cyperus rotundus, L.,

3. Family : Compositae

Ageratum convzoides, L., Xanthium strumarium, L., Lunia sp, Cass.,

4. Family : Euphorbiaceae

Acalypha indica, L., Euphorbia dracunculoids, Lamk.,
Euphorbia indica, L., Euphorbia sp

5. Family : Commelinaceae

Commelina bengolensis, L., Commelina noduflora

6. Family : Convolvulaceae

Convolvulus arvensis, L.,

7. Family : Labiatae

Lucas aspera, Spreng.,

8. Family : Nyctaginaceae

Boerhevia diffusa, L.,

9. Family : Acanthaceae

Digeria arvensis, Forsk.,

10. Family : Tiliaceae

^h ^h
Cercorus sp

11. Family : Solaraceae

Physalis minima, L.,



TABLE - 7

Analysis of variance technique was used for finding out the significance.

SKELETON ANALYSIS OF VARIANCE

S.No.	Source of variation	D.F.
1.	Replication	3
2.	Treatments	15
3.	Herbicides	11
4.	Cultural practises	2
5.	Methods	2
6.	Error	45
7.	Total	63

$$S.E.m = \pm \sqrt{\frac{\text{Error M.S.S}}{N}}$$

$$L.S.D. = S.E.m \times \sqrt{2 \times t}$$

* RESULTS AND DISCUSSION *
* *

RESULTS AND DISCUSSION

Effect of various treatments were studied on crop stand, crop growth, weed intensity, fresh and dry weight of weeds, yield and yield contributing characters of soybean. The results obtained were discussed under the following heads :-

A. PLANT POPULATION PER METER-ROW LENGTH

Initial and final stands of plant population were studied after 15 days of sowing and also at the time of crop harvest. The average plant population per meter-row length at both the stages were given in appendix Table-1.

TABLE - 1

PLANT POPULATION PER METER-ROW LENGTH

<u>HERBICIDES</u>		<u>CULTURAL PRACTICES</u>	
<u>Treatments</u>	<u>Average number of plants per meter-row length</u>	<u>Treatments</u>	<u>Average number of plants per meter-row length</u>
T ₁	18.00	T ₁₄	17.50
T ₂	17.75	T ₁₅	17.00
T ₁₂	16.75	T ₁₃	16.25
T ₁₁	16.75	T ₁₆	16.25
T ₁₀	16.75		
T ₄	16.75		
T ₃	16.25	S.E. _m = ± 0.55	
T ₅	16.25	L.S.D. = Non significant.	
T ₆	16.25		
T ₈	16.25		
T ₉	16.25		
T ₁₆	16.25		
T ₇	16.00		

The above table indicated that there was no significant difference in number of plants per meter-row length. Uniform plant population was maintained by thinning the plants in each plot.

B. CROP GROWTH STUDIES : Plant height :-

Plant height was measured in Cms. at monthly intervals to study the effect of different treatments on plant growth. The plant height was increased rapidly from 30 days to 60 days after sowing (Appendix Table -2). Though the plant height was increased at 90 days and at harvest, but the increase was meagre.

TABLE - 2
PLANT HEIGHT (Cms) AT CROP HARVEST

<u>HERBICIDES</u>		<u>CULTURAL</u>	<u>PRACTICES</u>
<u>Treatments</u>	<u>Average height (Cms)</u>	<u>Treatments</u>	<u>Average height (Cms)</u>
T ₁₂	58.00	T ₁₅	59.50
T ₂	57.50	T ₁₄	57.00
T ₁₁	57.00	T ₁₃	55.75
T ₄	55.50	T ₁₆	49.50
T ₁	54.25		
T ₃	53.50	S.E.m.	± 1.3
T ₈	52.25	L.S.D at 5% level	= 5.4
T ₇	50.75		
T ₅	50.00		
T ₁₆	49.50		
T ₆	49.00		
T ₉	42.00		
T ₁₀	41.00		

Significant difference was noted in plant height due to herbicidal effect and it ranged from 58.0 to 41.0 Cms. Among the herbicides, Preforan and Lasso at higher dose were the best in increasing plant height. Meloran at both the doses inhibited the plant growth due to severe crop injury thereby lessening the plant height. Sirmate and Tok E-25 also reduced the plant growth

more as compared to that of Preforan, clean cultivation and hand weeding at 20 and 30 days. It might be due to inefficiency of these herbicides to control weeds, thereby reducing the crop growth.

Among the cultural practices clean cultivation produced maximum plant height followed by hand weeding at 30 and 20 days after sowing, but all these treatments were at par.

Among the methods clean cultivation was the best followed by Preforan and Lasso at higher doses.

C. WEED CONTROL STUDIES :

1. Number of weeds :-

Twenty two species of weeds belonging to different families were identified in the experimental field throughout the crop growth period. Cyperus rotundus; Cynodon dactylon; Elucine indica; Acalypha indica; Commelena bengalensis; Boerhevia diffusa are the major weeds.

The number of weeds at different crops' stages of 30, 60, 90 and at crop harvest (Fig. 3 and 4) indicated that the same at 60 days of crop growth was maximum while it was comparatively less at crop harvest. It indicated that some of the kharif weeds completed their life cycle in the month of November there by reducing its population at crop harvest.

TABLE - 3

NUMBER OF WEEDS AT CROP HARVEST

HERBICIDES		CULTURAL PRACTICES	
Treatments	Number of weeds (30x30 Cms)	Treatments	Number of weeds (30x30 Cms)
T16	33.75	T16	33.75
T5	27.00	T13	14.00
T3	26.75	T14	12.25
T6	22.75	T15	Nil
T4	18.50		
T1	18.00	S.E _m =	± 1.72
T7	17.75	L.S.D. at 5% level =	7.15
T8	16.25		
T11	15.75		
T2	13.75		
T12	12.25		
T9	10.00		
T10	9.75		

Among all the herbicides Meloram at both the doses significantly reduced the number of weeds over weedy control. (Fig.3 and 4) followed by Preforan Lassø at higher dose and Preforan at lower dose. It may possibly be due to better control of weeds by these herbicides as also emphasized by Saimbhi et al. (1970), who noticed that there were absolutely no

■ AT 30 DAYS
■ AT 60 DAYS
■ AT 90 DAYS

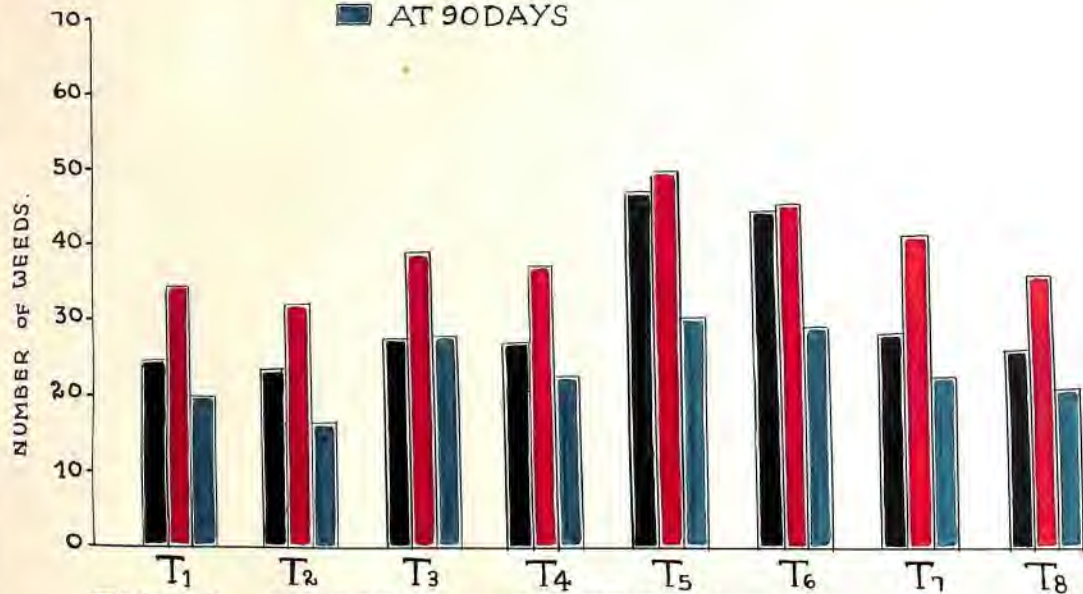


FIG:-3 NUMBER OF WEEDS IN (30 X 30 CM)

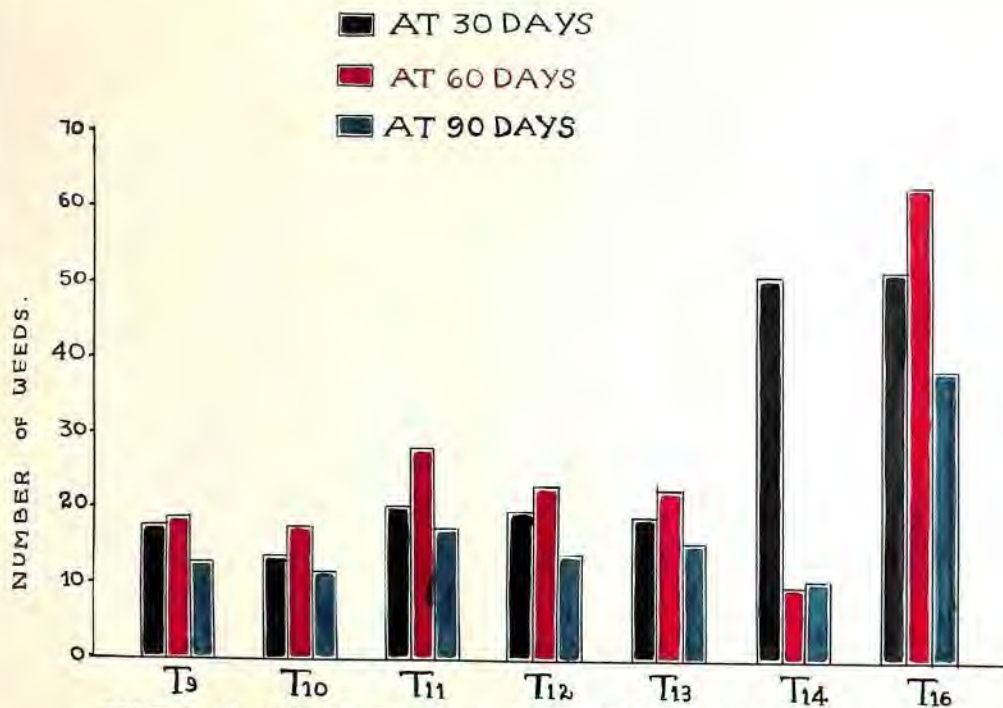


FIG.- 4 NUMBER OF WEEDS IN (30x30 CM)

weeds in the pea plots treated with Meloran (C6313). All these herbicides were at par and they were statistically significant. Sirmate at both the doses followed by Tenoran at lower dose could not remove the weeds and hence these herbicides were found to be ineffective in controlling the weeds. Tok E-25 at both the doses, Lasso at lower dose and Tenoran at higher dose were at par to suppress the weeds.

Among the cultural practices clean cultivation was the best followed by hand weeding at 30 days and 20 days. (Fig.3 and 4)

Among all the three methods weedy control had maximum weeds followed by Sirmate at both the doses. Clean cultivation was the best in reducing the weeds followed by Meloran at both the doses and Preforan and Lasso at higher doses.

2. Green weight of weeds :-

Green weight of weeds was found to increase with the progressive stages of the crop and was maximum at 60 days after sowing (appendix - Table -4). This may be due to luxurious growth of weeds at this stage while at crop harvest the green weight of weeds was low due to cessation of the life cycle of most of the kharif weeds.

TABLE - 4

GREEN WEIGHT OF WEEDS (Gms) 30x30 (Cms)

<u>H e r b i c i d e s</u>		<u>C u l t u r a l P r a c t i c e s</u>	
Treatments	Green weight of weeds (gm) (30x30 cms)	Treatments	Green weight of weed (30x30 cms)
T ₁₆	40.50	T ₁₆	40.50
T ₅	35.50	T ₁₄	27.50
T ₃	34.50	T ₁₄	15.50
T ₆	33.75	T ₁₅	Nil
T ₁	29.25	S.Em =	± 1.74
T ₇	28.75	L.S.D. at 5% level =	7.23
T ₄	28.25		
T ₈	27.75		
T ₁₁	24.50		
T ₂	24.00		
T ₉	21.75		
T ₁₂	18.50		
T ₁₀	18.00		

The range of green weight produced by different herbicides varied from 18.0 to 35.5 gm per 30x30 cms. Among all the herbicides Meloran at both the doses produced less green weight of weeds followed by Preforan and Lasso at higher doses. All the herbicide treatments were statistically significant and all were at Par. Maximum green weight of weeds was produced by

Sirmate and Tenoran at lower doses followed by Sirmate at higher dose and Lasso at lower dose. These herbicides were equal to that of Tok E-25 which evidently indicated that Sirmate did not control the weeds effectively thereby increasing green weight.

Among the cultural practices clean cultivation produced no weeds due to full time weed control by repeated hand weedings. Hand weeding at 30 days was significantly superior over hand weeding at 20 days. This was also explained by Bajpai et al. (1972) where hand weeding at 15 days after sowing was not found superior to hand weeding at 30 days, in soybean revealing the fact that the reappearance of weeds in later stages of crop growth was more there by increasing its green weight at crop harvest.

Among the various methods weedy control gave the maximum green weight of weeds followed by Sirmate and Tenoran. Meloran, Preforan at both the doses followed by Lasso at higher dose was the best herbicides in reducing green weight of weeds.

C. DRY WEIGHT OF WEEDS :

The dry weight of weeds at 30 days was low and it was increased as the number of days increased. Dry weight of weeds was maximum at crop harvest and its was due to maximum growth of weeds at this stage. Dry weight of weeds at crop harvest has been given in Table - 5.

TABLE - 5

DRY WEIGHT OF WEEDS (Gms) (30x30 Cms)

<u>HERBICIDES</u>		<u>CULTURAL PRACTICES</u>	
<u>Treatments</u>	<u>Dry weight of weeds (gm) (30x30 Cms)</u>	<u>Treatments</u>	<u>Dry weight of weeds (30x30 Cms)</u>
T ₁₆	24.22	T ₁₆	24.22
T ₅	22.90	T ₁₃	19.22
T ₃	21.50	T ₁₄	9.35
T ₇	21.07	T ₁₅	Nil
T ₆	20.80	S.E.m = ±	0.78
T ₈	20.65	L.S.D. at 5% Level =	3.24
T ₁	20.05		
T ₄	19.97		
T ₂	16.42		
T ₁₁	16.20		
T ₉	14.20		
T ₁₂	14.08		
T ₁₀	12.98		

A perusal of the data in Table - 5 showed that among all the herbicides Sirmate at lower dose produced maximum dry weight of weeds followed by Tenoran and Tok E-25 at lower dose. All the herbicidal treatments were statistically significant. Higher doses were superior to those of at lower doses in effective weed control possibly due to heavy soils with its high adsorptive

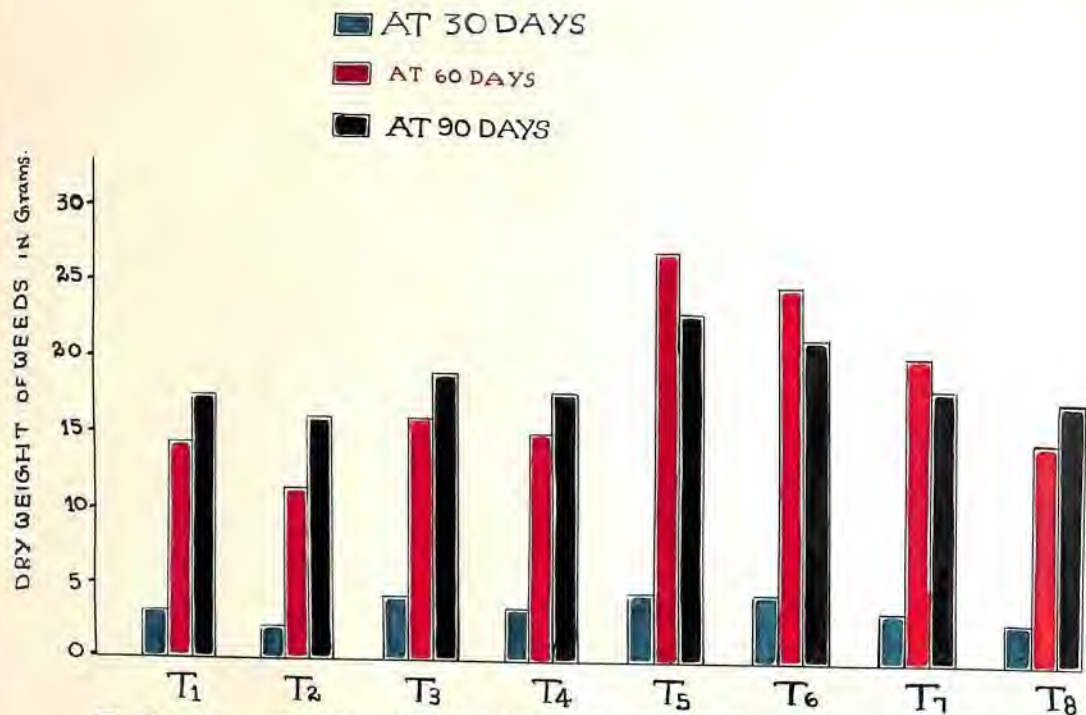


FIG-5 DRYWEIGHT OF WEEDS IN (30 X 30 CM) IN Grams.

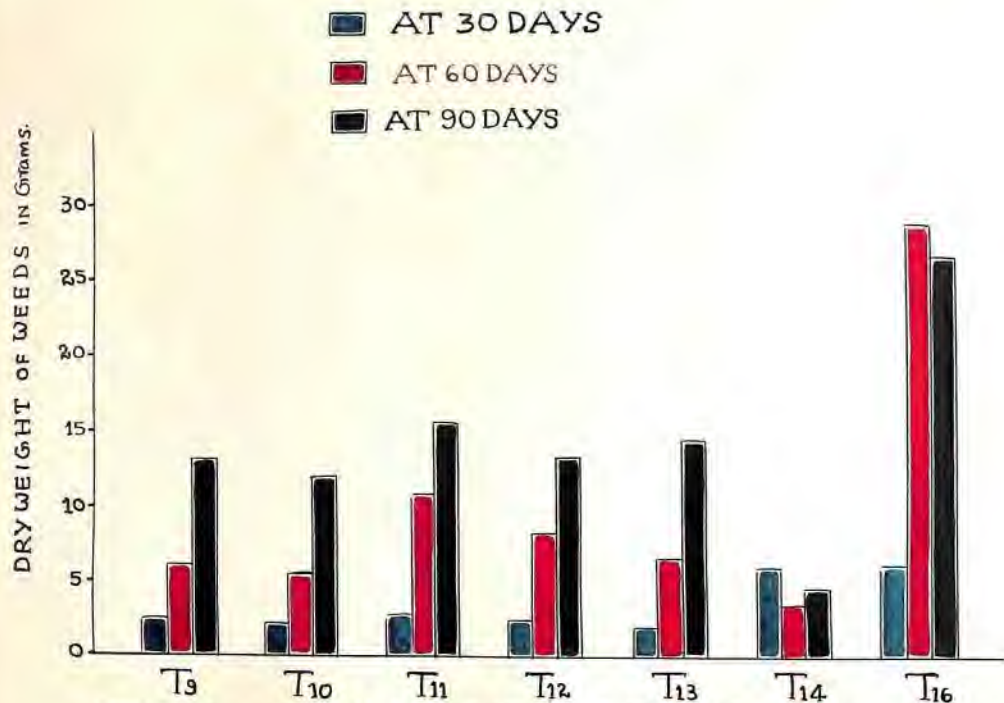


FIG:- 6 DRYWEIGHT OF WEEDS IN (30X30CM) IN grams.

capacity of the clay colloids. Less dry weight of weeds was observed in Meloran and Preforan at both the doses followed by Lasso at higher dose.

Among the cultural practices clean cultivation was the best. Hand weeding at 30 days was found to be superior over hand weeding at 20 days, and were statistically significant.

Out of the methods control with no weeding produced more dry weight followed by Sirmate, Tenoran and Tok E-25 at lower doses.

D. YIELD CONTRIBUTING CHARACTERS

1. Number of branches :-

TABLE - 6

NUMBER OF BRANCHES PER PLANT

<u>Treatments</u> <u>Number of branches</u>		<u>Treatments</u> <u>Number of branches</u>	
<u>per plant</u>		<u>per plant</u>	
<u>HERBICIDES</u>		<u>CULTURAL PRACTICES</u>	
T12	6.30	T15	6.90
T2	6.60	T13	6.40
T4	5.80	T14	6.17
T11	5.67	T16	4.40
T8	5.45		
T7	5.35		
T1	5.20		
T3	4.95	S.Em = ± 0.475	
T10	4.77	L.S.D. at 5% level = 1.97	
T9	4.55		
T16	4.40		
T6	4.30		
T5	4.27		

Among all the herbicides Preforan was found to be the best in increasing the number of branches followed by Lasso at higher dose. This might be due to some hormonal effect of these herbicides on the crop thereby increasing the number of branches. All the herbicides except Preforan and Lasso at higher doses were at par and they were statistically significant.

Increase in number of branches per plant was observed in clean cultivation. It might be due to full time weed control thereby less crop-weed competition. Hand weeding at 20 and 30 days after sowing was at par and were non-significant.

Among the three methods clean cultivation was the best, followed by Preforan and Lasso at higher doses. Though Meloran produced less dry weight of weeds, but due to crop injury it reduced the number of branches per plant.

2. Number of pods per plant :-

TABLE - 7

NUMBER OF PODS PER PLANT

<u>HERBICIDES</u>		<u>Cultural Practices</u>	
<u>Treatments</u>	<u>Number of pods per plant</u>	<u>Treatments</u>	<u>Number of pods per plant</u>
T12	27.60	T15	29.10
T2	24.90	T14	25.60
T11	24.50	T13	24.70
T1	22.02	T16	18.00
T4	21.10		
T8	21.05	S.Em =	± 0.936
T3	20.10	L.S.D. at 5% level =	3.89
T7	18.40		
T6	18.20		
T16	18.00		
T5	17.05		
T9	16.06		
T10	14.70		

All the herbicidal treatments were statistically significant. Among the herbicides, Preforan and Lasso at higher doses produced maximum number of pods per plant followed by Preforan at lower dose and all the above treatments were at par. It might be due to the fact that these herbicides destroyed the

weeds well in time thereby facilitating better utilization of moisture, and nutrients by the crop and increased the pod number. It was interesting to note that Meloran at both the doses reduced the number of pods per plant as compared to weedy control, which may be due to severe crop injury by this chemical as had also been noted by Kirtisingh (1973) and Saimbhi (1970) in Peas. Sirmate at both the doses produced less number of pods per plant next to Meloran. Severe weed infestation and inefficient control of weeds by this herbicide might be the cause for less pod number. Tok E-25 also produced less number of pods. It may be due to leaching of the herbicide due to heavy rains in the early stages of the crop there of reduced its effect on weeds, thereby reducing the number of pods.

All the cultural practises have been found to be statistically significant. Maximum number of pods were observed in clean cultivation plots due to weed free condition from sowing to the harvest of the crop. Hand weeding after 30 days was superior to that after 20 days in increasing number of pods.

Among the three methods, clean cultivation is best followed by Preforan at higher dose, hand weeding at 30 days in increasing the pod number followed by Lasso at higher dose, Breforan at lower dose and hand weeding at 20 days.

TABLE - 8

YIELD PER PLANT (Gms)

<u>HERBICIDES</u>		<u>CULTURAL PRACTICES</u>	
Treatments	Per plant yield (gm/plant)	Treatments	Per plant yield (gm/plant)
T ₁₂	6.8	T ₁₅	7.6
T ₂	6.0	T ₁₄	6.5
T ₁₁	5.7	T ₁₃	6.3
T ₁	5.2	T ₁₆	3.51
T ₄	4.8		
T ₈	4.7	S.Em = \pm 0.35	
T ₇	4.5	L.S.D. at 5% level = 1.455	
T ₃	4.5		
T ₆	4.2		
T ₉	4.1		
T ₅	3.9		
T ₁₆	3.9		
T ₁₀	3.6		

^{and}
 Preforan, Lasso at higher dose gave higher yield per plant followed by Preforan at lower dose and all the above treatments were at Par and the herbicidal treatments were statistically significant. Meloran at higher dose produced less per plant yield than that of weedy control. It might be due to severe crop injury. Sirmate at both the doses also produced

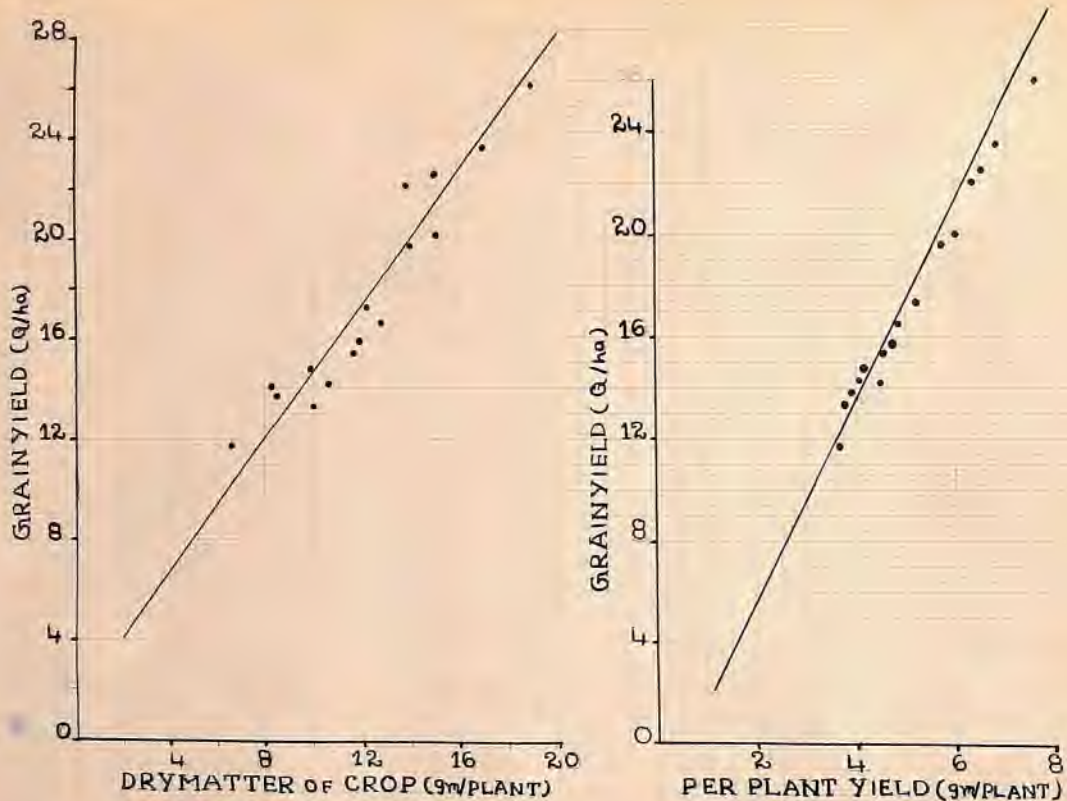


FIG:- 7 REGRESSION RELATIONSHIP

less per plant yield followed by Tenoran and Tok E-25 and all these treatments were at par. Ineffectiveness of Sirmate on the weeds might be the cause for less per plant yield.

Among the cultural practices clean cultivation produced maximum per plant yield. It was due to better growth of the crop as revealed by dry matter production by the crop (Fig.7). This was further explained by significant correlation and regression relationship between dry matter of crop and grain yield. Hand weeding at 30 days was superior over ~~hand-weeding at 30 days was superior over~~ handweeding at 20 days, but all these cultural practices were at par and were statistically significant.

Among all the methods Meloran at higher dose produced less per plant yield even to weedy control. Clean cultivation, was the best followed by Preforan and Lasso at higher doses and hand weeding at 30 days and at 20 days, in increasing per plant yield.

4. Test weight :TABLE - 9THOUSAND GRAIN WEIGHT (Gms)

<u>HERBICIDES</u>		<u>CULTURAL PRACTICES</u>	
<u>Treatments</u>	<u>1000 grain weight</u> (grams)	<u>Treatments</u>	<u>1000 grain weight</u> (grams)
T ₂	202.25	T ₁₅	205.00
T ₁	200.75	T ₁₃	204.75
T ₁₂	200.50	T ₁₄	201.75
T ₄	200.00	T ₁₆	181.001
T ₈	199.00		
T ₁₁	198.25	S.Em. = ± 1.09	
T ₇	198.25	L.S.D. at 5% level = 4.53	
T ₃	198.00		
T ₆	197.25		
T ₉	197.25		
T ₅	196.75		
T ₁₀	195.50		
T ₁₆	187.00		

Among all the herbicide treatments Lasso at both the doses produced significantly higher test weight, followed by Preforan at higher dose and these herbicides treatments were at

par. Meloran at both the doses produced comparatively less test weight, but most of the herbicides like Sirmate, Tenoran and Tok E-25 at both the doses and Preforan at lower dose were at par. It indicated the fact that there was less effect of herbicides on test weight. The above statement was supported by Johnson, (1971).

Clean cultivation was produced maximum weight of thousand grains followed by hand weeding at 20 days and at 30 days. All the cultural practices have been noted to be at par, and they were statistically in significant.

Among all the methods no weeding control gave less test weight. It may be due to severe crop-weed competition there by reducing the grain weight. The present results are in agreement with those found by Johnson (1971) which showed that the soybean quality was lower and seed size smaller when herbicide treatments failed to control weeds throughout the growing season. Clean cultivation followed by hand weeding at 20 days, Lasso, hand weeding at 30 days and Preforan at higher

dose were the best treatments among all in increasing the test weight.

E. GRAIN YIELD Q/HA.

TABLE - 10
GRAIN YIELD Q/HA.

<u>HERBICIDES</u>		<u>CULTURAL PRACTICES</u>	
<u>Treatments</u>	<u>Grain yield Q/ha.</u>	<u>Treatments</u>	<u>Grain yield Q/ha.</u>
T12	23.44	T15	25.77
T2	19.99	T14	22.44
T11	19.55	T13	21.99
T1	17.33	T16	13.33
T4	16.55		
T8	15.77	S.Em = ± 0.274	
T3	15.44	L.S.D. at 5% level = 4.93	
T6	14.66		
T7	14.22		
T9	13.88		
T5	13.66		
T16	13.33		
T10	11.66		

Among the herbicides Preforan and Lasso at higher doses were significantly increased the grain yield over no weeding control. Increase in grain yield in the above herbicide

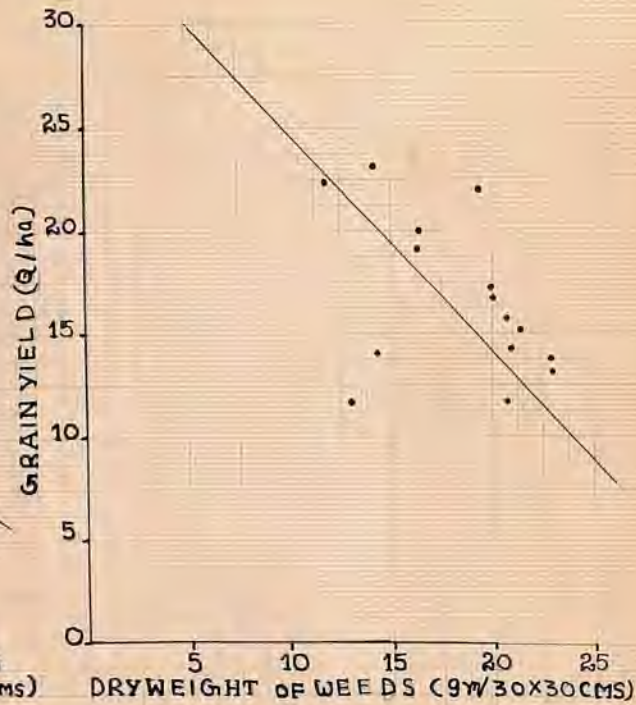
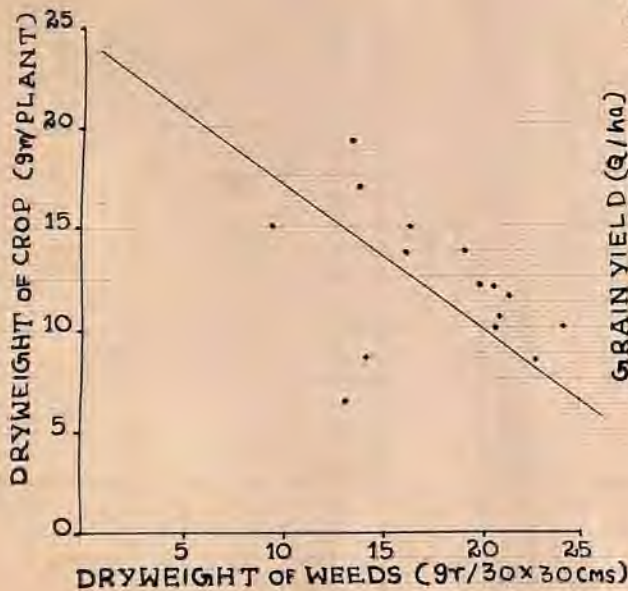


FIG:- 8 REGRESSION RELATIONSHIP

treatments was due to better growth of the crop as revealed by dry weight produced by the crop (Fig.7). This was further explained by significant positive correlation and regression relationship between dry matter of the crop and grain yield (Fig.7). Better growth of the crop in the above herbicide treated plots was due to better weed control (Fig. 3 and 4) and also significant negative correlation and regression relationship between dryweight of weeds and dryweight of crop; and dry weight of weeds and grainyield (Fig.8).

Meloran at both the doses was inefficient in increasing the yield and its higher dose was inferior to no weeding control. Though Meloran treated plots were the best in controlling weeds, but due to severe crop injury the crop yields were very much reduced, as also found by Saimbhi (1970) and Kirti Singh et al (1973) in peas.

Sirmate at both the doses were ineffective in controlling most of the weeds there by less grain was produced in Sirmate treated plots. Meloran, Sirmate at both the doses, Tone E-25 at lower dose and no weeding control were at par. Tok E-25 at both the doses were significantly reduced the grain yield over Preforan and Lasso. Tok E-25 at higher dose was superior over lower dose in increasing the grain yield. This was also supported by Saxena (1971); Bajpai et al (1972).

Further it was noted that all the herbicides at higher doses were increasing grain yield when highly compared to their lower doses, except in Meloran which at higher dose produced toxic effect. Higher dose of the herbicide was more effective due to high fixing capacity of the herbicide by the organic clay colloids in heavy soils and also by microbial digradation in the soil as also revealed by Klingman (1961).

Among all the cultural practices clean cultivation was the best. It was due to full time weed control by repeated hoeings there by reducing crop-weed competition for moisture and nutrients thereby increasing yields. Hand weeding at 30 days was superior over hand weeding at 20 days. It may be due to reappearing of the weeds at later stages of crop growth (Fig.3 and 4; 5 and 6) thereby reducing the yield.

Among all the three methods, clean cultivation was the best in increasing the grain yield followed by Preforan at higher dosehand weeding at 30 days and Lasso at higher dose. Preforan and Lasso at lower dose were second best in increasing the grain yield. Meloran and Sirmate at both the doses were ineffective in increasing the grain yield. Tenoran at higher dose was superior over Tok E-25 and Sirmate.

F. CHEMICAL ANALYSIS STUDIES

1. Oil and Protein percentage :-

Oil and protein per centages have been given in appendix

Table-15. There was no correlation between oil and protein percentage. Generally a weedicide at higher concentration has given more oil percentage in soybean seed. It is likely that that the weedicides might have affected the constituents of the soybean seed. This ofcourse is only a conjecture. In Meloran treated plots the oil percentage was maximum, though yields were very much reduced due to crop injury than that of all the treatments. If yields were less it was likely to increase in the oil percentage. The above statement has also been supported by

2. Nutrient uptake by weeds and crop :-

Uptake of Nitrogen, Phosphorus and Potash by the weeds and soybean crop has been given in (appendix Table 16-17).

So far as nutrient uptake were taken into account the herbicides Preforan and Lasso at higher dose increased the nutrient uptake by the crop by reducing weed population. No weeding control, followed by Sirmate at both the doses reduced the efficiency of the crop to extract more nutrients from the soil. It was due to severe crop-weed competition for nutrients.

Among the cultural practices one hand weeding at 30 days was superior over hand weeding at 20 days after sowing because it was likely that the nutrients removed by 20 days after sowing are far less than those removed after 30 days.

REGRESSION RELATIONSHIP

1) Grain yield Vs. per plant yield :-

Highly significant positive correlation was obtained between grain yield and per plant yield. This indicated that the per plant yield is increased the grain yield also increases.

$r = + 0.8289^{**}$

Table value of r at 5% = 0.4973
at 1% = 0.6226

2) Grain yield Vs. Dry matter of crop :-

Highly significant positive correlation was obtained between grain yield and dry weight of crop.

$r = + 0.898^{**}$

Table value of r at 5% = 0.4973
at 1% = 0.6226

3) Dry matter of weeds Vs. Dry matter of crop :-

Significant negative correlation was observed between drymatter of weeds and dry matter of crop which indicated that if the dry matter of the weeds increased, the dry matter of the crop is decreased.

$r = -0.5487^{*}$

Table value of r at 5% = 0.4973
at 1% = 0.6226

4) Dry weight of weeds Vs. grain yield :-

Highly significant negative correlation was observed between dry weight of weeds and grain yield.

$$r = - 0.849^{**}$$

$$\text{Table value of } r \text{ at } 5\% = 0.4973$$

$$\text{at } 1\% = 0.6226$$

5) Oil and protein percentage :-

Non significant negative correlation was observed between oil and protein per cent. That is if oil per cent is increased, the protein per cent also decreased.

$$r = - 0.4176$$

$$\text{Table value of } r \text{ at } 5\% = 0.4973$$

$$\text{at } 1\% = 0.6226$$

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SUMMARY AND CONCLUSIONS
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SUMMARY AND CONCLUSIONS

The present investigation was undertaken at the College of Agriculture, Indore Farm, in the kharif season of 1973-74 to determine the effect of various herbicides and cultural practices to control weeds and their effect on the growth and yield of soybean under 'Malwa' conditions of Madhya Pradesh. Six herbicides at two different concentration along with three cultural practices and weedy control were the treatments in the present investigation.

EFFECT OF HERBICIDES

Among the six herbicides at two different doses, Preforan at 4.0 lit a.i/ha. was the best in increasing the yields, followed by Lasso at 2.0 lit a.i/ha. Preforan and Lasso at 4.0 lit and 2.0 lit/ha. produced 23.44 and 19.39 q/ha. grain yield of soybean over 13.33 q/ha. in no weeding control respectively giving 75.8 and 49.9 per cent increase in yield over no weeding control. Meloran at 2 and 4.0 lit/ha. though controlled weeds very effectively, but its toxic effects were observed, and hence reduced the crop yields. Sirmate at 2.0 and 4.0 lit/ha. were ineffective in controlling weeds and there by yields were reduced. All the herbicides at higher doses were superior over lower dose in increasing grain yield of

soybean. Tenoran and Tok E-25 at both the doses were ineffective in controlling weeds there by yielding poor, but Tenoran at 2.0 kg ai/ha. was superior over Preforan and Lasso at 2.0 lit. and 1.0 lit./ha.

EFFECT OF CULTURAL PRACTICES :

Clean cultivation (four hand weedings) proved significantly superior in producing grain yield. Clean cultivation produced 25.77 q/ha. grain yield over 13.33 q/ha. in weedy control, thus 93.3 per cent increase over weedy control was noted. Hand weeding at 30 days after sowing was superior over hand weeding at 20 days. Hand weeding at 20 days and 30 days produced 65.0 and 68.3 per cent increase in grain yield over no weeding control.

It may therefore, be concluded that clean cultivation, (Four hand weedings), proved to be the best over other treatments. However, in kharif season Four hand weedings were impracticable as well as costly. Where labour problem is acute, Preforan at 4.0 lit. a i/ha. and Lasso at 2.0 lit. a.l/ha. could be used successfully without any adverse effect on the soybean crop. If herbicide spray was not possible due to heavy rains at pre-emergence stage and unavailability of the herbicides in the local market, Hand weeding at 30 days by manual labour may be recommended for increasing Soybean Yields.







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APPENDIX
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TABLE - 1

MEAN PLANT POPULATION

(One meter length)

Treatments	Initial population	Final population
T ₁	19.0	18.0
T ₂	18.8	17.75
T ₃	17.25	16.25
T ₄	17.75	16.75
T ₅	17.25	16.25
T ₆	17.75	16.25
T ₇	17.00	16.00
T ₈	18.00	16.25
T ₉	16.75	16.75
T ₁₀	17.25	16.75
T ₁₁	17.50	16.75
T ₁₂	17.25	16.75
T ₁₃	17.50	16.25
T ₁₄	18.50	17.50
T ₁₅	18.25	17.00
T ₁₆	17.75	16.25

TABLE - 2

MEAN PLANT HEIGHT AT HARVEST (Cms)

Treatments	At 30 days	At 60 days	At 90 days	At harvest
T ₁	24.75	42.25	49.50	54.25
T ₂	26.25	44.00	50.50	57.50
T ₃	24.00	42.50	49.00	53.50
T ₄	24.75	44.00	50.25	55.50
T ₅	22.75	38.00	45.25	52.00
T ₆	22.25	37.75	44.25	49.00
T ₇	22.00	39.25	45.50	50.75
T ₈	22.25	39.50	46.00	52.25
T ₉	17.25	34.00	39.25	42.00
T ₁₀	14.25	31.50	38.75	41.00
T ₁₁	24.75	42.25	50.25	57.00
T ₁₂	26.00	43.50	50.00	58.00
T ₁₃	26.25	43.25	49.25	55.75
T ₁₄	25.25	44.25	50.75	57.00
T ₁₅	25.50	46.50	55.25	59.50
T ₁₆	21.00	37.00	44.75	49.50

TABLE - 3

MEAN NUMBER OF WEEDS

(30 cm x 30 cm)

<u>Treatment</u>	<u>At 30 days</u>	<u>At 60 days</u>	<u>At 90 days</u>	<u>At harvest</u>
T ₁	24.50	34.50	20.00	18.00
T ₂	23.25	32.25	15.00	13.75
T ₃	27.75	39.00	28.00	26.25
T ₄	27.50	37.50	22.50	18.50
T ₅	46.75	49.25	30.75	27.00
T ₆	44.00	44.50	29.00	22.75
T ₇	28.00	40.75	22.25	17.75
T ₈	26.00	35.50	21.00	16.25
T ₉	17.75	18.50	12.75	10.00
T ₁₀	13.75	17.50	11.75	9.75
T ₁₁	20.25	27.50	17.25	15.75
T ₁₂	19.25	22.75	13.75	12.25
T ₁₃	13.75	22.25	15.25	14.00
T ₁₄	50.50	9.50	10.00	10.25
T ₁₅	N11	N11	N11	N11
T ₁₆	51.00	61.75	37.75	33.75

TABLE - 4

MEAN GREEN WEIGHT OF WEEDS (Grams)
(30x30 cms)

Treatments	At 30 days	At 60 days	At 90 days	At harvest
T ₁	13.85	54.00	46.40	29.25
T ₂	12.75	47.90	41.50	24.00
T ₃	15.25	61.40	47.90	34.50
T ₄	14.50	58.80	43.70	28.25
T ₅	26.90	86.30	60.10	35.50
T ₆	26.05	96.60	55.00	33.75
T ₇	15.40	56.70	46.10	28.75
T ₈	12.30	55.65	43.00	27.75
T ₉	9.50	24.15	32.50	21.75
T ₁₀	8.90	20.80	25.00	18.00
T ₁₁	10.40	43.50	40.50	24.50
T ₁₂	9.75	38.25	33.90	18.50
T ₁₃	5.4	21.75	34.50	27.00
T ₁₄	30.8	20.2	11.30	15.50
T ₁₅	Nil	Nil	Nil	Nil
T ₁₆	31.9	106.70	76.9	40.50

TABLE - 5

MEAN DRY WEIGHT OF WEEDS (Grams)

(30x30 cms)

Treatments	At 30 days	At 60 days	At 90 days	At harvest
T1	2.90	14.40	17.40	20.05
T2	2.05	11.10	15.80	16.42
T3	4.05	15.30	18.70	21.50
T4	3.35	14.80	17.50	19.97
T5	5.90	26.85	22.80	22.90
T6	4.25	24.30	20.90	20.80
T7	3.40	19.80	17.70	21.07
T8	2.70	14.25	16.80	20.65
T9	2.30	5.97	12.90	14.20
T10	2.00	5.37	11.80	12.98
T11	2.60	10.72	15.50	16.20
T12	2.35	7.90	13.10	14.08
T13	1.80	6.40	13.90	19.22
T14	5.60	3.10	4.30	9.35
T15	N11	N11	N11	N11
T16	5.80	28.2	25.9	24.22

ANALYSIS OF VARIANCE

TABLE - 6

PLANT HEIGHT AT HARVEST

Variation due to	D.F.	S.S.	M.SS	Observed F	Table value at	
					5%	1%
Blocks	3	4.8	1.60	0.86 NS	2.851	4.255
Treatments	15	1136.9	75.79	40.75**	1.873	2.516
Herbicides	11	768.40	69.85	37.55**	2.00	2.66
Cultural practices	2	78.00	39.00	20.97**	3.20	5.10
Methods	2	290.25	145.12	78.02**	3.20	5.10
Error	45	83.7	1.56			
Total	63					
S.Em	= ± 1.30					
L.S.D. at 5% level	= 5.40					

TABLE - 7

NUMBER OF WEEDS (30x30 cms)

Variation due to	D.F.	S.S.	M.SS	Observed F	Table value at	
					5%	1%
Blocks	3	20.9	6.97	0.59 NS	2.851	4.255
Treatments	14	2745.2	196.09	16.48**	1.873	2.516
Herbicides	11	1431.7	130.15	11.78**	2.00	2.660
Cultural practices	1	28.13	28.13	2.36NS	3.20	5.100
Methods	2	1285.37	642.68	54.08**	3.20	5.100
Error	42	499.60	11.9			
Total	59					
S.Em	± 1.72					
L.S.D. at 5% level	= 7.15					

TABLE - 8

ANALYSIS OF VARIANCE

Green weight of weeds at harvest.

Variation due to	D.F.	S.S.	M.S.S	Observed F	Total value at	
					5%	1%
Blocks	3	18.8	6.27	0.56 N.S.	2.851	4.255
Treatments	14	2777.8	198.40	16.79**	1.873	2.516
Herbicides	11	1521.0	138.30	11.44**	2.00	2.66
Cultural practises	1	264.5	264.50	23.57**	3.00	5.10
Methods	2	891.80	495.90	44.20**	3.20	5.10
Error	42	505.70	12.04			
Total	59					
S.E.m		±1.74				
L.S.D. at 5% level		= 7.23				

TABLE - 9

ANALYSIS OF VARIANCE

Dry weight of weeds at harvest.

Variation due to	D.F.	S.S.	M.S.S	Observed F	Total value at	
					5%	1%
Blocks	3	19.69	6.56	2.69 N.S.	2.851	4.255
Treatments	14	975.6	69.70	28.57**	1.873	2.516
Herbicides	11	510.83	46.44	19.03**	2.00	2.66
Cultural practises	1	195.03	195.03	79.90**	3.20	5.10
Methods	2	269.37	134.68	55.2*	3.20	5.10
Error	42	102.31	2.44			
Total	59					
S.E.m		± 0.78				
L.S.D. at 5% level		3.24				

TABLE - 10

ANALYSIS OF VARIANCE

Number of branches

Variation due to	D.F.	S.S.	M.SS.	Observed F	Table value at	
					5%	1%
Blocks	3	5.54	1.84	2.03 N.S	2.851	4.255
Treatments	15	50.48	3.36	3.704**	1.873	2.516
Herbicides	11	30.51	2.774	3.058**	2.00	2.66
Cultural practises	2	1.17	0.585	0.644 N.S	3.20	5.10
Methods	2	18.80	9.40	10.363**	3.20	5.10
Error	45	40.80	0.907			
Total	63					
S.Em \pm		\pm 0.475				
L.S.D. at 5% level = 1.97						

TABLE - 11

ANALYSIS OF VARIANCE

Number of pods per plant

Variation due to	D.F.	S.S.	M.SS	Observed F	Table value at	
					5%	1%
Blocks	3	13.97	4.66	1.332 N.S	2.851	4.255
Treatments	15	1084.13	72.28	20.663 * *	1.873	2.576
Herbicides	11	643.43	58.49	16.75 * *	2.0	2.66
Cultural practises	2	43.58	21.79	6.23 * *	3.20	5.10
Methods	2	397.12	198.56	56.80 * *	3.20	5.10
Error	45	157.39	3.498			
Total	63					
S.Em		\pm 0.936 (0				
L.S.D. at 5% level = 3.89						

TABLE - 12

ANALYSIS OF VARIANCE

Per plant yield (Grams)

Variation due to	D.F.	S.S.	M.SS	Observed F	Table value at	
					5%	1%
Blocks	3	2.53	0.843	1.727 N.S.	2.851	4.255
Treatments	15	88.63	5.91	12.11**	1.873	2.516
Herbicides	11	39.71	3.61	7.40**	2.00	2.66
Cultural practises	2	3.61	1.80	3.69*	3.20	5.10
Methods	2	45.30	22.65	46.41**	3.20	5.10
Error	45	21.94	0.488			
Total	63					
S.Em \pm		0.35				
L.S.D. at 5%		1.455				

TABLE - 13

ANALYSIS OF VARIANCE

1000 grain weight (grams)

Variation due to	D.F.	S.S.	M.SS	Observed F	Table value at	
					5%	1%
Blocks	3	9.1	3.03	0.74 N.S	2.857	4.255
Treatments	15	982.4	65.50	14.00**	1.873	2.516
Herbicides	11	163.75	14.89	3.182**	2.00	2.66
Cultural practises	2	23.17	11.58	2.474 N.S	3.20	5.10
Methods	2	795.33	397.66	84.97**	3.20	5.10
Error	45	210.7	4.68			
Total	63					
S.Em \pm		1.09				
L.S.D. at 5% level		= 4.53				

TABLE - 14

ANALYSIS OF VARIANCE

Grain yield kg per plot

Variation due to	D.F.	S.S.	M.SS	Observed	Table value at	
					5%	1%
Blocks	3	0.1	0.033	1.93 N.S	2.851	4.255
Treatments	15	8.5	0.563	33.12**	1.873	2.516
Herbicides	11	3.835	0.349	20.53**	2.00	2.66
Cultural practices	2	0.282	0.141	8.29**	3.20	5.10
Methods	2	4.365	2.182	128.38**	3.20	5.10
Error	45	0.76	0.017			
Total	63					
S.E.M ±		0.066				
L.S.D. at 5% level		= 0.274				

N.S. = Non-significant.

** = Highly significant

* = Significant.

TABLE - 15

OIL AND PROTEIN PER CENTAGE

<u>Treatments</u>	<u>Oil percentage</u>	<u>Protein percentage</u>
T ₁	17.40	38.31
T ₂	18.60	39.81
T ₃	18.00	41.81
T ₄	18.00	40.93
T ₅	17.00	41.06
T ₆	15.00	40.18
T ₇	18.00	38.37
T ₈	18.50	37.50
T ₉	20.90	36.50
T ₁₀	21.80	35.30
T ₁₁	18.30	37.68
T ₁₂	18.00	39.75
T ₁₃	18.60	38.31
T ₁₄	19.00	38.93
T ₁₅	19.20	39.56
T ₁₆	18.30	37.56

NUTRIENT UPTAKE BY SOYBEAN PLANTS AND WEEDS IN KG/HA.

Treat- ments	L E A F			P O D S			S T E M			T O T A L			W E E D S			Total nutrients by plants & weeds		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
	T ₁	30.72	2.40	12.83	96.79	7.19	49.72	8.54	2.47	37.05	136.05	12.06	99.60	30.41	4.21	74.99	166.46	16.27
T ₂	44.20	2.70	20.85	132.00	7.90	57.60	13.48	3.16	35.80	189.68	13.76	114.45	22.31	5.20	60.76	211.99	18.96	175.21
T ₃	54.02	2.13	15.12	79.63	5.77	38.59	5.08	3.30	25.14	138.73	11.20	78.85	37.80	3.07	76.33	176.53	14.27	155.18
T ₄	32.20	1.39	11.92	73.14	5.74	40.43	8.91	5.35	29.94	114.25	12.48	82.34	32.60	2.70	81.98	146.85	15.18	164.32
T ₅	32.68	2.27	13.86	43.37	2.39	20.06	8.94	4.04	17.75	84.99	9.20	51.67	44.80	4.79	75.31	129.79	13.99	126.98
T ₆	29.05	1.14	9.74	41.23	2.42	23.72	4.45	5.80	18.61	74.73	9.36	52.07	39.10	2.88	70.65	113.83	12.24	123.72
T ₇	27.80	1.00	8.50	51.92	3.52	38.72	4.31	1.94	15.96	84.03	6.46	63.18	31.90	6.30	47.78	115.93	12.76	110.96
T ₈	26.33	1.14	10.42	69.04	5.94	42.90	5.58	2.85	20.84	101.00	9.93	74.16	28.30	6.90	48.95	129.30	16.83	123.11
T ₉	31.78	1.73	11.43	36.66	3.36	23.63	3.76	2.47	14.10	72.20	7.56	49.16	13.20	2.92	41.95	85.40	10.48	91.11
T ₁₀	34.68	1.14	11.75	29.96	2.97	20.63	3.50	0.93	9.30	68.14	5.08	42.18	13.70	1.82	22.36	81.84	6.90	64.54
T ₁₁	34.96	1.43	13.20	107.64	9.61	71.09	11.40	5.30	17.65	154.00	16.34	101.94	21.75	3.89	41.73	175.75	20.23	143.67
T ₁₂	33.12	1.39	11.84	109.02	13.89	78.08	14.10	3.17	27.17	156.24	18.45	117.09	17.64	4.30	34.96	173.38	22.75	152.15
T ₁₃	33.82	1.69	12.65	69.77	10.35	56.29	10.90	2.80	21.00	114.49	15.34	90.03	27.30	3.21	46.39	141.79	18.55	136.42
T ₁₄	40.29	1.51	13.77	98.44	9.10	61.98	12.70	3.20	24.48	151.43	13.81	100.19	14.40	1.78	22.20	165.83	15.59	122.39
T ₁₅	48.20	2.68	18.17	114.65	15.16	79.93	14.97	6.22	46.75	173.83	22.05	144.85	-	-	-	173.83	22.05	144.85
T ₁₆	31.55	1.84	12.32	46.28	4.63	35.51	4.85	4.16	13.84	82.44	10.63	61.67	45.30	4.50	75.94	127.74	15.13	137.61

TABLE - 17

Percentage removal of nutrients by soybean crop and weeds

Treatment	N		P ₂ O ₅		K ₂ O	
	Crop	Weeds	Crop	Weeds	Crop	Weeds
T ₁	81.73	18.27	74.10	25.90	57.05	42.95
T ₂	89.50	10.50	72.57	27.43	65.32	34.68
T ₃	78.59	21.41	78.57	21.43	50.81	49.19
T ₄	77.80	22.20	82.21	17.79	50.11	49.89
T ₅	65.47	34.53	65.76	34.24	40.69	59.31
T ₆	66.62	33.38	76.47	23.53	42.08	57.92
T ₇	72.48	27.52	50.63	49.37	56.94	43.06
T ₈	78.11	21.89	59.00	41.00	60.24	39.76
T ₉	84.66	15.34	72.13	27.87	54.00	46.00
T ₁₀	83.26	16.74	73.62	26.38	65.36	34.64
T ₁₁	87.62	12.38	80.77	19.23	70.95	29.05
T ₁₂	89.85	10.15	81.10	18.90	76.96	23.04
T ₁₃	80.74	19.26	82.69	17.31	66.00	34.00
T ₁₄	91.32	8.68	88.58	11.42	81.04	18.96
T ₁₅	*	*	*	*	*	*
T ₁₆	64.54	35.46	70.26	29.74	45.54	54.46

* Observation was not taken.