CHEMICAL AND CONVENTIONAL METHODS OF WEED CONTROL IN WHEAT (*Triticum aestivum* L.)

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ABSTRACT

Weeds are of great menance as they interfere with the production of crops and add to the cost of cultivation. So it is highly imperative to devise suitable methods of weed control. A field investigation was conducted at the Instructional Farm, Gujarat Agricultural University, Junagadh Campus, Junagadh on clayey soil during the rabi season of 1980-81 to evolve suitable chemical and conventional methods of weed control in wheat (*Triticum aestivum* L.). Twelve treatments consisting of chemical and conventional methods of weed control viz., A - TOK E-25 8.0 l/ha pre-emergence, B - TOK E-25 12.0 l/ha pre-emergence, C - Basalin 1.5 l/ha pre-emergence, D - Basalin 3.0 l/ha pre-emergence, E - 2,4-D.S.S. 1.5 kg/ha pre-emergence, F - 2,4-D.S.S. 3.0 kg/ha pre-emergence, G - 2,4-D.S.S. 1.5 kg/ha post-emergence, H - 2,4-D.S.S. 3.0 kg/ha post-emergence, I - Weedone 1.2 kg/ha post-emergence, J - Two hand weeding at 4 and 6 weeks after sowing, K - Weed free condition and L - Control was laid out in randomised block design with four replications.

The results revealed that highest grain yield of 46.12 q/ha was recorded under weed free condition, followed by basalin at 1.5 l/ha as pre-emergence spray. The plot treated with basalin at 1.5 l/ha as pre-emergence yielded as high as that of two hand weeding at 4 and 6 weeks after sowing. Among different herbicides tried in the experiment, basalin at 1.5 l/ha as pre-emergence yielded signficantly higher grain yield of 45.97 q/ha. Application of basalin at 1.5 l/ha as pre-emergence also produced significantly higher straw yield of 50.25 q/ha as compared to rest of the treatments except weed free condition. The herbicide basalin at 1.5 and 3.0 l/ha as pre-emergence established its superiority by keeping down weed population and dry weight of weeds remarkably as compared to cultural

methods as well as different herbicides tested in the experiment and showed its better efficacy for weed control in wheat crop. The chemical methods i.e. basalin at 1.5 and 3.0 l/ha as pre-emergence and conventional method involving two hand weeding at 4 and 6 weeks after sowing removed minimum plant nutrients (N, P and K). Maximum net profit of Rs. 4155/ha was accrued under basalin at 1.5 l/ha as pre-emergence.

Thus, the results of the present investigation indicated that potential production and profit from irrigated wheat can be secured by spraying the crop with basalin at 1.5 l/ha as pre-emergence under Junagadh conditions.

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CERTIFICATE

This is to certify that the thesis entitled "Chemical and conventional methods of weed control in wheat (Triticum aestivum L.)" submitted by Shri Bhagabhai Shankarbhai Patel in partial fulfilment of the requirements for the degree of Master of Science (Agriculture) in Agronomy of the Gujarat Agricultural University is a record of bonafide research work carried out by him under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

Jamnagar

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I. INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important food crop cultivated in several countries of the world. Being rich in protein in addition to carbohydrate, it is solely used as food by majority of people. In India, it covered an area of 221.04 lakh hectares with a total production of 364.60 lakh tonnes (Anonymous, 1981). Thus, in terms of both area and production, India today ranks fourth among wheat growing countries of the world. In India wheat is extensively cultivated in Uttar Pradesh, Madhya Pradesh, Punjab, Haryana, Bihar, Gujarat, Maharashtra and Rajasthan. Its cultivation is gradually increasing in states such as Karnataka, West Bengal, Assam and Jammu-Kashmir. Thus, wheat has became not only the staple food of a large population in India, but also became the hope of warding off extensive starvation.

In Gujarat state, this crop occupies an area of 6.56 lakh hectares producing 12.98 lakh tonnes of grains (Anonymous, 1981). In near future, area under irrigation is likely to be increased tremendously due to various irrigation projects including Narmada irrigation project. Wheat is the only crop which can be best suited in rabi cropping and this crop is likely to play vital role in economy in near future in Gujarat state.

Indian farmers pay reasonable attention to its cultivation especially in respect of seed bed preparation, manuring and irrigation. However, sufficient attention has not been paid to weed control aspect which remains one of the constraints in boosting up the wheat production.

With the increased use and higher cost of fertilizers and irrigation water, weed control must assume added significance in modern intensive farming as a total loss of crop with increased cost of cultivation would cause greater economic loss. Weeds not only compete for nutrients, water, light and space, but also increase the cost of labour and render threshing and harvesting operations difficult. In India, the losses in wheat ranged from 15 to 60 per cent depending on the type of weed flora, intensity of weeds and soil fertility (Yaduraju and Mani, 1979). Further they harbour pest and diseases which reduce the net returns and quality of the produce. Weed infestation results in reduction of land value also. In India, according to Verma and Bhardwaj (1966) taking a conservative figure of 10 per cent as the average loss in yield and total production of wheat to be eight million tonnes, the total loss to the nation worked out to be Rs. 313 million annually.

The predominant method of weed control by mechanical hoeing and manual weeding over extensive scale is bound to decline because of shift of agricultural labourers to industries for better and assured wages. The current trend and future development of intensive agriculture is likely to seek the help of chemicals as an effective weed control measures and replace the conventional methods of weed control.

Chemical weed control is a new and developing science. The use of herbicides had revolutionised weed control, reduced the cost of production in many countries and has resulted in the revoluation of many conventional agricultural practices.

Wheat is a close spaced crop and restricts to carry out frequent interculturing operations with bullock, whereas, mechanical means to control weeds are slow and labourious. At peak period the labourers are not available in sufficient number and their rates are also high, because of industrial engagement. Under these circumstances mechanical methods of weed control in wheat lose its importance.

The field of chemical weed control is practically unexplored particularly in Gujarat. The cultivators are not aware of proper doses of herbicides, their time of application and its economics. Several selective herbicides are available in market which are treated to be effective for particular crop. The farmers have to make decisions about the selection of right type of herbicides. In past practically, no systematic research work has been conducted to evaluate the efficiency of several new herbicides. In view of the paucity of adequate research on chemical weed control in the wheat particularly for Junagadh region, the present investigation was undertaken at Instructional Farm, Gujarat Agricultural University, Junagadh Campus, Junagadh during rabi season of 1980-81.

The specific objectives envisaged to be achieved from this study are as follows :

1. To study the efficiency of different herbicides and to workout its proper rate and time for effective weed control in wheat crop.

2. To compare the efficiency and economics of weed control through herbicides and conventional method of weed control

3. To study the weed flora in wheat crop.

4. To study the nutrients removal by weeds.

II. REVIEW OF LITERATURE

Weed control studies have become an important aspect of research conducted in the field of irrigated as well as rainfed agriculture. The practices of weed control such as rate, time, method of application and selection of suitable herbicides have been changed during the last three decades. Economic and less labourious method of weed control including use of herbicides in India, however, have been taken up only recently. The knowledge of weed control is indispensable for increasing crop production.

Considerable research work has been done in the field of weed control. The subject has received greater attention after the discovery of herbicides. Research work conducted in this direction has been reviewed from time to time by several workers (Nageswara Rao, 1973; Gill and Brar, 1975a; Bhattcharya and Kunda, 1977; Mani *et al.*, 1977; Chauhan and Verma, 1978; Negi, 1979; Mukhopadhyay and Beru, 1980; Anonymous, 1981 and Pandey, 1981). In the last few years the concept of weed control has undergone a major change due to the invention and innovation of new selective chemical herbicides, particularly those of synthetic hormone type. The salient findings of these investigations have been highlighted and reviewed in subsequent pages with emphasis on the work carried out by eminent scientists in India and abroad relating to the problem under study under the following broad topics :

1. Losses caused by weeds.

2. Effect of herbicides on growth, development and yield of wheat.

3. Integrated approach of weed control through herbicides and conventional methods in wheat.

2.1 Losses caused by weeds

Weed compete with crop plant for light, space, moisture and nutrients. The competition between crop and weeds entails serious damage to the crops and enormous loss to farmer.

In India, where agriculturalists still follow the primitive methods, it is apprehanded that over figures for losses will surpass those of other advanced countries, but in absence of much statistical data, it is difficult to assess the exact loss from some of these scattered information. However, all such available information has been complied to get an idea about this most menacing problem.

From the results of three experiments on wheat conducted at the Indian Agricultural Research Institute Farm, New Delhi, during the rabi seasons of 1959 to 1961 in sandy loam soil comprised of fourteen treatments, Mukhopadhyay et al. (1965) revealed that unchecked weed growth removed on an average as much as 19 kg N, 2.65 kg P_2O_5 and 25.52 kg K_2O per hectare.

Chokey Singh and Tendon (1966) conducted an experiment at the students Instructional Farm, Agriculture College, Kanpur, during the years 1951-52 and 1952-53 and found out that the presence of weeds led to the reduction in the uptake on N and P by wheat.

Mani et al. (1968) compiled exhaustive data on losses in crop yields due to weeds from several experiments conducted in different parts of India. They reported that weed free plot had given average yield of 23.7 q/ha while, weedy plot had given average yield of 19.9 q/ha. Thus, 16 per cent average yield reduction occurred due to weeds in wheat crop.

A survey carried out by Punjab Agricultural University in 1973-74. From the results Gill and Brar (1975a) reported that irrespective of the intensity of infestation about 30-85 percentage of wheat crop in Punjab was infested with canary grass and wild oats.

Nearly 10-15 per cent area was heavily infested which needs immediate attention. In weed infested area, 15-20 per cent grain yield was reduced. Thus, Punjab alone suffers annual losses in wheat grain worth 4.36 crore rupees.

Mani (1975) surveyed for competition of nutrients in wheat. The average uptake of nutrients were as much as 24.2 kg N, 3.6 kg P_2O_5 and 26.3 kg K_2O per hectare.

Reeves (1976) reported that the presence of rye grass reduced wheat dry matter production and grain yield by decreasing fertile tillers and fertile spikelets production.

Zemanek (1976) conducted trials under glass house in microplots and in field condition and reported that Scentless may weed (T. maritimum) may reduced grain yields of winter wheat as much as 90 per cent.

An investigation was conducted at Agricultural College Farm, Dharwar on deep black soil during rabi season of 1974-75. From the results Prabhakar Setty et al. (1977) found that infestation of hariali (Cynodon dactylon Pers.) significantly reduced the plant height, number of earheads per plant, number of seeds per earhead and 1000-grain weight. Thus, there was significant reduction in all the characters of wheat. Grain yield of wheat was only 175 g in infested plot and 515 g in control plot. The extent of yield reduction was 65 per cent.

Field studies were carried out by Appleby *et al.* (1977) at grain field of Western Oregon and Washington. The result showed that with increasing density of *Lolium multiflorum*, wheat grain yields were reduced. It had reduced grain yield by 4100 kg/ha with increasing its density from 0.7 to 93 plant/m^2.

Rao and Bhardwaj (1979) conducted an experiment at Indian Agricultural Research Institute, New Delhi and found that in north western India where the major wheat area is located two grassy weeds viz., wild oats and canary grass have become a serious weeds to wheat crop. and reduced crop yield as high as 70 to 80 per cent.

A trial was conducted during the period of 1971 to 1977 at Department of Botany, Agricultural University, Faisalabad, Pakistan. From the data, Saeed *et al.* (1979) observed *Chenopodium album* and *Chenopodium murale* at a density of 23 plants/ft^2 which reduced wheat grain and straw yield by about 16 per cent in Punjab. Weeds germinating six weeks after crop emergence had little effect on yield.

An experiment was conducted at Department of Botany, Banaras Hindu University, Varanasi, Uttar Pradesh, India. From the results of this experiment Soni and Ambasht (1979) concluded that weeds growing with crop plants significantly affected the mineral status of plants and the uptake, return and retention of elements by plants.

Yadurju and Mani (1979) reported that about 3.6 lakh hectares of wheat in Punjab and same order in Haryana were infested by wild oat and phalaris weeds. In Uttar Pradesh 56000 hectares of crop is infested by these weeds. The situation in parts of Himachal Pradesh, Rajasthan, Madhya Pradesh, Jammu and Kashmir and Delhi is also alarming. An average reduction of 15 to 60 per cent had been reported in wheat grain yield from many parts of country. However, in areas where the intensity is very high the farmers are experiencing about 80 to 100 per cent loss.

An experiment was conducted by Panday et al. (1980) with wheat genotype HD-1102 on calcareous soil at Tirhut College of Agriculture, Dholi, Farm of Rajendra Agricultural University, Bihar, India, during rabi season of 1977-78. They found that grassy weeds reduced maximum crop production which was about 14.09 q/ha.

2.2 Effect of herbicides on growth, development and yield of wheat

2.2.1 2,4-D sodium salt

2,4-D.S.S. is a selective herbicide mostly used in cereals, sugarcane, loan and grass land to control broad leaves as pre-emergence as well as post-emergence application. They persisted for 2 to 4 weeks in soil.

An experiment was conducted at the Indian Agricultural Research Institute, New Delhi. It was found (Anonymous, 1971) that the best combination was the application of 2,4-D and dalapon at the rate of 2 kg/ha twice and ploughing the field two times to control weeds in wheat crop. The weedicides being applied immediately after ploughing.

An experiment was planned at College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar, India. Bhan and Maurya (1972) revealed that 0.5 kg a.e. of 2,4-D/ha sprayed 32 to 35 days after sowing was enough to control weeds in wheat crop and recorded better yield than unweeded control plots.

Pellet and Saghir (1972) reported that 2,4-D application at the rate of 2,4 and 8 kg/ha at the jointing stage showed an increase in the protein content of wheat.

Trials were carried out at Regional Agricultural Research Station, Meerut, Uttar Pradesh, India, in rabi season during 1970-71 on a loam soil of alluvial origin. Machete was applied as a pre-emergence and 2,4-D.S.S. as a post-emergence at 4 to 6 leaf stage. Application of 2,4-D at 0.8 kg/ha + 3 % urea solution and machete 3 kg/ha or machete 1.5 kg combined with 2,4-D.S.S. 0.8 kg/ha were effective and increased the yield by 20.2 to 21.5 per cent as compared to unweeded control (Verma et al., 1975).

Abdulla and Amin (1976) conducted an experiment in Agronomy Department, Assint University, Cairo, Egypt. MCPA was applied at 0.75 to 1.0 lb/feddan (1 feddan = 1.038 acres), while 2,4-D was used at 0.33 to 1.0 lb/feddan. The herbicides were applied at two stages of growth at two and three months from sowing. The results showed that both MCPA and 2,4-D were efficient in controlling weeds, especially broad-leaved weeds in wheat. Increase in the yield was more when herbicides were applied at the early rather than at later stage.

Field experiment were conducted during 1971 and 1972 at Crop Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar. From the results, Bhan et al. (1976) found that yield was significantly reduced when 2,4-D was sprayed 30 days after sowing as compared to late application and weed free check. Mixed application of 2,4-D and urea did not increase the wheat yield.

A field trial was conducted at Plant Pathology Department, University of Agriculture, Lyallpur, Pakistan. Kausar and Ghaffar (1976) revealed that aerial application of 2,4-D at 0.5 pints in 2 gallon water/acre before the jointing stage reduced the number of weeds and increased the number of earheads and yield of grain as compared to the unsprayed plot.

An experiment was conducted at Department of Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, India. Patil and Kale (1977) found that in wheat 2,4-D, atratf, taphazine at 250, 500 and 1000 ppm increased the protein content of the grain by upto 56.8 per cent, but only 2,4-D at the rate of 500 ppm had increased the 1000 grain weight and yield.

The influence of 2,4-D Methabenzthiazuron, nitrofen, triallate and terbutryne was studied on the population of *Phalaris minor* and on the yield of the wheat crop in the Tarai region of Uttar Pradesh during 1973-74. Except 2,4-D all other herbicides had reduced the population of phalaris in wheat fields (Sharma *et al*., 1977).

Kulkedi (1979) tested different herbicides for the control of *Polygonum convalvulus* in winter wheat during the year 1974-75 and 76. In cool weather, 2,4-D and MCPA were unsatisfactory, while Keropur lacked selectively.

Two field experiments were conducted at Haryana Agricultural University, Hissar, India, during 1975 to 1976 and 1976 to 1977, to study the action of MSMA, benzoylpropethyl, nitrofen, dichlormate, terbutryne and methabenzthiazuron and their mixture with 2,4-D for control of grass weeds in spring wheat. From the results Kataria and Kumar (1980) found that 2,4-D at 0.5 kg/ha in mixture had control 55 per cent of Phaleris spp. and 40 per cent of Avena spp. and increased wheat grain yield compared with control.

Dekov *et al*. (1981) reported that MCPA and 2,4-D were applied at the end of tillering stage of wheat variety Apulikum-233 with and without 10 kg ammonium nitrate per hectare. The herbicides especially 2,4-D at 1.2 kg/ha controlled weeds well and not toxic to the crop.

El-kadi et al. (1981) conducted field trials with wheat variety Giza-155 for two seasons. Dicuran at 0.68 kg and igran at 0.84 kg/feedan (1 feedan = 4200 m^2) as a pre-emergence and Gesaran-2079 at 0.453 kg, 2,4-D.S.S. 0.756 kg and Dicuran 0.6 kg per feedan as a post-emergence treatment, gave good control of annual broad-leaved weeds, but 2,4-D reduced the number of tillers, the number of spikes and dry weight per plant and depressed the grain yield.

A field trial was conducted at the University Research Farm, Kanpur, during the rabi season in 1978-79 and 1979-80, to study the effect of seven herbicides viz., 2,4-D.S.S., Tok E-25, Machete, Dosanex, Tribunil, Terbutryne and Avadex on the sugar contents and diastatic activity of aestivum var. Sonalika and durum var. Raj-911 of wheat by the application of their recommended concentration at 0.5, 15.0, 2.0, 1.5, 1.5, 0.75 and 1.0 kg a.i./ha, respectively. Pandey [illegible] (1981) noted that all the treatments except terbutryne significantly increased the sugar contents and diastic activity in both wheats of aestivum var. Sonalika and durum var. Raj-911.

2.2.2 Weedone (2,4-D ethyl ester)

The weedone is an oil based herbicide, it has a greater power of penetration through foliage and stems of herbaceous weeds. This is an effective, low cost product for sedge and broad-leaf weed control in wheat, maize, rice, jowar and other cereals and sugarcane.

Trials were carried out from 1969 to 1972 on pale chestnut soils, in winter wheat crops under dryland farming. Wherein, Erezhepov (1975) tested the best of the five formulations of 2,4-D. Among them 2,4-D amine at 1 kg and 2,4-D ester 0.6 to 0.9 kg/ha gave more than 85 per cent control of weeds (mostly broad leaved species).

The uniform droplet sprayer was used to spray spring wheat and barley. Sokolov et al. (1975) found that at a droplet size of 150 to 180 ppm, 2,4-D in ethyl carrier did not affect plant productivity and diesel fuel oil was recommended for wheat and barley.

An investigation was conducted on a yellow-brown heavy loam chernozen soil, during the years 1970-1971. Zinchenko and Tabolina (1976) found that spraying with 2,4-D low volatile esters at 0.3 kg/ha at the flowering stage and with 2, 3 6-TBA at 0.5 kg/ha at both tillering and flowering stages reduced the wheat grain yield, but increased the total nitrogen content of the grain.

Mcglamery and Slife (1977) concluded from the trials conducted in three countries in Illinois that 2,4-D ester applied to wheat crop at the three to six leaf stage was more effective as compared to 2,4-D amine formulation in controlling wild garlic.

The effect of timing of herbicide treatment on crop response was studied in respect of 2,4-D low-volatile ester at the rate of 0.75 lb/acre, 2,4-D amine 0.25 lb, dicamba 0.125 lb and dicamba alone at 0.125 lb per acre applied to spring wheat under weed free conditions. Yield data indicated that, it was not advisable to apply any of the herbicides between the boot and bloom stages, but there was no loss of yield where applied at the fully tillered stage or after blossom when the grains were fully formed (Heikes, 1980).

Zinchenko <u>et</u> <u>al</u>. (1980b) reported that wheat variety, Saratovskaya-201 was treated for five to six years at tillering stage with herbicides mixture of c_7 - c_9 esters of 2,4-D at the rate of 0.3 to 0.6 kg dicamba-di-methylamine 0.15-0.30 kg and picloram potassium 0.05-0.10 kg/ha. Herbicides effects on wheat was much greater after year by year use than after the first application only and reduced the growth, yield and number of grains in the earhead, but increased the relative protein content of the grain.

Field trials were carried out in N-Kazakhastan, 2,4-D c_7 - c_9 ester at the rate of 0.3 kg, dicamba-dimethylamine 0.15 kg and piclorum-potassium 0.05 kg/ha were applied at the tillering stage, under the arid conditions. Zinchenko et al. (1980a) found that treatments with 2,4-D applications reduced tillering, number of earheads, 1000-grain weight and total protein contents of the grain.

2.2.3 TOK E-25

TOK E-25 can be sprayed for the control of many grasses and broad leaved weeds in field crops such as cereals and vegetables and orchards as well as ornamental trees. As pre-emergence application, it is recommended for groundnut, potato, rice, peas, soybeans, sugarbeets, cabbage, cauliflower, beans and carrots. It is recommended for post-emergence application in cotton, onion, cumin, fennel, mustard, garlic, cabbage, cauliflower, pineapple, grapes, strawberries, rape seed and carrots.

Field experiment was conducted at the Punjab Agricultural University, Ludhiana, India, during the years 1971-72 and 1972-73, in light textured soil. Gill and Brar (1975b)reported that nitrofen at the rate of 1.20 kg a.i./ha and methabenzthiazuron at 0.70 to 1.05 kg a.i./ha as a pre-emergence gave 90 per cent control of Phalaris minor (canary grass) and gave 1790 and 2510 kg/ha higher yield, respectively, as compared to control.

Trials were carried out in 1972-73 in the main cereals growing regions of France to evaluate four grass herbicides in winter wheat. Neburon and nitrofen 18 % + linuron 6.25 % were applied at the lowest and the highest rate recommended by the manufacutres as a pre-emergence treatments. Madelon and Lescar (1975) found that lowest herbicide rates gave the best results.

Reyes (1975) studied the principal winter weeds of the region, and recommendations were given for chemical weed control. Convolvulus arvensis, Phalaris minor and Avena fatua were most troublesome weeds of the region. Convolvulus arvensis was control with 2,4-D spray, while Avena fatua was controlled by TOK E-25 at the rate of 10 l/ha on light soil, 14 l/ha on heavy soil as pre-emergence and 12 l/ha as post-emergence treatment.

Trials were carried out with pre-emergence herbicide during 1971 to 73 in western Portland region. Neiolinger (1976) concluded that wheat yield were increased by 13.4, 15.4 and 16.0 per cent over control, for nitrofen rated 2, 3 and 4 lb/acre in the year of 1971, 1972 and 1973, respectively.

Field experiments were conducted at the Punjab Agricultural University, Ludhiana (India), during 1973-74 and 1974-75. Pre-emergence application of nitrofen at the rate of 1.25 kg a.i./ha was effective against <u>Phalaris minor</u> only and gave substantial increase in grain yield (Gill and Brar, 1977a).

Field experiment were conducted at Punjab Agricultural University, Ludhiana, during 1971-72, 1973-74, 1974-75 and 1975-76. Gill and Brar (1977b) observed promising control of <u>Phalaris minor</u> with pre-emergence application of nitrofen and gave 300 to 800 kg/ha more grain yield than the unweeded crop.

A field experiment was planned at Research Farm, Department of Agronomy, Haryana Agricultural University, Hissar, in which nitrofen, trialate and diuron with and without 2,4-D were used against wild canary grass and wild oats. Hooda <u>et al</u>. (1977) found that nitrofen at 2.5 kg/ha, as a pre-emergence treatment was promising against _Phalaris minor_ and showed considerable activity against _Avena fatua_.

Trials were carried out in rabi season of 1972 to 1976 at Old Dairy Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, to develop suitable herbicidal technique for weed control in wheat with special reference to _Phalaris minor_. Singh _et al_. (1978) revealed that TOK E-25 and terbutryne brought out the best control of _Phalaris minor_, but had lesser control over other weeds.

Rajak (1979) while working at Agricultural Universities of Punjab and Uttar Pradesh found in increase in the yield of wheat crop upto the extent of about 45 per cent with application of nitrofen at the rate of 4 to 6 l/ha as a pre-emergence treatment in the _Phalaris minor_ infested crop.

The results were critically discussed in the National Seminar on Control of Weeds, organized by the All India Co-ordinated Wheat Improvement Project of the Indian Council of Agricultural Research in 1978 at Hyderabad. Rao _et al_. (1979) reported that a pre-emergence application of TOK E-25 at 1.5 kg/ha in 750 liters of water had given satisfactory results in controlling _Phalaris minor_ in wheat.

An experiment was conducted at the Farm of Indian Agricultural Research Institute, New Delhi. Methabenzthiazuron and nitrofen were applied alone at 1.4 kg/ha and 1.0 kg/ha, respectively. Kulshrestha et al. (1980) found both the herbicides selectively controlled weeds and safely recommended for weed control in wheat crop.

Kover and Zemanek (1981) carried out the small plot trials in winter wheat during 1976-77 and 1977-78. They found that igran at 2.6 kg + dicuran-80 at 1.0 kg and trazalex (nitrofen 20 % + simazin 30 %) 9 kg/ha as a post-emergence treatment had given 94 per cent control of weeds in wheat crop.

2.2.4 Basalin

Basalin is a modern sophisticated pre-planting and pre-emergence weed killer.

It is a selective herbicide and controls, most of the weeds, without harming the crop in any way. Basalin is based on fluchloralin (common name) which is N-propyl-N (2 chloroethyl) 2,6-dinitro-n-trifluoromethyl-aniline (chemical name). The crops where basalin has been found to be highly effective are, rice, cotton, jute, groundnut, onion, pea, pulses, potatoes, tomatoes, brinjal, chillies, beans, soybean, etc. Basalin has also shown good degree of selectivity in wheat, direct seeded and flooded rice, jowar, lady's finger, cabbage, etc. It has an ideal duration of residual toxicity in soil for two to three months and not harmful to leguminous crop and control weed from the very beginning of crop life.

Field trials were carried out on a sandy loam soil at Melle and Kwatrecht. Himme et al. (1976) observed that fluchloralin at 1.27 and 1.75 kg/ha as a pre-emergence treatments controlled both narrow and broad-leaved weeds more effectively than trifluralin at the same rate. Fluchloralin at 1 kg/ha reduced Alopecurus myosuroides panicle numbers to a greater extent. No injury to the crop were occured with Fluchloralin alone or in mixture.

Field trials were conducted at Indian Agricultural Research Institute, New Delhi to evaluate the direct effect of pre-plant, pre-emergence and post-emergence application of herbicides to potato and the residual effect on wheat, planted as a relay crop before the potato tuber was harvested, during the years 1974-75 and 1975-76 using six herbicides. From the results Mani et al. (1977) revealed that fluchloralin at 0.5 kg/ha applied as a pre-plant treatment had reduced the weed population significantly over the unweeded check and had not left residues in the soil to effect the growth, development and grain production of wheat.

An experiment was conducted on wheat variety Kalyan Sona under irrigated conditions at the Upland Crop Research Farm, Orissa, University of Agriculture and Technology, Bhubaneshwar, during 1976-77. Treatments comprised of 10 herbicides with weed free condition and unweeded control in sandy loam soil. Tosh and Misra (1977) reported that fluchloralin at 1.0 l/ha as pre-emergence showed effective control of monocot weeds and check the dry matter accumulation in weeds significantly better than other herbicides. By recording less weed competition index and maximum number of panicles ($452/m^2$) fluchloralin at 1.0 l/ha as pre-emergence had given highest grain yield of 1815 kg/ha, while fluchloralin at 1.0 l/ha as post-emergence gave more weed competition index, less number of panicles and recorded only 934 kg/ha grain yield.

Field experiment were conducted at Punjab Agricultural University, Ludhiana, during 1975-76 and 1976-77, to study the comparative efficiency of different herbicides including fluchloralin for weed control in autumn sown potato crop. Gill *et al.* (1979) revealed that tuber yield remain unaffected and none of the herbicides showed any residual phytotoxic effect on wheat sown after potato harvest.

Negi (1979) conducted field experiment at G.B. Pant University of Agriculture and Technology, Pantnagar India, during 1976-77. He found fluchloralin at 2-3 l/ha was effective against *Phalaris minor* and *Lathyrus aphala*.

Preliminary pre-emergence herbicide screening trial was carried out in the rabi season of 1977, at Orissa, University of Agriculture and Technology, Bhubaneshwar. Misra and Tosh (1980) found that fluchloralin 1.0 kg and dichlormate 1 liter/ha provided excellent weed control without any phytotoxic effect and finally they enhanced yield of the crops.

2.3 Integrated approach of weed control through herbicides and conventional methods in wheat

Two field experiments were conducted during the period of 1970-71, one at the Agronomy Division Farm, IARI, New Delhi and the other at Karnal Sub-station, to evaluate avadex, machete, 2,4-D + urea and hand weeding for controlling *Avena fatua* and

Phalaris minor in a triple gen dwarf wheat. Mani *et al*. (1973) concluded that the yield obtained from hand weeding, avadex and machete treatments were almost equal, however, net profit was more in case of chemical weeding as compared to hand weeding.

The experiment was conducted to evaluate and determine the efficiency, proper rate and time of 2,4-D application in comparison with the traditional method of hand weeding at the Mechanized Commercial Farm, Gujarat Agricultural University, Junagadh, during the rabi season of 1971-72 on medium black soil with wheat variety Kalyan Sona. From the results of this experiment Nageswararao (1973) reported that it is possible to replace hand weeding which is a conventional practice for weed control by 2,4-D.S.S. application at the rate of 0.56 to 1.12 kg a.e./ha at four weeks after sowing. Second experiment was also carried out by the same author at the same location to study the comparative effect of nine herbicides viz., TOK E-25, tafacide-80, fernoxone, agroxone, eptam, machete, lasso, 2,4-D and MCPA as well as two hand weeding at 4 and 6 weeks, one hand hoeing at 4 weeks + one hand weeding at 6 weeks and unweeded control, during the rabi season of 1971-72, with wheat variety Kalyan Sona. They indicated that two hand weeding at 4 and 6 weeks after sowing recorded the highest yield of 40.82 q/ha which was equally effective as TOK E-25 with yield of 40.59 q/ha. Agroxone, 2,4-D, MCPA and fernoxone were also found to be equally effective as TOK E-25. However, economically two hand weeding at 4 and 6 weeks after sowing was as remunerative as TOK E-25. In case of protein percentage 2,4-D at the rate of 3.75 kg/ha as post-emergence ranked first and recorded 14.14 per cent, followed by TOK E-25 at 4·0l/ha as pre-emergence treatment. Significantly lowest protein percentage was recorded under unweeded check (control) plot.

An experiment was laid out at the Research Farm of the Department of Agronomy, Haryana Agricultural University, Hissar, during 1971-72 and 1972-73. Treatments consisted of two levels of 2,4-D and hand weeding with and without 3 % urea for the control of weeds in dwarf wheat. Jain et al. (1974) found that 2,4-D alone and in combination with 3 % urea gave 5 to 20 and 20 to 30 per cent increased, grain yield, respectively, over control. Hand weeding with and without urea gave 12 and 9 per cent increased grain yield, respectively, over control.

Gill and Brar (1975a) while working at the Farm of Agronomy Department, Punjab Agricultural University, Ludhiana reported that basalin appears promising against phalaris, but need further work for standardising its rate and technique of application. At the moment three herbicides are recommended for weed control in wheat in Punjab. i.e. Avadex BW for control of wild oats, TOK E-25 for control of phalaris and 2,4-D for control of wild oats and broad-leaved weeds. Hoeing treatment was less effective as compared to chemical weed control.

An experiment was conducted in Tamil Nadu Agricultural University, Coimbatore, during November 1975 to compare the different weed control methods in winter irrigated wheat, variety Kalyan Sona. Rethinam et al. (1975) found that pre-emergence herbicides like denitramine 0.5 kg nitrofen 2.0 kg, RH-2512 1.2 kg, alachlor 1.5 kg/ha and hand weeding twice yielded 1835, 1758, 1562, 1614 and 1504 kg/ha, respectively. The cost of weed control was less in the herbicide treatments as compared to hand weeded plot.

A field trial was carried out with a view to test the efficiency of chemical herbicides in controlling various weed species particularly annual weeds in wheat field at Regional Agricultural Research Station, Meerut, Madhya Pradesh, during rabi season of 1970-71 to test the ten treatments. Verma et al. (1975) concluded that an alternative to one hand weeding by khurpi and post-emergence application of 2,4-D.S.S. at 0.8 kg a.i./ha with 3 % urea solution as well as machete at 1.5 kg a.i./ha (pre-emergence) in combination with 2,4-D.S.S. at 0.8 kg a.i./ha (post-emergence) showed their effectiveness in killing the weeds to a great extent, resulting significant positive effect on the yield of wheat.

Hooda et al. (1976) while working at Haryana Agricultural University, Hissar, India, found that nitrofen at 1.25 kg a.i./ha controlled more than 30 per cent of wild canary grass, while, tri-allate at 1.0 kg a.i./ha controlled more than 90 per cent of wild oats. Both herbicides were as effective as two hand weeding and increased the grain yield of wheat by 46 and 34 per cent, respectively.

An experiment was conducted by Bhattacharya and Kunda (1977) at the Haringhata Teaching Farm, B.C. Krishi Viswa Vidyalaya, Kalyani (West Bengal) with the herbicide basalin. Basalin was tested at 1.25 and 1.50 l/ha at presowing and post-emergence at 10, 15 and 20 days after sowing. They found that basalin as a presowing treatment cause adverse effect on germination and reduced plant population and ultimately crop yield. Basalin at 1.25 l/ha at 10 days after sowing as a post-emergence treatment gave best result and recorded 35.0 q/ha grain yield, followed by hand weeding twice (33.33 q/ha). Significantly lowest yield was recorded under basalin at 1.50 l/ha as presowing that was 13.75 q/ha.

A field trial was carried out in 1975-76 at the Division of Agronomy, IARI, New Delhi, with dwarf wheat variety Arjun. Mani et al. (1977) reported that the soil applied chemicals (Fluchloralin at 0.25 kg/ha, methybenzthiazuron at 1.40 kg/ha and terbutryne at 0.80 kg/ha immediately followed by an irrigation, gave grain yields as comparable with hand weeded control. The post-emergence spray with benzaylpropethyl at the rate of 1.0 kg/ha and a combination of 2,4-D at 0.42 kg/ha + 3 % urea also resulted in high grain production.

A field trial was carried out at Indian Agricultural Research Institute, New Delhi, for studying the reaction of wheat cultivars to herbicides, during rabi season of 1975-76 with two cultivars of wheat (Arjun and Sonalika). Pandey and Mani (1977) observed that in Sonalika, the grain yield from methabenzthiazuron treatment was superior to hand weeded and 2,4-D treatments, while in case of Arjun, the grain yield from 2,4-D treated plot was significantly more as compared to hand weeded plot.

Field experiments were conducted at Central Jail Farm, Ambala City and Kurukshetra University Farm, Kurukshetra, during rabi season of 1974-75 to determine the performance of methabenzthiazuron and nitrofen and some combination of these herbicides for the effective control of canary grass and broad leaf weeds in wheat. In Ambala, nitrofen at 1.25 kg/ha gave 84 per cent control of canary grass and 9.5 per cent of bread leaf weeds. While, in Kurukshetra, nitrofen controlled 76 per cent canary grass and 12 per cent of broad leaf weeds. Both herbicides were as effective as methabenzthiazuron + one hand weeding or nitrofen alone or nitrofen + one hand weeding. Pre-emergence application of methabenzthiazuron followed by post-emergence application of 2,4-D at 5 weeks after sowing was found promising for higher grain production (Tyagi et al., 1977).

The field experiment was conducted during rabi season of 1976-77 at the Central Farm, College of Agriculture, Gwalior on a sandy loam soil having 8.2 pH to study the effect of times of application of basalin and hand weeding on the control of weeds in dwarf wheat variety Kalyan Sona, comprising of sixteen treatments of basalin at 1.0, 1.25 and 1.5 l/ha at presowing, 10, 15 and 20th days after sowing, hand weeding at 10, 15 and 20th days after sowing and unweeded control. Chauhan and Verma (1978) reported the presence of *Phalaris minor*, *Avena fatua*, *Chenopodium album*, *Anagalis arvensis*, *Convolvulus arvensis*, *Spergula arvensis* and *Melitotus parviflora* type of weeds with percentage infestaton of 12.5, 4.4, 25.5, 10.8, 10.7, 9.3, 12.4 and 14.4, respectively. Maximum plant height, number of total tillers per plant and 1000-grain weight were found in basalin treated plots as compared to hand weeded and control plots. Weed control by using basalin at different rate gave 40 to 119 per cent, while increase due to weeding by hand gave 53 to 75 per cent. Spraying basalin at 1.0 l/ha 15 days after sowing increased the yield by 119 per cent, while hand weeding 20 days after sowing increased the yield by 75 per cent over the control.

A study was undertaken at the Research Farm of Haryana Agricultural University, Hissar, during rabi season of 1974-75 to evaluate the weed control efficiency of various herbicides and thus to estimate the removal of nutrients by crop and associated weeds. Thirteen herbicides including hand weeding at 3 and 5 weeks were tested in this trial. Sharma and Agarwal (1978) reported that weedy check removed highest quantity of nitrogen and phosphorus. But control of weeds either early stage by pre-emergence application of TOK E-25 or even at late stage by post-emergence application of 2,4-D or hand weeding appreciably brought down nutrients removal by weeds, because their density as well as dry matter accumulation decreased.

An investigation was conducted at the College of Agriculture Farm, Sriniketan and Visva-Bharti, in wheat during rabi season of 1976-77 and 1977-78. Mukhopadhyay and Ghosh (1979) revealed that nitrofen at 1.0, 1.5 and 2.0 liter a.i./ha applied as pre-emergence proved superior in boosting up the yield of wheat grains and were almost at par with two hand weeding. There was no significant difference between the different formulations of 2,4-D, with or without 3 % urea.

From the results of experiments conducted under All India Co-ordinated Wheat Improvement Project, IARI, New Delhi, Rao (1979) reported that if only non-graminaceous broad leaf weeds like Chenopodium spp.

Hirakuri, etc. are present, give a spray of 2,4-D at 0.4 kg a.i./ha in 750 liters of water at five weeks after sowing. If only Phalaris minor is present give pre-emergence spray of TOK E-25 at 1.5 kg a.i./ha in 750 liters of water. If chemicals are not available hand weeding should be followed to remove weeds that can be identify.

A field experiment was conducted at the College of Agriculture Farm (P.S.S.) Sriniketan, West Bengal to findout the comparative efficiency of new herbicides and cultural method in controlling weeds in wheat crop in semi-arid lateritic tract of the state. Treatments comprised of different level and time of basalin application, hand weeding and unweeded control. Mukhopadhyay and Beru (1980) revealed that Cyperus rotundus, Cynodon dactylon, Echinochalo colonum, Chenopodium album and Anagalis arvensis type of weed flora were present in the field. Basalin as pre-emergence and soil incorporation application showed better control of grass weed population, while basalin as pre-emergence, soil incorporation and just at emergence showed better control of total weed population than basalin applied as post-emergence at 21 days after sowing. Basalin at the rate of 1.0 kg a.i./ha as a pre-emergence recorded maximum number of effective tillers, number of grains per earhead and 1000-grain weight as compared to hand weeded and unweeded plots. Basalin 1.0 kg a.i./ha as a pre-emergence treatment recorded 25.05 q/ha, while, hand weeding yielded only 23.83 q/ha grain yield.

An experiment was conducted with wheat genotype HD-1102 on calcarious soil at Tirhut College of Agriculture, Bihar (India) during rabi season of 1977-78. Twelve treatments were tested among which Pandey et al. (1980) found highest yield and net profit under nitrofen pre-emergence treatments at the rate of 0.5, 1.0 and 1.25 and 2,4-D 0.80 kg a.i./ha, but post-emergence gave significantly lowest grain yield. One and two hand weeding treated plot had also given higher grain yield.

Fourteen treatment combinations of two formulation of 2,4-D, three methods of application with and without mixing of 3 % urea solution alone with control and hand weeding were compared in rainfed wheat from 1971-72 to 1973-74. The 2,4-D treatments did not gave favourable response. Hand weeding had gave highest wheat yield (Rai, 1980).

An experiment was conducted at the Department of Agronomy, Gujarat Agricultural University, Junagadh to find out critical period for crop weeds competition stages in wheat, consisting eight treatments involving weeding at different intervals. It was found (Anonymous, 1981 a) that different treatments tried in the experiment did not exert significant effect on grain and straw yield of wheat.

Two parellel field experiments were conducted at the Gujarat Agricultural University, one at Instructional Farm, Junagadh on medium black soil, while another at Wheat Research Station, Vijapur on sandy loam soil during rabi season of 1978-79, 1979-80 and 1980-81 to compare the efficiency of different herbicides with conventional method of hand weeding and control. Treatment comprised of eight herbicides viz., basalin, 2.5 l/ha, tribunil 2.0 kg/ha, TOK E-25 8.01/ha, lasso 3.435 l/ha as a pre-emergence, tribunil 2.0 kg/ha pre-emergence + 2,4-D.S.S. post-emergence 1.200 kg/ha, TOK E-25 8.01/ha pre-emergence + 2,4-D.S.S. 1.200 kg/ha post-emergence, lasso 3.435 l/ha pre-emergence + 2,4-D.S.S. 1.200 kg/ha post-emergence, 2,4-D.S. 1.200 kg/ha post-emergence, local method (hand weeding) and control with wheat variety J-24.

It was reported (Anonymous, 1981 b) that at Junagadh the lowest total dry weight of weeds 55 kg/ha was recorded under basalin treated plot, while highest dry weight of weed was recorded under control (1206 kg/ha). The basalin treatment was at par with TOK E-25 pre-emergence + 2,4-D.S.S. post-emergence treatment. While in case of Vijapur the highest net income of Rs. 5614 per hectare was recorded under TOK E-25 pre-emergence + 2,4-D.S.S. post-emergence treatment followed by basalin treated plot. While lowest income of Rs. 4050/ha was recorded under TOK E-25 pre-emergence treated plot.

An experiment was conducted at Tirhut College of Agriculture, Dholi, Muzafarpur, Bihar (India) during rabi season of 1978-79 and 1979-80 on sandy loam type soil, using five herbicides. Panday (1981) reported that fluchloralin at the rate of 0.75 kg a.i./ha and nitrofen at 2.0 kg a.i./ha as a pre-emergence treatment gave 29.44 and 26.66 q/ha grain yield, respectively. While, lowest number of weed population and dry weight of weeds was 6.85 number/m^2 and 71.72 g/m^2 under fluchloralin treated plot, respectively.

III. MATERIALS AND METHODS

Materials used and the techniques adopted during the course of this investigation are presented in this chapter.

3.1 Experimental site

The investigation was laid out on D-8 plot of Instructional Farm, Gujarat Agricultural University, Junagadh during the rabi season of 1980-81.

3.2 Climatic and weather condition

Geographically, Junagadh is situated at 21.5° N Latitude and 70.5° E Longitude with an altitude of 60 meters above mean sea level.

This region enjoys a typical sub-tropical climate. In general, monsoon is warm and moderately humid the winter are fairly cold and dry, while the summer are quite hot and dry. The monsoon usually commences by third week of June and ends by middle of September. July and August are the months of heavy precipitation. Partial failure of monsoon once in three to four years is very common in this area. Total rainfall during the year was 2459.6 mm. Generally, the temperature is higher in month of October and starts dropping in beginning of November. The winter season sets in during this month and continues till the end of February. December and January are the coldest months of year. Usually, summer season commences in the first fortnight of March and ends by the middle of June. May is the hottest month of the year.

The weekwise meteorological data on mean maximum and minimum temperature, relative humidity, sunshine hours, wind velocity and rainfall for the period of experimentation (November 1980 to February 1981) as recorded at the Meteorological Observatory of Farm of the Gujarat Agricultural University, Junagadh Campus are presented in Table 1.

It could be seen that the weather condition was more or less normal and favourable for satisfactory growth and development of wheat crop under irrigated condition except that the month of December had unusual cloudy weather accompanied by little shower which did not have any adverse effect on yield of wheat.

3.3 Physico-chemical properties of soil

Composite soil samples were collected from 0-15, 15-30 and 30-45 cm soil depths from the

Table 1 : Meteorological data recorded at the Meteorological Observatory of the Farm of the Gujarat Agricultural University, Junagadh Campus, during the crop season of the year 1980-81 (weekly mean)

Month		Meteorological week	Dates	Temperature °c		Relative humidity (%)	Bright sunshine hours	Rainfall (mm)
				Maximum	Minimum			
November	'80	46	13-19	34.16	21.04	59	4.06	-
		47	20-26	34.83	16.73	66	9.00	-
		48	27-3	32.60	14.26	69	9.29	-
December	'80	49	4-10	31.97	10.29	58	9.55	-
		50	11-17	32.49	9.67	66	8.93	-
		51	18-24	30.34	7.74	68	5.32	4.00
		52	25-31	27.44	11.49	71	7.72	-
January	'81	1	1-7	31.11	11.99	72	9.54	-
		2	8-14	28.64	10.14	50	10.04	-
		3	15-21	30.40	10.00	63	10.09	-
		4	22-28	29.46	12.64	75	10.07	-
February	'81	5	29-4	31.13	10.61	65	10.14	-
		6	5-11	30.40	8.64	46	10.64	-
		7	12-18	31.36	11.33	69	9.66	-
		8	19-25	36.13	14.46	46	9.41	-
		9	26-4	37.73	14.20	50	10.33	-

experimental plot. The average values of physico-chemical properties of the soil are presented in Table 2.

It appears from the Table 2 that soil of the experiment was clay in texture with medium status of total nitrogen and available phosphorus. It was high in potash. The soil was on the alkaline range having 7.9 pH.

3.4 Choice of wheat variety, sowing and harvesting

Improved wheat variety LOK-1 a cross of S-308 x S-331 evolved at the Institute of Lokbharti Sanosara, district Bhavnagar, Gujarat state under All India Co-ordinated Wheat Varietal Trials in the Central Zone was used in this study. This variety has been identified for release in the Central Zone by the 17th All India Wheat Research Worker's Workshop and released in 1979 for general cultivation in Gujarat state.

The crop was sown keeping 22.5 cm inter-row spacing using seed rate of 120 kg/ha on 19th November, 1980 and harvested from 21st February to 22nd February, 1981.

Table 2 : Physico-chemical properties of the soil

Particulars	Values of different soil depth (cm) 0-15	15-30	30-45	Method employed
Physical determination				
Sand %	19.50	25.00	37.00	International
Silt %	15.50	15.00	12.50	Pipette Method
Clay %	65.00	60.00	50.50	(Piper, 1950)
Chemical determination				
Organic carbon %	0.81	0.69	0.62	Walkey and Black method (Piper, 1950)
Total nitrogen %	0.09	0.05	0.04	Kjeldhal's method (Jackson, 1967)
Available P_2O_5 kg/ha	17.90	10.40	10.20	Olsen's method (Olsen *et al.*, 1954)
Available K_2O kg/ha	325.40	287.70	279.00	Flame Photometric method (Jackson, 1967)
Soil reaction (pH)	7.9	7.9	7.9	Backman pH meter (1 : 2.5 soil water suspension)
Electrical conductivity millimhos/cm at 25°c	0.47	0.29	0.31	Solubridge method (U.S.S.L., 1954)

3.5 Fertilization

The crop was uniformly fertilized with 60 kg nitrogen, 60 kg P_2O_5 and 40 kg K_2O per hectare in the form of urea, di-ammonium phosphate and muriate of potash, respectively, as a basal application at the time of sowing. Remaining 60 kg nitrogen was top dressed at 25 days after sowing.

3.6 Experimental details

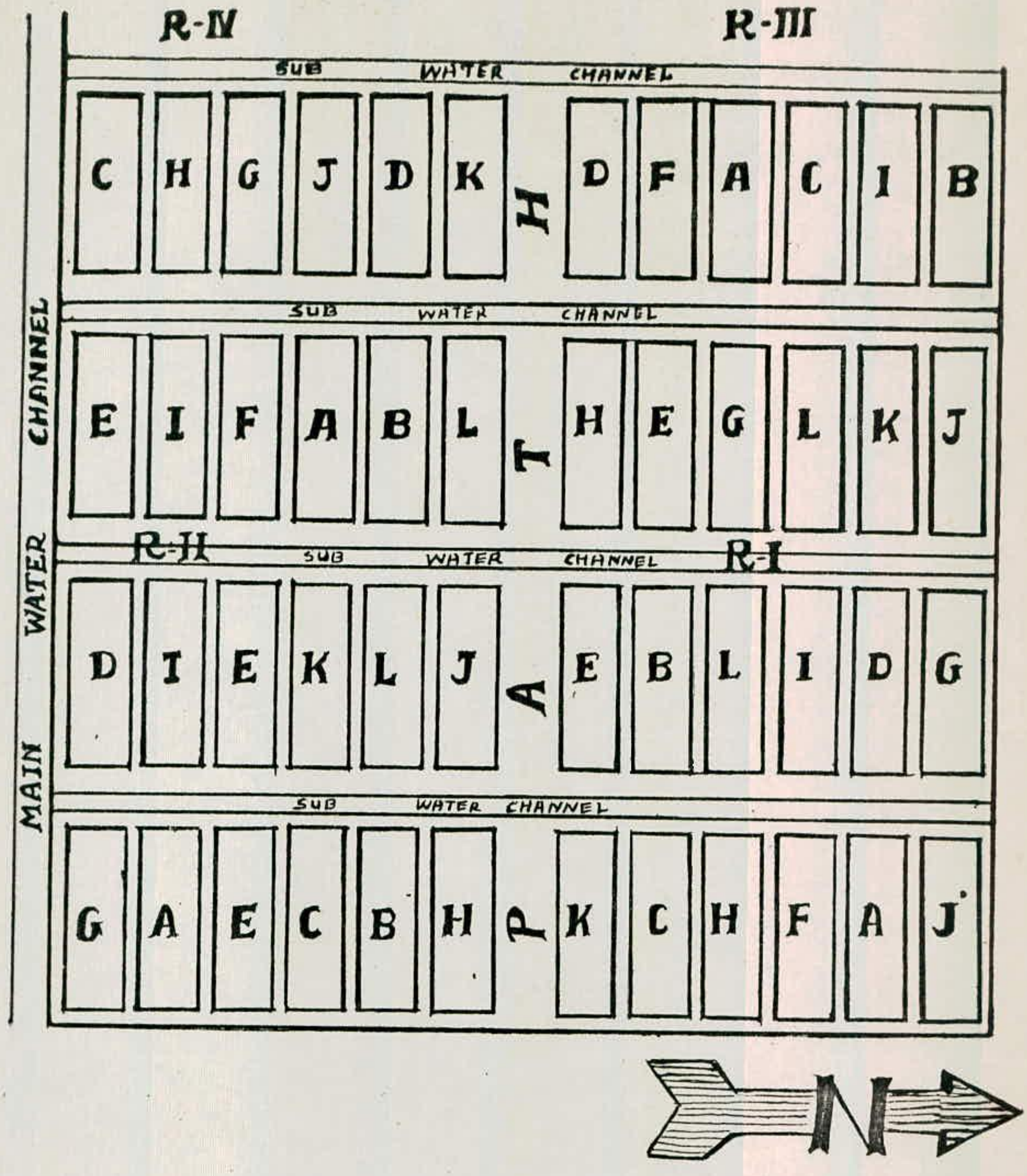
In order to study the efficiency of different herbicides with conventional method for weed control in wheat crop, field investigation was conducted with four herbicides at different rates and time of application together with two conventional methods of weed control and an unweeded control. The details of treatment are given below :

Treatment	Name of herbicide	Rate (product)	Time of application
1	2	3	4
A.	TOK E-25	8.0 l/ha	Pre-emergence
B.	TOK E-25	12.0 l/ha	-"-
C.	Basalin	1.5 l/ha	-"-
D.	Basalin	3.0 l/ha	-"-

1	2	3	4
E.	2,4-D.S.S.	1.5 kg/ha	Pre-emergence
F.	2,4-D.S.S.	3.0 kg/ha	-"-
G.	2,4-D.S.S.	1.5 kg/ha	Post-emergence 35 days after sowing
H.	2,4-D.S.S.	3.0 kg/ha	-"-
I.	Weedone	1.2 kg/ha	-"-
J.	Two hand weeding at 4 and 6 weeks after sowing		
K.	Weed free condition		
L.	Control (unweeded)		

3.6.1 Lay out

The experiment was laid out in randomised block design with four replications. The treatments were assigned at random to each experimental plot in replication. The plan of lay out is depicted in Fig. 1. The gross and net plot size were 2.7 x 8.0 m and 1.8 x 6.0 m, respectively.



DESIGN :- RANDOMIZED BLOCK DESIGN

REPLICATION :- FOUR

PLOT SIZE :-

GROSS :- 2·7 X 8·0 M

NET :- 1·8 X 6·0 M

SPACING :- 22·5 c.m BETWEEN TWO ROWS

FIG. 1 PLAN OF LAYOUT

3.7 Cropping history

The plot No. D-8 of Instructional Farm in which the present experiment was conducted during the rabi season of the year 1980-81, was cropped and fertilized as shown below during the two years preceding the experiment i.e. from 1978-79 to 1980-81 :

Year	Season	Crop and variety	Fertilization (kg/ha) N	P	K
1978-79	Kharif	Groundnut Punjab-1	12.5	25	0
	Rabi	Mustard Varuna	40	40	0
1979-80	Kharif	Groundnut GAU-G-10	12.5	25	0
	Rabi	Wheat J-24	120	60	40
1980-81	Kharif	Cowpea Pusa Falguni	12.5	25	0
	Rabi	Present experiment	120	60	40

3.8 Preparation and application of herbicidal solution

The quantity of herbicides actually required for different treatments were calculated as per schedule. Packets of required quantity of 2,4-D sodium salt and weedone were weighed and kept ready for preparation of herbicidal solution. The liquid form of herbicides viz., TOK E-25 and basalin were measured by measuring cylinder as per required quantity at the time of preparation of solution. The details regarding recommended dose of each herbicide and water are furnished in Table 3.

3.9 Cultural operations

The calender of cultural operations is presented in Table 4.

3.10 Morphological parameters and yield attribute studies

The morphological parameters and yield attributes studied during the course of investigation are shown in Table 5.

3.11 Bio-chemical studies

Bio-chemical studies pertaining to nutrients uptake by weed and protein content of grain were carried out as described hereafter.

Table 3 : Recommended dose of herbicides, time and water

Sr. No.	Name of herbicide	Local name of herbicide	Technical name of herbicide	Dose of herbicide (product)	Water l/ha	Time of application
1.	TOK E-25	TOK E-25	Nitrofen	8.0 l/ha	700 to 800	Pre-emergence. After sowing of crop, but before germination on 20th November
2.	TOK E-25	TOK E-25	Nitrofen	12.0 l/ha	-do-	-do-
3.	Basalin	Basalin	Fluchloralin	1.5 l/ha	500	-do-
4.	Basalin	Basalin	Fluchloralin	3.0 l/ha	500	-do-
5.	2,4-D.S.S.	2,4-D (S.S.)	2,4-D (S.S.)	1.5 kg/ha	700 to 800	-do-
6.	2,4-D.S.S.	2,4-D (S.S.)	2,4-D (S.S.)	3.0 kg/ha	-do-	-do-
7.	2,4-D.S.S.	2,4-D (S.S.)	2,4-D (S.S.)	1.5 kg/ha	-do-	Post-emergence. After emergence of both crop and weeds at 35 days after sowing on 24th December.
8.	2,4-D.S.S.	2,4-D (S.S.)	2,4-D (S.S.)	3.0 kg/ha	-do-	-do-
9.	Weedone	Weedone	2,4-D Ethyl ester	1.2 kg/ha	-do-	-do-

Table 4 : Calender of cultural operations

Sr.No.	Operation	Date
1.	Ploughing twice with country plow	6-11-80 8-11-80
2.	Preparation of land with blade harrow	10-11-80
3.	Field lay out	15-11-80
4.	Preparing beds and water channels	16-11-80
5.	Fertilizer application basal dose half dose of nitrogen full dose of P_2O_5 and K_2O	18-11-80
6.	Sowing, keeping inter-row spacing of 22.5 cm and using the seed rate of 120 kg/ha and covering seeds	19-11-80
7.	Weeding	As per treatment schedules
8.	Top dressing second dose of nitrogen at crown root initiation stage	13-12-80
9.	Irrigation	19-11-80 28-11-80 7-12-80 15-12-80 23-12-80 1-1-81 9-1-81 16-1-81 24-1-81 2-2-81
10.	Harvesting : Replication I, II Replication III, IV	21-2-81 22-2-81
11.	Threshing and winnowing Replication I, II Replication III, IV	 26-2-81 27-2-81

Table 5 : Biometric observations recorded during the investigation

Character	Sample size	Days after sowing
Initial plant ppulation	0.90 m^2	15
Final plant population	0.90 m^2	At harvest
Plant height	Total five plants from four rows	At harvest
Total shoots	0.90 m^2	At harvest
Productive shoots	0.90 m^2	At harvest
Weed counts	Net plot	After harvest
Earhead length	10 earheads per net plot	After harvest
Spikelets/earhead	10 earheads per net plot	After harvest
Grains/earhead	10 earheads per net plot	After harvest
Grain weight/ earhead	10 earheads per net plot	After harvest
1000 grain weight	One composite sample from each treatment	After harvest
Dry weight of weeds	Net plot	After harvest
Grain yield	Net plot	After threshing
Straw yield	Net plot	After threshing

3.11.1 Nutrient uptake

Representative samples of grain and weed were drawn from each plot for chemical studies. They were oven dried at 70°c for 24 hours and then powdered by mechanical milly grinder. Samples, thus prepared were analysed for nigrogen, phosphorus and potash uptake by weeds and nitrogen content in grain for determining protein content.

Powdered material was digested by a mixture of concentrated HNO_3 concentrated H_2SO_4 and 60 per cent $HClO_4$ mixed in volume ratio of 10 : 1 : 4, respectively (Warnke and Barber, 1974). Suitable aliquotes were drawn for the estimation of P_2O_5 and K_2O.

3.11.1.1 Estimation of nitrogen

Total nitrogen was determined by modified Kjeldhal's method as described by Jackson (1967).

3.11.1.2 Estimation of phosphorus

Phosphorus was determined by Vanadomolybdo phosphoric yellow colour method in HNO_3 system as described by Jackson (1967).

3.11.1.3 Estimation of potassium

Potassium was determined by flame photometer (Type 121 Sr.No. 7218) as described by Jackson (1967).

3.11.2 Protein content

Protein content of grain was determined from the composite grain samples of each treatment by multiplying their nitrogen percentages by a factor 6.25.

3.12 Pest and disease

No serious disease and pest attack was observed during the life period of crop.

3.13 Statistical analysis

Statistical analysis of the data of the characters studied was carried out through the procedure appropriate to the design of the experiment. The significance of difference was tested by the 'F' test (Snedecor and Cochran, 1967).

Summary tables for treatment effects have been prepared and presented with S.Em. critical differences at 5 per cent level has also been given where the treatment effects were significant.

3.14 Correlation studies

In the present investigation an attempt has been made to analyse the yield attributing characters of dwarf wheat (LOK-1) which have substantial influence on grain yield. With a view to determine the relationship, if any, between grain yield and yield attributes viz., number of total shoots/0.90 m^2, number of productive shoots/0.90 m^2, number of spikelets/ earhead, number of grains/earnead, grain weight/earhead, length of earhead and 1000-grain weight, correlation studies were carried out. Regression equation for such characters, those indicated significant correlation, were also worked out.

3.15 Economics

The gross realization in terms of rupees per hectare was worked out taking into consideration of the prevailing market price of grain and straw of each treatment during 1980-81. Likewise, the cost of cultivation was worked out by considering the expenses incurred for cultivation operations from preparatory tillage to harvesting including threshing, cleaning as well as cost of inputs viz., seeds, fertilizer, herbicides and irrigation applied to each treatment.

The cost of cultivation was then deducted from the gross realization to work out net profit for each treatment and recorded accordingly.

IV. EXPERIMENTAL RESULTS

Results of the field experiment entitled "Chemical and conventional methods of weed control in wheat" conducted at Instructional Farm, Gujarat Agricultural University, Junagadh in rabi season of 1980-81 are presented in this chapter along with statistical inferences. The data pertaining to growth, yield attributes and yield, weed count and nutrients uptake by weeds were subjected to statistical analysis and "Analysis of Variance" for these data have been given in Appendices I, II and III with the level of significance. The efficacy of various treatments was adjudged by a comparative assesment of vegetative and yield characteristics, studies on weed control, weed counts and nutrients uptake by weeds.

4.1 Growth studies

4.1.1 Initial plant population

The data on the effect of different treatments on initial plant population of wheat recorded at 15 days after sowing are presented in Table 6 and their analysis of variance are furnished in Appendix I.

Table 6 : Effect of different treatments on initial plant population, final plant population and plant height at harvest of the wheat

Treatments		Initial plant population (1.0 x 0.9 m)	Plant population at harvest (1.0 x 0.9 m)	Plant height (cm)
A. TOK E-25 8.0 l/ha	Pre-em.	150.75	150.75	63.95
B. TOK E-25 12.0 l/ha	-do-	151.50	151.25	62.38
C. Basalin 1.5 l/ha	-do-	149.75	149.75	63.50
D. Basalin 3.0 l/ha	-do-	147.25	147.25	63.32
E. 2,4-D.S.S. 1.5 kg/ha	-do-	153.50	153.00	62.25
F. 2,4-D.S.S. 3.0 kg/ha	-do-	151.50	151.50	62.95
G. 2,4-D.S.S. 1.5 kg/ha	Post-Em.	150.50	150.25	64.17
H. 2,4-D.S.S. 3.0 kg/ha	-do-	148.75	148.50	62.55
I. Weedone 1.2 kg/ha	-do-	148.25	148.00	62.90
J. Two hand weeding at 4 and 6 weeks after sowing		149.50	149.25	62.85
K. Weed free condition		149.25	149.25	63.75
L. Control		149.00	149.00	63.00
S.Em. ±		1.265	1.1626	1.133
C.D. at 5%		N.S.	N.S.	N.S.
C.V. (%)		1.686	1.552	3.589

N.S. = Not significant

A perusal of data presented in Table 6 indicated that different treatments tried in the experiment did not exert their significant effects on the initial plant population. There was no phytotoxic effect on germination of wheat due to different herbicides tried in the experiment. However, application of basalin at 3.0 l/ha as pre-emergence showed some depressing effect on germination, but the same was not found to be significant.

4.1.2 Plant population at harvest

The data on the effects of different treatments on plant population at harvest of wheat are presented in Table 6 and their analysis of variance are furnished in Appendix I.

A perusal of data presented in Table 6 indicated that the different treatments tried in the experiment did not exert their significant effects on the plant population at harvest. There was no phytotoxic effect on population of wheat due to different herbicides tried in the experiment.

4.1.3 Plant height

The data on the effect of different treatments on final plant height recorded at harvest are presented in Table 6 and their analysis of variance are furnished in Appendix I.

A perusal of data presented in Table 6 indicate that final plant height of wheat did not affect significantly due to different treatments tried in the experiment.

4.2 Productive attributes and yield

4.2.1 Number of total shoots per 0.90 m^2

The data on the effects of different treatments on the number of total shoots (0.90 m^2) are presented in Table 7 and their analysis of variance in Appendix I.

The results summarised in Table 7 indicate that different treatments exhibited their significant influence on number of total shoots (0.90 m^2) of wheat. Treatments K (weed free condition), C (Basalin 1.5 l/ha pre-emergence), D (Basalin 3.0 l/ha pre-emergence) and J (two hand weeding at 4 and 6 weeks after sowing) were statistically at par, but recorded significantly more total shoots by 439, 431, 421 and 409 per 0.90 m^2, respectively, as compared to rest of the treatments. Treatment L (control) recorded significantly less total shoots by 245 per 0.90 m^2 as compared to rest of the treatments. Treatments E and F as well as B and A did not differ significantly and found intermediate in recording total shoots per 0.90 m^2.

The results indicated that herbicides viz., basalin at 1.5 and 3.0 l/ha as pre-emergence were found as effective as that of conventional method viz., weed free condition and hand weeding at 4 and 6 weeks with respect to number of total shoots per 0.90 m^2.

4.2.2 Number of productive shoots per 0.90 m^2

The data on the effects of different treatments on the number of productive shoots per 0.90 m^2 are presented in Table 7 and their analysis of variance are given in Appendix I.

A perusal of data presented in Table 7 reveal that number of productive shoots recorded under treatments K (weed free condition), C (basalin 1.5 l/ha pre-emergence), D (basalin 3.0 l/ha pre-emergence) and J (two hand weeding at 4 and 6 weeks after sowing) did not differ significantly, but produced significantly

Table 7 : Effect of different treatments on the total number of shoots and number of productive shoots per 0.90 m^2 of the wheat

Treatments		Total number of shoots (1.0 x 0.9 m)	Number of productive shoots (1.0 x 0.9 m)
A. TOK E-25 8.0 l/ha	Pre-em.	2.5245 (334.75)	2.5083 (322.50)
B. TOK E-25 12.0 l/ha	-do-	2.5267 (336.50)	2.5120 (325.25)
C. Basalin 1.5 l/ha	-do-	2.6345 (431.25)	2.6122 (409.75)
D. Basalin 3.0 l/ha	-do-	2.6247 (421.50)	2.5984 (396.75)
E. 2,4-D.S.S. 1.5 kg/ha	-do-	2.5663 (369.00)	2.5468 (352.75)
F. 2,4-D.S.S. 3.0 kg/ha	-Do-	2.5615 (364.50)	2.4918 (348.50)
G. 2,4-D.S.S. 1.5 kg/ha	Post-em.	2.4919 (310.50)	2.4774 (300.25)
H. 2,4-D.S.S. 3.0 kg/ha	-do-	2.4922 (310.75)	2.4794 (301.75)
I. Weedone 1.2 kg/ha	-do-	2.4747 (298.50)	2.4511 (282.75)
J. Two hand weeding at 4 and 6 weeks after sowing		2.6116 (409.00)	2.5907 (389.75)
K. Weed free condition		2.6431 (439.75)	2.6187 (415.75)
L. Control		2.3831 (245.50)	2.3632 (231.75)
S.Em. ±		0.011	0.021
C.D. at 5%		0.032	0.059
C.V. (%)		0.880	1.635

the highest number of productive shoots as compared to treatments B, A, F, H, G, I and L. The respective number of productive shoots per 0.90 m^2 were 415, 409, 396 and 389 under treatments K, C, D and J. Treatment L (control) recorded significantly less number of productive shoots by 231 per 0.90 m^2 than that of treatments K, C, D, J, E and B.

These findings would show that treatments C (Basalin 1.5 l/ha pre-emergence) and D (Basalin 3.0 l/ha pre-emergence) proved to be the best next to treatment K (weed free condition) in producing the number of productive shoots per 0.90 m^2.

4.2.3 Earhead length

The data on the effect of the different treatments on earhead length of wheat are presented in Table 8 and their analysis of variance in Appendix I.

A perusal of data presented in Table 8 indicate that treatments K (weed free condition) and C (Basalin 1.5 l/ha pre-emergence) were statistically at par, but recorded significantly the highest earhead length of 7.05 and 6.94 cm, respectively, as compared to rest of the treatments except treatment D (Basalin

3.0 l/ha pre-emergence). Treatments D (Basalin 3.0 l/ha pre-emergence) and J (two hand weeding at 4 and 6 weeks after sowing) did not differ significantly, but produced significantly higher earhead length than rest of the treatments and stood second next to treatments K (weed free condition) and C (Basalin 1.5 l/ha pre-emergence). Treatments G (2,4-D.S.S. 1.5 kg/ha post-emergence), L (control) and I (Weedone 1.2 kg/ha post-emergence) were statistically at par and recorded significantly less earhead length as compared to rest of the treatments except treatment H (2,4-D.S.S. 3.0 kg/ha post-emergence). The respective earhead length under treatments G, L and I were 6.80, 6.30 and 6.08 cm, respectively.

Application of basalin at 1.5 and 3.0 l/ha as pre-emergence application established its superiority in recording earhead length as high as that of conventional method i.e. weed free condition.

4.2.4 Spikelets per earhead

The data pertaining to the effects of different treatments on spikelets per earhead are given in Table 8 and their analysis of variance are furnished in Appendix I.

Table 8 : Effect of different treatments on earhead length, spikelets and number of grains/ earhead in wheat

Treatments		Earhead length (cm)	Spikelets per earhead	Number of grains per earhead
A. TOK E-25 8.0 l/ha	Pre-em.	6.43	11.43	29.95
B. TOK E-25 12.0 l/ha	-"-	6.58	11.60	29.80
C. Basalin 1.5 l/ha	-"-	6.94	12.05	32.73
D. Basalin 3.0 l/ha	-"-	6.81	11.80	32.55
E. 2,4-D.S.S. 1.5 kg/ha	-"-	6.53	11.73	31.10
F. 2,4-D.S.S. 3.0 kg/ha	-"-	6.56	11.63	30.85
G. 2,4-D.S.S. 1.5 kg/ha	Post-em.	6.18	11.40	29.38
H. 2,4-D.S.S. 3.0 kg/ha	-"-	6.29	11.30	29.20
I. Weedone 1.2 kg/ha	-"-	6.08	11.25	28.58
J. Hand weeding at 4 and 6 weeks after sowing		6.75	11.85	31.90
K. Weed free condition		7.05	12.10	33.15
L. Control		6.13	11.15	28.53
S.Em. ±		0.066	0.057	0.336
C.D. at 5%		0.189	0.163	0.969
C.V. (%)		2.021	0.979	2.190

Results presented in Table 8 revealed that treatments K (weed free condition) and C (Basalin 1.5 l/ha pre-emergence) topped the list by recording significantly the highest spiekelets by 12.10 and 12.05 per earhead, respedtively, followed by treatments J (two hand weeding at 4 and 6 weeks after sowing) D (Basalin 3.0 l/ha pre-emergence) and E (2,4-D.S.S. 1.5 kg/ha pre-emergence). Treatments K (weed free condition) and C (Basalin 1.5 l/ha pre-emergence) and treatments J, D and E did not differ significantly among themselves. Significantly the lowest spikelets per earhead were recorded under treatments H, I and L as compared to rest of the treatments, except treatment G (2,4-D.S.S. 1.5 kg/ha post-emergence). Treatments H, I and L were statistically at par.

The findings revealed that application of basalin at 1.5 l/ha as pre-emergence produced spikelets per earhead as high as that of conventional method comprised of weed free condition.

4.2.5 Number of grains per earhead

The data pertaining to the effects of different treatments on number of grains per earhead are furnished in Table 8 and their analysis of variance in Appendix II.

Data presented in Table 8 revealed that treatments K (weed free condition) C (Basalin 1.5 l/ha pre-emergence) and D (Basalin 3.0 l/ha pre-emergence) were statistically at par, but significantly superior to rest of the treatments, except treatment J (two hand weeding at 4 and 6 weeks after sowing) by recording 33.1, 32.7 and 32.5 number of grains per earhead, respectively. Treatments G, H, I and L were statistically at par and recorded significantly less number of grains per earhead than that rest of the treatments except treatments A and B.

It is interesting to note that application of basalin at 1.5 and 3.0 l/ha as pre-emergence was found as effective as that of weed free condition in respect of production of number of grains per earhead.

4.2.6 <u>Grain weight per earhead</u>

The data on the effects of different treatments on grain weight per earhead are presented in Table 9 and their analysis of variance in Appendix II.

The grain weight per earhead did not significantly influence due to different treatments tried in the experiment.

Table 9 : Effect of different treatments on grain weight per earhead and test weight (1000-grain weight) of wheat

Treatments		Grain weight per earhead (g)	Test weight (g)
A. TOK E-25 8.0 l/ha	Pre-Em.	1.746	55.390
B. TOK E-25 12.0 l/ha	-"-	1.821	55.233
C. Basalin 1.5 l/ha	-"-	1.924	55.995
D. Basalin 3.0 l/ha	-"-	1.880	55.878
E. 2,4-D.S.S. 1.5 kg/ha	-"-	1.837	55.578
F. 2,4-D.S.S. 3.0 kg/ha	-"-	1.870	55.735
G. 2,4-D.S.S. 1.5 kg/ha	Post-em.	1.750	55.193
H. 2,4-D.S.S. 3.0 kg/ha	-"-	1.770	55.330
I. Weedone 1.2 kg/ha	-"-	1.653	55.025
J. Two hand weeding at 4 and 6 weeks after sowing		1.912	55.893
K. Weed free condition		1.930	56.083
L. Control		1.618	54.990
S.Em. ±		0.1642	0.1005
C.D. at 5%		N.S.	0.2894
C.V. (%)		18.16	0.3600

N.S. = Not significant

4.2.7 Test weight

The data pertaining to the effects of different treatments on test weight are furnished in Table 9 and their analysis of variance are given in Appendix II.

Treatments K (weed free condition) C (Basalin 1.5 l/ha pre-emergence), J (two hand weeding at 4 and 6 weeks after sowing) and D (Basalin 3.0 l/ha pre-emergence) were statistically at par, but recorded significantly the highest test weight (1000-grain weight) by 56.0, 55.9, 55.8 and 55.8 g, respectively over rest of the treatments, except treatment F (2,4-D.S.S. 3.0 kg/ha pre-emergence). Treatments B, G, I and L were statistically at par and recorded significantly lower test weight than that of rest of the treatments, except treatments A and H.

The results revealed that spraying of basalin at 1.5 and 3.0 l/ha as pre-emergence secured test weight as high as that of conventional methods viz., weed free condition and hand weeding at 4 and 6 weeks after sowing.

4.2.8 Crop yield of wheat

4.2.8.1 Grain yield

Data pertaining to the effects of different treatments on grain yield of wheat are presented in Table 10 and their analysis of variance are furnished in Appendix II. The data are also graphically depicted in Fig. 2.

The results revealed that grain yield of wheat was significantly affedted due to different treatments. Treatments K (weed free condition) and C (Basalin 1.5 l/ha pre-emergence) were statistically at par, but outdid the rest by yielding significantly the highest grain yield of 46.12 and 45.97 q/ha, respectively, followed by treatments J (two hand weeding at 4 and 6 weeks after sowing) and D (Basalin 3.0 l/ha pre-emergence). Treatment C (Basalin 1.5 l/ha pre-emergence), however, fail to attain the level of significance over treatment J (two hand weeding at 4 and 6 weeks after sowing) which produced grain yield of 44.11 q/ha. Treatments J (two hand weeding at 4 and 6 weeks after sowing) and D Basalin 3.0 l/ha pre-emergence) were statistically at par. The grain yield obtain under control (unweeded check) was

Table 10 : Effect of different treatments on yield (q/ha) of wheat

Treatment		Yield (q/ha) Grain	Straw
A. TOK E-25 8.0 l/ha	Pre-em.	39.20	41.15
B. TOK E-25 12.0 l/ha	-"-	40.22	42.89
C. Basalin 1.5 l/ha	-"-	45.97	50.25
D. Basalin 3.0 l/ha	-"-	43.82	48.20
E. 2,4-D.S.S. 1.5 kg/ha	-"-	40.96	45.98
F. 2,4-D.S.S. 3.0 kg/ha	-"-	41.39	44.27
G. 2,4-D.S.S. 1.5 kg/ha	Post-em.	37.41	37.29
H. 2,4-D.S.S. 3.0 kg/ha	-"-	38.65	37.88
I. Weedone 1.2 kg/ha	-"-	34.12	34.37
J. Two hand weeding at 4 and 6 weeks after sowing		44.11	48.51
K. Weed free condition		46.12	50.28
L. Control		31.06	32.49
S.Em. ±		0.512	0.429
C.D. at 5%		1.474	1.236
C.V. (%)		2.540	2.005

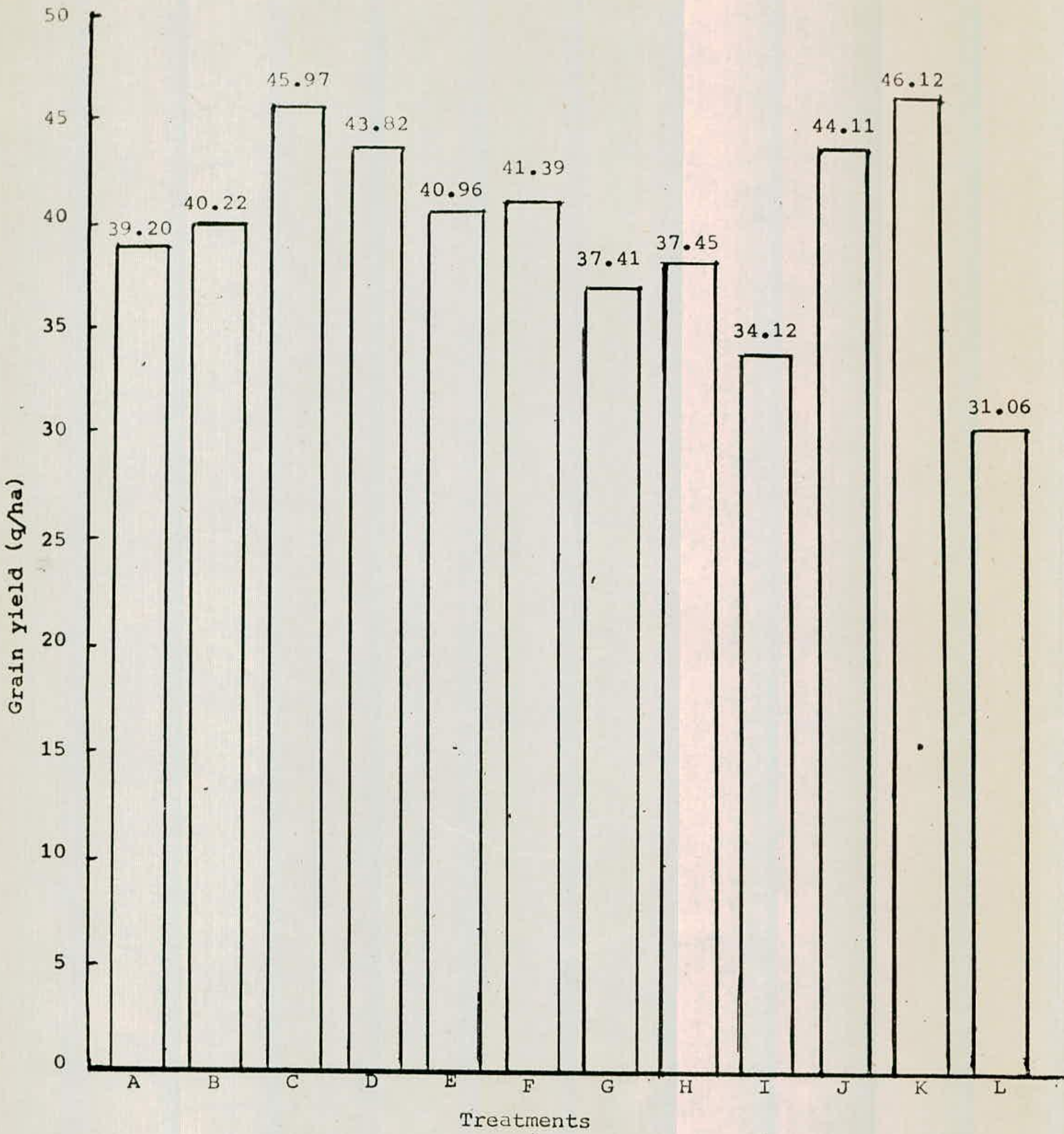


Fig. 2. Effect of different treatments on grain yield of wheat

significantly less as compared to rest of the treatments (Fig. 2). The respective yield increases were 48.49, 48.00, 42.02 and 41.08 per cent under treatments K (weed free condition), C (Basalin 1.5 l/ha pre-emergence), J (two hand weeding at 4 and 6 weeks after sowing) and D (Basalin 3.0 l/ha pre-emergence) over control.

Treatment C involving spraying of basalin at 1.5 l/ha as pre-emergence proved equally effective as weed free condition in producing grain yield of wheat (Fig. 2). Among the different herbicides tried in the experiment basalin at 1.5 and 3.0 l/ha as pre-emergence significantly surpassed the rest of the herbicides by recording highest grain yield (Table 10).

4.2.8.2 <u>Straw yield</u>

The data pertaining to the effect of different treatments on straw yield of wheat are presented in Table 10 and their analysis of variance are furnished in Appendix II. The straw yield was also graphically depicted in Fig. 3.

The data presented in Table 10 showed that straw yield of wheat was significantly affected by different treatments exercised in the experiment.

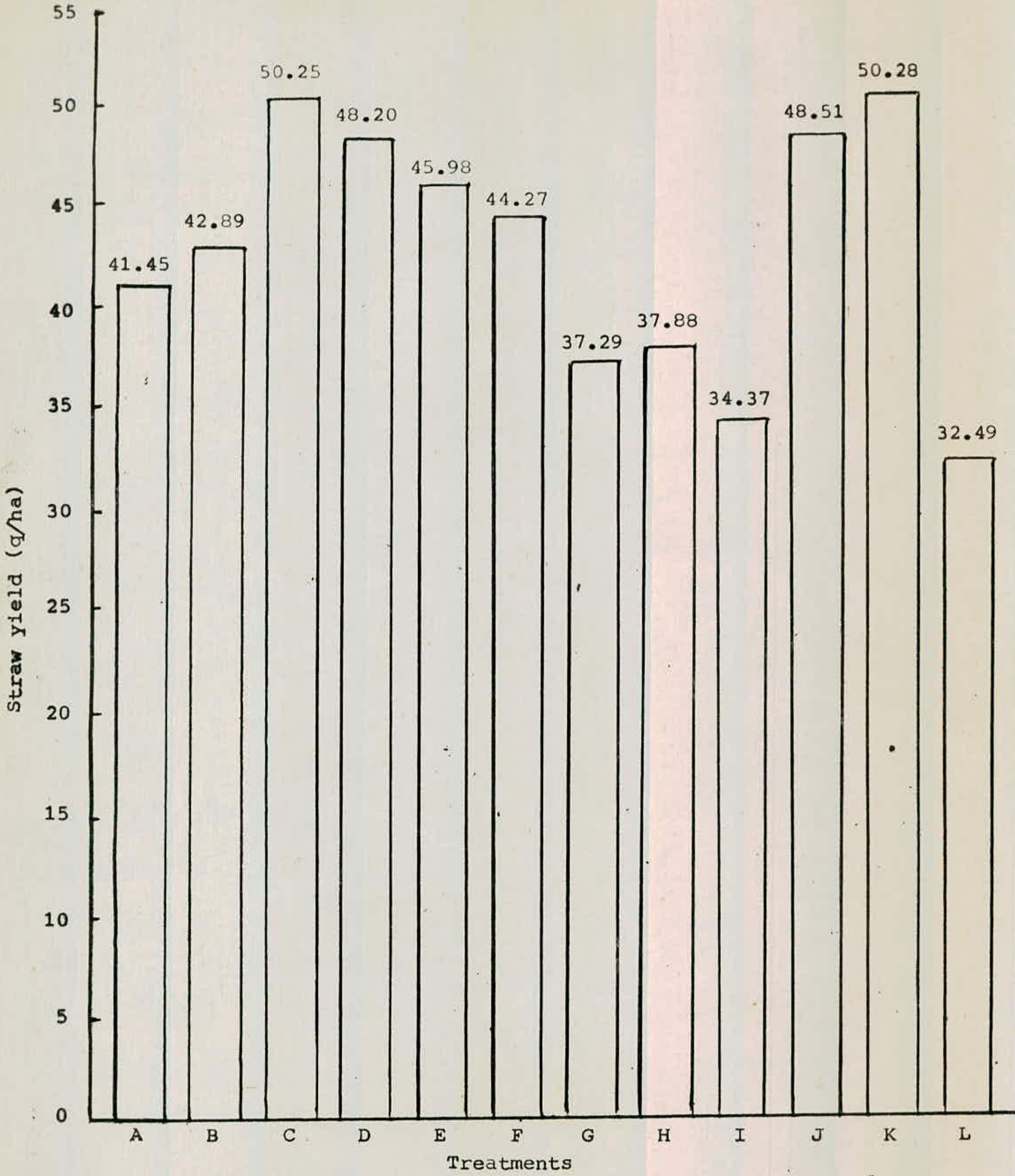


Fig. 3. Effect of different treatments on straw yield

Treatments K (weed free condition) and C (Basalin 1.5 l/ha pre-emergence) were statistically at par (Fig. 3), but outdid the rest by yielding significantly the highest straw yield of 50.28 and 50.25 q/ha, followed by treatments J (two hand weeding at 4 and 6 weeks after sowing) and D (Basalin 3.0 l/ha pre-emergence). Treatments J (two hand weeding at 4 and 6 weeks after sowing) and D (Basalin 3.0 l/ha pre-emergence) were statistically at par producing straw yield of 48.51 and 48.20 q/ha, respectively. Likewise, grain yield treatment L (control) produced significantly less straw yield (32.49 q/ha as compared to rest of the treatments). The magnitude of increases were 54.76, 54.66, 49.31 and 48.35 per cent under treatments K, C, J and D, respectively, over treatment L (control).

Application of basalin at 1.5 l/ha as pre-emergence spray was found as effective as weed free condition in recording straw yield of wheat and turned out to be superior among different herbicides used in the experiment.

4.3.1 Weed studies

The weed flora in the present experiment comprised of eleven species both monocots and dicots, Description of Plate No. 1

	Common name	Scientific name
1.	Jangli gobhi	*Launea nudicaulis* H.K.
2.	Bathua	*Chenopodium album* L.
3.	Savank	*Echinochloa crusgalli* (L) Beauv.
4.	Safed murga	*Celosia argentea* L.
5.	Thoya	*Digera arvensis* Forsk
6.	Saroto	*Acanthospermum hispidum* (L) DC
7.	Sesamol	*Commelina nudiflora* L.
8.	Bara lunia	*Portulaca oleracea* L.
9.	Makra	*Dactyloctenium aegyptium* Beauv.
10.	Moth	*Cyperus rotundus* L.
11.	Dub	*Cynodon dactylon* Pers.

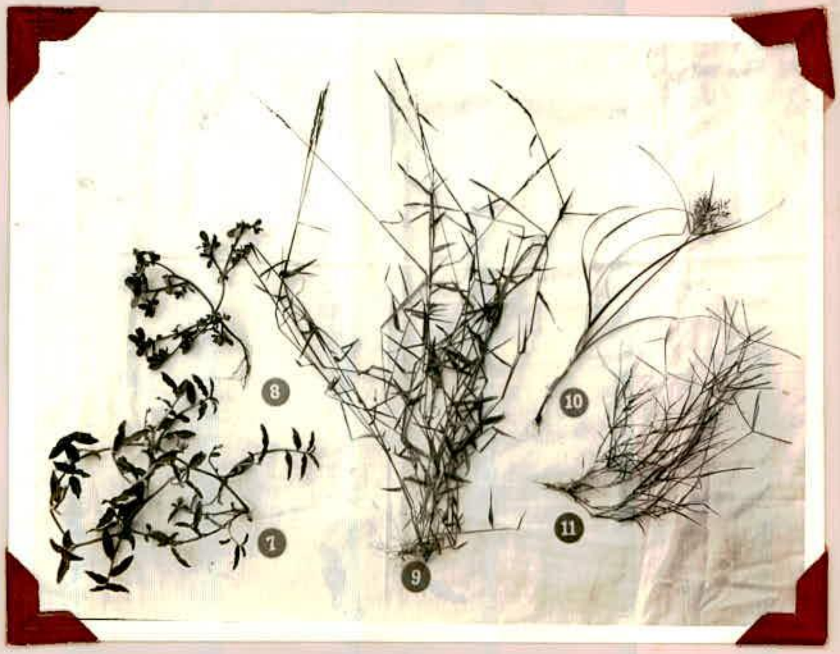


PHOTO PLATE 1 :

Weed species found in wheat

which are recorded in the order of occurence as under and shown in Plate 1. The scientific name of different weeds are written as given by Joshi (1974).

Sr. No.	Common name	Scientific name
1.	Savank	Echinochloa crusgalli (L) Beauv.
2.	Makra	Dactyloctenium aegyptium Beauv.
3.	Sesamol	Commelina nudiflora L.
4.	Moth	Cyperus rotundus L.
5.	Dub	Cynodon dactylon Pers.
6.	Bathua	Chenopodium album L.
7.	Thoya	Digera arvensis Forsk.
8.	Safed murga	Celosia argentea L.
9.	Saroto	Acanthospermum hispidum (L) DC.
10.	Jangli gobhi	Launea nudicaulis H.K.
11.	Bara lunia	Portulaca oleracea L.

4.3.2 Weed population

The data on weed population recorded at harvest are presented in Table 11 and depicted in Fig. 4. The effects of different treatments on weed population are shown in Plate 2, whereas, the comparison of basalin at 1.5 l/ha as pre-emergence and control (unweeded check) are shown in Plate 3 and their analysis of varience are given in Appendix III.

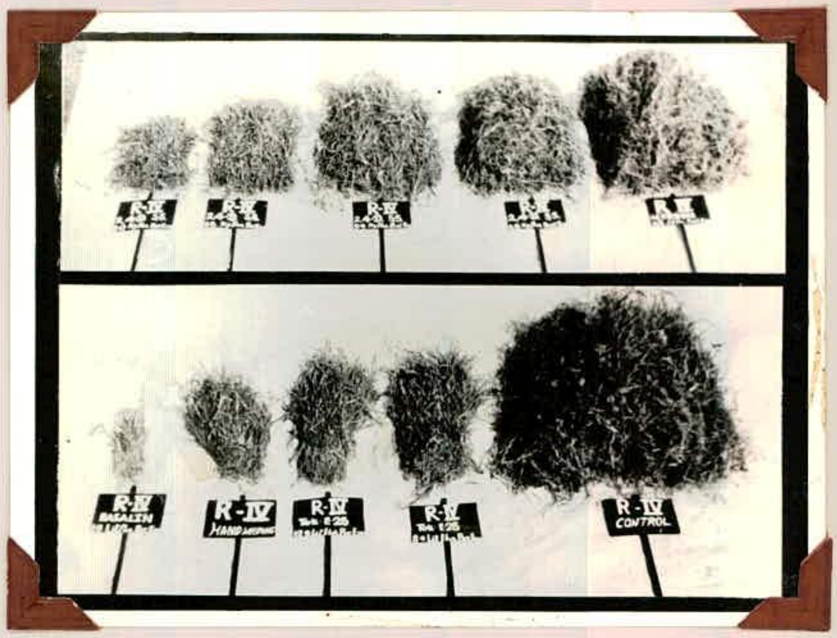
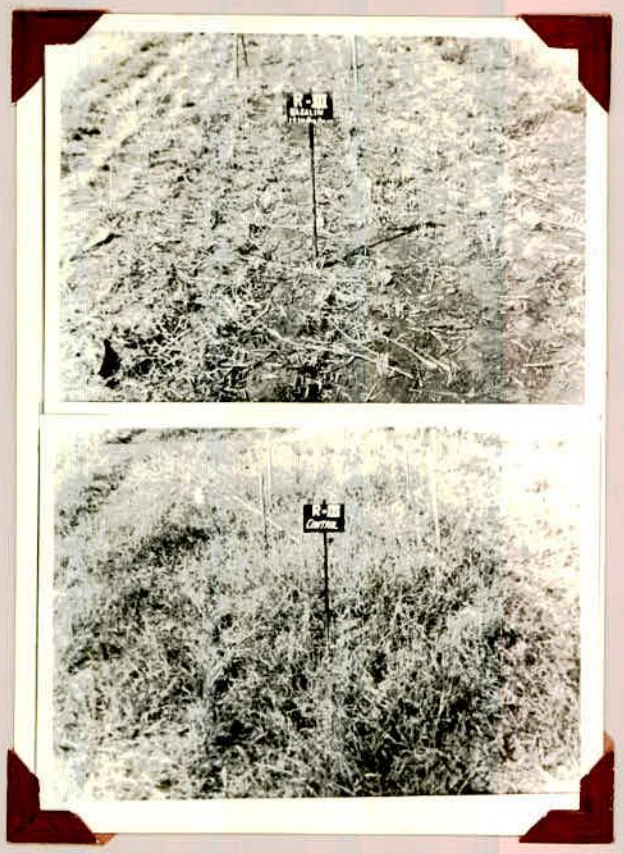


PHOTO PLATE 2 :

The effects of different treatments on weed population in wheat

Table 11 : Effect of different treatments on weed population and dry weight of weeds

Treatment		Weed population	Dry weight of weeds (kg/ha)
A. TOK E-25 8.0 l/ha	Pre-em	2.50 (315.25)	313.56
B. TOK E-25 12.0 l/ha	-"-	2.44 (277.25)	258.19
C. Basalin 1.5 l/ha	-"-	1.65 (52.75)	30.09
D. Basalin 3.0 l/ha	-"-	1.25 (19.00)	8.73
E. 2,4-D.S.S. 1.5 kg/ha	-"-	2.20 (161.25)	211.55
F. 2,4-D.S.S. 3.0 kg/ha	-"-	2.13 (137.25)	175.14
G. 2,4-D.S.S. 1.5 kg/ha	Post-em	2.56 (364.25)	442.66
H. 2,4-D.S.S. 3.0 kg/ha	-"-	2.53 (341.00)	383.68
I. Weedone 1.2 kg/ha	-"-	2.67 (495.50)	621.63
J. Hand weeding at 4 and 6 weeks after sowing		1.77 (62.25)	45.11
K. Weed free condition		-	-
L. Control		2.74 (555.00)	648.19
S.Em. ±		0.060	12.190
C.D. at 5%		0.172	35.099
C.V. (%)		5.382	8.545



<u>PHOTO PLATE</u> 3 :

Comparision of basalin at 1.5 l/ha as pre-emergence and control for weed population in wheat

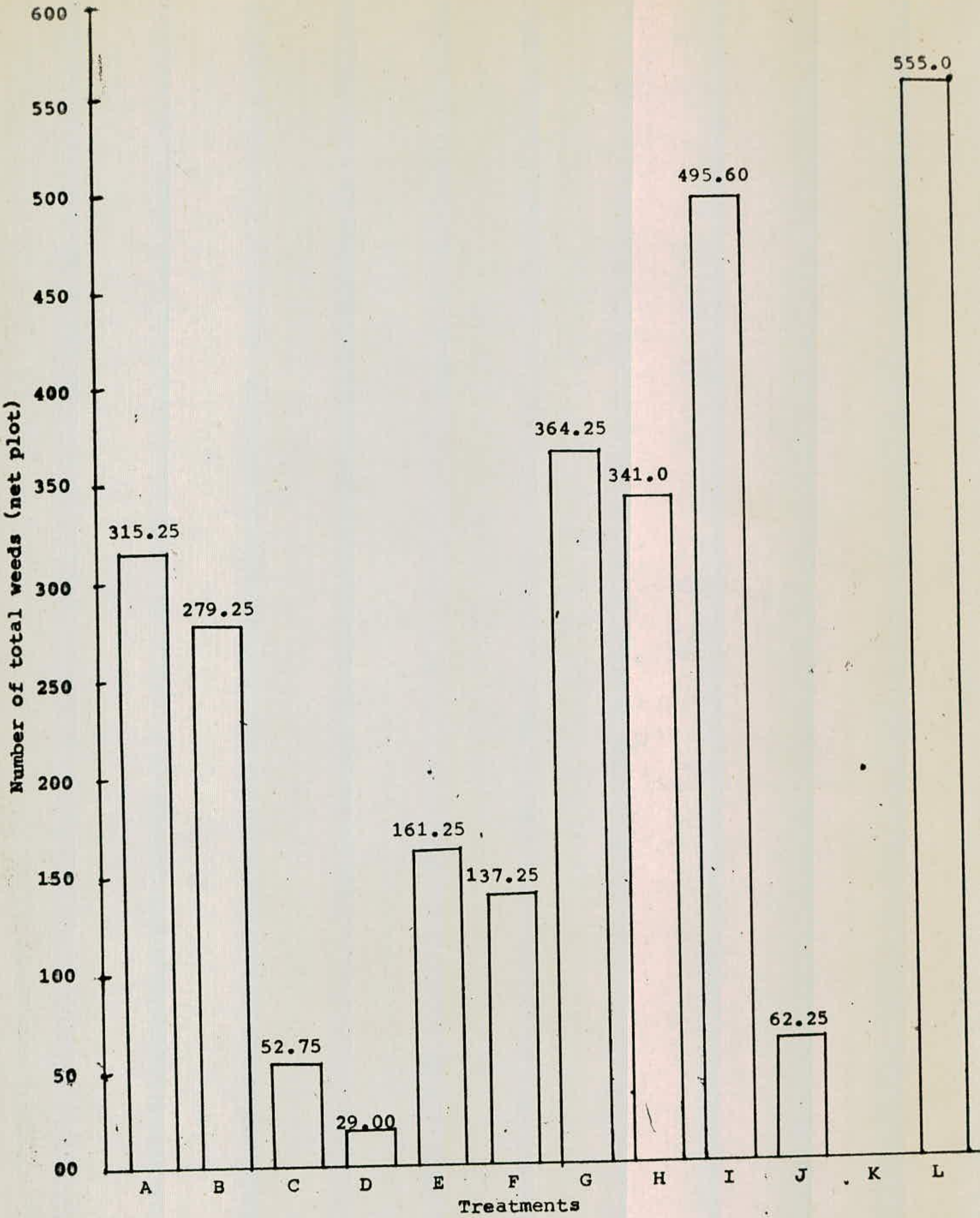


Fig. 4. Effect of different treatments on number of total weeds per net plot

The data presented in Table 11 showed that weed population was significantly affected under different treatments. Treatment L (control) and I (Weedone 1.2 kg/ha post-emergence) were statistically at par and proved significantly inferior by recording the highest number of weeds by 555 and 495 per net plot, respectively (Fig. 4, Plate 2), followed by treatments G (2,4-D.S.S. 1.5 kg/ha post-emergence), H (2,4-D.S.S. 3.0 kg/ha post-emergence) and A (TOK E-25 8.0 l/ha pre-emergence). Treatment I (Weedone 1.2 kg/ha post-emergence) did not differ significantly from treatments G, H and A, which recorded 364, 341 and 315 number of weeds per net plot, respectively. Application of basalin at 3.0 l/ha as pre-emergence spray established its superiority over rest of the treatments by recording significantly lower number of weeds by 19 per net plot, followed by treatments C (Basalin 1.5 l/ha pre-emergence) and J (two hand weeding at 4 and 6 weeks after sowing). Treatments C and J, however, were statistically at par and recorded significantly lower number of weeds by 52 and 62 per net plot, respectively, over rest of the treatments, except treatment D (Basalin 3.0 l/ha pre-emergence). Treatments C and J were proved best next to treatment D in controlling the weeds. The results reveal that application of basalin at 3.0 l/ha was found significantly superior over conventional method involving two hand weeding at 4 and 6 weeks after sowing (treatment J), whereas, application of basalin at 1.5 l/ha as pre-emergence was proved equally effective as conventional method viz., two hand weeding at 4 and 6 weeks after sowing in controlling weed population (Plate 3). The magnitude of decreases in weed population under D, C and J were 97, 91 and 89 per cent, respectively, over treatment L (control).

4.3.3 <u>Dry weight of weeds</u>

The data on the effects of different treatments on dry weight of weeds are furnished in Table 11 and graphically depicted in Fig. 5 and their analysis of variance are given in Appendix III.

A perusal of data presented in Table 11 indicated that different treatments excercised in the experiment significantly influenced the dry weight of weeds. Likewise, weed population treatment L (control) and I (Weedone 1.2 kg/ha post-emergence) were statistically at par and recorded significantly the highest dry weight of weeds by 648 and 621 kg/ha, respectively, as compared to all other treatments.

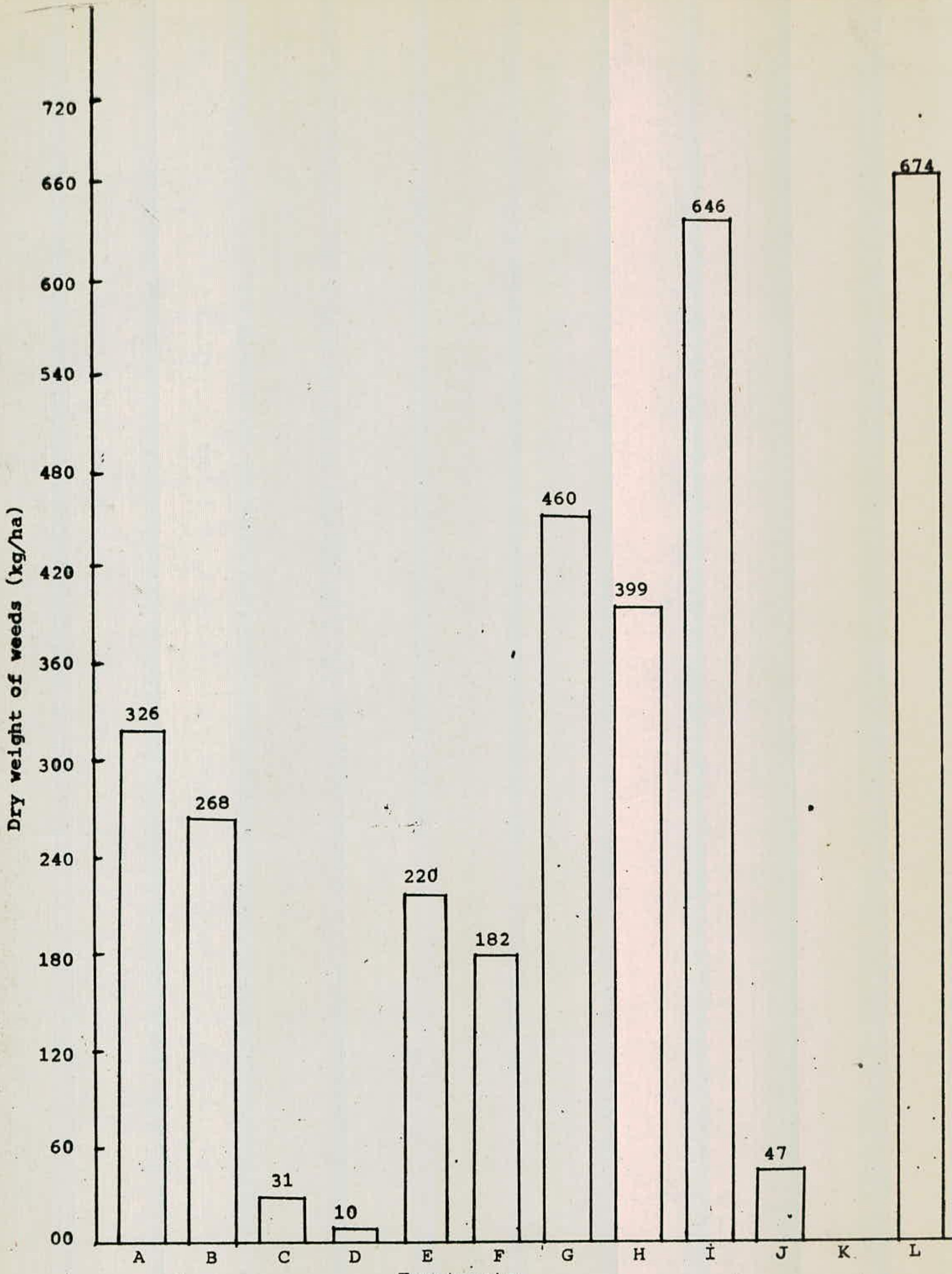


Fig. 5. Effect of different treatments on dry weight of weeds

Treatments C (Basalin 1.5 l/ha pre-emergence) and D (Basalin 3.0 l/ha pre-emergence) did not differ significantly, but proved significantly superior by recording lower dry weight of weeds by 30.09 and 8.73 kg/ha, respectivelyk over rest of the treatments, except treatment J (two hand weeding at 4 and 6 weeks after sowing). Treatments C and J were statistically at par.

This findings would show that application of basalin at 3.0 and 1.5 l/ha as pre-emergence proved equally effective as conventional method involving two hand weeding at 4 and 6 weeks after sowing of wheat crop (Treatment J).

4.4 Bio-chemical studies

The data pertaining to the effects of different treatments on nitrogen, phosphorus and potash uptake by weeds are presented in Table 12 and graphically depicted in Fig. 6 and their analysis of variance are presented in Appendix III.

Table 12 : Effect of different treatments on nitrogen, phosphorus and potash uptake (kg/ha) by weeds

Treatment		Nutrients removal (kg/ha)		
		Nitrogen	Phosphorus	Potash
A. TOK E-25 8.0 l/ha	Pre-em.	7.52	1.69	15.62
B. TOK E-25 12.0 l/ha	-"-	5.96	1.43	11.63
C. Basalin 1.5 l/ha	-"-	0.52	0.14	0.93
D. Basalin 3.0 l/ha	-"-	0.16	0.04	0.29
E. 2,4-D.S.S. 1.5 kg/ha	-"-	4.47	1.09	7.54
F. 2,4-D.S.S. 3.0 kg/ha	-"-	3.86	0.89	7.23
G. 2,4-D.S.S. 1.5 kg/ha	Post-em.	11.19	2.49	23.25
H. 2,4-D.S.S. 3.0 kg/ha	-"-	10.09	2.12	22.28
I. Weedone 1.2 kg/ha	-"-	18.45	3.62	36.15
J. Hand weeding at 4 and 6 weeks after sowing		0.89	0.22	1.55
K. Weed free condition		-	-	-
L. (Control		19.77	3.80	41.60
S.Em. ±		0.313	0.071	0.740
C.D. at 5%		0.901	0.200	2.130
C.V. (%)		8.306	8.853	9.681

4.4.1 Nitrogen uptake by weeds

Results presented in Table 12 reveal that significantly the highest nitrogen uptake was recorded by treatment L (control) followed by treatments I (Weedone 1.2 kg/ha post-emergence), G (2,4-D.S.S. 1.5 kg/ha post-emergence), H (2,4-D.S.S. 3.0 kg/ha post-emergence), A (TOK E-25 8.0 l/ha pre-emergence) and B (TOK E-25 12.0 l/ha pre-emergence), the difference being significant at each level. The respective uptake of nitrogen under treatment L, I, G, H, A and B were 19.7, 18.4, 11.1, 10.0, 7.5 and 5.9 kg/ha. Treatments J (two hand weeding at 4 and 6 weeks after sowing), C (Basalin 1.5 l/ha pre-emergence) and D (Basalin 3.0 l/ha pre-emergence) were statistically at par, but significantly superior by recording less nitrogen uptake of 0.8, 0.5 and 0.1 kg/ha, respectively, as compared to rest of the treatments (Fig. 6). The magnitude of decreases in nitrogen uptake under treatments J, C and D were 95, 97 and 99 per cent over treatment L(control).

Application of basalin at 3.0 and 1.5 l/ha as pre-emergence were proved as good as conventional method i.e. two hand weeding at 4 and 6 weeks after sowing in respect of nitrogen uptake.

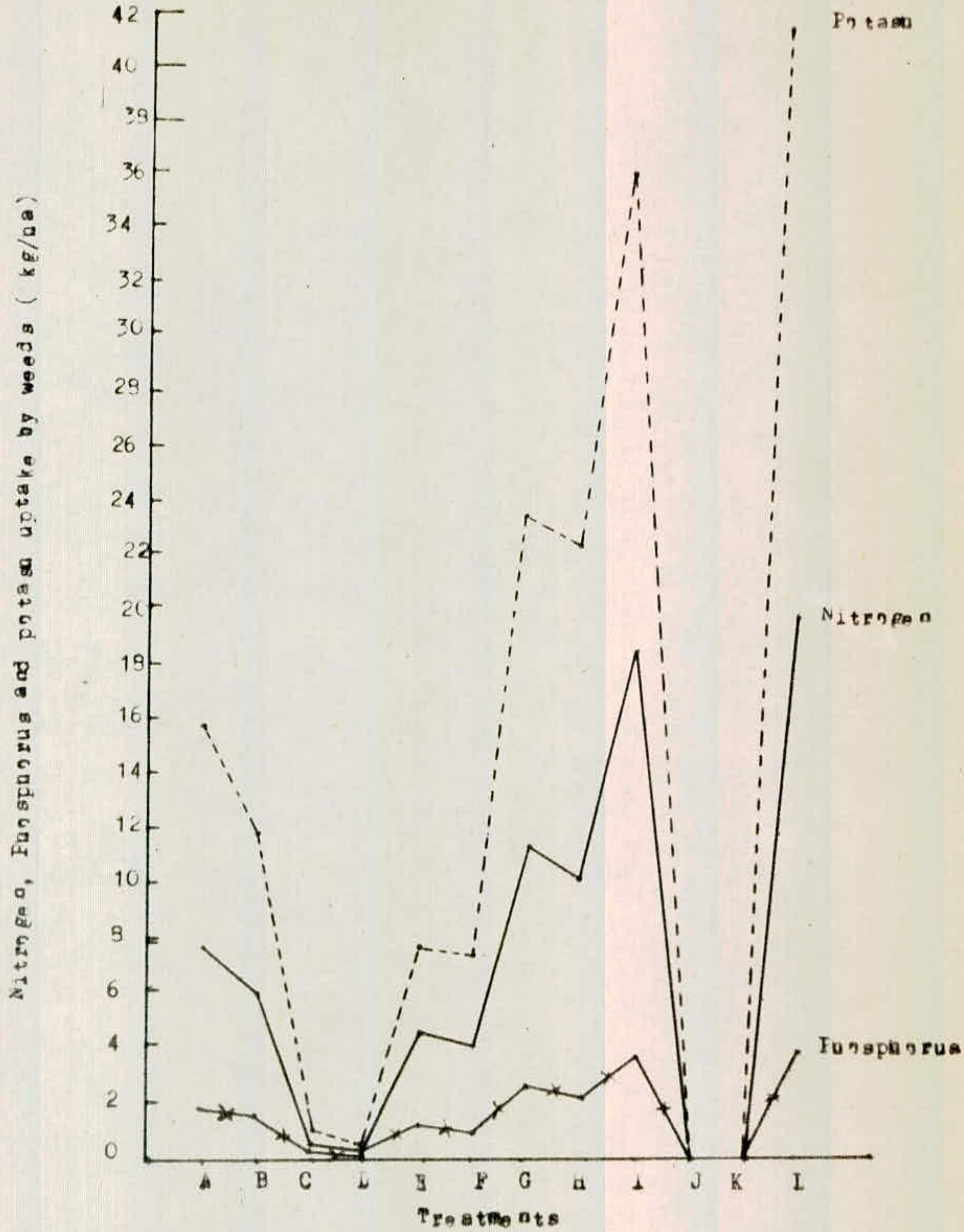


Fig. 6. Effect of different treatment on N,P and K uptake by weeds

4.4.2 Phosphorus uptake by weeds

The data presented in Table 12 showed that likewise, nitrogen uptake treatment L (control) and I (Weedone 1.2 kg/ha post-emergence) were statistically at par and recorded significantly the highest phosphorus uptake by 3.8 and 3.6 kg/ha (Fig. 6), respectively, followed by treatments G (2,4-D.S.S. 1.5 kg/ha post-emergence), H (2,4-D.S.S. 3.0 kg/ha post-emergence). A (TOK E-25 8.0 l/ha pre-emergence) B (TOK E-25 12.0 l/ha pre-emergence) and F (2,4-D.S.S. 3.0 kg/ha pre-emergence). Treatments J (two hand weeding at 4 and 6 weeks after sowing), C (Basalin 1.5 l/ha pre-emergence) and D (Basalin 3.0 l/ha pre-emergence) were statistically at par, but established their superiority by recording significantly less phosphorus uptake by 0.2, 0.1 and 0.03 kg/ha, respectively, as compared to rest of the treatments, in case of phosphorus uptake also basalin at 3.0 and 1.5 l/ha as pre-emergence proved as effective as that of conventional method (Treatment J).

4.4.3 Potash uptake

The results given in Table 12 indicated that significantly the highest potash uptake by 41.1 kg/ha was redorded under control (unweeded check) as compared to rest of the treatments (Fig. 6). In case of potash also basalin at 3.0 and 1.5 l/ha as pre-emergence (Treatment D and C) emerged out as effective as conventional method (Treatment J). The respective decreases in potash uptake under treatments J (two hand weeding at 4 and 6 weeks after sowing), C (Basalin 1.5 l/ha pre-emergence) and D (Basalin 3.0 l/ha pre-emergence) were 96, 98 and 99 per cent, respectively, over control plot.

4.4.4 Protein content

The data pertaining to the effect of different treatments on protein content of wheat are given in Table 13 and their analysis of variance are furnished in Appendix III.

Application of 2,4-D.S.S. at 1.5 and 3.0 kg/ha (Treatment G and H) as post-emergence spray were statistically at par, but recorded significantly the highest protein per cent by 12.4 and 12.7, respectively, than rest of the treatments. Treatment G (2,4-D.S.S. 1.5 kg/ha post-emergence), however, failed to attain the level of significance over treatments K (weed free

Table 13 : Effect of different treatments on protein content of wheat grain

Treatment		Protein content (%)
A. TOK E-25 8.0 l/ha	Pre-em.	11.68
B. TOK E-25 12.0 l/ha	-"-	11.32
C. Basalin 1.5 l/ha	-"-	12.17
D. Basalin 3.0 l/ha	-"-	11.56
E. 2,4-D.S.S. 1.5 kg/ha	-"-	11.62
F. 2,4-D.S.S. 3.0 kg/ha	-"-	11.60
G. 2,4-D.S.S. 1.5 kg/ha	Post-em.	12.45
H. 2,4-D.S.S. 3.0 kg/ha	-"-	12.74
I. Weedone 1.2 kg/ha	-"-	10.95
J. Hand weeding at 4 and 6 weeks after sowing		12.09
K. Weed free condition		12.34
L. Control		10.25
S.Em. $\pm$		0.127
C.D. at 5%		0.364
C.V. %		2.130

condition), C (Basalin 1.5 l/ha pre-emergence) and J (two hand weeding at 4 and 6 weeks after sowing). Significantly the lowest protein per cent of 10.2 was recorded with control treatment as compared to rest of the treatments. The magnitude of reduction in protein content under control treatments were 24 and 21 per cent than treatments H (2,4-D.S.S. 3.0 kg/ha post-emergence) and G (2,4-D.S.S. 1.5 kg/ha post-emergence) respectively.

In case of protein concentration also application of basalin at 1.5 l/ha as pre-emergence proved equally effective and recorded protein per cent as high as that of treatments J (two hand weeding at 4 and 6 weeks after sowing) and K weed free condition).

4.5 Economics

The data pertaining to the economics of various treatments are furnished in Table 14 and graphically presented in Fig. 7.

A perusal of data presented in Table 14 reveal that application of basalin at 1.5 l/ha as pre-emergence (Treatment C) topped the list by recording the highest net profit of Rs. 4155 followed by treatments J (two hand weeding at 4 and 6 weeks after sowing),

Table 14 : Economics of different treatments tried for weed control in wheat

Treatments		Gross realization from grain and straw (Rs/ha)	Variable treatment (Rs/ha)	Cost of cultivation + cost of variable treatment (Rs/ha)	Net profit (Rs/ha)	Net profit over control (Rs/ha)
A. TOK E-25 8.0 l/ha	Pre-em	7624.25	424.00	4989.59	2634.66	1160.34
B. TOK E-25 12.0 l/ha	-"-	7829.41	624.00	5189.59	2639.82	1165.50
C. Basalin 1.5 l/ha	-"-	8961.01	240.00	4805.59	4155.42	2681.10
D. Basalin 3.0 l/ha	-"-	8544.83	456.00	5021.59	3523.24	2048.92
E. 2,4-D.S.S. 1.5 kg/ha	-"-	7996.39	76.50	4642.09	3354.30	1879.98
F. 2,4-D.S.S. 3.0 kg/ha	-"-	8058.46	129.00	4694.59	3363.87	1889.55
G. 2,4-D.S.S. 1.5 kg/ha	Post-em	7256.36	76.50	4642.09	2614.27	1339.95
H. 2,4-D.S.S. 3-0 kg/ha	-"-	7490.35	129.00	4635.19	2795.76	1321.44
I. Weedone 1.2 kg/ha	-"-	6621.73	69.60	4694.59	1986.54	512.22
J. Hand weeding at 4 and 6 weeks after sowing		8601.39	240.00	4805.59	3795.80	2321.48
K. Weed free condition		8988.85	660.00	5225.59	3763.26	2288.94
L. Control		6039.91	-	4565.59	1474.32	-

The sale price of wheat grain and straw were Rs. 184 and Rs. 10 per quintal, respectively.

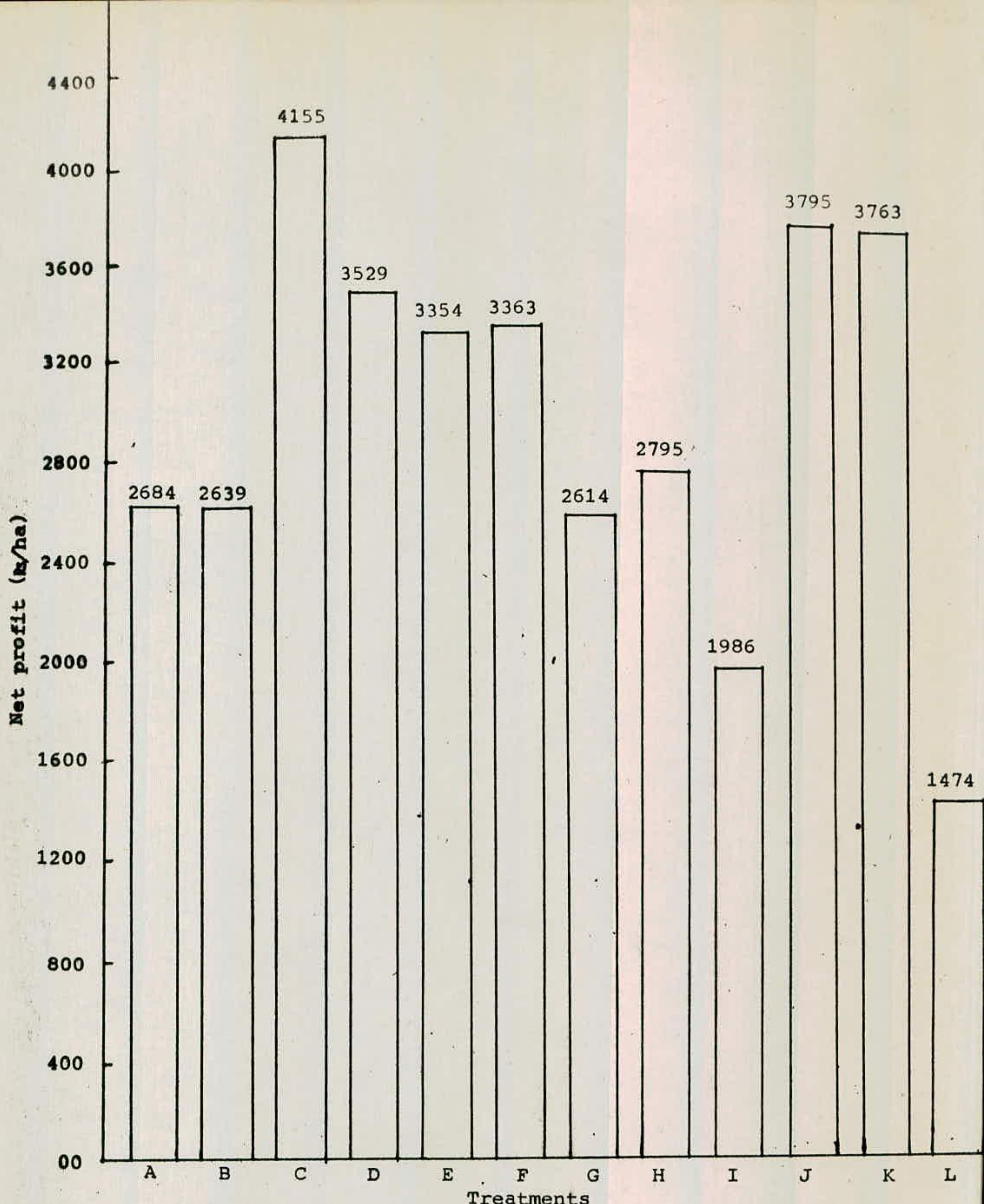


Fig. 7. Effect of different treatments on net profit (Rs/ha)

K (weed free condition) and D (Basalin 3.0 l/ha pre-emergence). The respective net profit accrued under treatments J (two hand weeding at 4 and 6 weeks after sowing), K (weed free condition) and D (Basalin 3.0 l/ha pre-emergence) were 3795, 3765 and 3523 Rs/ha was accured with control treatment (unweeded check). In case of economics also spraying of basalin at 1.5 l/ha as pre-emergence established its superiority by recording maximum net profit among all the treatments. The net profit recorded under treatment C (Basalin 1.5 l/ha pre-emergence) were 360, 392 and 2681 rupees more per hectare over treatments J, K and L, respectively.

4.6 Correlation studies

Relation between variables

The relationship between the grain yield (kg/ha) and other yield attributing characters have been studies with following variables :

Character number	Description of variables
1.	Grain yield (kg/ha)
2.	Number of total shoots/0.90 m^2
3.	Number of productive shoots/0.90 m^2
4.	Earhead length in cm
5.	Number of spikelets/earhead
6.	Number of grains/earhead
7.	Grain weight (g)/earhead
8.	Test weight (g)

The data on the linear regression and correlation of the form $Y = a + bx$, where Y = expected grain yield for the level of any other factor x and coefficients of correlation are presented in Table 15.

It was observed that yield attributes viz., number of total shoots/0.90 m^2, number of productive shoots/0.90 m^2, earhead length in cm, number of spikelets/earhead, number of grains/earhead, grain weight (g)/earhead and test weight (g) showed a positive significant correlation with grain yield (Table 15). The correlation between grain yield and number of productive shoots/0.90 m^2 is highest (r_{13} = 0.982) followed by between grain yield and number of total

Table 15 : Constant of the regression line of the yield on other individual growth and yield attributes and coefficient of correlation and regression equation

Character number	a	b	r	$100r^2$
2	16.000	0.073	0.970	94.090
3	13.446	0.079	0.982	96.430
4	-47.314	13.420	0.940	88.360
5	-124.129	14.166	0.957	91.580
6	-39.162	2.593	0.936	87.590
7	-31.120	39.473	0.938	87.980
8	-580.670	11.182	0.943	88.920

shoots per 0.90 m^2 (r_{12} = 0.970), number of spikelets/earhead (r_{15} = 0.957), test weight (r_{18} = 0.943), earhead length (r_{14} = 0.940), grain weight/earhead (r_{17} = 0.938) and number of grains/earhead (r_{16} = 0.936) in that descending order. This means that 96.4 per cent variation in grain yield is explained by variation in number of productive shoots/0.90 m^2 Similarly, 94.0, 91.5, 88.9, 88.3, 87.9 and 87.5 per cent variation in yield is explained on account of variation in number of total shoots/0.90 m^2, number of spikelets/earhead, test weight, earhead length, grain weight and number of grains/earhead, respectively.

V. DISCUSSION

During the course of presenting the results of the experiment many significant variations, among different treatments were reported. In this chapter it is contemplated to discuss the variations obtained in growth and yield, weed studies and nutrients uptake by weeds under the influence of different treatments. It has been attempted to established the effect and cause relationship in light of available evidences and literature. The entire discussion has been divided into four parts viz.,

1. Effects of different treatments on growth, yield attributes and yield of wheat
2. Weed studies
3. Nutrients (N, P and K) uptake by weeds and quality characters of wheat grain
4. Economics of different treatments

The meteorological data (Table 1) showed that weather was more or less normal during crop season. The stand of the crop was satisfactory. Experimental crop was free from pests and diseases. Whatever variations observed in the investigation are, therefore, attributed to differential treatments exercised in the experiment.

5.1 Effect on growth, yield attributes and yield of wheat

The results revealed that, the highest grain yield of 46.12 q/ha was recorded under treatment K i.e. weed free condition (Table 10 and Fig. 2) which was significantly higher than the rest of treatments. Yield obtained under above treatment was highest which evidently has resulted from highest number of total shoots/0.90 m^2 (Table 7), number of productive shoots/ 0.90 m^2 (Table 7), maximum length of earhead (Table 8), highest number of spikelets/earhead (Table 8), number of grains/earhead (Table 8) and 1000-grain weight (Table 9). Complete weed control under this treatment led to favourable effects on growth and yield attributes and ultimately the higher grain yield. The reason for higher yield is also because of checking weed crop competition completely under this treatment.

The highest grain yield recorded by treatment K (weed free condition) was closely followed by treatment C (Basalin 1.5 l/ha pre-emergence) producing grain yield of 45.97 q/ha, but it was at par with treatment J (two hand weeding at 4 and 6 weeks after sowing). Thus, among the different treatments tried in the experiment, basalin at 1.5 l/ha as pre-emergence (Treatment C) showed its better efficiency for weed control, next to weed free condition which recorded maximum grain yield (Plate No. 3).

Basalin at 1.5 l/ha as pre-emergence surpassed the rest of the herbicidal treatments by recording remarkably higher grain yield, which evidently has resulted from highest number of total shoots/0.90 m^2 (Table 7), number of productive shoots/0.90 m^2 (Table 7), maximum length of earhead (Table 8), highest number of spikelets/earhead (Table 8), number of grains/earhead (Table 8) and 1000-grain weight (Table 9). These are the important growth and yield components which showed significantly positive correlation with grain yield (Table 15). The combined effects of these yield attributes resulted in to higher grain yield with basalin at 1.5 l/ha as pre-emergence. Significantly lowest number of uptake viz., nitrogen, phosphate and potash (Table 12) may also be responsible for higher grain yield. Significantly lower weed population (Table 11) under treatment C (Basalin 1.5 l/ha pre-emergence) may also be responsible for higher grain yield by avoiding weed crop competition. Thus, lower weed population and dry weight of weeds coupled with more status and availability of plant nutrients (N, P and K) might have promoted more vegetative growth and there by, more photosynthetic activities which reflected into higher grain yield under this treatment, Availability of more plant nutrients accelerated the various growth and yield attributes to the better advantage of grain yield of wheat. These findings are in accordance with those reported by Bhattacharya and Kunda (1977), Mani et al. (1977), Tosh and Misra (1977), Chauhan and Verma (1978), Misra and Tosh (1980), Mukhopadhyay and Beru (1980) and Pandey (1981).

Besides grain yield, treatment C (Basalin 1.5 l/ha pre-emergence) was also found to have favourable effect on number of total tillers/0.90 m^2 (Table 7) and 1000-grain weight (Table 9) similar increase in total number of tillers/plant and 1000-grain weight by basalin at 1.0 kg a.i./ha were also reported by Chauhan and Verma (1978). Basalin at 1.5 l/ha as pre-emergence had also recorded the highest number of productive shoots/0.90 m^2 among different treatments tried in the experiment, except weed free condition. Mukhopadhyay and Beru (1980) also obtain highest number of productive shoots/plant and 1000-grain weight by application of basalin at 1.0 l/ha as pre-emergence treatment.

The grain yield of 44.11 q/ha obtained under treatment J (two hand weeding at 4 and 6 weeks after sowing) was as high as that of treatment C (Basalin 1.5 l/ha pre-emergence). The reasons postulated for higher yield in case of treatment C (Basalin 1.5 l/ha pre-emergence) are also applicable to treatment J involving two hand weeding at 4 and 6 weeks after sowing.

Treatment D (Basalin 3.0 l/ha pre-emergence) recorded poor grain yield of 43.82 q/ha as compared to weed free condition and application of basalin at 1.5 l/ha as pre-emergence treatments. While it was at par with treatment J (two hand weeding at 4 and 6 weeks after sowing). The reason for poor yield as compared to the treatment K and C, seems to be due to the slight phytotoxic effect on germination as well as yield and growth attributes.

Treatment L (control) recorded significantly poor grain yield of 31.06 q/ha, which evidently has resulted from lower number of total shoots/0.90 m^2 (Table 7), number of productive shoots/0.90 m^2 (Table 7), length of earhead (Table 8), number of spikelets/ earhead (Table 8), number of grains/earhead (Table 8) and 1000-grain weight (Table 9). Highest dry weight of weeds and N, P and K removed under this treatment may also be responsible for poor yield under this treatment.

Treatment K (weed free condition) outyielded the rest of the treatments by recording significantly the highest straw yield of 50.28 q/ha followed by treatment C involving basalin 1.5 l/ha as pre-emergence (Fig. 3). Favourable effect on growth parameters viz., number of total shoots/0.90 m^2 (Table 7) and number of productive shoots/0.90 m^2 (Table 7) might have attributed towards higher straw yield under these treatments. Minimum removal of plant nutrients (Table 12) by weeds under these treatments also led to higher straw yield. In case of straw yield, basalin at 1.5 l/ha as pre-emergence also established its superiority by producing significantly higher straw yield as compared to rest of the treatments and stood second next to weed free condition.

Thus, from all the measurable sources evaluated in the present study, it is proved that among all the herbicides tried in the experiment, basalin at 1.5 l/ha as pre-emergence spray was found to be the best for effective weed control in irrigated wheat. The conventional method of two hand weeding at 4 and 6 weeks after sowing can safely be substituted by application of basalin at 1.5 l/ha as pre-emergence. Application of basalin at 1.5 l/ha as pre-emergence also accrued maximum net profit of Rs. 4155.42/ha (Table 14). Under the circumstances of acute labour shortage, when interculturing operations are not possible because of close spaced crop and considering the economics of different treatments the weeds in irrigated wheat can effectively and economically be controlled by application of basalin at 1.5 l/ha as pre-emergence spray.

5.2 Weed Studies

Different weed flora recorded in the present experiment were Savank (*Echinochola crusgalli*), Kariyu (*Dactyloctenium aegyptium* L.), Crab grass (*Digitaria sangunalise*), Moth (*cyperus rotundus* L.), Dub grass (*Cynodon dactylon* L.), Bath (*Chenopodium album* L.)

Thoya (Digera arvensis Forsk), Safed Murga (Celosia argentea L), Sarota (Acanthospermum hispidum (L) DC), Jangali Gobhi (Launea nudicaulis H.K.) and Bara Lunia (Portulaca oleracea L.) in order of occurence (Plate 1). It was observed from the data on weed population (Table 11) that, maximum number of weeds were recorded under unweeded plot (Treatment L) followed by treatment I (Weedone 1.2 kg/ha post-emergence), showing their poor efficiency in weed control (Fig. 4 and Plate 3). Treatment D (Basalin 3.0 l/ha pre-emergence) established its superiority by keeping down weed population significantly as compared to conventional method, as well as different herbicides tested in the experiment. The treatment C (Basalin 1.5 l/ha pre-emergence) stood second for keeping down weed population and was closely followed by treatment J (two hand weeding at 4 and 6 weeks after sowing). Thus, basalin turned out to be the most efficient for weed control in wheat (Fig. 4 and Plate 3). The plot sprayed with basalin at 1.5 l/ha as pre-emergence recorded only 52 weeds/net plot, which was 1052, 892, 692, 646, 598 and 526 per cent less as compared to unweeded check, Weedone at 1.2 kg/ha as post-emergence, 2,4-D.S.S. at 1.5 kg/ha as post-emergence, 2,4-D.S.S. at 3.0 kg/ha as post-emergence

TOK E-25 at 8.0 l/ha as pre-emergence and TOK E-25 at 12.0 l/ha as pre-emergence, respectively. Basalin at 3.0 l/ha and 1.5 l/ha as pre-emergence application also recorded significantly less dry weight of weeds as compared to rest of the treatments (Table 11 and Fig. 5). Significantly less weed population might have resulted into lower dry weight of weeds under the plot treated with basalin. These findings are in complete agreement with those of Gill and Brar (1975 a), Himme and Stryckers (1976), Misra and Tosh (1977), Chauhan and Verma (1978), Negi (1979), Misra and Tosh (1980), Mukhopadhyay and Beru (1980), Anaonymous 1981 b) and Panday (1981). It is evident from the above results, that basalin at 1.5 l/ha as pre-emergence was found to be the most effective than conventional methods and different herbicidal treatments tried in the experiment, except basalin at 3.0 l/ha as pre-emergence, for controlling weed population and growth in irrigated wheat fields.

5.3 Nutrient (N, P and K) uptake by weeds

The treatment L (control) resulted in the highest uptake of N (19.77 kg/ha), P (3.80 kg/ha) and K (41.60 kg/ha), significantly higher weed population (Table 11) and dry weight of weeds (Table 11) under this treatment may be responsible for maximum removal of these nutrients. Treatment D (Basalin 3.0 l/ha pre-emergence) removed minimum N, P and K followed by treatment C (Basalin 1.5 l/ha pre-emergence) and J (two hand weeding at 4 and 6 weeks after sowing). Significantly lower weed population and dry weight of weeds might have attributed for lower uptake of N, P and K under these treatments. Here also basalin proved its superiority in minimum removal of nutrients as compared to different herbicides tried in the experiments.

The highest protein percentage 12.45 was obtained with treatment H (2,4-D.S.S. 3.0 kg/ha post-emergence) followed by treatment G (2,4-D.S.S. 1.5 kg/ha post-emergence), K (weed free condition), C (Basalin 1.5 l/ha pre-emergence) and J (two hand weeding at 4 and 6 weeks after sowing) in that descending order (Table 13). Basalin 1.5 l/ha as pre-emergence stood second next to 2,4-D.S.S. as post-emergence treatment in respect of protein percentage. In respect of quality aspect 2,4-D.S.S. as post-emergence was best as compared to rest of the treatments. 2,4-D.S.S. acts as a hormone and led to favourable effects on quality aspect. Similar increase in protein percentage by 2,4-D.S.S. as post-emergence application were reported by Pellet and Saghir (1972) and Nageswararao (1973).

5.4 Economics of different treatments

Maximum net profit of Rs. 4155.42/ha was recorded under treatment C (Basalin 1.5 l/ha pre-emergence) closely followed by treatment J (two hand weeding at 4 and 6 weeks after sowing). This treatment recorded net profit of Rs. 3795.80/ha (Table 14). The higher grain and straw yields recorded under these treatments may be responsible for higher net profit per hectare. Considering the economic of different herbicides and conventional methods, basalin at 1.5 l/ha as pre-emergence emerged out to be the most economics for weed control in wheat. From the economic point of view and under acute labour shortage specially at peak periods of farm operations, the weeds in irrigated wheat can be effectively controlled by spraying basalin at 1.5 l/ha as pre-emergence.

VI. SUMMARY AND CONCLUSIONS

An experiment was conducted on the clayey soil of Instructional Farm, Gujarat Agricultural University, Junagadh to evaluate the suitable chemical and conventional methods for weed control in wheat (Triticum aestivum L.) during rabi season of 1980-81. The twelve treatments comprising of chemical and conventional methods viz., A - TOK E-25 8.0 l/ha pre-emergence, B - TOK E-25 12.0 l/ha pre-emergence, C - Basalin 1.5 l/ha pre-emergence, D - Basalin 3.0 l/ha pre-emergence, E - 2,4-D.S.S. 1.5 kg/ha pre-emergence, F - 2,4-D.S.S. 3.0 kg/ha pre-emergence, G - 2,4-D.S.S. 1.5 kg/ha post-emergence, H - 2,4-D.S.S. 3.0 kg/ha post-emergence, I - Weedone 1.2 kg/ha post-emergence, J - two hand weeding at 4 and 6 weeks after sowing, K - weed free condition and L - unweeded control were laid out in a Randomised block design with four replications.

The results presented and discussed in the preceding chapters are summarised in this chapter.

1. The highest grain yield of 46.12 q/ha was recorded under weed free condition (Treatment K) closely followed by Basalin at 1.5 l/ha as

pre-emergence spray (Treatment C). The treatment C (Basaline 1.5 l/ha pre-emergence) was closely followed by two hand weeding at 4 and 6 weeks after sowing (Treatment J). The respective yields under these treatments were 45.97 and 44.11 q/ha. Basalin at 1.5 l/ha as pre-emergence treatment stood second next to weed free plot in producing grain yield of wheat per hectare.

2. Among all the treatments tried in the experiment basalin at 1.5 l/ha as pre-emergence turnedout to be the superior next to weed free condition by producing significantly higher straw yield. Basalin at 1.5 l/ha as pre-emergence outyielded the rest of the treatments including conventional methods in respect of straw yield (50.25 q/ha) except weed free condition.

3. Weed free condition (Treatment K) and basalin at 1.5 l/ha as pre-emergence (Treatment C) remarkably increased growth and yield attributes viz., number of total shoots/0.90 m^2, number of productive shoots/0.90 m^2, earhead length, spikelets per earhead, grain numbers per earhead

and 1000-grain weight. These are the important growth and yield attributing characters which showed a positive significant correlation with grain yield.

4. Maximum number of weeds (555/net plot) and the highest dry weight of weeds (648 kg/ha) were recorded under unweeded plot (control). Spraying of basalin at 3.0 l/ha and 1.5 l/ha as pre-emergence established their superiority by keeping down significantly weed population (19 and 53/net plot, respectively) and dry weight of weeds (9 and 30 kg/ha, respectivelY) as compared to conventional methods as well as different herbicides tested in the experiment and turnedout to be the most effective for weed control in irrigated wheat.

5. Unweeded plot resulted in highest uptake of nitrogen (19.77 kg/ha), phosphorus (3.80 kg/ha) and potash (41.15 kg/ha). The lowest uptake of N, P and K was recorded under basalin at 3.0 and 1.5 l/ha as pre-emergence and two hand weeding at 4 and 6 weeks after sowing. The plot treated with basalin removed significantly

less N, P and K as compared to rest of the herbicides tested in the present experiment.

6. Maximum net profit of Rs. 4155/ha was accrued under treatment C (Basalin 1.5 l/ha pre-emergence).

7. Complete weed control was possible only by conventional method i.e. hand weeding five times (weed free condition). But this method was not economical and feasible under acute labour shortage specially at peak period of farm operations.

CONCLUSION

Based on the results from the one year experimentation, it seems quite indicative that, complete weed control is possible only by hand weeding at five time (weed free condition) which is not economical and possible under acute labour shortage specially at peak period of farm operations. Considering the economics of different treatments and efficacy for weed control, spraying of basalin at 1.5 l/ha as pre-emergence holds a great promise for effectively and timely weed control and to boost up crop yield in irrigated wheat. The conventional methods of weed control can safely be substituted by spraying of basalin at 1.5 l/ha as pre-emergence for weed control in irrigated wheat on clayey soils of Junagadh.

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*Original not seen.

Appendix I : Analysis of variance for various plant characters and yield attributes of wheat

Source of variation	d.f.	Mean square						
		Initial plant population	Plant population at harvest	Plant height (cm)	No. of total shoots	No. of productive shoots	Earhead length (cm)	Spikelets/ earhead
Replication	3	2.806	1.4333	0.9167	0.00003	0.0011	0.028	0.012
Treatment	11	11.492	10.6091	1.552	0.024	0.0232	0.386	0.384
Error	33	6.397	5.4061	5.135	0.0005	0.0017	0.018	0.013

Appendix II : Analysis of variance for yield attributes of wheat

Source of variation	d.f.	Mean square					
		Grain number per earhead	Grain weight per earhead (g)	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Protein content (%)
Replication	3	0.491	0.0002	0.005	0.095	0.037	0.060
Treatment	11	10.812	0.043	0.591	83.003	152.834	1.919
Error	33	0.453	0.108	0.041	1.049	0.737	0.063

Appendix III : Analysis of variance for various characters

Source of variation	d.f.	Mean square				
		Weed population	Dry weight of weeds (kg/ha)	N-uptake by weeds (kg/ha)	P-uptake by weeds (kg/ha)	K-uptake by weeds (kg/ha)
Replication	3	0.0314	1468.067	0.139	0.044	0.803
Treatment	10	0.919	199069.184	184.693	6.900	799.279
Error	30	0.0143	594.413	0.392	0.020	2.188