STUDIES ON THE INFLUENCE OF HERBICIDES ON GROWTH AND YIELD OF GROUNDNUT (*Arachis hypogaea* L.)

A THESIS SUBMITTED TO
THE ORISSA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, BHUBANESWAR
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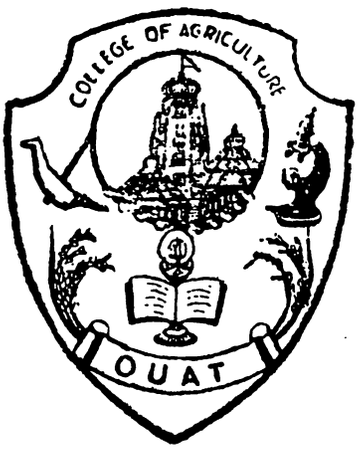
FOR THE DEGREE OF

MASTER OF SCIENCE IN AGRICULTURE

(PLANT PHYSIOLOGY)

BY

Sanjaya Kumar Pani



Department of Plant Physiology
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C E R T I F I C A T E - I

Certified that the thesis entitled "STUDIES ON THE INFLUENCE OF HERBICIDES ON GROWTH AND YIELD OF GROUNDNUT (*Arachis hypogaea* L.)" submitted by Sanjaya Kumar Pani in partial fulfilment of the requirements for the award of the DEGREE OF MASTER OF SCIENCE IN AGRICULTURE (PLANT PHYSIOLOGY) to the Orissa University of Agriculture and Technology, Bhubaneswar is an authentic record of *bona fide* research work carried out by him under my direct supervision and guidance. No part of the thesis has been submitted for any other degree or diploma or published in any other form.

The assistance and help received during the course of investigation have been duly acknowledged.

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

This is to certify that the thesis entitled "STUDIES ON THE INFLUENCE OF HERBICIDES ON GROWTH AND YIELD OF GROUNDNUT(*Arachis hypogaea* L.)" submitted by Sanjaya Kumar Pani in partial fulfilment of requirements for the award of degree of MASTER OF SCIENCE IN AGRICULTURE(PLANT PHYSIOLOGY) to the Orissa University of Agriculture and Technology, Bhubaneswar has been approved by the advisory committee after an oral examination on the same in collaboration with an external examiner.

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IN
SWEET MEMORY
OF
MY
BELOVED FATHER

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

I have the unique privilege and opportunity of expressing my profound sense of gratitude and heart felt thanks to Sri S. K. Mohanty, M.Sc.(Ag.),Junior Scientist (Plant Physiology),AICARP on Weed Control O.U.A.T, Bhubaneswar for his valuable guidance, constant supervision, sustained interest and constructive criticism during the entire course of the investigation for preparation of the manuscript.

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C O N T E N T S

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L I S T O F F I G U R E

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A B S T R A C T

1.	TITLE OF THE THESIS	: Studies on the influence herbicides on growth and yield of groundnut (Arachis hypogaea L.).
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3.	MAJOR ADVISOR AND DESIGNATION	: Sri Saroj Kumar Mohanty, M.Sc (Ag) Junior Scientist (Plant Physiology) AICRP on weed control, O.U.A.T, Bhubaneswar.
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A field experiment was conducted in Central Research Station, O.U.A.T.,Bhubaneswar to assess and to compare the effect of systemic herbicides like fluchloralin(0.75, 1.0,1.25 kg/ ha) and pendimethalin (1.0, 1.25, 1.5 kg/ha) with that of hand weeding on growth and development of groundnut cv. AK 12-24 (Arachis hypogaea L.) and its associated weeds. The experiment was laid out in a randomised block design with three replicatio-ns. Recommended dose of N,P,K was applied as basal alongwith the well decomposed FYM. Both fluchloralin and pendimethalin were applied to soil as pre-sowing and pre-emergence weedicides.

The various observations taken on different parameters and at different sampling dates revealed the followings:seed emergence in groundnut was more in pendimethalin than the other

treatments when compared between all the three sampling days. This was the only parameter where pendimethalin superceeded fluchloralin as the rest of parameters were most adversely affected in former than the latter. Nodule number,dry weight,leg-haemoglobin content in nodules, chlorophyll content and NRA in leaves were dramatically higher in fluchloralin than in pendimethalin ,the lowest more often being registered in control treatment. Dry matter of root, shoot,shoot to root ratio,RGR,CGR,LAI, dry matter at harvest and the harvest index were significantly higher in fluchloralin treatments at its lowest dose(0 .75 kg/ha), although there was little inconsistancy observed in the few parameters cited above at different sampling stages. As regards the yield and its attributes varied significantly amongst the treatments and substantial values were obtained in fluchloralin in respect of these parameters. The enhancement in pod yield due to various weeding treatments was in the tune of 28 to 55% over the control. The shelling percentage was noted to be slightly affected. On contrary, nitrogen and crude protein content in kernel were higher in weedy check, whereas the oil percent, harvested protein and harvested oil were more in herbicidal treatments than the control. Both germinability and viability were slightly affected in fluchloralin than in pendimethalin as observed from the dehydrogenase activity and the germination count recorded three weeks after harvest. From the present revealings it is concluded that, fluchloralin is superior to

pendimethalin and manual weeding in respect of all the above parameters listed above.Though pendimethalin exhibited its superiority over fluchloralin so far as the weed killing efficiency was concerned, its phytotoxic nature adversely affected the various growth parameters in groundnut.

* * *

CHAPTER - I

INTRODUCTION

I N T R O D U C T I O N

Oilseed crops essentially play an indispensable role in the agricultural economy of India.The diversity of climatic condition in this sub -continent generally favours the cultivation of various oilseed crops including groundnut,which is grown on large scale as compared to other line crops.Among all the oilseed crops groundnut accounts for more than 40% acerage and 60% production in the country.Groundnut seeds contain about 45% oil and 26% protein. From the stoichiometry point of view about 5.8 food calories is obtained from 1g kernel compared with 4 calories per gram for sugars, 3.5 calories for wheat and 2.6 calories for bread.It is also considered as a good rotation crop as it enriches the soil fertility by fixing the atmospheric nitrogen symbiotically in its nodules .

So far as its productivity is concerned the per hectare yield of groundnut of our country is very gloomy (1.0 ton/ha) compared to other developed countries. Such a poor yield of groundnut under Indian conditions can be attributed to an array of factors.Paradoxically the majority of the area is ranifed and the crop is also grown during Kharif not only under the vagaries of monsoon but also under numerous biotic and abiotic stresses resulting in deplorably low yield. Besides, excessive rainfall leads to heavy weed infestation,which by its manifold harmful effects,has been reported to yield loss of 52%

to 73% and 18% in errect and spreading varieties of groundnut respectively (Kulkarni et al., 1963 and Praveen et al., 1987). So any attempt to bring a breakthrough in yield should aim at growing groundnut in Rabi season and intensifying the efforts on location specific research. The productivity of groundnut in the state can be augmented by adoption of modern management systems like efficient weed management, balanced fertilizer and proper maintenance of plant population etc. The present yield levels in groundnut in the state is not satisfactory. One of the major production constraints is severe weed infestation during the crop growth period.

The weed competition in early stages of groundnut is maximum because of slow initial foliage growth depending upon the degradation of food reserve in the cotyledons.Although emergence of radicle in groundnut is fast, root development is slow. Only when the root is capable of absorbing nutrients the epicotyl is exposed to light in groundnut, whereas the situation is reverse in the case of weeds which emerge faster and grow rapidly as compared with groundnut and consequently take a lead in crop-weed competition.The sepctrum of weed flora associated under Orissa situations is mostly grasses and broad leaves.

Hence, a modest attempt has been made in this investigation to identify suitable herbicides to combat the weed menace. The farmers have already felt the pinch of manual weeding operations which are not only tedious, time consuming and at the same

time expensive. But then, a realistic evaluation of the manual method with that of chemical methods needs to be thoroughly examined before the technology is put into use.

Introduction of use of chemicals i.e. selective herbicides has opened new vistas for several of its edge over the mechanical methods because of its high economic value and effectiveness.

Amongst the chemical herbicides, fluchloralin and Pendimethalin have successfully been utilised in reducing the weed stand particularly annual grasses and broad leaves,thereby limiting the weed-crop competition (Bhan et all.,1983).

The herbicides, in addition to controlling the weeds also have considerable effect on various biometrical : Yield and yield attributing characters, biochemical : Leghaemoglobin, chlorophyll, nitrate reductase, de-hydrogenase activity, protein and oil etc. and physiological traits: dry matter accumulation, crop growth rate (CGR), relative growth rate (RGR), Leaf area index (LAI) etc.

This highly desiderates an accentuated study on the response of Rabi groundnut to different levels of selective herbicide in respect of the characters mentioned erstwhile.

Hence, an attempt has been made in this investigation on the following lines.

* To study the bionomics of associate weeds of Rabi groundnut in response to application of herbicides,

* To identify the appropriate locally available herbicides with its threshold value to control the weeds associated with Rabi groundnut,
* To determine the differential action of herbicides on various Physio-biochemical parameters,
* To assess the effect of herbicides on crop growth,yield attributing characters,
* To assess the comparative economics of these herbicides.

CHAPTER - II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Groundnut(Arachis hypogaea L.) is cultivated in extensive areas both in Kharif and Rabi season in well drained light textured soils. But in Rabi seasons this is grown in irrigated tracts. Flood irrigation at the time of sowing creates congenial condition for germination, seedling establishment and growth of plants which also favours the abundant weed germination and growth. The germinated weeds pose serious competition with the crop starting from seedling stage to maturity causing serious reduction in quality and quantity of pod yield of groundnut. Presence of weeds reduce pod yield to the extent of 52 to 70% and 18% in erect and spreading variety of groundnut respectively (Kulkarni et al.,1963 and Praveen et al., 1987).

2.1. Weed Studies

2.1.1 Crop Weed Association

The predominant weeds associated with groundnut crops are Digera arvensis, Celosia argentea, Commelina benghalensis, Eclipta alba, Phyllanthus niruri, Physalis minima, Leucas aspera, Euphorbia hirta, Brachiaria ramosa, Cyperus rotundus, Cynodon dactylon, Panicum colonum and Chloris verigata (Raghvani et al.,1984).Ravikumar et al.(1989) observed that in irrigated groundnut the important weed flora were Cyperus rotundus, Cynodon dactylon , Commelina benghalensis, Chloris barbata, Trianthema portulacastrum, Amaranthus viridis,Boerhaavia diffusa, Euphorbia

hirta, Cleome viscosa, Gyanondropsis pentaphylla, Tribulus terventris, Phyllanthus niruri, Panicum colonum. Rao et al.(1987) found that the dominant broad leaved weeds of irrigated grountnut were Digera muricata,Acalypha indica, Cleome viscosa and Croton bonplandianum and among the grasses were Brachiaria reptans, Cyperus rotundus, Urochlo setigera, Commelina benghalensis, and Cynodon dactylon. Prusty et al. (1990) conducted an experiment on Kharif groundnut cv. AK 12 - 24 at Central Research Station, O.U.A.T, Bhubaneswar, and revealed that the weed flora of the experimental site included grasses viz. Echinochloa colonum, Eleusine indica, Brachiaria distachya, Digitaria ciliaris, Dactyloctenium aegyptium and Cynodon dactylon sedges viz. Cyperus iria and Cyperus rotundus broad leaf weeds viz. Ludwigia parviflora, Ageratum conyzoides, Crozofera rottleri, Commelina benghalensis, Leucas aspera, Cleome viscosa, Portulaca oleracea, Mimosa pudica etc.

2.1.2 Critical Stages of Crop Weed Competition

Competition means the action of endeavouring to gain what another endeavours to gain at the same time. Weeds compete with crop plants for moisture, nurients, space and light leading to reduction of pod yield in groundnut (Ravikumar et al.,1989). Such losses could be minimised if the sensitive period of crop - weed competition is identified. Hill and Santleman (1969) reported that in groundnut, crop weed competition from 4 to 8 weeks after sowing caused enoromous losses. The findings of Raghvani et

al.(1984) revealed that the critical period of weed competition was 15 to 60 days after sowing while Aslam et al. (1989) pointed out that the critical period for competition between weeds and crops was 10-12 days after emergence.

Everaarts (1992) opined that, competition with weeds reduced the yield and yield attributing characters. About 15 weed free days after sowing was sufficient to prevent the yield losses in groundnut.

2.2 Methods of Weed Control

In order to combat weed menace in groundnut crop, appropriate weed management practices are absolutely necessary. Efficient weed management can bring about a breakthrough in groundnut yield. Aslam et al. (1989) employed different methods for controlling weeds which included preventative methods such as mechanical and hand weeding, cultural methods viz. crop rotation, deep and dry ploughing and chemical methods including use of pre and post emergence herbicides.

Due to escalation in wage rates and unavailability of human labour at the peak demand period, hand weeding is becoming a costlier affair for the farmers. Besides, mechanical methods of weed control may disturb the penetrating pegs of of groundnut and finally reduce yield specially when weeding is done at pegging stage (Ravikumar et al.,1989).

Presently,weed control by herbicides is gaining more and more importance in India due to higher weed control efficien-

cy (57 to 85%) resulting in higher yield (Prusty et al.,1990). Chemical weed control was reported to be easier, time saving and economical as compared to hand weeding (Kulandaivelu and Sankaran, 1977). Several workers also reported that chemical weeding gives rich dividends (Bhan and Singh, 1971, Brar et al.,1980, Rathi et al., 1988).

2.3 Pre-emergence application of herbicides

The evaluation of critical stages of weed incidence revealed the necessity of weed control at the initial stage of crop growth (Bhan et al., 1971, Dhindsa et al.,1972, Verma and Prakash, 1977, Shah et al., 1980). Out of the several pre-emergent herbicides, the following two have been proved to be most effective and non-toxic to groundnut keeping the growth and development of the crop in mind.

2.3.1 Fluchloralin (Basalin)

Fluchloralin is a recent herbicide and is gaining importance for control of weeds in groundnut (Soundarajan et al., 1976, Hedge et al., 1977, Kulandaivelu et al., 1978).A dose varying from 0.75 to 1.5 Kg/ha could be used for control of major spectrum of weed flora (Rajan et al., 1979). Geethalakhmi et al. (1989) observed that 1 Kg fluchloralin/ha gave similar and effective weed control as 2 hand weedings. Fluchloralin (1-2 Kg/ha) was most effective than nitrofen (2-4 Kg/ha) and alachlor (2-4 Kg/ha) and gave yields similar to those on weed free plots (Yaduraju et al. 1980). Yaduraju et al.(1981) pointed out that,

fluchloralin markedly decreased the weed competition during early stages of crop growth in groundnut.

Prasad et al. (1987) observed that fluchloralin @ 0.68 kg/ha was more effective against grasses than broad leaved weeds under irrigated groundnuts. Although highest groundnut yield was obtained with 1.5 Kg/ha fluchloralin + 1 hand weeding but the net income was inconsistent. Whereas application of fluchloralin alone resulted in maximum net profit per rupee invested (Masthan et al., 1991).

2.3.2 Pendimethalin (Stomp)

Pendimethalin is found to be very much effective in controlling the weeds associated with groundnut. A dose ranging from 0.75 to 1.5 kg/ha of pendimethalin gives most effective weed control in irrigated groundnut and produced yields similar to those under weed free condition (Bhola et al., 1985).

Experiment conducted by Kondop et al.(1989) on the effectiveness of different herbicides and cultral practices on groundnut showed that pendimethalin gave yield similar to those achieved by hand weeding twice, and performed better than weeding in controlling grasses. Similar observations were reported by Jain et al. (1991). Ramakrishna et al.(1991) pointed out that application of 1 kg Pendimethalin is equivalent to a single hand weeding done at 30 DAS in groundnut.

2.4 Effect of Herbicides on Weeds

2.4.1 Weed Population

Herbicides by its unique mechanism and mode of action have got the capacity to reduce the weed population to the extreme extent either by inhibiting the germination or interferring with its growth (Audus, 1964 and Crafts, 1964). The weeds are either susceptible or resistant to different herbicides which depend upon the selectivity nature of herbicide.

Brar et al. (1989) observed that pendimethalin @ 0.75 kg/ha and flucloralin @ 0.75 kg/ha reduced the weed population in groundnut from 135/m^2 in weedy check to 38 & 59 per m^2 respectively. In soyabean,Maurya et al.(1990) studied that fluchloralin and pendimethalin @ 1 & 1.5 kg/ha have 11.93, 12.81 and 14.52, 13.86 number of weeds per m^2 as against 62.26/m^2 in weedy. The control of carpet weed was 40 to 50% with both pendimethalin and fluchloralin applied alone (Panwar et al. 1988).Effective control of weeds, both emergence and development, in cabbage has also been reported by Sugiyama et al. (1987).

2.4.2 Dry Matter of Weeds

Experimental findings on groundnut revealed that pre-emergence application of pendimethalin and fluchloralin @ 0.75 kg/ha caused 4 to 5 fold reduction in dry matter of weeds. (Brar et al. 1989). Both fluchloralin and pendimethalin at rates 0.8, 1.2 and 1.0, 1.5 kg/ha caused significant reduction in weed biomass in groundnut (Jain et al.,1991).The weed control effi-

ciency of fluchuloralin and pendimethalin @ 1 kg/ha was 56.7 and 61% respectively in groundnut (Vijaya Kumar, 1991).

2.5 Effect of Herbicide on Crop Growth and Yield

2.5.1 Seed emergence

Although herbicides inhibit the germinatioin of weed seed, its effect on groundnut kernel germination has not been observed.However,studies undertaken with fluchloralin in groundnut crop revealed that varying dose from 0.75 to 1 Kg/ha did not have any adverse effect on kernel germination and seedling establishment (Singh et al., Tosh and Patro, 1981).Geethalakhmi et al. (1989) found no adverse effect of fluchloralin (1 Kg/ha) on groundnut seed germination . Similarly the residual effect of fluchloralin and pendimethalin had no adverse effect on seedling emergence of sequential crops like bengal gram, safflower(Shelke and Bhosle,1990). In contrast,the results of AICRP on weed control (1991), indicated that the germination of sesamum was affected by 85 and 63 percent in pre plant and pre emergence application of pendimethalin and fluchloralin,respectively.

2.5.2 Crop growth

The adverse effects of both fluchloralin and pendimethalin on different growth components of groundnut crop like root growth, shoot growth, plant height, branching, and dry matter accumulation are not so far evident (Co-ordinated Research Programme on weed control, 1979,Shah et al.,1980,Singh et al., 1980,and Kulandaivelu, 1981).

On the otherhand,stimulatory effect of herbicide at lower concentrations on these traits of a crop have been reported. Pahwa et al.(1992) reported that lower concentrations of fluchloralin and pendimethalin (1 kg and 0.75 kg,respectively) increased the root and shoot length of groundnut which decreased at higher concentrations. However, they pointed out that there was no effect of herbicides on number of leaves upto 30 DAS but the same was found to decrease at later stages of the growth. Atrazine and 2, 4-D increased the LAI upto the last stage of crop growth in sorghum as reported by Sairam et al.(1988)

Dry weight of groundnut shoot and root were not affected by fluchloralin and pendimethalin at initial stages but high concentrations reduced it significantly at later stages while lower concentration were at par with control(Pahwaet al.,1992).

Fluchloralin at a concentration of 1kg/ha produced 6.67, 10.33 and 6.77 branches in groundnut as compared to 7.00, 9.33 and 7.66 branches in weed free treatent in 1984, 85 and 86 respectively (Agasimani et al.,1992). Selvamani and Sankaran (1989) noted that both pendimethalin and fluchloralin at 1 kg/ha produced 4.9 number of branches at par with 5 number of branches in two hand weeding in groundnut.

The plant height of groundnut crop was also little affected by herbicide like fluchloralin (Agasimani et al.,1992).Pendimethalin and fluchloralin at @ 1 kg/ha resulted

in 29.2cm and 29.4cm height of the primary branch respectively in groundnut as against 29cm in two hand weeding at 20 and 40 DAS (Selvamani and Sankaran ,1989).

2.5.3. Nodulation

Groundnut, being a legume crop bears nodules in its roots for symbiotic nitrogen fixation. The number and dry weight of nodules plays a significant role in the nutrition of the plant and, on the whole, reflect the growth and development of crop.

Herbicides are known to cause varying effects on the nodulation and yield of leguminous crops. A reduction in nodule formation is the common feature following seed treatment with herbicides (Choudhri and Rajgopal,1958, Gracia and Jordan,1969, Malavia et al.,1989,Novo et al.,1990),whereas no adverse effect on nodulation in legumes was recorded by field doses of herbicides (Edward and Dunigan, 1972,Kishinevsky et al.,1988).Moreover,enhanced rate of nodulation in certain legumes due to herbicide treatment was also reported (Rankov et al.,1966).The reports of Brar et al., (1989) concluded that pre-emergence application of pendimethalin and pre sowing application of fluchloralin @ 0.75 kg/ha had no adverse effect on the groundnut nodulation. At lower doses of fluchloralin (0.5 kg/ha) and pendimethalin (0.75 kg/ha),the nodulation was not adversely affected in Cicer arietinum (Pahwa and Prakash,1992).Jain et al.(1990) also reported that fluchloralin had no inhibitory effect on the nodulation of soyabean.

Sidhu et al. (1985) revealed that fluchloralin @ 0.72 kg/ha and pendimethalin @ 0.75 kg/ha increased the number and weight of nodules per plant over control. However, with the increase in concentration of fluchloralin from 1 to 1.5 kg/ha and pendimethalin from 0.75 to 1.25 kg/ha decreased the number of nodules and nodule mass in groundnut (Pahwa and Prakash, 1992).

2.5.4 Chlorophyll

Different herbicide viz. amitrole, dichlormate and pyrichlor have been reported to inhibit normal carotenogenesis in eiolated wheat seedlings (Burns et al.1971). The phytotoxicity of these herbicides was reported to be due to inhibition of synthesis of carotenoids and to the consequent photoreduction of chlorophyll and chloroplast disruption.The herbicide sandoz-6706 at a concentration of 0.05 µg/g reduced the B-carotene and chlorophylls in 21-days old wheat seedlings by 55% and 29% respectively,with no effect on fresh or dry matter of the seedlings.Its effect on chlorophyll-b was much stronger than chlorophyll-a (Ben-Aziz and Koren,1974) in the biosynthetic pathway of carotinoids and resulting in bleaching of chlorophyll.

The report of Parl et al.(1970) suggested that sandoz-6706 blocked the carotenoid synthesis but not chlorophyll pigments of wheat seedling.

The work of Willemot et al.(1982) revealed that BASF -13-338 inhibited photosynthesis in spinach etiolated chloroplast by increasing the proportion of diacylgalactosylglycerol

and decreasing the level of phosphatidylcholine. Similar results were obtained with pea, linseed and wheat as well.But according to Sairam et al.(1988) the application of herbicides viz.atrazine and 2,4-D increased the chlorophyll content in the leaves of sorghum as compared to control.Initial decrease in chlorophyll content, in response to fluchloralin and pendimethalin application without affecting the carotenoids, has also been reported in Vigna mungo (Prakash and Pahwa,1985). At later stages of growth the synthesis of all the pigments was affected in groundnut when subjected to higher dose of herbicides (Pahwa and Prakash,1992).

2.5.5 Nitrate reductase

Experimental results of Wu et al.(1971) indicated that sublethal concentration of S- triazine compound affected the physiological and biochemical events in the leaves of pea and corn which favoured nitrate reductase activity. Similarly,simazine,atrazine and 2,4-D have been reported to stimulate the activity of nitrate reductase in many cereal crops (Suseela Devi and Perur,1982; Sairam et al.,1988).On contrary,Keniset al. (1992) suggested that, paraquat inhibited the nitrate reductase activity in oat leaves.

2.5.6 Groundnut quality (Protein and oil)

Shifts in plant constituents are of usual incident following the herbicide application. Many fundamental reactions are affected including the biosynthesis of RNA and proteins (Pulver and Ries, 1973). There are evidences that herbicides

increase the protein synthesis by increasing the nucleic acid synthesis (Penner and Early, 1972).

According to Sairam et al.(1988) both atrazine and 2, 4 - D resulted in increased protein content in sorghum, Patel et al.1987, observed that fluchloralin @ 0.9 kg/ha and pendimethalin @ 0.75 kg/ha improve the quality of groundnuts.

In constrast,Maziny and Sayed (1991) reported that pendimethalin decreased the seed crude protein, self extractable protein in cowpea seeds. Similar finding was also observed in groundnut (Phawa and Prakash, 1992), where the insoluble protein content of leaves decreased with the application fluchloralin and pendimethalin at higher concentrations. The experiment of Girijesh and Patil, (1989) on groundnut and sunflower intercropping reaveled that,there was no significant difference between pendimethalin, fluazifop-butyl, hand weeding and control with regard to the groundnut seed oil. However, highest oil content (%) for sunflower was obtained in hand weeding (40.4%),and fluazifop-butyl at 0.187kg + hand weeding and all pendimethalin treatments gave comparable results. Hand weeding also provided the highest sunflower oil yield (0.58 t/ha), followed by pendimethalin 0.75 kg + cultivation (0.51t) and fluazifop-butyl 0.187 + hand weeding (0.51t).

2.5.7 Yield and yield attributing characters

Herbicides have got the ability to control the weeds (grasses,sedges and broad leaved) associated with groundnut

there by increasing the pod yield. Sometimes, manual weeding appeared to be ineffective against weeds where as herbicides like fluchloralin and pendimethalin have been reported to decrease the weed denstities efficiently and also imporoved the yield and yield attributing characters viz. number of pods, number of kernels, weight of pods, kernel weight, 100 kernel weight and shelling percent. (Kondap et al., 1989, Kumar and Ready, 1989, Selvamani and Sankaran, 1989, Selvan and Ramdoss,1990,and Jain et al., 1991)

Fluchloralin @0.8 kg/ha recorded higher pod yield (2.04%) of groundnut than that of cultural treatment of two hand weeding (Tosh and Pattanaik, 1982).Similarly, pendimethalin both at 1 kg/ha and 1.5 kg/ha yielded at par with hand weeding in rainfed groundnut (Jain et al.,1991). Sudhakar and Muniyappa,1990, observed that pendimethalin @ 0.5 and 0.,75 kg/ha yielded 2655 and 2634 kg/ha groundnut pod respectively as against 1077 kg/ha in control. Similar studies on groundnut indicated that fluchloralin (0.75kg) and pendimethalin (0.75kg) produced 18.4 and 14.6 q/ha as against 8.5q/ha in control (AICRP on weed control, 1991).

Yaduraju, et al (1980) pointed out that higher rates of herbicides viz.fluchloralin, nitrofen and alachlor were more effective than the lower rates against weeds and in increasing yield of groundnut. Similarly higher rates of fluchloralin (1.2 kg/ha) yielded more than the lower rates (0.8kg/ha) in groundnut.

But two rates of pendimethalin (1 and 1.5 kg/ha) did not differ significantly in respect of yield (Jain et al., 1991). According to Pahwa and Prakash,(1992) these herbicides decreased the number and weight of pods, seeds and weight of seeds per plant in groundnut.Supporting evidence also came from Mallik and Tasfai, 1985, who obtained lower yield in soyabean with trifluralin. In contrast to the above views increased rates of fluchloralin (1 to 1.5 kg/ha) and pendimethalin (0.75 to 1.25 kg/ha) significantly reduced the number of pods per plant from 16.1 to 9.2 and 11.5 to 7.5 respecctively. Similarly, the weight of pods was also significantly decreased from 5.64 to 3.94 g and 3.81 to 2.1 g with the incease in doses of fluchloralin and pendimethalin respectively (Pahwa and Praksh, 1992).

2.6 Comparative Economics

Brar and Walia,1989, demonstrated that herbicides were economical to cultural methods in controlling the weeds associated with groundnut. Fluchloralin at 0.68 Kg/ha and oxyfluorfen @ 0.12 to 0.15 Kg/ha produced returns of Rs.2481.00/ha to 2724.00/ha compared with Rs.1965.00 for hand weeding and hoeing (Prasad et al., 1987). Rathi et al.,1988, compared cultural treatments with fluchloralin and pendimethalin @ 1.5 Kg/ha in groundnut, and concluded that herbicides alone were most economical. Similarly, Masthan et al.,1991, incurred maximum net profit per rupee invested with fluchloralin (1.5 Kg/ha) treatment alone in groundnut.

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CHAPTER - III

MATERIALS AND METHODS

MATERIALS AND METHODS

A field experiment was conducted at the Central Research Station, O.U.A.T, Bhubaneswar, during the Rabi season of 1993-94 to study the influence of herbicides on the growth and yield of groundnut.

3.1 Experimental Site and Soil Characteristics

The soil of the experimental site in the 'A' block of the Central Research Station,Bhubaneswar was well drained and was sandy loam in nature. Composite soil sample to a depth of 0.15 cm was collected before sowing from the experimental site and was analysed for important physiochemical characters. The details of which are presented under Table 1.

3.2 Crop Season and Climate

Bhubaneswar is situated at 85° 52' E longitude and 20° 15'N latitude with an elevation of 25.5 m above sea level.

The crop season was from November to March. It was experienced by scanty rainfall, cool temperature in the earlier months of November and December. But subsequently onwards there was hot and dry weather with more sunny days. Thus the entire period provided reasonably good weather for groundnut cultivation.

On further verification of the climatological data, it was observed that the total rainfall during the entire crop season (November to March) worked out to 48.6 mm. The mean maximum temperature for the entire period was 30.6°C and the mean

minimum temperature was 17.4°c . The relative humidity during morning and afternoon hours was 90.8 ,40.2 respectively. The mean climatological data during the crop period (November to March) recorded at the Meteorological observatory,Bhubaneswar is presented under Table 2. and Fig.1 & 2.

TABLE 1.

Physiochemical Properties of the Soil of the Experimental site

i. Mechanical Composition:

Particulars	Percentage composition	Methods adopted for analysis
Sand	75.4	Bouyoucos hydrometer Method(Piper,1950)
Silt	13.4	
Clay	11.2	
Textural class	Sandy loam	

ii. Chemical Properties:

Chemical constituents	Contents	Method adopted for analysis
Total nitrogen (%)	0.04	Modified Kjeldahl's Method(Jackson,1967)
Available P_2O_5 kg/ha	38.7	Olsen's Method (Jackson,1967)
Available K_2O kg/ha	111.9	Flame photometer method(Jackson,1967)
Organic Carbon (%)	0.38	Walkley and Black's rapid titration Method(Jackson,1967)
pH	5.8	Backman pH meter with 1:2.5 Soil:Water ratio

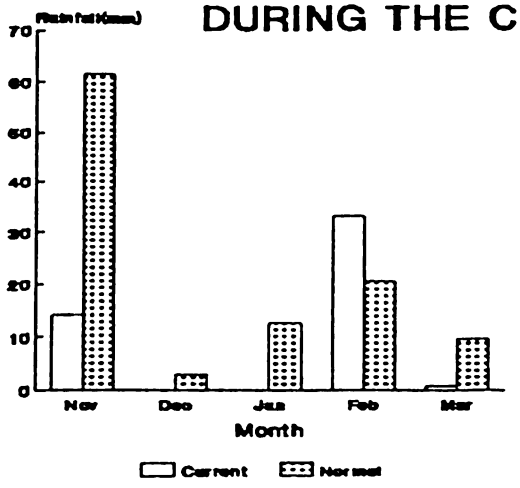
TABLE 2.

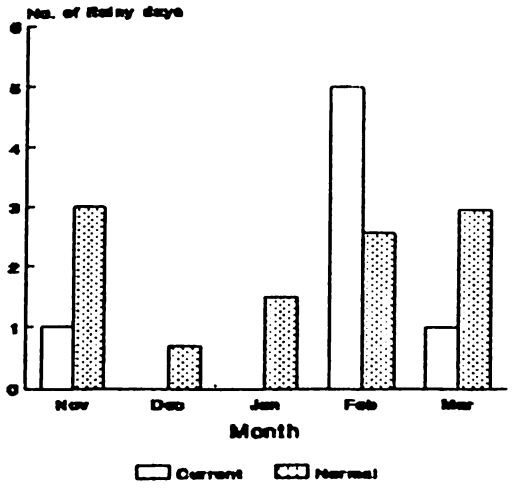
Meteorological data of Central Research Station,O.U.A.T. Bhubaneswar,during cropping period (November, 1993 to March,1994) and normal data for preceeding 10 years(1983-93)

Month	Particulars	Rainfall (mm)	Rainy days	Temperature(^{o}C)		Bright Sunshine	Wind velocity	Relative humidity	
				Max.	Min.	hr/day	Km/hr	7AM	2PM
November	Current	14.2	1.0	31.4	17.9	8.4	1.3	92.0	46.0
	Normal	61.1	3.0	30.3	18.6	7.8	3.2	86.0	48.9
	Deviation	- 46.9	- 2.0	+ 1.1	- 0.7	+ 0.6	-1.9	+ 6.0	- 2.9
December	Current	0	0	27.6	13.1	8.0	1.2	87.0	38.0
	Normal	2.9	0.7	28.5	15.4	8.4	2.9	87.6	42.4
	Deviation	-2.9	-0.7	-0.9	-2.3	-0.4	-1.7	-0.6	-4.4
January	Current	0	0	29.3	14.6	8.7	1.9	91.0	35.0
	Normal	12.9	1.5	28.6	15.8	8.5	3.0	88.8	43.9
	Deviation	-12.9	-1.5	+0.7	-1.2	+0.2	-1.1	+2.2	-8.9
February	Current	33.6	5.0	29.8	18.6	8.3	2.9	93.0	49.0
	Normal	21.0	2.6	31.5	18.5	8.8	4.1	89.4	41.3
	Deviation	-12.6	+2.4	-1.7	+0.1	-0.5	-1.2	+3.6	+7.7
March	Current	0.8	1.0	35.0	22.9	9.0	5.3	91.0	41.0
	Normal	9.8	3.0	34.9	22.1	8.9	13.3	90.0	43.0
	Deviation	-9.0	-2.0	+ 0.1	+ 0.8	+0.1	-8.0	+1.0	-2.0

DISTRIBUTION OF RAINFALL & NO. OF RAINY DAYS DURING THE CROP SEASON

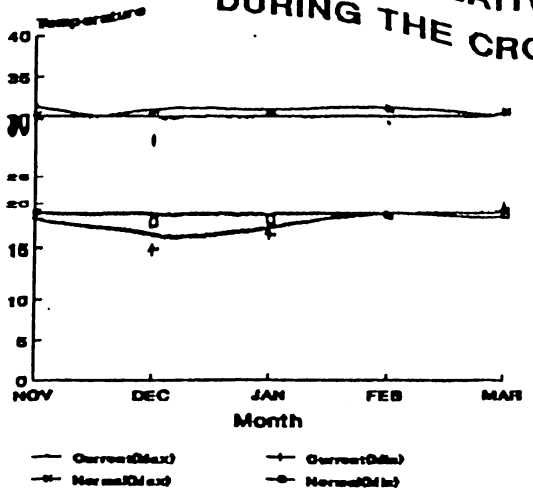
FIG. 1

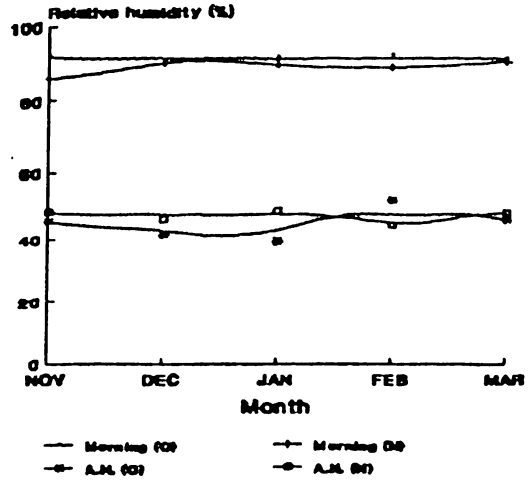




FLUCTUATIONS IN TEMPERATURE & RELATIVE HUMIDITY DURING THE CROP SEASON

FIG. 2





3.3 Crop History

The sequence of bulk cropping adopted at the experimental site during the last three years prior to the commencement of the experiment is furnished under Table 3.

TABLE 3.

Cropping history of the experimental plot:

Year	Crop season		
	Kharif	Rabi	Summer
1990-91	Upland rice	mustard	groundnut
1991-92	Inter cropping of annual fodder legumes in maize	groundnut	falllow
1992-93	Upland rice	maize intercropping	fallow
1993-94	Rice	groundnut	fallow

3.4 Experimental Design and Lay Out

Design - Randomised block design

Treatments- Eight

T_1 - Control

T_2 - Hand weeding at 25 DAS

T_3 - Fluchloralin @ 0.75 Kg/ha

T_4 - Fluchloralin @ 1.00 Kg/ha

T_5 - Fluchloralin @ 1.25 Kg/ha

T_6 - Pendimethalin @ 1.00 Kg/ha

T_7 - Pendimethalin @ 1.25 Kg/ha

T_8 - Pendimethalin @ 1.50 Kg/ha

Replication - Three

Combination - Twenty four.

Gross plot size - 5.0m x 3.25m

Net plot size - 4.6m x 2.5m

The details of the treatments and layout are presentd in Fig.3.

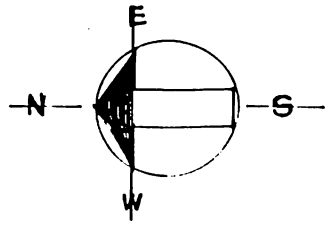
3.5 Details of the Field Operation

The following field operations were conducted during the course of investigation.

Calender of field operations

i. Land preparation and layout	Date
First ploughing	2.11.93
Second ploughing and laddering	10.11.93
Third ploughing and laddering	16.11.93
Removal of weeds and stubbles	17.11.93
Levelling	18.11.93
Layout	18.11.93
ii. Manure and fertilizer application:	
Manuring with FYM @ 10 tons/ha	16.11.93
Application of basal dose of NPK fertilizer	20.11.93
iii. Herbicidal treatment:	
Pre-sowing application of fluchloralin	20.11.93
Pre-emergence application of pendimethalin	22.11.93

Fig.3 PLAN OF LAY-OUT



T_1	T_4	T_7	T_2	T_5	T_3	T_8	T_6	R I
→ IRRIGATION → →								
T_8	T_6	T_3	T_1	T_4	T_2	T_7	T_5	R II
→ IRRIGATION → →								
T_2	T_5	T_4	T_8	T_9	T_6	T_1	T_3	R III

DESIGN — R B D

GROSS PLOT SIZE — 5 M X 3.25 M

NET PLOT SIZE — 4.6 M X 2.5 M

NUMBER OF REPLICATION — 3

NUMBER TREATMENTS — 8

T_1 — CONTROL

T_2 — HAND WEEDING (ONCE AT 25 DAS)

T_3 — FLUCHLORALIN @ 0.75 Kg/ha

T_4 — FLUCHLORALIN @ 1.00 Kg/ha

T_5 — FLUCHLORALIN @ 1.25 Kg/ha

T_6 — PENDIMETHALIN @ 1.00 Kg/ha

T_7 — PENDIMETHALIN @ 1.25 Kg/ha

T_8 — PENDIMETHALIN @ 1.50 Kg/ha

iv. Seed treament and sowing:

Seed treatment with rhizobium culture	20.11.93
Sowing of seeds(kernels)	20.11.93

v. Irrigation schedule:

Pre sowing irrigation	1.11.93
Post sowing irrigation	21.11.93
1st irrigation	2.12.93
2nd irrigation	15.12.93
3rd irrigation	30.12.93
4th irrigation	12.01.94
5th irrigation	25.01.94
6th irrigation	05.02.94
7th irrigation	19.02.94
8th irrigation	03.03.94
9th irrigation	16.03.94
Pre-havesting irrgation	29.03.94

vi. Intercultural operations:

Hoeing	10.12.93
Hand weeding (on T_2 only)	20.12.93

vii. Pest and disease managment:

Treatment of BHC 10% dust @ 12Kg/ha	20.11.93
Spraying of Endosulphan @ 750ml/ha	02.01.94
Spraying of Bavistin with plantomycin	10.01.94

viii. Harvesting : 30.03.94

Removal of pods from plants 31.03.94

Drying the pods under sun 01.04.94 to 03.04.94

3.6 Herbicide Application Technique and Quantities Used

The required quantity of herbicide was prepared in to a thick slurry by adding small quantity of water and allowing it to stand for 5 - 10 minutes.Then it was diluted with balanced quantity of water and stirred for 5 - 10 minutes.Then it was sprayed with the help of a high volume knapsack sprayer.The spraying of herbicide was given as uniform blanket spray over the soil.Fluchloralin was applied as pre-sowing and pre-plant incorparation where as pendimethalin was applied as pre-em and post sowing.All the spraying operations were done during evening hours.The quantities of various herbicides used in the experiment are given below:

Commercial formulation	Active Ingradient of the commercial product	% of active material	Dose in Kg a.i/ha	Amount of total herbicide used per plot in cc
Basalin	Fluchloralin	45	0.75	8.75
			1.00	11.7
			1.25	14.6
Stomp	Pendimethalin	30	1.00	17.5
			1.25	21.85
			1.50	26.25

3.7 Seed Treatment

Groundnut seeds were treated with Rhizobium culture before sowing @ 200g per 10-12 Kg kernel.

3.8 Application of Manures and Fertilizer

One cart load of FYM was applied to the soil uniformly before 3rd ploughing. Basal dose of N:P:K: @ 20:40:40 Kg/ha in the form of urea, single super phosphate and murate of potash respectively, was giving to plots prior to sowing.

3.9 Sowing of Seeds

The groundnut seeds cv.AK 12-24 was sown in lines after treatment with Rhizobium culture. The lines were drawn 25cm apart by trench hoe and seeds were sown in furrows at equal depth maintaining a spacing of 10cm.

3.10 General Features of AK 12 -24

a) Genetic name:- Arachis hypogaea (L.)

b) Sowing time :- i) Kharif June to July
ii) Rabi October to November
iii) Summer January to February

c) Germination:- 5-8 days (depending upon soil,moisture and temperture)

d) Growth habit:- Bunch

e) Germination to 1st flowering :- 21 to 24 days.

f) Flowering to peg formation:- 8 to 10 days.

g) Harvesting time:- i) Kharif - October to November
ii) Rabi - February to March
iii) Summer - May to June

h) Avarage pod yield in kg/ha i) Kharif - 8 to 10q/ha
ii) Rabi - 20 to 25q/ha
iii) Summer - 18 to 20q/ha

i) Kernel colour :- Pink

j) Weight of 100 Kernel (g):- 38 to 40

k) Oil content (%):- 50%

l) Shelling (%):- 73 to 75

m) Special feature :- Commercial variety for light to medium soil

n) Area of adoption :- Eastern region

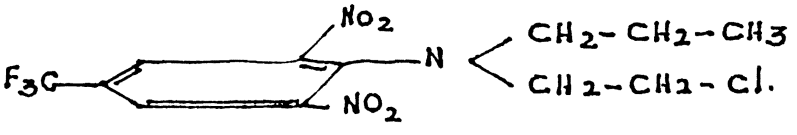
3.11 General Characteristics of Herbicides Used :

a) Fluchloralin

Chemical name: N-Propyl-N-(2'-Chloroethyl)-2, 6-dinitro-n-tri-fluoromethyl-aniline.

Trade name: Basalin

Structural formula:



Empirical formula: $C_{12}H_{13}ClF_3N_3O_4$

Chemical and Physical Properties:

Molecular weight - 355.7

Physical state - Cystalline Solid

Colour - Orange Yellow

Melting point - 42-43°C

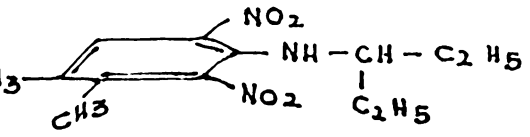
Solubility - IPPM in water at 20°C

Fluchloralin is a selective pre-emergence herbicide effective against annual grasses and broad leaved weeds. It remains active in soil for two to three months. It does not affect the next crop in rotation.

b) Pendimethalin:

Chemical name : N-(1-ethylpropyl) - 3,4 -dimethyl-2, b-dinitrobenzenamine

Trade name: Stomp

Structural formula: 

Empirical formula: $C_{13}H_{19}N_3O_4$

Physical properties:

Purity : 90% W/W minimum

Molecular weight : 281.3

Physical state : Orange to reddishbrown crystals

Melting point : 56 - 57°C

Boiling point : 330°C at 760mm Hg

Vapour pressure: 9.4 x 10^{-6} mm Hg at 25°C

Specific gravity : 1.19 at 25°C

Viscosity : 19.6 centipoises at 60°C, 14.1 centipoises at 70°C

Stability : Stable to alkaline and acidic conditions at normal ambient temperatures. No loss during 12 months storage at 37°

Solubility : Soluble in most organic solvents such as acetone, xylen,monochlorobenzene.Essentially insoluble in water (0.275 ppm in distilled water at 25°C)

Pendimethalin kills mostly grassy weeds and broad leaved weeds when applied as pre-emergence spray.

3.12 BIOMETRIC STUDIES

Biometric observations were recorded at periodic intervals on associated crop growth and weed growth. The details of the parameters are mentioned below.

3.12.1 Weed Studies

3.12.1.1 Bionomics of associated weeds

The bionomics of associated weeds were studied from the commencement of the crop till its maturity in the unweeded control treatments. The weeds, so observed were arranged under different taxonomic classes.

3.12.1.2 Weed population studies

Population counts of the weeds were recorded from the sampling units of size 50 cm x 50 cm choosen at 2 places at random at 20,40,80 DAS and harvest, averaged and finally expressed as number/m^2.

3.12.1.3 Studies on dry weight of weeds

The weeds from the sampling units of size 50cm x 50cm area were removed at 40, 80 DAS and at harvest,thoroughly washed, roots removed, air dried and then dried in oven at $80^{o}C$ for 48h.The dry weight was recorded and expressed as g/sq.m.

3.12.1.4 Weed Control Efficiency (WCE)

Weed Control efficiency was computed by using the weed biomass (dry weight) data (Mani et al., 1973).

$$WCE = \frac{DWWCP - DWWTP}{DW\ WCP} \times 100$$

Where, DWWCP - Dry weight of weeds in control plot

DWWTP - Dry weight of weeds in treated plot.

3.12.1.5 Weed Index (WI)

Weed index for each treatment was calculated by the

procedure as outlined by Gill and Kumar (1969) which is defined as the "reduction in yield due to presence of weeds in comparision to no weed plot."

$$W\ I = \frac{X - Y}{X} \times 100$$

Where, X = Yield from weed free control plot (best treatment)

Y = Yield from treatment for which WI is to be obtained.

But in the present investigation, weed Index was calculated taking treatment of best yield as no weed plot (T3 - fluchloralinl @ 0.75 Kg/ha).

3.12.2 Crop studies (Pre harvest morphological)

3.12.2.1 Seed emergence

Seed emergence was observed at 8th 12th and 16th day following sowing by counting the germinated plant in each and every line of all treatments to observe adverse effect if any, on germination of crop due to pre-emergence application of herbicides.

3.12.2.2 Root biomass/plant

Four adjacent plants were uprooted randomly from two consecutive sample lines. The root portion of all the four plants were washed thoroughly, separated from the shoot, dried at 80°C in hot air oven for 48 h and weighed. Observations on this and succeeding two parameters were recorded at 20,40,60,80 days after sowing and also at harvest.

3.12.2.3 Shoot biomass/plant

Those 4 plants which were uprooted for studying the dry weight of roots, were also used to record the shoot biomass after removing the root portions. Dry weight of shoot portions of those 4 plants were recorded after keeping 48 h in hot air over at 80°C.

3.12.2.4 Shoot to root ratio

The shoot, root ratio was determined by dividing the root dry weight with its corresponding shoot dry weight.

3.12.2.5 Number and dry weight of nodules

Four plants were choosen at random and uprooted along with intact roots. The root portions were washed thoroughly and the number of nodules of each plant were counted under simple microscope. Thereafter, the nodules were separated from the roots very carefully to record the oven dry weight at 80°C for 48h.Such observation was recorded at 30 and 60 days after sowing.

3.12.2.6 Leaf area/plant

The leaf area of 4 plants were averaged to get leaf area per plant. For calculation of leaf area 20 leaves of different sizes were randomly selected from bottom to top and the actual leaf area was calculated using graph paper. The average leaf area was computed and multiplied with the total number of leaves in the plant to give the total leaf area of individual plant in different treatments.

3.12.2.7 Leaf area index (LAI)

The leaf area index was determined at 60 and 80 days after sowing. This was worked out with the following formula

$$LAI = \frac{\text{Leaf area/plant}}{\text{ground area}}$$

3.12.2.8 Relative growth rate (RGR)

The increase in dry weight per unit original dry weight of the plant per unit time is called relative growth rate. It was expressed in g/g/day. It was computed as reported by Leo Pold and Kriedemann, 1975.

$$RGR = \frac{\ln W_2 - \ln W_1}{t_2 - t_1}$$

Where, W_1 = Dry weight of the whole plant at start of the test period.

W_2 = Dry weight of the whole plant at the end of the test period.

$(t_2 - t_1)$= period in days between initial and final observation.

3.12.2.9 Crop growth rate (CGR)

This is an index of the amount of growing material per unit dry weight per unit time. If W_1 and W_2 are total dry weight per unit time t_1 and t_2, respectively, the mean value of CGR for the time interval $t_2 - t_1$ was computed by formula as given by (Friends et al. 1962),

$$CGR = \frac{W_2 - W_1}{t_2 - t_1}$$

The crop growth rate was computed for each treatment and was expressed as g/plant/day.

3.12.2.10 Plant height

Plant height was measured from the ground level upto the tip of the freshly opened leaf emerging from the main shoot a day before harvest from the selected sample plants at random which were 10 in numbers from each treatment.

3.12.2.11 Number of branches/plant

The number of branches/plant were also recorded a day before harvest from the selected sample plants as in the case of plant height.

3.12.3 Crop studies (Pre harvest biochemical analysis)

3.12.3.1 Chlorophyll estimation

Total Chlorophyll of leaves were determined using acetone extraction method (Arnon,1949). Second leaf from the top was collected 45 and 65 DAS for chlorophyll estimation. Fresh leaf weighing 250 mg from each treatment was macerated thoroughly in a glass mortar and pestle with a small quantity of 80% acetone to get a fine pulp. The pulp was filtered to a 25 ml. volumetric flask through Whatman No.1 filter paper. The residue was washed twice and the final volume was made upto 25ml with 80% acetone. Then the absorbance was recorded at 645 nm and 663 nm, using JAYSO spectro photometer. The total chlorophyll per g of fresh weight of leaf were calculated as per the formulae given below:

Total chlorophyll (mg total chlorophyll/g fresh tissue

= 20.2 (D 645) + 8.02 (D 663) x V/1000 x 1/W

Where, D = the absorbance reading of chloropohyll extracts at specified wave length.

V = Final volume of the chlorophyll extracts

W = Fresh weight in g of tissue extracted.

3.12.3.2 Nitrate Reductase

The assay of nitrate reductase activity in the leaves was done according to Klepper et al. (1971)

Reagents

* Phosphate buffer 0.4M (pH 7.5)

* Potassium nitrate solution: 0.4M

* Sulphanilamide solution: 1% in 1N HCl.

* NEDD (1-Napthylethylene diamine-dihydrochloride solution: 0.02% in distilled water.

Procedure

Leaf samples were collected from the field usingmoist blotting paper. Leaves of each sample were cut into very fine and thin pieces and mixed together. Leaf tissues weighing 250 mg were taken in a specimen tube containing 2.5 ml of 0.4M potassium nitrate, 2.5 ml of 0.4M phosphate buffer (7.5pH). The reaction mixture alongwith the sample was infiltrated for one minute using vaccum pump. The infiltrated leaves were then allowed to incubate for 30 minutes at 33^{o}C in dark. The reaction was then stopped by boiling the reaction mixture for 2 minutes without letting the

chlorophyll to come out of the leaf tissues. An aliquot of 2ml of reaction mixture was taken and 1ml of 1% sulphanilamide, 1ml. of 0.02%. NEED and 2ml of distilled water were added to make the final volume 6 ml. It was kept for 15 minutes for colour development. Absorbance was measured at 540 nm in spectrophotometer. Values of absorbance obtained were computed from a standard curve prepared for nitrite and the activity of the enzyme was expressed as mole NO_2 produced per g of fresh leaf per hour (μ mole NO_2^- g^{-1} h^{-1}).

3.12.3.3 Determination of leg-haemoglobin

Leg-haemoglabin content was determined following the method of Wilson and Reisenauer (1963).Fresh nodule weighing 0.5 g was collected at 45 DAS and crushed in a chilled mortar and pestle with 3 ml Drabkin's solution prepared by dissolving 52 mg of potassium cyanide,198 mg of potassium ferricyanide and 1 g of sodium bicarbonate per liter of distilled water.The volume was made up to 7 ml and the homogenate was centrifuged at 5000 rpm for 25 minutes. The clear supernatant thus obtained was made to 10 ml with Drabkin's reagent.The absorbance of clear supernatant was read at 540 nm using Drabkin's reagent as reference solution.The amount of leg-haemoglobin present was calculated from a calibration curve prepared with known concentration of cyanomethemoglobin and the results were expressed as mg g^{-1} fr.wt.

3.12.4 Post Harvest Morphological Studies

3.12.4.1 Number of pods per plant

Ten plants which were selected at random from each experimental plot for recording the plant height and number of branches were uprooted carefully and the effective pods were counted individually. In this case the plants in the boarder and also the destructive sample units were avoided.

3.12.4.2 Weight of pods per plant

The pods obtainded from the sample plants were separated and were washed, dried in the sun for three days and then their weights were recorded.The weight of pods per plant was obtained by dividing the number of plants i.e. 10 with the total weight of pods.

3.12.4.3 Kernel weight per plant

The pods from the sample plants were decoaticated and the kernel weight (g) per plant obtained by dividing with the number of plants.

3.12.4.4 100 Kernel weight

100 kernels were choosen from the sample plants at random and were weighed(g) after three cosecutive sundrying for four hours a day under paper cover.

3.12.4.5 Shelling percent (%)

Shelling percentage was determined by adopting the following formula.

$$\text{Shelling \%} = \frac{\text{Weight of Kernels}}{\text{Weight of pods}} \times 100$$

3.12.4.6 Pod yield

One row on both sides of the length and 20cm boarder from breadth side of the gross plot were removed to eliminate the boarder effect. The pod yield from the individial net plots were recorded in kg after three consecutive sun drying.From this observation the yield per hectar was comupted in quintal per hectare.

3.12.4.7 Harvest index

Harvest index(%) was calculated by using the formula:

$$\text{Harvest index (HI)} = \frac{\text{Economical yield}}{\text{Biological yield}} \times 100$$

3.12.4.8 Germination

To assess the germinability of the harvested seeds the same was sown in a tray containing sterilized sand. The germination count was taken after seven days after sowing in each treatment and the data was expressed as percentage.

3.12.5 Post Harvest Biochemical Studies

3.12.5.1 Estimation of grain protein and nitrogen content of different plant parts

Nitrogen and grain protein content of kernel were estimated by following the procedure of A.O.A.C. (1970). Two hundred mg of powdered Kernel smaples were taken in 100 ml Kjeldahl digestion flasks. About 200 mg of digestion mixture (K_2SO_4 : $CuSO_4$ = 5:1) and 4 ml of concentrated H_2SO_4 were added. These

flasks were kept as such for about one hour and then heated slowly till froathing occurred. To check the froathing, two crystals of sodium thiosulphate were added to each digestion flask. Thereafter, digestion was continued until clear blue syrupy liquid was obtained.The flask was cooled and content was diluted to 50 ml with distilled water. Then 10 ml of diluted sample extract was transferred into a micro-kjeldahl distillation unit. The digestion flask was washed twice with little amount of distilled water and all the washings were transferred into the distillation unit. Thereafter, 10 ml of 40% NaOH was added and distillation was continued for 10 minutes. The distillate was collected in a 150 ml conical flask containing 10 ml of 4% boric acid with 2 drops of mixed indicator. After completion of distillation, distillate was titrated against 0.02 N HCl.

Calculation:

$$\% \text{ N in sample} = \frac{(\text{Sample titre} - \text{blank titre}) \times N \text{ of HCl} \times 14 \times 100 \times 5}{\text{Sample weight (g)} \times 1000}$$

Percentage of crude protein present in grains was extrapolated by multiplying the % N with 6.25.

3.12.5.2 Harvested protein

Harvested protein was computed from percent protein in pods and the pod yield and expressed as q/ha.

3.12.5.3 Oil estimation

Two grams of groundnut seeds from each treatment were crushed in a glass mortar and placed in a thimble. The thimble

containing crushed seeds was placed in a Soxhlet extraction apparatus connected with a pre-weighed extraction (receiving) flask containing 150ml. of petroleum ether. Extraction flask was heated on water bath for about 3 to 4 hrs. The solvent (petroleum ether) was circulated through the condenser of soxhlet apparatus continuously over the entire refluxing period. Receiving flask was detached and placed in an oven at 60 - 80°C for complete removal of petroleum ether. After complete removal of petroleum ether, the receiving flask containing oil was calculated as follows (Singh,1977).

$$\text{Percentage Oil} = \frac{Wo}{Ws} \times 100$$

Where, Wo = Weight of oil in gram (final weight of receiving flask with oil-initial weight of receiving flask)

Ws = Weight of seeds taken in gram.

3.12.5.4 Harvested oil

Harvested oil was computed from percent of oil present in kernel and pod yield and expressed as q/ha.

3.12.5.5 Estimation of dehydrogenase activity of seeds

After three weeks of harvest, the seeds were analysed to assess its germinability and viability in response to herbicidal application.The viability of seeds was tested by determining the dehydrogenase activity (Kittock&Law, 1968).

Fifteen seeds of each seed lot were put in distilled water for 9 hours. After soaking, four embryoes with the cotyl-

don were separated from pericarp. Then the embryoes were rinsed with distilled water and put in 25 ml test-tubes. Five ml of 0.2% tetrazolium chloride solution was added to each test-tube and the tubes were kept at 32°C for four hours in dark. During the incubation period, dehydrogenase enzyme present in the embryo reduced to 2,3,5 tetrazolium chloride to formazàn which imparted red colouration in embryoes. Then the tetrazolium solution was de canted and embryoes were washed thrice with distilled water and embryoes were put in 9 ml methyl cellosolve for 9 hours with occasional shaking. Then the absorbance of the methyl cellosolve containing red chromogen was measured at 470 nm by spectronic-20. The dehydrogenase activity was expressed as OD/g of fresh weight.

3.12.6 Comparative Economics

In the present study, prevailing market price of herbicides and labour charges were used for calculating the economics of different management pratices.Net profit over control for each treatment was computed by deducting the cost incurred towards weeding from the price of the produce(pod yield).

3.12.7 Statistical Analysis

The data obtained on different parameters were subjected to statistical analysis as per randomised block design (Panse and Sukhatme,1985). Here 5% levels of 'F'test has been used for testing the significance of the findings.Appropriate standard error of the parameters was calculated.The critical difference (C.D.) value was worked out at 5% level of probability to compare

the treatment means by using the following formula:

$$SE(m)\pm = \sqrt{\frac{EMS}{r}}$$

Where, SE(m)= Standard error of mean

EMS = Error mean sum of square

r = Number of replication

C.D = $\sqrt{2}$ SE(m) x 't' value at error degrees of freedom.

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CHAPTER - IV

EXPERIMENTAL FINDINGS

EXPERIMENTAL FINDINGS

A field experiment was conducted at the Central Research Station,O.U.A.T,Bhubaneswar, during Rabi 1993-94 to assess the effect of fluchloralin and pendimethalin on associated weeds as well as growth and development of groundnut cv. AK 12-24. The results thus obtained were highlighted as follows:

4.1 Weed Studies

4.1.1 Study on weed flora

The floristic composition of the experimental plot revealed that altogether 12 different weed species were observed and are presented in Table 4.

Both the grassy and broad leaved weeds found dominant. Among 5 grassy weeds Cynodon dactylon, Echinochloa colona, Digitaria sanguinalis, Dactyloctenium aegyptium, Eleusine indica were observed to be dominant whereas Acanthospermum hispidum, Cleome viscosa, Croton sparsiflorus, Crozofera rotteleri were indentified as dominant broad leaved weeds. Cyperus rotundus was the only dominant among sedges.

4.1.2 Species-wise weed control (%)

The percentage control of major weeds by different treatments over the unweeded control was computed and presented in Table 5 & Fig. 4.

It was revealed from the data fluchloralin and pendimethalin fully controlled the grassy weeds, Digitaria sanguina

Table 4. Major weeds observed in the experimental plot.

Category	Scientific Name	Family
Grasses	Cynodon dactylon (L.) Pers	Poaceae
	Digitaria sanguinalis(L.) Scop	Poaceae
	Dactyloctenium aegyptium(L.)Beauv.	Poaceae
	Echinochloa colona(L.) Link	Poaceae
	Eleusine indica Gaertn.	Poaceae
Sedges	Cyperus rotundus(L.)	Cyperaceae
Broad leaved	Acanthospermum hispidum D.C	Asteraceae
	Cleome viscosa (L.)	Capparidaceae
	Croton sparsiflorus Morong	Euphorbiaceae
	Crózofera rottleri Klotzsch	Euphorbiaceae
	Alternanthera sessilis (L.)D.C	Amaranthaceae
	Ageratum conizoides (L.)	Asteraceae

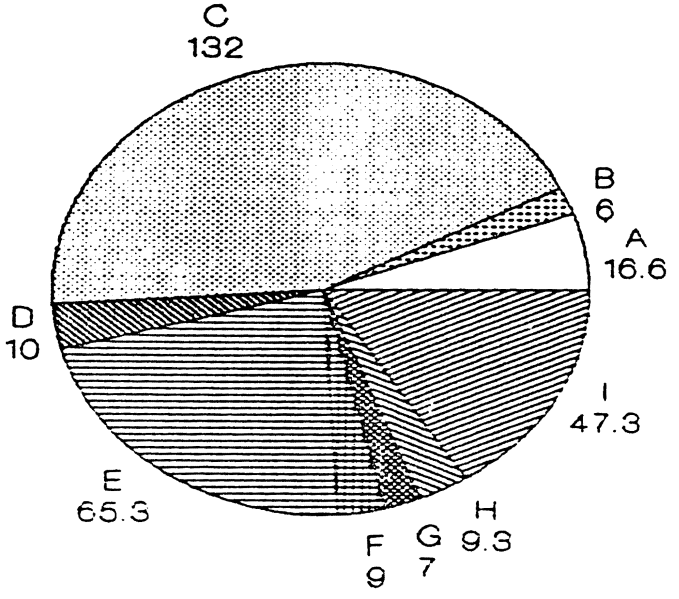
Table 5. Species-wise weed control(%) as affected by varying levels of fluchloralin and pendimethalin at 20 days after sowing.

Treatment	Dose	Ec	Ei	Da	Ds	Cv	Al	Cs	Cd	Cr
Control	-	16.6	6.0	132	10	65.3	9.0	7.0	9.3	47.3
Hand weeding	-	-	-	-	-	-	-	-	-	-
Fluchloralin	0.75	88 (2)	100 (0)	100 (0)	100 (0)	65.4 (22.6)	65.5 (3.1)	28.5 (5)	24.7 (7)	-29.6 (61.3)
Fluchloralin	1.00	100 (0)	100 (0)	100 (0)	100 (0)	70.4 (19.3)	71.1 (2.6)	14.85 (6.7)	35.5 (6)	-1.5 (48)
Fluchloralin	1.25	100 (0)	100 (0)	100 (0)	100 (0)	71.5 (18.6)	71.1 (2.6)	14.3 (6.0)	43.0 (5.3)	-15 (54.6)
Pendimethalin	1.0	100 (0)	100 (0)	100 (0)	100 (0)	53.1 (30.6)	48.8 (4.6)	0 (7.0)	18.3 (7.6)	12.7 (41.3)
Pendimethalin	1.25	100 (0)	100 (0)	100 (0)	100 (0)	66.3 (22.0)	63.3 (3.3)	14.3 (6.0)	30.1 (6.5)	0.63 (47.0)
Pendimethalin	1.50	100 (0)	100 (0)	100 (0)	100 (0)	73.5 (17.5)	77.7 (2.0)	0 (7.0)	35.5 (6.0)	-19.7 (56.6)

NB:- The absolute values are in Parenthesis and percentage(%) control are in the original table.
The abbreviations: Ec - Echinochloa colona, Ei- Elusine indica, Da - Dactyloctenium aegyptium, Ds - Digitaria sanguinalis, Cv - Cleome viscosa, Al -Acanthospermum hispidum,Cs - Croton sparsiflorus, CD - Cynodon dactylon, Cr - Cyperus rotundus.

FLORISTIC COMPOSITION OF MAJOR WEEDS AT 20 DAS

FIG. 4



NB: A- Echinochloa colona, B - Elusine indica,
C- Dactyloctenium aegyptium, D- Digitaria sanguinalis,
E- Cleome viscosa, F - Acanthospermum hispidum,
G- Croton sparsiflorus, H - Cynodon dactylon,
I- Cyprus rotundus.

lis, Dachyloctenium aegyptium, Eleusine indica, irrespective of the doses tried in this investigation. Echinochloa colona was controlled cent-percent by various doses of the herbicides included in the investigation except fluchloralin applied @0.75/ha which noted 88% control. Fluchloralin and pendimethalin gave 65.71% and 53-73% control of Cleome viscosa, respectively. The percentage control of the weed increased with the increasing in the levels of the herbicides. Acanthospermum hispidum was controlled to the tune of 65-71% and 49-77% with fluchloralin and pendimethalin, respectively. The broad leaved weeds Croton sparsiflorus, Crosofera rottleri were found resistance to the application of both the herbicides. On the contrary, the perennial weeds such as Cynodon dactylon and Cyperus rotundus had sparce distribution and were found resistant to these herbicides. But fluchloralin at 1.25 kg/ha controlled Cynodon dactylon to the tune of 43%.

4.1.3 Total weed population

Data presented in Table 6. and depicted in fig 5 would evince that the unweeded control recorded significantly higher weed population over all other weed control measures adopted throughout the crop growth period. Further it was noted that the total weed population tended to increase upto 40 DAS in unweeded control but subsequently declines.

Weed population study at 20 DAS revealed that, in general, herbicides use irrespective of doses proved better in

Table 6. Effect of weed management practices on total weed population/m^2 at four sampling stages.

TREATMENT	DOSE (Kg a.i/ha)	DAYS AFTER SOWING			Harvest
		20	40	80	
Control		371.3	414.7	217.0	201.7
Hand weeding		333.3 (10.2)	42.7 (89.7)	84.0 (61.3)	70.7 (64.9)
Fluchloralin	0.75	142.7 (61.56)	108.0 (73.9)	66.7 (69.3)	72.0 (64.3)
Fluchloralin	1.00	107.3 (71.1)	72.0 (82.6)	58.7 (72.9)	68.0 (66.3)
Fluchloralin	1.25	114.7 (69.1)	54.7 (86.8)	55.3 (74.5)	61.3 (69.6)
Pendimethalin	1.00	135.3 (63.5)	70.7 (82.95)	54.0 (75.0)	74.7 (62.9)
Pendimethalin	1.25	104.7 (71.8)	57.3 (86.18)	48.7 (77.5)	69.3 (65.6)
Pendimethalin	1.50	118.0 (68.2)	48.0 (88.42)	41.7 (80.8)	56.0 (72.2)
Mean	-	178.4	108.5	78.67	84.21
SE(m)±	-	32.4	21.11	10.05	8.49
C.D (0.05)-		98.28	64.04	30.48	25.49

N.B- Data in parenthesis indicate percent control of weeds over unweeded control.

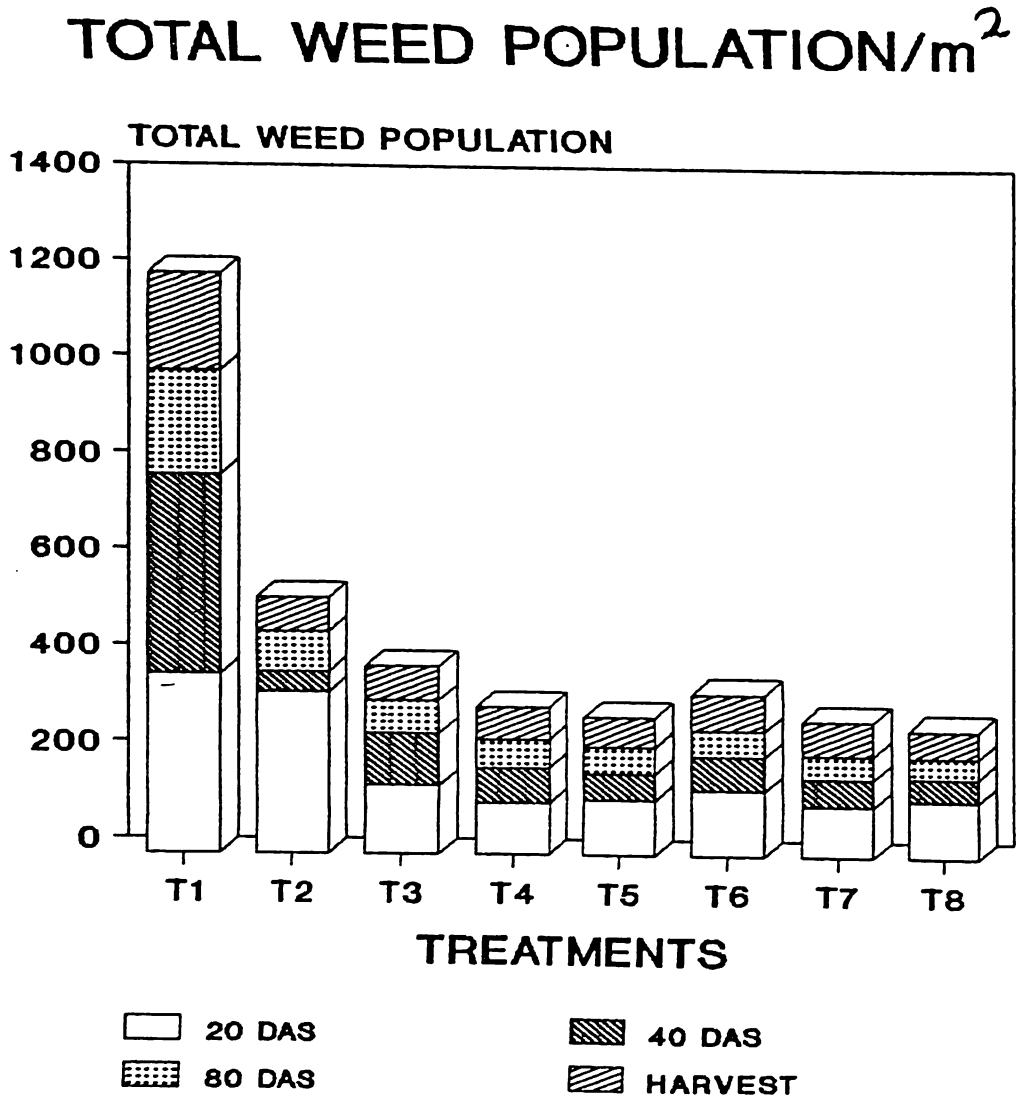

TOTAL WEED POPULATION/m2
TOTAL WEED POPULATION
1400
1200
1000
800
600
400
200
0
T1
T2
T3
T4
T5
T6
T7
T8
TREATMENTS
20 DAS
40 DAS
80 DAS
HARVEST

FIG. 5

reducing weed density. Among the various herbicides, application of pendimethalin @1.25kg/ha registered lowest weed population of 104.7/m^2 followed by fluchloralin @1.0 kg/ha(107.3/m^2).

More or less similar trend was noticed at 40 DAS with respect to weed population except mannual weeded plot, while pendimethalin use @1.5kg/ha recorded the minimum weed population of 48/m^2 and fluchloralin @1.25 kg/ha recorded 54.7/m^2.

From the data pertaining to weed population of 80 DAS, it was observed that, herbicide effect was conspicuous and maintain their superiority over manual weeding till this period. The effect of pendimethalin @1.5 kg/ha persists till harvest of the crop in recording lowest weed population incomparison to rest of the treatments . Unweeded control proved inferior in reducing the weed population throughout the crop growth period.

4.1.4 Dry weight of weeds

Data on dry weight of weed are presented in Table 7. and illustrated in Fig.6 . Total dry weight of weeds was maximum in unweeded control at all stages of crop growth. The unweeded plot registered the maximum dry weight of39.4, 56.7, 116.7g/m^2 at 40, 80 DAS and at harvest, respectively. At 40 DAS the farmer's method of weed control recorded the least dry matter of weeds (6g/m^2) and remained at par with higher doses of pendimethalin.

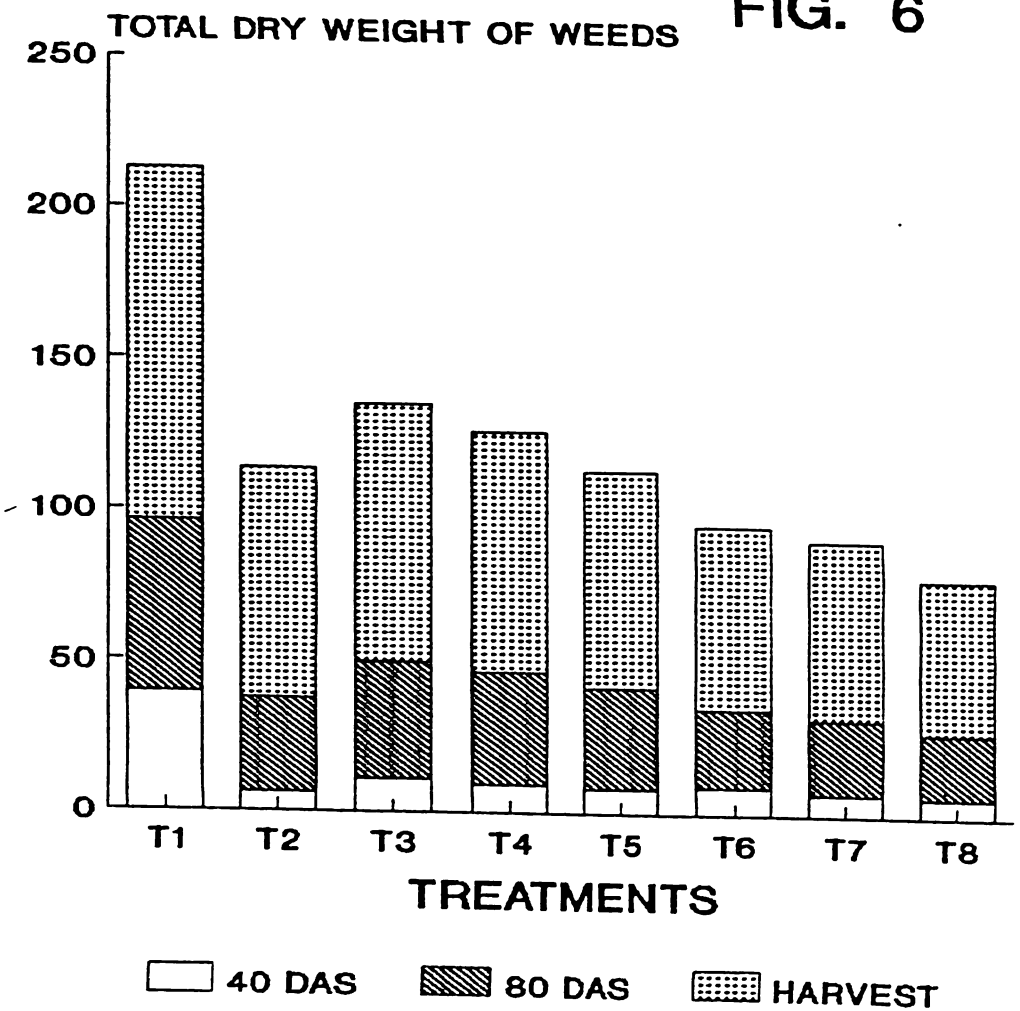
In general, pre-emergence application of pendimethalin @1.5kg/ha registered the minimum dry matter accumulation at 80DAS and at harvest stages of crop and remained at par with its lower

Table 7. Effect of weed mangement practices on dry matter production(g) by weeds/m^2 at three sampling stages.

TREATMENT	DOSE (Kg a.i/ha)	40DAS	80DAS	Harvest
Control		39.4	56.7	116.7
Hand weeding		6.0	31.7	75.9
Fluchloralin	0.75	10.9	38.9	85.4
Fluchloralin	1.00	9.3	37.3	79.4
Fluchloralin	1.25	8.2	33.5	71.5
Pendimethalin	1.00	8.9	25.9	60.2
Pendimethalin	1.25	6.9	24.8	58.8
Pendimethalin	1.50	6.2	21.2	50.9
Mean	-	10.02	33.75	72.37
SE(m)±	-	0.68	3.04	7.69
C.D(0.05)	-	2.06	9.23	23.32

TOTAL DRY WEIGHT OF WEEDS (g/m^2)

FIG. 6



doses during these stages. However, at harvest it is statistically at par with the use of fluchloralin @ 1.25 kg/ha.

4.1.5 Weed control efficiency (WCE)

Weed control efficiency was recorded at 40, 80 DAS and at harvest and presented in Table 8. At 40 DAS the farmer's method of weed control recorded the maximum weed control efficiency of 84.8%. Use of pendimethalin @1.5 kg/ha was 84.3% efficient in reducing dry weight of weeds and this was closely followed by its other dose of 1.25 kg/ha (82.5%) while, its lower dose found inferior in this respect. On an average fluchloralin exhibited lower efficiency in controlling the weeds and weed control efficiency was 72.3,76.4 and 79.2% with 0.75,1.0 and 1.25 kg/ha respectively. The weed control efficiency of various doses of pendimethalin maintain its superiority over all doses of fluchloralin till harvest of the crop.

4.1.6 Weed Index (WI)

Weed index was studied at harvest of the crop and data on this respect are presented in Table 8 .

A perusal of the data of various weed control methods revealed that application of pendimethalin @1kg/ha as Pre-emergence recorded the minimum weed index (1.5%). Fluchloralin @1kg/ha, hand weeding once, fluchloralin@1.25 kg/ha, pendimethalin@1.25 kg/ha and 1.5 kg/ha recorded weed index value of 10.8, 12.3, 12.8, 15.3, and 17.2 respectively, while unweeded control recorded the maximum weed index value of 35.5.

Table 8. Effect of weed mangement practices on Weed Control Efficiency(%) (WCE) and Weed Index (%) (WI).

TREATMENT	DOSE (Kg a.i/ha)	WCI(%) at different DAS			WI(%)
		40DAS	80DAS	Harvest	
Control		-	-	-	35.5
Hand weeding		84.8	44.1	35.0	12.3
Fluchloralin	0.75	72.3	31.4	26.8	-
Fluchloralin	1.00	76.4	34.2	32.0	10.8
Fluchloralin	1.25	79.2	40.9	38.7	12.8
Pendimethalin	1.00	77.4	54.3	48.4	1.5
Pendimethalin	1.25	82.5	56.3	49.6	15.3
Pendimethalin	1.50	84.3	62.6	56.4	17.2

4.2 Crop Studies

4.2.1 Seed emergence

The observations on seed emergence (%) were taken at three sampling stages and presented in Table 9. It was observed that seed emergence was significantly more in pendimethalin at all the sampling stages than control, hand weeded and fluchloralin treated plots. The lowest concentration of pendimethalin (1kg/ha) registered the highest emergence percentage at the later stages as compared to other treatments. Fluchlorain had the lowest seed emergence percent in groundnut. There was a spurt in seed emergence at 12 and 16 days after sowing with reference to initial observation (8 DAS) in all the treatments.

4.2.2 Dry matter of root,shoot and shoot to root ratio

The data pertaining to the dry matter of root, shoot as well as shoot to root ratio are given in table 10. Both the root and shoot dry weight were significantly higher in fluchloralin and pendimethalin than the hand weeded and the control treatments and between the latter two, control had the lowest dry matter accumulation. There was no much significant difference between the fluchloralin and pendimethalin treated plots. In both the cases,lowest concentration of the herbicide registered highest dry matter accumulation which declined consistently with increasing chemical concentrations. Both the parameters were found to increase gradually with advancing age. In respect of shoot to root ratio which behaved in similar fashion like the

Table 9. Seed emergence(%) in groundnut cv. AK 12-24 in response to varying levels of fluchloralin and pendimethalin at three sampling stages.

TREATMENT	DOSE (Kg a.i/ha)	8 DAS	12 DAS	16 DAS	Mean	Overall mean
Control	-	7.47	48.40	85.03	46.97	
Hand weeding	25 DAS	12.20	48.13	81.67	47.33	
Fluchloralin	0.75	2.07	33.60	75.50	37.06	
Fluchloralin	1.00	5.67	35.47	79.83	40.32	38.12
Fluchloralin	1.25	3.07	32.27	75.63	36.99	
Pendimethalin	1.00	7.20	51.93	95.20	51.44	
Pendimethalin	1.25	15.47	49.73	86.40	50.53	50.94
Pendimethalin	1.50	9.53	50.30	92.70	50.84	
Mean	-	7.84	43.73	83.96		
SE(m)±	-	3.92	5.50	4.64		
C.D.(0.05)	-	11.88	16.68	14.08		

Table 10. Root, Shoot dry weight (g/plant) and shoot to root ratio of groundnut cv. AK 12-24 in response to varying levels of fluchloralin and pendimethalin at four sampling stages.

TREATMENT	DOSE	Root dry weight(g)						Shoot dry weight(g)						Shoot:Root					
		20 DAS	40 DAS	60 DAS	80 DAS	Mean	O.M	20 DAS	40 DAS	60 DAS	80 DAS	Mean	O.M	20 DAS	40 DAS	60 DAS	80 DAS	Mean	O.M
Control		0.060	0.122	0.17	0.40	0.188		0.283	0.73	3.1	18.7	5.70		4.72	6.32	12.43	24.27	11.93	
Hand weeding		0.070	0.133	0.25	0.55	0.251		0.363	0.92	4.7	20.6	6.65		5.18	6.92	18.90	37.46	17.12	
Fluchloralin	0.75	0.062	0.150	0.40	0.65	0.316		0.363	0.99	5.9	23.6	7.71		5.87	6.65	14.76	36.33	15.90	
Fluchloralin	1.00	0.063	0.116	0.26	0.60	0.260	0.267	0.342	0.89	5.5	22.4	7.28	7.19	5.43	7.76	21.25	37.40	18.00	17.65
Fluchloralin	1.25	0.057	0.102	0.20	0.54	0.225		0.326	0.84	4.9	20.3	6.59		5.79	8.24	24.60	37.59	19.06	
Pendimethalin	1.00	0.070	0.124	0.35	0.70	0.311		0.350	0.85	5.1	24.8	7.78		5.00	6.99	14.58	35.46	15.50	
Pendimethalin	1.25	0.070	0.111	0.28	0.55	0.253	0.259	0.326	0.79	4.4	23.4	7.23	7.2	4.66	7.28	15.72	42.69	17.59	17.30
Pendimethalin	1.50	0.057	0.094	0.20	0.50	0.213		0.303	0.73	3.5	21.8	6.58		5.39	8.47	17.57	43.75	18.80	
Mean	-	0.064	0.119	0.26	0.56			0.332	0.84	4.6	21.9			5.25	7.33	17.48	36.88		
SE(m)±	-	0.002	0.012	0.01	0.02			0.004	0.02	0.1	0.3			0.23	0.84	0.97	1.17		
C.D(0.05)	-	0.007	0.035	0.03	0.05			0.012	0.06	0.4	1.0			0.68	2.46	2.85	3.43		

NB: Abbriviation; O.M Overall Mean

aforesaid characters, was significantly higher in chemically treated as well as hand weeded plots than the control plants, the maximum being recorded in fluchloralin treated plants.

4.2.3 Nodulation

Both the nodule number and nodule dry weight, at two sampling stages, were higher in hand weeded plants than the other treatements (Table 11.) the lowest being obtained in weedy check (control). The variation among them was statistically significant. The effect of fluchloralin was significantly superior to pendimethalin at all the doses as well as at all the sampling stages. Both the attributes declined with increase in concentration of the chemical. The sampling done at later stage (60 DAS) had higher nodulation in groundnut than the initial sampling (30 DAS).

4.2.4 Chlorophyll, Nitrate reductase activity and leg-haemoglobin content

Total chlorophyll content, nitrate reductase activity in leaves and leg-haemoglobin content in nodules of groundnut were depicted in the Table 12. Chlorophyll content was significantly higher in hand weeding plants (1.87 mg) followed by fluchloralin (1.80 mg), control (1.6 mg) and pendimethalin (1.59 mg). The values obtained in handweeded and fluchloralin plants were statistically at par, while no significant variation was observed between the control and pendimethalin values. Both fluchloralin and pendimethalin treated leaves contained 1.79 and 1.62 mg of chlorophyll respectively, at their lowest doses which

Table 11. Nodule number and nodule dry weight(mg) per plant of groundnut cv. AK 12-24 in response to varying levels of fluchloralin and pendimethalin at two sampling stages.

TREATMENT	DOSE (Kg ai/ha)	Nodule Number				Nodule dry weight(mg)			
		30DAS	60DAS	Mean	O.M	30DAS	60DAS	Mean	O.M
Control		62.00	132.00	97.00		37.50	60.00	48.75	
Hand weeding	25 DAS	76.00	233.67	154.84		45.00	147.60	96.30	
Fluchloralin	0.75	78.00	231.00	154.50		45.40	123.00	84.20	
Fluchloralin	1.00	73.00	208.67	140.84	141.95	40.10	88.50	64.30	67.32
Fluchloralin	1.25	66.00	195.00	130.50		27.93	79.00	53.47	
Pendimethalin	1.00	62.67	171.00	116.84		37.00	71.40	54.20	
Pendimethalin	1.25	60.00	169.00	114.50	114.67	35.90	68.20	52.05	50.67
Pendimethalin	1.50	58.33	167.0	112.67		33.90	57.60	45.75	
Mean	-	67.00	188.42			37.84	86.91		
SE(m)±	-	1.54	3.15			3.44	1.35		
C.D(0.05)	-	4.53	9.26			10.13	3.97		

NB: Abbriviation; O.M Overall Mean

Table 12. Total chlorophyll content (mg/g FW), nitrate reductase activity (μ mol NO_2^- formed/ g FW/h) in leaves and leg-haemoglobin content(mg/g FW) in nodules of groundnut cv. AK 12-24 in response to varying levels of fluchloralin and pendimethalin at different sampling stages.

TREATMENT	DOSE (Kg ai/ha)	Chlorophyll content (mg/g FW)				Nitrate Reductase Activity (μ mol NO_2^- formed/g FW/h)		Leg-haemoglobin content	
		45DAS	60DAS	Mean	Overall Mean	45DAS	Overall Mean	45DAS	Overall Mean
Control	-	1.60	1.60	1.60		2.13		4.7	
Hand weeding	25 DAS	1.87	1.87	1.87		2.17		5.9	
Fluchloralin	0.75	1.83	1.90	1.87		2.70		5.5	
Fluchloralin	1.00	1.77	1.80	1.79	1.80	2.73	2.79	4.9	5.00
Fluchloralin	1.25	1.73	1.77	1.75		2.93		4.6	
Pendimethalin	1.00	1.57	1.67	1.62		2.20		4.5	
Pendimethalin	1.25	1.60	1.63	1.62	1.59	2.40	2.39	4.3	4.33
Pendimethalin	1.50	1.47	1.57	1.52		2.57		4.2	
Mean	-	1.68	1.73						
SE(m)$\pm$	-	0.03	0.02			0.20		0.22	
C.D(0.05)	-	0.08	0.07			0.58		0.64	

tended to decline with increasing concentrations. There was a little increase in chlorophyll content at 60DAS compared to 45 DAS.

Nitrate reductase activity in leaves taken at 45 DAS was significantly higher in fluchloralin treated plants than the other treatments, the lowest being recorded in control. The activity of the enzyme increased with increasing levels of the both fluchloralin and pendimethalin and the value thus obtained were statistically at par with each other.

As regards the leg-haemoglobin content in nodules was maximum in hand weeded plants (5.9 mg) followed by fluchloralin (5.0 mg),control (4.7 mg) and pendimethalin (4.33 mg). However,the values between hand weeding and pendimethalin were statistically non-significant. Unlike NR activity, the leg-haemoglobin content declined with increasing levels of both the herbicides.

4.2.5 Relative growth rate (RGR), crop growth rate (CGR) and leaf area index (LAI)

The growth parameters viz. RGR, CGR and LAI taken at different sampling dates were presented in Table 13. In respect of RGR,no significant variation was observed among the treatments as indicated from their mean values.Further with increasing concentrations of weedicides the values recorded both in fluchloralin and pendimethalin were inconsistent. The RGR value sampled at 40-60d was more than the other two samplings. On contrary,the CGR value was maximum in pendimethalin followed by

Table 13. Relative growth rate(g/g/day), Crop growth rate(g/day) and Leaf Area Index per plant of groundnut cv. AK 12-24 in response to varying levels of fluchloralin and pendimethalin at different sampling stages.

TREATMENTS	DOSE (Kg/ha)	Relative Growth Rate					Crop Growth Rate					Leaf Area Index			
		20-40 days	40-60 days	60-80 days	Mean	Overall Mean	20-40 days	40-60 days	60-80 days	Mean	Overall Mean	60 DAS	80 DAS	Mean	Overall Mean
Control		0.045	0.067	0.089	0.067		0.025	0.120	0.792	0.312		2.07	3.93	3.00	
Hand weeding		0.044	0.077	0.073	0.065		0.031	0.190	0.810	0.344		2.17	4.37	3.27	
Fluchloralin	0.75	0.048	0.087	0.068	0.068		0.034	0.260	0.907	0.400		2,83	5.17	4.00	
Fluchloralin	1.00	0.046	0.087	0.069	0.067	0.067	0.030	0.240	0.862	0.377	0.372	3.07	5.20	4.14	4.36
Fluchloralin	1.25	0.045	0.085	0.070	0.067		0.028	0.200	0.790	0.339		3.97	5.90	4.94	
Pendimethalin	1.00	0.042	0.086	0.077	0.068		0.028	0.220	1.003	0.417		2.17	3.97	3.07	
Pendimethalin	1.25	0.041	0.082	0.082	0.068	0.068	0.025	0.190	0.964	0.393	0.391	2.27	4.17	3.22	3.30
Pendimethalin	1.50	0.042	0.075	0.090	0.069		0.023	0.140	0.930	0.364		2.50	4.70	3.60	
Mean -		0.044	0.081	0.077			0.028	0.197	0.882			2.63	4.68		
SE(m)± -		0.001	0.002	0.002			0.001	0.006	0.019			0.05	0.07		
C.D(0.05)-		0.003	0.006	0.006			0.003	0.018	0.056			0.16	0.20		

fluchloralin, hand weeded and control. The chemically treated plants gave significantly higher values than the control. The values of pendimethalin vs fluchloralin and control vs hand weeded were statistically at par. In both the weedicide treatments,this attribute declined with increase in concentrations. Among the different samplings, 60-80d resulted in higher CGR value than the other two samplings.

With regards to LAI the value of fluchloralin treatment was spectacular over to other treatments, the lowest being obtained in control. LAI increased with increase in concentration of both the weedicides at the two sampling stages. While the value of fluchloralin treatment was significantly superior to other three treatment, no significant variation was noticed amongst the latter treatments. The sampling done at later stage had higher LAI than the initial sampling (60 DAS).

4.2.6 Number of branches and plant height

Both number of branches and plant height were recorded at harvest and presented in Table 14. The fluchloralin treated plants had higher number of branches than the other treatments. However, there was no significant variation amongst the treatments so far as the above parameters were concerned. On the other hand, the plant height had the maximum in hand weeded plants followed by control, pendimethalin and fluchloralin. The variation among the latter three was statistically non-significant. No consistency was observed in respect of both the parameters with

Table 14. Number of branches and plant height(cm) of groundnut cv. AK 12-24 at harvest in response to varying levels of fluchloralin and pendimethalin.

Treatment	Dose Kg ai/ha	Number of branches		Plant height (cm)	
		At harvest	Over all mean	At harvest	over all mean
Control	-	4.9		46.6	
Hand weeding	25 DAS	5.2		50.6	
Fluchloralin	0.75	5.3		44.8	
Fluchloralin	1.00	5.5	5.53	46.2	
Fluchloralin	1.25	5.8		47.3	46.10
Pendimethalin	1.00	5.1		44.77	
Pendimethalin	1.25	5.5	5.30	47.8	46.26
Pendimethalin	1.50	5.3		46.2	-
SE(m)±	-	0.16		1.06	
CD(0.05)	-	0.4		3.10	

increasing doses of both fluchloralin and pendimethalin.

4.2.7 Dry matter and harvest index

The data on extent of dry matter accumulation and also the harvest index recorded at maturity were presented in Table 15. It was observed that the dry matter accumulation varied significantly amongst the different treatments, the maximum being recorded in fluchloralin and the lowest with control. In both the herbicide treatments, the dry matter accumulation was in its peak at the lowest dose of the chemical which gradually declined as the concentration increased. The hand weeded plot was also found to be superior to the control. On the other hand, no significant variation was recorded among the treatments in respect of harvest index . The order in which the harvest index varied was between 50.5 to 52.93%. The maximum value of harvest index was obtained in hand weeded (52.93%) followed by fluchloralin (51.22%), control (50.86%) and pendimethalin (50.5%). On contrary to dry matter, this character tended to increase, of course nonsignificantly, with increasing doses of the herbicides.

4.2.8 Yield and its attributes

Final pod yield and its accessory parameters viz., number of pods, pod weight, kernel weight, 100 kernel weight,shelling(%) etc. were recorded and presented in Table 16 and 17 . The number to pods/plant was significantly higher in fluchloralin and pendimethalin than hand weeding and control plants. The former two were statistically at par with each other

Table 15. Dry matter(g) accumulation at harvest and and harvest index(%) of groundnut cv. Ak 12-24 in response to varying levels of fluchloralin and pendimethalin.

Treatment	Dose Kg ai/ha	Dry matter(g)		Harvest Index(%)	
		At harvest	over all mean	At harvest	over all mean
Control	-	21.45		50.86	
Hand weeding	25 DAS	24.01		52.93	
Fluchloralin	0.75	30.73		49.80	
Fluchloralin	1.00	28.11	28.29	51.63	51.22
Fluchloralin	1.25	26.03		52.23	
Pendimethalin	1.00	29.69		48.97	
Pendimethalin	1.25	25.98	26.63	50.07	50.50
Pendimethalin	1.50	24.23		52.47	
SE(m)±	-	0.37		1.62	
CD(0.05)	-	1.13		4.77	

while the latter two treatments varied significantly. The lowest concentration of both the chemicals gave higher number of pods than their highest ones. Similarly, pod weight and kernel weight were recorded maximum in fluchloralin and pendimethalin and the minimum being recorded in control. In both the cases, hand weeding lied in between these treatments. The values in respect of both kernel weight and pod weight were found to be consistent, both decreasing at higher doses of the herbicides.

With regards to 100-kernel weight, the same was higher in fluchloralin (39.63g) followed by hand weeding (39.1g), pendimethalin (37.87g) and the weedy check (36.9g). No significant variation was observed amongst fluchloralin, pendimethalin and hand weeding treatments. The highest concentration of both fluchloralin and pendimethalin resulted decrease in 100 kernel weight significantly over their lowest concentrations.

As regards the pod yield was highest in fluchloralin followed by pendimethalin, hand weeded and the control. The variation among the former three treatments was statistically non-significant. The control treatment produced significantly lowest yield as compared to other weed free treatments. In both the herbicidal treatments, the pod yield decreased with increase in concentrations of chemicals. On the other hand, the highest shelling percentage was obtained in hand weeded treatment. The shelling percentage between the two herbicide treatments were statistically at par and both were superior to controlled treat-

Table 16. Number of pods, pod weight(g) and kernel weight(g) per plant of groundnut cv. AK 12-24 at harvest in response to varying levels of fluchloralin and pendimethalin.

Treatment	Dose Kg ai/ha	Number of pods/plant		Pod weight (g/plant)		Kernel weight (g/plant)	
			Overall mean		Overall mean		Overall mean
Control		12.20 (0)		10.9 (0)		7.80 (0)	
Hand weeding		15.60 (27.9)		12.7 (16.5)		10.2 (30.8)	
Fluchloralin	0.75	19.8 (62.3)		15.3 (40.4)		11.73 (50.4)	
Fluchloralin	1.00	19.5 (59.8)	18.33 (50.2)	14.5 (33.0)	14.47 (32.8)	11.10 (42.3)	11.13 (42.7)
Fluchloralin	1.25	15.7 (28.7)		13.6 (24.8)		10.57 (35.5)	
Pendimethalin	1.00	19.7 (61.5)		14.5 (33.0)		10.53 (35.0)	
Pendimethalin	1.25	17.6 (44.3)	17.87 (46.5)	13.0 (19.3)	13.41 (23.0)	9.8 (25.6)	10.03 (28.6)
Pendimethalin	1.50	16.30 (33.6)		12.7 (16.5)		9.77 (25.3)	
SE(m)±	-	0.56		0.33		0.44	
CD(0.05)	-	1.63		0.98		1.2	

(Figures in parenthesis indicate the increase or decrease over control)

Table-17. Hundred kernel weight(g),pod yield(q/ha) and shelling percent(%) of groundnut cv. AK 12-24 in response to varying level of fluchloralin and pendimethalin.

Treatment	Dose Kg ai/ha	100 Kernel weight (g)		Pod yield (q/ha)		Shelling(%)	
			Overall mean		Overall mean		Overall mean
Control		36.90 (0)		13.1 (0)		71.6 (0)	
Hand weeding		39.10 (6.0)		17.8 (35.9)		80.0 (11.7)	
Fluchloralin	0.75	40.5 (9.8)		20.3 (55.0)		76.50 (6.8)	
Fluchloralin	1.00	40.2 (9.0)	39.63 (7.4)	18.1 (38.2)	18.70 (42.7)	76.60 (7.0)	76.93 (7.4)
Fluchloralin	1.25	38.2 (3.5)		17.7 (35.1)		77.70 (8.5)	
Pendimethalin	1.00	40.0 (8.4)		20.0 (52.7)	18.0 (37.4)	74.20 (3.6)	75.50 (5.4)
Pendimethalin	1.25	37.8 (2.4)	37.87 (2.6)	17.2 (31.3)		75.4 (5.3)	
Pendimethalin	1.50	35.8 (3.0)		16.8 (28.2)		76.90 (7.4)	
SE(m)±	-	0.81		0.40		1.54	
CD(0.05)	-	2.40		1.23		4.68	

ment. No significant variation was noticed in respect of shelling percentage among the concentrations of both fluchloralin and pendimethalin.

4.2.9 Nitrogen and crude protein content in kernel and harvested protein

Table 18. indicates the nitrogen and crude protein content in kernel as well as the harvested protein of groundnut. Both nitrogen and crude protein content in kernel were higher in control followed by hand weeding, fluchloralin and pendimethalin treated plants. The latter (pendimethalin) had significantly lower nitrogen content than the former three treatments which were statistically at par to each other. In contrast, the crude protein content in kernel amongst the treatments varied significantly, the lowest being recorded in pendimethalin treated plants. Albeit, no significant variation was seen among different concentrations of weedcides so far as these two attributes were concerned, nevertheless, the lowest concentrations seemed to be superior to their highest concentrations.

The harvested protein (q/ha), computed from the pod yield and crude protein, was highest in fluchloralin (5q.) followed by hand weeding (4.9q), pendimethalin (4.7q) and weedy check having the significantly lowest value (3.8q.) . The former three treatments were statistically at par to each other. With increasing concentration of the weedicides, both fluchloralin and pendimethalin, crude protein content in kernel declined.

Table-18. Nitrogen(%) and crude protein(%) in kernel, and harvested protein(q/ha) groundnut cv. AK 12-24 in response to varying levels of fluchloralin and pendimethalin.

Treatment	Dose Kg ai/ha	Nitrogen in kernel (%)		Crude protein in kernel(%)		Harvest protein (q/ha)	
			Overall mean		Overall mean		Overall mean
Control		4.57 (0)		28.77 (0)		3.8 (0)	
Hand weeding		4.40 (-3.7)		27.5 (-4.4)		4.9 (28.9)	
Fluchloralin	0.75	4.4 (-3.7)		27.53 (-4.3)		5.60 (47.4)	
Fluchloralin	1.00	4.3 (-5.9)	4.29 (-6.1)	26.9 (-6.5)	26.91 (-6.5)	4.90 (28.9)	5.00 (31.6)
Fluchloralin	1.25	4.17 (-8.8)		26.3 (-8.6)		4.60 (21.1)	
Pendimethalin	1.00	4.17 (-8.8)		26.33 (-8.5)		5.30 (39.5)	4.70 (23.7)
Pendimethalin	1.25	4.13 (-9.6)	4.19 (-8.3)	25.4 (-11.7)	25.69 (-10.7)	4.4 (15.8)	
Pendimethalin	1.50	4.27 (-6.6)		25.33 (-12.0)		4.30 (13.2)	
SE(m)±	-	0.13		0.15		0.14	
CD(0.05)	-	0.37		0.44		0.40	

4.2.10 Oil Content and harvested oil

Oil content in kernel and the harvested oil (extrapolated from oil content and pod yield) were depicted in Table 19. While no significant variation was observed in respect of oil content among the treatments, the harvested oil varied significantly. Both oil content and harvested oil were highest in hand weeded treatment, the lowest being recorded in pendimethalin and control treatments respectively. Although no consistency was maintained among the concentrations of both the herbicides, nontheless, the values of both the attributes were lowest at their highest concentrations.

4.2.11 Seed viability and germination

To assess the residual effect of both the herbicides it was necessary to test the viability and germinability of the harvested seeds. Hence, observations were taken on dehydrogenase activity and the percent germination of the kernel after three weeks of the harvest (Table 20). Both the parameters were found to decline in herbicidal treatments. The same was highest in hand weeded treatment followed by control, fluchloralin and pendimethalin. With increase in concentrations of weedicides, both the enzyme activity and germination percent increased in fluchloralin treatment while in pendimethalin these parameters were found to decrease.

4.3 Comparative economics

It was revealed from the data under Table 21.that

Table-19. Oil content(%) in kernel and harvest oil(q/ha) of groundnut cv. Ak 12-24 in response to varying levels of fluchloralin and pendimethalin.

Treatment	Dose Kg ai/ha	Oil(%) in kernel		Harvest oil(g/ha)	
			Overall mean		overall mean
Control	-	46.75 (0)	-	6.10 (0)	-
Hand weeding	-	49.30 (5.6)	-	8.80 (44.3)	-
Fluchloralin	0.75	43.90 (-6.0)	-	8.90 (45.9)	-
Fluchloralin	1.00	49.60 (6.2)	46.73 (0)	8.97 (47.0)	8.71 (42.8)
Fluchloralin	1.25	46.70 (0)	-	8.27 (35.6)	-
Pendimethalin	1.00	43.10 (-7.7)	-	8.62 (41.3)	-
Pendimethalin	1.25	47.10 (0.9)	43.77 (-6.3)	8.10 (32.8)	7.87 (29.0)
Pendimethalin	1.50	41.10 (-12.0)	-	6.90 (13.1)	
SE(m)±	-	1.86		0.44	
CD(0.05)	-	5.47		1.34	

Table-20 Dehydrogenase activity in kernel and germination(%) of groundnut cv. Ak 12-24 in response to varying levels of fluchloralin and pendimethalin.

Treatment	Dose Kg ai/ha	Dehydrogenactivity	Overall mean	Germination(%)	overall mean
Control		0.236 (0)		90 (0)	
Hand weeding		0.240 (1.7)		92 (2.2)	
Fluchloralin	0.75	0.206 (-12.7)		80 (-11.1)	
Fluchloralin	1.00	0.238 (0.8)	0.232 (-1.7)	90 (0)	88.7 (-1.4)
Fluchloralin	1.25	0.253 (7.2)		96 (6.7)	
Pendimethalin	1.00	0.222 (-5.9)		86 (-4.4)	
Pendimethalin	1.25	0.197 (-16.5)	0.202 (-14.4)	78 (-13.3)	78.7 (12.6)
Pendimethalin	1.50	0.187 (-20.8)		72 (-2.0)	
SE(m)±	-	0.001	Mean=	85.5	
CD(0.05)		0.004	S.D.=	7.6	
			C.V.=	8.9	

Table-21. Comparative economics of different weed management practices.

Treatment	Cost incurred towards weeding(Rs./ha)	Price of produce Rs.in thousand/ha	Cost of extra yield (Rs.)	Net profit over control
Control	-	13.1	-	-
Hand weeding	1250	17.8	4,700	3,450
Fluchloralin @0.75kg/ha	559	20.3	7,200	6,641
Fluchloralin @1.00kg/ha	697	18.1	5,000	4,303
Fluchloralin @1.25kg/ha	848	17.7	4,600	3,752
Pendimethalin @1kg/ha	891	20.0	6,900	6,009
Pendimethalin @1.25kg/ha	1084	17.2	4,100	3,016
Pendimethalin @1.5kg/ha	1275	16.8	3,700	2,425

Cost of herbicide : Fluchloralin- Rs. 260/lit.
Pendimethalin- Rs. 230/lit.
Manday - Rs. 25/day.

highest net profit over control was recorded in treatment with fluchloralin @ 0.75Kg/ha.Use of pendimethalin @ 1.00 Kg/ha resulted in net profit of Rs.6009/ha over control and second in order. However, a net profit of Rs.3450/ha over control was observed in hand weeding treatment. Minimum net profit of Rs.2425/ha over control was incurred under the treatment with pendimethalin @ 1.5 Kg/ha.

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CHAPTER - V

DISCUSSION

D I S C U S S I O N

In the present investigation the effect of most popular and systemic herbicides like fluchloralin and pendimethalin on weed flora as well as growth and development of groundnut was assessed. The most important aspects viz. physiological growth parameters, yield and yield attributing characters, leghaemoglobin and chlorophyll content, nitrate reductase activity , oil and protein content and moreover, the bionomics of associated weed were studied. The literatures available on the above aspects are very scanty and what ever the reports avaiable are mainly aimed at agronomical rather than physiological and biochemical studies. Hence, an attempt has been made here to correlate and corroborate the present revealings with the findings of available reports and results.

5.1 Weed Studies

5.1.1 Weed flora

On close examination of weed association from sowing till maturity of the crop revealed that there were as many as twelve different types of weeds in the groundnut field (Table 4). From numerical assessment it was noted that both grasses and broad leaved weeds found dominant in the crop field.

Amongst five grassy weeds, the predominant among them were Cynodon dactylon, Echinochloa colona, Digitaria sanguinalis, Dactylotenium acgyptium were the dominant and observed throughout

the crop growth period. Out of 6 broad leaved weeds, Cleome viscosa, Acanthospermum hispidum, Croton sparciflorus and Crozofera rotteleri were identified as dominant which infested the crop severely during the growth period. In the later part of the growth the broad leaved weeds suppressed the grasses. Among sedges only Cyperus rotundus was found dominant and their growth was continued till the maturity of the crop. An overall appraisal of the occurance of the weeds would indicate that all categories of weeds decreased with the advancement of crop growth which could be possibly due to the suppressive effect of the crop canopy.

5.1.2 Weed population

An overall assessment of various herbicidal performance would indicate that during earlier stages of crop growth, all levels of herbicides drastically knocked down the grassy weed population except Cynodon dactylon and partially effective against annual broad leaved weeds such asCleome viscosa and Acanthospermum hispidum and proved significantly superior over unweeded control.

In case of manually weeded plots, weeds were removed and thus proved beneficial at latter stages of growth as hand weeding was done at 25 DAS. Further soil incorporation of fluchloralin at all rates of application exhibited wide spectrum of activities and effectively control grassy weeds and to some extent broad leaved weeds. These results were in agreement with

the findings of Rajan et al. (1979). This might be ascribed to the effect of fluchloralin through its better absorption by emerged seedlings and its persistence in the soil as a result of which the crop grow under weed free condition. Significant difference was not found among various levels of fluchloralin and pendimethalin in respect of controlling weeds. However, fluchloralin @1.25 kg/ha and pendimethhalin @1.5kg/ha showed satisfactory results till maturity in this respect. These results are in agreement with those reported by Maurya et al.(1990) in soyabean crop.

These berbicides at different doses could not control Cyperus rotundus which might be due to the fact that these chemicals are only sparingly soluble in water and the dose used in this experiment might not have reach the desired soil depth in quantities toxic to sedges on absorption and translocation to plant tissues. The annual grassy weeds were effectively controlled presumably due to the fact that, their root systems were combined to the top soil layer and consequently the chemicals were absorbed by them.

With respect to control of broad leaved weed, both the herbicides failed to control Crozofera rottelari and Croton sparsiflorus. This coroborates the findings of Prasad et al. (1987) The various levels of both the herbicides exhibited lower performance in respect to control of sedges which might be due to low solubility of herbicides.

5.1.3 Weed dry weight

Weed population alone may not necessarily always represent a true and realistic picture of crop-weed competition and their relationship,. If we evaluate the dry weight of weeds at various stages of crop growth, the results will be still more revealing. The unweeded control had the maximum weed dry weight throughout the crop growth period due to unhindered growth of weeds associated with the crop. The dry matter production of weeds varied with the weed control efficiency of various treatments. In general the weed dry weight increased with the enhancement of crop growth. But a comparative evaluation of relative efficiency during the various crop growth stages would evince the superiority of pendimethalin use @1.5kg/ha in effectively reducing the weed growth, while both the herbicides fluchloralin and pendimethalin at varying levels noted significant reduction in weed biomass in the early stages of crop growth. This could be obviously due to the toxic action of herbicides in hindering the growth of the predominant weeds. Further this results confirms the findings of Jain et al.,1991.

5.1.4 Weed control efficiency (WCE)

Pendimethalin at 1.5kg/ha recorded the highest weed control efficiency among all the treatments through out the crop period.The other treatments like hand weeding,pendimethalin @1.25kg/ha,fluchloralin @1.25kg/ha, fluchloralin @ 1kg/ha and 0.75/ha were in order of their merit in this respect during early

stages of crop growth, but their performance decreased with the advancement of crop growth. This might be probably due to the degradation of herbicides in the soil at later stages and also phasic germination of weed seeds during the crop growth period.

5.2 Crop Studies

5.2.1 Seed emergence

The seedling counts taken at three different sampling stages indicated that seed emergence is more in pendimethalin than the other treatments, the lowest being recorded in fluchloralin. The reduction in seed emergence in fluchloralin as compared to other treatments is to the tune of 8.85 to 12.82 % which might be due to the phytotoxic effect of the herbicide. The adverse effect of this herbicide has not been reported elsewhere in groundnut (Singh et al,1980,Geethalakhmi et al., 1989, Shelke et al., 1991) but has been reported in sesamum (AICRP,1991). Similarly inhibition of rice seed germination by 2,4-DEE (Emmanuvel et al.,1991) and groundnut germinatioin by nitrofen (Reddy et al.,1978) explains the phytotoxic effect of the herbicides on seed emergence.

5.2.2 Growth parameters

The various physiological growth parameters viz., dry matter of root and shoot, shoot to root ratio, RGR, CGR and LAI are greatly affected due to the herbicidal applications (Table 2 & 3). Both fluchloralin and pendimethalin were found to stimulate most of the above growth parameters at their lowest concen-

trations with exception to shoot to root ratio and LAI Nonetheless, the lowest value was always obtained in weedy check as compared to other treatments. The present findings strongly agrees to the results of Pahwa and Prakash(1992), Patel et al.(1990), Pannu et al.(1989) in groundnut. The highest CGR and RGR values obtained at 60-80 d suggests the maximum increase in crop vigour in this date as compared to rest of the sampling dates(Tosh and Mishra, 1977).

In respect of both number of branches and plant height(Table-6), the variation among the treatments was found to be minimum. Nevertheless fluchloralin and hand weeded resulted in higher number of branches and plant height respectively than their control. The present finding is in agreement with the results of both Selvamani and Sankaran,(1989) and Kondap et al.(1989) in groundnut who obtained approximately twice the number of braches in herbicidal treatments compared to weedy check.

The other two prime growth parameters like dry matter and harvest index were seen to be influenced greatly by the application of both the herbicides. Keeping all the growth parameters in view already discussed erstwhile, it is quite natural to obtain a significant diffence in respect of both these parameters among the treatments compared to the control. In both the cases fluchloralin exhibited its superiority over pendimethalin. In the present finding the dry matter gradually decrease with increase in concentration of herbicide (Sairam et al.,1988) while

the harvest index increases.

5.2.3 Nodulation and leg-haemoglobin

Although nodule number, nodule dry weight and leg-haemoglobin content in nodules at various sampling stages were higher in fluchloralin than in pendimethalin treatments, hand weeded plants exhibited its suprimacy over all the treatments. Decrease in nodulation and leg-haemoglobin content with increasing levels to herbicides(Pahwa and Prakash, 1992) might be due to adverse effect of the higher concentration of the herbicides on metabolic activities of the nodules . Reports pertaining both stimulation (Rankov et al., 1966, Sidhu et al.,1985) and inhibition(Malavia and Patel, 1989, Novo et al., 1990,) in different legume crops are also available. In the present findings there was enhancement in nodule number and nodule dry weight in fluchloralin and pendimethalin over the control to the tune of 46 to 19% and 58 % to 5% respectively.

5.2.4 Chlorophyll and Nitrate Reductase Activity

The primary plant process like photosynthesis is greatly regulated by the concentration of various pigments in the leaves the major constituent being chlorophyll. It is observed that in the present finding the chlorophyll content significantly differs amongst the various treatments, the maximum and the minimum values being registered in hand weeded and pendimethalin tratements respectively . From the present findings,it seems to be clear that pendimethalin has got more

adverse effect than fluchloralin so far as the biosynthesis of chlorophyll is concerned. Several reports (Burns et al., 1971,Pahwa and Prakash, 1992) indicating the interference of these chemicals on de novo synthesis of chlorophyll in different crops confirm the present finding . Further the phytotoxic effect of these herbicides increases with increasing concentration as is observed in our investigation.The decrease in total chlorophyll might be due to concomitant decrease in chlorophyll-b(Ben- Aziz and Koren, 1974) the synthesis of which is greatly affected than chlorophyll-a under herbicidal treatment.

To ascertain the effect of herbicides at cellular level, one of the most important key enzymes of plant nutrition,nitrate reductase activity in leaves was determined. The activity taken at lone sampling date does not indicate any inhibitory effect of the chemical on enzyme, compared to that of control rather fluchloralin and pendimethalin ranked first and second respectively in respect of the activity of the enzyme . Though the activity of the enzyme increases with increase in levels of herbicides the variation among them was statistically insignificant. Increase in NRA has also been reported in Pea(Wu et al., 1971), corn (Suseela and Perur, 1982) and Sorghum (Sairam et al., 1988) in response to different systemic herbicides. The reason for enhancement in enzymatic activity might be attributed to absorption of a good amount of soil nitrate by the crop plant in the absence of weeds which have been swept away by the appli-

cation of herbicides.

5.2.5 Yield and Yield Attributes

The yield characters like number of pods, pod weight, kenel weight, 100 kernel weight and pod yield increase substantially in fluchloralin compared to rest of of the treatments. And even in most of the cases pendimethalin surpassed the hand weeding. In respect of number of pods, pod weight and kernel weight the increase is in order of 27.9 to 63.3%, 16.5 to 40.4% and 25.3 to 50.4% respectively over their control(Selvamani and Sankaran 1989,Kondap et al.,1989). Between fluchloralin and pendimethalin there was reduction in aforesaid yield parameters to a tune of 40 to 50 % suggesting the phytotoxic nature of the herbicides at their highest concentration(Ravikumar and Krishnna Reddy , 1989).

In respect of kernel weight, the variation among the treatments was found to be very meagre. The trend was more or less similar to the parameters already discussed (Kondap et al.,1989, Ravikumar and Krishnna Reddy, 1989). In contrast, the finding of Kumar and Kairon(1988) reveals that pendimethalin results in higher grain weight than fluchloralin in summer mung bean.

All the yield attributes discussed earlier, as a whole, reflected the pod yield (q/ha) in groundnut.The variation in pod yield among the treatmentas was in order of 3.7 to 7.2 q/ha. The overall mean value indicates approximately, 40% in-

crease in pod yield in herbicidal treatments over the control. Even the yield obtained at the higher does of herbicides was superior to weedy check (control).Substantial increase in pod yield has also been reported in groundnut(Selvamani and Sankaran,1989;Ravikumar and Krishana Reddy,1989, Jain et al., 1991), due to herbicidal treatment to which the present finding strongly agrees.However, these authors have reported higher pod yield in hand weeding than the herbicidal treatments, contradicting our findings.

Weedy check registered lowest shelling percentage compared to other treatments however, the variation among them was very minimum, fluctuating between 3.6 to 11.7%. The percent shelling efficacy was more in hand weeding than fluchloralin and pendimethalin. The reason for this highest shelling effeciency in hand weeding is not known and needs further experimentation.

5.2.6 Seed quality (protein and oil)

The effect of herbicide on seed quality was assessed for which the biochemical parameters like nitrogen, crude protein and oil percent in kernel as well as harvested protein and harvested oil were determined. Both nitrogen and crude protein content were highest in control while hand weeding registered higher oil content than the other treatments. The decline in nitrogen and crude protein content in various treatments has not been reflected in harvested protein because the same was highest in fluchloralin followed by hand weeding and pendimethalin. The

apparent increase in nitrogen and crude protein content in control might be due to the lowest accumulation of dry matter as has been pointed out earlier. Reports pertaining both decrease (Pahwa and Prakash, 1992) and increase (Patel et al. 1987) in protein content with herbicidal treatements in groundnut confirm the present revealing with slightest exceptions.

Unlike nitrogen and protein, the oil content in kernel was higher at second dose of fluchloralin(49.6%) nearly equals to hand weeding(49.3%) compared to other treatments.The decrease in oil content in control over other treatments was in tune of 0.9 to 6.2%. It is well convincing from the present findings that fluchloralin stimulates oil biosynthesis, hence increases seed quality (Patel et al., 1987;Girijesh and Patil, 1989) whereas the same was found to be affected in pendimethalin. Increase in seed quality has also been reported (Dhindsa et al.,1972;Singh et al.,1980) in groundnut with the application of different herbicides coroborating the present research.

On the other hand, both the harvested protein and harvested oil obtained, through extrapolation, were higher in fluchloralin and hand weeding respectively.However the values obtained in hand weeding, fluchloralin and pendimethalin did not differ significantly among themselves.Both the traits were lowest in control varied by a margin of 4.4 to 47.4% and 13.1 to 47.0% respectively. Enhancement in harvested protein and harvested oil might have been resulted from the concomitant increase

in pod yield due to the treatments in groundnut.

5.2.7 Seed germinability and viability

To assess the effect residual herbicides on germinability and viability of groundnut, observations on dehydrogenase activity and the germination count were recorded after three weeks of harvest. Both the traits drastically reduced in pendimethalin than the other treatment and the variation among the latter three treatments was found to minimum. This suggests the residual effect of fluchloralin is much less on aforesaid characters compared to pendimethalin, the toxic effect of which has already been noticed in most of the important parameters discussed erstwhile.

5.3 Comparative economics

Keeping all the facts in mind the economics of the present investigation was determined (Table). The net dividend obtained in fluchloralin was substantially higher than rest of the treatements. In spite of phytotoxicity nature of pendimathalin it also resulted in better dividend than hand weeding. In the present study it is well established that, herbicidal treatment, especially with fluchloralin (0.75 kg/ha) in groundnut would yield higher without affecting much of its germinability and viability.

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CHAPTER - VI

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

A field experiment was conducted at the Central Research Station, O.U.A.T.,Bhubaneswar, during Rabi 1993-94 to find out the effect of systemic herbicides like fluchoralin and pendimethalin, on associated weeds as well as the growth and development of groundnut. The experimental findings of the present study was summerised briefly under following titles:

6.1 Weed Studies

6.1.1 Study on weed flora

The floristic composition of the experimental plot revealed that altogether 12 differeent weeds species among which five grassy, six broad leaved and only one sedge were found.

6.1.2 Species wise weed control(%)

Fluchloralin and pendimethalin controlled the grassy weeds fully. Among the broad leaved weeds Cleome viscosa and Acanthospermum hispidum were controlled to the tune of 50 - 77% whereas Croton sparsiflorus and Crosofera rottleri were found resistant to both the herbicides. Similarly, perennial weeds such as Cynodon dactylon and Cyperus rotundus were also resistant to these herbicides.

6.1.3 Total weed population

Use of fluchloralin and pendimethalin irrespective of their doses proved better in reducing weed density with the later having a edge over the former. At different sampling stages such as 20, 40 and 80 DAS this trend continued and proved superior

to unweeded control in reducing the weed population.

6.1.4 Dry weight of weeds

The total dry weight of weeds was maximum in unweeded control at all the stages of crop growth. Among both the herbicides pendimethalin accumulated lowest dry matter which was even lower than hand weeding plot at 80 DAS and at harvest. Increasing doses of both herbicides reduced the dry matter production consistently.

6.1.5 Weed control efficiency

The weed control efficiency of different doses of pendimethalin maintained its superiority over different doses of fluchloralin and even over hand weeding till harvest of the crop except at 40 DAS. However, the higher level of herbicides were more efficient in controlling the weeds than their lower levels.

6.1.6 Weed Index

The unweeded control recorded the maximum weed index value 35.5% whereas the minimum (1.5%) was due to the application of pendimethalin @1.0 kg/ha.

6.2 Crop studies

6.2.1 Seed emergence

Pendimethalin was seen to be significantly superior to all other treatments in respect of groundnut seed emergence. The lowest concentration of pendimethalin was found to be better than others.

6.2.2 Dry matter of Root, Shoot and Shoot to Root Ratio

Both the herbicides viz. fluchloralin and pendimethalin exhibited significantly higher root and shoot dry matter as well as shoot to root ratio than hand weeded and control. In both the cases lower concentration registered highest dry matter accumulation which declined consistently with increasing concentrations.

6.2.3 Nodulation

The effect of fluchloralin on both nodule number and nodule dry weight was significantly superior to pendimethalin,irrespective of concentrations and sampling stages. But these two parameters were highest in hand weeded compared to other treatments.

6.2.4 Chlorophyll, Nitrate Reductase Activity and Leg-haemoglobin content

The total chlorophyll content was significantly higher in hand weeding (1.87 mg) which was at par with the fluchloralin (1.8 mg). Similar relationship was also obtained in case of control (.1.6 mg) and pendimethalin (1.59 mg).

The activity of nitrate reductase enzyme was significantly higher in fluchloralin treated plants than others which increased with increase in concentrations of the herbicides.

Maximum leg-haemoglobin content in nodules was observed in hand weeded (5.9 mg) plants followed by fluchloralin (5.0 mg), control (4.7 mg) and pendimethalin (4.33 mg).

6.2.5 Relative Growth Rate (RGR), Crop Growth Rate (CGR) and Leaf Area Index (LAI)

There was no significant variation observed among the treatments in respect of RGR. Further, with increasing concentrations of the herbicides no consistent results were obtained in any of the treatments.

On contrary, the CGR value was maximum in pendimethalin followed by fluchloralin, which was significantly higher compared to hand weeeding and control treatments.

With regards to LAI spectacular results were obtained in fluchloralin treatment and with increase concentrations of herbicides the LAI value significantly increase in all the treatments.

6.2.6 Number of Branches and Plant Height

The fluchloralin treated plants had higher number of branhes (5.53) followed by pendimethalin (5.3), land weeding (5.2) and control (4.9) whereas hand weeding (50.6 cm) had the maximum plant height followed by control, (46.6 cm) pendimethalin (46.26 cm) and fluchloralin (46.1 cm).However, no consistency was observed in respect of both the parameters with increasing doses of herbicides.

6.2.7 Dry matter and Harvest Index

The dry matter accumulation at harvest was maximum in fluchloralin treated plants and minimum in control. The lowest concentrations of both the herbicides accumulated highest dry matter declining with their increasing doses.

As regards the harvest index, no significant variation was observed among the treatments which lies in the ranges between 52.93 (hard weeding) to 50.50% (Peendimethalin). This character tended to increase,although non-significant with increasing doses of herbicides.

6.2.8 Yield and Yield Attributes

The number of pods per plant was statistically at par in fluchloralin and pendimethalin treated plants but significantly higher than hand weeded and control plants. Both the chemicals produced higher number of pods at their lowest concentration. Similar relationship was also observed in respect of pod weight. But in case of kernel and 100-kernel weight the maximum value was observed in fluchloralin followed by hand weeding, pendimethalin and control. No significant variation with respect to kernel weight per plant and 100-kernel was obtained between hand weeding and pendimethalin as well as within fluchloralin and hand weeding treatments. However, all the above yield attributing characters decrease with increase levels of both fluchloralin and pendimethalin.

As regards the pod yield was highest in fluchloralin followed by pendimethalin, hand weeding and the control. The control treatment produced yield which was highly significant to other treatments. The former three treeatments were non-significant to each other. In both the herbicidal treatments, the pod yield decrease with increase levels of these chemicals.

On the other hand, highest shelling percentage was found in hand weeded treatment and this character was statistically at par to the herbicides besides superior to the weedy check.

6.2.9 Nitrogen and crude protein content in kernel and harvested protein

Both nitrogen and crude protein content in kernel were higher in control followed by hand weeding, fluchloralin and pendimethalin treated plants. Besides, there was no significant variation observed between different doses of herbicides in respect of these two parameters.But the harvested protein obtained through extrapolation from the crude protein in kernel and pod yield, was highest in fluchloralin (5q/ha) followed by hand weeeding (4.99/ha), pendimethalin (4.79/ha) and weedy check (3.89/ha). Although the former three treatments did not varied significantly among themselves, the latter one showed significant reduction in protein yield.

6.2.10 Oil content and harvested oil

While no significant variation was observed in respect of oil content among the treatments, the harvested oil varied significantly. Both oil content and harvested oil were highest in hand weeded treatment, the lowest being recorded in control. No consistency was maintained among the concentrations of both herbicides.

6.2.11 Seed viability and germination

Both the dehydrogenase activity and germination of the kernel were found to increase with increasing levels of fluchloralin whereas reverse trend was observed in pendimethalin. Besides,application of herbicide resulted in decreased dehydrogenase activity and germination percent than the hand weeding and control.

6.3 Comparative economics

From the economic point of view application of fluchloralin was profitable than pendimethalin and hand weeding.The lowest dose of both fluchloralin and pendimethalin gave profit of Rs.6641.00/ha, Rs.6009.00/ha whereas highest dose incurred Rs.3752.00/ha and Rs.2425.00/ha.

C O N C L U S I O N

It was concluded from the present study that most of the prime physiological and biochemical traits of groundnut cv.AK 12-24 were stimulated due to herbicidal treatments. Between the two herbicides, fluchloralin was seen to be better than pendimethalin,espcially at its lowest dose(0.75 kg/ha), in respect of aforesaid characters. Moreover, the pod yield (q/ha) and its attributes were significantly higher in fluchloralin than the others treatments, although its weed killing effciency was lower than pendimethalin. Hence the present finding reveals the more phytotoxic nature of pendimethalin compared to fluchlor-

alin as it adversely affects the various parameters.In the context of above revealings,it is concluded that application of fluchloralin (0.75 kg/ha) would enhance the various growth biometrics, metabolic activities and above all, the pod yield in groundnut keeping its weed killing efficiency and its economics in mind.

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ABBREVIATIONS USED

a.i.	...	Active ingradient
BLW	...	Broad leaved weed
CD	...	Critical difference
C	...	Degree Centrigrade
cm	...	centimetre
CGR	...	Crop growth rate
DAS	...	Days after sowing
DAA	...	Days after application of herbicides
DBS	...	Day before sowing
DMP	...	Dry matter production
EC	...	Emulsifiable concentratee
g	...	Gram
g/m^2	...	Gram per square meter
ha	...	Hectare
HI	...	Harvest Index
i .e	...	That is
HW	...	Hand weeding
kg	...	Kilogram
kg/ha	...	kilogram per hectare
kg a.i./ha	...	Kilogram Active Ingradient per hectare.
LAI	...	Leaf area Index.

Lb	...	Pounds
LD_{50}	...	Lethal dose to kill 50% of the population
mm	...	mullimetre
mg	...	milligram
MOP	...	Muriate of Potash
N	...	Nitrogen
NS	...	Non Significant
O.M	...	Over all mean
P	...	Phosphurus
PE	...	Pre-emergence
ppm	...	Parts per million
q	...	Quintal
SE(m)	...	Standard Error of Mean
PPI	...	Preplanting incorporation.
Sqm	...	Square meter
SPP	...	Species
SSP	...	Single super Phosphate
U.W.C.	...	Unweeded control
Viz.	...	such as
WCE	...	Weed Control Efficiency
WI	...	Weed Index
WP	...	Wettable Powder
@	...	At the rate of
%	...	per cent

±	...	plus or minus
=	...	Equal to
&	...	And
>	...	Greater than
<	...	Less than
√	...	Square root
Σ	...	Summation
( )	...	Parenthesis