

EFFECT OF HERBICIDES AND CROP WEED
COMPETITION ON PHYSIOLOGICAL ASPECTS OF
DIVERSE GROUNDNUT (*Arachis hypogaea* L.) CULTIVARS

SHIVAKUMAR M. HIREMATH



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**EFFECT OF HERBICIDES AND CROP WEED
COMPETITION ON PHYSIOLOGICAL ASPECTS OF
EARLY SEASON PEARL MILLET (Arachis hypogaea L.) CULTIVARS**

BY
SHIVAKUMAR M. HIREMATH

THESIS SUBMITTED TO THE
ANDHRA PRADESH AGRICULTURAL UNIVERSITY
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF
DOCTOR OF PHILOSOPHY

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1990

CERTIFICATE

Mr. SHIVAKUMAR M. HIREMATH has satisfactorily prosecuted the course of research and that the thesis entitled "EFFECT OF HERBICIDES AND CROP WEED COMPETITION ON PHYSIOLOGICAL ASPECTS OF DIVERSE GROUNDNUT (*Arachis hypogaea* L.) CULTIVARS" submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part thereof has not been previously submitted by him for a degree of any University.

Date : 29-3-1990


(Dr. A. SHIV RAJ)
Major Advisor

CERTIFICATE

This is to certify that the thesis entitled "EFFECT OF HERBICIDES AND CROP WEED COMPETITION ON PHYSIOLOGICAL ASPECTS OF DIVERSE GROUNDNUT (*Arachis hypogaea* L.) CULTIVARS" submitted in partial fulfilment of the requirements for the degree of **Doctor of Philosophy** in Agriculture, of the Andhra Pradesh Agricultural University, Hyderabad, is a record of the bonafide research work carried out by **Mr. SHIVAKUMAR M. HIREMATH** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee.

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

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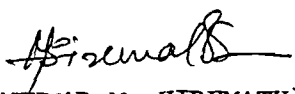
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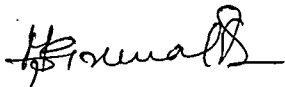
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(SHIVAKUMAR M. HIREMATH)

DECLARATION

I, Shivakumar M. Hiremath, hereby declare that the thesis entitled "EFFECT OF HERBICIDES AND CROP WEED COMPETITION ON PHYSIOLOGICAL ASPECTS OF DIVERSE GROUNDNUT (*Arachis hypogaea* L.) CULTIVARS" is the result of the original research work done by me. I, further, declare that the thesis or any part thereof has not been published earlier elsewhere in any manner.

Date : 3 - 4 - 1990


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Title : Effect of herbicides and crop weed competition on physiological aspects of diverse groundnut (*Arachis hypogaea* L.) cultivars
Degree to which it is submitted : Doctor of Philosophy
Faculty : Agriculture
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ABSTRACT

Groundnut is an important oilseed crop of India, where it occupies first position in area and production. Field experiments on the effect of herbicides and crop weed competition on physiological aspects of diverse groundnut (*Arachis hypogaea* L) cultivars were conducted in sandy loam soils (pH 7.30; EC 0.24 d Sm⁻¹) at the College Farm, College of Agriculture, Rajendranagar, during rabi (November to April) 1987 and 1988. Knowledge of herbicides usage and weed competition are helpful in developing weed management systems.

The present study using diverse cultivars of groundnut, that is Spanish (JL-24), Valencia (Gangapuri) and Virginia (K-3), were conducted by using herbicides, and simultaneously subjecting the crop to weed competition with a view to study the physiological aspects, nature and association of C₃ and C₄ weed flora, to evaluate the relative efficacy of herbicides and to find out phytotoxic effects if any. Growth analysis technique was adopted in order to determine the ability of these cultivars to withstand weed competition and the emphasis was on morpho-physiological traits that affect yield and yield components.

C₄ weeds, *Cyperus rotundus*, *Dactyloctenium aegyptium* and *Digitaria sanguinalis*; C₃ weeds *Ocimum canum*, *Lagasca mollis* and *Parthenium hysterophorus* were found to be the important competing weeds. Differences in growth rate of weed species were also found in relation to seasonal temperature. During rabi 1987, C₄ weeds, *Dactyloctenium aegyptium* and *Cyperus rotundus* and C₃ weeds *Ocimum canum* and *Lagasca mollis* were dominant. Whereas, in rabi 1988, low temperature prevailed, as a result C₄ weeds,

Cyperus rotundus, **Dactyloctenium aegyptium**; C₃ weeds **Lagasca mollis** and **Parthenium hysterophorus** were predominant. Among these weeds **Cyperus rotundus** had the capacity to grow at a very fast rate.

In weedy control plots during rabi 1987, weed dry matter reached a maximum value of 328.1 g m⁻² (C₃ weeds); 311.3 g m⁻² (C₄ weeds) and 382.1 g m⁻² (C₃ + C₄ weeds) on 110 DAS. The corresponding values for the crop were 274.5, 334.2 and 267.6 g m⁻². In weed free plots and in plots where herbicides were applied the weed dry matter was lowest. Pre-emergence application of pendimethalin (@ 1.5 kg a.i. ha⁻¹) and oxyfluorfen (@ 0.25 kg a.i. ha⁻¹) were very effective in controlling both C₃ and C₄ weeds. Whereas, pre-emergence application of alachlor (@ 1.5 kg a.i. ha⁻¹) fluchloralin (@ 1.5 kg a.i. ha⁻¹) and the post-emergence herbicide glyphosate (@ 1.5 kg a.i. ha⁻¹ which was applied in between rows with rubber foam) were not very effective in checking weeds. When these herbicides were used , improved growth characteristics, yield and yield components were obtained. Glyphosate was found to be phytotoxic to groundnut.

In weed free check and herbicides used plots the LAI of groundnut cultivars attained a maximum value on 90 DAS for cvs. K-3(4.29), JL-24(3.82) and Gangapuri (2.91) in rabi 1987. Weedy control (C₃+C₄) plots showed greater percentage of reduction in LAI, K-3(61.1), JL-24(61.8) and Gangapuri (56.4). C₃ and C₄ weeds were equally detrimental in reducing pod yield. During both the years weedy control (C₃+C₄) recorded lowest pod yield. Cv. K-3 was found to be least efficient in competing with either C₃ or C₄ weeds. Whereas, JL-24 and Gangapuri withstood the weed competition better by producing higher, TDM g m⁻² (K-3, 219.8; JL-24, 279.7; Gangapuri, 285.3 at maturity), CGR g m⁻² d⁻¹ (K-3, 1.63; JL-24, 5.70; Gangapuri, 5.31 on 90 DAS), RGR g g⁻¹ d⁻¹ (K-3, 0.039; JL-24, 0.047; Gangapuri, 0.053 on 50 DAS), NAR g dm⁻² d⁻¹ (K-3, 0.048; JL-24, 0.054; Gangapuri 0.059 on 50 DAS), LAD days (K-3, 13.7; JL-24, 17.3; Gangapuri, 15.9 on 50 DAS) and pod yield, g m⁻² (K-3, 63.3 ; JL-24 135.4 ; Gangapuri, 122.6). The reduction in the yield was mainly due to less number of matured pods per plant and low TDM coupled with low HI and kernel weight partitioning index. The critical period of crop weed competition was found to be 40-50 DAS when crop growth decreased significantly due to weed competition. Hence, the crop must be maintained free of weeds to prevent yield losses.

Weeds showed differences in the uptake of nitrogen, phosphorus and potassium. It appears cvs. JL-24 and Gangapuri have utilised the atmospheric N fixed and thus avoided competition for N with the weeds, than K-3. Cv. JL-24 contained more leghaemoglobin.

The present study indicates that high seedling vigour and LAD during early stages, maintainance of high RGR, CGR, NAR during pod filling to maturity and efficient translocation of photosynthates to seeds are important for high yields.

The results of these field experiments showed that shoot competition for light is more important. Shoot competition in weedy control plots improved plant height and LAR in JL-24 and Gangapuri. These cultivars withstood weed competition better by maintaining high rates of CGR, RGR, NAR, CO₂ assimilation, greater sink size, more number of matured pods, seeds per plant, filled pods and protein, than K-3. Further, JL-24 and Gangapuri were found to resist low seasonal temperature during rabi 1988 than K-3. Pod yield, number of matured pods, haulm yield and TDM at harvest showed a very high ($r > 0.90$) positive correlation with kernel yield in both the years.

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LIST OF ABBREVIATIONS

A_1	:	Total leaf area at initial time
A_2	:	Total leaf area at final time
a.i.	:	Active ingredient
C_3	:	Calvin cycle pathway
C_4	:	Dicarboxylic acid cycle pathway
^{14}C	:	Radio active carbon
CD	:	Critical difference
CGR	:	Crop growth rate
cm	:	Centimeter
Cv	:	Cultivar
d	:	Day
DAS	:	Days after sowing
DM	:	Dry matter
d Sm	:	Deci siemen meter
Fig:	:	Figure
g	:	Gram
ha	:	Hectare
HI	:	Harvest index
hr	:	hour
K	:	Potassium
kg	:	kilogram
KWPI	:	Kernel weight partitioning index
L	:	Liter
LA	:	Leaf area
LAD	:	Leaf area duration
LAI	:	Leaf area index

xx

LAR : Leaf area ratio
LTR : Light transmission ratio
LW : Leaf weight
LWR : Leaf weight ratio
m : Meter
Max : Maximum
Mg : Milligram
min : Minimum
ml : Milliliter
N : Nitrogen
NAR : Net assimilation rate
NMR : Nuclear magnetic resonance spectrometry
NS : Non significant
P : Phosphorus
RF : Rainfall
RGR : Relative growth rate
RH : Relative humidity
RLGR : Relative leaf growth rate
S.Ed : Standard error difference
SLW : Specific leaf weight
t : tonne
 t_1 : Initial time
 t_2 : Final time
TDM : Total dry matter
TWD : Total weed density
TWDM : Total weed dry matter
 W_1 : Initial dry weight of plants

W_2 : Final dry weight of plants
WCE : Weed control efficiency
WGR : Weed growth rate
WI : Weed index
 V_1 : Kadiri-3
 V_2 : JL-24
 V_3 : Gangapuri
viz., : Namely

INTRODUCTION

CHAPTER I .

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is the most important oilseed crop of India, grown on an area of 6.73 m.ha with a production of 5.7 m. tonnes. In Andhra Pradesh, it occupies 1.79 m. ha with a production of 1.7 m. tonnes (DES, 1989). India ranks first in the world with around 40 per cent cultivated area, but occupies tenth position, with 33 per cent production (Patel, 1988). In Semi-Arid Tropics its average yield is around 800-1000 kg ha⁻¹, compared to around 3000 kg ha⁻¹ in U.S.A.

Climate, soil and biotic factors influence crop productivity. At times biotic stress factors like presence of weeds and diseases reduce yield significantly. It is estimated that nearly 1800 weed species compete with crops and reduce yield. About 300 of these weed species are known to cause serious yield losses in crops throughout the world (McWhorter, 1984). Apart from environmental and soil constraints, weeds reduce productivity of groundnut as they compete with crop plants for nutrients, moisture, sunlight and affect various physiological processes which lead to reduction in yield. Hence, controlling weeds and understanding crop weed competition in relation to productivity is very important. The establishment of dominance by crop or weeds depends on rapidity of germination and seedling growth rates. The differences in photosynthetic rates and root development determine the competitive ability of plants.

The extent of weed competition is determined by the weed species, density of infestation and duration of infestation.

Weed competition is serious in groundnut, because of slow seedling emergence and slow seedling growth. On the other hand, weeds often have a higher initial rate of growth and compete effectively. The critical period of weed competition was found to be from 4-8 weeks after sowing (Hamada, 1988). It is estimated that weeds cause as much as 70-76 per cent yield loss in groundnut (Rao, et al., 1982 and 1987).

Groundnut cultivars are classified into three distinct groups based on growth habit viz. Virginia, Valencia and Spanish. Kondap et al. (1980) reported differences among groundnut cultivars to withstand weed competition. Therefore assessing the physiological variations in the yield potential of diverse groundnut cultivars when weeds are controlled by herbicides and when crop is subjected to weed competition is important to improve yield. Plant species are divided into three groups based on their method of fixing carbon dioxide. These are plants possessing calvin-cycle (C_3), C_4 dicarboxylic acid cycle (C_4) and the crassulacean acid pathway (CAM). These three types are present among weed species. C_4 plants are of recent findings and these occur in a small percentage (< 1%) among the plant species. But C_4 plants constitute 78 per cent of the 18 "worst weeds" of the world (Holm et al., 1977). In comparison, only 20 per cent of the 15 crops that feed the world are C_4 plants, the remaining

80 per cent are C_3 . Groundnut has C_3 photosynthetic pathway (Patterson, 1985). Physiological aspects of C_4 pathway include apparent competitive advantages such as higher rates of CO_2 fixation, reduced photorespiration and decreased transpiration.

The high cost of hand and mechanical weed control and their damaging effect on groundnut plant have led to herbicide use as a necessary economic practice (Cardina et al., 1986). The search for herbicides with specific modes of action requires physiological knowledge of the target weed and the crop involved. It was reported that both monocot and dicot weeds or monocot weeds alone are equally detrimental to the crop (Kondap et al., 1980). Hence, it is necessary to find out herbicides which control monocots as well as dicots.

The important weeds found in groundnut at College of Agriculture, Rajendranagar, Hyderabad are *Cyperus rotundus*, *Cynodon dactylon*, *Dactyloctenium aegyptium*, *Digitaria sanguinalis*, *Amaranthus viridis*, *Lagasca mollis*, *Celosia argentea* and *Parthenium hysterophorus*. Except *Lagasca mollis*, *Celosia argentea* and *Parthenium hysterophorus*, other weeds possess C_4 pathway.

At present, less information is available on physiological parameters of different weed flora found at the College Farm, Rajendranagar, Hyderabad. Studies on the influence of C_3 and C_4 weeds competition and their control by herbicides in diverse groups of groundnut is essential to know their relative

competitive ability in order to improve productivity. The present research on diverse groups of groundnut cultivars was conducted using herbicides to control weeds and simultaneously raising the crop with weed competition. The objectives were:

1. To study the nature and association of weed flora with Virginia, Valencia and Spanish groundnut cultivars.
2. To classify the weeds based on C_3 and C_4 photosynthetic pathway along with other important physiological traits.
3. To evaluate the relative efficiency of herbicides to control annual and perennial C_3 and C_4 weeds.
4. To determine the phytotoxicity of various herbicides if any among diverse groundnut cultivars.
5. To evaluate the morpho-physiological traits of groundnut cultivars as affected by herbicides and crop weed competition.
6. To study the effect of herbicides and crop weed competition on yield, yield components and seed quality.

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

2.1 PHYSIOLOGICAL CHARACTERISTICS OF GROUNDNUT

The three distinct groundnut types, that is Virginia, Valencia and Spanish are well recognised (Bhagat, 1986). These are *Arachis hypogaea* sub sp. *hypogaea* var. *hypogaea* (Virginia bunch); *Arachis hypogaea* sub sp. *fastigiata* (i) var *fastigiata* (Valencia) (ii) var *vulgaris* (Spanish). The various physiological and yield attributes in groundnut are summarised in Table 1.

Table 1 : Various Physiological aspects and yield attributes in groundnut.

Character described	Reference
Temperature Requirements	
Base temperature 8 - 11.5°C	Mohammed et al. (1988)
Optimum temperature for growth 30°C	Ketring (1984)
Optimum mean temperature for growth 27.5°C and below 15.5°C no growth was reported.	Cox (1979)
Photosynthesis	
Groundnut possess C ₃ pathway	Patterson (1985)
Photosynthesis 24 to 37 mg CO ₂ dm ⁻² hr ⁻¹	Bhagsari and Brown (1976)
" 50 mg CO ₂ dm ⁻² hr ⁻¹	Pallas (1980)
Cultivar differences in photo- synthetic rate exist.	Rao and Das (1981); Pallas (1982) and Hiremath et al. (1984)

Contd..

Contd..

Character described	Reference
Plant Height	
Wide variation among genotypes exist	Das (1986)
Number of Branches	
4-5 in bunch cultivars on 7th week but increased upto 13th week in Robout 33-1	NRCG (1982)
Total Dry Matter (TDM)	
Varietal differences in total and rate of dry matter accumulation have been found.	Shashidhar et al. (1977); Hiremath et al. (1984) and Padma (1989).
For maximum yield in early ₋₂ Cvs TDM should be 500 g m	Forestier (1973)
TDM range 21-25.2 g plant ⁻¹	Padma (1989)
In erect varieties rapid rate of growth was observed upto 60 DAS but in spreading varieties growth continued for longer time.	Bhan (1973)
Progressive increase in TDM upto harvest	Sastry et al. (1980)
Stem and Leaf Dry matter	
Early cessation of DM accumulation in stem is desirable	Sastry et al. (1980)
Leaf and stem DM increased in sigmoidal fashion with peak at 90-100 DAS and afterwards decreased.	Darold et al. (1982)
Leaf Area/LAI	
High leaf area in Virginia than Spanish and Valencia	Rao (1980)

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Contd..

Character described	Reference
Maximum LA Plant ⁻¹ 0.5 - 1.5 m ² in Spanish types 0.4 - 1.6 m ² in semi-prostrate Virginia types	Maeda (1970)
Range of LAI among Cvs 3.0 - 4.3 3.3 - 3.9 4.0 - 5.0	Hiremath et al. (1984) Padma (1989) Sastry et al. (1980)
Leaf senescence starts from 75 DAS in erect and from 90 DAS in spreading varieties	Bhan (1973)
Leaf Area Duration (LAD)	
Marked differences among cultivars exist.	Janamatti (1979)
Positive relationship between LAD and seed yield	Enyi (1977)
Crop Growth Rate (CGR)	
Wide variation among Cvs exist and variation in CGR accounted for 96 per cent variation in yield	Enyi (1977)
No significant difference in CGR among five Cvs	Duncan et al. (1978)
Maximum CGR values upto 60-75 DAS in Virginias, 35-45 DAS in Valencia and Spanish.	Murthy et al. (1983)
Range of 65th DAS, 9.0 to 13.2 g m ⁻² d ⁻¹	Padma (1989)
Relative Growth Rate (RGR)	
Progressive decrease in RGR as growth advanced	Janamatti (1979)

Contd..

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Character described	Reference
Range on 35th DAS, 0.056 to 0.070 g g ⁻¹ d ⁻¹	Padma (1989)
Net Assimilation Rate (NAR)	
NAR did not differ much among Cvs	Enyi (1977)
Mean NAR in spreading types 0.130 g dm ⁻² week ⁻¹	Enyi (1977)
Bunch types 0.134 g dm ⁻² week ⁻¹	
Range on 30th DAS 7.0 to 9.3 g m ⁻² d ⁻¹	Hiremath et al. (1984)
Range on 50th DAS 0.058 to 0.086 g dm ⁻² d ⁻¹	Padma (1989)
Chlorophyll Content	
Range 4.0 to 7.2 mg g ⁻¹ fresh weight	Bhagsari and Brown (1976)
3.94 to 6.41 mg dm ⁻² LA	Hiremath et al. (1984)
1.52 to 3.36 mg g ⁻¹ fresh weight	Dhopte and Kudupley (1986)
Stomatal Density	
Range 100-500 mm ⁻²	Hiremath et al. (1984)
Number of Pegs, Pods and Pod Growth Rates	
Virginia types showed more number of pegs than Valencia and Spanish types	Rao (1980)
Number of Pegs	
Range 20 - 26.8 plant ⁻¹	Chen (1986)
34 - 45 plant ⁻¹	Padma (1989)

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Character described	Reference
Spanish and Valencia types showed more number of matured pods and kernels than Virginia types	Rao (1980) and Reddy et al. (1984)
Bunch types have higher percentage of pods near the far root than runner types	Walton (1981)
Number of matured pods	
Range 13 - 22.8 plant ⁻¹	Reddy and Shah (1985)
9.7 - 12.4 plant ⁻¹	Chen (1986)
11.0 - 13.2 plant ⁻¹	Padma (1989)
Cultivara differences in pod growth rate exist.	Duncan et al. (1978)
Rate of DM accumulation in pods 5-10 g m ⁻² d ⁻¹	Young et al. (1979)
Pod weight range 12.2 - 18.8 g _{plant} ⁻¹	Reddy and Shah (1985)
Yield and Yield Parameters	
Partitioning of assimilates between vegetative and reproductive parts had greatest effect on yield.	Duncan et al. (1978) and Tsai et al. (1987).
High seedling vigour during early stages, maintenance of high LAD during pod filling to maturity and efficient translocation of photosynthates are important for high yields.	Murthy and Rao 1986
Pod DM was dependent on current assimilates rather than remobilization of resources.	Tsai et al. (1987)
Yield potential of cv JL-24 was superior to Virginia bunch	Patil et al. (1983) and Dhoble et al. (1985).

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Character described	Reference
Pod yield range 1.98 - 3.7 t ha ⁻¹	Reddy and Shah (1985)
319.- 392 g m ⁻²	Padma (1989)
Harvest Index (HI)	
HI was more in bunch Cvs than in semi spreading Cvs.	Natarajaratnam (1979)
Range 36 - 48%	Dhopte and Zade (1981) and Padma (1989)
Shelling Percentage (SP)	
Cultivaral differences in SP exist.	Reddy and Shah (1985)
Range 55.2 - 72.0	Reddy and Shah (1985)
69.0 - 78.0	Padma (1989)
100 Kernel Weight	
100 kernel wt. was maximum in Virginia; medium in Spanish and low in Valencia types	Rao (1980)
Range 48.0 - 108 g	Sheshadri (1962)
33.2 - 51.6 g	Dhopte and Kudupley (1986)
34.2 - 56.4 g	Reddy and Shah (1985)
Oil and Protein Percentage	
Oil Range 49.0 - 54 per cent	Badami et al. (1978)
44.4 - 49.9 "	Georgieve (1985)
44.0 - 47.6 "	Padma (1989)

Contd..

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Character described	Reference
Protein Range	
20.0 - 36.0	Young (1978)
31.0 - 35.8	Padma (1989)
Effects of Shading	
Shading reduced TDM, nodulation, pod no plant ⁻¹ , 100 kernel weight, pod yield but increased total chlorophyll content	Rao and Mittra (1988)
Correlations	
High positive correlation was observed between	
Peg number and yield	Rahman and Rahman (1976)
Number of matured pods and pod yield	Chandola et al. (1973) Enyi (1975) Rahman and Rahman (1976) Labana et al. (1980)
No. of pods m ⁻² and seed yield Min air temp. and seed yield	Kudo and Syodai (1986)
100 kernel wt. and pod yield	Enyi (1975) Labana et al. (1980)
HI and seed yield	Dhopte and Zade (1981)
TDM and pod yield Haulm yield and pod yield	Hiremath et al. (1984)

2.2 PHYSIOLOGICAL CHARACTERISTICS OF C₃ AND C₄ WEEDS

Approximately 6700 species of weeds are found all over the world. Among these, 76 have been found to be the "world's

worst weeds". Whereas only 15 species of crops supply 90 per cent of the world's food. Therefore, we know more about the physiological characteristics of the 15 major crops than weeds (Holm et al., 1979).

Plant species are divided into three groups based on their method of fixing carbon dioxide. These include C_3 Calvin cycle type, C_4 dicarboxylic acid cycle type and Crassulacean acid pathway type (CAM plants). All the three photosynthetic pathways are found in weed species (Elmore and Paul, 1983).

Crookston and Moss (1970) classified some weed flora based on carbon dioxide compensation point and leaf anatomy. Ramadas and Raghavendra (1973) screened some of the dicotyledonous weed flora for C_4 pathway. Among 32 species belonging to 9 families, 17 species showed the C_4 pathway. Hesla et al. (1982) made a survey of C_3 and C_4 photosynthesis in Cyperaceae and reported that out of 68 species tested 40 species showed C_4 pathway.

Black (1976) pointed out that many of the major weeds of the world have C_4 pathway, rather than more prevalent C_3 pathway and also suggested that photosynthetically "efficient" plants with C_4 pathway are more competitive than the "non-efficient" plants that possess the C_3 . C_4 plants account for a small fraction of the total number of plant species (fewer than 1000 out of 2,50,000) and a larger proportion of world's weed species possess C_4 pathway (Elmore and Paul, 1983). Surveys for

C_4 photosynthesis are by no means complete, existing data indicate that the pathway occurs in relatively few plants (Patterson, 1985). Paul and Elmore (1984) gave a ranking for the world's 18 worst weeds and out of these 14 were C_4 species.

Physiological characteristics of the C_4 photosynthesis include apparent competitive advantages such as higher rates of CO_2 fixation, reduced photorespiration and decreased transpiration and therefore C_4 plants grow faster, become larger and are more competitive than C_3 plants (Patterson, 1985). C_4 weeds have competitive advantage over crop species especially under high light intensities and temperatures and in dry situations (Elmore and Paul, 1983).

The proportion of C_4 species is greater at lower latitudes, lower elevations and along aridity gradients (Tieszen et al., 1979). The C_4 weeds, which are very effective competitors are *Amaranthus viridis*, *Cyperus rotundus* and *Cyperus esculentus* (Elmore and Paul, 1983). However, Rodosevich and Holt (1984) reported that climate to which weed, crop combinations are exposed, slight to severe competition could be expected. Patterson (1985) reported that in peanuts, weed flora comprised of more than 60 per cent C_4 plants.

Patterson (1985) described the adaptive characteristics of weeds in relation to physiology, growth and competitiveness. These are (1) High relative growth rates in seedling stage (2) High rates of photosynthesis, rapid development of exploitative

root systems (3) Rapid partitioning of photosynthate into new leaf area production (4) Rapid vegetative growth to reproductive phase (5) High capacity for acclimation to changing environment.

Table 2: Classification of some important weeds found at Rajendranagar based on photosynthetic pathway

Species	Photosynthetic pathway	Reference
<i>Amaranthus viridis</i>	C ₄	Downton (1971)
<i>Cynodon dactylon</i>	C ₄	Patterson (1985)
<i>Cyperus rotundus</i>	C ₄	Downton (1971)
<i>Dactyloctenium aegyptium</i>	C ₄	Patterson (1985)
<i>Celosia argentea</i>	C ₃	Krenzer et al. (1975)
<i>Commelina benghalensis</i>	C ₃	Chen et al. (1970)
<i>Parthenium hysterophorus</i>	C ₃	Hegde and Patil (1982)

The net photosynthetic rate in *Amaranthus viridis* (C₄) was 95.9 mg CO₂ dm⁻² h⁻¹ (Patterson and Flint, 1983) and in *Cynodon dactylon* (C₄) it was 82.0 mg CO₂ dm⁻² h⁻¹ (Chen et al., 1970). In spite of the advantages of the C₄ pathway, some of the most troublesome agronomic weeds have C₃ pathway (Patterson, 1985).

2.2.1 Importance of C₃ and C₄ weed species in competition and growth analysis

C₄ pathway has distinct physiological characters of that this property of numerous weeds and crops must b

consideration by weed scientists for evaluating herbicides specific for C_4 weeds or for conducting competition studies (Elmore and Paul, 1983). According to Patterson (1985) the competitiveness is not an intrinsic property of any weed or crop but it is only measurable in comparison with another species. Grime (1979) indicated that the competitive plants should be those which quickly establish a canopy either from stored reserve energy or from immediate photosynthesis that can achieve both height and lateral spread effectively. Competition tends to be greater between plants of similar vegetative characteristics viz., broad leaved weeds compete more with broad leaved crops (Sen, 1981).

The concepts of principles of plant growth analysis have been developed and extensively reviewed (Evans, 1972; and Patterson, 1985). The important growth parameters that influence competition are RGR, NAR, LAR and LAD (Patterson, 1985). Rijsdijk (1986) reported that the damage of weeds to a crop can be directly derived from the ratio of leaf area indices of weeds and crop. Grime and Hunt (1975) used RGR as an indicator of overall potential competitive ability and they observed that majority of the weeds have higher RGR values than crop plants. Potter and Jones (1977) reported that RGR and relative leaf area expansion rates were greater in the weeds than in crop species. Patterson and Flint (1983) reported that the net photosynthetic rate, NAR and water use efficiency was more in C_4 weeds than C_3 . Ahrens and Stoller (1983) recorded different growth parameters of

C₄ weed (*Amaranthus hybridus* L.) after 11 weeks of seeding. The values for RGR, NAR and SLW were 0.159 g g⁻¹ d⁻¹; 0.205 g dm⁻² d⁻¹ and 5.83 mg cm⁻² respectively. Patterson and Flint (1980) reported significant increase of NAR, LAD and dry matter in C₃ plants due to increase in CO₂ concentration but these parameters either decreased or did not change in C₄ species. Patterson (1985) indicated that weed phenology models developed through growth analysis, and the identification of limiting resources, may aid in determining critical stage in weed life cycles and in scheduling timely application of control practices.

2.3 WEED SPECTRUM IN GROUNDNUT

A variety of weeds occur in groundnut, though grassy weeds dominate, serious competition is exercised by broad leaved weeds also. Besides the above, a sedge *Cyperus rotundus* L dominates, and emergence of different flushes of weeds is seen at different stages of crop (Reddi, 1988). Similarly Tosh and Misra (1977) listed 14 species of weeds occurring in groundnut and found that monocot weeds were prominent.

Rao et al. (1982) reported that among 17 weed species found in groundnut, *Cynodon*, *Cyperus*, *Dactyloctenium*, *Digitaria*, *Celosia*, *Digera* and *Lagasca* were the dominant weeds. Rajan et al. (1984) observed that among weed species, *Cyperus rotundus*, *Celosia argentea* were dominant. Predominance of grassy weeds was reported in groundnut (Ray and Patra, 1986; Akobundu, 1988; and Hamada, 1988).

Rajan et al. (1981), Reddi (1982), Choudhary (1983), Jain et al. (1983), Pitelli et al. (1984), Yadav et al. (1984), Colvin et al. (1985), Lifshitz et al. (1985), Prasad et al. (1987), Akobundu (1988), Hamada (1988) and Kondap et al. (1989) reported the presence of following weeds in groundnut i.e., *Commelina benghalensis*, *Cynodon dactylon*, *Cyperus rotundus*, *Cyperus esculentus*, *Digitaria sanguinalis*, *Digitaria marginata*, *Dactyloctenium aegyptium* and *Echinochloa colonum* among monocots, *Amaranthus viridis*, *Celosia argentea*, *Digera arvensis*, *Euphorbia hirta*, *Flavaria australasica*, *Lagasca mollis*, *Leucas aspera*, *Phyllanthus niruri*, *Portulaca oleracea*, *Trichodesma indicum* and *Tridax procumbens* among dicot weeds.

2.4 CRITICAL PERIOD OF CROP WEED COMPETITION

The "critical period" of weed interference has been determined for a variety of crops. It is a specific minimum period of time during which the crop must be free of weeds in order to prevent loss in yield and represents the overlap of two separate components (a) the length of time, weeds can remain in a crop before interference begins and (b) the length of time that weed emergence must be prevented so that subsequent weed growth does not reduce crop yield (Weaver and Tan, 1983). Groundnut is very susceptible to weed competition during both early and late stages of growth (Yaduraju et al., 1981). The critical period of weed competition was reported to be 4-8 weeks after sowing (Bhan et al., 1971; Singh and Gupta 1973; Chamblee et al., 1982; Yadav et al., 1984; and Hamada, 1988).

Murthy **et al.** (1981) reported that critical period of weed competition was between 40-50 days after sowing and the competition was related to cultivars.

The critical period of crop weed competition in groundnut was upto 45 DAS and weeds should be removed prior to the critical period (Naidu, 1977; Naidu **et al.**, 1982; Rajan **et al.**, 1982; Patel **et al.**, 1985; Singh **et al.**, 1987). However, the critical period of weed competition for groundnut was also reported to be 42-56 days after sowing by Pitelli **et al.** (1984) and 15-60 days after sowing by Raghvan **et al.** (1984). But Kusdarwati (1987) in their studies revealed that groundnut growth and development parameters were not related to duration of weeding and weeding in the first two weeks after sowing is recommended.

Weeding and hoeing given 50 days after sowing did not contribute towards increased pod yield eventhough weeds were effectively controlled (Rajan **et al.**, 1976).

2.5 LOSSES CAUSED BY WEEDS

2.5.1 Loss in Yield and Yield Components

The loss ^{in yield} depends upon the density of weeds, duration of weeds, type of weed species and crop competing ability. Weed problem is severe in the early stages because of slow initial growth of groundnut. Complete ground cover of Spanish bunch is usually attained at about 60-75 days after seeding and a few days later in Virginia runner (Reddi, 1988). Several studies have

described the effects of weed competition on peanut yield, but most dealt primarily with annual species (Hackett et al., 1987).

Weed competition reduces peanut seed yield and quality (Chamblee et al., 1982; Murdock et al., 1986). Gooden et al. (1983) made field surveys to analyse the cause of low yields in groundnut grown in South Carolina and reported that weeds reduced the yield upto 66%. Similarly, Bhan and Malik (1986) reported that among the major food crops the greatest losses due to weeds occurred in groundnut.

Yield reduction occurred if weeds were allowed to compete longer than 3 weeks after crop emergence and the competitive effects of the weeds increased with each week thereafter (Hauser et al., 1975). Grass weeds were more detrimental than broad leaved weeds in reducing groundnut yields (Cardina et al., 1986). The loss in yield of groundnut pods due to competition by weeds ranged from 30 to 34% (Singh and Gupta, 1973); 42.9% (Seshaiah, 1979). The weeds are reported to cause as much as 70-76 per cent yield loss in groundnut (Yaduraju et al., 1980; Murthy, 1982; Rao et al., 1982; Choudhary and Lagoke, 1985; Rao et al., 1987 and Kondap et al., 1989) and 80-90% (Hamada, 1988).

Hammerton (1976) reported that delay of 40 to 60 days in weeding resulted in significantly lower yields and fewer pods plant⁻¹ but did not affect seed number pod⁻¹ in groundnut. Drennan and Jennings (1977) estimated that the average crop

losses due to weed competition was 1.49 t ha^{-1} of groundnut pods. Kondap *et al.* (1980) indicated that the yield reduction due to the presence of monocot + dicot weeds was maximum (24.6%) followed by monocots alone (20.6%) and dicots alone (12.8%). They further showed that among the varieties K 71-1 performed well in all weed groups and gave higher yields than EC-21137-1 which gave lowest yields. They also recorded maximum weed dry matter in EC-21137-1 (858.6 g m^{-2}) and minimum in K 71-1 (423.3 g m^{-2}).

The pod yield with weed free condition for 15, 30 and 45 DAS was 0.81, 1.87 and 3.71 t ha^{-1} respectively as compared to 0.61 t ha^{-1} in unweeded control (Singh *et al.*, 1982). Bhan *et al.* (1983) obtained higher pod yield of 3090 kg ha^{-1} in hand weeding treatment in comparison to 1250 kg ha^{-1} in weedy check. Similarly, Patel *et al.* (1985) recorded highest pod yield (2.21 t ha^{-1}) under weed free conditions and lowest yield (1.39 t ha^{-1}) in unweeded control. Gill *et al.* (1986) reported that weeding throughout the growing season resulted in pod yields of 1.61 t ha^{-1} as compared to 0.87 t ha^{-1} in unweeded treatment and low yields were related to high weed density. Pitelli *et al.* (1984) observed that in groundnut cv. Tatu-53, the critical competition by weeds began at 42 and 56 days and affected seed and pod production plant^{-1} and percentage distribution of dry matter.

Rao (1970) observed decrease in both shelling percentage and test weight of kernels to an extent of 15 and 22 per cent

respectively in unweeded control when compared to complete weed free treatment.

Weed dry matter is a better parameter to measure competition than weed number since it more precisely measures the quantities of growth factors captured by the weeds (Bhanumurthy and Subramanian, 1989). Several researchers reported a significant negative relationship between dry matter production of weeds and yields in groundnut (Tosh and Misra, 1977; Sessaiah *et al.*, 1979; Hauser *et al.*, 1982; Kumar, 1986 and Singh *et al.*, 1987).

2.5.2 Qualitative losses

Weeds also cause qualitative losses by reducing the oil and protein content. Saini *et al.* (1973) recorded a loss of 283 kg of oil ha⁻¹ due to weeds. Singh and Gupta (1974) observed a significant reduction in oil content (12.4%) in an unweeded groundnut compared to hand weeded crop. However, Gowda and Cajanan (1978) opined that kernel yield is the main contributory factor of oil and crude protein yield in groundnut. Murthy (1982) estimated 43.9% oil content in hand weeded treatment as compared to 37.6% in weedy check. Significant reduction in oil and crude protein due to weed competition was also reported by Kumar (1986).

2.5.3 Growth, development and Physiological Characteristics

Chamblee *et al.* (1982) identified the early vegetative and reproductive stages, through pod setting and filling, as

critical periods in the growing season in which peanuts are very sensitive to weed interference. First groundnut growth reduction was observed at 42 days after emergence which indicated critical period for groundnut (Banyikwa and Rulangaranga, 1985).

Saini and Tripathi (1974) reported that there was increase in height and reduction in the number of branches due to weeds. Hamada (1988) reported that the continuous presence of broad leaved weeds reduced the number of branches plant^{-1} and increased the length of stems and internodes in groundnut.

In groundnut weed competition reduced dry matter production plant^{-1} , and dry matter distribution to economic parts (Murthy et al., 1981). Similarly, Wells and Walker (1983) reported that the total dry matter of groundnuts (cv. Florunner) and *Acanthospermum hispidum* was 19.95 and 18.20 t ha^{-1} respectively when grown separately; but reduced by 44 and 52% respectively in mixed populations. Dry matter production in groundnut crop kept weed free from 45 DAS until harvesting was 8.5 to 8.7 g plant^{-1} and it was 5.4 g plant^{-1} for unweeded crop (Singh et al., 1987). Banyikwa and Rulangaranga (1985) studied the effect of shoot, root and whole plant competition from *Ageratum conyzoides* on growth of groundnuts and concluded that both whole plant and shoot competition reduced the RGR, NAR and seed dry weights but increased LAR of groundnuts.

Kumar (1986) reported reduction in nodule number due to weed competition. However, Yaduraju et al. (1980) reported that nodulation was not affected by weeds in groundnut.

2.6 NATURE OF CROP WEED COMPETITION

Competition was defined by Aldrich (1984) as the "relationship between two or more plants in which the supply of a growth factor falls below their combined demands. Weeds compete with crops for moisture, nutrients, light, space and carbon dioxide, thereby reduce the yield and quality of produce. Under normal conditions, moisture, nutrients and light are considered major factors in determining degree and nature of crop weed competition.

2.6.1 Moisture

The water requirement or the amount of water lost per unit of dry matter produced, ranged from 1068 in the C₃ alfalfa to 303 in the C₄ weed *Amaranthus* spp (Patterson, 1985). The water use efficiencies of C₄ weeds like *Amaranthus hypochondriacus*, *A. retroflexus* and *Portulaca oleracea* was higher than C₃ species at all levels of water supply (Miller et al., 1984). The status of water in the plant represents an integration of the atmospheric demand, soil water potential, rooting density and distribution, as well as other plant characteristics (Scott and Geddes, 1979).

2.6.2 Nutrients

Together with light and water, soil mineral nutrients comprise the major environmental resources for which weeds and crops compete. Depending on the relative supply of these

resources and the degree of plant cover, competition may be more or less severe (Zimdahl, 1980). Weeds accumulate greater quantities of nutrients than crop species since weeds are more competitive than crop plants (Rao and Agarwal, 1984).

Among the major plant nutrients, competition for N is most severe (Patterson, 1985). Weeds are the major competitors with cultivated plants for nitrogen and potassium (Sen, 1981; Naidu et al., 1982; Rao and Agarwal, 1984). Sessaiah (1979) reported that at harvest, weeds in irrigated groundnut removed 14.7, 4.65 and 20.7 kg N, P and K per hectare respectively in no weeding plots and among the weeds narrow leaved weeds showed higher uptake of N, P and K. The N, P, K requirements for 100 kg pods of groundnut were 18.5, 2.34 and 6.40 kg respectively under unweeded condition and weeding increased the productive efficiency of nutrients (Rajan et al., 1981). However, a comparative study of nutrient removal by weeds and crops in unweeded check showed that weeds removed 16.2 and 20.3 kg ha⁻¹ more P₂O₅ and K₂O respectively than in crop indicating their vigorous uptake (Naidu et al., 1982).

Kondap et al. (1985) reported that NPK uptake by the weeds in cv. JL-24 was significantly higher than in cv. Kadiri-3. Kondap et al. (1982) reported that the amount of N, P, K required by the crop to produce 100 kg pods was 8.54, 1.37 and 7.27 kg with hand weeding and 29.56, 4.36 and 30.57 in no weeding treatments. Negative correlation coefficient for nitrogen uptake by weeds and groundnut crop was observed (Setty and Hosmani,

1977). Evaluation of growth analysis parameters like NAR and LAR are useful in assessing the effects of nutrient deficiencies arising from weed-crop competition (Patterson, 1985).

2.6.3 Light

Light is the prime factor which is limiting under a thick canopy. Light supplies the energy for photosynthetic CO₂ fixation and controls the development and morphology of the plant (Patterson, 1985). In the presence of adequate water and nutrients and favourable temperatures, light energy sets the limits for plant productivity.

Simple overtopping of one species by another due to height differences leads to a predictable consequences in the competition for light (Remington, 1984). Height and foliage inclination angles and leaf area are very important in light competition and leaves maintaining an angle close to perpendicular with the solar beam are most effective in competition for light (Caldwell, 1987 and Walker et al., 1988). Iwata et al. (1983) reported that weeds reduce growth and yields of groundnut and competition for light was one of the major factor in reducing the yields. Banyikwa and Rulangaranga (1985) studied the effects of shoot, root and whole plant competition from weed *Ageratum conyzoides* on growth of groundnuts and concluded that competition for light was important.

2.6.4 Carbon dioxide (CO₂)

In a rapidly photosynthesizing weed or crop canopy, the CO₂ concentration may be depressed below normal ambient levels and competition for CO₂ is most intense in mixtures of C₃ and C₄ plants, because of their differing ability to withdraw CO₂ (Patterson, 1985).

Patterson and Flint (1980) indicated possible doubling of the atmospheric CO₂ concentration from 330 ppm by 2025 AD. In weed crop interactions the growth rates of C₃ plants are stimulated more by CO₂ enrichment than those of C₄ plants (Patterson and Flint, 1980 and Patterson, 1986). Under field conditions, zones of CO₂ depletion may occur within a canopy but competition for CO₂ probably may not be significant because CO₂ concentrations in the atmosphere are always greater than the CO₂ compensation point of plants (Patterson, 1986). He further reported that the future increases in the atmospheric CO₂ concentration will significantly affect weed/crop interactions and will increase the competitive impact of C₃ weeds in C₄ crops and decrease the impact of C₄ weeds in C₃ crop.

2.7 VARIETAL TOLERANCE FOR CROP WEED COMPETITION

Kondap et al. (1980), Murthy et al. (1981) and Kondap et al. (1989) showed varietal differences in groundnut for weed competition. Kondap et al. (1980) studied the effect of different weed groups on five groundnut cultivars and reported that cv. K 71-1 performed well in all weed groups and produced

maximum pod yield and recorded minimum weed growth, due to its ability to suppress and compete effectively with the weeds. Among the groundnut Cvs. Tatu-53 was more tolerant to weed competition (Pitelli et al., 1983).

2.8 METHODS OF WEED CONTROL IN GROUNDNUT

Weed control in the past years has been based on programmes that utilize mechanical cultivation, hand hoeing or pulling, but intensive herbicide treatments produced higher yields and gross profits (Bridges et al., 1984). The optimum weed management programmes must provide effective weed control with minimum cost.

2.8.1 Physical methods

Rajan et al. (1976) reported that one hand weeding given at 30 days after sowing increased pods per plant, pod weight and also reduced the dry weight of weeds appreciably thereby increasing the pod yield but weeding at 50 days after sowing was not useful. Naidu et al. (1977) found that weed free environment maintained upto 45 days from sowing by giving 3 hand weedings at an interval of 15 days, resulted in higher yield components and consequently higher pod yield. But when hand weeding was done beyond 45 DAS, pod yield was reduced. Kondap et al. (1989) also reported that hand weeding at 15 and 35 days after sowing resulted in highest pod yields and the per cent increase in yield over weedy check was 302 per cent.

2.8.2 Chemical methods

Where labour is scarce and expensive, the use of herbicides hold good promise for cheap and efficient weed control, (Rathi et al., 1986; Reddi, 1988). There are only a limited number of herbicides with selective action which can be used in groundnut. Several herbicides have been tried for the control of weeds in groundnut but fluchloralin, alachlor, oxyfluorfen, pendimethalin were found to be most effective (Lagoke et al., 1982; Upadhayay, 1985; Reddi, 1988 and Kondap et al., 1989). Most weeds either emerge before or along with crop thereby necessitate the use of pre-emergence herbicides.

The herbicides used for weed control are classified according to their time of application.

2.9 PRE EMERGENCE HERBICIDES

2.9.1 Alachlor : (Anilide group)

2.9.1.1 Mode of action

Alachlor is a selective pre-emergence herbicide. It is absorbed primarily between seed and first node of germinating seedling. It inhibits seed germination and early seedling growth by interfering with the metabolic activities (Rao, 1988). Alachlor inhibited GA₃ induced α amylase production in susceptible species during germination (Devlin and Cunningham, 1970). It severely inhibited protein synthesis (Rao and Duke, 1976) and inhibited polyribosome formation (m RNA-ribosome complexing) by

inhibiting ribosome synthesis and nascent peptide synthesis only in susceptible species but not in tolerant species (Rao and Duke, 1974). Rao and Duke (1976), Deal et al. (1980) and Akobundu (1988) concluded that protein synthesis was the primary site of action and their effects on hydrolytic enzymes was secondary. Alachlor did not inhibit hill reaction but inhibited cell division and cell enlargement (Deal and Hess, 1980). Tolerant plant species degrade the herbicide into non phytotoxic metabolites (Akobundu, 1988). In groundnut seedlings alachlor did not affect α amylase and catalase activity (Devi and Perur, 1982).

2.9.1.2 Alachlor (Lasso) use in groundnut

Alachlor (2-chloro-2', 6'-diethyl-N (methoxy-methyl) - acetanilide) is used for pre-emergence weed control in legumes (Akobundu, 1988).

Alachlor is a selective herbicide and groundnut was highly tolerant to pre-emergence treatments and the herbicide was particularly active against most grasses and wide range of broad leaved weeds (Joshi, 1987).

Armstrong et al. (1973) reported that pre-emergence application of alachlor @3.36 or 4.48 kg a.i. ha⁻¹ effectively controlled *Cyperus esculentus*. Brecke and Teem (1983) reported that the pre-emergence treatment of alachlor provided best control of both annual grasses and broad leaved weeds. In irrigated groundnuts application of 2-4 kg alachlor ha⁻¹

effectively suppressed the growth of *Cyperus rotundus* and grassy weeds (Rajan et al., 1984). Lunsford et al. (1987) observed 60 per cent control of grasses (*Digitaria ciliaris*; *Dactyloctenium aegyptium*) in groundnuts due to application of Lasso @ 3 lb a.i. ha⁻¹. Doub et al. (1988) also reported good control of *Digitaria sanguinalis* in groundnut due to alachlor treatment.

Alachlor was a better herbicide for groundnut and pre-emergence application significantly increased number of pods and yield of peanuts (Hauser et al., 1977; Kulandaivelu and Sankaran, 1981; Devi and Perur, 1982; and Wilcut et al., 1987).

Reddy et al. (1980) from their experiments showed that alachlor @ 1.0 kg a.i. ha⁻¹ gave 1225 kg pods ha⁻¹ which was on par with hand weeding. The optimum rate of pre-emergence application of alachlor in groundnuts was 1.5 kg a.i. ha⁻¹ which resulted in best weed control and maximum pod yield (Kulandaivelu and Sankaran, 1976; Rethinam et al., 1976; Patro et al., 1981; Lagoke et al., 1982; Kulandaivelu and Sankaran, 1986; Rathi et al., 1986). However, Hegde et al. (1977) reported that alachlor treatment @ 1.5 kg a.i. ha⁻¹ was partially effective in controlling weeds in groundnut and require supplemental hand weeding to obtain satisfactory weed control.

Moody (1979) reported that weeds in groundnut can be effectively controlled by alachlor @ 1.9 kg a.i. ha⁻¹ applied as pre-emergence. However, Reddi et al. (1976) showed that among different herbicides alachlor @ 2.00 kg ha⁻¹ or alachlor 1.0 kg

a.i. ha^{-1} + one hand weeding at 30 DAS effectively controlled weeds. But Rajan et al. (1981) and Tosh and Jena (1983) reported in groundnut cv. AH-1192 that application of alachlor 2 kg a.i. ha^{-1} with supplementary hand weeding provided highest yields. Alachlor @ 1.5 - 3.0 kg ha^{-1} was effective in controlling weeds and gave significantly higher yields comparable to those of hoe weeded controls (Choudhary and Lagoke, 1985). Best net economic returns and good weed control were obtained in groundnuts with the application of alachlor @ 3.36 kg a.i. ha^{-1} (Colvin et al., 1986); 3.57 kg a.i. ha^{-1} (Hamdoun, 1976); 4.0 kg a.i. ha^{-1} (Rangaiah et al., 1976) and 4.4 kg a.i. ha^{-1} (Dowler and Scott, 1981; Bridges et al., 1984).

Hamdoun (1976) reported that pre-emergence treatment of alachlor at 2.38 and 3.57 kg a.i. ha^{-1} did not cause visual crop injury or a significant stand reduction, but highest dose of alachlor at 4.76 kg a.i. ha^{-1} was phytotoxic. However, Dowler and Scott (1981) reported that alachlor @ 4.4 kg a.i. ha^{-1} applied through a centre-pivot irrigation system to groundnuts before emergence did not show any crop injury.

Raj and Wong (1977) conducted experiments with alachlor and reported that the herbicides delayed the germination and initial growth, but stimulated subsequent growth of the plants. Saini and Tripathi (1974) reported that the pre-emergence spray of lasso @ 5.0 kg ha^{-1} resulted in significant improvement in plant characters of groundnut. The plant height reduced from 16.6 cm to 13.55 cm, the number of secondary branches increased

from 8.6 to 11.3 (13%) and weight of matured pods plant⁻¹ enhanced from 6.9 to 9.6 g (39%). Singh et al. (1980) also reported increased number of pods, branches plant⁻¹, oil content of kernels, oil yield, crude protein, due to the application of Lasso @ 6 L ha⁻¹. Kulandaivelu and Morachan (1981) showed that in groundnut cv. POL-2 alachlor treatment did not affect growth components like number of branches, root weight, nodulation, kernel weight, shelling per cent but pod number plant⁻¹ increased. Application of alachlor increased the dry matter accumulation by groundnut (Kulandaivelu and Sankaran, 1986). Kishinevsky et al. (1988) also reported that the recommended doses of alachlor in peanuts did not show any adverse effect on nodulation. However, Sankaran et al. (1974) and Kulandaivelu (1979) observed increased nodulation with the use of alachlor.

2.9.2 Pendimethalin and Fluchloralin (Dinitroanilines)

2.9.2.1 Mode of action

Pendimethalin and fluchloralin are selective herbicides. The active ingredient penetrates germinating seedling through the hypocotyl and roots thus inhibits root and shoot growth. The roots develop swellings and appear thick and are devoid of secondary roots (Parka and Soper, 1977). Nucleic acid inhibition is considered to be the primary mechanism of action of these herbicides (Schultz et al., 1968). Wang et al. (1974) concluded that the major mechanism of dinitroanilines was disruption of ATP formation, either by interfering with the energy generating

mechanism or by blocking the energy transfer mechanism of mitochondria. These herbicides inhibit photosynthesis, oxidative phosphorylation, protein, nucleic acid and lipid synthesis (Moreland et al., 1972; Ashton and Crafts, 1981). The selectivity in groundnut is based on enzymatic degradation (Akobundu, 1988).

2.9.2.2 Pendimethalin (Stomp) use groundnut

Pendimethalin (N-(1-ethylpropyl)-3, 4 dimethyl-2, 6-dinitro benzenamine) is a pre-emergence herbicide for the control of grassy weeds in groundnut and it has a narrow weed control spectrum (Akobundu, 1988).

Pre-emergence application of pendimethalin to peanuts provided best control of both annual grasses and broad leaved weeds and gave good pod yields (Rao et al., 1982; Brecke and Teem, 1983; Kondap et al., 1989). Thomson (1979) was of the opinion that pendimethalin as a pre-emergence herbicide was effective against *Echinochloa colonum*, *Panicum repens*, *Sorghum halepense* by its translocative action but could not control *Cyperus rotundus*.

Bhan et al. (1980) mentioned that yield due to pendimethalin (Stomp) @ 1.5 kg a.i. ha⁻¹ (3692 kg ha⁻¹) and was on par with that of hand weeding (3689 kg ha⁻¹). Similarly application of pendimethalin @ 1.5 kg a.i. ha⁻¹ gave good weed control efficiency, produced highest yields and was comparable

with two times hand weeding (Silva *et al.*, 1983; Ray, 1986; Rathi *et al.*, 1986; and Kondap *et al.*, 1989).

Murthy (1982) and Yadav *et al.* (1983) reported that pendimethalin was effective in checking most of the monocot as well as dicot weeds and thereby improved the yield components like number of pods per plant, shelling percentage and test weight. Bhan *et al.* (1983) reported increased yield of groundnuts 3090 kg ha⁻¹ due to pendimethalin 1.0 to 2.0 kg a.i. ha⁻¹ over weedy control (1250 kg ha⁻¹). Bhola *et al.* (1985) stated that application of pendimethalin @ 0.75-1.5 kg a.i. ha⁻¹ in combination with one hand weeding was most effective in controlling weeds in irrigated groundnuts.

Kondap *et al.* (1982) stated that the requirements of N, P, K to produce 100 kg pods were 8.6, 1.4 and 7.5 kg with pendimethalin treatment and 29.6, 4.4 and 30.6 kg N, P, K in no weeding treatment. The N, P, K uptake by weeds was greatly reduced by the application of 1.5 kg pendimethalin ha⁻¹ to groundnuts (Kondap *et al.*, 1985).

Kulandaivelu (1979) observed that application of Stomp (Pendimethalin) to groundnuts did not show any phytotoxic symptoms and Stomp treatments reduced plant height. Choudhary and Lagoke (1985) showed that in groundnut pendimethalin treatment decreased crop stand at 3.0 kg a.i. ha⁻¹ but pod yield was comparable to weed free plot. In groundnut cv. POL-2 application of pendimethalin @ 2 kg a.i. ha⁻¹ unaffected the

growth components like number of branches, root weight, nodulation but increased dry matter production (Kulandaivelu and Morachan, 1981). Kondap et al. (1989) reported increased number of matured pods plant⁻¹, number of seeds plant⁻¹ and 100 kernel weight due to pendimethalin @ 1.5 kg a.i. ha⁻¹.

Sidhu et al. (1985) reported that in groundnut cv. M-145 application of pendimethalin @ 0.375 or 0.75 kg a.i. ha⁻¹ did not affect nodule number and nodule weight plant⁻¹. Jayakumar et al. (1985) reported slight reduction in oil content due to application of pendimethalin @ 1.0 kg a.i. ha⁻¹ in groundnut but crude protein was similar to that of hand weeded treatments.

2.9.2.3 Fluchloralin (Basalin) use in groundnut

Fluchloralin [N-(2-chloroethyl)-2, 6-dinitro-N-propyl-4 (trifluoromethyl) aniline] is a pre-emergence herbicide which controls many annual broad leaved and grassy weeds (Rao, 1988). Kulandaivelu et al. (1978) and Joshi (1987) reported that fluchloralin herbicide controls most of the weeds like *Amaranthus viridis*, *Commelina benghalensis*, *Dactyloctenium aegyptium*, *Portulaca oleracea* and *Euphorbia hirta*. However, Prasad et al. (1987) reported that fluchloralin was more effective in controlling grasses than broad leaved weeds.

Hegde et al. (1977), Kulandaivelu et al. (1978), Brar et al. (1980), Singh et al. (1980), Yaduraju et al. (1980) and Bhan et al. (1983) found that pre-emergence application of fluchloralin @ 0.76 - 2.0 kg a.i. ha⁻¹ was effective in

controlling weeds and resulted in significantly higher yields. However, Patro *et al.* (1981) showed that fluchloralin at 1.5 kg a.i. ha⁻¹ was less effective in irrigated rabi groundnut.

Rajah *et al.* (1984), Bholá *et al.* (1985) and Ray (1986) reported that application of fluchloralin @ 1.5 to 2.0 kg a.i. ha⁻¹ with one hand weeding gave effective control of weeds in irrigated groundnuts and resulted in significantly higher pod yields. Shah *et al.* (1980) reported an increased pod yield to the extent of 50 per cent by the application of fluchloralin (2.5 kg a.i. ha⁻¹) over weedy control. Yadav *et al.* (1983) also recorded higher pod yields with the application of fluchloralin due to the improvement in all the yield components. Kondap *et al.* (1982) reported that the amount of N P K required by groundnut to produce 100 kg pods was 8.5, 1.4 and 7.1 kg ha⁻¹ with fluchloralin treatment and 29.6, 4.4 and 30.6 kg in weedy control plots. Fluchloralin @ 0.72 kg did not significantly affect nodule number per plant (Sidhu *et al.*, 1985). However, fluchloralin @ 0.75 kg a.i. ha⁻¹ resulted in higher oil and crude protein content in kernels (Jayakumar *et al.*, 1985).

2.9.3 Oxyfluorfen (Diphenyl ether group)

2.9.3.1 Mode of action

Oxyfluorfen is a selective herbicide. It is adsorbed strongly to soil organic matter (Fadayomi and Warren, 1977). Kunert and Boger (1981) reported that light and oxygen are essential for phytotoxic action. When it is used as pre-

emergence, weeds are killed by contact action as the plumule pushes through treated soil zones (Pritchard et al., 1980). Herbicide enters the plants through the roots, leaves and stems. They kill the plants by first damaging the membranes and causing cellular substances to leak into intercellular spaces followed by necrosis (Pritchard et al., 1980). Pritchard et al. (1980) also reported that photosystem II linked phosphorylation and photosystem II electron transport were inhibited by oxyfluorfen. Protein damage is a primary phytotoxic consequence of oxyfluorfen (Kunert et al., 1985).

2.9.3.2 Oxyfluorfen (Goal) for weed control in groundnut

Oxyfluorfen [2-chloro-1-(3-ethoxy-4-nitro-phenoxy) -4-(trifluoromethyl) benzene] is a selective herbicide in legume crops (Akobundu, 1988).

Most of the annual broad leaved weeds and grasses are controlled at relatively low rates of active ingredient when used as pre-emergence treatment (Fadayomi et al., 1977; Joshi, 1987). Joshi (1987) reported that oxyfluorfen controls most of the weeds like *Amaranthus spinosus*; *Commelina benghalensis*, *Digitaria marginata*, *Euphorbia hirta*, *Portulaca oleracea* and *Trianthema portulacastrum*.

Yadav et al. (1983) reported moderate control of weeds in groundnuts with pre-emergence application of oxyfluorfen @ 0.1 - 0.2 kg ha⁻¹. Prasad et al. (1987) reported that application of oxyfluorfen pre-emergence to groundnuts cv. TMV-2 @ 0.12 to 0.15

kg ha⁻¹ gave effective control of broad leaved weeds and grasses upto 60 days after sowing and gave pod yields of 3.21 - 3.25 t ha⁻¹ which was comparable with hand weeded plots.

According to Jessinger (1978) oxyfluorfen @ 0.125 kg a.i. ha⁻¹ gave maximum pod yield of 1660 kg ha⁻¹. Raghavan et al. (1983) reported that pre-emergence application of oxyfluorfen (0.24 kg a.i. ha⁻¹) + one interculturing at 45 DAS was effective in controlling weeds and resulted in higher yields of groundnut by 79.5 per cent over control. Yadav et al. (1983) reported significant increase in yield of groundnut (1852, 2263 kg ha⁻¹) due to oxyfluorfen application (0.1 and 0.2 kg a.i. ha⁻¹) over weedy check (1263 kg ha⁻¹). Similarly Kondap et al. (1989) reported application of oxyfluorfen @ 0.25 kg a.i. ha⁻¹ to groundnut cvs. JL-24 and Kadiri-3 resulted in 238 per cent increased yield over weedy control and this was due to increased yield components like number of matured pods plant⁻¹, number of seeds and 100 kernel weight.

Pahuja et al. (1985) and Kumar (1986) reported that application of oxyfluorfen @ 0.2 kg a.i. ha⁻¹ was phytotoxic during the early growth stages which disappeared at later stages. Kulandaivelu and Morachan (1981) reported that application of diphenyl ether herbicides to irrigated groundnuts increased the number of branches, dry matter production, root weight and pod number but nodulation was unaffected. In groundnut application of oxyfluorfen @ 0.25 kg a.i. ha⁻¹ also increased oil and crude protein content (Jayakumar et al., 1985).

2.10 POST EMERGENCE HERBICIDE

2.10.1 Glyphosate (Unclassified herbicide)

2.10.1.1 Mode of action

Glyphosate is a foliar applied herbicide which translocate readily in treated plants, mainly in the symplast. Glyphosate caused chlorosis and affected leaves showed swollen fret channels, more diffused stroma and disrupted chloroplasts (Hoagland and Paul, 1978). Glyphosate inhibited aromatic amino acid synthesis and specifically it is an inhibitor of enzyme 5-enolpyruvylshikimate-3-phosphate synthetase (Cole, 1982). Tymonko and Foy (1978) reported that glyphosate inhibits protein synthesis and in plants it stops the incorporation of aromatic amino acids-phenylalanine, tryptophan and tyrosine into proteins. Glyphosate inhibited photosynthesis and ion absorption (Brecke and Duke, 1977). Glyphosate has soil residual activity in sandy and in soils with high organic matter (Salazar and Appleby, 1982).

2.10.1.2 Glyphosate (Round up) use in groundnut

Glyphosate [N - (phosphonomethyl) glycine] is a broad spectrum, nearly non selective post emergence herbicide used for control of both annuals and rhizomatous perennial weeds (Brown et al., 1988). Glyphosate is extensively used for perennial weed control in plantation crops and in orchards (Rao, 1988). Glyphosate is very effective against *Cynodon dactylon*, *Digitaria sanguinalis*, *Amaranthus viridis* (Joshi, 1987) and used for

control of weeds that are taller than crop (Villanueva et al., 1985).

Post emergence application of glyphosate in groundnut with rope wick applicator or wiper gave effective control of weeds like *Digitaria sanguinalis* (Piggot et al., 1982); and *Cyperus esculentus* (Fenderson et al., 1982). Glyphosate treatment significantly inhibited the growth of *Cyperus spp* and caused chlorosis and leaf apex necrosis (Villanueva et al., 1985). Evidence of root transfer of glyphosate from treated to untreated plants was observed with application @ 2.0 Kg a.i. ha⁻¹ (Coupland and Lutman, 1982). Ray and Patra (1986) reported that application of glyphosate three days after sowing did not effectively control monocot weeds but controlled all dicot weeds. However, post emergence application of glyphosate with recirculating sprayer in peanut caused visual injury to peanuts (Banks et al., 1977).

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MATERIALS & METHODS

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CHAPTER III

MATERIALS AND METHODS

1 EXPERIMENTAL SITE

Field experiments on the effect of herbicides and crop weed competition on physiological aspects of diverse groundnut (*Arachis hypogaea* L.) cultivars were conducted at the College farm, College of Agriculture, Rajendranagar, Hyderabad during rabi (November to April) 1987 and 1988. The farm is located at an altitude of 542 meters above mean sea level, with geographical bearing of $77^{\circ} 55'$ E longitude and $16^{\circ} 59'$ N latitude.

1.2 SOIL

The soil was sandy loam with good drainage. Composite soil samples drawn from the samples collected at random from the experimental field prior to cropping was analysed for the following physical and chemical properties adopting the procedures described by Piper (1957) and Jackson (1967) respectively.

Soil mechanical analysis

Soil fraction	Component %
Sand	65.7
Silt	13.3
Clay	21.0
Textural class	Sandy loam

Chemical analysis

Soil character	Value
Soil reaction pH (soil and water in 1:2.5)	7.30
Electrical conductivity (at 25°C) ($d\text{ Sm}^{-1}$)	0.24
Organic carbon (%)	0.52

Soil character	Value
Available nitrogen (kg ha^{-1})	293.8
Available phosphorus (kg ha^{-1})	26.3
Available potassium (kg ha^{-1})	224.2

The analysis indicated that soil was medium in available nitrogen, phosphorus and potassium.

3.3 WEATHER DATA DURING THE CROP GROWTH PERIOD

The weekly meteorological data recorded during the entire crop growth period for both the years are given in Table 3 and 4.

The total rainfall received during the crop growth period was 163.5 mm and 49.0 mm during Rabi 1987 and 1988 growing seasons respectively, which was not sufficient for crop growth. Hence, irrigations were given at ten days interval.

The mean maximum and minimum temperatures during Rabi 1987 ranged from 26.1°C to 37.8°C and 9.7°C to 22.9°C respectively. Whereas, during Rabi 1988 it ranged from 25.7°C to 39.2°C and 10.8°C to 26.0°C respectively. The range of weekly

Table 3: Meteorological data for Rabl 1987 (from 18th November, 1987 to 9th April, 1988)

Standard week No.	Period	Mean temp. ($^{\circ}$ C)		Mean R.H.(%)		Mean sunshine hours	Mean rainfall (mm)
		Max.	Min.	0716 hrs.	1422 hrs.		
46	Nov. 12-18	26.1	20.5	92	65	2.7	121.6
47	Nov. 19-25	28.8	18.1	91	60	8.7	0.0
48	Nov. 26-Dec.02	28.4	11.8	80	44	10.7	0.0
49	Dec. 03-09	28.6	15.1	92	43	9.5	0.0
50	Dec. 10-16	27.0	17.8	87	50	3.8	1.7
51	Dec. 17-23	26.8	9.7	82	39	10.5	0.0
52	Dec. 24-30	27.8	13.3	83	43	9.8	0.0
1	Dec. 31-Jan.06	27.6	12.2	87	41	9.7	0.0
2	Jan. 07-13	27.6	12.8	84	38	10.3	0.0
3	Jan. 14-20	30.3	15.1	81	38	10.5	0.0
4	Jan. 21-27	30.7	14.4	79	36	10.5	0.0
5	Jan. 28-Feb.03	31.4	14.7	81	38	11.0	0.0
6	Feb. 04-10	31.8	13.1	69	30	10.9	0.0
7	Feb. 11-17	31.6	18.5	83	32	10.4	0.0
8	Feb. 18-24	33.2	20.1	87	38	10.4	27.2
9	Feb. 25-Mar. 02	33.9	20.4	88	35	10.3	1.4
10	Mar. 03-09	34.6	20.8	75	34	10.7	0.0
11	Mar. 10-16	36.5	20.7	68	32	11.6	0.0
12	Mar. 17-23	36.2	21.6	68	40	10.5	0.0
13	Mar. 24-30	36.2	20.6	59	30	9.4	11.6
14	Mar. 31-Apr.06	37.6	21.2	64	29	8.2	0.0
15	Apr. 07-13	37.8	22.9	61	22	8.4	0.0
Mean/Total		31.4	17.1	79.1	39.0	9.5	163.5

Table 4: Meteorological data for Rabi 1988 (from 19th November, 1988 to 22th April, 1989)

Standard week No.	Period	Mean temp. ($^{\circ}$ C)		Mean R.H.(%)		Mean sun-shine hours	Mean rain-fall (mm)
		Max.	Min.	0716 hrs.	1422 hrs.		
47	Nov. 19-25	29.9	11.9	76	27	10.2	0.0
48	Nov. 26-Dec.02	28.3	10.8	79	31	10.1	0.0
49	Dec. 03-09	28.5	11.4	75	33	9.8	0.0
50	Dec. 10-16	25.7	14.1	83	57	5.6	17.0
51	Dec. 17-23	27.6	11.7	90	44	9.8	0.0
52	Dec. 24-30	28.3	12.4	88	43	8.5	0.0
1	Dec. 31-Jan.06	28.3	12.7	88	40	9.9	0.0
2	Jan. 07-13	28.7	13.4	81	44	9.8	0.0
3	Jan. 14-20	29.6	12.3	83	39	9.7	0.0
4	Jan. 21-27	30.4	15.7	84	44	9.2	0.0
5	Jan. 28-Feb.03	31.3	10.9	73	30	10.4	0.0
6	Feb. 04-10	33.5	12.2	70	26	10.8	0.0
7	Feb. 11-17	33.2	13.4	62	28	10.6	0.0
8	Feb. 18-24	32.2	12.6	55	22	10.4	0.0
9	Feb. 25-Mar. 02	35.2	15.4	53	17	10.5	0.0
10	Mar. 03-09	34.2	17.5	69	29	9.7	25.0
11	Mar. 10-16	32.7	18.5	66	29	9.4	0.0
12	Mar. 17-23	35.7	21.5	54	26	10.2	0.0
13	Mar. 24-30	31.5	19.4	76	36	8.6	5.0
14	Mar. 31-Apr.06	37.5	19.2	49	18	11.7	0.0
15	Apr. 07-13	38.9	21.0	53	17	12.0	0.0
16	Apr.14-20	39.2	23.8	61	24	9.7	0.0
17	Apr.21-27	38.8	26.0	52	21	9.5	2.0
Mean/Total		32.1	15.6	70.4	31.5	9.8	49.0

mean relative humidity at 0716 hours was from 59 to 92 per cent, and at 1422 hours, it was 22 to 65 per cent in Rabi 1987; it varied from 49 to 90 per cent at 0716 hours and from 17 to 57 per cent at 1422 hours in Rabi 1988. The number of sunshine hours l^{-1} ranged from 2.7 to 11.6 during Rabi 1987 and 5.6 to 12.0 during Rabi 1988.

3.4 DESIGN AND LAYOUT

The experiment was laid out in split-plot design with nine main treatments, three sub-treatments and replicated thrice. The field plan layout is given in Fig 1.

3.4.1 Details of treatments

Main treatments

- T₁ : Pre-emergence application of Alachlor @ 1.5 kg a.i.ha⁻¹
- T₂ : Pre-emergence application of Pendimethalin @ 1.5 kg a.i.
ha⁻¹
- T₃ : Pre-emergence application of Oxyfluorfen @ 0.25 kg a.i.
ha⁻¹
- T₄ : Pre-emergence application of Fluchloralin @ 1.5 kg a.i.
ha⁻¹
- T₅ : Post-emergence application of Glyphosate @ 1.5 kg a.i.
ha⁻¹
- T₆ : Keeping only C₄ weeds
- T₇ : Keeping only C₃ weeds

T₈ : Keeping both C₃ and C₄ weeds (control; No weeding)

T₉ : Weed free throughout the crop growth period

Note: All the pre-emergence herbicides were sprayed 48 hours after sowing groundnut. The herbicide glyphosate was selective and it was applied with the help of rubber foam on weeds between groundnut rows 21 days after sowing.

Sub-treatments

V₁ : Kadiri-3 (K-3) (Virginia)

V₂ : JL-24 (Spanish)

V₃ : Gangapuri (Valencia)

Plot size - 4x3.0 m

Spacing - 30x10 cms

Fertilization - 20 kg N + 40 kg P + 40 kg K ha⁻¹

The characteristics of diverse groundnut cultivars is given in Table 5. The details of sowing and harvesting dates in two seasons are given in Table 6.

Table 5: Characteristics of the cultivars

Cultivar	Botanical group	Habit group	Duration (days)	Salient features
1. Kadiri-3	Virginia	Semi spreading	115-125	Semi spreading habit, pods 1-2 seeded
2. JL-24	Spanish	Bunch	100-110	Erect growth, pods 1-2 seeded
3. Ganga-puri	Valencia	Bunch	90-100	Erect growth, pods 1-3 seeded

Source : DOR, 1985 and ICRISAT, 1986

Table 6: Dates of sowing and harvesting in two seasons

Season	Date of sowing	Date of harvest		
		V1	V2	V3
1. Rabi 1987	18-11-1987	9-4-88	28-3-88	8-3-88
2. Rabi 1988	19-11-1988	22-4-89	9-4-89	21-3-89

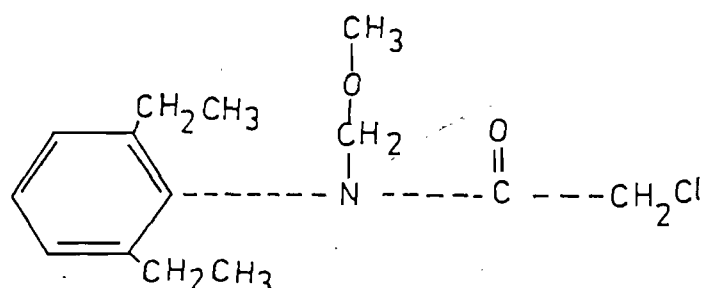
3.5 TECHNICAL INFORMATION OF HERBICIDES

I. Alachlor

Trade name : Lasso

Group : Anilides

Structure



Chemical name : 2-chloro-2', 6'-diethyl-N-(methoxy methyl)-acetanilide.

Formulation : Emulsifiable concentrate (EC)

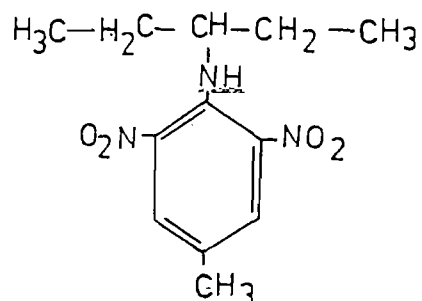
Active ingredient : 440 g L⁻¹

II. Pendimethalin

Trade name : Stomp

Group : Dinitroaniline

Structure :



Chemical Name : N-(1-Ethyl propyl)3,4-dimethyl-2, 6-dinitro benzenamine

Formulation: Emulsifiable concentrate (EC)

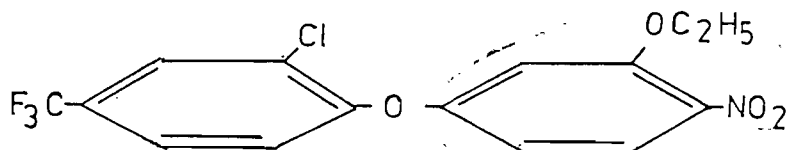
Active ingredient: 300 g L⁻¹

III. Oxyfluorfen

Trade Name : Goal

Group : Diphenyl ether compound

Structure :



Chemical name: 2-chloro-1-(3-ethoxy-4-nitro phenoxy)-4-(trifluoro methyl) benzene

Formulation: Emulsifiable concentrate (EC)

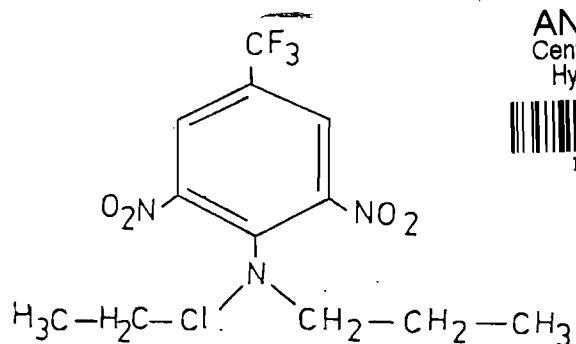
Active ingredient : 240 g L⁻¹

IV. Fluchloralin

Trade Name : Basalin

Group : Dinitroaniline

Structure :



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Hyderabad



D03332

Chemical name: N-propyl-N(2'-chloroethyl)-2, 6-dinitro-N-trifluoromethyl aniline

Formulation: Emulsifiable concentrate (EC)

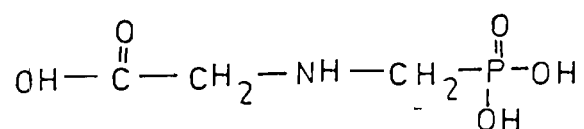
Active ingredient: 440 g L⁻¹

V. Glyphosate

Trade name : Round up

Group : Miscellaneous herbicide

Structure:



Chemical name: N-(Phosphonomethyl) glycine-
(isopropylamine salt)

Formulation : Water soluble concentrate (WSC)

Active ingredient: 410 g L⁻¹

3.6 CULTIVATION DETAILS

Field was ploughed twice and levelled with tractor drawn implements. The field was then laid out into plots measuring 4x3 m.

The fertilizer N, P, K @ 20:40:40 kg ha⁻¹ was applied as basal dose in the form of urea, single super phosphate and muriate of potash.

Bold and healthy seeds of all the cultivars were selected for sowing. These seeds were hand dibbled with a spacing of 30x10 cm.

In complete weed free treatment, hand weeding was done throughout crop growth at fortnightly interval. In T₆ and T₇ treatments selective weeding of C₃ and C₄ weeds was done at 10 days after germination of the crop and at fortnightly intervals during subsequent stages of the crop.

3.6.1 Pest control

Endosulfan 35% EC @ 1.5 ml L⁻¹ (500 L ha⁻¹), was sprayed on 30 and 60 days after sowing to prevent attack by pests like leaf minor, leaf roller, thrips etc. While Dithane M-45 @ 1.3 kg ha⁻¹ (500 L ha⁻¹) was sprayed on 30 and 60 days after sowing to prevent tikka leaf spot disease.

3.7 EXPERIMENTAL OBSERVATIONS ON WEED GROWTH

The weeds present in experimental area were classified into C₃ and C₄ based on photosynthetic pathway. Leaf anatomy was used as a criteria for classification, as described by Crookston and Moss (1970).

3.7.1 Criteria for classification

C₄ plants possess a characteristic type of leaf anatomy described as "Kranz" type which involves the occurrence of a chlorenchymatous bundle sheath in the leaves and when stained

with I_2KI (Iodo-potassium Iodide) these plants show selective staining of chloroplasts in the bundle sheaths. In C_3 species, the vascular bundle sheath is made up of loosely oriented chlorenchymatous cells and when stained with I_2KI , there is even staining throughout the entire leaf which indicates an even distribution of starch.

3.7.2 Weed spectrum

Weed counts were taken, species wise on 30, 50, 70 and 110 days after sowing from premarked permanent one square metre area. From weed number recorded on 70 DAS, relative density values of each species was calculated by the formula given by Sen (1981).

$$\text{Relative density of a species} = \frac{\text{Number of individuals of a species}}{\text{Total number of all weed species}} \times 100$$

3.7.3 Weed dry matter

Weeds were removed from 0.25 sq.m area marked outside of the net plot on 30, 50, 70, 90 and 110 days after sowing and their dry weights were recorded species wise. Based on the weed dry matter produced on 70 DAS, weed control efficiency was calculated using the following formula:

$$\text{Weed control efficiency} = \frac{\text{Weight of dry matter of weeds in no weeding plot/unit area (g m}^{-2}\text{)} - \text{Weight of dry matter of weeds in treatmental plot/unit area (g m}^{-2}\text{)}}{\text{Weight of dry matter of weeds in no weeding plot/unit area (g m}^{-2}\text{)}}$$

3.7.4 Weed Growth Rate (WGR) ($\text{g m}^{-2} \text{d}^{-1}$)

Weed growth rate was calculated by the formula given by Bhanumurthy and Subramanian (1989).

$$\text{WGR} = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{P}$$

where,

W_1 and W_2 are the dry weights of weeds at time t_1 and t_2 respectively.

P is the unit land area

3.7.5 Calculated Leaf Area Index of Weeds

Weed Leaf area index was calculated by the formula given in Rijsdijk (1986).

$$\text{LAI of weeds } (L_w) = \frac{L_c \times G_w}{G_c}$$

where,

G is growth rate ($\text{kg ha}^{-1} \text{d}^{-1}$)

L is the leaf area index; subscripts c, w refer to crop and weeds respectively

3.8 OBSERVATIONS ON CROP GROWTH

3.8.1 Germination percentage

The effect of pre-emergence herbicides on germination if any was noted after crop emergence.

3.8.2 Phytotoxicity scoring

Phytotoxicity scoring was taken on 10th day after crop emergence for pre-emergence herbicides as per Rao (1988). Post-emergence herbicide effects were also recorded on 10th day after spraying.

Effect	Rating	Visual symptoms
None	0	No injury, normal
Slight	1	Slight stunting, injury or discolouration
	2	Some stand loss, stunting or discolouration
	3	Injury more pronounced but not persistent
Moderate	4	Moderate injury, recovery possible
	5	Injury more persistent, recovery doubtful
	6	Near severe injury, no recovery possible
Severe	7	Severe injury, stand loss
	8	Almost destroyed, a few plants surviving
	9	Very few plants alive
Complete	10	Complete destruction

Source : Rao (1988)

3.8.3 Mortality percentage

This was calculated on 10th day after germination to find out any mortality in crop due to pre-emergence herbicides and for post-emergence herbicide, mortality percentage if any was calculated on 10th day after spraying.

3.8.4 Plant height

The plant height was measured in cm from the base of the plant to the tip of main shoot on 70 days after sowing.

3.8.5 50 per cent flowering

The number of days taken by fifty per cent of plants out of total number of plants in the plot to come to flowering was recorded.

3.8.6 Nodule number

Five plants from each treatment were sampled to count the root nodule number on 70 days after sowing.

3.8.7 Total number of branches

Primary branches are $n+1$ branches, include cotyledonary branches and primary laterals arising from the main axis (n). Branches arising from $n+1$ (including cotyledonary branches) were considered as secondary branches and referred to as $(n+2)$ branches (Bunting, 1955). This was recorded on 70 DAS.

3.8.8 Dry matter partitioning

For this purpose 5 plants were dug out carefully and thoroughly washed free of soil and the surface dried with filter paper. The plant samples were partitioned into different components viz., Lamina (leaves), stem (including petioles), roots and reproductive parts (flowers, pegs and pods). Prior to

subjecting leaves for dry matter estimation leaf area was measured using leaf area meter (LICOR 3100, Made in USA).

Then the different component parts were dried at 103°C in oven for one hour and again at 75°C for 48 hours to estimate the dry matter. These observations were recorded at 20 days interval starting from 30 DAS.

3.9 GROWTH ANALYSIS

The data on total plant dry weights, leaf dry weights and leaf area were used for calculation of growth parameters viz., Crop growth rate (CGR); Relative growth rate (RGR), Relative leaf growth rate (RLGR), Net assimilation rate (NAR), Leaf area index (LAI), Leaf weight ratio (LWR), Leaf area ratio (LAR), Specific leaf weight (SLW) by following the formulae as described by Watson (1952), Radford (1967) and Evans (1972).

3.9.1 Crop Growth Rate (CGR) ($\text{g m}^{-2} \text{d}^{-1}$)

$$\text{CGR} = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{P}$$

where,

W_1 and W_2 are the dry weights at times t_1 and t_2 respectively.

P is the unit land area

3.9.2 Relative Growth Rate (RGR) ($\text{g g}^{-1} \text{d}^{-1}$)

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

where,

W_1 and W_2 are the dry weights at times t_1 and t_2 respectively.

3.9.3 Relative Leaf Growth Rate (RLGR) ($\text{g g}^{-1} \text{d}^{-1}$)

$$\text{RLGR} = \frac{\log_e LW_2 - \log_e LW_1}{t_2 - t_1}$$

where,

LW_1 and LW_2 are leaf dry weights at time t_1 and t_2 respectively.

3.9.4 Net Assimilation Rate (NAR) ($\text{g dm}^{-2} \text{d}^{-1}$)

$$\text{NAR} = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{\log_e A_2 - \log_e A_1}{A_2 - A_1}$$

where,

W_1 and W_2 are plant dry weights and A_1 and A_2 are leaf area at times t_1 and t_2 respectively.

3.9.5 Leaf Area Index (LAI)

$$\text{LAI} = \frac{\text{Leaf area}}{\text{Unit ground area}}$$

3.9.6 Leaf Area Duration (LAD) (days)

Leaf area duration was worked out as per the formula suggested by Power et al. (1967).

$$LAD = \frac{L_i + (L_i + 1)}{2} \times (t_2 - t_1)$$

where,

LAD = Leaf area duration in days

L_i = LAI at any i th stage

$L_i + 1$ = LAI at $(i + 1)$ th stage

$(t_2 - t_1)$ = time interval between i and $(i+1)$ th stage in days

3.9.7 Leaf Weight Ratio (LWR) ($g\ g^{-1}$)

$$LWR = \frac{WL}{W}$$

where,

WL is total leaf dry weight

W is total plant dry weight

3.9.8 Leaf Area Ratio (LAR) ($cm^2\ g^{-1}$)

$$LAR = \frac{\text{Leaf Area}}{\text{Total plant dry weight}}$$

3.9.9 Specific Leaf Weight (SLW) (mg cm^{-2})

$$\text{SLW} = \frac{\text{Leaf dry weight}}{\text{Leaf area}}$$

Note: The data for crops and weeds were collected on 30, 50, 70, 90 and 110 DAS but the tables are given for 30, 70 and 110 DAS which approximately corresponds to Vegetative, pegging and pod filling stages respectively in groundnut. However, complete data collected has been used for preparing figures.

3.10 PHYSIOLOGICAL AND BIOCHEMICAL PARAMETERS

3.10.1 Stomatal frequency

The stomatal frequency was studied following leaf surface impressions by using quickfix (commercial preparation). The solution was smeared on the leaf surface. After about 2-3 minutes, the solidified layer was peeled, placed and mounted on a slide with a coverslip and observed under microscope. Number of stomata was recorded in crop and weeds at 40 x 10 magnification and expressed in terms of number of stomata per square millimeter leaf area.

3.10.2 Chlorophyll content

The procedure developed by Arnon (1949) was followed. One gram (fresh weight) of leaf material representing from all the trifoliates was placed in a clean mortar, to which 30 ml of

80 per cent (V/V) acetone and a pinch of CaCO_3 were added. Further the tissue was ground to a fine pulp and the contents were transferred to a 100 ml volumetric flask through a funnel having Whatman No.1 filter paper. After filtration, the left over pulp was again transferred to the mortar and grinding was repeated till the entire chlorophyll was extracted from the leaf material. Every time care was taken to rinse the mortar and walls of the funnel to ensure that all the chlorophyll was collected. The final volume of the filtrate was made upto 100 ml with 80 per cent acetone. The optical density of chlorophyll extract was read in colorimeter Spectronic-20 set at 652 nm, using 80 per cent acetone solvent as blank. Then the total chlorophyll present in the extract was calculated by using the following formula.

$$\text{Total chlorophyll (mg g}^{-1} \text{ fresh weight)} = \frac{(D_{652}) \times 100}{34.5} \times \frac{V}{1000} \times \frac{1}{W}$$

where,

D = Optical density

V = Final volume of the 80 per cent acetone chlorophyll extract

W = Fresh weight in grams of the tissue

3.10.3 Leghaemoglobin content

The procedure developed by Proctor (1963) was followed for the estimation of leghaemoglobin. Fresh nodules (0.5 g) was washed in the phosphate buffer (pH 5.4) and then crushed in ice

cold trisacetic acid buffer (pH 4.0) consisting of the following components.

0.1 M acetic acid (6.0 g L^{-1}) was adjusted to pH 4.0 with 0.2 M tris (hydroxy methyl) amino methane (24.23 g L^{-1}) using pH meter.

The nodule extract was centrifuged at 3000 rpm for 10 mts, and the supernatant was separated from the sediment. The aliquot of the supernatant (0.1 ml) was made to a final volume of 4.0 ml by the addition of trisacetic acid buffer. Later on 2.0 ml of freshly prepared benzidine reagent of following composition was added.

Benzidine - 100 ml

H_2O_2 (100 volumes) - 0.5 ml

Absolute alcohol - 50 ml

After an incubation period of thirty seconds the optical density was measured in colorimeter Spectronic-20 at 640 nm. A standard curve of the oxyblood haemoglobin of various concentrations was made from which the haemoglobin content of the nodules was computed and expressed as mg g^{-1} fresh weight of the nodules.

3.10.4 Photosynthetic efficiency (CO_2 assimilation rate)

The photosynthetic rate of leaves was estimated following $^{14}\text{CO}_2$ feeding technique as developed by Janardhan (1977). Excised leaves from the field were placed in test tubes which contained water. A petriplate containing $25 \mu \text{ ci}$ of Na_2

$^{14}\text{CO}_3$ (specific activity $47.6 \text{ m Ci m M}^{-1}$) was kept in the center. $^{14}\text{CO}_2$ was liberated by introducing 5 ml of 0.5 N HCl through one of the rubber tubing (connected to glass tubing inside the chamber) provided on top of the lid. The escape of $^{14}\text{CO}_2$ was prevented by closing the tube with a pinch cock. The air inside the chamber was thoroughly mixed by constant pumping of an aspirator connected to another rubber tubing. Thirty minutes were allowed for $^{14}\text{CO}_2$ fixation. At the end of this period about one ml of 1 N KOH was introduced, to trap excess $^{14}\text{CO}_2$. The lid was removed, leaf samples taken out and immediately dried in an oven at 80° . Then they were powdered in a porcelain mortar. Twenty mg dried leaf powder samples were uniformly spread in aluminium planchets and ^{14}C activity was measured in a Geiger counting system (2% counting efficiency, CGS 16, ECIL, Hyderabad). The photosynthetic activity in leaf was expressed as $^{14}\text{C cpm g}^{-1} \text{ leaf dry matter hr}^{-1}$ and calculated as

$$^{14}\text{C cpm g}^{-1} \text{ hr}^{-1} = C \times \frac{60}{30} \times \frac{1000}{W}$$

where,

C = Counts recorded by counter after deducting the background counts.

W = Weight of dried leaf sample (mg)

30 = Refers to feeding time in minutes

60 = Refers to one hour

3.10.5 Light transmission ratio (LTR)

Light interception was measured by using Weston Illumination Meter (Model 756). Light transmission ratio was calculated using the following formula

$$\text{LTR (\%)} = \frac{\text{Light intensity below the canopy}}{\text{Light intensity above the canopy}} \times 100$$

3.11 YIELD AND YIELD COMPONENTS

Plants in a square meter area from each treatment were dug out carefully at harvest along with roots. Then the plants were made free of soil particles and partitioned into different components. This data was used to calculate yield and yield components.

3.11.1 Total number of pods, number of matured pods and seeds per plant

Ten plants were chosen at random from each treatment plot to record the average number of total pods, matured pods (filled) and seed number per plant.

3.11.2 Number of pegs

From ten plants in each treatment, the number of pegs were recorded and expressed as number per plant.

3.11.3 Filled pods percentage

The percentage of filled pods to the total number of pods was calculated and expressed as filled pods percentage.

3.11.4 Shelling percentage

From each treatment, 100 g of cleaned pods were weighed, shelled separately and kernels weight was recorded. The shelling percentage was determined from this data.

$$\text{Shelling percentage} = \frac{\text{Weight of kernels}}{\text{Weight of pods}} \times 100$$

3.11.5 100 Kernel weight (Test Weight)

At random 100 kernels were selected from each treatment and the weights were recorded and expressed in grams.

3.11.6 Pod yield

Weight of pods after complete sun drying was recorded from of each treatment. Pod yield was expressed in grams per square meter of ground area.

3.11.7 Kernel yield

Weight of kernels was recorded from net plots of each treatment after shelling. Kernel yield was expressed in grams per square meter of ground area.

3.11.8 Haulm yield

The yield of the above ground dry matter was recorded after complete drying and the haulm yield was also expressed in grams per square meter of ground area.

3.11.9 Total dry matter at harvest

Completely dried samples were weighed to a constant weight. These data were used to estimate the total dry matter and was expressed in grams per square meter of ground area.

3.11.10 Kernel weight partitioning index (KWPI)

Kernel weight partitioning index was calculated using the following formula.

$$\text{KWPI} = \frac{\text{Dry kernel weight}}{\text{Total dry matter} - \text{Dry kernel weight}}$$

3.11.11 Harvest index

From the yield of pods and total dry matter, harvest index was calculated using the following formula.

$$\text{Harvest index} = \frac{\text{Pod yield at harvest (g m}^{-2}\text{)}}{\text{Total dry matter at harvest (g m}^{-2}\text{)}} \times 100$$

3.11.12 Sink size

Sink size was calculated and expressed in terms of g kernel m⁻² leaf area; kg kernel kg⁻¹ leaf dry matter and kg kernel kg⁻¹ leaf protein.

3.11.13 Weed index

Weed index was calculated based on the yield in various treatments using the formula suggested by Gill and Vijayakumar (1969).

$$\text{Weed index (\%)} = \frac{\text{Pod yield from hand weeding treatment} - \text{Pod yield from herbicide treatment}}{\text{Pod yield from hand weeding treatment}} \times 100$$

3.12 CHEMICAL ANALYSIS

The dried samples were ground in Wiley mill to pass through 40 mesh sieve and then used for the determination of nitrogen, phosphorus and potassium.

Composite samples were taken and analysed to find out the content of nitrogen, phosphorus and potassium in crop and weeds as on 70 days after sowing. The uptake was calculated based on per cent NPK and dry matter production. The leaf nitrogen on 70 days after sowing was also analysed in crop. Total nitrogen was determined by Kjeltic system method as described in technical bulletin by Tecator (1982).

Phosphorus and potassium contents were estimated in triacid extract (Piper, 1957).

3.12.1 Oil analysis

The oil in kernels was estimated by using Nuclear Magnetic Resonance Spectrometry method (NMR) (Jambunathan *et al.*, 1985).

3.12.2 Protein percentage

The nitrogen percentage in kernels was estimated and multiplied with the factor 6.25 to get crude protein per cent.

3.13 STATISTICAL ANALYSIS

The data on crop and weeds were analysed as per standard procedures given for split plot design by Snedecor and Cochran (1967). The weed counts were statistically analysed after transforming them by using the following formula.

$$X = \sqrt{x + 1}$$

where,

x = actual weed number

X = Transformed weed number

The results were tested at 5 per cent level of significance.

3.14 CORRELATION STUDIES

Simple correlation of coefficient ('r' values) were calculated between seed yield and weed dry matter production, pod yield, filled pod percentage, test weight, shelling percentage and harvest index to assess the degree of association between these characters by adopting standard procedures as outlined by Panse and Sukhatme (1978).

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RESULTS

CHAPTER IV

RESULTS

4.1 OBSERVATIONS ON WEED GROWTH

4.1.1 Weed Spectrum

During the crop growth period, sixteen weed species were found which included seven C_4 species and nine C_3 species (Table 7 and Plates 1 & 2). Weeds were classified into C_3 and C_4 based on leaf anatomy, staining technique and on published reports.

4.1.2 Number of Weeds (Species wise)

Species wise weed counts were recorded on 30 and 70 DAS in rabi 1987 and 1988 (Table 8,9,10,11). The relative density of various dominant weeds as on 70 DAS was also calculated Table (9 and 11).

During rabi 1987 weed species viz., *Dactyloctenium aegyptium*, *Cyperus rotundus*, *Digitaria sanguinalis*, *Cynodon dactylon* among C_4 weeds and *Ocimum canum*, *Lagasca mollis* among C_3 weeds were predominant. The relative density per cent of C_4 weeds in T_8 (C_3+C_4 weeds) as on 30 and 70 DAS was 89.5 and 78.2 respectively while that of C_3 weeds was 10.5 and 21.8. On 70 DAS in T_8 the relative density (%) of the predominant weed species was in the order of 41.2 (*Dactyloctenium aegyptium*), 25.9 (*Cyperus rotundus*), 9.1 (*Digitaria sanguinalis*), 1.4 (*Cynodon dactylon*) among C_4 weeds and 17.5 (*Ocimum canum*), 1.3 (*Lagasca mollis*) among C_3 weeds.

Table 7: Competing weed spectrum

Species	Family	Habit	Relative weed density (Per cent in T ₈) 70 DAS	
			Rabi 1987	Rabi 1988
Perennial weeds				
<i>Cyperus rotundus</i>	Cyperaceae	Perennial	25.9	50.3
<i>Panicum dactylon</i>	Poaceae	Perennial	1.4	3.3
<i>Setaria pectinata</i>	Poaceae	Annual	41.2	8.0
<i>Digitaria sanguinalis</i>	Poaceae	Annual	9.1	4.7
<i>Echinochloa hirta</i>	Euphorbiaceae	Annual	0.0	1.5
<i>Amaranthus viridis</i>	Amaranthaceae	Annual	0.4	2.4
<i>Lactuca oleracea</i>	Portulacaceae	Annual	0.2	0.6
Annual weeds				
<i>Aster mollis</i>	Asteraceae	Annual	1.3	12.8
<i>Chenium hysterophorus</i>	Asteraceae	Annual	0.7	11.0
<i>Humulus canum</i>	Labiatae	Annual	17.5	0.0
<i>Melina benghalensis</i>	Commelinaceae	Annual	1.1	0.8
<i>Phodesma indicum</i>	Boraginaceae	Annual	0.7	1.6
<i>Isia argentea</i>	Amaranthaceae	Annual	0.3	0.6
<i>Papone mexicana</i>	Papaveraceae	Annual	0.2	1.8
<i>Amaranthus arvensis</i>	Amaranthaceae	Annual	0.0	0.3
<i>Horis olitorius</i>	Tiliaceae	Annual	0.0	0.3



Plate 1: Competing C₄ weeds

- | | |
|----------------------------------|-------------------------------------|
| (1) <i>Cyperus rotundus</i> | (2) <i>Dactyloctenium aegyptium</i> |
| (3) <i>Digitaria sanguinalis</i> | (4) <i>Cynodon dactylon</i> |
| (5) <i>Amaranthus viridis</i> | (6) <i>Euphorbia hirta</i> |
| (7) <i>Portulaca oleracea</i> | |

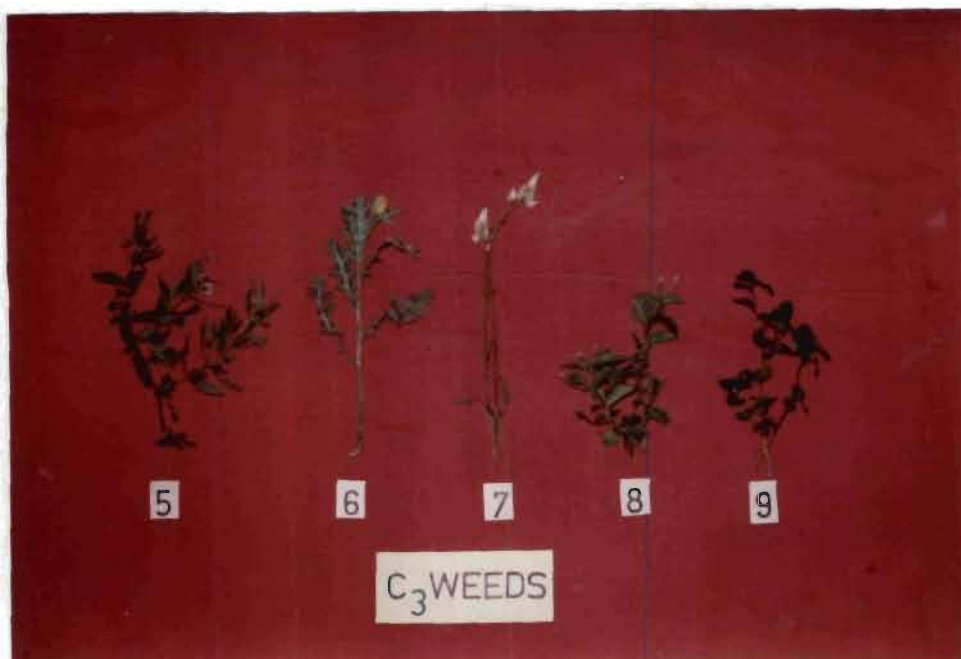


Plate 2: Competing C_3 weeds

- | | |
|-------------------------------------|-----------------------------------|
| (1) <i>Ocimum canum</i> | (2) <i>Lagassca mollis</i> |
| (3) <i>Parthenium hysterophorus</i> | (4) <i>Commelina benghalensis</i> |
| (5) <i>Trichodesma indicum</i> | (6) <i>Argemone mexicana</i> |
| (7) <i>Celosia argentea</i> | (8) <i>Digera arvensis</i> |
| (9) <i>Corchorus olitorius</i> | |

Table 8: Mean number of weed species (m^{-2}) under different treatments on 30 DAS (Rabi, 1987)

Species	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉
<i>Isotria medeolae</i>	73.00	65.40	98.30	72.90	80.70	150.70	-	145.40	-
<i>Digitaria pruriens</i>	4.00	2.00	0.70	0.68	2.00	9.30	-	17.20	-
<i>Stenium aegyptium</i>	0.00	1.32	0.00	1.32	11.30	26.00	-	32.10	-
<i>Eleusine indica</i>	1.00	0.00	0.40	0.00	0.90	0.00	-	1.00	-
<i>Setaria viridis</i>	0.00	0.00	0.00	0.00	6.70	3.32	-	2.90	-
<i>Portulaca oleracea</i>	0.00	0.00	0.00	0.00	0.00	1.32	-	2.90	-
Relative density of C ₄ species	93.9	98.6	100.00	90.7	91.3	100.00	0.00	89.50	-
<i>Chenopodium album</i>	1.80	0.70	0.00	4.90	3.90	-	16.90	3.00	-
<i>Eleusine hysterothorus</i>	0.00	0.00	0.00	0.70	0.00	-	1.70	1.30	-
<i>Portulaca canum</i>	2.10	0.00	0.00	0.70	4.00	-	55.90	14.90	-
<i>Portulaca benghalensis</i>	0.00	0.00	0.00	0.70	0.40	-	1.10	1.70	-
<i>Portulaca indica</i>	0.00	0.00	0.00	0.00	0.00	-	6.60	1.00	-
<i>Portulaca argentea</i>	0.00	0.00	0.00	0.70	0.00	-	2.30	0.70	-
<i>Portulaca mexicana</i>	0.40	0.00	0.00	0.00	0.00	-	1.70	0.70	-
<i>Portulaca arvensis</i>	0.40	0.33	0.00	0.00	0.00	-	1.50	0.40	-
<i>Portulaca oltorius</i>	0.40	0.00	0.00	0.00	1.30	-	0.40	0.00	-
Relative density of C ₃ species	6.10	1.40	0.00	9.30	8.70	0.00	100.00	10.50	-

an number of weed species (m^{-2}) and relative density (%) under different treatments on 70 DAS
(Abi, 1987)

Species	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉
Andropogon	92.90 (56.00)	95.40 (85.60)	151.00 (95.50)	109.60 (72.80)	45.40 (42.20)	92.60 (33.20)	-	122.40 (25.90)	-
Cyperus	18.70 (11.30)	6.60 (5.90)	1.00 (0.60)	15.30 (10.20)	2.00 (1.90)	2.68 (1.00)	-	6.70 (1.40)	-
Eleusine indica	4.00 (2.40)	1.20 (1.10)	0.00 (0.00)	2.00 (1.30)	4.00 (3.60)	131.00 (47.00)	-	194.60 (41.20)	-
Imperata	2.70 (1.60)	0.00 (0.00)	4.00 (2.40)	0.00 (0.00)	0.00 (0.00)	50.00 (17.90)	-	42.70 (9.10)	-
Pennisetum	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.00 (0.90)	0.00 (0.00)	-	0.00 (0.00)	-
Rottboellia	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	2.00 (1.90)	1.30 (0.50)	-	2.00 (0.40)	-
Setaria	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.00 (0.40)	-	1.00 (0.20)	-
Density of C ₄	71.30	92.60	98.50	84.30	50.50	100.00	0.00	78.20	-
Andropogon	12.70 (7.70)	7.00 (6.30)	2.10 (1.50)	14.20 (9.40)	22.00 (20.40)	-	29.0 (14.30)	6.00 (1.30)	-
Cyperus	1.30 (0.80)	0.00 (0.00)	0.00 (0.00)	3.30 (2.30)	0.00 (0.00)	-	4.00 (2.00)	3.30 (0.70)	-
Eleusine indica	28.30 (17.00)	0.00 (0.00)	0.00 (0.00)	0.40 (0.30)	26.00 (24.10)	-	150.50 (73.90)	82.60 (17.50)	-
Imperata	0.00 (0.00)	1.20 (1.10)	0.00 (0.00)	2.70 (1.80)	2.00 (1.90)	-	2.70 (1.30)	5.30 (1.10)	-
Pennisetum	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-	2.00 (1.00)	3.30 (0.70)	-
Rottboellia	0.70 (0.40)	0.00 (0.00)	0.00 (0.00)	0.40 (0.30)	0.00 (0.00)	-	5.30 (2.60)	1.30 (0.30)	-
Setaria	3.30 (2.02)	0.00 (0.00)	0.00 (0.00)	1.30 (0.80)	2.00 (1.90)	-	4.00 (1.90)	1.00 (0.20)	-
Andropogon	1.30 (0.78)	0.00 (0.00)	0.00 (0.00)	1.30 (0.80)	1.30 (1.20)	-	6.00 (3.00)	0.00 (0.00)	-
Density of C ₃	28.7	7.40	1.50	15.70	49.50	0.00	100.00	21.60	-

Figures in parenthesis indicate relative density in percentage

Mean number of weed species (m^{-2}) under different treatments on 30 DAS (Rabi, 1988)

Species	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉
<i>Andropogon</i>	43.2	91.4	161.9	119.8	59.5	249.5	-	192.1	-
<i>Cyperus</i>	8.7	4.6	3.0	6.0	5.3	6.0	-	4.0	-
<i>Echinochloa aegyptium</i>	0.0	0.0	0.0	0.0	1.0	0.7	-	16.0	-
<i>Eleusine indica</i>	0.0	0.0	0.0	0.0	0.0	0.0	-	3.0	-
<i>Digitaria viridis</i>	0.0	0.0	0.0	0.0	1.3	2.0	-	6.6	-
<i>Eleusine indica</i>	0.0	0.0	0.0	0.0	0.0	0.0	-	2.0	-
Density of C ₄	94.9	100.0	100.0	63.1	75.1	100.0	0.0	73.2	-
<i>Eleusine indica</i>	0.8	0.0	0.0	50.6	15.5	-	125.8	32.8	-
<i>Echinochloa polystachya</i>	2.0	0.0	0.0	23.0	6.7	-	63.0	35.0	-
<i>Echinochloa benghalensis</i>	0.0	0.0	0.0	0.0	0.0	-	0.0	2.0	-
<i>Eleusine indica</i>	0.0	0.0	0.0	0.0	0.0	-	1.0	3.0	-
<i>Echinochloa polystachya</i>	0.0	0.0	0.0	0.0	0.0	-	2.0	1.0	-
<i>Echinochloa polystachya</i>	0.0	0.0	0.0	0.0	0.0	-	16.0	8.0	-
Density of C ₃	5.1	0.0	0.0	36.9	24.9	0.0	100.0	26.8	-

Mean number of weed species (m^{-2}) and relative density (%) under different treatments on 70 DAS

(Rabi, 1988)

Species	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉
<i>rotundus</i>	84.1 (53.6)	148.5 (87.8)	191.0 (89.0)	106.6 (40.5)	50.0 (30.2)	227.2 (77.2)	-	169.1 (50.3)	-
<i>stactylon</i>	9.0 (5.7)	8.0 (4.7)	6.5 (3.0)	8.7 (3.3)	8.6 (5.2)	13.0 (4.4)	-	11.0 (3.3)	-
<i>statum aegyptium</i>	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	4.0 (2.4)	6.0 (2.0)	-	27.0 (8.0)	-
<i>a sanguinalis</i>	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	3.0 (1.1)	12.0 (7.3)	45.0 (15.3)	-	16.0 (4.7)	-
<i>a hirta</i>	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	-	5.0 (1.5)	-
<i>es viridis</i>	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	2.0 (1.2)	3.0 (1.1)	-	8.0 (2.4)	-
<i>a oleracea</i>	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	-	2.0 (0.6)	-
Density of C ₄	59.3	92.5	92.0	44.9	46.3	100.0	0.0	70.8	-
<i>callis</i>	41.9 (26.7)	7.4 (4.4)	15.1 (7.0)	108.0 (40.9)	61.4 (37.1)	-	178.6 (62.7)	43.1 (12.8)	-
<i>a hysterothorus</i>	22.0 (14.0)	5.3 (3.1)	2.0 (1.0)	37.2 (14.2)	25.3 (15.3)	-	76.0 (27.1)	39.0 (11.0)	-
<i>a benghalensis</i>	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	-	0.0 (0.0)	3.0 (0.8)	-
<i>psa indicum</i>	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	-	6.0 (2.1)	5.3 (1.6)	-
<i>argentea</i>	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	-	7.0 (2.5)	2.0 (0.6)	-
<i>a mexicana</i>	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	2.0 (1.3)	-	13.0 (4.6)	6.0 (1.8)	-
<i>arvensis</i>	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	-	1.0 (0.3)	1.0 (0.3)	-
<i>es olitorius</i>	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	-	2.0 (0.7)	1.0 (0.3)	-
Density of C ₃	40.7	7.5	8.0	55.1	53.7	0.0	100.0	29.2	-

Figures in parenthesis indicate relative density in percentage

All the herbicide treatments showed lesser number of dominant C₃ and C₄ weeds than T₈ on 30 and 70 DAS in rabi 1987. Pendimethalin and oxyfluorfen completely controlled C₄ weeds like *Amaranthus viridis*, *Portulaca oleracea* and C₃ weed species like *Ocimum canum*, *Parthenium hysterophorus* and *Trichodesma indicum*. The relative density (%) of C₃ weeds was lesser with oxyfluorfen and pendimethalin and was highest with glyphosate on 70 DAS in rabi 1987.

During rabi 1988 weed species; *Cyperus rotundus*, *Dactyloctenium aegyptium*, *Digitaria sanguinalis*, *Cynodon dactylon* among C₄ weeds and *Lagasca mollis*, *Parthenium hysterophorus* among C₃ weeds were predominant. The relative density (%) of C₄ weeds in T₈ as on 30 and 70 DAS was 73.2 and 70.8 respectively while that of C₃ weeds was 26.8 and 29.2 respectively. On 70 DAS in T₈ the relative density (%) of the predominant weed species was in the order of 50.3 (*Cyperus rotundus*), 8.0 (*Dactyloctenium aegyptium*), 4.7 (*Digitaria sanguinalis*), 3.3 (*Cynodon dactylon*) among C₄ weeds and 12.8 (*Lagasca mollis*), 11.0 (*Parthenium hysterophorus*) among C₃ weeds.

During rabi 1988 also all the herbicide treatments showed lesser number of dominant C₃ and C₄ weeds than T₈ on 30 DAS, and herbicide treatments showed less number of C₃ weeds than T₈ except *Lagasca mollis* in T₄, T₅ and T₁ on 70 DAS. The herbicides pendimethalin and oxyfluorfen completely controlled all C₃ species on 30 DAS and showed lesser number of dominant C₃

weeds (*Lagasca mollis*, *Parthenium hysterophorus*) on 70 DAS. The relative density (%) of C_3 weeds was least in T_2 followed by T_3 .

4.1.3 Total Weed Density (TWD) (Weed Number m^{-2})

The differences in TWD found among diverse groundnut cultivars on 30, 70, and 110 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 12,13,14). Highest TWD was found in T_8 followed by T_6 and T_7 in both the years. All the herbicide treatments significantly reduced TWD at all the stages of crop growth. The differences in TWD among diverse groundnut cultivars were significant on 30 DAS in rabi 1988 and on 70 DAS in both the years. Cv. JL-24 plots showed significantly lower TWD on 30 DAS. The interactions among the cultivars and treatments on 30, 70 and 110 DAS were significant in both the years except on 70 and 110 DAS in rabi 1988 (Fig.2).

4.1.4 C_3 Weed Density (Weed number m^{-2})

The differences in density of C_3 weeds on 30, 70 and 110 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 15,16,17). Highest density of C_3 weeds was found in T_7 followed by T_8 at all the crop growth stages. All the herbicide treatments significantly reduced density of C_3 weeds and the density was lowest with oxyfluorfen and pendimethalin. The differences in the density of C_3 weeds found among diverse groundnut cultivars were not significant at all the stages except on 110 DAS in rabi 1988. The interactions among the cultivars

Table 12: Effect of herbicides and crop weed competition on total weed density (weed number m^{-2}) in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	30 DAS				30 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
Alachlor	8.17 (65.75)	9.79 (94.84)	10.24 (103.86)	9.40 (87.36)	7.42 (54.06)	7.74 (58.91)	7.55 (56.00)	7.57 (56.30)
Dimethalin	8.07 (64.12)	9.21 (83.82)	8.13 (65.10)	8.47 (70.74)	9.45 (88.30)	8.95 (79.10)	11.14 (123.09)	9.85 (96.02)
Fluorfen	11.88 (140.13)	9.34 (86.24)	8.90 (78.21)	10.04 (99.80)	14.73 (215.97)	11.34 (127.60)	12.57 (157.01)	12.88 (164.89)
Chloralin	9.96 (98.20)	8.20 (66.24)	9.96 (98.20)	9.38 (86.98)	15.97 (254.04)	14.52 (209.83)	14.01 (195.28)	14.83 (218.93)
Phosate	9.91 (97.21)	12.67 (159.50)	11.09 (121.99)	11.22 (124.89)	11.14 (123.10)	9.62 (91.54)	8.39 (69.39)	9.72 (93.48)
Weeds	12.86 (164.38)	14.94 (222.20)	13.05 (169.30)	13.61 (184.23)	16.15 (259.82)	16.39 (267.63)	15.77 (247.69)	16.10 (258.21)
Weeds	9.27 (84.93)	9.63 (91.74)	8.92 (78.57)	9.27 (84.93)	14.42 (206.94)	13.64 (185.05)	15.49 (238.94)	14.52 (209.83)
+ C ₄ weeds	16.62 (275.20)	15.66 (244.20)	13.07 (169.82)	15.12 (227.61)	18.03 (324.08)	17.96 (321.56)	16.75 (279.56)	17.58 (308.06)
Weed free	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
	9.75 (94.06)	10.05 (100.00)	9.37 (86.79)		12.03 (143.72)	11.24 (125.34)	11.41 (129.19)	

W's of statistical	S. Ed+	CD(0.05)	S. Ed+	CD(0.05)
Treatments	0.76	1.60	0.78	1.65
Herbicides	0.31	NS	0.34	0.68
Herbicide A:	0.93	1.89	0.01	2.05
Herbicide B:	1.20	2.48	1.24	2.58

1 = Two sub means at same level main.

2 = Two main means at same or different levels sub.

NS = Not significant

Table 13: Effect of herbicides and crop weed competition on total weed density (weed number m^{-2}) in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
Alachlor	12.53 (156.00)	13.12 (171.13)	13.26 (174.83)	12.97 (167.22)	12.79 (162.58)	12.37 (152.02)	13.29 (175.62)	12.82 (163.35)
Endimethalin	10.02 (99.40)	10.13 (101.62)	12.10 (145.41)	10.75 (114.56)	14.01 (195.28)	14.07 (196.96)	11.52 (131.71)	13.20 (173.24)
Cyflufen	13.37 (177.76)	10.26 (104.27)	14.32 (204.06)	12.65 (159.02)	16.98 (287.32)	13.15 (171.92)	15.50 (239.25)	15.21 (230.34)
Alachlor + Phosphate	12.65 (159.02)	11.12 (122.65)	14.17 (199.79)	12.65 (159.02)	17.55 (307.00)	16.52 (271.91)	15.52 (239.87)	16.53 (272.24)
weeds	9.74 (93.87)	9.91 (97.21)	11.79 (138.00)	10.48 (108.83)	14.91 (221.31)	12.48 (154.75)	11.41 (129.19)	12.93 (166.18)
weeds	16.20 (261.44)	17.41 (302.11)	16.57 (273.56)	16.73 (278.89)	17.06 (290.04)	17.64 (310.17)	16.84 (282.59)	17.18 (294.15)
weeds	12.20 (147.84)	15.58 (241.74)	15.13 (227.92)	14.30 (203.49)	14.96 (222.80)	18.98 (359.24)	16.39 (267.63)	16.78 (280.57)
weeds	20.61 (423.77)	21.59 (465.13)	23.36 (544.69)	21.86 (476.86)	19.40 (375.36)	17.92 (320.13)	18.31 (334.26)	18.54 (342.73)
weed free	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
	12.04 (143.96)	12.24 (148.82)	13.52 (181.79)		14.29 (203.20)	13.79 (189.16)	13.31 (176.16)	

Tests of statistical	S. Ed+	CD(0.05)	S. Ed+	CD(0.05)
ns				
treatment	0.62	1.31	0.92	1.95
treatment	0.36	0.73	0.46	0.94
Location A:	1.08	2.19	1.39	NS
Location B:	1.08	2.21	1.53	NS

A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Figures in parenthesis denote actual values

Effect of herbicides and crop weed competition on total weed density (weed number m^{-2}) in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	110 DAS				110 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
Control	10.23 (103.65)	9.61 (91.35)	7.18 (50.55)	9.01 (80.18)	13.10 (170.61)	12.29 (150.04)	12.33 (151.03)	12.58 (157.26)
Methalin	10.12 (101.41)	8.99 (79.82)	9.97 (98.40)	9.69 (92.90)	10.44 (107.99)	12.63 (158.52)	9.83 (95.63)	10.97 (119.34)
Propen	8.25 (67.06)	8.60 (72.96)	9.94 (97.80)	8.93 (78.74)	12.46 (154.25)	10.93 (118.47)	12.97 (167.22)	12.12 (145.89)
Alachlor	8.42 (69.90)	7.45 (54.50)	11.57 (132.86)	9.15 (82.72)	13.39 (178.29)	13.60 (183.96)	14.95 (222.50)	13.98 (194.44)
Fluroxypyr	10.76 (114.78)	6.70 (43.89)	8.99 (79.82)	8.82 (76.79)	12.57 (157.00)	11.23 (125.11)	12.36 (151.76)	12.06 (144.44)
Hand weeding	12.77 (162.07)	12.79 (162.58)	10.57 (110.72)	12.04 (143.96)	15.38 (235.54)	16.65 (276.22)	15.12 (227.61)	15.71 (245.80)
Hand weeding + herbicide	81.06 (63.96)	13.43 (179.36)	11.47 (130.56)	10.99 (119.78)	12.27 (149.55)	16.36 (266.65)	12.57 (157.00)	13.74 (187.78)
C ₄ weeds	13.38 (178.02)	13.64 (185.05)	13.63 (184.78)	13.55 (182.60)	17.29 (297.94)	16.42 (268.62)	17.48 (304.55)	17.07 (290.38)
Free	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
	9.22 (84.01)	9.13 (82.36)	9.37 (86.79)		11.99 (142.76)	12.35 (151.52)	12.07 (144.68)	

Source of statistical variation	S.E.d ₊	CD(0.05)	S.E.d ₊	CD(0.05)
Treatment	1.76	1.62	0.70	1.48
Block	0.53	NS	0.45	NS
Interaction A:	1.59	3.22	1.34	NS
Interaction B:	1.41	2.90	1.25	NS

A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Figures in parenthesis denote actual values

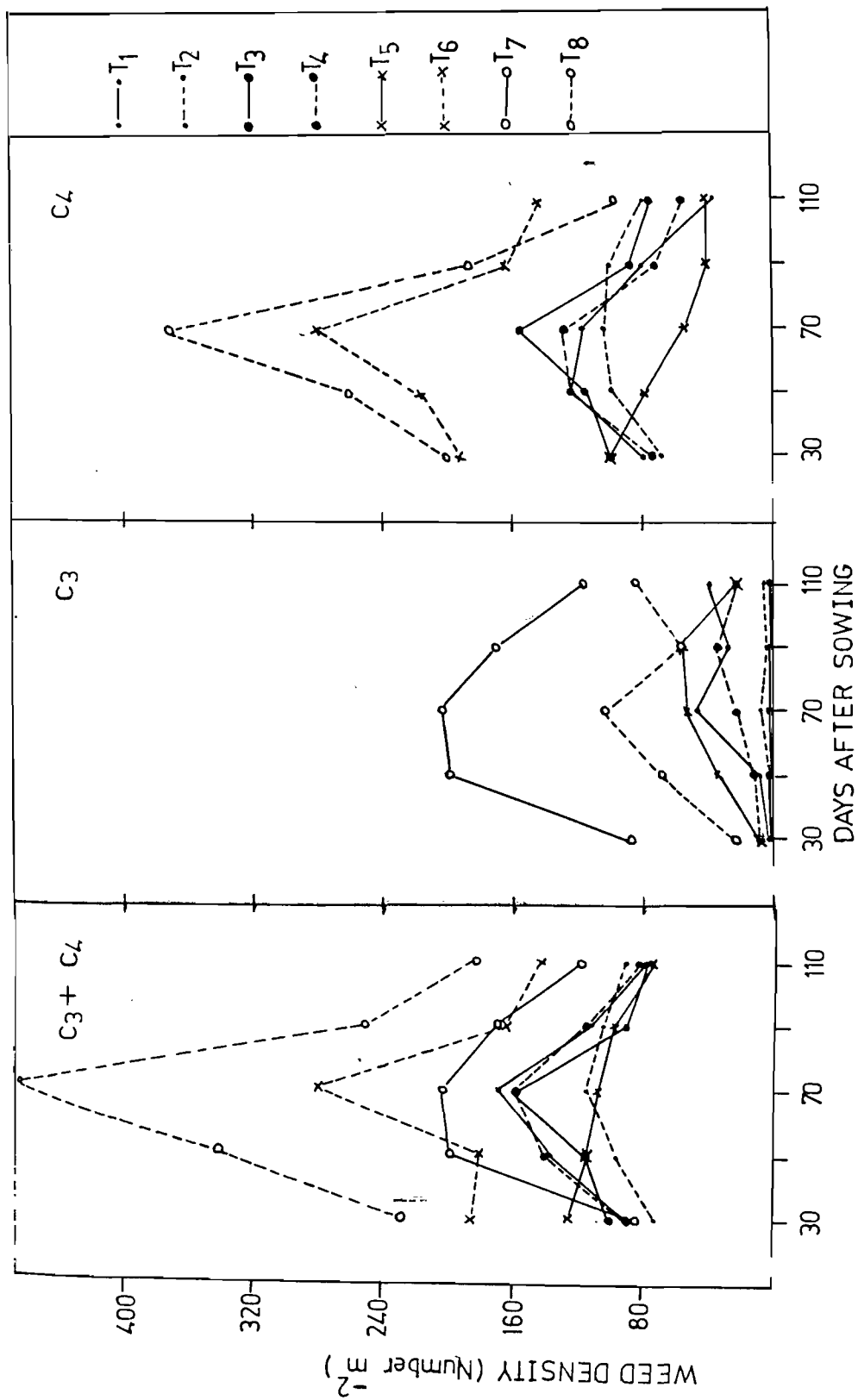


Fig. 2: EFFECT OF HERBICIDES AND CROP WEED COMPETITION ON WEED DENSITY (RABI 1987)

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15: Effect of herbicides and crop weed competition on density of C_3 weeds (weed number m^{-2}) in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	30 DAS				30 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
chlor	2.08 (3.33)	1.00 (0.00)	4.33 (17.75)	2.47 (5.10)	1.65 (1.72)	3.20 (9.24)	1.00 (0.00)	1.95 (2.80)
tridimethalin	1.00 (0.00)	1.00 (0.00)	2.08 (3.33)	1.36 (0.85)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
cyflufen	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
trichloralin	3.92 (14.37)	3.91 (14.29)	1.00 (0.00)	2.94 (7.64)	11.16 (123.55)	8.57 (72.44)	6.18 (37.19)	8.64 (73.65)
lyphosate	2.75 (6.56)	2.42 (4.86)	4.62 (20.34)	3.26 (9.63)	5.71 (31.60)	4.76 (21.66)	3.99 (14.92)	4.82 (22.23)
C_3 weeds	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
C_2 weeds	9.79 (94.84)	9.63 (91.74)	8.90 (78.21)	9.44 (88.11)	14.42 (206.94)	13.64 (185.05)	15.49 (238.94)	14.52 (209.83)
$C_3 + C_4$ weeds	6.30 (38.69)	4.81 (22.14)	3.82 (13.59)	4.97 (23.70)	7.50 (55.25)	10.72 (113.92)	9.09 (81.63)	9.10 (81.81)
weed free	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
SE	3.20 (9.24)	2.86 (7.18)	3.08 (8.49)		4.94 (23.40)	4.98 (23.80)	4.42 (18.54)	

Means of statistical

Analysis

	S.E.d+	CD(0.05)	S.E.d+	CD(0.05)
No treatment	0.76	1.61	1.49	3.16
1st treatment	0.33	NS	1.35	NS
Interaction A:	0.98	1.98	1.06	2.16
Interaction B:	1.21	2.51	2.20	4.61

NS = Two sub means at same level main.

S = Two main means at same or different levels sub.

NS = Not significant

Figures in parenthesis denote actual values

Effect of herbicides and crop weed competition on density of C_3 weeds (weed number m^{-2}) in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
Chlor	7.12 (49.69)	5.71 (32.06)	8.07 (64.12)	6.97 (47.58)	9.64 (91.93)	5.52 (29.47)	9.02 (80.36)	8.06 (63.96)
Dimethalin	1.66 (1.76)	4.25 (17.06)	3.20 (9.24)	3.04 (8.24)	4.99 (23.90)	3.42 (10.70)	2.71 (6.34)	3.70 (12.69)
Flufen	1.00 (0.00)	3.31 (9.96)	1.00 (0.00)	1.77 (2.13)	2.08 (3.33)	6.18 (37.19)	4.49 (19.16)	4.25 (17.06)
Fluralin	5.71 (31.60)	5.97 (34.64)	3.20 (9.24)	4.96 (23.60)	11.48 (130.79)	14.15 (199.22)	10.64 (112.21)	12.09 (145.17)
Phosate	7.81 (59.99)	6.64 (43.09)	7.67 (57.83)	7.37 (53.32)	9.94 (97.80)	9.48 (88.87)	8.97 (79.46)	9.47 (88.68)
Weeds	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
Weeds	12.20 (147.84)	15.58 (241.74)	15.13 (227.92)	14.30 (203.49)	14.96 (222.80)	18.99 (359.62)	16.39 (267.63)	16.78 (280.57)
+ C_4 weeds	11.56 (132.63)	8.29 (67.72)	10.71 (113.70)	10.19 (102.84)	8.77 (75.91)	9.96 (98.20)	11.19 (124.22)	9.97 (98.40)
if free	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
	5.45 (28.70)	5.75 (32.06)	5.66 (31.04)		7.09 (49.27)	7.74 (58.91)	7.27 (51.85)	

Tests of statistical	S. Ed ₊	CD(0.05)	S. Ed ₊	CD(0.05)
eris				
reatment	0.54	1.14	0.81	1.72
reatment	0.25	NS	0.61	NS
ection A:	0.75	1.52	1.82	NS
ection B:	0.88	1.81	1.55	NS

A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Values in parenthesis denote actual values

7. Effect of herbicides and crop weed competition on density of C_3 weeds (weed number m^{-2}) in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	110 DAS				110 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
Control	7.55 (56.00)	6.42 (40.22)	5.10 (25.01)	6.36 (39.45)	11.74 (136.83)	11.03 (120.66)	10.11 (101.21)	10.96 (119.12)
Alachlor	2.63 (5.92)	3.08 (8.49)	2.30 (4.29)	2.67 (6.13)	4.35 (17.92)	6.93 (47.02)	3.62 (12.10)	4.97 (23.70)
Carbaryl	1.74 (2.03)	2.15 (3.62)	1.75 (2.06)	1.88 (2.53)	3.99 (14.92)	6.24 (37.94)	5.55 (29.80)	5.26 (26.67)
Carbaryl	6.22 (37.69)	3.65 (12.32)	4.82 (22.23)	4.89 (22.91)	11.79 (138.00)	10.79 (115.42)	8.99 (79.82)	10.52 (109.67)
Carbaryl	5.77 (32.29)	4.82 (22.23)	4.08 (15.65)	4.89 (22.91)	10.57 (110.72)	9.94 (97.80)	10.02 (99.40)	10.18 (102.63)
Control	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
Control	8.08 (64.30)	12.93 (166.19)	11.48 (130.79)	10.83 (116.28)	12.27 (149.55)	16.36 (266.65)	12.57 (157.00)	13.74 (187.78)
Control	9.15 (82.70)	9.72 (93.48)	8.94 (78.92)	9.27 (84.93)	11.96 (142.04)	10.79 (115.42)	10.07 (100.40)	10.94 (118.68)
Control	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
	4.79 (21.94)	4.97 (23.70)	4.49 (19.16)		7.63 (57.22)	8.23 (66.73)	6.99 (47.86)	

Statistical	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Control	0.48	0.96	0.47	0.99
Control	0.33	NS	0.41	0.82
Control A:	0.98	1.98	1.22	NS
Control B:	0.88	1.78	0.97	NS

Two sub means at same level main.

Two main means at same or different levels sub.

Not significant

Values in parenthesis denote actual values

and treatments on 30, 70 and 110 DAS were significant in both the years except on 70 and 110 DAS in rabi 1988 (Fig. 2).

4.1.5 C_4 Weed Density (Weed number m^{-2})

The differences in density of C_4 weeds on 30, 70 and 110 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 18,19,20). Highest density of C_4 weeds was found in T_6 followed by T_8 . All the herbicide treatments significantly reduced density of C_4 weeds. The differences in density of C_4 weeds found among the plots of diverse groundnut cultivars were significant on 30 DAS in rabi 1988 and 70 DAS in both the years. The interactions among the cultivars and treatments were significant on 30 and 70 DAS in rabi 1987 and on 70 DAS in rabi 1988 (Fig. 2).

4.1.6 Total Weed Dry Matter of ($C_3 + C_4$) Competing Weeds (TWDM)

The differences in TWDM on 30, 70 and 110 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 21,22,23). Highest TWDM was found in T_8 followed by T_6 since 30 to 70 DAS in both the years. Whereas, on 110 DAS weedy controls (T_8 , T_7 and T_6) showed significantly higher TWDM in that order. All the herbicide treatments significantly reduced TWDM and lower TWDM was found with pendimethalin and oxyfluorfen on 70 and 110 DAS. The differences in TWDM found among the diverse cultivars were significant at all the stages except on 30 DAS and 110 DAS in rabi 1988. Lower TWDM was found with Cv. Gangapuri and JL-24

B: Effect of herbicides and crop weed competition on density of C₄ weeds (weed number m⁻²) in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	30 DAS				30 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
Chlor	7.90 (61.41)	9.81 (95.24)	8.98 (79.64)	8.90 (78.21)	7.28 (51.99)	6.98 (47.72)	7.55 (56.00)	7.27 (51.85)
methalin	8.05 (63.80)	9.18 (83.27)	7.82 (60.15)	8.35 (68.72)	9.45 (88.30)	8.95 (79.10)	11.15 (123.32)	9.85 (96.02)
torfen	11.85 (139.42)	9.32 (85.86)	8.88 (77.85)	10.02 (99.40)	14.73 (215.97)	11.34 (127.60)	12.57 (157.00)	12.88 (164.89)
thoralin	9.10 (81.81)	7.07 (48.98)	9.95 (98.00)	8.71 (74.86)	11.28 (126.23)	10.23 (103.66)	12.26 (149.31)	11.26 (125.79)
osate	9.70 (93.09)	10.72 (113.92)	9.96 (98.20)	10.13 (101.62)	9.11 (81.99)	8.38 (69.22)	7.24 (51.42)	8.25 (67.06)
weeds	12.85 (164.12)	15.63 (243.29)	13.04 (169.04)	13.84 (190.55)	16.15 (259.82)	16.39 (267.63)	15.77 (247.69)	16.10 (258.21)
weeds	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
+ C ₄ weeds	15.38 (235.54)	14.79 (217.74)	12.52 (155.75)	14.23 (201.49)	16.38 (267.30)	14.49 (208.96)	14.10 (197.81)	14.99 (223.70)
free	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
	8.54 (71.93)	8.73 (75.21)	8.13 (65.10)		9.59 (90.97)	8.75 (75.56)	9.18 (83.27)	

of statistical	S.Ed+	CD(0.05)	S.Ed+	CD(0.05)
treatment	0.45	0.95	0.46	0.97
trient	0.24	NS	0.31	0.64
tion A:	0.73	1.47	0.94	NS
tion B:	0.76	1.57	0.84	NS

* Two sub means at same level main.

* Two main means at same or different levels sub.

* Not significant

Values in parenthesis denote actual values

19: Effect of herbicides and crop weed competition on density of C_4 weeds (weed number m^{-2}) in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
Chlor	10.34 (105.92)	11.85 (139.42)	10.56 (110.51)	10.92 (118.25)	8.39 (69.39)	11.11 (122.43)	9.60 (91.16)	9.70 (93.09)
Methalin	9.92 (97.41)	9.21 (83.82)	11.50 (131.30)	10.21 (103.24)	13.10 (170.61)	13.39 (178.29)	11.16 (123.55)	12.55 (156.50)
Flufen	13.37 (177.76)	9.75 (94.06)	14.32 (204.06)	12.48 (154.75)	16.86 (283.26)	10.75 (114.56)	14.66 (213.92)	14.09 (197.53)
Caralin	11.26 (125.79)	9.00 (80.00)	13.66 (185.60)	11.31 (126.92)	13.21 (173.50)	8.30 (67.89)	11.24 (125.33)	10.92 (118.25)
osate	5.91 (33.93)	7.41 (53.91)	9.00 (80.00)	7.44 (54.35)	11.14 (123.09)	8.15 (65.42)	7.12 (49.69)	8.81 (76.62)
seeds	16.20 (261.44)	17.39 (301.41)	16.57 (273.56)	16.72 (278.55)	17.06 (290.04)	17.64 (310.17)	16.84 (282.59)	17.18 (294.15)
seeds	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
C_4 weeds	17.02 (288.68)	19.96 (397.40)	20.78 (430.80)	19.25 (369.56)	17.34 (299.68)	14.56 (210.99)	14.50 (209.25)	15.46 (238.01)
free	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
	9.56 (90.39)	9.62 (91.54)	10.93 (118.46)		11.01 (120.22)	9.54 (90.01)	9.68 (92.70)	

Statistical	S. Ed+	CD(0.05)	S. Ed+	CD(0.05)
ment	0.66	1.39	0.83	1.76
ent	0.33	0.68	0.40	0.80
n A:	0.99	2.00	1.19	2.41
n B:	1.09	2.25	1.36	2.81

Two sub means at same level main.

Two main means at same or different levels sub.

Not significant

es in parenthesis denote actual values

33: Effect of herbicides and crop weed competition on density of C_4 weeds (weed number m^{-2}) in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	110 DAS				110 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
Control	6.87 (46.19)	7.08 (49.13)	4.65 (20.62)	6.20 (37.44)	5.90 (33.81)	5.52 (29.47)	7.13 (49.84)	6.18 (37.19)
Flumethalin	8.88 (77.85)	8.56 (72.27)	9.71 (93.28)	9.05 (80.90)	9.53 (89.82)	10.60 (111.36)	9.00 (80.00)	9.71 (93.28)
Flurofen	8.02 (63.32)	8.41 (69.73)	9.80 (95.04)	8.74 (75.39)	11.73 (136.59)	9.00 (80.00)	11.73 (136.59)	10.82 (116.07)
Fluralin	5.74 (31.95)	6.57 (42.16)	10.59 (111.15)	7.63 (57.22)	6.40 (39.96)	8.30 (67.89)	11.96 (142.04)	8.89 (78.03)
Flusate	6.86 (46.06)	4.35 (17.92)	8.10 (64.61)	6.44 (40.47)	6.85 (45.92)	5.24 (26.46)	7.27 (51.85)	6.45 (40.60)
C_4 weeds	12.80 (162.84)	12.76 (161.82)	10.55 (110.30)	12.03 (143.72)	15.38 (235.54)	16.65 (276.20)	15.12 (227.60)	15.71 (245.80)
weeds	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
C_4 weeds	9.84 (95.83)	9.67 (92.51)	10.05 (100.00)	9.85 (96.02)	12.46 (154.25)	11.75 (137.06)	14.11 (198.09)	12.77 (162.07)
weeds free	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
	6.78 (44.97)	6.60 (42.56)	7.27 (51.85)		7.81 (59.99)	7.67 (57.83)	8.70 (74.69)	

df statistical	S.Ed+	CD(0.05)	S.Ed+	CD(0.05)
Treatment	0.95	1.90	0.71	1.50
Location	0.47	NS	0.47	NS
Location A:	1.41	NS	1.40	NS
Location B:	1.57	NS	1.28	NS

+ Two sub means at same level main.

+ Two main means at same or different levels sub.

- Not significant

Values in parenthesis denote actual values

Table 21: Effect of herbicides and crop weed competition on total dry matter of (C_3+C_4) weeds ($g\ m^{-2}$) in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	30 DAS				30 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T_1 : Alachlor	15.33	19.00	18.40	17.58	14.53	19.37	19.20	17.70
T_2 : Pendimethalin	18.00	20.00	15.97	17.99	19.78	24.40	23.77	22.64
T_3 : Oxyfluorfen	28.00	24.93	16.87	23.27	36.03	28.83	31.87	32.24
T_4 : Fluchloralin	16.60	15.00	22.67	18.09	26.80	26.67	29.07	27.51
T_5 : Glyphosate	26.73	34.40	32.80	31.31	15.80	17.80	19.80	17.80
T_6 : C_4 weeds	36.33	43.87	35.07	38.42	49.20	47.07	43.07	46.44
T_7 : C_3 weeds	9.43	7.87	10.20	9.17	26.80	15.80	19.60	20.73
T_8 : $C_3 + C_4$ weeds	80.00	60.67	45.33	62.00	58.60	48.87	47.87	51.78
T_9 : Weed free	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	25.60	25.08	21.92		27.51	25.42	26.02	

Results of statistical analysis

	S.Ed+	CD(0.05)	S.Ed+	CD(0.05)
Main treatment	3.13	6.63	2.12	4.49
Sub treatment	1.49	3.03	1.69	NS
Interaction A:	4.47	9.08	5.09	NS
Interaction B:	5.12	10.59	4.21	NS

Note: A = Two sub means at same level main

B = Two main means at same or different levels sub.

NS = Not significant

22: Effect of herbicides and crop weed competition on total dry matter of (C₃+C₄) weeds (g m⁻²) in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
alachlor	92.5	84.0	90.0	88.8	112.8	81.1	96.7	96.9
indimethalin	42.0	44.6	59.5	48.7	69.2	76.0	81.0	75.4
cyflufen	86.0	64.0	84.0	78.0	77.9	70.0	82.0	76.2
luchloralin	133.7	133.2	111.6	126.0	120.5	82.0	116.3	106.3
lyphosate	107.0	112.0	82.8	100.6	105.9	88.3	108.0	100.8
weeds	220.0	207.7	210.0	212.6	171.0	162.0	150.7	161.2
weeds	208.0	166.0	169.1	181.0	157.3	143.0	145.0	148.4
+ C ₄ weeds	261.0	244.7	222.0	242.6	208.0	202.0	199.0	203.0
weed free	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	127.8	117.4	114.3		113.6	100.5	108.7	

Source of statistical variation	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Treatment	10.37	21.98	4.98	10.57
Treatment	5.26	10.68	4.69	9.51
Interaction A:	15.79	NS	14.07	NS
Interaction B:	17.27	NS	10.76	NS

A = Two sub means at same level main

B = Two main means at same or different levels sub.

S = Not significant

Table 23: Effect of herbicides and crop weed competition on total dry matter of (C_3+C_4) weeds ($g \ m^{-2}$) in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	110 DAS				110 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	234.0	296.0	213.7	247.9	250.7	225.3	210.3	228.8
T ₂ : Pendimethalin	84.0	64.3	90.0	76.4	130.0	158.7	180.0	156.2
T ₃ : Oxyfluorfen	55.3	52.3	58.7	55.4	144.0	158.7	168.3	157.0
T ₄ : Fluchloralin	156.0	234.0	134.0	174.7	303.3	244.0	214.7	254.0
T ₅ : Glyphosate	181.3	203.1	274.0	219.5	255.3	221.3	276.0	250.9
T ₆ : C ₄ weeds	320.0	370.0	244.0	311.3	264.0	248.0	278.0	263.3
T ₇ : C ₃ weeds	290.3	404.0	290.0	328.1	281.0	330.7	336.0	315.9
T ₈ : C ₃ + C ₄ weeds	370.0	414.7	361.7	382.1	378.7	308.0	320.0	335.6
T ₉ : Weed free	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean	187.9	226.5	185.1		223.0	210.5	220.4	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	18.18	38.55	24.05	50.98
Sub treatment	10.44	21.18	10.00	NS
Interaction A:	31.32	63.54	30.03	NS
Interaction B:	31.43	64.73	38.17	NS

Note: A = Two sub means at same level main

B = Two main means at same or different levels sub.

NS = Not significant

on 70 DAS. The interactions among the cultivars and treatments were significant on 30 and 110 DAS in rabi 1987 (Fig.3).

4.1.7 Per cent Composition of C_4 Weed DM on Total Weed DM

The differences in per cent composition of C_4 weed DM on 30, 70 and 110 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 24,25,26). Highest per cent composition of C_4 weed DM was found in T_6 followed by oxyfluorfen and pendimethalin. During early stages the per cent composition of C_4 weed DM was more and gradually it decreased at later growth stages. The herbicide treatments recorded lower per cent composition of C_4 weed DM on 70 and 110 DAS. The differences in per cent composition of C_4 weed DM among the cultivars were significant on 70 DAS in rabi 1987 and on 30 and 110 DAS in rabi 1988. The interactions among the cultivars and treatments were significant at all the stages except on 110 DAS in rabi 1988.

4.2 WEED CONTROL EFFICIENCY (WCE)

The differences in WCE found among diverse groundnut cultivars on 70 DAS in various treatments were significant in rabi 1987 and 1988 (Table 27). Among the herbicide treatments pendimethalin and oxyfluorfen showed significantly higher WCE. All the herbicide treatments (T_2 , T_3 , T_1 , T_5 and T_4) showed significantly higher WCE in that order. The differences in WCE found among the cultivars were significant. Cv. JL-24 plots showed significantly higher WCE in both the years. The interac-

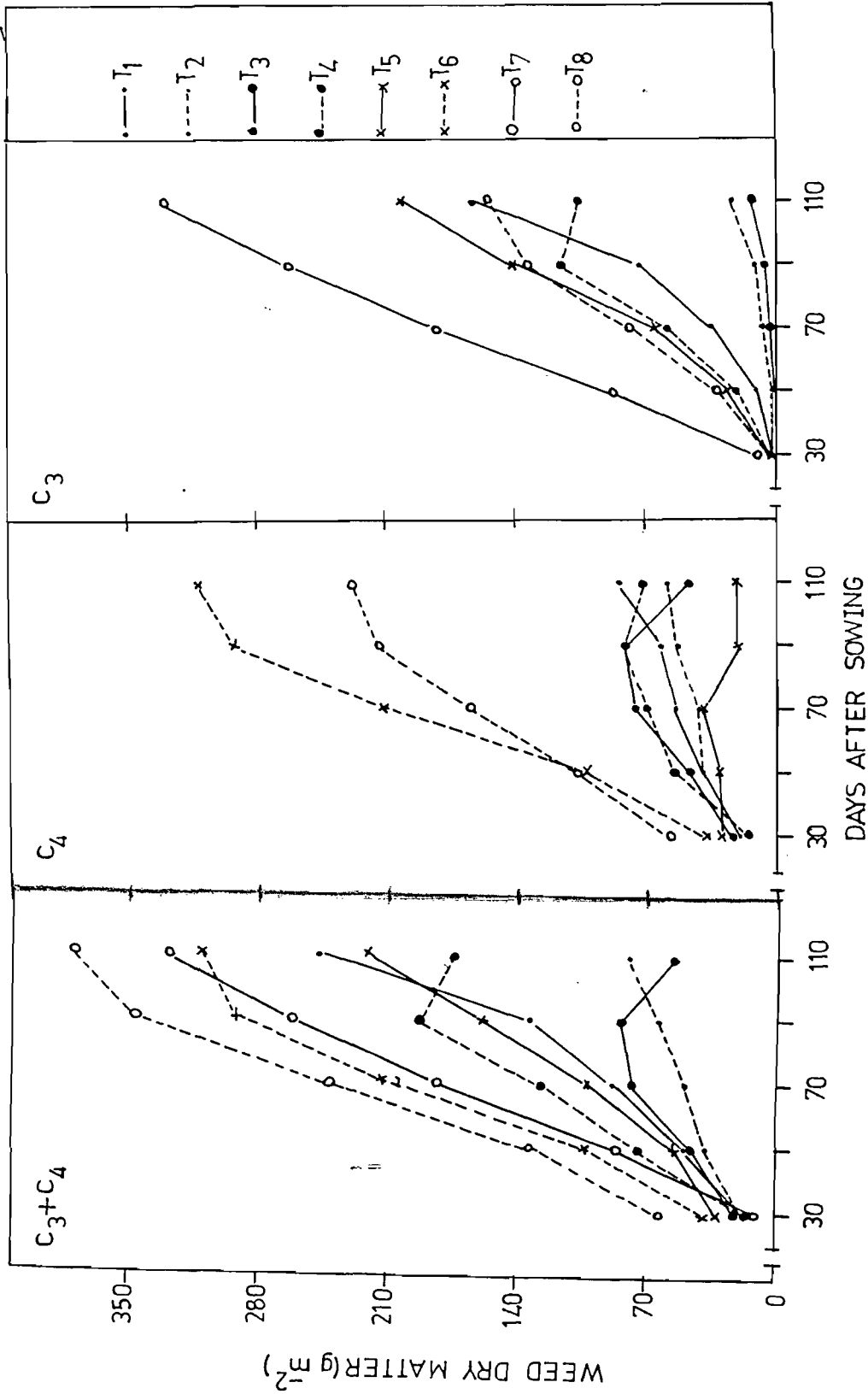


Fig.3: EFFECT OF HERBICIDES AND CROP WEED COMPETITION ON WEED DRY MATTER (RABI 1987)

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Table 24: Effect of herbicides and crop weed competition on per cent composition of C₄ weed dry matter to total weed dry matter in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	30 DAS				30 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	96.3	100.0	87.3	94.6	98.0	90.0	100.0	96.0
T ₂ : Pendimethalin	100.0	100.0	93.3	97.8	100.0	100.0	100.0	100.0
T ₃ : Oxyfluorfen	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
T ₄ : Fluchloralin	94.3	71.3	100.0	88.6	74.9	87.4	93.2	85.2
T ₅ : Glyphosate	93.3	98.7	87.7	93.2	77.5	77.1	87.5	80.7
T ₆ : C ₄ weeds	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
T ₇ : C ₃ weeds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T ₈ : C ₃ + C ₄ weeds	96.7	90.0	91.0	92.6	90.6	87.0	83.0	86.9
T ₉ : Weed free	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean	75.6	73.3	73.3		71.2	71.3	73.7	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	2.49	5.30	5.12	10.84
Sub treatment	1.73	NS	1.13	2.29
Interaction A:	5.18	10.52	3.39	6.88
Interaction B:	4.63	9.51	7.49	15.73

Note: A = Two sub means at same level main

B = Two main means at same or different levels sub.

NS = Not significant

Table 25: Effect of herbicides and crop weed competition on per cent composition of C₄ weed dry matter to total weed dry matter in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	63.0	63.0	59.5	61.8	35.5	80.8	55.0	57.1
T ₂ : Pendimethalin	98.0	84.0	86.5	89.5	86.5	93.1	85.0	88.2
T ₃ : Oxyfluorfen	100.0	89.5	100.0	96.5	98.5	87.0	95.0	93.5
T ₄ : Fluchloralin	61.0	27.5	77.5	55.3	36.5	68.3	40.9	48.6
T ₅ : Glyphosate	24.0	42.5	48.5	38.3	58.5	41.5	54.1	51.4
T ₆ : C ₄ weeds	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
T ₇ : C ₃ weeds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T ₈ : C ₃ + C ₄ weeds	59.0	76.0	69.5	68.2	77.2	57.8	53.0	62.7
T ₉ : Weed free	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean	56.1	53.6	60.2		54.7	58.7	53.7	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	4.23	8.53	3.58	7.59
Sub treatment	1.48	3.00	2.86	NS
Interaction A:	4.44	9.01	8.58	17.42
Interaction B:	6.52	13.16	7.08	14.51

Note: A = Two sub means at same level main

B = Two main means at same or different levels sub.

NS = Not significant

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Table 26: Effect of herbicides and crop weed competition on per cent composition of C₄ weed dry matter to total weed dry matter in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	110 DAS				110 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	51.0	41.7	9.3	34.0	14.1	10.9	27.0	17.5
T ₂ : Pendimethalin	90.3	73.7	52.3	72.1	53.0	74.5	81.0	69.5
T ₃ : Oxyfluorfen	72.7	80.3	92.3	81.8	80.0	74.5	75.0	76.5
T ₄ : Fluchloralin	40.0	29.7	50.7	40.1	7.9	42.0	26.5	25.5
T ₅ : Glyphosate	12.3	4.7	10.0	9.0	15.5	26.0	25.5	22.3
T ₆ : C ₄ weeds	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
T ₇ : C ₃ weeds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T ₈ : C ₃ + C ₄ weeds	52.7	62.7	63.0	59.4	25.4	25.5	46.4	32.4
T ₉ : Weed free	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean	46.6	43.6	41.9		32.9	39.3	42.4	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	10.84	21.80	3.86	8.20
Sub treatment	3.68	NS	3.39	6.89
Interaction A:	11.05	22.42	10.19	NS
Interaction B:	16.60	33.51	8.03	NS

Note: A = Two sub means at same level main

B = Two main means at same or different levels sub.

NS = Not significant

Table 27: Effect of herbicides and crop weed competition on weed control efficiency (%)

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	64.5	65.7	59.5	63.2	46.2	59.8	52.7	52.9
T ₂ : Pendimethalin	83.9	81.9	73.2	79.7	66.8	63.3	61.2	63.8
T ₃ : Oxyfluorfen	67.1	73.8	62.2	67.7	62.5	65.6	60.3	62.8
T ₄ : Fluchloralin	48.9	45.6	49.7	48.1	42.3	43.3	41.5	42.4
T ₅ : Glyphosate	58.9	54.2	62.7	58.6	49.0	56.4	45.5	50.3
T ₆ : C ₄ weeds	15.8	15.1	5.4	12.1	17.9	19.8	24.1	20.6
T ₇ : C ₃ weeds	20.4	32.1	23.7	25.4	24.5	29.5	27.0	27.0
T ₈ : C ₃ + C ₄ weeds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T ₉ : Weed free	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Mean	51.1	52.0	48.5		45.5	48.6	45.8	

Results of statistical analysis	S.Ed ₊	CD(0.05)	S.Ed ₊	CD(0.05)
Main treatment	3.88	7.82	2.12	4.50
Sub treatment	1.09	2.21	1.28	2.61
Interaction A:	3.27	6.64	3.85	NS
Interaction B:	5.81	11.72	3.74	NS

Note: A = Two sub means at same level main

B = Two main means at same or different levels sub.

NS = Not significant

tions among the cultivars and treatments were significant only in rabi 1987.

4.3 PER CENT NITROGEN, PHOSPHORUS AND POTASSIUM CONTENT IN COMPETING C₄ AND C₃ WEEDS

Among the competing C₄ weeds the per cent N, P and K was highest in *Amaranthus viridis* in rabi 1987 and 1988 (Table 28). Among the competing C₃ weeds per cent N, P and K was highest in *Digera arvensis*, *Celosia argentea* and *Parthenium hysterophorus* respectively in both the years.

4.4 NITROGEN, PHOSPHORUS AND POTASSIUM UPTAKE BY COMPETING WEEDS

The differences in NPK uptake of weeds on 70 DAS in various treatments were significant in rabi 1987 and 1988 (Table 29,30,31). The weedy controls showed significantly higher NPK uptake and it was highest in T₈. All the herbicide treatments significantly reduced NPK uptake by weeds and it was lowest with pendimethalin followed by oxyfluorfen. The differences in NPK uptake by weeds found among the cultivars were significant. The NPK uptake by weeds was higher in Cv. K-3 plots than Gangapuri and JL-24. The interactions among the cultivars and treatments were not significant.

4.5 CO₂ ASSIMILATION RATE IN WEEDS

In general, C₄ weeds showed higher CO₂ assimilation rate (Table 32) than C₃ weeds. In C₄ weeds higher CO₂ assimilation

Table 28: Per cent Nitrogen, Phosphorus and Potassium in competing C₄ and C₃ weeds

Competing weeds	Rabi 1987 (70 DAS)			Rabi 1988 (70 DAS)		
	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Nitrogen (%)	Phosphorus (%)	Potassium (%)
C ₄ weeds						
<i>Cyperus rotundus</i>	2.16	0.37	2.26	2.25	0.40	2.12
<i>Cynodon dactylon</i>	2.12	0.31	1.91	2.21	0.30	1.81
<i>Dactyloctenium aegyptium</i>	1.89	0.41	2.34	1.73	0.45	2.56
<i>Digitaria sanguinalis</i>	1.83	0.39	2.49	1.79	0.37	2.41
<i>Euphorbia hirta</i>	3.15	0.39	2.21	3.0	0.30	2.65
<i>Amaranthus viridis</i>	3.16	0.47	3.31	3.35	0.54	3.43
<i>Portulaca oleracea</i>	2.17	0.42	1.70	2.72	0.33	1.76
C ₃ weeds						
<i>Lagasca mollis</i>	2.65	0.44	2.69	2.41	0.51	2.42
<i>Parthenium hysterophorus</i>	2.73	0.48	4.42	2.41	0.56	3.65
<i>Ocimum canum</i>	2.86	0.53	2.13	2.71	0.56	2.10
<i>Commelina benghalensis</i>	1.82	0.26	2.73	2.12	0.56	2.65
<i>Trichodesma indicum</i>	2.62	0.30	3.00	2.71	0.35	3.16
<i>Celosia argentea</i>	2.61	0.54	4.12	2.74	0.57	3.61
<i>Argemone mexicana</i>	2.65	0.41	3.56	2.21	0.47	3.10
<i>Digera arvensis</i>	3.15	0.36	4.05	3.30	0.37	3.74

Table 29: Effect of herbicides and crop weed competition on nitrogen uptake by weeds (kg ha⁻¹) in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	23.0	20.9	22.4	22.1	28.3	20.4	24.3	24.3
T ₂ : Pendimethalin	9.8	10.5	13.9	11.4	16.8	18.5	19.1	18.1
T ₃ : Oxyfluorfen	18.5	15.2	19.7	17.8	18.9	17.0	20.0	18.6
T ₄ : Fluchloralin	33.5	33.3	28.2	31.7	30.3	20.5	29.2	26.7
T ₅ : Glyphosate	26.8	27.9	21.4	25.4	26.8	22.3	27.1	25.4
T ₆ : C ₄ weeds	51.8	48.9	48.9	49.8	41.7	39.5	36.8	39.3
T ₇ : C ₃ weeds	54.6	43.9	44.7	47.8	40.4	36.7	37.2	38.1
T ₈ : C ₃ + C ₄ weeds	64.9	60.6	55.3	60.3	52.4	50.2	48.8	50.5
T ₉ : Weed free	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean	31.4	29.0	28.3		28.4	25.0	26.9	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	2.61	5.53	1.29	2.74
Sub treatment	1.33	2.70	1.18	2.41
Interaction A:	3.99	NS	3.56	NS
Interaction B:	4.35	NS	2.75	NS

Note: A = Two sub means at same level main

B = Two main means at same or different levels sub.

NS = Not significant

Table 30: Effect of herbicides and crop weed competition on phosphorus uptake by weeds (kg ha⁻¹) in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	3.80	3.44	3.69	3.64	4.84	3.48	4.16	4.16
T ₂ : Pendimethalin	1.63	1.74	2.32	1.89	2.63	2.88	3.07	2.86
T ₃ : Oxyfluorfen	3.35	2.49	3.28	3.04	2.95	2.66	3.12	2.91
T ₄ : Fluchloralin	5.48	5.46	4.59	5.18	5.19	3.52	4.99	4.57
T ₅ : Glyphosate	4.39	4.59	3.39	4.12	4.55	3.79	4.64	4.33
T ₆ : C ₄ weeds	8.58	8.09	8.26	8.31	6.49	6.16	5.73	6.13
T ₇ : C ₃ weeds	8.74	6.96	7.09	7.59	7.58	6.86	6.96	7.13
T ₈ : C ₃ + C ₄ weeds	10.71	10.33	9.11	10.05	8.97	8.50	8.21	8.56
T ₉ : Weed free	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	5.19	4.79	4.63		4.81	4.21	4.54	

Results of statistical analysis	S.Ed ₊	CD(0.05)	S.Ed ₊	CD(0.05)
Main treatment	0.43	0.90	0.22	0.47
Sub treatment	0.22	0.44	0.20	0.41
Interaction A:	0.65	NS	0.61	NS
Interaction B:	0.71	NS	0.47	NS

Note: A = Two sub means at same level main

B = Two main means at same or different levels sub.

NS = Not significant

Table 31: Effect of herbicides and crop weed competition on potassium uptake by weeds
(kg ha⁻¹) in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	27.00	24.40	26.20	25.90	31.10	22.20	26.40	26.60
T ₂ : Pendimethalin	10.30	11.00	14.60	11.90	16.60	18.20	19.40	18.10
T ₃ : Oxyfluorfen	21.30	15.50	18.20	18.30	18.40	16.80	19.70	18.30
T ₄ : Fluchloralin	38.90	38.70	32.40	36.70	32.90	22.60	31.90	29.10
T ₅ : Glyphosate	31.10	32.50	24.60	29.40	29.00	24.20	29.60	27.60
T ₆ : C ₄ weeds	54.20	51.10	51.90	52.40	41.50	38.90	36.10	38.90
T ₇ : C ₃ weeds	69.40	55.40	56.50	60.40	47.60	42.60	42.60	44.30
T ₈ : C ₃ + C ₄ weeds	75.90	71.10	64.60	70.60	57.20	53.80	53.10	54.70
T ₉ : Weed free	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	36.50	33.30	32.10		30.50	26.60	28.80	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	2.96	6.29	1.31	2.78
Sub treatment	1.59	3.23	1.22	2.48
Interaction A:	4.77	NS	3.66	NS
Interaction B:	5.02	NS	2.81	NS

Note: A = Two sub means at same level main

B = Two main means at same or different levels sub.

NS = Not significant

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Table 32: Mean CO₂ assimilation rate (¹⁴C cpm g⁻¹ leaf DM hr⁻¹ x 10³) and number of stomata mm⁻² in dominant weeds and groundnut cultivars (70 DAS) Rabi 1988

Weed species	CO ₂ assimilation rate	Number of stomata mm ⁻²
C ₄ weeds		
1. <i>Cyperus rotundus</i>	72.60	369
2. <i>Cynodon dactylon</i>	81.72	462
3. <i>Dactyloctenium aegyptium</i>	197.90	328
4. <i>Digitaria sanguinalis</i>	144.70	382
5. <i>Amaranthus viridis</i>	93.00	295
6. <i>Euphorbia hirta</i>	57.60	418
C ₃ weeds		
1. <i>Parthenium hysterophorus</i>	65.52	306
2. <i>Lagasca mollis</i>	47.60	302
3. <i>Ocimum canum</i>	40.90	357
4. <i>Celosia argentea</i>	28.90	392
5. <i>Digera arvensis</i>	25.80	265
Groundnut cultivars		
1. K-3	25.13	283
2. JL-24	32.17	270
3. Gangapuri	38.79	272

rates were observed in *Dactyloctenium aegyptium* and *Digitaria sanguinalis*. Among C_3 weeds *Parthenium hysterophorus* and *Lagasca mollis* showed higher rates of CO_2 assimilation. In general dominant C_4 and C_3 weeds showed higher CO_2 assimilation rates than groundnut cultivars.

4.6 NUMBER OF STOMATA m^{-2} IN WEEDS

Among C_4 weeds higher stomatal number was recorded in *Cynodon dactylon* and *Euphorbia hirta* (Table 32). Among C_3 weeds *Celosia argentea* and *Ocimum canum* showed higher stomatal number. In most of the dominant C_3 and C_4 weeds the stomatal number was higher than in groundnut cultivars.

4.7 WEED GROWTH RATE (WGR)

The differences in WGR on 50, 70 and 90 DAS due to treatments in rabi 1987 and 1988 were calculated. Maximum WGR was found on 70 DAS in rabi 1987 and on 90 DAS in rabi 1988 (Table 33). T_6 , T_7 and T_8 treatments showed higher WGR. All the herbicide treatments lowered WGR and it was least with pendimethalin followed by oxyfluorfen at all the stages. During 30 and 70 DAS in both the years WGR was more in cv K-3 plots than in JL-24 and Gangapuri.

4.8 CALCULATED LEAF AREA INDEX (LAI) OF WEEDS

The differences in LAI of weeds were calculated on 50 and 90 DAS in rabi 1987 and 1988 (Table 33). Maximum weed LAI was found on 90 DAS in both the years. T_6 , T_7 and T_8 treatments

Table 33: Effect of herbicides and crop weed competition on weed growth rate ($g\ m^{-2}\ d^{-1}$), weed LAI and ratio of weed LAI to crop LAI

Treatments	Weed growth rate ($g\ m^{-2}\ d^{-1}$)						Calculated LAI (weeds)						LAI weeds/LAI crop					
	Rabi 1987		Rabi 1988		Rabi 1987		Rabi 1988		Rabi 1987		Rabi 1988		Rabi 1987		Rabi 1988			
	70	90	70	90	70	90	70	90	70	90	70	90	70	90	70	90		
T ₁	1.49	1.93	2.25	1.75	2.01	2.00	0.40	0.73	0.48	0.87	0.29	0.34	0.92	0.48				
T ₂	0.85	0.55	0.70	0.89	1.26	1.19	0.20	0.19	0.24	0.65	0.15	0.07	0.42	0.28				
T ₃	0.98	1.49	0.36	0.95	1.12	1.41	0.25	0.13	0.22	0.63	0.17	0.05	0.34	0.30				
T ₄	2.78	2.63	2.73	1.95	2.20	2.90	0.79	1.11	0.50	1.31	0.70	0.50	1.09	0.72				
T ₅	0.79	2.56	2.93	1.47	2.56	3.95	0.19	0.94	0.46	1.81	0.22	0.55	0.97	0.95				
T ₆	3.15	5.47	3.99	2.45	3.19	2.41	0.84	1.69	0.64	1.98	0.83	0.89	1.44	1.22				
T ₇	3.69	5.11	4.04	3.58	2.82	3.87	0.93	1.15	0.96	2.11	1.03	1.12	2.19	1.53				
T ₈	3.78	5.69	5.21	3.98	3.26	3.19	1.08	2.47	1.06	2.21	1.13	1.63	2.81	1.42				
T ₉	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
V ₁	2.05	3.21	2.21	2.15	2.18	2.64	0.56	1.30	0.63	1.87	0.59	0.83	1.57	1.21				
V ₂	1.87	2.82	2.73	1.84	1.90	2.47	0.49	0.84	0.44	1.21	0.46	0.47	0.94	0.69				
V ₃	1.91	2.44	2.46	1.68	2.06	1.86	0.50	0.66	0.45	0.77	0.45	0.42	0.89	0.41				

showed higher LAI and it was highest in T₈. All the herbicide treatments showed lower weed LAI and it was least with pendimethalin followed by oxyfluorfen. Weed LAI was more in cv K-3 plots than in Gangapuri and JL-24.

4.9 RATIO OF WEED LAI TO CROP LAI

The differences in ratio of weed LAI to crop LAI on 50 and 90 DAS due to the treatments in rabi 1987 and 1988 were calculated (Table 33). T₆, T₇ and T₈ treatments showed higher values and it was highest in T₈. All the herbicide treatments showed lower values and it was lowest with pendimethalin followed by oxyfluorfen. The values were more in cv K-3 plots than in Gangapuri and JL-24.

4.10 PHYTOTOXICITY SCORING

Among the pre-emergence herbicides, oxyfluorfen showed more phytotoxicity in early growth stages (Table 34). It reduced the height of crop and induced slight discolouration of leaves followed by pendimethalin which caused lesser phytotoxicity. Whereas, alachlor and fluchloralin were less phytotoxic in early stages. These phytotoxic effects were not prolonged and disappeared by 30 DAS. Among the cultivars K-3 showed slightly higher phytotoxic effect than JL-24 and Gangapuri. Post emergence application of glyphosate caused higher phytotoxicity. Herbicides neither affected germination nor caused any mortality of crop.

Table 34: Phytotoxicity scoring

Herbicide treatments	Mean phytotoxicity scoring			
	10 days after crop emergence		30 DAS	
	Rabi			
	1987	1988	1987	1988
K-3				
1. Alachlor 1.5 kg a.i./ha	0.40	0.50	0.0	0.0
2. Pendimethalin 1.5 kg a.i./ha	0.66	0.66	0.0	0.0
3. Oxyfluorfen 0.25 kg a.i./ha	1.00	1.00	0.0	0.0
4. Fluchloralin 1.5 kg a.i./ha	0.33	0.33	0.0	0.0
5. Glyphosate 1.5 kg a.i./ha	--	--	1.70	1.75
JL-24				
1. Alachlor 1.5 kg a.i./ha	0.33	0.33	0.0	0.0
2. Pendimethalin 1.5 kg a.i./ha	0.50	0.33	0.0	0.0
3. Oxyfluorfen 0.25 kg a.i./ha	0.66	0.66	0.0	0.0
4. Fluchloralin 1.5 kg a.i./ha	0.33	0.33	0.0	0.0
5. Glyphosate 1.5 kg a.i./ha	--	--	1.50	1.60
Gangapuri				
1. Alachlor 1.5 kg a.i./ha	0.33	0.33	0.0	0.0
2. Pendimethalin 1.5 kg a.i./ha	0.33	0.33	0.0	0.0
3. Oxyfluorfen 0.25 kg a.i./ha	0.66	0.66	0.0	0.0
4. Fluchloralin 1.5 kg a.i./ha	0.33	0.33	0.0	0.0
5. Glyphosate 1.5 kg a.i./ha	--	--	1.50	1.50

4.11 PLANT HEIGHT

The differences in plant height of diverse groundnut cultivars on 70 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 35). T₆, T₇ and T₈ treatments showed significantly higher plant height than weed free treatment. All the herbicide treatments showed lesser plant height and it was lowest with glyphosate. The differences in plant height among the cultivars were significant. Cvs. Gangapuri and JL-24 attained significantly higher plant height than K-3. The interactions among the cultivars and treatments were significant.

4.12 TOTAL NUMBER OF BRANCHES

The differences in total number of branches of diverse groundnut cultivars on 70 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 36). The crop plants in weed free treatment showed highest total number of branches followed by pendimethalin and oxyfluorfen which were on par with each other. Whereas, T₆, T₇ and T₈ treatments showed significantly less number of branches. All the herbicide treatments significantly improved branching except glyphosate. The differences in number of branches among the cultivars were significant. Cv. K-3 showed significantly higher total number of branches than JL-24 and Gangapuri. The interactions among the cultivars and treatments were significant.

Table 35: Effect of herbicides and crop weed competition on plant height (cm) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	13.1	17.8	15.6	15.5	11.6	12.0	15.2	12.9
T ₂ : Pendimethalin	13.9	15.6	21.9	17.1	11.0	13.5	18.1	14.2
T ₃ : Oxyfluorfen	13.1	15.9	20.8	16.6	11.8	14.8	17.0	14.6
T ₄ : Fluchloralin	13.4	17.9	21.6	17.6	12.1	13.1	17.5	14.2
T ₅ : Glyphosate	12.4	14.6	12.1	13.0	11.3	12.5	13.8	12.5
T ₆ : C ₄ weeds	17.9	21.1	22.8	20.6	13.6	17.5	18.6	16.6
T ₇ : C ₃ weeds	15.7	22.9	19.8	19.5	12.8	18.1	20.5	17.2
T ₈ : C ₃ + C ₄ weeds	21.4	22.4	24.5	22.8	12.6	17.8	19.1	16.5
T ₉ : Weed free	12.5	15.1	18.7	15.4	10.8	11.6	14.8	12.4
Mean	14.8	18.1	19.8		11.9	14.6	17.2	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.89	1.91	0.89	1.88
Sub treatment	0.42	0.85	0.25	0.51
Interaction A:	1.26	2.56	0.75	1.53
Interaction B:	1.47	3.03	1.33	2.77

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 36: Effect of herbicides and crop weed competition on total number of branches (number plant⁻¹) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	9.90	7.6	5.8	7.7	9.5	5.5	5.2	6.8
T ₂ : Pendimethalin	13.0	7.8	6.3	9.0	9.0	6.0	5.5	6.8
T ₃ : Oxyfluorfen	12.5	7.8	6.4	8.9	9.5	6.5	5.8	7.3
T ₄ : Fluchloralin	10.8	6.0	5.4	7.4	9.2	6.5	5.6	7.1
T ₅ : Glyphosate	9.2	6.0	6.9	7.4	7.3	5.0	4.8	5.7
T ₆ : C ₄ weeds	8.1	5.3	5.4	6.2	7.0	5.0	5.0	5.7
T ₇ : C ₃ weeds	7.3	5.2	4.9	5.8	6.5	4.9	5.0	5.5
T ₈ : C ₃ + C ₄ weeds	8.1	5.4	4.7	6.1	6.8	5.4	4.7	5.7
T ₉ : Weed free	13.3	9.1	6.9	9.8	10.5	7.5	7.0	8.4
Mean	10.3	6.7	5.8		8.4	5.8	5.4	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.47	1.01	0.36	0.76
Sub treatment	0.27	0.54	0.14	0.27
Interaction A:	0.80	1.63	0.41	0.82
Interaction B:	0.82	1.68	0.56	1.16

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

4.13 NUMBER OF NODULES PLANT⁻¹

The differences in nodule number found in diverse groundnut cultivars on 70 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 37). The weed free treatment showed highest root nodule number. T₆, T₇ and T₈ treatments showed lower nodule number. Except glyphosate all herbicide treatments significantly improved nodule number. Among the cvs, K-3 was significantly superior over JL-24 and Gangapuri. The interactions among the cultivars and treatments were also significant.

4.14 TOTAL DRY MATTER (TDM)

The differences in TDM of diverse groundnut cultivars on 30, 70 and 110 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 38,39,40). Highest TDM was found in weed free treatment. T₆, T₇ and T₈ treatments showed significantly lower TDM. Among the herbicides T₂, T₃, T₁ and T₄ significantly improved TDM in that order on 70 and 110 DAS except glyphosate which showed less TDM. The differences in TDM among the cultivars were significant. Cvs. JL-24 and Gangapuri showed significantly higher TDM than K-3. The interactions among the cultivars and treatments on 30, 70 and 110 DAS were significant in both the years except on 30 DAS in rabi 1987 (Fig.4).

4.15 LEAF DRY MATTER

The differences in leaf DM of diverse groundnut cultivars on 30, 70 and 110 DAS due to the treatments were

Table 37: Effect of herbicides and crop weed competition on number of nodules (plant^{-1}) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	70.1	65.2	64.0	66.4	46.2	40.4	35.1	40.6
T ₂ : Pendimethalin	76.6	63.2	62.7	67.5	42.6	43.6	36.2	40.8
T ₃ : Oxyfluorfen	66.0	62.3	61.2	63.1	44.6	43.2	39.9	42.6
T ₄ : Fluchloralin	68.5	68.5	60.0	65.7	39.5	42.0	33.5	38.3
T ₅ : Glyphosate	48.5	54.2	49.4	50.7	33.2	37.0	25.6	31.9
T ₆ : C ₄ weeds	63.5	52.0	43.4	52.9	30.5	28.5	32.1	30.4
T ₇ : C ₃ weeds	60.0	59.0	46.2	55.1	35.0	28.1	24.8	29.3
T ₈ : C ₃ + C ₄ weeds	53.0	56.0	45.2	51.4	32.1	24.1	29.6	28.6
T ₉ : Weed free	78.8	72.1	65.2	72.0	48.1	42.0	39.8	43.3
Mean	65.0	61.4	55.2		39.1	36.5	32.9	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	3.19	6.78	2.43	5.14
Sub treatment	1.36	2.76	0.93	1.89
Interaction A:	4.08	8.28	2.79	5.66
Interaction B:	5.10	10.57	3.79	7.87

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 38: Effect of herbicides and crop weed competition on total dry matter (g m^{-2}) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	30 DAS				30 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	29.7	43.1	34.3	35.7	17.6	19.9	19.9	19.1
T ₂ : Pendimethalin	26.3	34.5	28.3	29.7	21.3	19.6	17.2	19.4
T ₃ : Oxyfluorfen	25.7	42.8	34.9	34.5	13.9	17.6	19.9	17.2
T ₄ : Fluchloralin	32.1	37.3	32.6	33.9	20.7	13.7	21.3	18.5
T ₅ : Glyphosate	19.8	27.2	20.7	22.6	14.8	21.6	22.9	19.8
T ₆ : C ₄ weeds	18.9	28.5	27.2	24.9	15.4	20.5	16.3	17.4
T ₇ : C ₃ weeds	28.4	30.1	24.8	27.8	18.8	17.0	17.9	17.9
T ₈ : C ₃ + C ₄ weeds	19.8	30.9	22.6	24.5	17.9	21.6	18.9	19.5
T ₉ : Weed free	36.6	45.8	43.3	41.9	25.3	30.9	28.2	28.2
Mean	26.4	35.6	29.9		18.4	20.3	20.3	

Results of statistical analysis	S.Ed+	CD(0.05)	S.Ed+	CD(0.05)
Main treatment	1.39	2.95	0.62	1.32
Sub treatment	1.02	2.07	0.41	0.83
Interaction A:	3.06	NS	1.22	2.48
Interaction B:	2.64	NS	1.13	2.32

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 39: Effect of herbicides and crop weed competition on total dry matter (g m^{-2}) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	234.8	290.3	290.1	271.7	188.7	193.4	187.8	189.9
T ₂ : Pendimethalin	294.0	300.5	384.6	326.4	218.2	211.5	233.1	220.9
T ₃ : Oxyfluorfen	277.7	298.8	333.9	303.5	212.9	234.9	212.8	220.2
T ₄ : Fluchloralin	227.5	263.2	252.5	247.7	174.9	182.2	170.7	175.9
T ₅ : Glyphosate	143.2	198.3	245.0	195.5	118.5	159.1	101.6	126.4
T ₆ : C ₄ weeds	203.1	219.8	226.4	216.5	166.9	174.9	158.9	166.9
T ₇ : C ₃ weeds	136.5	158.5	156.0	150.3	136.5	129.2	141.5	135.7
T ₈ : C ₃ + C ₄ weeds	195.5	156.0	146.5	166.0	140.8	172.1	153.9	155.6
T ₉ : Weed free	320.9	398.2	405.0	374.7	271.2	314.5	306.8	297.5
Mean	225.9	253.7	271.1		180.9	196.9	185.2	

Results of statistical analysis	S.Ed ₊	CD(0.05)	S.Ed ₊	CD(0.05)
Main treatment	12.84	27.23	5.18	11.00
Sub treatment	6.03	12.23	2.83	5.75
Interaction A:	18.09	36.70	8.50	17.24
Interaction B:	20.95	43.33	8.82	18.19

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 40: Effect of herbicides and crop weed competition on total dry matter (g m^{-2}) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	110 DAS				110 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	376.3	476.2	472.9	441.8	286.3	404.3	416.0	368.9
T ₂ : Pendimethalin	556.1	619.4	689.3	621.6	358.0	506.3	509.7	458.0
T ₃ : Oxyfluorfen	652.7	572.8	669.3	631.6	349.7	478.0	493.0	440.2
T ₄ : Fluchloralin	366.2	439.6	432.9	412.9	299.7	365.0	376.0	346.9
T ₅ : Glyphosate	314.7	391.3	442.9	382.9	231.0	340.0	286.7	285.9
T ₆ : C ₄ weeds	297.7	355.2	349.6	334.2	253.0	303.0	313.0	289.7
T ₇ : C ₃ weeds	241.4	279.8	302.4	274.5	223.3	269.7	288.0	260.3
T ₈ : C ₃ + C ₄ weeds	248.1	269.7	285.0	267.6	208.3	251.0	291.0	250.1
T ₉ : Weed free	732.6	799.2	735.9	755.9	535.3	731.0	682.7	649.7
Mean	420.6	467.0	486.7		304.9	405.4	406.2	

Results of statistical analysis	S.Ed+	CD(0.05)	S.Ed+	CD(0.05)
Main treatment	10.43	22.11	9.18	19.48
Sub treatment	3.84	7.79	5.39	10.94
Interaction A:	11.52	23.37	16.18	32.81
Interaction B:	16.18	33.63	16.00	32.94

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

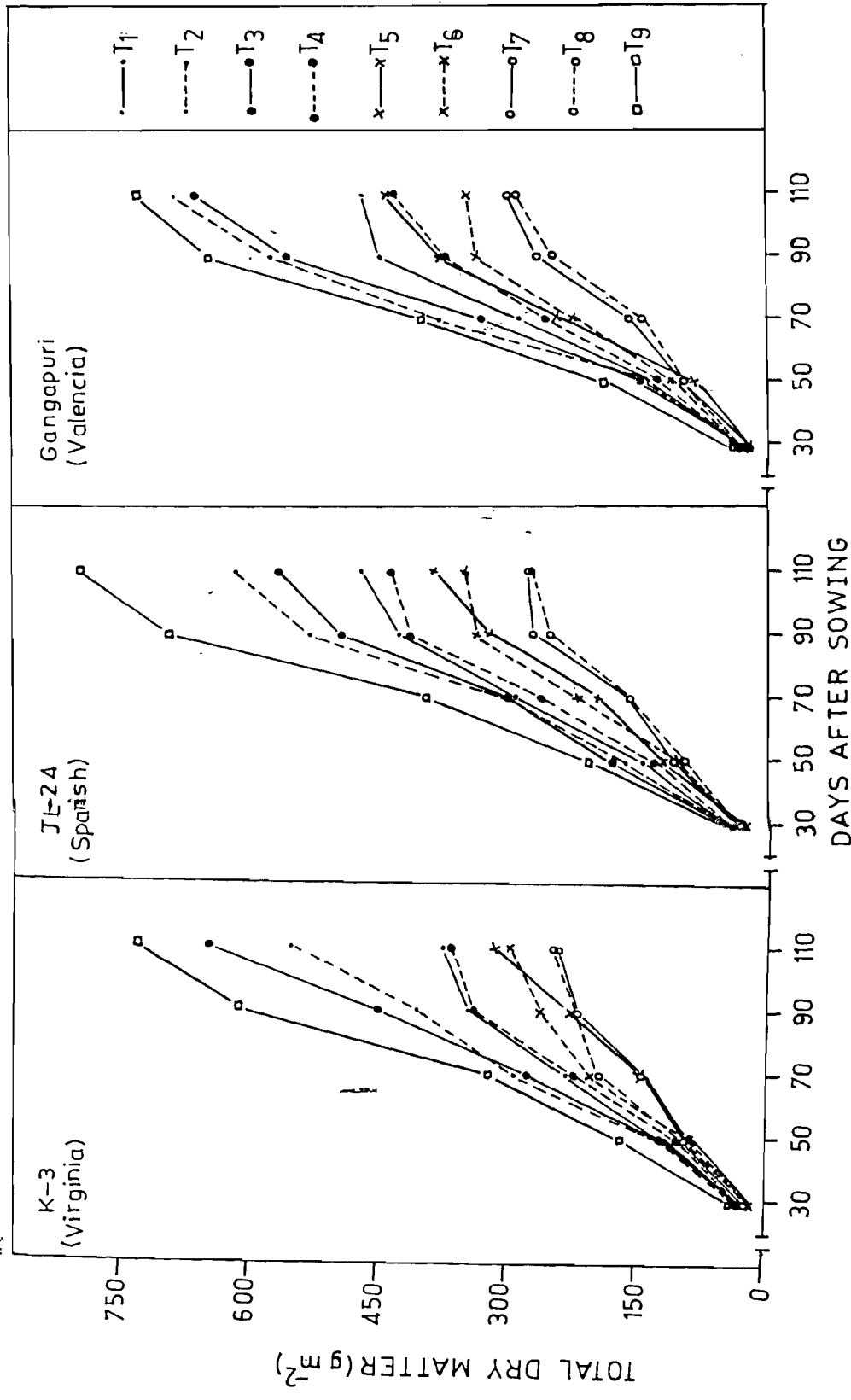


Fig. 4 : EFFECT OF HERBICIDES AND CROP-WEED COMPETITION ON TDM OF DIVERSE GROUNDNUT CULTIVARS (RABI 1987)

significant in rabi 1987 and 1988 (Table 41,42,43). Highest leaf DM was found in weed free treatment. The treatments containing weeds showed significantly lower leaf DM. Among the herbicides T₂, T₃, T₁ and T₄ significantly improved leaf DM in that order on 70 and 110 DAS except glyphosate which showed lower values. The differences in leaf DM among the cultivars were significant at all the stages except on 70 DAS in rabi 1987. Cvs. JL-24 and Gangapuri were significantly superior over K-3 on 30 DAS, whereas on 70 and 110 DAS Gangapuri showed lower values. The interactions among the cultivars and treatments were significant in both the years except on 30 DAS in rabi 1987 and 110 DAS in rabi 1988 (Fig.5 and 6).

4.16 LEAF AREA INDEX (LAI)

The differences in LAI of diverse groundnut cultivars on 30, 70 and 110 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 44,45,46). Highest LAI was found in weed free treatment at all the stages followed by pendimethalin and oxyfluorfen on 70 and 90 DAS. The treatments containing weeds showed significantly lower LAI. All the herbicide treatments improved LAI except glyphosate. The differences in LAI among the cultivars were significant at all the stages except on 110 DAS in rabi 1988. Cvs. JL-24 and Gangapuri showed significantly higher LAI than K-3 on 30 DAS. However, on 110 DAS cv K-3 had significantly higher LAI than Gangapuri. The interactions among the cultivars and treatments were significant in both the years except on 30 DAS in rabi 1987 and 110 DAS in rabi 1988 (Fig.7).

Table 41: Effect of herbicides and crop weed competition on leaf dry matter (g m^{-2}) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	30 DAS				30 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	14.7	22.3	20.0	19.0	6.9	9.3	9.0	8.3
T ₂ : Pendimethalin	14.7	19.3	14.7	16.3	10.3	8.7	7.3	8.7
T ₃ : Oxyfluorfen	13.7	23.0	20.7	19.0	6.3	8.0	9.3	8.0
T ₄ : Fluchloralin	18.7	21.3	17.3	18.9	9.0	5.7	9.7	8.0
T ₅ : Glyphosate	8.3	15.7	11.3	11.7	7.3	10.3	10.3	9.3
T ₆ : C ₄ weeds	10.3	16.0	16.0	14.0	6.3	8.7	7.0	7.3
T ₇ : C ₃ weeds	13.9	13.7	12.7	13.3	8.7	7.7	8.3	8.3
T ₈ : C ₃ + C ₄ weeds	10.3	14.3	12.3	12.3	8.0	11.0	9.3	9.3
T ₉ : Weed free	22.3	30.3	29.6	27.3	12.0	15.3	12.7	13.3
Mean	13.9	19.7	17.3		8.3	9.3	9.3	

Results of statistical analysis	S.Ed ₊	CD(0.05)	S.Ed ₊	CD(0.05)
Main treatment	1.13	2.39	0.38	0.80
Sub treatment	0.77	1.53	0.24	0.47
Interaction A:	2.26	NS	0.71	1.43
Interaction B:	2.07	NS	0.68	1.40

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 42: Effect of herbicides and crop weed competition on leaf dry matter (g m^{-2}) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70. DAS				70. DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	116.6	122.5	123.2	120.9	77.9	90.9	80.9	83.3
T ₂ : Pendimethalin	126.2	134.2	147.5	135.9	107.6	99.6	92.9	100.0
T ₃ : Oxyfluorfen	140.2	129.5	117.9	129.2	106.2	99.5	84.2	96.6
T ₄ : Fluchloralin	100.9	112.9	95.9	103.2	73.3	77.3	70.9	73.9
T ₅ : Glyphosate	70.3	92.6	103.9	88.9	53.6	66.6	39.6	53.3
T ₆ : C ₄ weeds	92.9	79.6	94.9	89.2	71.3	71.6	66.3	69.6
T ₇ : C ₃ weeds	66.9	58.9	73.3	66.3	58.3	52.6	52.3	54.3
T ₈ : C ₃ + C ₄ weeds	84.6	70.3	67.9	74.3	59.6	70.3	58.6	62.9
T ₉ : Weed free	154.5	163.5	156.2	158.2	125.9	144.9	118.9	129.9
Mean	105.9	107.2	108.9		81.6	85.9	73.9	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	3.99	8.33	2.53	5.36
Sub treatment	2.23	NS	1.69	3.46
Interaction A:	6.69	13.55	5.13	10.39
Interaction B:	6.86	14.12	4.63	9.52

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table- 43: Effect of herbicides and crop weed competition on leaf dry matter (g m^{-2}) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	110 DAS				110 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	106.2	111.2	64.9	94.2	119.9	128.2	120.2	122.5
T ₂ : Pendimethalin	208.1	150.8	111.2	156.8	144.5	154.2	136.2	144.9
T ₃ : Oxyfluorfen	213.8	116.2	110.9	146.9	134.2	143.9	132.9	136.9
T ₄ : Fluchloralin	98.9	86.3	59.3	81.3	119.2	118.9	112.9	116.9
T ₅ : Glyphosate	104.2	67.3	46.3	72.6	90.9	104.9	78.6	91.6
T ₆ : C ₄ weeds	105.9	75.6	35.9	72.5	102.2	107.2	94.9	101.6
T ₇ : C ₃ weeds	51.3	34.6	32.0	39.3	87.2	98.2	88.6	91.2
T ₈ : C ₃ + C ₄ weeds	69.3	60.3	29.6	52.9	78.9	92.9	86.3	86.3
T ₉ : Weed free	236.1	174.5	130.5	180.2	213.1	238.4	216.1	222.4
Mean	132.5	97.2	68.9		121.2	131.9	118.6	

Results of statistical analysis	S.Ed ₊	CD(0.05)	S.Ed ₊	CD(0.05)
Main treatment	6.23	13.32	2.63	5.63
Sub treatment	1.96	3.99	2.26	4.56
Interaction A:	5.93	11.99	6.76	NS
Interaction B:	9.46	19.65	5.43	NS

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

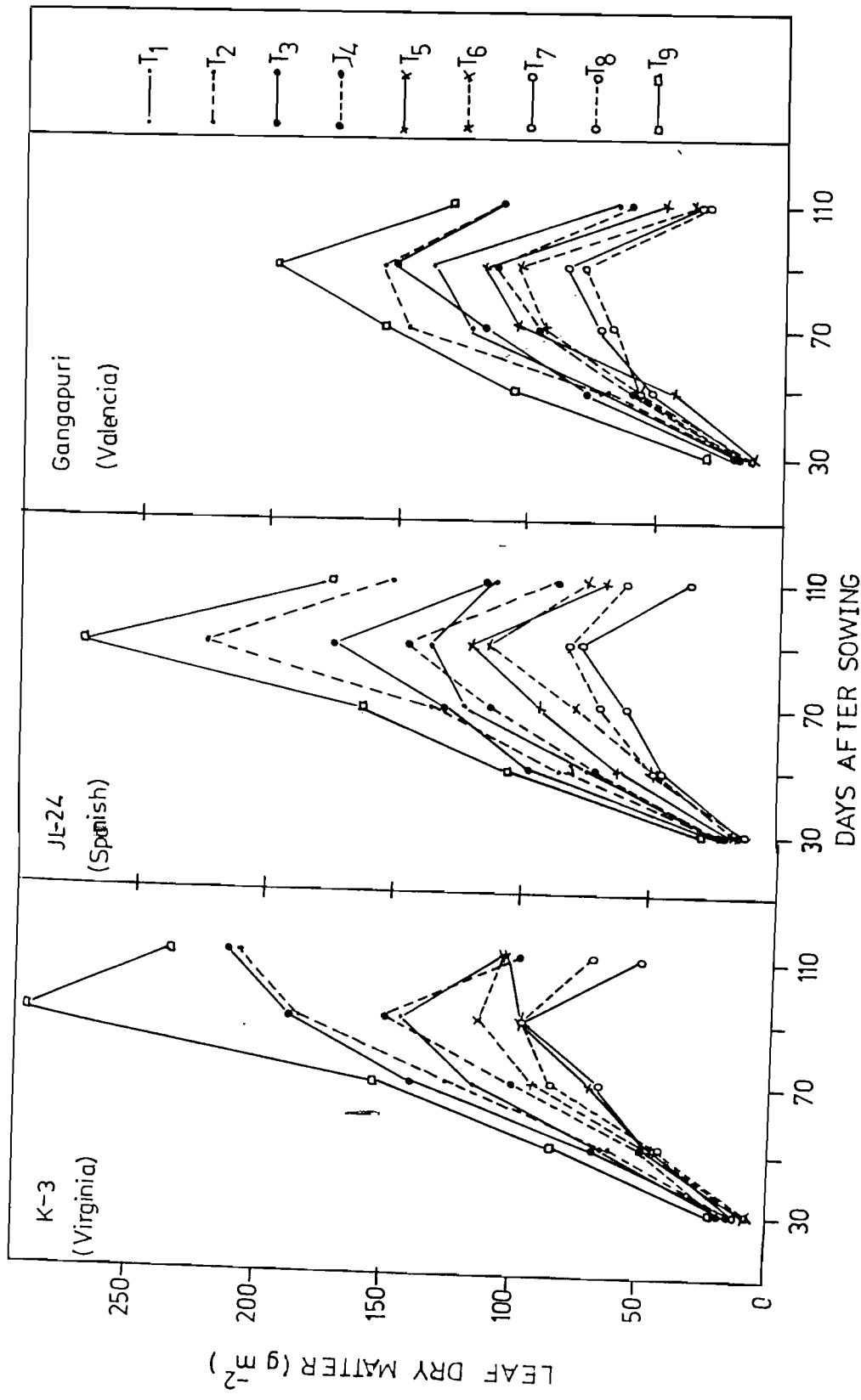


Fig. 5 : EFFECT OF HERBICIDES AND CROP WEED COMPETITION ON LEAF DM OF DIVERSE GROUNDNUT CULTIVARS (RABI 1987)

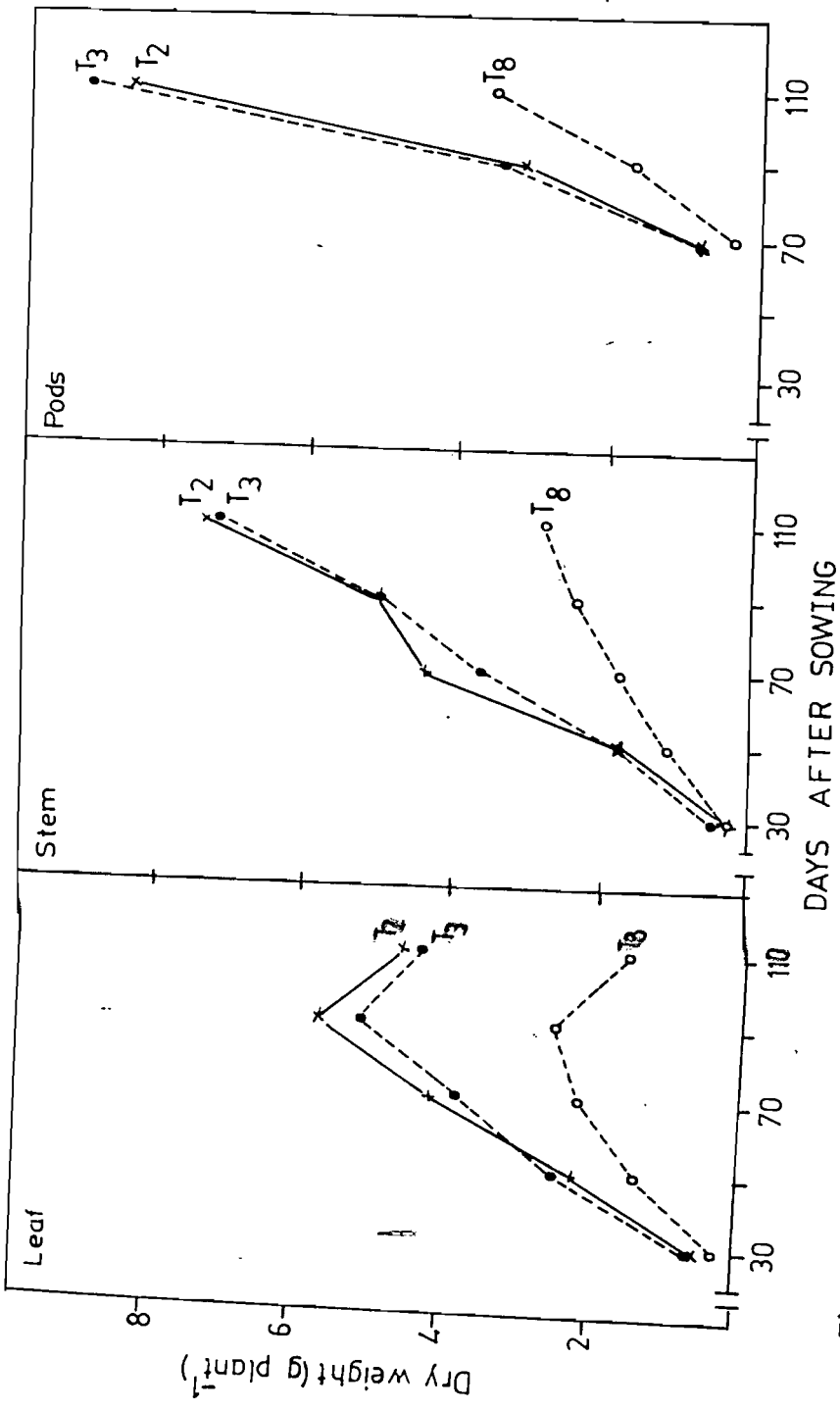


Fig. 6: EFFECT OF HERBICIDES (PENDIMETHALIN T₂; OXYFLUORFEN T₃) AND CROP WEED COMPETITION (T₈) ON DRY WEIGHT OF LEAF, STEM AND PODS (Mean values) (RABI 1987)

Table 44: Effect of herbicides and crop weed competition on leaf area index of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	30 DAS				30 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	0.30	0.47	0.43	0.40	0.14	0.17	0.16	0.16
T ₂ : Pendimethalin	0.28	0.42	0.35	0.35	0.19	0.16	0.14	0.17
T ₃ : Oxyfluorfen	0.28	0.50	0.43	0.40	0.12	0.15	0.18	0.15
T ₄ : Fluchloralin	0.38	0.48	0.41	0.42	0.17	0.11	0.18	0.15
T ₅ : Glyphosate	0.18	0.34	0.27	0.26	0.14	0.19	0.20	0.18
T ₆ : C ₄ weeds	0.23	0.34	0.39	0.32	0.12	0.17	0.13	0.14
T ₇ : C ₃ weeds	0.32	0.29	0.29	0.30	0.17	0.13	0.16	0.15
T ₈ : C ₃ + C ₄ weeds	0.26	0.34	0.32	0.31	0.15	0.21	0.18	0.18
T ₉ : Weed free	0.42	0.56	0.57	0.51	0.21	0.25	0.22	0.23
Mean	0.29	0.41	0.38		0.15	0.17	0.17	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.022	0.050	0.007	0.015
Sub treatment	0.015	0.031	0.005	0.011
Interaction A:	0.046	NS	0.016	0.032
Interaction B:	0.041	NS	0.013	0.027

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 45: Effect of herbicides and crop weed competition on leaf area index of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	1.93	1.94	1.89	1.92	1.37	1.44	1.41	1.41
T ₂ : Pendimethalin	2.19	2.19	2.43	2.27	1.89	1.62	1.53	1.68
T ₃ : Oxyfluorfen	2.19	2.04	2.10	2.11	1.81	1.66	1.46	1.64
T ₄ : Fluchloralin	1.54	1.87	1.71	1.71	1.33	1.39	1.23	1.32
T ₅ : Glyphosate	1.19	1.58	1.69	1.49	1.01	1.18	0.72	0.97
T ₆ : C ₄ weeds	1.63	1.39	1.62	1.55	1.34	1.22	1.16	1.24
T ₇ : C ₃ weeds	1.19	1.05	1.29	1.17	1.07	0.93	0.97	0.99
T ₈ : C ₃ + C ₄ weeds	1.46	1.29	1.16	1.30	1.13	1.31	1.03	1.16
T ₉ : Weed free	2.27	2.35	2.42	2.35	2.01	2.11	1.86	1.99
Mean	1.73	1.75	1.81		1.44	1.43	1.26	

Results of statistical analysis	S.Ed ₊	CD(0.05)	S.Ed ₊	CD(0.05)
Main treatment	0.055	0.117	0.037	0.079
Sub treatment	0.034	0.068	0.028	0.057
Interaction A:	0.104	0.205	0.085	0.172
Interaction B:	0.098	0.201	0.072	0.147

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

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Table 46: Effect of herbicides and crop weed competition on leaf area index of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	110 DAS				110 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	1.42	1.51	0.89	1.27	2.03	2.34	2.22	2.19
T ₂ : Pendimethalin	2.44	2.41	1.44	2.09	2.45	2.73	2.43	2.54
T ₃ : Oxyfluorfen	2.81	1.44	1.48	1.91	2.34	2.62	2.33	2.43
T ₄ : Fluchloralin	1.48	1.31	1.07	1.28	2.10	2.12	2.02	2.09
T ₅ : Glyphosate	1.40	1.04	0.72	1.05	1.66	1.98	1.47	1.70
T ₆ : C ₄ weeds	1.28	1.22	0.57	1.02	1.91	2.02	1.72	1.88
T ₇ : C ₃ weeds	0.72	0.52	0.61	0.62	1.73	2.01	1.67	1.80
T ₈ : C ₃ + C ₄ weeds	0.90	1.03	0.55	0.83	1.55	1.83	1.56	1.65
T ₉ : Weed free	2.93	2.26	1.60	2.26	3.41	3.95	3.52	3.63
Mean	1.71	1.41	0.99		2.13	2.41	2.10	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.083	0.177	0.319	0.680
Sub treatment	0.031	0.062	0.186	NS
Interaction A:	0.092	0.186	0.557	NS
Interaction B:	0.129	0.269	0.555	NS

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

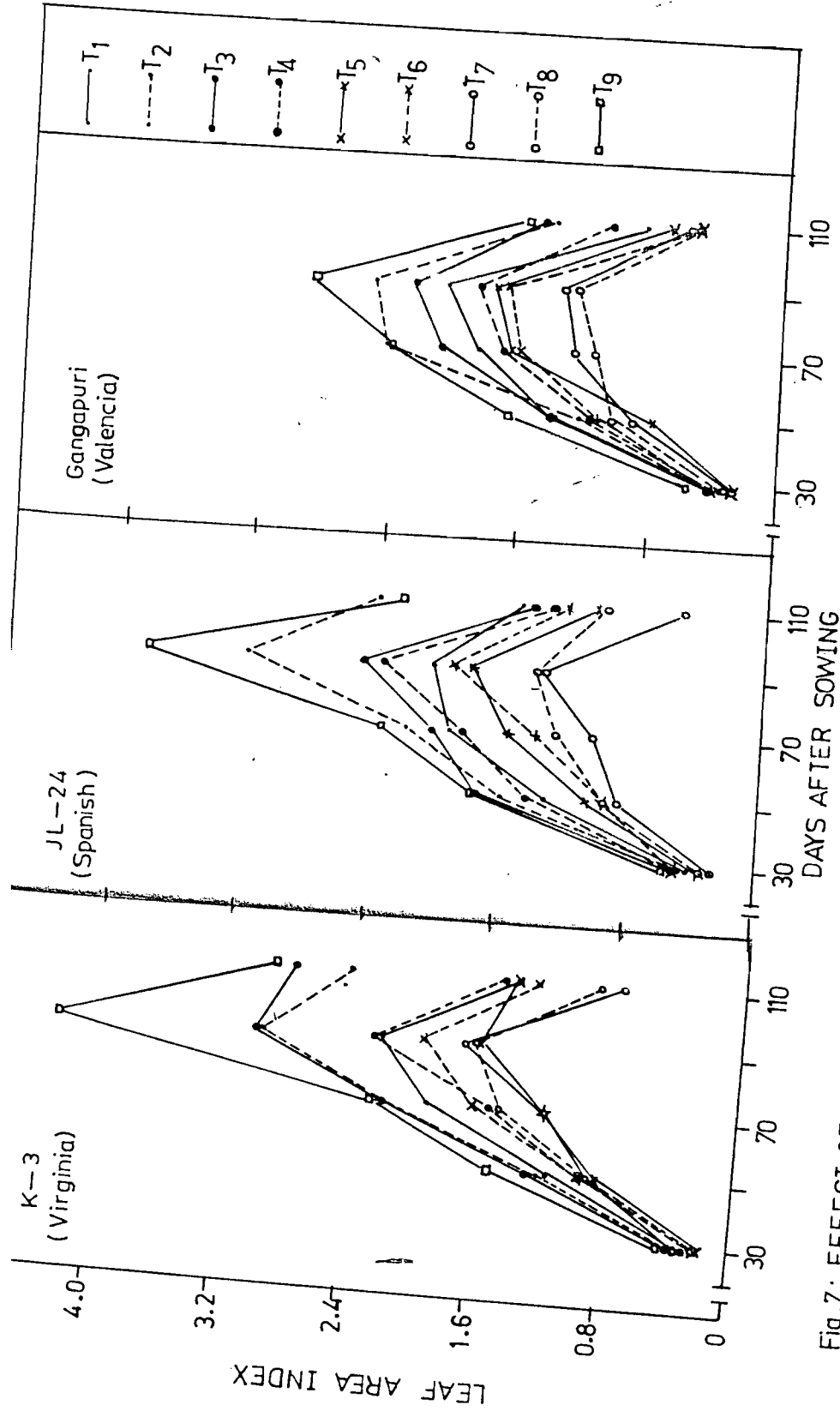


Fig.7: EFFECT OF HERBICIDES AND CROP WEED COMPETITION ON LAI OF DIVERSE GROUNDNUT CULTIVARS (RABI 1987)

4.17 CROP GROWTH RATE (CGR)

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The differences in CGR of diverse groundnut cultivars on 50, 70 and on 90 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 47,48,49). Highest CGR was found in weed free treatment followed by oxyfluorfen and pendimethalin. The treatments containing weeds showed significantly lower CGR. All the herbicide treatments significantly increased CGR except glyphosate on 50 and 70 DAS. The differences in CGR found among the cultivars were significant. Cvs. JL-24 and Gangapuri showed significantly higher CGR than K-3 on 50 and 90 DAS. The interactions among the cultivars and treatments on 50, 70 and 90 DAS were significant in both the years except on 90 DAS in rabi 1987. Cv. JL-24 showed the highest growth rate on 50 DAS followed by least growth in K-3 in the early stages. Whereas, on 70 DAS Gangapuri showed the maximum CGR and on 90 DAS JL-24 (Fig.8 and 9).

4.18 RELATIVE GROWTH RATE (RGR)

The differences in RGR of diverse groundnut cultivars on 50, 70 and 90 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 50,51,52). Highest RGR values were found in pendimethalin followed by oxyfluorfen and weed free treatment on 50 and 70 DAS. The treatments containing weeds showed lower RGR. Herbicide treatments improved RGR at all the stages except glyphosate on 70 DAS. The differences in RGR found among the cultivars were significant on 50 DAS in rabi 1988 and 70 DAS in

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Table 47: Effect of herbicides and crop weed competition on crop growth rate ($\text{g m}^{-2} \text{d}^{-1}$) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	50 DAS				50 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	4.57	5.01	5.22	4.93	1.64	2.11	2.14	1.96
T ₂ : Pendimethalin	4.61	6.54	5.38	5.51	1.68	2.26	2.73	2.22
T ₃ : Oxyfluorfen	4.87	6.84	5.63	5.78	2.09	3.33	2.89	2.77
T ₄ : Fluchloralin	3.22	4.73	4.64	4.20	1.47	2.61	1.66	1.91
T ₅ : Glyphosate	3.45	4.71	3.28	3.82	1.61	1.86	1.14	1.54
T ₆ : C ₄ weeds	3.41	3.59	4.38	3.79	1.43	1.88	2.09	1.80
T ₇ : C ₃ weeds	3.28	3.82	3.74	3.61	1.26	1.84	2.03	1.71
T ₈ : C ₃ + C ₄ weeds	3.21	3.25	3.58	3.35	1.06	1.71	1.76	1.51
T ₉ : Weed free	6.57	8.18	7.33	7.36	2.79	4.71	4.47	3.99
Mean	4.13	5.19	4.80		1.67	2.48	2.32	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.37	0.78	0.09	0.18
Sub treatment	0.14	0.29	0.04	0.08
Interaction A:	0.43	0.86	0.12	0.25
Interaction B:	0.58	1.20	0.14	0.29

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 48: Effect of herbicides and crop weed competition on crop growth rate ($g\ m^{-2}\ d^{-1}$) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	5.67	7.35	7.60	6.87	6.74	6.56	6.24	6.51
T ₂ : Pendimethalin	8.77	6.74	12.35	9.29	8.17	7.36	8.05	7.86
T ₃ : Oxyfluorfen	7.72	5.96	9.44	7.71	7.84	7.52	6.75	7.37
T ₄ : Fluchloralin	6.54	6.56	6.34	6.48	6.24	5.81	5.91	5.99
T ₅ : Glyphosate	2.71	3.83	7.94	4.83	3.56	5.01	2.51	3.69
T ₆ : C ₄ weeds	5.79	5.96	5.67	5.81	5.14	5.83	4.16	5.04
T ₇ : C ₃ weeds	3.50	4.00	3.81	3.77	4.61	3.76	4.14	4.17
T ₈ : C ₃ + C ₄ weeds	5.57	3.90	3.67	4.38	5.07	5.77	4.97	5.27
T ₉ : Weed free	8.10	9.44	10.75	9.43	9.50	9.47	9.42	9.46
Mean	6.04	5.97	7.51		6.32	6.34	5.79	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.66	1.39	0.37	0.78
Sub treatment	0.33	0.67	0.45	0.31
Interaction A:	0.98	1.99	0.46	0.94
Interaction B:	1.09	2.25	0.58	1.21

Note: A = Two sub means at same level main.
 B = Two main means at same or different levels sub.

(3)

Table 49: Effect of herbicides and crop weed competition on crop growth rate ($\text{g m}^{-2} \text{d}^{-1}$)
of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	90 DAS				90 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	5.57	6.79	7.80	6.72	2.20	6.72	5.84	4.92
T ₂ : Pendimethalin	8.44	11.62	9.84	9.97	2.63	7.82	5.91	5.46
T ₃ : Oxyfluorfen	8.59	9.87	11.30	9.92	3.36	6.07	6.50	5.31
T ₄ : Fluchloralin	5.78	7.65	6.02	6.49	2.50	7.12	5.50	5.04
T ₅ : Glyphosate	4.12	6.41	6.69	5.74	3.94	4.19	5.07	4.40
T ₆ : C ₄ weeds	3.01	5.99	5.49	4.83	1.31	2.34	3.54	2.40
T ₇ : C ₃ weeds	4.33	5.39	5.59	5.10	1.69	3.64	3.94	3.09
T ₈ : C ₃ + C ₄ weeds	1.63	5.70	5.31	4.21	1.81	2.00	3.87	2.56
T ₉ : Weed free	14.80	14.90	12.28	13.99	6.07	10.90	10.52	9.16
Mean	6.25	8.26	7.81		2.84	5.65	5.63	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.56	1.19	0.45	0.95
Sub treatment	0.43	0.87	0.16	0.33
Interaction A:	1.29	NS	0.49	0.98
Interaction B:	1.09	NS	0.69	1.44

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

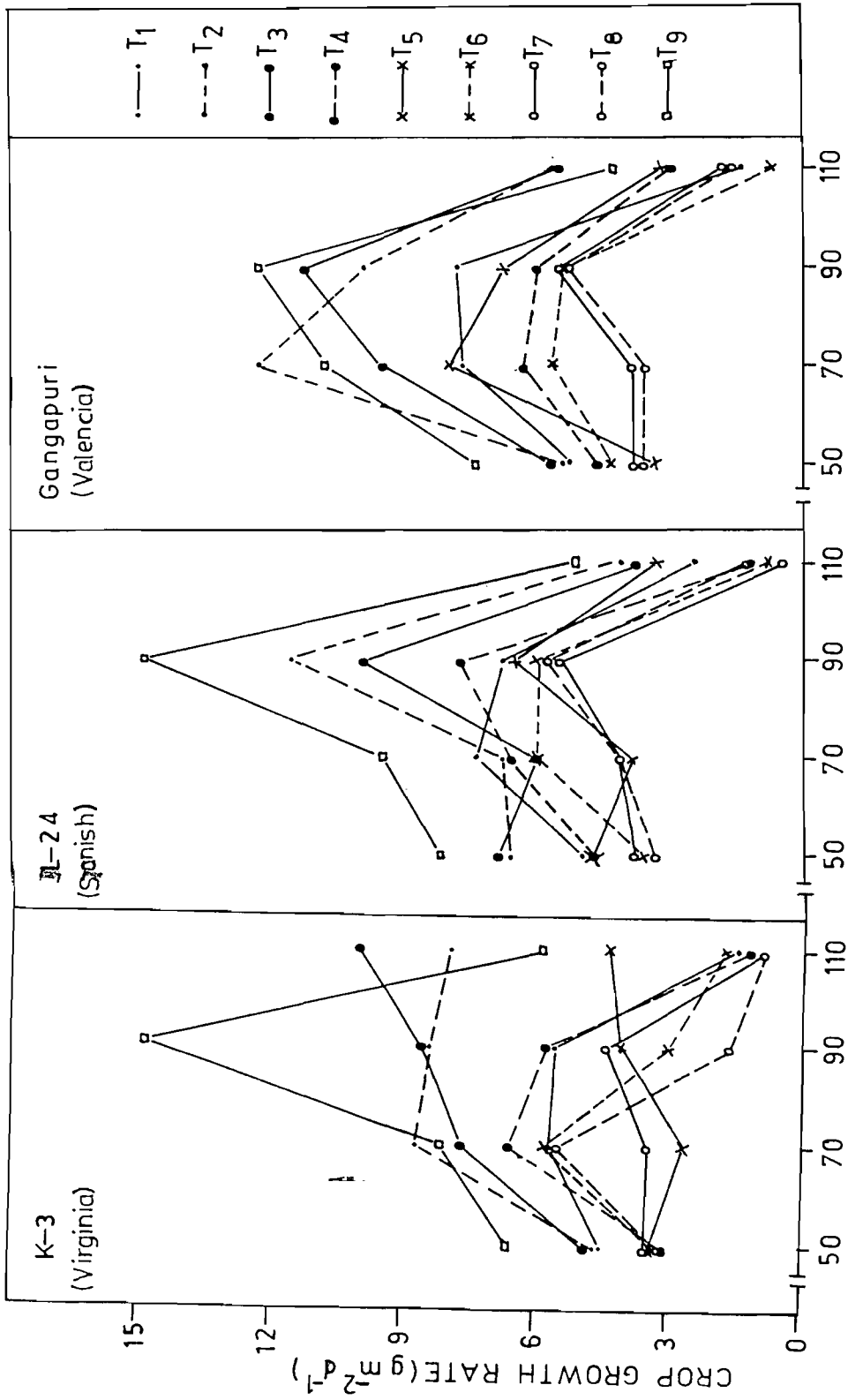
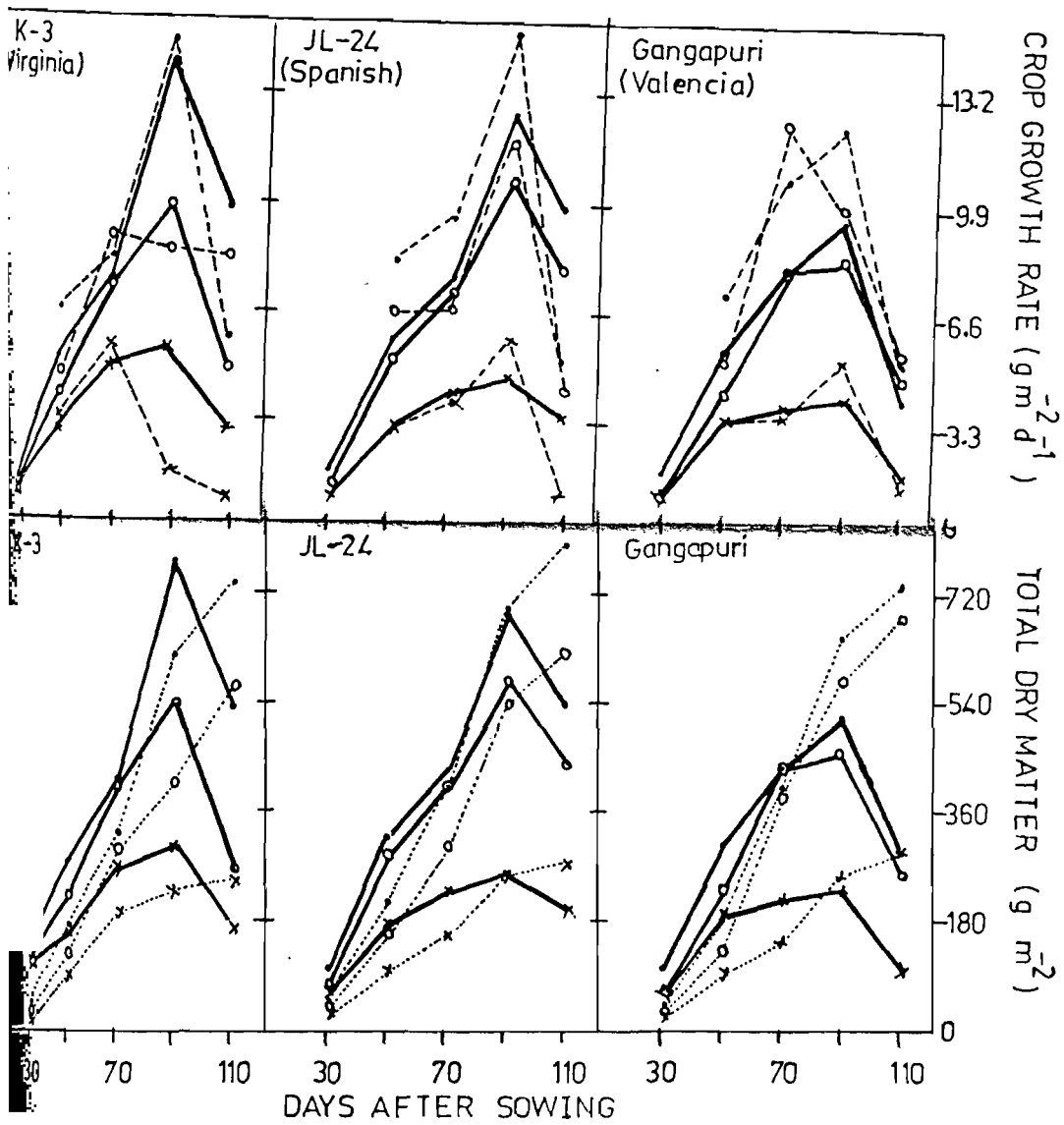


Fig.8 : EFFECT OF HERBICIDES AND CROP-WEED COMPETITION ON CGR OF DIVERSE GROUNDNUT CULTIVARS.(RABI 1987).



—LAI - - - - CGR TDM ○ ○ T₂ × × T₈ ● ● T₉

EFFECT OF HERBICIDE PENDIMETHALIN (T₂), CROP WEED COMPETITION (C₃+C₄) (T₈) AND WEED FREE TREATMENT (T₉) ON LAI, CGR AND TDM OF DIVERSE GROUNDNUT CULTIVARS (RABI 1987)

Table 50: Effect of herbicides and crop weed competition on relative growth rate ($g\ g^{-1} d^{-1}$) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	50 DAS				50 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	0.071	0.060	0.070	0.067	0.048	0.057	0.057	0.054
T ₂ : Pendimethalin	0.075	0.078	0.078	0.077	0.051	0.060	0.071	0.061
T ₃ : Oxyfluorfen	0.079	0.072	0.072	0.074	0.069	0.078	0.068	0.072
T ₄ : Fluchloralin	0.055	0.063	0.067	0.062	0.044	0.068	0.047	0.053
T ₅ : Glyphosate	0.075	0.074	0.072	0.074	0.056	0.050	0.040	0.049
T ₆ : C ₄ weeds	0.076	0.063	0.071	0.070	0.053	0.051	0.061	0.055
T ₇ : C ₃ weeds	0.060	0.063	0.069	0.064	0.042	0.057	0.059	0.053
T ₈ : C ₃ + C ₄ weeds	0.072	0.057	0.071	0.067	0.039	0.047	0.053	0.046
T ₉ : Weed free	0.075	0.076	0.074	0.075	0.051	0.070	0.071	0.064
Mean	0.071	0.067	0.072		0.050	0.060	0.059	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.004	0.007	0.004	0.007
Sub treatment	0.002	NS	0.002	0.003
Interaction A:	0.005	NS	0.005	0.009
Interaction B:	0.006	NS	0.006	0.012

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 52: Effect of herbicides and crop weed competition on relative growth rate ($g\ g^{-1}\ d^{-1}$) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	90 DAS				90 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	0.019	0.019	0.022	0.020	0.012	0.027	0.024	0.021
T ₂ : Pendimethalin	0.016	0.028	0.021	0.022	0.025	0.028	0.021	0.025
T ₃ : Oxyfluorfen	0.024	0.021	0.026	0.024	0.027	0.021	0.024	0.024
T ₄ : Fluchloralin	0.020	0.023	0.019	0.021	0.025	0.025	0.026	0.026
T ₅ : Glyphosate	0.023	0.020	0.022	0.022	0.026	0.021	0.024	0.024
T ₆ : C ₄ weeds	0.013	0.022	0.019	0.018	0.010	0.012	0.018	0.013
T ₇ : C ₃ weeds	0.018	0.019	0.019	0.019	0.012	0.022	0.022	0.018
T ₈ : C ₃ + C ₄ weeds	0.010	0.022	0.021	0.018	0.013	0.010	0.020	0.014
T ₉ : Weed free	0.033	0.028	0.024	0.028	0.026	0.027	0.026	0.027
Mean	0.020	0.022	0.021		0.020	0.021	0.023	

Results of statistical analysis	S.Ed ₊	CD(0.05)	S.Ed ₊	CD(0.05)
Main treatment	0.0023	0.005	0.0018	0.004
Sub treatment	0.0013	NS	0.0014	NS
Interaction A:	0.0040	0.008	0.0043	0.009
Interaction B:	0.0040	0.008	0.0036	0.007

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 51: Effect of herbicides and crop weed competition on relative growth rate ($g\ g^{-1}\ d^{-1}$) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70. DAS				70. DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	0.033	0.035	0.037	0.035	0.064	0.056	0.055	0.058
T ₂ : Pendimethalin	0.045	0.030	0.052	0.042	0.069	0.059	0.059	0.062
T ₃ : Oxyfluorfen	0.041	0.025	0.041	0.036	0.067	0.052	0.050	0.056
T ₄ : Fluchloralin	0.043	0.035	0.034	0.037	0.062	0.050	0.057	0.056
T ₅ : Glyphosate	0.024	0.024	0.031	0.026	0.046	0.049	0.036	0.044
T ₆ : C ₄ weeds	0.040	0.033	0.035	0.038	0.059	0.055	0.050	0.055
T ₇ : C ₃ weeds	0.019	0.020	0.022	0.020	0.056	0.043	0.040	0.046
T ₈ : C ₃ + C ₄ weeds	0.024	0.024	0.022	0.023	0.058	0.056	0.051	0.055
T ₉ : Weed free	0.035	0.036	0.033	0.036	0.062	0.051	0.054	0.056
Mean	0.034	0.030	0.035		0.060	0.052	0.050	

Results of statistical analysis	S.Ed ₊	CD(0.05)	S.Ed ₊	CD(0.05)
Main treatment	0.0036	0.008	0.0020	0.004
Sub treatment	0.0017	0.003	0.0012	0.002
Interaction A:	0.0052	0.010	0.0035	0.007
Interaction B:	0.0059	0.012	0.0035	0.007

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

both the years. Cvs. JL-24 and Gangapuri showed significantly higher RGR than K-3 on 50 DAS. The interactions among the cultivars and treatments were significant in both the years except on 50 DAS in rabi 1987 (Fig.10).

4.19 NET ASSIMILATION RATE (NAR)

The differences in NAR of diverse groundnut cultivars on 50, 70 and 90 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 53,54,55). The weed free treatment recorded highest NAR followed by pendimethalin and oxyfluorfen. The treatments containing weeds showed significantly lower NAR. All the herbicide treatments significantly improved NAR at all the stages except glyphosate which showed lower values. The differences among the cultivars were significant at all stages of growth except in 50 DAS in rabi 1987. Cvs. JL-24 and Gangapuri showed significantly higher NAR than K-3 on 50 and 90 DAS. The interactions among the cultivars and treatments on 50, 70 and 90 DAS were significant in both the years except on 50 and 90 DAS in rabi, 1987 (Fig.11).

4.20 LEAF WEIGHT RATIO (LWR)

The differences in LWR of diverse groundnut cultivars due to the treatments were significant on 30 and 110 DAS in rabi 1987 and on 70 DAS in rabi 1988 (Table 56,57,58). During 30 and 110 DAS highest LWR was found in weed free treatment. The treatments containing weeds showed significantly lower LWR than T₉. All the herbicide treatments improved LWR except glyphosate

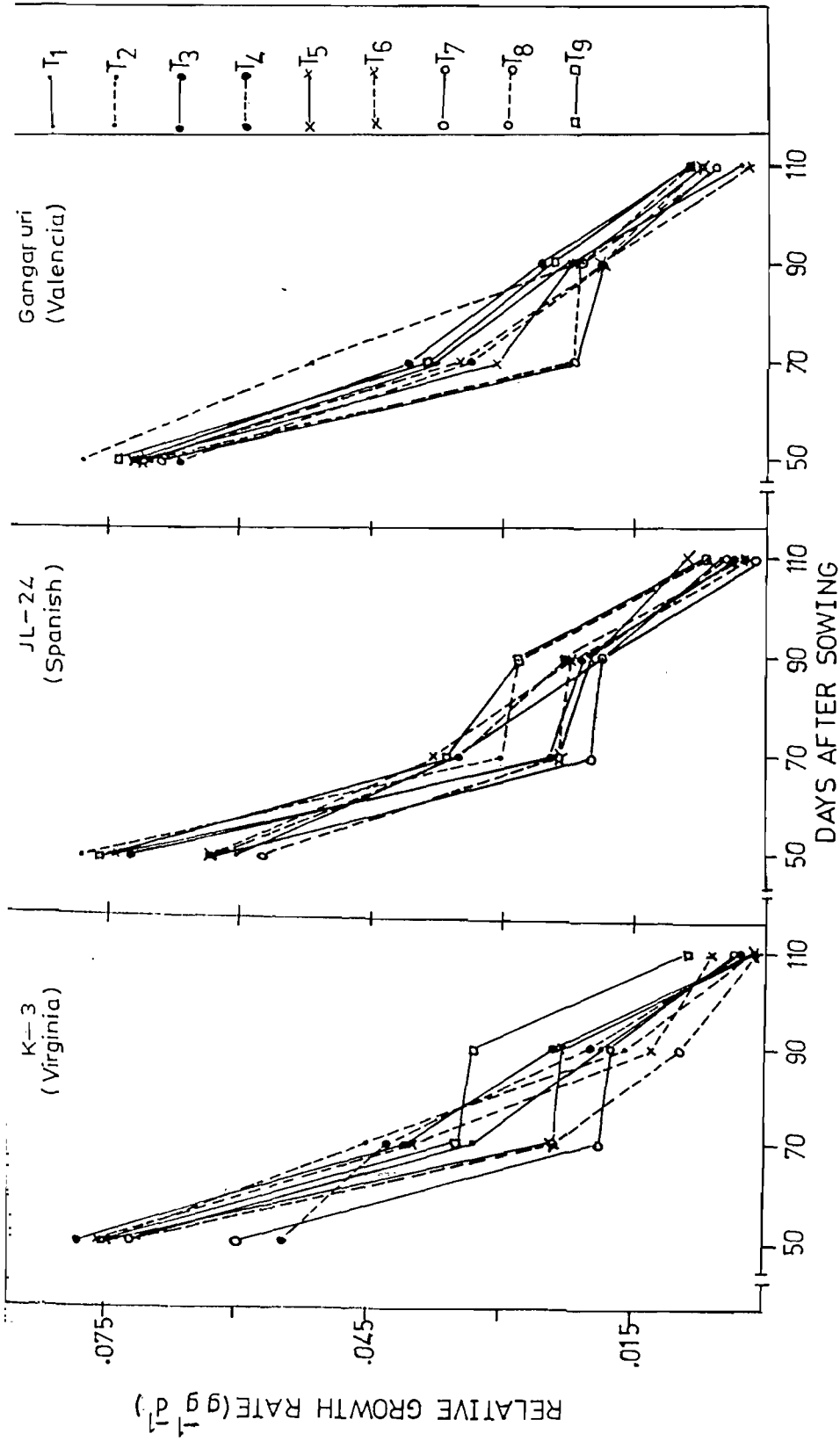


Fig.10 : EFFECT OF HERBICIDES AND CROP WEED COMPETITION ON RGR OF DIVERSE

GROUNDNUT CULTIVARS (RABI 1987)

Table 53: Effect of herbicides and crop weed competition on net assimilation rate ($\text{g dm}^{-2} \text{d}^{-1}$) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	50 DAS				50 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	0.072	0.061	0.064	0.066	0.059	0.068	0.065	0.064
T ₂ : Pendimethalin	0.073	0.075	0.077	0.075	0.052	0.071	0.083	0.069
T ₃ : Oxyfluorfen	0.074	0.069	0.069	0.070	0.071	0.085	0.074	0.077
T ₄ : Fluchloralin	0.079	0.073	0.069	0.074	0.049	0.089	0.058	0.065
T ₅ : Glyphosata	0.052	0.054	0.064	0.057	0.060	0.064	0.040	0.055
T ₆ : C ₄ weeds	0.068	0.060	0.063	0.064	0.062	0.062	0.070	0.065
T ₇ : C ₃ weeds	0.059	0.072	0.071	0.067	0.047	0.063	0.069	0.061
T ₈ : C ₃ + C ₄ weeds	0.063	0.054	0.059	0.059	0.048	0.054	0.059	0.054
T ₉ : Weed free	0.079	0.079	0.072	0.076	0.069	0.090	0.091	0.083
Mean	0.069	0.066	0.068		0.057	0.072	0.058	

Results of statistical analysis

	S.Ed+	CD(0.05)	S.Ed+	CD(0.05)
Main treatment	0.004	0.009	0.003	0.005
Sub treatment	0.002	NS	0.001	0.003
Interaction A:	0.007	NS	0.004	0.008
Interaction B:	0.007	NS	0.004	0.009

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 54: Effect of herbicides and crop weed competition on net assimilation rate ($\text{g dm}^{-2} \text{d}^{-1}$) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	0.038	0.046	0.046	0.043	0.073	0.073	0.067	0.071
T ₂ : Pendimethalin	0.050	0.043	0.068	0.054	0.076	0.073	0.080	0.076
T ₃ : Oxyfluorfen	0.046	0.032	0.054	0.044	0.073	0.069	0.065	0.069
T ₄ : Fluchloralin	0.049	0.039	0.044	0.044	0.074	0.069	0.077	0.073
T ₅ : Glyphosate	0.027	0.030	0.056	0.038	0.054	0.068	0.041	0.053
T ₆ : C ₄ weeds	0.046	0.048	0.042	0.045	0.069	0.072	0.063	0.068
T ₇ : C ₃ weeds	0.020	0.027	0.026	0.024	0.068	0.056	0.058	0.061
T ₈ : C ₃ + C ₄ weeds	0.045	0.027	0.022	0.031	0.073	0.065	0.069	0.069
T ₉ : Weed free	0.048	0.051	0.054	0.051	0.079	0.072	0.076	0.076
Mean	0.041	0.038	0.046		0.071	0.069	0.066	

Results of statistical analysis	S.Ed ₊	CD(0.05)	S.Ed ₊	CD(0.05)
Main treatment	0.0041	0.009	0.0027	0.006
Sub treatment	0.0023	0.005	0.0012	0.002
Interaction A:	0.0069	0.014	0.0036	0.007
Interaction B:	0.0071	0.015	0.0044	0.009

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 55: Effect of herbicides and crop weed competition on net assimilation rate ($\text{g dm}^{-2} \text{d}^{-1}$) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	90 DAS				90 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	0.027	0.034	0.039	0.033	0.014	0.038	0.038	0.030
T ₂ : Pendimethalin	0.021	0.042	0.038	0.034	0.016	0.033	0.036	0.030
T ₃ : Oxyfluorfen	0.034	0.032	0.050	0.039	0.018	0.032	0.037	0.029
T ₄ : Fluchloralin	0.031	0.035	0.034	0.034	0.015	0.032	0.035	0.028
T ₅ : Glyphosate	0.026	0.033	0.033	0.032	0.023	0.023	0.032	0.027
T ₆ : C ₄ weeds	0.017	0.037	0.032	0.029	0.010	0.015	0.027	0.018
T ₇ : C ₃ weeds	0.020	0.030	0.030	0.027	0.014	0.020	0.030	0.022
T ₈ : C ₃ + C ₄ weeds	0.010	0.025	0.021	0.019	0.020	0.012	0.029	0.020
T ₉ : Weed free	0.046	0.049	0.046	0.047	0.026	0.040	0.043	0.037
Mean	0.026	0.035	0.036		0.018	0.029	0.034	

Results of statistical analysis

	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.004	0.009	0.004	0.008
Sub treatment	0.002	0.004	0.001	0.002
Interaction A:	0.006	NS	0.003	0.006
Interaction B:	0.007	NS	0.006	0.012

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

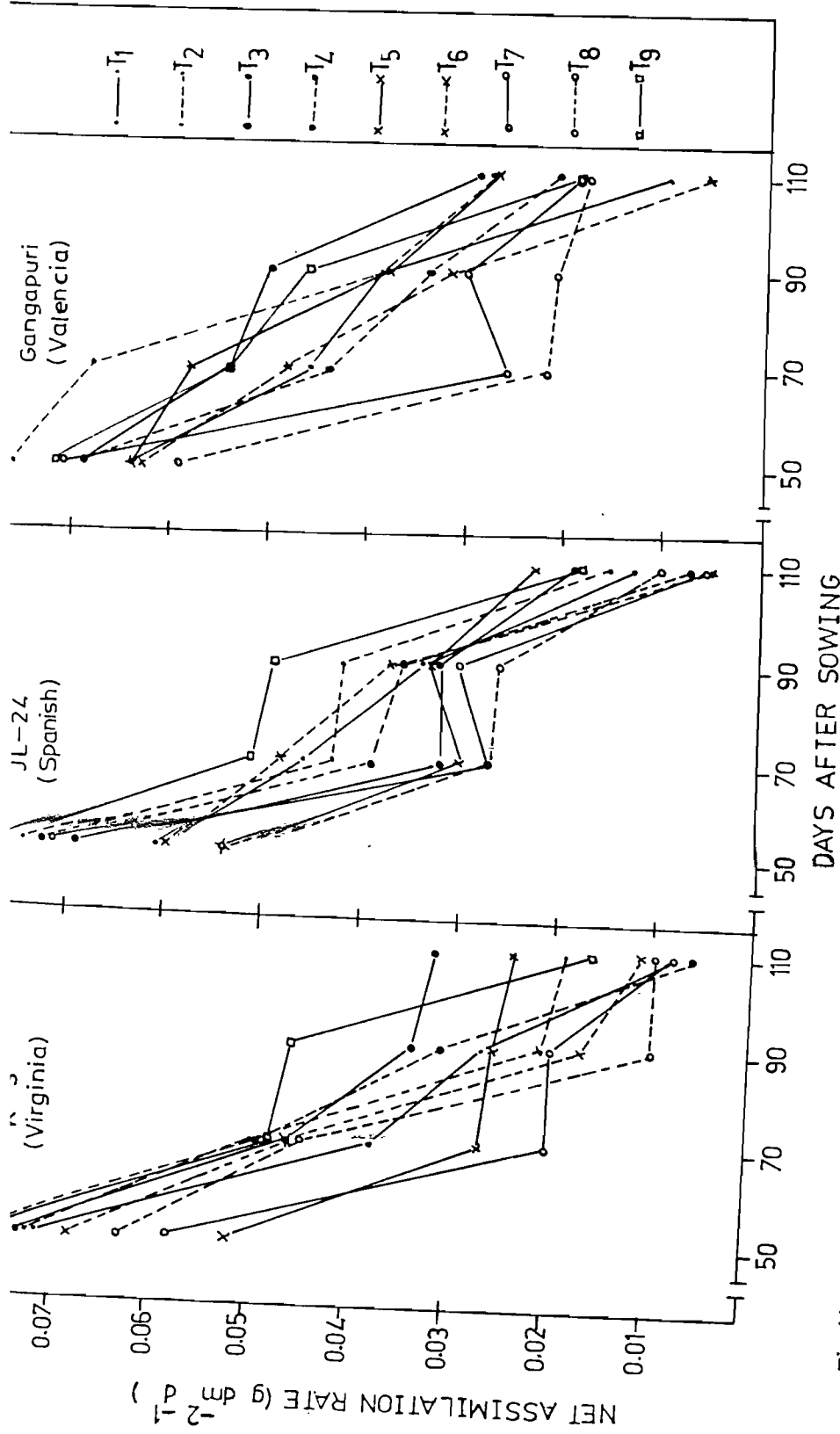


Fig.11: EFFECT OF HERBICIDES AND CROP WEED COMPETITION ON NAR OF DIVERSE GROUNDNUT CULTIVARS. (RABI 1987)

Table 56: Effect of herbicides and crop weed competition on leaf weight ratio ($g\ g^{-1}$) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	30 DAS				30 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	0.49	0.52	0.58	0.53	0.41	0.47	0.45	0.44
T ₂ : Pendimethalin	0.56	0.56	0.52	0.55	0.48	0.44	0.42	0.45
T ₃ : Oxyfluorfen	0.53	0.54	0.59	0.55	0.45	0.45	0.47	0.46
T ₄ : Fluchloralin	0.58	0.57	0.53	0.56	0.44	0.41	0.45	0.43
T ₅ : Glyphosate	0.42	0.57	0.55	0.51	0.46	0.48	0.44	0.46
T ₆ : C ₄ weeds	0.54	0.56	0.59	0.56	0.41	0.42	0.43	0.42
T ₇ : C ₃ weeds	0.49	0.45	0.51	0.48	0.45	0.45	0.46	0.45
T ₈ : C ₃ + C ₄ weeds	0.52	0.46	0.54	0.51	0.44	0.48	0.45	0.46
T ₉ : Weed free	0.60	0.66	0.69	0.65	0.47	0.50	0.47	0.48
Mean	0.53	0.54	0.57		0.45	0.46	0.45	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.025	0.053	0.016	NS
Sub treatment	0.015	0.031	0.008	NS
Interaction A:	0.046	NS	0.023	NS
Interaction B:	0.044	NS	0.026	NS

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 57: Effect of herbicides and crop weed competition on leaf weight ratio ($g\ g^{-1}$) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	0.49	0.42	0.42	0.44	0.42	0.47	0.43	0.44
T ₂ : Pendimethalin	0.43	0.45	0.38	0.42	0.49	0.47	0.39	0.45
T ₃ : Oxyfluorfen	0.50	0.43	0.35	0.43	0.49	0.42	0.40	0.44
T ₄ : Fluchloralin	0.44	0.43	0.38	0.42	0.42	0.42	0.41	0.42
T ₅ : Glyphosata	0.49	0.47	0.42	0.46	0.45	0.41	0.39	0.42
T ₆ : C ₄ weeds	0.46	0.36	0.42	0.41	0.43	0.41	0.42	0.42
T ₇ : C ₃ weeds	0.49	0.37	0.46	0.44	0.43	0.40	0.37	0.40
T ₈ : C ₃ + C ₄ weeds	0.43	0.45	0.46	0.45	0.42	0.41	0.38	0.40
T ₉ : Weed free	0.43	0.41	0.39	0.43	0.46	0.46	0.39	0.44
Mean	0.46	0.42	0.41		0.45	0.43	0.40	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.017	NS	0.010	0.020
Sub treatment	0.007	0.051	0.006	0.011
Interaction A:	0.022	0.045	0.017	0.033
Interaction B:	0.027	0.057	0.017	0.034

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 58: Effect of herbicides and crop weed competition on leaf weight ratio ($g\ g^{-1}$) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	110 DAS				110 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	0.29	0.24	0.14	0.22	0.41	0.32	0.29	0.34
T ₂ : Pendimethalin	0.37	0.25	0.16	0.26	0.40	0.30	0.27	0.32
T ₃ : Oxyfluorfen	0.33	0.20	0.16	0.23	0.39	0.30	0.27	0.32
T ₄ : Fluchloralin	0.27	0.19	0.14	0.20	0.40	0.33	0.30	0.34
T ₅ : Glyphosate	0.33	0.17	0.11	0.20	0.39	0.31	0.27	0.32
T ₆ : C ₄ weeds	0.36	0.22	0.10	0.23	0.41	0.35	0.30	0.35
T ₇ : C ₃ weeds	0.21	0.13	0.11	0.15	0.39	0.36	0.20	0.32
T ₈ : C ₃ + C ₄ weeds	0.28	0.22	0.12	0.21	0.38	0.37	0.30	0.35
T ₉ : Weed free	0.32	0.22	0.18	0.24	0.40	0.33	0.32	0.35
Mean	0.31	0.20	0.14		0.40	0.33	0.28	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.009	0.020	0.022	NS
Sub treatment	0.005	0.010	0.013	0.027
Interaction A:	0.014	0.029	0.040	NS
Interaction B:	0.016	0.032	0.039	NS

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

which showed lower LWR. The differences in LWR found among the cultivars were significant at all growth stages except on 30 DAS in rabi 1988. Cv. Gangapuri showed significantly higher LWR than K-3 on 30 DAS. During 70 and 110 DAS, cvs. K-3 and JL-24 were superior over Gangapuri. The interactions among the cultivars and treatments were significant on 70 and 110 DAS in rabi 1987 and 70 DAS in rabi 1988 (Fig.12).

4.21 LEAF AREA RATIO (LAR)

The differences in LAR of diverse groundnut cultivars on 30, 70 and 110 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 59,60,61). The treatments containing weeds showed higher LAR values than weed free treatment. All the herbicide treatments showed lower LAR than T_8 . The differences in LAR found among the cultivars were significant in both the years except on 30 DAS in rabi 1988. Cv. JL-24 showed significantly higher LAR than K-3 on 30 DAS. However, on 70 and 90 DAS, Cv.K-3 showed significantly higher LAR. The interactions among the cultivars and treatments on 70 and 110 DAS were significant in both the years (Fig.13).

4.22 SPECIFIC LEAF WEIGHT (SLW)

The differences in SLW of diverse groundnut cultivars on 30, 70 and 110 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 62,63,64). The weed free treatment showed highest SLW at all the stages followed by oxyfluorfen, pendimethalin and alachlor. The treatments containing weeds

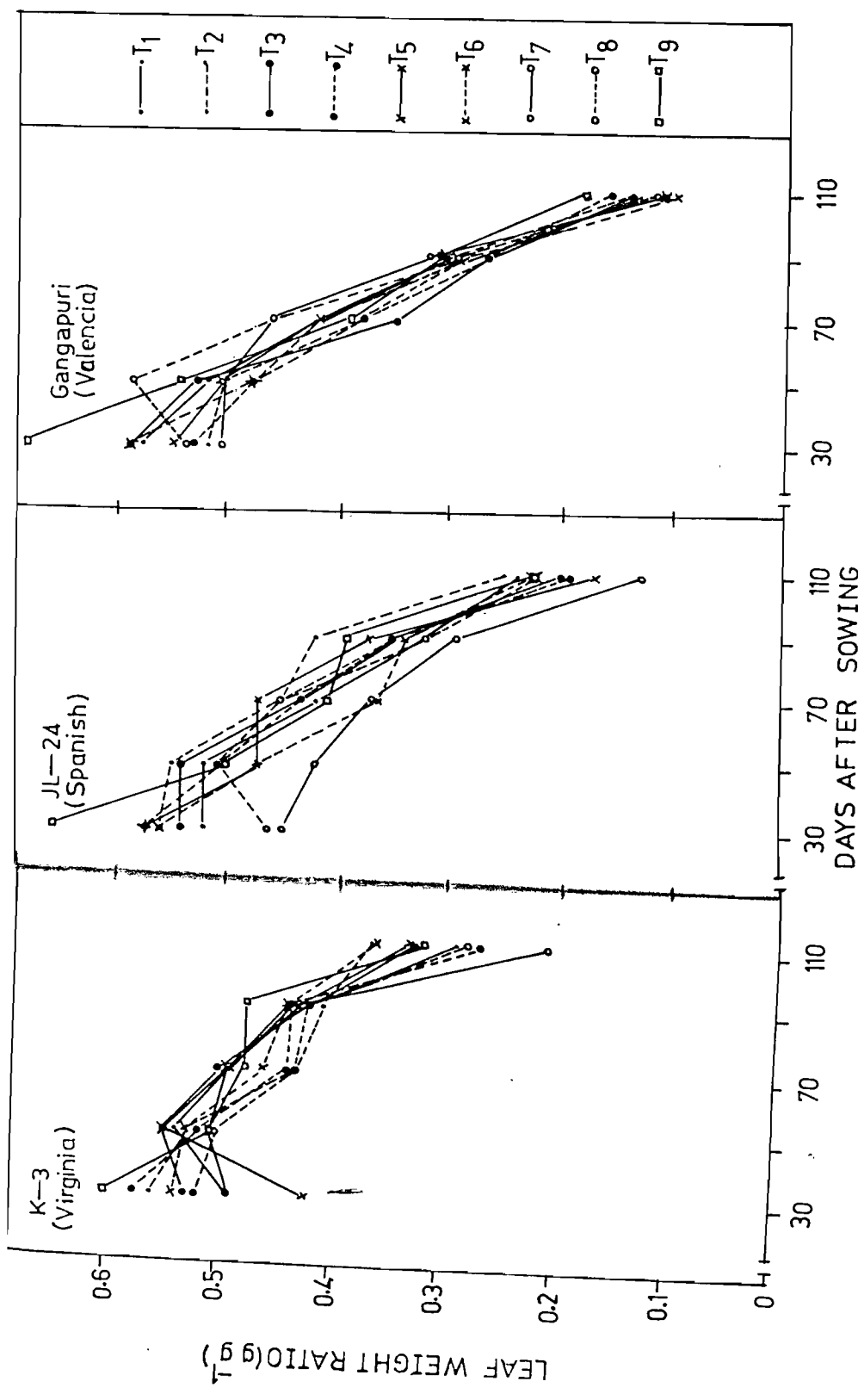


Fig.12: EFFECT OF HERBICIDE AND CROP WEED COMPETITION ON LWR OF DIVERSE
GROUNDNUT CULTIVARS (RABI 1987)

Table 59: Effect of herbicides and crop weed competition on leaf area ratio ($\text{cm}^2 \text{g}^{-1}$) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	30 DAS				30 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	101	110	124	111.7	81.5	86.7	83.3	83.8
T ₂ : Pendimethalin	108	119	122	116.3	90.6	83.1	80.3	84.8
T ₃ : Oxyfluorfen	111	116	122	116.4	88.1	86.8	83.3	89.4
T ₄ : Fluchloralin	117	129	127	124.4	82.3	78.0	82.3	81.0
T ₅ : Glyphosate	89	123	128	113.2	93.3	89.2	83.4	90.3
T ₆ : C ₄ weeds	121	119	143	127.8	78.3	80.6	81.6	80.1
T ₇ : C ₃ weeds	114	95	116	108.3	89.5	80.4	87.0	85.6
T ₈ : C ₃ + C ₄ weeds	131	112	140	127.7	87.0	95.4	94.7	92.4
T ₉ : Weed free	114	110	121	115.0	84.4	83.8	79.1	82.4
Mean	111.8	114.8	127.0		86.1	84.9	83.7	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	4.87	10.34	2.33	5.32
Sub treatment	3.88	7.88	2.27	NS
Interaction A:	11.65	NS	5.79	NS
Interaction B:	9.64	NS	5.75	NS

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 60: Effect of herbicides and crop weed competition on leaf area ratio ($\text{cm}^2 \text{g}^{-1}$) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	82.2	66.8	64.9	71.3	73.1	74.2	74.9	74.1
T ₂ : Pendimethalin	74.6	72.8	63.5	70.3	86.6	76.5	65.5	76.2
T ₃ : Oxyfluorfen	78.5	68.3	62.9	69.9	84.8	70.6	68.5	74.6
T ₄ : Fluchloralin	68.0	71.0	67.6	68.9	75.9	76.4	71.0	74.5
T ₅ : Glyphosate	83.0	79.5	69.0	77.2	85.0	74.2	67.5	75.6
T ₆ : C ₄ weeds	80.2	63.0	71.6	71.6	80.3	69.9	73.5	74.6
T ₇ : C ₃ weeds	87.0	66.2	82.5	78.6	78.3	72.0	68.0	72.8
T ₈ : C ₃ + C ₄ weeds	74.9	82.9	79.5	79.1	80.6	75.5	67.9	74.7
T ₉ : Weed free	70.0	58.0	59.7	62.6	73.9	66.7	60.9	67.1
Mean	77.6	69.8	69.0		79.8	72.9	68.7	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	3.08	6.54	0.86	1.83
Sub treatment	1.29	2.62	0.89	1.81
Interaction A:	3.87	7.85	2.68	5.44
Interaction B:	4.89	10.16	1.97	4.03

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 61: Effect of herbicides and crop weed competition on leaf area ratio ($\text{cm}^2 \text{g}^{-1}$) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	110 DAS				110 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	37.8	31.5	18.5	29.3	70.9	57.8	53.5	60.7
T ₂ : Pendimethalin	43.1	38.9	20.8	34.3	68.4	53.8	47.7	56.6
T ₃ : Oxyfluorfen	42.9	24.8	21.9	29.9	66.9	54.8	47.3	56.3
T ₄ : Fluchloralin	40.1	29.5	24.6	31.4	70.1	59.5	53.7	61.1
T ₅ : Glyphosate	44.2	26.5	16.3	29.0	71.6	58.3	51.1	60.3
T ₆ : C ₄ weeds	42.7	34.5	16.4	31.1	75.4	66.7	54.9	65.7
T ₇ : C ₃ weeds	28.1	18.6	20.0	22.3	77.5	74.4	57.9	69.9
T ₈ : C ₃ + C ₄ weeds	36.3	37.8	19.6	31.2	74.5	72.5	53.5	66.9
T ₉ : Weed free	40.0	28.3	21.7	30.0	63.9	53.8	51.5	56.4
Mean	39.5	30.0	19.9		71.0	61.3	52.4	

Results of statistical analysis	S.Ed ₊	CD(0.05)	S.Ed ₊	CD(0.05)
Main treatment	1.34	2.83	1.13	2.40
Sub treatment	0.74	1.50	0.53	1.07
Interaction A:	2.22	4.50	1.58	3.21
Interaction B:	2.28	4.70	1.84	3.81

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

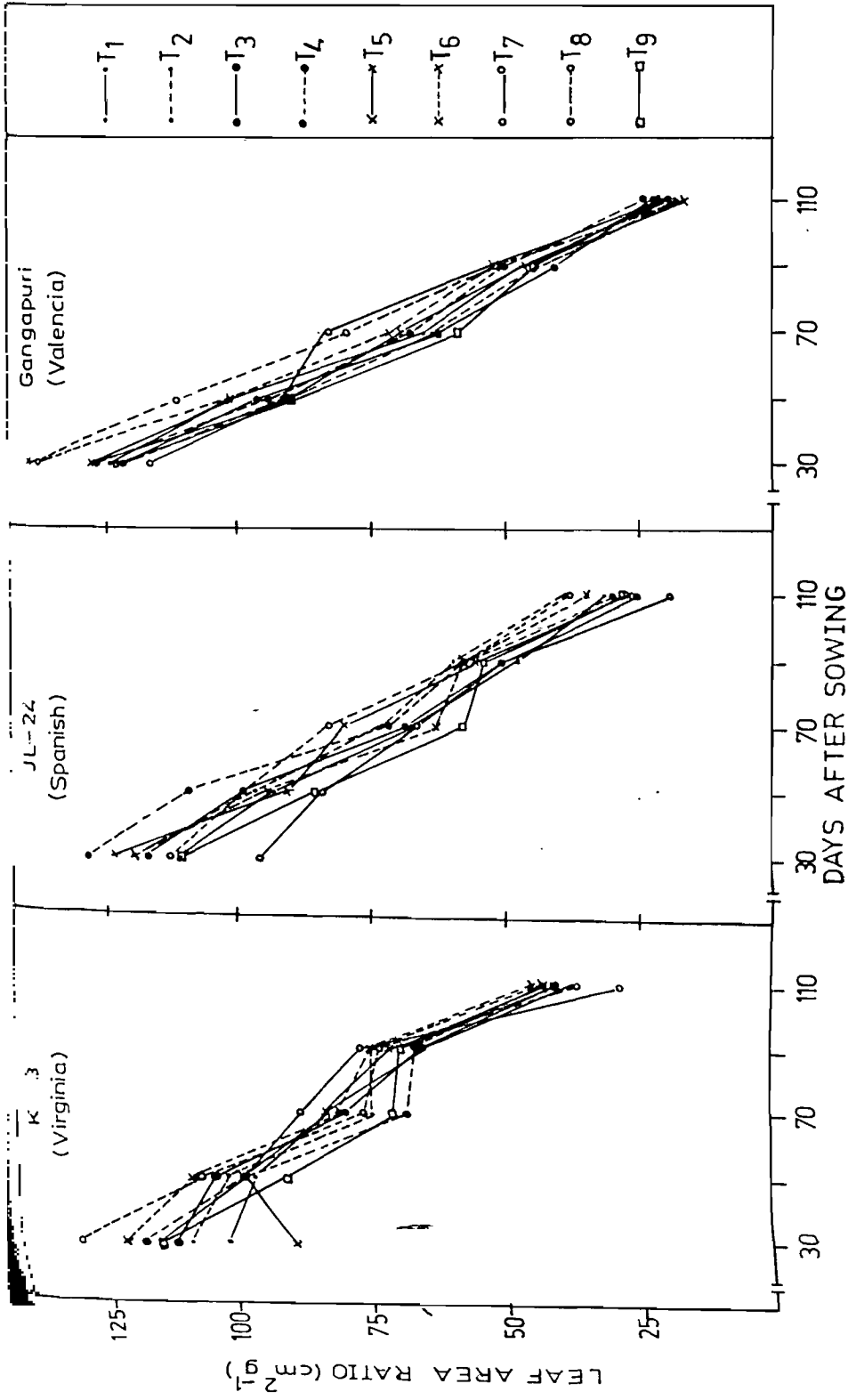


Fig.13: EFFECT OF HERBICIDE AND CROP WEED COMPETITION ON LAR OF DIVERSE GROUNDNUT CULTIVARS (RABI 1987)

Table 62: Effect of herbicides and crop weed competition on specific leaf weight (mg cm^{-2}) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	30 DAS				30 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	4.92	4.72	4.71	4.78	5.05	5.38	5.39	5.27
T ₂ : Pendimethalin	5.10	4.65	4.27	4.68	5.25	5.25	5.23	5.24
T ₃ : Oxyfluorfen	4.83	4.61	4.87	4.77	5.05	5.28	4.98	5.10
T ₄ : Fluchloralin	4.94	4.43	4.20	4.52	5.21	5.33	5.40	5.31
T ₅ : Glyphosate	4.77	4.62	4.25	4.55	5.32	5.31	5.08	5.23
T ₆ : C ₄ weeds	4.52	4.66	4.09	4.42	5.24	5.35	5.37	5.32
T ₇ : C ₃ weeds	4.35	4.80	4.40	4.52	5.25	5.70	5.32	5.42
T ₈ : C ₃ + C ₄ weeds	4.03	4.09	3.93	4.01	5.18	5.66	5.28	5.37
T ₉ : Weed free	5.36	5.47	5.25	5.36	5.47	5.93	5.63	5.68
Mean	4.76	4.67	4.44		5.23	5.47	5.30	

Results of statistical analysis	S.Ed ₊	CD(0.05)	S.Ed ₊	CD(0.05)
Main treatment	0.113	0.240	0.018	0.039
Sub treatment	0.061	0.120	0.017	0.035
Interaction A:	0.183	0.370	0.052	0.104
Interaction B:	0.191	0.390	0.039	0.081

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 63: Effect of herbicides and crop weed competition on specific leaf weight (mg cm^{-2}) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	6.04	6.32	6.54	6.30	5.70	6.33	5.75	5.93
T ₂ : Pendimethalin	5.76	6.14	6.07	5.99	5.68	6.18	6.09	5.98
T ₃ : Oxyfluorfen	6.39	6.34	5.61	6.11	5.88	5.97	5.77	5.87
T ₄ : Fluchloralin	6.55	6.06	5.63	6.08	5.50	5.55	5.76	5.61
T ₅ : Glyphosate	5.90	5.87	6.15	5.97	5.31	5.65	5.77	5.58
T ₆ : C ₄ weeds	5.71	5.75	5.87	5.78	5.33	5.86	5.67	5.62
T ₇ : C ₃ weeds	5.64	5.62	5.71	5.66	5.44	5.65	5.49	5.53
T ₈ : C ₃ + C ₄ weeds	5.78	5.46	5.83	5.69	5.28	5.37	5.58	5.41
T ₉ : Weed free	6.80	6.96	6.45	6.74	6.25	6.88	6.37	6.50
Mean	6.06	6.05	5.98		5.59	5.94	5.81	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.093	0.197	0.049	0.103
Sub treatment	0.049	NS	0.026	0.054
Interaction A:	0.149	0.303	0.079	0.161
Interaction B:	0.157	0.324	0.083	0.171

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 64: Effect of herbicides and crop weed competition on specific leaf weight (mg cm^{-2}) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	110 DAS				110 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	7.53	7.39	7.28	7.40	5.90	5.48	5.41	5.60
T ₂ : Pendimethalin	8.53	6.29	7.72	7.51	5.90	5.65	5.63	5.73
T ₃ : Oxyfluorfen	7.61	8.07	7.44	7.70	5.78	5.50	5.68	5.65
T ₄ : Fluchloralin	6.75	6.61	5.57	6.31	5.70	5.51	5.61	5.61
T ₅ : Glyphosate	7.45	6.52	6.36	6.78	5.50	5.28	5.37	5.38
T ₆ : C ₄ weeds	8.36	6.19	6.28	6.94	5.30	5.30	5.52	5.37
T ₇ : C ₃ weeds	7.15	6.74	5.26	6.38	5.05	4.90	5.31	5.08
T ₈ : C ₃ + C ₄ weeds	7.73	5.86	5.42	6.34	5.10	5.10	5.57	5.26
T ₉ : Weed free	8.05	7.74	8.16	7.98	6.24	6.15	6.15	6.15
Mean	7.68	6.83	6.61		5.61	5.42	5.58	

Results of statistical analysis	S.Ed ₊	CD(0.05)	S.Ed ₊	CD(0.05)
Main treatment	0.079	0.169	0.051	0.108
Sub treatment	0.033	0.066	0.030	0.061
Interaction A:	0.098	0.199	0.090	0.183
Interaction B:	0.126	0.262	0.089	0.183

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

showed significantly lower SLW. All the herbicide treatments significantly improved SLW. The differences in SLW found among the cultivars were significant at all stages of growth except on 70 DAS in rabi 1987. Cvs. JL-24 and Gangapuri showed significantly higher SLW than K-3 on 30 and 70 DAS in rabi 1988. Whereas, on 110 DAS K-3 was superior over other cultivars. The interactions among the cultivars and treatments were significant (Fig.14).

4.23 RELATIVE LEAF GROWTH RATE (RLGR)

The difference in RLGR of diverse groundnut cultivars on 50, 70 and 90 DAS due to the treatments in rabi 1987 and 1988 were calculated (Table 65). During early stages higher RLGR values were recorded and it gradually decreased with ageing. Pendimethalin and oxyfluorfen showed higher RLGR values in early stages. In both the years on 90 DAS the treatments containing weeds showed lower RLGR values than T_9 . Among the herbicide treatments pendimethalin and oxyfluorfen showed higher RLGR values than T_8 in both the years.

4.24 LEAF AREA DURATION (LAD)

The difference in LAD of diverse groundnut cultivars on 50, 70 and 90 DAS due to the treatments in rabi 1987 and 1988 are presented in (Table 65). The LAD values increased from 50 DAS to 90 DAS in both the years. The weed free treatment showed highest LAD. The treatments containing weeds showed lower LAD values. All the herbicide treatments except glyphosate improved

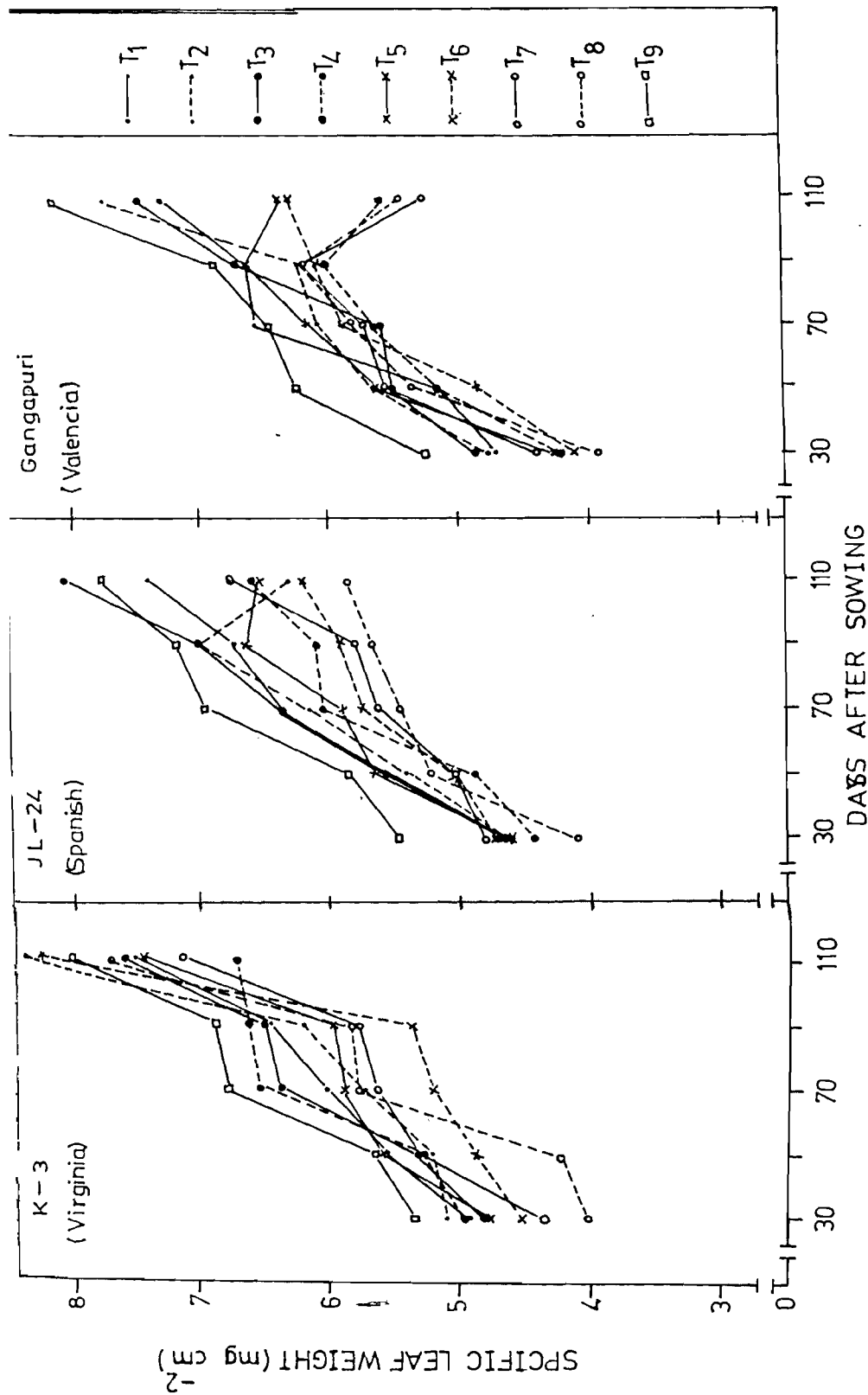


Fig.14: EFFECT OF HERBICIDES AND CROP WEED COMPETITION ON SLW OF DIVERSE GROUNDNUT CULTIVARS (RABI, 1987)

Table 65: Effect of herbicides and crop weed competition on relative leaf growth rate ($g\ g^{-1}\ d^{-1}$), leaf area duration (days) and light transmission ratio (%) in diverse groundnut cultivars

Treatments	Relative leaf growth rate $g\ g^{-1}\ d^{-1}$												Leaf area duration (days)						Light transmission ratio (%)		
	Rabi 1987			Rabi 1988			Rabi 1987			Rabi 1988			Rabi 1987			Rabi 1988					
	50 DAS	70 DAS	90 DAS	50 DAS	70 DAS	90 DAS	50 DAS	70 DAS	90 DAS	50 DAS	70 DAS	90 DAS	50 DAS	70 DAS	90 DAS	70 DAS	90 DAS	70 DAS	90 DAS		
T ₁	0.066	0.027	0.0073	0.062	0.052	0.013	17.1	32.3	40.5	6.9	19.4	32.9	12.2	21.9							
T ₂	0.075	0.032	0.015	0.064	0.058	0.017	17.0	36.1	51.7	7.3	22.5	39.5	11.2	19.0							
T ₃	0.073	0.025	0.017	0.075	0.051	0.019	19.0	36.1	46.7	7.9	22.7	37.5	11.9	20.2							
T ₄	0.057	0.027	0.014	0.057	0.054	0.015	16.1	29.0	38.8	6.1	17.8	31.1	9.7	14.6							
T ₅	0.074	0.027	0.011	0.049	0.037	0.016	11.8	24.0	32.2	6.5	14.5	24.3	11.2	20.4							
T ₆	0.063	0.029	0.011	0.059	0.051	0.011	13.3	25.6	34.1	6.1	17.0	28.2	8.5	13.3							
T ₇	0.063	0.016	0.011	0.054	0.040	0.016	12.1	20.8	26.5	5.9	14.4	24.1	4.3	14.8							
T ₈	0.067	0.022	0.0065	0.040	0.049	0.014	12.6	22.6	27.4	5.9	15.6	26.8	6.2	9.6							
T ₉	0.067	0.025	0.021	0.068	0.047	0.020	21.9	40.1	60.1	10.7	28.3	49.9	15.3	27.4							
V ₁	0.071	0.030	0.016	0.056	0.057	0.014	13.7	28.1	41.4	6.3	19.2	32.3	10.9	23.2							
V ₂	0.063	0.021	0.014	0.060	0.049	0.016	17.3	30.6	40.1	7.2	19.8	35.2	11.1	13.9							
V ₃	0.067	0.025	0.0083	0.061	0.041	0.017	15.9	30.2	37.9	7.6	18.4	30.7	8.2	16.7							

LAD and it was higher with pendimethalin and oxyfluorfen. On 50 DAS lower values of LAD were found in Cv. K-3 than Gangapuri and JL-24.

4.25 LIGHT TRANSMISSION RATIO (LTR%)

The differences in LTR of diverse groundnut cultivars on 70 DAS due to various treatments were recorded in rabi 1987 and 1988 (Table 65). The weed free treatment showed maximum LTR values. The treatments containing weeds showed lesser LTR values than T_9 . All the herbicide treatments showed higher values of LTR than T_8 .

4.26 50% FLOWERING STAGE

The differences in days required for 50% flowering of diverse groundnut cultivars due to the treatments were significant in rabi 1987 and 1988 (Table 66). During rabi 1988 flowering was delayed. Among the treatments only glyphosate delayed flowering. The differences among the cultivars were significant. In cv. K-3 flowering was delayed significantly than cvs. JL-24 and Gangapuri. The interaction among the cultivars and treatments were significant in rabi 1988.

4.27 TOTAL CHLOROPHYLL

The differences in total chlorophyll content of diverse groundnut cultivars on 70 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 67). The treatments containing weeds had significantly higher chlorophyll. The

Table 66: Effect of herbicides and crop weed competition on number of days taken for 50% flowering in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	43.0	39.0	34.7	38.9	54.3	50.7	46.0	50.3
T ₂ : Pendimethalin	43.0	39.3	33.7	38.7	53.7	49.7	47.0	50.1
T ₃ : Oxyfluorfen	42.7	38.7	34.7	38.7	52.3	48.7	45.0	48.7
T ₄ : Fluchloralin	42.7	39.0	35.0	38.9	53.3	49.7	47.3	50.1
T ₅ : Glyphosate	46.0	40.3	41.0	42.4	57.3	53.0	49.7	53.3
T ₆ : C ₄ weeds	42.7	38.3	36.0	39.0	53.3	50.3	44.3	49.3
T ₇ : C ₃ weeds	42.3	39.0	35.7	39.0	52.3	51.0	45.3	49.6
T ₈ : C ₃ + C ₄ weeds	42.0	39.7	34.3	38.7	53.0	50.7	45.0	49.6
T ₉ : Weed free	43.7	38.7	35.7	39.3	55.0	52.0	47.0	51.3
Mean	43.1	39.1	35.6		53.9	50.6	46.3	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.53	1.12	0.31	0.66
Sub treatment	0.41	0.83	0.15	0.31
Interaction A:	1.24	NS	0.45	0.92
Interaction B:	1.03	NS	0.51	1.06

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 67: Effect of herbicides and crop weed competition on total chlorophyll content (mg g^{-1} fresh weight) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Gangapur	Mean	K-3	JL-24	Gangapur	Mean
T ₁ : Alachlor	1.97	1.71	1.54	1.74	1.62	1.42	1.32	1.45
T ₂ : Pendimethalin	2.23	1.84	1.82	1.96	1.76	1.57	1.46	1.59
T ₃ : Oxyfluorfen	2.25	1.86	1.98	2.03	2.10	1.67	1.58	1.78
T ₄ : Fluchloralin	2.35	1.88	1.73	1.99	1.81	1.56	1.62	1.66
T ₅ : Glyphosate	1.86	1.69	1.40	1.65	1.48	1.44	1.16	1.36
T ₆ : C ₄ weeds	2.41	1.86	1.92	2.06	1.99	1.69	1.49	1.72
T ₇ : C ₃ weeds	2.37	2.18	1.86	2.14	2.23	1.75	1.61	1.86
T ₈ : C ₃ + C ₄ weeds	2.56	2.31	1.91	2.26	2.15	1.76	1.59	1.83
T ₉ : Weed free	2.22	1.76	1.70	1.89	1.79	1.51	1.39	1.56
Mean	2.25	1.89	1.76		1.88	1.59	1.47	

Results of statistical analysis	S.Ed+	CD(0.05)	S.Ed+	CD(0.05)
Main treatment	0.057	0.122	0.062	0.131
Sub treatment	0.032	0.065	0.024	0.049
Interaction A:	0.096	0.194	0.073	0.148
Interaction B:	0.098	0.202	0.097	0.202

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

herbicide treatments showed lower chlorophyll content and the values were similar to weed free treatment. Glyphosate reduced the chlorophyll content. The differences among the cultivars were significant. Cv. K-3 showed significantly higher total chlorophyll than Cv. JL-24 and Gangapuri. The interactions among the cultivars and treatments were significant.

4.28 LEGHAEMOGLOBIN CONTENT OF NODULES

The differences in leghaemoglobin content of diverse groundnut cultivars on 70 DAS due to the treatments were significant in rabi 1988 (Table 68). Weedy treatments showed significantly lower leghaemoglobin content in root nodules of groundnut cultivars. Among the herbicides oxyfluorfen, alachlor and pendimethalin showed significantly higher leghaemoglobin content in that order. Lowest leghaemoglobin was found with glyphosate. The differences among the cultivars were significant. Cv. JL-24 was significantly superior over cv K-3 and Gangapuri. The interactions among the cultivars and treatments were also significant.

4.29 CO_2 ASSIMILATION RATE (^{14}C cpm g^{-1} LEAF DM $\text{hr}^{-1} \times 10^3$)

The differences in mean CO_2 assimilation rate of diverse groundnut cultivars was recorded on 70 DAS in rabi 1988 (Table 68). The weed free treatment showed highest leaf photosynthetic rate. The treatments containing weeds recorded the lower rates. Among the herbicides oxyfluorfen, pendimethalin, alachlor, and fluchloralin possessed higher rate of photosynthesis, and it was

Table 68: Effect of herbicides and crop weed competition on leghaemoglobin content ($\mu\text{g g}^{-1}$ fresh wt. nodules) and CO_2 assimilation rate ($^{14}\text{C cpm g}^{-1}$ leaf dry matter $\text{hr}^{-1} \times 10^3$) of diverse groundnut cultivars

Treatments	Rabi 1988				Rabi 1988			
	Leghaemoglobin content(70 DAS)				CO_2 assimilation rate (70 DAS)			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	5.53	5.25	5.04	5.27	33.60	31.92	35.28	33.60
T ₂ : Pendimethalin	5.02	5.03	5.40	5.15	30.24	46.56	38.90	38.56
T ₃ : Oxyfluorfen	6.55	6.38	6.53	6.49	44.60	30.72	58.10	44.47
T ₄ : Fluchloralin	5.23	6.12	2.46	4.60	24.00	36.00	25.40	28.47
T ₅ : Glyphosate	3.56	3.65	3.68	3.63	24.84	10.92	14.50	16.75
T ₆ : C ₄ weeds	5.01	5.12	3.92	4.68	8.40	17.28	28.10	17.93
T ₇ : C ₃ weeds	3.66	5.25	3.88	4.26	11.16	22.80	40.20	24.72
T ₈ : C ₃ + C ₄ weeds	4.28	4.85	2.69	3.94	8.04	26.28	36.50	23.61
T ₉ : Weed free	5.86	6.28	6.72	6.29	41.28	67.08	72.10	60.15
Mean	4.96	5.33	4.48		25.13	32.17	38.79	

Results of statistical analysis

	S.Ed±	CD(0.05)
Main treatment	0.39	0.83
Sub treatment	0.19	0.39
Interaction A:	0.59	1.19
Interaction B:	0.65	1.34

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

lowest with glyphosate. Among the cvs. Gangapuri and JL-24 showed higher photosynthetic rate than K-3.

4.30 POD YIELD

The differences in pod yield of diverse groundnut cultivars in various treatments were significant in rabi 1987 and 1988 (Table 69). Highest pod yield was found in weed free treatment followed by pendimethalin and oxyfluorfen which were on par with each other. The treatments containing weeds showed lower pod yield and it was lowest in T₈. The differences between T₆ and T₇ were not significant in both the years. All the herbicide treatments (T₂, T₃, T₁, T₄ and T₅) significantly improved pod yield in that order. Among the cvs Gangapuri and JL-24 were significantly superior over K-3. The interactions among the cultivars and treatments were also significant (Fig.15 and 16). The effects of weed free condition and weed competition (C₃+C₄) on plant growth and pod development are shown in Plates 3 and 4.

4.31 KERNEL YIELD

The differences in kernel yield of diverse groundnut cultivars in various treatments were significant in rabi 1987 and 1988 (Table 70). Lower kernel yields were found in rabi 1988. The weed free treatment produced highest kernel yield followed by pendimethalin and oxyfluorfen which were on par with each other. The treatments containing weeds produced lower kernel yield and it was lowest in T₈. All the herbicide treatments T₂, T₃, T₁, T₄

Table 69: Effect of herbicides and crop weed competition on pod yield (g m^{-2}) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	Harvest				Harvest			
	K-3 142 DAS	JL-24 130 DAS	Ganga- puri 110 DAS	Mean	K-3 152 DAS	JL-24 140 DAS	Ganga- puri 122 DAS	Mean
T ₁ : Alachlor	228.5	210.8	209.8	216.4	106.9	202.9	188.9	166.2
T ₂ : Pendimethalin	336.3	283.6	319.7	313.2	163.2	240.5	248.1	217.3
T ₃ : Oxyfluorfen	329.7	299.7	303.1	310.8	147.9	271.9	228.1	215.9
T ₄ : Fluchloralin	158.7	169.2	204.8	177.6	96.7	176.7	175.8	149.7
T ₅ : Glyphosate	164.2	139.9	212.0	172.0	63.8	137.8	161.3	120.9
T ₆ : C ₄ weeds	81.6	152.1	135.4	123.0	58.7	160.4	147.2	122.1
T ₇ : C ₃ weeds	47.6	142.1	132.2	107.3	51.2	139.3	146.0	112.1
T ₈ : C ₃ + C ₄ weeds	63.3	135.4	122.6	107.1	39.7	117.2	108.1	88.4
T ₉ : Weed free	400.7	386.3	366.3	384.4	344.0	354.4	338.3	345.6
Mean	201.2	213.2	222.8		119.1	200.1	193.5	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	9.01	19.11	5.90	12.51
Sub treatment	4.50	9.12	3.35	6.80
Interaction A:	13.49	27.37	10.06	20.41
Interaction B:	14.94	30.85	10.16	20.93

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

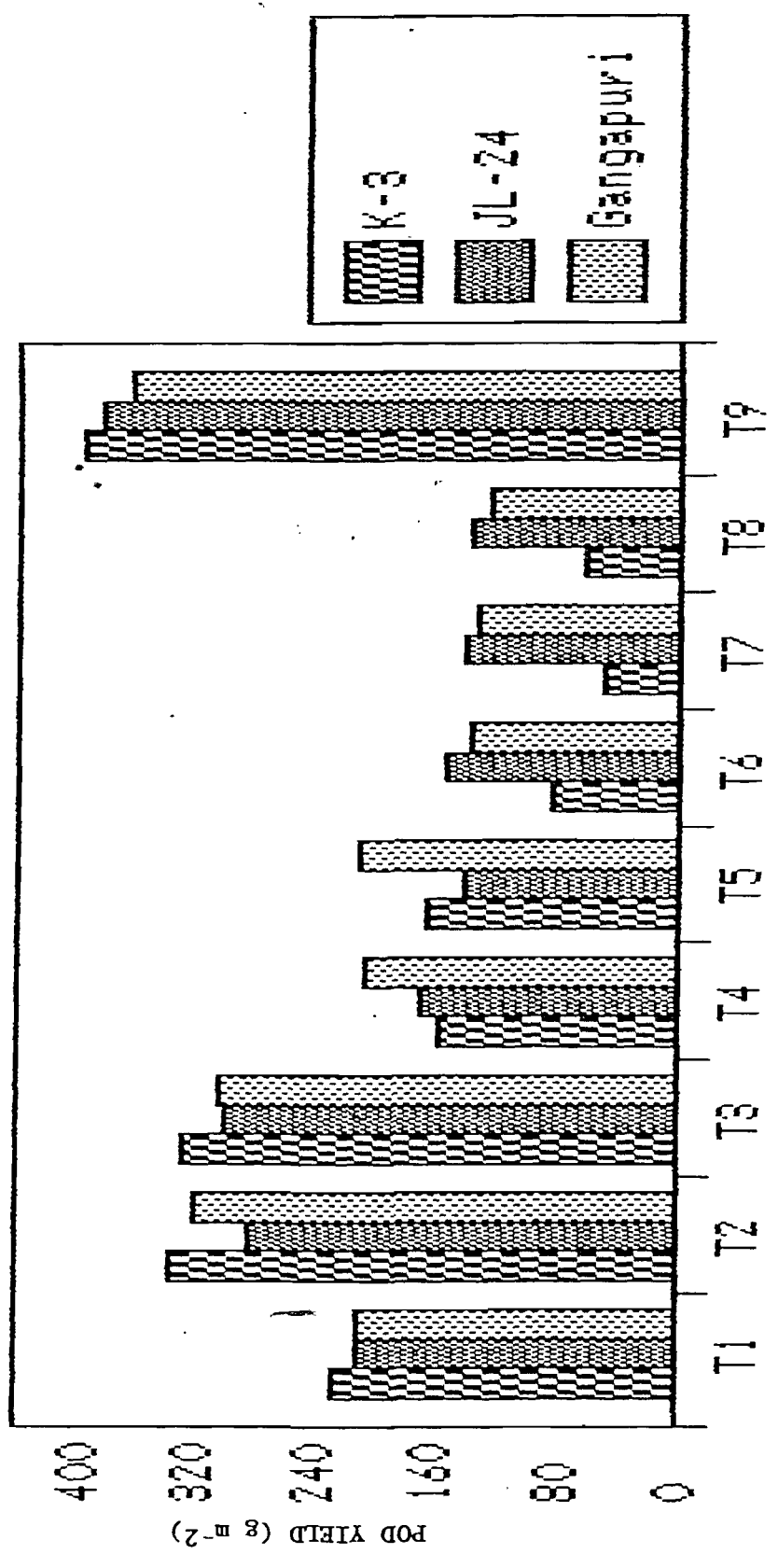


Fig.15: Effect of herbicides and crop weed competition on pod yield of diverse groundnut cultivars (Rabi, 1987)

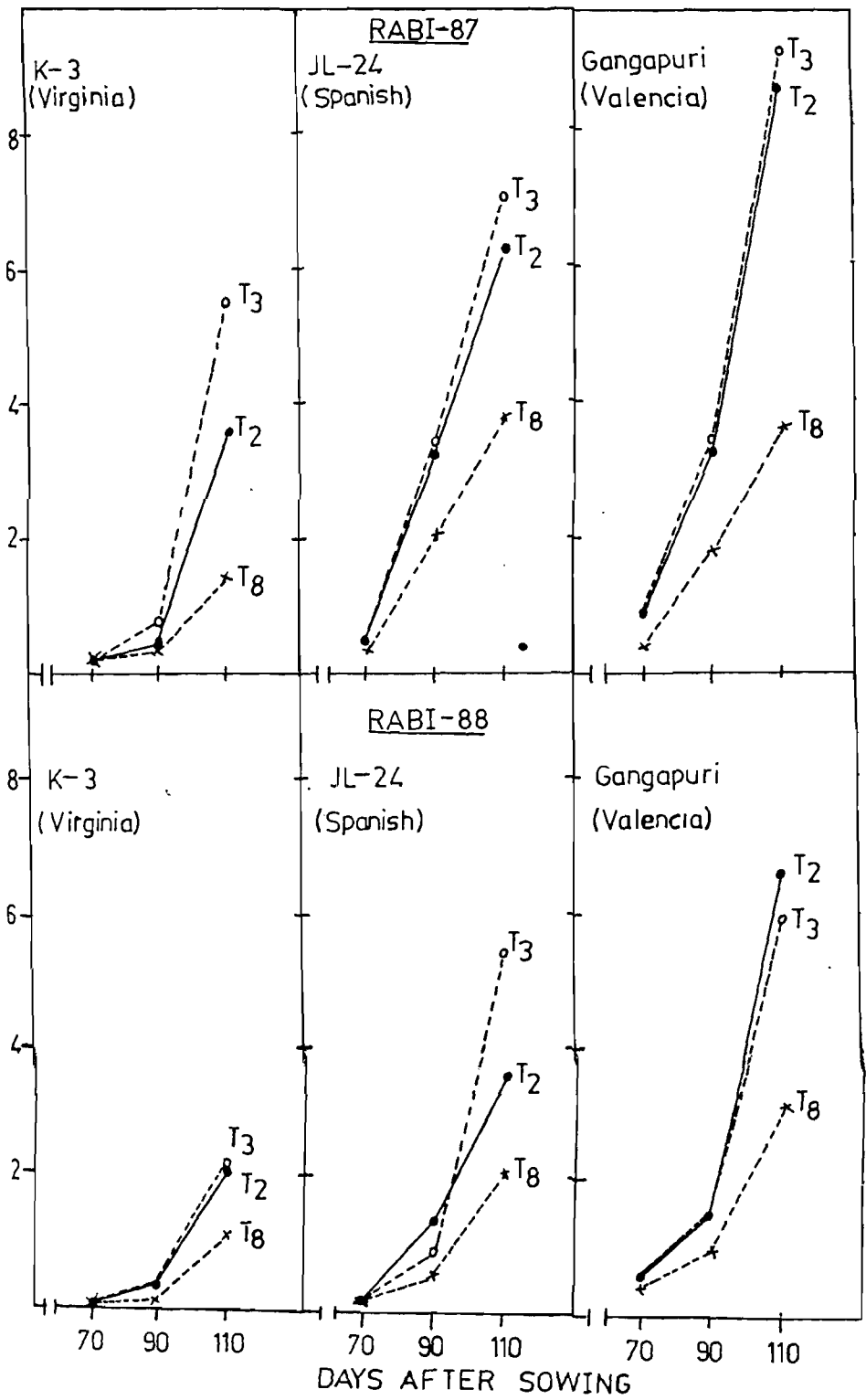


Fig.16: EFFECT OF HERBICIDES (PENDIMETHALIN T₂, OXYFLUOFEN T₃) AND CROP WEED COMPETITION (C₃ + C₄) ON POD DRY MATTER



Plate 3: Effect of weed free condition and weed competition (C_3+C_4) on plant growth and pod development in cvs. (K-3 and JL-24)



Plate 4: Effect of weed free conditions and weed competition (C_3+C_4) on plant growth and pod development cv. (Gangapuri)

Table 70: Effect of herbicides and crop weed competition on kernel yield (g m^{-2}) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	Harvest				Harvest			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	171.6	153.9	153.4	159.6	76.9	147.1	136.2	120.1
T ₂ : Pendimethalin	257.3	208.5	234.3	233.4	116.8	175.6	180.2	157.5
T ₃ : Oxyfluorfen	251.6	223.0	218.8	231.1	104.4	201.6	164.2	156.7
T ₄ : Fluchloralin	120.8	126.9	147.5	131.7	65.4	127.6	126.6	106.5
T ₅ : Glyphosate	118.2	98.1	143.8	120.0	42.2	96.6	111.3	83.4
T ₆ : C ₄ weeds	59.7	108.8	97.5	88.7	38.2	106.8	102.3	82.4
T ₇ : C ₃ weeds	35.2	102.6	92.6	76.8	33.1	94.8	101.0	76.3
T ₈ : C ₃ + C ₄ weeds	46.3	97.5	87.2	77.0	27.1	80.4	75.7	61.1
T ₉ : Weed free	312.1	287.8	267.8	239.2	249.7	260.2	246.9	252.3
Mean	150.6	156.3	160.3		83.8	143.4	138.3	

Results of statistical analysis	S.Ed+	CD(0.05)	S.Ed+	CD(0.05)
Main treatment	6.88	14.58	5.05	10.71
Sub treatment	3.11	6.32	3.05	6.19
Interaction A:	9.34	18.95	9.16	18.60
Interaction B:	11.12	23.02	8.89	18.28

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

and T₅ significantly improved kernel yield in that order. Among the cvs Gangapuri was significantly superior over K-3 in rabi 1987 and cultivars JL-24 and Gangapuri were significantly superior in rabi 1988. The interactions among the cultivars and treatments were also significant.

4.32 TOTAL DRY MATTER AT HARVEST (TDM)

The differences in TDM of diverse groundnut cultivars at harvest due to the treatments were significant in rabi 1987 and 1988 (Table 71). The weed free treatment showed highest TDM followed by pendimethalin and oxyfluorfen which were on par with each other. Weedy treatments showed significantly lower TDM and it was lowest in T₈. All the herbicide treatments significantly improved TDM. The differences in TDM found among the cultivars were significant in rabi 1988. Cvs. JL-24 and Gangapuri were significantly superior over K-3. The interactions among the cultivars and treatments were also significant.

4.33 KERNEL WEIGHT PARTITIONING INDEX (KWPI)

The differences in KWPI of diverse groundnut cultivars in various treatments were significant in rabi 1987 and 1988 (Table 72). Lower KWPI values were found in rabi 1988. Highest KWPI was found in weed free treatment followed by pendimethalin and oxyfluorfen which were on par with each other in rabi 1987. The treatments containing weeds showed significantly lower KWPI and it was lowest in T₈. All the herbicide treatments significantly improved KWPI except glyphosate. Among the cvs. JL-

Table 71: Effect of herbicides and crop weed competition on total dry matter (g m^{-2}) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	Harvest				Harvest			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	512.8	492.8	472.9	492.8	351.4	444.4	436.4	410.7
T ₂ : Pendimethalin	755.9	592.7	689.3	679.3	460.9	537.9	566.2	521.7
T ₃ : Oxyfluorfen	679.3	619.4	669.3	656.0	431.9	616.4	542.6	530.3
T ₄ : Fluchloralin	396.3	402.9	432.9	410.7	322.7	437.4	391.2	383.8
T ₅ : Glyphosate	356.3	372.9	442.9	390.7	271.2	361.6	409.4	347.4
T ₆ : C ₄ weeds	229.8	346.3	349.6	308.6	284.5	366.4	382.8	344.6
T ₇ : C ₃ weeds	230.9	293.1	303.0	275.7	263.0	347.1	356.4	322.2
T ₈ : C ₃ + C ₄ weeds	219.8	279.7	285.3	261.6	234.5	295.9	319.6	283.1
T ₉ : Weed free	859.1	829.2	735.9	808.1	608.1	792.7	742.5	781.1
Mean	471.1	469.9	486.8		380.9	466.6	460.8	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	14.88	31.56	12.90	27.36
Sub treatment	8.86	NS	6.79	13.78
Interaction A:	26.59	53.94	20.38	41.35
Interaction B:	26.05	53.62	21.72	44.79

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 72: Effect of herbicides and crop weed competition on kernel weight partitioning index (KWPI) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	Harvest				Harvest			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	0.50	0.46	0.48	0.48	0.28	0.49	0.45	0.41
T ₂ : Pendimethalin	0.52	0.55	0.52	0.53	0.34	0.49	0.47	0.43
T ₃ : Oxyfluorfen	0.59	0.56	0.49	0.55	0.32	0.49	0.45	0.42
T ₄ : Fluchloralin	0.44	0.46	0.51	0.47	0.25	0.41	0.47	0.38
T ₅ : Glyphosate	0.49	0.36	0.48	0.44	0.18	0.36	0.37	0.30
T ₆ : C ₄ weeds	0.35	0.45	0.39	0.40	0.15	0.41	0.36	0.31
T ₇ : C ₃ weeds	0.18	0.48	0.44	0.37	0.14	0.38	0.39	0.30
T ₈ : C ₃ + C ₄ weeds	0.26	0.49	0.44	0.39	0.13	0.37	0.31	0.27
T ₉ : Weed free	0.57	0.54	0.56	0.56	0.44	0.49	0.50	0.48
Mean	0.43	0.48	0.48		0.25	0.43	0.42	

Results of statistical analysis	S.Ed ₊	CD(0.05)	S.Ed ₊	CD(0.05)
Main treatment	0.025	0.053	0.017	0.035
Sub treatment	0.010	0.021	0.008	0.016
Interaction A:	0.031	0.063	0.023	0.047
Interaction B:	0.039	0.083	0.027	0.056

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

24 and Gangapuri showed significantly higher KWPI than K-3. The interactions among the cultivars and treatments were also significant (Fig.17).

4.34 HARVEST INDEX (HI%)

The differences in HI among diverse groundnut cultivars due to the treatments were significant in rabi 1987 and 1988 (Table 73). The weed free treatment showed highest HI followed by oxyfluorfen and pendimethalin which were on par with each other. The treatments containing weeds showed significantly lower HI. All herbicide treatments improved HI. The differences in HI found among the cultivars were significant. Cvs. JL-24 and Gangapuri were significantly superior over K-3. The interactions among the cultivars and treatments were significant (Fig.18).

4.35 WEED INDEX (%)

The differences in weed index (%) found among diverse groundnut cultivars in various treatments were significant in rabi 1987 and 1988 (Table 74). The treatments containing weeds showed higher values of weed index and it was highest in T₈. The herbicide treatments showed significantly lower values of weed index and it was lowest with pendimethalin followed by oxyfluorfen. The differences among the cultivars were significant. Cvs. Gangapuri and JL-24 showed significantly lower weed index than K-3. The interactions among the cultivars and treatments were significant.

KERNEL WEIGHT PARTITIONING INDEX

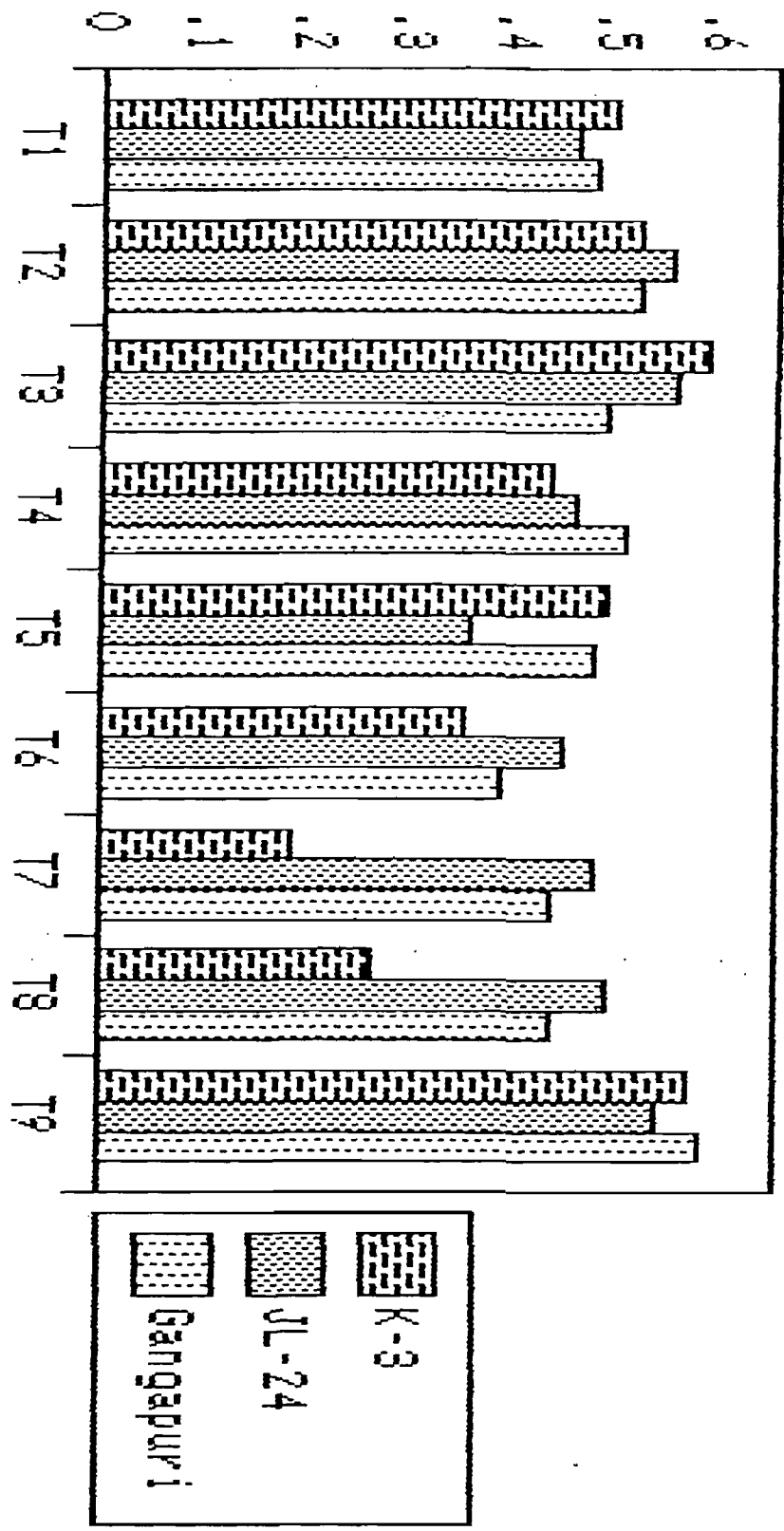


Fig. 17: Effect of herbicides and crop weed competition on KWPI of diverse groundnut cultivars (Rabi, 1987)

Table 73: Effect of herbicides and crop weed competition on harvest index (%) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	Harvest				Harvest			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	44.7	43.1	44.4	44.0	30.4	45.7	42.7	39.6
T ₂ : Pendimethalin	44.9	47.8	46.4	46.4	35.2	44.8	43.8	41.3
T ₃ : Oxyfluorfen	49.1	48.5	45.3	47.6	34.2	44.1	42.1	40.1
T ₄ : Fluchloralin	40.7	42.1	47.3	43.4	29.9	40.3	44.6	38.3
T ₅ : Glyphosate	46.1	37.8	47.8	43.9	23.5	38.2	39.4	33.7
T ₆ : C ₄ weeds	35.8	44.0	38.7	39.5	20.7	43.8	38.5	34.3
T ₇ : C ₃ weeds	20.6	48.5	42.9	37.3	19.5	40.0	41.0	33.5
T ₈ : C ₃ + C ₄ weeds	28.2	48.1	43.2	39.8	17.0	39.5	33.8	30.1
T ₉ : Weed free	46.7	46.6	49.8	47.7	42.3	44.8	45.6	44.2
Mean	39.7	45.2	45.1		28.1	42.4	41.3	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	2.71	5.76	1.28	2.73
Sub treatment	1.37	2.76	0.57	1.16
Interaction A:	4.11	8.33	1.71	3.48
Interaction B:	4.51	9.32	2.07	4.29

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

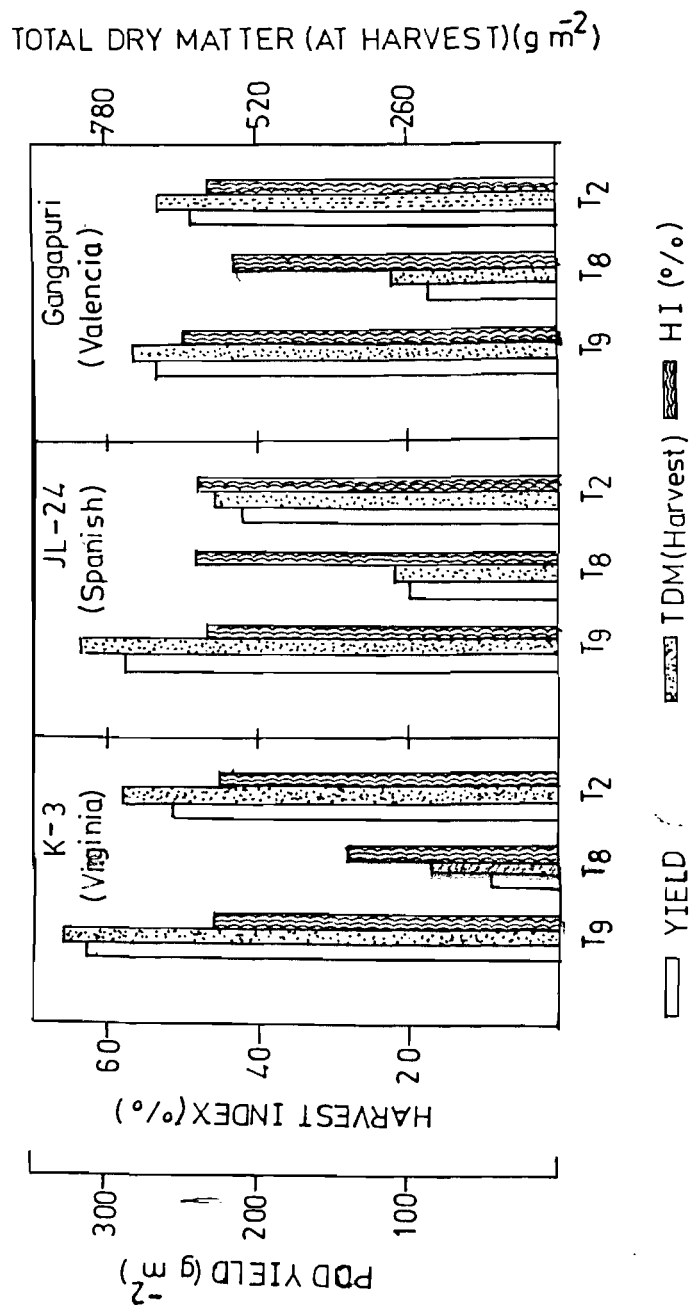


Fig.18 : EFFECT OF HERBICIDE (PENDIMETHALIN), CROP WEED COMPETITION(C₃ + C₄) AND WEED FREE TREATMENT ON TDM (AT HARVEST), HI AND POD YIELD AMONG DIVERSE GROUNDNUT CULTIVARS (RABI 1987)

12R77

Table 74: Effect of herbicides and crop weed competition on weed index (%) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	Harvest				Harvest			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	42.9	45.3	42.7	43.6	68.9	42.7	44.1	51.9
T ₂ : Pendimethalin	15.9	26.5	12.7	18.4	52.6	32.8	26.6	37.3
T ₃ : Oxyfluorfen	17.7	22.4	17.2	19.1	56.9	23.3	32.5	37.6
T ₄ : Fluchloralin	60.4	56.1	43.9	53.5	71.9	51.3	48.3	57.1
T ₅ : Glyphosate	59.1	63.8	42.1	54.9	81.5	61.0	52.2	64.9
T ₆ : C ₄ weeds	79.6	60.6	62.9	67.7	82.9	54.7	56.4	64.7
T ₇ : C ₃ weeds	88.1	63.2	64.1	71.8	85.1	60.8	56.7	67.5
T ₈ : C ₃ + C ₄ weeds	84.3	64.9	66.6	71.9	88.4	67.0	67.9	74.4
T ₉ : Weed free	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean	49.8	44.7	39.2		65.3	43.7	42.7	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	1.94	4.11	1.70	3.61
Sub treatment	1.15	2.34	0.99	2.03
Interaction A:	3.46	7.02	2.99	6.08
Interaction B:	3.39	6.98	2.96	6.09

Note: A = Two sub means at same level main

B = Two main means at same or different levels sub.

NS = Not significant

4.36 HAULM YIELD

The differences in haulm yield of diverse groundnut cultivars at harvest due to the treatments were significant in rabi 1987 and 1988 (Table 75). The weed free treatment recorded highest haulm yield followed by pendimethalin and oxyfluorfen which were on par with each other. The treatments containing weeds showed significantly lower haulm yield and it was least in T₈. All the herbicide treatments significantly improved haulm yield. The differences among the cultivars were not significant. The interactions among the cultivars and treatments were significant.

4.37 TOTAL NUMBER OF PODS PLANT⁻¹

The differences in total number of pods of diverse groundnut cultivars at harvest due to the treatments were significant in rabi 1987 and 1988 (Table 76). The weed free treatment produced highest number of pods followed by pendimethalin and oxyfluorfen. The treatments containing weeds showed significantly lower total pods and were on par with each other. All the herbicide treatments significantly improved total number of pods per plant. The differences among the cultivars were significant. Cv. JL-24 was significantly superior in rabi 1987 and cvs. JL-24 and Gangapuri were significantly superior over K-3 in rabi 1988. The interactions among the cultivars and treatments were significant in rabi 1987 only.

Table 75: Effect of herbicides and crop weed competition on haulm yield (g m^{-2}) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	Harvest				Harvest			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	284.0	282.0	263.0	276.3	244.3	241.3	247.7	244.4
T ₂ : Pendimethalin	419.3	309.0	369.3	365.9	298.0	297.7	317.7	304.4
T ₃ : Oxyfluorfen.	349.7	319.3	366.0	345.0	283.7	344.3	315.0	314.3
T ₄ : Fluchloralin	237.7	233.7	228.0	233.1	226.0	262.7	216.7	235.1
T ₅ : Glyphosate	192.3	232.7	230.7	218.6	206.7	223.7	247.7	226.0
T ₆ : C ₄ weeds	148.0	194.3	214.3	185.6	226.3	206.0	235.0	222.4
T ₇ : C ₃ weeds	183.0	151.3	173.0	169.1	211.7	208.0	209.7	209.8
T ₈ : C ₃ + C ₄ weeds	156.3	144.3	162.3	154.3	193.3	179.0	211.3	194.6
T ₉ : Weed free	458.0	442.7	369.3	423.3	464.0	438.0	401.3	434.4
Mean	269.8	256.6	264.0		261.6	266.7	266.9	

Results of statistical analysis	S.Ed ₊	CD(0.05)	S.Ed ₊	CD(0.05)
Main treatment	18.51	39.24	11.58	24.54
Sub treatment	10.53	NS	4.95	NS
Interaction A:	31.73	64.36	14.85	30.12
Interaction B:	31.95	65.79	18.48	38.30

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 76: Effect of herbicides and crop weed competition on total number of pods plant⁻¹
in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	Harvest				Harvest			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	8.75	10.70	7.60	9.02	5.73	11.00	8.20	8.31
T ₂ : Pendimethalin	14.43	12.80	12.03	13.09	8.90	12.20	8.70	9.93
T ₃ : Oxyfluorfen	12.10	11.80	11.00	11.63	7.21	13.70	10.13	10.35
T ₄ : Fluchloralin	8.40	10.40	8.50	9.10	5.82	9.63	7.40	7.62
T ₅ : Glyphosate	9.70	7.00	8.20	8.30	4.80	7.35	6.30	6.15
T ₆ : C ₄ weeds	3.35	8.10	6.30	5.92	4.70	8.50	6.70	6.63
T ₇ : C ₃ weeds	2.91	8.30	4.70	5.30	3.45	7.20	5.31	5.32
T ₈ : C ₃ + C ₄ weeds	3.00	7.50	6.10	5.53	3.40	6.30	5.45	5.05
T ₉ : Weed free	17.00	14.60	12.83	14.81	16.02	18.30	14.95	16.42
Mean	8.85	10.13	8.58		6.67	10.47	8.13	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.53	1.12	0.82	1.74
Sub treatment	0.42	0.85	0.42	0.85
Interaction A:	1.26	2.56	1.26	NS
Interaction B:	1.04	2.14	1.37	NS

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

4.38 TOTAL NUMBER OF MATURE PODS PLANT⁻¹

The differences in total number of mature pods found in diverse groundnut cultivars at harvest due to the treatments were significant in rabi 1987 and 1988 (Table 77). The weed free treatment showed highest total number of mature pods followed by pendimethalin and oxyflurofen which were on par with each other. The treatments containing weeds showed significantly lesser number of mature pods. All the herbicide treatments significantly improved total number of matured pods except glyphosate in rabi 1988. The differences among the cultivars were significant. Cv. JL-24 was significantly superior in rabi 1987 and cvs. JL-24 and Gangapuri were significantly superior over K-3 in rabi 1988. The interactions among the cultivars and treatments were significant in rabi 1987 only.

4.39 FILLED PODS PERCENTAGE

The differences in filled pods percentage found in diverse groundnut cultivars at harvest due to the treatments were significant in rabi 1987 and 1988 (Table 78). The weed free treatment produced highest filled pods percentage followed by pendimethalin and oxyfluorfen. The treatments containing weeds showed significantly lower percentage of filled pods and it was least in T₈. All the herbicide treatments significantly improved the percentage of filled pods. The differences among the cultivars were significant. Cvs. JL-24 and Gangapuri were

Table 77: Effect of herbicides and crop weed competition on total number of mature pods plant⁻¹ in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	Harvest				Harvest			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	5.66	8.60	5.50	6.62	4.60	8.50	5.35	6.15
T ₂ : Pendimethalin	11.24	9.90	9.80	10.31	7.70	9.20	6.20	7.70
T ₃ : Oxyfluorfen	9.10	10.50	8.90	9.50	5.10	11.20	7.81	8.03
T ₄ : Fluchloralin	5.20	7.60	6.00	6.27	4.00	7.30	4.95	5.41
T ₅ : Glyphosate	6.30	5.50	6.20	6.00	3.60	6.40	4.20	4.73
T ₆ : C ₄ weeds	2.30	6.60	4.20	4.37	3.10	7.20	4.64	4.98
T ₇ : C ₃ weeds	1.43	6.30	3.50	3.74	2.23	5.60	3.41	3.74
T ₈ : C ₃ + C ₄ weeds	1.80	6.40	4.00	4.07	2.00	5.00	3.90	3.63
T ₉ : Weed free	13.50	12.60	10.30	12.13	13.00	15.10	12.20	13.43
Mean	6.28	8.22	6.51		5.04	8.39	5.90	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.52	1.09	0.64	1.35
Sub treatment	0.37	0.74	0.34	0.69
Interaction A:	1.09	2.23	1.02	NS
Interaction B:	0.97	1.98	1.08	NS

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 78: Effect of herbicides and crop weed competition on filled pods percentage in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	Harvest				Harvest			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Ailachlor	64.6	80.3	73.6	72.8	74.9	77.9	77.3	76.7
T ₂ : Pendimethalin	77.8	81.0	81.7	80.2	80.0	79.0	81.3	80.1
T ₃ : Oxyfluorfen	76.2	86.0	81.0	81.1	76.8	81.8	81.3	79.9
T ₄ : Fluchloralin	61.8	73.2	70.5	68.5	72.1	76.0	73.3	73.8
T ₅ : Glyphosate	64.8	76.2	75.6	72.2	72.0	76.0	69.6	72.5
T ₆ : C ₄ weeds	61.0	76.0	66.6	67.9	65.5	75.1	67.0	69.2
T ₇ : C ₃ weeds	62.7	76.0	68.0	68.9	63.7	73.7	67.1	68.2
T ₈ : C ₃ + C ₄ weeds	60.0	75.0	65.5	66.8	58.8	72.3	68.2	66.4
T ₉ : Weed free	79.5	86.3	83.2	83.0	81.3	82.3	82.8	82.1
Mean	67.6	78.9	73.9		71.7	77.2	74.2	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	2.42	5.14	2.07	4.38
Sub treatment	1.39	2.83	0.95	1.93
Interaction A:	4.19	NS	2.88	5.79
Interaction B:	4.19	NS	3.35	6.94

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

significantly superior over K-3. The interactions among the cultivars and treatments were significant in rabi 1988 only.

4.40 NUMBER OF SEEDS PLANT⁻¹

The differences in seed number per plant found in diverse groundnut cultivars at harvest due to the treatments were significant in rabi 1987 and 1988 (Table 79). The weed free treatment showed highest seed number per plant followed by pendimethalin and oxyfluorfen. The treatments containing weeds showed significantly lower seed number and it was lowest in T₈. All the herbicide treatments T₂, T₃, T₁, T₄ and T₅ significantly improved seed number in that order. Among the cultivars Gangapuri and JL-24 were significantly superior over K-3. The interactions among the cultivars and treatments were also significant.

4.41 TOTAL NUMBER OF PEGS PLANT⁻¹

The differences in total peg number found in diverse groundnut cultivars at harvest due to the treatments were significant in rabi 1987 and 1988 (Table 80). The weed free treatment showed highest peg number followed by pendimethalin and oxyfluorfen. The treatments containing weeds showed significantly least peg number and were on par with each other. All the herbicide treatments T₂, T₃, T₁, T₄ and T₅ significantly improved peg number in that order. The differences among the cultivars were significant. Cv. K-3 was significantly superior

Table 79: Effect of herbicides and crop weed competition on number of seeds plant⁻¹ in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	Harvest				Harvest			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	9.2	10.3	11.6	10.4	5.3	11.0	10.9	9.1
T ₂ : Pendimethalin	13.3	13.2	16.4	14.3	7.7	12.9	13.5	11.4
T ₃ : Oxyfluorfen	13.1	13.7	14.9	13.9	6.9	15.1	12.1	11.4
T ₄ : Fluchloralin	7.2	9.8	10.9	9.3	4.4	9.8	9.8	8.0
T ₅ : Glyphosate	7.3	6.9	11.8	8.7	3.3	7.8	9.6	6.9
T ₆ : C ₄ weeds	4.4	8.3	8.0	6.9	2.9	8.2	9.0	6.7
T ₇ : C ₃ weeds	2.8	8.2	7.9	6.3	2.6	8.1	8.3	6.3
T ₈ : C ₃ + C ₄ weeds	3.1	7.8	7.7	6.2	2.3	6.5	6.9	5.2
T ₉ : Weed free	15.4	16.9	18.6	16.9	14.3	16.8	18.0	16.4
Mean	8.4	10.6	12.0		5.5	10.7	10.9	

Results of statistical analysis

	S.Ed+	CD(0.05)	S.Ed+	CD(0.05)
Main treatment	0.49	1.03	0.30	0.62
Sub treatment	0.17	0.34	0.21	0.42
Interaction A:	0.51	1.03	0.62	1.25
Interaction B:	0.75	1.56	0.55	1.12

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 80: Effect of herbicides and crop weed competition on total number of pegs plant⁻¹ in diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	Harvest				Harvest			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	26.8	16.8	14.3	19.3	18.0	17.5	16.3	17.3
T ₂ : Pendimethalin	39.2	20.1	21.6	26.9	26.6	28.1	19.0	24.6
T ₃ : Oxyfluorfen	28.1	19.6	16.6	21.4	19.6	21.7	16.8	19.4
T ₄ : Fluchloralin	14.8	18.0	14.1	15.6	16.2	15.1	12.8	14.7
T ₅ : Glyphosate	18.3	13.0	15.3	15.5	12.1	10.2	14.2	12.2
T ₆ : C ₄ weeds	9.8	12.0	11.8	11.2	10.0	12.6	12.1	11.6
T ₇ : C ₃ weeds	8.3	10.2	10.7	9.7	8.5	12.0	13.2	11.2
T ₈ : C ₃ + C ₄ weeds	9.6	9.9	11.6	10.3	9.2	12.4	13.2	11.6
T ₉ : Weed free	42.0	24.2	21.3	29.2	46.0	30.0	33.0	36.3
Mean	21.9	15.9	15.3		18.5	17.7	16.7	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.45	0.96	1.32	2.79
Sub treatment	0.79	1.62	0.79	1.60
Interaction A:	2.39	4.85	2.37	4.81
Interaction B:	1.52	3.09	2.31	4.76

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

over Gangapuri in both the years. The interactions among the cultivars and treatments were also significant.

4.42-- SHELLING PERCENTAGE

The differences in shelling percentage of diverse groundnut cultivars due to the treatments were significant in **rabi** 1987 and **rabi** 1988 (Table 81). The weed free treatment showed significantly highest shelling percentage followed by pendimethalin and oxyfluorfen. The treatments containing weeds showed significantly lower shelling percentage. All the herbicide treatments improved shelling percentage except glyphosate. The differences among the cultivars were significant. Cv. K-3 was significantly superior in **rabi** 1988. The interactions among the cultivars and treatments were not significant.

4.43 100 KERNEL WEIGHT

The difference in 100 kernel weight of diverse groundnut cultivars due to the treatments were significant in **rabi** 1987 and 1988 (Table 82). The weed free treatment showed highest kernel weight followed by oxyfluorfen and pendimethalin. The treatments containing weeds showed significantly lower kernel weight. All the herbicide treatments significantly improved the kernel weight except glyphosate in **rabi** 1988. The differences among the cultivars were significant. Cv. K-3 was significantly superior over JL-24 and Gangapuri. The interactions among the cultivars and treatments were significant.

Table 81: Effect of herbicides and crop weed competition on shelling percentage of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	Harvest				Harvest			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	75.1	73.0	73.1	73.7	72.0	72.5	72.1	72.2
T ₂ : Pendimethalin	76.5	73.5	73.3	74.4	71.6	73.0	72.6	72.4
T ₃ : Oxyfluorfen	76.3	74.6	72.2	74.4	70.6	74.0	72.0	72.2
T ₄ : Fluchloralin	76.1	75.0	72.0	74.4	67.6	72.2	72.0	70.6
T ₅ : Glyphosate	72.0	70.1	67.8	69.9	66.2	70.1	69.0	68.4
T ₆ : C ₄ weeds	73.2	71.5	72.0	72.2	65.0	66.6	69.5	67.0
T ₇ : C ₃ weeds	74.0	72.2	71.2	72.5	64.7	68.0	69.2	67.3
T ₈ : C ₃ + C ₄ weeds	73.2	72.0	71.1	72.1	68.3	68.6	70.0	68.9
T ₉ : Weed free	77.9	74.5	73.0	75.1	72.6	73.4	73.0	73.0
Mean	74.9	72.9	71.7		68.7	70.9	71.0	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	1.03	2.19	1.29	2.74
Sub treatment	0.66	1.37	0.70	1.42
Interaction A:	2.03	NS	2.11	NS
Interaction B:	1.87	NS	2.19	NS

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 82: Effect of herbicides and crop weed competition on 100 kernel weight (g) of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	Harvest				Harvest			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	56.7	45.0	39.8	47.2	44.1	40.0	36.8	40.3
T ₂ : Pendimethalin	58.5	47.9	43.1	49.8	46.2	41.0	40.4	42.5
T ₃ : Oxyfluorfen	57.7	49.2	44.2	50.4	47.1	40.2	41.1	42.6
T ₄ : Fluchloralin	50.5	39.2	40.6	43.4	44.2	39.1	38.4	40.6
T ₅ : Glyphosate	48.7	43.0	36.9	42.9	38.6	37.0	34.7	36.8
T ₆ : C ₄ weeds	40.5	39.8	36.9	39.1	38.7	38.9	34.2	37.3
T ₇ : C ₃ weeds	38.4	37.7	35.2	37.1	37.6	32.6	33.3	34.5
T ₈ : C ₃ + C ₄ weeds	37.0	38.1	34.3	36.5	36.5	36.9	32.8	35.4
T ₉ : Weed free	61.1	51.1	46.7	52.9	52.5	46.6	44.4	47.8
Mean	49.9	43.4	39.7		42.8	39.1	37.3	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	1.17	2.48	1.67	3.54
Sub treatment	0.71	1.44	0.49	0.99
Interaction A:	2.13	4.32	1.46	2.96
Interaction B:	2.06	4.24	2.50	5.23

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

4.44 OIL PERCENTAGE

The differences in oil percentage of diverse groundnut cultivars at harvest due to the treatments were significant in rabi 1987 and 1988 (Table 83). The weed free treatment had significantly highest oil percentage followed by alachlor and oxyfluorfen which were on par with each other. The treatments containing weeds showed significantly lower oil percentage and were on par with each other. The herbicide treatments T₁, T₃, T₄ and T₂ improved oil percentage in that order except glyphosate (T₅). The differences among the cultivars were significant. Cv. K-3 was significantly superior over cvs. JL-24 and Gangapuri. The interactions among the cultivars and treatments were not significant.

4.45 PROTEIN PERCENTAGE IN KERNELS

The differences in per cent protein of diverse groundnut cultivars due to the treatments were significant in rabi 1987 and 1988 (Table 84). The weed free treatment possessed significantly highest protein percentage followed by alachlor and pendimethalin which were on par with each other. The weedy treatments showed significantly lower protein percentage and it was least in T₈. The differences among the cultivars were significant. Cvs. Gangapuri and JL-24 were significantly superior over K-3. The interactions among the cultivars and treatments were not significant.

Table 83: Effect of herbicides and crop weed competition on oil percentage of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	Harvest				Harvest			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	49.1	48.3	46.5	48.0	48.0	47.0	46.4	47.1
T ₂ : Pendimethalin	47.0	47.0	45.0	46.3	46.2	45.0	45.2	45.5
T ₃ : Oxyfluorfen	48.5	48.0	47.0	47.8	47.8	47.2	46.6	47.2
T ₄ : Fluchloralin	47.8	45.5	46.8	46.7	46.6	45.8	46.1	46.2
T ₅ : Glyphosate	46.5	44.0	42.9	44.5	46.3	45.0	44.5	45.3
T ₆ : C ₄ weeds	46.5	44.8	46.0	45.8	45.0	44.5	45.0	44.8
T ₇ : C ₃ weeds	47.0	44.5	45.0	45.5	44.5	44.2	44.2	44.3
T ₈ : C ₃ + C ₄ weeds	47.1	45.1	45.3	45.8	45.0	44.1	44.0	44.4
T ₉ : Weed free	49.8	48.2	47.2	48.4	49.6	48.1	47.0	48.2
Mean	47.7	46.2	45.7		46.6	45.7	45.4	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	1.11	2.35	0.81	1.69
Sub treatment	0.62	1.27	0.37	0.74
Interaction A:	1.87	NS	1.10	NS
Interaction B:	1.90	NS	1.29	NS

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 84: Effect of herbicides and crop weed competition on protein percentage of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	Harvest				Harvest			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	29.1	29.3	29.8	29.4	26.8	28.8	30.3	28.6
T ₂ : Pendimethalin	28.2	29.6	30.8	29.5	26.5	28.0	29.2	27.9
T ₃ : Oxyfluorfen	27.9	28.3	30.9	29.0	26.0	27.0	30.6	27.9
T ₄ : Fluchloralin	27.9	27.9	29.2	28.3	25.7	28.1	29.1	27.6
T ₅ : Glyphosate	24.9	26.2	27.0	26.0	24.5	27.2	23.6	25.1
T ₆ : C ₄ weeds	24.1	26.9	28.2	26.4	23.2	25.1	28.6	25.6
T ₇ : C ₃ weeds	24.4	26.8	29.2	26.8	22.1	24.6	27.8	24.8
T ₈ : C ₃ + C ₄ weeds	22.6	26.6	28.3	25.8	21.8	23.8	27.3	24.3
T ₉ : Weed free	29.8	30.6	32.6	31.0	29.3	30.4	32.8	30.8
Mean	26.5	28.0	29.6		25.1	27.0	28.8	

Results of statistical analysis	S. Ed±	CD(0.05)	S. Ed±	CD(0.05)
Main treatment	0.87	1.85	1.18	2.49
Sub treatment	0.47	0.96	0.61	1.25
Interaction A:	1.42	NS	1.84	NS
Interaction B:	1.48	NS	1.97	NS

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

4.46 NITROGEN UPTAKE BY GROUNDNUT CULTIVARS

The differences in N uptake of diverse groundnut cultivars on 70 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 85). The weed free treatment showed significantly highest N uptake followed by pendimethalin and oxyfluorfen which were on par with each other. The treatments containing weeds showed significantly lower N uptake. The herbicide treatments T₂, T₃, T₁ and T₄ significantly improved N uptake in that order except glyphosate which showed lower values. The differences among the cultivars were significant. Cvs. Gangapuri and JL-24 were significantly superior over K-3 in rabi 1987, whereas in rabi 1988 Cvs. JL-24 and K-3 were superior. The interactions among the cultivars and treatments were significant.

4.47 PHOSPHORUS UPTAKE BY GROUNDNUT CULTIVARS

The differences in P uptake of diverse groundnut cultivars on 70 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 86). The weed free treatment showed significantly highest P uptake. The treatments containing weeds showed significantly lower P uptake. The herbicide treatments T₂, T₃, T₁, T₄ and T₅ significantly improved P uptake in that order except glyphosate in rabi 1988. The differences among the cultivars were significant. Cv. JL-24 was significantly superior over K-3 in both the years. The interactions among the cultivars and treatments were significant.

Table 85: Effect of herbicides and crop weed competition on nitrogen uptake (kg ha^{-1}) of diverse groundnut cultivars.

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	74.2	95.3	95.2	88.2	61.6	58.7	56.0	58.8
T ₂ : Pendimethalin	96.5	94.9	133.5	108.3	76.0	63.3	69.3	69.5
T ₃ : Oxyfluorfen	96.6	101.3	106.8	101.6	72.6	73.9	66.4	70.9
T ₄ : Fluchloralin	78.7	85.5	81.7	81.9	56.8	57.3	53.2	55.8
T ₅ : Glyphosate	50.9	65.3	70.4	62.2	41.1	46.6	26.5	38.0
T ₆ : C ₄ weeds	73.7	63.8	68.4	68.6	56.5	52.7	44.7	51.3
T ₇ : C ₃ weeds	47.1	46.1	48.9	47.4	43.9	33.5	40.7	39.4
T ₈ : C ₃ + C ₄ weeds	63.2	50.3	47.4	53.6	44.4	46.2	46.0	45.5
T ₉ : Weed free	116.4	146.6	141.8	134.9	95.2	113.9	106.6	105.2
Mean	77.5	83.2	88.2		60.9	60.7	56.6	

Results of statistical analysis	S.Ed ₊	CD(0.05)	S.Ed ₊	CD(0.05)
Main treatment	4.17	6.84	1.64	3.47
Sub treatment	2.04	4.15	0.92	1.87
Interaction A:	6.13	12.44	2.77	5.61
Interaction B:	6.87	14.21	2.81	5.79

Note: A = Two sub means at same level main.

B = Two main means at same or different levels sub.

NS = Not significant

Table 86: Effect of herbicides and crop weed competition on phosphorus uptake (kg ha^{-1})
of diverse groundnut cultivars

Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	6.84	9.01	9.86	8.57	5.85	6.42	5.44	5.90
T ₂ : Pendimethalin	9.45	10.57	11.86	10.63	6.56	6.99	6.95	6.83
T ₃ : Oxyfluorfen	8.71	9.28	10.69	9.56	7.29	7.52	7.24	7.35
T ₄ : Fluchloralin	7.60	8.41	7.09	7.70	5.81	6.04	4.54	5.46
T ₅ : Glyphosate	4.01	5.95	6.87	5.61	3.61	4.65	2.97	3.74
T ₆ : C ₄ weeds	6.37	6.37	5.88	6.21	5.18	5.54	4.29	5.01
T ₇ : C ₃ weeds	4.10	4.44	4.22	4.25	4.51	3.49	3.72	3.91
T ₈ : C ₃ + C ₄ weeds	5.06	4.21	4.19	4.49	3.81	4.09	4.16	4.02
T ₉ : Weed free	10.50	13.52	12.97	12.33	9.24	11.00	10.53	10.26
Mean	6.96	7.97	8.18		5.76	6.19	5.54	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	0.39	0.84	0.19	0.39
Sub treatment	0.18	0.37	0.10	0.21
Interaction A:	0.55	1.11	0.30	0.62
Interaction B:	0.64	1.33	0.32	0.66

Note: A = Two sub means at same level main

B = Two main means at same or different levels sub.

NS = Not significant

4.48 POTASSIUM UPTAKE BY GROUNDNUT CULTIVARS

The differences in K uptake of diverse groundnut cultivars on 70 DAS due to the treatments were significant in rabi 1987 and 1988 (Table 87). The weed free treatment showed significantly highest K uptake followed by pendimethalin and oxyfluorfen. The treatments containing weeds showed significantly lower K uptake. The herbicide treatments T₂, T₃, T₁ and T₄ significantly improved K uptake in that order. With glyphosate treatment lowest K uptake was noticed. The differences among the cultivars were significant. Cvs. JL-24 and Gangapuri were significantly superior over K-3. The interactions among the cultivars and treatments were significant.

4.49 LEAF PROTEIN CONTENT (%)

The differences in leaf protein content (%) found among diverse groundnut cultivars on 70 DAS due to the treatments in rabi 1987 and 1988 are presented in (Table 88). Lower leaf protein content was found in rabi 1988. The weed free treatment showed highest leaf protein content. The treatments containing weeds showed lower leaf protein content. All the herbicide treatments except glyphosate showed higher values of leaf protein and it was higher with pendimethalin and oxyfluorfen than T₈. Among the Cvs. higher leaf protein content was found in K-3 than Gangapuri and JL-24.

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Table 87: Effect of herbicides and crop weed competition on potassium uptake (kg ha^{-1})
of diverse groundnut cultivars -

-Treatments	Rabi 1987				Rabi 1988			
	70 DAS				70 DAS			
	K-3	JL-24	Ganga-puri	Mean	K-3	JL-24	Ganga-puri	Mean
T ₁ : Alachlor	51.9	67.6	63.3	60.9	40.2	47.5	45.6	44.4
T ₂ : Pendimethalin	67.5	79.9	85.6	77.7	55.2	54.1	53.4	54.2
T ₃ : Oxyfluorfen	65.0	69.4	70.2	68.2	44.6	53.8	52.1	50.2
T ₄ : Fluchloralin	48.1	59.2	60.0	55.8	38.8	40.9	43.1	40.9
T ₅ : Glyphosate	28.2	44.3	53.3	41.9	24.1	36.7	25.3	28.7
T ₆ : C ₄ weeds	47.7	59.5	48.5	51.9	40.2	41.7	44.0	41.9
T ₇ : C ₃ weeds	35.1	42.6	37.5	38.4	35.4	32.9	35.5	34.6
T ₈ : C ₃ + C ₄ weeds	48.9	37.7	33.9	40.2	34.9	39.0	36.1	36.7
T ₉ : Weed free	85.4	115.1	98.2	99.6	69.1	83.5	82.7	78.4
Mean	53.1	63.9	61.2		42.5	47.8	46.4	

Results of statistical analysis	S.Ed±	CD(0.05)	S.Ed±	CD(0.05)
Main treatment	3.21	6.80	1.41	2.98
Sub treatment	1.39	2.83	0.71	1.45
Interaction A:	4.18	8.48	2.14	4.34
Interaction B:	5.14	10.65	2.34	4.83

Note: A = Two sub means at same level main

B = Two main means at same or different levels sub.

NS = Not significant

Table 88: Effect of herbicides and crop weed competition on kernel yield, leaf area, specific leaf weight, leaf area index, leaf protein and sink size in diverse groundnut cultivars (Mean values).

Treatments	Kernel yield g m ⁻²		Leaf area cm ² pl ⁻¹		Specific leaf weight mg cm ⁻²		Maximum LAI		Leaf protein content (%)		Sink size g ₂ kernel m ² leaf		Sink size kg kernel kg leaf protein	
	Rabi 1987	Rabi 1988	Rabi 1987	Rabi 1988	Rabi 1987	Rabi 1988	Rabi 1987	Rabi 1988	Rabi 1987	Rabi 1988	Rabi 1987	Rabi 1988	Rabi 1987	Rabi 1988
T ₁	159.6	120.1	399	389	6.04	5.59	2.12	2.19	20.3	19.3	120.9	93.1	1.92	1.64
T ₂	233.4	157.5	556	443	5.85	5.66	2.91	2.55	20.7	19.6	126.2	106.4	2.06	1.86
T ₃	231.1	156.7	563	430	5.81	5.57	2.56	2.43	21.0	20.0	124.0	109.6	2.12	1.91
T ₄	131.7	106.5	425	366	5.35	5.43	2.17	2.09	20.6	19.4	92.7	87.2	1.70	1.62
T ₅	120.0	83.4	346	304	5.54	5.37	1.73	1.70	20.0	18.6	104.3	82.5	1.85	1.51
T ₆	88.7	82.4	336	331	5.25	5.39	1.87	1.88	19.8	19.1	79.9	74.9	1.44	1.39
T ₇	76.8	76.3	269	303	5.28	5.28	1.47	1.80	19.7	18.1	86.3	76.3	1.65	1.43
T ₈	77.0	61.1	285	297	5.06	5.31	1.44	1.64	19.3	18.5	81.1	62.3	1.54	1.15
T ₉	289.2	252.3	677	607	6.47	6.17	3.66	3.63	22.5	21.9	128.5	124.9	1.94	2.00

V ₁	150.6	83.8	472	387	5.73	5.47	2.40	2.13	21.4	20.8	97.1	65.5	1.65	1.16
V ₂	156.3	143.4	420	399	5.60	5.58	2.26	2.41	20.0	18.7	111.6	108.6	1.88	1.91
V ₃	160.3	138.3	382	355	5.78	5.60	1.98	2.11	19.9	18.6	126.2	117.2	2.08	2.03

Harvest Harvest Grand Grand 90 110 70 DAS 70 DAS														
mean mean mean mean DAS DAS														

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4.50 SINK SIZE (g KERNEL m^{-2} LEAF; kg KERNEL kg^{-1} LEAF AND kg
KERNEL kg^{-1} LEAF PROTEIN)

The differences in the sink size of diverse groundnut cultivars due to the treatments in rabi 1987 and 1988 were calculated (Table 88). Lower sink size in terms of g kernel m^{-2} leaf and kg kernel kg^{-1} leaf were found in rabi 1988. The weed free treatment showed highest sink size. The treatments containing weeds showed reduced sink size and it was lowest in treatment T₈. All the herbicide treatments improved sink size in terms of g kernel m^{-2} leaf, kg kernel kg^{-1} leaf and kg kernel kg^{-1} leaf protein and sink size improved to a greater extent with oxyfluorfen and pendimethalin. Among the Cvs. higher sink size was found in Gangapuri and JL-24 than K-3.

4.51 REDUCED VEGETATIVE GROWTH (PER CENT REDUCTION IN LAI
OVER T₉)

The differences in per cent reduction in LAI of diverse groundnut cultivars on 30, 50, 70 and 90 DAS due to the treatments in rabi 1987 and 1988 were calculated (Table 89). Weedy treatments showed greater reduction in LAI. All the herbicide treatments except glyphosate showed less reduction in LAI and reduction in LAI was least with pendimethalin followed by oxyfluorfen.

Table 89: Effect of herbicides and crop weed competition reduced vegetative growth (per cent reduction in LAI over T_9) and reduced reproductive growth (per cent reduction in matured pods over T_9) in diverse groundnut cultivars

	Reduced vegetative growth (%)								Reduced reproductive growth (%)	
	Rabi 1987				Rabi 1988				Rabi 1987	Rabi 1988
	30 DAS	50 DAS	70 DAS	90 DAS	30 DAS	50 DAS	70 DAS	90 DAS	Harvest	Harvest
	23.0	21.8	18.1	41.0	30.4	36.1	29.3	37.3	45.1	54.8
	32.3	19.5	3.8	19.9	28.2	31.6	15.6	23.8	14.3	43.0
	22.9	10.8	10.0	29.7	34.8	24.0	17.6	29.2	20.9	40.8
	18.0	28.9	27.3	40.2	32.2	44.0	33.9	39.9	47.6	60.1
	50.5	45.1	36.9	51.4	25.0	42.5	51.7	51.6	49.8	65.1
	39.5	39.1	34.0	48.3	39.4	44.8	37.7	46.9	63.2	63.5
	40.9	45.5	49.9	59.3	34.1	46.1	50.2	52.4	68.5	72.6
	40.5	42.0	44.3	60.4	23.0	52.0	42.4	48.8	65.7	73.1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30.7	28.5	23.7	44.0	26.6	30.5	28.3	31.8	53.5	61.2
	26.0	26.4	25.8	40.7	31.6	40.5	32.4	37.4	34.7	44.4
	32.5	29.3	25.3	32.0	24.2	35.9	32.0	40.8	36.9	51.9

4.52 REDUCED REPRODUCTIVE GROWTH (PER CENT REDUCTION IN NUMBER OF MATURED PODS OVER T₉)

The differences in per cent reduction in number of matured pods of diverse groundnut cultivars at harvest due to the treatments in **rabi** 1987 and 1988 were calculated (Table 89). Greater reduction in number of matured pods was found in **rabi** 1988 and than in 1987. The treatments containing weeds showed greater reduction in number of matured pods. All the herbicide treatments showed less reduction in number of matured pods and it was lesser with pendimethalin and oxyfluorfen than T₈. Cv. K-3 showed greater reduction in number of matured pods than JL-24 and Gangapuri in both the years.

4.53 CORRELATION STUDIES

Simple correlation coefficients ('r' values) were calculated between kernel yield and pod yield, shelling percentage, 100 kernel weight, number of matured pods, filled pods percentage, harvest index, haulm yield and total dry matter at harvest (TDM) in **rabi** 1987 and 1988 (Table 90). The correlation coefficient values were positive and significant at five and one per cent level indicating that an increase in these characters, would result in increased seed yield and vice versa. Among these characters, pod yield, number of matured pods, haulm yield and TDM showed a very high ($r > 0.9$) correlation with kernel yield in both the years.

Table 90: Correlation coefficient values

	'r' values Rabi 1987	'r' values Rabi 1988
Kernel yield		
1. Pod yield	0.98**	0.99**
2. Shelling percentage	0.51**	0.79**
3. 100 kernel weight	0.75**	0.53**
4. Number of matured pods	0.94**	0.92**
5. Filled pods percentage	0.77**	0.83**
6. Harvest index	0.64**	0.77**
7. Haulm yield	0.95**	0.89**
8. Total dry matter (Harvest)	0.98**	0.98**
9. Weed dry matter at 30 DAS	-0.56**	-0.62**
10. Weed dry matter at 50 DAS	-0.85**	-0.81**
11. Weed dry matter at 70 DAS	-0.89**	-0.84**
12. Weed dry matter at 90 DAS	-0.91**	-0.90**

** Significant at 1% and 5% level

The correlation coefficients between kernel yield and weed dry matter at 30, 50, 70 and 90 DAS showed significant negative correlation at five and one per cent level in both the years indicating that increased weed dry matter would result in decreased kernel yield and vice versa.

DISCUSSION

CHAPTER V

DISCUSSION AND CONCLUSIONS

Groundnut is very susceptible to weed competition during both early and late stages of growth (Yaduraju et al., 1981). The critical period of weed competition was reported to be 4 - 8 weeks after sowing (Chamblee et al., 1982; Yadav et al., 1984 and Hamada, 1988). During the crop growth period sixteen weeds were observed out of which seven possessed C_4 and nine C_3 pathway (Plate 1 and 2). C_4 weeds dominated during early stages of crop growth and at pod filling stage C_3 . C_4 weeds, *Cyperus rotundus*, *Dactyloctenium aegyptium*, *Digitaria sanguinalis*, *Cynodon dactylon* and C_3 weeds, *Ocimum canum*, *Lagasca mollis* and *Parthenium hysterophorus* were predominant. Rao et al. (1982); Choudhary (1983); Prasad et al. (1987) and Kondap et al. (1989) also reported the predominance of these weeds in groundnut.

Pendimethalin and oxyfluorfen gave season long weed control and effectively checked most dominant C_3 and C_4 weeds. Fluchloralin, alachlor and glyphosate were less effective in controlling C_3 weeds at later stages of crop growth. Murthy (1982); Rao et al. (1982); Brecke and Teem (1983); and Kondap et al. (1989) also reported the efficacy of pendimethalin and oxyfluorfen for controlling annual broad leaved weeds and grasses. Pendimethalin checked grasses and broad leaved weeds but it could not control *Cyperus rotundus* (Thomson, 1979). Pendimethalin is known to inhibit photosynthesis, oxidative phosphorylation, protein, nucleic acid and lipid synthesis

(Moreland *et al.*, 1972; Ashton and Crafts, 1981). Whereas, oxyfluorfen kills the susceptible plants by damaging cellular membranes followed by necrosis (Pritchard *et al.*, 1980). It also inhibits photosystem II electron transport and causes protein damage (Kunert *et al.*, 1985). The selectivity in groundnut is based on enzymatic degradation (Akobundu, 1988).

The reduction in weed density on 90 DAS is due to senescence. Herbicides significantly reduced weed density at all the stages of crop growth. Many researchers have reported lower weed densities with the use of herbicides like alachlor (Joshi, 1987; Lunsford *et al.*, 1987), pendimethalin (Brecke and Teem, 1983; Yadav *et al.*, 1983 and Kondap *et al.*, 1989); oxyfluorfen (Fadayomi *et al.*, 1977 and Joshi, 1987), fluchloralin (Joshi, 1987 and Rao, 1988) and glyphosate (Fenderson *et al.*, 1982 and Piggot *et al.*, 1982).

Murthy (1982) and Bhanumurthy and Subramanian (1989) opined that weed dry matter is a better parameter to measure competition than weed number since it more precisely measures the quantity of growth related factors utilized by weeds. Total weed dry matter (TWDM) increased upto 110 DAS in weedy controls. All the herbicides reduced TWDM at all the stages of crop growth and lower TWDM was found with pendimethalin and oxyfluorfen. Use of fluchloralin, glyphosate and alachlor led to more C_3 weed DM indicating their less efficiency in controlling C_3 weeds. Whereas, pendimethalin and oxyfluorfen produced lower C_3 weed DM. Cvs. Gangapuri and JL-24 plots showed lower TWDM on 70 DAS than

K-3 in weedy controls. This is due to vigorous growth of these cvs. during early stages. Patro *et al.* (1981), Kondap *et al.* (1989) reported cultivaral differences in checking weed growth.

Weed control efficiency percentage (WCE) on 70 DAS was in the order of (79.7 and 63.8) with pendimethalin, oxyfluorfen (67.7 and 62.8); alachlor (63.2 and 52.9), glyphosate (58.6 and 50.3) and fluchloralin (48.1 and 42.4) in rabi 1987 and 1988 respectively. Pendimethalin and oxyfluorfen checked C₃ and C₄ weeds efficiently and thus allowed the crop to grow more vigorously resulting in higher yields. Patro *et al.* (1981) and Prasad *et al.* (1987) reported that fluchloralin was less effective in controlling broad leaved weeds. Piggot *et al.* (1982) reported good control of *Digitaria sanguinalis* in post emergence application with glyphosate.

C₄ weeds containing highest number of stomata were *Cynodon dactylon* followed by *Euphorbia hirta*. In C₃ weeds stomatal number was high in *Celosia argentea* and *Ocimum canum*. Most dominant C₃ and C₄ weeds had greater stomatal number than groundnut cultivars. Higher number of stomates may lead to high rates of transpiration and photosynthesis.

Weed growth rate (WGR) was more in weedy controls. Herbicides reduced WGR and it was lesser with pendimethalin and oxyfluorfen. WGR was high in cv. K-3 plots than in JL-24 and Gangapuri on 70 DAS. Grime and Hunt (1975) indicated that maintenance of high RGR is important for competitive ability and

majority of weeds had higher RGR values than the crop. The mean RGR for weeds (C_3 and C_4) on 50 DAS was $0.080 \text{ g g}^{-1} \text{ d}^{-1}$ and it was $0.067 \text{ g g}^{-1} \text{ d}^{-1}$ for crop with weed competition indicating higher competitive ability of weeds.

Calculated LAI of weeds was highest in weedy controls which in turn affected crop LAI. Herbicide treatments reduced weed LAI and it was lowest with pendimethalin followed by oxyfluorfen. Weed LAI was more in K-3 plots than in Gangapuri and JL-24 indicating susceptibility of K-3 to weed competition.

In the present study it is seen that some weeds compete exclusively for nitrogen and others for phosphorus and potassium. Among the competing C_4 weeds the per cent NPK found was highest in *Amaranthus viridis* (3.35, 0.54 and 3.43) and in C_3 weeds per cent N was highest in *Digera arvensis* (3.30), P was highest in *Celosia argentea* (0.57) and K was highest in *Parthenium hysterophorus* (4.42). Previous research reports showed that weeds compete with crops for NPK (Sen, 1981; Naidu et al., 1982; Rao and Agarwal, 1984). The weedy controls showed higher NPK uptake and produced higher weed DM. Similar observations were made by Rajan et al. (1981); Naidu et al. (1982) and Kondap et al. (1985). Herbicides reduced NPK uptake by weeds and the uptake was lowest when pendimethalin and oxyfluorfen were applied. The N P K uptake by weeds was more in K-3 plots. Negative correlation between N uptake of weeds and groundnut crop was reported by Setty and Hosmani (1977). Cvs. JL-24 and

Gangapuri appeared to have utilized fixed N and were relatively free from competition for this nutrient than K-3.

C₄ weeds had higher rates of ¹⁴CO₂ assimilation than C₃. ¹⁴CO₂ assimilation was highest in C₄ weeds like *Dactyloctenium aegyptium* (197.9 cpm g⁻¹ leaf DM hr⁻¹) followed by *Digitaria sanguinalis* (144.7 cpm g⁻¹ leaf DM hr⁻¹). Among C₃ weeds CO₂ assimilation was more with *Parthenium hysterophorus* (65.52 cpm g⁻¹ leaf DM hr⁻¹) *Lagasca mollis* (47.60 cpm g⁻¹ leaf DM hr⁻¹). Chen et al. (1970); Patterson and Flint (1983) and Patterson (1985) also reported high rates of photosynthesis in C₄ weeds.

Among the pre-emergence herbicides oxyfluorfen showed slight discolouration of leaves during early stages followed by pendimethalin. However, these phytotoxic effects disappeared on 30 DAS. Similar reports were made by Kulandaivelu (1979) and Pahuja et al. (1985). Post emergence application of glyphosate caused higher phytotoxicity (persistent discolouration of leaves and stunted growth). Banks et al. (1977) also reported visual injury to crops due to post emergence application of glyphosate.

Light transmission ratio (LTR) was more in weed free and herbicide treatments and it was less in weedy controls. The lower LTR values in weedy controls is due to sufficient growth of weeds which captured maximum light. Iwata et al. (1983) reported reduction in growth and yield of groundnuts when weeds compete for light. Walker et al. (1988) found that height, leaf angles and leaf area affect competition for light. Grime (1979)

indicated that competitive plants achieve greater plant height when weed competition sets in. Shoot competition, that is plant height increased in weedy controls in both the years and JL-24 and Gangapuri attained higher height indicating their ability to compete with weeds better than K-3. Saini and Tripathi (1974) and Hamada (1988) found increased length of stems and internodes of crop when subjected to weed competition. Plant height was relatively less in weed free treatment and with herbicides. Glyphosate caused greater reduction in plant height due to phytotoxicity (Banks et al., 1977). Saini and Tripathi (1974) and Hamada (1988) reported reduction in number of branches in groundnut due to presence of weeds. The per cent reduction in total number of branches in weedy controls was less in cvs. JL-24 and Gangapuri than K-3.

Root nodule number in the cultivars was more in weed free and herbicide treatments, than in weedy controls. Reduction in nodule number due to weeds was reported by Kumar (1986). Except glyphosate all herbicides improved nodule number. Increase in nodule number was reported with the application of alachlor (Kishinevsky et al., 1988), pendimethalin and oxyfluorfen (Kulandaivelu and Morachan, 1981; and Sidhu et al., 1985) and fluchloralin (Sidhu et al., 1985).

The amount of dry matter produced is an indication of overall utilization of resources and better light interception. Chamblee et al. (1982) indicated that the early vegetative and reproductive stages in groundnut are very sensitive to weed

competition. Total dry matter (TDM) of all the cultivars increased with age and the increase in TDM was linear upto 90 DAS (Fig.4). Sastry *et al.* (1980) also reported progressive increase in TDM upto harvest. The differences between treatments upto 30 DAS were less and it gradually increased with age indicating the magnitude of competition. Chamblee *et al.* (1982), Yadav *et al.* (1984) and Hamada (1988) reported that the critical period in groundnut is 4 - 8 weeks after sowing. TDM was highest in weed free and herbicide treatments and it significantly decreased in weedy controls at all growth stages. Wells and Walker (1983) and Singh *et al.* (1987) also reported decrease in dry matter with weed competition. The per cent reduction in TDM at maturity was less in cvs. Gangapuri and JL-24 in weedy controls than K-3. TDM at maturity was highly correlated with kernel yield (Table 90). Pitelli *et al.* (1983) and Kondap *et al.* (1989) also reported cultivaral differences in dry matter with weed competition.

TDM was low in rabi 1988 on account of low temperatures during germination and pegging stages and affected flowering and increased the duration of crop thereby duration of weed competition by 10 - 12 days. During germination minimum temperatures were ($> 18.0^{\circ}\text{C}$ and $< 12.0^{\circ}\text{C}$) and before pegging ($> 15.3^{\circ}\text{C}$ and $< 12.5^{\circ}\text{C}$), in rabi 1987 and 1988 respectively which affected crop growth and development. Temperature plays an important role in groundnut growth and development, the optimum growth occurs at 27°C and minimum growth at $< 20^{\circ}\text{C}$ (Ketring,

1984). Cox (1979) also found optimum growth of groundnut at 27.5°C and below 15.5°C no growth occurred. Cvs. JL-24 (Spanish) and Gangapuri (Valencia) were found to be resistant to low temperature and yield was relatively higher in rabi 1988 than K-3 (Virginia).

Leaf DM was highest in weed free treatment indicating better utilisation of resources including light. Leaf and stem DM decreased in weedy controls. Singh et al. (1987) also reported reduction in leaf DM with weed competition. Herbicides pendimethalin and oxyfluorfen improved leaf and stem DM (Fig.6).

Leaf area index (LAI) increased upto 90 DAS and decreased later due to leaf senescence. Bhan (1973) also reported occurrence of leaf senescence after 90 DAS in groundnut cultivars. Leaf area depends on number of leaves and rate of leaf expansion. Light and temperature affect their growth. LAI values were low in rabi 1988 upto 70 DAS which resulted in slow growth in the initial stages. LAI was highest in weed free plots and significantly less in weedy controls. Cvs. JL-24 and Gangapuri had higher LAI than K-3 during early stages. The per cent reduction of LAI in weedy controls was less during early stages in Gangapuri and JL-24. Higher LAI in weed free plots led to higher yield in K-3 during rabi 1987. However, due to low temperature in 1988, K-3 LAI values decreased indicating its susceptibility to low temperature.

Leaf weight ratio (LWR) was high in weed free and herbicide treatments and decreased in weedy controls. Leaf area ratio (LAR) is the amount of leaf area produced per unit of total plant dry weight. LAR decreased with ageing. LAR is one of the important growth parameters that influences competition (Patterson, 1985). Cultivars JL-24 and Gangapuri grown in weedy control (C_3+C_4) showed higher per cent increase in LAR upto pegging than weed free treatment indicating their ability to utilise light, soil nutrients and fixed atmospheric N. Banyikwa and Rulangaranga (1985) also reported increase in LAR of groundnut with weed competition and attributed to competition with soil nutrients. Cvs. Gangapuri and JL-24 showed higher LAR than K-3 during early stages.

Specific leaf weight (SLW) is an index of leaf thickness. SLW showed increasing trend upto 110 DAS and then decreased. Positive relationship was found between CO_2 fixation and SLW. Bhagsari and Brown (1976) observed positive correlation of photosynthetic rate with SLW.

Relative leaf growth rate (RLGR) values gradually decreased with ageing (Table 65). All the cultivars in weedy controls showed lower RLGR on 90 DAS than weed free. pendimethalin and oxyfluorfen increased it.

Leaf area duration (LAD) is the total amount of leaf area present over a particular period of growth. LAD is an important growth parameter that influences competition

(Patterson, 1985). LAD values were highest in weed free and herbicide treatments. Cvs. JL-24 and Gangapuri had better LAD than K-3. Enyi (1977) reported positive relationship between LAD and seed yield.

Crop growth rate (CGR) is influenced by LAI, leaf photosynthetic rate and leaf angle and is an index of the amount of light intercepted. CGR showed increasing trend upto 90 DAS and thereafter decreased (Fig. 8). CGR was highest in weed free treatment and it significantly decreased in weedy controls. Cvs. JL-24 and Gangapuri had higher CGR (8.26 and 7.81 $\text{g m}^{-2}\text{d}^{-1}$ respectively) than K-3 (6.25 $\text{g m}^{-2}\text{d}^{-1}$) on 90 DAS in rabi 1987. The per cent reduction in CGR with weeds was less in cvs. Gangapuri and JL-24 during pod filling stages than K-3. Enyi (1977) also reported varietal variation in CGR and concluded that variation in CGR affects yield. Except glyphosate, the herbicides used significantly improved CGR. During rabi 1987 optimum LAI for cultivars K-3 (4.29), JL-24 (3.82) and Gangapuri (2.91) was found in weed free plots on 90 DAS.

Relative growth rate (RGR) is the rate of growth per unit weight of plant and it decreased with ageing (Fig. 10). Janamatti (1979) and Padma (1989) also observed progressive decrease in RGR with ageing. Grime and Hunt (1975) and Patterson (1985) opined that RGR is an important growth parameter that determines competition. Cvs. JL-24 and Gangapuri had higher RGR than K-3 on 50 DAS. The per cent reduction in RGR was less

in weedy control plots of JL-24 and Gangapuri than K-3 during pod filling. Banyikwa and Rulangaranga (1985) also reported reduction in RGR due to weed competition.

Net assimilation rate (NAR) shows the growth rate per unit leaf area i.e. assimilatory surface. NAR decreased as growth advanced (Fig. 11) mainly due to shading and senescence. NAR was higher in weed free and herbicide treatments and significantly decreased in weedy controls. Banyikwa and Rulangaranga (1985) also reported reduction in NAR due to weed competition. Cvs. JL-24 and Gangapuri had higher NAR than K-3 during flowering and pod filling. The per cent reduction in NAR with weeds was less in cvs. Gangapuri and JL-24 during pod filling. Enyi (1977) reported higher NAR in bunch cvs. than in spreading.

The crop raised in weedy controls had higher total chlorophyll content than weed free treatment which may be attributed to shading by weeds. Rao and Mittra (1988) also observed increased chlorophyll content with shading. Herbicide treatments except glyphosate showed lower chlorophyll content and were similar to weed free treatment. Cvs. JL-24 and Gangapuri had lower total chlorophyll content than K-3. Similarly cultivaral differences for total chlorophyll was also reported (Bhagsari and Brown 1976; Dhopte and Kudupley, 1986). Bhagsari and Brown (1976) reported that chlorophyll content was weakly correlated with photosynthetic rate and yield.

Cultivar JL-24 had higher leghaemoglobin than K-3. All herbicides except glyphosate improved leghaemoglobin and its content was positively related to N uptake.

Single leaf photosynthesis is the basis for dry matter production which in turn determines the yield. Groundnut possess C_3 pathway (Patterson, 1985). CO_2 assimilation rates were highest (41.28 ^{14}C cpm g^{-1} leaf DM hr^{-1} for K-3; 67.08 for JL-24 and 72.10 for Gangapuri) in weed free followed by herbicide treatments than weedy controls, due to decreased light availability. Iwata *et al.* (1983) and Banyikwa and Rulangaranga (1985) reported that competition for light is very important in weed competition than for soil nutrients. Cvs. Gangapuri and JL-24 showed higher rates of CO_2 assimilation than K-3. Similarly Rao and Das (1981) and Pallas (1982) showed cultivaral variation in photosynthesis and attributed to mesophyll and stomatal resistance and RUBP carboxylase activity and resistance to CO_2 diffusion.

The loss in pod yield depends upon the density of weeds, duration of weeds, type of weed species present and competing ability of crops (Reddi, 1988). Pod yield was highest in weed free treatment and significantly decreased in weedy controls. The loss in pod yield in weedy control ($C_3 + C_4$) was 71.9 and 74.4 per cent, in rabi 1987 and 1988 respectively as compared to weed free treatment. The reduction in pod yields due to weed competition ranged from 70 - 76 per cent (Yaduraju *et al.*, 1980; Rao *et al.*, 1982; Rao *et al.*, 1987; Kondap *et al.*,

1989) and 80 - 90 per cent (Hamada, 1988). Less pod yield was obtained in **rabi** 1988 due to low temperatures. However, JL-24 and Gangapuri showed resistance to low temperature.

During both the years weedy controls (C_3) and (C_4) did not show any significant differences among them which suggests that both C_3 and C_4 weeds were equally detrimental in reducing yields of groundnut. During both the years weedy control ($C_3 + C_4$) recorded lowest yield. Kondap **et al.** (1980) indicated that the yield reduction due to the presence of monocot + dicot weeds was maximum followed by the presence of monocot and dicot only. Cardina **et al.** (1986) reported that grass weeds were more detrimental than broad leaved weeds in reducing groundnut yields. Black (1976) pointed out that C_4 weeds are more competitive than C_3 . However, Reddi (1988) reported that although grassy weeds dominate in groundnut, serious competition is also due to broad leaved weeds. Sen (1981) stated that competition tends to be greater between plants of similar vegetative characters viz. broad leaved weeds compete more with broad leaved crops. In weed free treatment, K-3 produced the highest yield but with weed competition yield was reduced to greater extent.

Cultivars Gangapuri and JL-24 significantly produced higher pod yield than K-3. The per cent reduction in pod yield was less in cvs. Gangapuri and JL-24 in weedy controls. Kondap **et al.** (1980); Murthy **et al.** (1981) and Pitelli **et al.** (1983) reported cultivaral differences in groundnut for weed competition. Application of Herbicides significantly improved

pod yield and the increase was highest with pendimethalin followed by oxyfluorfen. These two herbicides effectively checked both C₃ and C₄ weeds and thereby contributed for higher TDM, CGR and other yield components resulting in high pod and kernel yield. Similarly Silva et al. (1983), Ray (1986) and Kondap et al. (1989) have reported that use of pendimethalin results in high yields. Yadav et al. (1983) and Prasad et al. (1987) have also observed effective control of weeds using oxyfluorfen.

Kernel yield also followed the same trend as that of pod yield. Kernel yield was also highest in weed free and herbicide treatments and significantly decreased in weedy controls. The increase in kernel yield was highest with pendimethalin followed by oxyfluorfen because of efficient weed control and improvement in yield components. Chamblee et al. (1982) and Murdock et al. (1986) reported reduction in seed yield due to weed competition.

Kernel weight partitioning index (KWPI) was higher in weed free and herbicide treatments than in weedy controls (Fig.17). Lower KWPI values were found in rabi 1988 which may be attributed to increased duration of weed competition, low temperature and lower TDM. Cultivars JL-24 and Gangapuri had higher KWPI than K-3. All herbicides improved KWPI and greater increase was observed with pendimethalin and oxyfluorfen. Duncan et al. (1978) and Tsai et al. (1987) also opined that partitioning of assimilates between vegetative and reproductive parts had greatest effect on yield. The present study indicates

that high seedling vigour and LAD during early stages, maintainance of high RGR, CGR, NAR during pod filling to maturity and efficient translocation of photosynthates to seeds are important for high yields.

Weed dry matter was negatively correlated with kernel yield (Table 90). Several researchers reported a significant negative relationship between weed dry matter and yield in groundnut (Tosh and Misra, 1977; Sessaiah et al., 1979; Hauser et al., 1982 and Singh et al., 1987).

Harvest index (HI) reveals the efficiency of translocation of assimilates to economic parts. Positive correlation between HI and kernel yield was found (Table 90). HI was highest in weed free and herbicide treatments and significantly decreased in weedy controls cultivars JL-24 and Gangapuri had higher HI than K-3. Natarajaratnam (1979) also observed higher HI in bunch cultivars than semi-spreading. Dhopte and Zade (1981) reported positive correlation between HI and seed yield.

Positive correlation between haulm yield and kernel yield was observed (Table 90). Haulm yield was highest in weed free treatment which significantly reduced in weedy controls. Lowest haulm yield was found in weedy control (C_3+C_4) followed by (C_3) and (C_4). Herbicides improved haulm yield and greater increase was observed with pendimethalin and oxyfluorfen.

Number of pegs per plant were highest in weed free and herbicide treatments and decreased significantly in weedy controls. Herbicides improved peg number except glyphosate. Cv K-3 had higher number of pegs than Gangapuri and JL-24. Apparently these pegs in K-3 could not produce pods.

Yield contributing parameters like total number of pods plant⁻¹, number of matured pods plant⁻¹, filled pods percentage, and number of seeds plant⁻¹ were highest in weed free and herbicide treatments and these decreased drastically in weedy controls. Similarly Hammerton (1976) and Pitelli *et al.* (1984) also reported reduction in number of pods plant⁻¹, number of seeds plant⁻¹ and percentage distribution of dry matter with weed competition. Cvs JL-24 and Gangapuri showed higher filled pods percentage and number of seeds plant⁻¹ than K-3. The percent reduction in all yield parameters were less in cvs Gangapuri and JL-24 in weedy controls. Rao (1980) and Reddy *et al.* (1984) observed more number of kernels in Spanish types than Virginia.

Correlation between kernel yield and pod yield, shelling percentage, number of matured pods, filled pods percentage, haulm yield, TDM at harvest were positive and significant. Among these, pod yield, number of matured pods, haulm yield and TDM at harvest showed a very high ($r > 0.9$) positive correlation with kernel yield in both the years. Similarly high positive correlation between number of matured pods and pod yield were observed by Chandola *et al.* (1973); Enyi (1975) and Labana *et al.*

(1980) and number of pods m^{-2} and seed yield by Kudo and Syodai (1986).

Kernel weight and shelling percentage were higher in weed free and herbicide treatments and it decreased in weedy controls. Cv. K-3 had higher values of shelling percentage in rabi 1987 whereas cvs Gangapuri and JL-24 were superior in rabi 1988. Cv K-3 had higher 100 kernel weight than JL-24 and Gangapuri. However, the percent reduction in shelling and 100 kernel weight in weedy check was more in cv K-3 than Gangapuri and JL-24. Rao (1980) and Reddy and Shah (1985) also reported cultivaral differences for kernel weight and shelling percentage.

Weed competition reduced protein and oil content of kernels. Herbicides improved these characteristics and higher values were found with pendimethalin and oxyfluorfen than weedy controls. Cultivars Gangapuri and JL-24 had higher protein than K-3. Saini *et al.* (1973); Singh and Gupta (1974); Murthy (1982) and Kumar (1986) reported reduction in oil and protein content due to presence of weeds. Jayakumar *et al.* (1985) also reported that the herbicides pendimethalin, oxyfluorfen and fluchloralin increased oil and protein content. It seems higher protein content is related to increased resistance to low temperature. Higher leaf protein (%) was found in weed free and herbicide treatments and decreased in weedy controls. All herbicides except glyphosate increased leaf protein and it was more with pendimethalin and oxyfluorfen.

Glyphosate treatment led to lower NPK uptake than pendimethalin and oxyfluorfen. Cvs JL-24 and Gangapuri had better N and P uptake than K-3 in rabi 1987, and K uptake was more in cvs. Gangapuri and JL-24 in both the years. Sessaiah (1979) and Rajan *et al.* (1981) reported least uptake of nutrients in weedy control. Setty and Hosmani (1977) observed negative correlation between nitrogen uptake by weeds and N uptake of crop.

Use of herbicides improved sink size and it was higher with pendimethalin and oxyfluorfen. Cvs JL-24 and Gangapuri had higher sink size than K-3.

Based on the above discussion, the following conclusions could be drawn :

C_4 weeds *Cyperus rotundus*, *Dactyloctenium aegyptium*, *Digitaria sanguinalis*, *Cynodon dactylon* and C_3 weeds, *Ocimum canum*, *Lagasca mollis* and *Parthenium hysterophorus* were predominant during the crop growth period. Weeds removed greater quantities of nutrients (NPK) and thus reduced uptake of NPK by crop. Competition for NPK differed with weed species. Dominant C_4 and C_3 weeds had high rates of CO_2 assimilation and contained more number of stomata. Cvs JL-24 and Gangapuri suppressed weed growth during early stages.

Weed competition reduced important morpho-physiological traits and greatly affected sink size and protein content leading

to decrease in yield and yield components. Greater groundnut growth reductions were found with weed competition between 40 and 50 DAS (vegetative to flowering) indicating critical period for groundnut. Cultivar differences among the diverse groups of groundnut exist in their ability to compete with weeds during their growth and development. Cv. K-3 was found to be least efficient in competing with either C_3 or C_4 weeds, whereas, cvs. JL-24 and Gangapuri withstood the competition better by producing higher TDM, CGR, RGR and NAR. During early growth stages cvs JL-24 and Gangapuri maintained higher values for LAI, LAD and leaf DM and the percentage decrease in RGR, CGR and NAR at pod filling stages was also less with weed competition. Greater increase in plant height and LAR were also observed in these cultivars with weed competition. JL-24 and Gangapuri also maintained higher rate of CO_2 assimilation, leghaemoglobin content, protein content and improved sink size. In addition, these cultivars maintained high rate of kernel weight partitioning index, harvest index and other yield components i.e., total number of pods, number of matured pods, filled pods percentage and number of seeds per plant. The per cent reduction in oil, 100 kernel weight and shelling percentage were less in these cultivars with weed competition.

In susceptible cv. K-3 the values for important traits like CO_2 assimilation rate, leaf DM, LAR, LWR, LAI, LAD were low during early stages and RGR, CGR, NAR drastically decreased during pod filling with weed competition except chlorophyll

content.

It is seen that cv. K-3 had higher oil percentage than protein when compared to JL-24 and Gangapuri, which had more protein. This aspect needs further research. In order to explain cultivar differences, studies have to be made on rooting pattern and internodal elongation as these affect competition for extracting nutrients from the soil and the plants ability to intercept light.

C₄ and C₃ weeds were equally detrimental in reducing the yield. Hence, it is very essential to control both weeds. It would be interesting to evaluate further the ability of the cultivars to compete for CO₂.

Among the herbicides pendimethalin @ 1.5 kg a.i. ha⁻¹ and oxyfluorfen @ 0.25 kg a.i. ha⁻¹ were found to be very efficient in controlling C₃ and C₄ weeds and these enhanced all growth characteristics, yield and yield components. Glyphosate is phytotoxic to groundnut and its use may be discouraged.

SUMMARY

CHAPTER VI

SUMMARY

Field experiments were conducted to know the effect of herbicides and crop weed competition on physiological aspects of diverse groundnut (*Arachis hypogaea* L.) cultivars at the College Farm, College of Agriculture, Rajendranagar, Hyderabad, during rabi (November to April) 1987 and 1988. Three cultivars viz., Virginia (K-3); Valencia (Gangapuri) and Spanish (JL-24) were selected for the study. Four pre-emergence herbicides (alachlor @ 1.5 kg a.i. ha⁻¹; pendimethalin @ 1.5 kg a.i. ha⁻¹; oxyfluorfen @ 0.25 kg a.i. ha⁻¹; fluchloralin @ 1.5 kg a.i. ha⁻¹) and one post emergence herbicide (glyphosate @ 1.5 kg a.i. ha⁻¹ which was applied in between rows with rubber foam) were used.

Weeds were classified into C₃ and C₄ based on leaf anatomy and staining techniques. During the crop growth period sixteen weeds were observed out of which seven possessed C₄ and nine C₃. C₄ weeds dominated during early stages of crop growth while C₃ at pod filling stage. C₄ weeds, *Cyperus rotundus*, *Dactyloctenium aegyptium*, *Digitaria sanguinalis*, *Cynodon dactylon* and C₃ weeds, *Ocimum canum*, *Lagasca mollis* and *Parthenium hysterophorus* were predominant. Pendimethalin and oxyfluorfen gave season long weed control and effectively checked most of the dominant C₃ and C₄ weeds. Fluchloralin, alachlor and glyphosate

were less effective in controlling C_3 weeds at later stages of crop growth.

Weed density had no relationship with weed dry matter. Cvs. JL-24 and Gangapuri suppressed weed growth during early stages. Calculated LAI values for weeds was more in cv. K-3 plots than Gangapuri and JL-24. Herbicides reduced weed growth rate (WGR). Nutrient uptake by weeds was high and resulted in decreased uptake by crop. Competition for NPK differed with weed species. Herbicides improved efficiency of nutrient uptake by the crop.

C_4 weeds showed higher CO_2 assimilation rate than C_3 . High photosynthetic rates were found in dominant C_4 weeds like *Dactyloctenium aegyptium*, *Digitaria sanguinalis* and C_3 weeds like *Parthenium hysterophorus* and *Lagasca mollis*. Dominant C_3 and C_4 weeds showed more number of stomata than groundnut cultivars.

Weed competition reduced important morpho-physiological traits of groundnut and increased plant height. The growth parameters LAI, CGR, RGR, NAR, RLGR, LWR, SLW and LAD decreased with weed competition, while LAR increased. The dry matter of leaves, stems and TDM also decreased with weed competition. All the herbicides except glyphosate significantly improved these morpho-physiological characters.

CO_2 assimilation rate, leghaemoglobin content of nodules, nutrient uptake, sink size and leaf protein reduced with weed competition, but chlorophyll content increased. Weed

competition also reduced light transmission values. Herbicides except glyphosate significantly improved these traits.

During rabi 1988, low temperatures prevailed during germination and pegging stages which affected crop growth and development and thus increased duration of crop by 10 - 12 days and registered lower TDM, pod yield, harvest index and kernel weight partitioning index.

C_3 and C_4 weeds were equally detrimental in reducing pod yield. The loss in pod yield in weedy control ($C_3 + C_4$) was 71.9 and 74.4 per cent as compared to weed free check in rabi 1987 and 1988 respectively. Cv. K-3 was found to be susceptible to weed competition cvs. JL-24 and Gangapuri withstood the competition and produced better yields. Among the cvs. loss in pod yield with competition ($C_3 + C_4$) was 84.3, 88.4 per cent in K-3; 64.9 and 67.0 per cent in JL-24; 66.6 and 67.9 per cent in Gangapuri during rabi 1987 and 1988 respectively.

Weed competition significantly reduced kernel yield, total number of pods, number of matured pods, filled pods percentage, number of seeds plant⁻¹, shelling percentage and kernel weight. Herbicides improved all these components and the increase was more with pendimethalin and oxyfluorfen. Weed competition also reduced TDM (at maturity), haulm yield, KWPI and HI.

Weed competition reduced protein and oil content of kernels. Herbicides improved these characteristics and higher values were found with pendimethalin and oxyfluorfen.

Weed DM was negatively correlated with yield. Among various characters, a high positive correlation ($r = > 0.9$) was found between kernel yield and TDM at maturity, haulm yield, number of matured pods and these parameters showed highest decrease in cv. K-3.

Among the herbicides pendimethalin @ 1.5 kg a.i. ha⁻¹ and oxyfluorfen @ 0.25 kg a.i. ha⁻¹ effectively controlled C₃ and C₄ weeds and these enhanced all growth characteristics, yield and yield components. Whereas, glyphosate was toxic to groundnut.

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