

**CHEMICAL WEED CONTROL IN ESTABLISHED  
MULBERRY GARDEN AND ITS EFFECT ON  
SILKWORM AND COCOON PRODUCTION**

**H. R. SHIVAKUMAR**

**DEPARTMENT OF AGRONOMY  
UNIVERSITY OF AGRICULTURAL SCIENCES  
BANGALORE**

1992

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**CHEMICAL WEED CONTROL IN ESTABLISHED  
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SILKWORM AND COCOON PRODUCTION**

**H. R. SHIVAKUMAR**

Thesis submitted to the  
**University of Agricultural Sciences, Bangalore**  
in partial fulfilment of the requirements  
for the award of the Degree of  
**MASTER OF SCIENCE (Agriculture)**  
in  
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**BANGALORE**

**NOVEMBER 1992**

*Dedicated to*  
*My Beloved Parents*  
**Smt. Gowramma**  
*and*  
**Sri H. C. Ramaiah**

DEPARTMENT OF AGRONOMY  
UNIVERSITY OF AGRICULTURAL SCIENCES  
BANGALORE

CERTIFICATE

This is to certify that the thesis entitled "CHEMICAL WEED CONTROL IN ESTABLISHED MULBERRY GARDEN AND ITS EFFECT ON SILKWORM AND COCOON PRODUCTION" submitted by Mr.H.R. SHIVAKUMAR, in partial fulfilment of the requirement for the degree of MASTER OF SCIENCE (AGRICULTURE) IN AGRONOMY to the University of Agricultural Sciences, Bangalore, is a record of bona fide research work done by him during the period of his study in this University, under my guidance and supervision and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles.

Bangalore,

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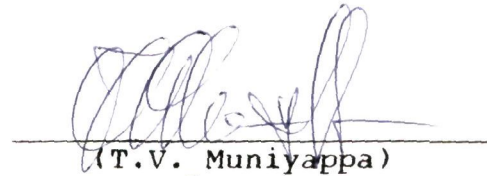


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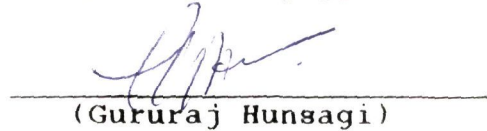
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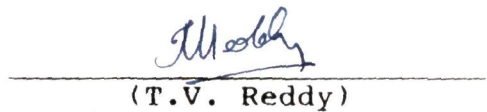
  
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*H.R. Shivakumar*  
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## CONTENTS

<u>CHAPTER</u>	<u>TITLE</u>	<u>PAGE</u>
I	INTRODUCTION	1-4
II	REVIEW OF LITERATURE	5-25
III	MATERIAL AND METHODS	26-46
IV	EXPERIMENTAL RESULTS	47-130
V	DISCUSSION	131-144
VI	SUMMARY	145-148
VII	REFERENCES	149-155
	APPENDIX	156

---

## LIST OF TABLES

TABLE	TITLE	PAGE
1	Physical and Chemical characteristics of experimental site at G.K.V.K., Bangalore.	27
2	Normal (From 1975 to 1990 and 91) and Actual (1991 and 92) monthly weather data prevailed during crop growth period at Gandhi Krishi Vignana Kendra, (G.K.V.K.), Bangalore.	29
3	Weed control and crop toxicity ratings (EWRC System) as influenced by weed control treatments at different crop growth stages in Mulberry.	48
4	Monocot weed population (in 1.0 m <sup>2</sup> area) at different crop growth stages as influenced by different weed control treatments in Mulberry.	51
5	Dicot weed population (in 1.0 m <sup>2</sup> area) at different crop growth stages as influenced by different weed control treatments in Mulberry.	56
6	Sedge weed population (in 1.0 m <sup>2</sup> area) at different crop growth stages as influenced by different weed control treatments in Mulberry.	61
7	Total weed population (in 1.0 m <sup>2</sup> area) at different crop growth stages as influenced by different weed control treatments in Mulberry.	65

TABLE	TITLE	PAGE
8	Drymatter production of monocot weeds (in 0.5 m <sup>2</sup> area) at different crop growth stages as influenced by different weed control treatments in Mulberry.	70
9	Drymatter production of dicot weeds (in 0.5 m <sup>2</sup> area) at different crop growth stages as influenced by different weed control treatments in Mulberry.	75
10	Drymatter production of sedges (in 0.5 m <sup>2</sup> area) at different crop growth stages as influenced by different weed control treatments in Mulberry.	79
11	Total drymatter production of weeds (in 0.5 m <sup>2</sup> area) at different crop growth stages as influenced by different weed control treatments in Mulberry.	84
12	Plant height (cm) at different crop growth stages as influenced by different weed control treatments in Mulberry.	89
13	Number of branches per plant (primary and secondary) as influenced by different weed control treatments in Mulberry at the harvest of each crop.	92
14	Number of leaves per plant at different crop growth stages as influenced by different weed control treatments in Mulberry.	95
15	Leaf area per plant (cm <sup>2</sup> ) at different crop growth stages as influenced by different weed control treatments in Mulberry.	99

TABLE	TITLE	PAGE
16	Leaf dry weight per plant (g) at different crop growth stages as influenced by different weed control treatments in Mulberry.	103
17	Leaf yield (g/plant and kg/ha), Weed Index (%) and Weed Control Efficiency (%) as influenced by different weed control treatments in Mulberry at the harvest of each crop.	107
18	Nutrient uptake (kg/ha) by Mulberry crop and weeds as influenced by different weed control treatments at the harvest of each crop.	112
19	Moisture (%) and Total Chlorophyll (mg/g) content of Mulberry leaves as influenced by different weed control treatments at the harvest of each crop.	116
20	Larval development and Larval duration of Silkworm as influenced by different weed control treatments.	118
21	Cocoon and Silk quality characters of Silkworm as influenced by different weed control treatments.	122
22	Economics of weed control treatments in Mulberry.	126
23	Residual effect of herbicides applied to Mulberry on germination percentage, root and shoot growth of Cucumber.	129

## LIST OF FIGURES

<u>FIGURES</u>	<u>TITLE</u>	<u>PAGE</u>
1	Normal (from 1975-1990 and 1991) and Actual (1991 and 92) mean monthly meteorological data prevailed during crop growth period at G.K.V.K., Bangalore.	29-30
2	Plan of lay-out of Experimental plot.	31-32
3	Total drymatter production of weeds (g/0.5 m <sup>2</sup> ) at different growth stages as influenced by different weed control treatments in Mulberry.	84-85
4	Leaf yield ( kg/ha) as influenced by different weed control treatments in Mulberry.	107-108
5	Weed control efficiency (%) as influenced by different weed control treatments in mulberry.	108-109
6	Net returns (Rs/ha) and benefit cost ratio (MR/MC) as influenced by different weed control treatments in mulberry.	126-127

## LIST OF PLATES

<u>Plate</u>	<u>Title</u>	<u>Between pages</u>
1	<u>Digitaria marginata</u> Link. var. <u>fimbriata</u> stapf. Family : Poaceae.	47-48
2	<u>Cyperus rotundus</u> L. Nutgrass, Nutsedge Family : Cyperaceae	47-48 .
3	<u>Cynodon dactylon</u> Pers. Bahama grass, Hariyali Family : Poaceae.	47-48
4	<u>Eragrostis</u> spp. Family : Poaceae.	47-48
5	<u>Commelina benghalensis</u> L. Family : Commelinaceae	47-48
6	<u>Amaranthus viridis</u> L. Family : Amaranthaceae.	47-48
7	<u>Acanthespermum hispidum</u> De. Family : Asterceae.	47-48
8	<u>Ageratum conyzoides</u> L. Geratum Family : Asteraceae.	47-48
9	<u>Bidens pilosa</u> L. Family : Asteraceae.	47-48
10	A view of silkworms fed with the leaves from control (weedy check) plot.	118-119
11	A view of silkworms fed with the leaves from weed free (Repeated hand weeding) plot.	118-119
12	A view of silkworms fed with the leaves from Diuron (1.25 kg a.i./ha) treated plot.	118-119
13	A view of silkworms fed with the leaves from Butachlor (1.5 kg a.i./ha) treated plot.	118-119
14	A view of silkworms fed with the leaves from Isoproturon(1.5 kg a.i./ha) treated plot.	118-119

<u>Plate</u>	<u>Title</u>	<u>Between pages</u>
15	A view of silkworms fed with the leaves from Alachlor (1.5 kg a.e./ha) treated plot.	118-119
16	A view of silkworms treated with the leaves from Metolachlor (1.5 kg a.e./ha) treated plot.	118-119
17	A view of silkworms fed with the leaves from Pendimethalin (1.5 kg a.e./ha) treated plot.	118-119
18	A view of silkworms fed with the leaves from Oxyfluorfen (0.25 kg a.e./ha) treated plot.	118-119

LIST OF APPENDIX

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Appendix	Title	Page
1	List of herbicides used in the experiment along with the common name, trade name, chemical name and address of the manufacturer.	156

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# **INTRODUCTION**

## I INTRODUCTION

Sericulture is an agro-based cottage industry par excellence. It is one of the most labour intensive sector of Indian economy comprising both Agriculture and Industry. In its production process sericulture makes a long chain of interdependent specialised operations which provide means of livelihood to a large section of population like silkworm seed producer, farmer-cum-rearer, reeler, twister, weaver, hand spinner of silk waste, traders etc.

High yield with low inputs has been the main objective of Agricultural technology from time immemorial. The same holds good for mulberry cultivation. This objective attains greater importance for success of sericulture industry since the silkworm (Bombyx mori L.) has universal preference for mulberry (Morus spp.) as food plant. The genus Morus belonging to the family Moraceae, has more than twenty species. It is native to Indo-China and found widely distributed in the lower sub-Himalayan region up to an elevation of 2100m above sea level covering both temperate and subtropical regions of the northern hemisphere.

India ranks second among the silk producing countries of the world (10,550 tonnes, Anon., 1990), having an area of 2,21,603 hectares under mulberry. In recent years much emphasis has been given to produce higher quantity of superior quality of raw silk to compete in the International market (Anon., 1988). To achieve this, good efforts are being made to increase the production of good quality mulberry leaves which have a direct influence on the

quality and quantity of raw silk produced.

Karnataka produces more than 60 percent of the country's raw silk production (49.70 lakh Kgs) by having 1,40,456 hectares of area under mulberry cultivation. Today, Karnataka commands the lion's share in silk production. The previous two decades have experienced several structural changes in the Indian Agriculture, in general, by way of green revolution in farming. In particular, Karnataka noticed yet another yellow revolution in increasing her contribution meeting 65.75% of countries demand for mulberry silk.

Mulberry leaf forms the basic food material for silkworm and bulk of the silk produced in the world comes from mulberry silkworm. Mulberry leaf protein is the chief source for a silkworm to biosynthesise the silk which is made up of two proteins fibroin and serine. Nearly 70 percent of the silk protein produced by the silkworm is directly derived from mulberry protein.

Growing of mulberry is the first and foremost prerequisite for successful sericulture. Mulberry is a hardwood plant, the leaves of which constitute a good silkworm feed. Improved quality of leaf at economic cost has a direct bearing on cocoon production which ultimately enhances the income of rural people.

Attempts have been made to improve the pattern of cultivation, methods of pruning and application of fertilizers to maximise the leaf yield per unit area at minimum cost. Weed competition in early stage of crop growth virtually affects the

leaf or grain yield potential of any crop by affecting growth parameters as well as yield components and mulberry is no exception to this. Both Rainfed and Irrigated crops are infested with weeds. India being a tropical country, high temperature and humidity pave the way for luxuriant growth of weeds. The weeds rob the limited soil moisture, nutrients, light and space. As an irrigated crop mulberry receives adequate fertilization and irrigation which are complementing the weed competition with crop.

The age old practice of weed control in mulberry gardens, such as hand weeding and digging is a tedious, time consuming and expensive. The effective weed control methods are essential to obtain higher leaf yield in mulberry crop. The urge towards the scientific farming during recent years emphasise the need for chemical weed control in mulberry crop.

Manual weeding and digging are the chief measures of weed control practised in mulberry cultivation. However, information on chemical weed control in mulberry crop is very scanty. Besides, most of the herbicides were tried at higher doses as a pre or post-emergence for a maximum weed control without considering their effects on the safety of the crop and quality of leaf on silk worm rearing. Therefore, this study entitled "chemical weed control in established mulberry garden and its effect on silkworm and cocoon production" was conducted with the following objectives.

1. To assess the efficacy of herbicides for control of weeds in the established mulberry garden

2. To assess the effect of chemical weed control treatments on growth and leaf yield of mulberry
3. To know the effect of herbicide sprayed mulberry leaves on silkworms and cocoon production and
4. To work out the economics of different weed control treatments.

# **REVIEW OF LITERATURE**

## II REVIEW OF LITERATURE

Weed infestation is one of the limiting factors in crop production. Weeds are often referred to as unwanted, prolific, persistent, competitive and harmful to the total environment. They occur in every crop field particularly in tropical countries like India. Weeds grow at the expense of the crop. As a consequence of this the crop suffers in growth and yield. The relative competitive ability of the crop on one hand and the weeds on the other decides the resultant damage or otherwise.

In this chapter, a brief review pertaining to various aspects of present study have been presented in the following headings:

1. Weed flora in mulberry crop fields
2. Crop-weed competition
3. Methods of weed control and
4. Residual effect of herbicides.

### 2.1 Weed flora in mulberry crop

Das et al. (1971) surveyed the weed flora in mulberry farms of West Bengal and reported 141 species from 44 families of dicotyledons, monocotyledons and Pteridophytes. The most prominent weed flora consisted of Ageratum conyzoides Linn., Blumea mollis (Don.) Merr., Sonchus arvensis Linn., Emillia sonchifolia (L.) D.C., Eupatorium oderatum Linn., Tridax procumbens Linn., Vernonia cinerea (L.) Less., Argemone mexicana Linn., Cleome viscosa Linn., Corchorus olitorius Linn., Oxalis corniculata Linn., Cardiospermum helicacabum Linn., Cassia

accidentalis Linn., Melilotus alba Desr., Tephrosia purpurea (L.)  
Perl., Borreria articularis Linn., Oldenlandia corymbosa Linn.,  
Helitropium indicum Linn., Trichodesma indicum R.Br., Physalis  
minima Linn., Solanum nigrum Linn., Amaranthus viridis Linn.,  
Justicia betonica Linn., Euphorbia hirta Linn., Phyllanthus  
fraternus Webst., Commelina benghalensis Linn., Cyperus rotundus  
Linn., Cyperus iria Linn., Fimbristylis diphylla (Retz.) Valil.,  
Cynodon dactylon Pers., Dactyloctenium aegypticum Beauv.,  
Dicanthium annulatum Stapt., Digitaria setigera Roth., Echinochloa  
colonom (L.) Link., Eleusine indica Caertn., Eragrostis  
diarrhena(Schhrutt) steud., Eragrostis tenella (L.) Beau. and  
Imperata Cylindrica (L.) Beauv.

Dhar et al. (1975) studied the density of weeds in spring and summer season of Kashmir. Most common weeds grown in a normally cultivated mulberry fields during the spring were Caprella bursapastoris Linn., (27.4%), Ageratum conyzoides Linn., (21.4%), Stellaria spp. (21.7%), Chorispora tenella (2.8%), Papaver rhoes Linn., (13.9%) and Fumaria vailantii Lois., and some of the common weed species and their densities in summer were Portulaca oleraceae Linn., (3.8%), Cyperus rotundus Linn., (66.7%), Convolvulus arvensis Linn., (18.3%), Amaranthus viridis Linn., (2.2%), Echinochloa crusgalli (L.) Beauv., (6.2%) and others (2.8%). About a dozen weeds were studied in these fields of which Caprella bursapastoris Linn., Ageratum conyzoides Linn., Stellaria spp., Papaver rhoes Linn. and Chorispora tenella accounted for 95% of the total population.

Further, they have classified the common weeds observed in mulberry plantations of Kashmir valley into broad leaved weeds (Dicots) like Raphanus ramphinistrum Linn., Erophila vulgaris Linn., Brassica rapa Linn., Ageratum conyzoides Linn., Erigeron canadensis Linn., Taraxacum officinate Webster., Conyza stricta Wall., Melilotus alba Medic., Trifolium repens Linn., Trifolium pratense Linn., Medicago lupulina Linn., Lotus corniculatus Linn., Indigofera geradiana Wall., Ranunculus arvensis Linn., Lycopsis arvensis Linn., Thymus serpyllum Linn., Veronica persica Poir., Daucus carota Linn., Convolvulus arvensis Linn., Solanum nigrum Linn., Hypersicum perforatum Linn., Portulaca oleraceae Linn., Oxalis corniculata Linn., Polygonum plebejum Br., Papavera rhoes Linn., Anagalis arvensis Linn., Amaranthus viridis Linn., and narrow leaved weeds (monocots) like Cynodon dactylon Pers., Poa pratensis Linn., Bromus mollis Linn., Agrostis tenuis Sibth., Echinochloa crusgalli (L.) Beauv., Cyperus rotundus Linn., Fumaria vailantii Lois., and Equisetum palustre Linn.

Vijaya and Razi (1975) studied the weed flora of mulberry gardens of Mysore. The most dominant weed species in these gardens belonged to Papilionaceae, Poaceae, Austraceae and Euphorbiaceae. The most prominent weed flora consisted of Lagasca mollis Cav., Tridax procumbens Linn., Celosia argentic Linn., Hibiscus panduraeformis Burm., Bidens biternata (Lour) Merr. and Sherff., Cardiospermum halicacabum Linn., Indigofera glandulosa Linn., Alysicarpus bupleurifolius D.C., Alysicarpus glumaceus (Vahl) DC., Polygala chinensis Linn., Tephrosia pumila Linn., Commelina benghalensis Linn., Striga angustifolia Don., Trianthema

portulacastrum Linn., Mollugo cerviana Linn., and Oxalis carniculata dominated the space between the rows of mulberry. mulberry fields in Annaka district of Japan where a sophisticated refinery is located. They observed 31 families and 72 species of weeds. The most common weeds were observed to be Galinsoga parviflora Cav., Digitaria adscendens Henr., Equisetum arvensis Linn., and Paederia scandens Merrill ( Youzo Usami, 1976).

Vijaya and Razi (1977) and Sikdar and Rao (1977) conducted extensive weed survey of the mulberry gardens of Central Sericultural Research and Training Institute of Mysore. They reported that the occurrence of 130 weeds belonging to 36 families. Papilionaceae and Poaceae represented the dominant families with 23 and 17 species, respectively.

Common weed species observed in mulberry gardens of Central Sericultural Research and Training Institute were (Dicots) Acanthospermum hispidum DC., Ageratum conyzoides Linn., Bidens pilosa Linn., Emilia sonchifolia (L.) DC., Langasca mollis Cav., Parthenium hysterophorus Linn., Galinsoga parviflora Cav., Tridax procumbens Linn., Vernonia cinerea (L.) Less., Xanthium strumarium Linn., Achyranthus aspera Linn., Alternanthera sessilis (L.) R.Br., Polycarpea corymbosa Lamk., Cassia accidentalis Linn., Cleome monophylla Linn., Cleome viscosa Linn., Commelina benghalensis Linn., Euphorbia geniculata art., Croton bonplandianum Baill., Phyllanthus asperulatus Hutch., Phyllanthus niruri auctnon Linn., Phyllanthus maderasoatensis Linn., Convolvulus arvensis Linn., Merremia tridentata (L.) Hall., Leucas aspera (wild) Link.,

Abutilon indicum Sweet., Pavonia Zeylanica Cav., Malvastrum coromandelianum (L.) barcke., sida vernonicaefolia Lamk., Mullugo serviana Ser., Boerhavia diffusa Linn., Oxalis corniculata Linn., Argemone mexicana Linn., Alysicarpus spp., Clitoria ternates Linn., Dermodium trifolium (L) DC., Indigofera Spp., Portulaca oleraceae Linn., Portulaca quadrifolia Linn., Borreria articularis (L) F.N.Will., Cardiospermum halicacabum Linn., Physalis minima Linn., Solanum nigrum Linn., Corchorus trilocularis Linn., Stachytarpheta jamaicensis (L) Vahl., Tribulus terrestris Linn., Cardiospermum halicacabum Linn. and Oldenlandia aspera D.C. And the monocot weeds were Dactyloctenium aegypticum (L) Beauv., Digitaria marginata Link., Echinochloa colonum (L) Link., Eragrostis Pilosa (L) Beauv., Chloris barbata Sw., Brachiaria ramosa (L) stapf., Panicum repens Linn., Cyperus rotundus Linn., Cynodon dactylon Pers., Commelina benghalensis Linn., Cynotis cucuta Kunth. and Eleusine indica Gaertn.

## 2.2 Crop-weed competition

Competition (Milne, 1961) or interference (Harper, 1960) or contest (Miller, 1967) are generally referred to denote the rivalry between the crop and weeds for common demand which eventually runs out of supply or in other words, become a limiting factor. Effect of such a rivalry is reflected through the competitive ability of weeds which can be measured either in terms of weed population, their drymatter production or their nutrient removal, specially nitrogen (Vinod shankar, 1971). It is evident that being adopted to rapid multiplication and better

dissemination, the weeds compete at every stage of crop for nutrients, moisture, light and carbon-di-oxide, thus reducing the quality and quantity of life (Moolani and Sachin, 1966). According to Kulkarni et al., (1973) weeds, apart from reducing the yield, serve as hosts for several pathogens.

### 2.2.1 Critical period of competition

Presence of weeds in crop interferes with crop growth at any stage. Although this may be true to some extent, It is neither economical nor feasible to maintain a completely weed free situation throughout the crop growth period. One must therefore identify the stages of the crop when the damage is severe. Such stages are considered as critical for establishment crop.

Nieto et al. (1968) demonstrated that the maize was most vulnerable to weed competition between 10 and 30 days after emergence, weeds present before and after the critical period had a negligible effect on yield. Panchal and Krishnasastry (1974) reported that the cereal crops should be kept free of weeds for the first 30 to 45 days after sowing to get good yields.

Lawson and Wiseman (1976) have shown that the critical period for weed competition in newly planted raspberry occurs in early summer when the young canes emerge. Weeds left uncontrolled beyond this stage not only smother but also kill some plants, reduce cane vigour, with serious long-term effects on the new plantation. Govinda singh and Vikram singh (1978) observed that the weed free condition in sunflower maintained for the first 60

days after sowing was good at pantanagar. Lall and Yadav (1983) reported that the critical period in case of cereals is generally upto 30 to 35 days from sowing or planting, where as in case of long duration crops the critical period may extend upto 45 days.

### 2.2.2 Effect of weed competition on growth and leaf yield of mulberry

Dhar et al .(1975) reported that the weeds were the constant menace to all cultivated crops including mulberry which was raised as a field crop in Mysore, West Bengal, Tamil Nadu and Andhra Pradesh and as trees in the univoltine belt of India. Weeding, an established cultural operation, has to be carried out regularly to overcome the significant loss of crop yields.

Sikdar (1979) conducted the pot culture experiment to study the effect of nutsedge (Cyperus rotundus L.) on dry weight of mulberry leaves. Two weeds per pot resulted in reduction of mulberry leaf yield by 32.93 to 45.69% over the control. Densities of four, eight and sixteen weeds per pot reduced the dryweight of mulberry leaf to the extent of 47.2 to 48.7%, 52.2 to 54.4% and 64.1 to 89.9% respectively.

Sikdar et al. (1981) assessed the loss of mulberry leaf yield due to different densities of weeds, (0, 4, 8, 16 and 32 /m<sup>2</sup>) maintained by periodic weeding. It was found that the weed densities four, eight, sixteen and thirty-two per square metre reduced the leaf yield by 30.59, 41.29, 45.58 and 57.23 percent, respectively, over weedfree control during the first year and

32.13, 44.15, 52.64 and 62.15 percent, respectively, during the second year. Even the presence of four weeds per sq.m. has reduced the height of the plants, number of branches, number of leaves per plant, dryweight of 20 leaves and finally, the green leaf yield, over the control. The trend is maintained with the increase in weed population. Hence, clean cultivation is suggested to avoid the reduction in plant growth and consequent leaf yield.

### 2.2.3 Competition for Nutrients

Sikdar et al. (1981) reported that weeds compete with mulberry crop for space and nutrients, thus causing considerable reduction in the growth and leaf yield of mulberry.

Rao and Agarwal (1984) reported that the weeds in general accumulated greater nutrients particularly nitrogen and potassium when compared to crop plants. Under competitive situations, the plants with greater competitive ability to dominate over others in respect of the quantum of resources including the available nutrients. Thus, weeds with their prolific seed production, greater root growth and greater number of stomata might have utilised the available nitrogen, potassium and phosphorus in greater quantities at the expense of associate crop plants.

Srinivasan et al. (1987) studied the effect of weed density on nutritive value of mulberry. Weed densities at 4, 8, 16 and 32 weeds per sq.metre reduced the nutrient status of mulberry leaf and the resultant loss was of the order of 4,590 to 8,615 kg. of

moisture, 302 to 371 kg. of crude protein, 39.43 to 72.37 kg. of reducing sugars and 219.7 to 449.9 kg. of total sugar per hectare.

Srinivasan et al. (1987) reported that the competition of weeds had resulted in the reduction of moisture content of the mulberry leaves. Weed densities at 4, 8, 16 and 32 weeds per sq.m. reduced the nutrient content of mulberry leaf and the resultant loss was of the order of 62.36 to 65.42% moisture, 7.95 to 11.12% of crude protein, 0.56 to 1.20% of reducing sugars and 6.37 to 8.94% of total sugars on dryweight basis.

Since the mulberry leaf is the only source for the silkworm to synthesize the silk protein, the leaf protein loss due to different weed densities significantly reduced the yield of silk. The crude protein of mulberry leaf and its loss was calculated on drymatter basis. It was estimated that the reduction in crude protein value ranged from 1.08 to 3.17% from the density of 4 to 32 (Srinivasan et al., 1987).

Total sugar content of mulberry was also affected by weed density. With increase in weed densities, the corresponding loss in total sugar content was also highly significant as compared to the control plots with no weeds, leaf samples from plots with 32 weeds showed the higher loss in total sugars (Srinivasan et al., 1987).

De et al. (1988) reported the mineral composition of important weeds of lateritic belt of West Bengal. It was also revealed that the individual weed species could have nutrient elements to the maximum amount of 3.93% N, 0.57% P, 4.37% K, 1.70% Ca, 0.55% Fe, 0.015% Zn, 0.23% Mn, 0.016% Cu and 0.754% Na.

#### 2.2.4 Competition for moisture

Arakeri et al. (1962) have inferred that the moisture lost through transpiration by weeds was often much greater than that of transpiration through crop. Under dry land conditions at Sholapur, the transpiration co-efficient at flowering stage of some of the weeds were 556 for Ischaenum pilosum, 813 for Cynodon dactylon, 1108 for Tephrosia purpurea, and 1402 for Tridax procumbens (Kanitkar et al., 1960), while the transpiration co-efficient for crops like Jowar, Wheat, Maize and Rice was 437, 554, 337 and 811 respectively.

Bodade (1965) calculated that every ton of weeds removed 7.6 cm of rainfall which was sufficient to retard the growth of crop for want of moisture.

#### 2.2.5 Competition for light

About 90 percent of drymatter in plants is made up of organic matter that is dependent on solar energy. When plants were mutually shaded, their production potential is greatly reduced even though water and other nutrients are available in abundance. During the seasons when weeds grow earlier to crop plants in the field, the crop seedling even in newly planted mulberry cuttings get shaded and became chlorotic and weak. This effect of weeds was most pronounced in slow germinating crops like sugarcane, potatoes and groundnut (Donald, 1961). Under these situations, crops and weeds could be growing simultaneously, but weeds owing to the faster development rate, would out-grow the crop plants in a short span of time and thus shade the crop plants, particularly,

newly planted mulberry crop deprived from the much needed solar energy. This has been very clearly evidenced in the work of Moolani and Sachin (1966).

#### 2.2.6 Competition for Space

Weeds compete for space both in the rhizosphere and atmosphere, crop plants growing amidst weeds develop limited root volume which absorbs less moisture and mineral nutrients from the soil than the weed free crop plants. In the presence of weeds, crop plants also have limited space to develop their shoots which accounts to reduced photosynthesis. King (1966) reported that in many cases, smothering out of crops by masses of weed growth is literally what takes place, through the dwarfing and eventual disappearance of the crop plant in such situations is probably due to shading.

Sikdar et al. (1981) reported the loss of mulberry yield due to different weed densities. The results indicated that the growth of mulberry was affected due to weed densities, 4, 8, 16 and 32 per sq.m. and also reduced the leaf yield by 31, 41, 46 and 57 percent, respectively. Thus, competition for space involves occupying space around or very near to the crop plants.

#### 2.3 Methods of Weed Control

The most commonly employed methods of weed control are mechanical (hand weeding, cultural operations, etc.) and chemical methods. The final choice of any method will depend largely on its effectiveness and economy.

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### 2.3.1 Mechanical Methods

The mechanical and cultural methods of weeding are most common methods of weed control. Although herbicides are fast replacing the traditional methods, mechanical methods of weed control are still practiced in India. Mechanical methods include tillage, hoeing, hand weeding, mowing, digging, burning, flooding, etc.

Bodade (1965) reported that harrowing and hoeing some times helps in the multiplication of weeds rather than killing the weeds. Another disadvantage of hoeing was that, it disturbed the soil and brings the weed seeds from the lower strata to the surface, thus aiding in their continued emergence throughout the crop season (Hosmani, 1966).

Santelmann and Davis (1965) observed that the removal of weeds by machinery, though effective were often laborious, costly and became impossible when plants spread in the later stages. They concluded that the weeds in the crop rows escape unhurt and in the absence of other weeds in between rows, the weeds grow with added vigour.

Gupta and Lamba (1978) stated that in any weed control system for crop land, there is no substitute to good crop husbandry methods, involving selective stimulation of crops, stale seed beds, crop rotation, summer fallowing, competitive crops, suitable time and method of planting. Rotation of crops helps in improvement of soil physical properties and also check the weeds growth.

Krishna sastry et al. (1980) stated that wherever possible, it is better to prevent the outgrowth of weeds rather than attempting to control, after it's establishment. Use of clean seeds, well decomposed farmyard manure, keeping irrigation channel and bunds free from weeds and implements free from contamination with weed seeds, helps in preventing agricultural fields from weed infestation.

### 2.3.2 Chemical Methods

Weed control in any crop can be achieved by cultural methods and by using herbicides. Hand weeding is commonly adopted in almost all areas in Asia. Since manual weeding does not provide timely control apart from its time-consuming and expensive nature, inclination towards use of herbicides for control of weeds is gaining importance in recent past.

Ashton and Crafts (1973) reported that the chemical method of weed control appeared as a miracle of our technological age; the very word miracle, implies that chemical control of weeds with very small quantities of herbicides is beyond human understanding and it is true that few general principles of chemical weed control have been formulated, rather, each use of a particular herbicide for selective weed control in any individual crop is highly specific. The choice of herbicide for a particular situation depend upon several variables including climate, soil type, prevalence of weed species, crop cultivar, method of propagation and management. A herbicide effective and safe for strawberries in North America may not be so in Scotland (Stephens, 1982).

Use of chemicals to control weeds has become an established practice in many of the technologically advanced countries. It is claimed that in recent years, invention and use of weedicides in agriculture has been the most revolutionary technology. In India it is becoming popular, but usage is very limited. A chemical, when sprayed in a crop field controls weeds without any damage to the crop is called a weedicide or herbicide (Krishna sastry et al., 1980).

The earliest known account of selective chemical weed control is by Varro in the first century B.C., who refers to the use of 'amurca', the fluid residue left after the extraction of olive oil from olives, poured around the base of olive trees or whenever noxious growth of weeds grow in the fields, the weeds were, he claimed, killed. The herbicidal compound most consistently referred to over the centuries is common salt (Sodium chloride) and the phytotoxicity of amurca may well have been due to its salt content. Several other inorganic compounds including Sodium arsenite, Sodium chlorate, Borax, Ammonium thiocyanate and more recently Ammonium sulphamate have been found highly effective as total weed killers for use on uncropped areas (Stephens, 1982).

#### 2.3.2.1 Pre-emergence application of herbicides

Herbicides must be applied at proper time, dose, soil condition and through proper method of application, where it should be more destructive to weeds without interfering with the growth of crop plants.

Das and Prasad (1972) conducted the chemical weed control experiment in mulberry with pre-emergence application of Dalapon and Simazine in order to determine the optimum dose and time of application at Central Sericultural Research and Training Institute, Berhampur, West Bengal. Simazine was found to be more efficient than Dalapon for controlling most of the weeds except Cyperus rotundus L. The combination of Dalapon and Simazine at 5-6 kg and 1-3 kg/ha was most effective as compared to other combinations as pre-emergence than post-emergence.

Kim et al. (1973) conducted the experiment on chemical weed control in mulberry with Pre-emergence application of Simazine, Alachlor, Butachlor, Diuron and Linuron in spring and autumn, Simazine at 1.5 kg/ha and Alachlor at 3.5 kg/ha gave best weed control. When weed density was low in spring, no differences in mulberry yield were found between treatments. But there was a significant difference in leaf yield in autumn, where Simazine gave highest leaf yield.

Kasiviswanathan et al. (1978) reported that out of ten herbicides screened, Diuron 3 kg/ha significantly reduced the weed density, and no phytotoxicity on the foliage of mulberry and obtained increased leaf yield over control. Dalapon, Atrazine, 2,4-D Sodium salt and Simazine though effective in controlling weeds, had phytotoxic effect on mulberry.

Sikdar et al. (1985) reported the effects of diuron and 2,4-D Sodium salt on mulberry at 2.0, 4.0, 8.0 and 16.0 kg/ha, respectively. First spray was soil applied as pre-emergence after

bottom pruning of mulberry in the month of April and second spray after the harvest of leaves in the month of July. The results indicated that higher concentration of both the herbicides were detrimental to mulberry crop as compared to lower concentrations. The leaf yield of mulberry as compared with control (water spray) was not reduced in the lower concentrations of herbicides.

Muniyappa and Bommegowda (1988) reported that out of the fourteen pre-emergence herbicides screened in three concentrations along with unweeded check and hand weeding, the pre-emergence application of Diuron, Metaxuron, Isoproturon, Methabenzthiazuron, Fluchloralin, Oxyfluorfen and Oxadiazine were effective in controlling weeds and gave higher yield per plant as compared to unweeded check. Whereas, pre-emergence application of Metribuzine, Atrazine, Simazine and Dicamba inhibited germination, growth and resulted in reduced yield of mulberry leaves.

Chandrasekaran and Venkatakrishnan (1991) conducted the field experiment to evaluate the effect of Pendimethalin, Diuron, Alachlor, Atrazine and Butachlor on weed control in mulberry nursery. Though highest concentration of Diuron (2.5 kg/ha) and Pendimethalin (4.0 kg/ha) has also controlled the weeds effectively, phytotoxicity symptoms were observed in Alachlor treated plots.

#### 2.3.2.2 Effect of herbicides on nutritive value of Mulberry

Homma and Itoh (1977) reported the effect of Simazine on the drymatter budget of plants. The results indicated that the treatment with  $10^{-4}$  M Simazine per kg drysoil reduced the

photosynthesis, respiration, chlorophyll, sugar and starch content in mulberry leaves. There was decrease in these parameters with higher concentration of simazine.

Homma and Itoh (1977) further reported the effect of Simazine, on the nutrient uptake by mulberry roots. The results indicated that the treatment with  $10^{-4}$  M and higher concentrations of Simazine strikingly inhibit uptake of phosphorus, the inhibition co-efficient being 85-93% in 96 hours after the treatment and tended to inhibit the uptake of potassium, Nitrogen, water and ammonia. The uptake of calcium was less inhibited than the uptake of above-cited nutrients, the co-efficient of inhibition with  $10^{-5}$  M being about 25% in 96 hours.

Homma and Mochizuki (1977) reported that the increased concentration of Simazine in soil resulted in decreased amount of reducing sugar, non-reducing sugar and starch contents of mulberry trees. The carbohydrate contents were particularly decreased in the samplings from the plot treated with  $10^{-3}$  M Simazine per kg dry soil. The decreased carbohydrate contents may be considered to be attributed to the effect that the photosynthesis in leaves of the samplings had been suppressed by the treatment. Thus, the growth of mulberry trees is greatly retarded.

#### 2.3.2.3 Effect of herbicides on growth and yield of mulberry

Homma and Itoh (1977) reported that the Simazine treatment retarded the dryweight and growth of mulberry plants and decreased the carbohydrate contents of mulberry leaves as compared to

untreated plants. Even if the residual Simazine in the plant disappeared by the following spring, the decreased storage of carbohydrates would greatly influence the early growth of plant.

Kasiviswanathan et al. (1978) reported that the leaf yields obtained from no weeding, hand hoeing and Diuron treated plots were same during first year. In subsequent year, Diuron treated plots gave the highest leaf yield followed by hand-hoeing as compared to unweeded plots. Whereas Simazine treated plots have the highest leaf yield in the third year followed by hand-hoeing, Alachlor and Diuron, the differences were not significant. Among ten herbicides screened, Butachlor, 2,4-D Sodium Salt and Diuron showed no phytotoxicity on the foliage of mulberry, while the remaining seven herbicides showed slight to severe injury on the foliage of mulberry.

Sikdar and Krishnaswamy (1980) reported that the hand weeding gave better control of weeds and highest leaf yield of 17,040 kg/ha, followed by Paraquat 4 lit/ha (post-emergence) with 16,391 kg/ha leaf yield as compared to no weeding (13,501 kg/ha). Here the Paraquat was sprayed after each leaf harvest, physical injury was not observed throughout the course of study.

Sikdar et al. (1987) conducted the field experiment to evaluate the effectiveness of 4 combinations of 3 herbicides, viz. MSMA+ Diuron, MSMA + Paraquat, Diuron + paraquat and MSMA + Paraquat + Diuron herbicidal combinations, as well as hand weeding gave satisfactory weed control. No toxic effects of herbicides were found on the foliage of mulberry. Significant increase in

growth parameters like plant height, branches per plant, number of leaves per plant and dryweight of hundred leaves over unweeded control. Nearly 47-54 percent increase in leaf yield was obtained in all the treatments over no weeding. MSMA 1 litre + Paraquat 1.2 litre a.i./ha and MSMA 2 litres + Diuron 1 kg a.i./ha were compared favourably with hand weeding.

#### 2.3.2.4 Effect of herbicides on Silkworm larvae, cocoon and silk production

Verry little work has been done on the effect of herbicides on silkworm rearing, its influence on larvae, cocoon and silk production,

Kasiviswanathan et al. (1978) studied that the mulberry leaves from herbicides treated plots were harvested and fed to the silkworm from 4th instar onwards. The results indicated that weight of mature larvae was lower when fed with leaves from unweeded plots and higher larval weight was recorded in case of those fed with leaves from herbicide treated plots like Diuron, Alachlor, 2,4-D, Simazine, Amitrol and Atrazine.

Miyashita (1986) reported that the main factors contributing for successful harvest of cocoon crops are identified as a mulberry leaf 38.2 per cent, Silkworm eggs 3.1 per cent and others 6.6 per cent. Thus the physical and chemical properties of leaves have significant effect on silkworms.

Muniyappa (1990) studied that the mulberry leaves from herbicide treated plots were harvested and fed to the silkworm

from 2nd instar onwards. The results indicated that weight of mature larvae, cocoon and silk quality parameters were lower in case of those fed with the leaves from unweeded plots and higher in case of those fed with the leaves from plots treated with herbicides like Diuron, Diuron + Paraquat, Fluchloralin, Fluchloralin + Paraquat and 2,4-D Na salt. In respect of single cocoon, single shell weight, shell percentage and absolute silk content, there was not much difference between herbicides and unweeded control plots and thereby indicating that there was no residual effect of herbicides on silkworm. Further more, there was no deleterious effect on using the leaves from herbicide treated plots after safety period, viz., two months after spraying. No phytotoxicity effect on mulberry was noticed under Diuron treated plots.

#### 2.4 Residual effect of herbicides on mulberry

Homma and Itoh (1977) reported that the treatment with  $10^{-4}$  M Simazine per kg. of dry soil resulted in slight phytotoxicity. However, the Simazine with  $10^{-2}$  M per kg of dry soil inhibited the development of new leaves and gave rise to chlorosis and necrosis of the mulberry leaves, leading to leaf fall.

Krishnaswami et al. (1978) reported that out of ten herbicides screened, Butachlor, 2,4-D Na Salt and Diuron showed no phytotoxicity on the foliage of mulberry. However, 2,4-D Amine salt, 2,4-D Ethyl ester and Aminotriazole treated plots showed moderate injury to the foliage of mulberry, whereas Dalapon, Atrazine and Simazine treated plots showed severe injury to the foliage of mulberry, besides controlling all the broad leaved

weeds by the all herbicide treatments. Cynodon dactylon was effectively controlled by Diuron, Atrazine, Dalapon and Simazine while Cyperus rotundus was fairly controlled by 2,4-D Sodium salt, Butachlor and Dalapon. diuron applied to the soil controlled almost all annual weeds without any phytotoxic effects.

Sikdar et al. (1985) observed that the highest concentration of Diuron (Diuron 4.0 and 16 kg a.i./ha) resulted in severe leaf burning and death of the stumps, whereas at higher concentration of 2,4-D Na salt, morphological (2,4-D Na salt, 8.0 and 16 kg. a.i./ha) defects like chlorosis and interveinal chlorosis were observed for a period of 30 days after which plants were able to resume normal growth. Diuron at 8.0 and 16.0 kg. a.i./ha reduced the height of the plants, number of leaves per plant and their weight and the leaf yield was significantly reduced in 16.0 kg. a.i./ha concentration only. On the other hand, 2,4-D Na salt reduced the plant height in all the higher concentrations and number of leaves at 16.0 kg. a.i./ha. Thus higher concentration of Diuron was harmful and adversely affected the growth and leaf yield of mulberry. However, the lower concentration of both the herbicides did not reduce leaf yield compared to control (water spray).

Muniyappa and Bommegowda (1988) observed that the pre-emergence application of Metribuzine 1.5 kg/ha, Atrazine 1.5 kg/ha, Simazine 1.5 kg./ha and Dicamba 0.75 kg./ha inhibited germination and growth of newly planted Mulberry.

# **MATERIAL AND METHODS**

### III MATERIAL AND METHODS

The details of materials used and techniques adopted during the course of study on "Chemical weed control in established Mulberry Garden and its effect on silkworms and cocoon production" are described in this Chapter.

#### 3.1 Location of the experimental plot

The experimental site is situated at 12° 58' North Latitude and 77° 35' East Longitude at an elevation of 930 metres above mean sea level.

#### 3.2 Soil

The topography of the experimental site was fairly uniform with a gentle gradient towards western side. The physical and chemical properties of the soil along with the methods followed for determination are presented in Table-1.

The soil type of the experimental site was red sandy clay loam. The clay content of the soil varied from 18.9 to 34.6 percent as the depth increased. The silt content varied from 8.6 to 9.48 percent and fine sand from 29.1 to 38.0 percent. The field capacity values of the soil in 0-15 and 15-30 cm depths were 14.3 and 17.7 percent, respectively. The bulk density of the soil in 0-15 and 15-30 cm depths were 1.59 g and 1.54 g per cc. respectively. The soil of the experimental site (0-15 cm.) was slightly acidic in reaction (6.2) and was low in available nitrogen and phosphorus and medium in respect of available potassium.

Table - 1: Physical and Chemical Characteristics of Experimental site.

Characters	Soil depth(cm)		Method
	0-15	15-30	
<b>I. <u>Physical properties</u></b>			
<b>A. Mechanical composition: (% on over-dry basis)</b>			
1. Coarse Sand	34.50	26.75	Bouyoucos Hydro- meter method (Piper, 1966)
2. Fine Sand	38.00	29.10	
3. Silt	8.60	9.48	
4. Clay	18.90	34.67	
5. Soil type	Red sandy	Clay loam	
<b>B. Single value physical constants:</b>			
1. Bulk density (g/cc)	1.59	1.54	Core Sampler method (Piper, 1966) Field method (Piper, 1966)
2. Field capacity (%)	14.30	17.70	
3. Permanent wilting point (%) at 1500 megapascal	6.50	9.30	Pressure Plate metho (Richards, 1954)
<b>II. <u>Chemical Properties</u></b>			
1. Soil reaction (pH)(1:2.5)	6.20		Potentiometry (Jackson, 1973)
2. Electrical conductivity at 25°C (mmhos/cm)	0.24		Conductivity bridge (Jackson, 1973)
3. Organic carbon (%)	0.38		Walkely & Blacks Wet Oxidation method (Jackson, 1973)
4. Available Nitrogen (kg/ha)	188.00		Alkaline Permanganat method (Jackson, 1973)
5. Available Phosphorus (kg/ha)	18.40		Bray's method (Jackson, 1973)
6. Available Potassium (kg/ha)	224.00		Flame Photometer (Jackson, 1973)

### 3.3 Climatic conditions

The normal (1975-90 and 1975-91) as well as actual weather data on total rainfall (mm), mean monthly maximum and minimum temperature ( $^{\circ}\text{C}$ ), mean relative humidity (%), mean daily bright sunshine hours and open pan evaporation (mm/day) that prevailed during the period of crop growth (September 1991 to February 1992) are presented in Table-2, and graphically illustrated in Fig 1.

The total rainfall during the crop growth period was 766.00 mm, which was more than normal by 335.00 mm. The rainfall during the crop growth was more than the normal in the months of October (+405.90 mm), November (+96.60 mm) and January (+4.60 mm), while it was less than the normal in the months of September (-149.80 mm), December (-13.80 mm) and February (-8.50 mm).

The mean maximum temperature during the crop growth period was more than the normal in the months of September ( $+0.60^{\circ}\text{C}$ ) and December ( $+0.30^{\circ}\text{C}$ ), while it was less than the normal in the months of October ( $-1.30^{\circ}\text{C}$ ), November ( $-1.40^{\circ}\text{C}$ ), January ( $-1.4^{\circ}\text{C}$ ) and February ( $-0.8^{\circ}\text{C}$ ). The mean minimum temperature during the crop growth period was more than the normal in the months of September ( $+0.3^{\circ}\text{C}$ ), October ( $+0.2^{\circ}\text{C}$ ), November ( $+0.6^{\circ}\text{C}$ ) and February ( $+1.3^{\circ}\text{C}$ ), while it was less than the normal in the months of December ( $-1.4^{\circ}\text{C}$ ) and January ( $-1.4^{\circ}\text{C}$ ).

The mean relative humidity during the crop growth period was more than the normal in the months of October (+7.0%), November (+7.0%), December (+2.0%), February (+7.0%), while it was less than the normal in the months of September (-3.0%) and January (-1.0%).

Table - 2: Normal (From 1975-1990 and 1975-1991) and Actual (1991 and 1992) monthly weather data prevailed during Crop Growth period at Gandhi Krishi Vignana Kendra (G.K.V.K.), Bangalore.

Months	Rainfall (mm)		Mean Temperature (°C)				Mean Relative Humidity (%)				Mean Daily Sunshine (hrs./day)				Open Pan Evaporation (mm/day)			
	1975-90		1975-90		1975-90		1975-90		1975-90		1975-90		1975-90		1975-90		1975-90	
	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D
September	216.70	66.90	-149.80	28.10	28.70	+0.60	18.70	19.00	+0.30	73.00	70.00	-3.00	5.10	8.10	+3.00	5.80	5.50	-0.30
October	135.00	540.90	+405.90	28.10	26.80	-1.30	18.10	18.30	+0.20	70.00	77.00	+7.00	6.80	5.60	-1.20	5.20	5.00	-0.20
November	55.60	152.20	+96.60	26.90	25.50	-1.40	16.30	16.90	+0.60	70.00	77.00	+7.00	7.00	6.20	-0.80	4.70	4.80	+0.10
December	13.80	0.00	-13.80	26.40	26.70	+0.30	14.50	13.10	-1.40	67.00	69.00	+2.00	7.90	9.20	+1.13	4.90	5.30	+0.40
1975-91	1975-91	1992	1975-91	1975-91	1975-91	1992	1975-91	1992	1975-91	1992	1975-91	1992	1975-91	1992	1975-91	1992	1975-91	1992
January	1.40	6.00	+4.60	27.20	25.80	-1.40	13.60	12.20	-1.40	62.00	61.00	-1.00	9.30	8.50	-0.80	5.60	5.00	-0.60
February	8.50	0.00	-8.50	30.00	29.20	-0.80	15.10	16.40	+1.30	55.0	62.00	+7.00	10.00	9.50	-0.50	6.80	5.70	-1.10
Total: Seasonal Rainfall	431.00	766.00	+335.00															

Note: N = Normal (1975-1990/91)  
A = Actual (1991/1992)  
D = Deviation.

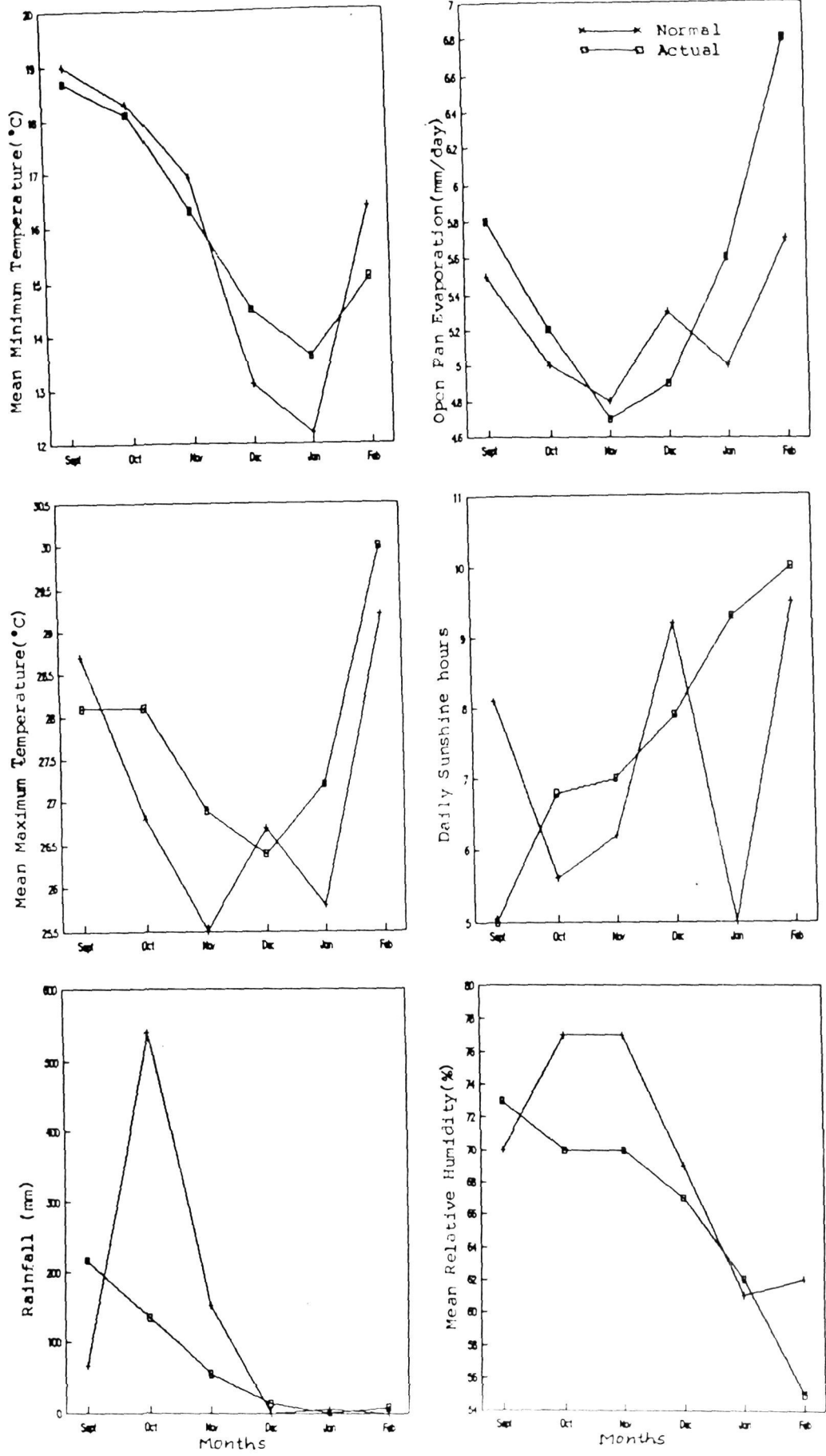


Fig.1: Normal (From 1975-1990 and 91) and Actual (1991 and 92) mean monthly meteorological data for crop growth period at G.K.V.K., Bangalore.

The daily sunshine hours during the crop growth period were more than the normal in the months of September (+3.0 hr), December (+1.3 hr) and less in the months of October (-1.2 hr), November (-0.8 hr), January (-0.8 hr) and February (-0.5 hr).

The open pan evaporation was more than the normal in the months of November (+0.1 mm/day), December (+0.4 mm/day) and was less in the months of September (-3.0 mm/day), October (-0.2 mm/day), January (-0.6 mm/day) and February (-1.1 mm/day).

### 3.4 Cropping History

The field experiment was laid out in plot 7 of block-F, GKVK, University of Agricultural Sciences, Bangalore. The experimental site was maintained with mulberry crop for last 3-4 years.

### 3.5 Experimental details

The treatments of the experiment consisted of 5 emulsified concentrations and 2 powder formulation of herbicides used as pre-emergence application, repeated hand weeding and unweeded control. Thus, there were 16 weed control treatments.

#### 3.5.1 Treatment details

T<sub>1</sub>: Repeated hand weeding at 15 day intervals throughout the crop period.

T <sub>2</sub> : Diuron	1.00 kg a.i./ha pre-em.
T <sub>3</sub> : Diuron	1.25 kg a.i./ha pre-em.
T <sub>4</sub> : Butachlor	1.25 kg a.e./ha pre-em.
T <sub>5</sub> : Butachlor	1.50 kg a.e./ha pre-em.
T <sub>6</sub> : Isoproturon	1.25 kg a.i./ha pre-em.
T <sub>7</sub> : Isoproturon	1.50 kg a.i./ha pre-em.

T <sub>8</sub> : Alachlor	1.25 kg a.e./ha pre-em.
T <sub>9</sub> : Alachlor	1.50 kg a.e./ha pre-em.
T <sub>10</sub> : Metolachlor	1.25 kg a.e./ha pre-em.
T <sub>11</sub> : Metolachlor	1.50 kg a.e./ha pre-em.
T <sub>12</sub> : Pendimethalin	1.25 kg a.e./ha pre-em.
T <sub>13</sub> : Pendimethalin	1.50 kg a.e./ha pre-em.
T <sub>14</sub> : Oxyfluorfen	0.12 kg a.e./ha pre-em.
T <sub>15</sub> : Oxyfluorfen	0.25 kg a.e./ha pre-em.
T <sub>16</sub> : Unweeded control	-

### 3.5.2 Design and layout

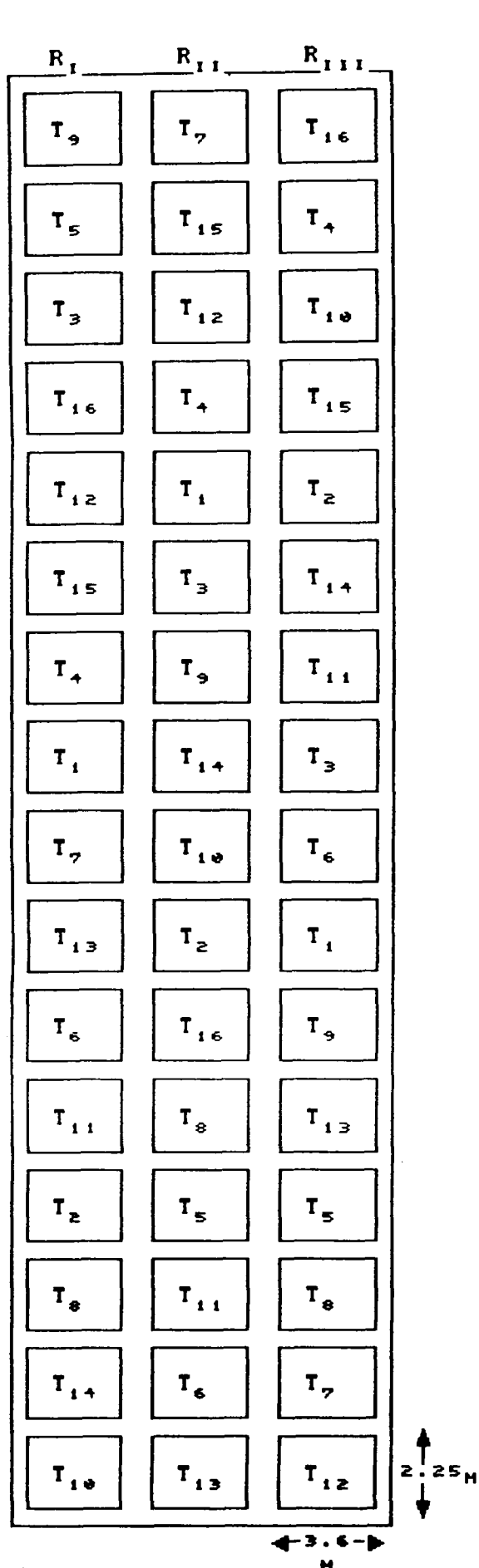
The experiment was laid out in randomized complete block design with 3 replications. The plan of layout of the experiment is given in Fig. 2.

### 3.5.3 Plot size

Gross plot size:	3.60 m x 2.25 m = 8.10 m <sup>2</sup>
Net plot size:	2.40 m x 1.80 m = 4.32 m <sup>2</sup>

### 3.5.4 Variety

The mulberry variety selected for the study was Kanva-2 (Mysore selection No.5), which is an improved selection from local, evolved by the Central Sericultural Research and Training Institute, Mysore. Now it is widely grown under intensive cultivation in almost all parts of Karnataka. It is a high yielder than local variety and yields 40,000 to 45,000 kg per hectare under recommended package of practices for a period of one year with 5-6 leaf pickings or cuttings.



**LEGEND :**

- T<sub>1</sub> = Repeated Hand Weeding
- T<sub>2</sub> = DIURON 1.00 Kg a.i./ha
- T<sub>3</sub> = DIURON 1.25 Kg a.i./ha
- T<sub>4</sub> = BUTACHLOR 1.25 Kg a.e./ha
- T<sub>5</sub> = BUTACHLOR 1.50 Kg a.e./ha
- T<sub>6</sub> = ISOPROTURON 1.25 Kg a.i./ha
- T<sub>7</sub> = ISOPROTURON 1.50 Kg a.i./ha
- T<sub>8</sub> = ALACHLOR 1.25 Kg a.e./ha
- T<sub>9</sub> = ALACHLOR 1.50 Kg a.e./ha
- T<sub>10</sub> = METOLACHLOR 1.25 Kg a.e./ha
- T<sub>11</sub> = METOLACHLOR 1.50 Kg a.e./ha
- T<sub>12</sub> = PENDIMETHALIN 1.25 Kg a.e./ha
- T<sub>13</sub> = PENDIMETHALIN 1.50 Kg a.e./ha
- T<sub>14</sub> = OXYFLUORFEN 0.12 Kg a.e./ha
- T<sub>15</sub> = OXYFLUORFEN 0.25 Kg a.e./ha
- T<sub>16</sub> = Unweeded Control.

**FIG. 2: PLAN OF LAY-OUT.**

### 3.5.5 Spacing

The spacing given was 60 cm between rows and 22.5 cm between plants within rows.

### 3.5.6 Date of establishment

The mulberry was planted on September 22, 1987.

### 3.5.7 Herbicides used

#### 1. Diuron (Karmex) 80 WP

It belongs to Urea group, the chemical name of Diuron is 3-(3,4-dichlorophenyl)-1,1-dimethyl urea. It is a pre-emergence selective herbicide for controlling emerging grass and broad leaved weeds.

#### 2. Butachlor (Machete) 50 EC

It belongs to amide group, the chemical name of Butachlor is N-(butoxymethyl)2-chloro-2, 6-diethyl acetanilide. It controls most annual grasses and some broad leaved weeds. It is applied at pre-emergence in EC formulation and at post-emergence in the form of granules.

#### 3. Isoproturon (Aerlon) 75 WP

It belongs to Urea group. The chemical name of Isoproturon is 3(4-Isopropyl phenyl)1,1-dimethyl urea. It controls most annual grasses and some broad leaved weeds. It is recommended as pre-emergence and also as early post-emergence herbicide.

#### 4. Alachlor (Lasso) 50 EC

It belongs to amide group. The chemical name of alachlor is 2-chloro-2,6-diethyl-N-(methoxymethyl)acetanilide. It controls most annual grasses and certain broad leaved weeds. It is recommended as pre-emergence and also as early post-emergence herbicide.

#### 5. Metolachlor (Dual) 50 EC

It belongs to amide group. The chemical name of Metolachlor is 2-chloro-N(2-ethyl 1, 6-methyl phenyl)-N-(2-methoxy-1-methylethyl) acetanilide. Metolachlor is applied at pre-emergence for the control of annual and some perennial grasses.

#### 6. Pendimethalin (Stomp) 30 EC

It belongs to dinitroaniline group. The chemical name is N-(1-ethyl propyl)-3,4-dimethyl 1-2,6-dinitro benzenamine. It controls most annual grasses and certain broad leaved weeds. It is recommended as pre-emergence and also applied as a pre-plant soil-incorporation treatment.

#### 7. Oxyfluorfen (Goal) 235 EC

It belongs to Diphenyl ethers group. The chemical name is 2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-trifluoromethyl)benzene. It is used as a pre-emergence and also as post-emergence herbicide found to be effective against broad leaved weeds.

### 3.6 Cultural practices

#### 3.6.1 Land preparation

The established mulberry land was dug with the help of

guddali for twice to get good tilth. The bunds were reconstructed and each plot was levelled using manual labour.

### 3.6.2 Pruning of Mulberry

Before taking up the proposed treatments the mulberry crop was pruned to the bottom by leaving 30-40 cm shoots above the ground level.

### 3.6.3 Fertilizer application

Fertilizers were placed near the root zone and mixed well into the soil. A common fertilizer dose of 300 N, 120 P<sub>2</sub>O<sub>5</sub> and 120 K<sub>2</sub>O kg/ha/year, respectively. As basal dose 'N' was applied at 60 kg/ha and the remaining 'N' was applied after each harvest of a total of five harvests in a year. Source of nutrients was complex fertilizers 17:17:17 (N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O) and Urea.

### 3.6.4 Pre-emergence application of herbicides

Powder formulation and liquid formulation herbicides were applied on the second day after pruning. The calculated quantity of herbicide formulations were prepared and sprayed uniformly in the plots as per the treatment.

## 3.7 After care

### 3.7.1 Water management

The experimental plot was irrigated once in 10 to 15 days based on climatic conditions.

### 3.7.2 Weeding

In case of hand weeding treatment where it was to be

maintained as weed free, and hand weeding was done on 15th, 30th, 45th and 60th day after pruning and at harvest. Plots receiving the treatment number 16 were left unweeded as per the treatment. No weeding was done in the plots receiving herbicide application.

### 3.8 Harvesting of leaves

Harvesting of the leaves was done by hand picking. The total amount of leaves harvested in each net plot was recorded and converted into hectare for comparison of yields. However, five labelled plants were exclusively maintained for recording biometric observations. At the end of each leaf harvest, yield per plant was recorded based on the mean of these five plants. Care was taken not to pluck any leaves from these plants at any stage of growth period. The crop harvested at an interval of two and half months (75 days).

### 3.9 Silkworm rearing

The worms were reared on these leaves obtained in the experimental plots after second instar onwards of silkworms. Assessment of larval growth and its effect on cocoon production was studied. The rearing performance was evaluated with only one rearing, during winter.

### 3.10 Observations

All observations were recorded as described on next page separately for each treatment in the net plot area of each plot and the mean figures are presented for comparison.

### 3.10.1 Observations on weeds

#### 3.10.1.1 Weed control and crop toxicity ratings

Visual ratings were made at 15th, 30th, 45th, 60th day after pruning of mulberry and at harvest, to know the extent of weed control and to know the extent of toxicity caused by different herbicides as given by De Datta et al. (1968).

The weed control ratings were made from one to five point scale as follows.

<u>Scale</u>	<u>Weed control</u>
1.00	Excellent control
2.00	Good control
3.00	Fair control
4.00	Poor control
5.00	No control

The crop toxicity ratings made from one to five point scale as follows.

<u>Scale</u>	<u>Weed control</u>
1.00	No toxicity
2.00	Slight toxicity
3.00	Moderate toxicity
4.00	Severe toxicity
5.00	Toxic

#### 3.10.1.2 Weed count

Observations on monocot, dicot, sedges and total weed populations were separately recorded from a square meter area which was permanently marked in the net plot at different growing periods and at harvest.

#### 3.10.1.3 Dry matter production of weeds (g)

Observations on monocot, dicot, sedges and total dry matter

production of weeds were separately recorded at 15, 30, 45 and 60 days after pruning and at harvest. In the destructive sampling area, weeds were removed from 0.5 square meter area, air dried and oven dried at 65 - 70°C and dry weight was recorded.

#### 3.10.1.4 Weed Index(%)

Weed index was worked out by following the procedure given by Gill and Vijaykumar (1969). Weed Index is the reduction in crop yield due to the presence of weeds in comparison with weed-free plot expressed as percentage. In other words, the Weed index expresses the competition offered by weeds as measured by percent reduction in yield owing to their presence in the field.

$$\text{Weed Index} = \frac{x - y}{x} \times 100$$

where, x = Leaf yield of weed free plot, and

y = Leaf yield from the treatment for which weed index is to be worked out.

#### 3.10.1.5 Weed Control Efficiency (%)

Weed Control Efficiency was calculated using the formula:

$$\text{Weed Control Efficiency (\%)} = \frac{\text{DWC} - \text{DWT}}{\text{DWC}} \times 100$$

where, DWC = Drymatter of weeds in unweeded control plot, and

DWT = Drymatter of weeds in the treated plot.

and is expressed as a percentage.

#### 3.10.1.6 Nutrient Uptake by weeds

Nitrogen, phosphorus and potassium uptake by weeds were

estimated. The dried weed samples were finely ground and powdered samples were used for the estimation of nutrients. Nitrogen estimation was made by Kjeldahl's method, Phosphorus was determined by Wet acid digestion method and Potassium content was estimated by Flame photometer, as described by Jackson (1973). Total uptake of nutrients by weeds was calculated by multiplying the percent content with their total dry matter production values.

### 3.10.2 Observations on Crop Growth

Five plants selected at random were labelled in a net plot area excluding the border rows, for recording all growth and yield parameters during the course of investigations.

#### 3.10.2.1 Plant height (cm)

The plant height was measured in cm, from the base of the plant to the base of topmost fully opened leaf at 15 day-intervals upto the harvest from 5 randomly labelled plants. This was recorded from base of all the shoots and mean plant height was calculated from the total height of all the shoots of 10 plants.

#### 3.10.2.2 Number of branches per plant

The number of branches including both primary and secondary shoots were recorded at an interval of fifteen days from the same plants labelled for taking up plant height with the same interval of time between two observations and mean number of shoots per plant was obtained.

#### 3.10.2.3 Number of leaves per plant

Periodical observations on the rate of leaf production was

taken at 15 day intervals from randomly labelled 5 plants. Observations started right from the time of first flush of leaves appeared till their harvest.

#### 3.10.2.4 Leaf area per plant (cm<sup>2</sup>)

Leaf area was estimated randomly selecting 25 leaves in each harvest. The leaf area was determined by using LI-3100 leaf area meter (LI-COR Inc/LI-COR Limited, Nebraska, U.S.A.). The oven dry weight of the leaves was recorded in grams and leaf area per plant in cm<sup>2</sup> was calculated as mentioned below:

$$LAP = \frac{A \times DM}{DW}$$

where, LAP = Leaf area per plant (cm<sup>2</sup>)

A = Area of 25 leaves (cm<sup>2</sup>)

DM = Leaf drymatter yield per plant (g)

DW = Dryweight of 25 leaves (g).

#### 3.10.2.5 Moisture percent in leaf at harvest

Moisture percentage in leaf was estimated at the time of leaf harvest, by taking differences of fresh weight and dry weight of leaf and expressed in per cent. It was computed by using the following formula suggested by A.O.A.C. (1970).

$$\text{Moisture per cent} = \frac{\text{Fresh weight of leaf} - \text{Dryweight of leaf}}{\text{Fresh weight of leaf}} \times 100$$

For leaf moisture studies, leaf samples were removed from the plants and immediately transferred to polythene bags to prevent loss of moisture. The leaves were weighed along with the cover

and differences were worked out and later leaves were dried in oven at 70°C and moisture per cent was calculated by using the formula.

### 3.10.2.6 Chlorophyll content of leaf at harvest

Top fifth and sixth leaves were collected from five labelled plants for estimation of chlorophyll content. Fresh leaf of 0.1 gram was taken in a test tube with a six ml acetone and 4 ml of dimethyl sulphoxide. Samples were plugged and kept in dark condition overnight. The chlorophyll 'a', chlorophyll 'b' and total chlorophyll contents were estimated by recording the absorbance in spectronic-21 at 663nm and 645 nm by using the following formula (Arnon.,1949).

$$\text{Total chlorophyll} = 20.2D_{645} + 8.02 D_{663} \times V / 1000 \times W$$

where,

$D_{663}$  and  $D_{645}$  are the absorbance values at respective nanometers.

$V$  = Volume made up (ml)

$W$  = Weight of fresh sample (g)

$$\text{Chlorophyll 'a'} = (12.7 D_{663} - 2.69 D_{645}) \times V / 1000 \times W$$

$$\text{Chlorophyll 'b'} = (22.9 D_{645} - 4.68 D_{663}) \times V / 1000 \times W$$

Chlorophyll content was expressed in mg/g of fresh weight.

### 3.10.2.7 Leaf yield and yield components

#### 3.10.2.7.1 Leaf yield per plant (g)

Leaves from five labelled plants were harvested and their weight was recorded and the mean yield per plant was worked out.

### 3.10.2.7.2 Leaf yield per hectare (Kg)

Leaves from corresponding plots were harvested in different pickings. These leaves were used for silk worm rearing. After completion of rearing, the leaves that remained in the plots were also harvested and total weight of the leaves per plot was obtained and then converted into yield as kg per hectare.

### 3.10.2.7.3 Leaf dry matter per plant (g)

The leaves from any three unlabelled plants were harvested and dried in an oven at 70°C and their dry weight was recorded at all the growth stages and the mean dry matter per plant (g) was worked out.

### 3.10.2.7.4 Nutrient uptake by mulberry

Nitrogen, Phosphorus and Potassium uptake by mulberry was estimated. The dried leaf samples were finely ground and powdered samples were used for the estimation of nutrients, as described earlier in section 3.10.1.6.

## 3.10.3 Observations on silk-worm rearing

### 3.10.3.1 Larval Characters

#### 1 Larval weight

Five worms were randomly picked from each replication immediately after moult and weight was recorded from second to fourth instar and mean weight of worms was worked out.

#### 2 Weight of mature worms

Five mature larvae were randomly picked from each treatment and weighed using torsion balance. This was also

recorded in all the replications, treatmentwise and mean larval weight was computed.

### 3.10.3.2 Cocoon Characters

#### 1 Mean weight of cocoon

After complete spinning and allowing five days of interval, ten cocoons were harvested randomly from each treatment, replicationwise and mean cocoon weight was recorded.

#### 2 Mean pupal weight

After obtaining cocoon weight, the same ten cocoons were cut, pupae recovered and weighed in a torsion balance. Mean pupal weight was worked out.

#### 3 Mean Shell weight

After removing the pupae and exuvia (last larval skin) the remaining shell was weighed and mean shell weight was recorded.

#### 4 Shell percentage

The shell percentage was calculated by using the formula,

$$\text{Shell percentage} = \frac{\text{Weight of cocoon shell (g)}}{\text{Weight of whole cocoon (g)}} \times 100$$

#### 5 Effective Rate of rearing

The effective rate of rearing was calculated using the formula,

$$\text{ERR} = \frac{\text{Number of cocoons obtained/harvested}}{\text{Number of worms brushed}} \times 100$$

### 3.10.3.3 Post cocoon parameters

#### 1 Mean filament length

Ten cocoons were randomly selected in each treatment and replication wise to find out the mean filament length of the cocoon. Each cocoon was reeled using Epprouvette, the filament length was determined by using the formula,

$$L = R \times 1.125$$

where, L = Total filament length (m/cocoon)

R = Number of revolutions recorded by Epprouvette

1.125 = Circumference of Epprouvette.

#### 2 Mean weight of single filament

Individual single filament was dried under shade for some time, weight was recorded and average weight of single filament was calculated for each replication.

#### 3 Denier

The single cocoon filament length recorded from the Epprouvette was dried in oven at 70°C and denier was determined by using the standard formula,

$$D = \frac{W}{L} \times 9000$$

where, D = Denier

W = Weight of single cocoon filament (g)

L = Total length of single cocoon filament (m)

9000 = Constant value.

#### 4 Renditta

It is the quantity of cocoons required to produce a unit of

raw silk. Renditta was calculated by using following formula,

$$\text{Renditta} = \frac{\text{Fresh cocoon weight}}{\text{Weight of raw silk}}$$

### 5 Reelability percentage (R.P.)

Reelability percentage was calculated in each of the replications by using the following formula;

$$\text{R.P.} = \frac{\text{Mean weight of single filament}}{\text{Mean shell weight}} \times 100$$

### 3.11 Bio-assay studies

After harvest of the main crop mulberry, investigation was carried out to study the residual effect of herbicides on cucumber (Guntur local) used as indicator plant. Soil sample from top 15 cm depth of each of the experimental plot was collected and sundried for one week. About 425 g of this soil sample was sieved and then filled into plastic bowls of uniform size (12.0 cm diameter at the top). Each bowl was sown with 10 seeds on 16th March 1992. The bowls were watered uniformly at regular intervals.

#### 3.11.1 Observations on cucumber

##### 3.11.1.1 Germination(%)

The number of seeds germinated out of 10 seeds sown was counted on the 6th day after sowing and then calculated the percent germination.

##### 3.11.1.2 Root length (cm)

5 plants selected randomly, carefully uprooted, roots were

washed of the soil and the average length of roots (cm) was recorded on 15th day after sowing.

#### 3.11.1.3 Root weight (mg)

The average root dryweight (mg) of the sampled plants was recorded on 15<sup>th</sup> day after sowing and expressed as mg/plant.

#### 3.11.1.4 Shoot length (cm)

The mean shoot length (cm) was recorded on 15<sup>th</sup> day after sowing from the separated shoots of the sampled plants.

#### 3.11.1.5 Shoot weight (mg)

The mean shoot dryweight (mg) was recorded on 15th day after sowing from the separated shoots of the sampled plants.

### 3.12 Economics of weed control treatments

To study the economics of different weed control treatments, information on market price of herbicides, labour units required for application and hand weeding was considered in addition to the regular components of the cost of cultivation. Cost of labour was calculated taking into account the prevailing labour wages at the time of investigation at Rs.16.60 per man and woman. Gross returns from leaves and cocoon yield were also calculated. Economics of weed control treatments was recorded using the following formulae:

Net return = Gross return - cost of cultivation.

Marginal return = Gross return from the particular weed control treatments - Gross return from the unweeded control treatment

Cost of weed control itself was the Marginal cost.

$$\text{Profit per rupee spent on weed control} = \frac{\text{Marginal return}}{\text{Marginal cost}}$$

### 3.13 Statistical analysis of data

#### 3.13.1 Transformation of the data

Data on weed count and weed dryweight showed high variations. To make the analysis of variance valid, the data were subjected to square root transformation, using  $\sqrt{x + 0.5}$ .

#### 3.13.2 Statistical analysis and interpretation of data

Data were analysed statistically for test of significance using Fisher's method of "Analysis of Variance" as outlined by Sunderraj et al. (1972). The level of significance on 'F'test was tested at five percent (5%). The interpretation of data was done using LSD values calculated at  $P = 0.05$ .

# **EXPERIMENTAL RESULTS**

## IV EXPERIMENTAL RESULTS

The results of the field experiment entitled "Chemical weed control in established mulberry garden and its effect on silkworm and cocoon production" conducted during winter season of 1991 are presented in this chapter.

### 4.1 Weeds observed in the experimental field

The important weed species observed in the experimental field include monocots like Digitaria marginata Link., Commelina benghalensis Linn., Dactyloctenium aegyptium Beauv., Eragrostis gangetica Steud., Eragrostis ciliensis (Wall) Link., Commelina benghalensis Linn., Cynodon dactylon Pers., Dicanthium annulatum (Forsk) Stapf., Eragrostis laminaria and among dicots like Spillanthus clava DC., Ageratum conyzoides Linn., Emelia sanchifolia (L) DC., Bidens pilosa L., Euphorbia hirta Linn., Euphorbia geniculata Art., Acanthospermum hispidum DC., Amaranthus viridis Linn., and among sedges, Cyperus rotundus L., were the predominant weeds.

### 4.2 Studies on weed control and crop toxicity ratings

#### 4.2.1 Weed control ratings

Visual observations on weed control ratings recorded at 15, 30, 45 and 60 days after pruning and at harvest are presented in table 3.

Differences in weed control ratings were noticed among the treatments. The treatments which received the repeated hand weeding (1.0) followed by Diuron at both the levels (1.00 and 1.25

Plate 1. Digitaria marginata Link. var.  
fimbriata stapf.  
Family : Poaceae.

Plate 2. Cyperus rotundus L.  
Nutgrass, Nutsedge  
Family : Cyperaceae

Plate 3. Cynodon dactylon Pers.  
Bahama grass, Hariyali  
Family : Poaceae.

Plate 4. Eragrostis spp.  
Family : Poaceae.

Plate 5. Commelina benghalensis L.  
Family : Commelinaceae

Plate 6. Amaranthus viridis L.  
Family : Amaranthaceae.

Plate 7. Acanthospermum hispidum De.  
Family : Asterceae.

Plate 8. Ageratum conyzoides L.  
Geratum  
Family : Asteraceae.

Plate 9. Bidens pilosa L.  
Family : Asteraceae.



Plate 7



Plate 8

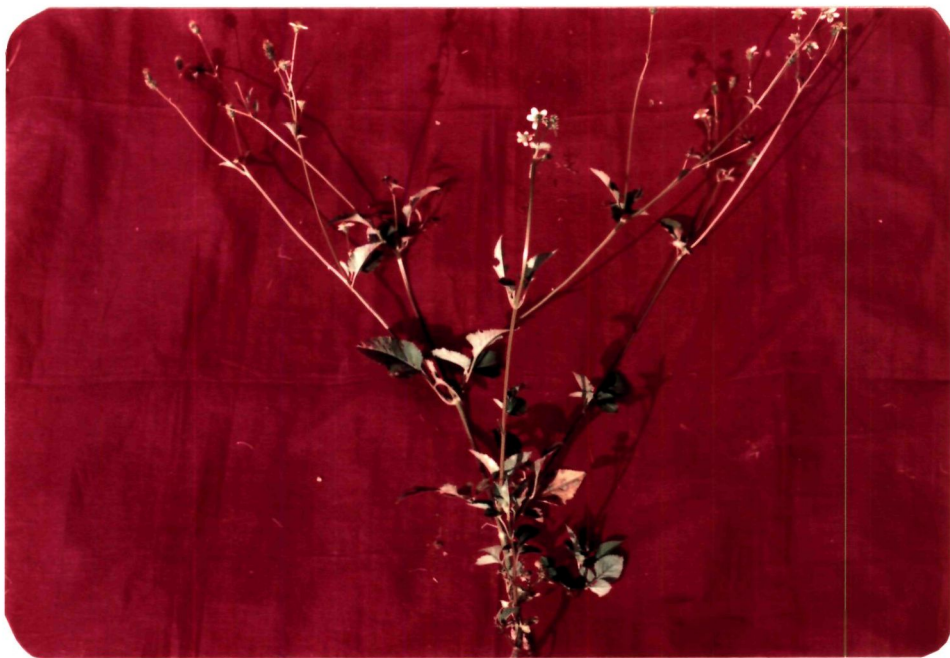


Plate 9

Table 3: Weed control and crop toxicity ratings (EWRC system) as influenced by different weed control treatments at different crop growth stages in Mulberry.

Treatments	Herbicide rate (Kg. a.i./ha or a.e./ha)	Weed control ratings					Crop toxicity ratings				
		Days after pruning					Days after pruning				
		15	30	45	60	At harvest	15	30	45	60	At harvest
Repeated hand weeding		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Diuron	1.00	1.00	1.33	1.66	2.00	2.33	1.00	1.00	1.00	1.00	1.00
Diuron	1.25	1.00	1.00	1.33	1.66	2.00	1.00	1.00	1.00	1.00	1.00
Butachlor	1.25	1.33	2.66	3.00	3.33	3.66	1.00	1.00	1.00	1.00	1.00
Butachlor	1.50	1.00	1.33	1.66	2.00	2.33	1.00	1.00	1.00	1.00	1.00
Isoproturon	1.25	2.00	3.00	3.33	3.66	4.00	1.00	1.00	1.00	1.00	1.00
Isoproturon	1.50	1.66	2.33	2.66	3.33	3.66	1.00	1.00	1.00	1.00	1.00
Alachlor	1.25	1.33	2.66	3.00	3.33	3.66	1.33	1.00	1.00	1.00	1.00
Alachlor	1.50	1.00	1.33	1.66	2.00	2.33	1.66	1.33	1.33	1.00	1.00
Metolachlor	1.25	1.00	1.33	1.66	2.00	2.33	1.00	1.00	1.00	1.00	1.00
Metolachlor	1.50	1.00	1.00	1.33	1.66	2.00	1.00	1.00	1.00	1.00	1.00
Pendimethalin	1.25	1.33	2.66	3.00	3.33	3.66	1.00	1.00	1.00	1.00	1.00
Pendimethalin	1.50	1.00	1.33	1.66	2.00	2.33	1.00	1.00	1.00	1.00	1.00
Oxyfluorfen	0.12	1.66	2.66	3.00	3.33	3.66	1.33	1.33	1.33	1.00	1.00
Oxyfluorfen	0.25	1.33	1.66	2.00	3.00	3.33	1.66	1.33	1.33	1.00	1.00
Unweeded control		5.00	5.00	5.00	5.00	5.00	1.00	1.00	1.00	1.00	1.00

Weed control ratings:

1.00 = Excellent control  
 2.00 = Good control  
 3.00 = Fair control  
 4.00 = Poor control  
 5.00 = No control

Crop toxicity ratings:

1.00 = No toxicity  
 2.00 = Slight toxicity  
 3.00 = Moderate toxicity  
 4.00 = Severe toxic  
 5.00 = Toxic

kg a.i./ha), Metolachlor at both the levels (1.25 and 1.50 kg a.e./ha) and higher levels of Butachlor (1.50 kg a.e./ha), Alachlor (1.50 kg a.e./ha), Pendimethalin (1.50 kg a.e./ha) gave good to excellent control of weeds at different crop growth stages as compared with other weed control treatments. However, the plots treated with lower levels of Butachlor (1.25 kg a.e./ha), Alachlor (1.25kg a.e./ha), Pendimethalin (1.25 kg a.e./ha), Oxyfluor-fen(0.12 kg a.e./ha), Isoproturon (1.25 kg a.i./ha) and higher levels of Oxyfluorfen (0.25 kg a.e./ha) and Isoproturon (1.50 kg a.i./ha) gave poor to fair control of weeds as compared to unweeded control.

#### 4.2.2 Crop toxicity ratings

Visual observations on crop toxicity ratings recorded at 15, 30, 45 and 60 days after pruning and at harvest are presented in table 3.

Among the weed control treatments only Oxyfluorfen and Alachlor caused slight toxicity/damage to the crop. Oxyfluorfen at both the levels (0.12 and 0.25 kg a.e./ha) and Alachlor at higher level (1.50 kg a.e./ha) caused the toxic effect on Mulberry crop at initial stages but crop was recovered in later stages of the growth. All other weed control treatments did not cause any toxicity/ damage to the crop.

#### 4.3 Weed count

Observations on Monocot, Dicot, sedges and total weed population recorded from one square meter fixed area at 15, 30,

45 and 60 days after pruning and at harvest in both First as well as second crop are presented in tables 4, 5, 6 and 7 respectively.

#### 4.3.1 Monocot weed population (First crop)

The data on monocot weed population at different growth stages of crop are presented in table 4. Monocot weed population differed significantly due to different weed control treatments at all the growth stages.

At 15 days after pruning, the lowest monocot weed population were recorded in repeated hand weeding (0.00/sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha recorded lower monocot weed population (2.67/sq.m) which was on par with all other herbicidal treatments except, Butachlor at 1.25 kg a.e./ha (6.00/sq.m), Isoproturon at 1.25 kg and 1.5 kg a.i./ha (7.00 and 5.67/sq.m respectively), Pendimethalin at 1.25 kg a.e./ha (6.33/sq.m) and Oxyfluorfen at 0.12 kg a.e./ha(6.67/sq.m). However, unweeded control recorded higher weed population of 12.00/sq.m.

At 30 days after pruning, the lowest monocot weed population were recorded with repeated hand weeding (0.00/sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha, Metolachlor at 1.5 kg a.e./ha and Pendimethalin at 1.5 kg a.e./ha gave satisfactory control of monocot weeds (4.00, 4.67 and 4.67/sq.m, respectively). However, unweeded control recorded higher weed population of 16.33/sq.m.

At 45 days after pruning, repeated hand weeding had



significantly lowest weed population (0.00/sq.m). Among the herbicidal treatments Diuron at 1.0 kg and 1.25 kg a.i./ha (8.00 and 5.67/sq.m, respectively), Metolachlor at 1.5 kg a.e./ha (7.00/sq.m) and Pendimethalin at 1.5 kg a.e./ha (8.00/sq.m) gave satisfactory control of weeds as compared to other herbicidal treatments and unweeded control (19.67/sq.m).

At 60 days after pruning, the lowest monocot weed population was recorded with repeated hand weeding (0.00/sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha recorded lower weed population (8.67/sq.m) which was on par with Diuron at 1.0 kg a.i./ha (1.00/sq.m), Alachlor at 1.5 kg a.e./ha (9.67/sq.m) and Metolachlor at 1.25 kg and 1.5 kg a.e./ha (10.67 and 8.67/ sq.m, respectively) where as, unweeded control recorded higher monocot weed population (22.33/sq.m).

At harvest also repeated hand weeding recorded lowest monocot weed population (0.00/sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha, Alachlor at 1.5 kg a.e./ha and Metolachlor at 1.5 kg a.e./ha gave efficient control of monocot weeds (10.00, 10.67 and 10.67/sq.m, respectively) as compared to other herbicidal treatments and unweeded control (23.67/sq.m).

#### 4.3.2 Monocot weed population (Second crop)

The data on monocot weed population at different growth stages of second crop are presented in table 4. Monocot weed population differed significantly due to different weed control treatments at all the growth stages.

At 15 days after first crop leaf harvest, the lowest monocot weed population were recorded with repeated hand weeding (0.00/sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha recorded lower monocot weed population (10.67/sq.m) which was on par with Metolachlor at 1.5 kg a.e./ha (11.0/sq.m) Butachlor at 1.5 kg a.e./ha (12.0/sq.m), Alachlor at 1.5 kg a.e./ha (12.0/sq.m) and Pendimethalin at 1.5 kg a.e./ha (12.33/sq.m). However unweeded control recorded higher monocot weed population (35.0/sq.m).

At 30 days after first crop leaf harvest, repeated hand weeding recorded the lowest monocot weed population (0.00/sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ ha (11.0/sq.m), Metolachlor at 1.5 kg a.e./ha (11.67 sq.m) Butachlor at 1.5 kg a.e./ha (12.33/sq.m), Alachlor at 1.5 kg a.e./ha (12.67/sq.m) and Pendimethalin at 1.5 kg a.e./ha (12.67/sq.m) gave satisfactory control of monocot weeds as compared to other herbicidal treatments and unweeded control (25.67/sq.m).

At 45 days after first crop leaf harvest, repeated hand weeding recorded lowest monocot weed population (0.00/sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha recorded lower monocot weed population (11.67/sq.m) which was on par with Metolachlor at 1.5 kg a.e./ha (12.0/sq.m), Butachlor at 1.5 kg a.e./ha (13.0 sq.m) and Pendimethalin at 1.5 kg a.e./ha (13.0/sq.m.), however unweeded control (25.67/sq.m) recorded higher monocot weed population.

At 60 days after first crop leaf harvest, the lowest monocot weed population was recorded with repeated hand weeding (0.00/sq.m). Among the herbicidal treatments, Diuron 1.25 kg a.i./ha recorded lower weed population (11.67/sq.m) which was on par with Metolachlor at 1.5 kg a.e./ha (12.67/sq.m) Butachlor at 1.5 kg a.e./ha (13.0/sq.m), Alachlor at 1.5 kg a.e./ha (14.0/sq.m), and Pendimethalin at 1.5 kg a.e./ha (13.67/sq.m), whereas unweeded control recorded higher monocot weed population (26.0/sq.m).

At harvest also repeated hand weeding recorded lowest monocot weed population (0.00/sq.m). Among the herbicidal treatments, the lowest monocot weed population was recorded with Metolachlor at 1.5 kg a.e./ha (13.0/sq.m) followed by Diuron at 1.25 kg a.i./ha (13.33/sq.m), Butachlor at 1.5 kg a.e./ha (14.0/sq.m), Pendimethalin at 1.5 kg a.e./ha (14.33/sq.m) and Alachlor at 1.5 kg a.e./ha (15.0/sq.m). However, unweeded control (26.33/sq.m) recorded higher monocot weed population.

#### 4.3.3 Dicot weed population (First crop)

The data on dicot weed population at different growth stages of first crop are presented in table 5. At all growth stages of crop, dicot weed population differed significantly due to different weed control treatments.

At 15 days after pruning, the lowest dicot weed population was recorded with repeated hand weeding (0.0/sq.m), Diuron at 1.25 kg a.i./ha (0.0/sq.m), Butachlor at 1.5 kg a.e./ha

(0.0/sq.m), Alachlor at 1.5 kg a.e./ha (0.0/sq.m), Pendimethalin at 1.5 kg a.e./ha (0.0/sq.m), Oxyfluorfen at 0.12 kg and 0.25 kg a.e./ha (0.0 and 0.0/sq.m respectively, Diuron at 1.0 kg a.i./ha (0.33/sq.m) and Butachlor at 1.25 kg a.e./ha (0.33/sq.m). However unweeded control recorded higher dicot weed population (5.0/sq.m).

At 30 days after pruning, repeated hand weeding recorded lowest dicot weed population (0.0/sq.m). Among the herbicidal treatments, Oxyfluorfen at 0.25 kg a.e./ha recorded lower dicot weed population (2.67/sq.m) followed by Diuron at 1.25 kg a.i./ha (3.0/sq.m), Metolachlor at 1.5 kg a.e./ha (3.0/sq.m), Oxyfluorfen at 0.12 kg a.e./ha (3.0/sq.m), Diuron at 1.0 kg a.i./ha (3.67/sq.m) and Butachlor at 1.5 kg a.e./ha (4.0/sq.m). Whereas, unweeded control (9.33/sq.m) recorded highest dicot weed population.

At 45 days after pruning, the lowest dicot weed population was recorded with repeated hand weeding (0.0/sq.m). Among the herbicidal treatments, Oxyfluorfen at 0.25 kg a.e./ha recorded lower weed population (3.0/sq.m) which was on par with Diuron at 1.0 kg and 1.25 kg a.i./ha (3.67 and 3.0/sq.m, respectively), Metolachlor at 1.25 kg and 1.5 kg a.e./ha (4.67 and 3.67/sq.m, respectively) and Oxyfluorfen at 0.12 kg a.e./ha (3.67/sq.m). However, unweeded control (14.33/sq.m) recorded higher dicot weed population.

At 60 days after pruning, repeated hand weeding recorded lowest dicot weed population (0.0/sq.m). Among the herbicidal



treatments, Diuron at 1.0 kg and 1.25 kg a.i./ha (4.33 and 3.67/sq.m, respectively), Metolachlor at 1.25 kg and 1.5 kg a.e./ha (4.67 and 4.0/sq.m, respectively), Oxyfluorfen at 0.12 kg and 0.25 kg a.e./ha (4.0 and 3.33/sq.m, respectively) gave efficient control of weeds as compared to other herbicidal treatments and unweeded control (16.0/sq.m).

At harvest also repeated hand weeding recorded lowest dicot weed population (0.0/sq.m). Among the herbicidal treatments, Diuron at 1.0 kg and 1.25 kg a.i./ha (5.67 and 4.37/sq.m, respectively), Metolachlor at 1.25 kg and 1.5 kg a.e./ha (5.0 and 4.67/sq.m, respectively), Oxyfluorfen at 0.12 kg and 0.25 kg a.e./ha (5.0 and 4.33/sq.m, respectively) recorded lower dicot weed population as compared to other herbicidal treatments and unweeded control (19.0/sq.m).

#### 4.3.4 Dicot weed population (Second crop)

The data on Dicot weed population at different growth stages of second crop are presented in table 5. Dicot weed population differed significantly due to different weed control treatments at all the growth stages.

At 15 days after first crop leaf harvest, the lowest Dicot weed population was recorded with repeated hand weeding (0.0/sq.m). Among the herbicidal treatments, Oxyfluorfen 0.25 at kg a.e./ha recorded lower dicot weed population (5.0/sq.m) followed by Metolachlor at 1.5 kg a.e./ha (5.33/sq.m), Oxyfluorfen at 0.12 kg a.e./ha (5.67/sq.m) and Diuron at 1.25 kg a.i./ha

(5.67/sq.m). However, Isoproturon at 1.25 kg a.i./ha (12.0/sq.m) and unweeded control (21.0/sq.m) recorded higher dicot weed population.

At 30 days after first crop leaf harvest, repeated hand weeding recorded minimum dicot weed population (0.0/sq.m). Among the herbicidal treatments, Diuron at 1.0 kg and 1.25 kg a.i./ha (6.67 and 6.0/sq.m, respectively), Metolachlor at 1.25 kg and 1.5 kg a.e./ha (6.33 and 5.67/sq.m, respectively) and Oxyfluorfen at 0.12 kg and 0.25 kg a.e./ha (6.0 and 5.67 /sq.m, respectively) gave satisfactory control of dicot weeds as compared to other herbicidal treatments and unweeded control (21.67 /sq.m).

At 45 days after first crop leaf harvest, repeated hand weeding recorded lowest dicot weed population (0.0 /sq.m). Among the herbicidal treatments, Oxyfluorfen at 0.25 kg a.e./ha (6.0 /sq.m) recorded lower dicot weed population followed by Metolachlor at 1.5 kg a.e./ha (6.0 /sq.m), Oxyfluorfen at 0.12 kg a.e./ha (6.67 /sq.m), Diuron at 1.25 kg a.i./ha (6.67 /sq.m) and Metolachlor at 1.25 kg a.e./ha (7.0 /sq.m). However, unweeded control (23.0 /sq.m) recorded higher dicot weed population.

At 60 days after first crop leaf harvest, the lowest dicot weed population was recorded with repeated hand weeding (0.0 /sq.m). Among the herbicidal treatments, Oxyfluorfen at 0.25 kg a.e./ha (7.0 /sq.m) recorded lower dicot weed population which was on par with Diuron at 1.25 kg a.i./ha (7.0 /sq.m), Metolachlor at 1.5 kg a.e./ha (7.33 /sq.m), Oxyfluorfen at 0.12 kg a.e./ha

(7.67/sq.m), Diuron at 1.0 kg a.i./ha (8.0 /sq.m) and Metolachlor at 1.25 kg a.e./ha (8.67 /sq.m). Whereas, unweeded control (23.0 /sq.m) recorded higher dicot weed population.

At harvest also repeated hand weeding recorded lowest dicot weed population (0.0 /sq.m). Among the herbicidal treatments, Oxyfluorfen at 0.12 kg and 0.25 kg a.e./ha (8.0 and 7.0 /sq.m, respectively), Diuron at 1.0 kg. and 1.25 kg a.i./ha (8.67 and 7.67 /sq.m, respectively) and Metolachlor at 1.25 kg. and 1.50 kg a.e./ha (9.0 and 7.67 /sq.m, respectively) gave satisfactory control of dicot weeds as compared to other herbicidal treatments and unweeded control (24.0 /sq.m).

#### 4.3.5 Sedge weed population (First crop)

The data on sedge population at different growth stages of first crop are given in Table 6. Sedges population differed significantly due to different weed control treatments at all the growth stages.

At 15 days after pruning, repeated hand weeding recorded lowest sedge population (0.00 /sq.m). Among the herbicidal treatments, Alachlor at 1.5 kg a.e./ha (19.33 /sq.m), Metolachlor at 1.5 kg a.e./ha (20.0 /sq.m) and Diuron at 1.25 kg a.i./ha (20.67/sq.m) recorded lower sedge population. However, Isoproturon at 1.25 kg a.i./ha and unweeded control recorded higher sedge population (45.0 and 56.33 /sq.m, respectively).

At 30 days after pruning, the lowest sedge population was

recorded with repeated hand weeding (0.00 /sq.m). Among the herbicidal treatments, Metolachlor 1.5 kg a.e./ha recorded lower sedge population (42.0/sq.m) which was on par with Alachlor at 1.5 kg a.e./ha (43.33/sq.m), Diuron at 1.25 kg a.i./ha (44.33/sq.m) and Pendimethalin at 1.5 kg a.e./ha (44.33/sq.m), However, unweeded control recorded higher sedge population (86.67/sq.m).

At 45 days after pruning, repeated hard weeding recorded lowest sedge population (0.00/sq.m), Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (53.33/sq.m), recorded lower sedge population as compared to other herbicidal treatments (60.0 to 76.67 /sq.m). However, Oxyfluorfen at 0.12 kg a.e./ha (77.67/sq.m) and unweeded control (113.33/sq.m) recorded higher sedge population.

At 60 days after pruning, repeated hard weeding recorded lowest sedge population (0.00/sq.m), Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (56.67/sq.m) recorded lower sedge population followed by Diuron at 1.25 kg a.i/ha (62.0/sq.m), Butachlor at 1.5 kg a.e./ha (67.33/sq.m) and Butachlor at 1.25 kg a.e./ha (69.0/sq.m), whereas unweeded control (148.33/sq.m) recorded higher sedge population.

At harvest also repeated hard weeding recorded lowest sedge population (0.00/sq.m), Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (56.67/sq.m) recorded lower sedge population (59.67/sq.m) . The next best herbicide was Diuron at 1.25 kg a.i/ha (68.33/sq.m) followed by Butachlor at 1.5 kg

**Table 6: Sedge weed population (in 1.0 m<sup>2</sup> area) at different crop growth stages as influenced by different weed control treatments in Mulberry.**

Treatments	Herbicide rate (kg a.i. or a.e./ha)	First crop				Second crop					
		Days after pruning				Days after first harvest					
		15	30	45	60	15	30	45	60	At harvest	
Repeated band weeding	-	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
Diuron	1.00	4.98(24.33)	7.64(58.00)	8.21(67.00)	8.61(73.67)	8.84(77.67)	9.10(82.33)	9.17(83.67)	9.19(84.00)	9.24(85.00)	9.28(85.67)
Diuron	1.25	4.60(20.67)	6.69(44.33)	7.78(60.00)	7.90(62.00)	8.29(68.33)	8.33(69.33)	8.35(69.33)	8.35(69.33)	8.39(75.00)	8.41(70.33)
Butachlor	1.25	5.01(24.67)	7.51(56.00)	8.17(66.33)	8.33(69.00)	8.89(78.67)	9.21(84.33)	9.19(84.33)	9.23(84.67)	9.24(85.00)	9.28(85.67)
Butachlor	1.50	5.01(24.67)	6.94(47.67)	7.69(58.67)	8.23(67.33)	8.59(73.33)	8.63(74.00)	8.63(74.00)	8.63(74.00)	8.73(75.67)	8.73(75.67)
Isoproturon	1.25	6.74(45.00)	7.60(57.33)	8.78(76.67)	9.19(84.00)	9.54(90.67)	9.92(98.67)	9.95(98.67)	9.97(99.00)	9.97(99.00)	10.00(99.67)
Isoproturon	1.50	6.12(37.00)	7.01(48.67)	8.32(68.67)	8.99(80.33)	9.48(89.33)	9.53(90.33)	9.70(93.67)	9.72(94.00)	9.74(94.33)	9.75(94.67)
Alachlor	1.25	5.21(26.67)	7.67(58.33)	8.31(68.67)	8.84(77.67)	9.23(84.67)	9.46(89.00)	9.51(90.00)	9.51(90.00)	9.56(90.67)	9.56(91.00)
Alachlor	1.50	4.44(19.33)	6.62(43.33)	8.07(64.67)	8.69(75.00)	8.69(75.00)	8.97(80.00)	8.99(80.33)	8.99(80.33)	9.04(81.33)	9.06(81.67)
Metolachlor	1.25	5.11(25.67)	7.54(56.33)	8.15(66.00)	8.55(72.67)	8.84(77.67)	8.97(80.00)	8.97(80.00)	9.01(80.67)	9.03(80.00)	9.06(81.67)
Metolachlor	1.50	4.53(20.00)	6.52(42.00)	7.34(53.33)	7.56(56.67)	7.75(59.67)	7.95(62.67)	7.97(63.00)	7.99(63.33)	8.01(63.67)	8.05(64.33)
Pendimethalin	1.25	5.39(28.67)	7.65(58.00)	8.11(65.33)	8.86(78.00)	9.03(81.00)	9.12(82.67)	9.14(83.00)	9.17(83.33)	9.15(83.67)	9.23(84.67)
Pendimethalin	1.50	4.98(24.33)	6.69(44.33)	7.73(59.33)	8.47(71.33)	8.67(74.67)	8.93(79.33)	8.93(79.33)	9.01(80.67)	9.03(81.00)	9.06(81.67)
Oxyfluorfen	0.12	6.15(37.33)	7.71(59.00)	8.84(77.67)	9.58(91.33)	9.60(91.67)	9.75(94.67)	9.77(95.00)	9.79(95.33)	9.80(95.67)	9.82(96.00)
Oxyfluorfen	0.25	4.84(23.00)	6.87(46.67)	8.39(70.00)	8.97(80.00)	9.03(81.00)	9.08(82.00)	9.12(82.67)	9.14(83.00)	9.15(83.33)	9.19(84.00)
Unweeded control	-	7.54(56.33)	9.34(86.67)	10.67(113.33)	12.19(148.33)	12.76(162.33)	13.03(169.33)	13.25(175.00)	13.28(176.00)	13.34(177.67)	13.37(178.33)
P-test		*	*	*	*	*	*	*	*	*	*
S.E.M +		0.12	0.16	0.18	0.17	0.15	0.10	0.10	0.10	0.09	0.09
C.D. 0.5%		0.33	0.45	0.49	0.46	0.43	0.29	0.27	0.28	0.26	0.26

Figures in the parenthesis indicate original values; Transformation used  $\sqrt{x + 0.5}$  significant at 5% probability level

a.e./ha (73.33/sq.m), Pendimethalin at 1.5 kg a.e./ha (74.67/sq.m) and Alachlor at 1.5 kg a.e./ha (75.0/sq.m). However, unweeded control recorded higher sedge population of 162.33/sq.m.

#### 4.3.6 Sedge weed population (Second crop)

The data on sedge population at different growth stages of second crop are presented in Table 6. sedges population differed significantly due to different weed control treatments at all the growth stages.

At 15 days after first crop leaf harvest, the lowest sedge population was noticed in repeated hand weeding (0.00/sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha recorded lower sedge population (62.67/sq.m) followed by Diuron at 1.25 kg a.i./ha (69.0/sq.m), Butachlor at 1.5 kg a.e./ha (74.0/sq.m) and Pendimethalin at 1.5 kg a.e./ha (79.33/sq.m). However, unweeded control (169.33/sq.m) recorded higher sedge population.

At 30 days after first crop leaf harvest, repeated hand weeding recorded lowest sedge population (0.00/sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha, Metolachlor at 1.5 kg a.e./ha, Butachlor at 1.5 kg a.e./ha and Pendimethalin at 1.5 kg a.e./ha recorded lower sedge population (69.33, 63.0, 74.0 and 79.33/sq.m respectively) as compared to other herbicidal treatments (80.00 to 98.67/sq.m) and unweeded control (175.0/sq.m).

At 45 days after first crop leaf harvest, the lowest sedge

population was noticed in repeated hand weeding (0.00/sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (69.33/sq.m), Metolachlor at 1.5 kg a.e./ha (63.33/sq.m) and Butachlor at 1.5 kg a.e./ha (74.0/sq.m) recorded lower sedge population as compared to other herbicidal treatments (80.33 to 99.0/sq.m) and unweeded control (176.0/sq.m).

At 60 days after first crop leaf harvest, the lowest sedge population was registered with repeated hand weeding (0.00/sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (63.67/sq.m) recorded lower sedge population followed by Diuron 1.25 at kg a.i./ha (75.0/sq.m), Butachlor at 1.5 kg a.e./ha (75.67/sq.m) and Metolachlor at 1.25 kg a.e./ha (80.0/sq.m). However, unweeded control recorded higher sedge population (177.67/sq.m).

At harvest also repeated hand weeding recorded minimum sedge population (0.00/sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (64.33/sq.m), Diuron at 1.25 kg a.i./ha (70.33/sq.m), Butachlor at 1.5 kg a.e./ha (75.67/sq.m) and Alachlor at 1.5 kg a.e./ha (81.67/sq.m) recorded lower sedge population as compared to other herbicidal treatments (84.0 to 99.67/sq.m) and unweeded control (178.33/sq.m).

#### 4.3.7 Total weed population (First crop)

The data on total weed population at different growth stages of first crop are presented in Table 7. Total weed population differed significantly due to different weed control treatments at

all the growth stages.

At 15 days after pruning, the lowest total weed population was recorded with repeated hand weeding (0.00/sq.m). Among different herbicides, Diuron at 1.25 kg a.i./ha, Alachlor at 1.5 kg a.e./ha and Metolachlor at 1.5 kg a.e./ha gave satisfactory control of total weed population (24.33, 22.67 and 22.67/sq.m, respectively) as compared to other herbicidal treatments (28 to 58.33/sq.m) and unweeded control (73.33/sq.m).

At 30 days after pruning, the lowest total weed population was recorded with repeated hand weeding (0.00/sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (49.67/sq.m) recorded lower weed population which was on par with Diuron at 1.25 kg a.i./ha (51.33/sq.m), Alachlor at 1.5 kg a.e./ha (52.67/sq.m), Pendimethalin at 1.5 kg a.e./ha (53.0/sq.m) and Oxyfluorfen at 0.25 kg a.e./ha (55.33/sq.m). However, unweeded control recorded significantly higher weed population of 112.33/sq.m.

At 45 days after pruning, repeated hand weeding recorded significantly lower total weed population (0.00/sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (68.67/sq.m) and Metolachlor at 1.5 a.e./ha (64.0/sq.m) gave better control of weeds as compared to other herbicidal treatments (68.67 to 98.00/sq.m) and unweeded control (147.33/sq.m).

At 60 days after pruning, the lowest total weed population was recorded with repeated hand weeding (0.00/sq.m). Among the

Table 7: Total weed population (in 1.0 m<sup>2</sup> area) at different crop growth stages as influenced by different weed control treatments in Mulberry.

Treatments	First crop				Second crop						
	Herbicide rate (kg a.i. or a.e./ha)		Days after pruning		Days after first harvest		Days after first harvest				
	15	30	45	60	15	30	45	60			
Repeated hand weeding											
	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)		
Diuron	1.00	5.42(29.00)	8.19(66.67)	8.89(78.67)	9.40(88.00)	9.74(94.33)	10.12(102.00)	10.24(104.33)	10.32(106.00)	10.45(108.67)	10.56(111.00)
Diuron	1.25	4.98(24.33)	7.20(51.33)	8.31(68.67)	8.65(74.33)	9.14(83.00)	9.26(85.33)	9.32(86.33)	9.39(87.67)	9.44(88.67)	9.58(91.33)
Butachlor	1.25	5.60(31.00)	8.33(69.00)	9.23(84.67)	9.56(91.00)	10.18(103.33)	10.48(109.00)	10.62(112.33)	10.68(113.67)	10.73(114.67)	10.79(116.00)
Butachlor	1.50	5.36(28.33)	7.60(57.33)	8.59(73.33)	9.24(85.00)	9.65(92.67)	9.77(95.00)	9.84(96.33)	9.92(98.00)	10.06(100.67)	10.14(102.33)
Isoproturon	1.25	7.33(53.33)	8.47(71.33)	9.92(98.00)	10.48(109.33)	10.88(118.00)	11.33(128.00)	11.41(129.67)	11.52(132.33)	11.62(134.67)	11.65(135.33)
Isoproturon	1.50	6.62(43.33)	7.80(60.33)	9.25(85.00)	10.02(100.00)	10.62(112.33)	10.73(114.67)	11.01(120.67)	11.11(123.00)	11.23(125.67)	11.32(127.67)
Alachlor	1.25	5.69(32.00)	8.43(70.67)	9.35(87.00)	10.07(101.00)	10.46(109.00)	10.76(115.33)	10.88(118.00)	10.91(118.67)	11.05(121.67)	11.11(123.00)
Alachlor	1.50	4.81(22.67)	7.29(52.67)	8.93(79.33)	9.60(91.67)	9.70(93.67)	10.07(101.00)	10.20(103.67)	10.27(105.00)	10.37(107.00)	10.45(108.67)
Metolachlor	1.25	5.55(30.33)	8.09(66.00)	8.95(79.67)	9.41(88.00)	9.77(95.00)	9.97(99.00)	10.07(101.00)	10.19(103.33)	10.30(105.67)	10.38(107.33)
Metolachlor	1.50	4.81(22.67)	7.08(49.67)	8.03(64.00)	8.36(69.33)	8.69(75.00)	8.91(79.67)	8.99(80.33)	9.04(81.33)	9.17(83.67)	9.25(85.00)
Pendimethalin	1.25	6.01(35.67)	8.42(70.33)	9.15(83.33)	10.04(100.33)	10.24(104.33)	10.43(108.33)	10.56(111.00)	10.67(113.33)	10.71(114.33)	10.81(116.33)
Pendimethalin	1.50	5.36(28.33)	7.30(53.00)	8.59(73.33)	9.46(89.00)	9.74(94.33)	10.02(100.00)	10.12(102.00)	10.29(105.33)	10.36(107.00)	10.43(108.33)
Oxyfluorfen	0.12	6.67(44.00)	8.37(69.67)	9.65(92.67)	10.48(109.33)	10.64(112.67)	10.84(117.00)	10.88(118.00)	10.96(119.67)	11.07(122.00)	11.10(122.67)
Oxyfluorfen	0.25	5.34(28.00)	7.47(55.33)	9.08(82.00)	9.80(95.67)	9.94(98.33)	10.07(101.00)	10.20(103.67)	10.27(105.00)	10.40(107.67)	10.45(108.67)
Unweeded control	-	8.59(73.33)	10.62(112.33)	12.15(147.33)	13.68(186.67)	14.33(205.00)	14.69(215.33)	14.93(222.33)	15.01(224.67)	15.07(226.67)	15.14(228.67)
P-test	0.14	0.14	0.11	0.09	0.13	0.13	0.10	0.10	0.10	0.09	0.09
S.E.M. ±	0.40	0.39	0.30	0.25	0.37	0.37	0.29	0.27	0.28	0.26	0.26
C.D. (5%)											

Figures in the parenthesis indicate original values; Transformation used  $\sqrt{x + 0.5}$  significant at 5% probability level

herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (69.33/sq.m) and Diuron at 1.25 kg a.i./ha (74.33/sq.m) gave satisfactory control of weeds as compared to other herbicidal treatments (88.0 to 109.33/sq.m) and unweeded control (186.67/sq.m).

At harvest also repeated hand weeding recorded lowest weed population (0.00/sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (75.0/sq.m) gave satisfactory control of weeds. The next best herbicide was Diuron at 1.25 kg a.i./ha (83.0/sq.m) followed by Butachlor at 1.5 kg a.e./ha (92.67/sq.m), Pendimethalin at 1.5 kg a.e./ha (94.33/sq.m) and Diuron at 1.0 kg at a.e./ha (94.33/sq.m). However, unweeded control recorded higher weed population (205.0/sq.m).

#### 4.3.8 Total weed population (Second crop)

The data on total weed population at different growth stages of second crop are presented in table 7. Total weed population differed significantly due to different weed control treatments at all the growth stages.

At 15 days after first crop leaf harvest, the lowest total weed population was recorded in repeated hand weeding (0.00/sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (79.67/sq.m) recorded significantly lower weed population. The next best herbicide was Diuron at 1.25 kg a.i./ha (85.33/sq.m) followed by Butachlor at 1.5 kg a.e./ha (95.0/sq.m) and Metolachlor at 1.25 kg a.e./ha (99.0/sq.m). However, unweeded control (215.33/sq.m) recorded higher weed population.

At 30 days after first crop leaf harvest, repeated hand weeding recorded lowest total weed population (0.00/sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (80.33 /sq.m) gave satisfactory control of weeds followed by Diuron at 1.25 kg a.i./ha (86.33 /sq.m) and Butachlor at 1.5 kg a.e./ha (96.33 /sq.m). However, unweeded control (222.33 /sq.m) recorded highest weed population.

At 45 days after first crop leaf harvest, repeated hand weeding recorded lowest total weed population (0.0 /sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (81.33 /sq.m) gave satisfactory control of weeds followed by Diuron at 1.25 kg a.i./ha (87.67 /sq.m) and Butachlor at 1.5 kg a.e./ha (98.0 /sq.m), as compared to other herbicidal treatments (105.33 to 132.33 /sq.m). Whereas, unweeded control recorded highest weed population (224.67 /sq.m).

At 60 days after first crop leaf harvest, the lowest total weed population were recorded with repeated hand weeding (0.00 /sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (83.67 /sq.m) and Diuron at 1.25 kg a.i./ha (88.67 /sq.m) recorded lower weed population as compared to other herbicidal treatments (100.67 to 134.67 /sq.m) and unweeded control (226.67 /sq.m).

At harvest also repeated hand weeding recorded lowest total weed population (0.00 /sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (85.0 /sq.m), Diuron at 1.25 kg

a.i./ha (91.33 /sq.m), Butachlor at 1.5 kg a.e./ha (102.33 /sq.m) recorded lower weed population as compared to other herbicidal treatments (108.33 to 135.33 /sq.m) and unweeded control (228.67 /sq.m).

In general, All the herbicidal treatments at higher concentrations gave better control of weed population as compared to their lower concentrations. At all the growth stages of crop, repeated hand weeding followed by Diuron at 1.25 kg a.i./ha and Metolachlor at 1.5 kg a.e./ha recorded lower weed population. The next best herbicides were Pendimethalin at 1.5 kg a.e./ha, Alachlor at 1.5 kg a.e./ha, Butachlor at 1.5 kg a.e./ha and Oxyfluorfen at 0.25 kg a.e./ha. Whereas, Isoproturon at 1.25 a.i./ha and unweeded control recorded higher weed population.

#### 4.4 Drymatter production of weeds

Observations on monocot, dicot, sedges and total drymatter production of weeds recorded from 0.5 square metre area at 15, 30, 45 and 60 days after pruning and at harvest in both first as well as second crop are presented in Tables 8, 9, 10 and 11.

##### 4.4.1 Drymatter production of monocot weeds (first crop)

The data on drymatter production of monocot weeds at different growth stages of first crop are presented in Table 8. At all the growth stages, drymatter production of monocot weeds differed significantly due to different weed control treatments.

At 15 days after pruning, the lowest weed dryweight was recorded with repeated hand weeding (0.0/0.5 sq.m). Among the

herbicidal treatments, Diuron at 1.25 kg and 1.0 kg a.i./ha (1.27 and 1.67 g/0.5 sq.m, respectively), Metolachlor at 1.5 kg a.e./ha (1.7 g/0.5 sq.m), Pendimethalin at 1.5 kg a.e./ha (1.7g/0.5 sq.m), Alachlor at 1.5 kg a.e./ha (1.83 g/0.5 sq.m) and Butachlor at 1.5 kg a.e./ha (1.87 g/0.5 sq.m) recorded lower weed dryweight as compared to other herbicidal treatments (2.37 to 3.27 g/0.5 sq.m) and unweeded control (5.67 g/0.5 sq.m).

At 30 days after pruning, repeated hand weeding recorded minimum dryweight of weeds (0.00/0.5 sq.m). Among the herbicidal treatments Diuron at 1.25 kg a.i./ha (1.87 g/0.5 sq.m) recorded lower weed dryweight followed by Diuron at 1.0 kg a.i./ha (2.33 g/0.5 sq.m), Metolachlor at 1.5 kg a.e./ha (2.4 g/0.5 sq.m) and Alachlor at 1.5 kg a.e./ha (2.8 g/0.5 sq.m). However, unweeded control recorded maximum dryweight of weeds (7.9 g/0.5 sq.m).

At 45 days after pruning, repeated hand weeding recorded lowest weed dryweight (0.00/0.5 sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (2.13 g/0.5 sq.m), Diuron at 1.25 kg a.i./ha (2.87 g/0.5 sq.m), Alachlor at 1.5 kg a.e./ha (3.0 g/0.5 sq.m) and Diuron at 1.0 kg a.i./ha (3.67 g/0.5 sq.m) recorded lower weed dryweight as compared to other herbicidal treatments (5.02 to 8.67 g/0.5 sq.m) and unweeded control (17.73 g/0.5 sq.m).

At 60 days after pruning, the lowest weed dryweight was recorded with repeated hand weeding (0.00/0.5 sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (10.4 g/0.5



sq.m), Metolachlor at 1.5 kg a.e./ha (11.07 g/0.5 sq.m), Butachlor at 1.5 kg a.e./ha (13.0 g/0.5 sq.m) and Metolachlor at 1.25 kg a.e./ha (13.67 g/0.5 sq.m) recorded lower weed dryweight as compared to other herbicidal treatments and unweeded control (32.27 g/0.5 sq.m).

At harvest also, repeated hand weeding recorded lowest weed dryweight (0.00/0.5 sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (10.3 g/0.5 sq.m) and Metolachlor at 1.5 kg a.e./ha (11.0 g/0.5 sq.m) recorded lower weed dryweight followed by Butachlor at 1.5 kg a.e./ha (12.2 g/0.5 sq.m), Metolachlor at 1.25 kg a.e./ha (12.73 g/0.5 sq.m) and Pendimethalin at 1.5 kg a.e./ha (13.53 g/0.5 sq.m). However, unweeded control (60.0 g/0.5 sq.m) recorded higher weed dryweight.

#### 4.4.2 Drymatter production of monocot weeds (second crop)

The data on drymatter production of monocot weeds at different growth stages of second crop are presented in Table 8. Drymatter production of monocot weeds differed significantly due to different weed control treatments.

At 15 days after first crop leaf harvest, the lowest weed dryweight was recorded with repeated hand weeding (0.0 g/0.5 sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha, Metolachlor at 1.5 kg a.e./ha, Butachlor at 1.5 kg a.e./ha and Pendimethalin at 1.5 kg a.e./ha recorded significantly lower weed dryweight (9.5 g, 10.0 g, 10.23 g and 11.5 g/0.5 sq.m respectively). Whereas, unweeded control recorded significantly highest weed dryweight (30.0 g/0.5 sq.m).

At 30 days after first crop leaf harvest, repeated hand weeding recorded lowest weed dryweight (0.00/0.5 sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (8.67 g/0.5 sq.m) recorded lower weed dryweight which was on par with Butachlor at 1.5 kg a.e./ha (9.8 g/0.5 sq.m), Metolachlor at 1.5 kg a.e./ha (9.2 g/0.5 sq.m) and Pendimethalin at 1.5 kg a.e./ha (10.5 g/0.5 sq.m). However, unweeded control recorded maximum dryweight of weeds (28.5 g/0.5 sq.m).

At 45 days after first crop leaf harvest, the lowest weed dryweight was recorded in repeated hand weeding (0.00/0.5 sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha, Metolachlor at 1.5 kg a.e./ha, Butachlor at 1.5 kg a.e./ha and Pendimethalin at 1.50 kg a.e./ha recorded lower weed dryweight (8.33 g, 8.4 g, 9.5 g and 9.5 g/0.5, sq.m respectively) as compared to other herbicidal treatments (10.50 to 17.6 g/0.5 sq.m) and unweeded control (27.6 g/0.5 sq.m).

At 60 days after first crop leaf harvest, the lowest weed dryweight was recorded with repeated hand weeding (0.00/0.5 sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (6.23 g/0.5 sq.m) and Metolachlor at 1.5 kg a.e./ha (7.2 g/0.5 sq.m), recorded significantly lower weed dryweight as compared to other herbicidal treatments (9.0 g to 16.5 g/0.5 sq.m) and unweeded control (26.0 g/0.5 sq.m).

At harvest also, repeated hand weeding recorded minimum weed dryweight (0.00/0.5 sq.m). Among the herbicidal treatments,

Diuron at 1.25 kg a.i./ha (6.0 g/0.5 sq.m) and Metolachlor at 1.5 kg a.e./ha (6.0 g/0.5 sq.m) recorded lower weed dryweight followed by Pendimethalin at 1.5 kg a.e./ha (7.5 g/0.5 sq.m), Butachlor at 1.5 kg a.e./ha (8.0 g/0.5 sq.m) and Alachlor at 1.5 kg a.e./ha (9.0 g/0.5 sq.m) and all other herbicidal treatments recorded lower weed dryweight (10.0 to 16.23 g/0.5 sq.m), as compared to unweeded control (30.5 g/0.5 sq.m).

#### 4.4.3 Drymatter production of Dicot weeds (First crop)

The data on drymatter production of dicot weeds at different growth stages of first crop are presented in Table 9. At all growth stages, drymatter production of dicot weeds differed significantly due to weed control treatments.

At 15 days after pruning, repeated hand weeding recorded significantly lower weed dry weight (0.00g/0.5 sq.m) which was on par with all other weed control treatments (0.17 to 0.6g/0.5 sq.m) except, Isoproturon at 1.25 kg and 1.5 kg a.i./ha (1.13 g and 0.70g/0.5 sq.m, respectively), Oxyfluorfen at 0.12 kg a.e./ha (0.77g/0.5 sq.m) and unweeded control (1.73g/0.5 sq.m).

At 30 days after pruning, repeated hand weeding recorded significantly lowest dry weight of weeds (0.00 g/0.5 sq.m) which was on par with all other weed control treatments (0.47 to 1.07 g/0.5 sq.m) except, Butachlor at 1.25 kg a.e./ha (1.67 g/0.5 sq.m). Isoproturon at 1.25 kg and 1.5 kg a.i./ha (2.77 and 1.8 g/0.5 sq.m, respectively), Pendimethalin at 1.25 kg a.e./ha (1.73 g/0.5 sq.m), Oxyfluorfen at 0.12 kg and 0.25 kg a.e./ha (2.10 and

1.50 g/0.5 sq.m, respectively) and unweeded control (2.37 g/0.5 sq.m).

At 45 days after pruning, the lowest weed dryweight was recorded significantly in case of repeated hand weeding (0.00 g/0.5 sq.m). Among the herbicidal treatments, Diuron at 1.0 kg and 1.25 kg a.i./ha (2.77 g and 2.00 g/0.5 sq.m, respectively), Metolachlor at 1.25 kg and 1.5 kg a.e./ha (2.9 g and 1.80 g/0.5 sq.m, respectively), Pendimethalin at 1.5 kg a.e./ha (3.00 g/0.5 sq.m) and Oxyfluorfen at 0.25 kg a.e./ha (2.53 g/0.5 sq.m) recorded significantly lower dryweight of weeds as compared to other herbicidal treatments (3.53 to 4.5 g/0.5 sq.m) and unweeded control (10.4 g/0.5 sq.m).

At 60 days after pruning, the lowest dryweight of weeds was recorded in repeated hand weeding (0.00 g/0.5 sq.m). Among the herbicidal treatments, Oxyfluorfen at 0.25 kg a.e./ha (3.0 g/0.5 sq.m) recorded lower weed dryweight followed by Metolachlor at 1.5 kg a.e./ha (4.0 g/0.5 sq.m), Diuron at 1.25 kg a.i./ha (4.5 g/0.5 sq.m), Pendimethalin at 1.5 kg a.e./ha (5.0 g/0.5 sq.m) and Oxyfluorfen at 0.12 kg a.e./ha (5.0 g/0.5 sq.m). However, unweeded control (19.33 g/0.5 sq.m) recorded higher weed dryweight.

At harvest also, repeated hand weeding recorded minimum weed dry weight (0.0 g/0.5 sq.m). Among the herbicidal treatments, Oxyfluorfen at 0.12 kg and 0.25 kg a.e./ha (4.63 g and 2.8 g/0.5 sq.m, respectively), Metolachlor at 1.25 kg and 1.5 kg a.e./ha

**Table 9: Dry matter production of Dicot weeds (g/0.5 m<sup>2</sup>) at different crop growth stages as influenced by different weed control treatments in Mulberry.**

Treatments	Herbicide rate (kg a.i. or a.e./ha)	First crop			Second crop									
		Days after pruning			Days after first harvest									
		15	30	45	15	30	45	60	At harvest					
Repeated hand weeding	-	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
Diuron	1.00	0.95 (0.43)	1.15 (0.83)	1.79 (2.77)	2.36 (5.07)	2.34 (5.00)	2.23 (4.50)	2.23 (4.50)	2.23 (4.50)	2.00 (3.53)	1.80 (2.77)	1.80 (2.77)	1.80 (2.77)	1.74 (2.53)
Diuron	1.25	0.80 (0.17)	0.98 (0.50)	1.57 (2.00)	2.23 (4.50)	2.23 (4.50)	2.23 (4.50)	1.92 (3.20)	1.81 (2.80)	1.81 (2.80)	1.57 (2.00)	1.57 (2.00)	1.60 (2.07)	
Butachlor	1.25	0.99 (0.53)	1.46 (1.67)	1.93 (3.27)	2.62 (6.40)	2.59 (6.27)	2.59 (6.27)	2.50 (5.80)	2.23 (4.50)	1.95 (3.33)	1.81 (2.80)	1.81 (2.80)	1.73 (2.53)	
Butachlor	1.50	1.00 (0.50)	1.17 (1.00)	1.90 (3.13)	2.50 (5.80)	2.45 (5.50)	2.45 (5.50)	2.23 (4.50)	2.23 (4.50)	1.95 (3.33)	1.81 (2.80)	1.81 (2.80)	1.64 (2.20)	
Isoproturon	1.25	1.27 (1.13)	1.80 (2.77)	2.23 (4.50)	3.56(12.20)	3.52(12.00)	3.52(12.00)	3.36(10.80)	3.31(10.50)	3.21 (9.80)	3.21 (9.80)	3.21 (9.80)	3.11 (9.20)	
Isoproturon	1.50	1.09 (0.70)	1.50 (1.80)	2.11 (4.00)	2.72 (7.00)	2.59 (6.27)	2.59 (6.27)	2.44 (5.50)	2.34 (5.00)	2.23 (4.50)	2.23 (4.50)	2.23 (4.50)	2.11 (4.00)	
Alachlor	1.25	1.01 (0.57)	1.33 (1.33)	2.00 (3.53)	2.50 (5.80)	2.51 (5.80)	2.51 (5.80)	2.23 (4.50)	2.12 (4.00)	1.94 (3.27)	1.94 (3.27)	1.94 (3.27)	1.80 (2.73)	
Alachlor	1.50	0.93 (0.40)	1.24 (1.07)	1.92 (3.20)	2.44 (5.50)	2.39 (5.27)	2.39 (5.27)	2.23 (4.50)	2.01 (3.53)	1.92 (3.20)	1.92 (3.20)	1.92 (3.20)	1.74 (2.53)	
Metolachlor	1.25	0.98 (0.50)	1.15 (0.93)	1.80 (2.80)	2.38 (5.20)	2.33 (5.00)	2.33 (5.00)	2.23 (4.50)	2.01 (3.53)	1.81 (2.80)	1.81 (2.80)	1.81 (2.80)	1.81 (2.80)	
Metolachlor	1.50	0.80 (0.17)	0.96 (0.47)	1.51 (1.80)	2.11 (4.00)	2.12 (4.00)	2.12 (4.00)	1.93 (3.27)	1.74 (2.53)	1.63 (2.20)	1.63 (2.20)	1.63 (2.20)	1.61 (2.10)	
Pendimethalin	1.25	1.03 (0.60)	1.49 (1.73)	1.94 (3.33)	2.67 (6.63)	2.59 (6.20)	2.59 (6.20)	2.45 (5.50)	2.23 (4.50)	2.23 (4.50)	1.92 (3.20)	1.92 (3.20)	1.81 (2.80)	
Pendimethalin	1.50	1.03 (0.57)	1.21 (1.00)	1.87 (3.00)	2.34 (5.00)	2.33 (5.00)	2.33 (5.00)	2.11 (4.00)	2.00 (3.50)	1.79 (2.73)	1.79 (2.73)	1.79 (2.73)	1.73 (2.50)	
Oryfluorfen	0.12	1.12 (0.77)	1.61 (2.10)	1.99 (3.50)	2.33 (5.00)	2.25 (4.63)	2.25 (4.63)	1.87 (3.00)	1.72 (2.50)	1.49 (1.73)	1.49 (1.73)	1.49 (1.73)	1.41 (1.50)	
Oryfluorfen	0.25	1.01 (0.57)	1.41 (1.50)	1.73 (2.53)	1.86 (3.00)	1.81 (2.80)	1.81 (2.80)	1.73 (2.80)	1.57 (2.00)	1.28 (1.13)	1.28 (1.13)	1.28 (1.13)	1.24 (1.07)	
Unweeded control	-	1.47 (1.73)	1.69 (2.37)	3.30(10.40)	4.45(19.33)	5.43(29.00)	5.43(29.00)	3.93(15.00)	3.83(14.20)	3.67(13.00)	3.67(13.00)	3.67(13.00)	3.94(15.00)	
P-test		*	*	*	*	*	*	*	*	*	*	*	*	*
S.E.m ±	0.11	0.14	0.10	0.11	0.10	0.10	0.10	0.10	0.08	0.07	0.08	0.07	0.08	
C.D. 0.5%	0.31	0.36	0.29	0.32	0.28	0.28	0.28	0.27	0.24	0.20	0.24	0.20	0.22	

Figures in the parenthesis indicate original values; Transformation used x + 0.5 significant at 5% probability level

(5.0 g and 4.0 g/0.5 sq.m, respectively) and Diuron at 1.0 kg and 1.25 kg a.i./ha (5.0 g and 4.5 g/0.5 sq.m, respectively) recorded lower weed dry weight as compared to other herbicidal treatments and unweeded control (29.0 g/0.5 sq.m).

#### 4.4.4 Dry matter production of Dicot weeds (Second crop)

The data on drymatter production of dicot weeds at different growth stages of second crop are presented in Table 9. Drymatter production of dicot weeds differed significantly due to different weed control treatments at all growth stages.

At 15 days after first crop leaf harvest, the lowest weed dry weight was recorded with repeated hand weeding (0.00g/0.5 sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (3.53 g/0.5 sq.m), Metolachlor at 1.5 kg a.e./ha (3.33 g/0.5 sq.m) and Oxyfluorfen at 0.25 kg a.e./ha (2.8 g/0.5 sq.m) recorded significantly lower weed dryweight as compared to other herbicidal treatments (4.0 to 11.13 g/0.5 sq.m) and unweeded control (16.23 g/0.5 sq.m).

At 30 days after first crop leaf harvest, repeated hand weeding recorded lowest weed dry weight (0.00 g/0.5 sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (3.2 g/0.5 sq.m), Metolachlor at 1.5 kg a.e./ha (3.27 g/0.5 sq.m), Oxyfluorfen at 0.12 kg and 0.25 kg a.e./ha (3.0 g and 2.5 g/0.5 sq.m, respectively) recorded lower weed dry weight as compared to other herbicidal treatments (4.00 to 10.8 g/0.5 sq.m) and unweeded control (15.0 g/0.5 sq.m).

At 45 days after first crop leaf harvest, repeated hand weeding recorded minimum weed dryweight (0.00 g/0.5 sq.m). Among the herbicidal treatments, Oxyfluorfen at 0.25 kg a.e./ha (2.0 g/0.5 sq.m) recorded lower weed dry weight followed by Oxyfluorfen at 0.12 kg a.e./ha (2.5 g/0.5 sq.m), Metolachlor at 1.5 kg a.e./ha (2.53 g/0.5 sq.m), Diuron at 1.25 kg a.i./ha (2.8 g/0.5 sq.m) and Butachlor at 1.5 kg a.e./ha (3.33.g/0.5 sq.m). However, unweeded control (14.2 g/0.5 sq.m) recorded higher weed dryweight.

At 60 days after first crop leaf harvest, the lowest weed dryweight was recorded with repeated hand weeding (0.00 g/0.5 sq.m). Among the herbicidal treatments, Oxyfluorfen at 0.25 kg and 0.12 kg a.e./ha (1.13 g and 1.73 g/0.5 sq.m, respectively) recorded lower weed dry weight followed by Diuron at 1.25 kg a.i./ha (2.0 g/0.5 sq.m), Metolachlor at 1.5 kg a.e./ha (2.2 g/0.5 sq.m) and Butachlor at 1.5 kg a.e./ha (2.77 g/0.5 sq.m). Whereas, unweeded control recorded maximum dryweight of weeds (13.0 g/0.5 sq.m).

At harvest also repeated hand weeding recorded lowest dry weight of weeds (0.0 g/0.5 sq.m). Among the herbicidal treatments, Oxyfluorfen at 0.12 kg and 0.25 kg a.e./ha (1.5 g and 1.07 g/0.5 sq.m, respectively), Diuron at 1.25 kg a.e./ha (2.071 g/0.5 sq.m) and Metolachlor at 1.5 kg a.e./ha (2.1 g/0.5 sq.m) recorded lower weed dry weight as compared to other herbicidal treatments (2.53 to 9.2 g/0.5 sq.m) and unweeded control (15.0 g/0.5 sq.m).

#### 4.4.5 Drymatter production of Sedge (First crop)

The data on drymatter production of sedge at different growth stages of first crop are presented in Table 10. Drymatter production of sedges differed significantly due to different weed control treatments at all growth stages.

At 15 days after pruning, the lowest dry weight of weeds was recorded with repeated hand weeding (0.00g/0.5 sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (7.87 g/0.5 sq.m) recorded significantly lower weed dryweight followed by Diuron at 1.25 kg a.i./ha (10.97 g/0.5 sq.m), Alachlor at 1.5 kg a.e./ha (11.8 g/0.5 sq.m), Metolachlor at 1.25 kg a.e./ha (14.43 g/0.5 sq.m) and Pendimethalin at 1.5 kg a.e./ha (14.53 g/0.5 sq.m). Whereas, unweeded control recorded higher weed dryweight (28.43 g/0.5 sq.m).

At 30 days after pruning, repeated hand weeding recorded lowest weed dry weight (0.00 g/0.5 sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (19.8 g/0.5 sq.m), followed Metolachlor at 1.5 kg a.e./ha (20.17 g/sq.m), Pendimethalin at 1.5 kg a.e./ha (21.27 g/0.5 sq.m) and Alachlor at 1.5 kg a.e./ha (21.47 g/0.5 sq.m) gave lower weed dry weight as compared to other herbicidal treatments (23.13 to 32.53 g/0.5 sq.m) and unweeded control (44.33 g/0.5 sq.m).

At 45 days after pruning, repeated hand weeding recorded lowest weed dry weight (0.00 g/0.5 sq.m). Among the herbicidal treatments, the lowest weed dryweight was recorded in Metolachlor

**Table 10:** Dry matter production of Sedge (g/0.5 m<sup>2</sup>) at different crop growth stages as influenced by different weed control treatments in Mulberry.

Treatments	Herbicide rate (kg a.i. or a.e./ha)	First crop				Second crop										
		Days after pruning				Days after first harvest										
		15	30	45	60	At harvest	15	30	45	60	At harvest					
Repeated hand weeding	-	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)		
Diuron	1.00	4.02(15.70)	5.36(28.30)	5.71(32.13)	5.73(32.40)	5.49(29.70)	5.31(27.73)	4.98(24.33)	4.91(23.60)	4.67(21.37)	4.36(18.57)	4.32(19.23)	4.40(18.87)	4.37(18.70)	4.33(18.23)	3.83(14.23)
Butachlor	1.25	3.99(15.43)	4.86(23.13)	5.56(30.43)	5.83(33.57)	5.28(27.43)	6.46(41.20)	6.39(40.40)	6.29(39.10)	6.04(36.00)	5.73(32.43)	5.77(32.83)	5.68(31.73)	5.57(30.50)	5.49(29.70)	5.34(28.07)
Isoproturon	1.25	3.95(15.10)	5.54(30.23)	5.80(33.20)	6.50(41.80)	6.16(37.47)	5.22(26.83)	5.21(26.70)	5.19(26.50)	4.91(23.67)	4.85(23.00)	5.78(32.93)	5.84(33.60)	5.83(33.50)	5.72(32.23)	5.63(31.27)
Alachlor	1.25	3.86(14.43)	5.06(25.13)	5.40(28.70)	6.15(37.40)	5.39(28.53)	4.95(24.00)	4.88(23.40)	4.79(22.47)	4.26(17.67)	3.78(13.87)	4.97(24.20)	4.95(24.10)	4.86(23.17)	4.68(21.10)	4.35(18.47)
Metolachlor	1.50	2.89 (7.87)	4.54(20.17)	5.00(24.53)	5.15(26.00)	4.78(22.40)	4.52(19.97)	4.27(17.73)	4.22(17.33)	3.99(15.43)	3.71(13.33)	4.52(19.97)	5.94(34.83)	5.82(33.87)	5.30(27.61)	5.13(25.90)
Pendimethalin	1.25	4.17(16.90)	5.53(30.13)	6.01(35.60)	6.37(40.10)	6.16(37.47)	5.96(35.10)	5.17(26.20)	5.11(25.67)	4.74(22.00)	4.36(18.57)	5.25(27.10)	6.22(38.30)	6.07(36.40)	5.88(34.10)	5.59(30.83)
Pendimethalin	1.50	3.87(14.53)	4.66(21.27)	5.27(27.37)	5.98(35.27)	5.31(27.87)	6.30(39.20)	6.22(38.30)	6.07(36.40)	5.12(26.77)	4.74(22.07)	6.30(39.20)	5.29(27.50)	5.22(26.77)	5.12(25.87)	4.74(22.07)
Oxyfluorfen	0.12	4.31(18.07)	5.98(35.30)	7.56(56.70)	5.00(48.53)	6.64(43.63)	5.51(29.90)	6.79(45.70)	6.34(39.77)	5.21(39.50)	6.13(37.13)	6.79(45.70)	6.34(39.77)	5.21(39.50)	6.13(37.13)	9.05(81.50)
Oxyfluorfen	0.25	4.07(16.10)	4.93(23.83)	6.25(38.67)	6.15(37.40)	5.58(30.70)	6.79(45.70)	6.34(39.77)	5.21(39.50)	6.13(37.13)	9.05(81.50)	6.79(45.70)	6.34(39.77)	5.21(39.50)	6.13(37.13)	9.05(81.50)
Unweeded control	-	5.38(28.43)	6.69(44.33)	7.47(55.33)	7.55(56.53)	10.81(116.50)	6.79(45.70)	6.34(39.77)	5.21(39.50)	6.13(37.13)	9.05(81.50)	6.79(45.70)	6.34(39.77)	5.21(39.50)	6.13(37.13)	9.05(81.50)
F-test		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
S.E.M +		0.08	0.12	0.11	0.10	0.15	0.09	0.11	0.12	0.13	0.12	0.09	0.11	0.12	0.13	0.12
C.D. 0.5%		0.23	0.34	0.31	0.37	0.41	0.25	0.30	0.33	0.35	0.35	0.25	0.30	0.33	0.35	0.35

Figures in the parenthesis indicate original values; Transformation used x + 0.5  
\* significant at 5% probability level

at 1.5 kg a.e./ha (24.53 g/0.5 sq.m) followed by Diuron at 1.25 kg a.i./ha (25.93 g/0.5 sq.m), Alachlor at 1.5 kg a.e./ha (25.93 g/0.5 sq.m) and Pendimethalin at 1.5 kg a.e./ha (27.39 g/0.5 sq.m). However, unweeded control (55.33 g/0.5 sq.m) and Oxyfluorfen 0.12 kg a.e./ha (56.7 g/0.5 sq.m) recorded higher weed dry weight.

At 60 days after pruning, the lowest weed dryweight was registered with repeated hand weeding (0.00 g/0.5 sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (26.0 g/0.5 sq.m) followed by Alachlor at 1.5 kg a.e./ha (28.23 g/0.5 sq.m) and Diuron at 1.25 kg a.i./ha (28.77 g/0.5 sq.m) recorded lower weed dryweight as compared to other herbicidal treatments (32.4 to 55.07 g/0.5 sq.m) and unweeded control (56.53 g/0.5 sq.m).

At harvest also repeated hand weeding recorded minimum weed dryweight (0.0 g/0.5 sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha and Metolachlor at 1.5 kg a.e./ha recorded lower weed dryweight (20.37 g and 22.4 g/0.5 sq.m, respectively) as compared to other herbicidal treatments (24.17 to 43.73 g/0.5 sq.m) and unweeded control (116.5 g/0.5 sq.m).

#### 4.4.6 Drymatter production of Sedge (Second crop)

The data on drymatter production of sedge at different growth stages of second crop are presented in Table 10. At all growth stages, drymatter production of sedges differed significantly due to different weed control treatments.

At 15 days after first crop leaf harvest, the lowest weed dry weight was recorded with repeated hand weeding (0.00 g/0.5 sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (19.23 g/0.5 sq.m) and Metolachlor at 1.5 kg a.e./ha (19.97 g/0.5 sq.m) gave lower weed dryweight as compared to other herbicidal treatments (26.20 to 41.2 g/0.5 sq.m) and unweeded control (45.7 g/0.5 sq.m).

At 30 days after first crop leaf harvest, repeated hand weeding recorded lowest weed dry weight (0.00 g/0.5 sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (17.73 g/0.5 sq.m) recorded lower weed dry weight followed by Diuron at 1.25 kg a.i./ha (18.87 g/0.5 sq.m) and Metolachlor at 1.5 kg a.e./ha (24.1 g/0.5 sq.m). However, unweeded control (39.77 g/0.5 sq.m) recorded higher weed dryweight.

At 45 days after first crop leaf harvest, the lowest weed dry weight was recorded with repeated hand weeding (0.00 g/0.5 sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (17.33 g/0.5 sq.m) recorded lower weed dry weight followed by Diuron at 1.25 kg a.i./ha (18.7 g/0.5 sq.m), Alachlor at 1.5 kg a.e./ha (22.47 g/0.5 sq.m) and Metolachlor at 1.25 kg a.e./ha (23.17 g/0.5 sq.m). However, unweeded control (39.5 g/0.5 sq.m) recorded maximum weed dryweight of sedges.

At 60 days after first crop leaf harvest, the lowest weed dry weight was recorded with repeated hand weeding (0.00 g/0.5 sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha

(15.43 g/0.5 sq.m), Alachlor at 1.5 kg a.e./ha (17.67 g/0.5 sq.m), Diuron at 1.25 kg a.i./ha (18.23 g/0.5 sq.m) and Butachlor at 1.5 kg a.e./ha (18.87 g/0.5 sq.m) recorded lower weed dry weight as compared to other herbicidal treatments (21.4 to 36.0 g/0.5 sq.m) and unweeded control (37.13 g/0.5 sq.m).

At harvest also repeated hand weeding recorded lowest weed dryweight (0.0 g/0.5 sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (13.33 g/0.5 sq.m) recorded lower weed dryweight followed by Alachlor at 1.5 kg a.e./ha (13.87 g/0.5 sq.m). Diuron at 1.25 kg a.i./ha (14.23 g/0.5 sq.m), Butachlor at 1.5 kg a.e./ha (17.93 g/0.5 sq.m) and Metolachlor at 1.25 kg a.e./ha (18.47 g/0.5 sq.m), whereas unweeded control recorded highest weed dryweight (81.5 g/0.5 sq.m).

#### 4.4.7 Dry matter production of total weeds (First crop)

The data on dry matter production of total weeds at different growth stages of First crop are presented in Table 11. Dry matter production of total weeds differed significantly due to different weed control treatments at all the growth stages.

At 15 days after pruning, the lowest total weed dry weight was recorded significantly in case of repeated hand weeding (0.00 g/0.5 sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha gave significantly lower weed dry weight (9.73 g/0.5 sq.m) followed by Diuron at 1.25 kg a.i./ha (12.4 g/0.5 sq.m), Alachlor at 1.5 kg a.e./ha (14.03 g/0.5 sq.m) and Pendimethalin at 1.5 kg a.e./ha (16.8 g/0.5 sq.m). However, unweeded control

(35.83 g/0.5 sq.m) recorded higher dry weight of weeds.

At 30 days after pruning, repeated hand weeding had significantly lowest weed dry weight (0.00 g/0.5 sq.m). Among the herbicidal treatments Diuron at 1.25 kg a.i./ha recorded significantly lower weed dry weight (22.17 g/0.5 sq.m) which was on par with Metolachlor at 1.5 kg a.e./ha (23.03 g/0.5 sq.m) followed by Alachlor at 1.5 kg a.e./ha (25.33 g/0.5 sq.m) and Pendimethalin at 1.5 kg a.e./ha (26.07 g/0.5 sq.m) and other weed control treatments recorded significantly higher weed dry weight (28.77 to 54.06 g/0.5 sq.m).

At 45 days after pruning, the lowest weed dry weight was recorded with repeated hand weeding (0.00 g/0.5 sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (28.47 g/0.5 sq.m), Diuron at 1.25 kg a.e./ha (30.8 g/0.5 sq.m), Alachlor at 1.5 kg a.e./ha (32.13 g/0.5 sq.m) and Pendimethalin at 1.5 kg a.e./ha (32.17 g/0.5 sq.m) recorded lower weed dry weight as compared to other herbicidal treatments and unweeded control (83.47 g/0.5 sq.m).

At 60 days after pruning, repeated hand weeding recorded lowest weed dry weight (0.00 g/0.5 sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (41.07 g/0.5 sq.m) followed by Diuron at 1.25 kg a.i./ha (43.67 g/0.5 sq.m), Butachlor at 1.5 kg a.e./ha (52.33 g/0.5 sq.m), and Diuron at 1.0 kg a.i./ha (52.97 g/0.5 sq.m) recorded lower weed dry weight as compared to other herbicidal treatments (56.27 to 89.47 g/0.5

Table 11: Total dry matter production of weeds (g/0.5 m<sup>2</sup>) at different crop growth stages as influenced by different weed control treatments in Mulberry.

Treatments	Herbicide rate (kg a.i. or a.e./ha)	First crop				Second crop						
		Days after pruning				Days after first harvest						
		15	30	45	60	15	30	45	60	At harvest		
Repeated hand weeding	-	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
Diuron	1.00	4.27(17.80)	5.65(31.47)	6.25(38.57)	7.31(52.97)	7.03(48.93)	6.80(45.73)	6.52(42.03)	6.32(39.47)	6.00(35.53)	5.63(31.30)	5.63(31.30)
Diuron	1.25	3.59(12.40)	4.76(22.17)	5.59(30.80)	6.64(43.67)	5.97(35.17)	5.72(32.27)	5.59(30.73)	5.50(29.83)	5.19(26.47)	4.77(22.30)	4.77(22.30)
Butachlor	1.25	4.50(19.73)	6.33(39.60)	6.63(43.47)	8.15(65.87)	7.79(60.23)	7.51(55.87)	7.35(53.60)	7.15(50.70)	6.87(46.70)	6.56(42.60)	6.56(42.60)
Butachlor	1.50	4.27(17.80)	5.40(28.77)	6.24(38.50)	7.27(52.33)	6.75(45.13)	6.46(41.23)	6.33(39.70)	6.18(37.77)	5.62(31.13)	5.35(28.13)	5.35(28.13)
Isoproturon	1.25	5.60(30.90)	6.93(47.67)	8.19(66.67)	9.48(89.47)	8.74(76.03)	8.54(72.53)	8.43(70.70)	8.23(67.20)	7.92(62.30)	7.64(57.87)	7.64(57.87)
Isoproturon	1.50	4.31(18.13)	6.23(38.40)	7.42(54.63)	8.46(71.07)	7.37(53.87)	7.04(49.20)	6.85(46.40)	6.72(44.73)	6.39(40.37)	6.12(37.00)	6.12(37.00)
Alachlor	1.25	4.53(20.00)	6.03(35.87)	6.49(41.73)	8.14(65.80)	7.77(59.93)	7.35(53.63)	7.19(51.30)	7.10(50.00)	6.94(47.73)	6.70(44.50)	6.70(44.50)
Alachlor	1.50	3.81(14.03)	5.08(25.33)	5.71(32.13)	7.04(49.13)	6.65(43.77)	6.42(40.73)	6.23(38.40)	6.08(36.57)	5.58(30.67)	5.09(25.40)	5.09(25.40)
Metolachlor	1.25	4.16(16.80)	5.47(29.43)	6.12(36.97)	7.53(56.27)	6.84(46.27)	6.45(41.07)	6.24(38.60)	6.14(37.20)	5.83(33.50)	5.56(30.27)	5.56(30.27)
Metolachlor	1.50	3.19 (9.73)	4.85(23.03)	5.38(28.47)	6.44(41.07)	6.15(37.40)	5.81(33.30)	5.53(30.20)	5.36(28.27)	5.03(24.83)	4.68(21.43)	4.68(21.43)
Pendimethalin	1.25	4.60(20.67)	6.17(37.67)	6.79(45.60)	8.18(66.40)	7.85(61.13)	7.61(57.50)	7.41(54.53)	7.23(51.87)	6.69(44.30)	6.38(40.30)	6.38(40.30)
Pendimethalin	1.50	4.16(16.80)	5.15(26.07)	6.05(36.17)	7.40(54.27)	6.85(46.40)	6.60(43.10)	6.42(40.70)	6.26(38.67)	5.84(33.73)	5.39(28.57)	5.39(28.57)
Oryfluorfen	0.12	4.75(22.10)	6.55(42.47)	8.28(68.03)	8.60(73.53)	8.28(68.13)	7.93(62.40)	7.70(58.90)	7.41(54.40)	7.13(50.33)	6.84(46.33)	6.84(46.33)
Oryfluorfen	0.25	4.41(18.97)	5.47(29.53)	6.88(46.87)	7.56(56.73)	7.00(48.57)	6.79(45.70)	6.52(42.00)	6.45(41.27)	6.13(37.20)	5.71(32.13)	5.71(32.13)
Unweeded control	-	6.03(35.83)	7.42(54.60)	9.16(83.47)	10.42(108.13)	14.35(205.50)	9.61(91.93)	9.15(83.27)	9.04(81.30)	8.75(76.13)	11.29(127.00)	11.29(127.00)
F-test		*	*	*	*	*	*	*	*	*	*	*
S.E.m +		0.08	0.14	0.11	0.10	0.11	0.12	0.12	0.13	0.12	0.13	0.13
C.D. @ 5%		0.23	0.39	0.31	0.27	0.31	0.32	0.32	0.36	0.32	0.35	0.35

Figures in the parenthesis indicate original values; Transformation used x + 0.5 significant at 5% probability level

INDEX

Fig 3. Total dry matter production of weeds (g/0.5 sq.m) as influenced by different weed control treatments.

Treatment details

T1	: Repeated hand weeding	1 = 15 DAP
T2	: Diuron 1 kg a.i./ha	2 = 30 DAP
T3	: Diuron 1.25 kg a.i./ha	3 = 45 DAP
T4	: Butachlor 1.25 kg a.e./ha	4 = 60 DAP
T5	: Butachlor 1.50 kg a.e./ha	5 = At harvest
T6	: Isoproturon 1.25 kg a.i./ha	DAP = Days after pruning.
T7	: Isoproturon 1.50 kg a.i./ha	
T8	: Alachlor 1.25 kg a.e./ha	
T9	: Alachlor 1.50 kg a.e./ha	
T10	: Metolachlor 1.25 kg a.e./ha	
T11	: Metolachlor 1.50 kg a.e./ha	
T12	: Pendimethalin 1.25 kg a.e./ha	
T13	: Pendimethalin 1.50 kg a.e./ha	
T14	: Oxyfluorfen 0.12 kg a.e./ha	
T15	: Oxyfluorfen 0.25 kg a.e./ha	
T16	: Unweeded control.	

Page 1

Page 2

Page 3

Page 4

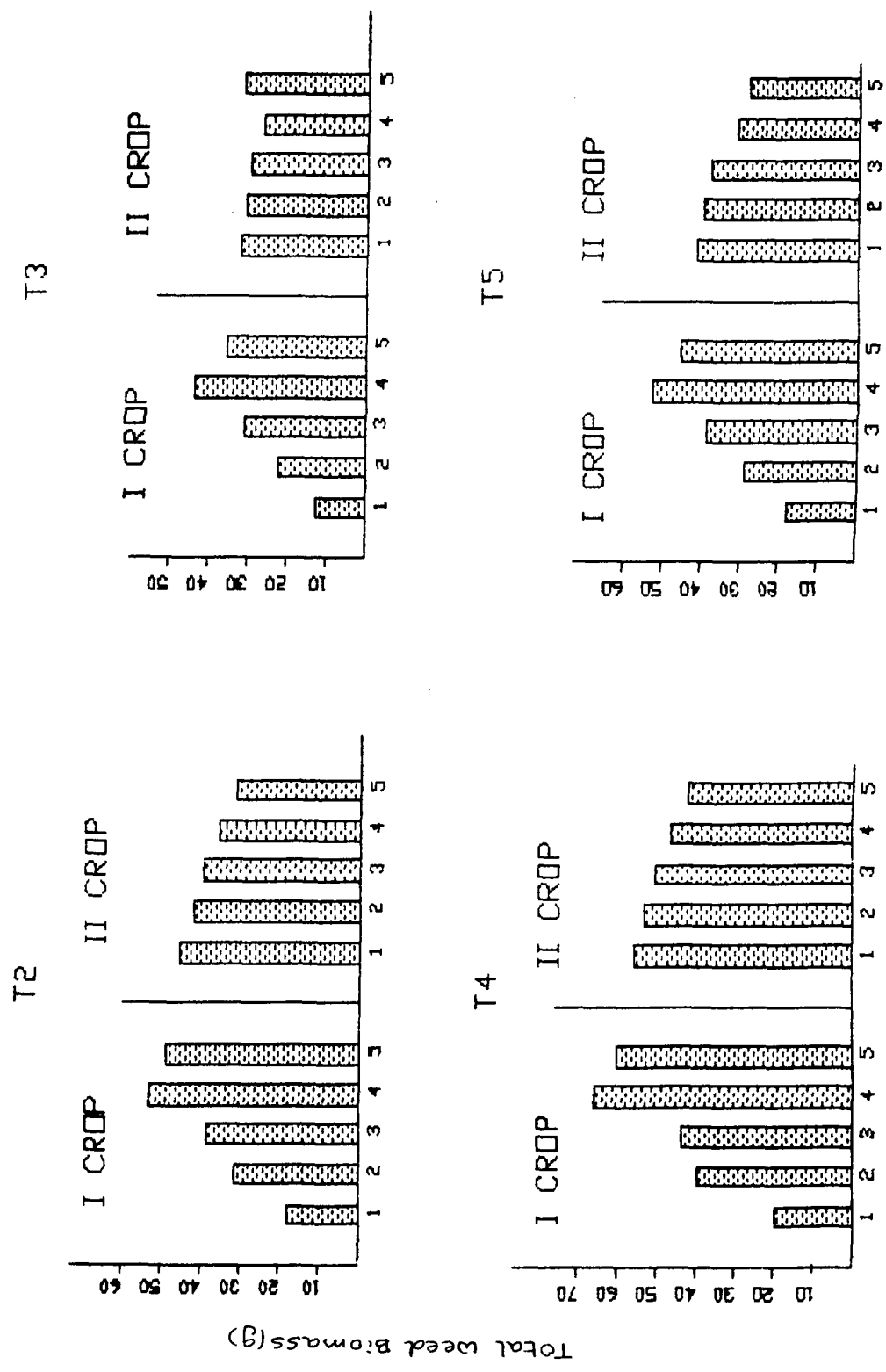
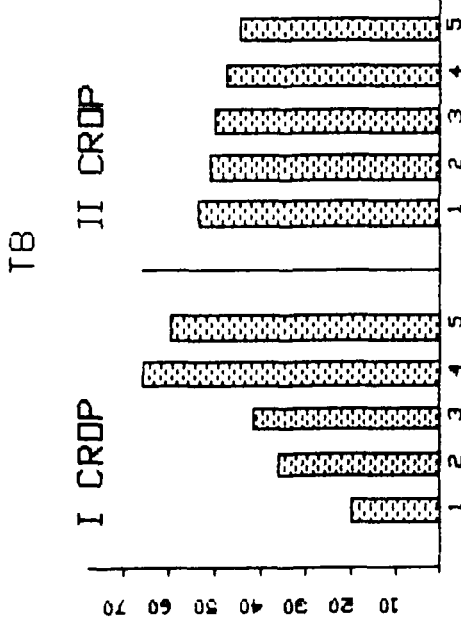
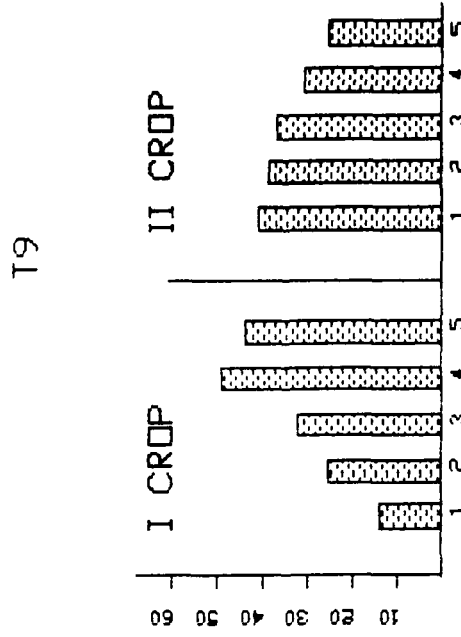
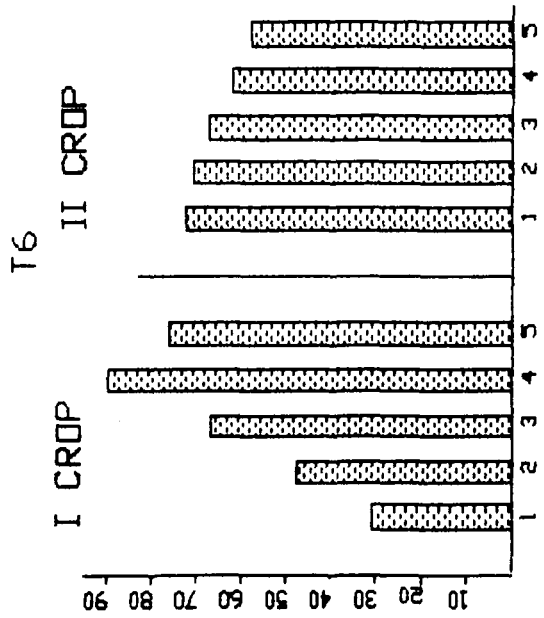
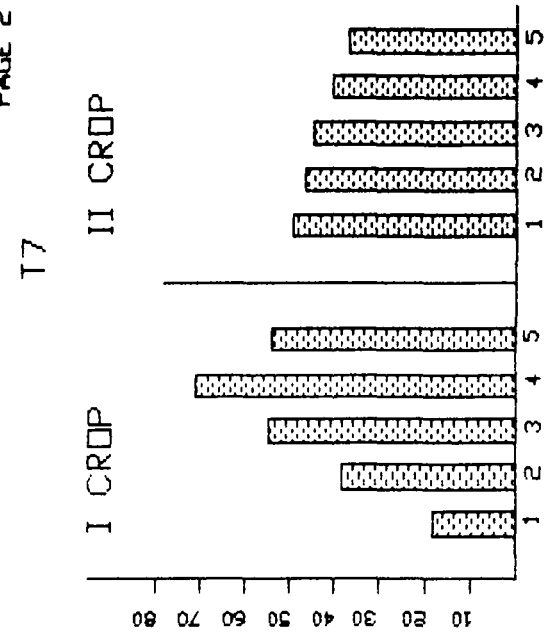


FIGURE 3: Total drymatter production of weeds (g/0.5 sq m) as influenced by different weed control treatments. (T2,T3,T4,T5)



Total weed biomass (g)

FIGURE 3: Total drymatter production of weeds(g/0.5 sq.m) as influenced by different weed control treatments(T6,T7,T8,T9)

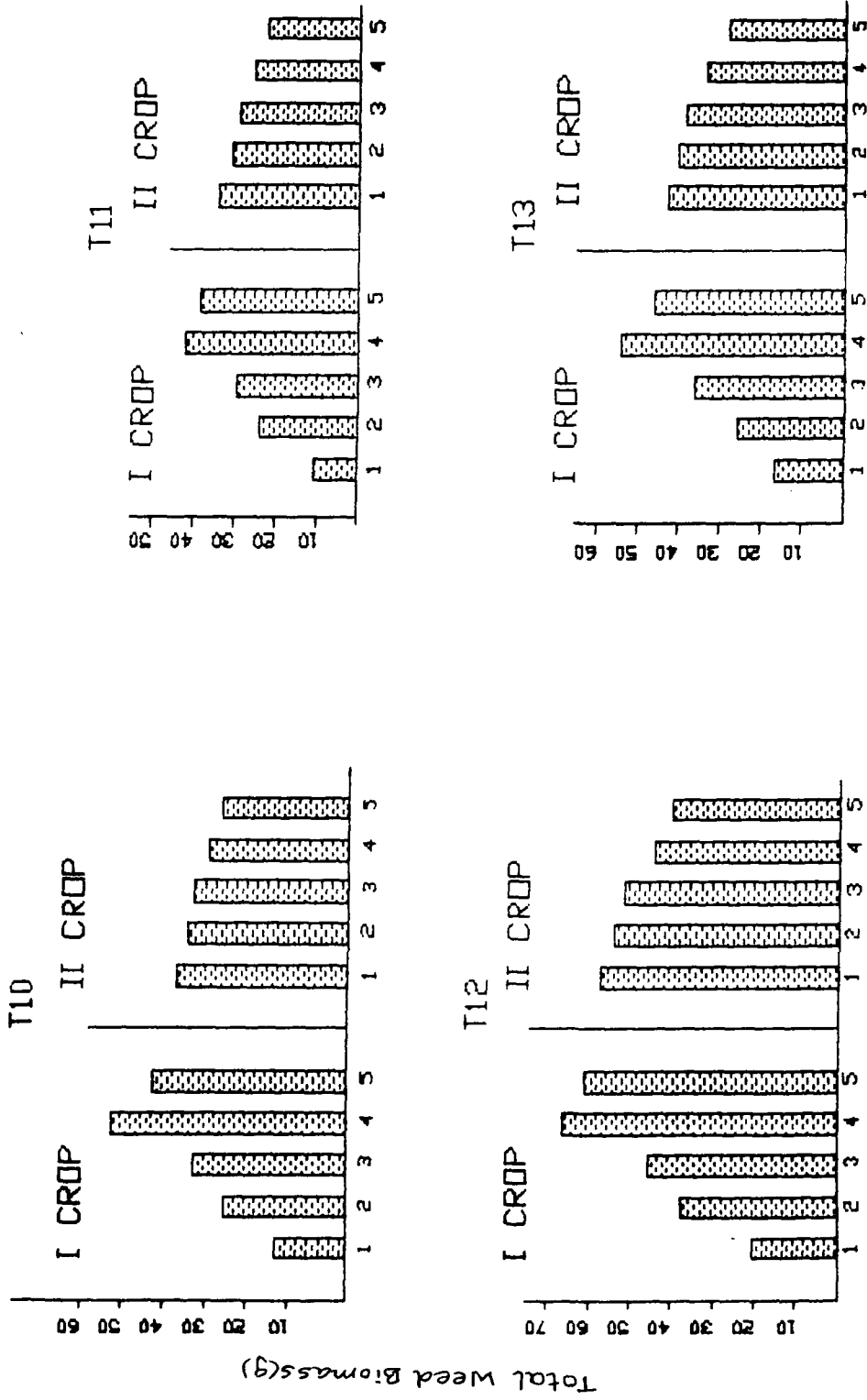


FIGURE 3: Total drymatter production of weeds (g/0.5 sq m) as influenced by weed control treatments (T10, T11, T12, T13)

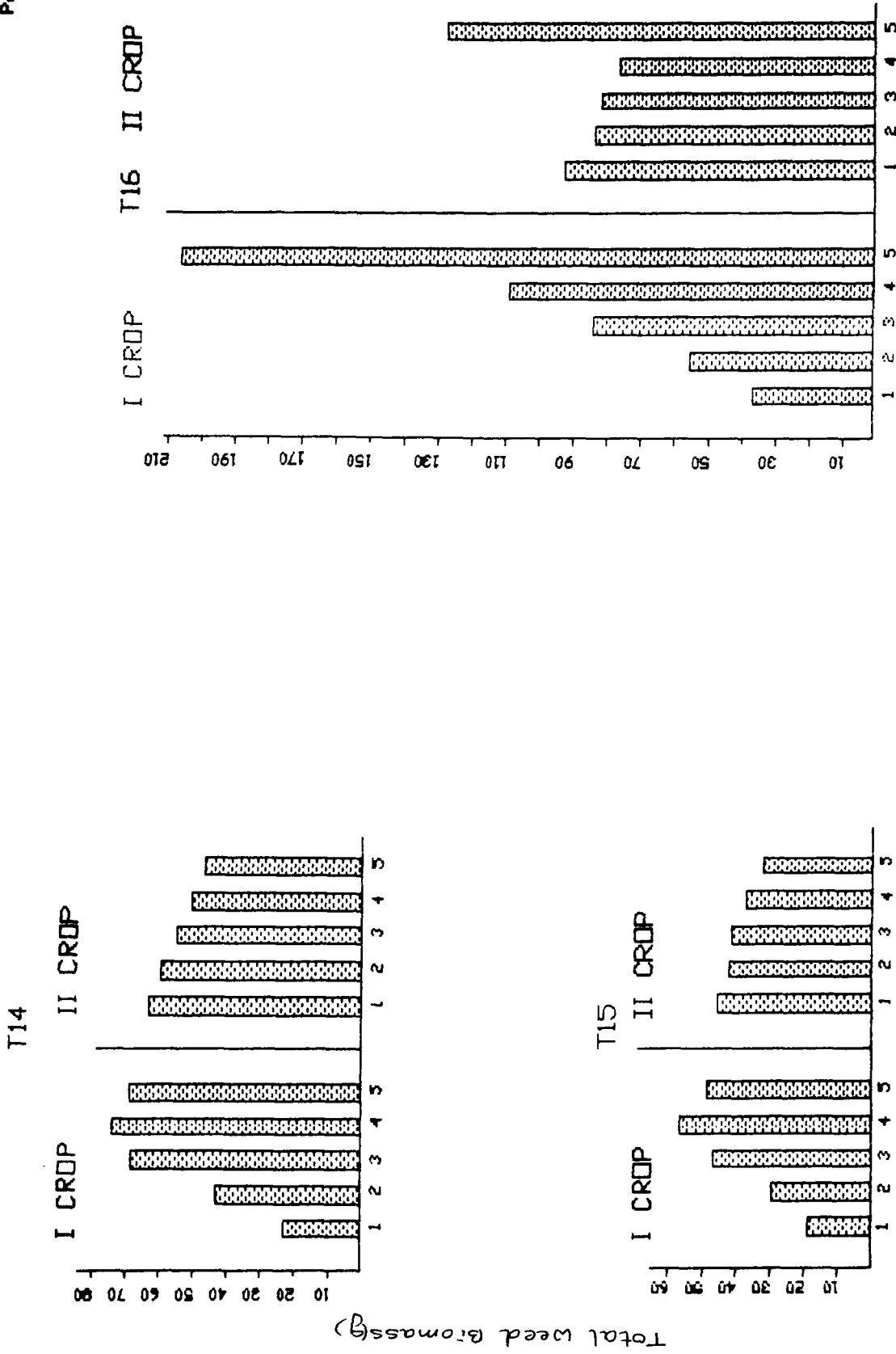


FIGURE 3: Total drymatter production of weeds(g/0.5 sqm) as influenced by different weed control treatments (T14,T15,T16)

sq.m) and unweeded control (108.13 g/0.5 sq.m).

At harvest also repeated hand weeding recorded minimum weed dry weight (0.0 g/0.5 sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha recorded lower weed dry weight (35.17 g/0.5 sq.m) followed by Metolachlor at 1.5 kg a.e./ha (37.4 g/0.5 sq.m), Alachlor at 1.5 kg a.e./ha (43.77 g/0.5 sq.m) and Butachlor at 1.5 kg a.e./ha (45.13 g/0.5 sq.m). whereas unweeded control recorded higher weed dry weight of 205.5 g/0.5 sq.m.

#### 4.4.8 Dry matter Production of total weeds (Second crop)

The data on dry matter production of total weeds at different growth stages of second crop are presented in Table 11. Dry matter production of total weeds differed significantly due to different weed control treatments at all the growth stages.

At 15 days after first crop leaf harvest, the lowest weed dry weight was recorded in case of repeated hand weeding (0.0 g/0.5 sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (32.27 g/0.5 sq.m) and Metolachlor at 1.5 kg a.e./ha (33.3 g/0.5 sq.m) recorded lower weed dry weight as compared to other herbicidal treatments (40.73 to 72.53 g/0.5 sq.m) and unweeded control (91.93 g/0.5 sq.m).

At 30 days after first crop leaf harvest, repeated hand weeding recorded lowest weed dry weight (0.0 g/0.5 sq.m). Among the herbicidal treatments, the lower weed dry weight was recorded with Metolachlor at 1.25 kg a.e./ha (30.2 g/0.5 sq.m) followed by

Diuron at 1.25 kg a.i./ha (30.73 g/0.5 sq.m), Alachlor at 1.5 kg a.e./ha (38.4 g/0.5 sq.m) and Metolachlor at 1.25 kg a.e./ha (38.6 g/0.5 sq.m). Whereas, unweeded control (83.27 g/0.5 sq.m) recorded higher dryweight of weeds.

At 45 days after first crop leaf harvest, the lowest weed dry weight was recorded with repeated hand weeding (0.0 g/0.5 sq.m). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha and Metolachlor at 1.5 kg a.e./ha recorded lower weed dry weight (29.83 g and 28.27 g/0.5 sq.m) as compared to other herbicidal treatments (36.57 to 67.2 g/0.5 sq.m) and unweeded control (91.93 g/0.5 sq.m).

At 60 days after first crop leaf harvest, the lowest weed dry weight was recorded with repeated hand weeding (0.0 g/0.5 sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (24.83 g/0.5 sq.m) recorded lower weed dryweight followed by Diuron at 1.25 kg a.i./ha (26.47 g/0.5 sq.m), Alachlor at 1.5 kg a.e./ha (30.67 g/0.5 sq.m) and Butachlor at 1.25 kg a.e./ha (33.5 g/0.5 sq.m). However, the higher weed dryweight was recorded with unweeded control (76.13 g/0.5 sq.m).

At harvest also repeated hand weeding recorded minimum weed dry weight (0.0 g/0.5 sq.m). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (22.3 g/0.5 sq.m), Alachlor at 1.5 kg a.e./ha (25.4 g/0.5 sq.m) and Butachlor at 1.5 kg a.e./ha (28.13 g/0.5 sq.m) recorded lower weed dry weight as compared to other herbicidal treatments and unweeded control (127.0 g/0.5 sq.m).

In general, All the herbicidal treatments at higher concentrations recorded lower weed dryweight as compared to their lower concentrations. At all the growth stages of crop, Repeated hand weeding followed by Diuron at 1.25 kg a.i./ha, Metolachlor at 1.5 kg a.e./ha, Pendimethalin at 1.5 kg a.e./ha, Alachlor at 1.5 kg a.e./ha, Butachlor at 1.5 kg a.e./ha and Oxyfluorfen at 0.25 kg a.e./ha recorded lower weed dry weight as compared to other herbicidal treatments and unweeded control.

#### 4.5 Studies on growth of crop

##### 4.5.1 Plant Height (First crop)

The data on plant at different growth stages of first crop are presented in Table 12. Plant height differed significantly due to different weed control treatments at all the growth stages.

At 15 days after pruning, the maximum plant height was recorded in repeated hand weeding (24.26 cm) which was on par with Diuron at 1.25 kg a.i./ha and 1.0 kg a.e./ha and 23.05 cm, and 21.16 cm, Metolachlor at 1.25 kg and 1.5 kg a.e./ha (22.68 and 24.04 cm respectively) and Pendimthalin at 1.5 kg a.e./ha (21.68 cm) and all other weed control treatments recorded significantly lower plant height (16.5 to 21.16 cm).

At 30 days after pruning, the maximum plant height was recorded in repeated hand weeding (47.82 cm). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha recorded maximum plant

height (44.63 cm) which was on par with Diuron at 1.25 kg a.i./ha (43.18 cm), Butachlor at 1.5 kg a.e./ha (41.96 cm) and Pendimethalin at 1.5 kg a.e./ha (41.39 cm). However, unweeded control recorded minimum plant height (28.5 cm).

At 45 days after pruning, the maximum plant height was recorded in repeated hand weeding (76.72 cm). Among the herbicidal treatments, Diuron 1.5 kg a.i./ha (69.07 cm) and Metolachlor at 1.5 kg a.e./ha (70.32 cm) recorded maximum plant height. However, unweeded control recorded minimum plant height of 41.34 cm.

At 60 days after pruning, the maximum plant height was recorded in repeated hand weeding (99.46 cm) which was on par with Diuron 1.0 kg and 1.25 kg a.i./ha (85.81 and 93.41 cm respectively), Butachlor at 1.5 kg a.e./ha (85.6 cm), Alachlor at 1.5 kg a.e./ha (87.56 cm), Metolachlor at 1.25 kg and 1.5 kg a.e./ha (86.1 and 94.83 cm respectively) and all other weed control treatments recorded significantly lower plant height (62.82 to 81.46 cm).

At harvest also, repeated hand weeding recorded maximum plant height (127.36 cm). Among the herbicidal treatments Metolachlor at 1.5 kg a.e./ha (119.63 cm) recorded maximum plant height followed by Diuron at 1.25 kg a.i./ha (116.49 cm), Butachlor at 1.5 kg a.e./ha (104.16 cm), Pendimethalin at 1.5 kg a.e./ha (103.29 cm) and Oxyfluorfen 0.25 kg a.e./ha (100.58 cm). Whereas, unweeded control recorded minimum plant height of 83.82 cm.

Table 12: Plant height(cm) at different crop growth stages as influenced by different weed control treatments in mulberry

Treatments	Herbicide rate (kg a.i. or a.e./ha)				First crop			Second crop			
	15	30	45	60	Days after pruning			Days after first crop			
					15	30	45	15	30	45	60
Repeated hand weeding	-	24.26	47.82	76.72	99.46	127.36	149.37	160.50	167.00	179.80	187.56
Diuron	1.00	21.16	39.97	63.31	85.81	109.91	128.08	137.80	145.72	151.85	157.65
Diuron	1.25	23.05	43.18	69.07	93.41	116.49	139.45	150.72	158.20	165.04	173.32
Butachlor	1.25	19.90	34.06	55.56	78.43	99.68	118.77	127.08	136.00	143.66	149.22
Butachlor	1.50	20.65	41.96	63.17	85.60	104.16	124.65	133.05	141.48	151.62	160.05
Isoproturon	1.25	17.08	30.07	48.08	67.36	88.08	107.65	116.40	123.48	129.65	135.53
Isoproturon	1.50	19.16	36.40	52.13	72.80	91.68	118.33	125.65	132.52	140.16	151.05
Alachlor	1.25	19.85	36.47	58.35	76.30	97.33	117.07	128.99	135.16	148.52	152.34
Alachlor	1.50	20.25	40.04	65.31	87.56	108.40	123.18	136.08	148.08	156.65	162.84
Metolachlor	1.25	22.68	38.38	65.52	86.10	108.64	126.88	135.38	143.25	152.60	158.50
Metolachlor	1.50	24.04	44.63	70.32	94.83	119.63	140.48	149.75	157.68	168.80	175.30
Pendimethalin	1.25	20.96	35.09	57.42	75.76	95.57	119.98	126.72	137.42	145.00	153.60
Pendimethalin	1.50	21.68	41.39	60.36	81.46	103.29	128.76	137.85	145.50	153.68	160.92
Oxyfluorfen	0.12	18.08	32.35	53.90	72.20	93.52	112.65	123.75	130.65	136.08	142.04
Oxyfluorfen	0.25	20.68	39.08	57.77	79.60	100.58	120.75	131.50	139.08	145.20	155.30
Unweeded control	-	16.50	28.50	41.34	62.82	83.82	101.45	110.58	118.05	124.34	131.72
P-test		*	*	*	*	*	*	*	*	*	*
S.E.M +	1.02	1.37	1.44	5.20	1.74	1.63	2.55	1.54	1.80	2.08	1.63
C.D. @ 5%	2.82	3.80	4.00	14.41	4.82	4.52	7.07	4.28	4.99	5.76	4.52

\* significant at 5% probability level

#### 4.5.2 Plant Height (Second crop)

The data on plant height on different growth stages of second crop are presented in Table 12. At all growth stages of crop plant height differed significantly due to different weed control treatments.

At 15 days after first crop leaf harvest, the maximum plant height was recorded with repeated hand weeding (149.37 cm). Among the herbicidal treatments Metolachlor at 1.5 kg a.e./ha recorded maximum plant height (140.48 cm) followed by Diuron at 1.25 kg a.i./ha (139.45 cm), Pendimethalin at 1.5 kg a.e./ha (128.76 cm) and Diuron at 1.0 kg a.i./ha (128.08 cm). However, unweeded control recorded minimum plant height (101.45).

At 30 days after first crop leaf harvest the maximum plant height was registered with repeated hand weeding (160.5 cm). Among the herbicidal treatments Diuron at 1.25 kg a.i./ha (150.72 cm), Metolachlor at 1.5 kg a.e./ha (149.75 cm) and Pendimethalin at 1.5 kg a.e./ha (137.85 cm) recorded higher as compared to other herbicidal treatments and unweeded control (110.58 cm). At 45 days after first crop leaf harvest, the maximum plant height was noticed in repeated hand weeding (167.00 cm). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha recorded maximum plant height (158.25 cm) which was on par with Metolachlor at 1.5 kg a.e./ha (157.68 cm) and differed significantly with all other herbicidal treatments and unweeded control (118.05 cm).

At 60 days after first crop leaf harvest, the maximum plant

height was noticed in repeated hand weeding (179.8 cm). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha recorded maximum plant height (168.8 cm) followed by Diuron at 1.25 kg a.i./ha (165.04 cm), Alachlor at 1.5 kg a.e./ha (156.65 cm) and Pendimethalin at 1.5 kg a.e./ha (153.68 cm). However, minimum plant height was recorded with unweeded control (124.34 cm).

At harvest also repeated hand weeding recorded maximum plant height (187.56 cm). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (175.30 cm) and Diuron at 1.25 kg a.i./ha (173.32 cm) recorded maximum plant height as compared to other herbicidal treatments and unweeded control (131.72 cm).

#### 4.5.3 Number of branches per plant

The data on number of branches per plant (primary and secondary) as influenced by different weed control treatments are presented in Table 13.

The number of primary shoots did not differ significantly due to different weed control treatments. However, the maximum number of primary shoots were recorded in Diuron at 1.25 kg a.i./ha (7.33/plant) and minimum in Oxyfluorfen 0.25 kg a.e./ha (5.33/plant).

The number of secondary shoots at harvest of first crop differed significantly due to different weed control treatments. The maximum number of secondary shoots were recorded with repeated hand weeding (15/plant) which was on par with Diuron at 1.25 kg a.i./ha (13/plant) and Metolachlor at 1.5 kg a.e./ha (14.33/plant)

Table 13: Number of branches per plant (Primary and Secondary) as influenced by different weed control treatments in mulberry at harvest of each crop.

Treatments	Herbicide rate (Kg a.i. or a.e./ha)	Primary shoots	Secondary shoots	
			I crop	II crop
Repeated hand weeding	-	6.80	15.00	17.53
Diuron	1.00	6.00	11.53	14.67
Diuron	1.25	7.33	13.00	16.23
Butachlor	1.25	5.67	10.33	12.53
Butachlor	1.50	6.67	12.57	14.67
Isoproturon	1.25	5.67	9.63	11.00
Isoproturon	1.50	5.33	10.57	13.67
Alachlor	1.25	5.67	9.53	13.67
Alachlor	1.50	6.00	11.67	15.00
Metolachlor	1.25	5.57	12.47	15.57
Metolachlor	1.50	7.33	14.33	16.00
Pendimethalin	1.25	5.33	10.00	13.47
Pendimethalin	1.50	6.00	12.33	14.53
Oxyfluorfen	0.12	5.97	9.67	12.00
Oxyfluorfen	0.25	5.33	11.00	14.53
Unweeded control	-	5.53	8.33	10.00
F-test		NS	*	*
S.Em $\pm$		0.51	0.77	0.83
C.D. @ 5%		1.42	2.13	2.31

NS Non significant  
\* significant at 5% probability level

and all other weed control treatments recorded significantly lower number of secondary shoots (8.33 to 12.47/plant).

The number of secondary shoots at harvest of second crop also differed significantly due to different weed control treatments. The highest number of secondary shoots were registered with repeated hand weeding (17.53/plant). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (16.23/plant), Metolachlor 1.25 and 1.5 kg a.e./ha gave higher number of secondary shoots (15.57 and 16.0/plant, respectively) as compared to other herbicidal treatments (11.0 to 14.67/plant) and unweeded control (10.0/plant).

#### 4.5.4 Number of leaves per plant (first crop)

The data on number of leaves per plant at different growth stages of first crop are presented in Table 14. Number of per plant differed significantly due to different weed control treatments at all the growth stages.

At 15 days after pruning, the highest number of leaves per plant was registered with repeated hand weeding (48.5/plant) which was on par with Diuron at 1.00 and 1.25 kg a.i./ha (42.4 and 45.7/plant, respectively), Butachlor at 1.5 kg a.e./ha (41.7/plant), Alachlor at 1.5 kg a.e./ha (43.7/plant), Metolachlor 1.25 and 1.5 kg a.e./ha (42.9 and 46.6/plant respectively) and all other herbicidal treatments were recorded higher number of leaves (34.6 to 41.2/plant) as compared to unweeded control (30.5/plant).

At 30 days after pruning, the highest number of leaves

per plant was recorded in repeated hand weeding ( 85.46/plant). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (75.07/plant), Diuron at 1.25 kg a.i./ha (74.27/plant) and Pendimethalin at 1.5 kg a.e./ha (71.87/plant) recorded higher number of leaves per plant as compared to other herbicidal treatments and unweeded control (55.73/plant).

At 45 days after pruning, repeated hand weeding recorded maximum number of leaves per plant (116.8/plant). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (109.67/plant) recorded maximum number of leaves per plants followed by Diuron at 1.25 kg a.i./ha (107.47/plant) and Pendimethalin at 1.5 kg a.e./ha of leaves per plant (75.33/plant).

At 60 days after pruning, the maximum number of leaves per plant was recorded with repeated hand weeding (136.93/plant). Which was on par with Diuron 1.0 kg and 1.25 kg a.i./ha (128.8 and 132.8/plant, respectively), Alachlor at 1.5 kg a.e./ha (129.47/plant), Metolachlor at 1.5 kg a.e./ha (130.73/plant) and Pandimethalin at 1.5 kg a.e./ha (128.27/plant) and other herbicidal treatments recorded higher number of leaves per plant (102.93 to 127.6/plant) as compared to unweeded control (89.47/plant).

At harvest also repeated hand weeding recorded maximum number of leaves per plant (158.2/plant). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (150.5/plant), Metolachlor 1.5 kg a.e./ha (149.5/plant) and Pendimethalin at 1.5 kg a.e./ha (147.67/plant) recorded higher number of leaves per plant as

**Table 14: Number of leaves per plant at different crop growth stages as influenced by different weed control treatments in mulberry**

Treatments	Herbicide rate (kg a.i. or a.e./ha)	First crop				Second crop					
		Days after pruning				Days after first crop					
		15	30	45	60	At harvest	15	30	45	60	At harvest
Repeated hand weeding	-	48.50	85.46	116.80	136.93	158.20	49.47	88.93	130.93	152.40	166.60
Diuron	1.00	42.50	70.13	98.47	128.80	142.37	41.63	75.77	108.77	132.27	142.50
Diuron	1.25	45.67	74.27	107.47	132.80	150.50	43.13	79.60	119.70	138.93	152.30
Butachlor	1.25	40.00	68.07	89.27	119.67	138.10	37.50	70.67	98.20	124.13	139.27
Butachlor	1.50	41.70	72.13	99.80	127.60	142.90	39.00	75.43	103.63	131.63	145.63
Isoproturon	1.25	34.00	64.60	79.27	102.93	119.40	32.10	62.20	86.10	102.20	121.43
Isoproturon	1.50	37.90	67.40	87.20	119.20	130.07	38.50	69.67	93.50	119.27	130.60
Alachlor	1.25	39.80	65.53	85.93	116.60	132.00	38.17	72.27	99.17	128.73	137.20
Alachlor	1.50	43.70	70.90	98.00	129.47	143.90	40.47	77.70	107.00	132.80	143.40
Metolachlor	1.25	42.90	71.60	101.87	125.67	140.93	39.67	76.13	106.70	130.73	141.50
Metolachlor	1.50	46.60	75.07	109.67	130.73	149.50	41.70	80.47	117.67	137.80	151.60
Pendimethalin	1.25	41.20	67.27	87.00	115.20	139.30	36.87	70.60	98.63	129.40	139.20
Pendimethalin	1.50	43.70	71.87	101.07	128.27	147.67	40.57	76.50	105.60	135.80	148.20
Oryfluorfen	0.12	38.10	66.33	85.73	112.07	129.10	37.73	68.20	93.40	120.07	130.73
Oryfluorfen	0.25	40.60	69.07	91.40	123.80	140.23	39.27	74.87	102.60	129.33	140.53
Unweeded control	-	30.50	55.73	75.33	89.47	109.97	28.73	56.00	72.43	97.20	112.80
P-test		*	*	*	*	*	*	*	*	*	*
S.E.m ±	2.52	2.49	1.97	3.37	1.90	1.33	1.67	1.74	2.06	1.62	1.62
C.D. @ 5%	6.97	6.89	5.46	9.05	5.27	3.68	4.62	4.81	5.72	4.50	4.50

\* significant at 5% probability level

compared to other herbicidal treatments (119.4 to 143.9/plant) and unweeded control (109.97/plant).

#### 4.5.5 Number of leaves per plant (second crop)

The data on number of leaves per plant at different growth stages of second crop are presented in Table 14. Number of leaves per plant differed significantly due to different weed control treatments at all the growth stages.

At 15 days after first crop leaf harvest, repeated hand weeding recorded highest number of leaves per plant (49.47/plant). Among the herbicidal treatments the higher number of leaves per plant was recorded in Diuron at 1.25 kg a.i./ha (43.13/plant) followed by Metolachlor at 1.5 kg a.e./ha (41.70/plant), Diuron at 1.0 kg a.i./ha (41.63/plant), Pendimethalin at 1.5 kg a.e./ha (40.57/plant) and Alachlor at 1.5 kg a.e./ha (40.47/plant). However, unweeded control recorded lower number of leaves per plant (28.73/plant).

At 30 days after first crop leaf harvest, repeated hand weeding recorded highest number of leaves per plant (88.93/plant). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha 1.5 kg a.e./ha (77.7/plant) and Pendimethalin at 1.5 kg a.e./ha (76.5/plant) recorded higher number of leaves per plant as compared to other herbicidal treatments and unweeded control (56.00/plant).

At 45 days after first crop leaf crop leaf harvest, repeated hand weeding recorded maximum number of leaves per plant

(130.93/plant). Among the herbicidal treatments, Diuron 1.25 kg a.i./ha (119.7/plant) and Metolachlor at 1.5 kg a.e./ha (117.67/plant) recorded higher number of leaves per plant as compared control (72.43/plant).

At 60 days after first crop leaf harvest, repeated hand weeding recorded maximum number of leaves per plant (152.4/plant). Among the herbicidal treatment, the higher number of leaves was recorded in Diuron at 1.25 kg a.i./ha (138.93/plant) followed by kg a.e./ha (135.8/plant) and Alachlor at 1.5 kg a.e./ha (132.8/plant). However unweeded control recorded lowest number of leaves per plant (97.2/plant).

At harvest also repeated hand weeding recorded maximum number of leaves per plant (166.6/plant). Among the herbicidal leaves per plant (152.3/plant) which was on par with Metolachlor at 1.5 kg a.e./ha (511.6/plant) and Pendimethalin at 1.5 kg a.e./ha (148.2/plant). Whereas unweeded control recorded lower number of leaves per plant (112.6/plant).

#### 4.5.6 Leaf area per plant (First crop)

The data on leaf area per plant at different growth stages of first crop are presented in Table 15. Leaf area per plant differed significantly due to different weed control treatments at all the growth stages.

At 15 days after pruning, repeated hand weeding recorded maximum leaf area per plant (912.5 cm<sup>2</sup>). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (858.83 cm<sup>2</sup>) Metolachlor at

1.5 kg a.e./ha (843.1 cm<sup>2</sup>) and Butachlor at 1.5 kg a.e./ha (832.06 cm<sup>2</sup>) recorded higher leaf area per plant as compared to other herbicidal treatments and unweeded control (542.5 cm<sup>2</sup>).

At 30 days after pruning, repeated hand weeding recorded maximum leaf area per plant (1892.7 cm<sup>2</sup>). Among the herbicidal treatments, the maximum leaf area per plant was noticed in Diuron at 1.25 kg a.i./ha (1756.97 cm<sup>2</sup>) followed by Metolachlor 1.5 kg a.e./ha (1724.03 cm<sup>2</sup>), Pendimethalin at 1.5 kg a.e./ha (1672.28 cm<sup>2</sup>), Butachlor at 1.5 kg a.e./ha (1644.96 cm<sup>2</sup>) and Alachlor at 1.5 kg a.e./ha (1629.17 cm<sup>2</sup>). However, unweeded control recorded minimum leaf area per plant (1048.28 cm<sup>2</sup>).

At 45 days after pruning, repeated hand weeding recorded maximum leaf area per plant (4072.07 cm<sup>2</sup>). Among herbicidal treatments, Diuron at 1.25 kg a.i./ha (3942.16 cm<sup>2</sup>) followed by Metolachlor at 1.5 kg a.e./ha (3905.99 cm<sup>2</sup>), Metolachlor at 1.25 kg a.e./ha (3495.92 cm<sup>2</sup>) and Butachlor at 1.5 a.e./ha (3470.42 cm<sup>2</sup>) recorded maximum leaf area per plant as compared to other herbicidal treatments and unweeded control (2022.03 cm<sup>2</sup>).

At 60 days after pruning, the maximum leaf area per plant was recorded in repeated hand weeding (6947.70 cm<sup>2</sup>), Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (6073.5 cm<sup>2</sup>) and Metolachlor at 1.5 kg a.e./ha (6077.0 cm<sup>2</sup>) recorded higher leaf area per plant as compared to other herbicidal treatments (4828.5 to 5895.25 cm<sup>2</sup>) and unweeded control (3955.79 cm<sup>2</sup>).

At harvest also repeated hand weeding recorded maximum leaf

Table 15: Leaf area/plant (cm<sup>2</sup>) at different crop growth stages as influenced by different weed control treatments in mulberry.

Treatments	Herbicide rate (kg a.i. or a.e./ha)	First crop				Second crop					
		Days after pruning				Days after first crop					
		15	30	45	60	At harvest	15	30	45	60	At harvest
Repeated hand weeding	-	912.50	1892.70	4072.07	6947.70	8987.84	895.50	1872.03	4213.65	7212.60	9002.38
Diuron	1.00	792.38	1521.52	3331.71	5822.70	7802.72	802.65	1665.97	3208.91	6053.29	7986.97
Diuron	1.25	858.83	1756.97	3942.16	6073.50	8579.71	825.47	1801.54	3966.06	6932.63	8530.51
Butachlor	1.25	712.64	1443.31	2806.26	5396.65	7263.35	705.47	1574.05	2985.50	5312.10	7462.50
Butachlor	1.50	832.06	1644.96	3470.42	5695.20	8003.24	798.64	1698.84	3388.69	5996.28	8012.08
Isoproturon	1.25	623.91	1246.22	2026.50	4828.50	6067.93	612.10	1412.24	2198.57	4586.85	6018.45
Isoproturon	1.50	675.50	1298.28	2134.37	5098.59	6700.79	665.94	1500.51	2988.00	4892.75	6853.21
Alachlor	1.25	718.60	1463.90	2667.19	5303.11	7418.48	709.87	1582.63	2975.29	5422.65	7645.21
Alachlor	1.50	804.29	1629.17	3326.55	5628.89	8091.75	769.58	1708.55	3252.68	5882.50	8122.58
Metolachlor	1.25	800.84	1568.19	3495.92	5993.50	7957.42	798.10	1657.54	3081.29	6069.75	8012.79
Metolachlor	1.50	843.10	1724.03	3905.99	6077.00	8608.73	822.45	1798.29	3898.65	6987.65	8612.57
Pendimethalin	1.25	740.75	1455.16	2830.02	5301.69	7232.40	710.18	1585.35	2899.93	5381.70	7325.64
Pendimethalin	1.50	842.60	1672.28	3226.03	5895.25	8044.43	775.50	1700.24	3422.48	5761.60	8112.27
Oxyfluorfen	0.12	678.00	1400.93	2558.40	5294.74	7021.90	675.95	1501.75	2665.24	5013.29	7091.47
Oxyfluorfen	0.25	762.18	1550.96	3012.34	5514.57	7867.69	752.60	1633.63	3185.47	5376.75	7986.53
Unweeded control	-	542.50	1048.28	2022.03	3955.79	5023.00	507.07	1120.24	2003.27	3412.48	4902.68
P-test		*	*	*	*	*	*	*	*	*	*
S.E.m ±		6.60	10.02	36.90	6.85	33.52	7.95	16.62	31.56	37.31	40.37
C.D. @ 5%		18.30	27.77	102.29	18.99	92.91	22.05	46.08	87.47	103.43	111.90

\* significant at 5% probability level

area per plant ( $8987.84 \text{ cm}^2$ ). Among the herbicidal treatments, the maximum leaf area per plant was recorded in Metolachlor at  $1.5 \text{ kg a.e./ha}$  ( $8679.73 \text{ cm}^2$ ) followed by Diuron at  $1.25 \text{ kg a.i./ha}$  ( $8579.71 \text{ cm}^2$ ), Alachlor at  $1.5 \text{ kg a.e./ha}$  ( $8091.75 \text{ cm}^2$ ) and Pendimethalin at  $1.5 \text{ kg a.e./ha}$  ( $8044.43 \text{ cm}^2$ ) and all other herbicidal treatments recorded higher leaf area per plant as compared to unweeded control ( $5023 \text{ cm}^2$ ).

#### 4.5.7 Leaf area per plant (Second crop)

The data on leaf area per plant at different growth stages of second crop are presented in table 15. At all growth stages of crop leaf area per plant differed significantly due to different weed control treatments.

At the 15 days after first crop leaf harvest, repeated hand weeding recorded maximum leaf area per plant ( $895.3 \text{ cm}^2$ ) followed by Diuron at  $1.25 \text{ kg a.i./ha}$  ( $825.47 \text{ cm}^2$ ), Metolachlor  $1.5 \text{ kg a.e./ha}$  ( $822.45 \text{ cm}^2$ ) and Diuron at  $1.0 \text{ kg a.i./ha}$  ( $802.65 \text{ cm}^2$ ). However, unweeded control ( $507.07 \text{ cm}^2$ ) recorded minimum leaf area per plant.

At the 30 days after first crop leaf harvest, repeated hand weeding recorded maximum leaf area per plant ( $1872.03 \text{ cm}^2$ ), Among the herbicidal treatments, Diuron at  $1.25 \text{ kg a.i./ha}$  ( $1801.54 \text{ cm}^2$ ), Metolachlor  $1.5 \text{ kg a.e./ha}$  ( $1798.29 \text{ cm}^2$ ), Alachlor at  $1.5 \text{ kg a.e./ha}$  ( $1708.55 \text{ cm}^2$ ) and Pendimethalin at  $1.5 \text{ kg a.e./ha}$  ( $1700.24 \text{ cm}^2$ ) recorded higher leaf area per plant as compared to other herbicidal treatments and unweeded control ( $1120.24 \text{ cm}^2$ ).

At the 45 days after first crop leaf harvest, repeated hand weeding recorded maximum leaf area per plant ( $4213.65 \text{ cm}^2$ ), followed by Diuron at  $1.25 \text{ kg a.i./ha}$  ( $3966.06 \text{ cm}^2$ ), Metolachlor at  $1.5 \text{ kg a.e./ha}$  ( $3898.65 \text{ cm}^2$ ), Pendimethalin at  $1.5 \text{ kg a.e./ha}$  ( $3422.48 \text{ cm}^2$ ) and Butachlor at  $1.5 \text{ kg a.e./ha}$  ( $3388.69 \text{ cm}^2$ ). However, unweeded control ( $2003.27 \text{ cm}^2$ ) recorded minimum leaf area per plant.

At the 60 days after first crop leaf harvest, the maximum leaf area per plant was registered with repeated hand weeding ( $7212.60 \text{ cm}^2$ ). Among the herbicidal treatments, Metolachlor at  $1.5 \text{ kg a.e./ha}$  ( $6987.65 \text{ cm}^2$ ) recorded maximum leaf area per plant followed by Diuron at  $1.25 \text{ kg a.i./ha}$  ( $6932.63 \text{ cm}^2$ ), Metolachlor at  $1.25 \text{ kg a.e./ha}$  ( $6069.75 \text{ cm}^2$ ), Diuron at  $1.0 \text{ kg a.i./ha}$  ( $6053.29 \text{ cm}^2$ ) and Butachlor at  $1.5 \text{ kg a.e./ha}$  ( $5996.28 \text{ cm}^2$ ). However, unweeded control ( $3412.48 \text{ cm}^2$ ) recorded minimum leaf area per plant.

At harvest also repeated hand weeding recorded maximum leaf area per plant ( $9002.38 \text{ cm}^2$ ) followed by Metolachlor  $1.5 \text{ kg a.e./ha}$  ( $8612.57 \text{ cm}^2$ ), Diuron at  $1.25 \text{ kg a.i./ha}$  ( $8530.51 \text{ cm}^2$ ), Alachlor at  $1.5 \text{ kg a.e./ha}$  ( $8122.58 \text{ cm}^2$ ) and Pendimethalin at  $1.5 \text{ kg a.e./ha}$  ( $8112.27 \text{ cm}^2$ ). However, Isoproturon at  $1.25 \text{ kg a.i./ha}$  and unweeded control recorded minimum leaf area per plant ( $6018.45$  and  $4902.68 \text{ cm}^2$ , respectively).

#### 4.5.8 Leaf dry weight per plant (g) (First crop)

The data on leaf dry weight per plant at different growth stages of first crop are presented in table 16. Leaf dry weight

per plant differed significantly due to different weed control treatments at all the growth stages.

At 15 days after pruning, the maximum leaf dry weight was recorded in repeated hand weeding (5.03 g/plant) which was on par with Diuron at 1.25 kg a.i./ha (4.9 g/plant), Metolachlor 1.5 kg a.e./ha (4.77 g/plant) and Butachlor at 1.5 kg a.e./ha (4.6 g/plant). Whereas, Isoproturon at 1.25 kg a.i./ha and unweeded control recorded minimum leaf dry weight (3.0g and 3.0g/plant, respectively).

At 30 days after pruning, repeated hand weeding recorded maximum leaf dry weight (9.5 g/plant) which was on par with Diuron at 1.25 kg a.i./ha (8.93 g/plant) and Metolachlor at 1.25 kg a.e./ha (8.7 g/plant). Whereas, unweeded control recorded minimum leaf dry weight (5.53 g/plant).

At 45 days after pruning, repeated hand weeding recorded maximum leaf dry weight (19.57 g/plant) which was on par with Diuron at 1.25 kg a.i./ha (18.83 g/plant) and Metolachlor 1.5 kg a.e./ha (18.8 g/plant). Whereas unweeded control recorded minimum leaf dry weight (12.03 g/plant).

At 60 days after pruning, the maximum leaf dry weight was recorded with repeated hand weeding (42.23 g/plant). Among the herbicidal treatments, Metolachlor at 1.5 kg a.e./ha (40.60 g/plant), Diuron at 1.25 kg a.i./ha (39.43 g/plant) and Alachlor at 1.5 kg a.e./ha (36.43 g/plant) recorded maximum leaf dry weight as compared to other herbicidal treatments and unweeded control (23.97 g/plant).

Table 16: Leaf dry weight per plant (g) at different crop growth stages as influenced by different weed control treatments in mulberry

Treatments	Herbicide rate (kg a.i. or a.e./ha)	First crop				Second crop					
		Days after pruning				Days after first crop					
		15	30	45	60	At harvest	15	30	45	60	At harvest
Repeated hand weeding	-	5.03	9.50	19.57	42.23	47.37	5.17	10.83	20.07	41.37	46.80
Diuron	1.00	4.27	8.20	17.93	35.20	39.33	4.33	8.63	16.03	33.37	40.33
Diuron	1.25	4.90	8.93	18.83	39.43	44.53	4.67	9.47	18.00	38.27	44.07
Butachlor	1.25	3.87	7.93	15.27	31.33	36.63	4.00	7.87	15.00	30.50	35.63
Butachlor	1.50	4.60	8.07	16.40	34.97	42.43	4.07	8.63	16.00	33.53	41.13
Isoproturon	1.25	3.00	5.70	13.73	26.13	29.87	2.63	6.63	13.20	25.30	28.33
Isoproturon	1.50	3.57	6.83	14.87	30.90	34.77	3.90	7.00	14.50	29.33	33.20
Alachlor	1.25	3.70	7.90	15.43	30.87	36.17	3.00	7.93	14.50	31.17	35.50
Alachlor	1.50	4.50	8.33	16.10	36.43	41.47	4.27	8.07	16.63	34.80	40.20
Metolachlor	1.25	4.00	8.03	17.23	33.47	40.03	4.20	8.63	17.03	34.57	40.20
Metolachlor	1.50	4.77	8.70	18.80	40.60	45.33	4.80	9.20	18.43	39.33	46.20
Pendimethalin	1.25	3.83	7.87	15.93	30.37	37.23	3.23	7.23	15.57	32.87	36.17
Pendimethalin	1.50	4.23	8.00	16.83	35.67	42.80	4.00	8.33	16.20	34.60	42.13
Oryfluorfen	0.12	3.10	7.03	14.50	28.03	33.70	3.03	7.13	14.07	28.43	31.17
Oryfluorfen	0.25	4.03	7.93	15.97	33.13	38.23	4.23	7.97	15.60	32.40	37.93
Unweeded control	-	3.00	5.53	12.03	23.97	28.50	3.27	6.33	12.80	22.83	27.63
P-test		*	*	*	*	*	*	*	*	*	*
S.E.M +		0.17	0.35	0.47	0.57	1.33	0.22	0.37	0.54	0.56	1.14
C.D. @ 5%		0.48	0.97	1.16	1.58	3.67	0.60	1.02	1.50	1.54	3.16

\* significant at 5% probability level

At harvest also repeated hand weeding recorded maximum leaf dry weight (47.37 g/plant) which was on par with Diuron at 1.25 kg a.i./ha (44.53 g/plant) and Metolachlor at 1.5 kg a.e./ha (45.33 g/plant). Whereas Isoproturon at 1.25 kg a.i./ha and unweeded control recorded minimum leaf dry weight (29.87 and 28.5 g/plant, respectively).

#### 4.5.9 Leaf dry weight per plant (g) (Second crop)

The data on leaf dry weight per plant at different growth stages of second crop are presented in table 16. Leaf dry weight per plant differed significantly due to different weed control treatments at all the growth stages.

At 15 days after first crop leaf harvest, the maximum leaf dry weight was recorded with repeated hand weeding (5.17 g/plant) which on par with Diuron at 1.25 kg a.i./ha (4.67 g/plant) and Metolachlor at 1.5 kg a.e./ha (4.8 g/plant). Whereas, Isoproturon 1.25 a.i./ha and Alachlor at 1.25 kg a.e./ha recorded minimum leaf dry weight (2.63 g and 3.0 g/plant, respectively).

At 30 days after first crop leaf harvest, the maximum leaf dry weight was recorded with repeated hand weeding (10.83 g/plant). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (9.47 g/plant), Metolachlor at 1.5 kg a.e./ha (9.2 g/plant) and Butachlor at 1.5 kg a.e./ha (8.63 g/plant) recorded maximum leaf dry weight as compared to other herbicidal treatments and unweeded control (6.33 g/plant).

At 45 days after first crop leaf harvest, repeated hand weeding recorded maximum leaf dry weight per plant (20.07 g/plant). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (18.0 g/plant) and Metolachlor at 1.5 kg a.e./ha (18.43 g/plant) recorded maximum leaf dry weight as compared to other herbicidal treatments and unweeded control (12.8 g/plant).

At 60 days after first crop leaf harvest, the maximum leaf dry weight was recorded in repeated hand weeding (41.37 g/plant) followed by Metolachlor at 1.5 kg a.e./ha (39.33 g/plant) and Diuron at 1.25 kg a.i./ha (38.27 g/plant) and all other herbicidal treatments recorded higher leaf dry weight (25.3 to 34.8 g/plant) as compared to unweeded control (22.83 g/plant).

At harvest also repeated hand weeding recorded maximum leaf dry weight (46.8 g/plant) which was on par with Metolachlor at 1.5 kg a.e./ha (44.07 g/plant) and Diuron at 1.25 kg a.i./ha (46.5 g/plant). Whereas, Isoproturon at 1.25 kg a.i./ha (28.33 g/plant) and unweeded control (27.63 g/plant) recorded lower leaf dry weight.

#### 4.6 Studies on Mulberry leaf yield

The data on leaf yield (g/plant and kg/ha), weed index (%) and weed control efficiency (%) as influenced by different methods of weed control treatments are presented in table 17. Leaf yield (kg/ha) and weed control efficiency (%) are illustrated in fig.4 and 5 respectively.

#### 4.6.1 Leaf yield (g/plant)

The leaf yield per plant at harvest of first crop differed significantly due to weed control treatments. The highest leaf yield per plant was recorded in case of repeated hand weeding (167.08 g). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha recorded higher leaf yield per plant (156.12 g) which was on par with Metolachlor at 1.5 kg a.e./ha (155.8g) and differed significantly with other herbicidal treatments. However, unweeded control recorded lowest leaf yield per plant (55.3 g).

The leaf yield per plant at harvest of Second crop differed significantly due to weed control treatments. The maximum leaf yield per plant was registered in case of repeated hand weeding (168.07 g) which was significantly superior over all other weed control treatments. Whereas Isoproturon at both levels 1.25 kg and 1.5 kg a.i/ha (86.37 g and 88.78 g, respectively) and unweeded control ( 51.43 g) recorded lower leaf yield per plant.

#### 4.6.2 Leaf yield (kg/ha)

The leaf yield per hectare at harvest of first crop differed significantly due to different weed control treatments. The maximum leaf yield per hectare was recorded in case of repeated hand weeding (8354.17 kg/ha). Among the herbicidal treatments, Diuron at 1.0 kg and 1.25 kg a.i./ha (7176.67 kg and 7805.83 kg/ha, respectively) and Metolachlor at 1.25 kg and 1.5 kg a.e./ha (6960.0 kg and 7790.0 kg/ha, respectively) recorded maximum leaf yield per hectare as compared to other herbicidal treatments (4293

**Table 17: Leaf yield (g/plant and Kg/ha), weed Index (%) and weed control efficiency (%) as influenced by different weed control treatments in mulberry at the harvest of each crop.**

Treatments	Herbicide: rate (Kg a.i. or a.e./ha)	Leaf yield (g/plant):		Leaf yield (Kg/ha)		Weed Index (%)		Weed control efficiency (%)	
		I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop
Repeated hand weeding	-	167.08	168.07	8354.17	8403.50	0.00	0.00	100.00	100.00
Diuron	1.00	143.53	145.39	7176.67	7269.33	14.07	13.51	76.12	75.38
Diuron	1.25	156.12	158.76	7805.83	7938.00	6.51	7.63	82.88	82.44
Butachlor	1.25	125.45	126.57	6272.50	6328.50	24.89	24.61	70.62	66.45
Butachlor	1.50	130.50	133.44	6525.00	6672.00	21.81	20.53	77.95	77.87
Isoproturon	1.25	85.86	86.37	4293.00	4318.50	48.60	48.56	62.86	54.35
Isoproturon	1.50	89.30	88.78	4465.00	4439.00	46.53	47.10	73.79	70.84
Alachlor	1.25	122.20	120.47	6110.00	6023.33	26.85	28.23	70.76	64.99
Alachlor	1.50	125.93	126.20	6296.67	6310.00	24.59	24.84	78.67	79.96
Metolachlor	1.25	139.20	140.12	6960.00	7006.00	16.63	16.58	77.44	76.13
Metolachlor	1.50	155.80	153.20	7790.00	7660.00	6.67	8.81	81.74	83.13
Pendimethalin	1.25	102.10	105.28	5105.00	5263.83	38.84	37.29	70.18	68.28
Pendimethalin	1.50	113.90	112.50	5695.00	5625.00	31.79	33.04	77.32	77.46
Oxyfluorfen	0.12	95.53	102.17	4776.50	5108.50	42.76	39.17	66.71	63.42
Oxyfluorfen	0.25	105.18	109.19	5257.50	5459.50	37.07	34.94	76.25	74.72
Unweeded control	-	55.30	51.43	2765.00	2571.50	66.51	69.39	0.00	0.00
P-test		*	*	*	*	*	*	*	*
S.E.M		2.72	2.68	135.92	133.94	1.57	1.42	0.83	1.18
C.D. @ 5%		7.53	7.43	376.74	371.28	4.35	3.93	2.30	3.28

\* significant at 5% probability level

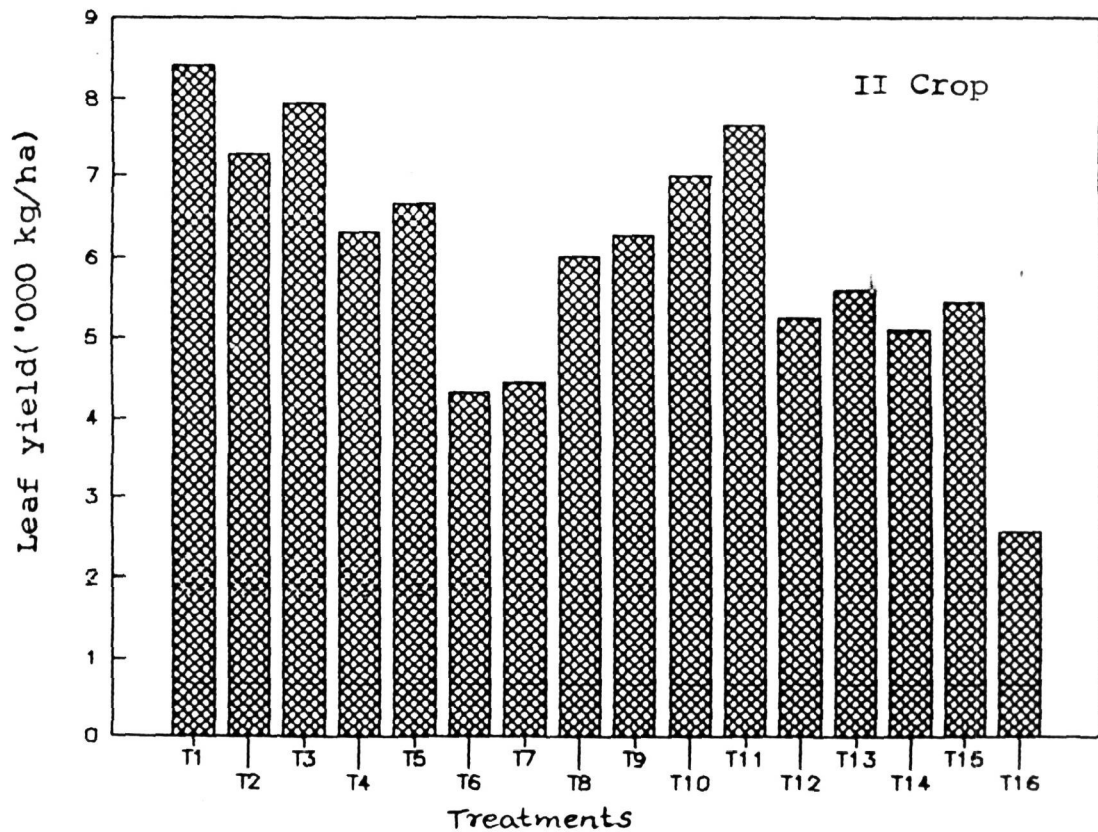
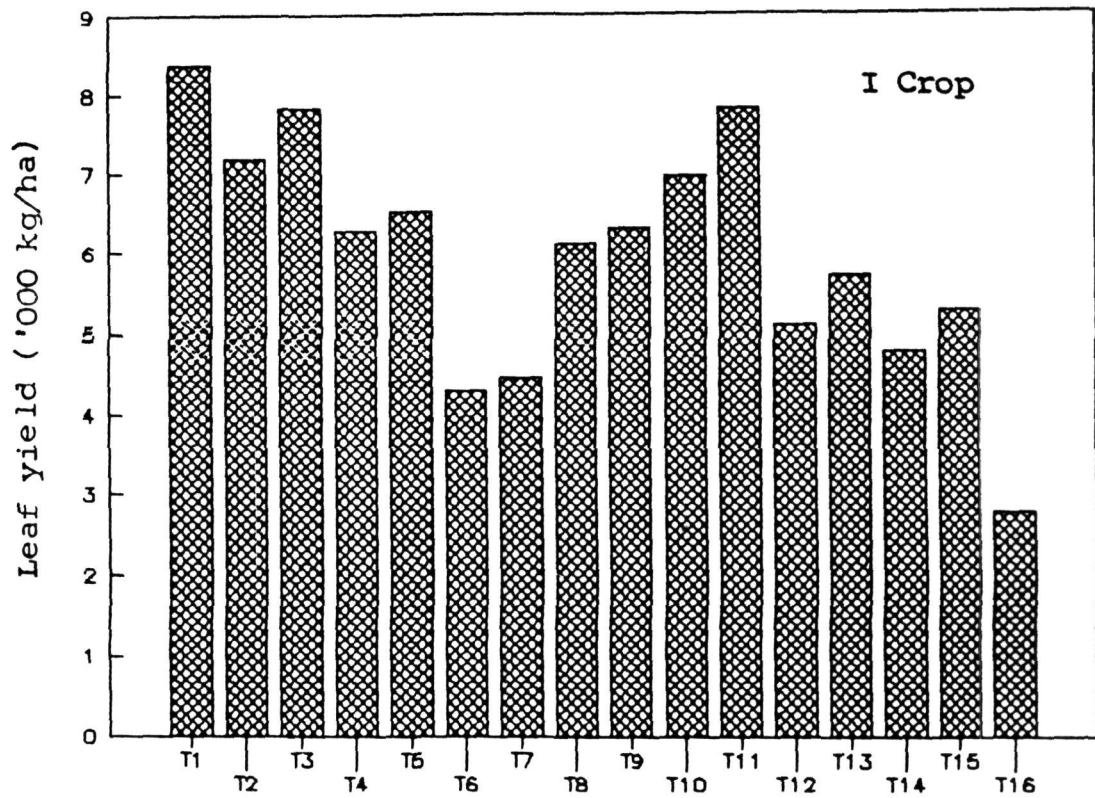


Fig.4: Leaf yield(kg/ha) as influenced by different weed control treatments in Mulberry.

to 6525 kg/ha) and unweeded control (2765 kg/ha).

The leaf yield per hectare at harvest of second crop differed significantly due to different weed control treatments. The highest leaf yield per hectare was noticed in case of repeated hand weeding (8403.5 kg/ha). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (7938 kg) and Metolachlor at 1.5 kg a.e./ha (7660 kg) recorded higher leaf yield per hectare as compared to other herbicidal treatments and unweeded control (2571.5 kg).

#### 4.6.3 Weed Index

The weed index at harvest of first crop differed significantly due to different weed control treatments. The lowest weed index was observed in repeated hand weeding (0.00%). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (6.51%) and Metolachlor at 1.5 kg a.e./ha (6.67%) recorded minimum weed index and there by causing less leaf yield reduction. Whereas, maximum weed index was recorded in unweeded control (66.51%) followed by Isoproturon at 1.25 kg a.i./ha (48.6%), Isoproturon at 1.5 kg a.i./ha (46.53%) and Oxyfluorfen 0.12 kg a.e./ha (42.76%).

The weed index at harvest of second crop also differed significantly due to different weed control treatments. The lowest weed index was recorded in repeated hand weeding (0.00%). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (7.63%) and Metolachlor at 1.5 kg a.e./ha (8.81%) recorded minimum weed index and thereby causing less leaf yield reduction, wherea

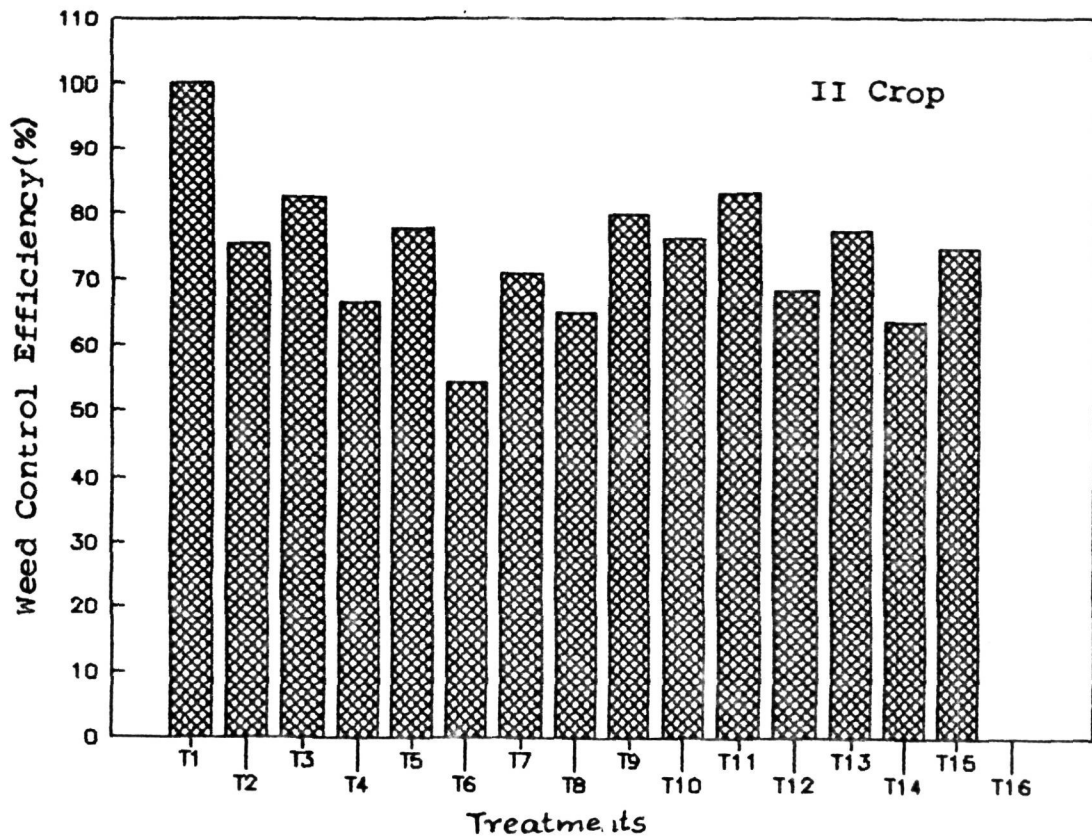
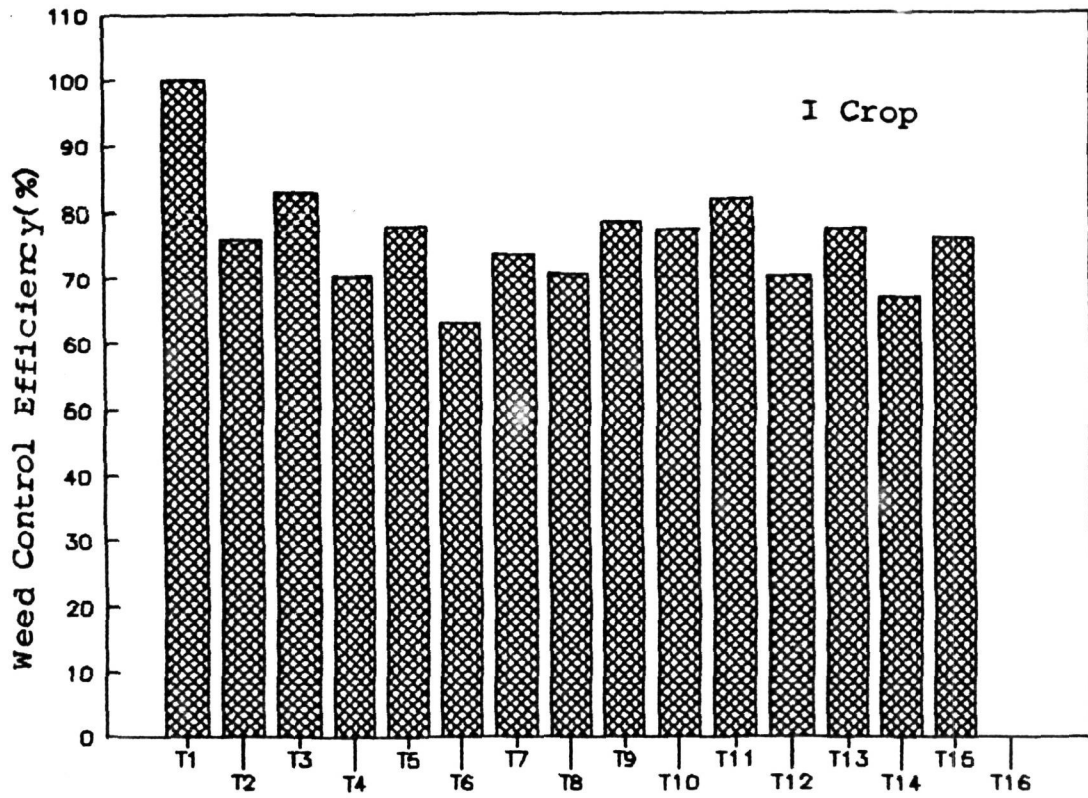


Fig.5: Weed control efficiency(%) as influenced by different weed control treatments.

Isoproturon 1.25 kg and 1.5 kg a.i./ha (48.56% and 47.1% respectively) and unweeded control (69.39%) recorded maximum weed index and thereby causing higher leaf yield reduction.

#### 4.6.4 Weed control efficiency (%)

The weed control efficiency at harvest of first crop differed significantly due to weed control treatments. The highest weed control efficiency was noticed in repeated hand weeding (100%). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (82.88%) and Metolachlor at 1.5 kg a.e./ha (81.74%) gave higher weed control efficiency as compared to other herbicidal treatments (62.86 to 77.95%) and unweeded control (0.00%).

The weed control efficiency at harvest of second crop differed significantly due different to weed control treatments. The highest weed control efficiency was registered with repeated hand weeding (100%). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha and Metolachlor at 1.5 kg a.e./ha gave higher weed control efficiency (82.44 and 83.13 % respectively) as compared to other herbicidal treatments. Whereas the lowest weed control efficiency was noticed in unweeded control (0.00%).

#### 4.7. Nutrient uptake by the mulberry crop and weeds as influenced by different weed control treatments at harvest of each crop

The data on uptake of Nitrogen, Phosphorus and potassium by the mulberry crop and weeds as influenced by different weed control treatments are presented in table 18.

#### 4.7.1 Nutrients uptake by Mulberry crop

##### 4.7.1.1 Nitrogen uptake (kg/ha)

The Nitrogen uptake of mulberry at harvest of first crop differed significantly due to different weed control treatments. The maximum amount of nitrogen uptake was recorded in repeated hand weeding (76.69 kg/ha) which was on par with Diuron at 1.25 kg a.i./ha (73.34 kg/ha) and Metolachlor at 1.5 kg a.e./ha (72.9 kg/ha). The next best herbicide was Metolachlor at 1.25 kg a.e./ha (71.04 kg/ha) followed by Diuron at 1.0 kg a.i./ha (70.44 kg/ha) and Pendimethalin at 1.5 kg a.e./ha (65.48 kg/ha). However, unweeded control (31.61 kg/ha) recorded lower nitrogen uptake by mulberry crop.

The nitrogen uptake of mulberry at harvest of second crop differed significantly due to different weed control treatments. The maximum amount of Nitrogen uptake was recorded in repeated hand weeding (80.6 kg/ha) followed by Diuron at 1.25 kg a.i./ha (75.61 kg/ha) and Metolachlor at 1.5 kg a.e./ha (74.48 kg/ha), Diuron at 1.0 kg a.i./ha (73.22 kg/ha) and Metolachlor at 1.25 kg a.e./ha (72.55 kg/ha). However, unweeded control (28.04 kg/ha) recorded lower Nitrogen uptake.

##### 4.7.1.2 Phosphorus uptake (kg/ha)

Phosphorus uptake by Mulberry at harvest of first crop differed significantly due to different weed control treatments. The maximum phosphorus uptake was in repeated hand weeding (14 kg/ha) which was on par with Diuron at 1.25 kg a.i./ha (12 kg/ha)

and Metolachlor at 1.5 kg a.e./ha (13.09 kg/ha) and all other herbicidal treatments recorded higher phosphorus uptake (4.72 to 10.72 kg/ha) as compared to unweeded control (3.0 kg/ha).

Phosphorus uptake by Mulberry at harvest of Second crop also differed significantly due to different weed control treatments. The maximum phosphorus uptake was in repeated hand weeding (14.05 kg/ha) Among the herbicidal treatments Metolachlor at 1.5 kg a.e./ha (13.25 kg/ha), Diuron at 1.25 kg a.i./ha (12.04 kg/ha), Pendimethalin at 1.5 kg a.e./ha (11.05 kg/ha) and Butachlor at 1.5 kg a.e./ha (11.0 kg/ha) recorded higher phosphorous uptake as compared to other herbicidal treatments and unweeded control (2.95 kg/ha).

#### 4.7.1.3 Potassium uptake kg/ha

Potassium uptake by mulberry at harvest first crop differed significantly due to different weed control treatments. The maximum potassium uptake was recorded with repeated hand weeding (87.43 kg/ha) followed by Diuron at 1.25 kg a.i./ha (85.32 kg/ha), Metolachlor at 1.5 kg a.e./ha (84.47 kg/ha), Diuron at 1.0 kg a.i./ha (81.0 kg/ha), Metolachlor at 1.25 kg a.e./ha (79.0 kg/ha) and Butachlor at 1.5 kg a.e./ha (76.47 kg/ha). however, unweeded control (20.2 kg/ha) recorded lower potassium uptake.

Potassium uptake by mulberry at harvest second crop differed significantly due to different weed control treatments. Repeated hand weeding recorded maximum potassium uptake (88.0 kg/ha), Diuron at 1.0 kg and 1.25 kg a.i./ha (81.0 and 84.26, kg/ha, respectively) Metolachlor at 1.25 kg and 1.5 kg a.e./ha (79.0 and

Table 18: Nutrient uptake (Kg/ha) by mulberry crop and weeds as influenced by different weed control treatments at the harvest of each crop.

Treatments	Herbicide: rate (kg a.i. or a.e./ha)	Nutrient uptake by crop						Nutrient uptake by weeds							
		Nitrogen		Phosphorus		Potassium		Nitrogen		Phosphorus		Potassium			
		I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop		
Repeated hand weeding	-	76.69	80.60	14.00	14.05	87.43	88.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diuron	1.00	70.44	73.22	9.34	9.95	81.00	81.00	2.53	2.01	0.89	0.69	5.42	5.31		
Diuron	1.25	73.34	75.61	12.00	12.04	85.32	84.26	1.52	1.35	0.30	0.30	4.60	4.57		
Butachlor	1.25	61.25	62.30	7.05	7.77	69.44	69.45	4.44	4.00	1.93	1.69	15.34	15.09		
Butachlor	1.50	65.00	68.32	10.09	11.00	76.47	77.00	2.30	2.04	1.21	1.03	12.25	11.42		
Isoproturon	1.25	48.06	47.33	4.72	4.30	52.40	51.00	15.35	14.22	4.80	3.58	19.07	18.44		
Isoproturon	1.50	52.61	50.60	6.90	6.00	58.22	56.08	10.61	9.64	3.06	2.97	17.66	15.73		
Alachlor	1.25	59.11	60.76	7.76	8.01	68.67	69.72	4.36	4.22	1.69	1.25	14.44	14.20		
Alachlor	1.50	63.63	65.69	9.90	10.05	75.40	74.47	2.87	2.35	1.05	1.02	11.42	11.26		
Metolachlor	1.25	71.04	72.55	10.01	10.65	79.00	79.00	2.32	2.31	0.82	0.68	5.42	5.13		
Metolachlor	1.50	72.90	74.48	13.09	13.25	84.47	84.04	1.75	1.64	0.63	0.36	4.63	4.50		
Pendimethalin	1.25	62.03	65.48	7.24	8.04	71.24	70.04	4.51	4.13	1.93	1.29	15.73	15.30		
Pendimethalin	1.50	65.48	69.06	10.72	11.05	76.26	77.00	2.88	2.35	1.29	1.02	12.25	11.45		
Oxyfluorfen	0.12	58.28	59.18	6.83	7.00	66.33	67.31	5.66	5.60	2.88	2.66	17.66	16.75		
Oxyfluorfen	0.25	62.06	63.63	9.72	9.77	72.24	72.44	3.60	3.08	2.26	2.11	13.60	12.25		
Unweeded control	-	31.61	28.04	3.00	2.95	20.20	18.00	32.40	29.31	12.67	10.62	61.60	53.20		
P-test		*	*	*	*	*	*	*	*	*	*	*	*		
S.E.M		1.43	1.61	0.85	0.91	1.69	2.58	0.46	0.36	0.25	0.20	0.74	0.65		
C.D. @ 5%		3.96	4.45	2.73	2.52	4.70	7.16	1.27	0.99	0.68	0.55	2.06	1.80		

\* significant at 5% probability level.

84.04 kg/ha, respectively) and Pendimethalin at 1.5 kg a.e./ha (77.0 kg/ha) recorded maximum potassium uptake as compared to other herbicidal treatments and unweeded control (18.0 kg/ha).

#### 4.7.2 Nutrients uptake by weeds

##### 4.7.2.1 Nitrogen uptake (kg/ha)

Nitrogen uptake by weeds at harvest of first crop differed significantly due to different weed control treatments. The maximum Nitrogen uptake was in unweeded control (32.4 kg/ha) which was significantly superior over all other weed control treatments. Whereas, Diuron at 1.25 kg a.i./ha, Metolachlor at 1.5 kg a.e./ha and repeated hand weeding recorded minimum Nitrogen uptake by weeds (1.52 kg, 1.75 kg and 0.0 kg/ha, respectively).

Nitrogen uptake by weeds at harvest of second crop also differed significantly due to different weed control treatments. The maximum Nitrogen uptake was in unweeded control (29.31 kg/ha) which was superior over all other weed control treatments. Whereas, Diuron at 1.25 kg a.i./ha (1.35 kg/ha), Metolachlor at 1.5 kg a.e./ha (1.64 kg/ha) and repeated hand weeding (0.0 kg/ha) recorded minimum Nitrogen uptake by weeds.

##### 4.7.2.2 Phosphorus uptake (kg/ha)

Phosphorus uptake by weeds at harvest of first crop differed significantly due to different weed control treatments. Unweeded control recorded higher phosphorus uptake (12.67 kg/ha) which was significantly superior over all other weed control treatments.

However, the lowest uptake of phosphorus by weeds was noticed in repeated hand weeding (0.0 kg/ha), Diuron at 1.0 kg and 1.25 kg a.i./ha (0.89 kg and 0.3 kg/ha, respectively) and Metolachlor at 1.25 kg and 1.50 kg a.e./ha (0.82 kg and 0.63 kg/ha, respectively).

Phosphorus uptake by weeds at harvest of second crop also differed significantly due to different weed control treatments. The maximum phosphorus uptake was noticed in unweeded control (10.62 kg/ha) which was significantly superior over all other weed control treatments. Whereas, Diuron at 1.0 kg and 1.25 a.i./ha (0.69 kg and 0.3 kg/ha, respectively), Metolachlor at 1.25 and 1.5 kg a.e./ha (0.68 kg and 0.36 kg/ha, respectively) and repeated hand weeding (0.0 kg/ha) recorded minimum phosphorus uptake.

#### 4.7.2.3 Potassium uptake (kg/ha)

Potassium uptake by weeds at harvest of first crop differed significantly due to different weed control treatments. The maximum potassium uptake was in unweeded control (61.6 kg/ha), which was significantly superior over all other weed control treatments. However, the lower potassium uptake was recorded in repeated hand weeding (0.00 kg/ha), Diuron at 1.25 kg and 1.0 kg a.i./ha (5.42 kg and 4.6 kg/ha, respectively) and Metolachlor at 1.5 and 1.25 kg a.e./ha (5.42 kg and 4.63 kg/ha, respectively).

Potassium uptake by weeds at harvest of second crop also differed significantly due to different weed control treatments. All the weed control treatments recorded significantly lower potassium uptake as compared to unweeded control (53.2 kg/ha).

Among the other weed control treatments, repeated hand weeding (0.0 kg/ha) recorded lower potassium uptake followed by Metolachlor at 1.5 kg a.e./ha (4.5 kg/ha), Diuron at 1.25 kg a.i./ha (4.57 kg/ha), Metolachlor at 1.25 kg a.e./ha (5.13 kg/ha) and Diuron at 1.0 kg a.i./ha (5.31 kg/ha).

#### 4.8 Moisture (%) and Total chlorophyll (mg/g) content of Mulberry leaves at harvest of each crop

The data on moisture percent and total chlorophyll content of mulberry leaves as influenced by different weed control treatments are presented in Table 19.

##### 4.8.1 Moisture (%)

The moisture percent of mulberry leaves at harvest of first crop differed significantly due to different weed control treatments. The maximum moisture percent was noticed in repeated hand weeding (73.78 %) which was on par with Diuron at 1.0 kg and 1.25 kg a.i./ha (70.63 and 71.57 % respectively). The next best herbicide was Metolachlor at 1.5 kg a.e./ha (70.26 %) followed by Butachlor at 1.5 kg a.e./ha (69.91 %), Alachlor at 1.5 kg a.e./ha (69.3 %) and Metolachlor at 1.25 kg a.e./ha (69.25). However, unweeded control (59.62 %) recorded lowest moisture percent.

The moisture percent of mulberry leaves at harvest of second crop also differed significantly due to different weed control treatments. The maximum moisture percent was observed in repeated

Table 19: Moisture (%) and Total chlorophyll (mg/g) content of mulberry leaves as influenced by different weed control treatments at harvest of each crop.

Treatments	Herbicide: rate (Kg a.i. or a.e./ha)	Moisture per cent		Total Chlorophyll (mg/g)	
		I crop	II crop	I crop	II crop
Repeated hand weeding	-	73.78	75.20	2.35	2.16
Diuron	1.00	70.63	69.00	2.00	2.01
Diuron	1.25	71.57	70.25	2.25	2.05
Butachlor	1.25	67.82	66.50	1.82	1.82
Butachlor	1.50	69.91	68.25	1.92	1.86
Isoproturon	1.25	61.53	60.00	1.59	1.52
Isoproturon	1.50	65.25	63.50	1.69	1.68
Alachlor	1.25	66.98	67.75	1.75	1.88
Alachlor	1.50	69.30	69.98	1.91	1.96
Metolachlor	1.25	69.25	69.75	1.96	1.92
Metolachlor	1.50	70.26	71.60	2.02	2.03
Pendimethalin	1.25	66.51	67.96	1.68	1.69
Pendimethalin	1.50	68.25	69.74	1.88	1.91
Oxyfluorfen	0.12	64.55	64.02	1.68	1.64
Oxyfluorfen	0.25	67.86	66.97	1.71	1.72
Unweeded control	-	59.62	55.75	1.42	1.47
F-test		*	*	*	NS
S.E.m q		1.20	1.01	0.05	0.14
C.D. @ 5%		3.34	2.81	0.15	0.40

NS = Non significant

\* = significant at 5% probability level

hand weeding (75.2 %). Among the herbicidal treatments, Diuron at 1.0 kg and 1.25 kg a.i./ha (69.0 and 70.25 % respectively), Metolachlor at 1.25 kg and 1.5 kg a.e./ha (69.75 and 71.6 % respectively), Alachlor at 1.5 kg a.e./ha (69.98 %) and Pendimethalin at 1.5 kg a.e./ha (69.74 %) recorded higher moisture percent as compared to other herbicidal treatments and unweeded control (55.75%).

#### 4.8.2 Total chlorophyll (mg/g)

The total chlorophyll content of mulberry leaves at harvest of first crop differed significantly due to different weed control treatments. The maximum chlorophyll content was noticed in repeated hand weeding (2.35 mg/g) which was on par with Diuron at 1.25 kg a.i./ha (2.25 mg/g) and the minimum chlorophyll content was recorded in unweeded control (1.42 mg/g).

The total chlorophyll content of mulberry leaves at harvest of second crop did not differ significantly due to different weed control treatments. However, repeated hand weeding recorded maximum chlorophyll content (2.16 mg/g) and minimum in unweeded control (1.47 mg/g).

#### 4.9 Larvae Development as influenced by different weed control treatments

The data on larval development covering the weight of larvae after second moult, third moult, fourth moult and at maturity and larvae duration are presented in Table 20. The treatment

Table 20: Larval Development and larval duration of silkworm as influenced by different methods of weed control treatments.

Treatments	Herbicide rate (Kg a.i. or a.e./ha)	Mean larval weight (g/5 worms)					Larval duration (days)
		After 2 <sup>nd</sup> Molt	After 3 <sup>rd</sup> Molt	After 4 <sup>th</sup> Molt	5DA. 4 <sup>th</sup> Molt	At maturity	
Repeated hand weeding	-	0.15	0.78	3.93	17.49	20.55	26.00
Diuron	1.00	0.15	0.73	3.76	17.13	20.53	28.00
Diuron	1.25	0.14	0.78	3.85	17.16	20.90	27.00
Butachlor	1.25	0.14	0.70	3.86	17.14	19.75	27.33
Butachlor	1.50	0.14	0.73	3.87	17.22	20.24	26.67
Isoproturon	1.25	0.14	0.70	3.62	16.68	19.22	28.33
Isoproturon	1.50	0.15	0.73	3.66	16.89	19.68	27.33
Alachlor	1.25	0.14	0.68	3.85	17.01	20.04	27.67
Alachlor	1.50	0.15	0.75	3.76	17.01	20.50	27.00
Metolachlor	1.25	0.14	0.75	3.89	16.99	20.10	27.33
Metolachlor	1.50	0.16	0.73	3.90	17.43	20.54	27.00
Pendimethalin	1.25	0.14	0.75	3.78	16.86	20.11	27.67
Pendimethalin	1.50	0.15	0.74	3.74	17.02	20.43	26.67
Oxyfluorfen	0.12	0.15	0.67	3.57	17.22	19.69	27.67
Oxyfluorfen	0.25	0.14	0.77	3.78	17.02	19.88	27.00
Unweeded control	-	0.14	0.63	2.92	15.27	17.84	28.33
P-test		NS	NS	NS	NS	*	NS
S.E.m ±		0.01	0.03	0.18	0.53	0.36	0.51
C.D. @ 5%		0.04	0.10	0.51	1.46	1.00	1.42

NS Not significant  
\* significant at 5% probability level

Plate 10. A view of silkworms fed with the leaves from control (weedy check) plot.

Plate 11. A view of silkworms fed with the leaves from weed free (Repeated hand weeding) plot.

Plate 12. A view of silkworms fed with the leaves from Diuron (1.25 kg a.i./ha) treated plot.



Plate 10

CONTROL



Plate 11

REPEATED HAND WEEDING



Plate 12

DIURON 1.25 kg a.e./ha

Plate 13. A view of silkworms fed with the leaves from Butachlor (1.5 kg a.i./ha) treated plot.

Plate 14. A view of silkworms fed with the leaves from Isoproturon(1.5 kg a.i./ha) treated plot.

Plate 15 A view of silkworms fed with the leaves from Alachlor (1.5 kg a.e./ha) treated plot.



Plate 13

BUTACHLOR 1.50 kg a.e./ha



Plate 14

ISOPROTURON 1.50 kg a.i./ha



Plate 15

Plate 16. A view of silkworms <sup>fed</sup> treated with the leaves from Metolachlor (1.5 kg a.e./ha) treated plot.

Plate 17. A view of silkworms fed with the leaves from Pendimethalin (1.5 kg a.e./ha) treated plot.

Plate 18. A view of silkworms fed with the leaves from Oxyfluorfen (0.25 kg a.e./ha) treated plot.



Plate 16

METOLACHLOR 1.50 kg a.e./ha



Plate 17

PENDIMETHALIN 1.50 kg a.e./ha



Plate 18

OXYFLUORFEN 0.25 kg a.e./ha

combinations consisting of different weed control treatments caused significant difference only at larvae maturity stage.

#### 4.9.1 Weight of larvae after second moult (g/ 5 worms)

Larval weight after second moult did not differ significantly due to different weed control treatments. However, the larval weight ranged from 0.14 to 0.16 g in all the treatments.

#### 4.9.2 Weight of larvae after third moult (g/ 5 worms)

Larval weight after third moult did not differ significantly due to different weed control treatments. However, the mean larval weight ranged from 0.63 to 0.78 g among different weed control treatments.

#### 4.9.3 Weight of larvae after fourth moult (g/5 worms)

Larval weight after fourth moult also did not differ significantly due to different weed control treatments. However, repeated hand weeding recorded maximum larval weight (3.93 g) and minimum in unweeded control (2.92 g).

#### 4.9.4 Weight of larvae five days after fourth moult (g/5 worms)

Larval weight five days after fourth moult also did not differ significantly due to different weed control treatments. However, the maximum larval weight was recorded in repeated hand weeding (17.49 g) and minimum in unweeded control (15.27 g).

#### 4.9.5 Larval weight at Maturity (g/5 worms)

Larval weight at maturity differed significantly due to

different weed control treatments. The maximum larval weight was recorded in Diuron at 1.25 kg a.i./ha (20.9 g) which was on par with all other weed control treatments except unweeded control (17.84 g), Oxyfluorfen at 0.12 kg and 0.25 kg a.e./ha (19.69 g and 19.88 g, respectively), Isoproturon at 1.25 kg and 1.5 kg a.i./ha (19.22 g and 19.68 g, respectively) and Butachlor at 1.25 kg a.e./ha (19.75 g) which recorded significantly lower larval weight.

#### 4.9.6 Larval duration

There was no significant difference in the larval duration due to different weed control treatments. However, the lower larval duration was recorded in repeated hand weeding (26 days) and highest in unweeded control (28.33 days).

#### 4.10 Cocoon and Silk quality characters

The data on cocoon and silk quality characters are presented in Table 21.

##### 4.10.1 Mean cocoon weight

There was significant difference in the mean weight of cocoon due to different weed control treatments. The maximum cocoon weight was recorded in repeated hand weeding (2.04 g) which was on par with Diuron at both the levels 1.0 kg and 1.25 kg a.i./ha (1.93 g and 2.0 g, respectively) and Metolachlor at both the levels 1.25 kg and 1.5 kg a.e./ha (1.88 g and 1.94 g, respectively) and other weed control treatments recorded significantly lower cocoon weight (1.61 g to 1.81 g).

#### 4.10.2 Mean pupal weight

The pupal weight differed significantly due to weed control treatments. Among the weed control treatments, repeated hand weeding recorded maximum pupal weight (1.6 g) which was on par with Diuron at 1.0 kg and 1.25 kg a.i./ha (1.59 g and 1.56 g, respectively) Butachlor at 1.5 kg a.e./ha (1.57 g), Metolachlor at 1.25 kg and 1.5 kg a.e./ha (1.5 g and 1.57 g, respectively), Pendimethalin at 1.25 kg and 1.5 kg a.e./ha (1.49 g and 1.57 g, respectively) and Oxyfluorfen at 0.12 kg and 0.25 kg a.e./ha (1.45 g and 1.5 g, respectively) and other weed control treatments recorded (1.28 g and 1.4 g) significantly lower pupal weight.

#### 4.10.3 Mean shell weight

The shell weight did not differ significantly due to weed control treatments. However, repeated hand weeding recorded maximum shell weight (0.46 g) and minimum in unweeded control (0.36 g).

#### 4.10.4 Shell percentage

The shell percentage differed significantly due to different weed control treatments. The maximum shell percentage was recorded in Butachlor at 1.5 kg a.e./ha (25.79 %) followed by Alachlor at 1.25 kg (25.44 %) and 1.5 kg a.e./ha (24.98 %), Oxyfluorfen at 0.25 kg a.e./ha (24.35 %) and Isoproturon at 1.5 kg a.i./ha (24.27 %), whereas unweeded control recorded minimum shell percentage (22.36 %).

Table 21: Cocoon and silk quality characters of silkworm as influenced by different weed control treatments.

Treatments	Herbicide rate (kg a.i. or a.e./ha)	Cocoon Weight (g)	Pupal Weight (g)	Shell Weight (g)	Shell per-centage (%)	Mean filament length (m)	Mean filament Weight (g)	75 Cocoon filament Weight (g)	Exuvial Weight (g)	B.R.R (%)	Denier	Reedita Percentage (%)	
Repeated hand weeding	-	2.04	1.60	0.46	22.75	1116.50	0.36	12.58	0.064	84.67	2.90	8.30	77.73
Diuron	1.00	1.93	1.59	0.45	23.57	1081.83	0.32	12.25	0.056	83.67	2.66	8.40	70.59
Diuron	1.25	2.00	1.56	0.45	22.62	1093.33	0.34	12.60	0.066	83.00	2.80	8.40	74.95
Butachlor	1.25	1.72	1.35	0.41	24.08	1082.75	0.28	11.77	0.041	80.67	2.36	8.50	68.07
Butachlor	1.50	1.76	1.57	0.45	25.79	1090.00	0.32	12.08	0.068	79.33	2.64	8.45	70.71
Isoproturon	1.25	1.71	1.35	0.41	23.97	1011.33	0.27	11.35	0.044	79.00	2.40	8.97	65.93
Isoproturon	1.50	1.73	1.40	0.42	24.27	1041.25	0.28	11.95	0.047	80.33	2.42	8.93	66.04
Alachlor	1.25	1.67	1.38	0.42	25.44	1075.29	0.29	11.82	0.041	80.67	2.43	8.58	68.47
Alachlor	1.50	1.81	1.40	0.45	24.98	1089.82	0.33	12.17	0.045	81.33	2.72	8.48	73.56
Metolachlor	1.25	1.88	1.50	0.44	23.46	1096.96	0.32	12.40	0.045	82.00	2.62	8.37	73.21
Metolachlor	1.50	1.94	1.57	0.45	23.25	1103.87	0.34	12.50	0.046	84.00	2.77	8.36	75.92
Pendimethalin	1.25	1.78	1.49	0.40	22.72	1077.43	0.29	11.60	0.043	82.67	2.42	8.58	71.98
Pendimethalin	1.50	1.80	1.57	0.41	22.77	1084.21	0.31	11.93	0.050	82.00	2.57	8.52	75.20
Oxyfluorfen	0.12	1.73	1.45	0.41	23.82	1037.75	0.28	11.50	0.049	78.33	2.43	8.78	69.15
Oxyfluorfen	0.25	1.77	1.50	0.43	24.35	1052.50	0.30	12.05	0.062	77.33	2.56	8.73	69.74
Unweeded control	-	1.61	1.28	0.36	22.36	1007.67	0.26	10.35	0.040	79.67	2.32	9.23	67.19
P-test				MS	*	*	*	*	*	*	*	*	MS
S.E.m		0.06	0.06	0.02	1.28	9.27	0.01	0.28	0.002	0.72	0.09	0.09	3.41
C.D. @5%		0.17	0.16	0.04	3.56	25.69	0.03	0.77	0.005	2.00	0.26	0.26	9.46

MS Non-significant \* Significant at 5% probability level. B.R.R. = Effective rate of rearing.

#### 4.10.5. Mean filament length

The mean filament length differed significantly due to different weed control treatments. Repeated hand weeding recorded maximum filament length (1116.5 m) which was on par with Diuron at 1.25 kg a.i./ha (1093.33 m) and Metolachlor at both the levels 1.25 kg and 1.5 kg a.e./ha (1096.96 and 1103.87 m, respectively) and all other weed control treatments recorded significantly lower filament length (1007.67 m to 1090 m).

#### 4.10.6 Mean filament weight

The mean filament weight differed significantly due to different weed control treatments. Repeated hand weeding recorded maximum filament weight (0.36 g) which was on par with Diuron at 1.25 kg a.i./ha (0.34 g) , Alachlor at 1.5 kg a.e./ha (0.33 g) and Metolachlor at 1.5 kg a.e./ha (0.34 g) and all other weed control treatments recorded (0.26 g to 0.32 g) significantly lower filament weight.

#### 4.10.7 Raw silk yield (g/75 cocoons)

The raw silk yield (g/75 cocoons) differed significantly due to different weed control treatments. The maximum raw silk yield was noticed in Diuron at 1.25 kg a.i./ha (12.6 g) which was on par with all other weed control treatments except unweeded control (10.35 g), Oxyfluorfen 0.12 kg a.e./ha (11.5 g), Pendimethalin 1.25 kg a.e./ha (11.60 g), Isoproturon at 1.25 kg a.i./ha (11.35 g) and Butachlor at 1.25 kg a.e./ha (11.77 g) which recorded significantly lower silk yield.

#### 4.10.8 Exuvial weight

The Exuvial weight also differed significantly due to different weed control treatments. Among the weed control treatments, the maximum exuvial weight was recorded with Butachlor at 1.5 kg a.e./ha (0.068 g) which was on par with repeated hand weeding (0.064 g) and Diuron at 1.25 kg a.i./ha (0.066 g) and all other weed control treatments recorded (0.04 g to 0.062 g) significantly lower exuvial weight.

#### 4.10.9 Effective rate of rearing

The data on effective rearing rate percentage differed significantly due to different weed control treatments. The maximum effective rearing rate percentage was registered with repeated hand weeding (84.67 %) which was on par with Diuron 1.0 kg and 1.25 kg a.i./ha (83.67 and 83 % respectively), Metolachlor at 1.5 kg a.e./ha (84 %) and Pendimethalin at 1.25 kg a.e./ha (82.67 %) and all other weed control treatments recorded significantly lower effective rearing rate percentage (77.33 to 82 per cent ).

#### 4.10.10 Denier

The Denier differed significantly due to different weed control treatments. Repeated hand weeding recorded higher Denier (2.9) which was on par with Diuron 1.0 kg and 1.25 kg a.i./ha (2.66 and 2.80 respectively), Butachlor at 1.5 kg a.e./ha (2.64), Alachlor at 1.5 kg a.e./ha (2.72) and Metolachlor at 1.5 kg a.e./ha (2.77) and all other weed control treatments recorded

(2.32 to 2.62) significantly lower Denier.

#### 4.10.11 Renditta

The Renditta also differed significantly due to different weed control treatments. Among the weed control treatments, unweeded control recorded maximum Renditta (9.23) which was on par with Isoproturon at 1.25 kg a.i/ha (8.97) and all other weed control treatments recorded significantly lower Renditta (8.3 to 8.93).

#### 4.10.12 Reelability Percentage

Reelability percentage did not differ significantly due to weed control treatments. Among the weed control treatments, the maximum Reelability percentage was recorded in repeated hand weeding (77.73 %) and minimum in Isoproturon at 1.25 kg a.i/ha (65.93%).

#### 4.11 Economics of weed control treatments

Economics of different weed control treatments on gross returns, cost of weed control (Marginal cost), total cost of cultivation, net returns, marginal returns (MR) and profit per rupee spent on weed control treatments are presented in table 22. Net returns and benefit cost ratio are graphically illustrated in Fig 6.

Gross return was maximum in weed free treatment (Rs.44001.00/ha), followed by Metolachlor at 1.5 kg a.e./ha (Rs.43981.01/ha), Diuron at 1.25 kg a.i./ha

Table 22: Economics of weed control treatments in Mulberry.

Treatments	Herbicide rate (Kg a.i. or a.e./ha)	Gross Return (Rs/ha)	Cost of weed Control (MC) (Rs/ha)	Total cost of cultivation (Rs/ha)	Net Return (Rs/ha)	Marginal Return (MR) (Rs/ha)	Profit per rupee spent on weed control (Rs/ha)
Repeated hand weeding	-	44001.00	3200.00	24245.23	19755.77	28331.00	8.85
Diuron	1.00	41021.56	350.10	21395.33	19626.23	25351.56	72.40
Diuron	1.25	43006.23	434.48	21479.71	21526.52	27336.23	62.91
Butachlor	1.25	30101.32	617.60	21662.83	8438.49	14431.32	23.36
Butachlor	1.50	35026.12	738.60	21783.83	13242.29	19356.12	26.26
Isoproturon	1.25	17203.61	423.74	21468.97	-4265.76	1533.61	3.61
Isoproturon	1.50	21982.21	505.96	21551.19	431.02	6312.21	12.47
Alachlor	1.25	29547.11	312.60	21357.83	8189.28	13877.11	44.39
Alachlor	1.50	34018.49	372.60	21417.83	12600.66	18348.49	49.20
Metolachlor	1.25	38932.51	425.10	21470.33	17462.18	23262.51	54.72
Metolachlor	1.50	43981.01	507.60	21552.83	22428.18	28311.01	55.70
Pendimethalin	1.25	31012.19	604.27	21649.50	9362.69	15342.19	25.38
Pendimethalin	1.50	35098.01	722.60	21769.83	13330.18	19428.01	26.88
Oxyfluorfen	0.12	24569.10	292.60	21337.83	3231.27	8899.10	30.40
Oxyfluorfen	0.25	26981.01	595.93	21641.16	5339.85	11311.01	18.98
Unweeded control	-	15670.00	-	21045.23	-5375.23	-	-

Cost of cultivation Excluding weed control = Rs 21,045.23

Diuron (80 WP) = Rs 270/Kg  
 Butachlor (50 EC) = Rs 242/Litre  
 Isoproturon (75 WP) = Rs 246.68/Kg  
 Alachlor (50 EC) = Rs 120/L

Metolachlor (50 EC) = Rs 165/Litre  
 Pendimethalin (30 EC) = Rs 142.00/Litre  
 Oxyfluorfen (30 EC) = Rs 70/100ml

Leaf yield = Rs 1.00/Kg  
 Labour cost:  
 Man Rs. 16.60/day  
 Woman Rs. 16.00/day

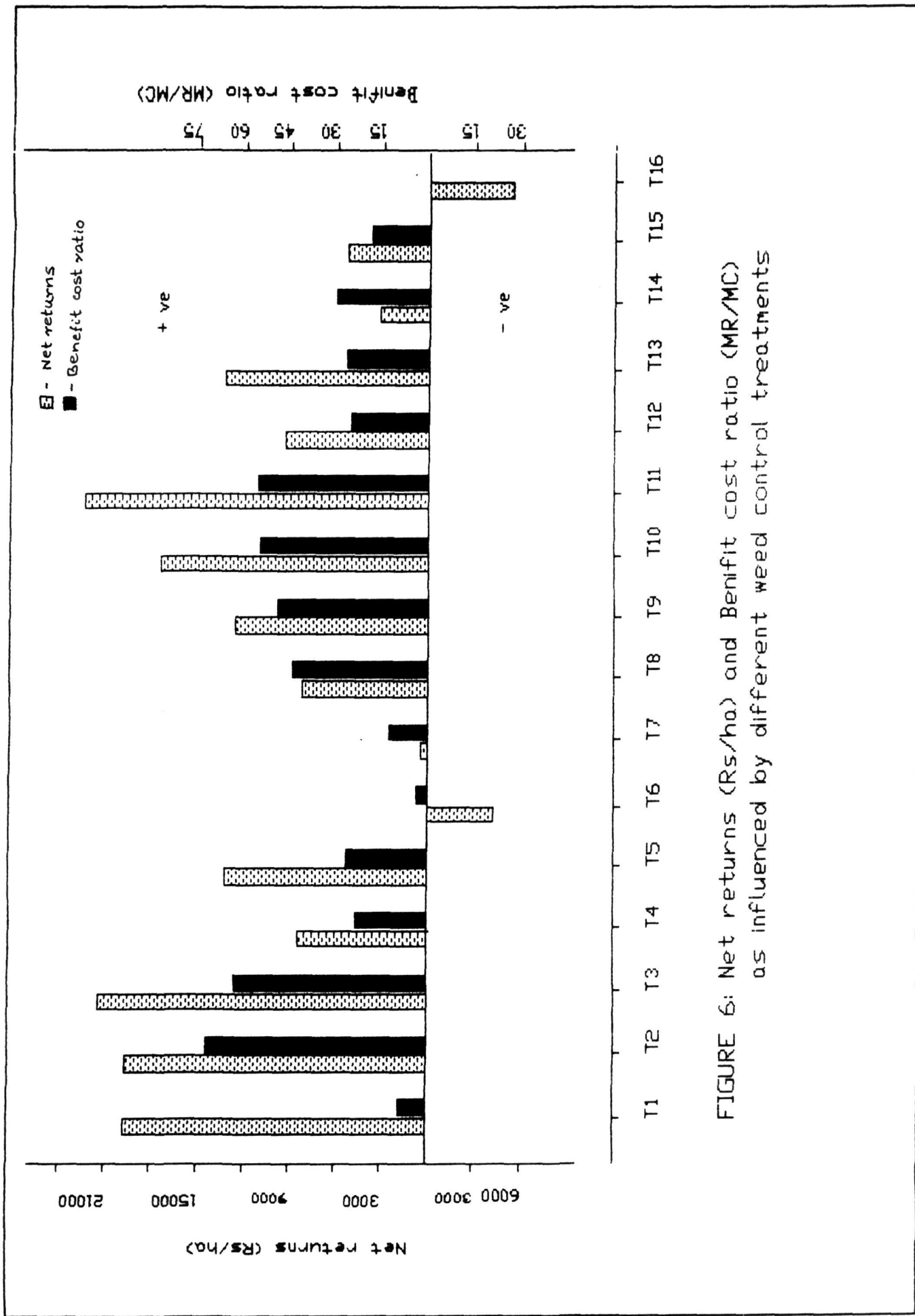


FIGURE 6: Net returns (Rs/ha) and Benefit cost ratio (MR/MC) as influenced by different weed control treatments

(Rs.43006.23/ha), Diuron at 1.0 kg a.i./ha (Rs.41021.56/ha), Metolachlor at 1.25 kg a.e./ha (Rs.38932.51/ha) and Pendimethalin at 1.5 kg a.e./ha (Rs. 35098.01/ha) as compared with Isoproturon at 1.25 kg a.i/ha (Rs.17203.61/ha) and unweeded control (Rs.15670.00/ha).

Cost of weed control was high in repeated hand weeding (Rs.3200.00/ha) followed by Butachlor at 1.5 kg a.e./ha (Rs.738.6/ha), Pendimethalin at 1.5 kg a.e./ha (Rs.722.6/ha) and Butachlor at 1.25 kg a.e./ha (Rs.617.6/ha) and all other herbicidal treatments recorded lower cost of weed control (Rs.292.6 to 604.27/ha). The minimum cost of weed control was recorded in Oxyfluorfen 0.12 kg a.e./ha (Rs.292.6/ha).

Total cost of cultivation was maximum in repeated hand weeding (Rs.24245.23/ha) followed by Butachlor at 1.5 kg a.e./ha (Rs.21783.83/ha), Pendimethalin at 1.5 kg a.e./ha (Rs.21769.83/ha) and Butachlor at 1.25 kg a.e./ha (Rs.21662.83/ha) and all other treatments recorded lower total cost of cultivation (Rs.21045.23 to 21649.5/ha).

The maximum net returns was obtained in Metolachlor at 1.5 kg a.e./ha (Rs.22428.18/ha) followed by Diuron 1.25 kg a.i./ha (Rs.21526.52/ha), repeated hand weeding (Rs.19755.77/ha), Diuron at 1.0 kg a.i./ha (Rs.19626.23/ha). The lowest net return recorded in unweeded control (Rs.-5375.23/ha), Isoproturon at 1.25 kg a.i/ha (Rs.-4265.76/ha) and 1.5 kg a.i./ha (Rs.431.02/ha).

The maximum marginal returns was recorded in repeated weeding (Rs.28331/ha) followed by Metolachlor at 1.5 kg

(Rs.28311.01/ha), Diuron at 1.25 kg a.i./ha (Rs.27336.23/ha) and 1.0 kg a.i./ha (Rs.25351.56/ha) and Metolachlor at 1.25 kg a.e./ha (Rs.23262.51/ha). The lowest marginal returns was obtained in Isoproturon 1.25 kg and 1.5 kg a.i/ha (Rs.1533.61 and 6312.21/ha, respectively).

The maximum profit per rupee spent on weed control was obtained in Diuron at 1.0 kg a.i./ha (72.4), followed by Diuron at 1.25 kg a.i./ha (62.91), Metolachlor 1.5 kg (55.7) and 1.25 kg a.e./ha (Rs.54.72) and lowest was in Isoproturon at 1.25 kg a.i/ha (3.61) and repeated hand weeding (8.85).

#### 4.12 Studies on residual effects

The test crop like Cucumber (Guntur local) was used in bio-assay experiment to assess the herbicidal residues in soil, if any, after mulberry crop.

The data on percent germination, root growth and shoot growth of cucumber are presented in Table 23.

##### 4.12.1 Percent Germination

The different herbicides applied in Mulberry did not show their residual effect on germination of cucumber (100%) whereas Butachlor at 1.5 kg a.e./ha recorded poor germination (86.67%) indicating more residual persistence in soil.

##### 4.12.2 Root growth

There were no significant difference in root length and root dryweight of cucumber due to different herbicidal treatments

Table 23: Residual effect of herbicides applied to Mulberry on germination percentage, root growth and shoot growth of cucumber.

Treatments	Herbicide rate (Kg a.i. or a.e./ha)	Germination percentage	Root Length (cm)	Root dry weight/seedling(mg)	Shoot Length (cm)	Shoot dry weight/seedling(mg)
Repeated hand weeding	-	100.00	14.77	9.50	4.37	16.60
Diuron	1.00	96.67	14.17	8.45	3.93	15.02
Diuron	1.25	93.33	14.37	9.03	4.10	15.33
Butachlor	1.25	93.33	13.03	8.80	3.23	14.25
Butachlor	1.50	86.67	11.17	8.03	3.10	13.02
Isoproturon	1.25	100.00	12.77	9.22	3.90	16.70
Isoproturon	1.50	93.33	14.33	8.50	4.30	15.25
Alachlor	1.25	100.00	13.33	8.45	4.37	16.33
Alachlor	1.50	96.67	12.67	8.45	3.50	14.36
Metolachlor	1.25	90.00	14.07	9.22	4.27	14.70
Metolachlor	1.50	90.00	14.70	9.03	3.27	15.89
Pendimethalin	1.25	100.00	13.17	8.50	4.17	15.02
Pendimethalin	1.50	96.67	12.47	8.22	4.03	13.33
Oxyfluorfen	0.12	100.00	13.60	9.25	4.03	15.33
Oxyfluorfen	0.25	93.33	12.67	8.30	3.27	14.39
Unweeded control	-	100.00	14.90	9.89	4.93	16.89
F-test S.E.m + C.D. @ 5%	NS 3.72 10.31	NS 1.00 2.78	NS 0.75 2.07	NS 0.47 1.30	NS 0.79 2.20	

NS = Non significant

applied in mulberry garden indicating their non-residual effect on root growth of cucumber. However, the lowest length (11.17 cm) and root weight (8.03 mg) of cucumber were observed in Butachlor at 1.5 kg a.e./ha, while the highest root length (14.9 cm) and root weight (9.89 mg) were recorded in unweeded control where herbicide was not applied.

#### 4.12.3 Shoot growth

Different herbicide treatments applied in mulberry crop did not show their residual effect on shoot length and shoot weight of cucumber significantly. However, the lowest shoot length (3.1 cm) and shoot weight (13.02 mg) of cucumber were obtained in Butachlor at 1.5 kg a.e./ha, while the highest shoot length (4.93 cm) and shoot weight (16.89 mg) were recorded in unweeded control where herbicide was not applied.

## **DISCUSSION**

## V DISCUSSION

Weeds growing in association with the crop plants utilize considerable amount of nutrients and deprive the opportunity for the crop to express its potential yield. Thus efficient weed control is an essential pre-requisite for increasing crop productivity. The present investigation was undertaken to find out suitable herbicide to control weeds in established Mulberry garden. The results have been discussed under the following major headings.

1. Effect of weed control treatments on growth and control of weeds
2. Effect of weed control treatments on growth, leaf yield and leaf quality of mulberry crop
3. Effect of weed control treatments on nutrients uptake by crop and weeds
4. Effect of weed control treatments on silkworms, cocoon yield and silk quality
5. Residual effect of herbicides and
6. Economics of weed control treatment.

### 5.1 Effect of different weed control treatments on growth and control of weeds

In the experimental plots, the weed infestation predominantly consisted of sedges followed by monocots and dicots. Among sedges, the most predominant one was Cyperus rotundus Linn., Among dicots Ageratum conyzoides Linn., Spillanthus calva D.C. and Emelia sanchifolia Linn. and Cynodon dactylon Pers. were the

predominant monocot weeds. Similar type of weed flora were observed by Dhar et al.(1975), Vijaya and Razi (1977) and Muniyappa (1990).

Visual observations on weed control ratings showed marked differences among the different herbicidal treatments. At initial stages, Diuron (1.0 and 1.25 kg a.i./ha), Metolachlor (1.25 and 1.5 kg a.e./ha), Alachlor (1.5 kg a.e./ha), Butachlor (1.5 kg a.e./ha) and Pendimethalin (1.5 kg a.e./ha) gave good to excellent control of weeds. At later stages, all the herbicide treatments gave moderate control of weeds.

Monocot, dicot, sedges and total weed population increased rapidly upto 60 days after pruning and later on, there was decline in their rapid increase in number. This may be attributed to shorter life cycle of some weeds and or due to smothering effect of crop on weeds. These results indicate that effective control of weeds during the early stages of the crop establishment and growth is essential in Mulberry. Similar results were reported by Muniyappa (1990) who observed that the first 45 days after pruning was found to be most critical stage in Mulberry crop.

Observations on weed count of monocot, dicot, sedges and total weeds recorded at different crop growth stages differed significantly due to weed control treatments.

The herbicides tested in this experiment were effective in controlling monocot and dicot weeds, but their effectiveness on sedges was relatively low. Since the sedges are known to be

sprouting from the rhizomes and tubers, the pre-emergence herbicides seem to have no specific effect in controlling the sprouting of these organs. It is needless to emphasize that there is a need to identify more effective chemicals which control the sedges when applied as pre-emergence herbicides.

With regard to the relative effectiveness of the herbicides tested, Diuron at 1.25 kg a.i./ha, Metolachlor at 1.5 kg a.e./ha, Alachlor at 1.5 kg a.e./ha, Butachlor at 1.5 kg a.e./ha and Pendimethalin at 1.5 kg a.e./ha were effective in decreasing the weed density, especially monocots and dicots, whereas Metolachlor 1.5 kg a.e./ha was found to be relatively more effective in suppressing the growth of sedges. Effective control of weeds by these herbicides have been reported by many workers (Kim et al. 1973; Kasiviswanathan et al., 1978; Sikdar et al., 1985; Muniyappa and Bomme gowda, 1988).

The drymatter production of weeds recorded at different stages appears to be a better reflection of the efficacy of herbicides tested. Weed dry weight increased upto 60th day after pruning and later on, there was decline in their dry weight. Perhaps, this may be attributed to shorter life cycle of some weeds and or due to smothering effect of crop on weeds. These results indicate that effective control of weeds during the early stages of crop establishment and growth is essential in Mulberry. However, present results also indicated that the herbicides tested were most effective in checking the weed growth at early stages of crop growth.

The drymatter production of monocot, dicot, sedges and total weeds at different crop growth stages differed significantly due to weed control treatments.

Weed dry weight per 0.5 square meter area at harvest of first and second crop was highest in unweeded control (205.5 and 127.0 g/0.5 sq.m. in first and second crop respectively), while all herbicidal treatments recorded significantly lower weed dry weight (35.17 to 76.03 g and 21.43 to 57.87 g/0.5 sq.m. in first and second crop respectively). Among the herbicidal treatments, Diuron at 1.25 kg a.i./ha (35.17 and 22.3 g/0.5 sq.m in first and second crop respectively) and Metolachlor at 1.5 kg a.e./ha (37.4 and 27.43 g/0.5 sq.m. in first and second crop respectively) were very effective in reducing the dry weight of weeds. The highest weed control efficiency was also noticed in Diuron at 1.25 kg a.i./ha (82.88 and 82.44 % in first and second crop respectively) and Metolachlor at 1.5 kg a.e./ha (81.74 and 83.13 % in first and second crop respectively) and this was due to effectiveness of these herbicides against both monocot and dicot weeds. Muniyappa (1990) reported that the pre-emergence application of Diuron at 1.25 kg a.i./ha was found to be effective in controlling total weed density and greater efficiency of Diuron was due to readily absorption by emerging weed roots and its nature of activation as reported by Chandrasekaran and Venkatakrishnan (1991). As a result, weed competition was reduced and hence there was an improvement in leaf yield.

## 5.2 Effect of weed control treatments on growth, leaf yield and leaf quality of Mulberry crop

### 5.2.1 Crop growth

Visual observations on crop toxicity ratings were made at 15, 30, 45 and 60 days after pruning and at harvest. Among the weed control treatments, Oxyfluorfen and Alachlor caused toxicity symptoms on mulberry leaves. Oxyfluorfen at both the levels (0.12 Kg and 0.25 Kg a.e./ha) caused severe chlorosis, whereas Alachlor at higher level (1.5 Kg a.e./ha) caused toxic symptoms such as necrosis, leaf drying at initial stages but the crop recovered in later stages of the growth. Chandrasekaran and Venkatakrisnan (1991) also reported that pre-emergence application of Alachlor at 3.0 to 6.0 Kg a.e./ha caused severe toxicity to mulberry crop.

The plant height obtained at harvest of first and second crop was significantly higher in repeated hand weeding (127.36 and 187.56 cm in first and second crop respectively) as compared to other weed control treatments (83.82 to 119.63 cm and 131.72 to 175.3 cm in first and second crop respectively). Among the herbicidal treatments, Diuron at 1.25 Kg a.i./ha (116.49 and 173.32 cm in first and second crop respectively) and Metolachlor at 1.5 a.e./ha (119.63 and 175.3 cm in first and second crop respectively) have recorded higher plant height. The reasons for higher plant height is attributed to better control of weeds throughout the crop growth which resulted in better availability of moisture and plant nutrients to the crop as evidenced from the beneficial effect on the crop growth. The lower plant height was obtained in Isoproturon at 1.25 Kg a.i./ha (88.08 and 135.53 cm in

first and second crop respectively) and unweeded control (83.82 and 131.72 cm in first and second crop respectively). This was mainly because of severe competition by weeds for resources which made the crop plant inefficient to take up moisture and nutrients. These results are in agreement with those of Dhar et al., 1975, Sikdar et al., 1987 and Muniyappa, 1990).

Number of secondary shoots per plant at harvest differed significantly due to different weed control treatments, while non-significant differences were observed in number of primary shoots. The maximum number of secondary shoots were recorded in repeated hand weeding (15 and 17.53/plant in first and second crop respectively) which was on par with Diuron at 1.25 kg a.i./ha (13 and 16.23/plant in first and second crop respectively) and Metolachlor at 1.5 a.e./ha (14.33 and 16/plant in first and second crop respectively). These herbicides provided weed-free condition in early growth stages of crop and have not suppressed the branching of Mulberry. The lower number of secondary shoots in Oxyfluorfen at 0.12 kg a.e./ha (9.67 and 12/plant in first and second crop respectively) could be attributed to its phytotoxic effect on mulberry during early stages of crop growth. On the other hand, reduction in number of secondary shoots in Isoproturon 1.25 a.i./ha treated plot (9.63 and 11/plant in first and second crop respectively) could be attributed to keen competition by weeds as they were not properly controlled. Sikdar et al., (1987) reported that the severe weed infestation minimised the branching habit in Mulberry which may be one of the causes for low yield.

The leaf dry matter production of Mulberry recorded at harvest of first and second crop was significantly higher in repeated hand weeding free treatment (47.37 and 46.8 g/plant in first and second crop respectively) as compared to other weed control treatments (28.5 to 45.33 and 27.63 to 46.2 g/plant in first and second crop respectively). Among the herbicidal treatments, Diuron at 1.25 Kg a.i./ha (44.53 and 44.07 g/plant in first and second crop respectively) and Metolachlor at 1.5 a.e./ha (45.33 and 46.2 g/plant in first and second crop respectively) have recorded significantly higher dry matter. This increase in drymatter production was due to better control of weeds in early stages of crop growth which provide better environment helping the plant to accumulate more drymatter. Severe infestation of weeds in unweeded control (28.5 and 27.63 g/plant in first and second crop respectively) and Isoproturon at 1.25 a.i./ha (29.87 and 28.33 g/plant in first and second crop respectively) resulted in decreased drymatter production of Mulberry leaf. Similarly, Sikdar et al., (1981) reported that the significant difference was noticed in dry weight of 100 leaves between control and other herbicidal treatment combinations.

Further, the accumulation of large quantity of dry matter is a consequence of higher leaf area and leaf number, which made the plant to utilize resources to photosynthesize and translocate efficiently. Among weed control treatments, Isoproturon at 1.25 Kg a.i./ha (6067.93 and 6018.45 cm<sup>2</sup>/plant in first and second crop respectively) and unweeded control (5023 and 4902.68 cm<sup>2</sup>/plant in first and second crop respectively) recorded lower leaf area at

harvest. This was due to severe competition by weeds for resources which made the crop plant inefficient to take up moisture and nutrients. Consequently, growth was affected. Repeated hand weeding (8987.84 and 9002.38 cm<sup>2</sup>/plant in first and second crop, respectively) recorded significantly higher leaf area followed by Metolachlor at 1.5 a.e./ha (8608.73 and 8612.57 cm<sup>2</sup>/plant in first and second crop respectively) and Diuron at 1.25 Kg a.i./ha (8579.71 and 8530.51 cm<sup>2</sup>/plant in first and second crop respectively). This was attributed to better control of weeds in early stages of crop growth which made the crop plant to utilize resources efficiently, resulting in better crop growth. Number of leaves followed the same trend as that of leaf area as influenced by various weed control treatments. Similarly, Sikdar *et al.* (1987) and Muniyappa (1990) reported that hand weeding recorded more leaf area as well as leaf number per plant as compared to herbicidal treatments.

### 5.2.2 Leaf yield and its components

The leaf yield per hectare at all growth stages of first and second crop differed significantly due to weed control treatments. The highest leaf yield per hectare at harvest of first and second crop was obtained in repeated hand weeding (8354.17 and 8403 kg/ha in first and second crop respectively) followed by Diuron at 1.25 Kg a.i./ha (7805.83 and 7938 kg/ha in first and second crop respectively), Metolachlor at 1.5 a.e./ha (7790 and 7660 kg/ha in first and second crop respectively), Butachlor at 1.5 Kg a.e./ha (6525 and 6672 kg/ha in first and second crop respectively) and Alachlor at 1.5 Kg a.e./ha (6296.67 and 6310 kg/ha in first and

second crop respectively). This increase in leaf yield is mainly attributed to efficient control of weeds throughout the crop growth period which resulted in better availability of plant nutrients and moisture to the crop as evidenced from the beneficial effect on the crop growth reflected through increased number of branches per plant, leaf area, leaf number and drymatter accumulation. Similar results of increased leaf yield due to Diuron, Butachlor and Alachlor applications had been reported by many earlier workers (Kim et al. 1973, Kasiviswanathan et al. 1978, Sikdar and Krishnaswami, 1980, Sikdar et al. 1987, and Muniyappa, 1990). Severe infestation of weeds in Isoproturon at 1.25 a.i./ha (4293 and 4318.5 kg/ha in first and second crop respectively) and unweeded control (2765 and 2571.5 kg/ha in first and second crop respectively) resulted in suppression of crop growth in terms of decreased branches per plant, leaf area, leaf number and drymatter accumulation, thereby reducing the leaf yield.

The percent increase in leaf yield over unweeded control ranged from 0 to 214 percent. Among the different weed control treatments, repeated hand weeding, Diuron at 1.25 kg a.i./ha and Metolachlor at 1.5 a.e./ha increased the leaf yield by 214, 195 and 189 percent, respectively over the unweeded control (0%) followed by Diuron at 1.0 kg a.i./ha (170 %), Metolachlor at 1.25 a.e./ha (161 %) and Butachlor at 1.5 kg a.e./ha (147 %).

Weed Index is the index of extent of yield variation due to weed control treatments in relation to weed free throughout crop

growth. Weed index followed the similar trend as that of leaf yield as influenced by various weed control treatments. Highest weed index (66.51 and 69.39% in first and second crop \*respectively) was observed in unweeded control and lowest (6.51 and 7.63% in first and second crop respectively) in Diuron at 1.25 kg a.i./ha. Similar results have been reported by Sikdar et al., (1981) and Muniappa (1990).

Moisture content in Mulberry leaves recorded at harvest of first and second crop was highest in repeated hand weeding (73.78 and 75.2 % in first and second crop respectively) followed by Metolachlor at 1.5 a.e./ha (70.26 and 71.6 % in first and second crop respectively) and Diuron at 1.25 kg a.i./ha (71.57 and 70.25 % in first and second crop respectively). This increased moisture percent was due to better control of weeds in early stages of crop growth which provide better environment helping the plant to take up more moisture. Decreased moisture content with unweeded control (59.62 and 55.75 % in first and second crop respectively) was attributed to severe competition of weeds for moisture and plant nutrients which made the crop plant inefficient to take up moisture and nutrients. Similar results have been reported by Muniyappa (1990).

### **5.3 Effect of weed control treatments on Nutrients uptake by crop and weeds**

Repeated hand weeding (76.69 and 80.6 kg/ha in first and second crop respectively), Diuron at 1.25 kg a.i./ha (73.34 and 75.61 kg/ha in first and second crop respectively) and Metolachlor at

1.5 a.e./ha (72.9 and 74.48 kg/ha in first and second crop respectively) recorded maximum Nitrogen uptake per hectare by established Mulberry crop. Higher nitrogen uptake of crop in these treatments is mainly due to lower weed population and weed dryweight which facilitated the crop to grow well and absorb more nutrients from the soil. Reduction of nitrogen uptake in unweeded control (62.05 and 28.04 kg/ha in first and second crop respectively) could be attributed to keen competition by weeds for resources which made the crop plant inefficient to take up nutrients and moisture. Similarly phosphorus and potassium uptake followed the same trend as that of nitrogen as influenced by various weed control treatments. The nutrients uptake of crop was inversely proportional to nutrients uptake by weeds. These results are in line with the results of Homma and Itoh (1977), Rao and Agarwal (1984), Srinivasan et al. (1987) and Muniyappa (1990).

#### 5.4 Effect of weed control treatments on Silkworm, cocoon yield and silk quality

The pre-emergent herbicides like Diuron, Butachlor, Isoproturon, Alachlor, Metolachlor, Pendimethalin and Oxyfluorfen were applied immediately after bottom pruning. Two leaf harvests were made over the period of five months with 75 days interval. The rearing of silkworms was made only for first crop.

The results on silkworm rearing as influenced by different weed control treatments revealed different effects on the silkworms, cocoon yield and other silk quality parameters. The larval weight did not differ significantly due to different weed

control treatments upto fourth moult. However, at maturity the larval weight differed significantly due to weed control treatments. The larval weight was lowest in unweeded control (17.84 g) and highest in Diuron at 1.25 Kg a.i./ha (20.9 g) followed by repeated hand weeding (20.55 g), Metolachlor at 1.5 a.e./ha (20.54 g). The effective rate of rearing was minimum in Oxyfluorfen at 0.25 Kg (77.33%) and 0.12 Kg a.e./ha (78.33%), Isoproturon at 1.25 a.i./ha (79.33%) and it was on par with unweeded check (79.67%) except Oxyfluorfen at 0.25 Kg a.e./ha. The mortality of silkworms indicated that the leaves fed from the plots treated with Oxyfluorfen and Isoproturon might be due to the toxicity of these herbicides to the silkworms and or due to the poor leaf quality resulted from severe weed competition for essential nutrients. However the larval duration did not differ among different weed control treatments. These results are in conformity with the results obtained by Kasiviswanathan et al. (1978) and Muniyappa (1990).

The cocoon and silk quality characters differed significantly among weed control treatments. The cocoon weight, pupal weight, shell percentage, mean filament length, 75 cocoon filament weight were decreased significantly in Oxyfluorfen treated plots. The decrease in these parameters maybe due to their toxic effect on silkworms. The decreased parameters in Isoproturon and unweeded control was due to severe weed competition for essential nutrients. Consequently, poor leaf quality might have resulted in altering the normal growth of silkworms.

### 5.5 Residual effect of herbicides

Residual effect of Diuron, Butachlor, Isoproturon, Alachlor, Metolachlor, Pendimethalin and Oxyfluorfen at different levels was experimented through bio-assay studies using cucumber as indicator plant. The observations were made on germination, root and shoot growth.

The germination of cucumber was not much affected due to any levels of herbicides tested on Mulberry. However, the germination percentage of cucumber was reduced by the residues left by Butachlor (1.5 Kg a.e./ha) application as compared to other herbicides. Reduction of 13.33 % cucumber germination due to the residues of Butachlor indicates that the herbicide was more persistent in soil even after the harvest of Mulberry crop.

Although there were marginal differences in root and shoot growth of cucumber, the herbicides applied on mulberry did not show significant residual effect.

### 5.6 Economics of weed control

Repeated hand weeding recorded maximum gross returns (Rs.44001/ha) and Metolachlor at 1.5 a.e./ha recorded maximum net returns (Rs.22428.18/ha), whereas unweeded control recorded lowest gross returns (Rs.15670/ha) and net returns (Rs.-5375.23/ha). The lowest net returns in unweeded control was due to lower leaf and cocoon yield which was due to severe weed infestation.

The benefit cost ratio was higher in Diuron at 1.0 Kg a.i./ha (72.4) followed by Diuron at 1.5 Kg a.i./ha (62.91),

Metolachlor at 1.5 Kg (55.7) and 1.25 Kg a.e./ha (54.72). This was mainly due to higher leaf and cocoon yield and lower cost involved for control of weeds which resulted in higher marginal returns in both the treatments.

### 5.7 Practical application of results

From this study, it can be concluded that pre-emergence application of Diuron at 1.25 Kg a.i./ha or Metolachlor at 1.5 kg a.e./ha would effectively control the weeds without causing any phytotoxic symptoms on Mulberry, thereby increasing the net returns.

### 5.8 Future line of work

1. There is need to study the type of weed flora controlled by different herbicides to improve the efficiency of herbicides in controlling weeds in Mulberry.
2. Effect of combinations of both pre and post-emergence herbicides on control of weeds in mulberry crop needs to be studied.
3. Determination of the threshold values of different herbicides for the mulberry crop and silkworm is essential to avoid phytotoxicity.

# **SUMMARY**

## VI SUMMARY

The field experiment entitled "Chemical weed control in established mulberry garden and its effect on silkworm and cocoon production" was conducted during rabi season of 1991 at the Agronomy Field unit, Gandhi Krishi Vignana Kendra, The University of Agricultural Sciences, Bangalore, to find suitable herbicides in mulberry. The treatments included were Diuron (1.0 and 1.25 kg a.e./ha), Butachlor (1.25 kg and 1.5 a.e./ha), Isoproturon (1.25 and 1.5 kg a.i./ha), Alachlor (1.25 and 1.5 kg a.e./ha), Metolachlor (1.25 and 1.5 kg a.e./ha), Pendimethalin (1.25 and 1.5 kg a.e./ha) and Oxyfluorfen (0.12 and 0.25 kg a.e./ha) and these treatments were compared with hand weeded at 15 day intervals throughout the crop growth period and unweeded control. Some of the important findings of the present investigations are summarised as follows.

The important weed flora observed in experimental field were Spillanthus calva DC., Ageratum conyzoides Linn., Emelia sanchifolia Linn. and Euphorbia hirta Linn., among dicot weeds. The monocot weeds were Cynodon dactylon Pers., Dactyloctenium aegypticum Beauv. and Eragrostis gangetica Steud. and among sedge Cyperus rotundus Linn. was the predominant weed.

Among the different herbicides, application of Diuron at 1.25 kg a.i./ha and Metolachlor at 1.5 kg a.e./ha reduced the weed population, weed dry weight effectively as compared to unweeded control and gave highest leaf yield comparable to repeated hand weeding. Next best promising herbicides were Butachlor at 1.5

kg a.e./ha, Alachlor at 1.5 kg a.e./ha and Pendimethalin at 1.5 kg a.e./ha for controlling the weeds and producing more leaf yield.

Throughout the crop growth period, sedges were dominant over monocot and dicot weeds. At all growth stages of first as well as second crop, unweeded control had significantly higher weed population and higher dry matter of weeds. In general, the weed population and weed dry weight was reduced in all weed control treatments. However, the magnitude of decrease in weed population and weed dry weight were less at lower doses. Diuron at 1.25 kg a.i./ha and Metolachlor at 1.5 kg a.e./ha were very effective in controlling the weeds especially monocots and dicots, whereas, Oxyfluorfen at 0.12 kg and 0.25 kg a.e./ha were effective in controlling dicot weeds than monocot weeds.

With regard to growth parameters, unweeded control, Isoproturon at 1.25 a.i./ha gave lowest plant height, number of branches, number of leaves, leaf area and leaf dry weight per plant in mulberry. Diuron at 1.25 kg a.i./ha and Metolachlor at 1.5 kg a.e./ha gave highest plant height, number of leaves, number of branches, leaf area and leaf dry weight per plant in mulberry. However, dry matter accumulation of crop was inversely proportional to the dry matter production of weeds.

Highest leaf yield per hectare was obtained in repeated hand weeding at harvest of first and second crop (8354.17 and 8403 kg/ha in first and second crop respectively) followed by Diuron at 1.25 kg a.i./ha (7805.83 and 7938 kg/ha in first and second crop respectively) and Metolachlor at 1.5 kg a.e./ha (7790 and 7660

1.25 Kg a.i./ha (4293 and 4318.5 kg/ha in first and second crop respectively) and Oxyfluorfen at 0.12 Kg a.e./ha (4776.5 and 5108.5 kg/ha in first and second crop respectively) recorded lower leaf yield. But these treatments were superior to unweeded control (2765 and 2571.5 kg/ha in first and second crop respectively). Highest weed index was observed in unweeded control (66.51 and 69.39 % in first and second crop respectively) followed by Isoproturon at 1.25 a.i./ha (48.6 and 48.56 % in first and second crop respectively).

The percent increase in leaf yield over unweeded control ranged from 0 to 214 percent. Among the different weed control treatments, repeated hand weeding and Diuron at 1.25 Kg a.i./ha increased the leaf yield by 214 and 195 percent respectively over the unweeded control (0%) followed by Metolachlor at 1.5 Kg a.e./ha (189%), Diuron at 1.0 Kg a.i./ha (170%), Metolachlor at 1.25 a.e./ha (161%) and Butachlor at 1.5 Kg a.e./ha (147 %).

The moisture content of mulberry leaf at harvest of first and second crop was maximum in repeated hand weeding (73.78 and 75.2 % in first and second crop respectively) followed by Metolachlor at 1.5 Kg a.e./ha (70.26 and 71.6 % in first and second crop respectively) and Diuron at 1.25 Kg a.i./ha (71.57 and 70.25 % in first and second crop respectively) whereas unweeded control (59.62 and 55.75 % in first and second crop respectively) recorded lower leaf moisture content.

Repeated hand weeding, Diuron at 1.25 Kg a.i./ha and Metolachlor at 1.5 Kg a.e./ha recorded maximum nutrient uptake by

Mulberry crop, whereas, Isoproturon at 1.25 a.i./ha and unweeded control recorded lowest nutrient uptake by Mulberry crop.

The silkworm larval weight and cocoon and silk quality characters, viz., cocoon weight, pupal weight, shell weight, shell percentage, mean filament length, single filament weight, 75 cocoon filament weight were higher in cultural treatments, Diuron at 1.25 Kg a.i./ha and Metolachlor at 1.5 Kg a.e./ha as compared to unweeded control and other herbicidal treatments.

Bio-assay experiment was conducted by using cucumber as indicator plant to assess the residual effect of herbicides. The germination of cucumber was not much affected due to any levels of herbicides tested on mulberry. Butachlor at 1.5 Kg a.e./ha gave lowest germination percentage compared to other herbicidal treatments showing more persistence in soil. With regard to root and shoot growth, although there was marginal difference, the different herbicides applied in mulberry did not show their residual effect on cucumber significantly.

Maximum gross returns were recorded in repeated hand weeding (Rs.44001/ha) and net returns in Metolachlor at 1.5 Kg a.e./ha (Rs. 22428.18/ha). The benefit-cost ratio was higher in Diuron at 1.0 Kg a.i./ha (72.4) followed by Metolachlor at 1.25 Kg (55.7) and 1.5 Kg a.e./ha (54.72). Whereas, unweeded control and Isoproturon at 1.25 Kg a.i./ha recorded lowest gross and net returns.

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# **APPENDIX**

APPENDIX - I

List of herbicides used in the experiment along with their common name, trade name, chemical name and address of the manufacturers.

Sl.No.	Common Name	Trade Name	Chemical Name	Address of the manufacturers
1.	Diuron	Karmex	3-3,4-dichlorophenyl)-1,1-dimethyl urea	M/s. National Organic Chemicals, Burmah Shell House, P.B.260, Bombay.
2.	Butachlor	Machete	N-(butoxymethyl)-2-chloro-2,6-diethyl acetanilide	H.O.: Mascot House, 875, West of Chord Road, Bangalore-56 Phone: 355600, 350913, 355082 GRAMS: MASCOF, Telex: 845 - 580.
3.	Isoproturon	Aerlon	3(4-Isopropyl-phenyl)1,1-dimethyl urea	M/s. Excel Industries Limited, 5/1, J.C. Road Bangalore - 560 002. Registered Office
4.	Alachlor	Lasso	OC-chloro-2',6'-diethyl-N(methoxymethyl) acetanilide	M/s.Monsanto Chemicals of India Ltd., Wakefield House, 11, Sprott Road, Ballard Estate, Bombay - 400 038.
5.	Metolachlor	Dual	2-chloro-N-(2 ethyl-6 methylphenyl)-N-methoxy-1 methyl ethyl) acetamide	M/s.Monsanto Chemicals of India Ltd., Wakefield House, 11, Sprott Road, Ballard Estate, Bombay - 400 038.
6.	Pendimethalin	Stomp	N-(1-ethyl propyl)-2,6-dinitro-3,4-oxylidine	M/s. Cyanamid India Limited, Nylloc House, 254 - D2, Dr. Annie Besant Road, Post Box: 9109, Bombay - 400 025.
7.	Oxyfluorfen	Goal	2-chloro-4-trifluoromethyl phenyl 3-ethoxy-4-nitrophenyl ether	M/s. Indofil Chemicals Limited, Mirilon House, Bombay - 400 025. Phone: 457391.

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