

INTEGRATED WEED MANAGEMENT IN ROSE

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DIVISION OF HORTICULTURE
UNIVERSITY OF AGRICULTURAL SCIENCES
BANGALORE
2000

INTEGRATED WEED MANAGEMENT IN ROSE

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*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 (HORTICULTURE)

in

FLORICULTURE

Bangalore

September, 2000

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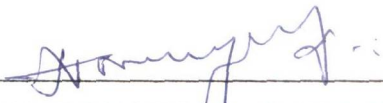
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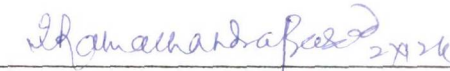
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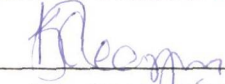
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ACKNOWLEDGEMENT

"Gratitude is the Memory of the Heart"

I place on record my deep sense of gratitude and heartfelt respect to esteemed Chairman of my Advisory Committee Dr.J.V.NARAYANA GOWDA, Professor and Head, Department of Horticulture, University of Agricultural Sciences, Bangalore for his sincere exhortations, invaluable and painstaking excellent guidance and continued calm endurance and inspiring encouragement during the course of investigation. It was a pleasure and privilege for me to be associated with him during my Master's degree programme.

Words are tools of expressing, but they fail miserably when it comes to thank DR.T.V.RAMACHANDRA PRASAD, Professor and Principal Investigator, AICRP on Weed Control Scheme, Hebbal, University of Agricultural Sciences, Bangalore, who served as Member of my Advisory Committee for his encouragement and guidance during the course of Research Work.

I gratefully thank Mr.K.SEENAPPA, Assistant Statistician, P.C.Unit, University of Agricultural Sciences, GKVK, Bangalore, who served as a Member of Advisory Committee. Words are not adequate to express my gratitude towards him for his valuable suggestions during the study.

I am greatly indebted to Mr.K.V.JAYAPRASAD, Assistant Professor, Department of Horticulture, University of Agricultural Sciences, Bangalore, who served as a Member of my Advisory Committee for his constant encouragement and guidance during the course of Research work.

I gratefully thank Dr.PARTHASARATHY, KSG's Educational Trust for their financial assistance throughout the Course period. Words

are not adequate to express my gratitude towards him for the valuable suggestions during the study period.

Needless to state that I am profoundly grateful to my Parents SRI.ADINARAYANA REDDY and SMT.LAKSHMI NARASAMMA, sister JALAJAKSHI and brother GURUPRASADA for their constant source of inspiration and support without which it would not have been possible to complete this work.

I owe my gratitude to my sister GEETHALAKSHMI and brother-in-law Sri AMARANARAYANA REDDY for their constant encouragement and support throughout the course of study.

Finally, I sincerely thank Mr.SAMUEL for his neat typing of this thesis.

GKVK, Bangalore
September , 2000

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INTRODUCTION

I. INTRODUCTION

Rose is one of the nature's beautiful creations and is universally acclaimed as the 'Queen of flowers'. No other flower is a better symbol of love, adoration, innocence and other virtues than the rose, and not in our time only, but so it has been for thousands of years. It has become the part and parcel of life, being connected with all phases of life right from birth to death. The growing of this beautiful flower in India developed with the distillation of roses as mentioned in Ayurveda by Charaka around 100 AD. The interest in cultivation, however, increased considerably during the last three decades and at present it has become the most important commercial flower.

The rose is an ornamental shrub with upright or climbing stems, usually prickly. It is grown for various purposes, such as garden flowers, for aesthetic value, as a cut flower, for decorative purposes and for making various products from rose petals, such as rose oil, rose water and gulkand.

About 1360 kgs of rose flowers are sold daily in each of the big cities of India. About 100-150 dozens of cut roses are sent daily to cities like Mumbai and Chennai from Bangalore alone (Kolavalli *et al.*, 1991). In Karnataka the area under rose is 1707 ha with the production of 4438 tonnes of rose flowers having productivity of 2.6 tonnes per ha (Anon., 1997).

There is a great demand for cut roses particularly from the European markets during winter months and throughout the year in India. The production of roses in India, particularly during winter months is highly profitable compared to temperate countries, where it is grown under green house conditions. Hence, there is ample scope for commercial production of roses in India both for export and to meet internal demand.

Rose is both a traditional and modern cut flower. It is also used in industries for extraction of rose oil and rose water. Use of rose as a traditional flower is a part of Indian culture and its demand comes from all classes and castes. Thus the demand for rose as a traditional flower in India is bound to grow with the improvement in the standard of living. The widespread demand for rose as a modern cut flower is of recent origin and is growing enormously due to the development of tourism, hotel industry and urbanization. For traditional use, flowers are harvested when fully open with a stem length of 7.5 – 15 cm. As a modern cut flower, a stem longer than 30 cm is a pre-requisite and flowers are harvested in the bud stage itself, enabling them to last longer (Kolavalli *et al.*, 1991)

Weeds pose a very serious problem in rose cultivation as heavy manurial and irrigation requirements of this crop create conditions conducive for the rank growth of numerous types of weeds. Weed infestation hampers the growth of rose plants in the early stages, besides harbouring many pests and diseases. The weeds not only consume water and nutrients from the soil

but also act as hosts for a number of pests and diseases. Though the quality of cut flower is primarily a varietal trait, it is greatly influenced by climatic, nutrition, crop composition, weed flora and other factors. Frequent irrigation and liberal use of manures and fertilizers provides favourable conditions for luxurious growth of weeds. More often, fields get so much infested with the weeds that crop production becomes uneconomical unless they are controlled. Thus weeds pose greatest hazards, increase the cost of cultivation and reduce the quantity and quality of rose flowers. Weed free conditions in early stages unfailingly produces the highest flower yields.

Manual weed control is effective if done frequently. But this procedure is very expensive, laborious, time consuming and, if not properly done, damages the root system. Use of herbicides in control of weeds is comparatively economical, convenient and efficient in eradicating weeds by one or two applications. Higher weed control efficiency and flower yield can be obtained through use of herbicides, in areas where labour is scarce and expensive. Non-availability of labour during critical period of crop growth causes weeds to compete effectively with rose. However, majority of the farmers in India is reluctant to use herbicides mainly due to lack of knowledge about dose, time, method of application, non-availability of herbicides and prohibitive cost.

Any herbicide when used in combination with cultural practices shows improvement. Herbicides keep the crop weed free right from the early

stages of crop growth. During later stages cultural practices help to reduce the cost of weeding and keep the weed population below the economic threshold level throughout the crop growth period. Keeping all these in view, the present study was carried out with the following objectives:

1. To know the relative efficacy of various herbicides alone and in combination with cultural practices on control of weeds in rose.
2. To know the effect of different weed management practices on growth, yield and quality of rose flowers.
3. To study the effect of the herbicides on post harvest life of rose flowers.
4. To compare the economics of different weed management practices.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

Weeds bring about heavy damages to flower crops by competing with them for water, nutrients, light and space besides acting as alternate host to a number of pests and diseases. Out of several factors affecting growth and production of flower crops, weeds are the most important ones. Reduction in crop yield has direct correlation with weed competition. Proper control of weeds is very essential in obtaining optimum plant growth, higher yield and quality flowers. The best way to control weeds is by adopting integrated approach involving cultural practices in combination with herbicides. The literature cited on weed control aspects is reviewed with the following headings:

1. Weed flora in commercial flower crops.
2. Crop weed competition.
3. Methods of weed management in Rose and other commercial flower crops.
4. Chemical weed control in Rose.
5. Chemical weed control in other commercial flower crops.
6. Herbicidal effect on growth, yield and quality.
7. Phytotoxicity.
8. Herbicidal effect on vase life.
9. Economics of weed control methods.

Rose, even though a hardy crop, the degree of damage caused by weeds is related to type, species and density of weeds growing in a crop community. Weed species are known to vary with the season and type of cultivation. Persistence of weeds in a location is largely influenced by climatic, edaphic and biotic factors, which affect their occurrence, abundance, range and distribution

Use of herbicides along with cultural practices has received much less attention and systematic investigation to assess the effect of herbicides along with cultural practices on growth and flower production in rose have not been reported under field conditions.

2.1 WEED FLORA IN COMMERCIAL FLOWER CROPS

The most prevalent and common weed species associated with commercial flower crops as reported were *Cynodon dactylon* Pers., *Digitaria sanguinalis* L., *Digitaria marginata* Link. Var. *fimbriata*, *Dactyloctenium aegyptium* Beauv., *Setaria* spp., *Chloris barbata* SW., *Poa annua* L., *Panicum repens* L., among grasses, while *Cyperus rotundus* L., was the only sedge. Broad leaved weeds noticed were, *Phyllanthus niruri* L., *Convolvulus arvensis*, *Chenopodium album* L., *Amaranthus* spp., *Euphorbia* spp., *Portulaca oleracea* L., *Lagasca mollis* Cav., *Tridox procumbens*, *Gomphrena decumbens*, *Mimosa pudica*, *Parthenium hysterophorus*, *Acanthospermum hispidum* D.C., *Achyranthus aspera* L., *Ageratum conyzoides* L., *Borreria articularis* L., *Commelina benghalensis*, *Phyllanthus fealeruns* Webston.,

Cleome viscosa, *Euphorbia hirta*, *Digera muricata*, *Indigo fleraglabra*, *Rumex* spp., *Plantago* spp., *Capsella bursapastoris*, *Artemisia vulgaris* and *Bidens pilosa* L. were the predominant weeds. (Day and Russels, 1955; Ross, 1962; Bivins and Elmore, 1972; M.G.D., 1981; Verm and Sharma, 1977; Rozanski, 1983; Gilreath, 1985; Brosh et al., 1985 and Bott and Prando, 1988).

2.2 CROP WEED COMPETITION

It is evident that weeds are adopted to rapid dissemination, faster growth and multiplication enabling them to compete at every stage of crop growth for nutrients, moisture, light, space and thus reduce the quality and quantity of yield (Moolani and Sachan, 1966). Besides harbouring many pests and diseases, the loss in flower yield depends upon the type of weed flora and intensity of weed competition infestation.

Georgieva and Kazakava (1982) reported that terbacil and caragard gave the best weed control, but either increased or decreased the individual carbohydrates in different organs compared with the cultivated control. In addition to these herbicides reduced the essential oil content of the flowers and yield per hectare.

Yield reduction as high as 61.11 per cent in tuberose (Anandamurthy and Narayanagowda, 1992) and 69.75 per cent in China aster was noticed due to weed competition (Basavaraju *et al.*, 1992).

2.2.1 Critical period of crop weed competition

The effect of competition of weeds on crop depends to a larger extent on the duration of the competition. Crops particularly slow growing, shallow rooted and short statured, during their early stages of growth are very much susceptible to weeds. Hence, elimination of competition by the weeds during this period would help the crop plants to grow better and consequently yield better. Therefore, it is imperative that the critical periods of crop weed competition are to be determined so as to obtain the maximum benefits from effective and efficient weed management practices.

Kher (1986) reported that the chrysanthemum crop yield suffers heavily if timely weeding is not done. The crop should be free from weed infestation for 80 to 100 days (8 to 10 weedings) during its life cycle to obtain satisfactory yield.

Arora (1989) stated that when weeds allowed to grow upto 40 days from the date of planting significantly reduced the yield in marigold.

2.3 METHODS OF WEED MANAGEMENT IN ROSE AND OTHER COMMERCIAL FLOWER CROPS

Different methods used to manage weeds in commercial flower crops have their own merits and demerits. The final selection of any method will depend largely on its effectiveness and economics. The different weed management methods followed in rose and other commercial flower crops are cultural methods and chemical weed control

2.3.1 Cultural methods

Carpentor and Watson (1955) reported that mulches in rose conserve soil moisture, supply humus and suppress weeds resulting in improved growth and flowering.

Cikalov (1962) noticed in essential oil yielding rose, straw mulch applied in the rows, restricted weed growth, improved the soil moisture regime, reduced soil compactness, protected the flowering by 71 per cent reduced labour requirements from 28-30 man days to 7-9 man days per hectare and reduced cost of flower production by 25 per cent.

Padget and Frazer (1962) reported that hand weeding is common weed control method, which is time consuming and expensive. It costs 25-30 per cent of total cost of cultivation in marigold.

Fairbrother (1970) reported that hoeing not only remove weeds but also help in giving a fine texture to the soil and the soil is sufficiently open to supply the air spaces with oxygen to the roots of rose plants.

Pal (1972) reported on the effect of plant density in production of quality roses per unit area and he recommended a spacing of 60 to 75 cm between plants and rows to get more number of quality roses per unit area.

Pimpini (1975) noticed that Black and photo-selective plastic mulching benefited the gladiolus crop. They gave good weed control besides

conserving water and keeping the temperature around the roots comparatively.

Paterson *et al.* (1979) found that mulched bushes of the rose cultivars Peace, Double Delight, Queen Elizabeth and Tropicana showed lower soil temperature compared to control. Growth was slightly less under the rock wool mulch than with the other treatments.

Randhawa and Mukhopadhyay (1985) reported that mulching will help to conserve the soil moisture by preventing evaporation, smother the majority of annual weeds during summer, breakdown into humus and will provide plant foods particularly if farm yard manure is used.

Rabinson (1988) studied the role of mulching and chemical weed control in effective economic weed control in herbaceous and woody ornamentals.

Defrank *et al.* (1989) evaluated herbicides and use of plastic ground cover in *Anthurium andraeanum* cv. Ozaki red. They concluded that application of 2.2 to 3.2 kg oxyfluorfen per ha + 1.1 or 2.5 kg oryzalin, 2.3 to 4.6 kg oxadiazon and plastic ground cover provides excellent weed control. Further, they recommended that application of diuron at 1.2 kg per ha gave the best control of weeds and increased number of side shoots, resulting in vigorous bushy plants.

Koster and Meerl (1989) recommended the use of herbicides and plastic cover in infested land to avoid further spreading of yellow nut sedge.

Seemanthini *et al.* (1989) reported, mulching of basins as the best method of weed control adopted in India in jasmine crop, after application of fertilizer.

2.4 CHEMICAL WEED CONTROL IN ROSE

When labour is scarce and expensive, use of herbicides hold a good promise for timely, effective and efficient weed control. Use of herbicides has received much attention and systematic investigation to assess the effect of herbicides on growth and flower production in rose.

The potential use of herbicides will delay the weed growth during cropping season owing to higher labour wages and unfavourable weather conditions for manual weeding. Herbicides are gaining importance in areas where they have not previously used.

Day and Russels (1955) tested various mixtures of relatively non-toxic kerosene with an aromatic oil and with dinitrobutyl-phenol and found that all formulations effective against weeds were more or less toxic to the roses. The emulsions of dinitrobutyl phenol applied in the same way kill all weeds except grasses and knot weed, Endathol controlled all weeds except *Chenoprodicum* spp.

Ross (1962) used simazine and diuron at 2.0 kg/ha as pre-emergent treatment in rose cutting and got good control of *Lolium* spp. whereas, Kemperman (1969) noticed satisfactory control of *Agropyron repens* and other grasses by isocil at 2.0 kg a.i./ha as pre-emergent spray.

Bivins and Elmore (1972) reported that nitrofen applied to rose beds infested with *Oxalis corniculata* at the rate of 13.0 kg a.i./ac gave over 95 per cent control and no crop damage was observed.

Roberts and Harris (1972) compared the standard treatment with simazine at 6.75 kg/ac, terbacil at 0.72 and 0.08 kg/ac, atrazine at 0.68 kg, propalachlor at 1.76 kg/ac or aziprotryne at 0.9 kg/ac under similar conditions in rose bushes. Weed control was satisfactory with all the treatments except aziprotryne and propalachlor, which did not control cruciferous weeds of *Poa annua*. There was no marked difference in the weight of rose bushes, which could be attributed to the treatments, but one cultivar showed some damage with terbacil at the high rate or when atrazine treatment was delayed until the weeds were 5 cm high.

Brosh (1976) reported that both oxadiazon 0.75 2.0 kg a.i./ha and oxyfluorfen 0.5 - 5 kg a.i./ha as liquid and granular formulations kept the rose plants weed free for three months. *Convolvulus* spp. was eliminated upto 80 per cent.

Verma and Sharma (1977) found that glyphosate (Roundup) at 1.0, 1.25 or 1.5 g/lit applied in rose beds gave best control of *Cyperus rotundas* with no adverse effect on the roses.

M.G.D (1981a) compared simazine, cyanazine, simazine + cyanazine, simazine + propalachlor and methobenzthiazuron in nursery beds on five root stocks and reported that simazine at 1.5 kg/ha gave better control of *Poa annua*, *Stellaria media*, *Polygonum persicana*, *Polygonum auriculata* and *Cutica urens*.

M.G.D (1981 b) reported that incase of rose cultivars Mors dog, Meinastur and Junior Miss, simazine Vitaminnyi VMVI and vorontborskii I, of the herbicides tested, caragard (terbumeton) at 3 kg/ha applied in early spring gave the best weed control without adverse effects on rose growth and cropping.

Strelets *et al.* (1982) studied in four year trials in plantations of two rose (*Rosa canina*) cultivars of metalachlor (Butisem S), simazine + metalachlor at 3.4 + 2.5 lit respectively. 1.25 + 0.25 + 1.7 kg respectively, metalachlor + isoxaben (Flexidor) + propyzamide (Kerb 50W) and oxadiazon (Ronstar) + diflufumican + isoproturon (Javelin).

Bentley (1990) used a range of residual herbicides and a wheat straw mulch (7.5 cm depth) were applied to newly sown *Rosa dumetorium* cv. Laxa rootstocks, on a heavy loam soil. Visible damage in the form of leaf

scorch was seen following applications of 4 ltrs per hectare. oxadiazon (Ronstar liquid) and a transient chlorotic leaf blotching was seen after applications of 1-2 ltrs of *diflufumican* + isoproturon (Javelin). Best weed control was given by use of oxadiazon (Ronstar) + simazine at 3-4 lit/ha. Good weed control was also given by straw mulch, 5 ltrs of atrazine + terbuthylazine (Gordoprim A500 FW) + 2.5 ltrs at 1.0 kg/ha, cyanazine 1.5 kg/ha and methobenythiazuron (3.5 kg/ha) when used singly did not cause plant damage but simazine + cyanazine (0.50 + 0.25 kg/ha) did so while giving the best weed control. Treatment with simazine or cyanazine gave reasonable control of four weed spp.

Rajamani *et al.* (1990) recorded the lowest number of weeds per square meter with diuron 2.5 kg a.i./ha and found better control of monocot weeds with glyphosate 1.0 kg a.i./ha and dicot weeds with oxyflurofen at 0.5 kg a.i./ha.

Out of many herbicides tried in rose cultivars Superstar, glyphosate (1 kg a.i./ha) treated plots exhibited the least number of weeds (210.25 m²). There was no significant difference in the effect of herbicides on the number of flowers per plant as compared to hand weeded control (Narayanagowda and Jayanthi, 1990).

2.5 CHEMICAL WEED CONTROL IN OTHER COMMERCIAL FLOWER CROPS

Baranowski (1974) evaluated nine herbicides in China aster and recommended the use of Nexoval (chloroprophan) spray at 4 kg per ha as

preplanting incorporation (one day before transplanting) to control weeds. Billat (1976) reported good control of weeds in chrysanthemum with the application of Tenuron (chloroxuron) at 6-9 kg per ha. Further, he observed the best weed control by Tenuron at 5 kg per ha combined with either planarin 1.5 kg (propyzamide) at 2 kg a.i./ha.

Moreau (1976) evaluated five herbicides on gladiolus on various soil types and noted efficient weed control with Metolachlor without phytotoxicity he also evaluated three herbicides on carnation and concluded that propalachlor as the best herbicide. Further, studies conducted with seven more herbicides on some annuals grown for seed production, he observed that in general the best result were with Metabromouron and Metribuzin.

Leela (1976) reported that Basalin 2.0 kg a.i./ha was the most effective herbicide to control weed population and for increased number of spikes and corm yield in gladiolus.

Wilfreet and Burgis (1977) working on flower crops viz., *Ageratum*, gladiolus and petunia, in fine sandy soils reported that application of EPTC, napropamide at 2.7 kg and MBR 825 (perfluridon) at 1.8 kg per acre were the most effective in reducing weed population.

Rolewaskaz and Sanicwski (1978) working on gladiolus with eight different herbicides reported that aresin (monolinuron) at 2.5 kg per ha

or Afalon and linuron at 3 kg per ha as most effective in control of annual weeds.

Bing (1981a) reported that when Alachlor at 1.8 kg Chloramben at 1.8 kg, oxadiazon at 0.9 kg per acre were very effective in controlling weeds, begonia, coleus, dahlia, impatiens, petunia, salvia, geranium and marigold. Bing (1981b) further reported that diphenamid at 1.8 kg per acre and napropamide at 1.8 kg per acre resulted in excellent selective weed control in newly planted annuals.

Pilt *et al.* (1981) found that application of liuron at 1.0 kg per ha 24 days after planting of gladiolus corms resulted in fairly good weed control and did not appreciably affect most of the growth and flower attributes.

Deuber and Aguiar (1982) studied that in silty soil, the application of 1 to 2 kg per ha granular oxadiazon was effective to control weeds in rose with higher rates in a clay soil.

Molnar (1982) noted that in carnation best weed control was obtained with tenuron, chlorofuron, at 300 g + lenacil at 200 g per 1000 m², applied after the establishment of rooted cuttings. Addition of metolachlor at 300 ml per 100 m² to the mixture enhanced weed control in chrysanthemum.

Bing (1983) studied that in chrysanthemum when grown in pots were free of weeds with application of 1.8 kg oxadiazon followed by the

some late of wettable powder formulation were effective to control weeds with 1.35 kg metolachlor 0.23 kg oxyfluorfen granules.

Haramaki and Kuhns (1983) observed that the best control of weeds in China aster and ageratum by application of Chloromben and Npropamide granules.

Rozanski *et al.* (1983) inferred that the effective control of cereals in gladiolus viz., *Digitaria sanguinalis*, *Elensine inotica* and *Paipalum auminatum* were effectively controlled by sethoxydiom.

Stewart *et al.* (1983) reported that in green house and in field experiments of gladiolus. Alachlor and metolachlor at 2.2 or 4.4 kg per ha are potential for control of *Cyperus esculentus* for six weeks.

Gilreath (1984a) recommended pre and post emergent application of 0.68 kg Alachlor + 0.9 kg napropamide, pronamide and 1.8 kg thiobencarb per acre for control of *Digitaria ciliaris* and *Amaranthus hybrids* in gladiolus.

Bing and Macksel (1984) observed that 1.8 kg and 3.6 kg napropamide, 1.26 kg trifluralin and 0.9 to 3.6 kg diphenamide per acre were effective against grasses in flowering annuals.

Gilreath (1984b) suggested the use of oryzalin at 2.2 kg/ha in gladiolus for control of *Digitaria ciliaris*, *Eleusine indica* and *Amaranthus hybridus*.

Brosh *et al.* (1985) reported that the best control of convolvulac weeds in gladiolus was obtained by pre-emergent and post-emergent application of oxadiazon and oxyfluorfen.

Lamount (1986) evaluated and recommended the herbicides viz., Alachlor, napropamide, oxadiazon, and oxyfluorfen suitability during summer for carnation, chrysanthemum, helichrysum and zinnias to control more than 90 per cent of grasses and 67 to 100 per cent broad leaved weeds.

Kuhns *et al.* (1986) recommended the use of pre emergence and post-emergence herbicides such as sethoxidim and flauzifop-butyl for control of grasses in annual flower crops.

Yadav and Bose (1987) in trials with tuberose cv. Single and gladiolus cv. Vinks glory observed that the better growth and flowering and higher yield, application of oxyfluorfen at 0.5 kg per ha in tuberose and gladiolus apart from maximum control of weeds.

Bing *et al.* (1988) reported that application of oryzalin, prodiamine and pendimethalin at 2.2 and 4.5 kg/ha as pre emergent did not affect the vigour or corm yield of gladiolus cv. promenade. metolachlor at 4.5 kg/ha applied one day after planting reduced the germination, vigour and corm yield.

Kelly and Whitwell (1989) observed that the application of sethonydium and fenoxaprop both at 0.22 and 0.44 kg per ha and flauzifop-butyl at 0.11 and 0.22 kg/ha were safe for use on day Lilly.

Narayanagowda and Muniyappa (1992) recommended diuron 1 kg a.i./ha in china aster for better weed control and higher yield of flowers as compared to other pre-emergent herbicides applied.

Anandamurthy and Narayanagowda (1992) reported higher flower yield, the highest return in tuberose and lower weed population with the application of pendimethalin 1.25 kg and pre-emergent application of Alachlor or Metolachlor at 2.0 kg a.i./ha and pendimethalin at 1.25 kg a.i./ha was very effective in reducing weed population (Anandamurthy and Narayanagowda, 1996).

Jefrey *et al.* (1996) pointed out that application of Mon12000 herbicide as pre emergent or post emergent gave effective control of yellow nut sedge for 4 weeks and 9 weeks respectively from the date of planting of ornamental nursery crop.

2.6 HERBICIDAL EFFECT ON GROWTH, YIELD AND QUALITY

There are various methods to control weeds in rose, but none can be said as best because each has its own merits and de-merits. The final choice of any weed control or herbicide will depend on effectiveness on the crop growth, yield and quality.

Salimov and Minkov (1963) reported effective control of broad-leaved weeds in an essential oil bearing rose plantation by spraying Na salt of 2,4-D on 25-30 days before flowering at 2 kg per 600 ltrs per hectares followed by cultivation of the soil to a depth of 6-10 cm. Soil moisture, shoot growth and the average weight and yield of flowers were increased by the treatment without any reduction in the yield of essential oils.

Bing (1977) reported that pre-emergence application of Alachlor or napropamide 0.9 kg per ac in the cultivation of gladiolus was effective in control weeds but Alachlor at higher dosage of 3.6 kg per acre markedly reduced cormel yield.

Rolewaska and Sonicwaski (1978) reported higher flower yield and corm yield in gladiolus with the application of aresin at 2.5 kg a.i./ha or linuron at 3 kg per ha.

Bing (1979) observed that use of napropamide upto 7.2 kg and prodiamine at 0.9 to 1.8 kg per acre, oxadiazon at 1.8 to 3.6 kg and oxyfluorfen 0.9 to 1.8 kg per acre were greatly reduced the production of gladiolus cormels. Further, he noted that Alachlor at 1.8 to 3.6 kg per hectare reduced corm production from cormels and cut flower yield.

Pitt *et al.* (1981) reported that when linuron at 1 kg per hectare applied 24 days after planting of corms on vertisol during the *kharif* did not appreciably increased the growth of flower attributes, however noted that the increase in leaf length, breadth and girth of the stem.

Kolbe (1982) reported that ustinex Z granulated (tribuonil = methabenzthiazuron + diuron) used in spring proved tolerant to herbicides, producing 38 per cent more shoots than in untreated plots, though the shoots were 6 per cent shorter. The herbicides were 90-100 per cent effective. Weed cover on control plots in a dry year (1976) was only 80 per cent. Whereas, lowest was with the cv. Lilly Marben and highest with Fashion.

Kouteas (1982) observed that in gladiolus the pre-emergent application of 3 kg a.i./ha metaxuron was responsible for increase in plant height, flowering percentage and cut flower weight besides causing early flowering by 5 to 8 days compared to unweeded control.

Gilreath (1984) evaluated the pre and post emergent application of 0.68 kg Alachlor and 3.6 kgs thiobencarb per acre in gladiolus and found that the application of thiobencarb was able to reduce the number of florets and weight of flower spikes.

Brosh *et al.* (1985) reported that 0.75 kg oxyfluorfen per ha as soil drench and 5 kg oxyfluorfen per ha as 2 per cent granules, 0.75 kg oxadiazon per ha and 0.5 kg simazine per ha as pre-emergent did not show any undesirable effects of on growth or yield. *Convolvulus* spp. was reduced upto 80 per cent by oxyfluorfen or oxadiazon besides lowering all annual weeds were eliminated.

Chapaugier (1979) reported that in roses the annual weeds were effectively controlled in base soils by simazine at 2.5 to 3.5 kg/ha or Alachlor

at 3.3 kg/ha. But he noted that in mulched soil the herbicide activity was much reduced, perennial weeds were controlled only by glyphosate at 0.9 to 4.32 kg/ha. Further he reported that under the glass house the most effective treatments were nitrofen at 2 kg ehlorothal dimethyl at 7.5 kg, propyzamide at 1.5 kg and propachlor at 7.15 kg per ha.

2.7 PHYTOTOXICITY

The length of time that a herbicide remains active or persists in the soil is extremely important as it relates to the length of weed control also residual toxicity is important. As it relates phytotoxic after efforts that may prove injurious to succeeding crops at planting. Herbicides may dissipate faster with large amount of water that provide leaching and with repeated cultivation or mixing of the soil.

Ewan (1966a and 1966b) tested the effect of repeated doses of simazine (1-2 kg a.i./ha) first soon after planting root stalks second, after budding and third in the following spring on rose cv. Superstar budding on *Rosa canina* rootstocks for two years on light loam soils overlying grass and observed that there was no adverse effect throughout.

Kolbe (1972) reported that Ustinex Z (metabenzthioazuron + diuron) gave good weed control in 10-polyantha rose cultivars. The weed control in untreated plots depends on the growth habit of the cultivar. No symptoms of phytotoxicity were observed in ten year trial with 15 hybrid rose cultivars, no phytotoxicity was observed.

Cristinzio *et al.* (1973) reported herbicide treatments for controlling *Cyperus rotundus* in rose nurseries using soil sterilants with polyvalent effects and EPTC. They found that good control of *Cyperus rotundus* was obtained from application of 50 and 65 g/mt methyl bromide. There was no phytotoxicity to the rates even when they were planted only 4 days after treatment Eptam (EPTC) applied at 6 kg per ha in mid March followed by 4 kg in mid May controlled the weeds for at least 3 months, but dwarfed the roses.

Cristinzio and Mamini (1973) used 7 herbicides before transplanting roses (*Rosa indica* cv. Major) methyl bromide at 50 g per m² gave the best result killing the weed roots to a depth of 40 cm without having the roses which could safely be planted after only 4 days. EPTC at 6 kg/ha gave promising result preventing any weed growth for at least 3 months. Di-trapex at 800 l/ha was also effective and roses could be safely planted after 32 days.

Khosla (1977) reported that the diuron or atrazine at 2 kg/ha or oxyfluorfen 1 kg/ha if applied with proper planning to rose plots, effectively control weeds without any phytotoxic effect on roses.

Georgieva and Kazakava (1982) reported that (simazine) at 4 kg/ha was applied in early spring plus ammidel (qalerpan + 2,4-D) at 8 kg/ha after harvest and caragnard-combi (terbuthylozine + terboundon) at 15 l/ha or terbaril at 2 kg/ha was applied in early spring only in a 5 year old

essential oil rose plantation on a meadow soil. At the end of the season of application and during the following growing season, the roots, 1 and 2 year old shoots, leaves and flowers were analysed for sugar (sucrose, glucose and fructose) and starch content. Terboril and caragard gave the best weed control, but either increased or decreased the individual carbohydrates in different organs compared with the cultivated control and reduced the essential oil content of the flowers and yield per hectare.

Himme *et al.* (1987) reported that rose cv. Hortiflora and Guitare, budded in July 1984 and treated in February 1985 with 1.25 kg propyzamide + 0.9 kg paraquat per ha and in March with 1 kg simazine per ha, late May application of 1.5 kg pendimethalin or ethofumerate per ha caused unacceptable injury. July application of 1 kg phendipham + 1 kg weather was less harmful than 0.6 kg phenmediphom + 0.3 kg desmediphan + 1 kg weather per ha.

Botta and Pando (1988) working on post-emergent herbicides in rose bushes with different weed control treatments, observed dominant dicot weeds such as *Rumex* spp. *Plantago* spp. *Capsella burredastoris* and *Artemisia vulgaris* and monocot weeds viz., *Digitaria* spp and *Setaria* spp and recommended mixture of 0.75 ltrs of *formasafen* per hectare of 1.5 ltrs of flauzifopbutyl and 1.0 litre of formesafen + 2.0 litre flauzifop-butyl for good weed control, without phytotoxic effect to the rose bushes. In field experiments in roses, Bolta and Prando (1988) reported that application of

0.75 lit formasafen per ha + 1.5 lit flauzitop-butyl and 1.0 lit formasafen + 2.0 lit flauzifop-butyl gave good weed control without being phytotoxic to the roses.

Mynett and Jagusz (1940) observed that application of metolachlor (1.5 kg/ha) pendimethalin (1.32 kg/ha) and pendimethalin + metamitron (1.32 kg/ha + 2.1 kg/ha) caused no injury to gladiolus plants but terbacil at 0.8 kg a.i./ha caused severe damage.

2.8 HERBICIDAL EFFECT ON VASE LIFE

Basavaraju *et al.* (1989) reported that herbicidal treatment did not alter on the vase life of cut China aster. Even though, there was little difference in cumulative uptake of vase life of China aster as influenced by different herbicides. Subsequently, Anandamurthy and Narayanagowda (1993) reported that the different herbicidal treatment did not differ significantly in prolonging the vase life of tuberose.

2.8.1 Effect of sucrose

Sugars play an important role in flower development and opening either as energy source for respiration or as osmotically active substances, which aid in maintaining the turgidity of the expanding corolla. Sugars have also beneficial effect on maintaining higher fresh weights in cut flowering shoots by inducing stomatal closure in the leaves and thus reducing water loss. The optimum concentration of sugar varies with the

treatment and the flower. Generally, for a given flower longer the exposure to the chemical solution, lowers the concentration required and vice versa.

Sugars were found effective in inducing bud growth and development, delaying the abscission of buds and flowers and showing greater percentage of full bloomed flowers (Pathak *et al.*, 1979)

Flower senescence during vase life is correlated with a reduction in sugar content of the flower (Bruszewki, 1970; Nowak, 1979; Ferreira and Wardt, 1980) which resulted in wilting (Belynskaja, 1964; Gombikoto *et al.*, 1968; Nichols, 1973; Lukaszewska, 1980). Supplying cut flowers with exogenous sugar maintains the respirable substrates in the flower (Nichols, 1973, 1975; Lukaszewska, 1986), promotes respiration (Wilkins, 1965, Coorts, 1973) encourages protein synthesis (Paulin, 1986) and delays the onset of excessive protein degradation (Paulin, 1986) and delays the onset of excessive protein degradation (Paulin, 1971; Coorts, 1973; Parups and Chan, 1973) and thus extends the longevity of cut flowers (Coorts, 1973; Rogers, 1973). Acock and Nichols (1979) and Narayanagowda (1986) confirmed that sugar improve the water balance and osmotic potential of flowers.

2.8.2 Water Relations

The termination of vase life of many cut flowers is characterized by wilting and therefore, many studies have been made at evaluation of events leading to this phenomenon (Halevy and Mayak, 1981). A high level

of turgidity is necessary for development of flower buds to full bloom maturity. It is also necessary for the normal metabolic activity in the cut flower. Turgidity in plants and flowers depend upon a balance between the rate of water loss or utilization and water supply (Rogers, 1973).

Earlier changes in the properties of inflorescence, which normally accompany senescence, are decrease in water uptake and loss in flower fresh weight and an increase in water loss (Faragher *et al.*, 1986). Simultaneous measurement of water uptake and water loss was determined in some cut flowers (Burdett, 1970; Destigter, 1980; Mayak *et al.*, 1974). These two parameters certainly influence each other and their interactions determined the water balance (Halevy and Mayak, 1981) which in turn influences flower turgidity (Rogers, 1973). Cut flowers lose water from all tissue depending on environmental and internal factors in roses and other cut flowers it was demonstrated that after cutting, water loss decreased sharply due to stomatal closure (Mayak *et al.*, 1974) water loss then paralleled water uptake (Burdett, 1970; Halevy *et al.*, 1974) and finally an increase in water loss occurred before wilting (Halevy *et al.*, 1974).

Water uptake and water loss may fluctuate cyclically with an overall declining trend (Carpenter and Rasmussen, 1973; Destigter, 1980). However, the balance of the two processes affects the fresh weight change (Halevy and Mayak, 1981). Typically cut flowers initially increase and subsequently reduce fresh weight (Rogers, 1973). Decreased rate of water

uptake led to the loss of petal turgidity and fresh weight (Durkin and Kuc, 1966); Burdett, 1970) which ultimately reduced the flower vase life (Faragher *et al.*, 1986). Increase in fresh weight can occur only when the rate of water absorption is greater than the transpiration rate (Rogers, 1973).

Water uptake and flower abscission are the major physiological factors which limit vase life (Faragher, 1986). Stem plugging and reduced water transport capacity has been related to the presence of microorganisms in holding solutions (Ford *et al.*, 1961). This can be resulted directly from the physical plugging substances released into the water by microbial contaminants (Aarts, 1957).

The reduction in water uptake coupled with a continuous transpiration leads to water deficit and reduced turgidity in the cut flowers (Halevy and Mayak, 1981). Water deficit water potential relationships of the petal changes with age resulting in a lower water holding capacity (Van Meeter, 1978, 1979; Acock and Nichols, 1979). A decline in water conductivity seems to be a general phenomenon in many ageing cut flowers (Halevy and Mayak, 1981). The reduction in stem conductivity is apparently caused by several factors. The major factors contributing for the rapid deterioration of cut flowers is vascular blockage, which begins at the cut end and moves upward in the stem with time (Chandrashekharaiyah, 1973 and Sacalis, 1975).

In treatments, where microbial growth was the greatest (as observed under microscope) water flow through the stems was least in carnations (Laurie, 1936). Germicides controlled microbial growth and partially reduced the resistance to water flow when used as vase solution for tuberose (Pathak *et al.*, 1979; Mukhopadhyay, 1980 and Narayanagowda, 1990) and other cut flowers (Aarts, 1957; Larsen and Cromarty, 1967; Marousky, 1969). Thus helps the flower stems to maintain a higher rate of water transport and increased keeping life (Laurie, 1936).

Bacterial plugging appears to be a much greater practical problem in naturally long lived flowers like tuberose and gladiolus than in short lived ones like rose, since there is more time for large population of microorganisms to build up (Rogers, 1973). Therefore, microorganisms were considered to be one of the main causes of reduced water uptake by cut flowers (Halevy and Mayak, 1977).

Cut flowers kept in solutions containing only bactericidal chemicals often keep no longer than those in plain water (Wiggins and Payne, 1963) in addition to microbial induced stem plugging, there are instances of physiological stem plugging that occur even under aseptic conditions (Rogers, 1973). Vascular blockage is of an oxidate nature resulting either from substance secreted by damaged cells (Aarts, 1957) or harvesting injury (Durkin and Kuc, 1966).

During floral senescence membrane permeability determined either by direct measurement of micro viscosity (Borchov *et al.*, 1976; Thompson *et al.*, 1982) or by indirect method like measuring the leakage of electrolytes (Sacalis, 1975) was found to be increased with advancing senescence and this increase was coincided with reduced water uptake (Van Meeteren, 1979; Mayak *et al.*, 1977). Water found to be better than deionised water for increasing the keeping quality of some flower (Coorts and Garther, 1963).

2.9 ECONOMICS OF WEED CONTROL METHODS

The final choice of any weed control method depends to a greater extent on the cost of herbicides and their relative efficiency. Although chemical weed control seems to be cheaper and effective, the overall economics of this practice does not justify its general adoption by grasses except in cereal where the labour is costly and scarce during the peak periods of farm operations.

Yadav and Rose (1987) indicated that usage of atrazine at 2.0 and 3.0 and oxyfluorfen at 0.5 kg a.i./ha gave the additional income of Rs.2102, Rs.13792 and Rs.1589 respectively per ha over the weeded control on tuberoses and gladiolus.

Basavaraju (1989) reported that the highest net return were realised in China aster in control of weeds with the application of diuron at

0.75 kg a.i./ha and 1.25 kg a.i./ha and 1.25 kg a.i./ha, Rs.15,354.08 and Rs.14,770.04/ha, respectively.

Anandamurthy (1991) reported that application of diuron 1.25 kg a.i. and pendimethalin 1.0 kg a.i./ha gave the highest net return compared to other treatments in tuberose Rs.70,599.00 and 70,457.00 per ha respectively.

MATERIAL AND METHODS

III. MATERIAL AND METHODS

The details of the material used and techniques adopted during the course of study on “Integrated weed management in Rose” are described in this chapter.

The present investigations were carried out in the ‘Floriculture Unit’ of Division of Horticulture, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bangalore during 1999-2000.

3.1 GEOGRAPHICAL LOCATION AND CLIMATE

The experiment was conducted at the Horticultural Research Station having elevation of 950 m above MSL with 13°N latitude and longitude of 77°35’ east. The soil was red sandy loam with pH of 5.9 and moderate fertility status. The monthly average weather data in respect of maximum and minimum temperature, sunshine hours, rainfall and relative humidity recorded during the crop period are presented in Appendix-I and soil analysed data are presented in Appendix-I.

3.2 PLANT MATERIAL

A seven year old rose crop was pruned as a winter pruning, to a height of 45 cm from the base and the pruned tip was pasted with blitox @ 0.2 per cent. Plants were spaced at 1 m x 1 m.

3.3 EXPERIMENT-I

3.3.1 Design and experimental details

The experiment was laid out by adopting the randomized complete block design (RCBD) with three replications.

Plot size : Net plot = 1.5 m x 1.5 m = 2.25 m²

The details of treatments were as follows:

- T1 : Unweeded control (weedy check)
- T2 : Hand weeding at 20, 40, 60 and 80 DAP
- T3 : Pendimethalin (30 E.C) 1.0 kg a.i./ha
- T4 : Pendimethalin (30 E.C) 1.0 kg a.i./ha + earthing up at 35 DAP
- T5 : Oxyfluorfen (23.5 E.C) 0.1kg a.i./ha
- T6 : Oxyfluorfen (23.5 E.C) 0.1kg a.i./ha + earthing up at 35 DAP
- T7 : Glyphosate (41 SL) 1.0 kg a.i./ha
- T8 : Glyphosate (41 SL) 1.0 kg a.i./ha + earthing up at 35 DAP
- T9 : Atrazine (50 WP) 1.0 kg a.i./ha
- T10: Atrazine (50 WP) 1.0 kg a.i./ha + earthing up at 35 DAP

DAP - Days after pruning

3.3.2 DESIGN AND LAYOUT

The experiment was laid out in randomized complete block design (RCBD) with three replications. The plan of the layout is given in Fig.1.

The treatments of the experiment consisted of two emulsified concentration, one soluble liquid and one powder formulation of herbicides used along with hand weeding, earthing up and unweeded control.

3.3.4 HERBICIDES APPLICATION

Pre-emergent herbicides such as oxyfluorfen, pendimethalin and atrazine were sprayed two days after pruning, while glyphosate, a post-emergent herbicide was applied 20 days after pruning on the emerged weeds

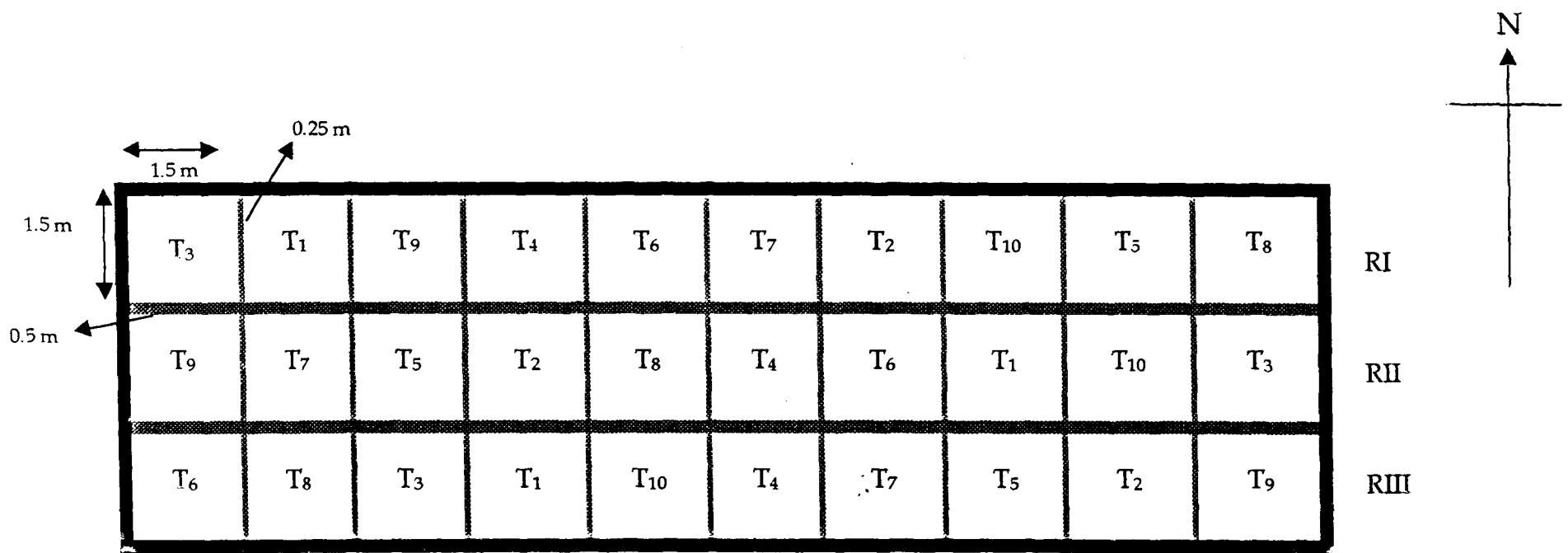


Fig.1: Plan of Layout of Experiment

Plate 1: General view of Experimental plot.



with the help of hand operated Ganesh hand sprayer. In case of hand weeding treatment, hand weeding was done at 20, 40, 60 and 80 days after pruning. In unweeded control weeds were kept as such without altering.

3.5 CULTURAL OPERATIONS

3.5.1 Preparation of experimental site

The land was brought to a fine tilth by digging and levelling later. A spacing of 0.5 m between each replication was provided for laying out irrigation channels and working space.

3.5.2 Application of manure and fertilizers

Well decomposed FYM 7.5 kg per square meter was applied at the time of land preparation. The recommended dosage 15 : 15 : 10 g of nitrogen, phosphorus and potassium per plant were applied after pruning in the form of urea, single super phosphate and muriate of potash.

3.5.3 Irrigation

Roses do not like waterlogging but need planting of water for their growth and development. The frequency of watering will depend upon the weather and the nature of soil. Since the soil of experimental plot is loam, so thorough watering once in ten days was done.

3.5.4 Hand weeding and earthing up

Hand weeding and earthing up operation was carried out as per treatments and the earthing up operation was done at 35 days after pruning according to the treatments.

3.6 HARVESTING

Flowers were cut along with the when the tip of the flower bud shows colour and still it is unopened and used for recording different parameters and to study the vase life. When flowers are fully opened, diameter was recorded.

3.7 HERBICIDES USED

3.7.1 Pendimethalin (Stomp 30% E.C)

Chemical name : [N-(1-ethylpropyl)-3,4-dimethyl-2, 6-dinitrobenzenamine]. It belongs to dinitro-aniline group of herbicide.

Formulation : Emulsifiable concentrate

Uses: : It controls most of grassy weeds and certain broad leaved weeds in potato, maize, cotton, soybean and garlic. It is a selective soil herbicide predominantly used for pre-emergence treatment. The herbicide is said to be highly volatile and persist in the soil for about 12 weeks.

3.7.2 Oxyfluorfen (Oxygoald 23.5% EC)

Chemical name : [2-Chloro-I-(3-ethoxy-nitrophenoxy)-trifluoromethyl) benzene]. It belongs to diphenyl group of herbicides

Formulation : Emulsifiable concentrate

Uses: : Used as pre-emergence or early post-emergence application in several crops like groundnut, potato, onion, carrot, and soybean for control of certain broad leaved and grassy weeds. The chemical is highly toxic and volatile in nature.

3.7.3 Glyphosate (Roundup or glycel 41SL)

Chemical name : N-9phosphomethyl) Glycine.

Formulation : Soluble liquid

Uses: : A non-selective broad spectrum herbicide is very effective on annual, biennial and perennial herbaceous species of grasses sedges and broad-leaved weeds. It is used as post-emergent herbicide to control perennial weeds in plantation crops like tea, coffee, rubber and orchard crops.

3.7.4 Atrazine (Atrataf - 50 WP)

Chemical name : [2-Chloro-4-ethylamino-6-isopropyl amino-s-trizine].

Formulation : Wettable powder

Uses: : A pre-emergence herbicide used to control annual grasses and broad-leaved weeds in sugarcane, maize, potato, etc.

3.7.2 EXPERIMENT - II

3.8.1 Vase life studies

Effect of different herbicidal treatments on uptake of solution (2% sucrose) on post harvest life of cut flowers.

Experiment was laid out to study the effect of different weed control treatments on uptake of 2 per cent sucrose in rose cut flowers. Flowers were harvested when the tip of the flower bud shows colour and still it is unopened. Recutting of the stalk bark before placing these in the solution, were essential (Lamper, 1981). After recording the fresh weight of each flower stalk was placed in the 500 ml dextrose bottle containing 200 ml of fully prepared vase solution.

3.8.2 Uptake of vase solution (ml per day)

The amount of vase solution in the bottle was measured every day. The difference in the consecutive volume of vase solution between days represents the uptake of vase solution.

3.8.3 Fresh weight of flowers (g)

The difference between the weight of bottle + solution + flower and the weight of the bottle + solution represents the full weight of the flower.

3.8.4 Vase life (days)

The point of estimation of vase life varies from the first sign of wilting or fading to the total death of all flowers, with all the intermediate values between these points (Halevy and Mayak, 1979).

The days taken by the flowers to wilt in the bottle was noted as vase life of the flower by the daily observation of flowers till they were found unfit for continuing in the vase.

3.9 ECONOMICS OF WEED CONTROL TREATMENTS

To study the economics of different weed control treatments, information on market prices of herbicides, labour units required for application and hand weeding were 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.50 per men and Rs. 30 for women. Gross returns from flower yield were calculated Economics of weed control treatments was worked out by the following formulae.

3.10 COLLECTION OF EXPERIMENTAL DATA

Following are the observations recorded and the techniques followed are described separately for each treatment in the net plot area of each plot.

3.10.1 Weed control and crop toxicity ratings

Visual ratings were made at 25, 45, 65 and at 85 days after treatment application to know the extent of weed control at 25, 45, 65 and 85

days after pruning and also to know the extent of toxicity caused by different herbicides on crop employing EWRC ratings.

The crop toxicity rating (EWRC system) was made from 1 to 5 point scale as follows:

Scale	Crop toxicity rating	Symptoms
1.00	No toxicity	Healthy
2.00	Slight toxicity	Small spot
3.00	Moderate toxicity	Coaliged spot
4.00	Severe toxicity	Burning symptom
5.00	Toxic	Complete death

The weed control ratings were made from 1 to 5 point scale as follows:

Scale	Weed control	% ability
1.00	Excellent control	90.0 - 100
2.00	Good control	75.0 - 89.9
3.00	Fair control	60.0 - 75.9
4.00	Poor control	30.0 - 59.9
5.00	No control	<29.9

3.10.2 Weed count

Observations on grasses, broad leaf weeds, sedges and total weed population were separately recorded from 0.25 m² area in a permanently marked spots were count in each plot after spraying of herbicides at 25, 45, 65 and 85 DAP.

3.10.3 Dry matter production of weeds (g)

Observations on dry weight of grasses, broad leaf weed, sedges and total dry matter of weeds were recorded separately at 25, 45, 65 and 85 DAP. They were cut up to ground level in 0.25 m² area in the plot. The net plot was divided into two halves for dry matter sampling of weeds and crop and another half for crop yield. The weeds were oven dried at 65°C to 70°C and dry weight were recorded.

At the time of harvest, dry weight of weeds was recorded from the net plot. Weeds were removed, sundried for 8 days oven dried at 65°C to 70°C and then dry weight was recorded.

3.10.4 Weed index (%)

Weed index is defined as the magnitude of yield reduction due to presence of weeds in comparison to weed free plot. Weed index was calculated by using the formula given by Gill and Vijaykumar (1969).

$$\text{Weed index} = \left(\frac{X - Y}{X} \right) 100$$

Where, X = Yield of hand weeded treatment

Y = Yield from the treatment for which weed index is to be calculated.

3.10.5 Weed control efficiency (%)

Weed control efficiency denotes the magnitude of weed reduction due to the weed control treatment. The weed control efficiency was calculated as follows:

$$\text{Weed control efficiency (\% (WCE))} = \frac{\text{Weed dry wt. of unweeded control} - \text{Weed dry wt. of the treatment}}{\text{Weed dry wt. of unweeded control}} \times 100$$

3.11 CROP OBSERVATIONS

Four plants from the net plot area were selected and tagged for recording observations viz., number of leaves, number of shoots, stalk length, flower diameter, number of flowers per plant and per hectare.

3.11.1 Number of leaves

The number of leaves was counted and the mean of four plants in each treatment was worked out.

3.11.2 Number of shoots

The number of shoots was counted which were emerged after pruning and the mean of four plants in each treatment was worked out.

3.11.3 Number of flowers per hectare

Number of flowers produced in a net plot area was recorded and it was converted to flower yield per hectare.

3.12 QUALITY PARAMETERS

3.12.1 Stalk length (cm)

Stalk length was recorded from the base of the flower bud to the knuckle, the point from the shoot originates with a scale and expressed in centimeter.

3.12.2 Flower diameter (cm)

Maximum diameter of the flower was recorded when it is fully opened and expressed in centimeters

3.12.3 Flower fresh weight and dry weight (g)

Flower fresh weight and dry weight was recorded after flower harvest.

3.13 VASE LIFE STUDIES

Effect of different herbicidal treatments on uptake of solution (2% sucrose) on post-harvest life of cut flowers.

Experiment was laid out to study the effect of weed control treatments on uptake of 2 per cent sucrose in rose cut flowers. Flowers were harvested in the tight-bud stage when the buds show full colour but the potash has not yet started unfolding. Resulting of the stalk base before planing them in the Net return = Gross return - Cost of cultivation.

$$B : C \text{ ratio} = \frac{\text{Net returns}}{\text{Total cost of cultivation}}$$

3.14 TRANSFORMATION OF THE DATA

Data on weed density and dry matter production of weeds showed high variation and the data was not normal, hence the data was subjected to square root transformation using $\sqrt{x + 0.5}$.

3.15 STATISTICAL ANALYSIS AND INTERPRETATION OF THE DATA

Data were analysed statistically for test of significance following the Fisher's method of "Analysis of variance" as outlined by Sundarajan *et al.* (1972). The level of significance 'F' test was tested at 5 per cent (5%) and 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 "Integrated weed management in Rose" conducted during the year 1999-2000 are presented in this chapter.

4.1 WEEDS OBSERVED IN THE EXPERIMENTAL FIELD

The important weed species observed in the experimental field in association with the rose include grasses like *Cynodon dactylon Pers.*, *Panicum repens* (L.), *Digitaria marginata* link, var. *Fimbrata* and *Dactyloctenium aegyptium* Beauv. Among broad leaf weeds, *Acanthospermum hispidum* D.C., *Achyranthus aspera* (L.), *Ageratum conyzoides* (L.), *Amaranthus spinosus* (L.), *Borreria articularis* (L.), *Commelina benghalensis* (L.), *Mimosa pudica* (L.) and *Leucas aspera* (Spreng) were predominant. Among sedges only a *Cyperus rotundus* (L.) was observed.

4.2 STUDIES ON WEED CONTROL AND CROP TOXICITY RATINGS

4.2.1 Weed control ratings

Visual observations recorded the data on weed control rating on 25, 45, 65 and 85 days after rose pruning are presented in Table 1. Marked differences in weed control ratings were noticed due to weed control treatments at various stages of crop growth

At 25 days after pruning

Marked difference in weed control rating was noticed among the weed control treatments. Hand weeding, glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up gave excellent control of weeds (1 to 1.50). Glyphosate 1.0 kg a.i./ha, oxyfluorfen 0.1 kg a.i./ha, pendimethalin 1.0 kg a.i./ha, atrazine 1.0 kg a.i./ha and atrazine 1.0 kg a.i./ha + earthing up gave fair control of weeds (3 to 3.25) whereas unweeded control resulted in very poor control of weeds (5.00).

At 45 days after pruning

Hand weeding, glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up gave excellent control of weeds (1.00 to 1.50). Glyphosate 1.0 kg a.i./ha, and oxyfluorfen 0.1 kg a.i./ha, atrazine 1.0 kg a.i./ha + earthing up gave good weed control (2.25 to 2.5). Whereas, pendimethalin 1.0 kg a.i./ha and pendimethalin 1.0 kg a.i./ha + earthing up and atrazine 1.0 kg a.i./ha gave fair control of weeds (3.00 to 3.25). Unweeded control gave no control of weeds (5.00).

At 65 days after pruning

Oxyfluorfen 0.1 kg a.i./ha + earthing up and glyphosate 1.0 kg a.i./ha + earthing up, hand weeding gave excellent control of weeds (1.70 to 1.75). Oxyfluorfen 0.1 kg a.i./ha, glyphosate 1.0 kg a.i./ha, atrazine 1.0 kg a.i./ha + earthing up gave good weed control (2.25 to 2.75). Whereas, pendimethalin 1.0 kg a.i./ha and pendimethalin 1.0 kg a.i./ha + earthing up

Table 1. Effect of weed control treatments on weed control ratings and crop toxicity ratings at different crop growth stages in rose

Treatments	Days after pruning							
	Weed Control Ratings				Crop Toxicity Ratings			
	25	45	65	85	25	45	65	85
T ₁ - Unweeded control (weedy check)	5.00	5.00	5.00	5.00	1.00	1.00	1.00	1.00
T ₂ - Hand weeding at 20, 40, 60 and 80 DAP	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
T ₃ - Pendimethalin (30 E.C) 1.0 kg a.i./ha	3.00	3.00	3.25	3.50	2.00	1.50	1.22	1.00
T ₄ - Pendimethalin (30 E.C) 1.0 kg a.i./ha + earthing up at 35 DAP	3.25	3.25	3.50	3.50	2.00	1.50	1.22	1.00
T ₅ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha	2.25	2.25	2.50	2.50	2.50	2.00	2.22	1.00
T ₆ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha + earthing up at 35 DAP	1.50	1.50	1.70	2.00	2.50	2.00	2.22	1.00
T ₇ - Glyphosate (41 SL) 1.0 kg a.i./ha	2.00	2.25	2.50	2.25	3.00	2.50	1.22	1.00
T ₈ - Glyphosate (41 SL) 1.0 kg a.i./ha + earthing up at 35 DAP	1.50	1.50	1.75	2.25	3.00	2.50	1.22	1.00
T ₉ - Atrazine (50 WP) 1.0 kg a.i./ha	3.00	3.00	3.25	4.50	1.50	1.22	1.00	1.00
T ₁₀ - Atrazine (50 WP) 1.0 kg a.i./ha + earthing up at 35 DAP	2.50	2.50	2.75	3.75	1.50	1.22	1.00	1.00
<i>Weed control ratings</i>	<i>Crop toxicity ratings</i>							
<i>1.00 - Excellent control</i>	<i>1.00 - No toxicity</i>							
<i>2.00 - Good control</i>	<i>2.00 - Slight toxicity</i>							
<i>3.00 - Fair control</i>	<i>3.00 - Moderate toxicity</i>							
<i>4.00 - Poor control</i>	<i>4.00 - Severe toxicity</i>							
<i>5.00 - No control</i>	<i>5.00 - Toxic</i>							

gave fair control of weeds (3.25 to 3.50). Unweeded control gave no control of weeds (5.00).

At 85 days after pruning

As observed in earlier stages, application of oxyfluorfen 0.1 kg a.i./ha + earthing up and glyphosate 1.0 kg a.i./ha + earthing up, glyphosate 1.0 kg a.i./ha and oxyfluorfen 0.1 kg a.i./ha gave good control of weeds (2.00 to 2.50). Whereas, pendimethalin 1.0 kg a.i./ha, pendimethalin 1.0 kg a.i./ha + earthing up, atrazine 1.0 kg a.i./ha + earthing up gave fair control of weeds (3.50 to 3.75). Further, atrazine 1.0 kg a.i./ha gave poor control of weeds (4.50) and similar to unweeded control (5.00).

4.2.2 Crop toxicity ratings

Visual observations on crop toxicity ratings at 25, 45, 65 and 85 days after pruning are presented in Table 1. Considerable variation in crop toxicity ratings was observed among herbicidal treatments. At later stages of crop growth, there was no variation in crop toxicity ratings among herbicidal treatments.

At 25 days after pruning application of glyphosate 1.0 kg a.i./ha caused moderate toxicity symptoms (3.00), while pendimethalin 1.0 kg a.i./ha and oxyfluorfen 0.1 kg a.i./ha gave slight toxicity symptoms (2.00 to 2.50). However, atrazine did not show any injury to the crop.

Plate 2 : Unweeded control (weedy check)

Plate 3 : Hand weeding at 20 , 40,60 and 80 DAP.



On 45 day slight injury to the crop (2.00 to 2.50) was observed in glyphosate 1.0 kg a.i./ha and oxyfluorfen 0.1 kg a.i./ha not show any injury to the crop.

On 65 days after pruning Glyphosate 1.0 kg a.i./ha showed slight toxicity (1.22), except this none of the herbicides showed any injury to the crop.

On 85 days after pruning, there were no crop toxicity symptoms due to herbicide treatments. The crop showed no toxicity symptom (1.00).

4.3 WEED POPULATION COUNTS

Observations recorded on weed population at different stages of crop growth are presented in Table 2.

4.3.1 Grassy weed population per 0.25 m²

The data presented in Table 2 indicated that unweeded control recorded significantly higher grass density at all stages of crop growth (12.33, 16.66, 21.00, 34.00 at 25, 45, 65 and 85 DAP respectively). Hand weeding, had the lowest density of grasses at all stages (0.66, 0.66, 1.33 and 1.33 at 25, 45, 65 and 85 DAP, respectively).

At 25 DAP, glyphosate 1.0 kg a.i./ha + earthing up registered significantly the lower number of grasses (0.66) and was found to be on par with oxyfluorfen 0.1 kg a.i./ha alone or with earthing up (0.66 and 2.66, respectively).

Table 2. Effect of weed control treatments on grassy weed density per 0.25 m² at different crop growth stages in rose

Treatments	Days after pruning			
	25	45	65	85
T ₁ - Unweeded control (weedy check)	12.33 (3.57)	16.66 (4.13)	21.00 (4.62)	34.00 (5.86)
T ₂ - Hand weeding at 20, 40, 60 and 80 DAP	0.66 (1.05)	0.66 (1.05)	1.33 (1.34)	1.33 (1.34)
T ₃ - Pendimethalin (30 E.C) 1.0 kg a.i./ha	5.66 (2.46)	7.66 (2.84)	12.33 (3.57)	20.00 (4.51)
T ₄ - Pendimethalin (30 E.C) 1.0 kg a.i./ha + earthing up at 35 DAP	5.00 (2.32)	1.66 (1.44)	8.00 (2.90)	14.00 (3.78)
T ₅ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha	2.66 (1.76)	3.66 (2.04)	7.00 (2.72)	12.00 (3.50)
T ₆ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha + earthing up at 35 DAP	0.66 (1.05)	2.66 (1.76)	5.00 (2.34)	9.66 (3.19)
T ₇ - Glyphosate (41 SL) 1.0 kg a.i./ha	2.66 (1.76)	1.66 (1.44)	5.00 (2.34)	10.00 (3.22)
T ₈ - Glyphosate (41 SL) 1.0 kg a.i./ha + earthing up at 35 DAP	0.66 (1.05)	1.00 (1.22)	3.66 (2.04)	8.33 (2.96)
T ₉ - Atrazine (50 WP) 1.0 kg a.i./ha	4.33 (2.18)	6.33 (2.61)	10.66 (3.33)	16.33 (4.08)
T ₁₀ - Atrazine (50 WP) 1.0 kg a.i./ha + earthing up at 35 DAP	4.00 (2.08)	2.00 (1.56)	6.66 (2.66)	12.00 (3.52)
F-test	*	*	*	*
SEm±	0.891 (0.199)	0.930 (0.180)	0.803 (0.126)	1.159 (0.140)
C.D. at 5%	2.647 (0.592)	2.764 (0.541)	2.387 (0.376)	3.445 (0.419)

Figures in the parentheses indicate transformed values: Transformation $\sqrt{x + 0.5}$

At 45 DAP, glyphosate 1.0 kg a.i./ha + earthing up recorded the lowest grass density (1.00) which was on par with rest of the treatments except pendimethalin 1.0 kg a.i./ha (7.66).

At 65 DAP, again glyphosate 1.0 kg a.i./ha + earthing up recorded the lowest weed density (3.66), treatment with oxyfluorfen 0.1 kg a.i./ha + earthing up (5.0), glyphosate 1.0 kg a.i./ha (5.0), atrazine 1.0 kg a.i./ha + earthing up (6.66) and oxyfluorfen 0.1 kg a.i./ha (7.00) were found to be superior and on par with each other, while pendimethalin 1.0 kg a.i./ha recorded the highest weed density (12.33).

At 85 DAP, glyphosate 1.0 kg a.i./ha + earthing up recorded the lowest number of grass density (8.33) which was on par with oxyfluorfen 0.1 kg a.i./ha + earthing up (9.66) and glyphosate 1.0 kg a.i./ha (10.00). Whereas the highest weed density was observed in pendimethalin 1.0 kg a.i./ha (20.00) among herbicidal treatments.

4.3.2 Broad leaved weed population per 0.25 m²

The data relating to the effect of weed control treatments on broad leaf weed density at different crop growth stages are presented in Table 3.

The data on broad leaf weed density indicated that unweeded control recorded significantly the highest weed density at all stages of crop growth (6.0, 11.33, 18.33 and 21.00 at 25, 45, 65 and 85 DAP respectively). Hand weeding recorded significantly the lowest values at all the stages.

At 25 DAP, glyphosate 1.0 kg a.i./ha + earthing up recorded the lowest broad leaf weed density (0.33), which was on par with glyphosate 1.0 kg a.i./ha, oxyfluorfen 0.1 kg a.i./ha and oxyfluorfen 0.1 kg a.i./ha + earthing up (1.33, 1.33, 0.66, respectively). The treatments receiving atrazine 1.0 kg a.i./ha + earthing up, atrazine 1.0 kg a.i./ha, pendimethalin 1.0 kg a.i./ha and pendimethalin 1.0 kg a.i./ha + earthing up (2.00, 3.00, 3.00, respectively) recorded the highest weed density and were on par with each other.

At 45 DAP, significantly the lowest weed density was observed in glyphosate 1.0 kg a.i./ha + earthing up (1.33), followed by rest of the treatments except atrazine 1.0 kg a.i./ha (4.33) and pendimethalin 1.0 kg a.i./ha (5.33).

At 65 DAP, oxyfluorfen 0.1 kg a.i./ha + earthing up and glyphosate 1.0 kg a.i./ha + earthing up were recorded significantly the lower weed density (3.0 and 3.0, respectively) followed by atrazine 1.0 kg a.i./ha + earthing up, glyphosate 1.0 kg a.i./ha and pendimethalin 1.0 kg a.i./ha + earthing up (3.00 and 5.33, respectively).

At 85 DAP, significantly lower broad leaf weed density was observed in glyphosate 1.0 kg a.i./ha + earthing up (5.33), which was on par with pendimethalin 1.0 kg a.i./ha + earthing up (6.00) and oxyfluorfen 0.1 kg a.i./ha + earthing up (8.00), while pendimethalin 1.0 kg a.i./ha (13.33)

Table 3. Effect of weed control treatments on broad leaf weed density per 0.25 m² at different crop growth stages in rose

Treatments	Days after pruning			
	25	45	65	85
T ₁ - Unweeded control (weedy check)	6.00 (2.54)	11.33 (3.43)	18.33 (4.32)	21.00 (4.62)
T ₂ - Hand weeding at 20, 40, 60 and 80 DAP	0.33 (0.88)	0.33 (0.88)	0.66 (1.05)	1.00 (.7.22)
T ₃ - Pendimethalin (30 E.C) 1.0 kg a.i./ha	3.00 (1.86)	5.33 (2.40)	11.33 (3.41)	13.33 (3.70)
T ₄ - Pendimethalin (30 E.C) 1.0 kg a.i./ha + earthing up at 35 DAP	3.00 (1.86)	2.66 (1.76)	5.33 (2.40)	6.00 (2.47)
T ₅ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha	1.33 (1.34)	3.00 (1.86)	9.00 (3.07)	11.33 (3.43)
T ₆ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha + earthing up at 35 DAP	0.66 (1.05)	2.00 (1.56)	3.00 (1.86)	8.00 (2.90)
T ₇ - Glyphosate (41 SL) 1.0 kg a.i./ha	1.33 (1.34)	2.33 (1.68)	5.00 (2.32)	9.00 (3.07)
T ₈ - Glyphosate (41 SL) 1.0 kg a.i./ha + earthing up at 35 DAP	0.33 (0.88)	1.33 (1.34)	3.00 (1.86)	5.33 (2.40)
T ₉ - Atrazine (50 WP) 1.0 kg a.i./ha	2.33 (1.65)	4.33 (2.18)	10.33 (3.28)	12.33 (3.57)
T ₁₀ - Atrazine (50 WP) 1.0 kg a.i./ha + earthing up at 35 DAP	2.00 (1.56)	2.00 (1.56)	5.00 (2.32)	9.33 (3.12)
F-test	*	*	*	*
SEm±	0.489 (0.166)	0.547 (0.138)	0.806 (0.119)	1.164 (0.205)
C.D. at 5%	1.454 (0.493)	1.627 (0.409)	2.396 (0.355)	3.461 (0.610)

Figures in the parentheses indicate transformed values: Transformation $\sqrt{x + 0.5}$

recorded the highest broad leaf weed density. Yet all these were significantly lower than unweeded control.

4.3.3 Sedge weed population per 0.25 m²

The data relating to the effect of weed control treatments on sedge weed density at different crop growth stages are presented in Table 4.

The data on sedge weed density indicated that unweeded control recorded significantly higher weed density at all the stages of crop growth (9.33, 12.00, 16.00, 22.33 at 25, 45, 65 and 85 DAP, respectively) than other weed control treatments. Hand weeding, had significantly lower density of sedge weeds at all the stages (0.66, 0.66, 0.33 and 0.66 at 25, 45, 65 and 85 DAP, respectively).

At 25 DAP, oxyfluorfen 0.1 kg a.i./ha + earthing up (1.33), glyphosate 1.0 kg a.i./ha + earthing up (1.33), oxyfluorfen 0.1 kg a.i./ha (2.00) and glyphosate 1.0 kg a.i./ha (2.00) were found to be superior and on par with each other. Whereas pendimethalin 1.0 kg a.i./ha + earthing up (5.00) and pendimethalin 1.0 kg a.i./ha (5.33) recorded the higher weed density.

At 45 DAP, significantly the lowest weed density was observed in glyphosate 1.0 kg a.i./ha + earthing up (1.00) and was on par with oxyfluorfen 0.1 kg a.i./ha + earthing up, atrazine 1.0 kg a.i./ha + earthing up and pendimethalin 1.0 kg a.i./ha + earthing up (1.00, 1.33, 1.66, respectively),

Plate 5 : Glyphosate 1.0 Kg a.i. / ha + earthing up at 35 DAP.



Table 4. Effect of weed control treatments on sedge weed density per 0.25 m² at different crop growth stages in rose

Treatments	Days after pruning			
	25	45	65	85
T ₁ - Unweeded control (weedy check)	9.33 (3.12)	12.00 (3.52)	16.00 (4.04)	22.33 (4.77)
T ₂ - Hand weeding at 20, 40, 60 and 80 DAP	0.66 (1.05)	0.66 (1.05)	0.33 (0.88)	0.66 (1.05)
T ₃ - Pendimethalin (30 E.C) 1.0 kg a.i./ha	5.33 (2.38)	5.33 (2.40)	12.00 (3.52)	14.00 (3.79)
T ₄ - Pendimethalin (30 E.C) 1.0 kg a.i./ha + earthing up at 35 DAP	5.00 (2.32)	1.66 (1.44)	5.33 (2.40)	10.66 (3.33)
T ₅ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha	2.00 (1.56)	3.33 (1.93)	7.00 (2.72)	9.00 (3.07)
T ₆ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha + earthing up at 35 DAP	1.33 (1.34)	1.00 (1.17)	3.00 (1.86)	5.66 (2.46)
T ₇ - Glyphosate (41 SL) 1.0 kg a.i./ha	2.00 (1.56)	2.66 (1.76)	4.00 (2.11)	6.66 (2.70)
T ₈ - Glyphosate (41 SL) 1.0 kg a.i./ha + earthing up at 35 DAP	1.33 (1.34)	1.00 (1.17)	2.00 (1.56)	3.00 (1.86)
T ₉ - Atrazine (50 WP) 1.0 kg a.i./ha	3.33 (1.93)	5.33 (2.37)	9.33 (3.10)	11.66 (3.47)
T ₁₀ - Atrazine (50 WP) 1.0 kg a.i./ha + earthing up at 35 DAP	3.00 (1.86)	1.33 (1.34)	4.33 (2.18)	8.33 (2.95)
F-test	*	*	*	*
SEm±	0.508 (0.104)	0.599 (0.127)	0.823 (0.144)	0.609 (0.090)
C.D. at 5%	1.509 (0.309)	1.780 (0.378)	2.446 (0.427)	1.811 (0.268)

Figures in the parentheses indicate transformed values: Transformation $\sqrt{x + 0.5}$

while pendimethalin 1.0 kg a.i./ha recorded highest number of sedge weeds (5.33) among herbicide applied plots.

At 65 DAP, glyphosate 1.0 kg a.i./ha + earthing up registered significantly the lower sedge weed density (2.00) followed by oxyfluorfen 0.1 kg a.i./ha + earthing up (3.0), glyphosate 1.0 kg a.i./ha (4.00) and atrazine 1.0 kg a.i./ha + earthing up (4.33). Whereas, highest sedge weed density was observed in pendimethalin 1.0 kg a.i./ha (12.00). Similar trend was noticed even among herbicide applied plots at 85 DAP.

4.3.4 Total weed population per 0.25 m²

The data pertaining to total weed density (Table 5) indicated that unweeded control recorded significantly the higher total weed density at all stages of crop growth (27.66, 40.00, 55.33, 77.33 at 25, 45, 65 and 85 DAP respectively). Hand weeding treated plots had the lowest weed density at all the stages (1.66, 2.00, 2.33 and 3.00 at 25, 45, 65 and 85 DAP, respectively).

At 25 DAP, glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up were recorded significantly the lower density of total weeds (2.33 and 2.66, respectively) and were on par with each other. These were followed by rest of the treatments except pendimethalin 1.0 kg a.i./ha + earthing up (13.00) and pendimethalin 1.0 kg a.i./ha (14.00).

At 45 DAP, significantly the lower number of total weeds was observed in glyphosate 1.0 kg a.i./ha + earthing up (3.00) which was on par with oxyfluorfen 0.1 kg a.i./ha + earthing up, pendimethalin 1.0 kg a.i./ha +

Table 5. Effect of weed control treatments on total weed density per 0.25 m² at different crop growth stages in rose

Treatments	Days after pruning			
	25	45	65	85
T ₁ - Unweeded control (weedy check)	27.66 (5.29)	40.00 (6.34)	55.33 (7.44)	77.33 (8.79)
T ₂ - Hand weeding at 20, 40, 60 and 80 DAP	1.66 (1.39)	2.00 (1.56)	2.33 (1.64)	3.00 (1.86)
T ₃ - Pendimethalin (30 E.C) 1.0 kg a.i./ha	14.00 (3.80)	18.33 (4.34)	35.66 (5.98)	47.33 (6.89)
T ₄ - Pendimethalin (30 E.C) 1.0 kg a.i./ha + earthing up at 35 DAP	13.00 (3.63)	6.00 (2.53)	18.66 (4.35)	34.00 (5.84)
T ₅ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha	6.00 (2.54)	9.33 (3.13)	20.66 (4.59)	32.33 (5.69)
T ₆ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha + earthing up at 35 DAP	2.66 (1.74)	5.66 (2.25)	11.00 (3.38)	23.32 (4.68)
T ₇ - Glyphosate (41 SL) 1.0 kg a.i./ha	6.00 (2.54)	6.65 (2.83)	14.00 (3.78)	25.66 (4.98)
T ₈ - Glyphosate (41 SL) 1.0 kg a.i./ha + earthing up at 35 DAP	2.33 (1.66)	3.00 (1.86)	8.66 (3.02)	16.66 (4.12)
T ₉ - Atrazine (50 WP) 1.0 kg a.i./ha	10.00 (3.23)	16.00 (4.05)	30.33 (5.52)	40.33 (6.36)
T ₁₀ - Atrazine (50 WP) 1.0 kg a.i./ha + earthing up at 35 DAP	9.00 (3.03)	5.33 (2.38)	16.33 (4.06)	26.66 (5.21)
F-test	*	*	*	*
SEm±	1.399 (0.218)	1.776 (0.213)	2.411 (0.216)	2.668 (0.194)
C.D. at 5%	4.159 (0.647)	5.279 (0.632)	7.164 (0.642)	7.928 (0.578)

Figures in the parentheses indicate transformed values: Transformation $\sqrt{x + 0.5}$

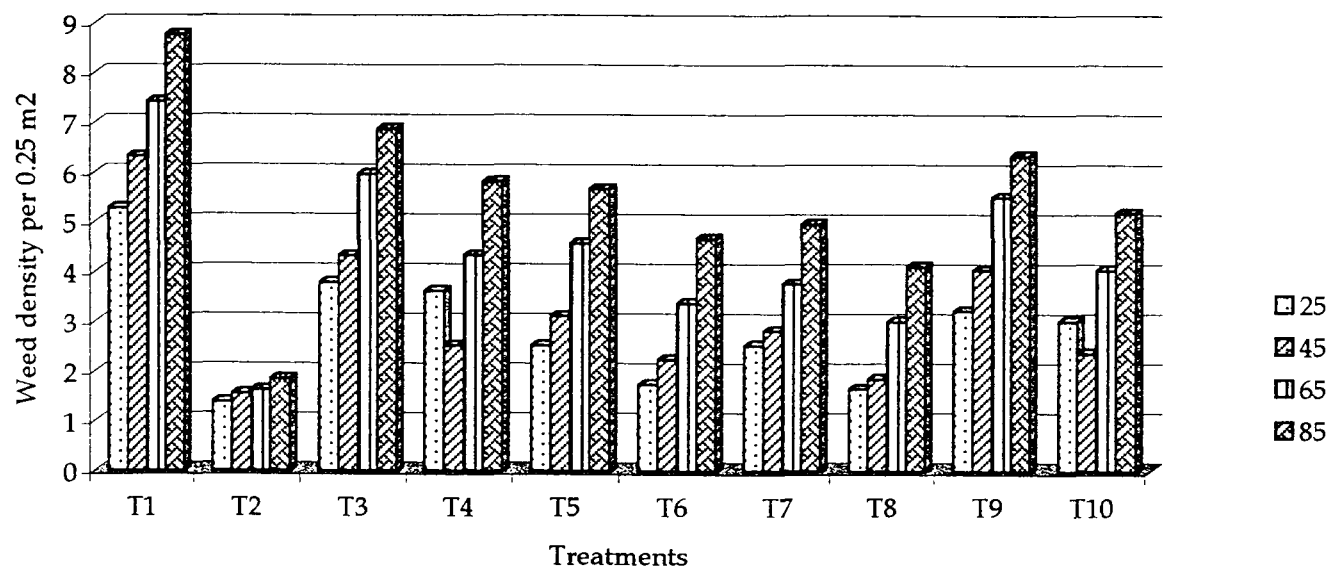


Fig.2: Effect of weed control treatments on total weed density per 0.25 m² in rose

Note: Graph given for transformed

earthing up and atrazine 1.0 kg a.i./ha + earthing up (7.66, 6.00 and 5.33 respectively). The treatment with pendimethalin 1.0 kg a.i./ha recorded higher density of total weed (18.33).

At 65 DAP, glyphosate 1.0 kg a.i./ha + earthing up registered significantly the lowest density of total weeds (8.66), followed by oxyfluorfen 0.1 kg a.i./ha + earthing up, glyphosate 1.0 kg a.i./ha and atrazine 1.0 kg a.i./ha + earthing up (11.00, 14.00 and 16.33, respectively). Whereas atrazine 1.0 kg a.i./ha and pendimethalin 1.0 kg a.i./ha recorded higher density of total weeds (30.33 and 35.66, respectively) and were on par with each other. Similar trend was noticed at 85 DAP.

4.4 DRY MATTER PRODUCTION OF WEEDS

The data on dry weight of weeds at different stages of crop growth are presented in Tables 6 to 9.

4.4.1 Dry matter production of grassy weeds (g/0.25 m²)

The data on dry weight of grasses recorded at different crop growth stages are presented in Table 6. The highest dry matter production of grasses was recorded with unweeded control (2.40, 8.86, 13.66, 24.66 at 25, 45, 65 and 85 DAP, respectively). Whereas, hand weeding recorded lowest dry matter production (0.12, 0.40, 0.52, 0.64 at 25, 45, 65 and 85 DAP, respectively).

At 25 DAP, significantly the lowest dry matter production of grasses was observed in glyphosate 1.0 kg a.i./ha + earthing up (1.16) and

Table 6. Effect of weed control treatments on dry matter production of grassy weeds per 0.25 m² at different crop growth stages in rose

Treatments	Days after pruning			
	25	45	65	85
T ₁ - Unweeded control (weedy check)	2.40 (1.67)	8.86 (3.05)	13.66 (3.74)	24.66 (5.00)
T ₂ - Hand weeding at 20, 40, 60 and 80 DAP	1.12 (1.27)	0.40 (0.95)	0.52 (1.04)	0.64 (1.06)
T ₃ - Pendimethalin (30 E.C) 1.0 kg a.i./ha	1.96 (1.56)	6.72 (1.29)	13.66 (3.75)	19.46 (4.46)
T ₄ - Pendimethalin (30 E.C) 1.0 kg a.i./ha + earthing up at 35 DAP	1.84 (1.53)	1.18 (1.95)	6.26 (2.58)	11.33 (3.43)
T ₅ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha	1.40 (1.38)	1.56 (1.43)	4.62 (2.26)	10.80 (3.34)
T ₆ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha + earthing up at 35 DAP	1.16 (1.29)	0.60 (1.04)	4.24 (2.16)	10.66 (3.32)
T ₇ - Glyphosate (41 SL) 1.0 kg a.i./ha	1.40 (1.38)	1.00 (1.22)	4.24 (2.16)	9.84 (3.21)
T ₈ - Glyphosate (41 SL) 1.0 kg a.i./ha + earthing up at 35 DAP	1.16 (1.29)	0.40 (0.95)	3.56 (1.99)	9.06 (3.07)
T ₉ - Atrazine (50 WP) 1.0 kg a.i./ha	1.78 (1.51)	3.66 (2.04)	10.66 (3.33)	15.06 (3.93)
T ₁₀ - Atrazine (50 WP) 1.0 kg a.i./ha + earthing up at 35 DAP	1.72 (1.49)	0.76 (1.12)	4.46 (2.22)	10.84 (3.34)
F-test	*	*	*	*
SEm±	0.187 (0.054)	0.500 (0.094)	0.542 (0.092)	0.617 (0.073)
C.D. at 5%	0.556 (0.161)	1.488 (0.282)	1.612 (0.2740)	1.835 (0.217)

Figures in the parentheses indicate transformed values: Transformation $\sqrt{x + 0.5}$

was on par with glyphosate 1.0 kg a.i./ha, oxyfluorfen 0.1 kg a.i./ha and oxyfluorfen 0.1 kg a.i./ha + earthing up (1.4, 1.4 and 1.16, respectively).

At 45 DAP, glyphosate 1.0 kg a.i./ha + earthing up registered significantly lower dry matter production (0.40) and was on par with oxyfluorfen 0.1 kg a.i./ha + earthing up, atrazine 1.0 kg a.i./ha + earthing up and glyphosate 1.0 kg a.i./ha (0.42, 0.76 and 0.4, respectively). The treatments atrazine 1.0 kg a.i./ha and pendimethalin 1.0 kg a.i./ha recorded the highest dry matter production of weeds (3.66 and 6.72, respectively).

At 65 DAP, again glyphosate 1.0 kg a.i./ha + earthing up recorded the lower weed dry weight (3.56) as compared to all other treatments except atrazine 1.0 kg a.i./ha and pendimethalin 1.0 kg a.i./ha (10.66 and 11.52, respectively).

At 85 DAP, once again glyphosate 1.0 kg a.i./ha + earthing up recorded the lower dry matter production of weeds (9.06) which was on par with glyphosate 1.0 kg a.i./ha, oxyfluorfen 0.1 kg a.i./ha + earthing up, oxyfluorfen 0.1 kg a.i./ha and atrazine 1.0 kg a.i./ha + earthing up (9.06, 10.66, 10.8 and 10.84, respectively). Whereas, pendimethalin 1.0 kg a.i./ha (19.46) recorded the highest dry matter production of weeds (19.46).

4.4.2 Dry matter production of broad leaf weeds (g/0.25 m²)

The data presented in Table 7 indicated that unweeded control recorded significantly the higher dry weight of weeds at all stages of crop

growth (4.40, 10.66, 40.24, 41.34 at 25, 45, 65 and 85 DAP, respectively). Whereas, hand weeding had lower dry weight of weeds.

At 25 DAP, glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up recorded significantly lower dry weight (0.8 and 1.12, respectively) and were on par with each other compared to over all other treatments except pendimethalin 1.0 kg a.i./ha, atrazine 1.0 kg a.i./ha alone or with earthing up at 35 DAP (1.84, 1.78 and 1.72 respectively).

At 45 DAP, glyphosate 1.0 kg a.i./ha + earthing up recorded significantly lower dry weight (1.24) and was on par with oxyfluorfen 0.1 kg a.i./ha + earthing up (2.16). Whereas, highest dry weight was observed in atrazine 1.0 kg a.i./ha and pendimethalin 1.0 kg a.i./ha (3.66 and 6.72, respectively).

At 65 DAP, treatments receiving glyphosate 1.0 kg a.i./ha + earthing up (6.14), oxyfluorfen 0.1 kg a.i./ha + earthing up (6.24), glyphosate 1.0 kg a.i./ha (8.46) and atrazine 1.0 kg a.i./ha + earthing up (8.50) were recorded lower dry weight and on par with each other.

At 85 DAP, again glyphosate 1.0 kg a.i./ha + earthing up recorded significantly lower dry weight (10.32) followed by rest of the treatments except atrazine 1.0 kg a.i./ha (29.46) and pendimethalin 1.0 kg a.i./ha (32.00).

Table 7. Effect of weed control treatments on dry matter production of broad leaf weeds per 0.25 m² at different crop growth stages in rose

Treatments	Days after pruning			
	25	45	65	85
T ₁ - Unweeded control (weedy check)	4.40 (2.20)	10.66 (3.32)	40.24 (6.35)	41.34 (6.46)
T ₂ - Hand weeding at 20, 40, 60 and 80 DAP	0.80 (1.14)	0.80 (1.14)	1.18 (1.29)	2.06 (1.59)
T ₃ - Pendimethalin (30 E.C) 1.0 kg a.i./ha	3.54 (1.99)	9.12 (3.08)	26.80 (5.22)	32.00 (5.69)
T ₄ - Pendimethalin (30 E.C) 1.0 kg a.i./ha + earthing up at 35 DAP	3.54 (1.99)	4.62 (2.26)	10.66 (3.32)	17.12 (4.19)
T ₅ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha	2.12 (1.61)	7.12 (2.74)	10.72 (3.34)	18.56 (4.34)
T ₆ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha + earthing up at 35 DAP	1.12 (1.24)	2.16 (1.61)	6.24 (2.56)	15.36 (3.96)
T ₇ - Glyphosate (41 SL) 1.0 kg a.i./ha	2.12 (1.61)	7.00 (2.72)	8.46 (2.97)	16.33 (4.09)
T ₈ - Glyphosate (41 SL) 1.0 kg a.i./ha + earthing up at 35 DAP	0.8 (1.13)	1.24 (1.31)	6.14 (2.58)	10.32 (3.26)
T ₉ - Atrazine (50 WP) 1.0 kg a.i./ha	2.4 (1.68)	9.12 (3.09)	25.78 (5.12)	29.46 (5.46)
T ₁₀ - Atrazine (50 WP) 1.0 kg a.i./ha + earthing up at 35 DAP	2.35 (1.66)	3.34 (1.94)	8.50 (2.99)	16.86 (4.14)
F-test	*	*	*	*
SEm±	0.337 (0.095)	0.650 (0.099)	1.465 (0.109)	0.993 (0.080)
C.D. at 5%	1.002 (0.284)	1.932 (0.294)	4.353 (0.326)	2.250 (0.238)

Figures in the parentheses indicate transformed values: Transformation $\sqrt{x + 0.5}$

4.4.3 Dry matter production of sedge weeds (g/0.25 m²)

The data presented in Table 8 indicated that unweeded control recorded significantly the higher sedge dry weight at all stages of crop growth (2.80, 10.46, 25.60, 36.40 at 25, 45, 65 and 85 DAP, respectively). Hand weeding, had the lower dry weight of sedges at all stages significantly.

At 25 DAP, glyphosate 1.0 kg a.i./ha recorded the lower dry weight (0.64) it was on par with glyphosate 1.0 kg a.i./ha + earthing up, oxyfluorfen 0.1 kg a.i./ha + earthing up, oxyfluorfen 0.1 kg a.i./ha and atrazine 1.0 kg a.i./ha + earthing up (0.68, 0.94 and 1.16, respectively).

At 45 DAP, glyphosate 1.0 kg a.i./ha + earthing up recorded the significantly lower dry weight (1.78) and was found to be on par with oxyfluorfen 0.1 kg a.i./ha + earthing up, atrazine 1.0 kg a.i./ha + earthing up and pendimethalin 1.0 kg a.i./ha + earthing up (1.8, 2.46 and 2.52, respectively).

At 65 DAP, significantly lower dry weight was observed in glyphosate 1.0 kg a.i./ha + earthing up (4.02) compared to rest of the treatments except oxyfluorfen 0.1 kg a.i./ha (6.42), atrazine 1.0 kg a.i./ha (6.84) and pendimethalin 1.0 kg a.i./ha (7.57).

At 85 DAP, again glyphosate 1.0 kg a.i./ha + earthing up recorded significantly lower sedge dry weight (6.02) and it was on par with oxyfluorfen 0.1 kg a.i./ha + earthing up (6.28) and glyphosate 1.0 kg a.i./ha

Table 8. Effect of weed control treatments on dry matter production of sedge weeds per 0.25 m² at different crop growth stages in rose

Treatments	Days after pruning			
	25	45	65	85
T ₁ - Unweeded control (weedy check)	2.80 (1.77)	10.46 (3.29)	25.60 (5.12)	36.40 (6.06)
T ₂ - Hand weeding at 20, 40, 60 and 80 DAP	0.60 (1.04)	1.16 (1.29)	0.80 (1.14)	1.12 (1.27)
T ₃ - Pendimethalin (30 E.C) 1.0 kg a.i./ha	1.66 (1.46)	4.66 (2.26)	7.57 (2.82)	10.00 (3.23)
T ₄ - Pendimethalin (30 E.C) 1.0 kg a.i./ha + earthing up at 35 DAP	1.60 (1.44)	2.52 (1.73)	5.57 (2.43)	10.00 (3.23)
T ₅ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha	1.16 (1.29)	3.60 (2.01)	6.42 (2.61)	8.04 (2.90)
T ₆ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha + earthing up at 35 DAP	0.99 (1.21)	1.80 (1.52)	4.28 (2.17)	6.28 (2.59)
T ₇ - Glyphosate (41 SL) 1.0 kg a.i./ha	0.68 (1.08)	3.32 (1.95)	4.60 (2.25)	7.16 (2.75)
T ₈ - Glyphosate (41 SL) 1.0 kg a.i./ha + earthing up at 35 DAP	0.64 (1.07)	1.78 (1.51)	4.02 (2.12)	6.02 (2.55)
T ₉ - Atrazine (50 WP) 1.0 kg a.i./ha	1.40 (1.38)	4.60 (2.25)	6.84 (2.68)	8.94 (3.06)
T ₁₀ - Atrazine (50 WP) 1.0 kg a.i./ha + earthing up at 35 DAP	1.38 (1.37)	2.46 (1.69)	5.16 (2.37)	9.00 (3.07)
F-test	*	*	*	*
SEm±	0.265 (0.080)	0.536 (0.099)	0.636 (0.121)	0.537 (0.101)
C.D. at 5%	0.789 (0.238)	1.593 (0.295)	1.891 (0.358)	1.598 (0.302)

Figures in the parentheses indicate transformed values: Transformation $\sqrt{x + 0.5}$

(7.16) followed by oxyfluorfen 0.1 kg a.i./ha, atrazine 1.0 kg a.i./ha and atrazine 1.0 kg a.i./ha + earthing up (8.04, 8.94 and 9.00, respectively).

4.4.4 Total dry matter production of weeds (g/0.25 m²)

The data on total dry matter production of weeds of weeds recorded at different crop growth stages are presented in Table 10. The highest dry matter production of total weeds was recorded with unweeded control (9.60, 28.44, 79.36, 102.40 at 25, 45, 65 and 85 DAP, respectively). Whereas the lowest dry matter production of total weeds were recorded with hand weeding at all the stages.

At 25 DAP, oxyfluorfen 0.1 kg a.i./ha + earthing up registered significantly lower total dry matter production of weeds (2.92) and it was on par with glyphosate 1.0 kg a.i./ha + earthing up (3.13), oxyfluorfen 0.1 kg a.i./ha (4.12) and glyphosate 1.0 kg a.i./ha (4.51).

At 45 DAP, glyphosate 1.0 kg a.i./ha + earthing up recorded significantly lower total dry matter production of weeds (3.76) and it was on par with oxyfluorfen 0.1 kg a.i./ha + earthing up (4.56) and atrazine 1.0 kg a.i./ha + earthing up (6.56). Whereas, pendimethalin 1.0 kg a.i./ha recorded higher total dry matter production of weeds (22.04).

At 65 DAP significantly the lowest total dry matter production of weeds was observed in glyphosate 1.0 kg a.i./ha + earthing up (13.72) and was on par with oxyfluorfen 0.1 kg a.i./ha + earthing up (14.76) when

Plate 4 : Oxyfluorfen 0.1 Kg a.i. / ha + earthing up at 35 DAP.



compared to over all other treatments except atrazine 1.0 kg a.i./ha and pendimethalin 1.0 kg a.i./ha (43.06 and 48.03, respectively).

Similarly at 85 DAP, once again glyphosate 1.0 kg a.i./ha + earthing up recorded the lowest weed dry weight (25.66) and was on par with oxyfluorfen 0.1 kg a.i./ha + earthing up (31.22). Whereas, pendimethalin 1.0 kg a.i./ha recorded the higher total dry matter production of weeds (102.40).

4.5 WEED INDEX (%) AND WEED CONTROL EFFICIENCY (%)

The data on effect of different weed control treatments on weed index and weed control efficiency are tabulated in Table 9.

4.5.1 Weed index (%)

The data pertaining to weed index (Table 10) indicated that Handweeding recorded significantly no yield reduction followed by glyphosate 1.0 kg a.i./ha + earthing up (13.6%) and oxyfluorfen 0.1 kg a.i./ha + earthing up (19.4%), whereas maximum weed index was recorded in unweeded control (40.8%). Among herbicides pendimethalin 1.0 kg a.i./ha alone recorded higher weed index (34.9%).

4.5.2 Weed control efficiency (%)

Weed control efficiency was excellent with hand weeding (96.36%) followed by glyphosate 1.0 kg a.i./ha + earthing up (74.94%) and oxyfluorfen 0.1 kg a.i./ha + earthing up (69.51%), however, pendimethalin 1.0 kg a.i./ha recorded relatively moderate weed control efficiency (39.9%).

Table 9. Effect of weed control treatments on dry matter production of total weeds per 0.25 m² at different crop growth stages in rose

Treatments	Days after pruning				WC E	WI
	25	45	65	85		
T ₁ - Unweeded control (weedy check)	9.60 (3.14)	28.44 (5.35)	79.36 (8.91)	102.40 (10.13)	0.00	40.78
T ₂ - Hand weeding at 20, 40, 60 and 80 DAP	1.52 (1.75)	2.80 (1.81)	2.42 (1.71)	3.72 (2.05)	96.36	-
T ₃ - Pendimethalin (30 E.C) 1.0 kg a.i./ha	7.16 (2.74)	22.04 (4.72)	48.03 (6.95)	61.46 (7.86)	39.90	34.95
T ₄ - Pendimethalin (30 E.C) 1.0 kg a.i./ha + earthing up at 35 DAP	6.98 (2.71)	7.60 (2.84)	21.69 (4.64)	35.18 (5.94)	65.64	29.12
T ₅ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha	4.12 (2.13)	12.28 (3.55)	21.42 (4.66)	37.40 (6.12)	63.47	26.21
T ₆ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha + earthing up at 35 DAP	2.92 (1.83)	4.56 (2.23)	14.76 (3.88)	31.22 (5.87)	69.51	19.40
T ₇ - Glyphosate (41 SL) 1.0 kg a.i./ha	4.51 (2.22)	11.32 (3.42)	17.30 (4.20)	34.28 (5.61)	66.55	22.31
T ₈ - Glyphosate (41 SL) 1.0 kg a.i./ha + earthing up at 35 DAP	3.13 (1.90)	3.76 (2.06)	13.72 (3.74)	25.66 (5.08)	74.94	13.57
T ₉ - Atrazine (50 WP) 1.0 kg a.i./ha	5.58 (2.45)	17.38(4.22)	43.06 (6.59)	52.46 (7.26)	48.76	28.13
T ₁₀ - Atrazine (50 WP) 1.0 kg a.i./ha + earthing up at 35 DAP	5.45 (2.43)	6.56 (2.63)	17.92 (4.28)	36.70 (6.07)	64.16	26.21
F-test	*	*	*	*		
SEm±	0.636 (0.108)	1.334 (0.121)	2.181 (0.144)	2.042 (0.142)		
C.D. at 5%	1.891 (0.302)	3.966 (0.361)	6.480 (0.428)	6.067 (0.421)		

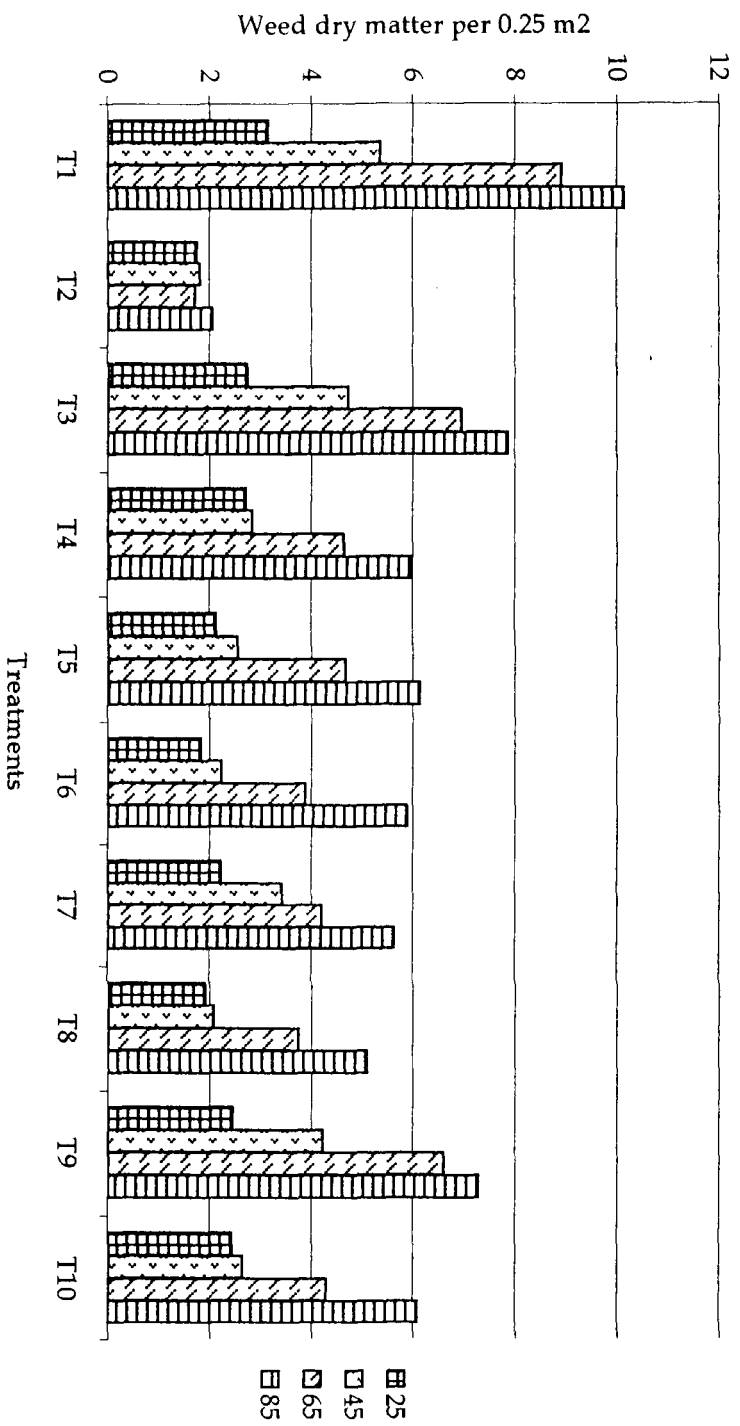


Fig.3: Effect of weed control treatments on dry matter production of total weeds per 0.25 m² in rose

4.6 PLANT GROWTH PARAMETERS

4.6.1 Number of leaves per plant

The data pertaining to the influence of various weed control treatments on number of leaves per plant at different crop growth stages are presented in Table 10. Different weed control treatments significantly differed with respect to number of leaves per plant except at 25 DAP.

At 45 DAP, hand weeding and glyphosate 1.0 kg a.i./ha + earthing up recorded significantly higher number of leaves per plant (130.03 and 97, respectively) as compared to all other treatments. Whereas pendimethalin 1.0 kg a.i./ha recorded lowest number of leaves (45.50) among herbicidal treatments.

At 65 DAP, again hand weeding and glyphosate 1.0 kg a.i./ha + earthing up recorded significantly the higher number of leaves per plant (145.34 and 116.84, respectively) as compared to all other treatments. Whereas, the lowest number of leaves per plant was found in pendimethalin 1.0 kg a.i./ha (52.17) among herbicidal treatments. Similar trend was noticed at 85 DAP.

4.6.2 Number of shoots per plant

The data pertaining to effect of different weed control treatments on number of shoots per plant at different stages of crop growth are presented in Table 11. Among the different treatments, hand weeding produced significantly higher number of shoots per plant (17.67, 23.00, 29.33

Table 10. Effect of weed control treatments on number of leaves per plant at different crop growth stages in rose

Treatments	Days after pruning			
	25	45	65	85
T ₁ - Unweeded control (weedy check)	24.78	42.67	48.84	53.17
T ₂ - Hand weeding at 20, 40, 60 and 80 DAP	77.56	130.03	145.34	157.84
T ₃ - Pendimethalin (30 E.C) 1.0 kg a.i./ha	26.00	45.50	52.17	55.50
T ₄ - Pendimethalin (30 E.C) 1.0 kg a.i./ha + earthing up at 35 DAP	29.89	52.00	56.34	63.17
T ₅ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha	41.33	73.50	81.67	90.00
T ₆ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha + earthing up at 35 DAP	53.11	80.00	86.17	93.17
T ₇ - Glyphosate (41 SL) 1.0 kg a.i./ha	45.00	74.34	84.00	92.34
T ₈ - Glyphosate (41 SL) 1.0 kg a.i./ha + earthing up at 35 DAP	61.00	97.00	116.84	123.00
T ₉ - Atrazine (50 WP) 1.0 kg a.i./ha	41.00	69.00	73.17	78.34
T ₁₀ - Atrazine (50 WP) 1.0 kg a.i./ha + earthing up at 35 DAP	41.11	70.00	79.50	85.67
F-test	NS	*	*	*
SEm±	9.73	14.82	16.40	16.90
C.D. at 5%	9.63	44.03	48.72	50.21

and 36.67, respectively). Whereas, unweeded control recorded significantly lower number of shoots per plant (6.33, 13.00, 16.33 and 17.67 at 25, 45, 65 and 85 DAP, respectively).

At 25 DAP, significantly higher number of shoots per plant was found with glyphosate 1.0 kg a.i./ha + earthing up (15.67), glyphosate 1.0 kg a.i./ha (14.67) and oxyfluorfen 0.1 kg a.i./ha (14.33) which was on par with rest of the treatments except pendimethalin 1.0 kg a.i./ha + earthing up (12.67) and pendimethalin 1.0 kg a.i./ha (11.67).

At 45 DAP, glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up recorded significantly higher number of shoots per plant and are on par with each other (22.67 and 21.33, respectively) followed by rest of the treatments except pendimethalin 1.0 kg a.i./ha (13.67).

At 65 DAP, significantly higher number of shoots per plant was found with glyphosate 1.0 kg a.i./ha + earthing up (29.33), oxyfluorfen 0.1 kg a.i./ha + earthing up (28.67) and glyphosate 1.0 kg a.i./ha (28.33) were on par with each other. Whereas pendimethalin 1.0 kg a.i./ha recorded lower number of shoots per plant (17.67). Similar trend was noticed at 85 DAP.

4.7 FLOWER ATTRIBUTES

4.7.1 Flower diameter (cm)

The data pertaining to effect of different weed control treatments on flower diameter at different crop growth stages in rose (Table

Table 11. Effect of weed control treatments on number of shoots per plant at different crop growth stages in rose

Treatments	Days after pruning			
	25	45	65	85
T ₁ - Unweeded control (weedy check)	6.33	13.00	16.33	17.67
T ₂ - Hand weeding at 20, 40, 60 and 80 DAP	17.67	23.00	29.33	36.67
T ₃ - Pendimethalin (30 E.C) 1.0 kg a.i./ha	11.67	13.67	17.67	18.33
T ₄ - Pendimethalin (30 E.C) 1.0 kg a.i./ha + earthing up at 35 DAP	12.67	17.33	18.67	20.33
T ₅ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha	14.33	19.00	20.67	24.33
T ₆ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha + earthing up at 35 DAP	14.67	21.33	28.67	34.07
T ₇ - Glyphosate (41 SL) 1.0 kg a.i./ha	14.67	19.00	28.33	31.33
T ₈ - Glyphosate (41 SL) 1.0 kg a.i./ha + earthing up at 35 DAP	15.67	22.67	29.33	34.67
T ₉ - Atrazine (50 WP) 1.0 kg a.i./ha	13.33	17.67	20.33	22.67
T ₁₀ - Atrazine (50 WP) 1.0 kg a.i./ha + earthing up at 35 DAP	13.67	17.67	20.67	24.00
F-test	*	*	*	*
SEm±	0.34	0.63	0.88	0.47
C.D. at 5%	1.02	1.88	1.74	1.40

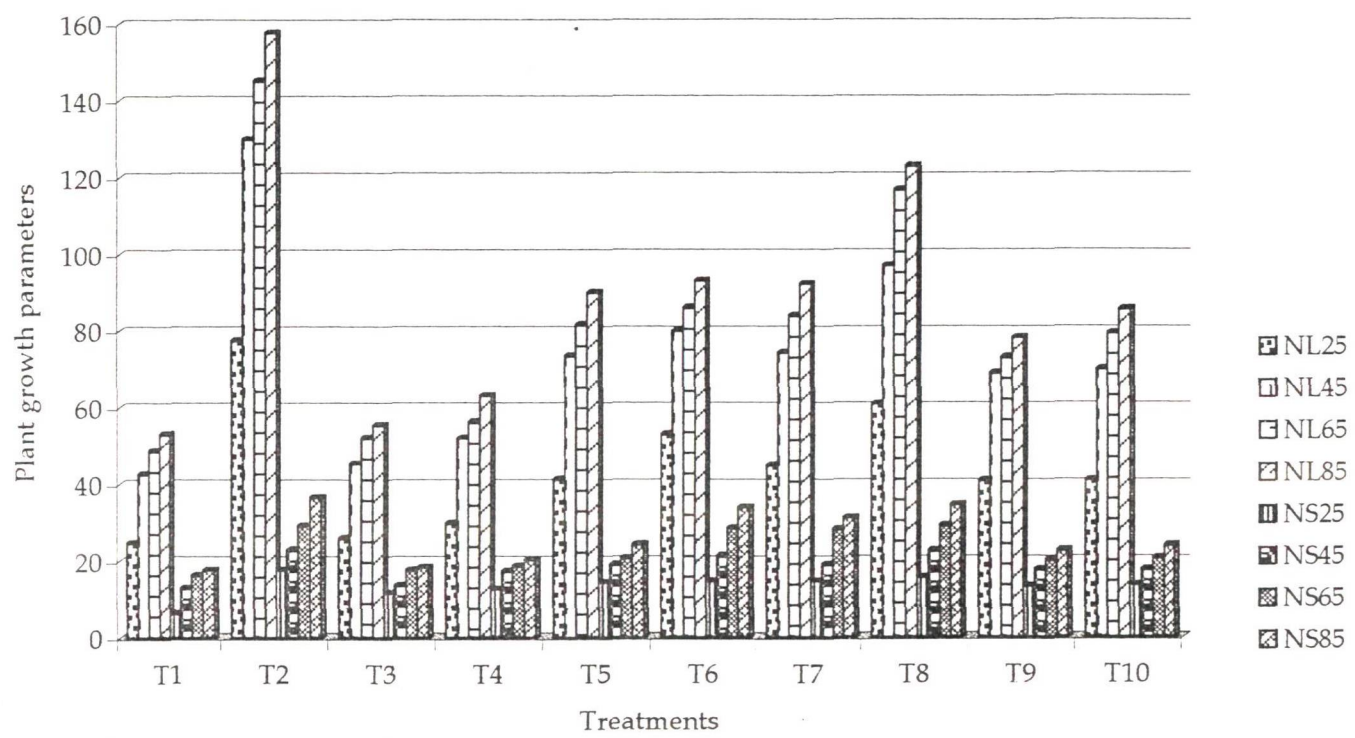


Fig.4: Effect of weed control treatments on number of leaves and number of shoots per plant in rose

NL = Number of leaves; NS = Number of shoots

12) indicated that hand weeding recorded significantly the highest flower diameter (6.59, 6.77, 7.64 at 45, 65 and 85 DAP, respectively). Whereas, unweeded control had the lowest flower diameter at all crop growth stages (4.07, 4.71, 6.07 at 45, 65 and 85 DAP, respectively).

At 45 DAP glyphosate 1.0 kg a.i./ha + earthing up recorded significantly the highest flower diameter (6.23) followed by oxyfluorfen 0.1 kg a.i./ha + earthing up (5.83) and glyphosate 1.0 kg a.i./ha (5.61). Whereas the lowest flower diameter was noticed with pendimethalin 1.0 kg a.i./ha (4.63).

At 65 DAP again glyphosate 1.0 kg a.i./ha + earthing up recorded significantly highest flower diameter (6.53) followed by oxyfluorfen 0.1 kg a.i./ha + earthing up (6.35) and glyphosate 1.0 kg a.i./ha (6.07). Whereas the lowest flower diameter was found with pendimethalin 1.0 kg a.i./ha + earthing up (4.84) and pendimethalin 1.0 kg a.i./ha (4.80). Similar trend was noticed at 85 DAP.

4.7.2 Flower stalk length (cm)

The data pertaining to effect of different weed control treatments on flower stalk length at different months (Table 12) indicated that hand weeding recorded significantly the highest flower stalk length (50.38, 51.39, 55.78 at 45, 65 and 85 DAP, respectively). Whereas, unweeded control had the lowest flower stalk length at all crop growth stages (24.35, 26.32 and 28.73 at 45, 65 and 85 DAP, respectively).

Table 12. Effect of weed control treatments on flower diameter and flower stalk length (cm) at different crop growth stages in rose

Treatments	Flower diameter (cm)			Flower stalk length (cm)		
	Days after pruning			Days after pruning		
	45	65	85	45	65	85
T ₁ - Unweeded control (weedy check)	4.07	4.71	6.07	24.35	26.32	28.73
T ₂ - Hand weeding at 20, 40, 60 and 80 DAP	6.50	6.73	7.64	50.38	51.39	55.78
T ₃ - Pendimethalin (30 E.C) 1.0 kg a.i./ha	4.63	4.80	6.09	24.48	27.22	29.75
T ₄ - Pendimethalin (30 E.C) 1.0 kg a.i./ha + earthing up at 35 DAP	4.77	4.84	6.31	25.45	28.46	31.39
T ₅ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha	5.23	5.67	7.26	36.01	38.87	43.34
T ₆ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha + earthing up at 35 DAP	5.83	6.35	7.44	40.39	41.42	48.42
T ₇ - Glyphosate (41 SL) 1.0 kg a.i./ha	5.61	6.07	7.35	36.33	39.65	43.88
T ₈ - Glyphosate (41 SL) 1.0 kg a.i./ha + earthing up at 35 DAP	6.23	6.53	7.50	46.33	44.96	49.94
T ₉ - Atrazine (50 WP) 1.0 kg a.i./ha	4.84	5.29	6.80	27.05	29.34	32.15
T ₁₀ - Atrazine (50 WP) 1.0 kg a.i./ha + earthing up at 35 DAP	4.89	5.34	7.14	29.20	32.83	34.57
F-test	*	*	*	*	*	*
SEm±	0.10	0.11	0.12	5.42	0.73	0.37
C.D. at 5%	0.30	0.31	0.36	16.09	2.18	1.11

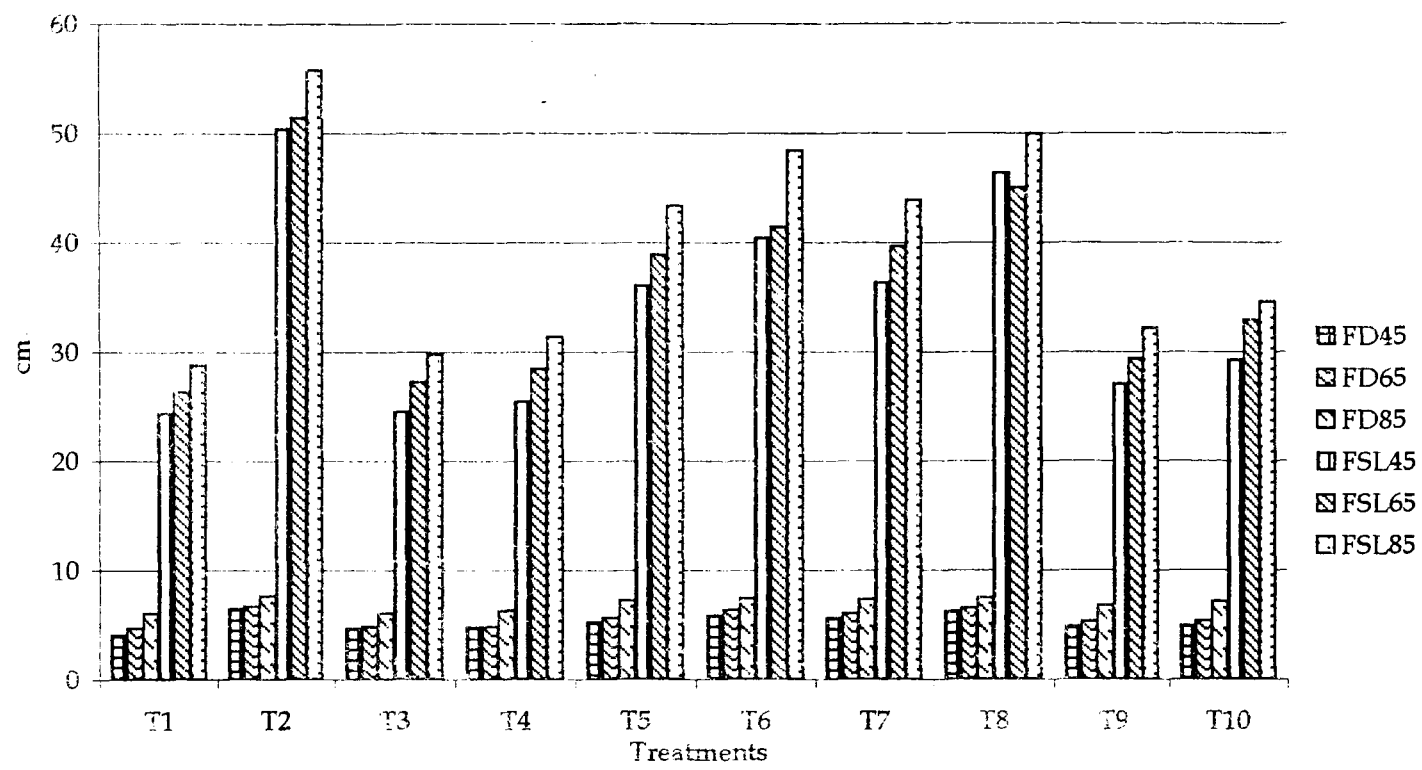


Fig.5: Effect of weed control treatments on Flower diameter, Flower stalk length
in rose
FD = Flower diameter; FSL = Flower stalk length

At 45 DAP significantly higher flower stalk length was found with glyphosate 1.0 kg a.i./ha + earthing up (46.33) compared to over all other treatments, the next highest flower stalk length was observed in oxyfluorfen 0.1 kg a.i./ha + earthing up (40.39), glyphosate 1.0 kg a.i./ha (36.33) and oxyfluorfen 0.1 kg a.i./ha (36.01) which were on par with each other, pendimethalin 1.0 kg a.i./ha recorded lowest flower stalk length (24.48) among herbicidal treatments.

At 65 DAP again glyphosate 1.0 kg a.i./ha + earthing up recorded highest flower stalk length (44.96) followed by oxyfluorfen 0.1 kg a.i./ha + earthing up (41.42). Whereas, pendimethalin 1.0 kg a.i./ha + earthing up and pendimethalin 1.0 kg a.i./ha recorded lowest flower stalk length (28.46 and 27.22, respectively) and on par with each other. Similar trend was noticed at 85 DAP.

4.7.3 Flower fresh weight and dry weight (g)/single flower

4.7.3.1 Flower fresh weight (g)

Significant differences was noticed among different weed control treatments, hand weeding recorded highest flower fresh weight (12.62) followed by glyphosate 1.0 kg a.i./ha + earthing up (10.59), glyphosate 1.0 kg a.i./ha (10.54), oxyfluorfen 0.1 kg a.i./ha + earthing up (10.45) and oxyfluorfen 0.1 kg a.i./ha (10.31). Whereas unweeded control recorded lowest flower fresh weight (6.24) followed by pendimethalin 1.0 kg a.i./ha, pendimethalin 1.0 kg a.i./ha + earthing up and atrazine 1.0 kg a.i./ha (6.4, 8.4 and 8.66, respectively).

4.7.3.2 Flower dry weight (g)

Flower dry weight recorded significantly the highest with hand weeding (4.58) followed by glyphosate 1.0 kg a.i./ha + earthing up (3.52), oxyfluorfen 0.1 kg a.i./ha + earthing up (2.58), glyphosate 1.0 kg a.i./ha (2.38) and oxyfluorfen 0.1 kg a.i./ha (2.36). Whereas, lower flower dry weight was obtained with unweeded control (1.23) followed by pendimethalin 1.0 kg a.i./ha, pendimethalin 1.0 kg a.i./ha + earthing up and atrazine 1.0 kg a.i./ha (1.48, 1.66 and 1.68, respectively).

4.7.4 Flower yield per plant (Number of flowers per plant)

The data pertaining to effect of different weed control treatments on number of flowers per plant at different stages of crop growth (Table 13) indicated that hand weeding recorded significantly the highest number of flowers per plant (14.33, 21.67, 34.33 at 45, 65 and 85 days after pruning, respectively). Whereas unweeded control recorded lowest number of flowers per plant (7.33, 8.67 and 20.33, respectively).

At 45 DAP, glyphosate 1.0 kg a.i./ha + earthing up recorded significantly highest number of flowers plant (13.67), it was on par with oxyfluorfen 0.1 kg a.i./ha + earthing up (12.67). While pendimethalin 1.0 kg a.i./ha and pendimethalin 1.0 kg a.i./ha + earthing up recorded the lowest number of flowers per plant (6.0 and 8.33, respectively).

At 65 DAP, again glyphosate 1.0 kg a.i./ha + earthing up recorded significantly highest number of flowers plant (18.67), it was on par

Table 13 Effect of weed control treatments on number of flowers per plant (flower yield per ha), fresh weight and dry weight of flowers at different crop growth stages in rose.

Treatments	Days after pruning			Flower yield per ha	Fresh wt.	Dry wt.
	45	65	85			
T ₁ - Unweeded control (weedy check)	7.33	8.67	10.67	61,689	6.24	1.23
T ₂ - Hand weeding at 20, 40, 60 and 80 DAP	14.33	21.67	34.33	1,52,577	12.62	4.58
T ₃ - Pendimethalin (30 E.C) 1.0 kg a.i./ha	8.00	10.67	22.33	99,244	6.40	1.48
T ₄ - Pendimethalin (30 E.C) 1.0 kg a.i./ha + earthing up at 35 DAP	8.33	12.33	24.33	1,08,133	8.40	1.66
T ₅ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha	10.33	15.67	25.33	1,18,724	10.31	2.36
T ₆ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha + earthing up at 35 DAP	12.67	18.33	27.67	1,22,977	10.54	2.58
T ₇ - Glyphosate (41 SL) 1.0 kg a.i./ha	11.33	16.67	26.67	1,18,533	10.45	2.38
T ₈ - Glyphosate (41 SL) 1.0 kg a.i./ha + earthing up at 35 DAP	13.67	18.67	29.67	1,31,866	10.59	3.52
T ₉ - Atrazine (50 WP) 1.0 kg a.i./ha	9.00	12.67	24.67	1,09,644	8.66	1.68
T ₁₀ - Atrazine (50 WP) 1.0 kg a.i./ha + earthing up at 35 DAP	8.67	14.67	25.33	1,12,577	10.13	1.92
F-test	*	*	*		*	*
SEm±	0.35	0.34	0.25		0.26	0.08
C.D. at 5%	1.05	0.99	0.75		0.74	0.26

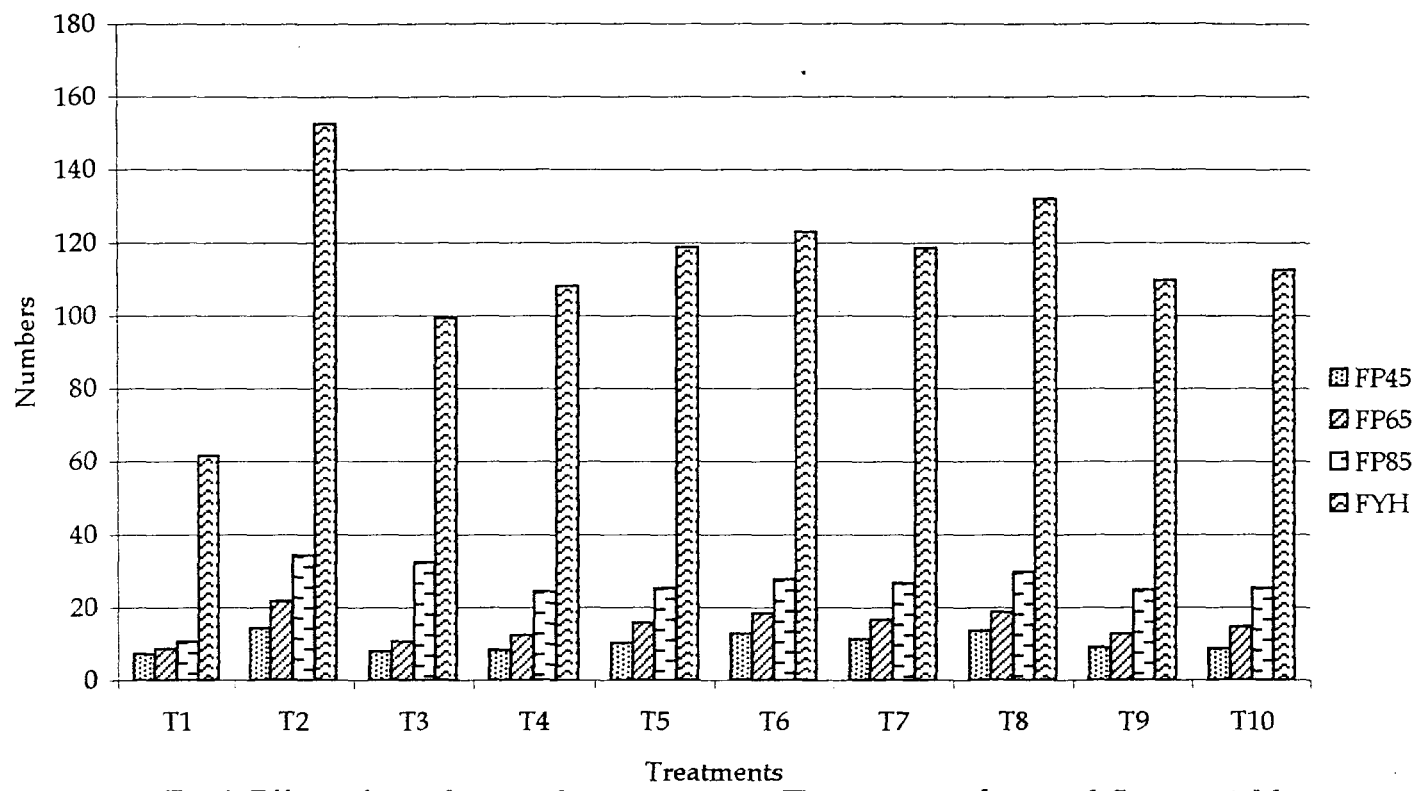


Fig.6: Effect of weed control treatments on Flowers per plant and flower yield per ha in rose
 FP = Flower per plant; FYH = Flower yield per ha

with oxyfluorfen 0.1 kg a.i./ha + earthing up (18.33). Whereas lowest number of flowers per plant found with pendimethalin 1.0 kg a.i./ha (10.67) and pendimethalin 1.0 kg a.i./ha + earthing up (12.33). Similar trend was noticed at 85 DAP.

4.7.4.1 Flower yield per hectare (Table 13)

The flower yield recorded highest in hand weeding (1,52,577) followed by glyphosate 1.0 kg a.i./ha + earthing up (1,31,866), oxyfluorfen 0.1 kg a.i./ha + earthing up (1,22,977), glyphosate 1.0 kg a.i./ha (1,18,533) and oxyfluorfen 0.1 kg a.i./ha (1,12,577). Whereas least flower yield was recorded in unweeded control (90,355). Pendimethalin 1.0 kg a.i./ha recorded lower yield (99244).

4.8 EXPERIMENT - II

Effect of weed control treatments on uptake of 2 per cent sucrose as a vase solution on post harvest life of rose cut flowers.

The data on post harvest life as influenced by effect of different weed control treatments with two per cent sucrose solution are presented in Table 14.

4.8.1 Uptake of solution (ml)

The uptake of 2 per cent sucrose solution significantly differed due to different weed control treatments tried.

Plate 6 : Vase life in rose.



On the first day, the maximum uptake of vase solution was recorded in glyphosate 1.0 kg a.i./ha + earthing up (13.48 ml) which was on par with oxyfluorfen 0.1 kg a.i./ha + earthing up (14.98 ml) followed by glyphosate 1.0 kg a.i./ha (13.55 ml), while minimum uptake of solution was noticed with unweeded control (8.13 ml).

On the second day, the maximum uptake of vase solution was recorded in glyphosate 1.0 kg a.i./ha + earthing up (9.48 ml) as compared to all other treatments. Whereas minimum uptake of solution was recorded in unweeded control (5.68 ml) and hand weeding (7.40 ml).

On the third day, glyphosate 1.0 kg a.i./ha + earthing up recorded maximum uptake (8.23 ml) of solution which was on par with glyphosate 1.0 kg a.i./ha (8.08 ml). Whereas minimum solution uptake was observed with unweeded control (3.72 ml).

On the fourth day, again glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up recorded maximum uptake of vase solution (5.40 and 5.40, ml respectively) which was on par with glyphosate 1.0 kg a.i./ha (5.33 ml) and oxyfluorfen 0.1 kg a.i./ha (5.23 ml). Whereas, minimum solution uptake was recorded with unweeded control (2.80 ml).

On the fifth day, glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up recorded maximum uptake of vase solution (4.25 and 4.20, ml respectively) which was on par with glyphosate

1.0 kg a.i./ha (3.95 ml) and oxyfluorfen 0.1 kg a.i./ha (3.95 ml). Whereas minimum solution uptake was recorded in unweeded control (2.0 ml).

On the sixth day, the maximum uptake of vase solution was observed in glyphosate 1.0 kg a.i./ha + earthing up (3.15 ml) which was on par with glyphosate 1.0 kg a.i./ha (2.95 ml), while less solution uptake was noticed with unweeded control (1.90 ml).

On the seventh day, again glyphosate 1.0 kg a.i./ha + earthing up recorded maximum solution uptake (1.58 ml) followed by oxyfluorfen 0.1 kg a.i./ha + earthing up (1.38 ml) and oxyfluorfen 0.1 kg a.i./ha (1.33 ml). Whereas minimum solution uptake was noticed with pendimethalin 1.0 kg a.i./ha (1.01 ml).

On the eighth day, the maximum uptake of vase solution was observed in glyphosate 1.0 kg a.i./ha + earthing up (1.15 ml) and oxyfluorfen 0.1 kg a.i./ha + earthing up (1.15 ml) followed by oxyfluorfen 0.1 kg a.i./ha (1.03 ml). Whereas, less solution uptake was noticed with unweeded control (0.61 ml).

On the ninth day, the maximum uptake of solution was noticed with oxyfluorfen 0.1 kg a.i./ha + earthing up (0.98 ml), oxyfluorfen 0.1 kg a.i./ha (0.98 ml) and pendimethalin 1.0 kg a.i./ha + earthing up (0.98 ml). Whereas, less solution uptake was noticed with unweeded control.

Table 14. Effect of weed control treatments on uptake of 2 per cent sucrose solution, total solution uptake at different crop growth stages in rose

Treatments	Uptake of solution (ml)/day									Total solution uptake (ml)	Vase life (days)
	1	2	3	4	5	6	7	8	9		
T ₁ - Unweeded control (weedy check)	8.13	5.68	3.72	2.80	2.0	1.90	1.30	0.61	0.00	26.14	8
T ₂ - Hand weeding at 20, 40, 60 and 80 DAP	10.13	7.40	4.68	2.96	2.19	2.03	1.05	0.80	0.78	32.52	9
T ₃ - Pendimethalin (30 E.C) 1.0 kg a.i./ha	13.13	8.60	4.03	3.70	3.00	2.03	1.01	0.72	0.62	36.82	9
T ₄ - Pendimethalin (30 E.C) 1.0 kg a.i./ha + earthing up at 35 DAP	13.38	9.00	4.18	3.78	3.10	2.18	1.02	1.00	0.98	37.73	9
T ₅ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha	13.30	9.23	5.88	5.23	3.95	2.83	1.33	1.03	0.98	43.76	9
T ₆ - Oxyfluorfen (23.5 E.C) 0.1 kg a.i./ha + earthing up at 35 DAP	14.98	9.43	6.25	5.40	4.20	2.88	1.38	1.15	0.98	46.73	9
T ₇ - Glyphosate (41 SL) 1.0 kg a.i./ha	13.55	9.05	8.08	5.33	3.95	2.95	1.10	0.85	0.81	45.67	9
T ₈ - Glyphosate (41 SL) 1.0 kg a.i./ha + earthing up at 35 DAP	15.48	9.48	8.23	5.40	4.25	3.15	1.58	1.15	0.95	49.72	9
T ₉ - Atrazine (50 WP) 1.0 kg a.i./ha	13.10	8.25	5.43	3.07	2.47	2.45	1.18	0.95	0.92	37.82	9
T ₁₀ - Atrazine (50 WP) 1.0 kg a.i./ha + earthing up at 35 DAP	13.43	8.48	5.58	3.16	2.58	2.33	1.18	0.95	0.88	38.57	9
F-test	*	*	*	*	*	*	*	*	NS	*	NS
SEm±	0.49	0.60	0.36	0.31	0.21	0.20	0.17	0.15	-	3.70	-
C.D. at 5%	0.95	1.18	0.69	0.61	0.41	0.40	0.33	0.28	-	9.79	-

The cumulative uptake of solution was maximum with glyphosate 1.0 kg a.i./ha + earthing up (49.72 ml) followed by oxyfluorfen 0.1 kg a.i./ha + earthing up (46.73 ml) and glyphosate 1.0 kg a.i./ha (45.67 ml). Whereas, minimum solution uptake was noticed in unweeded control (26.14 ml).

4.8.2 Vase life

There was no difference between the treatments, it is clear that the vase life of rose flowers was not influenced by herbicides sprayed as compared to control.

4.9 ECONOMICS OF WEED CONTROL

Economics of different weed control treatments in rose are presented in Table 15. The highest gross returns (Rs. 305154/ha) recorded with hand weeding followed by Glyphosate + earthing up (Rs.263732/ha). Herbicide treatments recorded gross income with large variations. The highest being in glyphosate + earthing up (Rs.263732/ha) whereas, the lowest was recorded in pendimethalin 1.0 kg a.i./ha (Rs.198488/ha). Unweeded control recorded the lowest gross returns (Rs.123378/ha) as compared to all other treatments.

The highest cost of weed control was incurred in hand weeding (Rs.4686/ha) followed by pendimethalin + earthing up (Rs.2611/ha). Lowest cost on weed control was realised in atrazine 1.0 kg a.i./ha (Rs.950/ha) followed by oxyfluorfen 1.0 kg a.i./ha (Rs.973/ha). However, among

Table 15. Economics of weed control methods in rose

Treatments	Herbicide rate	Earthing up, handweeding & spray rate	Cost of weed control	Cost of cultivation	Total cost of cultivation	Yield (no. per ha)	Gross return	Net returns	B : C ratio
T ₁ - Unweeded control (weedy check)	-	-	-	57896	57896	61689	123378	65482	1.13
T ₂ - Hand weeding at 20, 40, 60 and 80 DAP	-	4686	4686	57896	62582	152577	305154	247258	3.95
T ₃ - Pendimethalin 1.0 kg a.i./ha	1485	250	1735	57896	59631	99244	198488	140592	2.36
T ₄ - Pendimethalin 1.0 kg a.i./ha + earthing up at 35 DAP	1485	1126	2611	57896	60507	108133	216266	158370	2.64
T ₅ - Oxyfluorfen 1.0 kg a.i./ha	723	250	973	57896	58869	118724	237448	179552	3.05
T ₆ - Oxyfluorfen 1.0 kg a.i./ha + earthing up at 35 DAP	723	1126	1849	57896	59745	122977	245954	188058	3.12
T ₇ - Glyphosate 1.0 kg a.i./ha	1080	250	1330	57896	59226	118533	237066	179170	3.03
T ₈ - Glyphosate 1.0 kg a.i./ha + earthing up at 35 DAP	1080	1126	2206	57896	60102	131866	263732	205836	3.42
T ₉ - Atrazine 1.0 kg a.i./ha	700	250	950	57896	58846	109644	219288	161392	2.74
T ₁₀ - Atrazine 1.0 kg a.i./ha + earthing up at 35 DAP	700	1126	1826	57896	59722	112577	225154	167258	2.80

Herbicide cost:

1. Pendimethalin (30E.C) - Rs.450/lit
2. Oxyfluorfen (23.5 E.C) - Rs.1700/lit
3. Glyphosate (41 SL) - Rs.400/lit
4. Atrazine (50 WP) - Rs.350/kg

Spraying cost - Rs.250/ha

Handweeding cost - Rs.4686/ha

Flower cost - Rs.2/flower

Labour cost - Men Rs.50/day; Women Rs.30/day

herbicidal treatments pendimethalin + earthing up recorded highest cost of weed control (Rs.2611/ha) followed by glyphosate + earthing up (Rs.2206/ha) and no money was spent on weed control in unweeded control treatments in the total cost of cultivation also shown similar trend.

Highest net return was obtained with hand weeding (Rs.247258/ha) followed by glyphosate + earthing up (Rs.205836/ha) and oxyfluorfen + earthing up (Rs.188058/ha). Among herbicidal treatments pendimethalin 1.0 kg a.i./ha recorded least net return (Rs.140592/ha) compared to all other herbicidal treatments.

Highest cost benefit ratio was obtained with hand weeding (Rs.3.95/ha) followed by glyphosate + earthing up (Rs.3.42/ha) whereas least cost benefit ratio was obtained with unweeded control (Rs.1.13/ha). Among herbicidal treatments pendimethalin 1.0 kg a.i./ha recorded least cost benefit ratio (Rs.2.36/ha) followed by pendimethalin + earthing up (Rs.2.64/ha).

DISCUSSION

V. DISCUSSION

Rose is an important flower crop widely grown in India both for aesthetic and commercial purposes. The growth of the plants and flower yield depends on the cultivation practices followed. Weed free environment right from early stage ensures higher yield. Weed infestation hampers the growth of rose plants in the early stages besides harbouring many pests and diseases. They compete also for nutrients and moisture. Mechanical or manual methods of weed control in rose crop though are effective but have certain practical limitations. Manual weeding cannot be practiced in time effectively on large scale, as labour is scarce, costly and time consuming. Incessant rains during initial periods often render the hand weeding impossible. Hence chemical weed control appears to hold great promise in dealing with effective, timely and economic suppression (Yadav and Bose, 1986).

The present study was undertaken during 1999-2000 to find out most suitable, effective and feasible weed management practice for suppression of weeds in rose crop. The results obtained are discussed in this chapter.

5.1 EFFECT OF DIFFERENT WEED CONTROL TREATMENTS ON WEED CONTROL RATINGS AND CROP TOXICITY RATINGS

The important weed species observed in the experimental field in association with the rose include grasses like *Cynodon dactylon Pers.*, *Panicum repens* (L.), *Digitaria marginata* link, var. *Fimbrata* and *Dactyloctenium aegyptium* Beauv. Among broad leaf weeds, *Acanthospermum hispidum* D.C., *Achyranthus aspera* (L.), *Ageratum conyzoides* (L.), *Amaranthus spinosus* (L.), *Borreria articularis* (L.), *Commelina benghalensis* (L.), *Mimosa pudica* (L.) and *Leucas aspera* (Spreng) were predominant. Among sedges only a *Cyperus rotundus* (L.) was observed.

Visual observations on weed control ratings showed marked differences among the different weed control treatments. At initial stages, treatment hand weeding, oxyfluorfen 0.1 kg a.i./ha + earthing up, glyphosate 1.0 kg a.i./ha + earthing up gave excellent control of weeds. At later stages hand weeding, oxyfluorfen 0.1 kg a.i./ha, oxyfluorfen 0.1 kg a.i./ha + earthing up, glyphosate 1.0 kg a.i./ha and glyphosate 1.0 kg a.i./ha + earthing up gave good control of weeds. Similarly Gilreath (1986) working on gladiolus observed the excellent control of crab grass and pig weed due to application of alachlor + CIPC

Visual observations on crop toxicity ratings at 25, 45 and 65 DAP showed slight to moderate toxicity symptoms. All the herbicides did

not show any crop toxicity except in glyphosate 1.00 kg a.i./ha, which showed chlorosis of leaves at 25, DAP. All the cultural practices did not show any crop toxicity symptoms. On 45th day slight injury to the crop was observed in glyphosate 1.0 kg a.i./ha, all other treatments did not show any injury to the crop. Similarly, Baranowski (1974) working on China aster observed the phytotoxicity due to the application of tenuran (chloroxuron) at 6 kg/ha 10 days after transplanting. Freeland *et al.* (1981) observed that application of trifluralin 9 kg a.i./ha, oryzalin 2.2 kg a.i./ha and alachlor 4.5 kg a.i./ha, oryzalin 3.2 kg a.i./ha and alachlor 4.5 kg a.i./ha were injurious to snapdragon. Bing and Macksel (1984) reported phytotoxicity due to the application of 1.8 kg and 3.6 kg per acre of napropamide, 4.5 kg and 9.0 kg per acre of DCPA in flowering annuals of celosia, vinca, begonia and coleus. Defrank *et al.* (1989) noted that application of 3.3 or 6.6 kg oxadiazon were phytotoxic to anthurium leaves and emerging flowers, Narayanagowda and Muniyappa (1992) reported that application of pendimethalin at 1.25 kg a.i./ha showed slight toxicity to the china aster.

5.2 EFFECT OF WEED CONTROL TREATMENTS ON WEED GROWTH

5.2.1 Weed population per 0.25 m²

The number of grasses, broad leaf weeds, sedge and total weeds at all the crop growth stages (25, 45, 65 and at 85 DAP) differed significantly among the treatments (Tables 2 to 5).

Hand weeding recorded minimum weed density throughout the cropping season, since weeds were removed at regular intervals.. At 25 DAP all the weed control treatments recorded lower weed density proving their effectiveness in combating weed menace during initial stages of crop growth. Except unweeded control rest of the treatments recorded significantly lower grasses at all the stages of crop growth. Among the chemical treatments glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up recorded significantly lower grasses. This was mainly due to effectiveness of the integrated methods in combating grasses. The treatment with four hand weedings were effective at critical crop growth period, since the four hand weedings distributed during critical stages of crop growth period which did not allowed the weeds to establish. Higher grasses weed density in all the chemical treatments at later stages of crop growth justified their degradation and ineffectiveness. These results confirmed the findings of Rajamani *et al.* (1992).

Unweeded control recorded significantly higher number of broad leaf weeds as compared to all other treatments. All the herbicides used in combination with earthing up recorded significantly lower number of weeds over unweeded control. In general glyphosate 1.0 kg a.i./ha + earthing up recorded lowest number of broad leaf weeds followed by oxyfluorfen 0.1 kg a.i./ha + earthing up at all the stages of crop growth. The effectiveness of treatment glyphosate 1.0 kg a.i./ha + earthing up was due to

selective phytotoxicity of the herbicide and disturbance of late emerged weeds by earthing up. Similarly the oxyfluorfen 0.1 kg a.i./ha + earthing up suppressed the broad leaf weeds effectively.

Herbicidal treatments were not much effective in controlling sedges. Only glyphosate and oxyfluorfen were slightly effective in controlling sedges and the effectiveness of all other herbicides was relatively less. Since the sedges are known to be sprouting from 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-emergent herbicides. These results confirm the findings of Verma and Sharma (1977) on rose beds.

Total weed population was significantly higher in unweeded control and the lowest in hand weeding at all the crop growth stages. Glyphosate 1.0 kg a.i./ha + earthing up recorded lower number of total weeds which was on par with oxyfluorfen 0.1 kg a.i./ha + earthing up. These results suggest that the integration of herbicide and earthing up can keep the field free from weeds for a longer period of crop growth. Among the cultural methods, four hand weedings at 20, 45, 60 and 80 DAP recorded significantly lower weed density. Since hand weeding at 20, 45, 60 and at 80 DAP did not allowed the weeds to have profuse growth and establishment.

These results clearly indicated that herbicides were effective in increasing plant growth, early flowering and yield by suppressing the weed flora. Similar results were reported by Yadav and Bose (1987) in tuberose cv. Single and gladiolus with the application of 0.50 kg per ha oxyfluorfen which influenced on plant height and also effective in control of weeds were reported by Stewart *et al.* (1983) in gladiolus, Hatterman *et al.* (1987) observed the control of weeds by herbicides without reducing marketability in static flower and reduced the weed population was seen in petunia by EPTC and Napropamide at 2.7 kg per acre reported by Wilfreet and Burgis (1977), Narayanagowda and Jayanthi (1990) on rose.

5.2.2 Dry matter production of weeds (g/0.25 m²)

The dry matter production of weeds recorded at different stages is a better reflection of the efficiency of weed control treatments tested. Weed dry matter production of weeds was less at initial stages, but the weed dry matter production of weeds was maximum at 85 DAP. This was due to dominance of some weeds, which accumulated the biomass, suppressing the others. However, the results indicated that the weed control treatments tested were effective in checking the weed growth.

The dry matter production of grasses, broad leaf weeds, sedge and total weeds at different crop growth stages differed significantly due to weed control treatments.

With regard to the relative effectiveness of the weed control treatments tested for control of grasses at 85 DAP are oxyfluorfen 0.1 kg a.i./ha + earthing up and glyphosate 1.0 kg a.i./ha + earthing up were very efficient in controlling the growth of grasses. While only moderate control of weeds were observed in plot treated with pendimethalin 1.0 kg a.i./ha + earthing up and atrazine 1.0 kg a.i./ha. Dry matter production of grasses was the highest in unweeded control (24.66 g).

At 85 DAP glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up treatments were effective in control of broad leaf weeds and the highest dry matter of broad leaf weeds was obtained from unweeded control (41.34 g). The dry matter production of broad leaf weeds was higher as compared to grasses and sedges. Similarly Rajamani (1992) reported in Rose.

The dry matter production of sedges was the least in glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up.

Total dry matter production of weeds at harvest was the highest in unweeded control (102.40 g), while all the cultural practice with herbicidal treatments resulted in significantly lower dry matter production of weeds (25.66 to 61.46). Among herbicidal treatments glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up were very effective in controlling, weeds and their by decreased the dry matter production of

weeds. Lower weed dry matter production of weeds in weed control treatments may be ascribed to the less number of weeds, rapid depletion of carbohydrate reserve of weeds through rapid respiration and may also be due to inhibited photosynthetic activity as per Dakshinadas (1962).

5.2.3 Weed index (%)

Weed index indicating yield reduction due to weed competition was highest in unweeded control (40.98%) while the lowest (13.6%) was noticed in the treatment glyphosate 1.0 kg a.i./ha + earthing up followed by oxyfluorfen 0.1 kg a.i./ha + earthing up (19.40%). This may be due to unchecked weed growth in unweeded control, whereas satisfactory weed control in treatment oxyfluorfen 0.1 kg a.i./ha + earthing up and glyphosate 1.0 kg a.i./ha + earthing up which enable the crop to utilize available nutrients, moisture and space more effectively resulted in better growth and development and finally higher flower yield. The higher weed index obtained with unweeded control, pendimethalin 1.0 kg a.i./ha, atrazine 1.0 kg a.i./ha, these results in reduced crop growth and flower yield. This was mainly due to presence of higher number of weeds, which compete with crop. This is in conformity with findings of Stewart *et al.* (1983).

5.2.4 Weed control efficiency (%)

Needless to say the 96.36 per cent weed control efficiency in hand weeding because of prolonged weed free condition prevailed in that treatment. The next highest weed control efficiency (66.55 to 74.44%) was

obtained in case of oxyfluorfen 0.1 kg a.i./ha + earthing up and glyphosate 1.0 kg a.i./ha + earthing up, whereas, among other chemical treatments lowest weed control efficiency was obtained with pendimethalin 1.0 kg a.i./ha (39.90%) followed by atrazine 1.0 kg a.i./ha (48.76%). The higher weed control efficiency under these treatments can be accounted to the lower dry matter production of weeds per hectare. Anandamurthy and Narayanagowda (1992) recorded similar results with application of Diuron 1.0 kg and pendimethalin 1.25 kg a.i./ha in tuberose.

5.3 EFFECT OF DIFFERENT WEED CONTROL TREATMENTS ON CROP GROWTH AND YIELD

5.3.1 Crop growth

Vegetative growth is best measured in terms of number of leaves, number of shoot per plant and flower stalk length is an good indication of crop.

Number of leaves per plant differed significantly due to weed control treatments at all stages of crop growth except at 25 DAP. Hand weeding recorded higher number of leaves which was on par with all the herbicidal treatments and treatments in combination with earthing up. At 65 DAP maximum number of leaves was obtained from oxyfluorfen 0.1 kg a.i./ha + earthing up and glyphosate 1.0 kg a.i./ha + earthing up (86.17 to 116.84 treatments). At 85 DAP hand weeding (157.84) gave more number of leaves which was on par with glyphosate 1.0 kg a.i./ha + earthing up

(123.00). So this herbicide provided weed free condition in critical stages and have no adverse effect on rose. Lowest number of leaves was obtained from unweeded control (53.17). As observed in the present study, an increased LAI was reported by Basavaraju *et al.*, (1981) and Anandamurthy (1991) in China aster, gladiolus and tuberose, respectively due to less weeds owing to effective herbicides.

Number of shoots per plant differed significantly at 85 DAP. The higher number of shoots was obtained from hand weeding condition (18.34) followed by herbicidal treatments. Efficient utilization of moisture, light and nutrients by the crop due to maintenance of weed free condition throughout the crop growth period resulted in higher number of shoots per plant.

5.3.2 Quality components

Hand weeding recorded significantly the highest flower diameter at all the crop growth stages and was on par with glyphosate 1.0 kg a.i./ha + earthing up. Season long weed free condition in hand weeding and higher weed control efficiency in glyphosate 1.0 kg a.i./ha + earthing up attributed to better crop growth. As a consequence of this higher flower diameter was recorded. In three hand weeding treatment (hand weeding at 25, 40, 60 and 80 DAP) effective suppression of weeds during critical crop growth period combined with good physical condition of soil due to frequent hand weeding operations attributed for higher flower diameter.

Hand weeding recorded significantly the highest flower stalk length at all the crop growth stages and was highly on par with glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up. Season long weed free condition in hand weeding and higher weed control efficiency in glyphosate + earthing up attributed to better crop growth, as a consequence higher flower stalk length was recorded.

The flower stalk length and flower diameter are important quality attributes determining suitability as a cut flower. Quite often the value of the cut flowers generally varies with the flower stalk length and flower diameter. Usually cut flowers with longer stalk length and bigger size flowers fetch higher prices. This is obviously due to the usefulness of such flowers in flower arrangements, for making bouquets and garlands and even for their preference in beds, borders and in pot culture apart from its export value.

5.3.3 Fresh weight and dry weight of flowers (g/flower)

Significant difference in fresh and dry weight of flower was observed due to weed control treatments. The maximum fresh and dry weight of flower was recorded with hand weeding (12.62 and 4.58, respectively) followed by glyphosate 1.0 kg a.i./ha + earthing up, glyphosate 1.0 kg a.i./ha and oxyfluorfen 0.1 kg a.i./ha + earthing up treatments). The least fresh and dry weight of flower (6.20 and 1.23, respectively) was

obtained with unweeded control as reported by Anandamurthy (1991) on tuberose.

5.3.4 Flower yield (total number of flowers) per plant and per hectare

The flower yield per plant and number of flower per hectare (Table 12) indicate that there was significant difference at different stages of crop growth in the flower production due to weed control treatments. Hand weeding recorded highest number of flowers at different month interval of the crop growth followed by integrated treatments oxyfluorfen 0.1 kg a.i./ha + earthing up and glyphosate 1.0 kg a.i./ha + earthing up.

Flower yield per hectare (number of flowers) was significantly influenced by different weed control treatments. The maximum flower yield per hectare was recorded with hand weeding (1.52 lakhs flower/ha) which was on par with glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up, respectively. Efficient utilization of moisture, nutrients, space and light by the crop due to maintenance of weed free condition throughout the crop growth period resulted in higher flower yield per plant per hectare. Similarly, Yadav and Bose (1987), Mynett and Jagusz (1990) and Anandamurthy and Narayanagowda (1992) reported in gladiolus and tuberose Georgieva and Kazakova (1982), Kher (1986) in cherry.

5.3.6 Post harvest life of rose flowers

Use of preservatives to promote the quality and prolong the shelf life of cut flowers has been known from many years. Flower

preservatives composed mainly of two per cent sucrose. Loss of turgor due to depletion of water in cut flower contributes to deterioration. Chemically fortified flower preservatives have been shown to maintain turgor and prolong the cut flowers life. In the present investigation there was significant difference in uptake of solution except on 9th day. Treatments glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up recorded highest water uptake and least water uptake was noticed in unweeded control at throughout the vase life. At 7th day pendimethalin 1.0 kg a.i./ha recorded least water uptake. The total water uptake recorded least water uptake. The total water uptake during vase life was significantly differed among weed control treatments. The maximum water uptake of solution was recorded from glyphosate 1.0 kg a.i./ha + earthing up.

The different weed control treatments did not differ significantly on prolonging the vase life (in days) of cut flowers of rose. Even though there was difference in cumulative uptake of solution but was no difference in vase life of rose as influenced by different weed control treatments.

5.4 ECONOMICS OF DIFFERENT WEED CONTROL TREATMENTS IN ROSE

The highest net returns was obtained in hand weeding (Rs.247258/ha) followed by glyphosate + earthing up (Rs.205836/ha) and oxyfluorfen + earthing up (Rs.188058/ha). There is immediate need to work

out the cost of cultivation of all commercial flower crops with the use of different weed control treatments for the effective control of weeds. Similarly, Yadav and Bose (1987), Basavaraju (1989) and Anandamurthy (1991) reported on gladiolus, china aster and tuberose, respectively.

SUMMARY

VI. SUMMARY

Experiment entitled "Integrated weed management in Rose" was conducted during 1999-2000 at the Division of Horticultural Sciences, GKVK, University of agricultural Sciences, Bangalore-560065.

The experiment was laid out in randomised complete block design with ten treatments replicated thrice. Observations were recorded on weed, crop growth (at 25, 45, 65 and at 85 DAP) yield and yield components, and vase life of Rose flowers.

During the crop growth period monocot and sedge weeds were dominated over dicot. Among the weed control treatments glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up reduced the weed population next to hand weeding as compared to unweeded control.

In general weed control treatments recorded significantly lower number of weeds lower weed dry weight than unweeded control at all the stages of crop growth. Hand weeding recorded the lowest weed count and dry matter production of weeds as it maintained free of weeds throughout the crop growth period. However glyphosate 1.0 kg a.i./ha + earthing up recorded significantly lower weed count and dry matter production of weeds, which was on par with oxyfluorfen 0.1 kg a.i./ha + earthing up at all

the stages of crop growth. Mild phytotoxic symptoms were noticed in glyphosate 1.0 kg a.i./ha. However, the plants recovered in later stages.

Weed control efficiency was highly negatively correlated with dry weight of weeds at 25, 45, 65 and at 85 DAP. Glyphosate 1.0 kg a.i./ha + earthing up recorded significantly the highest weed control efficiency (74.94%), closely followed by oxyfluorfen 0.1 kg a.i./ha + earthing up (69.51) and was lower with pendimethalin 1.0 kg a.i./ha (39.90%) and unweeded control

Weed index was highly negatively correlated with yield. Percent reduction in yield of rose flower due to weed infestation was significantly higher in unweeded control (40.78) followed by pendimethalin 1.0 kg a.i./ha (34.95), whereas, the lowest yield reduction was in glyphosate 1.0 kg a.i./ha + earthing up (13.57) followed by oxyfluorfen 0.1 kg a.i./ha + earthing up (10.40).

Number of leaves differed significantly at all the crop growth stages owing to different weed control treatments. Hand weeding recorded highest number of leaves, which was on par with glyphosate 1.0 kg a.i./ha + earthing up at all, stages of crop growth.

Flower diameter was increased due to application of glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up next to hand weeding. The quality parameters such as flower diameter and flower stalk length were significantly increased with weed control treatments.

Flower diameter and flower stalk length were maximum with glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up next to the hand weeding.

There was remarkable increase in yield of flowers per plant due to application of glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up next to hand weeding. Dry matter production of flower was more with the treatments glyphosate 1.0 kg a.i./ha + earthing up and oxyfluorfen 0.1 kg a.i./ha + earthing up next to hand weeding.

Herbicides applied in control of weed did not influence the vase life of rose flowers.

The highest net return were obtained in hand weeding (Rs.247258/ha) followed by glyphosate 1.0 kg a.i./ha + earthing up (Rs.205836/ha) and oxyfluorfen 0.1 kg a.i./ha + earthing up (Rs.188088/ha), while unweeded control (Rs.65482/ha).

Cost benefit ratio was highest with hand weeding at 20, 40, 60 and 80 DAP (Rs.3.95) followed by glyphosate 1.0 kg a.i./ha + earthing up (Rs.3.42) and oxyfluorfen 0.1 kg a.i./ha + earthing up (Rs.3.12) whereas low cost benefit ratio with unweeded control (Rs.1.13). Among herbicidal treatments pendimethalin 1.0 kg a.i./ha recorded lowest cost benefit ratio (Rs.2.36).

Practical application of the results

Based on the results of the investigation carried out on the weed management practices in rose, the practical applicability of the results obtained is indicated below.

Application of glyphosate 1.0 kg a.i./ha applied as post emergent at 20 DAP resulted in higher flower yield and net returns besides giving effective weed control. Next best promising treatment was oxyfluorfen 0.1 kg a.i./ha + earthing up applied as pre-emergent.

These herbicides along with earthing up found to be promising to control weeds in Rose and would play an important role in areas where labour is too costly, scarce and at times not available.

It may be recommended that for use of glyphosate 1.0 kg a.i./ha and oxyfluorfen 0.1 kg a.i./ha + earthing up to control weeds in rose cultivation on commercial scale.

Future line of work

The aspects of which future investigation in weed management practices in rose suggested are as under.

1. The effect of different herbicides along with cultural practices on type of weed flora controlled is needed to be studied.
2. Use of mixtures of herbicides to achieve broad spectrum of weed control.
3. Need for weed management practices for rose based cropping system.
4. Residual effect of herbicides on succeeding crop needs to be studied.
5. Study on effect of these herbicides on soil microflora and fauna is needed.

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* *Original not seen*

APPENDICES

APPENDIX I

The physical and chemical properties of soil of the experimental site at
GKVK, Bangalore

Sl. No	Particulars	Value (0-15 cm)	Methods adopted
I	Mechanical analysis		
	1. Coarse sand (%)	34.55	International Pipette Method (Piper, 1966)
	2. Fine sand (%)	38.00	
	3. Silt (%)	8.60	
	4. Clay (%)	18.90	
	5. Textural class		Red sandy loam
II	Physical properties		
	1. Bulk density (g cc-1)	1.39	Coarse sample method (Piper, 1950)
	2. Moisture at field capacity (%)	14.30	Field method (Piper, 1950)
	3. Moisture at 15 bar (%)	6.50	Pressure plate method (Richards, 1954)
III	Physico-chemical properties		
	1. Soil pH (2.5)	6.0	Potentiometry (Jackson, 1973)
	2. Electrical conductivity (ds m-1 at 25°C)	0.08	Conductometry (Jackson, 1973)
IV	Chemical properties		
	1. Organic carbon (%)	0.53	Walkely and Blackwet oxidation method (Jackson, 1973)
	2. Available nitrogen (kg ha-1)	320	Alkaline permanganate method (Jackson, 1973)
	3. Available P ₂ O ₅ (kg ha-1)	65.0	Bray's extraction method (Jackson, 1973)
	4. Available K ₂ O (kg ha-1)	195.0	Neutral normal ammonium acetate method (Jackson, 1973)

APPENDIX II

Normal mean of (1975-97) and actual (1999) monthly meteorological data prevailed at University of Agricultural Sciences, GKVK, Bangalore

Months	Total rainfall (mm)			Mean maximum temperature (°C)			Mean minimum temperature (°C)			Relative humidity (%)			Mean daily sunshine hours			Open pan evaporation mm/day		
	N	A	D	N	A	D	N	A	D	N	A	D	N	A	D	N	A	D
July	100.9	49.4	-51.5	29.9	28.0	-1.9	18.7	19.0	+0.3	72	89	+17	4.6	3.8	-0.8	5.8	4.3	-1.5
August	115.3	205.8	+90.5	28.4	27.7	+0.7	18.6	19.4	+0.8	73	91	+18	4.8	4.3	-0.5	5.5	4.2	-1.3
September	207.9	238.7	+30.8	27.8	28.5	+0.7	18.6	19.1	+0.5	73	89	+16	5.4	6.6	+1.2	5.5	4.1	-1.4
Total rainfall of the season	424.1	493.9	69.8															

N = Normal (1975-97)
A = Actual (July-September)
D = Deviation

APPENDIX III

List of herbicides used in the experiment along with common name, trade name and address of the manufacturer

Sl. No.	Herbicides		Cost of the chemical	Name and address of the manufacturer
	Common name	Trade name		
1	Pendimethalin	Stomp (30 E.C.)	Rs.450 per litre	Cyanamide Agro Ltd., Mumbai-400025
2	Oxyfluorfen	Goal (23.5 E.C.)	Rs.1700 per litre	BAYER India Ltd., Mumbai
3	Glyphosate	Round up (41 SL)	Rs.400 per litre	M/s Mansanto Enterprises Pvt. Ltd., Mumbai-400038.
4	Atrazine	Atrataf (50 WP)	Rs.350 per litre	Rallie India Ltd., Bangalore