

ALLELOPATHIC EFFECT OF TEAK
AND CASUARINA ON THE
PERFORMANCE OF GREENGRAM
(*Vigna radiata* L.)

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ALLELOPATHIC EFFECT OF TEAK AND
CASUARINA ON THE PERFORMANCE
OF GREENGRAM (*Vigna radiata* L.)

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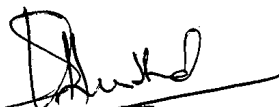
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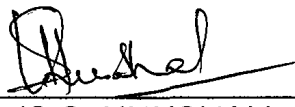
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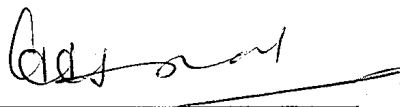
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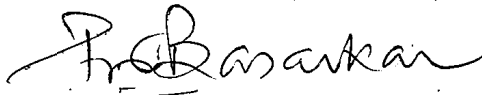
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*DEDICATED TO MY
BELOVED PARENTS*

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INTRODUCTION

I INTRODUCTION

India is losing about 50 million tonnes of food grains each year on account of loss of top fertile soil caused by deforestation which is a result of increasing population pressure. So to safeguard the long range interest of environment the National Forest Policy envisaged that an area of 110 million ha should be under forests keeping future social, economic and environmental requirements. However, the total area currently under forest cover is only about 75 million ha (Deb Roy and Gill , 1990). This situation is a result of burgeoning human and animal population as well as degradation of natural resources at an alarming rate which has led to an unbearable pressure on the forests for fuel, timber and fodder. Thus, to meet these multiple demands the lands under marginal, sub-marginal as well as cultivated lands are put under trees without impairing the food grain production capacity.. Keeping the long-range interest of both agriculture and forestry, the National Commission on Agriculture laid greater emphasis on “Agroforestry” to meet the needs of rural lot besides conserving natural resources.

Although trees were grown in agricultural land since generations the research efforts to improve the system have been initiated quite recently. Agroforestry combines the production of crops and forest/fruit trees simultaneously on the same unit of land and applies management practices compatible with the local cultural practices (King and Chandler, 1998).

Trees which are recommended for an agroforestry system ought to have some specific characters such as fast growth rate, good forage, food and wood value, morphology-which should permit the penetration of light to the ground etc. Among the trees recommended for agroforestry programme, multipurpose nitrogen fixing trees are seen as ideal as they contribute to the overall productivity and help to stabilize and enrich the soil.

Despite the fact that agroforestry gives supplementary returns per unit of land it has been criticized for adverse effects of trees for dominating the understory field crops in utilizing the limited growth resources (nutrients, moisture and light) (Rao *et al.*, 1998). Added to this, release of organic compounds with inhibitory effects on other organisms (allelopathy) is considered as an additional factor affecting growth conditions in any plant-plant environment (Rice, 1984). Tree-crops interactions, which are quite complex in nature, are of paramount importance in any agroforestry system to understand clearly (Tripathi *et al.*, 1998).

The research work carried out in the recent years has shown that it is not only the competition for physical growth resources but also interference of allelochemicals released by tree parts determine the performance of associated crops. This phenomenon of interference (phytotoxicity) was termed as "allelopathy" by Molisch in 1937.

Allelopathy is the effect of one plant on other associated plants and/or micro-organisms through release of chemicals and their breakdown metabolites. Phenolic acids and associated compounds are the most common growth inhibitors produced by living plants or released from decaying plant parts by microbial action or leaching or volatilisation process (Rice, 1984).

Allelopathy has both advantages and disadvantages as it helps in weed control through inhibiting the weed growth ; controls some diseases, nematodes and insects ; and influences nitrogen fixation capacity in leguminous crops. Some of the dis-advantages are inhibitory effect of one crop on another by releasing some of allelochemicals may reduce the nitrogen fixing capacity of plants, may kill some of beneficial micro-organisms, may hinder uptake of nutrients and bring about changes in the physico-chemical properties of soil.

With the increased recognition of agroforestry as an alternative land use system, several scientists have focussed their attention on trees (Palmberg, 1980). Like any living plant/organism, trees also release several phytotoxins or allelochemicals from leaves, stem, bark, roots, flowers, seeds, pollens and fruits which influence the growth of understorey vegetation (Suresh and Rai, 1988).

Allelopathic influence of multipurpose agroforestry tree species on crops is being investigated. Trees produce a large quantity of litter resulting in production/release of number of chemicals or organic compounds which vary in their chemical composition and concentration,

and they affect the growth of understorey vegetation (Tripathi *et al.*, 1998).

Allelochemicals mostly refer to the secondary metabolites produced by plants and are by-products of primary metabolic processes which are produced by all kinds of trees and tree parts with leaf being the main source and they escape into environment (soil) through exudation, leaching, volatilisation and decaying/decomposition which again depends on climatic and soil factors. According to Rice (1984), the allelopathy is depends upon radiation, mineral deficiencies, water stress, temperature, allelopathic agents, age of the plant organs(parts), genetics and pathogen predators. The compounds responsible for allelopathy range from simple aliphatic acids to complex terpenoides, phenols, alkaloids and steroids and affect through different mechanisms/mode of action.

Since it is a relatively new and latest area of research, one finds that field studies on allelopathic effect of tree species on associated crops has been quite limited in almost all the agroforestry tree species limiting to laboratory investigations in a few selected species *viz.*, teak (*Tectona grandis*), casuarina (*Casuarina equisetifolia*) and eucalyptus (*Eucalyptus tereticornis*) besides others.

In India, most of the allelopathic investigations are based on bioassay studies (Datta and Chatterjee, 1980; Melkania, 1984) and less successful attempts have been made to analyse the allelochemicals and to confirm allelopathy in field conditions. In fact, under natural conditions, the fate of allelochemicals depends on several interrelated factors including chemical disintegration of the allelochemicals.

Therefore, *in vitro* research cannot be perfectly true under *in vivo* conditions.

Further, only a limited number of crop species have been screened against the allelopathic potential of over storey species and other herbs. The action of allelopathy is selective; the toxic potential of a species cannot be generalized for all the associated species. Studies on the relative allelopathic potential of the plant parts, soil, the effect of seasonality and pheromones etc. on the toxic potential are meagre even under laboratory conditions.

Hence, in the present investigation, two field experiments were carried out one each with teak and casuarina to study the existence of their allelopathic effect on greengram crop under field conditions. The pot experiment was also carried out to evaluate the allelopathic effect of eucalyptus, teak and casuarina leachates on different cereals, pulses and oilseed crops. The objectives were as follows.

1. To study the allelopathic effect of teak (*Tectona grandis* L.) and casuarina (*Casuarina equisetifolia* L.) on greengram crop.
2. To assess the allelopathic effect of teak and casuarina on the nutrient availability and uptake of nutrients by greengram at critical stages of crop growth, and
3. To study soil moisture status at different crop growth stages as influenced by tree – crop interactions.

REVIEW OF LITERATURE

II REVIEW OF LITERATURE

The literature on allelopathic effects of various agroforestry systems involving teak, casuarina as well as eucalyptus has been reviewed. However, the literature on allelopathic effect of teak and casuarina on greengram crop is quite meager and hence other related crops have been reviewed in this chapter.

2.1 AGROFORESTRY

Agroforestry is a practice of managing or using land (alternate land use system) that combines trees with agricultural crops or horticultural crops or livestock. It will satisfy changing human needs while maintaining the quality of environment and conserving the natural resources. It improves soil physical and chemical properties and promotes nutrient cycling (Patil, 1999).

Nair (1983) opined that agroforestry is a land use system that involves socially and ecologically acceptable integration of trees with agricultural crops and/or animals simultaneously / sequentially so as to get increased total productivity from a unit of land, especially under conditions of low levels of technological inputs and marginal lands

Huxley (1983) was of the opinion that the agroforestry system provides multiple outputs from the same unit of land in a sustainable way and there are interactions between the two or more constituent plant species and one of which at least is a woody perennial.

2.2 RESOURCE USE IN AGROFORESTRY

Usually above ground resources include space and light. These resource sharing depends upon the age of the tree species and crops. The amount of light intercepted by tree depends on the amount of incident light and fraction of light intercepted through canopy. The rate of drymatter production by a crop is primarily determined by the amount of solar radiation intercepted by its foliage.

Low light intensity is one of the important constraints for higher yield. It will be more pronounced in an agroforestry system since one of the components (tree) is tall. The degree of shading to annual crops depends on the proportion of land occupied by tree canopy and its direction of alignment in crop production.

2.2.1 Light

Dhillon *et al.* (1982) reported that the yield of wheat, barley, potato and rice was adversely affected due to eucalyptus plantation at Ludhiana. The adversity of the eucalyptus varied with the direction of tree, time and purpose for which the crop was sown. The distance up to which the tree affected the crop depended on the tree crown, cropping season and type of crops. Hence management of the tree with respect to its canopy and the rooting habit appears to be very important in minimizing the adverse effect. The authors found that the tree had the adverse effect up to a distance of 32.16 m away from the tree line. The percent reduction in yield varied from 50.1 per cent at 1 m to 0.3 per

cent at 16m from the tree line. The lesser reduction in wheat yield on the southern side as compared to the northern side was attributed to better light received on the southern side, which increased the photosynthetic efficiency (Wassinck, 1954).

Relatively lesser yield reduction of wheat, rice and potato was reported when the crop was grown with trees in N-S direction and this was attributed to the fact that the crops on both sides might have received sufficient light for photosynthesis because when sun rises and sets in it eliminates shade effects on the eastern side in the forenoon and the western side in the afternoon. They have further indicated that the eastern side gives more yield than western side, which was attributed to the more photosynthetic activity of plants during early hours of morning when the plants have sufficient water for photosynthesis. It is, therefore, advisable to plant the tree in N-S direction to minimize reduction in yield of different crops grown along with the tree line. Drymatter production was lower due to decreased photosynthesis in paddy under shaded conditions (Hesse, 1984).

Oneywotu and Stigter (1995) reported that the shade pattern of eucalyptus shelterbelt was confined to an area of 6m from the tree row.

At Dharwad (Karnataka), highest light transmission ratio (LTR) was observed in teak followed by eucalyptus, leucaena and casuarina (Chandrasekaraiah, 1986 ; Bhat, 1988). Maize yield decreased almost proportionately up to 50 per cent with reduction in radiation (ICRAF, 1993). Plant stand and growth of pearl millet and cluster bean plants

were poor in the vicinity of *Acacia nilotica* trees up to 7.5m and uninhibited beyond 30m (Dhushan and Lakshminarayan, 1995).

The amount of light intercepted by an agroforestry system depends on the amount of incident light and the fraction of light intercepted through the system to the soil surface. Shading affects understorey crops by reducing temperature and the amount (quality) of light when competition for water and light favors the tree component, the tree canopy may suppress the crop canopy and reduce the crop light interception and productivity.

2.3 BELOW GROUND RESOURCE INTERACTION

Conventional belief suggests that trees and crops are complementary to each other because they exploit moisture and nutrients from different soil depths. This portrays trees as ideal “Nutrient pumps” and complementary uncompetitive extractors of water from the soil profile. Recent evidence indicated that trees aggressively exploit the crop root zone for nutrients and water (Mutanal, 1998).

2.3.1 Moisture / Soil water

Onyewotu and Stigter (1995) studied on eucalyptus shelterbelts and reported that most of the tree roots were distributed in the top 70 cm of soil and consisted of fine roots, which reached as far as 18m from the shelterbelt. Comparison of root pruned and non-root pruned plots showed that in the rainy season soil water near the unpruned trees was

significantly higher at and beyond 24m than it was closer to the trees (i.e. it matched root distribution) and that the distances 6m from the trees it was 20-30 per cent lower in non-root pruned plots. The millet yields were very poor up to 18m from unpruned trees. In the root pruned plots between 6 and 18m from the shelter belts millet yields were much higher, showing a reduction of only about 20 per cent which is attributed to shade. Grewal (1995) reported that eucalyptus consumed about 29 per cent more water from the soil profile than field crops.

It is evident that the resources like moisture, nutrient and recently attributed allelopathic interferences to be the most limiting factors in agroforestry. The overall demand for moisture is primarily determined by climatic factors and by the species composition of a complete canopy. As soil reserves are depleted, interplant competition may develop, the effect of this in a mixed species situation depend largely on the distribution and efficiency of the root system of the species.

Trenbath (1991) opined that component crops in a crop mixture may exploit different soil layers, thus in a combination they may exploit a greater total volume of soil. Having said that in any time of agroforestry system the competition for moisture is the most critical. Since fast growing trees absorb more moisture, the agricultural crops suffer due to lack of moisture. This competition depends on distribution and efficiency of the root system of the species involved. Chandrashekharaiiah (1986) noticed more moisture depletion under bamboo followed by casuarina, sissoo and eucalyptus and least under subabul.

2.3.2 Soil Nutrients

Growing of perennial tree species either for timber, firewood or for forage in a agroforestry system may bring about changes in physical and chemical properties of soil as they add dried leaves, branches and roots.

Chandrashekharaih (1986) reported increased available P_2O_5 under casuarina, *Dalbergia sissoo* and bamboo. The soil organic carbon and available K_2O increased by the influence of all tested tree species.

Organic carbon, available P_2O_5 and K_2O levels in soils immediately adjacent to the tree line were less than those at 2.7m and 5.4m from the tree line (Nadagouda, 1990).

Various agroforestry studies involving mixtures of trees and crop indicated existence of competition between them. The competition was more near the tree and decreased with increasing distance from the tree.

Hazra and Tripathi (1986) tried various trees in agroforestry and observed marked decrease in pH, EC and increase in organic carbon, available phosphorus and potassium. Similarly, organic carbon, available phosphorus and potassium increased due to presence of teak, *Dalbergia sissoo*, eucalyptus, *Acacia catechu* and *A. nilotica* at Bijapur (Itnal, 1987) and tree species viz., *Acacia auriculiformis*, *D. latifolia*, *D. sissoo*, eucalyptus, leucaena and teak at Raichur (Nadagouda, 1990).

2.4 COMPATIBILITY

Crops differ in their compatibility with different tree species. Different crops may respond in different way in association with different species of trees with respect to their growth and yield (Narwal, 1994).

Jayakodaya and Gunasena (1998) reported that performance (with respect to germination and seedling growth) of the glyricidia-cowpea combination was significantly poor than that of cowpea whereas the performance of the Glyricidia-rice combination was significantly better than that of the rice, indicating lower compatibility of cowpea than rice with glyricidia. At Bellary, Karnataka state. *Acacia nilotica* caused greater yield reduction in *rabi* sorghum and safflower than eucalyptus and the reduction was attributed to the competition for moisture, which increased with age (Srivastava, 1983).

2.5 *Tectona grandis*

Teak belongs to the family ; Verbenaceae. It is considered as king of timber species. It is deciduous in nature, straight, cylindrical bole with sparse canopy (if properly pruned and maintained) and deep root system which together make it more suitable for agroforestry system. Its durability, strength properties, workability, polishing qualities and versatile utility offer a distinctive position in worldwide timber trade. This tree can be integrated into agricultural system which is capable of meeting the present challenges of timber and fuel wood requirement for marginal and small farmers either by zonal or boundary planting.

In Karnataka teak forests cover an area of 77,900 ha with an annual production of 7080m³ (Kadambi, 1993). Farmers choose teak because of its high timber value, ready market and assured return as timber. Hence it is called as "Green gold". The leaves of this tree start shedding from November to January and it remains "naked". Teak is a fairly quick growing tree with annual girth increment of 5cm under proper conditions. It thrives in soils ranging from sandy to clay loams. It is a strong light demander, sensitive to drought, coppices and pollard vigorously.

Crops differ in their compatibility with teak based on site conditions, availability of growth resources in addition to allelopathic interferences.

2.5.1 Compatibility

It was reported that the crops like hill-paddy, chillies, ragi, tapioca, horsegram, ginger and blackgram can be grown along with teak without loss of height (Anon, 1949). Teak growth and yields of paddy and pulse crops were not affected appreciably by their combinations (Kapp, 1988).

2.5.2 Laboratory Studies

2.5.2.1 Leaf leachate

Jadhav and Gaynar (1992 and 1994) opined that the leaf leachates of teak and acacia inhibited germination of rice and cowpea, among them cowpea was more sensitive than rice.

Plumule and radicle growth of rice were inhibited by leachates, however in cowpea plumule growth was more inhibited than radicle growth. The inhibition increased progressively with leaf powder soaking time and radicle growth of cowpea was actually stimulated by short soaking time leachates. The leaf extracts of *Eucalyptus globulus* on the mineral uptake by sorghum revealed that the uptake of Zn, Ca and Mg were more affected than K, P, Fe or Mn by extract exposure and all nutrients uptake was reduced (Pawar and Chavan, 1999).

Tripathi *et al.* (1998) reported that the leaf extracts of *Tectona grandis*, *Albizia lebbek* and *Acacia* species showed stimulatory effects on germination, growth, chlorophyll, carbohydrates and protein content of soybean. The stimulatory activity was in the order of soil > leaf > root extracts.

The leaf leachate of *Tectona grandis* at 10 per cent concentration reduced the chlorophyll and diosgenin content of *Costus speciosa* a steroid precursor (Konar, 1998).

The aqueous extracts of dry teak leaves inhibited root and shoot growth of rice seedlings developing from seeds germinated on filter paper soaked in extracts (Mandal *et al.*, 1998).

Channal *et al.* (2000) opined that the leaf extract of teak at 5 to 10 per cent promoted germination in sorghum (15-32% over the control), but decreased seedling length of sorghum and also drymatter in sorghum and rice at both concentrations.

2.5.2.2 Root and / Bark leachate

Panneerselvam *et al.* (1998) showed that aqueous extracts of root and fully mature leaf leachate of *Tectona grandis* reduced the shoot length, root length, leaf area and chlorophyll content of peanut and maize seedlings. The allelopathic effects of these extracts were minimum in the early stages of growth and it increased with age of seedlings.

Swaminathan (1996) reported the bark leachate of *Tectona grandis* inhibited the germination, plumule elongation and radicle growth of maize, pigeonpea and sesame. Higher inhibition was on sesame and least on pigeonpea.

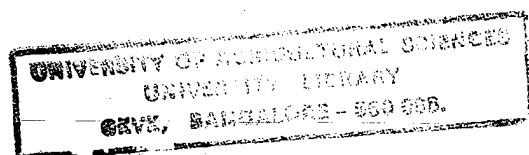
2.5.2.3 Monocarp extract

Masilamani *et al.* (1998) reported the monocarp extract of teak inhibited significantly the germination of soybean and cowpea.

2.5.2.4 Allelochemicals

Tripathi *et al.* (1998) reported the leaves of *Tectona grandis*, *Albizia lebbek* and *Acacia* were rich in phenols, poor in proteins and contained traces of alkaloids but were free from flavonoid, steroid and saponins.

Benzoic (BEN) and Cinnamic (CIN) acids are commonly found in soils and are considered as strong allelochemicals. It was suggested that BEN and CIN and other phenolic acids decrease plant growth in part by suppressing nutrient absorption. BEN and CIN lower the extra cellular



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sulfhydryl - group content in roots. These two allelochemicals induce lipid peroxidation, which results from free radical formation in plasma membranes, inhibit catalase and peroxidase activities and sulfhydryl - group depletion. It is concluded that the BEN and CIN induced decrease in soybean nutrient absorption may be a consequence of damage to cell membrane integrity caused by decrease in sulfhydryl - groups followed by lipid peroxidation (Baziramakenga *et al.*, 1997).

Tripathi *et al.* (1999) reported that polyphenols and glycosides were present in root, leaf and soil extracts of teak and their concentration was in the order of root and leaves and soil. HPLC revealed the presence of four phenolic acids in leaves, six in roots and six in soil extracts.

Panneerselvam *et al.* (1998) reported that the fully mature leaves contained phenolic compounds like p-chlorogenic acid, coumaric acid and ferulic acid and few unidentified phenolic compounds. At least two inhibitors and two stimulators were identified in the extracts of dry teak leaves (Mandal *et al.*, 1998).

Ramamurthy and Paliwal (1993) reported that *Glyricidia sepium* also contains coumarin and ferulic acid allelo-chemicals including other 13 allelochemicals. Li *et al.* (1993) opined soils collected from *Quercus mongolica* also contained ferulic acids and p-coumaric acids and were 3542 and 13382 μg per 100g soil, respectively. They concluded that these allelochemicals might have important roles in the distribution of forest species and understorey vegetation.

Kupidlowska *et al.* (1994) studied the effects of $6.8 \times 10^{-4}\text{m}$ coumarin on root elongation and cell structure of root meristems in

cucumbers, maize and garden peas. Cucumber seedlings were much more sensitive to coumarin than maize but garden peas were resistant. In sensitive plants coumarin affected the endomembrane system mostly dictyosomes and the endoplasmic reticulum. They stimulated the fragmentation of endoplasmic reticulum, cisternae and decreased the number of dictyosomes, which become less active. The mitochondrial matrix becomes condensed indicating a possible energy shortage in the cell.

2.5.2.5 Field Studies

Nadagouda (1990) reported that four-year-old trees of teak and eucalyptus reduced grain yield of groundnut by 20.4 and 41.6 per cent, respectively under irrigated condition.

Singh and Kohli (1992) reported the contents of soil phytotoxins (allelopathins) in different soil samples and measured the influence by assessing the effects on EDTA extracts of the soil on the germination of *Lens culinaris* (Lentil). Soil phytotoxins were maximum in the litter free soil surface (compared with the amounts found at 30 or 60 cm depths) at all distances from eucalyptus shelterbelt. The maximum content of phytotoxins was found at one meter distance from the tree line for all depths.

Jose and Gillespie (1998) conducted a study to quantify the spatial and temporal variation in soil juglone (5-hydroxy-1, 4-napthoquinone) in a 10 years old black walnut (*Juglans nigra*) maize alley cropping system. Juglone concentration decreased as much as 80per cent as the distance increased to 4.25 m from the tree row.

Mutanal (1998) reported grain/pod yield of sorghum/groundnut was higher in sole crop as compared to sorghum/groundnut with teak, teak plus grass or teak plus subabul. Grain/pod yield was higher on western side as compared to eastern side of teak alley. Grain/pod yield was increased with increase in distance from teak alley.

Patil (1999) reported wheat was adversely affected till 9 m from teak tree row. The greengram recorded lower yield till 12 m from eucalyptus tree row (Yekkelli, 1999). The adverse effect was attributed to allelopathic effect.

2.6 *Casuarina equisetifolia*

It belongs to the family Casuarinaceae and most of the species are native to Australia. It produces top quality firewood and is rapid growing and requires less care. It is planted to control erosion along coastal line, riverbanks and waterways because of the network of fine subsurface roots and needles that fall on the ground surface. It has root nodules containing nitrogen-fixing actinomycetes. Of late its value as wind break especially around fruit plantation is increasing. In many parts of the globe *Casuarina* spp. have been introduced for fuel and as wind breaks and landscaping. The species are known to survive in introduced area ranging from coastal areas to high altitudes, and often tolerate mild frosts. As wind breaks, *C. equisetifolia* is planted in many countries especially in Egypt, China, Senegal and India. In wind prone areas, planting casuarina bordering annual crops can considerably reduce damage and increase the yields.

2.6.1 Laboratory Studies

2.6.1.1 Leaf leachate

Jadhav and Gaynar (1995) reported the leaf leachates of *Casuarina equisetifolia* significantly affected germination and drymatter production in rice and cowpea. Rice was more sensitive to leachates than cowpea.

Singh (1993) concluded that the leaf leachate of casuarina inhibited and reduced radicle length and plumule length of sorghum, sunflower and cowpea. More pronounced effect was seen on radicle length than plumule length in rice but reverse was true in cowpea. Likewise sorghum and sunflower radicle length was affected more by leaf-leachates of casuarina than plumule length. Cowpea was less susceptible than sorghum.

John *et al.* (1999) reported that the leaf fall of *Casuarina equisetifolia* inhibited significantly the germination and growth of rice and cowpea. Response indices revealed that the inhibition of radicle and plumule growth was more pronounced than that of germination.

Suresh and Rai (1987) also observed inhibition of cowpea radicle development by casuarina leaf leachates. The plumule drymatter of rice and cowpea was reduced by same magnitude by the leachates but showed differential effect on accumulation of drymatter in radical of cowpea and rice wherein drastic reduction was noticed in rice. The differential inhibition by leaf leachates may be due to differential response of cells in presence of allelochemicals.

John and Nair (1999) reported inhibiting effect of casuarina leaf leachates on germination, plumule growth and radicle growth in rice and cowpea. Batish *et al.*, (1998) observed that leachates from fresh *Casuarina equisetifolia* leaves and litter and the understorey soil were rich in phenolics and exhibited phytotoxic effects against the species. Both the germination and seedling growth of *Bidens pinnata* and *Parthenium hysterophorus* species significantly reduced in response to leachates of the soils, leaves and litter of *C. equisetifolia*. The results indicated that allelopathy played a significant role in regulating the understorey vegetation dynamics of *C. equisetifolia*.

2.6.1.2 Bark leachate

Swaminathan (1996) reported that the bark leachates of *Casuarina equisetifolia* are most inhibitory to germination and radicle growth and elongation of sesame, maize and pigeonpea. The inhibitory effect was higher on sesame and least on pigeonpea. The inhibition was due to phytotoxins present in the extracts rather than osmotic inhibition.

2.6.1.3 Field Studies

Story (1967) attributed the lack of herbaceous growth under casuarinas species to allelopathic effect.

Batish *et al.*, (1998) opined that the vegetation under 14-years-old plantations of casuarina was affected compared to the vegetation at adjoining areas. The number of plants, species, diversity and biomass

were greatly reduced under the plantations. *Bidens pinnata* and *Parthenium hysterophorus*, which are excluded from the plantations area but were present in the adjoining area. The results indicated that allelopathy played a significant role in regulating the understorey vegetation dynamics of *C. equisetifolia*.

Patil (1999) reported that wheat crop was adversely affected till 6 m from casuarina tree row. Greengram recorded lower yield till 12m from eucalyptus tree row (Yekkelli, 1999). The adverse effect was attributed to allelopathic effect.

Swaminathan *et al.* (1999) found that the mean yield of vegetables declined from 49.6 q/ha in casuarina and 39.2 q/ha in eucalyptus association to 0.8 q/ha and 0.14 q/ha, respectively at the end of 6th year. All vegetables like moringa, bittergourd, clusterbean and vegetable cowpea grown in association with eucalyptus and casuarina showed dismal performance from fourth year onwards and it may be perhaps due to allelopathic effects.

2.6.1.4 Allelochemicals

June (1976) reported the presence of phytotoxins, phenolic, terpenoids and organic cyanamides in casuarina leachates to cause allelopathic effect.

Gui *et al.* (1996) reported five allelochemicals from casuarina leachates *viz.*, kaempferol-3- α -rhamnoside, quercetin-3- α -rhamnoside, Luteolin - 3, 4, dimethoxy - 7 β rhamnoside, Kaempferol - 3 - β

dirhamnoside and queracetin-3-beta- glucoside of which the first three have greater toxicity.

Batish *et al.*, (1998) observed that leachates from fresh *Casuarina equisetifolia* leaves and litter and the understorey soil were rich in phenolics.

2.7 *Eucalyptus tereticornis*

It belongs to the family Myrtaceae. This species was introduced in India as early as 18th century. The most promising and widely grown and accepted species are *E. globulus*, *E.tereticornis*, *E. citriodora*, *E.camaldulensis* and *E. grandis*.

Eucalyptus tereticornis is popularly known as eucalyptus hybrid and is planted extensively throughout the country on a large scale both in forest and agroforestry as it has wide adaptations.

Eucalyptus is one of the most controversial tree species in agroforestry system. Because of its fast growing nature, it extracts more moisture and nutrients from the soil. At the same time it is an efficient plant for moisture utilization and ranks first in drymatter production per unit of water consumed. There are reports indicating negative effects (both due to resource competition and allelopathy) on adjacent agricultural crops.

2.7.1 Laboratory Studies

2.7.1.1 Leachates

Srinivasan *et al.* (1990) studied the effect of leachates of eucalyptus on blackgram, greengram, cowpea, pigeonpea and soybean. Among these crops, cowpea was most tolerant and soybean was the most sensitive crop.

Melkania (1984) found that *E. globulus* produced volatile substance that inhibited root growth of cucumber seedlings and hypocotyle growth.

2.7.1.2 Leaf leachate

A comparative study of leaf leachates of different tree species revealed that the inhibitory activity of leaf leachates was in the order of *Leucaena leucocephala* > *Populus deltoids* > *Eucalyptus tereticornis* > *Bauhinia variegata* while that of root leachate was in the order of *B.variegata* > *E. tereticornis* = *P.deltoids* > *L.leucocephala*. The effects were concentration dependent and considered to be caused by glucosides and polyphenols and conjugation, which were present in relatively high concentration in the leachates. (Tripathi *et al.*, 1996).

John and Nair (1999) reported leaf leachates of *Eucalyptus tereticornis* inhibiting the germination of rice and also plumule length and radicle growth and greater inhibition of root growth. It is concluded that allelopathic interactions may occur through the leaching of inhibitors and decay of fallen leaves. Implications for agroforestry

management are suggested including the selection of trees with the least inhibitory allelopathic activity and intercropping techniques.

Leaf leachates of *E. tereticornis* inhibited germination of *Oryza sativa*, *Arachis hypogaea* and *Eleusine coracana* (Phlomia and Srivasuki, 1996).

Seed germination of maize, blackgram, sorghum, groundnut, cowpea and soybean was inhibited by eucalyptus leaf extract. Groundnut and cowpea were the most tolerant (4 and 6% decrease in germination respectively compared to control), whereas inhibition was high in sorghum (16.3%), soybean (19.9%), maize (8.9%) and blackgram (7.1%) (Devsagayam and Ebenezer, 1996).

Sreedevi *et al.* (1996) reported that *Eucalyptus tereticornis* leaf extracts had significant adverse effect on the germination of pigeonpea, groundnut, sunflower, sorghum and castor.

Dry leaf mulching or application of aqueous leaf extracts of *E.tereticornis* has been found to affect germination, root length and drymatter production of sorghum, cowpea and sunflower due to allelopathic effect (Suresh and Rai, 1988).

Padhy and Khan (1996) reported inhibitory effect of eucalyptus litter leachates on synthesis of chlorophyll, protein, nucleic acid and certain metabolic enzymes (amylase, catalase, peroxidase, DNA'se, RNA'se) in addition to the rate of germination and seedling growth.

The decreased germination of winter wheat due to mulching of eucalyptus leaves (Kimber, 1973) and the retardation of growth of maize

due to eucalyptus leaves (Trenabath, 1991). The adverse effect was due to allelopathic effect.

2.7.1.3 Bark leachate

Swaminathan (1996) reported the bark leachates of *E. tereticornis* inhibited germination, radicle growth and plumule elongation of maize, sesame and pigeonpea.

2.7.1.4 Stem Extract

Huang *et al.* (1997) reported the inhibitory action of stem extract of *Eucalyptus urophylla* on root growth and decreased the root length of mungbean and pea. Mungbean root numbers were decreased by *E.urophylla* extracts

2.7.1.5 Leaf and Root litter

Allelopathic effect of *E. tereticornis* fresh leaves, litter and root material on the performance of cowpea, maize and wheat indicated that initially the litter had more adverse effects on seedling emergence. Later on the root material proved to be the most phytotoxic. Perhaps the slow decomposition of roots released the phenolics slowly, thereby affecting plant growth at a later phase. The root growth was affected more than the shoot, probably due to the roots remaining in direct contact with allelochemicals (Blaise *et.al.*, 1997).

2.7.1.6 Leaf and stem extract

Sajjan *et al.* (1997) reported that the aqueous extracts of eucalyptus stem and leaves on seed germination and seedling growth of *Pennisetum glaucum*, sorghum, sunflower and soybean were investigated wherein leaf extracts were more effective than stem extracts in reducing the germination and seedling growth. *P. glaucum* was most tolerant and sunflowers were most susceptible to eucalyptus extracts.

2.7.1.7 Leaf and Bark extract

Singh *et al.* (1992) opined that eucalyptus leaf extract affected germination of leguminous crops more than bark extract. And the leaf litter extract at 3ml was most detrimental to germination (%) of chickpea, wheat and mustard.

2.7.1.8 Pot Experiment

A pot culture study to assess the effects of fresh and partially decomposed leaves and roots of eucalyptus on growth of wheat, maize and cowpea was conducted by Blaise and Tyagi (1996) and observed that wheat and maize were more adversely affected than cowpea. However soil from cleaned eucalyptus site did not have any negative influence on crops.

2.7.1.9 Allelochemicals

Sivagurunathan *et al.* (1997) concluded the allelopathic effect of phenolic compounds in the leachates of fresh leaves, litter, roots, bark and seeds of *Eucalyptus citriodora*, *E. globular* and *E. tereticornis* collected from 8 years old plantations and were analysed using paper and gas chromatography. Different phenolic compounds were caffeic, coumaric, gallic, gentisic, hydroxybenzoic, syringic and vanillic acids and catechol. Litter released more phenolic compounds than other parts.

Estimation of total phenol content revealed that it was maximum in the seed leachates of *E.citriodora* followed by fresh leaves and litter. The total phenol content in the leachates of *E.globulus* followed the order of fresh leaves > litter > seeds. While in *E. tereticornis* litter leachates contained maximum phenols. Higher total phenol content in fresh leaves could be attributed to the defence mechanism of the plant against pathogens, insects and browsers and the release of secondary metabolites during degradation of litter.

Trees release metabolites into soil, which may adversely affect the germination and growth of herbaceous species through allelopathic interactions.

Sivagurunathan *et al.* (1997) reported the phenolic compounds in eucalyptus like catechol and coumaric, gallic, hydroxy benzoic and syringic acids inhibited germination and (seedlings) vigour index in blackgram, greengram, rice and tomato in bioassay studies. Syringic acid at 1mM was inhibitory to blackgram and greengram, whereas gallic and hydroxybenzoic acids and catechol were inhibitory to rice at 2mM. At

the same concentration, mixture of the phenolic compounds showed greater inhibition than the individual phenolic compounds.

Phenolic compounds are the major group of chemicals present in fresh leaves, litter, root and seeds of eucalyptus species (Waller, 1989). Analysed contents of *E. citriodora*, *E. globulus* and *E. tereticornis* by using gas and paper chromatography indicated presence of caffeic, coumaric, gallic, gentisic, hydroxy benzoic, syringic and vanillic acids and catechol. *E. tereticornis* litter leachates contained maximum phenolic compounds (475 µg/ml) followed by seeds (210 µg/ml) and fresh leaves (150µg per ml).

2.7.1.10 Allelopathy

Due to the fact that the tree is known to have allelopathic characters, many workers have conducted bioassays and field studies. Lack of herbaceous growth under eucalyptus has been attributed to allelopathy (Del Moral and Muller, 1969 and 1970).

Del Moral and Muller (1970) reported very poor herbaceous vegetation under *E. comaldulensis* and *E. milothea* even though light, moisture and nutrient under the eucalyptus were sufficient for herbaceous growth. They attributed the failure of vegetation under eucalyptus to its allelopathic property rather than competition for essential resources.

All the reviews presented on teak, casuarina and eucalyptus indicated that these trees do have allelopathins. The contents of secondary metabolites or allelochemicals vary in their quantity in

different parts of plants. Because of their highly volatile nature it is very difficult to observe their effect on the vegetation in field conditions. This is in addition to the adverse effect due to competition for growth resources *viz.*, moisture, nutrients and light. Therefore growth resources and chemical influences/ interactions (allelopathy) are equally responsible in determining the compatibility of any tree crop combination and productivity.

MATERIALS AND METHODS

III MATERIAL AND METHODS

The details of materials used and techniques adopted in present investigations are briefly discussed in this chapter.

3.1 EXPERIMENTAL LOCATION

Two field experiments were conducted in the Northern Transitional Zone of Karnataka. Experiments were laid out for two consecutive years (1998-99 and 1999-2000 *kharif* season). The experiments were conducted at farmer's fields which were located 12 km (North of Dharwad) away from the University of Agricultural Sciences, Dharwad head quarters situated on Dharwad-Savadatti state highway.

An experiment on the allelopathic effect of teak tree row on the performance of greengram crop was at Marewad village. The farm is owned by Shri. Mahavir Desai. The second experiment was on allelopathic effect of casuarina tree row on greengram was located at Amminbhavi village and the farm was owned by Shri. Milind Deshpande. The crop greengram was selected for the experiment since it was one of the common crops in this region grown during *kharif* season. The teak and casuarina trees were selected as they are commonly grown agroforestry trees. Details of these trees are given in Table-1

Apart from these field experiments a pot culture experiment was carried out after completion of field experiments to test the effect of

Table 1: Details of trees at the experimental sites

Sl.No.	Particulars	Teak		Casuarina	
		1998	1999	1998	1999
1.	No. Of trees	11	11	19	19
2.	Age of trees (years)	18	19	11	12
3.	DBH (cm)	103.50	104.00	65.45	65.70
4.	Height (m)	9.08	9.30	13.20	14.00
5.	Tree spread (m)				
	East-West	3.34	3.40	1.75	1.80
	North-South	3.45	3.50	1.55	1.60
	Average	3.40	3.45	1.65	1.70
6.	Direction of bund plantation	East-West		North-South	
7.	Nature of tree	Deciduous		Evergreen	
8.	Leaf shedding period	During winter		Throughout year	

leachates/exudates of eucalyptus, teak and casuarina trees into soil on different cereals, pulses and oilseed crops. In pot studies the eucalyptus was included to gather additional information.

3.2 CLIMATE

The data on climatic parameters was recorded from the nearest location of experimental sites i.e. at University of Agricultural Sciences, Dharwad. The data on climatic parameters during experimental period and means of 48 years (1950-1997) is presented in Table-2 and Fig-1.

For the last 48 years mean annual rainfall received was 798.24 mm. Maximum rainfall (156.03 mm) was received in July followed by October (136.32 mm). About 77 per cent of rainfall was received between June to October. The highest (37.09°C) and the lowest mean monthly maximum temperature (13.41°C) was recorded in April and December, respectively. Mean monthly maximum (88.37%) and mean monthly minimum relative humidity values (50.82%) were recorded in the month of July and February, respectively.

Total rainfall of 742.20 mm and 422.80 mm were received during 1998 and 1999, which were less by 56.04 mm (7%) and 375.44 mm (47%), respectively as compared to average rainfall of 798.24 mm.

The mean monthly maximum temperatures of 38.30°C and 36.60°C were recorded during 1998 and 1999, respectively in the month of April and minimum temperatures of 14.10°C and 12.40°C in the months of December and January of 1998 and 1999, respectively.

Table 2: Mean monthly data of rainfall (mm), maximum and minimum temperature (°C) and relative humidity (%) for 48 years (1950-97) and for the year 1998 and 1999 recorded at Main Research Station, University of Agricultural Sciences, Dharwad

Month	Rainfall (mm)			Temperature (°C)						Relative humidity (%)		
				Maximum			Minimum					
	1950-97	1998	1999	1950-97	1998	1999	1950-97	1998	1999	1950-97	1998	1999
JANUARY	0.11	0.00	0.00	29.15	30.50	29.40	14.11	15.40	12.40	62.88	77	75
FEBRUARY	0.00	0.00	0.00	34.76	32.20	32.80	15.94	15.70	16.90	50.82	64	69
MARCH	7.77	0.00	0.00	35.76	35.80	36.20	18.76	19.10	20.20	56.48	61	57
APRIL	49.51	TRACE	14.70	37.09	38.30	36.60	21.37	22.10	21.10	79.10	63	58
MAY	87.62	33.20	32.80	36.75	35.90	32.20	21.45	21.90	21.30	67.10	65	65
JUNE	112.96	222.40	71.80	29.47	31.00	28.00	21.20	21.20	21.00	81.77	77	80
JULY	156.03	82.50	113.90	27.05	27.60	26.40	20.96	21.30	20.80	88.37	88	87
AUGUST	102.37	51.40	19.70	27.10	27.80	27.10	20.64	21.40	20.40	86.83	93	88
SEPTEMBER	104.13	214.40	8.80	28.75	28.20	28.30	20.16	21.00	20.00	83.24	83	87
OCTOBER	136.32	98.10	161.10	30.17	28.70	28.90	19.22	20.20	19.80	76.26	81	84
NOVEMBER	35.04	40.20	0.00	29.37	29.4	29.60	15.33	17.10	16.00	68.44	83	77
DECEMBER	6.08	0.00	0.00	29.17	28.70	28.90	13.41	14.10	13.40	64.99	81	73
ANNUAL/MEAN	798.24	749.50	422.80	31.22	31.2	30.40	18.55	19.20	18.60	72.19	76	75

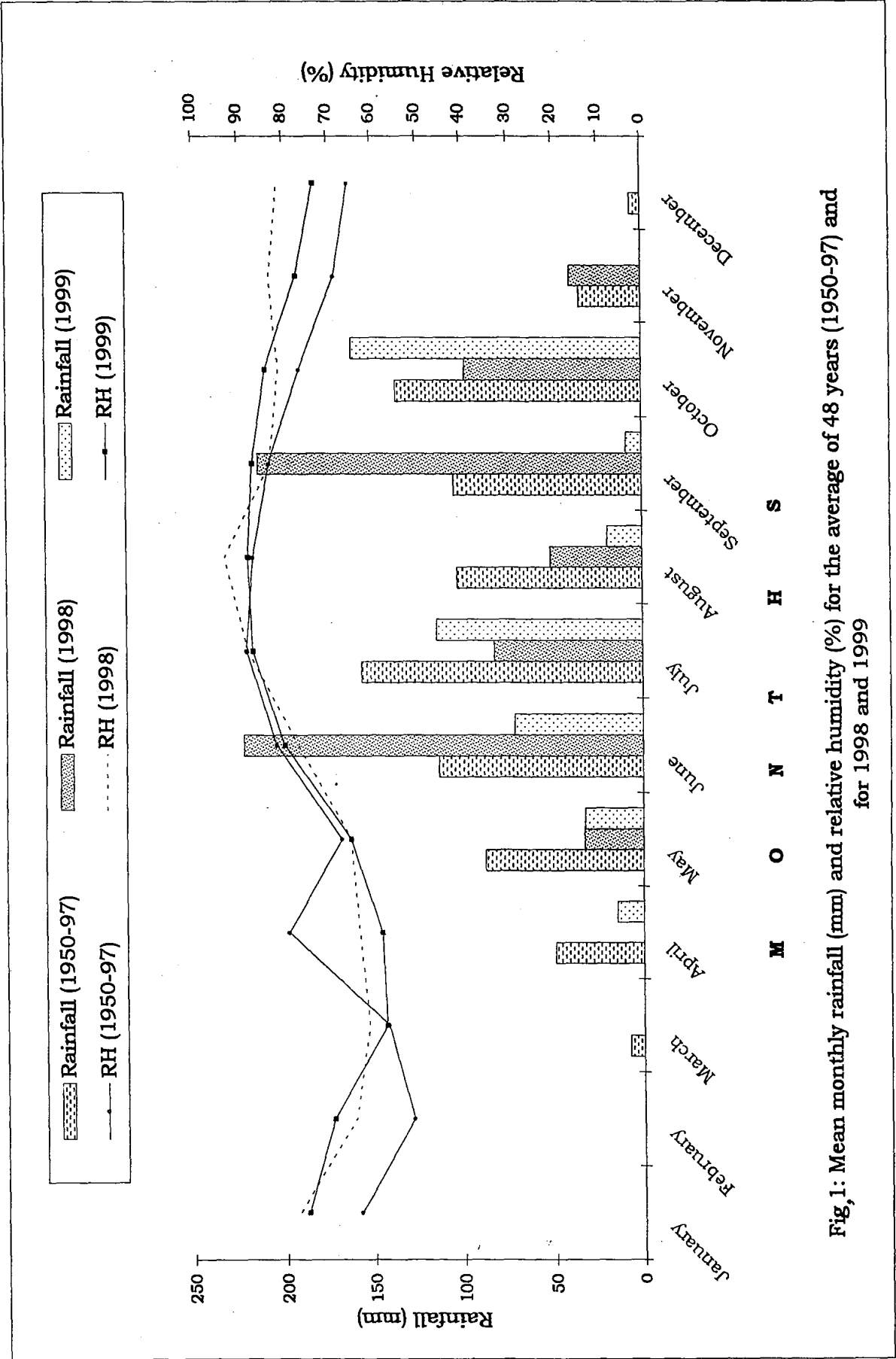


Fig. 1: Mean monthly rainfall (mm) and relative humidity (%) for the average of 48 years (1950-97) and for 1998 and 1999

The relative humidity ranged between 57 to 88 per cent and 63 to 89 per cent during 1998 and 1999 respectively.

3.3 SOILS

Soil samples were collected from top 30 cm as per treatments from each site before initiation of the experiments. The soil samples were air-dried, powdered and allowed to pass through 2 mm sieve and were analyzed for physical and chemical properties (Table-3).

3.4 PREVIOUS CROPS

The wheat crop was grown at both sites of experiments during both the consecutive years (1997-98 and 1998-99) in *rabi* season.

3.5 EXPERIMENTAL DETAILS (Table - 4)

In field experiment the cement rings in each distance treatment was inserted to bifurcate the trees competition with the associated greengram crop for growth resources (like nutrient and moisture). The soil in ring area was dug up and kept open in shade to volatile the allelochemicals present if any. This was followed at least two months prior to sowing. Before taking up of sowing the soil was refilled without affecting its profile.

Table 3 : Physico-chemical properties of experimental sites

Sl. No.	Particulars	Teak site		Casuarina site	
I	PHYSICAL PROPERTIES				
i	Partical Size Analysis				
	Coarse sand (%)	19.80		18.00	
	Fine sand (%)	22.20		22.00	
	Silt (%)	19.00		21.00	
	Clay (%)	37.00		39.00	
ii	Field capacity (%)	27.00		29.00	
iii	Bulk density (mg/m ³)	1.42		1.39	
II	CHEMICAL PROPERTIES	pH	EC	pH	EC
			(dSm ⁻¹)		(dSm ⁻¹)
	Distance from tree rows				
	1-3m	7.30	0.35	7.70	0.55
	3-6m	7.38	0.31	7.75	0.46
	6-9m	7.40	0.28	7.83	0.45
	9-12m	7.55	0.25	7.90	0.42
	12-15m	7.62	0.25	8.15	0.39
	15-18m	7.75	0.23	8.30	0.35

3.5.1 Experiment No. 1

Studies on allelopathic effect of teak row on the performance of greengram (Figure-2).

- Tree species : *Tectona grandis*
- Test crop : Greengram (*Vigna radiata* L.)
- Treatments : 12
- Factor A : Distance from tree row *viz.*, 0-3 m, 3-6 m, 6-9 m, 9-12 m, 12-15 m and 15-18 m.
- Factor B : Tree interference was checked by partitioning underground growth resources by inserting cement ring (60cm diameter and 90 cm depth) in each treatment at 3rd, 6th, 9th, 12th, 15th and 18th meter.
- Replications : Three
- Design : Two factor randomized complete block design
- Plot size : 3 m x 8 m (L X B) for factor A and for factor B cement rings of size 0.6 m diameter and 0.9 m deep were used.
- Gross plot : 3 m x 8 m = 24 m²
- Net plot : 5.4m x 2.5m = 13.5 m²
- Crop spacing : 30 cm inter-row spacing and 10 cm intra-row spacing
- Fertilizer : 50: 25 kg of N and P₂O₅/ha.
- Date of sowing : June 14th 1998 and June 18th 1999

Table 4 : Details of field experiments

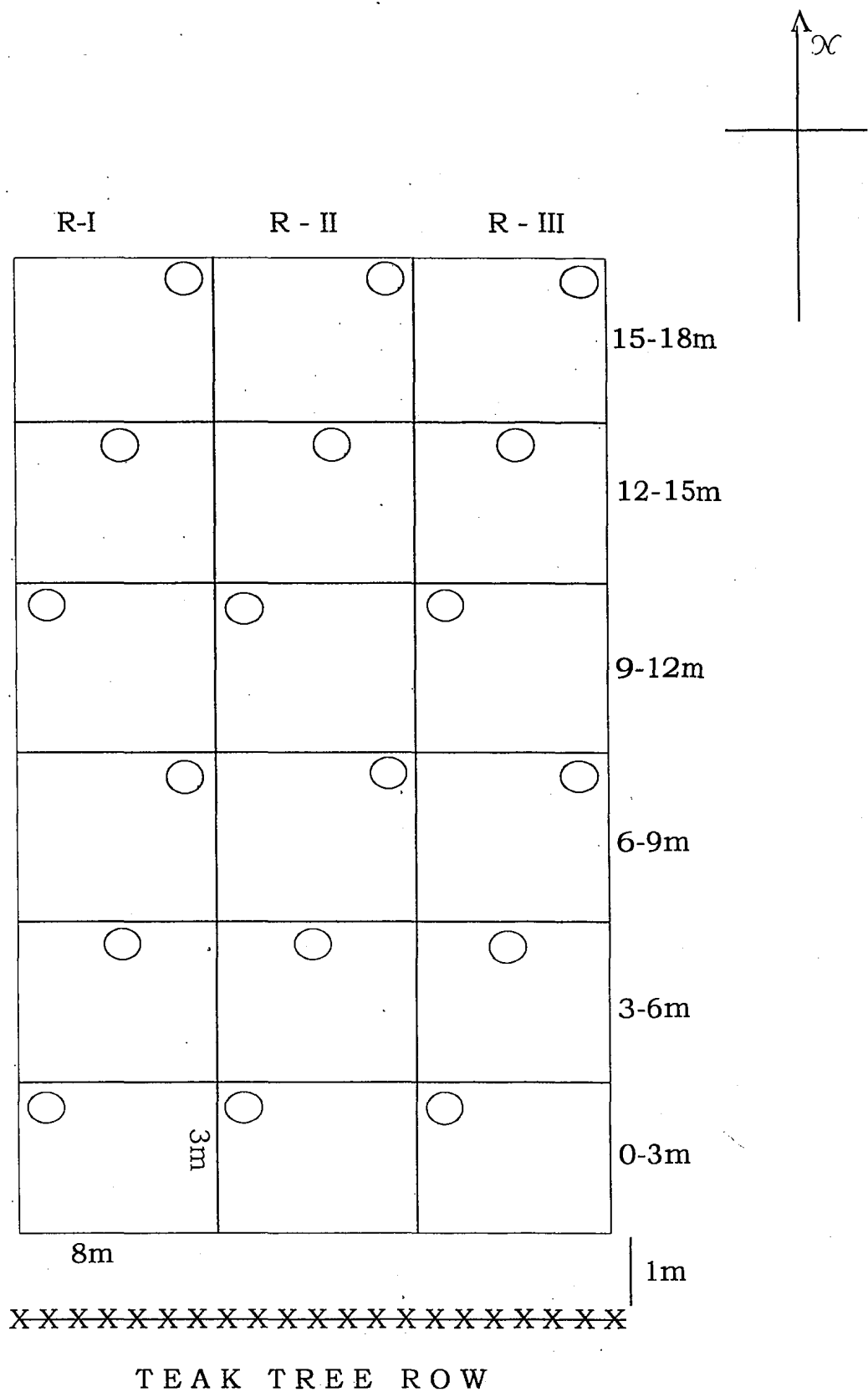
Experiment/ Details	Tree sp.	Test crop	Treatments		Repli- cations	Design	Plot Size	Crop spacing (cm)	Fertilizer (kg N: P ₂ O ₅ / ha)	Date of sowing	Date of harvest	
			Factor A	Factor B								
Experiment No.1	Allelopathic effect of casuarina tree row on greengram											
	<i>Tectona grandis</i>	Greengram (Chinamung)	Distance from tree row	Rings in each treatment were inserted at	3	RBD (Two Factor)	3m X 8m L X B (net plot size 2.5 X 5.4 m ²) for factor A and for factor B 0.6m diameter of ring with an area of 0.28m ²	30X10	50:25	14-6-1998 and 18-6-1999	25-8-1998 and 28-8-1999	
			T1- 0-3m	T7 - 3 rd m								
			T2- 3-6m	T8 - 6 th m								
			T3- 6-9m	T9 - 9 th m								
			T4- 9-12m	T10-12 th m								
			T5-12-15m	T11-15 th m								
			T6-15-18m	T12-18 th m								
Experiment No.2	Allelopathic effect of casuarina tree row on greengram											
	<i>Casuarina equisetifolia</i>	Greengram (Chinamung)	Distance from tree row	Rings in each treatment were inserted at	3	RBD (Two factor)	3m X 8m L X B (net plot size 2.5 X 5.4 m ²) for factor A and for factor B 0.6m diameter of ring with an area of 0.28m ²	30X10	50:25	12-6-1998 and 20-6-1999	22-8-1998 and 30-8-1999	
			T1- 0-3m	T7 - 3 rd m								
			T2- 3-6m	T8 - 6 th m								
			T3- 6-9m	T9 - 9 th m								
			T4- 9-12m	T10-12 th m								
			T5-12-15m	T11-15 th m								
			T6-15-18m	T12-18 th m								

Legend

R-I → First Replication

R-II → Second Replication

R-III → Third Replication



○ - Cement Ring

Fig 2 : Plan of layout of experiment - I at teak site

Date of harvest : August 25th 1998 and August 28th 1999.

3.5.2 Experiment No.2

Studies on allelopathic effect of casuarina tree row on the performance of greengram (Figure -3).

Tree species : *Casuarina equisetifolia*

Test crop : Greengram (*Vigna radiata* L.)

Treatments : 12

Factor A : Distance from tree row *viz.*, 0-3 m, 3-6 m, 6-9 m, 9-12 m, 12-15 m and 15-18 m.

Factor B : Tree interference was checked by partitioning underground growth resources by inserting cement ring (60cm diameter and 90 cm depth) in each treatment at 3rd, 6th, 9th, 12th, 15th and 18th meter.

Replications : Three

Design : Two factor randomized complete block design

Plot size : 3m x 8m (L X B) for factor A and for factor B cement rings of size 0.6m diameter and 0.9 m deep were used.

Gross plot : 3m x 8m = 24m²

Net plot : 5.4m x 2.5m = 13.5m²

Crop spacing : 30 cm inter-row spacing and 10 cm intra-row spacing

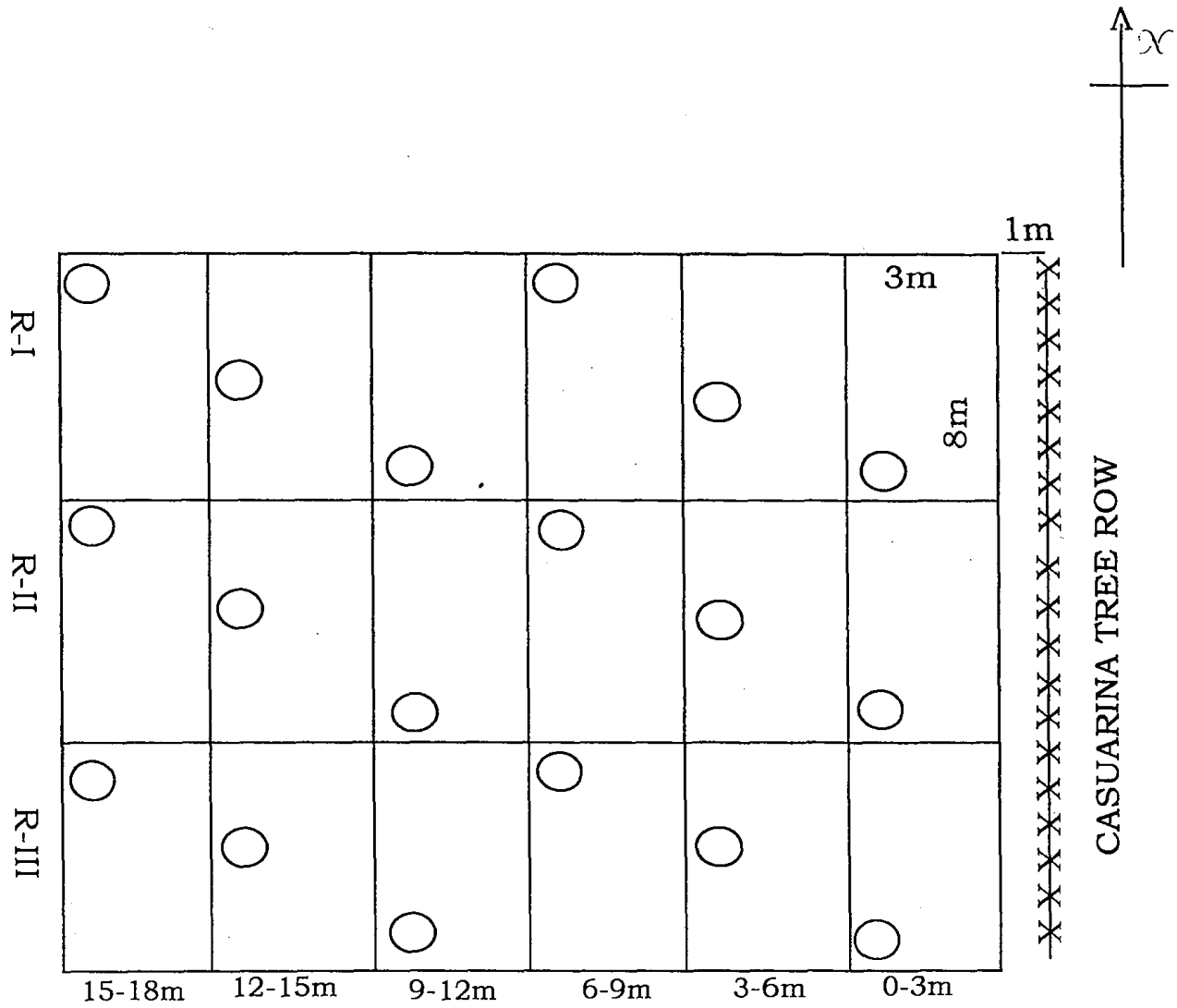
Fertilizer : 50: 25 kg of N and P₂O₅/ha.

Legend

R-I → First Replication

R-II → Second Replication

R-III → Third Replication



○ - Cement Ring

Fig 3 : Plan of layout of experiment - II at casuarina site

Date of sowing : June 12th 1998 and June 20th 1999

Date of harvest : August 22nd 1998 and August 25th 1999.

3.5.3 Pot culture experiment (Table-5)

Allelopathic effect of eucalyptus, teak and casuarina leachates on the performance of different cereals, pulses and oilseed crops.

The experiment was carried out in greenhouse at University of Agricultural Sciences campus Dharwad. The plastic pots were filled with sand and washed with distilled water. The seedlings of three years each tree species were planted in the pots individually and allowed to establish for two months. These pots were placed at higher elevation and were connected by nylon tubes to convey the leachate to the pots placed lower than these pots (which were also filled with sand washed with distilled water) in which various crop seeds were sown to test the allelopathic effect of the tree species root or root + leaf leachates on germination and initial growth of crops. The crops were grown without supplying any external nutrient.

The pots with tree sp. when connected to the pots below with the test crops delivered the root leachate when they were watered. In order to deliver root + leaf leachate, a known quantity of leaf litter (powdered) was mixed in the pots having crop seedlings (the quantity was worked out based on the litter observed in 3-6 m distance from the tree rows in the field). In case of the control, the leachate came from pots having no tree species. Crop seeds (ten) were dibbled in pots, which were placed at lower elevation (placed on the ground). The crop germination was recorded after seven days of sowing and retained six seedlings out of ten. The crop observations recorded were plant dry weight (dg/pl) and root and shoot

Table 5: Details of pot experiments

Date of sowing	Date of harvest	Crop	Factor A	Factor B	Design	Replication
Allelopathic effect of eucalyptus, teak and casuarina leachates on cereals.						
27-03-2000	27-04-2000	Wheat (DWR-162) Maize (DMH-2) Sorghum (M-35-1) Bajra (ICTP-8203)	1. Eucalyptus (<i>Eucalyptus tereticornis</i>) 2. Teak (<i>Tectona grandis</i>) 3. Casuarina (<i>Casuarina equisetifolia</i>).	Root leachate (RL) Root + Leaf leachate (RL + LL).	Two factor randomised complete block design	Three
Allelopathic effect of eucalyptus, teak and casuarina leachates on pulses.						
10-05-2000	10-06-2000	Greengram (Chinamung) Black gram (T-9) Cowpea (C-152) Chickpea (A-1)	1. Eucalyptus (<i>Eucalyptus tereticornis</i>) 2. Teak (<i>Tectona grandis</i>) 3. Casuarina (<i>Casuarina equisetifolia</i>).	Root leachate (RL) Root + Leaf leachate (RL + LL).	Two factor randomised complete block design	Three
Allelopathic effect of eucalyptus, teak and casuarina leachates on different oilseed crops.						
22-06-2000	22-07-2000	Groundnut (JL-24) Sunflower (Morden) Safflower (A-1) Soybean (JS-335)	1. Eucalyptus (<i>Eucalyptus tereticornis</i>) 2. Teak (<i>Tectona grandis</i>) 3. Casuarina (<i>Casuarina equisetifolia</i>).	Root leachate (RL) Root + Leaf leachate (RL + LL).	Two factor randomised complete block design	Three

length at 15 and 30 days after sowing and vigour index (VI) was calculated.

3.5.3.1 Pot experiment No. 1

Allelopathic effect of eucalyptus, teak and casuarina leachates on cereals.

Treatment Details

Date of sowing : 27th March 2000

Date of harvest : 27th April, 2000

Tree species (Factor A) : Three

1. Eucalyptus (*Eucalyptus tereticornis*)
2. Teak (*Tectona grandis*)
3. Casuarina (*Casuarina equisetifolia*).

Treatments (Factor B) : Two.

1. Root leachate (RL)
2. Root + Leaf leachate (RL + LL).

Control : One control in each crop was maintained for all three-tree species.

- Crops:
1. Wheat (variety: DWR-162)
 2. Maize (variety: DMH-2)
 3. Sorghum (variety: M-35-1)
 4. Bajra (variety: ICTP-8203)

Replications : Three

Design : Two factor single control (RBD).

3.5.3.2 Pot experiment No.2

Allelopathic effect of eucalyptus, teak and casuarina leachates on pulses.

Treatment Details

Date of sowing : 10th May, 2000

Date of harvest : 10th June, 2000

Tree species (Factor A) : Three

1. Eucalyptus (*Eucalyptus tereticornis*)
2. Teak (*Tectona grandis*)
3. Casuarina (*Casuarina equisetifolia*).

Treatments (Factor B) : Two

1. Root leachate (RL)
2. Root plus leaf leachate (RL + LL).

Control : One control in each crop was maintained for all three tree species.

- Crops:
1. Greengram (variety: Chinamung)
 2. Black gram (variety: T-9)
 3. Cowpea (variety: C-152)

4. Chickpea (variety: A-1).

Replications : Three

Design : Two factor single control (RBD).

3.5.3.3 Pot experiment No.3

Allelopathic effect of eucalyptus, teak and casuarina leachates on different oilseed crops.

Treatment Details

Date of sowing : 22nd June, 2000

Date of harvest : 22nd July, 2000

Tree species (Factor A) : Three

1. Eucalyptus (*Eucalyptus tereticornis*)
2. Teak (*Tectona grandis*)
3. Casuarina (*Casuarina equisetifolia*).

Treatments (Factor B) : Two.

1. Root leachate (RL)
2. Root leachate plus leaf leachate (RL + LL).

Control : One control in each crop was maintained for all three tree species.

Crops :

1. Groundnut (variety: JL-24)

2.Sunflower (variety: Morden)

3.Safflower (variety: A-2)

4. Soybean (variety: JS-335)

Replications: Three

Design : Two factor single control (RBD).

3.6 CULTURAL OPERATIONS

3.6.1 Land preparation

The land was ploughed once with a mould board plough in April and later with the onset of pre-monsoon showers, harrowed twice to bring the soil to fine tilth. Stubbles and weeds were collected and disposed off from the experimental area. Plots were laid out as per the plan.

3.6.2 Fertilizer application

The common recommended dose of 25: 50 kg N and P₂O₅ per ha applied in the form of Urea and Diammonium phosphate. The entire quantity of fertilizer was applied as basal at the time of sowing in the furrows opened 5 cm away and 5 cm deep from the seed lines.

3.6.3 Seeds and sowing

Greengram (Chinamung) was hand dibbled at a seed rate of 20 kg per ha. in 30 cm rows. Quantified amount of seeds as per the recommended seed rate was sown in the rings.

3.7 AFTER CARE

3.7.1 Irrigation

Though the crop was grown under rainfed condition one life saving irrigation was applied at 30 days after sowing just after weeding during second year of the experiment.

3.7.2 Intercultivation and weeding

The plots were intercultivated and handweeded at 30 DAS to keep the field free from weeds. Weeds within rings were removed manually as and when they appeared.

3.7.3 Harvesting

Crop was harvested plot wise at physiological maturity stage and net plot grains and stover were recorded. Grain and stover yield within the rings were harvested separately and recorded.

3.8 COLLECTION OF EXPERIMENTAL DATA

3.8.1 Crop parameters

3.8.1.1 Emergence (No. per m²)

Crop emergence was recorded at ten days after sowing by counting the number of seedlings per meter row length and converted the same to per square meter area. In the pot experiment the emergence count was recorded at six days after sowing.

3.8.1.2 Number of leaves

Number of leaves was recorded on ten plants and the data were averaged and recorded as number of leaves per plant at 15, 30, 45 DAS and at harvest. Similar procedure was followed inside cement rings for five plants.

3.8.1.3 Plant height (cm)

Plant height was measured from the base of the plant on ground surface to the tip of top most fully opened leaf at 15, 30, 45 DAS and at harvest. Average of ten randomly selected plants height was recorded for each treatment. Similar procedure was followed inside cement rings for five plants.

3.8.1.4 Shoot and root length (cm)

In pot experiment, shoot and root length of two plants was averaged and recorded at 15 and 30 DAS.

3.8.1.5 Dry matter accumulation

Dry matter of ten plants was recorded after oven drying of plants and then they were averaged and expressed in gram per plant. The dry weight of leaves, stem, reproductive parts and total dry matter accumulation was recorded at 15, 30, 45 DAS and at harvest whereas dry matter in reproductive parts was recorded at 45 DAS and at harvest. During similar crop growth stages two plants were selected inside ring for recording observations on drymatter.

The drymatter accumulation of two plants, in pot culture experiment, after oven drying of plants was recorded and expressed as decigram per plant. The dry matter accumulation in pot experiment was recorded at 15 and 30 DAS.

3.8.1.6 Number of days to 50 per cent flower initiation

Number of days taken for 50 per cent of the flower initiation in each treatment was recorded by averaging over the replications as number of days to 50 per cent flower initiation. Similar procedure was followed inside cement rings for four plants.

3.8.1.7 Number of branches per plant

Number of branches per plant was recorded for ten plants, and these plants were selected randomly in each treatment and were

expressed as number of branches per plant at 45 DAS and at harvest. Similar procedure was followed inside cement rings for four plants.

3.8.1.8 Length of pod (cm)

The pod length of randomly selected ten plants was measured from the base of the pod to the tip at harvest and average value was recorded. Similar procedure was followed inside cement rings for four plants.

3.8.1.9 Number of pods per plant

Pods from individual plants were counted and average of ten plants was recorded as number of pods per plant. Similar procedure was followed inside cement rings for four plants.

3.8.1.10 Number of seeds per pod

Seeds from all pods obtained from ten plants were counted and number of seeds per pod was worked out by dividing the total number of seeds by total number of pods. Similar procedure was followed inside cement rings for four plants.

3.8.1.11 Number of seeds per plant

Number of seeds from individual plant was recorded and average of ten plants recorded as number of seeds per plant. Similar procedure was followed inside cement rings for four plants.

3.8.1.12 Thousand seed weight (g)

One thousand seeds were counted at random from treatment, weighed and recorded as thousand seed weight in grams. Similar procedure was followed inside cement rings for four plants.

3.8.1.13 Grain yield (kg/ha)

Grain yield from each net plot was recorded after threshing the sun dried pods. Grain yield of ten sampled plants was also added to net plot produce and final seed yield per plot was recorded. The seed yield per net plot was converted to kg per hectare. Similar procedure was followed inside cement rings for four plants.

3.8.1.14 Stover yield (kg/ha)

The stover yield from each net plot was recorded when it was completely sun dried and expressed as kg per hectare. Similar procedure was followed inside cement rings for four plants.

3.8.1.15 Harvest index (%)

The harvest index was calculated by using the formula given by Donald (1962).

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

3.8.1.16 Vigour index (VI)

The vigour index was calculated by using the formula given by Abdul- Abaki and Anderson (1973).

$$\text{Vigour index (VI)} = \text{Germination per cent} \times \Sigma (\text{Shoot length} + \text{Root length})$$

3.8.2 Tree parameters

3.8.2.1 Tree height (m)

Average height of trees was determined by measuring height of each tree using clinometer during the first year and second year before the initiation of experiment.

3.8.2.2 Crown diameter (m)

Crown diameter was obtained by measuring the spread of branches in north-south and east-west direction and averaging of sum of diameter.

3.8.2.3 Diameter at breast height (DBH) (cm)

Trees were marked at 1.37 m from ground level and DBH measurements were made by using a diameter tape around the tree trunk and the average of all the trees was recorded.

3.8.2.4 Light transmission ratio (%)

The light transmission ratio (LTR) was worked out by using the following formula (Yoshida *et al.*, 1972) and expressed in percentage. Light transmission ratio was recorded at 15, 30, 45 DAS and at harvest by using lux meter. The light received at 18m was recorded as the light received above the tree canopy. And the light received in the treatments above the crop canopy is recorded as the light received below the tree canopy.

$$\text{LTR (\%)} = \frac{\text{Light intensity under the tree over greengram crop in each treatment}}{\text{Light intensity over greengram in the absence of Tree canopy or outside the treatment area (or at 15-18m distance from tree row)}} \times 100$$

3.8.2.5 Tree leaf fall (kg/ha)

Leaf fall pattern of the trees on ground was recorded by collecting and weighing leaves from each meter interval from one meter away from tree line up to 18 m on one m² area from all three replications. Then average of sum total of leaf fall from 0 to 3, 3 to 6, 6 to 9, 9 to 12, 12 to

15 and 15 to 18 m was recorded in treatments (Factor A). The cement rings were kept free from leaf fall till the end of the experiment. Leaf fall pattern was recorded at sowing, 15, 30, 45 DAS and at harvest and after recording the weight, the leaves were put back on the same surface without altering the natural situation. Total leaf fall at each stage was recorded in kg per hectare.

3.8.2.6 Crown spread (m² /tree)

Average crown spread of teak and casuarina trees was calculated by using following formula given by Kadambi (1993)

$$\text{CS (m}^2 \text{ / tree)} = \frac{(\text{Crown diameter})^2 \times n}{4}$$

3.8.3 Weed parameters

3.8.3.1 Total weed number per square meter area

Total number of weeds per m² area was recorded from one meter away from the tree line to 18 m and average of 0 to 3, 3 to 6, 6 to 9, 9 to 12, 12 to 15 and 15 to 18 m was calculated and recorded before first weeding operation.

3.8.3.2 Dry weight per per square meter area (g)

The weeds were collected from each treatment and were oven dried at 70°C to constant weight and the total biomass was recorded in gram per square meter area at the time of first weeding.

3.8.4 Soil moisture data

Soil samples were collected from top 0-15cm and 15-30 cm depth in each treatment at sowing, 15, 30, 45 DAS and at harvest with the help of screw auger during both the years. The soil moisture content was determined gravimetrically after oven drying the samples at 105°C for 48 hours and expressed on oven dry weight basis in percentage.

3.8.5 Soil analysis

Soil samples were collected from each treatment from top 0 to 30 cm depth before sowing and after the harvest of crop during both 1998-99 and 1999-2000 *kharif* seasons. The soil samples were air dried, crushed and passed through a 2 mm sieve. The physical properties viz., coarse sand, fine sand, silt and clay (in per cent). Physico-chemical properties viz., pH, available N, P₂O₅ and K₂O were determined by adopting following methods.

1. pH: It was measured by using pH meter in 1:2.5 dilution (Jackson, 1973).
2. Available nitrogen (kg/ha): It was determined by adopting alkaline permanganate method (Subbaiah and Asija, 1959).
3. Available phosphorus (kg/ha): It was extracted using Bray's extractant number 1. The phosphorus in the filtrate was determined using molybdate stannous chloride method. The intensity of blue colour was read on spectronic-20 at 660 nm (Jackson, 1973).

4. Available potassium (kg/ha): It was determined by flame photometer (Jackson, 1973).
5. Particle size distribution – International Pipette Method (Piper, 1966)

3.8.6 Plant analysis

After the harvest of crop a known quantity of stover and grains were ground, weighed and used for N, P and K content analysis in percentage and total uptake in kilogram per hectare was calculated by using total grain yield and stover yield of both the locations as per treatments. The total nitrogen uptake was estimated by modified Kjeldal's method (Jackson, 1973). The phosphorus uptake was determined by Vanadomolybdate yellow colour method using spectrophotometer as described by Jackson (1973). Potassium uptake was determined by flame photometer method as described by Muhr *et al.* (1965).

3.9 STATISTICAL ANALYSIS AND INTERPRETATION OF DATA

The data recorded on various characters were analyzed statistically following the procedure described by Gomez and Gomez (1984). The level of significance used in 'F' test and 't' test was $P = 0.05$. Least significance difference (LSD) values were calculated whenever the 'F' test was significant. The results were presented year-wise as well as on pooled basis. The results were presented based on the pooled data.

EXPERIMENTAL RESULTS

IV EXPERIMENTAL RESULTS

Results of two field experiments conducted on allelopathic effect of teak and casuarina on greengram during *kharif* season of 1998-99 and 1999-2000 and a pot experiment to study the allelopathic effect of eucalyptus, teak and casuarina leachates on cereals, pulses and oilseeds are presented in this chapter.

The two field experiments were conducted on different locations. Hence, they are presented separately. The results of pot experiment follows the field experimental results.

4.1 Teak

4.1.1. Emergence (No./m²) (Table – 6 and fig-4 and 5)

The emergence of greengram varied significantly with respect to partitioning effect, distance from tree and their interaction. The emergence recorded at 0-3 m (20) was significantly lower and increased over distance but was significantly lower till 12 m (20, 21 and 22 at 3-6, 6-9 and 9-12m respectively) than at 15-18m distances. Comparing inside cement ring (ICR) and outside cement ring (OCR), there was significantly higher (30) emergence ICR compared to OCR (17).

Emergence was on par with each other at all the distances ICR whereas OCR it was significantly lower till 15m compared with 15-18m distance.

Table 6 : Allelopathic effect of teak tree row on emergence of greengram crop (No/m²) at ten days after sowing over distance

Treatment / Distance(m)	1998			1999			Pooled		
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
	0-3	30	9	19	30	9	20	30	9
3-6	30	10	20	30	9	20	30	10	20
6-9	30	11	21	30	12	21	30	12	21
9-12	30	14	22	30	14	22	30	14	22
12-15	31	27	29	30	29	30	31	28	30
15-18	31	30	31	31	30	30	31	30	31
Mean	30	17	23	31	17	24	30	17	24
	SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%	
Distance(D)	0.41	1.20		0.83	2.43		0.46	1.31	
Ring(R)	0.24	0.70		0.48	1.41		0.27	0.77	
D X R	0.58	1.70		1.17	3.43		0.65	1.85	

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

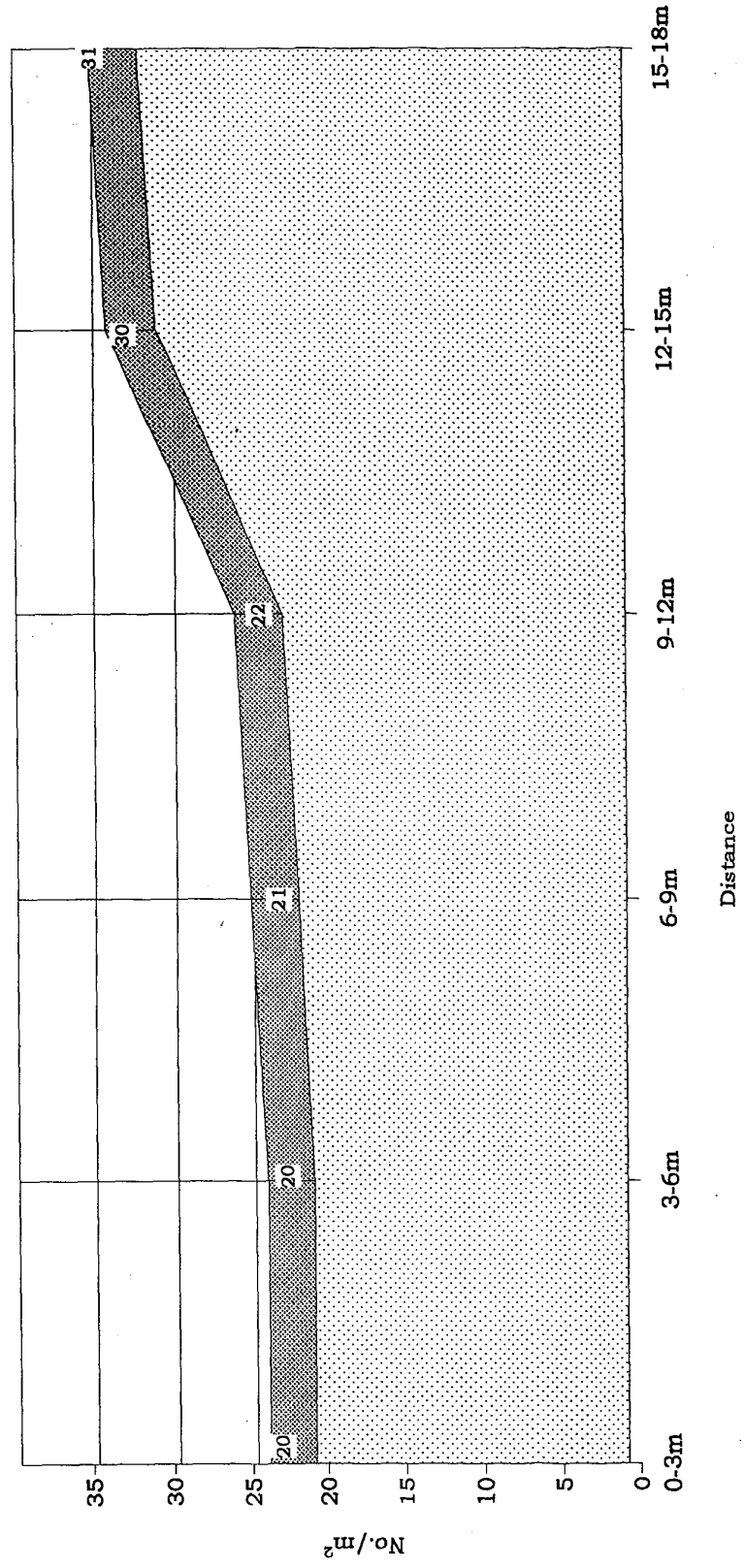


Fig.4 : Emergence (No./m²) of greengram at ten days after sowing over distances from teak tree row

■ ICR □ OCR

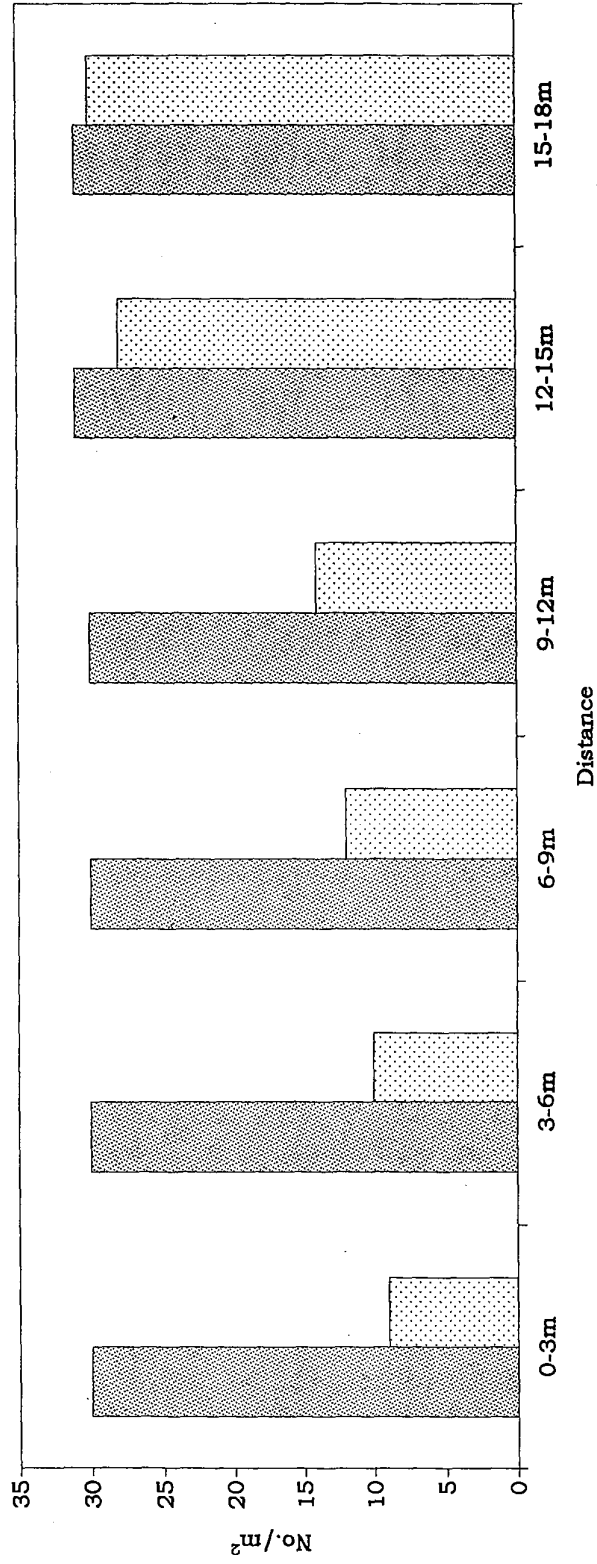


Fig. 5 : Emergence (No./m²) of greengram ICR and OCR at ten days after sowing over distances from teak tree row

4.1.2 Plant growth characters

4.1.2.1 Number of leaves per plant (Table - 7)

The number of leaves at various growth stages was influenced by partitioning the underground growth resources by rings as well as distance from the tree row.

The average number of leaves recorded at 15, 30, 45 days after sowing (DAS) and at harvest were 1.74, 2.80, 8.68 and 3.24 indicating that maximum number of leaves occurred at 45 DAS. Averaging over the rings and distance the number of green leaves recorded the lowest nearer to the tree and increased further away at all stages of crop growth. Significantly lower number of leaves was recorded till 12m and thereafter at 12-15 and 15-18m the number was significantly greater or was not influenced by tree.

Similarly, when comparing plants within and outside cement rings, the number was significantly greater in the cement rings at all stages. The interaction of these two factors indicated that the number within the cement rings at all distances remained almost same whereas outside cement rings the number was lowest nearer to the tree and recorded significantly low till 12m and thereafter the tree effect was not seen. Comparing inside and outside rings, the number of green leaves were on par at 12-15 and 15-18m distances.

Table 7 : Allelopathic effect of teak tree row on number of leaves of greengram at different crop growth stages over distance.

Treatment/ Distance (m)	30 DAS																																	
	15 DAS				Pooled				1998				1999				Pooled																	
	1998		1999		ICR		Mean		OCR		Mean		ICR		Mean		OCR		Mean		ICR		Mean											
0-3	1.90	0.91	1.41	0.74	1.36	1.94	0.83	1.38	2.74	1.18	1.96	3.50	1.56	2.18	3.12	1.37	2.25	1.90	0.91	1.41	0.74	1.36	1.94	0.83	1.38	2.74	1.18	1.96	3.50	1.56	2.18	3.12	1.37	2.25
3-6	1.99	1.19	1.59	0.88	1.50	2.06	1.04	1.55	2.80	1.38	2.09	3.18	1.57	2.38	2.99	1.48	2.24	1.99	1.19	1.59	0.88	1.50	2.06	1.04	1.55	2.80	1.38	2.09	3.18	1.57	2.38	2.99	1.48	2.24
6-9	2.07	1.21	1.64	1.28	1.70	2.10	1.25	1.68	3.17	1.62	2.27	3.38	1.74	2.56	3.27	1.68	2.48	2.07	1.21	1.64	1.28	1.70	2.10	1.25	1.68	3.17	1.62	2.27	3.38	1.74	2.56	3.27	1.68	2.48
9-12	2.05	1.64	1.84	1.54	1.75	2.00	1.59	1.79	3.48	2.58	3.03	2.96	3.10	3.03	3.22	2.84	3.03	2.05	1.64	1.84	1.54	1.75	2.00	1.59	1.79	3.48	2.58	3.03	2.96	3.10	3.03	3.22	2.84	3.03
12-15	2.30	1.86	2.08	2.10	1.86	2.20	1.74	1.97	3.18	3.26	3.22	3.07	3.48	3.27	3.12	3.37	3.25	2.30	1.86	2.08	2.10	1.86	2.20	1.74	1.97	3.18	3.26	3.22	3.07	3.48	3.27	3.12	3.37	3.25
15-18	2.23	2.20	2.22	1.83	2.07	1.95	2.14	2.08	3.52	3.46	3.52	3.47	3.52	3.50	3.50	3.52	3.57	2.23	2.20	2.22	1.83	2.07	1.95	2.14	2.08	3.52	3.46	3.52	3.47	3.52	3.50	3.50	3.52	3.57
Mean	2.09	1.50	1.50	2.02	1.36	2.06	1.43	2.08	3.13	2.26	3.26	2.50	3.26	3.50	3.20	2.38	3.57	2.09	1.50	1.50	2.02	1.36	2.06	1.43	2.08	3.13	2.26	3.26	2.50	3.26	3.50	3.20	2.38	3.57
Distance(D) Ring(R) D X R	SEM± 0.10 0.06 0.15	CD at 5% 0.29 0.18 0.44	SEM± 0.09 0.05 0.12	CD at 5% 0.26 0.15 0.35	SEM± 0.07 0.04 0.10	CD at 5% 0.20 0.11 0.28	SEM± 0.19 0.11 0.26	CD at 5% 0.56 0.32 0.76	SEM± 0.19 0.11 0.27	CD at 5% 0.56 0.32 0.79	SEM± 0.13 0.08 0.19	CD at 5% 0.37 0.23 0.54																						

Treatment/ Distance (m)	45 DAS												Harvest																							
	1998				1999				Pooled				1998				1999				Pooled															
	1998		1999		ICR		Mean		OCR		Mean		ICR		Mean		OCR		Mean		ICR		Mean													
0-3	8.78	5.08	6.93	9.31	5.72	7.51	9.05	5.40	7.22	3.78	1.13	2.46	3.34	1.37	2.35	3.56	1.25	2.41	8.78	5.08	6.93	9.31	5.72	7.51	9.05	5.40	7.22	3.78	1.13	2.46	3.34	1.37	2.35	3.56	1.25	2.41
3-6	8.90	6.78	7.84	8.93	7.02	7.98	8.92	6.90	7.91	4.29	1.45	2.87	2.99	1.75	2.37	3.64	1.60	2.62	8.90	6.78	7.84	8.93	7.02	7.98	8.92	6.90	7.91	4.29	1.45	2.87	2.99	1.75	2.37	3.64	1.60	2.62
6-9	9.40	6.67	8.04	8.93	7.34	8.14	9.17	7.01	8.09	4.24	1.62	2.93	3.34	2.05	2.70	3.79	1.84	2.81	9.40	6.67	8.04	8.93	7.34	8.14	9.17	7.01	8.09	4.24	1.62	2.93	3.34	2.05	2.70	3.79	1.84	2.81
9-12	9.17	8.33	8.75	9.80	9.00	9.40	9.48	8.67	9.08	4.27	2.92	3.59	3.34	2.90	3.12	3.80	2.91	3.36	9.17	8.33	8.75	9.80	9.00	9.40	9.48	8.67	9.08	4.27	2.92	3.59	3.34	2.90	3.12	3.80	2.91	3.36
12-15	9.84	9.75	9.80	9.68	10.22	9.95	9.70	9.99	9.88	4.68	2.85	3.76	3.99	3.99	3.99	4.33	3.42	3.88	9.84	9.75	9.80	9.68	10.22	9.95	9.70	9.99	9.88	4.68	2.85	3.76	3.99	3.99	3.99	4.33	3.42	3.88
15-18	9.47	9.87	9.67	10.00	10.33	10.17	9.74	10.10	9.92	4.72	4.32	4.52	3.99	4.33	4.16	4.35	4.33	4.34	9.47	9.87	9.67	10.00	10.33	10.17	9.74	10.10	9.92	4.72	4.32	4.52	3.99	4.33	4.16	4.35	4.33	4.34
Mean	9.26	7.75	8.27	9.44	8.27	9.34	8.01	9.34	8.01	4.33	2.38	4.33	3.50	2.73	4.16	3.91	2.56	4.34	9.26	7.75	8.27	9.44	8.27	9.34	8.01	9.34	8.01	4.33	2.38	4.33	3.50	2.73	4.16	3.91	2.56	4.34
Distance(D) Ring(R) D X R	SEM± 0.39 0.23 0.55	CD at 5% 1.14 0.45 1.61	SEM± 0.29 0.17 0.41	CD at 5% 0.85 0.50 1.20	SEM± 0.24 0.14 0.34	CD at 5% 0.68 0.40 0.97	SEM± 0.26 0.15 0.37	CD at 5% 0.76 0.44 1.08	SEM± 0.23 0.14 0.33	CD at 5% 0.67 0.41 0.97	SEM± 0.18 0.10 0.25	CD at 5% 0.51 0.28 0.71																								

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

4.1.2.2 Plant height (cm) (Table – 8)

The plant height recorded at different crop growth stages also varied significantly with respect to partitioning and distance from tree row.

The average plant height at different crop growth stages was 5.61, 8.24, 18.34 and 19.87cm at 15, 30, 45 DAS and at harvest. Comparing the plant height at various distances from tree row it was significantly lower till 12m compared to 15-18m. The plant height at 12-15m was on par with 15-18m. The average plant height ICR and OCR showed significantly greater height ICR than OCR at various crop growth stages. The partitioning effect showed that plant height ICR was significantly higher and was on par with each other at all distances from tree row. The plant height OCR was lowest nearer to tree and increased thereafter and then recorded higher at farther away from tree row with significantly lower height till 12 m. The height at 12-15 and 15-18m OCR were on par with ICR.

4.1.2.3 Drymatter accumulation (g/pl)

4.1.2.3.1 Leaf (Table - 9)

The dry weight of leaf recorded at various crop growth stages was also influenced by partitioning underground crop growth resources, distance from tree row and their interaction.

Averaging the drymatter accumulation in leaf at different crop growth stages leaf dry weight was 0.27, 1.36, 2.75 and 1.63 at 15, 30, 45

Table 8 : Allelopathic effect of teak tree row on plant height (cm) of greengram at different crop growth stages over distance

Treatment/ Distance (m)	15 DAS						30 DAS								
	1998			Pooled			1998			1999			Pooled		
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	7.10	0.71	3.91	6.60	0.59	3.60	6.85	0.65	3.75	10.70	0.90	5.80	10.30	0.70	5.50
3-6	6.80	1.85	4.33	7.20	1.59	4.40	7.00	1.72	4.36	10.90	2.30	6.60	10.76	2.20	6.48
6-9	7.10	4.11	5.60	6.70	4.01	5.36	6.90	4.06	5.48	10.70	4.90	7.80	10.64	4.84	7.74
9-12	7.15	4.15	5.65	6.75	4.05	5.40	6.95	4.10	5.53	11.40	5.00	8.20	11.28	4.80	8.04
12-15	7.60	7.00	7.30	7.56	6.64	7.10	7.58	6.82	7.20	11.20	11.20	11.20	10.80	8.80	9.80
15-18	7.70	7.20	7.45	7.50	7.00	7.25	7.60	7.10	7.35	11.30	11.40	11.35	11.10	9.60	10.35
Mean	7.24	4.17	5.39	7.05	3.98	7.15	7.15	4.07	7.35	11.03	5.95	11.35	10.81	5.16	10.92
Distance(D) Ring(R) D X R	SEM± 0.29 0.17 0.41	CD at 5% 0.85 0.50 1.20	SEM± 0.39 0.23 0.55	CD at 5% 1.14 0.45 1.61	SEM± 0.24 0.16 0.33	CD at 5% 0.67 0.46 0.92	SEM± 0.23 0.14 0.33	CD at 5% 0.67 0.41 0.97	SEM± 0.45 0.26 0.64	CD at 5% 1.32 0.76 1.88	SEM± 0.27 0.21 0.35	CD at 5% 0.76 0.59 0.99			

Treatment/ Distance (m)	45 DAS						Harvest								
	1998			Pooled			1998			1999			Pooled		
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	23.00	6.20	14.60	22.70	5.94	14.32	22.85	6.07	14.46	25.80	8.30	17.05	24.94	7.84	16.39
3-6	23.10	7.70	15.40	22.90	7.30	15.10	23.00	7.50	15.25	26.24	8.42	17.33	25.88	8.06	16.97
6-9	23.00	10.70	16.85	22.94	10.36	16.65	22.97	10.53	16.75	25.75	9.65	17.70	25.33	9.35	17.34
9-12	22.65	11.60	17.13	22.43	11.32	16.88	22.54	11.46	17.00	26.00	12.23	19.12	25.78	11.99	18.89
12-15	23.40	22.96	23.18	22.84	22.80	22.82	23.12	22.88	23.00	25.61	24.70	25.16	25.23	24.46	24.85
15-18	23.60	23.66	23.63	23.40	23.50	23.45	23.50	23.58	23.54	25.92	25.70	25.81	25.60	25.38	25.49
Mean	23.13	13.80	16.80	22.87	13.50	16.80	23.00	13.67	16.80	25.89	14.83	25.81	25.46	14.51	25.67
Distance(D) Ring(R) D X R	SEM± 0.67 0.39 0.95	CD at 5% 1.90 1.11 2.70	SEM± 0.66 0.38 0.93	CD at 5% 1.93 1.11 2.72	SEM± 0.26 0.18 0.36	CD at 5% 0.74 0.51 1.02	SEM± 0.19 0.11 0.27	CD at 5% 0.56 0.32 0.79	SEM± 0.27 0.15 0.37	CD at 5% 0.75 0.43 1.08	SEM± 0.30 0.10 0.41	CD at 5% 0.85 0.28 1.16			

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

Table 9 : Allelopathic effect of teak tree row on drymatter accumulation (g/pl) in leaf of greengram at different crop growth stages over distance.

Treatment/ Distance (m)	30 DAS															
	15 DAS						1999									
	1998		1999		Pooled		1998		1999		Pooled					
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	
0-3	0.33	0.14	0.24	0.27	0.14	0.21	0.30	0.14	0.22	1.82	0.78	1.30	1.68	0.44	1.06	
3-6	0.34	0.16	0.25	0.30	0.16	0.23	0.32	0.16	0.24	1.82	0.80	1.31	1.62	0.44	1.03	
6-9	0.30	0.19	0.25	0.30	0.17	0.24	0.30	0.18	0.24	1.82	0.80	1.31	1.62	0.52	1.07	
9-12	0.34	0.20	0.27	0.32	0.18	0.25	0.33	0.19	0.26	1.84	0.82	1.33	1.64	0.50	1.07	
12-15	0.36	0.31	0.34	0.32	0.29	0.31	0.34	0.30	0.32	1.84	1.79	1.82	1.62	1.59	1.61	
15-18	0.32	0.33	0.33	0.34	0.27	0.32	0.33	0.30	0.32	1.84	1.80	1.82	1.62	1.60	1.61	
Mean	0.33	0.22	0.22	0.32	0.20	0.32	0.32	0.21	0.32	1.83	1.13	1.82	1.63	0.82	1.73	
	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	
Distance(D) Ring(R) D X R	0.02 0.01 0.03	0.06 0.03 0.09	0.02 0.01 0.03	0.02 0.01 0.03	0.06 0.03 0.09	0.02 0.01 0.03	0.02 0.01 0.03	0.06 0.03 0.09	0.06 0.03 0.09	0.12 0.07 0.19	0.35 0.21 0.56	0.10 0.06 0.16	0.10 0.06 0.16	0.29 0.18 0.47	0.08 0.04 0.16	0.23 0.11 0.45

Treatment/ Distance (m)	45 DAS															
	1998						1999									
	1998		1999		Pooled		1998		1999		Pooled					
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	
0-3	2.96	2.05	2.51	3.14	1.95	2.55	3.05	2.00	2.53	1.34	1.79	1.57	1.38	1.73	1.56	
3-6	3.17	2.14	2.66	3.07	2.06	2.57	3.12	2.10	2.61	1.32	1.84	1.58	1.46	1.78	1.62	
6-9	2.84	2.50	2.67	2.76	2.46	2.61	2.80	2.48	2.64	1.44	1.90	1.67	1.70	2.10	1.90	
9-12	3.00	2.52	2.76	2.94	2.48	2.71	2.97	2.50	2.74	1.55	2.29	1.92	1.55	2.11	1.83	
12-15	3.12	3.00	3.06	3.08	2.60	2.84	3.10	2.80	2.95	1.38	1.38	1.28	1.30	1.72	1.55	
15-18	3.12	3.10	3.11	3.08	2.90	2.99	3.10	3.00	3.05	1.52	1.60	1.56	1.50	1.50	1.50	
Mean	3.04	2.55	2.76	3.01	2.41	2.76	3.02	2.48	2.76	1.43	1.80	1.56	1.48	1.82	1.45	
	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	
Distance(D) Ring(R) D X R	0.06 0.04 0.11	0.18 0.12 0.32	0.07 0.04 0.13	0.07 0.04 0.13	0.21 0.12 0.38	0.17 0.11 0.34	0.06 0.04 0.12	0.06 0.04 0.12	0.17 0.11 0.34	0.04 0.03 0.07	0.12 0.09 0.21	0.02 0.01 0.03	0.02 0.01 0.03	0.06 0.03 0.09	0.05 0.03 0.09	0.14 0.09 0.26

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

DAS and at harvest. The leaf drymatter followed similar trend as that of number of leaves recording higher drymatter at 45 DAS. The drymatter recorded nearer to the trees was significantly lower till 9m at 15 DAS and 9-12m at 30 and 45 DAS compared to 15-18m distance. And ICR recorded significantly higher leaf drymatter than OCR. By studying the partitioning effect the drymatter accumulation ICR at various distances it was found to be on par with each other whereas OCR drymatter accumulation till 12m was significantly lower. The drymatter accumulation OCR at 12-15 and 15-18m was on par with ICR.

At harvest the drymatter accumulation in leaves did not differ significantly with respect to distance from tree row. Average of ICR recorded significantly lower drymatter accumulation at various distances. The 9-12m distance OCR recorded significantly higher drymatter accumulation.

4.1.2.3.2 Stem (Table - 10)

At various crop growth stages the stem drymatter varied significantly with respect to distance from the tree rows, partitioning of underground growth resources and their interaction.

Average drymatter of 0.27, 0.94, 1.61 and 1.66g was recorded at 15, 30, 45 DAS and at harvest respectively. The nearest distance to the tree row recorded always-lowest drymatter and it was found to be significantly lower till 12m compared with 15-18m. Average of ICR recorded significantly higher drymatter than OCR. ICR at various distances recorded similar drymatter as they were statistically on par

Table 10 : Allelopathic effect of teak tree row on drymatter accumulation (g/pl) in stem leaf of greengram at different crop growth stages over distance.

Treatment/ Distance (m)	30 DAS																	
	15 DAS				1998				1999				Pooled					
	1998		1999		Pooled		1998		1999		Pooled		1998		1999		Pooled	
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	0.31	0.16	0.24	0.31	0.12	0.22	0.31	0.14	0.23	1.00	0.44	0.72	1.10	0.80	0.95	1.05	0.60	0.83
3-6	0.32	0.16	0.24	0.32	0.14	0.23	0.32	0.15	0.24	1.00	0.50	0.75	1.20	0.74	0.97	1.10	0.62	0.86
6-9	0.32	0.16	0.24	0.3	0.14	0.23	0.32	0.15	0.24	1.02	0.51	0.77	1.18	0.75	0.97	1.10	0.63	0.87
9-12	0.30	0.18	0.24	0.36	0.14	0.25	0.33	0.16	0.25	1.06	0.51	0.79	1.14	0.77	0.96	1.10	0.64	0.87
12-15	0.31	0.32	0.32	0.31	0.32	0.32	0.31	0.32	0.32	1.06	1.06	1.06	1.14	1.14	1.14	1.10	1.10	1.10
15-18	0.32	0.32	0.32	0.30	0.34	0.32	0.30	0.33	0.32	1.06	1.07	1.07	1.14	1.17	1.16	1.10	1.12	1.11
Mean	0.31	0.22		0.32	0.20		0.32	0.21		1.03	0.68		1.15	0.90		1.09	0.79	
Distance(D) Ring(R) D X R	SEM± 0.02 0.01 0.03	CD at 5% 0.06 0.03 0.09		SEM± 0.02 0.01 0.03	CD at 5% 0.06 0.03 0.09		SEM± 0.02 0.01 0.03	CD at 5% 0.06 0.03 0.09		SEM± 0.06 0.04 0.11	CD at 5% 0.18 0.12 0.32		SEM± 0.04 0.02 0.07	CD at 5% 0.12 0.06 0.21		SEM± 0.06 0.04 0.11	CD at 5% 0.17 0.11 0.31	

Treatment/ Distance (m)	45 DAS																							
	1998				1999				Pooled				1998				1999				Pooled			
	1998		1999		Pooled		1998		1999		Pooled		1998		1999		Pooled		1998		1999		Pooled	
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	1.76	1.25	1.51	1.84	1.11	1.48	1.80	1.18	1.49	1.78	1.38	1.58	1.86	1.10	1.48	1.82	1.24	1.53	1.86	1.27	1.57	1.82	1.24	1.53
3-6	1.88	1.26	1.57	1.82	1.24	1.53	1.85	1.25	1.55	1.90	1.30	1.60	1.82	1.24	1.53	1.86	1.27	1.57	1.86	1.27	1.57	1.86	1.27	1.57
6-9	1.88	1.27	1.58	1.84	1.25	1.55	1.86	1.26	1.56	1.90	1.30	1.60	1.92	1.46	1.69	1.88	1.38	1.63	1.88	1.38	1.63	1.88	1.38	1.63
9-12	1.90	1.36	1.60	1.86	1.26	1.56	1.88	1.28	1.58	1.90	1.31	1.56	1.83	1.53	1.68	1.90	1.42	1.66	1.90	1.42	1.66	1.90	1.42	1.66
12-15	1.90	1.62	1.76	1.90	1.58	1.74	1.90	1.60	1.75	1.92	1.80	1.86	1.90	1.50	1.70	1.91	1.65	1.78	1.91	1.65	1.78	1.91	1.65	1.78
15-18	1.84	1.72	1.78	1.76	1.68	1.72	1.80	1.70	1.75	1.85	1.78	1.80	1.86	1.70	1.78	1.84	1.74	1.79	1.84	1.74	1.79	1.84	1.74	1.79
Mean	1.86	1.40		1.84	1.35		1.82	1.45		1.78	1.48		1.88	1.42		1.87	1.44		1.87	1.44		1.87	1.44	
Distance(D) Ring(R) D X R	SEM± 0.04 0.03 0.07	CD at 5% 0.12 0.09 0.21		SEM± 0.05 0.03 0.08	CD at 5% 0.15 0.09 0.23		SEM± 0.04 0.02 0.07	CD at 5% 0.11 0.06 0.20		SEM± 0.07 0.05 0.13	CD at 5% 0.21 0.15 0.38		SEM± 0.03 0.02 0.06	CD at 5% 0.09 0.06 0.18		SEM± 0.04 0.03 0.06	CD at 5% 0.11 0.09 0.17		SEM± 0.04 0.03 0.06	CD at 5% 0.11 0.09 0.17		SEM± 0.04 0.03 0.06	CD at 5% 0.11 0.09 0.17	

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

with each other. The OCR recorded significantly lower drymatter accumulation till 12m whereas rest of the distances was on par in drymatter accumulation with ICR.

4.1.2.3.3 Reproductive parts (Table-11)

The drymatter in reproductive parts responded similar to drymatter accumulation in stem at both 45 DAS and at harvest.

The average drymatter accumulation recorded at 45 DAS and at harvest was 1.30 and 4.81g respectively with highest recorded at harvest. The drymatter was significantly lower till 12m compared to 15-18m distance from tree row. The drymatter recorded till 12m distance was on par with each other at 45 DAS but at harvest, it was on par with 0-3 m and 3-6m, there after increased significantly with distance. The 12-15m distance was on par with 15-18m in drymatter accumulation. The average of ICR and OCR showed significantly higher drymatter in ICR. At various distances ICR recorded almost similar drymatter. Significantly lower drymatter till 12m was recorded OCR. The 12-15m and 15-18m OCR recorded drymatter on par with ICR.

4.1.2.3.4 Total of all the plant parts (Table-12 and fig-6 to 7)

The average drymatter was 0.53, 2.30, 5.68 and 8.12g at 15, 30, 45 DAS and at harvest. The drymatter increased with increase in distance from tree row. Comparing with 15-18m the drymatter was significantly lower till 12m at all the crop growth stages. The mean of ICR

Table 11 : Allelopathic effect of teak tree row on drymatter accumulation (g/pl) in reproductive parts of greengram at different crop growth stages over distance

Treatment/ Distance (m)	45 DAS																	
	1998			1999			Pooled			1998			1999			Pooled		
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	1.28	0.90	1.09	1.52	0.70	1.11	1.40	0.80	1.10	5.88	2.04	3.96	5.56	1.96	3.76	5.72	2.00	3.86
3-6	1.40	0.92	1.16	1.46	0.88	1.14	1.43	0.90	1.17	6.09	2.48	4.29	5.81	2.00	3.91	5.95	2.24	4.10
6-9	1.40	0.94	1.17	1.48	0.87	1.18	1.44	0.91	1.18	6.03	3.40	4.72	5.77	3.00	4.39	5.90	3.20	4.55
9-12	1.44	1.13	1.29	1.36	1.11	1.24	1.40	1.12	1.26	6.00	3.90	4.95	5.90	3.76	4.83	5.95	3.873	4.89
12-15	1.69	1.38	1.54	1.51	1.62	1.57	1.60	1.50	1.55	5.90	5.62	5.76	5.90	4.98	5.44	5.90	5.30	5.60
15-18	1.64	1.43	1.54	1.56	1.57	1.57	1.60	1.50	1.55	5.93	5.72	5.83	5.87	5.88	5.88	5.90	5.80	5.85
Mean	1.48	1.12		1.48	1.13		1.48	1.12		5.97	3.86		5.80	3.60		5.89	3.73	
Distance(D) Ring(R) D X R	SEm± 0.06 0.04 0.10	CD at 5% 0.18 0.12 0.29		SEm± 0.04 0.03 0.07	CD at 5% 0.12 0.09 0.21		SEm± 0.06 0.05 0.09	CD at 5% 0.18 0.14 0.26		SEm± 0.10 0.06 0.17	CD at 5% 0.29 0.18 0.50		SEm± 0.07 0.04 0.12	CD at 5% 0.21 0.12 0.35		SEm± 0.10 0.06 0.16	CD at 5% 0.28 0.17 0.45	

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

Table 12 : Allelopathic effect of teak tree row on total dry matter accumulation (g/pl) of greengram at different crop growth stages over distance.

Treatment/ Distance (m)	30 DAS																				
	15 DAS				1998				1999				Pooled								
	1998		1999		1998		1999		1998		1999		1998		1999		Pooled				
	ICR	OCR	Mean	SEm±	CD at 5%	ICR	OCR	Mean	SEm±	CD at 5%	ICR	OCR	Mean	SEm±	CD at 5%	ICR	OCR	Mean	SEm±	CD at 5%	
0-3	0.64	0.30	0.47	0.58	0.26	0.61	0.28	0.45	0.61	0.28	2.82	1.22	2.02	2.82	1.20	2.78	1.20	1.99	2.80	1.21	2.01
3-6	0.66	0.32	0.49	0.62	0.30	0.64	0.31	0.48	0.64	0.31	2.82	1.30	2.06	2.82	1.18	2.82	1.18	2.00	2.82	1.24	2.03
6-9	0.62	0.35	0.49	0.62	0.31	0.62	0.33	0.48	0.62	0.33	2.84	1.31	2.08	2.80	1.27	2.80	1.27	2.04	2.82	1.29	2.06
9-12	0.64	0.38	0.51	0.68	0.32	0.66	0.35	0.51	0.66	0.35	2.90	1.33	2.18	2.78	1.27	2.78	1.27	2.03	2.84	1.30	2.07
12-15	0.67	0.63	0.65	0.63	0.61	0.65	0.62	0.64	0.65	0.62	2.90	2.85	2.88	2.76	2.73	2.76	2.73	2.75	2.83	2.79	2.81
15-18	0.66	0.65	0.66	0.60	0.61	0.63	0.63	0.63	0.63	0.63	2.90	2.87	2.90	2.76	2.77	2.76	2.77	2.77	2.83	2.82	2.83
Mean	0.65	0.44	0.47	0.62	0.40	0.64	0.42	0.45	0.64	0.42	2.86	1.81	2.02	2.86	1.76	2.78	1.76	2.02	2.82	1.78	2.01
SEm±	0.03	0.09	0.09	0.03	0.09	0.04	0.11	0.11	0.04	0.11	0.10	0.29	0.29	0.19	0.56	0.19	0.56	0.56	0.21	0.59	0.59
Ring(R)	0.01	0.03	0.03	0.01	0.03	0.03	0.09	0.09	0.03	0.09	0.06	0.18	0.18	0.11	0.32	0.11	0.32	0.32	0.12	0.34	0.34
D X R	0.06	0.18	0.18	0.06	0.18	0.07	0.20	0.20	0.07	0.20	0.15	0.44	0.44	0.26	0.76	0.26	0.76	0.76	0.32	0.91	0.91

Treatment/ Distance (m)	45 DAS																													
	1998				1999				Pooled				1998				1999				Pooled									
	1998		1999		1998		1999		1998		1999		1998		1999		1998		1999		1998		1999		1998		1999		Pooled	
	ICR	OCR	Mean	SEm±	CD at 5%	ICR	OCR	Mean	SEm±	CD at 5%	ICR	OCR	Mean	SEm±	CD at 5%	ICR	OCR	Mean	SEm±	CD at 5%	ICR	OCR	Mean	SEm±	CD at 5%	ICR	OCR	Mean	SEm±	CD at 5%
0-3	6.00	4.20	5.10	6.50	4.00	6.25	4.10	5.18	6.25	4.10	9.00	5.21	7.11	9.00	5.21	8.80	4.79	6.80	9.00	5.21	8.80	4.79	6.80	8.90	5.00	6.95	8.90	5.00	6.95	
3-6	6.45	4.32	5.39	6.35	4.18	6.40	4.25	5.33	6.40	4.25	9.31	5.62	7.47	9.31	5.62	9.09	5.42	7.26	9.20	5.32	9.09	5.42	7.26	9.20	5.32	7.36	9.20	5.32	7.36	
6-9	6.12	4.71	5.42	6.08	4.59	6.10	4.65	5.38	6.10	4.65	9.37	6.60	7.99	9.37	6.60	9.33	6.56	7.95	9.35	6.58	9.33	6.56	7.95	9.35	6.58	7.97	9.35	6.58	7.97	
9-12	6.34	4.95	5.65	6.16	4.85	6.25	4.90	5.58	6.25	4.90	9.45	7.50	8.48	9.45	7.50	9.35	7.40	8.38	9.40	7.45	9.35	7.40	8.38	9.40	7.45	8.43	9.40	7.45	8.43	
12-15	6.71	6.00	6.36	6.49	5.80	6.60	5.90	6.25	6.60	5.90	9.20	8.80	9.00	9.20	8.80	9.10	8.20	8.65	9.15	8.50	9.10	8.20	8.65	9.15	8.50	8.83	9.15	8.50	8.83	
15-18	6.60	6.25	6.43	6.40	6.15	6.50	6.20	6.35	6.50	6.20	9.30	9.10	9.20	9.30	9.10	9.20	9.00	9.10	9.20	9.05	9.20	9.00	9.10	9.25	9.05	9.15	9.25	9.05	9.15	
Mean	6.37	5.07	5.10	6.33	4.93	6.35	5.00	5.18	6.35	5.00	9.27	7.14	7.11	9.27	7.14	9.15	6.90	6.80	9.21	7.02	9.21	7.02	6.80	9.21	7.02	6.95	9.21	7.02	6.95	
SEm±	0.24	0.70	0.56	0.19	0.56	0.28	0.80	0.80	0.28	0.80	0.14	0.41	0.41	0.14	0.41	0.08	0.23	0.23	0.25	0.71	0.25	0.08	0.23	0.25	0.08	0.71	0.25	0.71		
Ring(R)	0.18	0.53	0.32	0.11	0.32	0.21	0.60	0.60	0.21	0.60	0.07	0.21	0.21	0.07	0.21	0.04	0.12	0.12	0.19	0.54	0.19	0.04	0.12	0.19	0.04	0.54	0.19	0.54		
D X R	0.31	0.91	0.76	0.26	0.76	0.36	1.02	1.02	0.36	1.02	0.26	0.76	0.76	0.26	0.76	0.16	0.47	0.47	0.32	0.91	0.32	0.16	0.47	0.32	0.91	0.32	0.91			

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

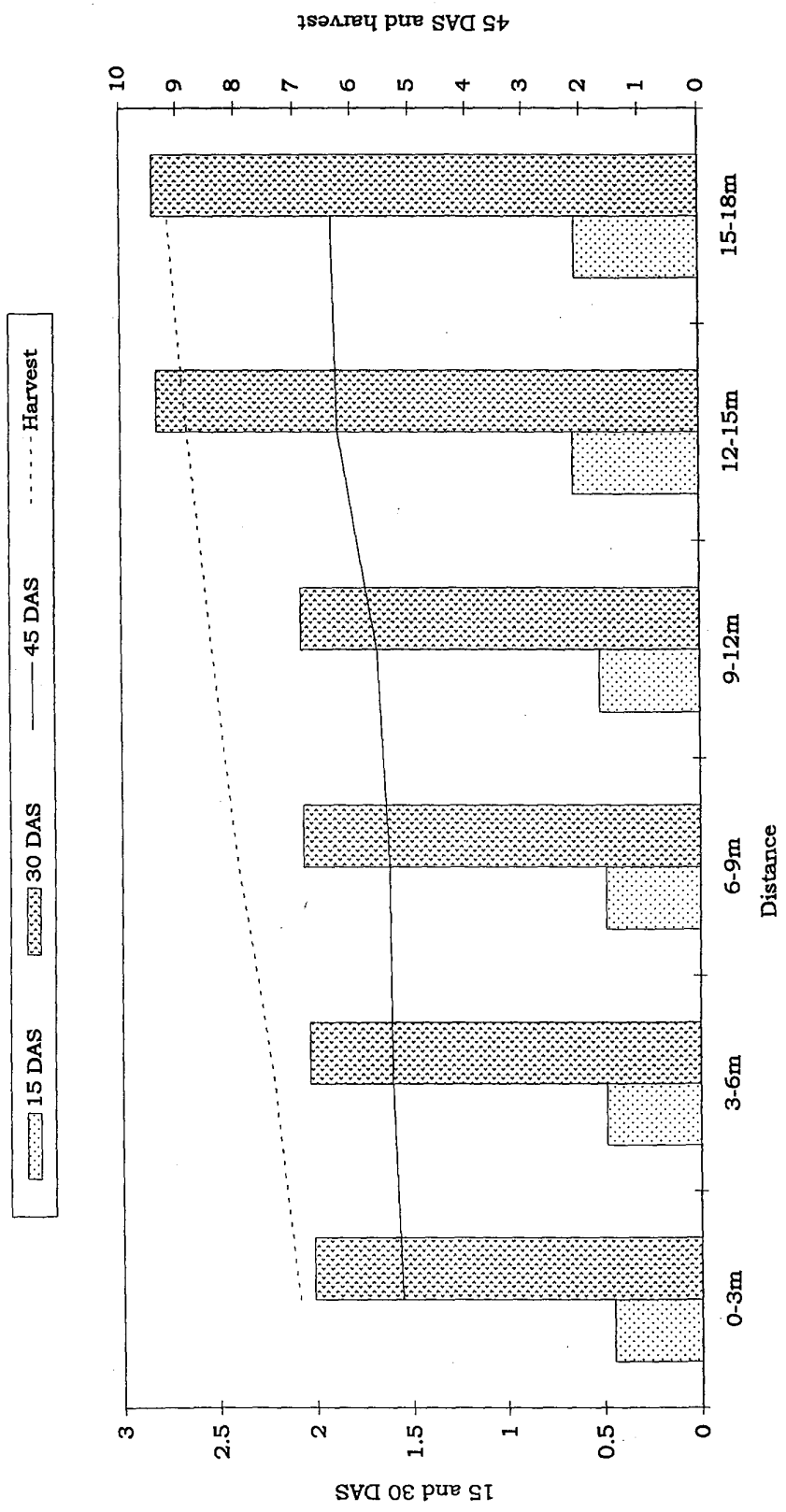


Fig.6 : Total drymatter accumulation (g/pi) over distances from teak tree row at different crop growth stages

ICR OCR

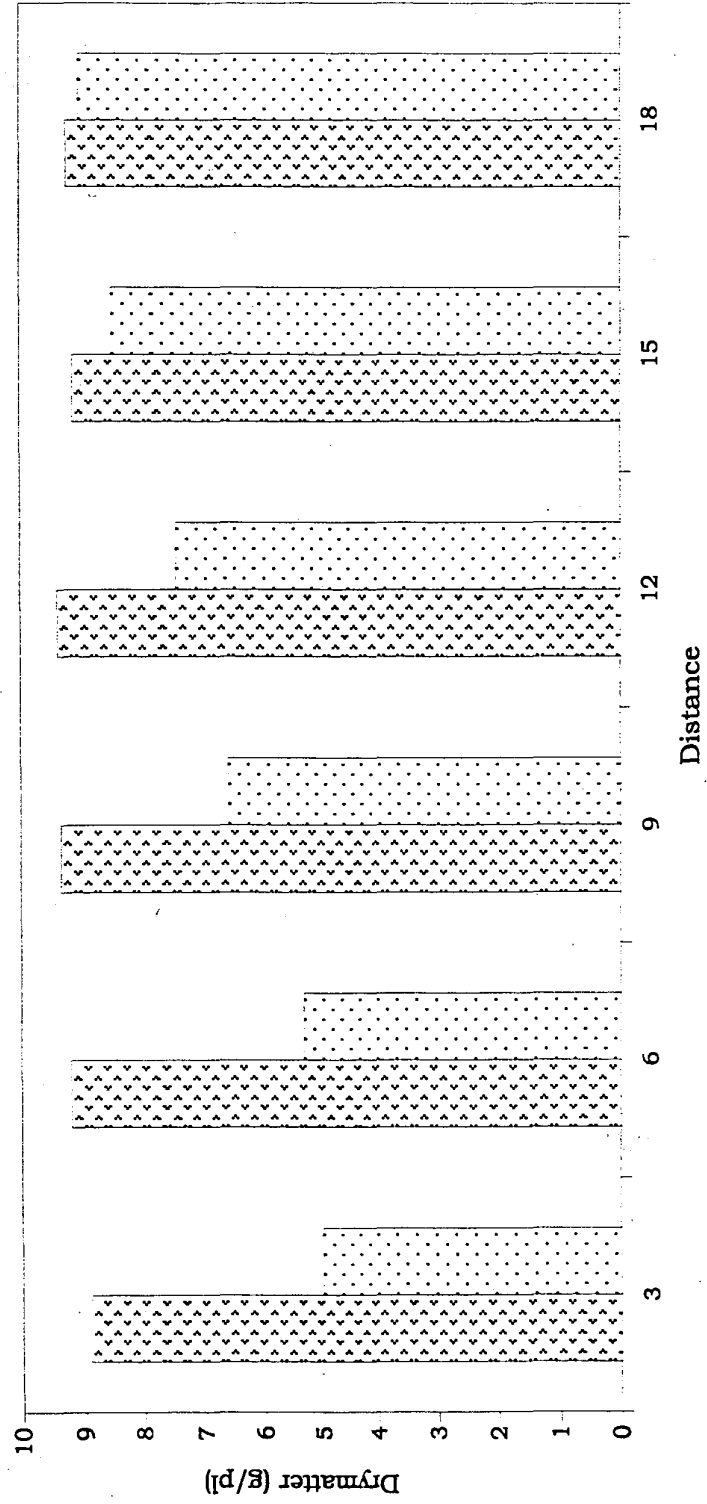


Fig 7 : Drymatter accumulation (g/pl) ICR and OCR at various distance from teak tree row at harvest

recorded significantly higher dry weight than OCR. At various distances the drymatter was on par ICR whereas it was significantly lower till 12m OCR and rest of the distances were on par with ICR.

4.1.2.4 Branches per plant (Table – 13)

Number of branches per plant varied significantly at 45 DAS and at harvest with respect to distance from tree row, partitioning of underground crop growth resources and their interaction.

Number of branches was 3.47 and 4.32 at 45 DAS and at harvest, respectively. Significantly lower number of branches were recorded till 12m compared to 15-18m at both crop growth stages. The average number of branches ICR was significantly higher. At various distances of ICR number of branches were similar as they were on par with each other. OCR recorded significantly lower number of branches per plant till 12m. Distances 12-15m and 15-18m OCR recorded number of branches, which were on par with ICR.

4.1.2.5 Number of days to 50 per cent flower initiation

(Table-14)

The days to 50 per cent flower initiation was higher at 0-3 m distance (40) and took 39 days at 3-6, 6-9 and 9-12m distances. Number of days at 12-15m and 15-18m distances were significantly lower compared to other distances.

Numbers of days were less (37) ICR compared to OCR (40). The interaction showed that within the rings number of days to 50 per cent

Table 13 : Allelopathic effect of teak tree row on number of days to 50% flower initiation leaf of greengram over distance

Treatment/ Distance (m)	Number of days to 50% flower initiation											
	1998				1999				Pooled			
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	37	42	40	38	42	40	38	42	40	42	40	
3-6	37	40	39	37	42	40	37	41	40	41	39	
6-9	38	40	39	37	40	39	38	40	39	40	39	
9-12	37	40	39	38	40	39	38	40	39	40	39	
12-15	37	37	37	37	37	37	37	37	37	37	37	
15-18	37	37	37	37	37	37	37	37	37	37	37	
Mean	37	39		37	40		37	40		40		
	SE _{mt} ±			SE _{mt} ±			SE _{mt} ±			SE _{mt} ±		
Distance (D)	0.45			0.42			0.29			0.82		
Ring (R)	0.26			0.31			0.17			0.48		
D X R	0.64			0.80			0.41			1.16		
	CD at 5%			CD at 5%			CD at 5%			CD at 5%		
	1.32			1.24			1.24			0.82		
	0.76			0.91			0.17			0.48		
	1.88			2.34			0.41			1.16		

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

Table 14 : Allelopathic effect of teak tree row on number of branches per plant leaf of greengram at different crop growth stages over distance

Treatment/ Distance (m)	45 DAS																	
	1998			1999			Pooled			1998			1999			Pooled		
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	4.10	1.75	2.93	4.00	1.25	2.63	4.05	1.50	2.78	5.00	2.20	3.60	4.80	1.90	3.35	4.90	2.10	3.50
3-6	4.15	2.00	3.08	4.15	1.88	3.02	4.15	1.94	3.05	5.10	2.30	3.70	5.10	2.26	3.68	5.10	2.34	3.72
6-9	4.30	2.10	3.15	4.20	2.00	3.10	4.25	2.05	3.15	5.25	2.65	3.95	5.15	2.59	3.87	5.20	2.62	3.91
9-12	4.40	2.40	3.40	4.40	2.44	3.42	4.40	2.42	3.41	5.30	3.20	4.25	5.26	3.05	4.16	5.34	3.12	4.23
12-15	4.40	3.90	4.15	4.20	3.82	4.01	4.30	3.86	4.08	5.42	5.10	5.26	5.38	5.00	5.19	5.40	5.05	5.23
15-18	4.40	4.32	4.36	4.32	4.26	4.29	4.36	4.32	4.34	5.35	5.35	5.35	5.25	5.35	5.30	5.30	5.35	5.33
Mean	4.29	2.75		4.21	2.61		4.25	2.68		5.24	3.47		5.16	3.36		5.21	3.43	
Distance(D) Ring(R) D X R	SEM± 0.19 0.11 0.27	CD at 5% 0.56 0.32 0.79		SEM± 0.14 0.07 0.26	CD at 5% 0.41 0.21 0.76		SEM± 0.12 0.07 0.17	CD at 5% 0.34 0.20 0.48		SEM± 0.19 0.11 0.20	CD at 5% 0.56 0.32 0.76		SEM± 0.24 0.14 0.34	CD at 5% 0.70 0.41 1.00		SEM± 0.18 0.10 0.25	CD at 5% 0.51 0.28 0.71	

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

flower initiation were on par with each other at various distances whereas OCR the farther distances recorded lower number of days than nearer ones. Both inside and outside rings were on par at 12-15m and 15-18m.

4.1.3 Weed growth (Table – 15)

Number of weeds and weed weight (g/m^2) near the trees were significantly lower and increased over distances recording maximum at 15-18m which was on par with 12-15m. ICR the weight and number was significantly higher than OCR.

The weed weight and number were significantly higher in cement rings compared to OCR at respective distances but they were on par at 12-15m and 15-18m.

4.1.4 Yield and Yield attributes

4.1.4.1 Yield attributes (Table – 16)

4.1.4.1.1 Length of pod (cm)

Significantly higher pod length was recorded at 15-18m (9.05) and it was on par with 12-15m. At other distances pod length was significantly lower than at 12-15 and 15-18m with lowest being recorded at 0-3 m (5.34).

The plants grown ICR recorded significantly higher pod length (8.93) than when grown outside. Interaction of these two factors indicated that plants in the rings over distances recorded similar pod length whereas outside rings the pod length was lowest at 0-3 m and increased

Table 15 : Allelopathic effect of teak tree row on weed number (No/m²) and weed dry weight (g/m²) at first weeding (25 DAS) over distance

Treatment/ Distance (m)	Weed number						Weed dry weight											
	1998		1999		Pooled		1998		1999		Pooled							
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean						
0-3	81	53	67	80	51	65	80	52	66	35.50	9.60	22.55	33.02	6.80	19.91	34.26	8.20	21.23
3-6	84	55	70	81	51	66	82	53	68	36.00	11.10	23.55	34.00	9.14	21.57	35.00	10.12	22.56
6-9	85	57	71	82	56	69	84	57	70	35.30	27.20	31.25	33.90	26.00	29.95	34.60	26.60	30.60
9-12	84	63	74	82	62	72	83	62	73	34.80	32.30	33.55	31.60	30.10	30.85	33.20	31.20	32.20
12-15	84	82	83	83	81	82	84	82	83	35.60	33.00	34.30	34.00	31.40	32.70	34.80	32.20	33.50
15-18	86	87	86	85	84	84	85	85	85	36.10	33.20	34.65	34.20	32.60	33.40	35.15	32.90	34.03
Mean	84	66		82	64		83	65		35.55	24.40		33.45	22.67		34.50	23.54	
Distance(D) Ring(R) D X R	SEm± 1.62 0.94 2.30	CD at 5% 4.75 2.75 6.74	SEm± 1.98 1.14 2.80	CD at 5% 5.80 3.34 8.20	SEm± 1.27 0.74 1.81	CD at 5% 3.61 2.10 5.14	SEm± 0.84 0.48 1.19	CD at 5% 2.46 1.41 3.49	SEm± 1.05 0.61 1.49	CD at 5% 3.08 1.79 4.37	SEm± 0.67 0.39 0.95	CD at 5% 1.90 1.11 2.70						

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

over distances but the values recorded till 12m were significantly lower than 12-15 and 15-18m. Similarly, comparing between ICR and OCR over distances the pod length recorded at 12-15 and 15-18m were at par.

4.1.4.1.2 Number of pods per plant

Similar to pod length, number of pods was significantly lower till 12m with the lowest at 0-3 m and further distances of 12-15 and 15-18m recorded significantly higher number.

The plants grown ICR recorded significantly higher number of pods (13.92) than OCR (6.33). The interaction showed that pod number within the rings remained almost same over distances whereas outside the cement rings number increased with distances with 15-18m recording significantly higher than all other distances. Between outside and inside rings the number was at par at 15-18m distance.

4.1.4.1.3 Number of seeds per pod

Significantly higher number of seeds per pod was recorded at 15-18m distance (9.13), which was on par with 12-15m. But these two were significantly higher than other distances wherein 3-6, 6-9 and 9-12m distances were on par with each other with significantly lowest at 0-3 m. Seed number was significantly greater ICR (9.08) than OCR (6.61).

The interaction effect showed that ICR at all the distances the seed number did not vary much whereas OCR the results were same as that of the mean values averaged over distance and cement rings (partitioning).

Table 16 : Allelopathic effect of teak tree row on length of pod (cm), pods per plant, seeds per pod and seeds per plant of greengram over distance

Treatment/ Distance (m)	Length of pod (cm)												Pods/plant											
	1998				1999				Pooled				1998				1999				Pooled			
	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±
0-3	8.80	1.95	5.38	0.28	8.70	1.91	5.31	0.21	8.75	1.93	5.34	0.21	13.80	1.65	7.73	0.74	13.20	1.35	7.28	0.42	13.50	1.50	7.50	0.28
3-6	9.15	2.40	5.78	0.20	8.85	2.32	5.59	0.12	9.00	2.36	5.68	0.12	14.20	2.20	8.20	0.43	13.80	1.80	7.80	0.31	14.00	2.00	8.00	0.16
6-9	9.10	3.42	6.26	0.57	8.90	3.34	6.12	0.30	9.00	3.38	6.19	0.30	13.90	3.90	8.90	1.04	13.60	3.60	8.60	0.80	13.75	3.75	8.75	0.39
9-12	9.30	5.55	7.43	1.67	9.20	5.43	7.32	0.85	9.25	5.49	7.37	0.85	14.10	4.22	9.16	3.05	13.90	3.78	8.34	1.04	14.00	4.00	9.00	0.39
12-15	8.80	8.34	8.57	0.82	8.70	8.24	8.47	0.82	8.75	8.29	8.52	0.82	14.35	12.80	13.58	0.82	14.15	12.70	13.43	0.82	14.25	12.75	13.50	0.82
15-18	8.90	9.40	9.15	0.82	8.70	9.20	8.95	0.82	8.80	9.30	9.05	0.82	14.10	14.15	14.13	0.82	13.90	13.85	13.88	0.82	14.00	14.00	14.00	0.82
Mean	9.01	5.18	6.69	0.82	8.84	5.07	6.61	0.82	8.93	5.13	6.61	0.82	14.08	6.49	13.76	0.82	13.76	6.18	13.92	0.82	13.92	6.33	13.92	6.33
Distance(D) Ring(R) D X R	SEM± 0.24 0.18 0.31	CD at 5% 0.70 0.53 0.91	SEM± 0.28 0.20 0.57	CD at 5% 0.82 0.59 1.67	SEM± 0.21 0.12 0.30	CD at 5% 0.59 0.34 0.85	SEM± 0.21 0.12 0.30	CD at 5% 0.59 0.34 0.85	SEM± 0.74 0.43 1.04	CD at 5% 2.17 1.26 3.05	SEM± 0.42 0.31 0.80	CD at 5% 1.24 0.91 2.34	SEM± 0.28 0.16 0.39	CD at 5% 0.79 0.45 1.10										

Treatment/ Distance (m)	Seeds/pod												Seeds per plant											
	1998				1999				Pooled				1998				1999				Pooled			
	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±
0-3	9.10	2.90	6.00	0.28	9.06	2.84	5.95	0.21	9.08	2.87	5.98	0.21	110.70	5.80	58.25	2.16	109.60	3.60	56.60	0.42	110.15	4.70	57.43	0.28
3-6	9.00	6.00	7.50	0.20	8.82	5.60	7.20	0.12	8.91	5.80	7.35	0.12	112.50	10.50	61.50	0.31	106.50	8.30	57.40	0.31	109.50	9.40	59.45	0.16
6-9	9.20	6.40	7.80	0.91	8.74	6.32	7.53	0.30	8.97	6.36	7.66	0.30	110.33	24.50	67.42	3.05	104.67	23.00	63.83	0.80	107.50	23.75	65.63	0.39
9-12	9.15	6.80	7.98	1.67	9.00	6.66	7.83	0.82	9.07	6.73	7.90	0.82	113.00	27.20	70.10	3.05	105.10	26.30	65.70	0.82	109.05	26.75	67.90	0.39
12-15	9.40	8.82	9.11	0.82	9.30	8.64	8.97	0.82	9.35	8.73	9.04	0.82	112.00	116.50	114.25	0.82	103.00	109.50	106.25	0.82	107.50	113.00	110.25	0.82
15-18	9.15	9.22	9.19	0.82	9.07	9.06	9.07	0.82	9.11	9.14	9.13	0.82	110.00	118.50	114.25	0.82	106.30	108.50	107.40	0.82	108.15	113.50	110.83	0.82
Mean	9.17	6.69	7.50	0.82	9.00	6.52	7.50	0.82	9.08	6.61	7.50	0.82	111.42	50.83	105.86	0.82	105.86	48.20	108.56	0.82	108.56	48.51	108.56	48.51
Distance(D) Ring(R) D X R	SEM± 0.24 0.18 0.31	CD at 5% 0.70 0.53 0.91	SEM± 0.28 0.20 0.57	CD at 5% 0.82 0.59 1.67	SEM± 0.30 0.18 0.43	CD at 5% 0.85 0.51 1.22	SEM± 0.30 0.18 0.43	CD at 5% 0.85 0.51 1.22	SEM± 2.52 1.34 3.20	CD at 5% 7.38 3.92 9.38	SEM± 2.16 1.25 3.05	CD at 5% 6.33 3.66 8.94	SEM± 1.52 0.88 2.15	CD at 5% 4.32 2.50 6.11										

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

However values recorded at 12-15 and 15-18m were on par between ICR and OCR.

4.1.4.1.4 Number of seeds per plant

Significantly lower number of seeds per plant (57.43) was recorded at 0-3 m distance compared to 15-18m distance (110.83). The values recorded at 6-9, 9-12 and 12-15 were significantly higher than 0-3 m but were significantly lower than 15-18m.

ICR recorded significantly more number of seeds per plant (108.56) than OCR (48.51). The interaction showed that values at various distances ICR were on par whereas OCR the values were significantly lower till 15m. The values at 15-18m OCR were on par with values ICR.

4.1.4.1.5 Thousand seed weight (g)

Thousand seed weight was significantly lower at 0-3 m (30.61) distance and increased with increase in distance, the highest being recorded at 15-18m distance (37.68). It was significantly lower till 12m distance. Thousand seed weight OCR (28.65) was significantly lower than ICR (37.90). At various distances ICR plants recorded significantly higher thousand seed weight than OCR except at 12-15 and 15-18m where they were on par with each other.

4.1.4.2 Yield (kg/ha), stover yield (kg/ha) and harvest index (%). (Table-17 and fig – 8 to 9)

4.1.4.2.1 Yield

Grain yield at 0-3 m (481.17) was the lowest and was on par with 3-6m (488.08) and 6-9m (491.67). Till 12m (541.75 at 9-12m) significantly lower grain yield was recorded than at 15-18m (608.05) which was on par with 12-15m (597). The grain yield was significantly lower OCR (465.75) than ICR (602.17).

Inside the rings at various distances the grain yield was on par with each other and were significantly higher than those recorded OCR except at 12-15 and 15-18m where they were on par with each other.

4.1.4.2.2 Stover yield

Stover yield responded similar to that of grain yield wherein significantly the lowest yield was recorded at 0-3 m (1681) distance and was on par with 3-6, 6-9, and 9-12m. The yield at 12-15 (1906) and 15-18m (1910) was on par with each other and significantly higher than other distances. Significantly lower stover yield was recorded OCR (1641) than at ICR (1907).

ICR crop recorded stover yield on par at various distances and was significantly higher than those recorded OCR except at 12-15 and 15-18m where they were on par with each other.

Table 17 : Allelopathic effect of teak tree row on thousand seed weight (g), grain yield (kg/ha), stover yield (kg/ha) and harvest index of greengram over distance

Treatment/ Distance (m)	Thousand seed weight												Grain yield												
	1998				1999				Pooled				1998				1999				Pooled				
	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	
0-3	39.06	22.42	30.74	37.85	23.11	30.48	38.46	22.77	30.61	603	372	487	592	358	475	597	365	481							
3-6	37.88	23.81	30.85	38.85	22.12	38.49	38.37	22.97	30.67	604	388	496	593	366	480	599	377	488							
6-9	37.00	27.91	30.96	37.39	22.79	30.09	37.19	23.85	30.52	610	388	499	594	375	484	601	381	492							
9-12	37.58	25.05	31.32	37.76	29.78	33.79	37.67	27.42	32.54	607	502	555	600	458	529	604	480	542							
12-15	37.59	36.72	37.15	38.89	37.25	38.07	38.24	36.98	37.61	608	588	598	600	592	596	604	590	597							
15-18	37.50	36.78	37.14	37.45	39.00	38.23	37.47	37.89	37.68	607	600	604	607	602	604	607	601	604							
Mean	37.77	28.28	37.14	38.03	29.01	37.90	37.90	28.65	37.68	606	473	598	459	459	602	465	465	604							
Distance(D) Ring(R) D X R	SEM± 0.99 0.57 1.40	CD at 5% 2.90 1.67 4.09	SEM± 0.89 0.51 1.26	CD at 5% 2.60 1.49 3.69	SEM± 0.65 0.38 0.94	CD at 5% 1.84 1.08 2.66	SEM± 11.45 6.61 16.19	CD at 5% 35.43 19.30 47.28	SEM± 13.17 7.61 18.63	CD at 5% 28.59 22.30 54.59	SEM± 8.73 5.04 12.34	CD at 5% 35.06 14.31 35.07													

Treatment/ Distance (m)	Stover yield (kg/ha)												Harvest index											
	1998				1999				Pooled				1998				1999				Pooled			
	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±
0-3	1905	1462	1683	1903	1456	1679	1904	1459	1681	24.03	20.28	23.72	19.74	21.73	23.88	20.01	21.95							
3-6	1907	1464	1686	1906	1456	1681	1907	1460	1683	24.06	20.95	23.73	20.09	21.91	23.90	20.52	22.21							
6-9	1911	1467	1688	1908	1465	1687	1910	1466	1688	24.19	20.92	23.74	20.38	22.06	23.97	20.65	22.31							
9-12	1906	1647	1776	1904	1645	1774	1905	1646	1775	24.15	23.36	23.96	21.78	22.87	24.06	22.57	23.32							
12-15	1912	1902	1907	1909	1901	1905	1910	1902	1906	24.13	23.61	23.91	23.75	23.83	24.02	23.68	23.85							
15-18	1908	1912	1910	1907	1911	1909	1908	1912	1910	24.15	23.89	24.14	23.96	24.05	24.15	23.93	24.04							
Mean	1908	1642	1910	1906	1639	1907	1641	1641	1907	24.12	22.17	23.87	21.62	24.00	24.00	21.90	21.90							
Distance(D) Ring(R) D X R	SEM± 22.24 12.38 44.50	CD at 5% 65.16 36.27 130.39	SEM± 23.48 13.21 46.91	CD at 5% 68.80 38.71 137.45	SEM± 38.49 25.68 51.30	CD at 5% 108.93 72.78 145.18	SEM± 0.03 0.02 0.05	CD at 5% 0.09 0.06 0.15	SEM± 0.20 0.09 0.26	CD at 5% 0.57 0.26 0.76	SEM± 0.13 0.08 0.19	CD at 5% 0.37 0.23 0.54												

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

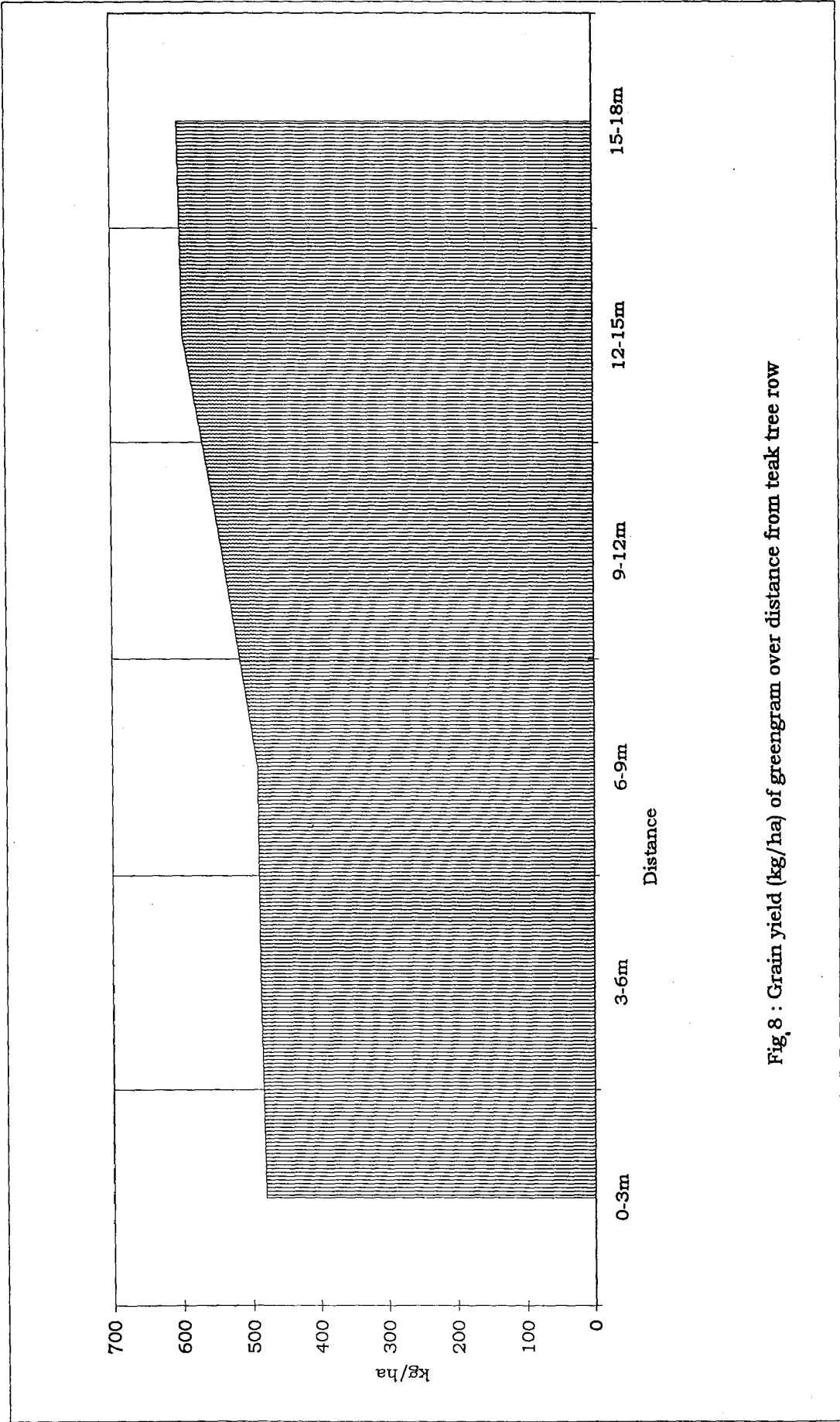


Fig.8 : Grain yield (kg/ha) of greengram over distance from teak tree row

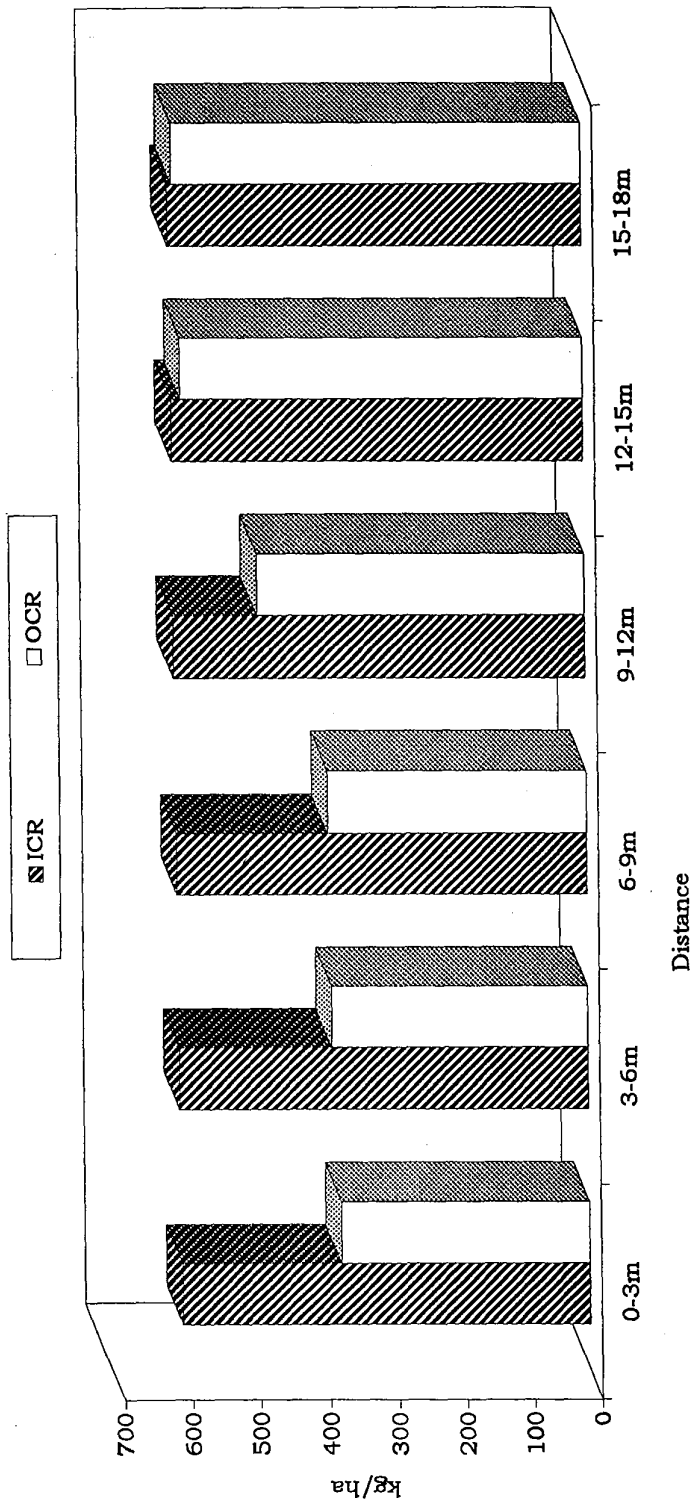


Fig 9 : Grain yield (kg/ha) of greengram ICR and OCR over distances from teak tree row

4.1.4.2.3 Harvest index

Significantly lower harvest index was recorded at 0-3 m (21.95) and higher at 15-18m distance (24.04). Till 12m the harvest index was lower than that recorded at 15-18m distance. Outside cement ring recorded significantly lower (21.90) harvest index than inside ring (24). At various distances the harvest index recorded ICR were on par with each other and were significantly higher than those recorded outside cement ring except at 12-15 and 15-18m distances.

4.1.5 Leaf fall pattern (kg/ha) (Table - 18 and fig- 10)

Leaf fall at different crop growth stages varied significantly wherein the amount of leaf fall increased with increasing age of crop. The overall picture indicated that leaf fall of teak was maximum at 0-3 m which slowly reduced till 12m but there after the leaf fall was very less with lowest being at 15-18m (2, 4, 6, 10 and 15 kg/ha at 15, 30, 45 DAS and at harvest respectively) and this was on par with 12-15m.

4.1.6 Light transmission ratio (LTR) (Table - 19)

Light transmission ratio (%) recorded significantly lower till 6m at all crop growth stages compared with 15-18m (100).

The interaction showed that irrespective of presence or absence of rings significantly lower LTR was recorded till 6m compared with 15-18m.

Table 18 : Cumulative leaf fall pattern of teak (kg/ha) at different crop growth stages of greengram over distance

Treatment/ Distance(m)	Sowing			15 DAS			30 DAS		
	1998	1999	Pooled	1998	1999	Pooled	1998	1999	Pooled
	0-3	201	204	202	215	246	231	261	293
3-6	114	110	112	137	169	153	167	219	193
6-9	86	95	91	120	129	125	146	159	152
9-12	80	91	86	96	115	105	139	147	143
12-15	13	12	13	16	18	17	24	27	26
15-18	2	1	2	3	5	4	4	8	6
SE _m ±	10.30	13.88	10.66	10.08	8.20	6.94	18.73	5.61	9.41
CD at 5%	32.45	43.72	31.27	31.75	35.60	20.35	59.00	17.67	27.60

Treatment/ Distance(m)	45 DAS			Harvest		
	1998	1999	Pooled	1998	1999	Pooled
	0-3	320	324	322	357	379
3-6	251	252	252	292	310	301
6-9	167	219	193	190	261	226
9-12	146	185	166	168	226	197
12-15	32	41	37	39	45	42
15-18	7	14	10	15	16	15
SE _m ±	10.72	11.30	9.49	10.28	10.31	7.02
CD at 5%	33.77	35.60	27.83	32.38	32.48	20.58

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

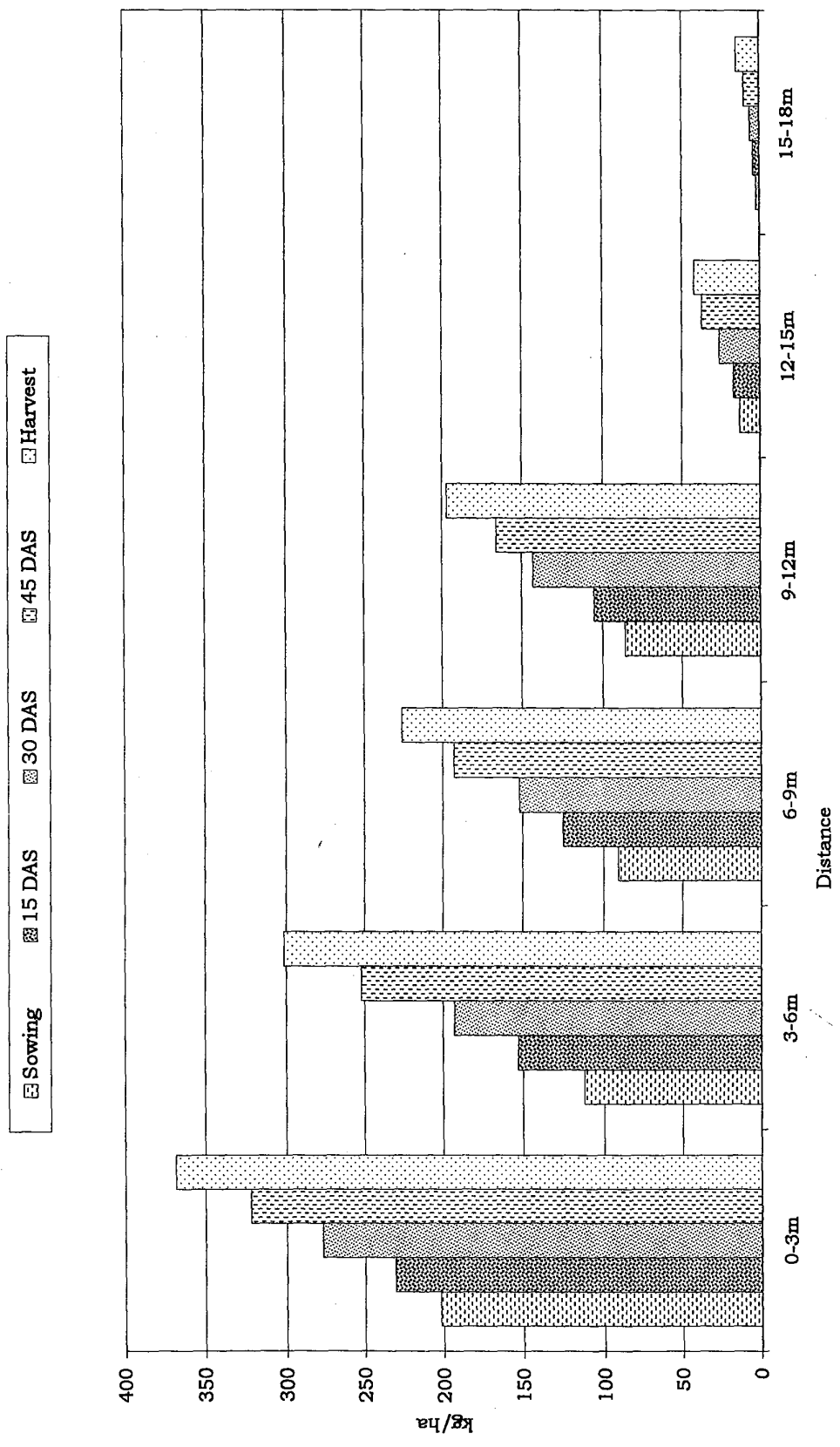


Fig 10 : Cumulative leaf fall (kg/ha) pattern of teak trees at various crop growth stages over distances from tree row

Table 19 : Light transmission ratio (%) at different crop growth stages of greengram in teak tree row over distance

Treatment/ Distance (m)	30 DAS																	
	15 DAS				1998				1999				Pooled					
	1998		1999		ICR		Mean		1998		1999		ICR		Mean		Pooled	
0-3	85	86	94	93	94	90	90	90	94	94	94	94	96	97	97	95	96	96
3-6	89	91	90	96	97	94	94	94	94	95	95	95	99	97	98	97	96	97
6-9	100	100	100	94	95	98	97	97	100	97	99	100	100	98	99	100	98	99
9-12	100	100	100	97	97	98	99	99	100	97	99	100	100	98	99	100	98	99
12-15	100	100	100	99	99	100	100	100	100	99	100	100	100	99	100	100	99	100
15-18	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Mean	96	96	96	97	97	97	97	97	97	98	97	97	98	97	98	99	98	99
SEm±	1.25	3.66	SEm±	1.03	3.02	SEm±	1.34	3.80	SEm±	0.39	1.14	SEm±	0.41	1.20	SEm±	0.65	1.85	
CD at 5%	0.74	NS	CD at 5%	0.59	NS	CD at 5%	0.87	NS	CD at 5%	0.28	0.82	CD at 5%	0.31	0.91	CD at 5%	0.39	NS	
Ring(R)	1.56	4.57	Ring(R)	1.45	4.25	Ring(R)	1.65	4.67	Ring(R)	0.65	1.90	Ring(R)	0.66	1.93	Ring(R)	0.90	2.56	
D X R			D X R			D X R			D X R			D X R			D X R			

Treatment/ Distance (m)	45 DAS																	
	1998				1999				Pooled				Harvest					
	1998		1999		ICR		Mean		1998		1999		ICR		Mean		Pooled	
0-3	89	85	87	95	96	93	90	92	99	94	97	93	96	95	96	96	95	96
3-6	84	90	87	99	98	91	95	93	99	98	99	95	94	95	97	96	96	97
6-9	98	94	96	100	100	99	97	98	99	98	99	100	100	100	100	99	99	100
9-12	91	96	94	100	100	96	98	97	100	99	100	100	99	100	100	100	99	100
12-15	92	96	94	100	98	94	98	96	100	100	100	100	98	99	100	100	100	100
15-18	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Mean	92	94	93	99	99	96	96	96	100	98	99	96	98	98	98	99	98	99
SEm±	0.48	1.40	SEm±	0.32	0.94	SEm±	0.90	2.56	SEm±	0.34	1.00	SEm±	0.26	0.76	SEm±	0.93	2.64	
CD at 5%	0.35	1.03	CD at 5%	0.28	NS	CD at 5%	0.77	NS	CD at 5%	0.26	0.76	CD at 5%	0.20	NS	CD at 5%	0.62	1.76	
Ring(R)	0.70	2.05	Ring(R)	0.45	1.32	Ring(R)	1.36	3.86	Ring(R)	0.50	1.47	Ring(R)	0.38	1.11	Ring(R)	1.40	3.98	
D X R			D X R			D X R			D X R			D X R			D X R			

4.1.7 Soil moisture (%) (Table – 20 to 22)

Soil moisture recorded at different crop growth stages showed that the moisture levels were slightly higher during first year of experimentation than second year. However the differences in moisture at different layers of soil during the respective crop growth stages was not significantly influenced by the treatments.

4.1.8 Nutrient uptake (kg/ha) by crop plant and their parts

4.1.8.1 Grain (Table - 23)

Highest uptake was recorded at 15-18m distance (29.85, 2.80 and 10.22 N, P₂O₅ and K₂O respectively) while till 12m significantly lower uptake was recorded. With respect to uptake of all nutrients, 12-15m was on par with 15-18m. Nitrogen and phosphorus uptake from tree to 12 m distance was on par, whereas potash uptake at 3 to 12m was on par with each other with significantly higher uptake than at 0-3m (7.94).

Uptake of nutrients was significantly higher ICR (30.14, 2.73 and 10.28 kg/ha N, P₂O₅ and K₂O respectively) than OCR (17.28, 1.66 and 7.78 kg/ha N, P₂O₅ and K₂O respectively).

The uptake due to partitioning were on par at various distances ICR with respect to N, P₂O₅ and K₂O. Till 12m OCR recorded significantly lower uptake whereas 12-15 and 15-18m were on par with ICR.

Table 20 : Soil moisture (%) status of teak tree row at sowing and 15 days after sowing of greengram crop

Treatment/ Distance (m)	Sowing																						
	1998						1999						Pooled										
	0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm				
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean		
0-3	26.70	26.40	26.55	26.50	27.00	26.75	26.00	26.30	26.15	26.60	26.90	26.75	26.35	26.35	26.35	26.55	26.95	26.75	26.35	26.35	26.35		
3-6	26.00	25.80	25.90	26.75	26.60	26.68	26.20	26.00	26.10	26.90	26.50	26.70	26.10	25.90	26.00	26.83	26.55	26.69	26.10	25.90	26.00		
6-9	26.60	26.40	26.50	27.00	27.00	27.00	26.30	26.10	26.20	26.90	26.50	26.70	26.45	26.25	26.35	26.95	26.75	26.85	26.45	26.25	26.35		
9-12	26.40	26.40	26.40	27.00	26.20	26.60	26.30	26.30	26.30	26.80	26.90	26.85	26.35	26.35	26.35	26.90	26.55	26.73	26.35	26.35	26.35		
12-15	25.20	25.40	25.30	26.00	26.40	26.20	25.20	25.40	25.30	25.80	25.70	25.75	25.20	25.40	25.30	25.90	26.05	25.98	25.20	25.40	25.30		
15-18	25.20	25.30	25.25	25.50	25.40	25.45	25.00	25.20	25.10	25.20	25.50	25.35	25.10	25.25	25.18	25.35	25.45	25.40	25.10	25.25	25.18		
Mean	26.02	25.95	25.98	26.46	26.43	26.45	25.83	25.88	25.86	26.37	26.33	26.35	26.35	25.92	25.92	26.41	26.38	26.40	26.41	26.38	26.40		
SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%	
Distance (D)	0.39	NS		0.89	NS		0.70	NS		0.67	NS		0.65	NS		0.92	NS		0.65	NS		0.92	NS
Ring(R)	0.23	NS		0.51	NS		0.40	NS		0.39	NS		0.35	NS		0.55	NS		0.35	NS		0.55	NS
D X R	0.65	NS		1.26	NS		1.02	NS		0.95	NS		0.92	NS		1.11	NS		0.92	NS		1.11	NS

Treatment/ Distance (m)	15 DAS																						
	1998						1999						Pooled										
	0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm				
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean		
0-3	24.60	25.80	25.20	25.00	26.20	25.60	24.60	25.40	25.00	25.00	26.00	25.50	24.60	25.60	24.80	25.00	26.10	25.55	24.60	25.60	24.80		
3-6	24.60	25.70	25.15	24.80	26.00	25.40	24.80	25.20	25.00	25.00	25.80	25.40	24.70	25.45	25.08	24.90	25.90	25.40	24.60	25.45	25.08		
6-9	24.40	25.70	25.05	24.60	26.00	25.30	24.80	25.00	24.90	25.25	25.80	25.54	24.60	25.35	24.98	24.93	25.90	25.42	24.60	25.35	24.98		
9-12	24.00	25.00	24.50	24.40	25.70	25.05	24.50	25.00	24.75	25.50	25.70	25.60	24.25	25.00	24.63	24.95	25.70	25.33	24.25	25.00	24.63		
12-15	24.00	24.20	24.10	24.20	25.00	24.60	24.20	24.30	24.25	24.60	24.90	25.75	24.10	24.25	24.18	24.40	24.95	24.68	24.10	24.25	24.18		
15-18	24.00	24.00	24.00	24.40	24.70	24.55	24.00	24.40	24.20	24.20	24.60	24.40	24.30	24.20	24.10	24.30	24.65	24.48	24.30	24.20	24.10		
Mean	24.27	25.07	24.67	24.57	25.60	25.08	24.48	24.88	24.68	25.26	25.74	25.00	24.38	24.98	24.63	24.75	25.53	25.14	24.38	24.98	24.63		
SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%	
Distance (D)	0.52	NS		0.85	NS		0.66	NS		0.45	NS		0.42	NS		0.72	NS		0.42	NS		0.72	NS
Ring(R)	0.31	NS		0.44	NS		0.38	NS		0.26	NS		0.26	NS		0.41	NS		0.26	NS		0.41	NS
D X R	0.70	NS		1.11	NS		0.93	NS		0.64	NS		0.65	NS		1.05	NS		0.65	NS		1.05	NS

Table 22 : Soil moisture (%) status of teak tree row at harvest of greengram crop

Treatment/ Distance (m)	Harvest																	
	1998						1999						Pooled					
	0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		Mean	
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	25.60	25.80	25.70	26.20	26.90	26.55	25.20	25.60	25.40	25.70	26.20	25.95	25.40	25.70	25.55	25.95	26.55	26.25
3-6	25.60	25.80	25.70	26.30	26.90	26.60	25.00	25.40	25.20	25.80	26.00	25.90	25.30	25.60	25.45	26.05	26.45	26.25
6-9	25.40	25.80	25.60	26.20	26.90	26.55	25.00	25.40	25.20	25.40	26.00	25.70	25.20	25.60	25.40	25.80	26.45	26.13
9-12	25.40	25.60	25.50	26.20	26.40	26.33	24.80	25.40	25.10	25.60	26.00	25.80	25.10	25.50	25.30	25.9	26.20	26.05
12-15	25.00	25.20	25.10	26.00	25.90	25.95	24.60	25.00	24.80	25.20	25.80	25.50	24.80	25.10	24.95	25.60	25.85	25.73
15-18	25.00	25.00	25.00	25.60	25.70	25.65	24.60	24.80	24.70	25.20	25.60	25.40	24.80	24.90	24.85	25.40	25.65	25.53
Mean	25.33	25.33	25.43	26.08	26.45	26.27	24.87	25.27	25.07	25.48	25.93	25.70	25.10	25.40	25.18	25.62	26.20	
Distance(D) Ring(R) D X R	SE _{mt}	CD at 5%		SE _{mt}	CD at 5%		SE _{mt}	CD at 5%		SE _{mt}	CD at 5%		SE _{mt}	CD at 5%		SE _{mt}	CD at 5%	
	0.28	NS		0.50	NS		0.76	NS		0.38	NS		0.33	NS		0.94	NS	
	0.20	NS		0.29	NS		0.41	NS		0.25	NS		0.22	NS		0.50	NS	
	0.50	NS		0.84	NS		1.34	NS		0.71	NS		0.41	NS		1.43	NS	

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

Table 23: Allelopathic effect of teak tree row on nutrient uptake (kg/ha) by grain of greengram over distance.

Treatment/ Distance (m)	Nitrogen												Phosphorus										
	1998				1999				Pooled				1998			1999			Pooled				
	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean
0-3	32.50	12.22	22.36	0.78	27.50	9.00	18.25	0.81	30.00	10.61	20.31	0.56	3.05	1.15	2.10	0.30	2.25	0.75	1.50	2.65	0.95	1.80	0.18
3-6	31.15	13.14	22.15	0.45	28.00	9.34	18.65	0.47	29.58	11.22	20.40	0.33	3.15	1.20	2.18	0.17	2.35	0.87	1.61	2.75	1.04	1.89	0.10
6-9	31.27	14.27	22.77	1.10	29.01	9.40	19.20	1.15	30.14	11.84	20.99	0.80	2.90	1.34	2.12	0.45	2.50	0.92	1.71	2.70	1.13	1.92	0.26
9-12	32.00	16.00	24.00	3.22	28.56	9.67	19.09	1.15	30.25	12.83	21.54	0.80	3.12	1.40	2.26	0.21	2.45	1.01	1.73	2.79	1.21	2.00	0.30
12-15	32.25	29.76	31.01	0.45	29.00	26.50	27.75	0.47	30.63	28.13	29.38	0.33	3.20	3.25	3.22	0.09	2.35	2.34	2.35	2.78	2.80	2.79	0.26
15-18	31.75	33.43	31.59	1.10	28.75	25.47	27.11	1.10	30.25	29.45	29.85	0.80	3.00	3.30	3.25	0.21	2.50	2.40	2.45	2.75	2.85	2.80	0.26
Mean	31.82	19.00			28.46	14.89			30.14	17.28			3.07	1.94			2.40	1.38		2.73	1.66		
Distance(D) Ring(R) D X R	SEM± 0.78 0.45 1.10	CD at 5% 2.29 1.32 3.22		SEM± 0.81 0.47 1.15	CD at 5% 2.37 1.38 3.37		SEM± 0.56 0.33 0.80	CD at 5% 1.59 0.94 2.27		SEM± 0.30 0.17 0.45	CD at 5% 0.88 0.50 1.32		SEM± 0.15 0.09 0.21	CD at 5% 0.44 0.26 0.62		SEM± 0.18 0.10 0.26	CD at 5% 0.51 0.30 0.72						

Treatment/ Distance (m)	Potassium											
	1998				1999				Pooled			
	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±
0-3	10.01	6.75	8.43	0.21	9.55	5.33	7.44	0.22	9.83	6.04	7.94	0.22
3-6	11.17	7.80	9.49	0.12	10.00	5.52	7.76	0.13	10.58	6.66	8.62	0.13
6-9	11.32	7.83	9.58	0.30	9.22	6.13	7.68	0.31	10.27	6.98	8.63	0.31
9-12	11.18	7.90	9.54	0.88	9.77	6.42	8.10	0.88	10.47	7.16	8.82	0.88
12-15	11.02	10.25	10.64	0.21	9.37	9.15	9.26	0.21	10.19	9.70	9.95	0.21
15-18	11.02	10.68	10.85	0.30	9.60	9.57	9.59	0.30	10.31	10.13	10.22	0.30
Mean	10.97	8.52			9.50	7.02			10.28	7.78		
Distance(D) Ring(R) D X R	SEM± 0.21 0.12 0.30	CD at 5% 0.62 0.35 0.88		SEM± 0.39 0.23 0.55	CD at 5% 1.14 0.67 1.61		SEM± 0.22 0.13 0.31	CD at 5% 0.63 0.36 0.89				

4.1.8.2 Stover (Table - 24)

Uptake by stover responded similar to that of nutrient uptake in grain wherein significantly lower uptake was recorded till 12m compared to 15-18m which recorded significantly higher uptake with respect to all nutrients wherein 12-15m was on par with 15-18m. ICR uptake was significantly higher than OCR.

Interaction effects showed that ICR recorded almost similar uptake at various distances whereas OCR recorded significantly lower uptake till 12m and the 12-15 and 15-18m were on par with ICR.

4.1.8.3 Total uptake (Table - 25 and fig - 11 to 20)

The total uptake by the crop was also similar to grain and stover recorded significantly lower till 12m compared to 15-18m which recorded significantly higher uptake, whereas 12-15m distance was on par in nutrient uptake with 15-18m. ICR recorded significantly higher uptake than OCR.

The uptake ICR at various distances were on par with each other and were also on par with OCR at 12-15 and 15-18m. OCR till 12m recorded significantly lower uptake with respect to N, P₂O₅ and K₂O.

Table 24 : Allelopathic effect of teak tree row on nutrient uptake (kg/ha) by straw of greengram over distance

Treatment/ Distance (m)	Phosphorus											
	Nitrogen						Phosphorus					
	1998		1999		Pooled		1998		1999		Pooled	
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	40.25	25.75	33.00	37.50	22.22	29.86	38.38	23.99	31.43	3.90	2.25	3.08
3-6	40.50	26.62	33.56	38.00	23.00	30.50	39.25	24.81	32.03	4.22	2.34	3.28
6-9	41.40	27.26	34.33	37.00	23.50	30.25	39.20	25.38	32.29	4.15	2.72	3.44
9-12	41.50	28.00	34.75	38.00	24.32	31.16	39.75	26.16	32.96	4.15	2.95	3.55
12-15	42.00	38.90	40.45	38.50	36.70	37.60	40.25	37.80	39.03	4.21	4.00	4.11
15-18	42.00	39.00	41.58	38.50	37.00	38.15	40.25	38.00	39.86	4.70	4.15	4.43
Mean	41.34	30.92		37.92	27.84		39.60	29.36		4.22	3.07	
	SE \pm	CD at 5%		SE \pm	CD at 5%		SE \pm	CD at 5%		SE \pm	CD at 5%	
Distance(D)	0.53	1.55		0.56	1.64		0.38	1.08		0.20	0.59	
Ring(R)	0.31	0.91		0.32	0.94		0.22	0.63		0.12	0.35	
D X R	0.75	2.20		0.79	2.32		0.54	1.53		0.29	0.85	
										SE \pm	CD at 5%	
										0.16	0.47	
										0.09	0.26	
										0.23	0.67	
												SE \pm
												0.13
												0.08
												0.18
												0.37
												0.21
												0.52

Treatment/ Distance (m)	Potassium											
	1998						1999					
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	13.35	8.00	10.68	11.85	7.10	9.48	12.60	7.55	10.08	12.60	7.55	10.08
3-6	13.50	7.95	10.83	12.00	7.55	9.78	12.75	7.75	10.25	12.75	7.75	10.25
6-9	13.05	8.75	10.90	12.25	7.50	9.88	12.65	8.13	10.39	12.65	8.13	10.39
9-12	13.40	8.90	11.25	12.25	7.83	10.04	12.83	8.37	10.60	12.70	12.70	12.70
12-15	13.25	13.25	13.25	12.15	12.15	12.15	12.70	12.70	12.70	12.70	12.70	12.70
15-18	13.35	13.50	13.43	12.25	12.20	12.23	12.80	12.85	12.83	12.80	12.85	12.83
Mean	13.32	10.05		12.13	9.05		12.72	9.55		12.72	9.55	
	SE \pm	CD at 5%		SE \pm	CD at 5%		SE \pm	CD at 5%		SE \pm	CD at 5%	
Distance(D)	0.46	1.35		0.36	1.06		0.29	0.83		0.29	0.83	
Ring(R)	0.27	0.79		0.21	0.62		0.17	0.48		0.17	0.48	
D X R	0.65	1.91		0.51	1.49		0.41	1.17		0.41	1.17	

Table 25 : Allelopathic effect of teak tree row on total nutrient uptake (kg/ha) by the greengram crop over distance

Treatment/ Distance (m)	Phosphorus																	
	Nitrogen				1998				1999				Pooled					
	1998		1999		1998		1999		1998		1999		1998		1999		Pooled	
0-3	72.75	37.97	55.36	65.00	31.22	48.11	68.88	34.60	51.74	6.95	3.40	5.18	5.70	2.25	3.98	6.33	2.83	4.58
3-6	71.65	39.76	55.71	66.00	32.30	49.15	68.83	36.03	52.43	7.37	3.54	5.46	5.60	2.52	4.06	6.49	3.03	4.76
6-9	72.67	41.53	57.10	66.00	32.90	49.45	69.34	37.22	53.28	7.05	4.06	5.56	5.75	2.62	4.19	6.40	3.34	4.87
9-12	73.50	44.00	58.75	66.50	33.99	50.24	70.00	38.99	54.50	7.27	4.35	5.81	5.98	2.86	4.42	6.63	3.61	5.12
12-15	74.25	68.66	71.46	67.50	63.20	65.35	70.88	65.93	68.40	7.41	7.25	7.33	5.80	5.84	5.82	6.60	6.55	6.57
15-18	73.75	72.43	73.09	67.25	62.43	64.86	70.50	67.45	68.97	7.70	7.45	7.58	6.00	5.80	5.90	6.85	6.63	6.74
Mean	73.10	50.73		66.38	42.68		69.74	46.70		7.29	5.01		5.81	3.65		6.55	4.33	
Distance(D) Ring(R) D X R	SE \pm 1.05 0.60 1.48	CD at 5% 3.08 1.76 4.34		SE \pm 1.20 0.69 1.69	CD at 5% 3.52 2.02 4.95		SE \pm 0.79 0.46 1.12	CD at 5% 2.26 1.30 3.19		SE \pm 0.46 0.27 0.65	CD at 5% 1.35 0.79 1.91		SE \pm 0.26 0.15 0.37	CD at 5% 0.76 0.44 1.08		SE \pm 0.27 0.15 0.37	CD at 5% 0.75 0.43 1.06	

Treatment/ Distance (m)	Potassium											
	1998				1999				Pooled			
	ICR	OCR	Mean	SE \pm	ICR	OCR	Mean	SE \pm	ICR	OCR	Mean	SE \pm
0-3	23.45	14.75	19.10	21.40	12.43	16.92	22.43	13.59	18.00	22.43	13.59	18.00
3-6	24.67	15.75	20.21	22.00	13.07	17.53	23.33	14.41	18.87	23.33	14.41	18.87
6-9	24.37	16.58	20.48	21.47	13.63	17.55	22.92	15.11	19.01	22.92	15.11	19.01
9-12	24.58	16.80	20.69	22.02	14.25	18.14	23.30	15.53	19.41	23.30	15.53	19.41
12-15	24.27	23.50	23.88	21.52	21.30	21.41	22.89	22.40	22.65	21.52	21.30	21.41
15-18	24.37	24.18	24.28	21.85	21.77	21.81	23.11	22.98	23.04	21.85	21.77	21.81
Mean	24.28	18.59		21.71	16.08		23.00	17.34		23.00	17.34	
Distance(D) Ring(R) D X R	SE \pm 0.45 0.26 0.64	CD at 5% 1.32 0.76 1.88		SE \pm 0.63 0.37 0.89	CD at 5% 1.85 1.08 2.61		SE \pm 0.39 0.22 0.55	CD at 5% 1.11 0.64 1.56				

ICR OCR

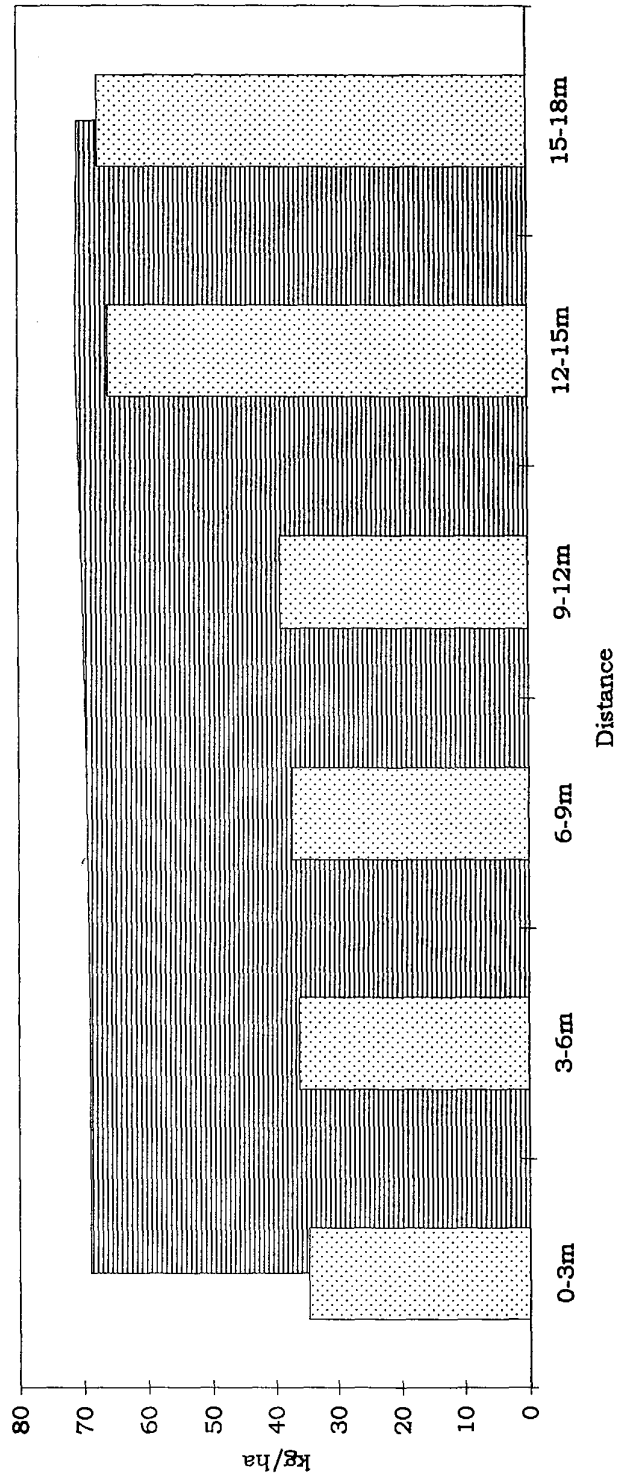


Fig.12 : Uptake of nitrogen (kg/ha) by greengram ICR and OCR at harvest over distances from teak tree row

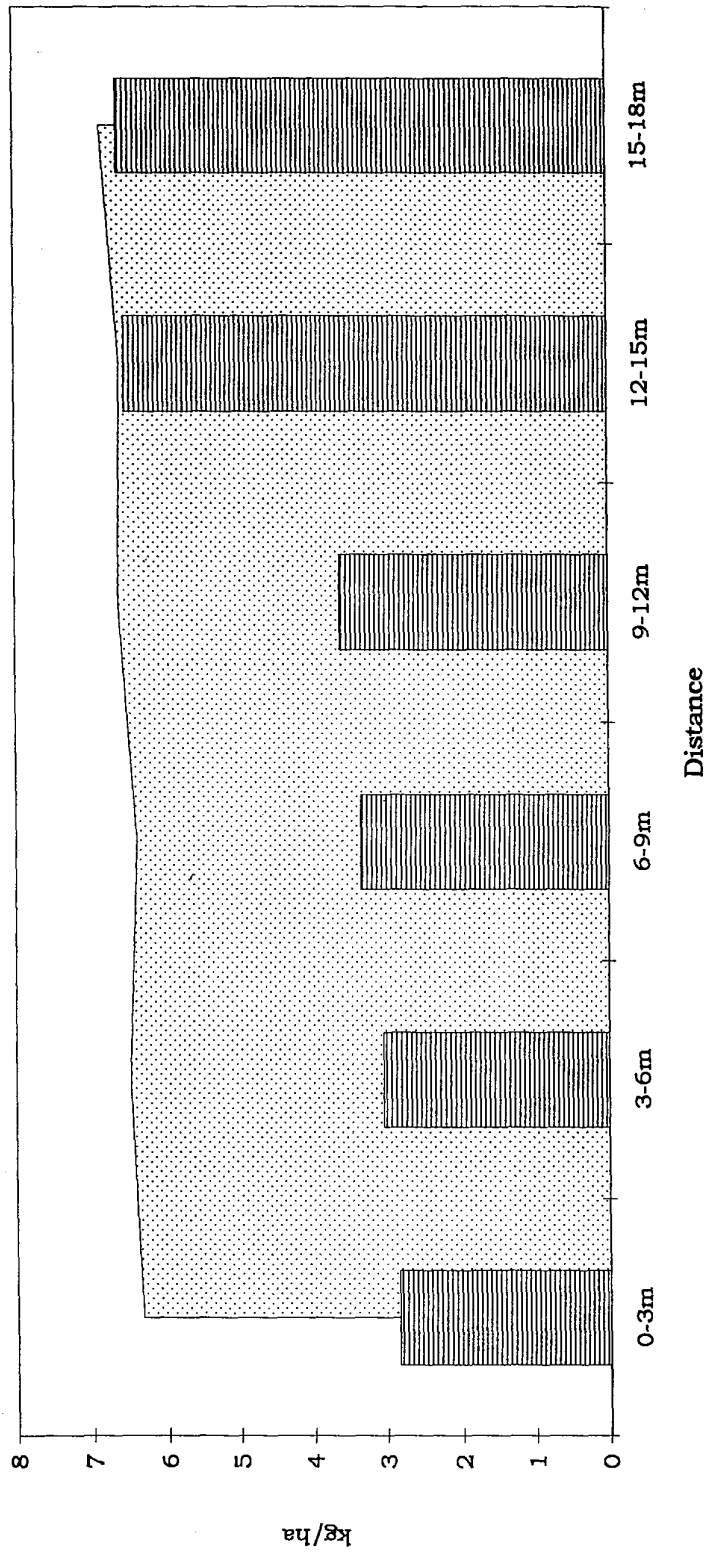


Fig. 13 : Uptake of phosphorus (kg/ha) by greengram ICR and OCR at harvest over distances from teak tree row

ICR
OCR

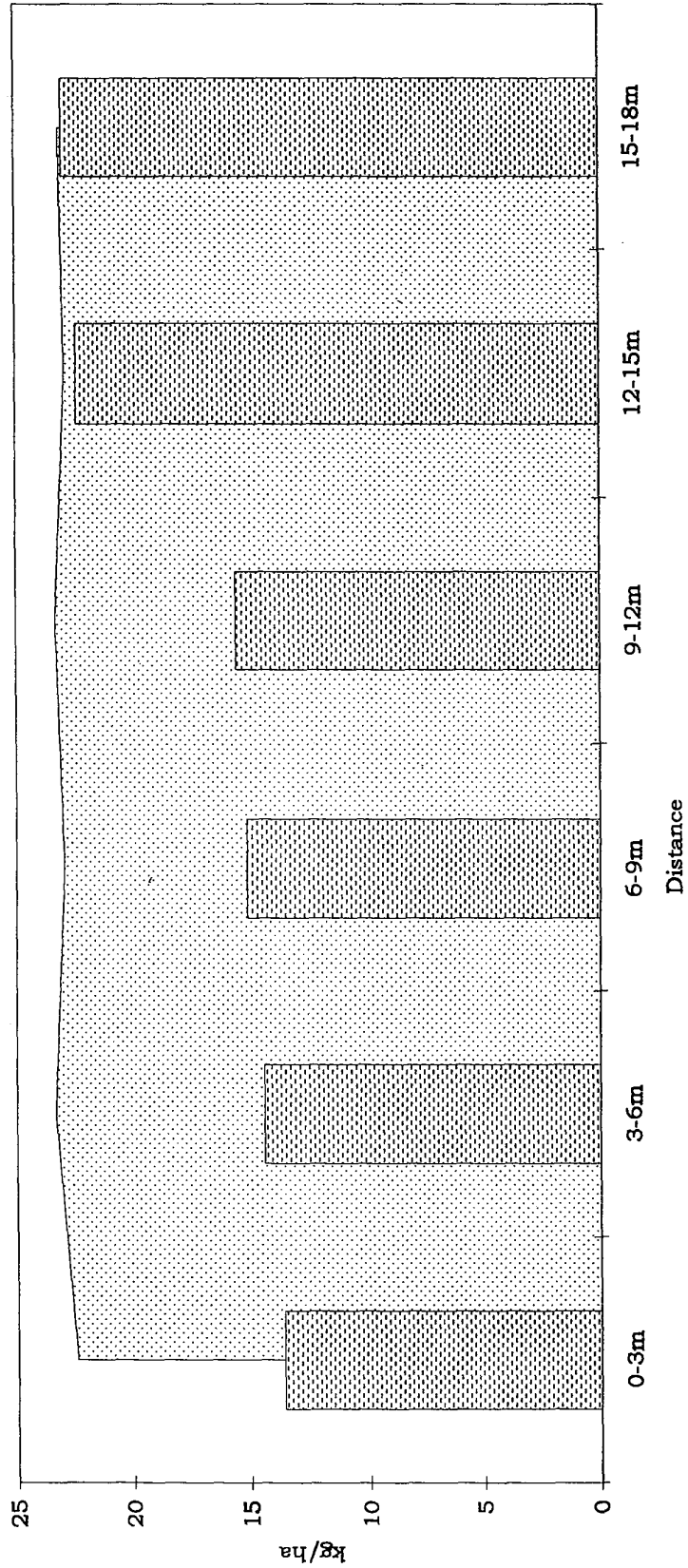


Fig. 14 : Uptake of potassium (kg/ha) by greengram ICR and OCR at harvest over distances from teak tree row

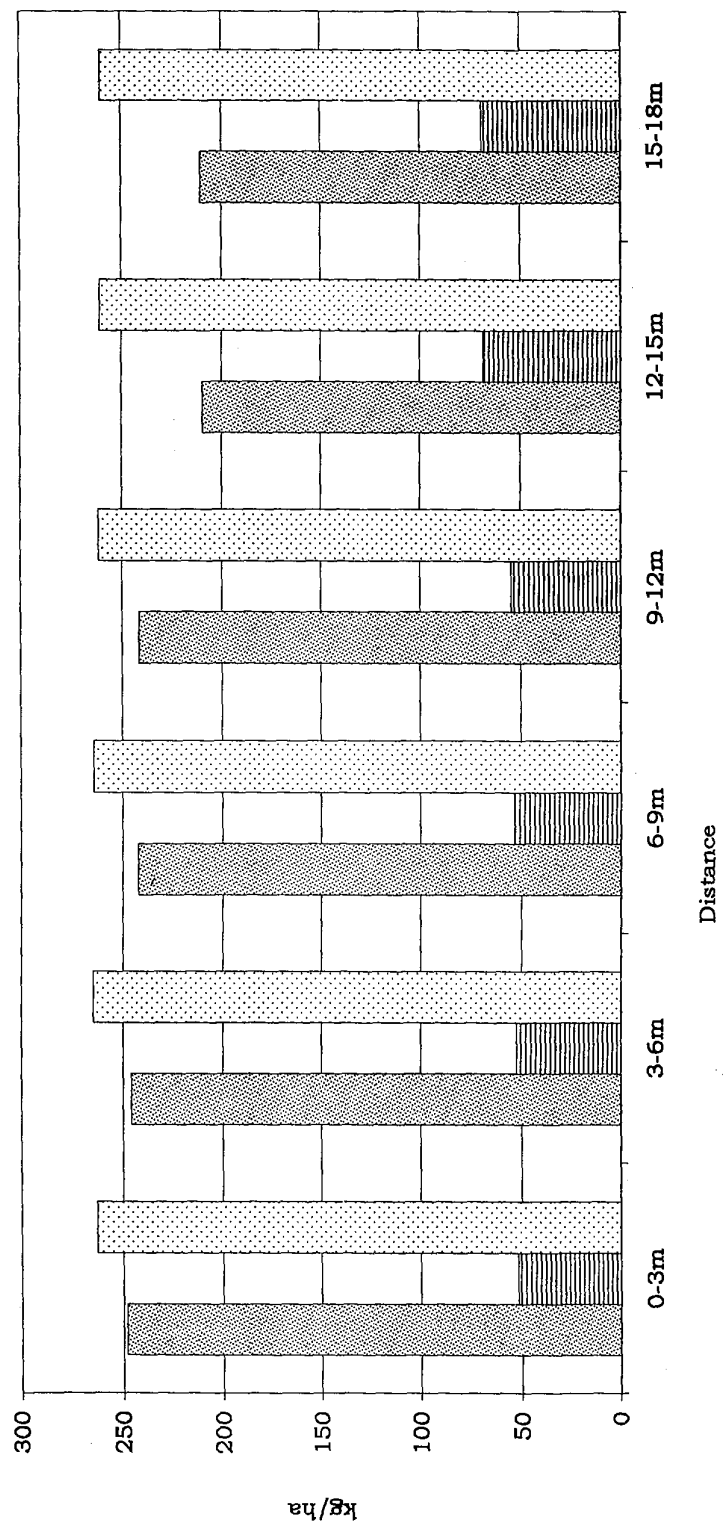
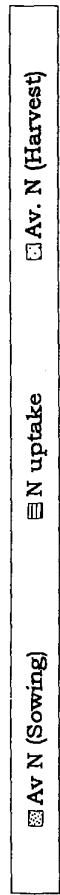


Fig. 15 : Nitrogen availability and uptake (kg/ha) by greengram over distances from teak tree row

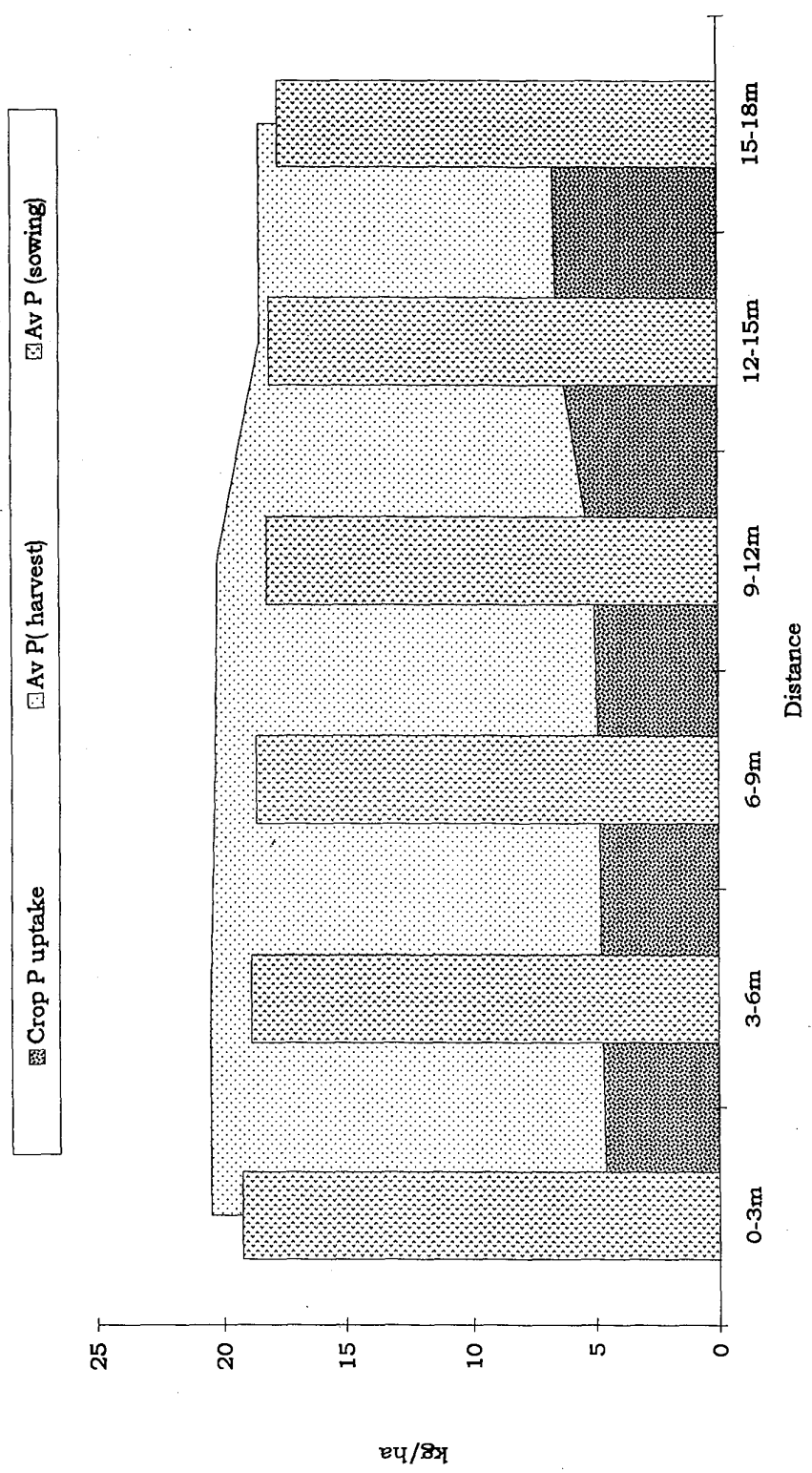


Fig.16 : Phosphorus availability and uptake (kg/ha) by greengram over distances from teak tree row

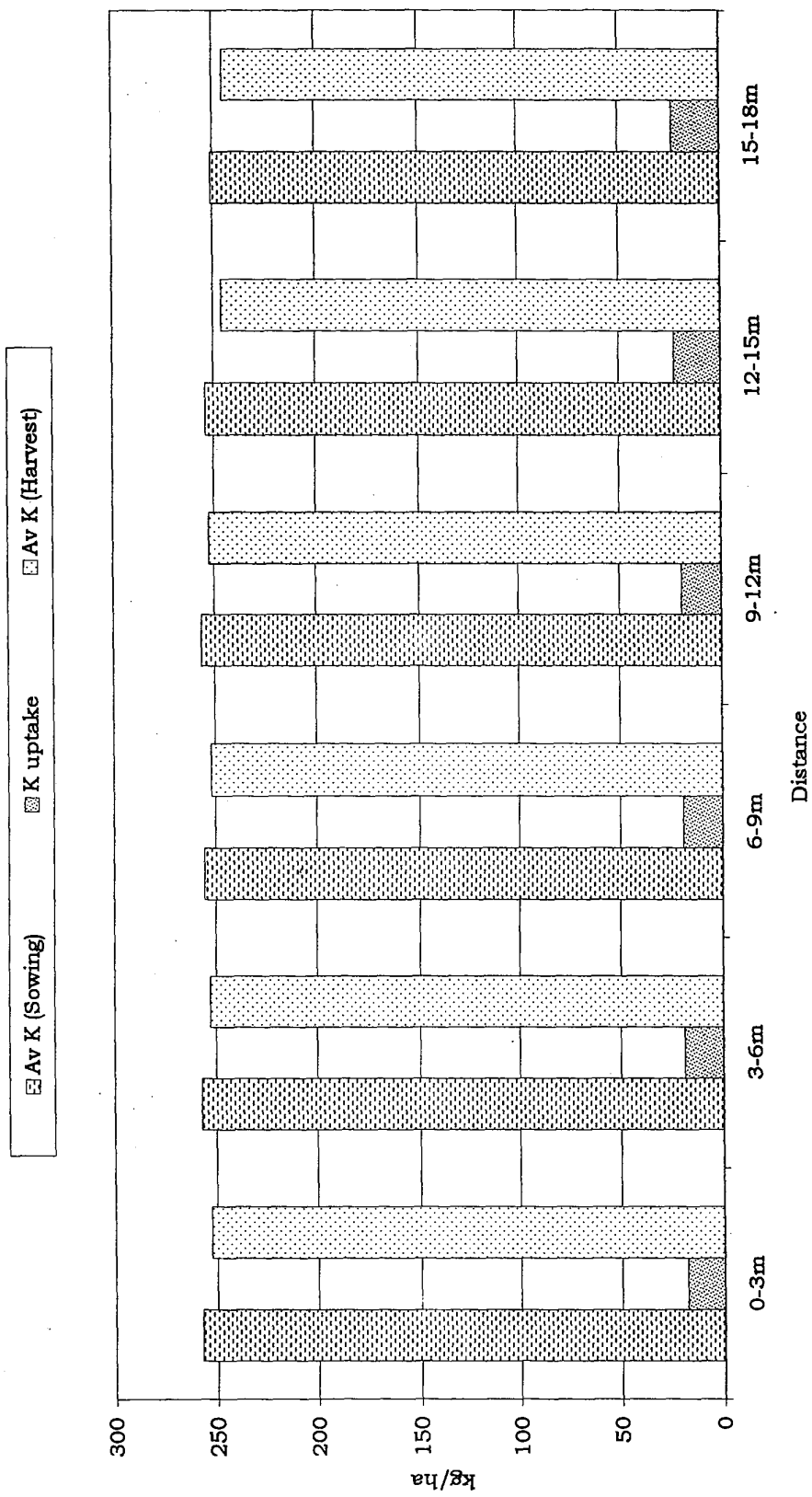


Fig. 17 : Potassium availability and uptake (kg/ha) by greengram over distances from teak tree row

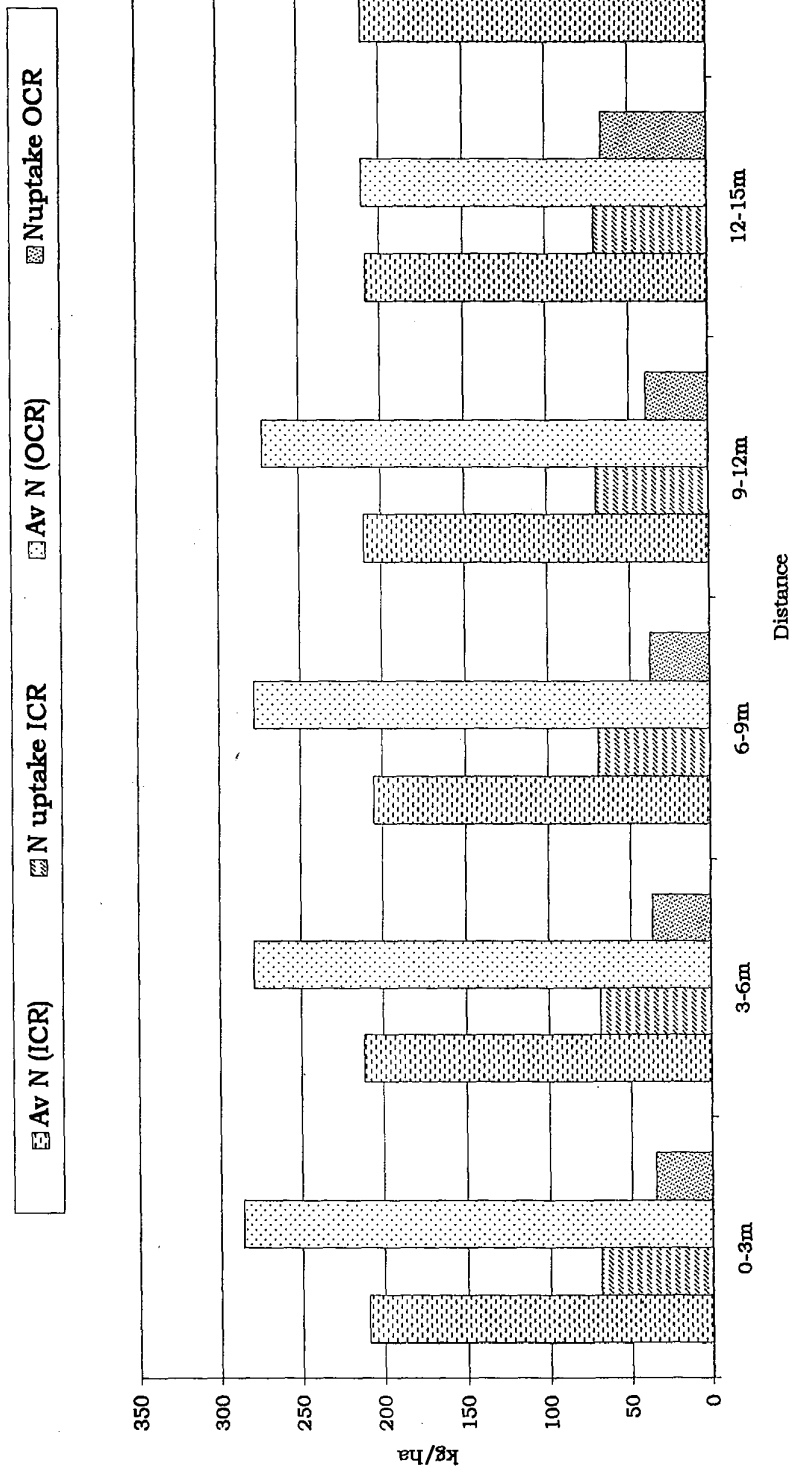


Fig. 18 : Nitrogen availability and uptake (kg/ha) by greengram ICR and OCR over distances from teak tree row

Available "P" ICR
 "P" uptake ICR
 Available "P" OCR
 "P" uptake OCR

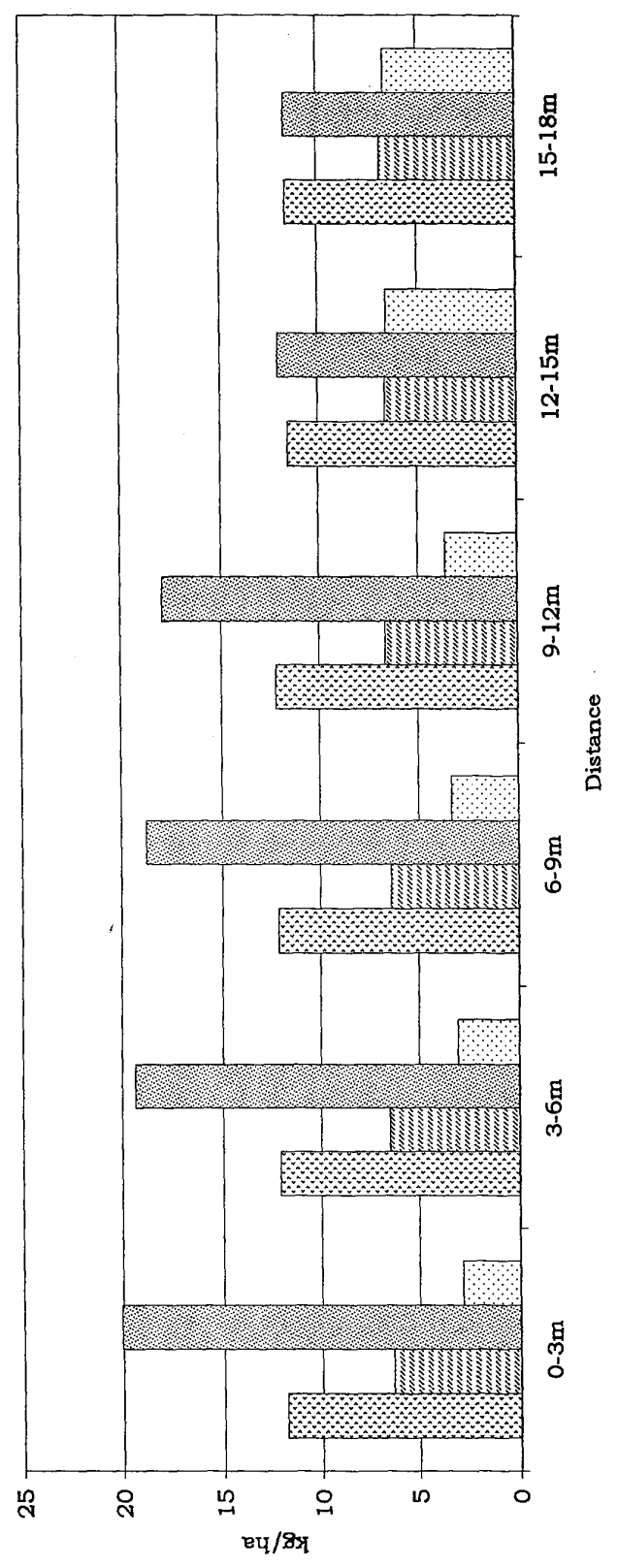


Fig 19 : Phosphorus availability and uptake (kg/ha) by greengram ICR and OCR over distances from teak tree row

"K" availability ICR
 "K" uptake ICR
 "K" availability OCR
 "K" uptake OCR

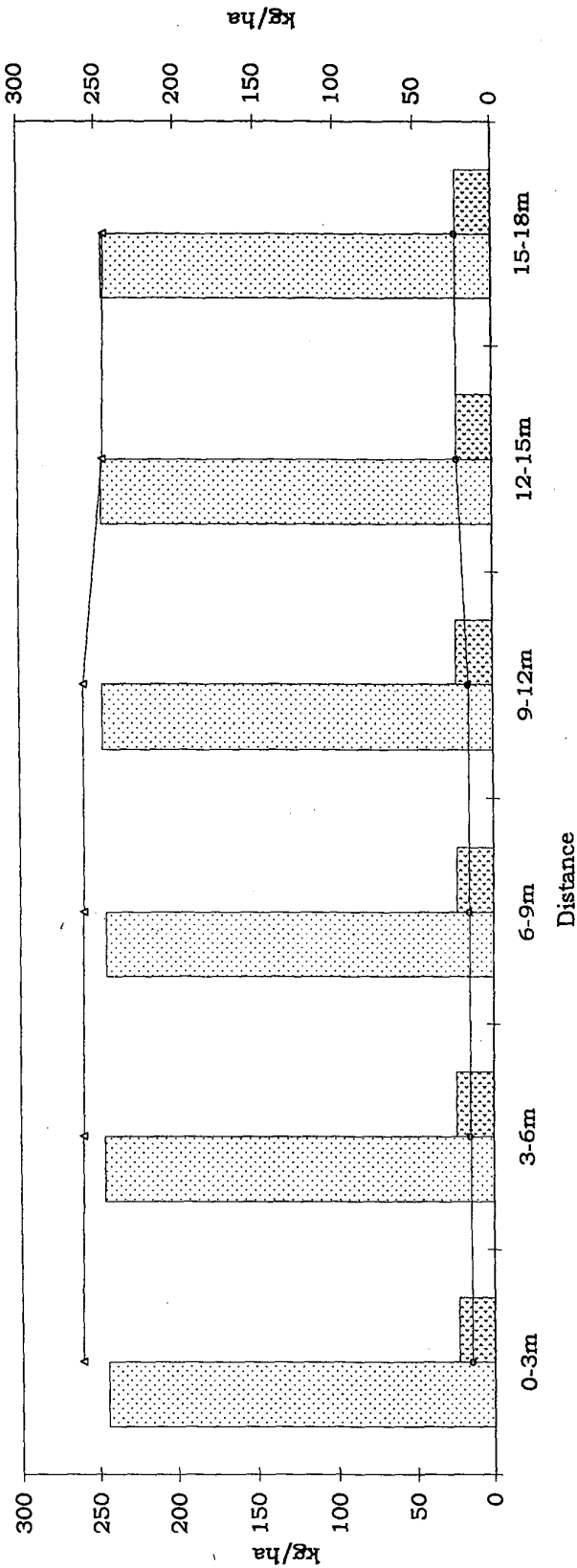


Fig. 20 : Potassium availability and uptake (kg/ha) by greengram ICR and OCR over distances from teak tree row

4.1.9 Nutrient status of soil

4.1.9.1 Nutrient status of soil before sowing of greengram

(Table-26)

The availability of nitrogen with respect to the distance and comparisons made between ICR and OCR differed non-significantly, although, presence of nitrogen was slightly higher nearer to trees and decreased away from trees. The nitrogen availability was higher OCR than ICR. With respect to distances the availability did not vary much ICR whereas the availability was comparatively much higher till 12m than at 12-15m and 15-18m distances OCR.

The availability of phosphorus and potassium also had similar trend as in case of nitrogen, except, comparisons made between averaged over various distances ICR and OCR differed significantly. The availability was significantly higher OCR than ICR with respect to phosphorus and potassium.

4.1.9.2 Nutrient status of soil after harvest of greengram

(Table-27)

The availability of nitrogen, phosphorus and potassium were slightly lower in magnitude than before sowing. With respect to nutrient status were similar to as recorded before sowing. The nutrient availability and uptake is presented in fig – 15 to 20.

Table 26: Available N, P₂O₅ and K₂O content of teak tree row soil (kg/ha) before sowing of greengram crop over distance

Treatment/ Distance(m)	Nitrogen												Phosphorus											
	1998				1999				Pooled				1998			1999			Pooled					
	ICR	OCR	Mean	S.E.m±	ICR	OCR	Mean	S.E.m±	ICR	OCR	Mean	S.E.m±	ICR	OCR	Mean	S.E.m±	ICR	OCR	Mean	S.E.m±	ICR	OCR	Mean	S.E.m±
0-3	258.79	268.70	263.75	250.02	272.25	261.13	254.40	270.48	262.44	17.11	20.21	18.66	17.55	22.00	19.78	17.33	21.11	19.22	17.33	21.11	19.22	17.33	21.11	19.22
3-6	259.95	265.58	262.77	261.15	269.90	265.53	260.55	267.74	264.15	17.23	19.45	18.34	17.48	21.15	19.32	17.36	20.30	18.83	17.36	20.30	18.83	17.36	20.30	18.83
6-9	260.65	264.45	262.55	261.75	268.27	265.01	261.20	266.36	263.78	17.33	18.73	18.03	17.64	20.76	19.20	17.49	19.75	18.62	17.49	19.75	18.62	17.49	19.75	18.62
9-12	257.63	262.85	260.24	260.85	264.44	262.65	259.24	263.65	261.44	17.28	17.68	17.48	17.70	20.00	18.85	17.49	18.84	18.17	17.49	18.84	18.17	17.49	18.84	18.17
12-15	260.86	259.75	260.31	260.89	262.25	261.57	260.88	261.00	260.94	17.38	17.50	17.44	17.58	19.75	18.67	17.48	18.63	18.05	17.48	18.63	18.05	17.48	18.63	18.05
15-18	260.10	259.75	259.93	262.00	260.15	261.08	261.05	259.95	260.50	17.24	17.43	17.34	17.00	19.00	18.00	17.12	18.22	17.67	17.12	18.22	17.67	17.12	18.22	17.67
Mean	259.66	263.51	263.51	259.44	266.21	261.08	259.55	264.86	260.50	17.26	28.50	17.34	17.49	20.44	18.00	17.38	19.47	17.67	17.38	19.47	17.67	17.38	19.47	17.67
Distance Ring D X R	S.E.m± 6.89 3.98 9.75	CD at 5% NS NS NS	S.E.m± 3.76 2.17 5.31	CD at 5% NS 6.34 NS	S.E.m± 3.93 2.27 5.55	CD at 5% NS NS NS	S.E.m± 0.56 0.33 0.80	CD at 5% NS 0.97 NS	S.E.m± 0.43 0.25 0.61	CD at 5% NS 0.73 NS	S.E.m± 0.36 0.21 0.50	CD at 5% NS 0.46 NS												

Treatment/ Distance (m)	Potassium												
	1998				1999				Pooled				
	ICR	OCR	Mean	S.E.m±	ICR	OCR	Mean	S.E.m±	ICR	OCR	Mean	S.E.m±	
0-3	248.76	262.50	255.63	251.15	264.24	257.70	249.96	263.37	256.66	4.98	NS	2.81	NS
3-6	250.98	261.75	256.37	251.50	262.25	256.88	251.24	262.00	256.62	2.87	NS	1.62	4.75
6-9	249.11	260.40	254.76	250.55	260.54	255.55	249.83	260.47	255.15	7.04	NS	3.97	NS
9-12	253.43	259.25	256.34	252.25	260.25	256.25	252.84	259.75	256.29				
12-15	250.87	257.00	253.94	252.50	254.00	253.25	251.69	255.50	253.59				
15-18	250.05	249.76	249.91	250.45	252.25	251.35	250.25	251.01	250.63				
Mean	250.53	258.44	258.44	251.40	258.92	251.35	250.97	258.68	250.63				
Distance Ring D X R	S.E.m± 4.98 2.87 7.04	CD at 5% NS NS NS	S.E.m± 2.81 1.62 3.97	CD at 5% NS 4.75 NS	S.E.m± 2.86 1.65 4.04	CD at 5% NS 4.69 NS							

4.2 CASUARINA SITE

4.2.1 Emergence (No./m²) (Table – 28 and fig –21 to 22)

Crop emergence was significantly lower till 15m with lowest at 0-3 m (19) compared to 15-18m (32). The emergence ICR (31) was significantly higher than OCR (21).

Inside ring the emergence was on par at various distances whereas emergence was significantly lower till 12m OCR. The emergence at 12-15 and 15-18m were on par with ICR.

4.2.2 Plant growth characters

4.2.2.1 Number of leaves (Table - 29)

Number of leaves recorded at various distances were significantly lower till 9 and 12m at 15 DAS and at harvest, respectively and was 6m at 30 and 45 DAS compared to 15-18m (2.45, 3.77, 9.91 and 4.31 at 15, 30, 45 DAS and at harvest, respectively). The average number of leaves were 1.99, 3.38, 9.01 and 3.48 at 15, 30, 45 DAS and at harvest with highest recorded at 45 DAS.

Number of leaves recorded ICR at various crop growth stages (2.33, 3.90, 9.73 and 4.20 at 15, 30, 45 DAS and at harvest, respectively) were significantly higher than OCR (1.66, 2.87, 8.28 and 2.75 at 15, 30, 45 DAS and at harvest, respectively).

The interaction showed that, at various distances almost same number of leaves were recorded ICR. Whereas till 6m at 30 DAS, 6-9m at 45 DAS and 9-12m at 15 DAS and at harvest recorded significantly lower

Table 28 : Allelopathic effect of casuarina tree row on emergence of greengram crop (No/m²) at ten days after sowing over distance

Treatment / Distance(m)	1998			1999			Pooled		
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
	0-3	30	9	20	30	9	19	30	9
3-6	30	11	21	30	13	22	30	12	21
6-9	31	17	24	31	22	27	31	19	25
9-12	31	26	29	31	26	29	31	26	28
12-15	32	29	31	31	29	30	31	29	30
15-18	31	31	31	32	30	31	32	31	32
Mean	31	21		31	22		31	21	
Distance(D)	SEm± CD at 5%			SEm± CD at 5%			SEm± CD at 5%		
Ring(R)	0.74	2.17		0.85	2.49		0.56	1.59	
D X R	0.43	1.26		0.49	1.44		0.32	0.91	
	1.04	3.05		1.20	3.52		0.79	2.24	

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

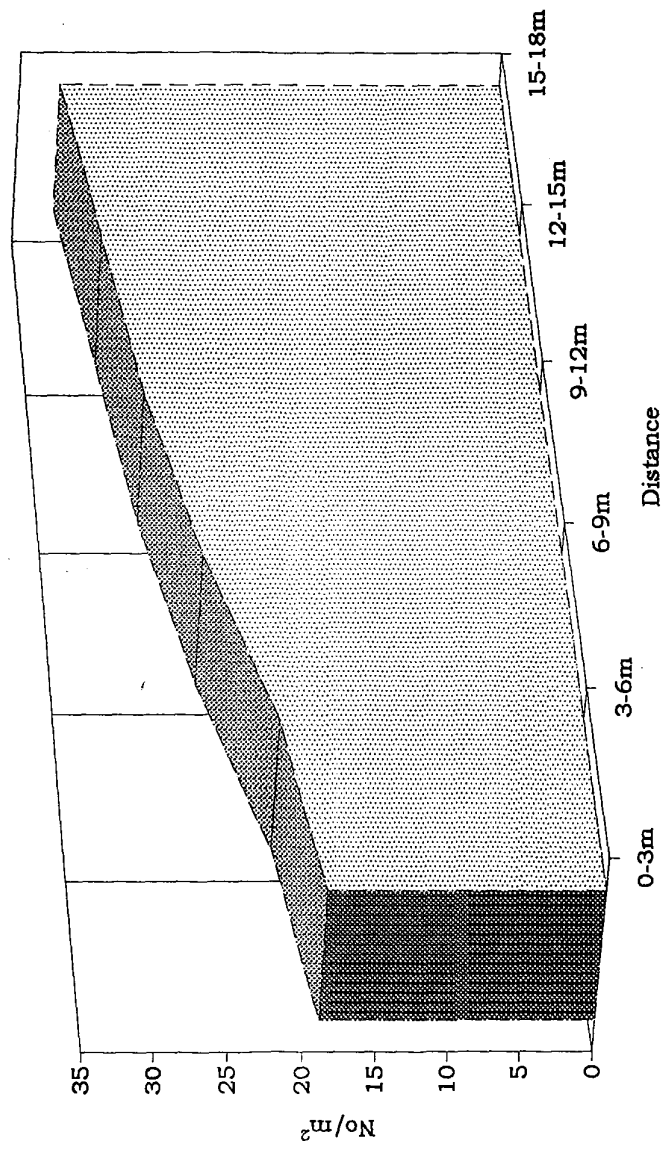


Fig. 21 : Emergence (No./m²) of greengram at ten days after sowing over distances from casuarina tree row

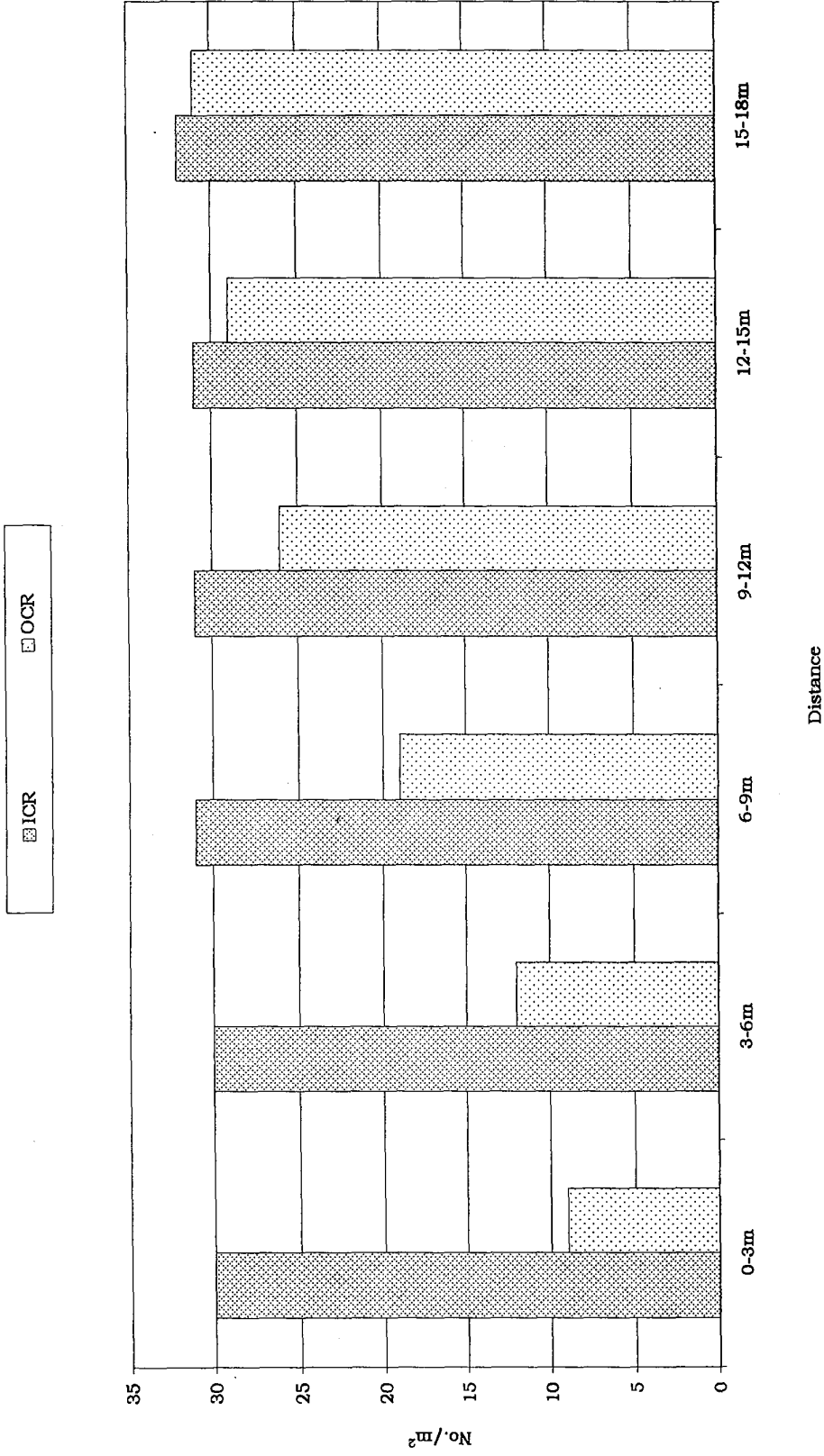


Fig 22 : Emergence (No./m²) of greengram ICR and OCR at ten days after sowing over distances from casuarina tree row

Table 29 : Allelopathic effect of casuarina tree row on number of leaves of greengram at different stages of crop growth over distance

Treatment/ Distance (m)	30 DAS																	
	15 DAS						1998						1999					
	1998		1999		Pooled		1998		1999		Pooled		1998		1999		Pooled	
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	2.27	0.84	1.56	1.99	0.69	1.34	2.13	0.76	1.45	3.65	1.40	2.53	3.90	1.47	2.69	3.78	1.44	2.61
3-6	2.42	0.90	1.66	2.07	1.25	1.66	2.25	1.08	1.66	3.85	2.12	2.99	4.13	1.51	2.82	3.99	1.82	2.90
6-9	2.63	1.69	2.16	2.44	1.32	1.88	2.54	1.51	2.02	4.00	2.44	3.22	3.85	2.12	2.99	3.93	2.28	3.19
9-12	2.38	2.16	2.27	2.44	1.49	1.97	2.41	1.83	2.12	4.13	3.36	3.74	3.43	3.58	3.51	3.78	3.47	3.63
12-15	2.11	2.67	2.39	2.76	1.48	2.12	2.43	2.08	2.25	4.22	3.36	3.79	3.69	3.78	3.74	3.95	3.57	3.76
15-18	2.30	2.66	2.48	2.13	2.71	2.42	2.21	2.69	2.45	4.01	3.69	3.85	3.76	3.63	3.70	3.88	3.56	3.77
Mean	2.35	1.82		2.31	1.49		2.33	1.66		4.01	2.83		3.79	2.90		3.90	2.87	
Distance(D) Ring(R) D X R	SEmt	CD at 5%		SEmt	CD at 5%		SEmt	CD at 5%		SEmt	CD at 5%		SEmt	CD at 5%		SEmt	CD at 5%	
	0.16	0.47		0.19	0.56		0.12	0.34		0.18	0.53		0.20	0.58		0.13	0.37	
	0.09	0.26		0.11	0.32		0.07	0.20		0.11	0.32		0.11	0.32		0.08	0.23	
	0.23	0.67		0.26	0.76		0.17	0.48		0.26	0.76		0.27	0.79		0.19	0.53	

Treatment/ Distance (m)	45 DAS																	
	1998						1999						Harvest					
	1998		1999		Pooled		1998		1999		Pooled		1998		1999		Pooled	
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	9.12	5.58	7.35	9.00	6.15	7.53	9.06	5.87	7.46	3.97	1.19	2.58	3.73	1.80	2.77	3.85	1.49	2.67
3-6	8.89	6.85	7.87	9.87	5.93	7.90	9.38	6.39	7.89	4.07	1.32	2.70	4.02	1.75	2.88	4.04	1.54	2.79
6-9	9.52	7.10	8.30	9.40	6.22	7.80	9.46	6.66	8.06	4.48	2.30	3.39	3.93	2.78	3.36	4.20	2.54	3.37
9-12	10.03	9.25	9.64	9.67	9.67	9.67	9.85	9.46	9.66	4.18	2.89	3.53	4.42	3.29	3.85	4.30	3.09	3.69
12-15	9.25	10.39	9.82	10.09	9.31	9.70	9.67	9.85	9.76	4.12	3.59	3.85	4.51	3.90	4.21	4.31	3.74	4.03
15-18	9.53	10.69	10.11	10.44	8.97	9.70	9.99	9.83	9.91	4.25	4.00	4.12	4.73	4.24	4.49	4.49	4.12	4.31
Mean	9.55	8.45		9.90	8.11		9.73	8.28		4.18	2.55		4.22	2.96		4.20	2.75	
Distance(D) Ring(R) D X R	SEmt	CD at 5%		SEmt	CD at 5%		SEmt	CD at 5%		SEmt	CD at 5%		SEmt	CD at 5%		SEmt	CD at 5%	
	0.36	0.61		0.32	0.93		0.24	0.68		0.17	0.50		0.29	0.50		0.17	0.48	
	0.21	1.05		0.18	0.53		0.14	0.40		0.10	0.29		0.17	0.85		0.10	0.28	
	0.51	1.49		0.45	1.31		0.34	0.97		0.23	0.67		0.40	1.17		0.23	0.65	

number of leaves compared with their respective 15-18m distance value, then onwards they were on par with each other.

4.2.2.2 Plant height (cm) (Table - 30)

At various crop growth stages significantly lower plant height was recorded till 9m compared to their respective 15-18m values (*viz.*, 6.73, 10.72, 23.25 and 25.25 cm at 15, 30, 45 DAS and at harvest, respectively). The averaged values at different crop growth stages were 5.32, 8.45, 18.72 and 21.03 at 15, 30, 45 DAS and at harvest, respectively with highest recorded at harvest.

ICR and OCR plant height comparison at various crop growth stages showed significantly higher plant height recorded ICR than OCR.

The interactions showed that ICR plant height at various distances was on par with each other at all the respective crop growth stages and whereas in OCR plants were significantly lower till 9m at 12-15 and 30 DAS, 9-12m at 45 DAS and 12-15 m at harvest. The heights in ICR and OCR were at par at a distance of 9-12m and onwards at 15 and 30 DAS and 12-15m at 45 DAS.

4.2.2.3 Drymatter accumulation (g/ pl)

4.2.2.3.1 Leaf (Table - 31)

The averaged drymatter accumulation in leaf was 0.24, 1.29, 2.74 and 1.90 at 15, 30, 45 DAS and at harvest, respectively with highest recorded at 45 days after sowing. The drymatter was significantly lower

Table 30: Allelopathic effect of casuarina tree row on plant height(cm) of greengram at different stages of crop growth over distance.

Treatment/ Distance (m)	15 DAS						30 DAS										
	1998		1999		Pooled		1998		1999		Pooled						
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean					
0-3	6.70	0.70	3.77	6.30	0.46	3.38	6.50	0.58	3.54	10.40	1.00	5.70					
3-6	6.60	1.30	3.95	6.20	1.02	3.61	6.40	1.16	3.78	11.20	1.62	6.41					
6-9	6.30	3.46	3.88	6.10	3.18	4.64	6.20	3.32	4.76	11.30	5.26	8.28					
9-12	6.20	6.42	6.31	6.20	6.28	6.19	6.15	6.35	6.50	10.45	10.20	10.33					
12-15	6.50	7.01	6.76	6.00	6.97	6.49	5.25	6.99	6.62	10.24	10.41	10.33					
15-18	6.80	7.00	6.90	6.72	6.40	6.56	6.76	6.70	6.73	11.10	10.72	10.91					
Mean	6.52	4.32		6.25	4.05		6.38	4.27		10.78	6.54						
Distance(D) Ring(R) D X R	SEm± 0.24 0.14 0.34	CD at 5% 0.70 0.41 1.00		SEm± 0.29 0.17 0.40	CD at 5% 0.50 0.85 1.17		SEm± 0.27 0.19 0.34	CD at 5% 0.76 0.54 0.97		SEm± 0.18 0.11 0.26	CD at 5% 0.53 0.32 0.76		SEm± 0.32 0.18 0.45	CD at 5% 0.93 0.53 1.31		SEm± 0.30 0.24 0.37	CD at 5% 0.85 0.68 1.05

Treatment/ Distance (m)	45 DAS						Harvest										
	1998		1999		Pooled		1998		1999		Pooled						
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean					
0-3	23.12	4.00	13.56	22.68	3.16	12.92	22.90	3.58	13.24	24.62	7.02	15.82					
3-6	23.40	5.62	14.51	23.06	4.96	14.01	23.23	5.29	14.26	25.60	10.80	18.20					
6-9	23.10	9.12	21.11	22.50	8.88	15.69	22.80	9.00	15.90	26.00	10.90	18.45					
9-12	23.56	22.00	22.78	23.40	21.12	22.60	23.48	21.56	22.52	25.60	24.22	24.94					
12-15	23.23	23.52	23.38	23.03	22.78	22.91	23.13	23.15	23.14	25.42	24.76	25.09					
15-18	23.40	23.50	33.45	23.10	23.00	23.05	23.25	23.25	23.25	25.00	25.76	25.38					
Mean	23.30	14.63		22.96	13.98		23.13	14.31		25.37	17.24						
Distance(D) Ring(R) D X R	SEm± 0.32 0.26 0.63	CD at 5% 0.94 0.76 1.85		SEm± 1.03 0.59 1.45	CD at 5% 3.02 1.73 4.25		SEm± 0.29 0.16 0.40	CD at 5% 0.82 0.45 1.13		SEm± 0.67 0.38 0.94	CD at 5% 1.96 1.11 2.7		SEm± 0.45 0.26 0.64	CD at 5% 1.32 0.76 1.88		SEm± 0.36 0.22 0.47	CD at 5% 1.02 0.62 1.33

Table 31 : Allelopathic effect of casuarina tree row on dry matter accumulation (g/pl) in leaf of greengram at different stages of crop growth over distance

Treatment/ Distance (m)	30 DAS														
	15 DAS				1998				1999						
	1998		1999		Pooled		1998		1999		Pooled				
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	0.30	0.14	0.22	0.24	0.12	0.18	0.27	0.13	0.20	1.54	0.70	1.12	1.50	0.54	1.02
3-6	0.32	0.15	0.24	0.24	0.13	0.19	0.28	0.14	0.21	1.54	0.72	1.13	1.52	0.56	1.04
6-9	0.30	0.17	0.24	0.26	0.13	0.20	0.28	0.15	0.22	1.55	0.72	1.14	1.51	0.60	1.06
9-12	0.28	0.26	0.27	0.28	0.26	0.27	0.28	0.26	0.27	1.52	1.50	1.51	1.50	1.44	1.47
12-15	0.30	0.26	0.28	0.26	0.26	0.26	0.28	0.26	0.27	1.52	1.52	1.52	1.48	1.44	1.46
15-18	0.30	0.27	0.29	0.26	0.27	0.27	0.28	0.27	0.28	1.52	1.54	1.53	1.48	1.44	1.46
Mean	0.30	0.21		0.26	0.19		0.28	0.20		1.53	1.12		1.50	1.00	
	S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±	CD at 5%	
Distance	0.02	0.06		0.02	0.06		0.02	0.06		0.09	0.26		0.10	0.29	
Ring	0.01	0.03		0.01	0.03		0.01	0.03		0.06	0.18		0.06	0.18	
D X R	0.03	0.09		0.03	0.09		0.03	0.09		0.17	0.50		0.17	0.50	

Treatment/ Distance (m)	45 DAS														
	1998				1999				Harvest						
	1998		1999		Pooled		1998		1999		Pooled				
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	3.00	2.10	2.55	2.80	1.80	2.30	2.90	1.95	2.43	1.38	2.88	2.13	1.68	2.76	2.22
3-6	2.90	2.12	2.51	2.88	1.96	2.42	2.89	2.04	2.47	1.75	3.69	2.72	1.85	3.39	2.62
6-9	3.08	2.13	2.61	3.02	1.97	2.50	3.05	2.05	2.55	1.77	1.52	1.65	1.59	2.06	1.83
9-12	3.04	2.91	2.98	2.96	2.89	2.93	3.00	2.90	2.95	1.37	1.94	1.66	1.29	1.36	1.33
12-15	3.15	2.98	3.07	3.05	2.92	2.99	3.10	2.95	3.03	1.43	1.93	1.68	1.55	1.81	1.68
15-18	3.05	3.03	3.04	2.95	3.03	2.99	3.00	3.03	3.02	1.44	1.92	1.68	1.42	1.72	1.57
Mean	3.02	2.53		2.96	2.45		2.99	2.49		1.52	2.31		1.56	2.18	
	S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±	CD at 5%	
Distance	0.08	0.23		0.09	0.26		0.10	0.28		0.17	0.50		0.16	0.47	
Ring	0.05	0.15		0.06	0.18		0.06	0.17		0.10	0.29		0.10	0.29	
D X R	0.17	0.50		0.18	0.53		0.17	0.48		0.25	0.73		0.24	0.70	

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

till 9m at all crop growth stages except at harvest when compared to 15-18m (0.28 and 1.50 at 15 and 30 DAS, respectively) and 12-15m at 45 days after sowing. Except at harvest the drymatter was significantly higher ICR than OCR.

The interaction study showed till 45 days after sowing, the dry matter was significantly lower OCR up to 9m. Then onwards they were on par with each other as well as with ICR values. The drymatter recorded ICR at various distances was on par with each other.

At harvest, significantly higher dry weight was recorded at 3-6m (2.67) and it was on par with 0-3 m. The rest of distances were significantly lower compared to 3-6m. Outside cement ring recorded significantly lower drymatter than ICR. And in an interaction, the drymatter at various distances ICR were on par with each other and were significantly lower than OCR at 0-3 and 3-6m while with remaining they were on par.

4.2.2.3.2 Stem (Table - 32)

At various stages of crop growth, the average drymatter accumulation was 0.23, 0.97, 1.33 and 1.40 at 15, 30, 45 DAS and at harvest, respectively with maximum at harvest. At various stages drymatter was significantly lower till 9m compared to 15-18m (0.23, 1.12, 1.41 and 0.51 at 15, 30, 34 days after sowing and at harvest). In partitioning effect the plants OCR recorded significantly lower drymatter in stem than ICR.

The interaction at various crop growth stages indicated that, similar drymatter accumulation was recorded at various distances ICR whereas the values in OCR followed similar trend as that obtained when averaged over ICR and OCR over distances. From 12m onwards they were on par with ICR.

4.2.2.3.3 Reproductive parts (Table - 33)

The drymatter accumulation in reproductive parts followed a similar trend as that of leaf and stem wherein significantly lower dry weight was recorded till 9 m at 45 DAS and at harvest compared to 15-18m (1.68 and 5.79 at 45 DAS and at harvest respectively). Averaged over distance and partitioning, drymatter was 1.52 and 4.7g per plant at 45 DAS and at harvest, respectively with highest recorded at harvest. Inside cement ring greengram recorded significantly higher drymatter than OCR.

At both the growth stages the drymatter accumulation was similar at all the distances ICR. Outside cement ring the drymatter accumulation was significantly lower till 9m and then onwards they were on par with ICR.

4.2.2.3.4 Total drymatter (Table- 34 and fig-23 to 24)

Similar trend was followed in case of total drymatter accumulation as in reproductive parts. The average drymatter was 0.47, 2.25, 5.58 and 8.05 at 15, 30, 45 DAS and at harvest, respectively recording highest at harvest. The drymatter was significantly lower till 9m compared to 15-

Table 33 : Allelopathic effect of casuarina tree row on dry matter accumulation (g/pl) in reproductive parts of greengram at different stages of crop growth over distance

Treatment/ Distance (m)	45 DAS																		
	1998			1999			Pooled			1998			1999			Pooled			
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	
0-3	1.88	1.02	1.45	1.56	0.98	1.27	1.72	1.00	1.36	5.92	1.25	3.59	5.38	1.11	3.25	5.65	1.18	3.42	
3-6	1.72	1.17	1.45	1.60	0.95	1.28	1.66	1.06	1.36	5.83	1.56	3.68	5.57	1.45	3.51	5.70	1.51	3.61	
6-9	1.74	1.20	1.47	1.66	0.96	1.31	1.70	1.08	1.39	5.60	3.84	4.72	5.60	2.82	4.21	5.60	3.33	4.50	
9-12	1.66	1.72	1.69	1.54	1.72	1.63	1.60	1.72	1.66	5.76	5.46	5.61	5.66	5.34	5.50	5.72	5.40	5.56	
12-15	1.61	1.75	1.68	1.59	1.75	1.67	1.60	1.75	1.68	5.97	5.77	5.87	5.69	5.49	5.59	5.83	5.63	5.73	
15-18	1.61	1.75	1.68	1.59	1.75	1.67	1.60	1.75	1.68	5.82	5.85	5.84	5.82	5.67	5.75	5.82	5.76	5.79	
Mean	1.72	1.46		1.57	1.33		1.65	1.39		5.82	3.96		5.62	3.65		5.72	3.80		
Distance(D)	S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±
Ring (R)	0.06	0.18		0.07	0.21		0.06	0.17		0.19	0.56		0.27	0.79		0.19	0.54		0.19
D X R	0.04	0.12		0.04	0.12		0.04	0.11		0.12	0.35		0.19	0.56		0.12	0.34		0.12
	0.11	0.32		0.12	0.35		0.11	0.31		0.29	0.85		0.36	1.06		0.26	0.74		0.26

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

Table 34 : Allelopathic effect of casuarina tree row on total dry matter accumulation (g/pl) of greengram at different stages of crop growth over distance

Treatment/ Distance (m)	30 DAS																
	15 DAS				Pooled				1998				1999				
	ICR	OCR	Mean	SEm±	ICR	OCR	Mean	SEm±	ICR	OCR	Mean	SEm±	ICR	OCR	Mean	SEm±	
0-3	0.54	0.26	0.40	0.48	0.24	0.36	0.51	0.25	0.38	2.71	1.28	2.00	2.49	1.02	1.76	2.60	
3-6	0.56	0.28	0.42	0.48	0.26	0.37	0.52	0.27	0.40	2.74	1.32	2.03	2.56	1.02	1.79	2.65	
6-9	0.56	0.32	0.44	0.50	0.26	0.38	0.53	0.29	0.41	2.68	1.36	2.02	2.58	1.06	1.82	2.63	
9-12	0.55	0.55	0.55	0.53	0.53	0.53	0.54	0.54	0.54	2.70	2.62	2.66	2.52	2.52	2.52	2.61	
12-15	0.58	0.55	0.57	0.52	0.53	0.53	0.55	0.54	0.55	2.68	2.68	2.68	2.56	2.52	2.54	2.62	
15-18	0.58	0.56	0.57	0.52	0.54	0.53	0.55	0.55	0.55	2.68	2.70	2.69	2.56	2.52	2.54	2.62	
Mean	0.56	0.42		0.51	0.39		0.53	0.41		2.70	1.99		2.55	1.78		2.62	
	SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%
Distance(D)	0.03	0.09		0.04	0.12		0.27	0.76		0.03	0.09		0.08	0.23		0.30	0.85
Ring(R)	0.01	0.03		0.02	0.06		0.19	0.54		0.01	0.03		0.04	0.12		0.24	0.68
D X R	0.06	0.18		0.07	0.21		0.34	0.97		0.06	0.18		0.16	0.47		0.37	1.05

Treatment/ Distance (m)	45 DAS																
	1998				Pooled				1999				Harvest				
	ICR	OCR	Mean	SEm±	ICR	OCR	Mean	SEm±	ICR	OCR	Mean	SEm±	ICR	OCR	Mean	SEm±	
0-3	6.28	4.22	5.25	5.76	3.78	4.77	6.02	4.00	5.01	8.72	5.28	7.00	8.48	4.92	6.70	8.60	
3-6	6.00	4.42	5.21	5.80	3.98	4.89	5.90	4.20	5.05	9.00	6.42	7.71	8.80	5.98	7.39	8.90	
6-9	6.30	4.60	5.45	6.10	4.00	5.05	6.20	4.25	5.23	8.92	6.56	7.74	8.66	6.04	7.35	8.80	
9-12	6.12	6.01	6.07	5.88	5.99	5.94	6.00	6.00	6.00	8.60	8.90	8.75	8.40	8.10	8.25	8.50	
12-15	6.20	6.12	6.16	6.00	6.08	6.04	6.10	6.10	6.10	8.90	9.22	9.06	8.70	8.78	8.74	8.80	
15-18	6.10	6.20	6.15	5.90	6.20	6.05	6.00	6.20	6.10	8.80	9.30	9.05	8.70	8.90	8.80	8.75	
Mean	6.17	5.26		5.91	5.01		6.04	5.13		8.82	7.61		8.62	7.12		8.73	
	SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%
Distance(D)	0.10	0.29		0.14	0.41		0.29	0.82		0.08	0.23		0.12	0.35		0.36	1.02
Ring(R)	0.06	0.18		0.07	0.21		0.16	0.45		0.04	0.12		0.07	0.21		0.22	0.62
D X R	0.15	0.44		0.26	0.76		0.40	1.13		0.16	0.47		0.21	0.62		0.47	1.33

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

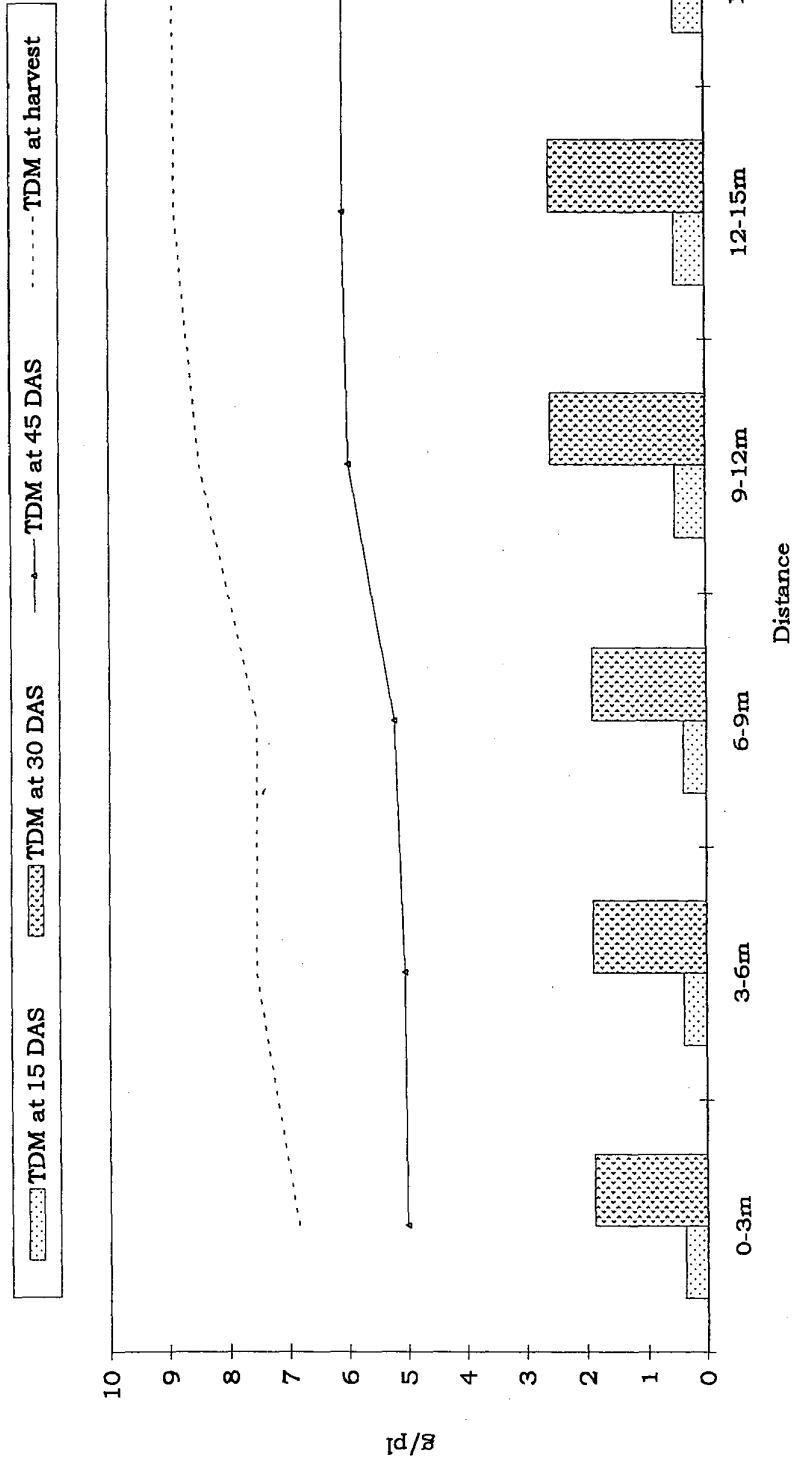


Fig.23.: Total drymatter (TDM) accumulation (g/pi) of greengram over distances from casuarina tree row at different crop growth stages

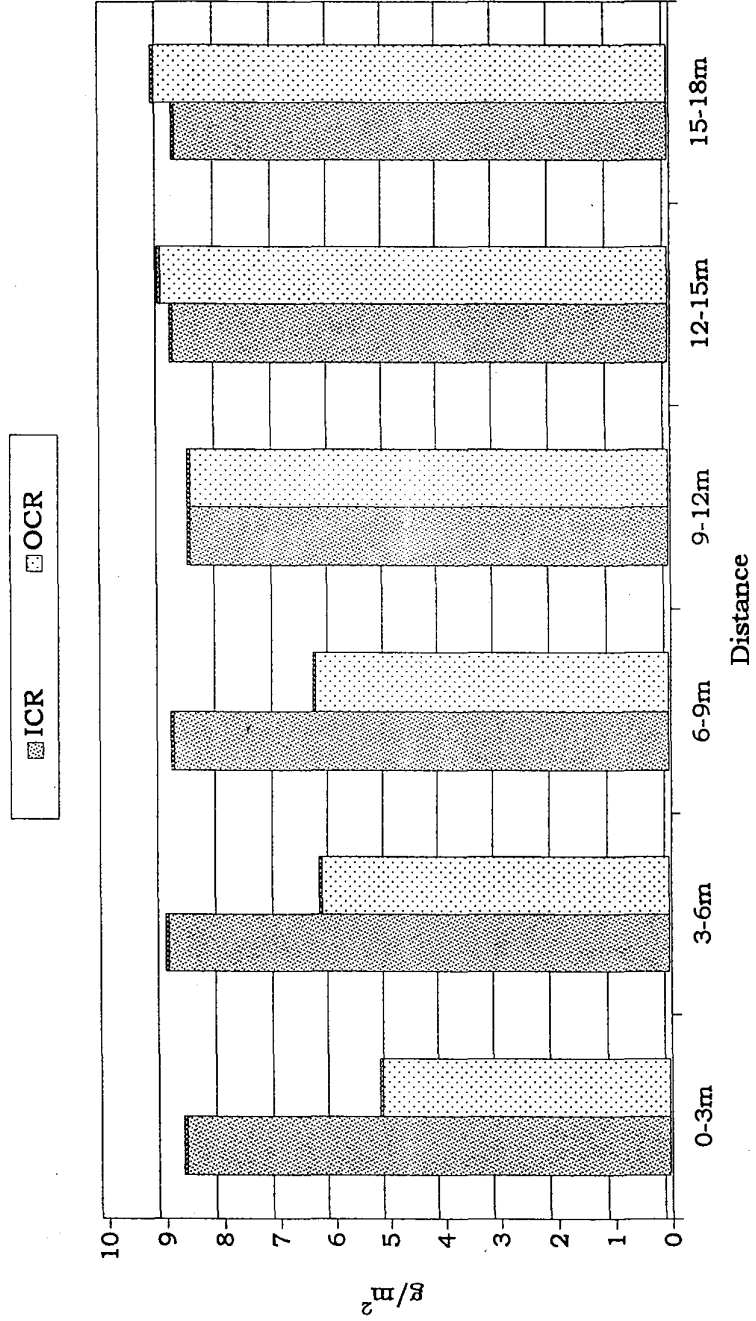


Fig. 24 : : Total drymatter (TDM) accumulation (g/pl) of greengram ICR and OCR over distances from casuarina tree row at harvest

18m (0.55, 2.62, 6.05 and 8.93 at 15, 30, 45 DAS and at harvest, respectively). While 9-12 and 15m distances values were on par with 15-18m. ICR recorded significantly higher drymatter than OCR.

The interaction study showed similar values at various distances during different crop growth stages ICR. The drymatter was significantly lower till 9m OCR and rest of the distances were on par with ICR.

4.2.2.4 Number of days to 50 per cent flower initiation

(Table-35)

Plants at 0-3 , 3-6 and 6-9m (40 and 39 days, respectively) recorded significantly higher number of days compared to 15-18m (37). The plants at 9-12 and 12-15m distances also took 37 days for 50 per cent flower initiation. ICR recorded significantly lower number of days to 50 per cent flower initiation (37) than OCR (40).

Interaction studies showed that at various distances number of days was 37 ICR compared to OCR. Significantly lower number of days was recorded till 9m and rest of the distances recorded similar number of days as ICR.

4.2.2.5 Number of branches per plant (Table - 36)

At 45 DAS and at harvest, significantly lower number of branches per plant was recorded till 9m compared to 15-18m (4.28 and 5.15 at 45 DAS and at harvest, respectively). Average number of branches was 3.62 and 4.38 at 45 days after sowing and at harvest, respectively. Inside

Table 35 : Allelopathic effect of casuarina tree row on number of branches per plant at different stages of crop growth over distance

Treatment/ Distance (m)	45 DAS												Harvest						
	1998			1999			Pooled			1998			1999			Pooled			
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	
0-3	4.14	1.51	2.83	4.06	1.41	2.74	4.10	1.46	2.78	5.00	2.05	3.53	4.80	1.95	3.38	4.90	2.00	3.45	
3-6	4.22	2.09	3.16	4.18	2.01	3.10	4.20	2.05	3.13	5.15	2.15	3.65	5.13	2.13	3.63	5.14	2.14	3.64	
6-9	4.32	2.13	3.23	4.28	2.07	3.18	4.30	2.10	3.20	5.20	2.55	3.88	5.14	2.49	3.82	5.17	2.52	3.85	
9-12	4.32	4.00	4.16	4.28	3.88	4.08	4.30	3.94	4.12	5.25	5.00	5.13	5.15	4.60	4.88	5.20	4.85	5.03	
12-15	4.35	4.15	4.25	4.35	4.05	4.20	4.35	4.10	4.23	5.30	5.14	5.22	5.20	4.86	5.03	5.25	5.00	5.13	
15-18	4.30	4.32	4.31	4.30	4.18	4.24	4.30	4.25	4.28	5.25	5.20	5.23	5.15	5.00	5.08	5.20	5.10	5.15	
Mean	4.28	3.03		4.24	2.93		4.26	2.98		5.19	3.68		5.10	3.51		5.14	3.60		
Distance Ring D X R	S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±	CD at 5%		CD at 5%
	0.29	0.85		0.27	0.79		0.20	0.57		0.27	0.79		0.29	0.85		0.29	0.82		0.82
	0.16	0.47		0.16	0.47		0.11	0.31		0.16	0.47		0.16	0.47		0.17	0.48		0.48
	0.40	1.17		0.38	1.11		0.28	0.80		0.38	1.11		0.40	1.17		0.40	1.14		1.14

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

Table 36 : Allelopathic effect of casuarina tree row on number of days to 50% flower initiation of greengram over distance

Treatment/ Distance (m)	Number of days to 50% flower initiation									
	1998			1999			Pooled			Mean
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	
0-3	37	42	40	36	43	40	37	43	40	
3-6	37	42	40	37	43	40	37	43	40	
6-9	37	40	39	36	41	39	37	41	39	
9-12	36	36	36	37	37	37	37	37	37	
12-15	37	37	37	36	37	37	37	37	37	
15-18	37	37	37	37	36	37	37	37	37	
Mean	37	39		37	40		37	40		
Distance(D) Ring (R) D X R	S.Em± 0.38 0.26 0.50	CD at 5% 1.11 0.76 1.47		S.Em± 0.28 0.16 0.40	CD at 5% 0.82 0.47 1.17		S.Em± 0.57 0.33 0.80	CD at 5% 1.62 0.94 2.27		

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

cement ring greengram recorded significantly higher number of branches compared to OCR.

The interaction study showed that branches recorded ICR at various distances, were on par with each other. Number of branches was significantly lower till 9m OCR compared to 15-18m distance whereas rest of distances were on par with ICR plants at 15-18m.

4.2.2.6 Weed growth (Table - 37)

Number of weeds and dry weight (g/m^2) were significantly lower till 9m and 12m, respectively compared to 15-18m (93 and 40.85, respectively) with lowest number of weeds and drymatter recorded at 0-3 m distance. ICR recorded significantly higher number and weed weight than OCR. The interaction showed that the values were on par ICR at various distances where as outside rings the number and weed weight were significantly lower till 9m and 12m, respectively and rest of the distances were on par with ICR.

4.2.3 Yield and yield attributes (Tables-38 to 39)

4.2.3.1 Yield attributes

4.2.3.1.1 Length of pod (cm)

Significantly higher pod length was recorded at 15-18m (9.0) and this was on par with 9-12 and 12-15m (8.92 and 9.0, respectively). The lowest pod length was recorded at 0-3 m (5.37). Significantly lower pod

Table 37 : Weed number (No/m²) and weed dry weight (g/m²) at first weeding as influenced by casuarina tree row over distance

Treatment Distance (m)	Weed Number												Weed dry weight											
	1998			1999			Pooled			1998			1999			Pooled								
	OCR	ICR	Mean	OCR	ICR	Mean	OCR	ICR	Mean	OCR	ICR	Mean	OCR	ICR	Mean	OCR	ICR	Mean						
0-3	97	49	73	93	50	72	94	53	74	39.40	16.20	27.80	38.40	14.00	26.20	38.90	15.10	27.00						
3-6	98	57	78	92	57	74	96	54	75	41.20	17.60	29.40	37.80	16.80	27.30	39.50	17.20	28.35						
6-9	97	77	87	93	70	82	95	74	84	42.00	24.60	33.30	38.40	19.90	29.15	40.20	22.25	31.23						
9-12	97	86	92	93	84	89	95	85	90	43.10	26.00	34.55	37.30	25.00	31.15	40.20	25.50	32.85						
12-15	96	92	94	90	89	89	93	90	92	42.00	41.00	41.50	39.20	37.80	38.50	40.60	39.40	40.00						
15-18	97	91	94	94	91	92	96	91	93	41.40	42.30	41.85	39.60	40.10	39.85	40.50	41.20	40.85						
Mean	97	75		93	74		85	74		41.57	27.95		38.45	25.60		39.98	26.78							
Distance(D)	SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%							
Ring(R)	1.03	3.02		3.66	10.72		1.90	5.40		0.83	2.43		0.67	1.96		0.53	1.51							
D X R	0.59	1.73		2.11	6.18		1.10	3.12		0.48	1.41		0.38	1.11		0.31	0.88							
	1.45	4.25		5.17	15.15		2.68	7.61		1.18	3.46		0.94	2.75		0.75	2.13							

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

length was recorded till 9m. ICR recorded longer pods (9.07) than OCR (5.82). Interaction of these two factors showed that, similar pod length was recorded ICR at various distances whereas it was significantly lower in OCR till 9m. The distances from 12 to 18m recorded length of pod similar to their respective distances in ICR.

4.2.3.1.2 Number of pods per plant

Significantly higher number of pods were recorded at 15-18m (15) whereas at other distances pods were significantly lower than that at 12-15 and 15-18m with lowest being recorded at 0-3 m (8).

The plants grown ICR recorded significantly more number of pods (14.46) than OCR (9.30). Interaction of these two factors indicated that plants in the rings over distances recorded similar number of pods per plant whereas outside cement rings number of pods were lowest at 0-3 m and increased over distances but the values recorded till 9m were significantly lower than 12-15 and 15-18m. Similarly, comparing between ICR and OCR over distances the number of pods recorded at 12-15 and 15-18m were on par with each other.

4.2.3.1.3 Seeds per pod

Number of seeds per pod was significantly lower at 0-3 m (7.05) and increased with increase in distance, the highest being at 15-18m distance (9.05). It was significantly lower till 9m distance. The number of seeds per pod OCR (7.24) was significantly lower than ICR

Table 38 : Allelopathic effect of casuarina tree row on length of pod (cm), pods per plant, seeds per pod and seeds per plant of greengram over distance

Treatment Distance (m)	Pods/plant												Seeds/pod												
	1998				1999				Pooled				1998				1999				Pooled				
	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	
0-3	9.00	2.00	5.50	0.10	8.60	1.88	5.24	0.24	8.80	1.94	5.37	0.19	14.20	2.10	8.15	0.45	14.20	2.10	8.15	0.45	13.80	1.90	7.85	0.29	
3-6	9.20	2.40	5.80	0.06	8.80	2.24	5.52	0.18	9.00	2.32	5.66	0.11	14.40	3.40	8.90	0.26	14.40	3.40	8.90	0.26	14.10	3.10	8.60	0.17	
6-9	9.30	4.20	6.75	0.15	9.14	4.12	6.63	0.31	9.22	4.16	6.69	0.27	14.60	4.75	9.68	0.64	14.40	4.75	9.68	0.64	14.40	4.25	9.33	0.41	
9-12	9.20	8.80	9.00	0.15	9.04	8.64	8.84	0.91	9.12	8.72	8.92	0.91	14.10	13.22	13.66	1.88	13.90	12.78	13.34	1.88	13.90	12.78	13.34	0.82	
12-15	9.30	9.00	9.15	0.15	9.20	8.50	8.85	0.91	9.25	8.75	9.00	0.91	15.10	14.42	14.76	1.88	14.90	13.58	14.24	1.88	14.90	13.58	14.24	0.82	
15-18	9.10	9.10	9.10	0.15	8.90	8.90	8.90	0.91	9.00	9.00	9.00	0.91	15.10	15.10	15.10	1.88	14.90	14.90	14.90	1.88	14.90	14.90	14.90	0.82	
Mean	9.18	5.92			8.95	5.71			9.07	5.82			14.58	8.83			14.33	8.42			14.46	9.30			
Distance(D) Ring(R) D X R	SEM± 0.10 0.06 0.15	CD at 5% 0.29 0.18 0.44		SEM± 0.24 0.18 0.31	CD at 5% 0.70 0.53 0.91		SEM± 0.19 0.11 0.27	CD at 5% 0.54 0.31 0.76		SEM± 0.45 0.26 0.64	CD at 5% 1.32 0.76 1.88		SEM± 0.42 0.31 0.80	CD at 5% 1.24 0.91 2.34		SEM± 0.29 0.17 0.41	CD at 5% 0.82 0.48 1.16								
Treatment Distance (m)	Seeds/plant												Seeds per plant												
	1998				1999				Pooled				1998				1999				Pooled				
	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	ICR	OCR	Mean	SEM±	
0-3	9.10	5.20	7.15	0.28	8.90	5.00	6.95	0.28	9.00	5.10	7.05	0.22	110.70	10.50	63.60	1.42	110.70	10.50	63.60	1.42	108.10	9.20	58.65	1.31	
3-6	9.30	5.40	7.35	0.20	9.22	5.04	7.13	0.59	9.26	5.22	7.24	0.13	108.20	19.60	63.90	0.71	108.20	19.60	63.90	0.71	104.70	13.40	59.05	0.75	
6-9	9.40	6.80	8.10	0.31	9.28	6.56	7.92	1.67	9.34	6.68	8.01	0.31	107.00	30.70	68.85	2.42	107.00	30.70	68.85	2.42	103.50	24.30	63.90	1.85	
9-12	9.30	8.80	9.05	0.57	9.20	8.50	8.85	1.67	9.25	8.65	8.95	0.88	108.80	108.20	108.50	0.88	108.80	108.20	108.50	0.88	106.30	100.60	103.45	1.85	
12-15	9.30	8.90	9.10	0.57	9.20	8.60	8.90	1.67	9.25	8.75	9.00	0.88	108.70	110.00	109.35	0.88	108.70	110.00	109.35	0.88	104.00	104.00	104.00	1.85	
15-18	9.20	9.10	9.15	0.57	9.10	9.00	9.05	1.67	9.15	9.05	9.10	0.88	110.60	108.25	109.43	0.88	110.60	108.25	109.43	0.88	105.52	105.15	105.34	1.85	
Mean	9.27	7.37			9.15	7.12			9.17	7.24			109.00	64.54			105.35	59.44			107.18	62.00			
Distance(D) Ring(R) D X R	SEM± 0.24 0.18 0.31	CD at 5% 0.70 0.53 0.91		SEM± 0.28 0.20 0.57	CD at 5% 0.82 0.59 1.67		SEM± 0.22 0.13 0.31	CD at 5% 0.62 0.37 0.88		SEM± 1.42 0.71 2.42	CD at 5% 4.16 2.08 7.09		SEM± 1.64 0.95 2.33	CD at 5% 4.81 2.78 6.83		SEM± 1.31 0.75 1.85	CD at 5% 3.72 2.13 5.25								

(9.27). At various distances ICR plants recorded significantly higher number of seeds per pod than OCR except at 9-12, 12-15 and 15-18m where they were on par with each other.

4.2.3.1.4 Number of seeds per plant

Significantly lower number of seeds per plant was recorded till 9m compared to 15-18m (107.38). Number of seeds per plant at 9-12m (105.98) and 12-15m (106.68) were on par with 15-18m distance. Higher number of seeds per plant was recorded ICR (107.18) than OCR (62.00). Seed number per plant at various distances recorded ICR were on par and were significantly higher than OCR till 9m and the remaining were on par with ICR.

4.2.3.1.5 Thousand seed weight (g)

Significantly lower thousand seed weight was recorded at 0-3 m (29.62) and till 9m they recorded significantly lower thousand seed weight than 15-18m (37.36). ICR recorded significantly higher thousand seed weight (37.24) than OCR (31.00)

At various distances ICR test weight was on par and were significantly higher than outside cement ring till 9m and then onwards they were on par.

4.2.3.2. Grain yield (kg/ha), stover yield (kg/ha) and harvest index (%) (Table – 39 and fig – 25 to 26)

4.2.3.2.1 Grain yield (kg/ha)

The grain yield of greengram recorded at 15-18m (607) was significantly higher. Comparing with this the grain yield at 0-3 m (489) was significantly lower. Then onwards there was increase in yield by moving away from tree row and till 9m significantly lower yield was recorded compared to 15-18m. The grain yield recorded at 9-12 and 12-15m were on par with 15-18m.

Outside cement rings recorded significantly lower grain yield (512) than ICR (604). The interaction of the partitioning effect recorded almost on par grain yield at various distances ICR whereas OCR plants recorded significantly lower grain yield till 9m and the rest of distances recorded grain yield on par with ICR.

4.2.3.2.2. Stover yield (kg/ha)

Similar to that of grain yield, Stover yield was significantly higher at 15-18m (1910) with lowest being at 0-3 m (1764). The distances 9-12 and 12-15m were on par with 15-18m and were significantly higher in stover yield than other distances.

The partitioning of underground crop growth resources showed significantly lower stover yield recorded OCR (1794) than ICR (1910). Interaction of these two factors showed on par stover yield ICR at various

Table 39 : Allelopathic effect of casuarina tree row on thousand seed weight(g), grain yield (kg/ha) , stover yield (kg/ha) and harvest index of greengram over distance

Treatment Distance (m)	Thousand seed weight												Grain yield											
	1998				1999				Pooled				1998				1999				Pooled			
	ICR	OCR	Mean	SEm±	ICR	OCR	Mean	SEm±	ICR	OCR	Mean	SEm±	ICR	OCR	Mean	SEm±	ICR	OCR	Mean	SEm±	ICR	OCR	Mean	SEm±
0-3	38.09	22.55	30.32	35.39	22.44	28.92	36.74	22.50	29.62	596	400	498	598	362	480	597	382	489						
3-6	37.92	23.13	30.53	37.09	22.22	29.66	37.51	22.68	30.09	602	412	507	600	375	488	601	394	497						
6-9	35.88	32.51	34.20	37.25	27.81	32.53	36.57	30.16	33.36	607	549	5787	611	455	533	609	502	555						
9-12	37.38	35.81	36.60	37.78	37.66	37.72	37.58	36.74	37.16	610	583	597	612	585	599	611	584	598						
12-15	37.55	37.33	37.44	37.11	36.65	36.88	37.33	36.99	37.16	611	608	610	597	599	598	604	604	604						
15-18	38.51	36.71	37.60	36.99	37.22	37.11	37.75	36.97	37.36	608	610	608	598	611	605	603	610	607						
Mean	37.55	31.34	37.60	36.93	30.67	37.11	37.24	31.00	37.36	606	528	603	498	603	605	604	512	607						
Distance(D) Ring(R) D X R	SEm± 0.66 0.38 0.93	CD at 5% 1.93 1.11 2.72	SEm± 0.78 0.45 1.10	CD at 5% 2.28 1.31 3.21	SEm± 0.51 0.29 0.72	CD at 5% 1.44 0.82 2.04	SEm± 1.140 6.58 16.12	CD at 5% 33.34 19.24 47.14	SEm± 9.68 5.53 13.69	CD at 5% 28.31 16.17 40.04	SEm± 14.46 8.35 20.44	CD at 5% 40.98 23.67 57.93												

Treatment Distance (m)	Stover yield												Harvest Index											
	1998				1999				Pooled				1998				1999				Pooled			
	ICR	OCR	Mean	SEm±	ICR	OCR	Mean	SEm±	ICR	OCR	Mean	SEm±	ICR	OCR	Mean	SEm±	ICR	OCR	Mean	SEm±	ICR	OCR	Mean	SEm±
0-3	1910	1623	1766	1908	1618	1763	1909	1620	1764	23.78	19.77	21.78	23.86	18.39	21.13	23.82	19.08	21.45						
3-6	1910	1639	1774	1909	1632	1771	1910	1635	1772	23.97	20.09	22.03	23.91	18.75	21.33	23.94	19.42	21.68						
6-9	1911	1800	1856	1910	1795	1853	1911	1798	1854	24.11	23.37	23.74	24.23	20.29	22.26	24.17	21.83	23.00						
9-12	1910	1900	1905	1908	1895	1901	1910	1897	1903	24.21	23.48	23.85	24.27	23.60	23.94	24.24	23.54	23.89						
12-15	1910	1906	1908	1909	1900	1905	1910	1903	1906	24.24	24.19	24.22	23.82	23.99	23.91	24.03	24.09	24.06						
15-18	1909	1912	1910	1907	1911	1909	1908	1912	1910	24.16	24.19	24.18	23.86	24.19	24.03	24.01	24.19	24.10						
Mean	1910	1797	1910	1909	1792	1910	1910	1794	1910	24.08	22.52	24.18	23.99	21.54	24.03	24.04	22.03	24.10						
Distance(D) Ring(R) D X R	SEm± 7.24 3.22 13.64	CD at 5% 21.21 9.43 39.97	SEm± 8.11 4.10 14.36	CD at 5% 23.76 12.01 42.08	SEm± 13.48 7.47 29.75	CD at 5% 38.15 20.86 84.19	SEm± 0.09 0.04 0.16	CD at 5% 0.26 0.12 0.47	SEm± 0.25 0.17 0.34	CD at 5% 0.73 0.50 1.00	SEm± 0.15 0.07 0.23	CD at 5% 0.43 0.20 0.65												

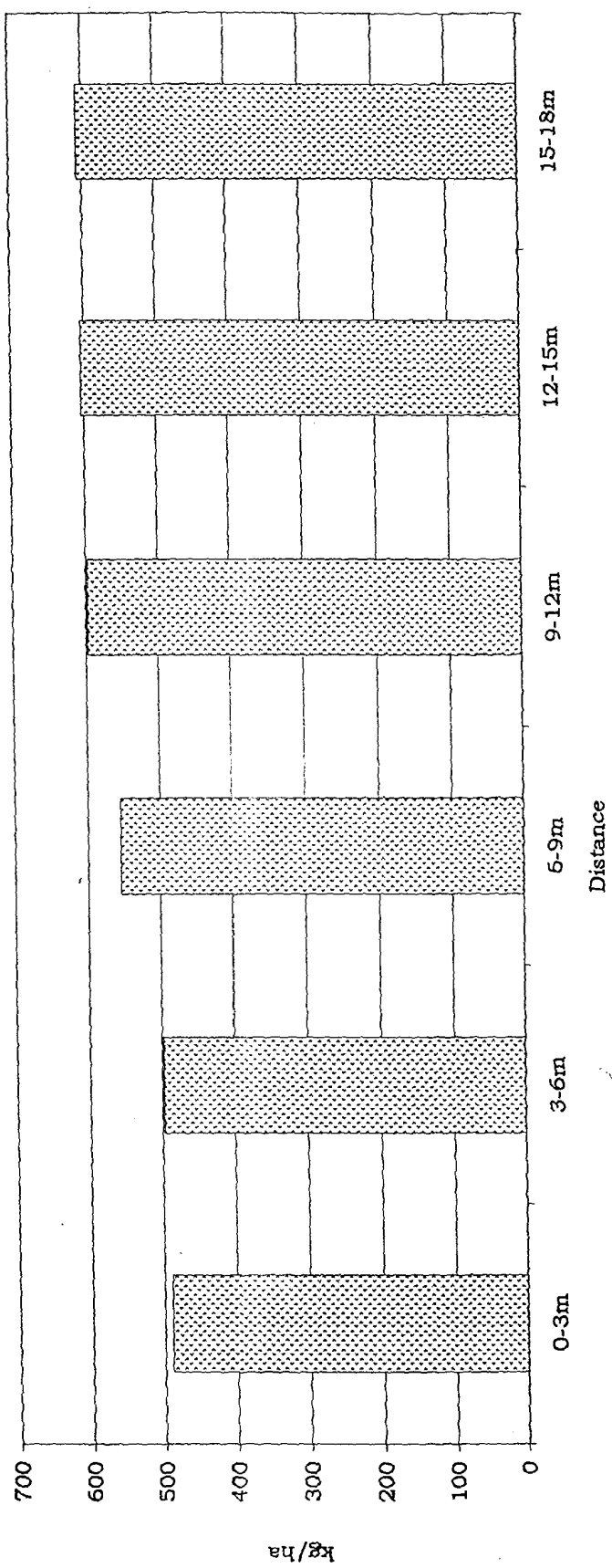


Fig.25 : Grain yield(kg/ha)of greengram over distances from casuarina tree row

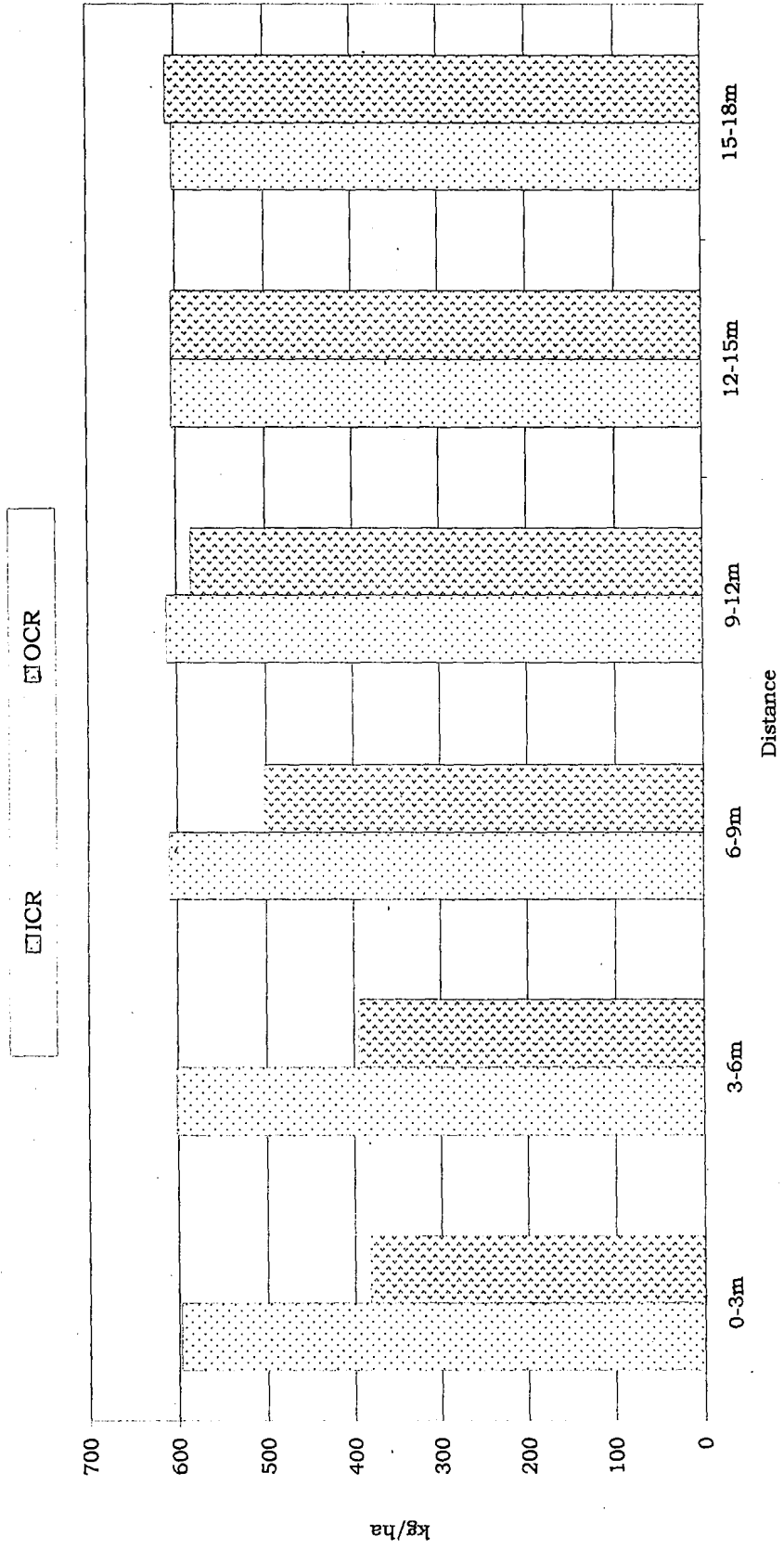


Fig.26 : Grain yield(kg/ ha)of greengram ICR and OCR over distances from casuarina tree row

distances. Whereas OCR till 9m the stover yield was significantly lower whereas with respect to other distances they were on par with ICR.

4.2.3.2.3 Harvest Index

Significantly higher harvest index was recorded at 15-18m (24.10) than any other distance and significantly lower at 0-3 m (21.45). The harvest index was significantly lower till 9m. Outside cement ring recorded significantly lower (22.03) harvest index than ICR (24.04).

Interaction showed that harvest index was on par ICR at various distances and were significantly higher than OCR till 9m and the rest were on par.

4.2.4 Light transmission ratio (Table – 40)

The LTR at various crop growth stages varied significantly with respect to distance, partitioning the underground growth resources and their interaction. While 100 per cent LTR was recorded at 15-18m, till 12m at all crop growth stages significantly lower LTR was recorded. The average LTR at different crop growth stages was 87, 92, 97 and 98 at 15, 30, 45 DAS and at harvest, respectively.

The average LTR over distances ICR and OCR showed that significantly lower LTR was recorded ICR than OCR at 15 DAS and at 30 DAS. Whereas at 45DAS and at harvest the LTR was same both ICR and OCR.

Table 40 : Cumulative leaf fall pattern of casuarina tree (kg/ha) at different crop growth stages of greengram over distance

Treatment Distance(m)	Sowing			15 DAS			30 DAS		
	1998	1999	Pooled	1998	1999	Pooled	1998	1999	Pooled
0-3	337	340	337	409	509	459	610	642	626
3-6	269	263	266	301	305	303	366	393	379
6-9	253	257	255	260	284	272	323	360	341
9-12	166	169	167	172	179	176	196	192	194
12-15	4	5	5	4	6	5	6	8	7
15-18	1	2	2	2	3	2	2	4	3
SEM±	24.79	21.54	16.07	25.53	11.99	13.51	45.29	26.69	25.24
CD at 5%	78.09	67.85	47.13	80.42	37.77	39.61	142.66	84.07	74.02

Treatment Distance(m)	45 DAS			Harvest		
	1998	1999	Pooled	1998	1999	Pooled
0-3	751	974	863	1112	1118	1115
3-6	373	408	390	397	412	405
6-9	337	363	350	352	372	362
9-12	216	229	222	272	253	263
12-15	6	8	7	7	8	8
15-18	3	3	3	3	4	4
SEM±	21.06	17.83	14.43	23.80	44.27	25.87
CD at 5%	66.34	56.17	42.32	74.97	139.45	75.87

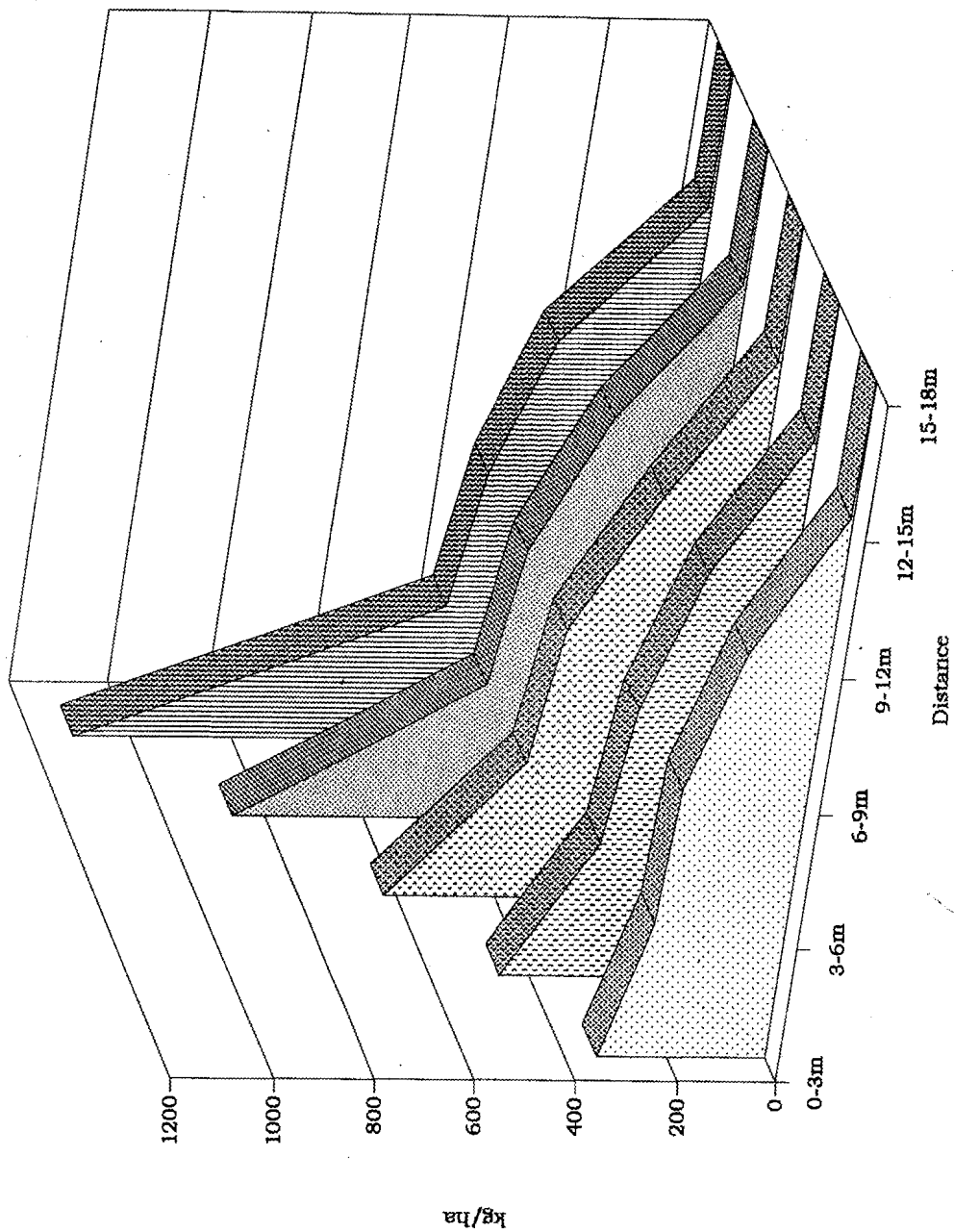
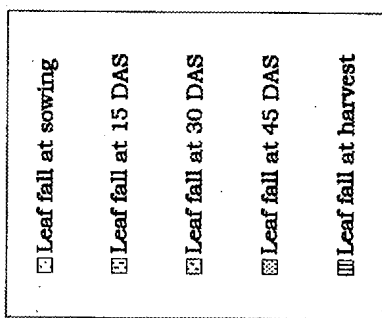


Fig 27 : Cumulative leaf fall pattern of casuarina trees at different crop growth stages of greengram over distance

The interaction effect showed that comparing with 15-18m irrespective of presence or absence of rings significantly lower LTR was recorded till 15m at 15, 30, 45 DAS and 12m at harvest.

4.2.5 Leaf fall (kg/ha) (Table - 41 and fig - 27)

The needle fall of casuarina at different crop growth stages showed that, significantly highest needle fall was collected at 0-3 m and there after it was reduced by increase in distances from tree and were higher than 12-15 and 15-18m. At 0-3 m at different crop growth stages collected needle fall was 337, 457, 626, 863 and 1115 kg/ha at sowing 15, 30, 45 DAS and at harvest, respectively.

4.2.6 Soil moisture (%) (Table - 42 to 44)

The soil moisture at different crop growth stages was not influenced significantly due to treatments.

4.2.7 Nutrient uptake by greengram crop and its plant parts (kg/ha)

4.2.7.1 Nutrient uptake by grain (Table - 45)

The nitrogen, phosphorus and potassium uptake was significantly higher at 15-18m (30.50, 4.13 and 12.84 kg/ha, respectively). Although lowest uptake was recorded at 0-3 m (19.69, 2.44 and 10.01 kg/ha of N, P₂O₅ and K₂O, respectively), N and P were significantly lower till 9m whereas potassium was significantly lower till 12 m compared to 15-18m.

Table 41 : Light transmission ratio (LTR) in casuarina tree row field at different stages of crop growth of greengram over distance

Treatment Distance (m)	15 DAS						30 DAS											
	1998			1999			1998			1999								
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean						
0-3	82	70	76	87	79	83	85	75	80	95	86	91	73	77	75	84	82	83
3-6	89	79	84	71	82	77	80	81	81	96	90	93	87	77	82	92	89	91
6-9	89	81	85	76	90	83	83	86	85	96	92	94	85	87	86	91	90	91
9-12	95	90	93	77	84	81	86	87	87	96	92	94	89	85	87	93	89	91
12-15	99	89	94	79	84	82	89	87	88	100	96	98	96	97	97	98	97	98
15-18	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Mean	92	85	89	82	87	84	87	86	87	97	93	95	88	87	88	93	91	92
S.E.m±	CD at 5%			CD at 5%			CD at 5%			CD at 5%			CD at 5%			CD at 5%		
Distance	0.21	0.62	0.38	0.38	1.11	1.19	0.42	0.42	1.19	0.20	0.20	0.59	0.28	0.28	0.82	0.42	0.42	1.19
Ring	0.14	0.41	0.30	0.30	0.88	0.94	0.33	0.33	0.94	0.13	0.13	0.38	0.19	0.19	0.56	0.34	0.34	0.97
D X R	0.31	0.90	0.45	0.45	1.32	1.42	0.50	0.50	1.42	0.28	0.28	0.82	0.36	0.36	1.06	0.50	0.50	1.42

Treatment Distance (m)	45 DAS						Harvest											
	1998			1999			1998			1999								
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean						
0-3	95	98	97	92	97	95	94	98	96	97	97	97	94	94	94	96	96	96
3-6	93	96	95	94	97	96	94	97	96	95	95	95	98	98	98	97	96	97
6-9	98	95	97	99	93	96	99	94	97	97	98	98	99	97	98	98	98	98
9-12	98	99	99	96	98	97	97	99	98	99	100	100	94	98	96	97	99	98
12-15	96	92	94	97	100	99	97	96	97	100	100	100	99	98	99	100	99	100
15-18	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Mean	97	97	97	96	98	97	97	98	97	98	98	98	97	98	98	98	98	98
S.E.m±	CD at 5%			CD at 5%			CD at 5%			CD at 5%			CD at 5%			CD at 5%		
Distance	0.42	1.23	0.70	0.70	2.05	2.05	0.51	0.51	1.45	0.25	0.25	0.73	0.27	0.27	0.79	0.29	0.29	0.82
Ring	0.33	NS	0.62	0.62	1.82	1.82	0.43	0.43	NS	0.14	0.14	NS	0.16	0.16	0.47	0.17	0.17	NS
D X R	0.51	1.49	0.79	0.79	2.32	2.32	0.62	0.62	1.76	0.35	0.35	1.03	0.38	0.38	1.11	0.40	0.40	1.14

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

Table 42 : Soil moisture (%) status of casuarina tree site at sowing and 15 days after sowing of greengram crop over distance

Treatment Distance (m)	Sowing												SEm±	CD at 5%	SEm±	CD at 5%		
	1998				1999				Pooled									
	0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm							
0-3	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
3-6	28.50	29.00	28.75	28.40	28.10	28.25	27.20	27.60	27.40	28.40	28.70	28.55	27.60	28.30	27.95	28.40	28.40	28.40
6-9	28.50	28.80	28.65	28.40	29.00	28.70	27.20	27.60	27.40	28.40	28.60	28.50	27.60	28.20	27.90	28.40	28.80	28.60
9-12	28.40	28.80	28.60	28.30	29.00	28.65	27.20	27.40	27.30	28.20	28.60	28.40	27.80	28.10	27.95	28.25	28.80	28.53
12-15	28.40	28.70	28.55	28.20	28.90	28.55	27.20	27.40	27.30	28.20	28.40	28.30	27.80	28.05	27.93	28.20	28.90	28.55
15-18	28.00	28.00	28.00	28.00	28.40	28.40	27.00	27.10	27.05	28.00	28.00	28.00	27.50	27.55	27.53	28.00	28.20	28.10
Mean	28.30	28.55	28.43	28.22	28.63	28.43	27.13	27.35	27.24	28.20	28.38	28.30	27.63	27.96	27.80	28.25	28.55	28.40
Distance(D) Ring(R) D X R	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
	0.39	NS	0.66	NS	0.82	NS	0.91	NS	0.26	NS	0.26	NS	0.17	NS	0.23	NS	0.45	NS

Treatment Distance (m)	15 DAS												SEm±	CD at 5%	SEm±	CD at 5%		
	1998				1999				Pooled									
	0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm							
0-3	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
3-6	24.40	25.40	24.90	25.20	26.20	25.90	24.20	24.80	24.50	24.80	25.40	25.10	24.30	25.10	24.70	25.00	25.80	25.40
6-9	24.20	25.40	24.80	25.00	26.00	25.50	24.20	24.80	24.50	24.80	25.20	25.00	24.20	25.10	24.65	24.90	25.60	25.25
9-12	24.20	25.30	24.75	24.60	26.00	25.30	24.00	24.60	24.30	24.60	25.20	24.90	24.10	24.95	24.53	24.60	25.60	25.10
12-15	24.00	25.20	24.60	24.60	26.00	25.30	24.00	24.60	24.30	24.60	25.20	24.90	24.00	24.90	24.45	24.60	25.60	25.10
15-18	24.00	24.80	24.40	24.20	25.20	25.10	23.75	24.00	23.88	24.20	24.60	24.40	23.98	24.40	24.14	24.70	24.90	24.80
Mean	24.13	24.88	24.63	24.60	25.76	25.37	23.96	24.47	24.21	24.53	25.03	24.78	24.06	24.80	24.42	24.73	25.40	25.07
Distance(D) Ring(R) D X R	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
	0.89	NS	0.98	NS	0.66	NS	0.66	NS	0.78	NS	0.66	NS	0.38	NS	0.52	NS	0.30	NS

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

Table 43 : Soil moisture (%) status of casuarina tree site at 30 and 45 days after sowing of greengram crop over distance

Treatment Distance (m)	30 DAS																					
	1998						1999						Pooled									
	0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm							
	ICR	OCR	Mean	SEM±	CD at 5%	ICR	OCR	Mean	SEM±	CD at 5%	ICR	OCR	Mean	SEM±	CD at 5%	ICR	OCR	Mean	SEM±	CD at 5%		
0-3	25.60	26.20	25.90	25.40	26.40	25.90	25.90	25.20	26.60	25.90	26.20	27.20	26.70	25.40	26.40	25.80	26.80	25.90	25.80	26.30	25.90	26.30
3-6	25.50	26.40	25.95	25.40	26.40	25.90	25.90	25.20	26.60	25.90	26.20	27.20	26.70	25.35	26.50	25.80	26.80	25.93	25.80	26.30	25.93	26.30
6-9	25.40	26.20	25.80	25.30	26.72	26.01	25.60	24.80	26.40	25.60	26.00	27.00	26.50	25.10	26.30	25.65	26.86	25.70	25.65	26.86	25.70	26.26
9-12	25.00	26.30	25.65	25.00	25.80	25.40	25.40	24.60	26.20	25.40	26.00	27.00	26.50	24.80	26.25	25.50	26.90	25.53	25.50	26.90	25.53	25.70
12-15	24.80	25.80	25.30	24.70	25.10	24.90	25.60	24.00	25.60	24.80	25.80	26.40	26.10	24.40	25.70	25.25	25.75	25.05	25.25	25.75	25.05	25.50
15-18	24.72	25.80	25.26	24.70	25.50	25.10	25.80	24.20	25.80	25.00	25.20	26.40	25.80	24.46	25.80	24.95	25.95	25.13	24.95	25.95	25.45	25.45
Mean	25.17	26.12	25.64	25.08	25.99	25.54	25.43	24.67	26.20	25.43	25.90	26.87	26.38	24.92	26.16	25.54	26.34	25.54	25.49	26.34	25.92	25.92
Distance(D) Ring(R) D X R	SEM± 1.05 0.60 1.48	CD at 5% NS NS NS	SEM± 0.79 0.46 1.12	CD at 5% NS NS NS	SEM± 0.82 0.66 1.25	CD at 5% NS NS NS	SEM± 0.78 0.45 1.10	CD at 5% NS NS NS	SEM± 0.90 0.71 1.41	CD at 5% NS NS NS	SEM± 0.66 0.38 0.93	CD at 5% NS NS NS	SEM± 0.66 0.38 0.93	CD at 5% NS NS NS	SEM± 0.66 0.38 0.93	CD at 5% NS NS NS	SEM± 0.66 0.38 0.93	CD at 5% NS NS NS	SEM± 0.66 0.38 0.93	CD at 5% NS NS NS	SEM± 0.66 0.38 0.93	CD at 5% NS NS NS

Treatment Distance (m)	45 DAS																								
	1998						1999						Pooled												
	0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm						
	ICR	OCR	Mean	SEM±	CD at 5%	ICR	OCR	Mean	SEM±	CD at 5%	ICR	OCR	Mean	SEM±	CD at 5%	ICR	OCR	Mean	SEM±	CD at 5%	ICR	OCR	Mean	SEM±	CD at 5%
0-3	26.50	27.60	27.05	27.14	28.30	27.72	26.20	27.00	26.60	26.60	26.70	27.80	27.25	26.35	27.30	26.92	28.05	26.83	26.92	28.05	26.92	28.05	27.49	26.92	27.49
3-6	26.62	27.70	27.16	27.20	28.70	27.95	26.20	27.00	26.60	26.60	26.60	27.50	27.05	26.41	27.35	26.90	28.10	26.88	26.90	28.10	26.90	28.10	27.50	26.90	27.50
6-9	26.78	27.40	27.09	27.30	28.40	27.85	26.10	27.00	26.55	26.55	26.70	27.50	27.10	26.44	27.20	26.44	27.95	26.82	27.00	27.95	26.44	27.95	27.48	26.44	27.48
9-12	26.60	27.20	26.90	27.24	28.40	27.82	26.20	27.10	26.65	26.65	26.80	27.00	26.90	26.40	27.15	26.40	27.70	26.72	27.02	27.70	26.40	27.70	27.36	26.40	27.36
12-15	25.80	26.60	26.20	26.00	27.50	26.75	25.20	26.00	25.60	25.60	26.10	27.00	26.55	25.50	26.30	25.50	27.25	25.90	25.90	27.25	25.50	27.25	26.63	25.50	26.63
15-18	25.80	26.20	26.00	26.16	27.54	26.85	25.30	26.00	25.65	25.65	26.00	27.00	26.50	25.55	26.10	25.83	27.27	25.83	26.08	27.27	25.55	27.27	26.68	25.55	26.68
Mean	26.35	27.12	26.73	26.84	28.14	27.49	25.87	26.68	26.28	26.28	26.48	27.30	26.89	26.1	26.90	26.66	27.72	26.50	26.66	27.72	26.66	27.72	27.19	26.66	27.19
Distance(D) Ring(R) D X R	SEM± 0.66 0.38 0.93	CD at 5% NS NS NS	SEM± 0.82 0.66 1.25	CD at 5% NS NS NS	SEM± 0.51 0.32 0.72	CD at 5% NS NS NS	SEM± 1.37 0.76 2.05	CD at 5% NS NS NS	SEM± 0.58 0.36 0.80	CD at 5% NS NS NS	SEM± 0.74 0.42 1.21	CD at 5% NS NS NS	SEM± 0.74 0.42 1.21	CD at 5% NS NS NS	SEM± 0.74 0.42 1.21	CD at 5% NS NS NS	SEM± 0.74 0.42 1.21	CD at 5% NS NS NS	SEM± 0.74 0.42 1.21	CD at 5% NS NS NS	SEM± 0.74 0.42 1.21	CD at 5% NS NS NS	SEM± 0.74 0.42 1.21	CD at 5% NS NS NS	

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

Table 44: Soil moisture (%) status of casuarina tree site at harvest of greengram crop over distance

Treatment Distance (m)	Harvest																	
	1998						1999						Pooled					
	0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm		0 - 15 cm		15 - 30 cm			
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	24.20	25.60	24.90	25.00	26.10	25.55	23.60	24.10	23.85	24.90	25.00	24.95	23.90	24.85	24.38	24.95	25.55	25.25
3-6	24.00	25.60	24.80	25.00	26.20	25.60	23.60	24.20	23.90	24.80	25.00	24.90	23.80	24.90	24.35	24.90	25.60	25.25
6-9	24.00	25.80	24.90	25.00	26.00	25.50	23.20	24.40	23.60	24.80	25.10	24.95	23.60	24.90	24.25	24.90	25.55	25.23
9-12	24.60	25.30	24.95	24.80	26.00	25.40	23.00	24.00	23.50	24.80	25.10	24.95	23.80	24.65	24.23	24.80	25.55	25.18
12-15	24.00	25.00	24.50	24.60	25.60	25.10	22.80	23.68	23.24	24.40	24.60	24.50	23.40	24.34	23.87	24.50	25.10	24.80
15-18	24.00	25.20	24.60	24.60	25.60	25.10	22.80	23.50	23.15	24.60	24.60	24.60	23.40	24.35	23.88	24.60	25.10	24.85
Mean	24.13	25.42	24.78	24.83	25.92	25.38	23.17	23.91	23.54	24.72	24.90	24.73	23.65	24.67	24.16	24.78	25.41	25.09
Distance(D) Ring(R) D X R	SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%	
	1.04	NS		1.05	NS		1.07	NS		1.24	NS		0.66	NS		0.37	NS	
	0.92	NS		0.94	NS		0.96	NS		0.72	NS		0.42	NS		0.28	NS	
	1.42	NS		1.48	NS		1.62	NS		2.00	NS		0.71	NS		0.51	NS	

ICR-Inside Cement Ring ; OCR-Outside Cement Ring

Table 45: Allelopathic effect of casuarina tree row on uptake of nutrients (kg/ha) by grain over distance

Treatment Distance (m)	Nitrogen						Phosphorus										
	1998			1999			1998			1999			Pooled				
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean		
0-3	30.00	11.25	20.63	27.00	10.50	18.75	28.50	10.88	19.69	3.85	1.22	2.54	3.60	1.10	2.35		
3-6	31.50	12.26	21.88	28.50	11.00	19.75	30.00	11.63	20.82	4.00	1.36	2.68	3.83	1.20	2.52		
6-9	30.50	16.00	23.25	29.25	14.45	21.85	29.88	15.23	22.55	4.15	1.38	2.77	4.00	1.18	2.59		
9-12	30.75	30.35	30.53	28.75	27.75	28.25	29.75	29.05	29.40	4.17	4.00	4.09	3.75	3.85	3.80		
12-15	31.00	31.15	31.08	28.00	28.50	28.25	29.50	29.83	29.66	4.05	4.15	4.10	4.00	4.00	4.00		
15-18	32.00	32.00	32.00	29.00	29.00	29.00	30.50	30.50	30.50	4.11	4.20	4.16	4.10	4.10	4.10		
Mean	30.96	22.17		28.42	20.20		29.69	21.18		4.06	2.72		3.88	2.57			
Distance Ring D X R	S.E.m± 0.91 0.53 1.29	CD at 5% 2.67 1.55 3.78		S.E.m± 0.85 0.49 1.20	CD at 5% 2.49 1.44 3.52		S.E.m± 0.62 0.36 0.88	CD at 5% 1.76 1.02 2.50		S.E.m± 0.29 0.16 0.40	CD at 5% 0.85 0.47 1.17		S.E.m± 0.23 0.14 0.32	CD at 5% 0.67 0.41 0.94		S.E.m± 0.17 0.08 0.25	CD at 5% 0.48 0.23 0.71

Treatment Distance (m)	Potassium								
	1998			1999			Pooled		
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	13.30	8.00	10.65	12.00	6.75	9.38	12.65	7.38	10.01
3-6	13.15	8.20	10.68	12.20	7.00	9.60	12.68	7.60	10.14
6-9	12.45	8.50	10.48	12.15	7.50	9.83	12.30	8.00	10.15
9-12	12.33	12.75	12.54	12.12	11.20	11.66	12.22	11.98	12.10
12-15	13.00	13.25	13.13	12.45	11.75	12.10	12.73	12.50	12.61
15-18	13.35	13.50	13.43	12.50	12.00	12.25	12.93	12.75	12.84
Mean	12.93	10.70		12.24	9.37		12.58	10.03	
Distance Ring D X R	S.E.m± 0.27 0.16 0.38	CD at 5% 0.79 0.47 1.11		S.E.m± 0.29 0.16 0.40	CD at 5% 0.85 0.47 1.17		S.E.m± 0.20 0.11 0.28	CD at 5% 0.57 0.31 0.80	

OCR recorded significantly lower uptake of nutrients (21.18, 2.65 and 10.03 kg/ha N, P₂O₅ and K₂O, respectively) than ICR (29.69, 3.97 and 12.58 kg/ha of N, P₂O₅ and K₂O, respectively).

The interaction of these two factors showed that, the uptake at various distances ICR were on par whereas OCR the uptake was significantly lower till 9m, the remaining distances were on par with ICR.

4.2.7.2 Nutrient uptake by stover (Table - 46)

The uptake by stover was significantly higher at 15-18m (39.88, 4.38 and 13.77 of N, P₂O₅ and K₂O, respectively). The uptake was significantly lower till 9m with respect to all three nutrients. The average uptake of N, P₂O₅ and K₂O were 36.15, 3.86 and 12.33, respectively. Inside cement ring recorded significantly higher nutrient uptake (38.93, 4.33 and 13.55 of N, P₂O₅ and K₂O, respectively) than OCR (33.37, 4.07 and 11.07 of N, P₂O₅ and K₂O, respectively).

The uptake of these three nutrients was on par at various distances ICR. Comparing ICR at respective distances with OCR significantly lower uptake of nutrient was noticed till 9m and there after they were on par with ICR.

4.2.7.3 Total uptake (Table - 47 and fig - 28 to 37)

The uptake of nitrogen, phosphorus and potassium was significantly lower till 9m compared with 5-18m (69.54 and 8.50 and

Table 46 : Allelopathic effect of casuarina tree row on uptake of nutrients (kg/ha) by stover over distance

Treatment Distance (m)	Nitrogen						Phosphorus								
	1998			1999			1998			1999			Pooled		
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	40.12	26.85	33.49	37.00	25.25	31.13	38.56	26.05	32.31	4.25	2.76	3.51	4.00	2.40	3.20
3-6	40.00	28.10	34.05	38.00	26.23	32.12	39.00	27.17	33.08	4.56	2.80	3.68	4.05	2.45	3.25
6-9	39.00	30.00	34.50	37.50	27.00	32.25	38.25	28.50	33.38	4.45	3.00	3.73	4.10	2.75	3.43
9-12	39.50	40.15	39.83	38.50	36.00	37.25	39.00	38.08	38.54	4.37	4.34	4.36	4.12	4.00	4.06
12-15	40.00	41.52	40.76	38.00	37.50	37.75	39.00	39.51	39.26	4.52	3.83	4.18	4.15	4.20	4.18
15-18	41.00	42.00	41.50	38.50	38.00	38.25	39.75	40.00	39.88	4.50	3.88	4.19	4.17	4.25	4.56
Mean	39.94	35.08	35.08	37.92	31.66	38.25	38.93	33.37	36.15	4.44	3.44	4.19	4.87	3.34	4.33
Distance (D)	S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±	CD at 5%	S.E.m±	CD at 5%		S.E.m±	CD at 5%	S.E.m±	CD at 5%
Ring (R)	1.01	2.96		1.26	3.69		1.38	3.92	0.20	0.59		0.17	0.23	0.23	0.65
D X R	0.60	1.76		0.73	2.14		0.80	2.27	0.11	0.32		0.09	0.14	0.14	0.40
	1.60	4.70		1.79	5.25		1.95	5.54	0.28	0.82		0.25	0.32	0.32	0.91

Treatment Distance (m)	Potassium									
	1998			1999			Pooled			
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	
0-3	13.00	9.28	11.14	13.20	8.00	10.60	13.10	8.64	10.87	
3-6	13.15	9.80	11.48	13.15	8.45	10.80	13.15	9.13	11.14	
6-9	14.00	10.00	12.00	13.75	9.00	11.38	13.88	9.50	11.69	
9-12	13.22	13.00	13.11	13.65	12.10	12.88	13.44	12.55	12.99	
12-15	13.63	13.75	13.69	13.80	12.50	13.15	13.72	13.13	13.42	
15-18	14.17	14.10	14.14	13.90	12.90	13.40	14.04	13.50	13.77	
Mean	13.53	11.66	13.53	13.58	10.49	13.40	13.55	11.07	12.33	
Distance (D)	S.E.m±	CD at 5%		S.E.m±	CD at 5%		S.E.m±	CD at 5%	S.E.m±	CD at 5%
Ring (R)	0.25	0.73		0.51	1.49		0.29	0.82	0.29	0.82
D X R	0.14	0.41		0.30	0.88		0.17	0.48	0.17	0.48
	0.35	1.03		0.73	2.14		0.40	1.14	0.40	1.14

Table 47: Allelopathic effect of casuarina tree row on total uptake of nutrients (kg/ha) by greengram over distance

Treatment Distance (m)	Nitrogen						Phosphorus								
	1998			1999			1998			1999			Pooled		
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	70.12	38.10	54.11	64.00	37.75	49.88	67.06	36.93	52.00	8.10	3.98	6.04	7.60	3.50	5.55
3-6	71.50	40.80	56.15	66.50	37.23	51.87	69.00	39.02	54.01	8.56	4.16	6.36	7.88	3.65	5.77
6-9	69.50	46.00	57.75	66.75	41.45	54.10	68.13	43.73	55.93	8.60	4.38	6.49	8.10	4.05	6.08
9-12	70.25	70.50	70.04	69.25	63.75	66.50	69.75	66.79	66.75	8.56	8.34	8.45	7.87	7.85	7.86
12-15	71.00	72.67	71.84	66.00	66.00	66.00	68.50	69.34	68.92	8.57	8.65	8.61	8.15	8.20	8.18
15-18	73.00	74.00	73.50	67.50	67.00	67.25	70.25	70.50	70.38	8.61	8.75	8.68	8.30	8.35	8.33
Mean	70.85	56.36	66.33	66.33	53.86	68.62	68.62	55.39	70.38	8.50	6.38	7.98	7.98	5.93	8.24
Distance(D)	SEm±	CD at 5%	SEm±	SEm±	CD at 5%	SEm±	SEm±	CD at 5%	SEm±	SEm±	CD at 5%	SEm±	SEm±	CD at 5%	SEm±
Ring(R)	3.58	10.49	1.74	1.74	5.09	1.99	1.99	5.65	5.65	0.21	0.62	0.34	0.34	1.00	0.20
D X R	2.07	6.05	1.00	1.00	2.92	1.15	1.15	3.27	3.27	0.12	0.35	0.20	0.20	0.59	0.12
	5.06	14.80	2.46	2.46	7.19	2.81	2.81	7.98	7.98	0.30	0.88	0.48	0.48	1.41	0.28

Treatment Distance (m)	Potassium								
	1998			1999			Pooled		
	ICR	OCR	Mean	ICR	OCR	Mean	ICR	OCR	Mean
0-3	26.30	17.28	21.79	25.20	14.75	19.98	25.75	16.02	20.88
3-6	26.30	18.00	22.15	25.35	15.45	20.40	25.83	16.73	21.28
6-9	26.45	18.50	22.48	25.90	16.50	21.20	26.18	17.50	21.84
9-12	25.55	25.75	25.65	25.77	23.30	24.53	25.66	24.53	25.09
12-15	26.75	27.00	26.88	26.25	24.25	25.25	26.50	25.63	26.06
15-18	27.52	27.63	27.58	26.40	24.90	25.65	26.96	26.27	26.61
Mean	26.48	22.36	25.81	25.81	19.86	26.15	26.15	21.11	26.15
Distance(D)	SEm±	CD at 5%	SEm±	SEm±	CD at 5%	SEm±	SEm±	CD at 5%	SEm±
Ring(R)	0.38	1.11	0.55	0.55	1.61	0.39	0.39	1.11	1.11
D X R	0.22	0.65	0.32	0.32	1.45	0.22	0.22	0.64	0.64
	0.54	1.58	0.77	0.77	2.26	0.55	0.55	1.56	1.56

"N" uptake
 "P" uptake
 "K" uptake

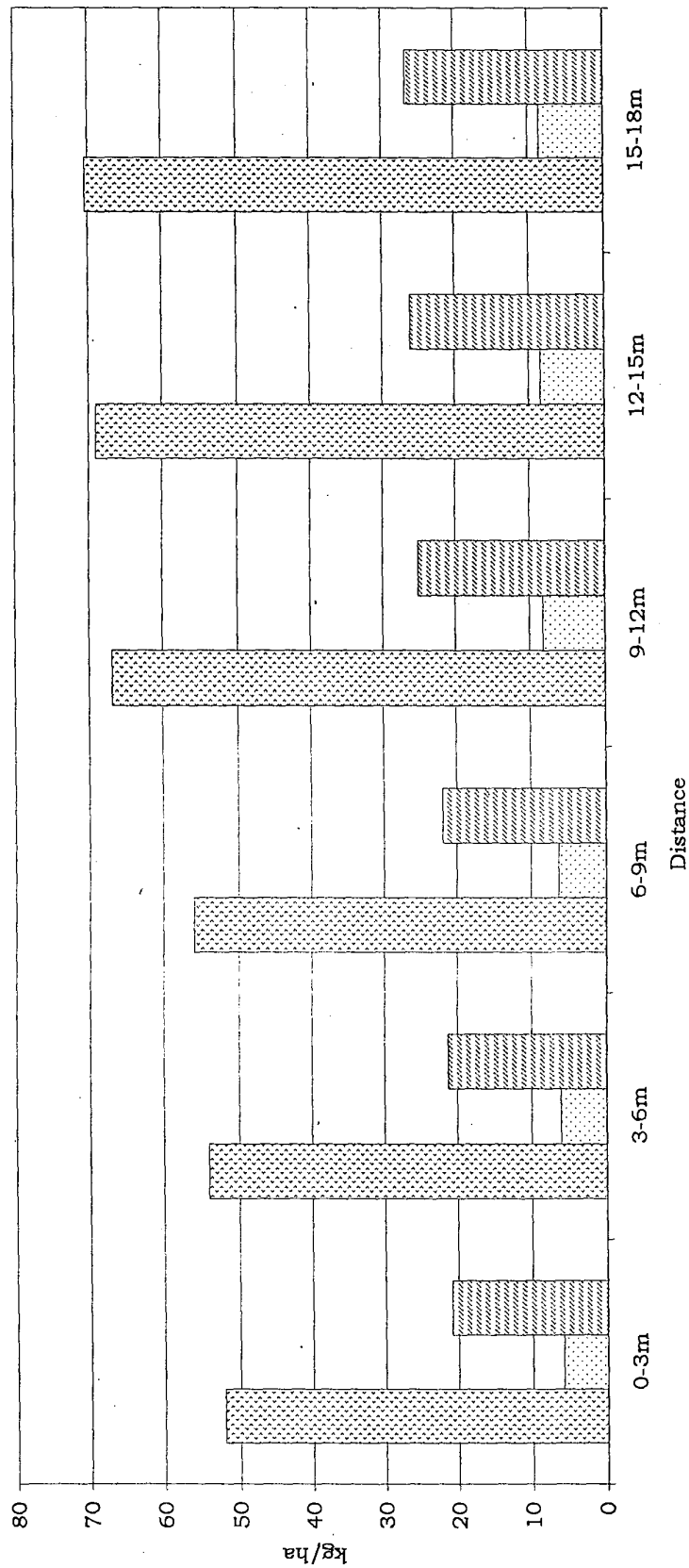


Fig. 28 : Uptake of nutrients by green gram crop at harvest over distances from casuarina tree row

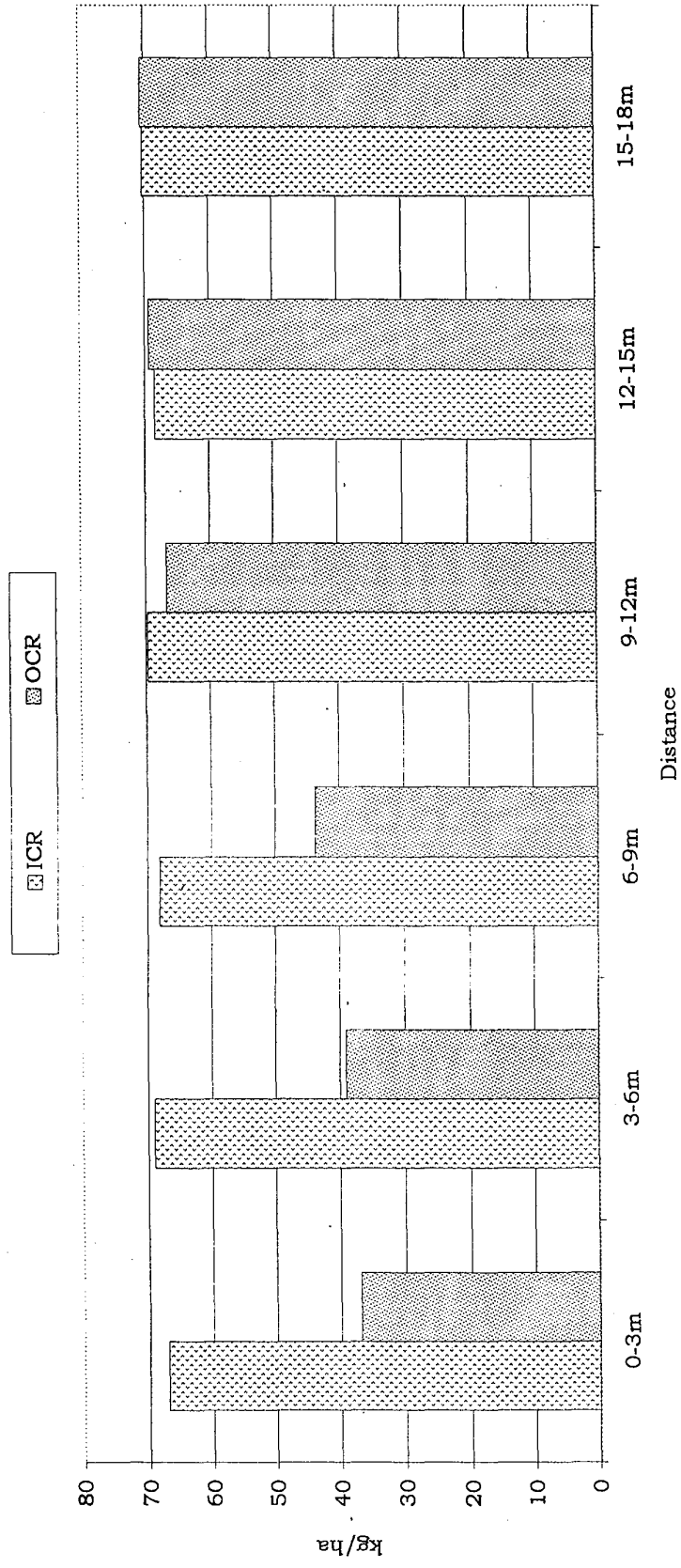


Fig.29 : Uptake of nitrogen (kg/ha) by greengram ICR and OCR at harvest over distances from casuarina tree row

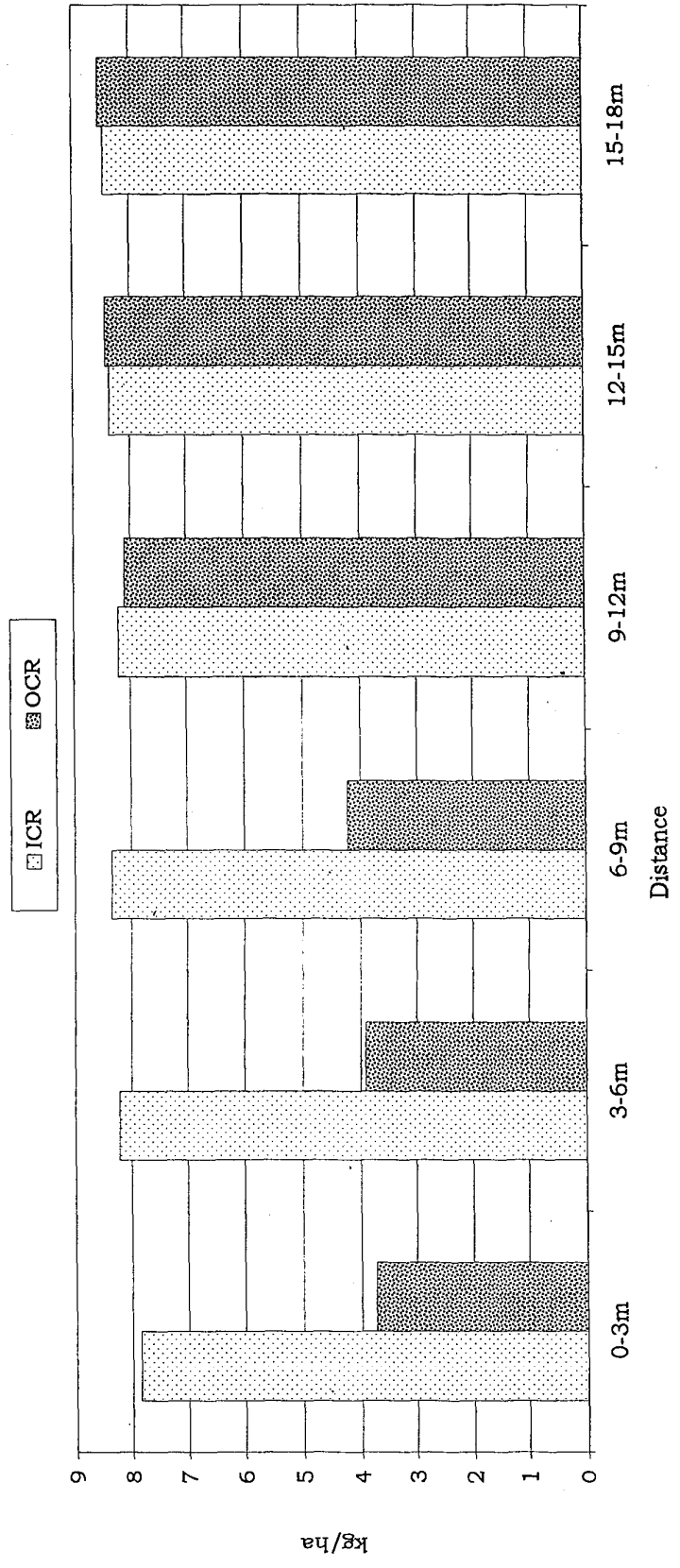


Fig.30: Uptake of phosphorus (kg/ha) by greengram ICR and OCR over distances from casuarina tree row

□ ICR ■ OCR

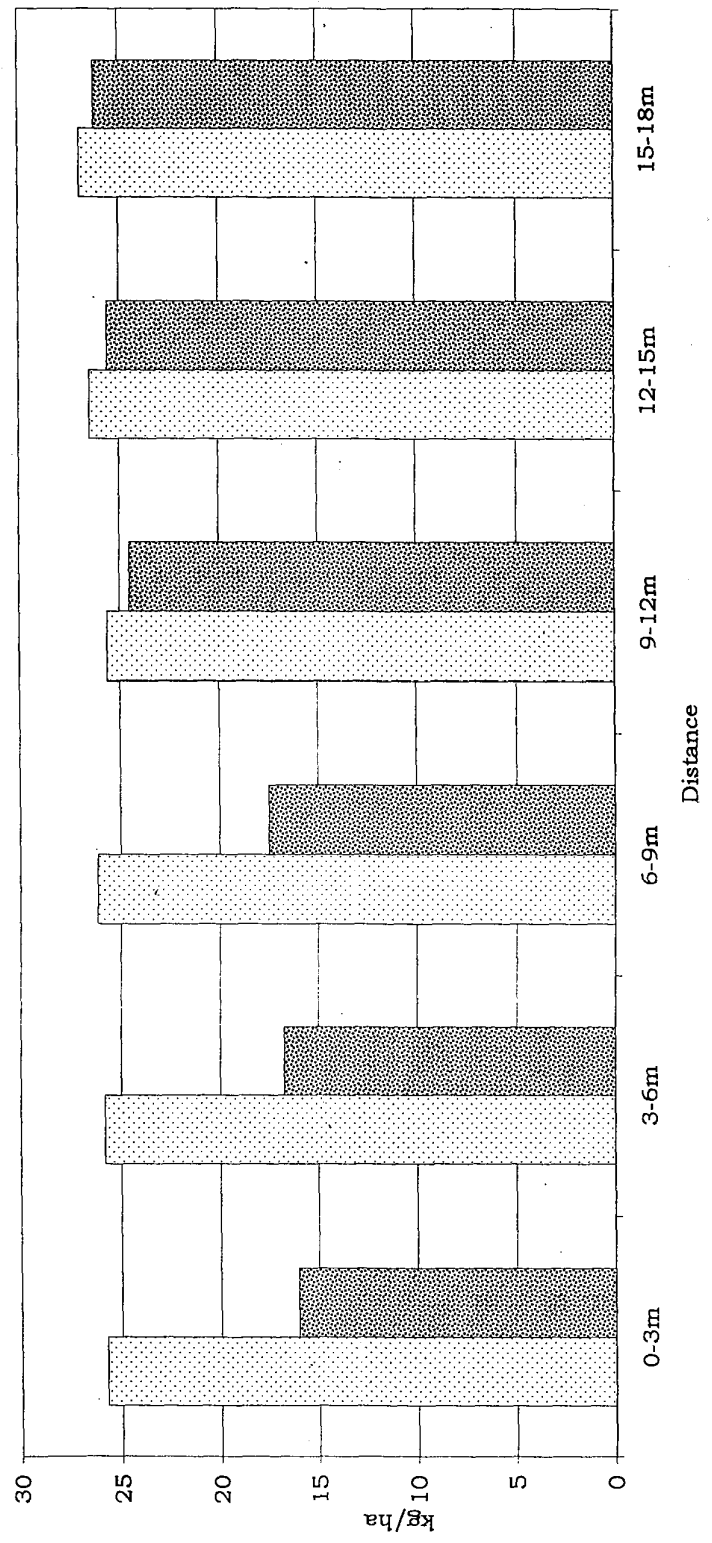


Fig.31 : Uptake of potassium (kg/ha) by greengram ICR and OCR at harvest over distances from casuarina tree row

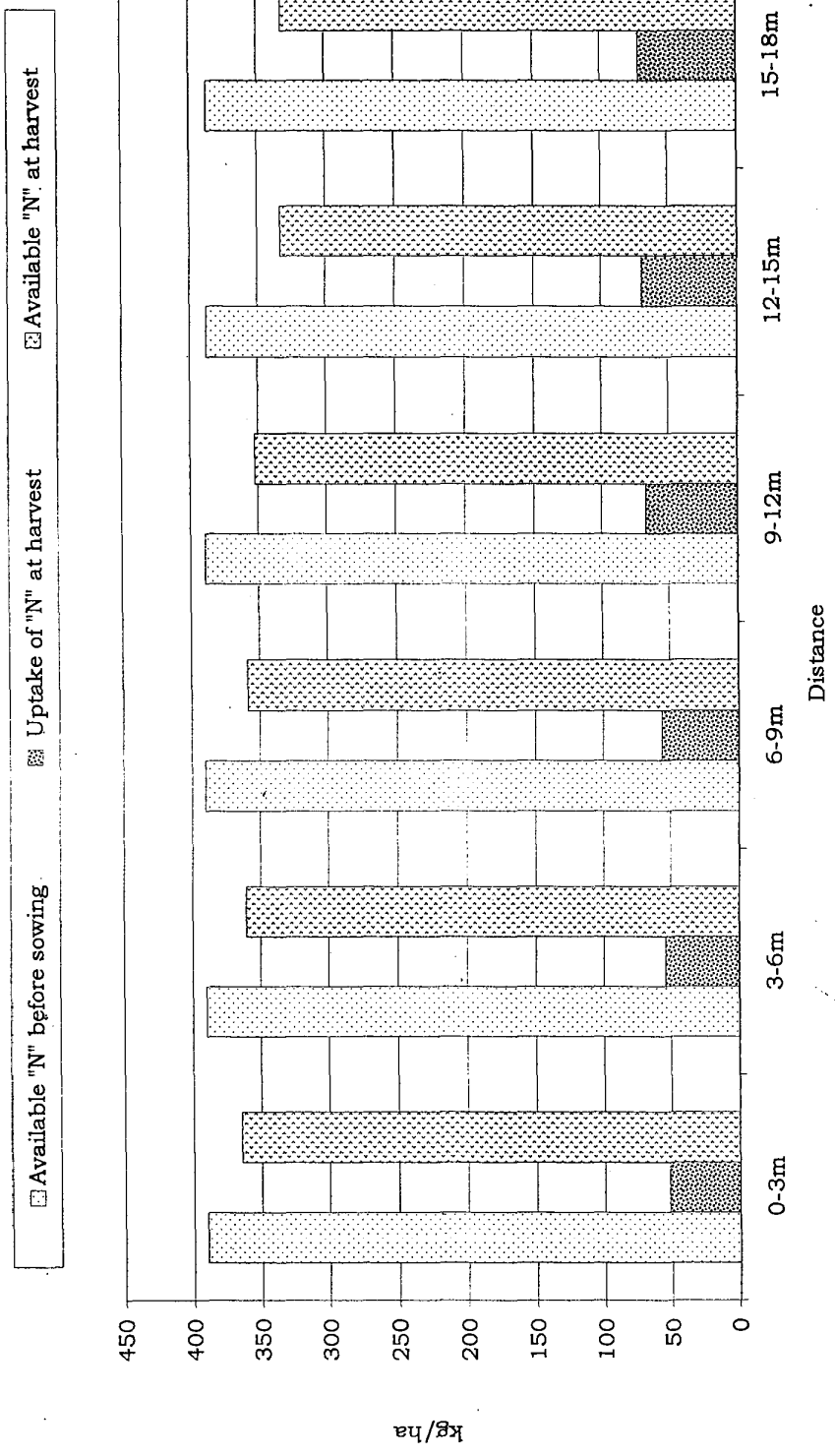


Fig.32 : Nitrogen availability and uptake (kg/ha) by greengram over distances from casuarina tree row

Available "p" before sowing
 Uptake of "p"
 Available "p" at harvest

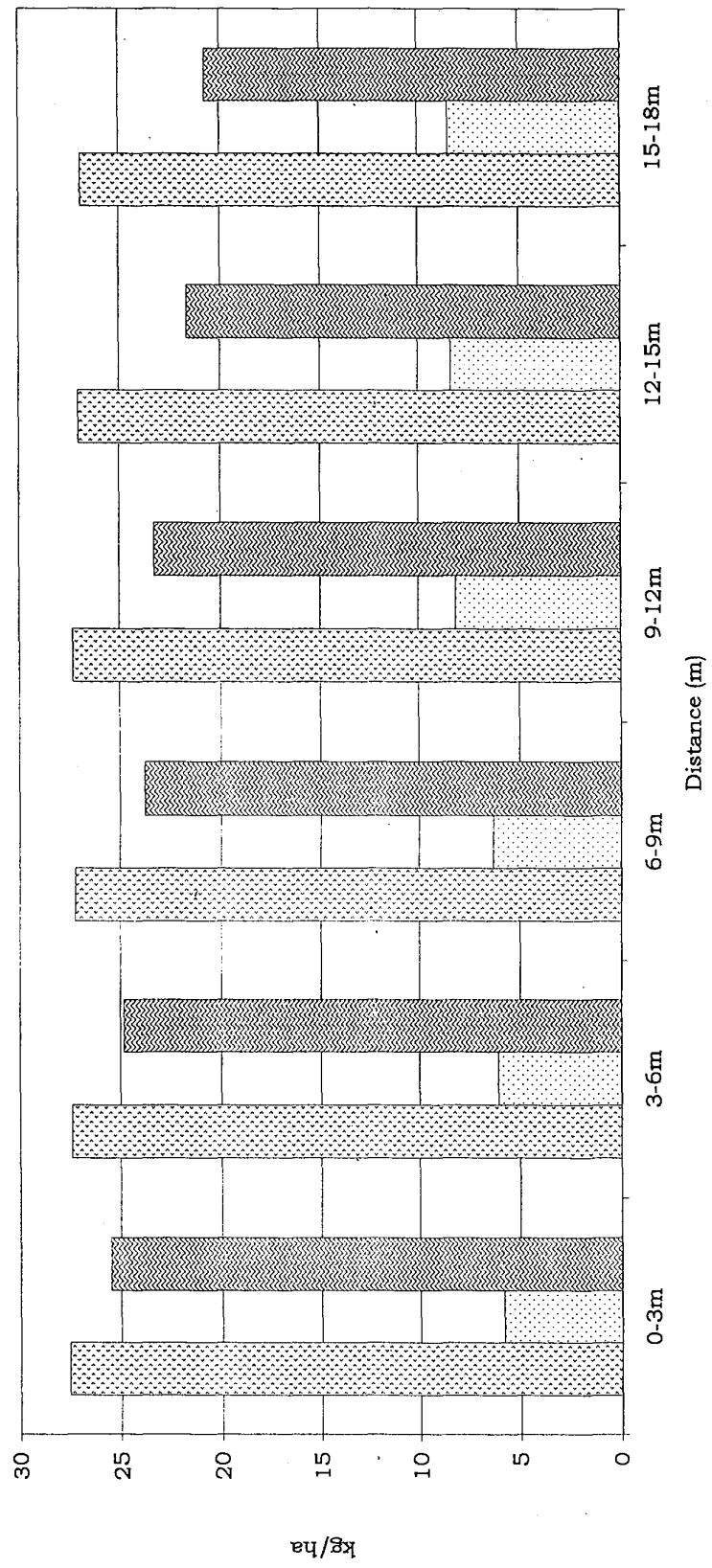


Fig. 33 : Phosphorus availability and uptake (kg/ha) by greengram over distances from casuarina tree row

Available "K" before sowing
 Uptake of "K"
 Available "K" at harvest

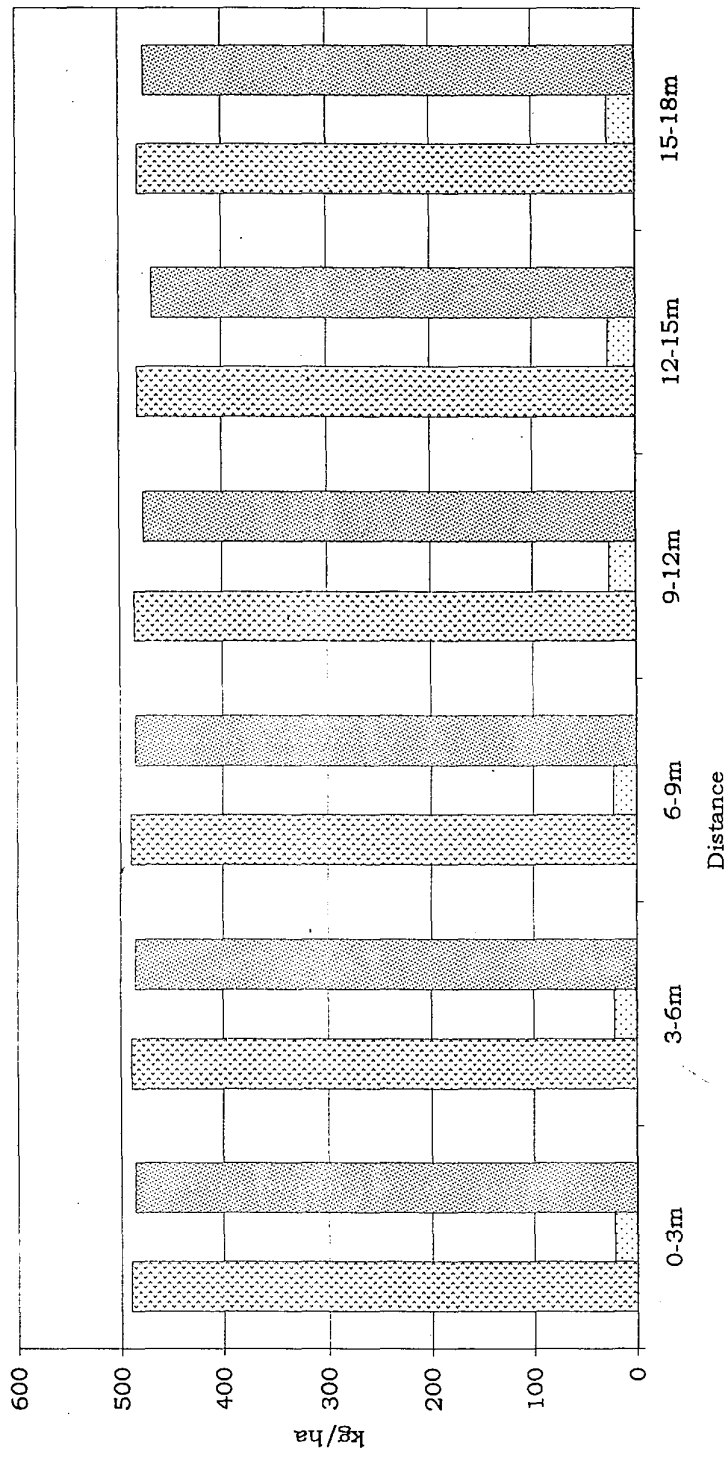


Fig. 34 : Potassium availability and uptake (kg/ha) by greengram over distances from casuarina tree

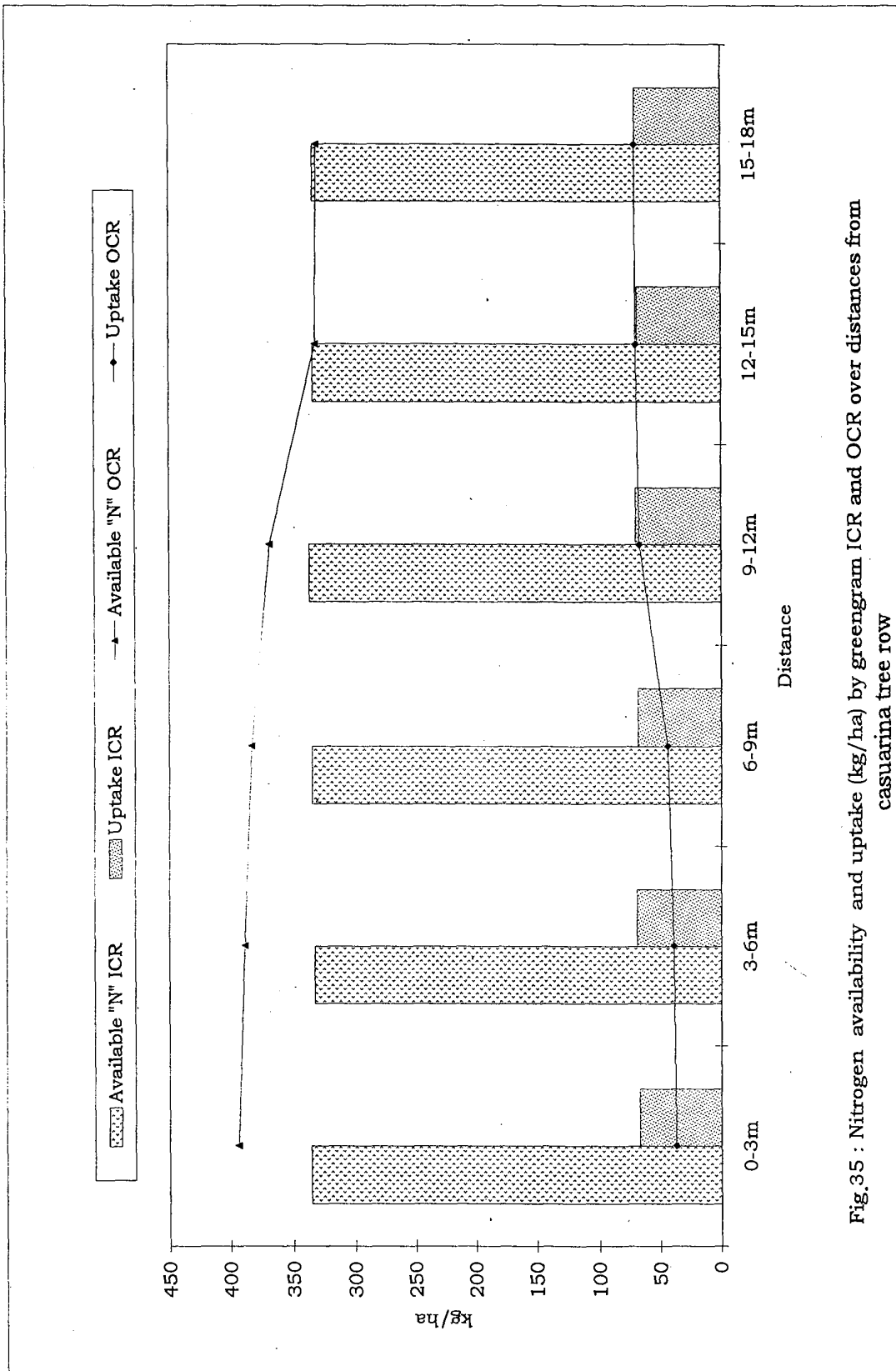


Fig.35 : Nitrogen availability and uptake (kg/ha) by greengram ICR and OCR over distances from casuarina tree row

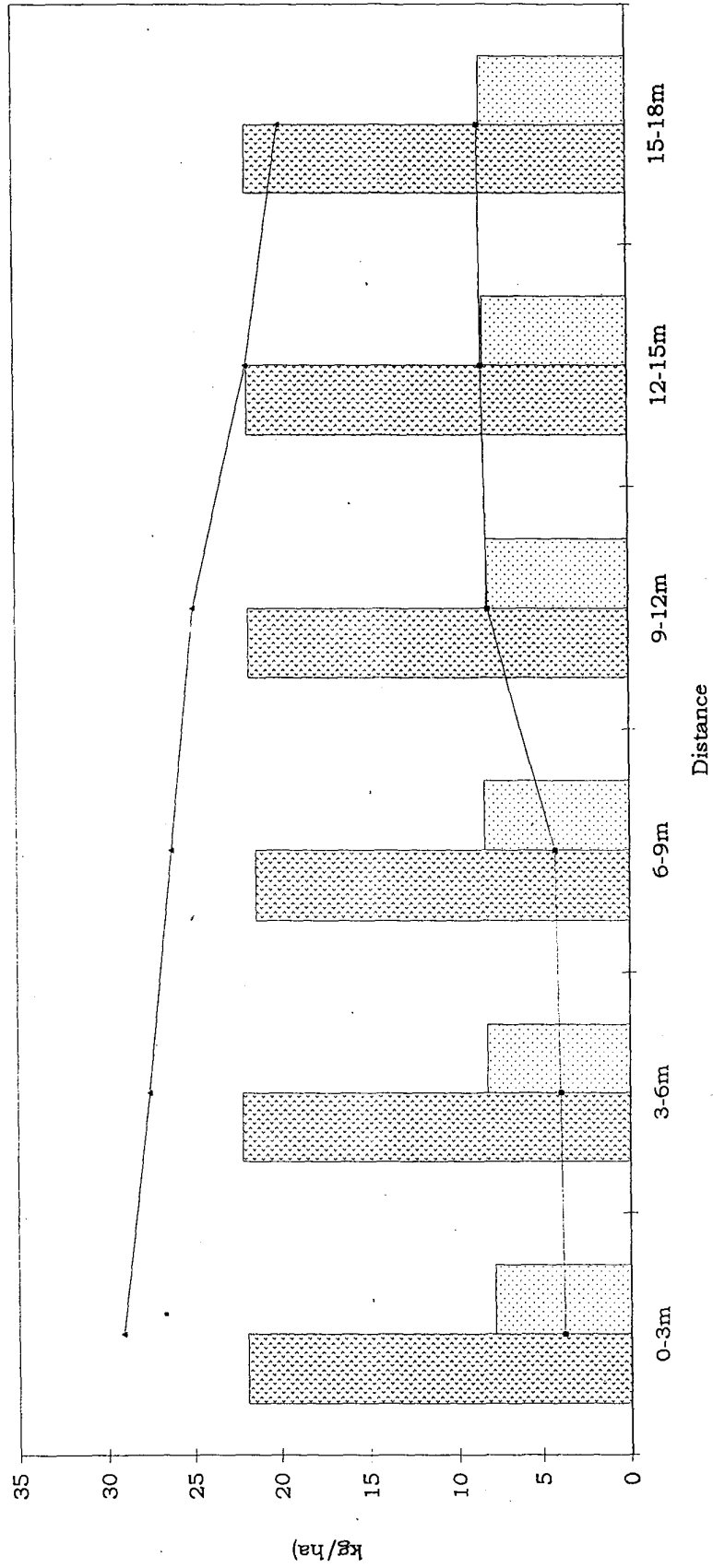


Fig.36 : Phosphorus availability and uptake (kg/ha) by greengram ICR and OCR over distances from casuarina tree (0W)

Available "K" ICR
 Uptake "K" ICR
 Available "K" OCR
 Uptake "K" OCR

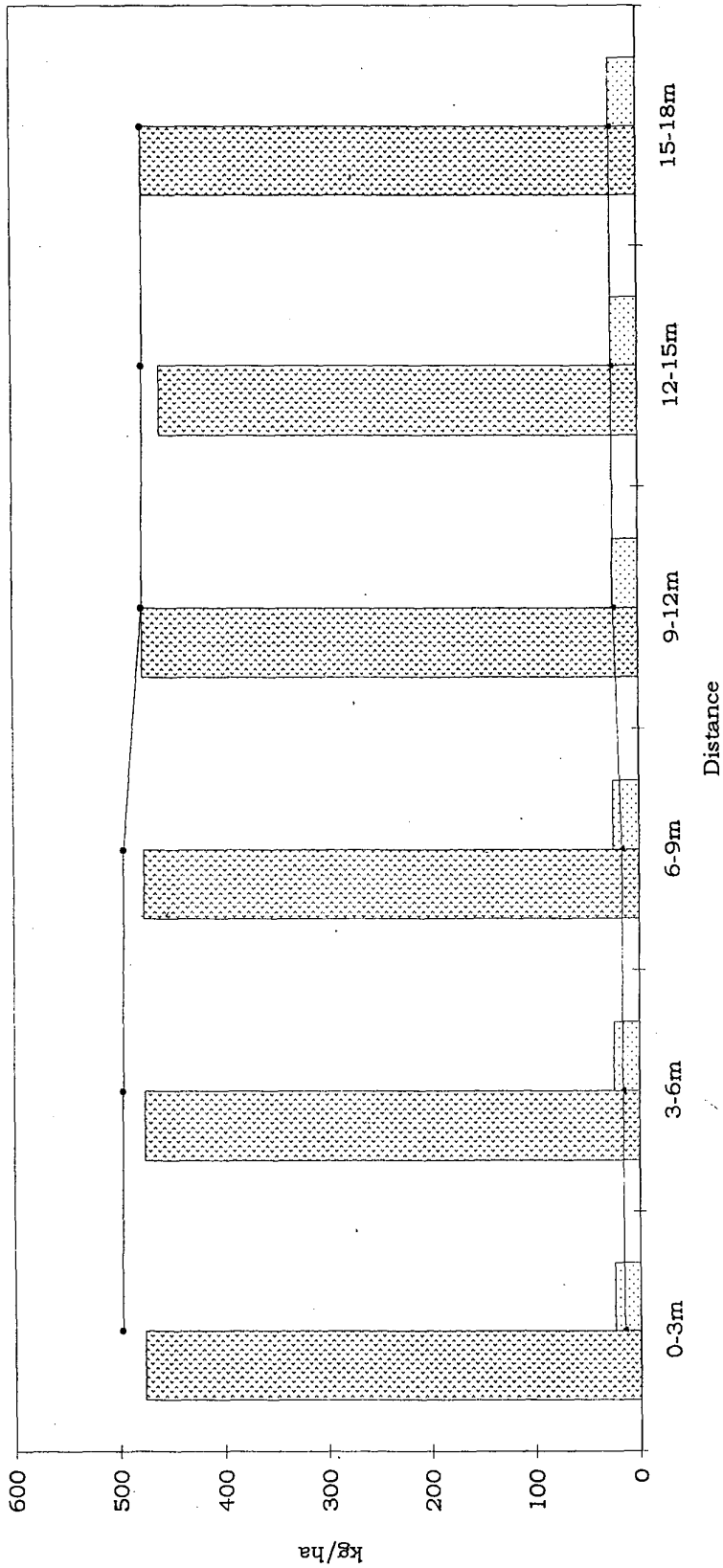


Fig.37 : Potassium availability and uptake (kg/ha) by greengram ICR and OCR over distances from casuarina tree row

26.61 kg/ha of nitrogen, phosphorus and potassium, respectively). The lowest uptake was noticed at 0-3 m (53.58, 5.80 and 20.88 of N, P₂O₅ and K₂O respectively). ICR recorded significantly higher nutrient uptake (68.62, 8.24 and 26.15 of N P₂O₅ and K₂O, respectively) than OCR (55.39, 6.16 and 21.11 of N, P₂O₅ and K₂O, respectively).

The uptake at various distances ICR were on par whereas OCR they were significantly lower till 9m and the remaining distances were on par with ICR.

4.2.8 Nutrient status of soil

4.2.8.1 Nutrient status of soil before sowing of greengram

(Table-48)

The availability of nitrogen, phosphorus and potassium with respect to the distance and comparisons made between ICR and OCR differed non-significantly, although, presence of these nutrients was slightly higher nearer to the trees compared to farther away distances. The availability was higher OCR than ICR. At various distances the availability of nutrients was comparatively lower ICR than OCR at various distances and within cement rings the availability did not vary much whereas OCR the availability was slightly higher till 9m than rest of distances.

Table 48 : Available N, P₂O₅ and K₂O content of casuarina tree row soil (kg/ha) before sowing of greengram crop over distance

Treatment Distance(m)	Nitrogen												Phosphorus															
	1998				1999				Pooled				1998				1999				Pooled							
	ICR	OCR	Mean	CD at 5%	ICR	OCR	Mean	CD at 5%	ICR	OCR	Mean	CD at 5%	S.E.m±	CD at 5%	ICR	OCR	Mean	CD at 5%	S.E.m±	CD at 5%	ICR	OCR	Mean	CD at 5%	S.E.m±	CD at 5%		
0-3	385.50	392.50	389.00	NS	387.54	394.50	391.02	NS	386.52	393.50	390.01	NS	1.61	NS	26.75	27.80	27.28	NS	3.13	NS	27.20	28.32	27.76	NS	26.98	28.06	27.52	NS
3-6	386.50	390.75	388.63	NS	388.80	393.25	391.03	NS	387.65	392.00	389.83	NS	0.93	NS	26.50	27.50	27.00	NS	1.81	NS	27.25	28.25	27.75	NS	26.88	27.88	27.38	NS
6-9	388.85	390.50	389.68	NS	389.00	393.00	391.00	NS	388.93	391.75	390.34	NS	2.27	NS	26.55	27.00	26.78	NS	4.43	NS	27.15	28.11	27.63	NS	26.85	27.56	27.20	NS
9-12	387.75	388.50	388.13	NS	389.00	392.50	390.75	NS	388.38	390.50	389.44	NS			26.83	28.00	27.42	NS			27.12	27.24	27.18	NS	26.98	27.62	27.30	NS
12-15	388.75	387.75	388.25	NS	388.50	387.50	388.00	NS	388.63	387.63	388.13	NS			26.90	26.75	26.83	NS			27.18	27.20	27.19	NS	27.04	26.98	27.01	NS
15-18	389.50	387.50	388.50	NS	388.90	386.00	387.45	NS	389.20	386.75	387.98	NS			26.80	26.50	26.65	NS			27.22	27.00	27.11	NS	27.01	26.75	26.88	NS
Mean	387.81	389.58			388.62	391.13			388.22	390.35				26.72	27.26					27.19	27.19			26.95	27.22			
Distance (D) Ring (R) D X R	S.E.m± 2.77 1.60 3.92	CD at 5% NS NS NS			S.E.m± 1.63 0.94 2.30	CD at 5% NS NS NS			S.E.m± 1.61 0.93 2.27	CD at 5% NS NS NS					S.E.m± 3.13 1.81 4.43	CD at 5% NS NS NS					S.E.m± 4.43 2.56 6.27	CD at 5% NS NS NS			S.E.m± 2.71 1.57 3.84	CD at 5% NS NS NS		

Treatment distance	Potassium													
	1998				1999				Pooled					
	ICR	OCR	Mean	CD at 5%	ICR	OCR	Mean	CD at 5%	ICR	OCR	Mean	CD at 5%	S.E.m±	CD at 5%
0-3	480.85	497.00	488.93	NS	482.25	499.85	491.05	NS	481.55	498.43	489.99	NS		
3-6	480.60	496.50	488.55	NS	482.35	499.25	490.80	NS	481.48	497.88	489.68	NS		
6-9	480.95	495.00	487.98	NS	483.00	498.65	490.83	NS	481.98	496.83	489.40	NS		
9-12	481.00	494.50	487.75	NS	482.58	483.10	482.84	NS	481.79	488.80	485.30	NS		
12-15	480.25	482.34	481.30	NS	482.85	482.85	482.85	NS	481.55	482.60	482.07	NS		
15-18	480.00	479.75	479.88	NS	482.95	482.25	482.60	NS	481.48	481.00	481.24	NS		
Mean	480.61	490.85			482.66	490.99			481.64	490.92				
Distance (D) Ring (R) D X R	S.E.m± 50.68 29.26 71.67	CD at 5% NS NS NS			S.E.m± 58.48 33.76 82.70	CD at 5% NS NS NS			S.E.m± 38.69 22.34 54.72	CD at 5% NS NS NS				

Table 49 : Available N, P₂O₅ and K₂O content of casuarina tree row soil (kg/ha) at harvest of greengram crop over distance

Treatment Distance (m)	Nitrogen												Phosphorus											
	1998				1999				Pooled				1998				1999				Pooled			
	ICR	OCR	Mean	CD at 5%	ICR	OCR	Mean	CD at 5%	ICR	OCR	Mean	CD at 5%	ICR	OCR	Mean	CD at 5%	ICR	OCR	Mean	CD at 5%	ICR	OCR	Mean	CD at 5%
0-3	332.16	390.05	361.11	NS	338.89	396.62	367.76	NS	335.53	393.34	364.44	NS	21.24	28.45	24.85	NS	22.57	29.65	26.11	NS	21.91	29.05	25.48	NS
3-6	324.45	386.45	355.45	NS	340.44	390.34	365.39	NS	332.45	388.40	360.43	NS	21.57	27.24	24.41	NS	22.68	27.73	25.21	NS	22.13	27.49	24.81	NS
6-9	328.29	380.00	354.15	NS	341.22	385.54	363.38	NS	334.76	382.77	358.77	NS	20.24	26.10	23.17	NS	22.35	26.32	24.34	NS	21.30	26.21	23.76	NS
9-12	333.18	375.76	354.47	NS	339.75	360.25	350.00	NS	336.47	368.09	352.28	NS	20.76	25.12	22.94	NS	22.56	24.60	23.58	NS	21.66	24.86	23.26	NS
12-15	327.75	325.45	326.60	NS	340.00	338.28	339.14	NS	333.88	331.87	332.87	NS	20.34	20.24	20.29	NS	23.00	23.12	23.06	NS	21.67	21.68	21.68	NS
15-18	326.60	324.25	325.43	NS	341.00	337.00	339.00	NS	333.80	330.63	332.21	NS	21.22	16.67	18.94	NS	22.20	22.89	22.55	NS	21.71	19.78	20.74	NS
Mean	328.74	363.66			340.22	368.01			334.48	365.85			20.90	23.97			22.56	25.72			21.72	24.84		
Distance (D) Ring (R) D X R	S.E.m± 18.21 10.52 25.76	CD at 5% NS 29.88 NS			S.E.m± 19.30 11.14 27.29	CD at 5% NS NS NS			S.E.m± 13.27 7.66 18.76	CD at 5% NS 21.75 53.28			S.E.m± 3.06 1.77 4.32	CD at 5% NS NS NS			S.E.m± 4.61 2.66 6.53	CD at 5% NS NS NS			S.E.m± 2.77 1.60 3.91	CD at 5% NS NS NS		

Treatment distance	Potassium											
	1998				1999				Pooled			
	ICR	OCR	Mean	CD at 5%	ICR	OCR	Mean	CD at 5%	ICR	OCR	Mean	CD at 5%
0-3	474.62	494.30	484.46	NS	476.65	499.60	488.13	NS	475.64	496.95	486.29	NS
3-6	473.95	492.25	483.10	NS	477.00	498.60	487.80	NS	475.48	495.43	485.45	NS
6-9	474.56	490.22	482.39	NS	476.89	497.86	487.38	NS	475.73	494.04	484.88	NS
9-12	475.85	475.20	475.53	NS	476.90	477.20	477.05	NS	476.38	476.20	476.29	NS
12-15	441.07	474.69	457.88	NS	477.20	476.30	476.75	NS	459.13	475.50	467.31	NS
15-18	474.45	474.20	474.33	NS	476.35	475.30	475.83	NS	475.40	474.75	475.08	NS
Mean	469.08	483.48			476.83	487.48			472.96	485.48		
Distance (D) Ring (R) D X R	S.E.m± 84.81 48.96 119.94	CD at 5% NS NS NS			S.E.m± 74.17 42.82 104.89	CD at 5% NS NS NS			S.E.m± 56.33 32.52 79.67	CD at 5% NS NS NS		

4.2.8.2 Nutrient status of soil after harvest of greengram

(Table-49)

The availability of nitrogen, phosphorus and potassium in soil were lower in magnitude compared to pre-sowing. Availability of nutrients at various distances from tree and with and without cement rings follows similar trend to that of pre-sowing. The nutrient availability and uptake by crop is presented in fig 40 to 45.

4.3 POT EXPERIMENT

4.3.1 Emergence (Fig- 38)

4.3.1.1 Cereals (Table - 50)

Among all the cereals maize and sorghum recorded higher emergence (7.83 and 6.89) than their respective controls (6.00 and 6.33). The tree species had significant effect on bajra, wheat, maize and sorghum wherein casuarina had higher emergence followed by teak and significantly lowest by eucalyptus. The leachates had significant effect wherein root + leaf leachate (RL+LL) had more detrimental effect than root leachate (RL).

4.3.1.2 Pulses (Table - 51)

All the pulses showed poor emergence than their respective controls. However, within the tree species casuarina had less effect followed by teak whereas eucalyptus had more detrimental effect on all crops. The root leachate of trees had less detrimental effect on pulses emergence than that of root + leaf leachate.

Table 50 : Allelopathic effect of tree seedlings on emergence of cereals at 6 days after sowing

Treatment Tree	Maize			Wheat			Sorghum			Bajra		
	T1	T2	Mean	T1	T2	Mean	T1	T2	Mean	T1	T2	Mean
Eucalyptus	8.67 (+44)*	5.67 (-6)	7.17 (+19)	5.67 (-29)	4.00 (-50)	4.83 (-40)	6.00 (-5)	4.33 (-31)	5.17 (-18)	6.00 (-18)	5.00 (-32)	5.50 (-25)
Teak	9.67 (+61)	7.00 (+17)	8.33 (+39)	6.00 (-25)	4.67 (-42)	5.33 (-33)	8.33 (+32)	6.67 (+5)	7.50 (+18)	8.33 (+14)	6.00 (-18)	7.17 (-2)
Casuarina	9.33 (+56)	6.67 (+11)	8.00 (+33)	6.67 (-17)	5.67 (-29)	6.17 (-23)	8.67 (+37)	7.33 (+16)	8.00 (+26)	9.33 (+27)	7.67 (+5)	8.50 (+16)
Mean	9.22 (+54)	6.44 (+7)	7.83 (+31)	6.11 (-24)	4.78 (-40)	5.44 (-32)	7.67 (+21)	6.11 (-3)	6.89 (+9)	7.89 (+8)	6.22 (-15)	7.06 (-4)
Control			6.00 (100)			8.00 (100)			6.33 (100)			7.33 (100)
	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)
Tree	0.35		1.07	0.43		1.32	0.48		1.48	0.54		1.65
Treatment	0.29		0.88	0.35		1.07	0.39		1.21	0.44		1.35
Interaction	0.49		1.50	0.60		1.84	0.68		2.09	0.76		2.33
Control V/S Rest	SEd±			SEd±			SEd±			SEd±		
	0.49		1.06	0.59		1.30	0.68		1.48	0.75		NS

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0- for no effect)

Table 51 : Allelopathic effect of tree seedlings on emergence of pulses at 6 days after sowing

Treatment Tree	Greengram			Blackgram			Cowpea			Chickpea		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	8.67 (-10)*	6.33 (-34)	7.50 (-22)	9.00 (-4)	7.67 (-18)	8.33 (-11)	8.67 (-10)	6.33 (-34)	7.50 (-22)	7.67 (-15)	7.00 (-22)	7.33 (-18)
Teak	9.00 (-7)	8.00 (-17)	8.50 (-12)	9.00 (-4)	8.00 (-14)	8.50 (-9)	9.33 (-3)	7.33 (-24)	8.33 (-14)	8.00 (-11)	6.33 (-30)	7.17 (-20)
Casuarina	9.33 (-3)	8.33 (-14)	8.83 (-9)	9.67 (+4)	9.33 (100)	9.50 (+2)	10.00 (+4)	9.67 (100)	9.83 (+2)	10.00 (+11)	9.33 (+4)	9.67 (+7)
Mean	9.00 (-7)	7.56 (-22)	8.28 (-14)	9.22 (-1)	8.33 (-11)	8.78 (-6)	9.33 (-3)	7.78 (-19)	8.56 (-11)	8.56 (-5)	7.56 (-16)	8.06 (-10)
Control			9.67 (100)			9.33 (100)			9.67 (100)			9.00 (100)
	SEm±	C.D.(5%)		SEm±	C.D.(5%)		SEm±	C.D.(5%)		SEm±	C.D.(5%)	
Tree	0.35	1.07		0.37	1.14		0.18	0.56		0.30	0.92	
Treatment	0.28	0.87		0.31	0.94		0.15	0.46		0.24	0.75	
Interaction	0.49	1.50		0.53	1.63		0.26	0.80		0.42	1.29	
	SEd±			SEd±			SEd±			SEd±		
Control V/S Rest	0.49	1.06		0.52	NS		0.27	0.59		0.42	0.92	

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect)

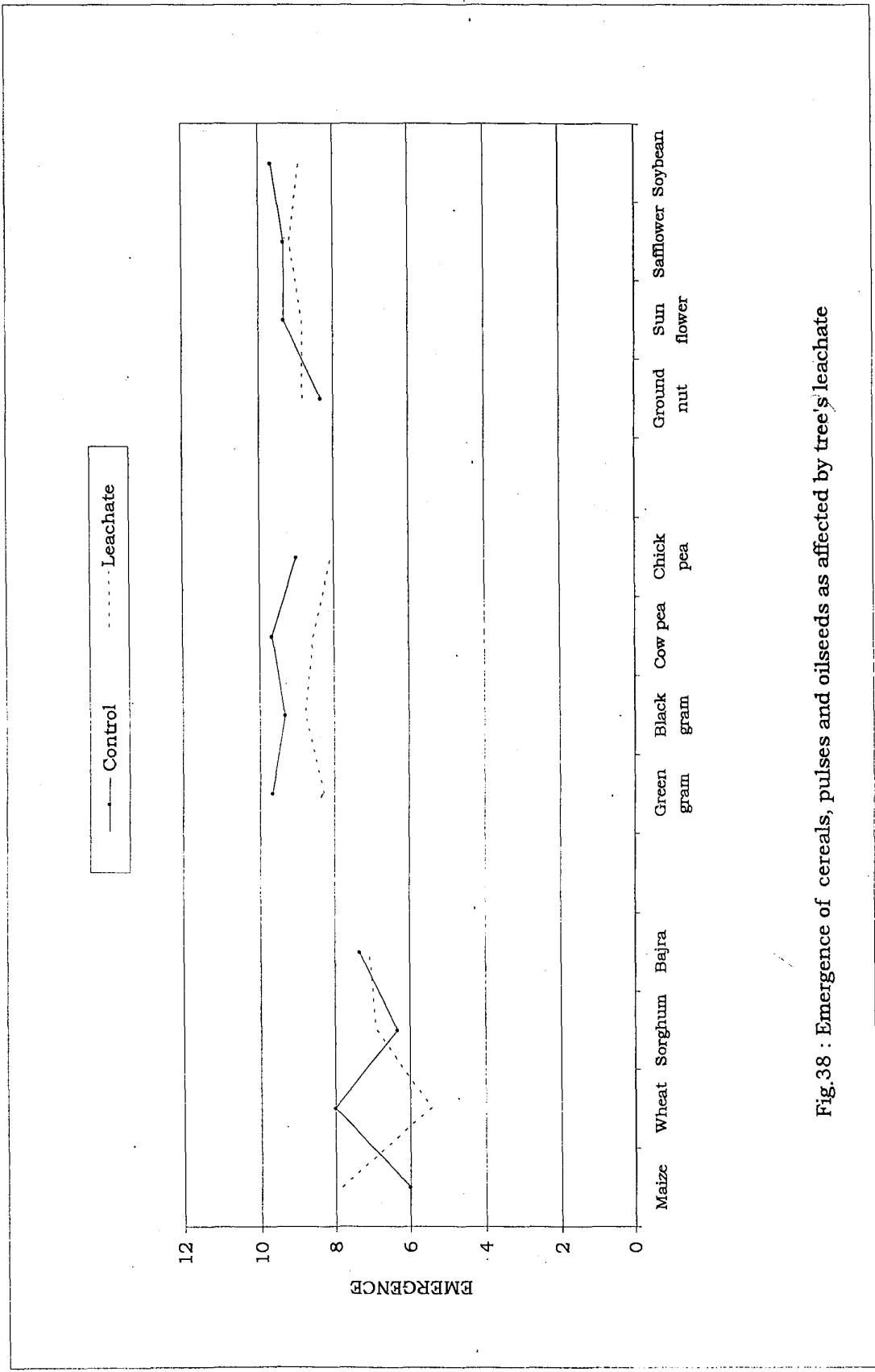


Fig.38 : Emergence of cereals, pulses and oilseeds as affected by tree's leachate

4.3.1.3 Oilseeds (Table - 52)

Similar to that of pulses, the tree species reduced the emergence of oilseeds but did not differ significantly except in case of groundnut and sunflower. Among the oilseed crops groundnut was significantly affected with the lowest emergence in eucalyptus whereas it was maximum in casuarina. Among the leachates RL + LL significantly reduced the emergence in sunflower, safflower, groundnut and soybean than RL.

4.3.2 Dry weight (dg/pl) (fig - 39)

4.3.2.1 Cereals (Table - 53 and 54)

All the tree species reduced the dry weight of all cereals except sorghum than their respective controls. Among the tree species dry weight of all cereals was reduced by eucalyptus with the lowest effect by casuarina and teak. RL + LL reduced the dry weight significantly more than RL alone in all cereals.

4.3.2.2 Pulses (Table - 55 and 56)

All pulse crops recorded significantly lower dry weight compared to their respective controls. The dry weight of the crops was significantly lower in eucalyptus leachates followed by teak and maximum was recorded in casuarina. RL + LL reduced the dry weight higher than RL.

Table 52 : Allelopathic effect of tree seedlings on emergence of oilseeds at 6 days after sowing

Treatment Tree	Groundnut			Sunflower			Safflower			Soyean		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	8.00 (-4)*	7.67 (-8)	7.83 (-6)	8.67 (-7)	8.00 (-14)	8.33 (-11)	9.33 (100)	8.67 (-7)	9.00 (-4)	9.00 (-7)	8.67 (-10)	8.84 (-9)
Teak	9.33 (+12)	9.00 (+8)	9.17 (+10)	9.33 (100)	8.33 (-11)	8.83 (-5)	9.33 (100)	8.67 (-7)	9.00 (-4)	9.33 (-3)	8.00 (-17)	8.67 (-10)
Casuarina	9.67 (+16)	9.33 (+12)	9.50 (+14)	9.67 (+4)	9.00 (-4)	9.33 (100)	9.67 (+4)	9.33 (100)	9.50 (+2)	9.67 (100)	8.67 (-10)	9.17 (-5)
Mean	9.00 (+8)	8.67 (+4)	8.83 (+6)	9.22 (-1)	8.44 (-10)	8.83 (-5)	9.44 (+1)	8.89 (-5)	9.17 (-2)	9.33 (-3)	8.44 (-13)	8.89 (-8)
Control			8.33 (100)			9.33 (100)			9.33 (100)			9.67 (100)
Tree	SEm± 0.30	C.D.(5%) 0.91		SEm± 0.28	C.D.(5%) 0.86		SEm± 0.22	C.D.(5%) 0.55		SEm± 0.35	C.D.(5%) 0.88	
Treatment	0.24	NS		0.23	0.70		0.18	NS		0.29	NS	
Interaction	0.42	1.29		0.39	NS		0.31	NS		0.49	NS	
Control V/S Rest	SEd± 0.42	NS		SEd± 0.39	NS		SEd± 0.30	NS		SEd± 0.49	NS	

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect)

Table 53 : Allelopathic effect of tree seedlings on dryweight (dg/pl) of maize and wheat at 15 and 30 DAS

Treatment Tree	Maize						Wheat					
	15 DAS			30 DAS			15 DAS			30 DAS		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	23.00 (-2)*	21.80 (-7)	22.40 (-5)	45.83 (-2)	44.23 (-5)	45.03 (-4)	16.40 (-13)	16.07 (-14)	16.23 (-13)	33.50 (-6)	33.10 (-7)	33.30 (-6)
Teak	22.80 (-3)	22.40 (-5)	22.60 (-4)	45.00 (-4)	44.73 (-4)	44.87 (-4)	16.83 (-10)	16.27 (-13)	16.55 (-12)	34.73 (-2)	34.30 (-4)	34.52 (-3)
Casuarina	23.10 (-2)	22.20 (-5)	22.65 (-4)	46.67 (100)	46.40 (-1)	46.53 (100)	17.60 (-6)	17.10 (-9)	17.35 (-7)	34.80 (-2)	34.43 (-3)	34.62 (-3)
Mean	22.97 (-2)	22.13 (-6)	22.55 (-4)	45.83 (-2)	45.12 (-3)	45.48 (-3)	16.94 (-10)	16.48 (-12)	16.71 (-11)	34.34 (-4)	33.94 (-5)	34.14 (-4)
Control			23.50 (100)			46.70 (100)			18.77 (100)			35.63 (100)
Tree	SE _{mt}	C.D.(5%)	SE _{mt}	SE _{mt}	C.D.(5%)	SE _{mt}	SE _{mt}	C.D.(5%)	SE _{mt}	SE _{mt}	C.D.(5%)	SE _{mt}
Treatment	0.20	NS	0.20	0.15	0.61	0.15	0.15	0.47	0.11	0.11	0.35	0.35
Interaction	0.16	0.50	0.16	0.12	0.50	0.12	0.12	0.38	0.09	0.09	0.28	0.28
Rest	0.28	0.86	0.28	0.28	0.86	0.28	0.22	NS	0.16	0.16	NS	NS
Control V/S	SE _d ±		SE _d ±	SE _d ±		SE _d ±	SE _d ±		SE _d ±	SE _d ±		SE _d ±
	0.28	0.61	0.28	0.22	0.61	0.22	0.22	0.47	0.15	0.15	0.33	0.33

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect)

Table 54 : Allelopathic effect of tree seedlings on dryweight (dg/pl) of sorghum and bajra at 15 and 30 DAS

Treatment Tree	Sorghum						Bajra					
	15 DAS			30 DAS			15 DAS			30 DAS		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	20.52 (-2)*	20.10 (-4)	20.31 (-3)	39.57 (+6)	38.83 (+4)	39.20 (+5)	19.02 (-3)	18.38 (-6)	18.70 (-5)	30.53 (-11)	30.70 (-11)	30.30 (-11)
Teak	20.05 (-4)	19.54 (-7)	19.80 (-6)	36.20 (-3)	35.97 (-4)	36.08 (-3)	19.24 (-2)	18.45 (-6)	18.85 (-4)	35.97 (+5)	33.73 (-2)	34.85 (+1)
Casuarina	20.80 (-1)	20.46 (-3)	20.63 (-2)	39.90 (+7)	38.07 (+2)	38.98 (+4)	19.40 (-1)	18.67 (-5)	19.04 (-3)	36.04 (+5)	35.53 (+3)	35.97 (+5)
Mean	20.46 (-3)	20.03 (-5)	20.25 (-4)	38.56 (+3)	37.62 (+1)	38.09 (+2)	19.22 (-2)	18.50 (-6)	18.86 (-4)	34.30 (-1)	33.11 (-4)	33.71 (-2)
Control			21.00 (100)			37.40 (100)			19.60 (100)			34.40 (100)
Tree Treatment Interaction	SE _{rm±} 0.27 0.22 0.39	SE _{ed±} 0.27 0.22 0.39	C.D.(5%) NS NS NS	SE _{rm±} 0.16 0.13 0.24	SE _{ed±} 0.16 0.13 0.24	C.D.(5%) 0.48 0.39 0.68	SE _{rm±} 0.15 0.13 0.22	SE _{ed±} 0.15 0.13 0.22	C.D.(5%) NS 0.38 NS	SE _{rm±} 0.11 0.09 0.15	SE _{ed±} 0.11 0.09 0.15	C.D.(5%) 0.34 0.27 0.47
Control V/S Rest	0.38		NS	0.22		0.47	0.22		0.47	0.15		0.33

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effectt ; - for inhibition effect ; 0 for no effect)

Table 55 : Allelopathic effect of tree seedlings on dryweight (dg/pl) of greengram and blackgram at 15 and 30 DAS

Treatment Tree	Greengram						Blackgram					
	15 DAS			30 DAS			15 DAS			30 DAS		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	16.73 (-14)*	15.43 (-20)	16.08 (-17)	29.07 (-15)	27.00 (-21)	28.03 (-18)	8.50 (-16)	8.27 (-18)	8.38 (-17)	20.80 (-6)	18.97 (-14)	19.88 (-10)
Teak	16.90 (-13)	16.00 (-17)	16.45 (-15)	29.77 (-13)	27.27 (-20)	28.52 (-17)	9.00 (-11)	8.87 (-13)	8.88 (-12)	23.40 (+6)	22.00 (100)	22.70 (+3)
Casuarina	17.50 (-10)	17.00 (-12)	17.25 (-11)	29.27 (-14)	28.97 (-15)	29.12 (-15)	9.27 (-8)	8.70 (-14)	8.98 (-11)	22.40 (+1)	21.63 (-2)	22.02 (100)
Mean	17.04 (-12)	16.14 (-17)	16.59 (-14)	29.37 (-14)	27.74 (-19)	28.56 (-16)	8.92 (-12)	8.58 (-15)	8.75 (-13)	22.20 (+1)	20.87 (-6)	21.53 (-3)
Control			19.40 (100)			34.20 (100)			10.10 (100)			22.10 (100)
	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)
Tree	0.14	0.42	0.17	0.51	0.11	0.34	0.24	0.24	0.24	0.24	0.24	0.74
Treatment	0.11	0.35	0.14	0.42	0.09	0.28	0.20	0.20	0.20	0.20	0.20	0.61
Interaction	0.19	0.58	0.23	0.72	0.15	NS	0.34	0.34	0.34	0.34	0.34	1.04
Control V/S Rest	SEd±	SEd±	SEd±	SEd±	SEd±	SEd±	SEd±	SEd±	SEd±	SEd±	SEd±	SEd±
	0.18	0.39	0.24	0.52	0.15	0.33	0.35	0.35	0.35	0.35	0.35	NS

T₁ - Root Leachate ; T₂ - Root + Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect)

Table 56 : Allelopathic effect of tree seedlings on dry weight (dg/pl) of cowpea and chickpea at 15 and 30 DAS

Treatment Tree	Cowpea						Chickpea					
	15 DAS			30 DAS			15 DAS			30 DAS		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	21.27 (-5)*	20.37 (-9)	20.82 (-7)	37.00 (-9)	36.53 (-10)	36.77 (-9)	16.70 (-5)	16.42 (-7)	16.56 (-6)	37.47 (+3)	36.03 (-1)	36.75 (+1)
Teak	22.00 (-2)	21.13 (-6)	21.57 (-4)	38.50 (-5)	37.80 (-7)	38.17 (-6)	16.23 (-8)	15.83 (-10)	16.03 (-9)	37.97 (+4)	36.60 (+1)	37.28 (+2)
Casuarina	23.73 (+6)	22.40 (100)	23.07 (+3)	42.30 (+4)	41.27 (+2)	41.78 (+3)	17.10 (-3)	16.80 (-5)	16.95 (-4)	39.77 (+9)	39.23 (+8)	39.50 (+9)
Mean	22.33 (100)	21.30 (-5)	21.82 (-3)	39.27 (-3)	38.53 (-5)	38.90 (-4)	16.68 (-5)	16.35 (-7)	16.51 (-6)	38.40 (+6)	37.29 (+2)	37.84 (+4)
Control			22.40 (100)			40.50 (100)			17.63 (100)			36.40 (100)
	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)
Tree	0.19	0.59	0.37	1.13	0.14	0.44	0.19	0.60				
Treatment	0.16	0.48	0.30	NS	0.12	NS	0.16	0.49				
Interaction	0.27	0.83	0.52	NS	0.20	NS	0.27	0.83				
	SEd±		SEd±		SEd±		SEd±					
Control V/S Rest	0.27	0.59	0.51	1.11	0.20	0.43	0.27	0.59				

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect)

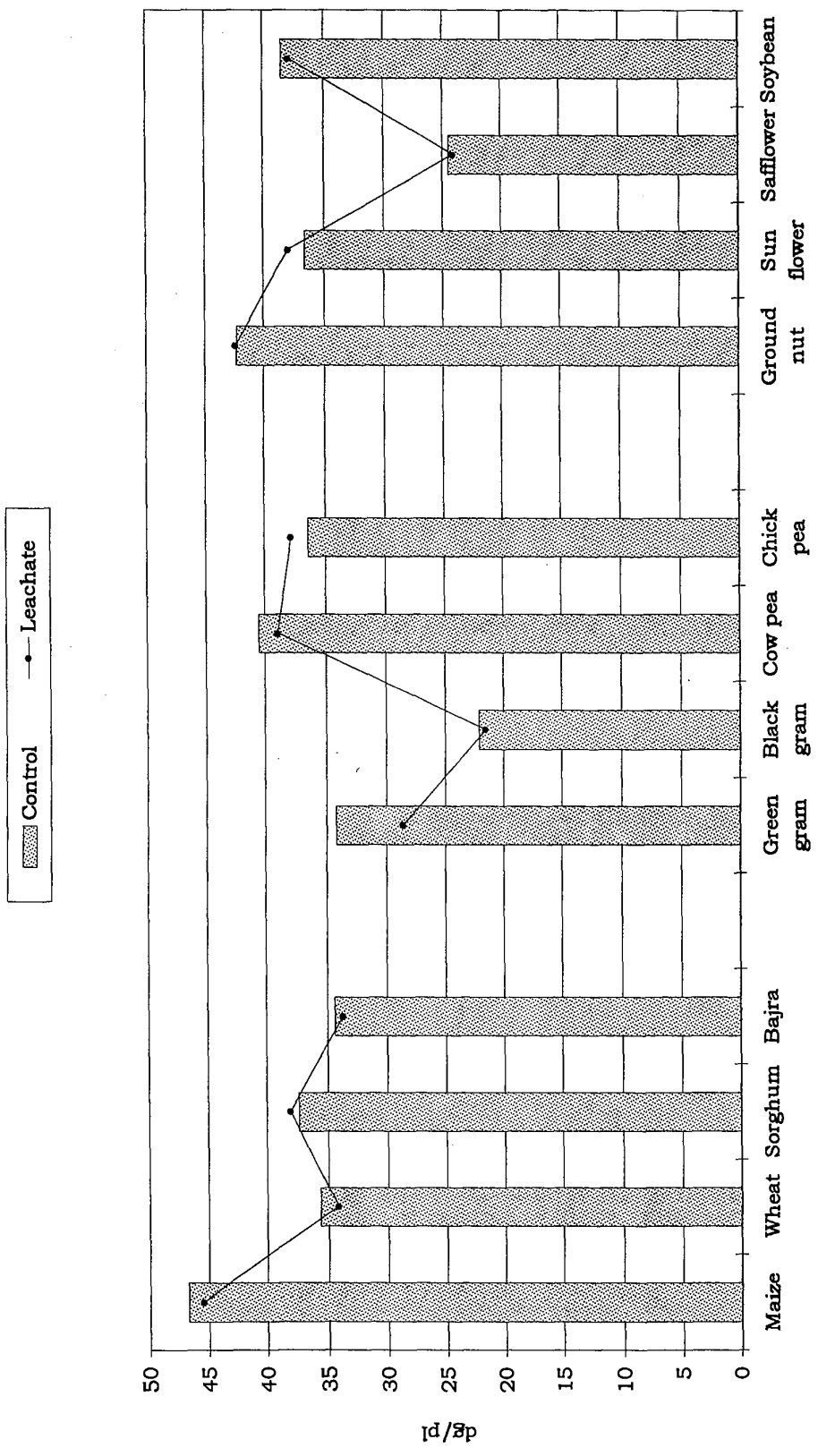


Fig 39: Dry weight (dg/pl) of cereals, pulses and oilseeds at 30 DAS as affected by different tree's leachate

4.3.2.3 Oilseeds (Table – 57 and 58)

The dry weight of sunflower and soybean was reduced significantly compared to their respective controls. Among the tree species casuarina recorded significantly higher dry weight of oilseed crops followed by teak and significantly lower dry weight was observed in eucalyptus leachates. RL+LL recorded significantly lower dry weight than RL.

4.3.3 Shoot and root length (cm) (fig – 40 to 43)

4.3.3.1 Cereals (Table – 59 to 62)

The mean values for root and shoot length of all the cereals were significantly not different from their respective controls except wheat where in controls recorded significantly higher values. In all the crops shoot length was higher than root length. Among different trees, casuarina leachates had lesser effect followed by teak whereas significantly lower shoot and root length were recorded in eucalyptus leachates. The RL + LL recorded significantly lower shoot and root length than RL in all the cereal crops.

The shoot length of wheat at 15 DAS was significantly influenced by trees and leachates. In the root leachate, eucalyptus recorded significantly lower length whereas casuarina produced greater length. The response was same in case of RL + LL but the values were lesser than RL.

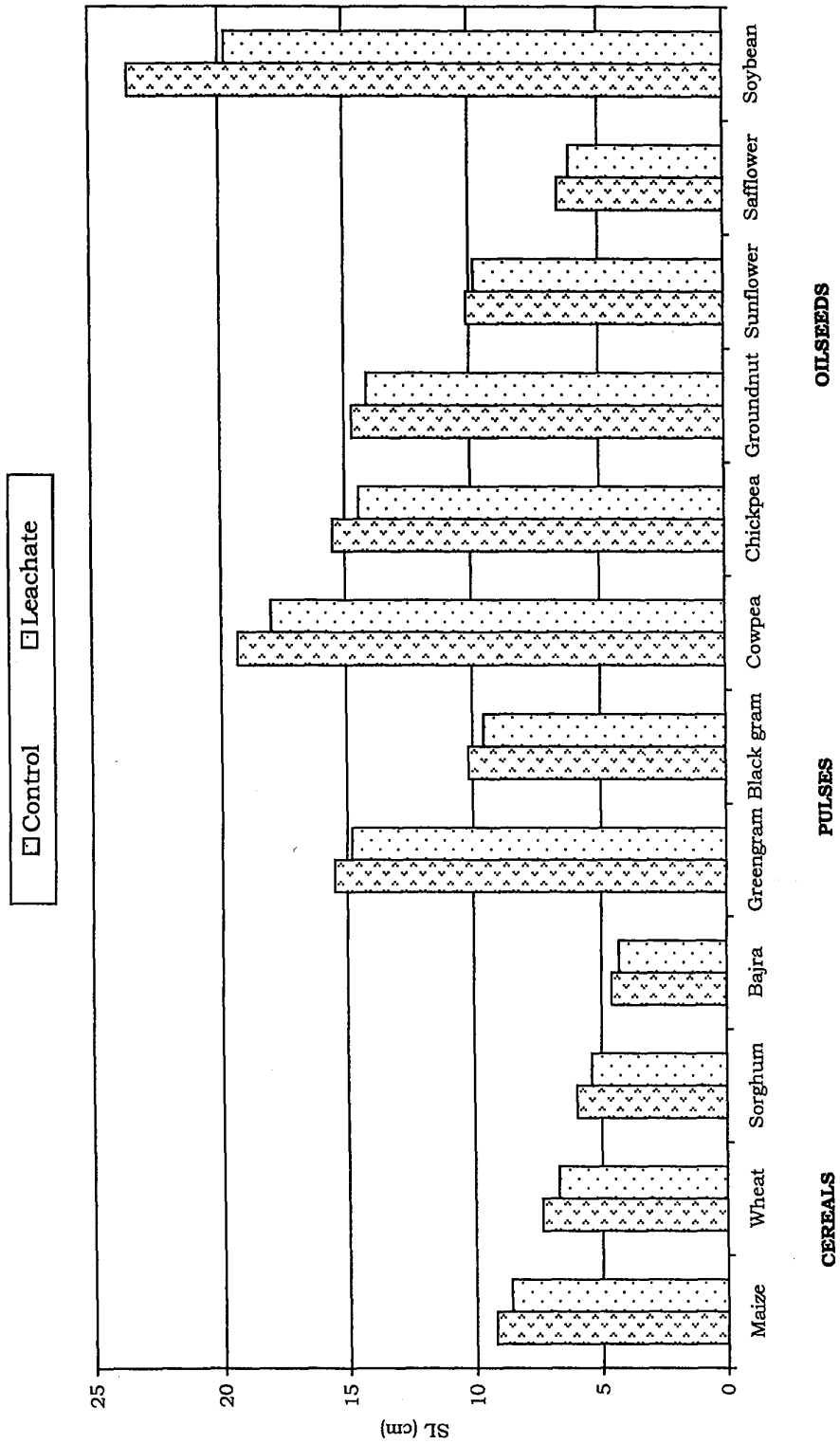


Fig 40 : Shoot length (cm) of cereals, pulses and oilseed crops as affected by tree leachates at 15DAS

Table 57 : Allelopathic effect of tree seedlings on dry weight (dg/pl) of groundnut and sunflower at 15 and 30 DAS

Treatment Tree	Groundnut						Sunflower					
	15 DAS			30 DAS			15 DAS			30 DAS		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	19.47 (-2)*	18.70 (-6)	19.08 (-4)	41.33 (-2)	40.57 (-4)	40.95 (-3)	17.60 (-8)	17.27 (-10)	17.43 (-9)	37.67 (+3)	36.60 (100)	37.13 (+2)
Teak	19.60 (-1)	18.90 (-4)	19.25 (-3)	42.37 (100)	41.60 (-2)	41.98 (-1)	18.40 (-4)	18.07 (-6)	18.23 (-5)	38.33 (+5)	37.60 (+3)	37.97 (+4)
Casuarina	19.72 (100)	19.05 (-4)	19.39 (-2)	44.47 (+5)	43.70 (+3)	44.08 (+4)	21.50 (+12)	19.73 (+3)	20.61 (+7)	39.20 (+7)	38.27 (+5)	38.73 (+6)
Mean	19.60 (-1)	18.88 (-5)	19.24 (-3)	42.72 (+1)	41.96 (-1)	42.34 (100)	19.17 (100)	18.36 (-4)	18.76 (-2)	38.40 (+5)	37.49 (+2)	37.94 (+4)
Control			19.80 (100)			42.30 (100)			19.20 (100)			36.60 (100)
Tree	SEm±	C.D.(5%)	SEm±	SEm±	C.D.(5%)	SEm±	SEm±	C.D.(5%)	SEm±	SEm±	C.D.(5%)	SEm±
Treatment	0.22	NS	0.31	0.31	0.95	0.21	0.21	0.65	0.16	0.16	0.50	0.50
Interaction	0.18	0.56	0.25	0.25	0.77	0.17	0.17	0.53	0.13	0.13	0.41	0.41
Control V/S Rest	0.31	NS	0.43	0.43	NS	0.30	0.30	0.92	0.23	0.23	0.71	0.71
	SEd±		SEd±	SEd±		SEd±	SEd±		SEd±	SEd±		SEd±
	0.31	NS	0.43	0.43	NS	0.29	0.29	NS	0.22	0.22	0.47	0.47

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect)

Table 58 : Allelopathic effect of tree seedlings on dryweight (dg/pl) of safflower and soybean at 15 and 30 DAS

Treatment Tree	Safflower						Soybean					
	15 DAS			30 DAS			15 DAS			30 DAS		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	10.80 (-4)*	10.53 (-6)	10.67 (-5)	23.17 (-5)	22.00 (-10)	22.58 (-8)	19.47 (-8)	18.20 (-14)	18.83 (-11)	37.33 (-3)	36.60 (-5)	36.97 (-4)
Teak	11.67 (+4)	9.90 (-12)	10.78 (-4)	23.77 (-3)	23.00 (-6)	23.38 (-5)	21.40 (+1)	20.77 (-2)	21.08 (-1)	38.13 (-1)	37.40 (-3)	37.77 (-2)
Casuarina	12.67 (+13)	9.90 (-12)	11.28 (+1)	26.37 (+8)	26.17 (+7)	26.27 (+7)	22.63 (+7)	21.63 (+2)	22.13 (+4)	39.50 (+3)	38.53 (100)	39.02 (+1)
Mean	11.71 (+5)	10.11 (-10)	10.91 (-3)	24.43 (100)	23.72 (-3)	24.08 (-2)	21.17 (100)	20.20 (-5)	20.68 (-2)	38.32 (100)	37.51 (-3)	37.92 (-1)
Control			11.20 (100)			24.50 (100)			21.20 (100)			38.50 (100)
Tree	SEm±	C.D.(5%)	SEm±	SEm±	C.D.(5%)	SEm±	SEm±	C.D.(5%)	SEm±	SEm±	C.D.(5%)	SEm±
Treatment	0.15	0.47	0.23	0.23	0.71	0.17	0.17	0.51	0.19	0.19	0.59	0.59
Interaction	0.13	0.38	0.19	0.19	0.58	0.14	0.14	0.42	0.16	0.16	0.48	0.48
Control V/S Rest	0.22	0.67	0.32	0.32	0.98	0.23	0.23	0.71	0.27	0.27	0.83	0.83
	SEd±		SEd±	SEd±		SEd±	SEd±		SEd±	SEd±		SEd±
	0.22	NS	0.32	0.32	NS	0.24	0.24	0.52	0.27	0.27	0.59	0.59

T₁ - Root Leachate ; T₂ - Root + Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect)



Fig.41 : Root length (cm) of cereals, pulses and oilseeds as affected by tree leachates at 15 DAS

Table 59 : Allelopathic effect of tree seedlings on shoot and root length (cm) of maize at 15 and 30 DAS

Treatment Tree	15 DAS						30 DAS					
	SL			RL			SL			RL		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	8.90 (-3)*	8.70 (-6)	8.80 (-4)	7.37 (-23)	7.17 (-25)	7.27 (-24)	22.00 (+4)	20.12 (-5)	21.06 (100)	11.63 (-5)	9.93 (-19)	10.78 (-12)
Teak	9.00 (-2)	8.90 (-3)	8.95 (-3)	8.27 (-14)	7.33 (-24)	7.80 (-19)	22.45 (+6)	21.67 (+3)	22.06 (+5)	12.53 (+3)	11.70 (-4)	12.12 (-1)
Casuarina	8.40 (-9)	7.70 (-16)	8.05 (-13)	8.80 (-8)	8.70 (-9)	8.75 (-9)	23.77 (+13)	22.37 (+6)	23.07 (+9)	15.43 (+26)	13.27 (+9)	14.35 (+17)
Mean	8.77 (-5)	8.43 (-8)	8.60 (-7)	8.14 (-15)	7.73 (-19)	7.94 (-17)	22.74 (+8)	21.38 (+1)	22.06 (+5)	13.20 (+8)	11.63 (-5)	12.42 (+2)
Control			9.22 (100)			9.60 (100)			21.10 (100)			12.23 (100)
Tree	SEm± 0.14	C.D.(5%) 0.43	SEm± 0.38	C.D.(5%) 1.16	SEm± 0.32	C.D.(5%) 0.98	SEm± 0.32	C.D.(5%) 0.80	SEm± 0.32	C.D.(5%) 0.46	SEm± 0.26	C.D.(5%) 1.41
Treatment	0.11	0.35	0.31	NS	0.26	0.80	0.26	0.26	0.26	0.26	0.26	0.81
Interaction	0.20	0.61	0.53	NS	0.45	1.38	0.45	0.45	0.46	0.46	0.46	1.41
Control V/S Rest	SEd± 0.18	0.40	SEd± 0.53	1.15	SEd± 0.44	NS	SEd± 0.44	0.44	NS	0.44	0.44	NS

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect) SL -Shoot length ; RL - Root length

Table 60 : Allelopathic effect of tree seedlings on shoot and root length (cm) of wheat at 15 and 30 DAS

Treatment Tree	15 DAS						30 DAS					
	SL			RL			SL			RL		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	6.20 (-16)*	6.00 (-19)	6.10 (-18)	5.70 (-10)	5.02 (-21)	5.36 (-15)	12.00 (-11)	11.00 (-19)	11.50 (-15)	9.25 (-16)	8.24 (-26)	8.75 (-21)
Teak	7.00 (-5)	6.83 (-7)	6.92 (-6)	5.26 (-17)	5.20 (-18)	5.23 (-17)	12.50 (-8)	12.30 (-9)	12.40 (-8)	9.45 (-15)	9.10 (-18)	9.28 (-16)
Casuarina	7.15 (-3)	7.10 (-4)	7.13 (-3)	5.13 (-19)	4.50 (-29)	4.82 (-24)	13.30 (-2)	12.20 (-10)	12.75 (-6)	10.75 (-3)	10.64 (-4)	10.70 (-3)
Mean	6.78 (-8)	6.64 (-10)	6.71 (-9)	5.37 (-15)	4.91 (-22)	5.14 (-19)	12.60 (-7)	11.83 (-12)	12.22 (-10)	9.82 (-11)	9.33 (-16)	9.57 (-14)
Control			7.37 (100)			6.33 (100)			13.53 (100)			11.08 (100)
	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)
Tree	0.11		0.33	0.22		NS	0.11		0.34	0.18		0.56
Treatment Interaction	0.09		NS	0.18		NS	0.09		0.28	0.15		0.46
	0.15		NS	0.31		NS	0.16		0.48	0.26		0.80
	SEd±			SEd±			SEd±			SEd±		
Control V/S Rest	0.15		0.33	0.30		0.66	0.15		0.33	0.27		0.59

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect) SL -Shoot length ; RL - Root length

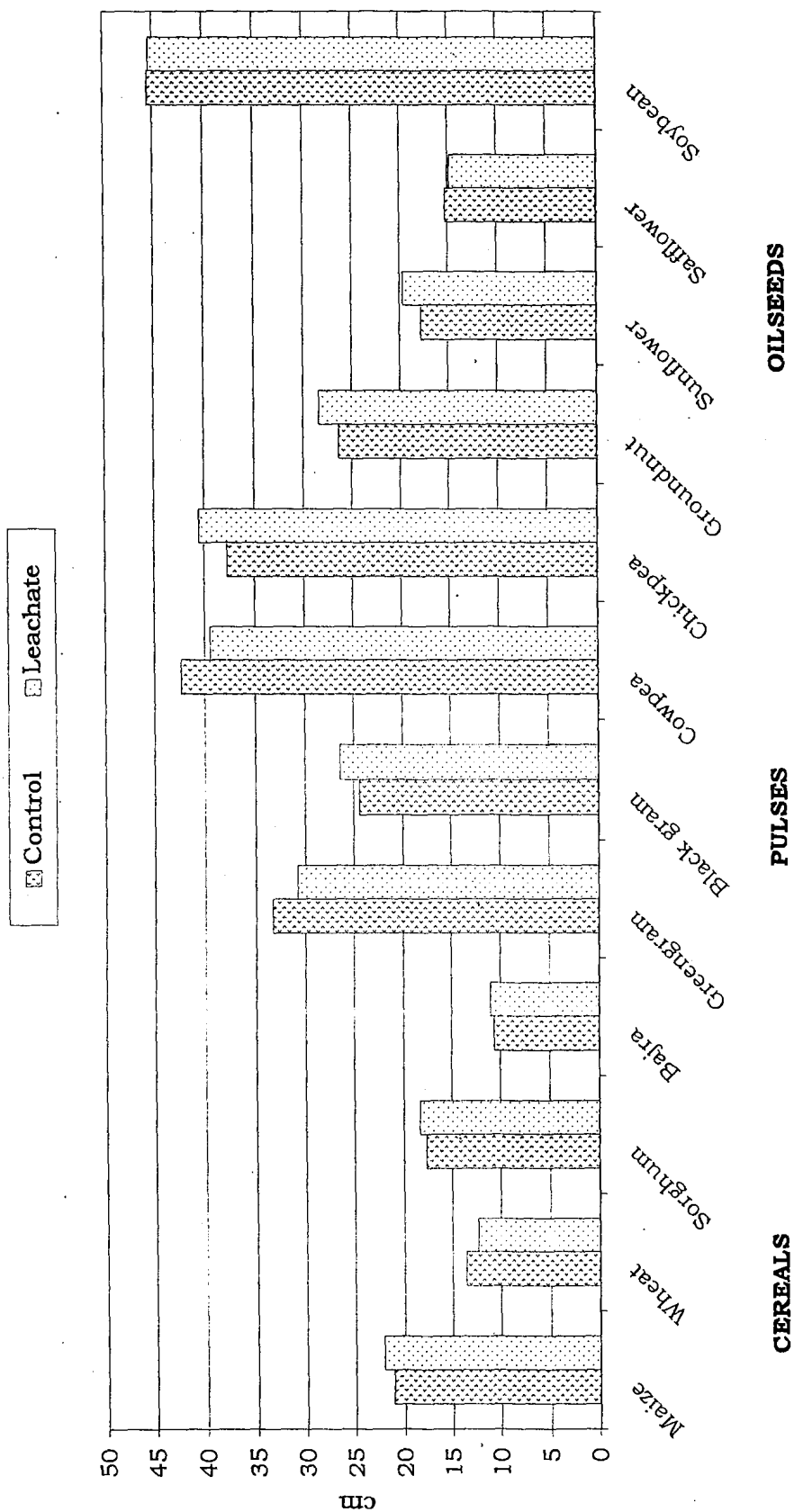


Fig. 42 : Shoot length (cm) of cereals, pulses and oilseeds as affected by tree leachates at 30 DAS

Table 61 : Allelopathic effect of tree seedlings on shoot and root length (cm) of sorghum at 15 and 30 DAS

Treatment/ Tree	15 DAS						30 DAS					
	SL			RL			SL			RL		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	5.80	5.24	5.52	4.67	3.30	3.98	16.40	16.93	16.67	10.13	9.33	9.73
	(-3)*	(-12)	(-7)	(+21)	(-15)	(+3)	(-6)	(-3)	(-5)	(-3)	(-11)	(-7)
Teak	5.22	5.10	5.16	4.87	3.17	4.02	18.50	18.20	18.35	10.67	9.80	10.23
	(-12)	(-14)	(-13)	(+26)	(-18)	(+4)	(+6)	(+4)	(+5)	(+2)	(-7)	(-3)
Casuarina	5.65	5.40	5.53	4.87	4.70	4.78	20.00	19.03	19.52	12.43	11.27	11.85
	(-5)	(-9)	(-7)	(+26)	(+22)	(+24)	(+14)	(+9)	(+11)	(+18)	(+7)	(+13)
Mean	5.56	5.25	5.40	4.80	3.72	4.26	18.30	18.06	18.18	11.08	10.13	10.61
	(-7)	(-12)	(-9)	(+24)	(-4)	(+10)	(+4)	(+3)	(+4)	(+6)	(-3)	(+1)
Control			5.97			3.87			17.53			10.50
			(100)			(100)			(100)			(100)
	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)
Tree	0.08	0.25	0.33	0.33	NS	NS	0.47	1.46	NS	0.20	0.61	0.61
Treatment	0.07	0.20	0.27	0.27	0.83	0.83	0.39	NS	NS	0.16	0.50	0.50
Interaction	0.11	0.34	0.46	0.46	NS	NS	0.67	NS	NS	0.28	0.86	0.86
	SEd±		SEd±				SEd±			SEd±		
Control V/S Rest	0.11	0.24	0.45	0.45	NS	NS	0.66	NS	NS	0.29	NS	NS

T₁ - Root Leachate ; T₂ - Root + Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect) SL - Shoot length ; RL - Root length

Table 62 : Allelopathic effect of tree seedlings on shoot and root length (cm) of bajra at 15 and 30 DAS

Treatment Tree	15 DAS						30 DAS					
	SL			RL			SL			RL		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	4.50 (-2)*	4.08 (-11)	4.29 (-7)	2.07 (-35)	1.93 (-40)	2.00 (-37)	10.93 (+3)	9.67 (-9)	10.30 (-3)	6.43 (+8)	5.75 (-4)	6.09 (+2)
Teak	4.34 (-6)	4.11 (-11)	4.23 (-8)	2.63 (-18)	1.60 (-50)	2.12 (-34)	12.37 (+17)	10.17 (-4)	11.27 (+16)	6.44 (+8)	5.58 (-7)	6.01 (+1)
Casuarina	4.70 (+2)	4.15 (-10)	4.43 (-4)	5.33 (+67)	4.63 (+45)	4.98 (+56)	12.07 (+14)	10.44 (-2)	11.25 (+6)	7.45 (+25)	6.26 (+5)	6.86 (+15)
Mean	4.51 (-2)	4.11 (-11)	4.31 (-6)	3.34 (+5)	2.72 (-15)	3.03 (-5)	11.79 (+11)	10.09 (-5)	10.94 (+3)	6.77 (+13)	5.86 (-2)	6.32 (+6)
Control			4.60 (100)			3.20 (100)			10.62 (100)			5.98 (100)
Tree	SEm± 0.15	C.D.(5%) NS	SEm± 0.19	C.D.(5%) 0.58	SEm± 0.28	C.D.(5%) 0.87	SEm± 0.17	C.D.(5%) 0.54				
Treatment	0.12	0.38	0.15	0.47	0.23	0.71	0.14	0.44				
Interaction	0.21	NS	0.27	0.83	0.40	1.23	0.25	0.77				
Control V/S Rest	SEd± 0.49	NS	SEd± 0.27	NS	SEd± 0.39	NS	SEd± 0.24	NS				

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect) SL -Shoot length ; RL - Root length

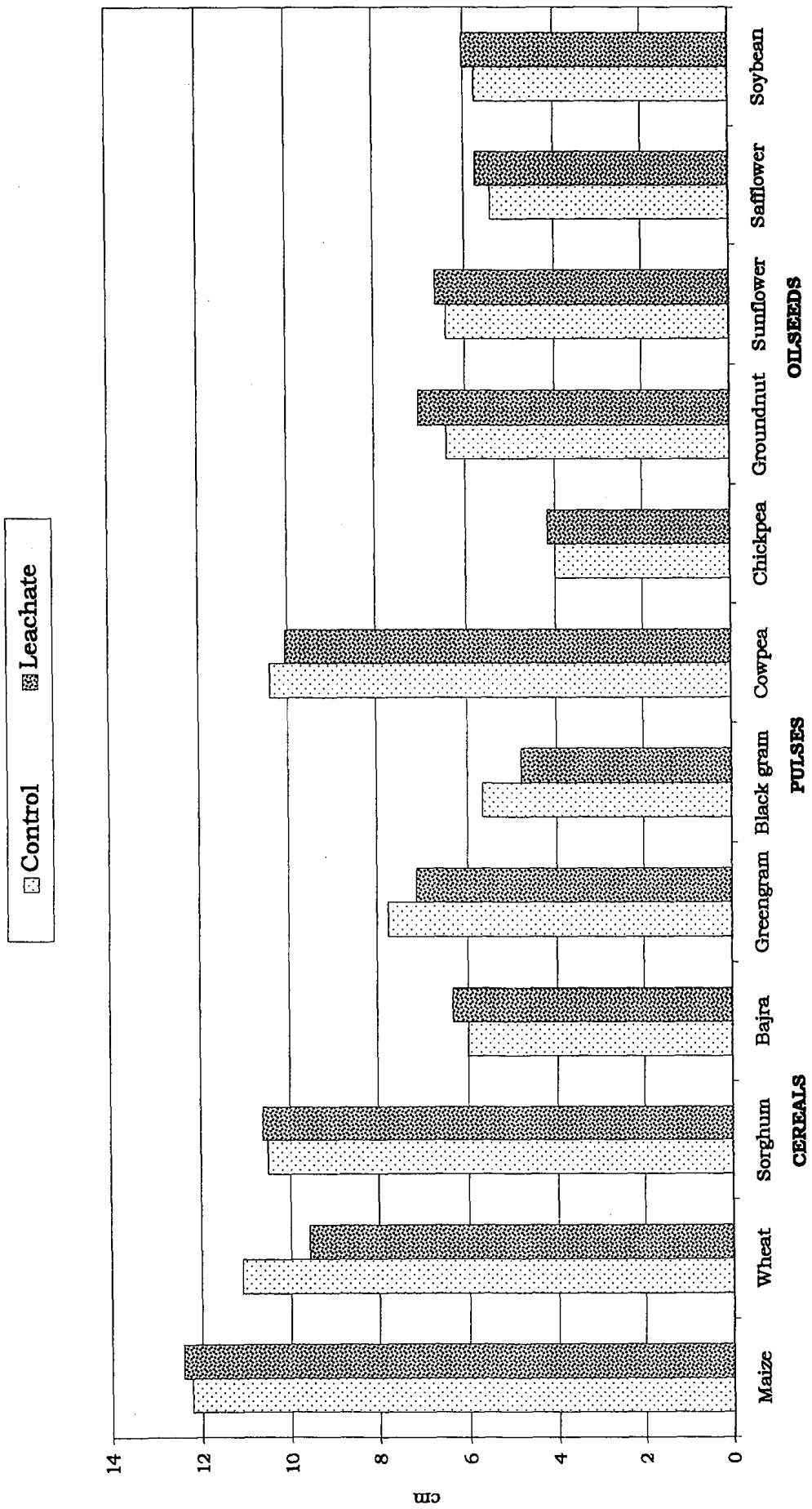


Fig 43 : Root length (cm) of cereals, pulses and oilseeds as affected by tree leachates at 30 DAS

4.3.3.2 Pulses (Table – 63 to 66)

The overall mean values of root length and shoot length of all pulses at 30 DAS indicated that shoot length of greengram, blackgram and chickpea were significantly higher than their respective controls whereas the shoot length of all pulses did not differ significantly from control except in blackgram which recorded lower value. Among the trees the root length and shoot length have been significantly reduced in eucalyptus than teak and least in casuarina. But the reduction has been greater in root length than shoot length in all pulses except cowpea wherein the reductions are similar in RL and SL. Among the leachates, RL + LL affected length of roots and shoots and more so root length.

4.3.3.3 Oilseeds (Table – 67 to 70)

At 30 DAS the overall root and shoot length indicated that groundnut, sunflower, safflower (root length) had greater values than their respective controls whereas there was no significant change in soybean compared with their respective controls. Eucalyptus leachates recorded significantly lower root and shoot length of groundnut, soybean, safflower followed by teak and lower adverse effect was observed in casuarina leachate. RL recorded significantly higher shoot and root length of all oilseed crops than RL + LL. Significant interactions between leachates and trees were observed in groundnut shoot and root length, sunflower shoot length at 30 DAS, safflower shoot and root length and soybean shoot length.

Table 63 : Allelopathic effect of tree seedlings on shoot and root length (cm) of greengram at 15 and 30 DAS

Treatment Tree	15 DAS						30 DAS					
	SL			RL			SL			RL		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	15.20 (-2)*	14.90 (-4)	15.05 (-3)	2.63 (-24)	2.00 (-43)	2.32 (-33)	30.00 (-10)	28.67 (-14)	29.33 (-12)	6.50 (-16)	5.67 (-27)	6.08 (-21)
Teak	14.70 (-5)	14.20 (-8)	14.45 (-7)	3.07 (-12)	2.67 (-23)	2.87 (-18)	31.33 (-6)	30.58 (-8)	30.96 (-7)	7.52 (-3)	6.22 (-20)	6.87 (-11)
Casuarina	15.22 (-2)	14.67 (-5)	14.95 (-4)	3.40 (-2)	2.53 (-27)	2.97 (-15)	33.33 (100)	31.33 (-6)	32.33 (-3)	8.77 (+13)	8.10 (+5)	8.44 (+9)
Mean	15.04 (-3)	14.59 (-6)	14.82 (-4)	3.03 (-13)	2.40 (-31)	2.72 (-22)	31.56 (-5)	30.19 (-9)	30.88 (-7)	7.60 (-2)	6.66 (-14)	7.13 (-8)
Control			15.50 (100)			3.48 (100)			33.30 (100)			7.75 (100)
Tree	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)
Treatment	0.19	0.58	0.22	NS	0.68	2.11	0.38	1.17	0.31	0.96	0.31	0.96
Interaction	0.16	0.48	0.18	NS	0.56	NS	0.54	NS	0.54	NS	SEd±	NS
Control V/S Rest	0.27	0.59	0.30	0.65	0.95	2.07	0.53	NS	0.53	NS	SEd±	NS

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect) SL -Shoot length ; RL - Root length

Table 64 : Allelopathic effect of tree seedlings on shoot and root length (cm) of blackgram at 15 and 30 DAS

Treatment/ Tree	15 DAS						30 DAS					
	SL			RL			SL			RL		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	10.10 (100)*	9.00 (-11)	9.55 (-6)	1.67 (-27)	1.50 (-35)	1.58 (-31)	24.50 (100)	23.90 (-2)	24.20 (-1)	3.67 (-35)	3.00 (-47)	3.33 (-41)
Teak	10.24 (+1)	9.27 (-9)	9.76 (-4)	2.17 (-6)	1.90 (-17)	2.03 (-12)	28.50 (+17)	27.13 (+11)	27.82 (+14)	5.67 (100)	4.67 (-18)	5.17 (-9)
Casuarina	10.00 (-1)	8.94 (-12)	9.47 (-7)	2.40 (+4)	2.07 (+10)	2.23 (-3)	28.00 (+15)	26.54 (+9)	27.27 (+12)	6.33 (+12)	5.33 (-6)	5.83 (+3)
Mean	10.11 (100)	9.07 (-11)	9.59 (-5)	2.08 (-10)	1.82 (-21)	1.95 (-15)	27.00 (+10)	25.86 (+6)	26.43 (+8)	5.22 (-8)	4.33 (-23)	4.78 (-16)
Control			10.15 (100)			2.30 (100)			24.45 (100)			5.67 (100)
	SE _{mt}	C.D.(5%)	SE _{mt}	C.D.(5%)	SE _{mt}	C.D.(5%)	SE _{mt}	C.D.(5%)	SE _{mt}	SE _{mt}	C.D.(5%)	SE _{mt}
Tree	0.18	NS	0.11	0.35	0.50	1.53	0.27	0.84	0.27	0.22	0.69	1.20
Treatment	0.15	0.46	0.09	NS	0.41	1.25	0.22	0.69	0.22	0.22	0.69	1.20
Interaction	0.26	0.80	0.16	NS	0.70	2.15	0.39	1.20	0.39	0.39	1.20	1.20
	SE _{dt}		SE _{dt}		SE _{dt}		SE _{dt}		SE _{dt}	SE _{dt}		SE _{dt}
Control V/S Rest	0.27	NS	0.15	0.33	0.69	1.51	0.38	0.82	0.38	0.38	0.82	0.82

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect) SL -Shoot length ; RL - Root length

Table 65 : Allelopathic effect of tree seedlings on shoot and root length (cm) of cowpea at 15 and 30 DAS

Treatment Tree	15 DAS						30 DAS					
	SL			RL			SL			RL		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	18.54 (-4)*	18.40 (-5)	18.47 (-4)	5.67 (100)	5.33 (-6)	5.50 (-3)	38.33 (-9)	37.70 (-11)	38.02 (-10)	9.93 (-4)	8.70 (-16)	9.32 (-10)
Teak	17.64 (-9)	16.84 (-13)	17.24 (-11)	6.00 (+6)	5.33 (-6)	5.67 (100)	37.71 (-11)	37.50 (-11)	37.61 (-11)	10.90 (+5)	10.17 (-2)	10.53 (+2)
Casuarina	18.40 (-5)	18.32 (-5)	18.36 (-5)	6.33 (+12)	5.33 (-6)	5.83 (+3)	43.03 (+2)	42.50 (100)	42.77 (+1)	10.77 (+4)	9.87 (-5)	10.32 (-1)
Mean	18.19 (-6)	17.85 (-8)	18.02 (-7)	6.00 (+6)	5.33 (-6)	5.67 (100)	39.69 (-6)	39.23 (-7)	39.46 (-7)	10.53 (+1)	9.58 (-8)	10.06 (-3)
Control			19.33 (100)			5.67 (100)			42.33 (100)			10.40 (100)
Tree	SEm±	C.D.(5%)	SEm±	SEm±	C.D.(5%)	SEm±	SEm±	C.D.(5%)	SEm±	SEm±	C.D.(5%)	SEm±
Treatment	0.34	1.06	0.28	0.28	NS	0.48	0.48	1.48	0.39	0.39	NS	NS
Interaction	0.28	NS	0.23	0.23	0.71	0.39	0.39	NS	0.32	0.32	0.99	0.99
Control V/S Rest	0.49	1.06	0.39	0.39	NS	0.67	0.67	1.46	0.56	0.56	1.20	1.20
	SEd±		SEd±	SEd±		SEd±	SEd±		SEd±	SEd±		SEd±
	0.49		0.39	0.39	NS	0.67	0.67	1.46	0.55	0.55	NS	NS

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect) SL -Shoot length ; RL - Root length

Table 66 : Allelopathic effect of tree seedlings on shoot and root length (cm) of chickpea at 15 and 30 DAS

Treatment Tree	15 DAS						30 DAS					
	SL			RL			SL			RL		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	15.40 (100)*	14.20 (-8)	14.80 (-4)	1.40 (-7)	1.37 (-9)	1.38 (-8)	38.75 (+3)	38.30 (+2)	38.53 (+2)	4.00 (100)	3.75 (-6)	3.88 (-3)
Teak	14.54 (-6)	14.24 (-8)	14.39 (-7)	1.40 (-7)	1.30 (-13)	1.35 (-10)	41.83 (+11)	39.40 (+4)	40.62 (+8)	3.98 (100)	3.89 (-3)	3.94 (-2)
Casuarina	14.20 (-8)	14.10 (-9)	14.15 (-9)	1.63 (+9)	1.50 (100)	1.57 (+4)	43.40 (+15)	41.43 (+10)	42.42 (+12)	4.97 (+24)	4.40 (+10)	4.68 (+17)
Mean	14.71 (-5)	14.18 (-8)	14.45 (-7)	1.48 (-1)	1.39 (-7)	1.43 (-4)	41.33 (+10)	39.71 (+5)	40.52 (+7)	4.32 (+8)	4.01 (100)	4.16 (+4)
Control			15.50 (100)			1.50 (100)			37.75 (100)			4.00 (100)
Tree	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)
Treatment	0.12	0.38	0.05	0.15	0.63	1.95	0.16	0.49	0.13	NS	0.23	0.71
Interaction	0.10	0.31	0.04	NS	0.52	2.73	SEd±	SEd±	SEd±	SEd±	SEd±	SEd±
Control V/S Rest	0.18	0.40	0.07	NS	0.88	1.91	0.22	NS	0.22	NS	NS	NS

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect) SL -Shoot length ; RL - Root length

Table 67 : Allelopathic effect of tree seedlings on shoot and root length (cm) of groundnut at 15 and 30 DAS

Treatment Tree	15 DAS						30 DAS					
	SL			RL			SL			RL		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	14.60 (-1)*	12.59 (-14)	13.60 (-7)	2.00 (-13)	1.93 (-16)	1.97 (-14)	26.80 (+2)	26.60 (+1)	26.70 (+1)	6.20 (-3)	6.20 (-3)	6.20 (-3)
Teak	14.54 (-1)	14.50 (-1)	14.52 (-1)	2.40 (+4)	2.13 (-7)	2.27 (-1)	29.00 (+10)	28.70 (+9)	28.85 (+9)	7.60 (+19)	7.20 (+13)	7.40 (+16)
Casuarina	14.63 (100)	13.60 (-7)	14.11 (-4)	2.80 (+22)	2.60 (+13)	2.70 (+17)	30.10 (+14)	29.00 (+10)	29.55 (+12)	7.70 (+20)	7.20 (+13)	7.45 (+16)
Mean	14.59 (-1)	13.56 (-8)	14.12 (-4)	2.40 (+4)	2.22 (-3)	2.31 (100)	28.63 (+9)	28.10 (+6)	28.37 (+8)	7.17 (+12)	6.87 (+7)	7.02 (+10)
Control			14.70 (100)			2.30 (100)			26.40 (100)			6.40 (100)
Tree	SEm± 0.23	C.D.(5%) 0.72	SEm± 0.08	C.D.(5%) 0.24	SEm± 0.25	C.D.(5%) 0.78	SEm± 0.14	C.D.(5%) 0.42	SEm± 0.11	C.D.(5%) NS	SEd± 0.19	C.D.(5%) 0.58
Treatment	0.19	0.58	0.07	NS	0.21	NS	0.11	NS	0.11	NS	0.11	NS
Interaction	0.33	1.01	0.11	0.34	0.36	1.11	SEd±	SEd±	SEd±	SEd±	SEd±	SEd±
Control V/S Rest	0.32	NS	0.11	NS	0.36	0.78	0.18	0.40	0.18	0.18	0.18	0.40

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect) SL -Shoot length ; RL - Root length

Table 68 : Allelopathic effect of tree seedlings on shoot and root length (cm) of sunflower at 15 and 30 DAS

Treatment Tree	15 DAS						30 DAS					
	SL			RL			SL			RL		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	10.08 (-1)*	9.64 (-4)	9.86 (-2)	3.10 (-9)	2.67 (-22)	2.88 (-15)	19.50 (+10)	18.50 (+5)	19.00 (+8)	6.27 (-2)	6.03 (-6)	6.15 (-4)
Teak	10.05 (100)	9.72 (-4)	9.89 (-2)	3.40 (100)	3.20 (-6)	3.30 (-3)	21.50 (+22)	18.83 (+7)	20.17 (+14)	7.10 (+11)	6.20 (-3)	6.65 (+4)
Casuarina	9.90 (-2)	9.60 (-5)	9.75 (-3)	3.60 (+6)	3.30 (-3)	3.45 (+2)	20.90 (+18)	18.53 (+5)	19.72 (+12)	7.50 (+17)	6.80 (+6)	7.15 (+12)
Mean	10.01 (-1)	9.65 (-4)	9.83 (-3)	3.37 (-1)	3.06 (-10)	3.21 (-6)	20.63 (+17)	18.62 (+5)	19.63 (+11)	6.96 (+9)	6.34 (-1)	6.65 (+4)
Control			10.10 (100)			3.40 (100)			17.67 (100)			6.40 (100)
Tree	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)
Treatment	0.18	NS	0.09	0.28	0.31	0.95	0.12	0.36	0.12	0.36	0.12	0.36
Interaction	0.15	NS	0.08	0.23	0.25	0.78	0.09	0.29	0.09	0.29	0.09	0.29
Control V/S Rest	0.27	NS	0.13	NS	0.43	0.94	0.15	NS	0.15	NS	0.15	NS
	SEd±		SEd±		SEd±		SEd±		SEd±		SEd±	

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect) SL -Shoot length ; RL - Root length

Table 69 : Allelopathic effect of tree seedlings on shoot and root length (cm) of safflower at 15 and 30 DAS

Treatment Tree	15 DAS						30 DAS					
	SL			RL			SL			RL		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	6.42 (-3)*	5.02 (-24)	5.72 (-13)	5.30 (+2)	5.00 (-4)	5.15 (-1)	14.25 (-7)	14.00 (-8)	14.13 (-7)	5.60 (+4)	5.40 (100)	5.50 (+2)
Teak	6.51 (-1)	6.34 (-4)	6.43 (-3)	5.77 (+11)	5.60 (+8)	5.68 (+9)	14.77 (-3)	14.60 (-4)	14.68 (-4)	5.97 (+11)	5.40 (100)	5.68 (+5)
Casuarina	6.30 (-4)	6.22 (-6)	6.26 (-5)	6.70 (+29)	6.10 (+17)	6.40 (+23)	15.60 (+2)	15.40 (+1)	15.50 (+2)	6.47 (+20)	5.60 (+4)	6.03 (+12)
Mean	6.41 (-3)	5.86 (-11)	6.14 (-7)	5.92 (+14)	5.57 (+7)	5.74 (+11)	14.87 (-2)	14.67 (-4)	14.77 (-3)	6.01 (+11)	5.47 (+1)	5.74 (+6)
Control			6.60 (100)			5.20 (100)			15.25 (100)			5.40 (100)
	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	SEm±	C.D.(5%)	SEm±
Tree	0.20	0.62	0.16	0.16	0.49	0.24	0.24	0.73	0.08	0.08	0.25	0.25
Treatment	0.16	0.50	0.13	0.13	NS	0.19	0.19	NS	0.07	0.07	0.20	0.20
Interaction	0.28	0.87	0.22	0.22	0.68	0.34	0.34	1.04	0.11	0.11	0.35	0.35
	SEd±		SEd±	SEd±		SEd±	SEd±		SEd±	SEd±		SEd±
Control V/S Rest	0.29	NS	0.22	0.22	0.47	0.32	0.32	NS	0.11	0.11	0.24	0.24

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect) SL -Shoot length ; RL - Root length

Table 70 : Allelopathic effect of tree seedlings on shoot and root length (cm) of soybean at 15 and 30 DAS

Treatment Tree	15 DAS						30 DAS					
	SL			RL			SL			RL		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	21.20 (-10)*	18.72 (-20)	19.96 (-15)	2.30 (-18)	2.10 (-25)	2.20 (-21)	42.75 (-6)	42.13 (-7)	42.44 (-7)	5.83 (+2)	5.40 (-6)	5.62 (-2)
Teak	20.24 (-14)	19.76 (-16)	20.00 (-15)	2.87 (+2)	2.63 (-6)	2.75 (-2)	46.00 (+1)	45.73 (+1)	45.87 (+1)	6.30 (+10)	5.83 (+2)	6.07 (+6)
Casuarina	20.76 (-12)	17.74 (-24)	19.25 (-18)	2.97 (+6)	2.73 (-2)	2.85 (+2)	48.33 (+6)	47.30 (+4)	47.82 (+5)	6.63 (+15)	6.10 (+6)	6.37 (+11)
Mean	20.73 (-12)	18.74 (-20)	19.74 (-16)	2.71 (-3)	2.49 (-11)	2.60 (-7)	45.69 (100)	45.06 (-1)	45.38 (100)	6.26 (+9)	5.78 (+1)	6.02 (+5)
Control			23.50 (100)			2.80 (100)			45.50 (100)			5.75 (100)
Tree	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)
Treatment	0.28	NS	0.07	0.22	0.26	0.81	0.15	0.45	0.15	0.45	0.15	0.45
Interaction	0.23	0.71	0.06	0.18	0.21	0.66	0.12	0.37	0.12	0.37	0.12	0.37
Control V/S Rest	0.40	1.23	0.10	0.31	0.37	1.14	0.21	NS	0.21	NS	0.21	NS
	SEd±		SEd±		SEd±		SEd±		SEd±		SEd±	
	0.39	0.85	0.11	NS	0.38	NS	0.22	NS	0.22	NS	0.22	NS

T₁ - Root Leachate ; T₂ - Root + Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect) SL - Shoot length ; RL - Root length

In safflower at 15 DAS the RL + LL had more detrimental effect on shoot length by eucalyptus than at 30 DAS. All the trees in both the leachates had synergetic effect on root length. At 15 DAS soybean and groundnut root length were significantly reduced by eucalyptus in RL + LL. But more significant effect was seen in soybean.

4.3.4 Vigour index (VI) (fig - 44 to 49)

4.3.4.1 Cereals (Table - 71 and 72)

Maize and sorghum recorded significantly higher VI whereas wheat and bajra recorded significantly lower VI than their respective controls. RL recorded significantly higher VI than RL + LL, casuarina recorded significantly higher VI followed by teak and significantly lower in eucalyptus in all cereals.

The VI clearly indicated that, in all the cereal crops all the trees RL + LL recorded significantly lower VI than RL. Although the casuarina tree leachates recorded significantly higher VI in both the treatments (*viz.*, RL + LL and RL) followed by teak and lowest was recorded in eucalyptus. Significantly highest and lowest VI were recorded in casuarina RL and eucalyptus RL + LL respectively.

4.3.4.2 Pulses (Table - 73 and 74)

All pulses recorded significantly lower VI than their respective controls. Casuarina recorded significantly higher VI followed by teak and

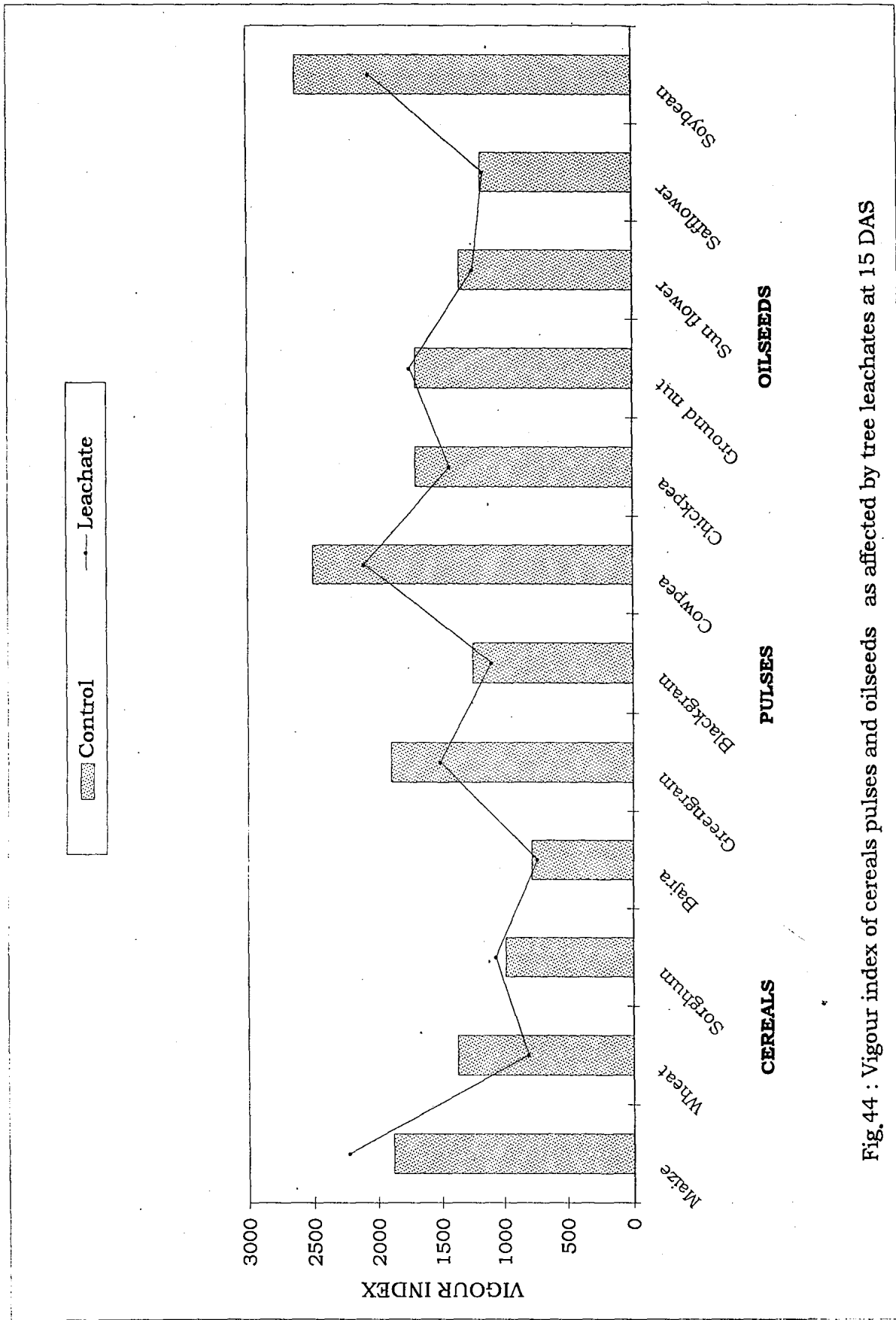


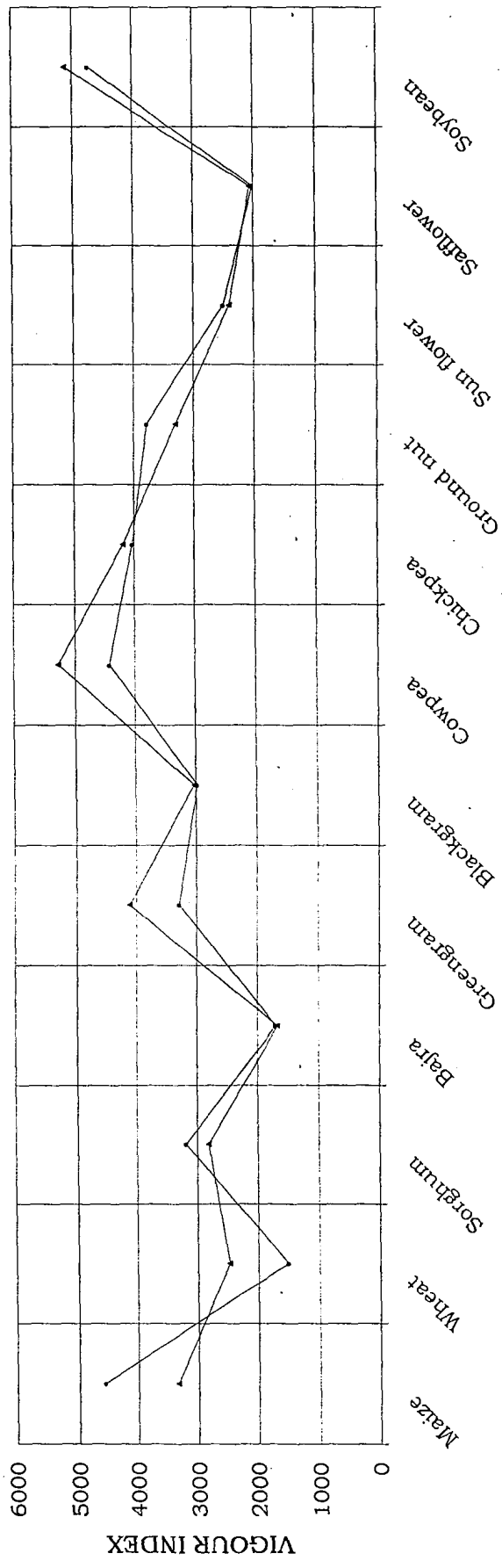
Fig. 44 : Vigour index of cereals pulses and oilseeds as affected by tree leachates at 15 DAS

Table 71 : Allelopathic effect of tree seedlings on vigour index of maize and wheat

Treatment Tree	Maize						Wheat					
	15 DAS			30 DAS			15 DAS			30 DAS		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	2350 (+25)	1832 (-3)	2091 (+11)	4858 (+46)	2838 (-15)	3848 (+16)	843 (-39)	551 (-60)	697 (-49)	1505 (-39)	962 (-61)	1234 (-50)
Teak	2782 (+48)	1894 (+1)	2338 (+24)	5636 (+69)	3893 (+17)	4765 (+43)	920 (-33)	702 (-49)	811 (-41)	1646 (-33)	1248 (-49)	1447 (-41)
Casuarina	2676 (+42)	1822 (-3)	2249 (+20)	6098 (+83)	3960 (+19)	5029 (+51)	1023 (-25)	822 (-40)	923 (-33)	2004 (-19)	1618 (-34)	1811 (-26)
Mean	2603 (+38)	1849 (-2)	2226 (+18)	5530 (+66)	3564 (+7)	4547 (+36)	929 (-32)	692 (-50)	810 (-41)	1719 (-30)	1276 (-48)	1497 (-39)
Control			1882 (100)			3333 (100)			1370 (100)			2461 (100)
Tree	SEM±	C.D.(5%)	SEM±	C.D.(5%)	SEM±	C.D.(5%)	SEM±	C.D.(5%)	SEM±	C.D.(5%)	SEM±	C.D.(5%)
Treatment	29.02	89.46	32.84	101.22	14.79	45.58	23.93	73.76	23.93	73.76	19.54	60.23
Interaction	41.05	126.51	46.44	143.14	20.92	64.22	33.85	104.32	33.85	104.32	SEd±	SEd±
Control V/S Rest	40.47	88.22	45.79	99.82	20.62	44.94	33.37	72.74	33.37	72.74		

T₁- Root Leachate ; T₂- Root + Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect)

--- Control --- Leachate



OILSEEDS

PULSES

CEREALS

Fig. 45: Vigour index (VI) of cereals, pulses and oilseeds as affected by different tree leachate at 30 DAS

Table 72 : Allelopathic effect of tree seedlings on vigour index of sorghum and bajra

Treatment Tree	Sorghum						Bajra					
	15 DAS			30 DAS			15 DAS			30 DAS		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	992 (+1)	585 (-41)	788 (-20)	2513 (-10)	1798 (-36)	2156 (-23)	538 (-31)	410 (-47)	474 (-39)	1420 (-14)	1051 (-37)	1236 (-25)
Teak	1328 (+35)	871 (-11)	1099 (-12)	3839 (+37)	2948 (+5)	3393 (+21)	792 (+2)	467 (-40)	630 (-19)	2138 (+29)	1289 (-22)	1713 (+3)
Casuarina	1440 (+46)	1170 (+19)	1305 (+33)	4438 (+58)	3509 (+25)	3974 (+42)	1277 (+64)	918 (+18)	1097 (+41)	2484 (+50)	1746 (+5)	2115 (+27)
Mean	1253 (+27)	875 (-11)	1064 (+8)	3597 (+28)	2751 (-2)	3174 (+13)	869 (+11)	598 (-23)	734 (-6)	2014 (+21)	1362 (-18)	1688 (+2)
Control			984 (100)			2803 (100)			780 (100)			1660 (100)
Tree	SEm±	C.D.(5%)		SEm±	C.D.(5%)		SEm±	C.D.(5%)		SEm±	C.D.(5%)	
Treatment	16.36	50.43		26.51	81.72		10.08	31.07		26.48	81.60	
Interaction	13.36	41.18		21.65	66.72		8.23	25.37		21.62	66.63	
	23.14	71.32		37.50	115.57		14.25	43.93		37.44	115.40	
Control V/S Rest	SEd±			SEd±			SEd±			SEd±		
	22.18	49.73		36.97	80.59		14.05	30.64		36.91	NS	

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect)

Euc leachate
 Teak leachate
 Cas leachate
 Control

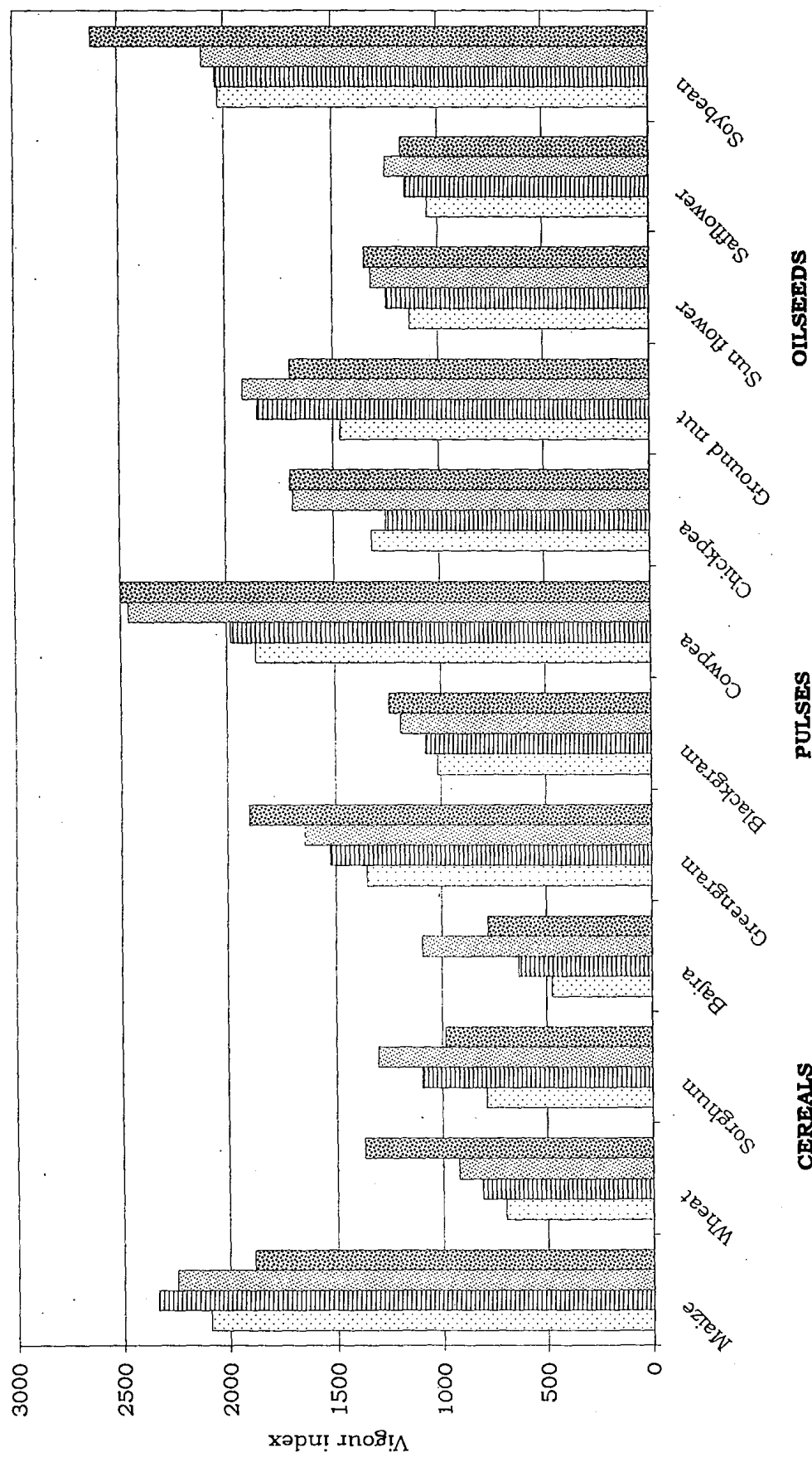


Fig. 46 : Vigour index of cereals, pulses and oilseeds as affected by eucalyptus, teak and casuarina tree leachates at 15 DAS

Table 73 : Allelopathic effect of tree seedlings on vigour index of greengram and blackgram

Treatment Tree	Greengram						Blackgram					
	15 DAS			30 DAS			15 DAS			30 DAS		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	1599 (-15)	1107 (-42)	1353 (-29)	3272 (-20)	2250 (-45)	2761 (-33)	1135 (-19)	894 (-28)	1015 (-18)	2716 (-10)	2291 (-26)	2504 (-17)
Teak	1654 (-13)	1396 (-26)	1525 (-20)	3617 (-12)	3046 (-26)	3331 (-19)	1197 (-4)	957 (-23)	1077 (-13)	3295 (+9)	2726 (-9)	3010 (100)
Casuarina	1798 (-5)	1483 (-22)	1640 (-14)	4065 (-1)	3399 (-17)	3732 (-9)	1284 (+3)	1101 (-12)	1193 (-4)	3556 (+18)	3187 (+6)	3371 (+12)
Mean	1684 (-11)	1329 (-30)	1506 (-21)	3651 (-11)	2898 (-29)	3275 (-20)	1205 (-3)	984 (-21)	1095 (-12)	3189 (+6)	2735 (-9)	2962 (-2)
Control			1898 (100)			4105 (100)			1245 (100)			3012 (100)
	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)
Tree	16.05	49.48	18.04	55.62	34.28	105.66	16.83	51.87				
Treatment	13.11	40.40	14.73	45.41	27.99	86.27	13.74	42.35				
Interaction	22.70	69.98	25.52	78.65	48.48	148.83	23.80	73.35				
	SEd±		SEd±		SEd±		SEd±					
Control V/S Rest	22.38	48.80	25.16	54.85	47.80	104.19	23.46	NS				

T₁ - Root Leachate ; T₂ - Root + Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect)

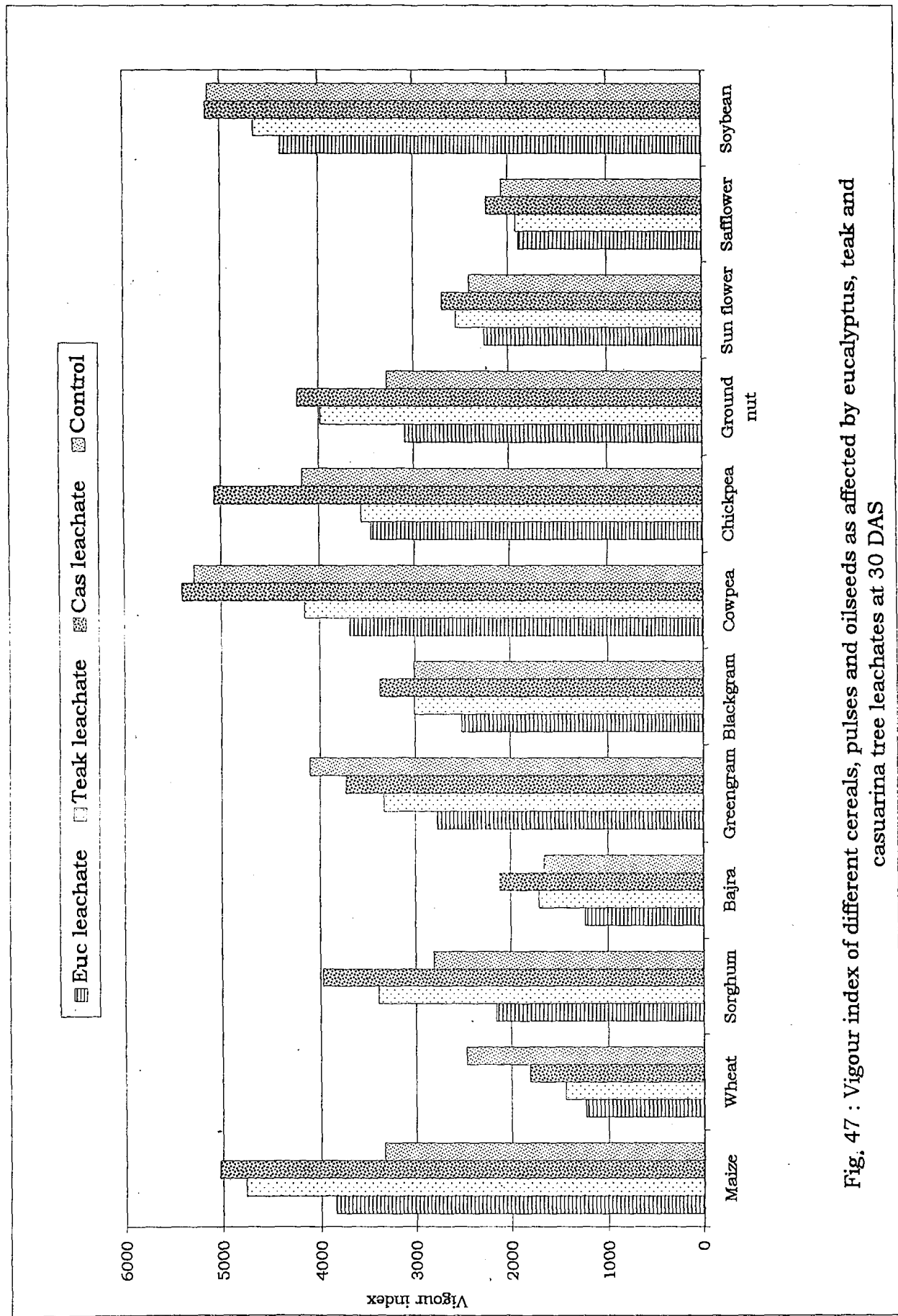


Fig. 47 : Vigour index of different cereals, pulses and oilseeds as affected by eucalyptus, teak and casuarina tree leachates at 30 DAS

Table 74 : Allelopathic effect of tree seedlings on vigour index of cowpea and chickpea

Treatment Tree	Cowpea						Chickpea					
	15 DAS			30 DAS			15 DAS			30 DAS		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	2170 (-13)	1555 (-38)	1863 (-25)	4327 (-18)	3040 (-42)	3683 (-30)	1431 (-16)	1211 (-29)	1321 (-23)	3642 (-13)	3271 (-22)	3456 (-17)
Teak	2282 (-9)	1682 (-33)	1982 (-21)	4693 (-11)	3616 (-31)	4155 (-21)	1417 (-17)	1094 (-26)	1255 (-22)	4072 (-2)	3046 (-27)	3559 (-15)
Casuarina	2558 (+19)	2365 (+7)	2462 (+13)	5566 (+34)	5237 (+24)	5401 (+29)	1759 (+4)	1618 (-8)	1688 (-2)	5374 (+22)	4753 (+2)	5064 (+12)
Mean	2337 (+8)	1867 (-3)	2102 (+3)	4862 (+18)	3965 (+11)	4413 (+15)	1536 (-2)	1307 (-25)	1422 (-8)	4363 (+14)	3690 (-6)	4026 (+4)
Control			2500 (100)			5273 (100)			1700 (100)			4175 (100)
Tree	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)
Treatment	11.4	35.25	13.70	42.23	20.01	61.67	17.74	54.68				
Interaction	9.34	28.78	11.19	34.48	16.34	50.35	14.48	44.64				
	16.17	49.85	19.38	59.72	28.29	87.21	25.09	77.32				
Control V/S Rest	SEd±	SEd±	SEd±	SEd±	SEd±	SEd±	SEd±	SEd±				
	15.95	34.76	19.10	41.65	27.90	60.81	24.73	53.92				

T₁ - Root Leachate ; T₂ - Root + Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect)



Fig. 48 : Vigour index of different cereals, pulses and oilseeds as affected by eucalyptus, teak and casuarina tree leachates at 15 DAS

lowest in eucalyptus and in all pulses RL + LL recorded significantly lower VI than RL.

Similar to cereals interaction in pulses was also same.

4.3.4.3 Oilseeds (Table - 75 and 77)

Significantly higher VI in groundnut and lower in remaining oilseeds than their respective controls were observed. The RL recorded significantly higher VI than RL + LL. Casuarina tree recorded significantly higher VI than teak and eucalyptus leachates.

The interaction effect was also similar to that of cereals and pulses.

Table 75 : Allelopathic effect of tree seedlings on vigour index of groundnut and sunflower

Treatment Tree	Groundnut						Sunflower					
	15 DAS			30 DAS			15 DAS			30 DAS		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	1594 (-6)	1336 (-21)	1465 (-14)	3168 (-3)	3018 (-8)	3093 (-6)	1224 (-9)	1055 (-22)	1139 (-16)	2393 (-4)	2103 (-13)	2248 (-9)
Teak	1897 (+12)	1796 (+6)	1847 (+9)	4099 (+25)	3877 (+18)	3988 (+22)	1345 (100)	1154 (-14)	1249 (-7)	2860 (+19)	2235 (-7)	2547 (+6)
Casuarina	2022 (+19)	1814 (+7)	1918 (+13)	4385 (+34)	4054 (+24)	4219 (+29)	1398 (+4)	1244 (-8)	1321 (-2)	2941 (+22)	2442 (+2)	2692 (+12)
Mean	1838 (+8)	1649 (-3)	1743 (+3)	3884 (+18)	3650 (+11)	3767 (+15)	1322 (-2)	1151 (-25)	1237 (-8)	2731 (+14)	2260 (-6)	2496 (+4)
Control			1700 (100)			3280 (100)			1350 (100)			2407 (100)
Tree	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)
Treatment	14.79	45.59	15.41	47.48	14.26	43.94	19.44	59.93	19.44	59.93	19.44	59.93
Interaction	12.08	37.22	12.58	38.77	11.64	35.88	15.88	48.93	15.88	48.93	15.88	48.93
Rest	20.92	64.47	21.79	67.15	20.16	61.89	27.50	84.75	27.50	84.75	27.50	84.75
Control V/S	SEd±		SEd±		SEd±		SEd±		SEd±		SEd±	
Rest	20.62	NS	21.48	46.83	19.88	43.33	27.11	59.10	27.11	59.10	27.11	59.10

T₁- Root Leachate ; T₂- Root +Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect)

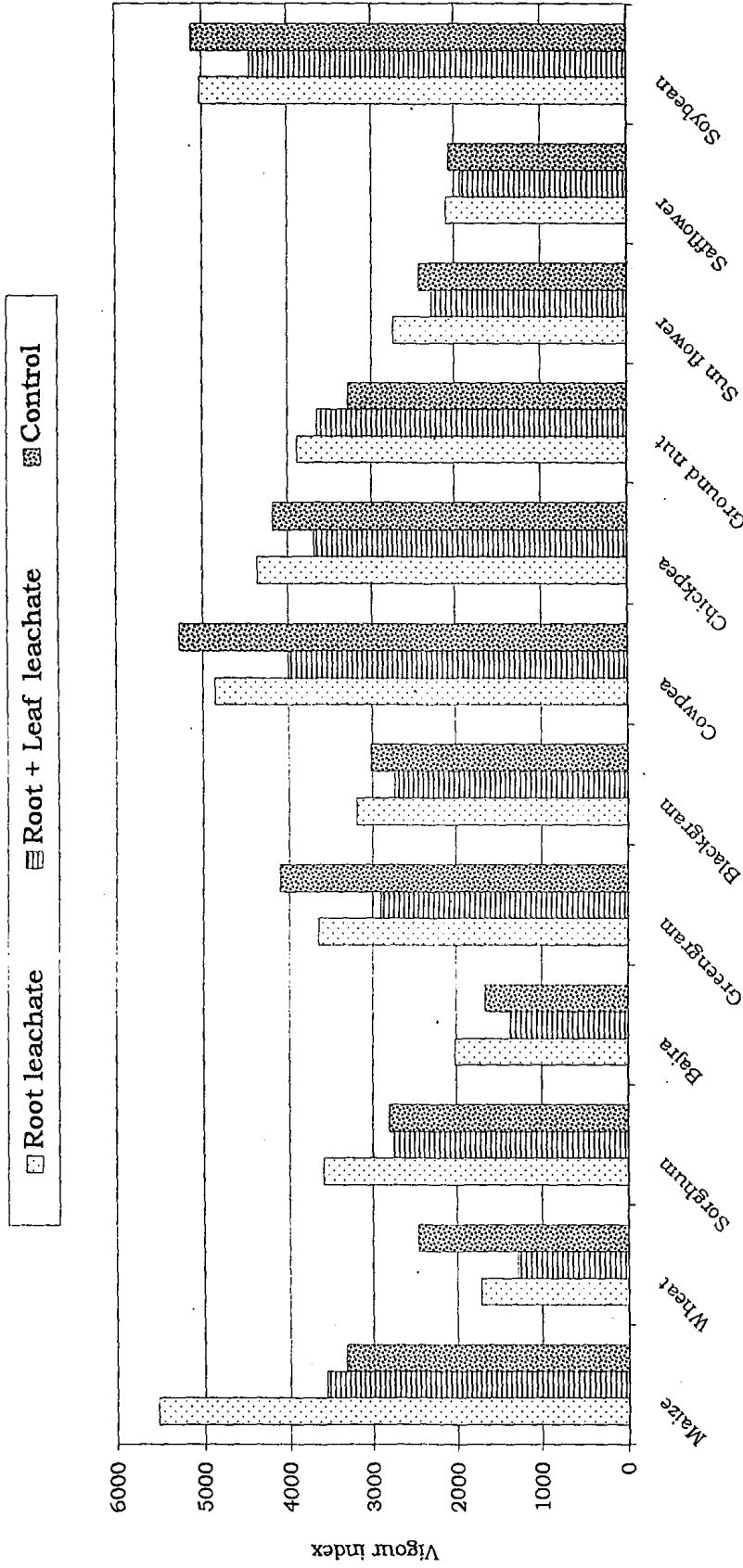


Fig. 49 : Vigour index of different cereals, pulses and oilseeds as affected by eucalyptus, teak and casuarina tree leachates at 30 DAS

Table 76 : Allelopathic effect of tree seedlings on vigour index of safflower and soybean

Treatment Tree	Safflower						Soybean					
	15 DAS			30 DAS			15 DAS			30 DAS		
	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean	T ₁	T ₂	Mean
Eucalyptus	1172 (-1)	930 (-21)	1051 (-11)	1985 (-4)	1801 (-13)	1893 (-8)	2188 (-17)	1867 (-29)	2027 (-23)	4523 (-12)	4261 (-17)	4392 (-14)
Teak	1228 (+4)	1090 (-8)	1159 (-2)	1985 (-4)	1857 (-10)	1921 (-7)	2231 (-15)	1853 (-29)	2042 (-22)	5050 (-1)	4267 (-17)	4658 (-9)
Casuarina	1323 (+12)	1182 (100)	1252 (+6)	2310 (+12)	2150 (+4)	2230 (+8)	2373 (-10)	1835 (-30)	2104 (-20)	5496 (+7)	4787 (-7)	5142 (100)
Mean	1241 (+5)	1068 (-9)	1154 (-2)	2093 (+1)	1936 (-6)	2015 (-2)	2264 (-14)	1852 (-30)	2058 (-22)	5023 (-2)	4439 (-13)	4731 (-8)
Control			1180 (100)			2065 (100)			2630 (100)			5125 (100)
	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)	SEm±	C.D.(5%)
Tree	10.69	32.94	15.17	46.74	22.36	68.91	14.73	45.41	14.73	45.41	14.73	45.41
Treatment	8.73	26.89	12.38	38.17	18.26	56.27	12.03	37.08	12.03	37.08	12.03	37.08
Interaction	15.11	46.58	21.45	65.85	31.62	97.46	20.84	64.22	20.84	64.22	20.84	64.22
	SEd±		SEd±		SEd±		SEd±		SEd±		SEd±	
Control V/S Rest	14.90	NS	21.15	46.10	31.17	67.96	20.54	44.78	20.54	44.78	20.54	44.78

T₁ - Root Leachate ; T₂ - Root + Leaf Leachate ; * - Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect)

DISCUSSION

V. DISCUSSION

Field experiments were conducted during *kharif* season (rainy season) of 1998-1999 and 1999-2000 to study the allelopathic effect of teak and casuarina on greengram crop (Plate-2 and 6). Pot experiments (Plate-10) were also conducted after completion of field experiments to know the allelopathic effect of root and leaf leachates of teak, casuarina and eucalyptus on different cereals, pulses and oilseed crops.

The basic idea in conducting the study was to evaluate the allelopathic effect of both the tree species on greengram. While doing this it was needed to bifurcate competitions due to moisture, nutrients, light and ultimately the allelopathic effect. In order to do this, cement rings (90 cm depth and 60 cm diameter) were inserted (plate-1) in each treatment (greengram was also grown inside the rings) to prevent the tree roots competing for moisture and nutrients with greengram. The allelopathic effect of the tree leaves in the cement rings was avoided by keeping cement rings free from tree leaves. Thus it was hypothesized that avoiding these competitions the allelopathic effect may be understood. However, there was a shade factor, which is discussed in this chapter.

The rainfall during crop growth indicated that during 1998 higher rainfall was received in June (222 mm) than July (82.50 mm) whereas during 1999 higher rainfall was received during July (114 mm) than June (72 mm). Therefore, a supplementary irrigation was provided during June 1999 (30 DAS).



Plate 1 : View of the area before installation of cement ring



Plate 2 : General view of teak site

5.1 *Tectona grandis*

Looking to the overall crop growth over distances from the tree row indicated that the greengram emergence at ten days after sowing was poor till 12 m with greater reduction at 0-3 m (35.48%) to a slightly lower reduction at 9-12 m (29.03%), compared to 12-15 m distance (31%). Similarly other crop growth factors like number of leaves, plant height, drymatter accumulation in different parts, number of branches per plant and yield attributes like pod length, seeds per pod, seeds per plant, number of pods per plant and thousand seed weight followed similar trend (Plate-3 to 5). And the grain yield, stover yield and harvest index were also affected in the same fashion. Similarly the weed growth (Table 15) was adversely affected till 12 m from tree row whereas its growth was vigorous inside cement ring (ICR) even nearer the trees (0-3 m). Regarding the 50 per cent flower initiation, it was delayed by 2-4 days nearer the trees (Table 14) compared to 12-15 and 15-18 meter distances and ICR.

The grain yield reduction varied between 10.26 to 20.36 per cent from tree row to till 12 m distance. Likewise length of pod, pods per plant, seeds per pod, seeds per plant, and thousand seed weight were reduced by 18.56-40.99, 35.71-46.43, 13.47-34.50, 38.73-48.18, and 13.64-19.00 per cent respectively. At the time of harvest, total drymatter reduction was between 7.87-24.04 per cent at 3-12 m distance (Table-16 and 17). The study of Dhushan and Lakshminarayan (1995) indicated that plant stand and growth of pearl millet and clusterbean plants were poor in the vicinity of



Plate 3 : Greengram at 0-3 m from teak tree row



Plate 4 : Greengram at 9-12m from teak tree row



Plate 5 : Greengram at 15-18 m from teak tree row

Acacia nilotica and were markedly inhibited upto 7.5 m. Nadagouda (1990) also reported reduction in groundnut yield to the extent of 20.40 per cent by four years old teak trees.

When comparisons were made between the crop grown inside cement ring and outside cement ring, it was found that the crop performed better ICR than OCR. Averaging the grain yield over the ICR and OCR, it was reduced by 22.76 per cent OCR. Likewise pod length, seeds per pod, pods per plant, seeds per plant, and thousand seed weight were reduced by 42.55, 27.20, 54.53, 55.31, and 24.41 per cent (Table -16 and 17). Similarly, other crop growth characters like number of leaves, plant height, number of branches per plant and drymatter accumulation were affected.

While studying the performance of greengram within the cement rings and outside the cement rings it was found that the crop growth ICR has been almost similar at all the distances whereas the growth OCR has been reducing more nearer to the tree line compared to the farther end. Analyzing the yield (Table 17) reduction OCR compared to ICR at each distance of 0-3 , 3-6, 6-9, 9-12, 12-15 and 15-18 m it was noticed that reduction has been to the extent of 38.86, 37.56, 36.60, 20.53, 2.32 and 0.99 per cent respectively. This shows that the yield has been reduced to a distance of 9-12 m indicating the possibility of competition between tree species and crops.

The eucalyptus shelter belt study made by Oneywotu and Stighter (1995) showed that in the case of un-pruned trees, millet yields were poor



Plate 6 : General view of casuarina site



Plate 7 : Greengram at 0-3m from casuarina tree row

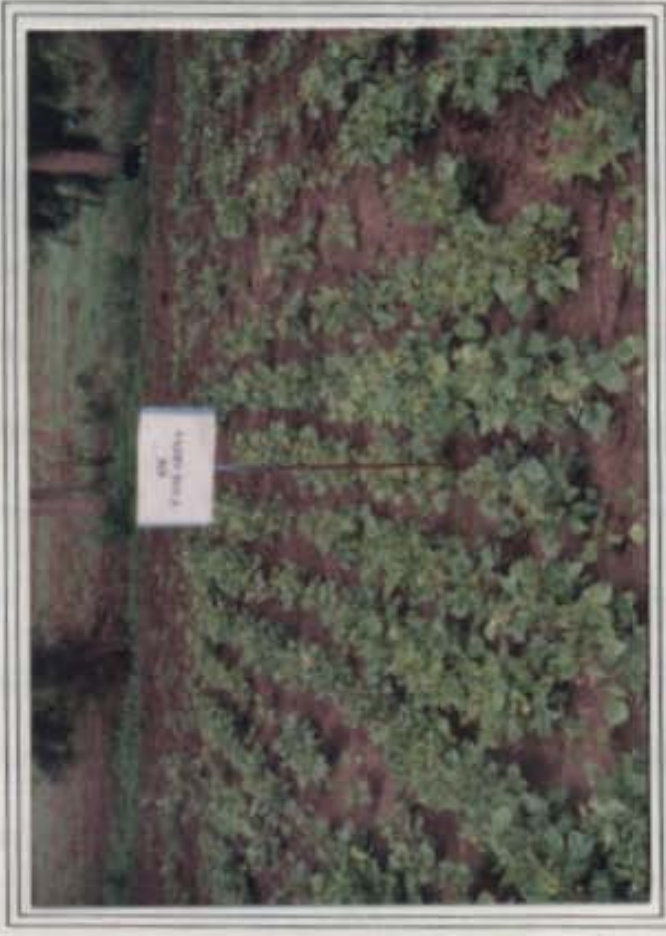


Plate 8 : Greengram at 6-9m from casuarina tree row

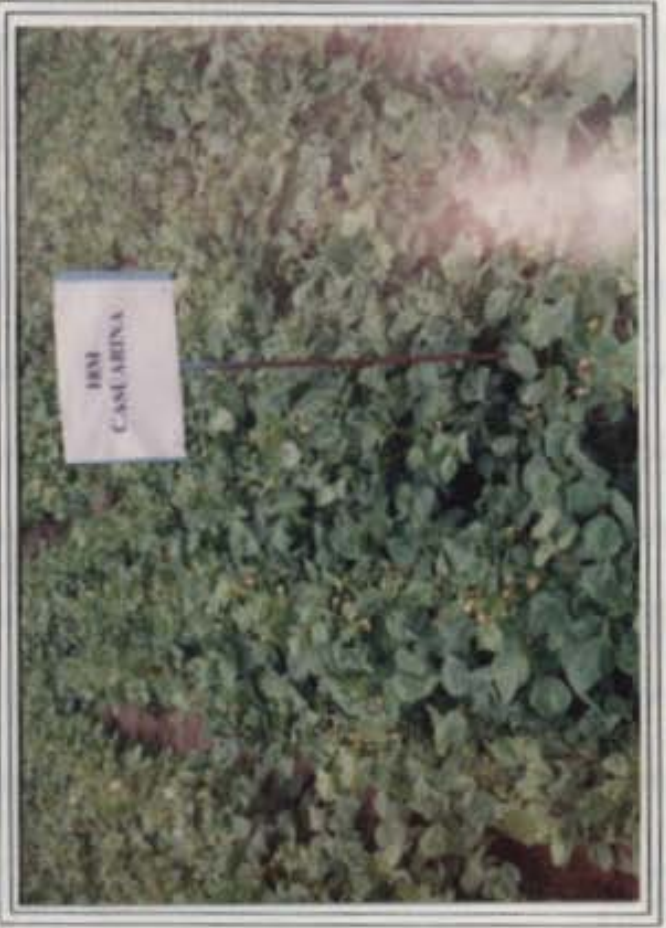


Plate 9 : Greengram at 15-18m from casuarina tree row

till 18 m whereas in the case of roots pruned treatment millet yields were much higher at 6 and 18 m distance from shelter belt. Panneerselvam *et al.* (1998) Concluded that aqueous extracts of root and fully mature leaf leachate of *Tectona grandis* reduced the shoot length, root length, leaf area and chlorophyll content of peanut and maize seedlings. The maximum content of phytotoxins was found at one meter distance from the tree line (eucalyptus) for all depths. Studies have shown presence of allelochemicals with varied concentration in different plant parts. The plant extracts of teak contained phenolic compounds like P-chlorogenic acid, coumaric acid, ferulic acid and also glycosides and their concentration was in the order of root>leaves>soil (Singh and Kohli, 1992 ; Tripathi *et al.*, 1999).

In order to see whether there was an allelopathic effect of tree species or competition for various growth resources have been analyzed in further discussion.

Soil moisture status (Table 20-22) at various growth stages of crop growth did not vary significantly over the distances from the tree line as well as between ICR and OCR. This indicated that there had been no competition for moisture between trees and greengram crop over distances. The total rainfall received was sufficient for growth. However, during second year due to lower rainfall (appendix) a supplementary irrigation was provided thus leaving no chance for moisture deficiency. The nutrient status of soils prior to sowing showed that the content was higher nearer to the tree than the farther end. Probably the higher

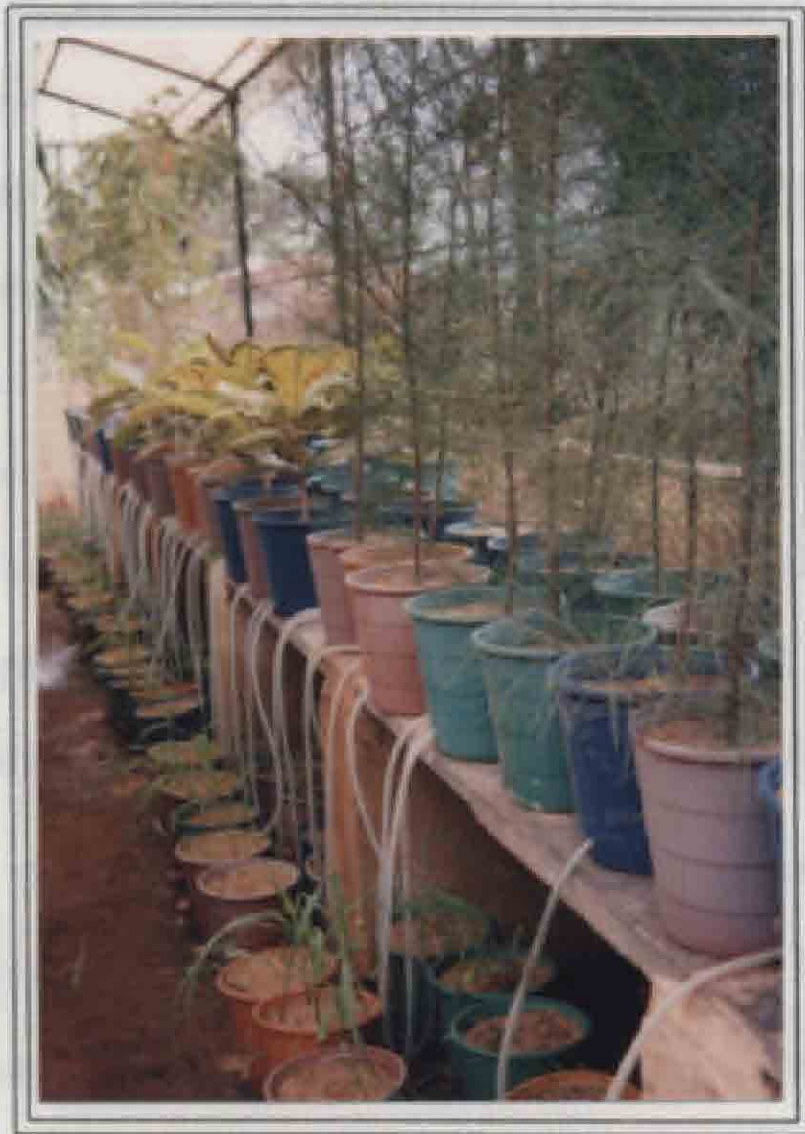


Plate 10 : General view of pot experiment

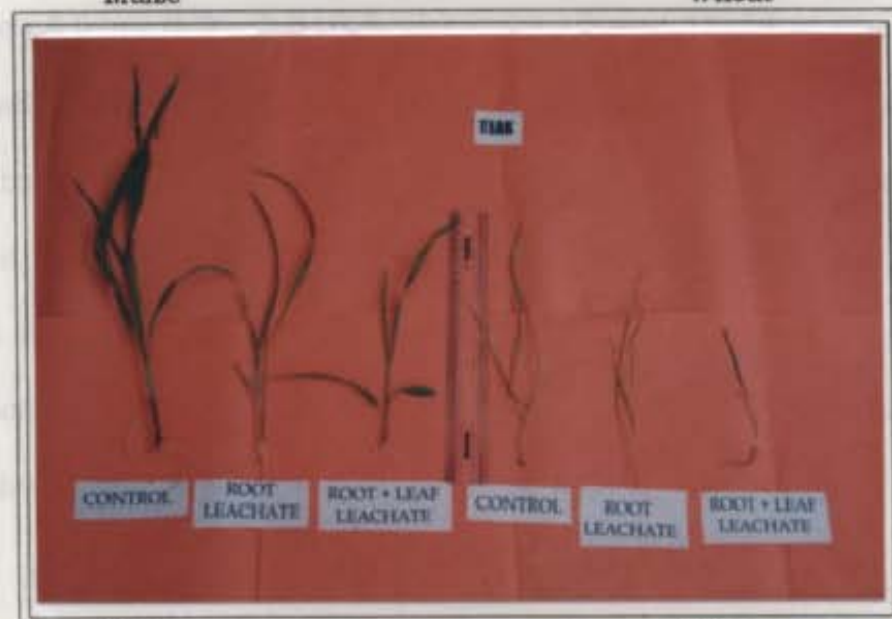
nutrient status nearer to the tree row is basically because of presence of higher amount of litter, which can be seen from Table 18 wherein leaf fall occurred till 12 m from the tree row. Although the nutrients availability was more nearer to the tree row but the uptake was lowest nearer to the tree row whereas it was higher beyond 12 m. Within the ICR nutrient uptake remained almost same at various distances thus indicating that due to partitioning there was no competition from the tree row whereas in the OCR although the nutrients were higher nearer the tree row the uptake was lower which meant that there was no competition for the nutrients but there seemed to be another factor which is inhibiting the uptake (although there was greater availability of nutrients). Baziramakenga *et al.* (1997) reported that the plant growth was decreased by suppressing nutrient absorption due to presence of benzoic acid, cinnamic acid and other phenolic acids. This may be termed as an allelopathic effect.

With regard to the competition for light, it can be seen from the Table 19 that light transmission ratio (LTR) was lower till 6 m and further onwards the LTR was better. The LTR between 3-6 meters was reduced by 6-10 per cent at 15 DAS, 3-4 per cent at 30 DAS, 7-8 per cent at 45 DAS and 3-4 per cent at harvest compared to the 15-18 m distance. This indicates that there must have been some competition for the light nearer to the trees. However, this competition remains same for both ICR and OCR



Maize

Wheat



Maize

Wheat



Maize

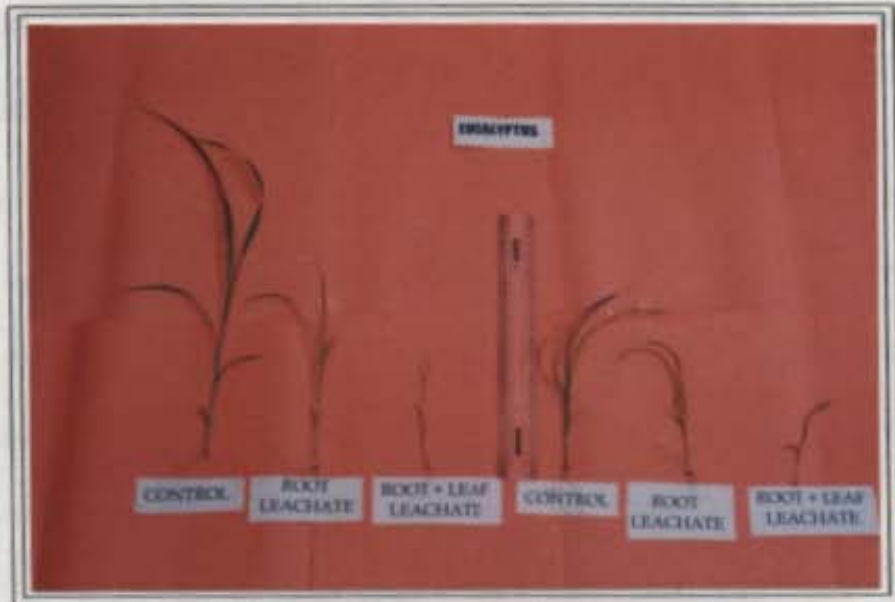
Wheat

Plate 11 : Allelopathic effect of eucalyptus, teak and casuarina root and root plus leaf leachate on maize and wheat

wherein the performance of ICR crop has not been significantly influenced. Since, this experiment was conducted during the rainy season it was presumed that due to cloudy condition existing during rainy season there might not have been significant variation in light over distances.

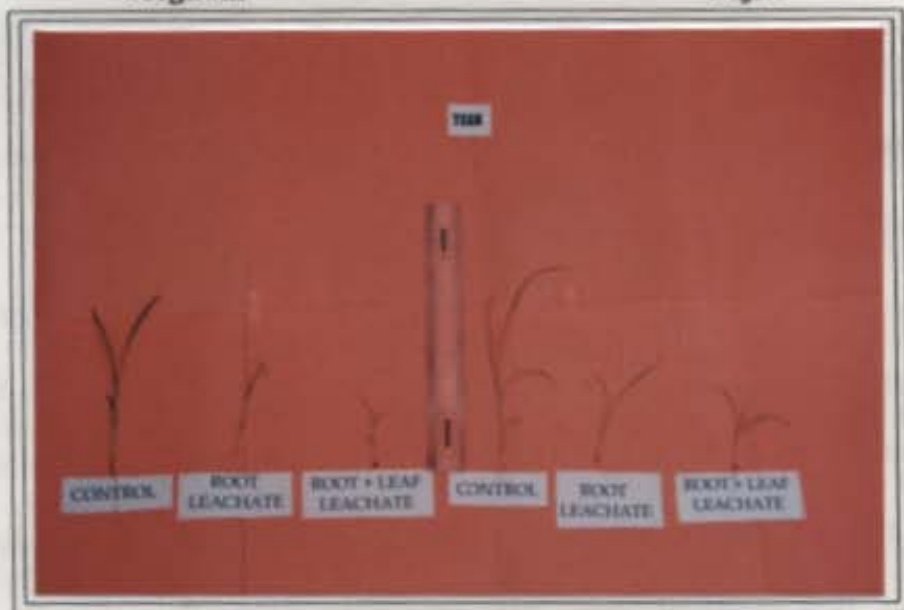
Thus it is clear from the above discussions that there has not been significant competition for moisture, light and nutrients so allelopathic interference may be one of the factors for reduction in crop growth and yield components. Yekkeli (1999) found that the greengram grown in soils collected from 0-3 , 3-6, 6-9, 9-12, 12-15 and 15-18 m eucalyptus indicated in soil nearer tree had more detrimental effect than at farther distance soils and they attributed the adverse effect to the allelopathic effect. Patil (1999) found that crops grown in soils collected from 3,6,9,12,15 and 18m away from eucalyptus, teak and casuarina had indicated more detrimental effect on soils nearer the tree than at farther distance. This adverse effect was attributed to the allelopathic effect as one of the factor.

In the present investigation also soon after the second year of field experiment a study was undertaken in pots to find out whether the allelopathic effects were more due to root or root plus leaf leachate in case of casuarina, teak and eucalyptus (Table 50-76). The results showed that the growth of various pulses, oilseeds and cereals were more affected by root plus leaf leachates (Plate-11 to 18). However, eucalyptus had more detrimental effect on greengram followed by teak and casuarina. Sivagurunathan *et al.* (1997) reported that the total phenols contained in the leachates of *Eucalyptus globulus* followed the order fresh leaves > litter >



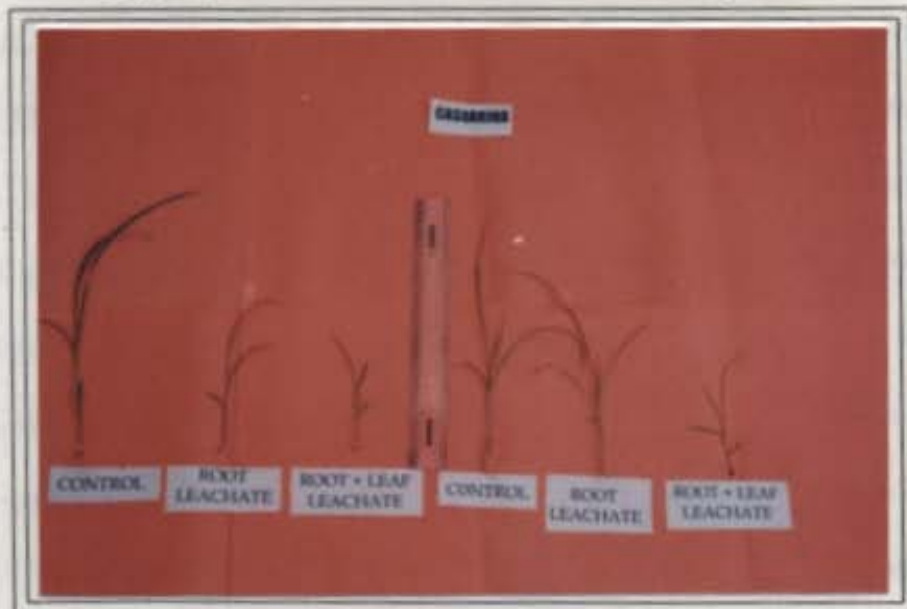
Sorghum

Bajra



Sorghum

Bajra



Sorghum

Bajra

Plate 12 : Allelopathic effect of eucalyptus, teak and casuarina root and root plus leaf leachate on sorghum and bajra

seeds. So phenolic mixture from leaves and roots together, probably caused greater inhibition than the individual phenolic compound

From the foregoing discussions it can be said that the reduction in the yield upto 12 m from the tree line could be due to allelochemicals produced by leaf of teak and possibly by roots too. The allelopathic effect may be responsible as one of the factors for reduction of crop growth and yield parameters.

5.2 *Casuarina equisetifolia*

The greengram emergence was reduced (compared to 15-18m) by 6.25 per cent at 12-15 m away from the tree line whereas at 0-3 m the reduction was as high as 40.62 per cent. The crop growth parameters like number of leaves, plant height, number of branches per plant, total drymatter accumulation, drymatter accumulation in stem at various stages of crop growth were poor till 9 m (Plate-7 to 9). The leaf drymatter (Table 31) was also similarly affected till 45 DAS but at harvest the values were higher at 3-6 m (2.67) only which could be attributed to early leaf senescence at the farther distances. Similarly, the data on 50 per cent flowering (Table 35) indicated that plants farther away flowered earlier than plants nearer the tree row, which was responsible for early senescence. Similar to that of growth of greengram the weed growth was low nearer to the trees than at further distance (Table 37). The reduction in total drymatter was between 15.45 (6-9m) to 23.29 (0-3 m) percent. The yield attributes were also affected similarly. The grain yield reduction was 8.57, 18.12 and 19.44 per cent at 6-9, 3-6 and 0-3 m from tree row. This showed that the crop performed poor under casuarina tree till

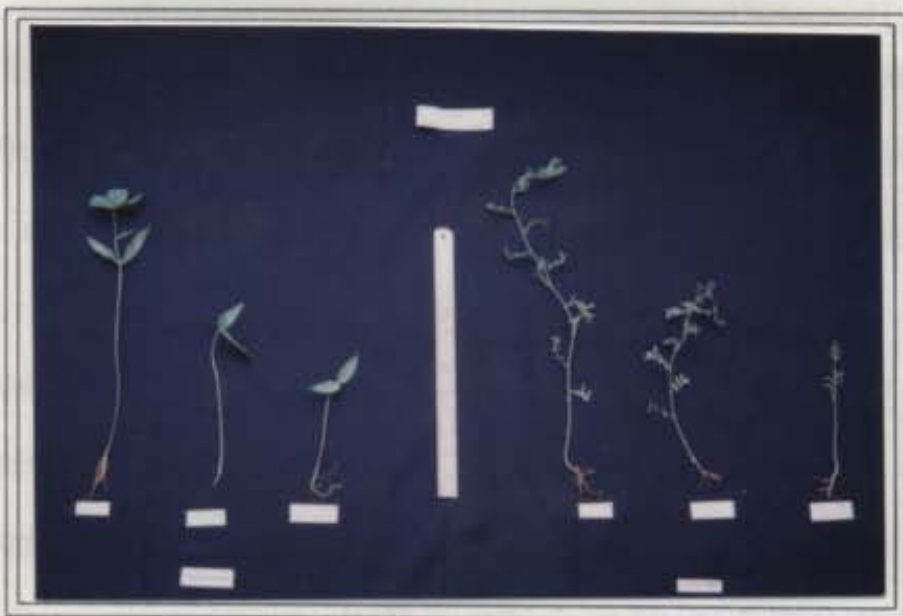


Plate 13 : Allelopathic effect of eucalyptus, teak and casuarina root and root plus leaf leachate on greengram and chickpea

9m. The findings of Swaminathan *et al.* (1998) showed decline in vegetable crop yield from 49.6 quintals per hectare to 0.8 quintals per hectare at the end of 6th year when vegetables were grown under the casuarina trees. Story (1967) reported lack of herbaceous growth under casuarina species. The 20-year-old *Eucalyptus tereticornis* tree line planted on the farm boundary reduced crop yields upto 10 m in case of greengram, upto 5 m in blackgram and only upto 2.0 m in sorghum (Srivastava and Narain, 1980).

The percent yield (table-39) reduction of greengram in casuarina was 19.44, 18.12, 8.57, 1.48 and 0.49 per cent at 0-3, 3-6, 6-9, 9-12 and 12-15 m, respectively whereas in teak the yield reduction was 20.36, 19.20, 18.54, 10.26 and 1.16, respectively at same distances. This indicated that the reduction in grain yield was up to 9 m in casuarina to an extent of 8.57-19.44 per cent whereas it was 12 m in case of teak and reduced by 10.26 - 20.36 per cent. These results can be confirmed from pot culture experiment studies, which indicated that the teak had more detrimental effect than casuarina.

While comparing the performance of crops within and outside cement rings it can be seen that the crop within the cement rings performed better since it had been isolated from the competition for moisture and nutrients from the tree. The weed growth prior to its removal at 30 DAS also showed that the growth was affected nearer to the tree than at farther distances similar to that of crop growth. It was not affected within the cement rings due to partitioning effect.



Plate 14 : Allelopathic effect of eucalyptus, teak and casuarina root and root plus leaf leachate on blackgram and cowpea

The overall reduction in pod length, pods per plant, seeds per pod, seeds per plant and thousand seed weight in OCR than ICR were 35.83, 35.69, 21.05, 42.15, 31.43 and 16.76 per cent, respectively and the yield reduced by 15.26 per cent.

Comparison of the crop growth in the ICR and OCR over distances indicated that the crop was not affected within the ICR over distances. The crop yield reduction in OCR compared to ICR at 0-3 , 3-6, 6-9 and 9-12 m was to the extent of 36.01, 34.44, 17.57 and 4.42, respectively and beyond 12 m the yields were on par with ICR. This indicated that the effect was significantly lower till 9 m. The various growth and yield parameters followed same trend as that of yield (Table 39).

The status of available moisture ICR and OCR was not affected. The soil nutrient status of soil was higher OCR than ICR (Table 48 and 49) which may be due to the rings being kept free from leaf fall otherwise would have contributed to nutrient buildup.

Supplementing to this, the greengram crop was screened for root and leaf leachates of casuarina, eucalyptus and teak. The crop was adversely affected with all the trees. With respect to leachates, root combined with leaf leachate adversely affected more than root leachate alone. The inhibition was lower in casuarina followed by teak and eucalyptus tree. Patil (1999) reported significantly lower wheat yield till 9m from casuarina tree row and Yekkeli (1999) reported significantly lower yield of greengram till 12m from



Plate 15 : Allelopathic effect of eucalyptus, teak and casuarina root and root plus leaf leachate on groundnut

eucalyptus tree row. Allelopathic effect is one of the factors for adverse effect.

Jadhav and Gaynar (1995) reported that leaf leachates of *Casuarina equisetifolia* significantly affected germination and drymatter production in rice and cowpea. Rice was more sensitive than cowpea. Singh (1993) concluded that the leaf leachates of casuarina inhibited radicle length and panicle length of sorghum, sunflower and cowpea. Batish *et al.* (1998) opined that the vegetation under 14 years old plantations of casuarina was affected compared to the vegetation at adjoining areas. The number of plant species diversity and biomass were greatly reduced under the plantations. Leachates from fresh *Casuarina equisetifolia* leaves and litter and the understorey soil were rich in phenols and exhibited phytotoxic effects against the species *Bidens pinnata* and *Parthenium hysterophorus* which was excluded from the plantations area but were present in the adjoining area. Both the germination and seedling growth of these two species significantly reduced in response to leachates of the soils, leaves and litter of *C. equisetifolia*.

In order to identify the reasons for reduction in yield, competition for various growth resources is discussed herein. Looking to the moisture status at various crop growth stages (Table 42-44) it can be seen that the moisture levels were same at various distances as well as ICR and OCR at respective growth stages. Thus indicating that there was no competition for

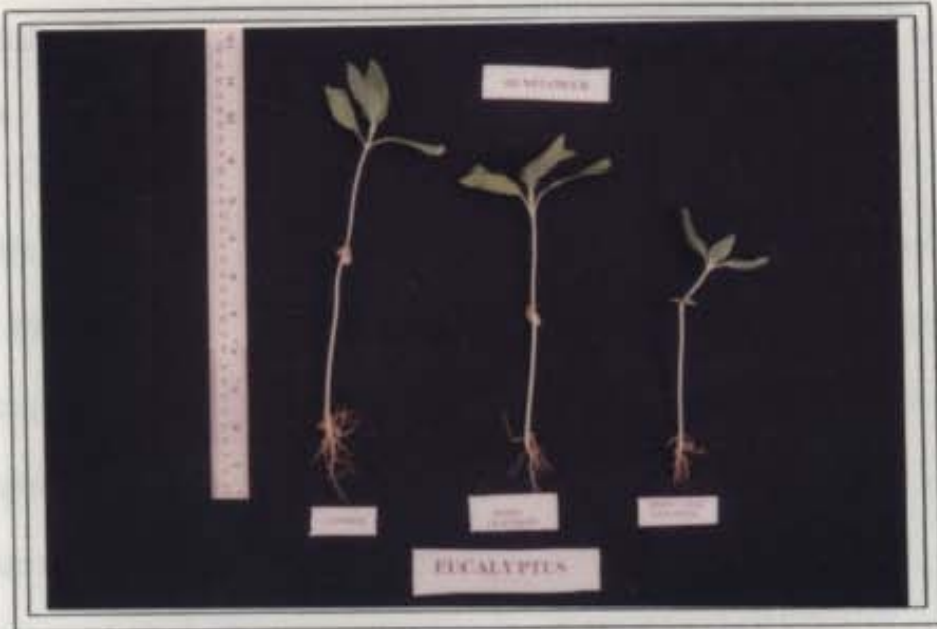


Plate 16 : Allelopathic effect of eucalyptus, teak and casuarina root and root plus leaf leachate on sunflower

moisture. The reason remains the same as explained for teak in previous pages.

Concerning the competition for light (Table 41) the LTRs have been slightly lower nearer the tree row in early crop growth period while after 30 DAS there has not been much change in the light availability at various distances. The variation in early crop growth stages could be accounted for changes in the cloud cover occurring generally in the rainy season and also changes occurring within the recording period of two hours. On the whole it can be said that the competition for light has not been quite significant to drastically influence the crop growth.

With regard to the nutrient availability (Table 48 and 49) status, both the sites recorded higher nutrient status (N, P_2O_5 , K_2O) and among two sites, casuarina site soils had higher nutrient status than that of teak site soils. It can also be due to fixing up of atmospheric nitrogen by casuarina roots. This is mainly because of the type of soil i.e. casuarina site had deep black soils whereas teak had shallow medium black soils. The nutrient status was higher nearer to the trees and by moving away from tree row the nutrient status decreased and lower nutrient status was recorded at 15-18m compared to 0-3m distance (this is directly proportional to leaf fall) in both the sites. Although the soils differed with respect to nutrient availability, the amount of uptake by greengram at both the sites remained almost same which means to say that there wasn't competition for nutrients between tree and the crop species.



Plate 17 : Allelopathic effect of eucalyptus, teak and casuarina root and root plus leaf leachate on safflower

Looking to the competition for various growth resources, it can be said that the growth was not significantly influenced by either of the growth resources, which may lead to another factor, termed as allelopathy affecting the crop growth. Thus to illustrate the effect of allelopathy pot culture studies were conducted wherein it was found that the leaf as well as root leachate had a detrimental effect on seedling growth of greengram as well as various other cereals, pulses and oilseeds. However, the effect by casuarina was lower than teak and eucalyptus.

Story (1967) reported that lack of herbaceous growth under casuarina species has been attributed to allelopathic effect. Batish *et al.* (1998) noticed the poor performance of vegetation under casuarina plantation, which was attributed to allelopathic effect. And leachates from casuarina leaves, litter and understory soils were rich in phenols and exhibited phytotoxic effects against *Bidens pinnata* and *Parthenium hysterophorus*. Suresh and Rai (1987) observed inhibition of cowpea radicle development by casuarina leaf leachates. The plumule drymatter of rice and cowpea was reduced by same magnitude by the leachates but showed differential effect on accumulation of drymatter in radicle of cowpea and rice wherein drastic reduction was noticed in rice. The differential inhibition by leaf leachates may be due to differential response of cells in presence of allelochemicals. June (1976) reported the presence of phytotoxins, phenols, terpenoids and organic cyanamides in casuarina leachates to cause allelopathic effect.

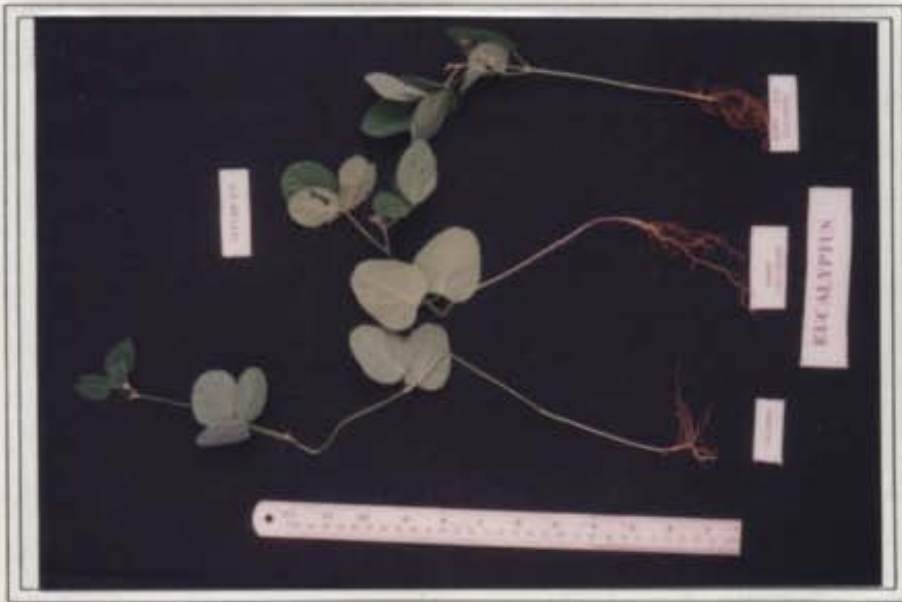


Plate 18 : Allelopathic effect of eucalyptus, teak and casuarina root and root plus leaf leachate on soybean

Although it is difficult to quantify the effects due to allelopathy, the results of above study gave an indication that the trees *viz.*, teak and casuarina adversely affected the greengram crop. This may be due to the allelopathic effect which also confirm the studies carried out elsewhere on other crops.

Practical utility of results

1. The greengram crop can be grown without reduction in yield 12 m away from teak and 9 m away from casuarina in *kharif*.

Future line of work

Since allelopathic studies in field are more tedious to be carried out on long term basis, most of the studies have been carried out in laboratory. The allelopathic effect of trees is very much influenced by soil, rainfall, temperature, irrigation, crops, sequence of crops etc. and as such it is difficult to generalize the effects. Thus the studies carried out should be site specific. Secondly, the analysis of allelochemicals and its quantification is quite difficult due to lack of instrumentation. Thus the research in allelopathy has been restricted to laboratory. Taking these factors into consideration various future lines of work are suggested.

1. To evaluate various field crops under agroforestry system and to find the most suitable combination(s).
2. To analyse the allelochemicals under each tree species in the agroforestry.
3. Lopping management in order to overcome competition for light.

SUMMARY

VI. SUMMARY

In the present study, two field experiments and a pot culture experiment were conducted.

Field experiments were conducted to study the allelopathic effect of teak and casuarina tree rows on greengram in *kharif* season for two consecutive years (1998 and 1999). These experiments were laid out in farmer's field about 12 km away from UAS, campus, Dharwad on Dharwad-Savadatti and Dharwad-Bailahongal roads. Casuarina and teak were 12 and 19 years of age respectively. The orientation of teak tree row was east-west whereas casuarina was north-south. There were twelve treatments, of them first six (factor A) were distance from teak/casuarina tree row *viz.*, 0-3 , 3-6, 6-9, 9-12, 12-15 and 15-18m. Remaining six treatments (factor B) were cement rings which were inserted at 3rd, 6th, 9th, 12th, 15th and 18th meter from tree row. In order to avoid competition between tree and crop for below ground growth resources. After completion of field experiment, the pot experiments was carried out to know the allelopathic effect of teak, eucalyptus and casuarina root and root plus leaf leachate on commonly grown cereals, pulses and oilseed crops.

Both field and pot experiments were laid out in randomized complete block design with three replications. In field experiment observations on crop growth characters and light transmission ratio were recorded at 15, 30, 45 DAS and at harvest ; soil moisture status and leaf fall pattern was recorded before sowing, 15, 30, 45 DAS and at harvest

whereas nutrient status of soil was recorded before sowing and after harvest of the crop. The observations recorded in pot experiment were emergence on 6th day after sowing whereas dry weight and shoot and root length on 15 and 30 DAS, and vigour index was calculated for 15 and 30 DAS observations. The results of field and pot experiment are summarized below.

Field Experiment

Greengram at 15-18m recorded higher emergence, number of leaves, plant height, number of branches per plant and dry matter accumulation at all the stages of crop growth in both the sites (teak and casuarina). But nearer to the trees (0-3 m) these parameters were very poor at all stages of crop growth, this situation improved with increase in distance from tree row. At 12-15 and 15-18m the crop growth was uniform. The poor performance of the crop was observed till 12m in teak and 9m in casuarina from tree row. Similarly, yield and yield parameters were affected in both the sites. The yield reduction was 10.26-20.36 per cent between 0-3 m to 9-12m distance, whereas it was 8.57-19.44 per cent in casuarina site from 0-3 m to 6-9m distance from tree row.

Looking to all the crop growth and yield parameters in both sites the greengram performance was poor outside cement ring compared to inside cement ring.

Growth and yield of greengram ICR was better than OCR over the distances whereas OCR the growth and yield was the poorest in 0-3m and got nullified after 9m in casuarina and 12m in teak

Leaf fall was maximum at 0-3m in casuarina (1115 kg/ha) whereas it was 36, 32 and 23 percent less at 3-6, 6-9 and 9-12 m respectively. In case of teak maximum leaf fall was recorded at 0-3m (368 kg/ha) and reduced by 81, 61 and 53 percent at 3-6, 6-9 and 9-12 m away from tree. Beyond 12m leaf fall was negligible in both the sites.

Crop uptake of nitrogen, phosphorus and potassium was lower till 12m in teak and 9m in casuarina. Nutrients uptake at 18m in both sites was higher. The uptake of nutrients was higher and at par inside cement rings at all distances compared to outside the cement rings. The OCR values were on par with ICR at 12-15 and 15-18m in teak and 9-12, 12-15 and 15-18m in casuarina, respectively.

The soil moisture status in two layers (0-15cm and 15-30cm) did not differ significantly due to distances as well as partitioning due to cement rings at each growth stage over the crop growth period.

The nutrient (available N, P_2O_5 and K_2O) status of soil before sowing and after harvest of crop at both the sites showed that the nutrient status of soil was higher nearer the trees(0-3 m) compared to further away(15-18m) from tree row. The higher availability of nutrient was observed till 12m from tree row.

Presence of nutrients was higher outside cement rings than inside the rings. At various distances from tree row, the nutrient status of soil

was lower inside cement rings when compared to outside cement rings till 9-12m.

The light transmission ratio was lower nearer the trees. Looking to all stages of crop growth, the light transmission ratio was lower till 6m in teak and 9m in casuarina site, respectively.

Pot Experiment

Among various cereals, pulses and oilseeds, pulses were more affected by tree leachate. Among all the crops, the performances of maize, sorghum and groundnut were not as much affected by trees leachate.

Among the three tree species, casuarina had lower adverse effect and infact had stimulatory effect on certain crops. The inhibitory effect of the trees was in the order of eucalyptus>teak>casuarina.

Comparing between root and root plus leaf leachate of teak, eucalyptus and casuarina showed that the root plus leaf leachate had more adverse effect on the crops than root leachate alone.

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APPENDICES

APPENDIX - I

Daily rainfall (mm) data for the year 1998 and 1999 from June to September months collected at Main Research Station , UAS , Dharwad

Month/ Date	Rainfall							
	1998				1999			
	June	July	August	September	June	July	August	September
1	0.00	17.80	4.20	0.00	0.00	0.00	0.50	0.00
2	0.00	6.40	0.00	0.00	0.00	0.00	0.80	0.00
3	0.00	9.80	0.00	2.00	0.00	0.00	0.80	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00
5	0.00	0.00	0.00	0.00	1.80	0.00	1.60	0.00
6	100.00	2.00	0.00	0.00	0.00	0.00	0.50	0.00
7	44.00	4.20	0.00	0.00	0.00	0.00	1.70	0.00
8	0.00	3.80	3.50	0.00	0.00	0.00	0.50	0.00
9	2.40	3.40	4.00	0.00	0.00	0.00	0.60	0.00
10	6.00	6.20	5.00	1.00	0.00	1.00	1.20	0.00
11	2.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	2.40	0.00	10.00	0.00	0.00	0.00
13	0.00	0.00	1.00	0.00	8.80	0.00	0.00	0.00
14	0.00	0.00	0.00	1.00	0.00	2.00	0.00	0.00
15	0.00	0.00	0.00	8.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	1.60	134.00	1.60	0.00
17	0.00	0.00	0.00	0.00	0.00	13.60	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00
19	23.60	0.00	0.00	0.00	7.20	2.00	0.00	0.00
20	0.00	3.00	0.00	0.00	9.40	23.00	0.00	0.00
21	1.60	0.00	0.00	0.00	1.20	10.40	0.00	0.00
22	5.30	1.80	3.20	0.00	2.00	29.00	0.00	0.00
23	0.80	0.50	16.40	0.00	1.20	6.00	0.00	0.00
24	2.30	0.00	0.80	0.00	9.80	2.00	0.00	0.00
25	2.00	0.00	0.00	6.60	11.00	0.60	0.00	0.00
26	15.00	0.00	5.00	149.00	3.40	0.00	0.00	0.00
27	2.40	0.00	2.00	31.40	2.00	0.80	0.50	0.00
28	1.00	6.60	1.20	3.00	2.40	2.60	3.50	0.00
29	1.80	14.40	1.00	2.00	0.00	0.50	5.40	0.00
30	12.20	2.00	0.70	10.40	0.00	1.00	0.00	1.20
31	-	0.60	0.00	-	-	2.00	-	7.60
Total	222.40	82.50	51.40	214.40	71.80	113.90	19.70	8.80

Appendix - II
Daily weather mark (cloud cover) of *kharif* season of 1998 and 1999 recorded at Main Research Station, UAS, Dharwad

Date	1998						1999									
	June		July		August		September		June		July		August		September	
	FN	AN	FN	AN	FN	AN	FN	AN	FN	AN	FN	AN	FN	AN	FN	AN
1	8.2	4.1	8.2	8.2	8.2	4.1	8.2	8.2	0.0	4.1	8.2	8.2	8.2	8.2	8.2	8.2
2	8.2	4.1	8.2	8.2	8.2	4.1	8.2	8.2	0.0	4.1	8.2	8.2	8.2	8.2	8.2	8.2
3	8.2	4.1	8.2	8.2	8.2	4.1	8.2	8.2	0.0	4.1	8.2	8.2	8.2	8.2	8.2	8.2
4	8.2	4.1	8.2	8.2	8.2	4.1	8.2	8.2	0.0	4.1	8.2	8.2	8.2	8.2	8.2	8.2
5	8.2	4.1	8.2	8.2	8.2	4.1	8.2	8.2	4.1	4.1	8.2	8.2	8.2	8.2	8.2	8.2
6	8.2	4.1	8.2	8.2	8.2	4.1	8.2	8.2	4.1	4.1	8.2	8.2	8.2	8.2	8.2	8.2
7	8.2	4.1	8.2	8.2	8.2	4.1	8.2	8.2	4.1	4.1	8.2	8.2	8.2	8.2	8.2	8.2
8	8.2	4.1	8.2	8.2	8.2	4.1	8.2	8.2	4.1	4.1	8.2	8.2	8.2	8.2	8.2	8.2
9	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	4.1	4.1	8.2	8.2	8.2	8.2	8.2	8.2
10	8.2	8.2	8.2	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
11	8.2	8.2	8.2	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
12	8.2	8.2	8.2	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
13	8.2	8.2	8.2	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
14	8.2	8.2	8.2	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
15	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
16	8.2	8.2	8.2	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
17	8.2	8.2	8.2	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
18	8.2	4.1	4.1	4.1	4.1	4.1	4.1	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
19	8.2	8.2	8.2	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
20	8.2	8.2	8.2	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
21	8.2	8.2	8.2	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
22	8.2	8.2	8.2	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
23	8.2	8.2	8.2	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
24	8.2	8.2	8.2	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
25	8.2	8.2	8.2	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
26	8.2	8.2	8.2	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
27	8.2	8.2	8.2	4.1	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
28	8.2	8.2	8.2	8.6	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
29	8.2	8.2	8.2	8.6	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
30	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
31	-	-	-	4.1	8.2	8.2	8.2	8.2	-	-	8.2	8.2	8.2	8.2	8.2	-

FN: Fore noon AN: After noon

**ALLELOPATHIC EFFECT OF TEAK AND CASUARINA ON THE
PERFORMANCE OF GREENGRAM (*Vigna radiata* L.)**

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2002

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Abstract

Field experiments were conducted during two crop seasons (1998-99 and 1999-2000 *kharij*) at farmers field to study the allelopathic effect of teak and casuarina on the performance of greengram. The treatments consisted of six distances *viz.*, 0-3, 3-6, 6-9, 9-12, 12-15 and 15-18 m (T₁ to T₆) at 3 m intervals from the tree row upto 18 m. In each interval, plot of 3 m x 8 m size were made. The T₇ to T₁₂ treatments consisted of cement rings (90 cm deep and 60 cm wide) inserted into the fields to a depth of 90 cm serially from T₁ to T₆ at 3rd, 6th, 9th, 12th, 15th and 18th m. Pot experiment was carried out after the field experiment to know the performance of various cereals, pulses and oilseeds to root and root + leaf leachates of casuarina, teak and eucalyptus.

Under field conditions, teak and casuarina trees reduced the greengram emergence, growth and yield parameters ultimately affecting the grain yield upto a distance of 12 m and 9 m respectively. The lowest grain yield was noticed at 3m (481 and 489 kg/ha at teak and casuarina site respectively) from tree row and the yield gradually ameliorated with increase in distance and tree effect got nullified after 12 m and 9 m in teak and casuarina respectively. The yield levels with casuarina at 9-12 and 12-15 m were on par with that of 15-18 m (607 kg/ha) and 12-15 m greengram yield was on par with that of 15-18 m (604 kg/ha) in teak. The grain yield of greengram within the cement rings which did not significant amongst themselves and were on par with the yield recorded at 15-18m distance outside cement ring.

In pot experiment, pulses were more adversely affected than cereals and oilseeds. Root + leaf leachate was detrimental than root leachate. Eucalyptus tree leachate has more adverse effect followed by teak and then casuarina on various cereals, pulses and oilseed crops.