STUDIES ON THE EFFECT OF GROWTH REGULATORS IAA, IBA AND GROWTH RETARDANT CCC ON GROWTH AND YIELD OF WINGED BEANS [*Psophocarpus tetragonolobus* (L) Dc.]

BY

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Reg. No. 93 PLS 10

A THESIS SUBMITTED TO THE AVINASHILINGAM INSTITUTE FOR HOME SCIENCE AND HIGHER EDUCATION FOR WOMEN (DEEMED UNIVERSITY) COIMBATORE - 641 043

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN LIFE SCIENCES

MAY 1995

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CERTIFIED AS BONAFIDE RESEARCH WORK

Signature of the Head of the Department	Signature of the Dean of Faculty	Signature of the Guide

Acknowledgement

ACKNOWLEDGEMENT

The author extends her sincere thanks to Padmashree, Colonel, **Dr. (Tmt). RAJAMMAL P. DEVADAS,** M.A., M.Sc., Ph.D. (Ohio State), D.Sc. (Madras), Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women (Deemed University), Coimbatore, for giving an opportunity to do this work.

The author extends her gratitude to **Dr . LAKSHMI SANTA RAJAGOPAL,** M.S. (Tennessee), Ph.D. (Madras), Vice Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women, (Deemed University) for the facilities provided to her by the institution.

She expresses her gratitude to **Dr. (Tmt.) SAROJA PRABAKARAN,** M.A., Dip in Ed. (Madras), Ph.D. (Mother Therasa), Registrar and to **Dr. (Tmt.) NIRMALA K. MURTHY,** B.Sc., (Hons), M.S., (IOWA), Ph.D. (Madras), Dean, Faculty of Science, Avinashilingam Institute for Home Science and Higher Education for Women, (Deemed University) for providing facilities to carry out the work.

The author extends her heartful and sincere thanks to **Dr. Selvi. A. VIJAYALAKSHMI,** M.Sc., M.Phil., Ph.D., Lecturer, Department of Botany, Avinashilingam Institute for Home Science and Higher Education for Women (Deemed University) for her help and timely advice throughout the investigation of the research programme.

She likes to thank **Dr. Selvi. C.V.R. INDIRA,** M.Sc., Ph.D., Head of the Department of Life Sciences for the encouragement during the course of study.

She also likes to thank Mrs. Rita Joseph and all the members of the Department of Life Science who have rendered help whenever required.

The author likes to thank **Dr. A. RANGASAMY,** M.Sc. (Ag.), Ph.D., Professor, Dept. of Agronomy and **Dr. C. CHINNUSAMY,** M.Sc. (Ag.), Ph.D., Asst. Professor (Agron), Dept. of Agronomy, Tamil Nadu Agrl. University, Coimbatore for their timely help during the course of her work.

The author wish to place on record her sincere thanks to **A. LOGAMADEVI,** Research Scholar, Avinashilingam Deemed University for her suggestions in statistical analysis.

She express her deep sense of gratitude to her parents, friends, and all other helping hands for their help and encouragement given during her course of investigation.

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FRONTISPIECE

WINGED BEAN - PSOPHOCARPUS TETRAGONOLOBUS

No politicking hog wash
No vote seeking hokus pokus
Real Nitrogen enfixing
Genus Psophocarpus
tetragonolobus

Soup and French cut
Formally served
Not only did not bloat us
But also pleased our palates
Long podded Psophocarpus
tetragonolobus.

Purple, Yellow, Brown and Green
Sometimes spotted
Sometimes clean
Grotesquely knotted
Roots unseen
Why do they call you
winged bean?

FRONTISPIECE

FRONTISPIECE

Nodulated tuber

Pole bean tall

Flowers, seed pods

Edible all

Who's the fairest

Bean of all

Soy or Psophocarpus

tetragonolobus?

Richard Buckminister

Fuller

January 1978

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Introduction

INTRODUCTION

In developing countries, cultivation of legumes is the best and quickest way of augmenting the production of food proteins. To feed the increasing population, biologists have been digging into nature's genetic stockpile for lesser known plants, which could drive away famine. The biggest interest today is in wild plants that would be brought under cultivation of cash crops. To enrich deficient diet with high quality protein a plant with promising economic value called "Winged bean" **Psophocarpus tetragonolobus (L.) DC.** has been chosen for the present investigation.

The winged bean has potential for improving human diet. The sprouts, shoots and leaves of the winged bean have the highest Vitamin A ever recorded in a tropical plant. Young pod makes a succulent green vegetable and seeds virtually duplicate soyabean in composition and nutritional value. Both are rich in proteins, oil, minerals, vitamins, and essential amino acids. The tubers have four times the protein content of potato. It is impressively nutritious and palatable diet. Due to its multiplicity of uses, it has gained the following names, **"A high protein crop for the tropics", "Poor man's soyabean", "A supermarket on a stalk", "the worlds premier protein crop", "a miracle crop", "A virtual"** and **"Winged bean - a boon to the poor".**

INTRODUCTION

In developing countries, cultivation of legumes is the best and quickest way of augmenting the production of food proteins. To feed the increasing population, biologists have been digging into nature's genetic stockpile for lesser known plants, which could drive away famine. The biggest interest today is in wild plants that would be brought under cultivation of cash crops. To enrich deficient diet with high quality protein a plant with promising economic value called "Winged bean" **Psophocarpus tetragonolobus (L.) DC.** has been chosen for the present investigation.

The winged bean has potential for improving human diet. The sprouts,shoots and leaves of the winged bean have the highest Vitamin A ever recorded in a tropical plant. Young pod makes a succulent green vegetable and seeds virtually duplicate soyabean in composition and nutritional value. Both are rich in proteins, oil, minerals, vitamins, and essential amino acids. The tubers have four times the protein content of potato. It is impressively nutritious and palatable diet. Due to its multiplicity of uses, it has gained the following names, **"A high protein crop for the tropics", "Poor man's soyabean", "A supermarket on a stalk", "the worlds premier protein crop", "a miracle crop", "A virtual"** and **"Winged bean - a boon to the poor".**

In order to improve the quality and quantity of winged bean Indole-3-acetic acid (IAA), Indole-butyric acid (IBA) and 2-chloro-ethyl-trimethyl ammonium chloride (CCC) are used in the present investigation.

Auxin is regarded as the main factor in promoting root initiation, growth of stem, root, leaf, adventitious root formation, apical dominance, flowering, sex-expression, parthenocarpy and several physiological phenomena. With adequate knowledge of the growth regulators, it is possible to control and improve the quality and quantity of the plants for they induce morphogenesis. Hence in the present study, an attempt is made to understand the impact of Indole-3- Acetic acid.

Indole-Butyric acid is one of the most widely used rooting promoters. In horticultural practice natural and synthetic auxins are widely used for stimulating rooting and the root promotion is due to higher stability of Indole - butyric acid to oxidation in the plants (Hartmann and Kester, 1983). The present work is to understand the effect of Indole-butyric acid on winged bean.

OBJECTIVES

1. In order to find out the effect of Indole-3 Acetic acid and Indole-Butyric acid on vegetative characters.

2. To assess the yield potential of winged bean under different treatments of Indole-3- acetic acid and Indole-butyric acid.

The trend in modern horticulture is towards high planting densities using dwarf plants and this can be achieved by the use of growth retardants. The formation of storage organs is associated with the suppression of vegetative growth. (Milthorpe and Moorby, 1966). Cathey (1964) defined plant growth retardants as a diverse group of chemicals which reduce stem elongation without causing malformation. Hence a trial has been conducted with the use of growth retardant, viz., cycocel (2-chloro-ethyl-trimethyl ammonium chloride) on winged beans.

OBJECTIVES

1. To reduce the vegetative growth.
2. To improve the root growth.
3. To work out the efficacy of retardant.
4. To assess the quality of the pods.
5. To assess the yield potential of winged beans under different treatments.

Review of Literature

REVIEW OF LITERATURE

INDOLE-3 ACETIC ACID

Julius Von Saches was the first to suggest the presence of hormone in plants in the later half of 19th centuary. Charles Darwin (1881) gave first experimental evidence on excised coleoptiles of _Phalaris canariensis_. Nencki and Siebar (1883) discovered that indole-3-acetic acid is a constituent of human urine. Kogl and Haagen smith confirmed this in 1931. Later kogl and Kostermans (1934) discovered in yeast and Thimann (1935) from the cultures of fungus, _Rhizopus suinus_.

Thimann (1936) observed that auxin increases the number of lateral roots in _Pisum sativum_. Bonner and Thurlow (1949) found the inhibitory effects of IAA in _Xanthium strumarium_, during inductive photoperiod. A decrease in flowering rate was noted in soyabean with high concentration of indole-3-acetic acid (Hamner and Nanda,1956).

IAA treatment at high concentration inhibited flower formation (Oota, 1965). Tizio _et al_., (1968) and Leechong _et al_., (1969) regarded auxin as main factor promoting root initiation. The natural auxin like IAA stimulates root initiation (Delvin, 1969).

An enhanced adventitious root formation on IAA treated stem cuttings of *Jasminum sambac* was reported by Pappiah and Muthuswamy (1976). In *Richardia scabra*, IAA reduced the germination percentage (Paul *et al*., 1976). Basu and Chakravarthy (1977) reported that IAA inhibited the flower formation but stimulated root growth in *Rauwolfia serpentina*. Bhattacharya *et al*., (1978) reported an increase in adventitious root formation in *Abelmoschus esculentus* with the treatment of IAA.

According to Wareing and Philips (1978) IAA is involved in internode elongation, root growth, leaf growth, initiation of vascular tissue, cambial activity, fruit set, fruit growth and apical dominance.

Ohta (1980) found a most effective promotion in root formation in the seedling of *Pinus thunbergii*. In *Brassica campestris* IAA gave good results on seed germination and seedling growth than GA3 (Sharma, 1980). According to Edwardo and West (1980) IAA and GA3 induced the elongation of seedling in *Leucaena leucocephala*. IAA promoted elongation of excised *Pinus taeda* hypocotyls (Carpita and Tarman, 1982). Abdel Aziz *et al*., (1985) noted that IAA stimulated germination, increased fresh weight, dry weight, N.P.K. concentration and uptake in Soyabean cv.Caland.

In Peas, the number of roots decreased due to illumination of stembase (0.3 w/m^2) or treatment with 10 µm IAA or 1-10 µm GA3 (Eliasson and Nordstrom, 1985). Highest rooting was noted at 6000 ppm of IAA in Cocoa (80-96.3%) by Keshavachandran and Nair (1985). In bitter gourd, 100 ppm of IAA enhanced hypocotyl elongation (Sharma and Govil, 1985).

A slight increase in pungency and a slight decrease in yield in IAA treated onion was observed by Gaward, (1986). Borisenko and Kornichuk (1986) observed best rooting in Chrysanthemum when treated with IAA. According to Diethelm (1986) IAA, IBA and GA had little effect on yields of *Vicia faba*. Hicks and Nair (1986) reported that IAA in combination with cytokinin induced growth. Hinchee and Rost (1986) IAA increased lateral root initiation in Pea seedlings. Foliar spray of kinetin and IAA increased the grain yield and yield components in rice. (Kaur and Singh, 1987).

Rahman *et al.*, (1989) observed that foliar application of 50 mg IAA/litre increased plant height, number of branches, pods per plant, flowering percentage, seed weight and seed yield in *Lathyrus sativus*. Tejbir singh and Kumar (1989) observed that with intermediate concentration of IAA, there is highest nodule number and dry weight in *Vigna* *unguiculata*. Oberholster *et al*., (1991) reported that IAA delayed the onset of pedicel abscission in terminal racemes of soyabean. The oxidative effect of IAA may stimulate cell division and early root formation in *Phaseolus vulgaris* (Vazquez and Mato, 1991). Behringer (1991) suggested that IAA application delayed red light inhibition of stem growth in pea.

Nagy *et al*., (1991) suggested that the accumulation of IAA correlated well with the increased root system of intact plants of *Phaseolus vulgaris*. Nordstrom and Eliasson (1991) reported that the steady state concentration is maintained by basipetal IAA transport from shoot apex.

Singh and Singh (1992) found that the growth regulators namely IAA, IBA, NA and GA increased the yield of vegetable crops. In wheat, Barbieri *et al*., (1992) reported that IAA had a major involvement in promoting the development of root system. Rangacharya and Bawankar (1992) discovered an increase in yield at 400 ppm with the growth regulators like, NAA, IAA, ascorbic acid and salicylic acid. Harb (1992) recorded the highest significant seed yield (43.42 - 44.58%) in faba bean with 40 ppm IAA. According to Clifford *et al*., (1992) the pod numbers in faba bean were increased when the reproductive structures were sprayed with IAA, GA or BA. Hinchee and Rost (1992) suggested that the

IAA/DPX - 1840 treatments inhibits the primary root elongation and fasciated lateral root emergence. Liu et al., (1992) suggested that IAA enhanced the elongation of growth of segments of *Vigna unguiculata* during osmotic stress. Meena and Goswami (1992) noted that in *Cajanus cajan* IAA and NAA treatments inoculated with rhizobium produced slight changes in nitrogen distribution in nodules and roots. Anshu Raghuwanshi et al., (1992) observed that addition of IAA, Kinetin or their combinations improved nodulation of pigeon pea.

According to Nordstrom and Eliasson (1993), IAA (1 µm) applied to Pea cuttings for 24 hours reduced the number of roots formed. Yang et al., (1993) suggested that IAA applied to Pea seedlings strongly promoted stem elongation. Kato et al., (1993) found that 0.1 mg/litre of EGF (human epidermal growth factor) and 2×10^{-4} M IAA, induced the number of roots in the cuttings of *Vigna angularis*.

Botia et al., (1994) examined that the elongation of etiolated hypocotyl segments of lupinus was stimulated by acid pH and IAA.

INDOLE BUTYRIC ACID:

IBA gave best rooting in cuttings of sour cherry cv Lutowka when treated with a concentration of 25, 50 mg/l. (Grzyb and Czynczyk, 1975). According to Mudge and Swanson (1978) IBA in combination with ethephon strongly promoted rooting in *Phaseolus aureus*. Singh and Motial, (1982) recorded an increase of 95% rooting in softwood cuttings of *Callistemon lanceolatus*.

Hartmann and Kester (1983) suggested that the increase in lateral root formation is due to higher stability of Indole butyric acid to oxidation in the plant. Struve *et al*., (1983) observed in *Quercus coccinea*, *Juglans nigra* and *Liriodendron tulipifera* the seedlings treated with IBA before planting increased the number of regenerated roots. According to Pain *et al*., (1983) treatment with IBA gave 100% rooting in *Dalbergia sissoo*. Negi and Tiwari, (1984), made a series of experiments using IBA, IAA & NAA at different concentration on *Pongamia pinnata* and reported that IBA speeds up rooting. Kumar *et al*., (1984) observed that rooting of *Ipomea fistulosa* was increased by treatment of IBA and adenosine monophosphate seperately or in combination but however sprouting was unaffected by combination treatments. Ellyard and Ollerenshaw (1984) reported in *Acacia flexifolia* 4000 ppm of IBA gave the best rooting.

From the work observed by Ram and Majumdar (1983) rooting (97.1%) and plant survival (94.3%) was increased when treated with a concentration of 2500 ppm of IBA in Litchi.

Bassiri et al., (1985) reported that IBA was more effective in establishing roots in chickpea. IBA markedly increased root length, number and dry weight of winged beans. (Mcardle and Bounkamp, 1985). Gatut, (1985) made a series of experiments in Coffea arabica cuttings using coffee bud extract, cow urine, IBA and Rootone F paste (NAA + NAAM + IBA) and obtained best rooting in 5% cow urine and 3000 ppm IBA solution. Sharma and Dhir, (1985) supplemented IBA in the medium where the vegetative axillary buds sprouted. It resulted a good subsequent growth in Bougainvillea.

IBA treatment improved the rooting in grapewine (Coppola and Forlani, 1985) Cashew nut (Palaniswami et al., 1985) and Coffea Canephora (Purushotham and Sulladmat, 1985). In order to improve the seedling survival by improving the seedling root system in Castanopsis kawakamii Li and Lin, (1986) used IBA in different concentration and found that 150 ppm is ideal.

Balboa et al., (1987) found that 100 ppm of IBA increased the rooting (93.7%) in Prosopsis.

Wiesman *et al.*, (1989) suggested that IBA serve as the source of auxin during the latter stages of rooting in mungbean. An increase in rooting upto 70% was obtained in *Malus pumila* due to IBA treatment (Amitrani *et al.*, 1989). Rooting success was highest in October for semihard wood and softwood cuttings of Edward Rose with the influence of IBA (Balakrishnamurthy and Rao, 1989).

Sultan *et al.*, (1990a) observed in *Lagestroemia indica* IBA at 1500 ppm increased rooting and foliage growth. Sultan *et al.*, (1990b) investigated in *Ficus elastica* and found that 1500-3000 ppm of IBA gave best rooting. Sultan *et al.*, (1990c) also done experiments in *Wisteria florebunda* using IBA and reported that 2000 ppm gave best rooting.

The maximum success in rooting is achieved by using IBA in *Casuarina equisetifolia* (Sunilpuri, 1990), Apricot (Hassan *et al.*, 1991),Pea (Cardi, 1991) and *Acacia magnum* (Ahmad, 1991). Kothari *et al.*, (1991) noted in *Glycine max* highest number of shoots formed in medium containing IBA along with benzyladenine. According to Nordstrom *et al.*, 1991) the root inducing ability of exogenous IBA was superior to that of IAA. According to Rao and Dhir, (1991) the foliar application of IBA increased the efficiency of N_2 fixation.

Muthoo *et al.*, (1992) observed that the highest percentage of rooted shoots, number, length and diameter of primary roots, number of secondary roots and tertiary roots were obtained with 10,000 ppm IBA treatment in cherry.

According to Epstein and Ackerman, (1993) incubation of *Leucodendron discolor* in IBA greatly increased the rooting percentage.

Ruichi and Zhijia, (1994) conducted experiments using 3 plant growth retardants and IBA in Mung bean. The effectiveness of the treatment were in the order, IBA followed by growth retardant, IBA + growth retardant together & IBA alone.

2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE

Cathey (1964) defined the plant growth retardants as a diverse group of chemicals which reduce stem elongation without causing malformation. The trend in modern horticulture is towards high planting densities using dwarf plants and this is achieved by the use of growth retardants. Growth retardants increases the resistance to adverse environmental conditions such as low temperature, high salt content, and pH changes of soil. The formation of storage organ is associated with the suppression of elongation of vegetative growth (Milth rope and Moorby, 1966).

Stunted growth due to CCC treatment has been reported by Humphries and Dyson (1967) in potatoes. According to Kaukovirta (1969), the B-nine, CCC and phosphon retarded the stem growth of _Phaseolus vulgaris_.

According to Muthukrishnan _et al_., (1975) CCC improved in dry matter partitioning efficiency by retarding the vegetative growth.

Bhatt (1975) reported an increase in yield of cotton cv MCU-1, MCU-5 and Laxmi with CCC at 40 ppm. Foliar application of CCC (2,500 or 5,000 ppm) decreased the plant elongation, increased the stem girth and root fresh weight but had little effect on yield (Wojtaszek _et al_., 1977). CCC increased the yield of sweet potato (Shasikala Khanna _et al_., 1980). A significant increase in the vine weight due to the application of CCC was noted by Annon (1981). According to Shadeque and Pandita (1982), the height and fresh weight of potato plants decreased with increasing concentration of CCC (100-1000 ppm). Nagy and Tabi (1982) observed a subsequent effect on the growth of seeds treated with CCC (500, 700 or 1000 mg/l). Gurbakh singh and Sharma (1982) found that 100 ppm CCC increased the number of gynophores, Pods/Plant, dry pod yield and 100 seed weight in groundnut.

In *Pelargonium zonale* CCC at higher concentrations was observed to be effective in the suppression of plant height (Systema, 1984). Application of 400 ppm CCC on *Phaseolus vulgaris* significantly decreased plant height and increased the seed yield (Rafique-Uddin, 1984). According to Islam (1984) the CCC treatment at (500 - 3000 ppm) in tomato reduced the plant height, stem diameter, internode length, number of leaves, fruit diameters and yield. Aboushoba *et al*., (1984) noted a decreased range in plant height and seed oil content of sunflower treated with CCC (1000, 2000 or 3000 ppm) in combination with boric acid solution (0.5 or 0.1%).

Reicosky and Brahnam (1985) observed that with the treatment of CCC, ethephon, mefluidide, paclobutrazol and terpal, a reduction in plant height and an increase in yield was noted. Singh and Rajput (1985) investigated an improvement in pod weight, number of seeds/pod, total protein percentage and low crude fibre percentage of the *Cyamopsis tetragonoloba* with the treatment of CCC.

A reduction in plant height and pod numbers of 5 varieties of *Vicia faba* was noted with the treatment of 0.8 CCC/ha in combination with 1.5 terpal and 0.5 ethephon/ha (Winstel, 1985). Harshan singh (1987) observed that CCC (300 ppm) or ethrel (200 ppm) reduced the shedding of flowers and immature pods and induced flowering and development of pods with increased seed yield of soyabean. Tovar *et al.*, (1987) observed that the medium supplemented with 500 ppm CCC, 5 ppm BA and 8% sucrose induced potato tubers.

In an experiment conducted on *Zea mays* by Kotting *et al.*, (1988), the grain dry matter yield/pot was reduced with the treatment of CCC. According to Lee (1988) CCC (75 or 100 ppm) effectively reduced the plant height upto about 8 weeks after planting in winged bean. CCC at 500 ppm in combination with alar (500 ppm) reduced the plant height and 250 ppm CCC increases the fruit yield in *Lycopersicon esculentum* (Arora *et al.*, 1989). Jasminum gradiflorum showed highest flower yield with CCC at 1000 ppm (Bhattacharjee, 1989). Papenhagen (1989) observed that *Pentas lanceolata* when sprayed with CCC (0.2, 0.3, or 0.4%) decreased the plant height when compared with other growth retardants. Shikamany and Reddy (1989) found that the highest yield of grapes was obtained with the treatment of CCC (3000 ppm). CCC retarded the shoot elongation, increased the leaf thickness and number of flower buds in holly-hock plants (20-30%) (Tezuka *et al.*, 1989).

A reduction in plant height of sunflower was noted with CCC application (Kumari et al., 1990). According to the experiments conducted by Ramaswamy (1991), the treatment of CCC at 500 ppm enhanced the yield and quality of tubers. Ma and Smith (1991) found that CCC retarded the main stem apex development and reduced the number of aborted spikelet primordia in barley. The CCC treatments (100 and 250 ppm) reduced the abscission percentage of buds, flowers and immature pods in vicia faba (Rabie et al., 1991). In Vigna radiata, treatment of CCC (1000 ppm) reduced the shoot length, increased shoot dry weight, leaf area, leaf thickness, number of pods/plant, seeds/pod and seed yield (Shah and Prathapasenan,1991). According to Sant Prasad and shukla (1991) the Brassica juncea when sprayed with CCC increased seed yield and seed protein content. CCC in combination with nitrogen increased leaf area, leaf area ratio and leaf area duration.

Linseed sprayed with CCC or with mepiquat and ethephon showed a decrease in plant height (Freer, 1992). Lotus uliginosus showed a highest seed yield with 2.50 kg CCC (Tabora and Hampton, 1992). Wasnik and Bagga (1992) observed that Vigna radiata sprayed with CCC (500 ppm) increased seed yield.

Naylor and Stephen (1993) suggested that mean grain weight of Triticale declined as yield increased, with nitrogen or CCC. Shah and Prathapasenan (1993) opined that 1000 and 1500 ppm of CCC treatment in Vigna radiata reduced the shoot growth, however 1000 ppm increased the number and dry weight of root nodules. According to Borner and Meinel (1993), CCC treatment reduced straw height and increased the yield in wheat.

Methodology

METHODOLOGY

Seeds of winged beans Psophocarpus tetragonolobus (L) DC. purchased from the seed centre, Agriculture University, Coimbatore were used for the investigations. Seeds of winged beans were sown in the experimental plots of Avinashilingam Deemed University.

Two sets of experiments were conducted.

EXPERIMENT I

For studying the various morphometric characters (Root length, Shoot length, Petiole length, Internodal length, Number of leaves, Number of nodules and volume of nodules) during the mid-vegetative period of growth, the seeds were sown in pots and the characters were statistically analysed.

EXPERIMENT II

The seeds were sown in statistically designed randomized compact blocks in the research field in Avinashilingam Deemed University and the investigations on pods and seeds such as pod length, circumference, weight, number of seeds/pod and weight of seeds/pod were carried out and statistically analysed.

EXPERIMENT I

EFFECT OF INDOLE-3 ACETIC ACID, INDOLE BUTYRIC ACID AND 2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE ON MID VEGETATIVE CHARACTERS

INDOLE-3 ACETIC ACID

To study the effect of indole-3 acetic acid on vegetative characters, different concentrations of indole-3 acetic acid were used such as 100 ppm, 150 ppm, 200 ppm and 250 ppm. Three foliar sprays were given at an interval of 7 days. A control was also maintained. On the 60th day the plants were uprooted from the pots and the following characters were studied.

1. Root length
2. Shoot length
3. Petiole length
4. Internodal length
5. Number of leaves
6. Number of nodules
7. Volume of nodules

INDOLE-BUTRIC ACID

To study the effect of Indole-butric acid on vegetative characters, indole-butric acid was used in different concentrations such as 100 ppm, 150ppm, 200 ppm and 250 ppm. Three foliar sprays were given at an interval of 7 days. A control was also maintained. The plants were uprooted from the pots on the 60th day and the following characters were studied.

1. Root length
2. Shoot length
3. Petiole length
4. Internodal length
5. Number of leaves
6. Number of nodules
7. Volume of nodules.

2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE

The plants were sprayed with the growth retardant, 2-chloro-ethyltrimethyl ammonium chloride at different concentrations (250 ppm, 500 ppm, 750 ppm and 1000 ppm) along with a control. Three sprays were given. On the 60th day, the following characters from the uprooted plants were observed.

1. Root length
2. Shoot length
3. Petiole length
4. Internodal length
5. Number of leaves
6. Number of nodules
7. Volume of nodules.

EXPERIMENT II

EFFECT OF INDOLE-3 ACETIC ACID, INDOLE BUTRIC ACID AND 2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE ON POD AND SEED CHARACTERS

INDOLE-3 ACETIC ACID

The pods were collected from each concentration (100 ppm, 150 ppm, 200 ppm and 250 ppm) after maturation. Twenty pods were collected at random and the following economically important traits were studied.

1. Pod length
2. Pod circumference
3. Pod weight
4. Number of seeds/pod
5. Weight of seeds/pod

INDOLE-BUTRIC ACID

The seeds were sown in the field and 20 pods were collected at random from each concentrations (100 ppm, 150 ppm, 200 ppm and 250 ppm). The characters studied were:

1. Pod length
2. Pod circumference
3. Pod weight
4. Number of seeds/pod
5. Weight of seeds/pod

2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE

Twenty pods were collected at random from each concentrations (250 ppm, 500 ppm, 750 ppm and 1000 ppm) and the following characters were noted

1. Pod length
2. Pod circumference
3. Pod weight
4. Number of seeds/pod
5. Weight of seeds/pod

Results and Discussion

RESULTS

EXPERIMENT - I

On the 60th day after sowing, the biometrical parameters like root length, shoot length, internodal length, petiole length, number of leaves, number of nodules and the volume of the nodules as influenced by the application of Indole-3 acetic acid, Indole-butyric acid, 2-chloro-ethyl-trimethyl ammonium chloride, was observed and presented below{Plate-1]

EFFECT OF INDOLE-3 ACETIC ACID ON VEGETATIVE CHARACTERS{Plate-2 Fig-1]

ROOT LENGTH AS INFLUENCED BY INDOLE-3-ACETIC ACID

Indole-3 acetic acid treatment showed appreciable increase in the results obtained for root length of winged bean at 60 days after sowing at 150 ppm (65.86 cms) when compared with the control (62.71 cms). Indole-3 acetic acid when applied at the rate of 100 ppm being on a par with control. But higher concentrations such as 200 ppm and 250 ppm showed a slight decrease when compared with the control.

SHOOT, PETIOLE AND INTERNODAL LENGTH AS INFLUENCED BY INDOLE-3-ACETIC ACID

Regarding the shoot ,petiole and internodal length, all the treatments (100, 150, 200 and 250 ppm) showed a decrease in length when compared with the control.

NUMBER OF LEAVES AS INFLUENCED BY INDOLE-3 ACETIC ACID

There was a significant influence of indole-3 acetic acid treatment on the number of leaves at 100ppm (50.57) 150ppm (46.57) and 200ppm (45.43) compared with the control (44.43).

NUMBER AND VOLUME OF NODULES AS INFLUENCED BY INDOLE-3 ACETIC ACID

Regarding the number of nodules, indole-3 acetic acid treatment showed a negative result. However the volume increased in 100ppm (0.34) and 150ppm (0.3) treatment when compared with the control (0.2).

EFFECT OF INDOLE BUTYRIC ACID ON VEGETATIVE CHARACTERS OF WINGED BEAN [Plate - 3 Fig - 2]

ROOT LENGTH AS INFLUENCED BY INDOLE BUTRIC ACID

An increase in the root length of winged bean was observed when treated with Indole butyric acid. All the treatments (100, 150, 200 and 250 ppm) significantly increased when compared to the control (64.5 cm) and the highest being at 250 ppm (72.3cm).

SHOOT LENGTH AS INFLUENCED BY INDOLE-BUTYRIC ACID

Indole - butyric acid treatment, regarding the shoot length revealed a decrease in length with all the treatments (100, 150, 200 and 250 ppm) when compared with the control.

PETIOLE LENGTH AS INFUENCED BY INDOLE-BUTYRIC ACID

There was a significant increase of Indole butyric acid treatment on the petiole length at 100 ppm (10.26 cm), 150 ppm (10 cm) and 200 ppm (9.83 cm), when compared with the control (9.57 cm).

INTERNODAL LENGTH AS INFLUENCED BYINDOLE-BUTYRIC ACID

The length of the internode increased significantly at 100 ppm (2.26 cm) when compared with the control (2.07 cm). But the higher concentrations such as 150 ppm, 200 ppm and 250 ppm showed a slight decrease when compared to the control.

NUMBER OF LEAVES AND NODULES AS INFLUENCED BY INDOLE - BUTYRIC ACID

Regarding the number of leaves and number of nodules, the indole - butyric acid treatment revealed a significant increase with all the concentrations (100, 150, 200 and 250 ppm) when compared with the control.

VOLUME OF THE NODULES AS INFLUENCED BY INDOLE BUTYRIC ACID

The volume increased slightly at 200 ppm (0.21) and 250 ppm (0.23) when compared with control (0.2).

EFFECT OF 2-CHLORO-ETHYL-TRIMETHYL-AMMONIUM CHLORIDE [Plate-4 Fig-3]

ROOT LENGTH AS INFLUENCED BY 2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE

2-chloro-ethyl-trimethyl - ammonium chloride showed an appreciable increase in the results obtained for the root length of winged bean. All the treatments (250,500,750 and 1000 ppm) significantly increased the root length and the highest length was at 1000 ppm (85.43 cm) when compared to the control (55.57 cm).

SHOOT LENGTH AS INFLUENCED BY 2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE

There was a significant increase of shoot length influenced by 2-chloro-ethyl-trimethyl ammonium chloride. All the treatments (250, 500, 750 and 1000 ppm) showed an increase in the length when compared to the control.

PETIOLE AND INTERNODAL LENGTH AS INFLUENCED BY 2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE

Regarding the petiole and internodal length, all the treatments (250, 500, 750 and 1000 ppm) showed a decrease in the length when compared with the control.

NUMBER OF LEAVES AS INFLUENCED BY 2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE

2-chloro-ethyl-trimethyl ammonium chloride, treatment decreased the number of all leaves in all the treatments given except in 1000 ppm where a slight increase is noted.

NUMBER AND VOLUME OF NODULES AS INFLUENCED BY 2-CHLORO-ETHYL-TRIMETHYL-AMMONIUM CHLORIDE

2-Chloro ethyl-trimethyl ammonium chloride treatment increased significantly the number and volume of the nodules in all the treatments (250, 500, 750 and 1000 ppm) when compared with the control.

EXPERIMENT - II

The effect of Indole-acetic acid, Indole-butyric acid and 2-chloro-ethyl-trimethyl ammonium chloride on characters such as pod length, circumference, weight, number of seeds/pod and weight of the seeds/pod were studied.

EFFECT OF INDOLE-3 ACETIC ACID ON POD AND SEED CHARACTERS [Fig-4]

POD LENGTH AS INFLUENCED BY INDOLE-3 ACETIC ACID

A significant increase in the length of the pod was noted in all the treatments, 100 ppm (20.24 cms), 150 ppm (20.33 cms), 200 ppm (21.73 cms) and 250 ppm (22.64 cms) when compared with the control (18.09 cms).

CIRCUMFERENCE OF THE POD AS INFLUENCED BY INDOLE-3 ACETIC ACID

The circumference of the pod increased significantly at 100 ppm (9.56 cms), 150 ppm (10.21 cms), 200 ppm (10.33 cms) and 250 ppm (12.06 cms) when compared with the control (8.97 cms).

POD WEIGHT AS INFLUENCED BY INDOLE-3 ACETIC ACID

All the treatments given increased the weight of the pod (100 ppm - 28 gms, 150 ppm - 29.8 gms, 200 ppm - 31.49 gms, 250 ppm - 35.54 gms) when compared with the control (27.53 gms).

NUMBER OF SEEDS/POD INFLUENCED BY INDOLE-3 ACETIC ACID

The number of seeds/pod increased significantly in all the concentrations of indole-3 acetic acid used when compared with the control.

WEIGHT OF SEEDS/POD AS INFLUENCED BY INDOLE-3 ACETIC ACID

The seeds/pod weight increased signficantly at 100 ppm (5.8 gms), 150 ppm (6.42 gms), 200 ppm (6.49 gms) and 250 ppm (8.35 gms) when compared with the control (5.63 gms).

EFFECT OF INDOLE-BUTYRIC ACID ON POD AND SEED CHARACTERS [Fig-5]

POD LENGTH AND CIRCUMFERENCE AS INFLUENCED BY INDOLE-BUTYRIC ACID

Regarding the pod length and circumference a significant increase is noted in all treatments given. The pod length increased at 100 ppm (18.44 cms), 150 ppm (18.7 cms), 200 ppm (18.85 cms) and 250 ppm (19.67 cms) When compared with the control (17.25 cms). The pod circumference increased at 100 ppm (9.82 cms), 150 ppm (10.05 cms), 200 ppm (10.78 cms) 250 ppm (11.37 cms) when compared with the control (9.25 cms).

POD WEIGHT AS INFLUENCED BY INDOLE-BUTYRIC ACID

The weight of the pod increased significantly at 100 ppm (31.09 gms), 150 ppm (31.37 gms), 200 ppm (34.29 gms), 250 ppm (34.79 gms) when compared with the control (26.65 gms).

NUMBER AND WEIGHT OF THE SEEDS/POD AS INFLUENCED BY INDOLE BUTYRIC ACID

The number of seeds/pod increased significantly at 100 ppm (9.1), 150 ppm (10.67), 200 ppm (10.68), 250 ppm (12.6) when compared with the control (8.99). Seeds weight/pod also increased significantly in all the concentrations used the highest being at 250 ppm (7.46 gms) when compared with the control (5.08 gms).

EFFECT OF 2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE ON POD AND SEED CHARACTERS OF WINGED BEAN [Fig-6]

POD LENGTH AND CIRCUMFERENCE AS INFLUENCED BY 2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE:

Pod length increased significantly at all the concentrations used and the highest at 1000 ppm (20.59 cms) when compared with the control (18.22 cms). Pod circumference increased at 250 ppm (8.8 cms), 500 ppm (8.85 cms), 750 ppm (9.12 cms) and 1000 ppm (9.5 cms) when compared with the control (8.02 cms).

WEIGHT OF THE POD AS INFLUENCED BY 2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE

The weight of the pod increased significantly at 250 ppm (22.4 gms), 500 ppm (25.75 gms), 750 ppm (28.15 gms) and 1000 ppm (34.65 gms) respectively when compared with the control (18.7 gms).

NUMBER OF SEEDS/POD AS INFLUENCED BY 2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE

The seeds number/pod increased at 250 ppm (10.83), 500 ppm (12.04), 750 ppm (12.62) and 1000 ppm (12.62) when compared with the control (10.25) respectively.

WEIGHT OF SEEDS/POD AS INFLUENCED BY 2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE

The seeds weight/pod increased at all the concentrations of 2-chloro-ethyl-trimethyl ammonium chloride used and the most significant result was obtained at 1000 ppm (7.49 gms) when compared with the control (4.94 gms).

INFLUENCE OF 2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE ON TUBER PRODUCTION

2-chloro-ethyl-trimethyl ammonium chloride treatments also increased the size and weight of the tubers increased at 250 ppm (78.60 gms), 500 ppm (85.43 gms), 750 ppm (89.48 gms) and 1000 ppm (93.35 gms) when compared with the control (60.63 gms) respectively.[Plate - 5].

PLATE 1

EFFECT OF IAA, IBA AND CCC ON WINGED BEAN

PLATE 2

EFFECT OF IAA ON VEGETATIVE CHARACTERS.

EFFECT OF IAA ON VEGETATIVE CHARACTERS.

PLATE 3

EFFECT OF IBA ON VEGETATIVE CHARACTERS.

EFFECT OF IBA ON VEGETATIVE CHARACTERS.

PLATE 4

EFFECT OF CCC ON VEGETATIVE CHARACTERS.

EFFECT OF CCC ON VEGETATIVE CHARACTERS.

PLATE 5

EFFECT OF CCC ON TUBER.

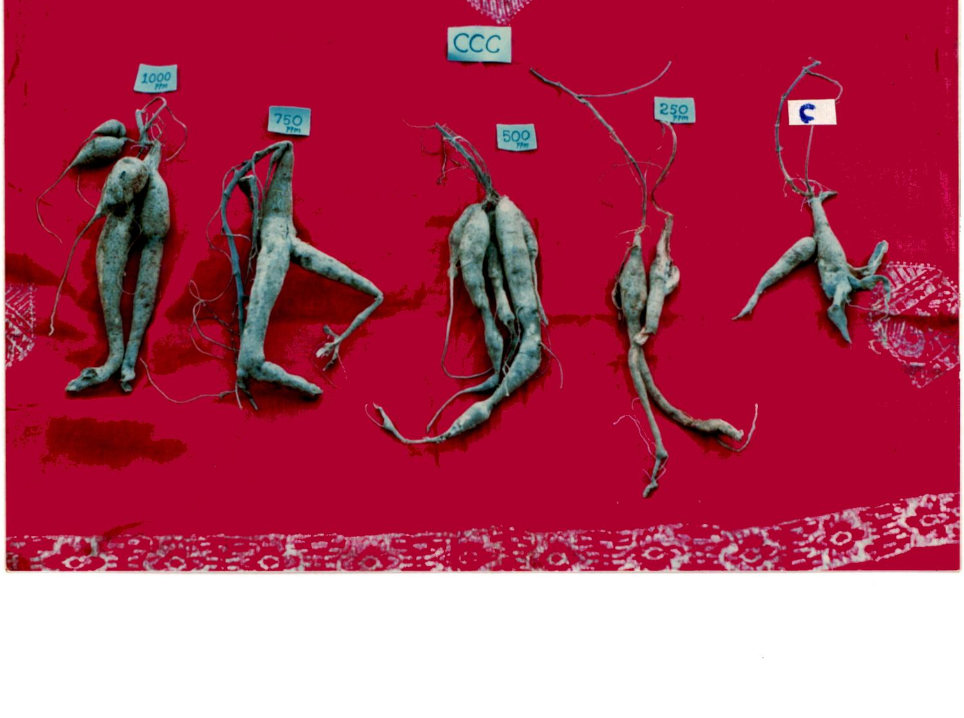


TABLE - I

INFLUENCE OF INDOLE-3-ACETIC ACID ON VEGETATIVE CHARACTERS OF WINGED BEAN

PLANT CHARAC-TERS	ROOT LENGTH (cm)	SHOOT LENGTH (cm)	PETIOE LENGTH (cm)	INTER NODAL LENGTH (cm)	No.OF LEAVES	No. OF NODULES	VOL. OF NODULES (ml)
CONTROL	62.71	89.71	9.16	3.03	44.43	24.14	0.2
100 (ppm)	62.29	88.29	9.14	1.93	50.57	23.43	0.34
150 (ppm)	65.86	83.86	8.5	1.64	46.57	22.86	0.3
200 (ppm)	59.57	83.14	8.57	1.57	45.43	22	0.13
250 (ppm)	54.57	73.0	8.79	1.86	42.71	18	0.24
S.E	6.93	9.54	0.672	0.593	23.195	1.233	0.077
C.D	10.26	14.14	0.995	0.449	7.136	1.829	0.113

TABLE - II

INFLUENCE OF INDOLE-BUTYRIC ACID ON

VEGETATIVE CHARACTERS OF WINGED BEAN

PLANT CHARACTERS	ROOT LENGTH (cm)	SHOOT LENGTH (cm)	PETIOE LENGTH (cm)	INTER NODAL LENGTH (cm)	No.OF LEAVES	No. OF NODULES	VOL. OF NODULES (ml)
CONTROL	64.5	92.43	9.57	2.07	34.36	16.63	0.2
100 (ppm)	67.57	89.5	10.26	2.26	34.57	22.0	0.18
150 (ppm)	67.71	87.67	10.0	2.0	39.03	22.21	0.17
200 (ppm)	71.17	77.17	9.83	2.0	40.57	26.43	0.21
250 (ppm)	72.30	72.86	9.33	1.67	45.67	31.0	0.23
S.E	7.99	13.18	0.325	0.329	5.08	5.34	0.045
C.D	11.84	19.53	0.845	0.487	7.528	7.915	0.066

TABLE - III

INFLUENCE OF 2-CHLORO-ETHYL TRIMETHYL AMMONIUM CHLORIDE ON VEGETATIVE CHARACTERS OF WINGED BEAN

PLANT CHARACTERS	ROOT LENGTH (cm)	SHOOT LENGTH (cm)	PETIOE LENGTH (cm)	INTER NODAL LENGTH (cm)	No.OF LEAVES	No. OF NODULES	VOL. OF NODULES (ml)
CONTROL	55.57	74.71	10.07	1.86	49.14	16.5	0.16
250 (ppm)	60.31	89.37	10.0	1.86	29.86	17.33	0.19
500 (ppm)	63.0	98.5	9.14	1.57	45.13	20.14	0.2
750 (ppm)	73.86	100.86	9.79	1.79	47.0	22.14	0.23
1000(ppm)	85.43	107.86	9.79	1.71	50.86	26.17	0.31
S.E	10.80	13.67	0.74	0.327	6.81	4.84	0.069
C.D	16.0	20.26	1.102	0.484	10.09	7.175	1.02

TABLE - IV

INFLUENCE OF INDOLE-3-ACETIC ACID ON POD AND SEED CHARACTERS OF WINGED BEAN

POD CHARACTERS	POD LENGTH (cm)	POD CIRCUMFERENCE (cm)	POD WEIGHT (gm)	No.OF SEEDS/POD	WEIGHT OF SEEDS/POD (gm)
CONTROL	18.09	8.97	27.53	10.2	5.63
100 (ppm)	20.24	9.56	28	10.75	5.8
150 (ppm)	20.33	10.21	29.8	11.7	6.42
200 (ppm)	21.73	10.33	31.49	12.9	6.49
250 (ppm)	22.64	12.06	35.54	14.35	8.35
S.E	1.71	0.985	2.96	2.24	1.269
C.D	2.53	1.46	4.38	2.50	1.88

TABLE - V

INFLUENCE OF INDOLE BUTYRIC ACID ON POD AND SEED CHARACTERS OF WINGED BEAN

POD CHARACTERS	POD LENGTH (cm)	POD CIRCUMFERENCE (cm)	POD WEIGHT (gm)	No.OF SEEDS/POD	WEIGHT OF SEEDS/POD (gm)
CONTROL	17.25	9.25	26.65	8.99	5.08
100 (ppm)	18.44	9.82	31.09	9.1	5.24
150 (ppm)	18.7	10.05	31.37	10.67	5.99
200 (ppm)	18.85	10.78	34.29	10.68	6.07
250 (ppm)	19.67	11.37	34.79	12.6	7.46
S.E	1.386	0.698	5.33	1.345	0.997
C.D	2.054	1.034	7.90	1.99	1.478

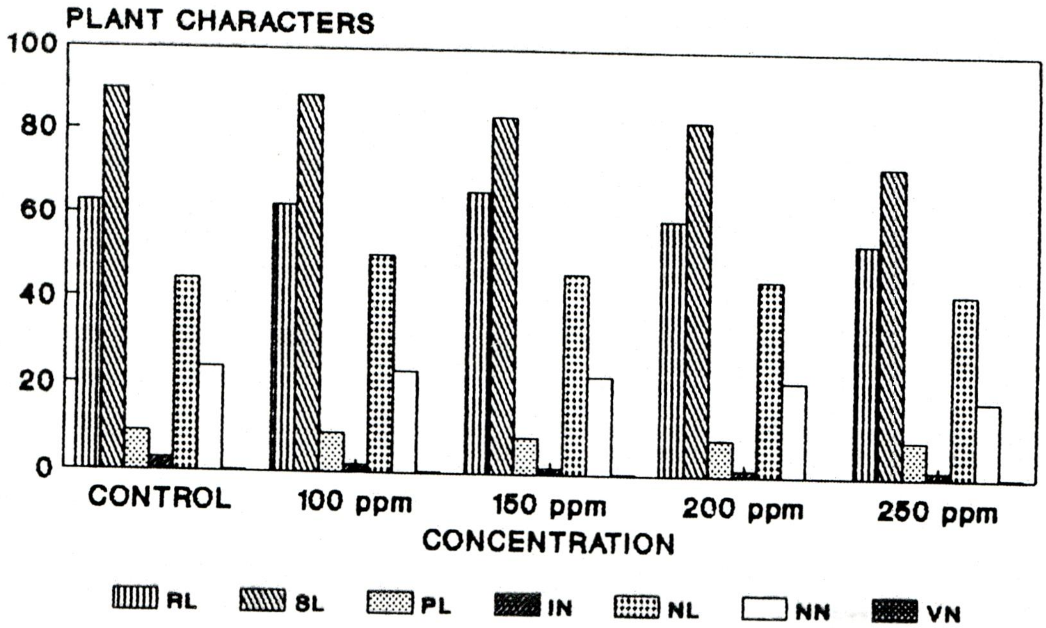
TABLE - VI

INFLUENCE OF 2-CHLORO-ETHYL TRIMETHYL AMMONIUM CHLORIDE ON POD AND SEED CHARACTERS OF WINGED BEAN

POD CHARACTERS	POD LENGTH (cm)	POD CIRCUMFERENCE (cm)	POD WEIGHT (gm)	No.OF SEEDS/POD	WEIGHT OF SEEDS/POD (gm)
CONTROL	18.22	8.02	18.7	10.25	4.94
250 (ppm)	18.93	8.80	22.4	10.83	6.2
500 (ppm)	19.25	8.85	25.75	12.04	6.24
750 (ppm)	19.72	9.12	28.15	12.62	6.98
1000(ppm)	20.59	9.50	34.65	12.62	7.49
S.E	1.177	0.857	4.801	3-391	8-996
C.D	1.744	1.269	7.194	1.758	1.31

Fig. 1

INFLUENCE OF IAA ON VEGETATIVE CHARACTERS OF WINGED BEAN



RL - ROOT LENGTH

SL - SHOOT LENGTH

PL - PETIOLE LENGTH

IN - INTERNODAL LENGTH

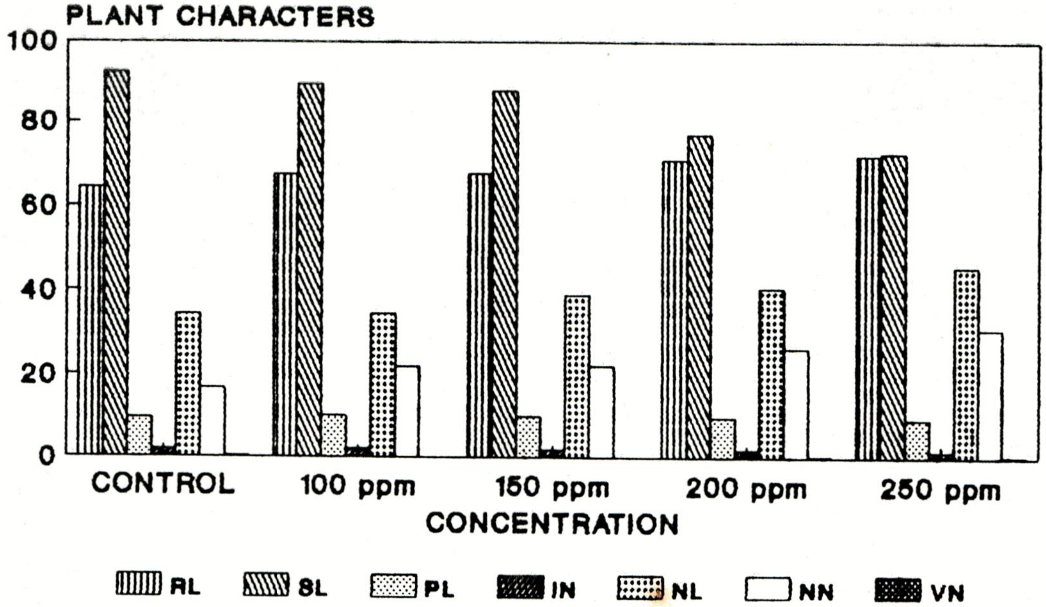
NL - NUMBER OF LEAVES

NN - NUMBER OF NODULES

VN - VOLUME OF NODULES

Fig. 2

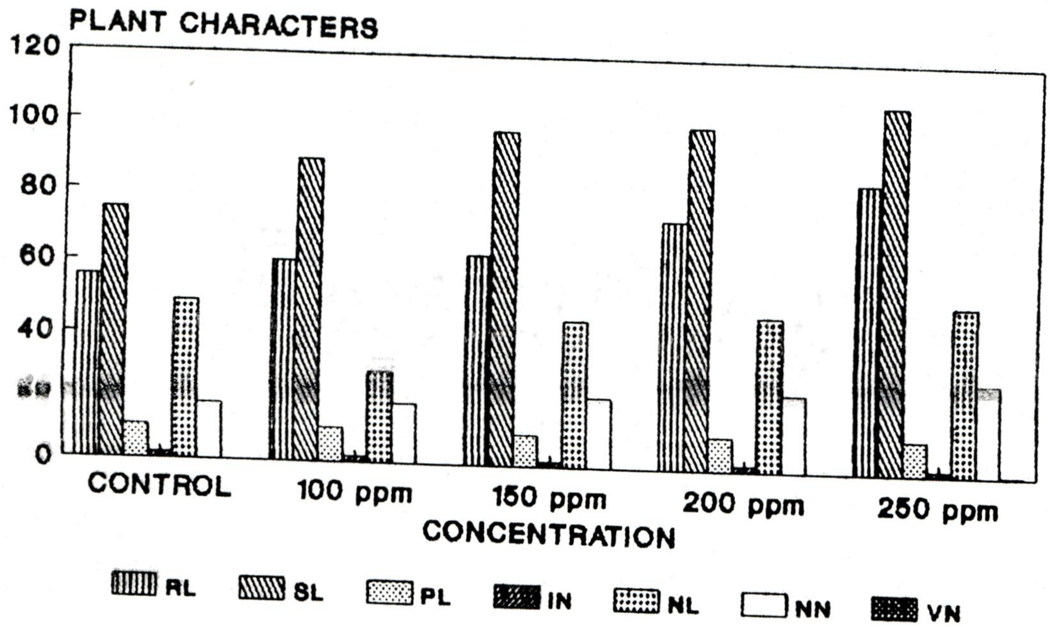
INFLUENCE OF IBA ON VEGETATIVE CHARACTERS OF WINGED BEAN



RL	–	ROOT LENGTH
SL	–	SHOOT LENGTH
PL	–	PETIOLE LENGTH
IN	–	INTERNODAL LENGTH
NL	–	NUMBER OF LEAVES
NN	–	NUMBER OF NODULES
VN	–	VOLUME OF NODULES

Fig. 3

INFLUENCE OF CCC ON VEGETATIVE CHARACTERS OF WINGED BEAN



RL - ROOT LENGTH

SL - SHOOT LENGTH

PL - PETIOLE LENGTH

IN - INTERNODAL LENGTH

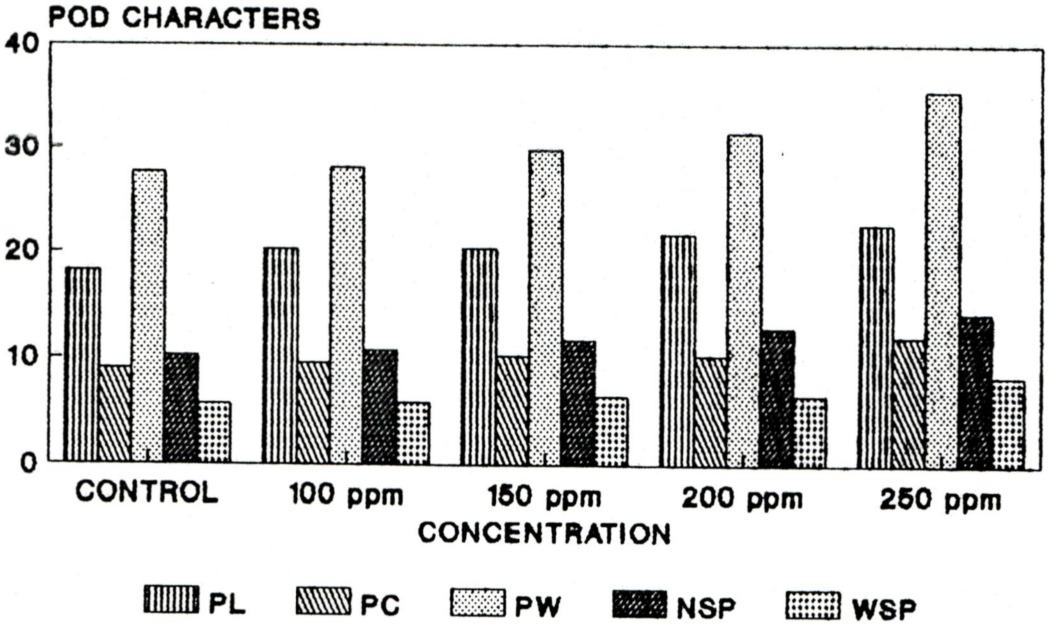
NL - NUMBER OF LEAVES

NN - NUMBER OF NODULES

VN - VOLUME OF NODULES

Fig. 4

INFLUENCE OF IAA ON POD & SEED CHARACTERS OF WINGED BEAN



PL - POD LENGTH

PC - POD CIRCUMFERENCE

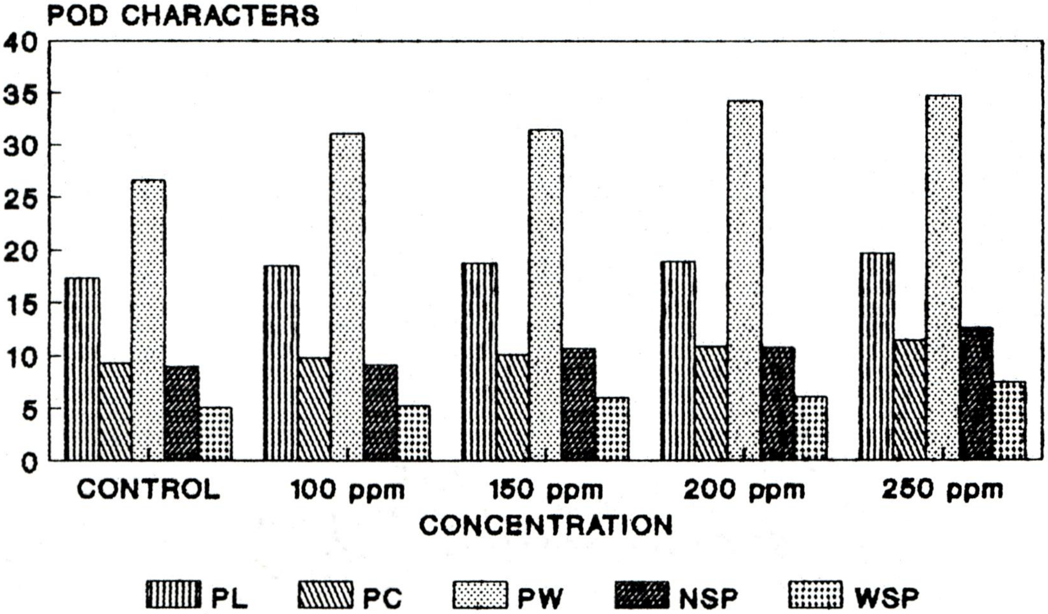
PW - POD WEIGHT

NSP - NUMBER OF SEEDS/POD

WSP - WEIGHT OF SEEDS/POD

Fig. 5

INFLUENCE OF IBA ON POD & SEED CHARACTERS OF WINGED BEAN



PL - POD LENGTH

PC - POD CIRCUMFERENCE

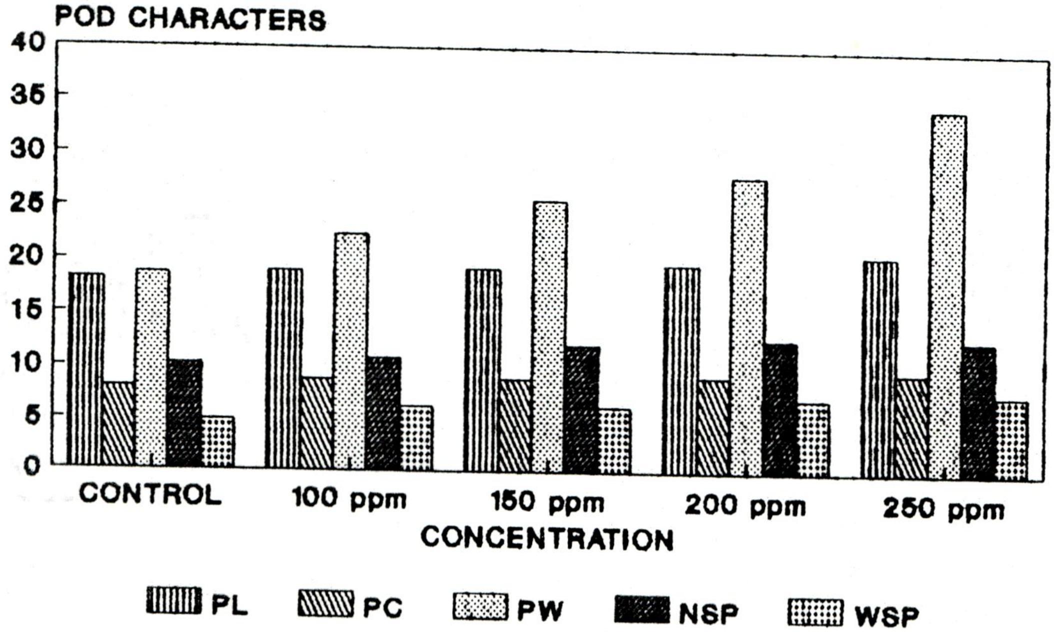
PW - POD WEIGHT

NSP - NUMBER OF SEEDS/POD

WSP - WEIGHT OF SEEDS/POD

Fig. 6

INFLUENCE OF CCC ON POD & SEED CHARACTERS OF WINGED BEAN



PL	-	POD LENGTH
PC	-	POD CIRCUMFERENCE
PW	-	POD WEIGHT
NSP	-	NUMBER OF SEEDS/POD
WSP	-	WEIGHT OF SEEDS/POD

DISCUSSION

EFFECT OF INDOLE-3-ACETIC ACID ON WINGED BEAN

The results obtained with the present study indicate that 150 ppm of IAA promote root length in winged bean. This is in agreement with the earlier work in *Jasminum sambac* (Pappiah and Muthuswamy, 1976), *Rauwolfia serpentina* (Basu and Chakravarthy, 1977), *Abelmoschus esculentus* (Bhattacharya *et al.*, 1978), bean (Friedman *et al.*, 1978), *Pinus thunbergii* (Ohta, 1980), Cocoa (Keshavachandran and Nair, 1985), Pea (Hinchee and Rost, 1986), *Chrysanthemum* (Borisenko and Korenichuck, 1986), *Phaseolus vulgaris* (Vazquez and Mato, 1991 and Nagy *et al.*, 1991), Pea (Nordstrom and Eliasson, 1991), wheat (Barbieri *et al.*, 1992), Pea (Hinchee and Rost, 1992), *Vigna angularis* (Kato *et al.*, 1993) and Lupin (Botia *et al.*, 1994) which demonstrated that IAA increased the root length.

The experimental results of IAA increased the number of leaves at 100, 150 and 200 ppm. However IAA decreased the shoot, internodal and petiole length. As in the present study an increase in leaf growth was noted by Wareing and Philips (1978) and Tejbir Singh and Kumar (1989) in *Vigna unguiculata*. Regarding the shoot length the results obtained in the present study is in contrary to the reports of Sharma (1980) in *Brassica campestris*, Edwardo and West (1980) in *Leucaena leucocephala*, Sharma and Govil (1985) in Bitter gourd, Carpita *et al*. (1989) in *Lathyrus sativus*, Behringer (1991) in garden pea, Barbieri *et al*., (1992) in wheat and Yang *et al*., (1993) in pea.

The experimental results of IAA showed an increase in the volume of the nodules at 100 and 150 ppm. The results for the volume of nodules is in agreement with the results obtained in Pigeon Pea (Anshu Raghuwanshi *et al*., 1992), Soyabean (Fedorova *et al*., 1992), *Vigna sinensis* and *Cajanus cajan* (Tejbir singh and Kumar, 1989) and *Casuarina equisetifolia* (Sunil Puri, 1990) which revealed an increase in the volume and number of nodules.

IAA significantly increased the pod length, circumference, weight, number of seeds/pod and weight of seeds/pod. As in the present study, the yield parameters were increased with the treatment of IAA in *Vicia faba* (Die thelm, 1986), Sunflower (Naphade *et al*., 1986), Pearlmillet (Rangacharya and Bawankar, 1992) *Gossypium barbadence* (Sakr *et al*., 1986), Faba bean and Cotton (Harb 1992), *Lathyrus sativus* (Rahman *et al*., 1989), Soyabean (Federova *et al*., 1992) and faba bean (Clifford *et al*., 1992).

EFFECT OF INDOLE-BUTYRIC ACID ON WINGED BEAN

The results obtained with the present study show that IBA singificantly increased the root length of the winged bean at all the concentrations. As in the present study, IBA induced the root growth in cherry (Muthoo et al., 1992), Pisum sativum (Cardi et al., 1991), apricot (Hassan et al., 1993), Olive (Daoud, 1989), Coffea arabica (Gatut suprijadji, 1985), Callistemon lanceolatus (Singh and Motial, 1986), Coffea canephora (Purushotham and Sulladmat, 1985), Prosopsis (Balboa et al., 1987), Cicer (Bassiri et al., 1985), Litchi (Ram and Majumdar, 1983), Phaseolus (Jarvis and Ali, 1984) and Acacia magnum (Darus Haji Ahmad, 1991).

The experimental results of IBA showed an increase in the internodal length, petiole length, number of leaves, number and volume of nodules. This is in agreement with the earlier work in Lagestroemia indica where best foliage was obtained with the treatment of 1500 ppm IBA (Sultan et al., 1990). Sharma and Dhir (1985) noticed sprouted axillary buds with the IBA treatment in Bougainvillea. Kumar et al. (1984) found an increased sprouting with IBA application in Ipomea fistulosa. The experiments of Rao and Dhir (1991) in Vigna radiata and Sunil Puri (1990) in Casuarina equisetifolia showed that IBA significantly raised the efficiency of nitrogen fixation. The present experimental results showed a decrease in the shoot length of winged bean with the treatment of IBA and it is not in agreement with the earlier work in *Glycine max* (Kothari *et al.*, 1991).

In the present investigation IBA significantly increased the pod length, circumference, weight, number of seeds/pod and weight of seeds/pod. This is in agreement with the early work in *Acacia magnum* (Ahmad,1991) where 500 ppm IBA was best for propagation.

EFFECT OF 2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE ON WINGED BEAN

The experimental results reveal an increase in the root length, number of nodules and volume of the nodules due to CCC treatment. This is in agreement with the results of early work in faba bean (Soleman *et al.*, 1988) and Potato (Shadeque and Pandita, 1982) where the quality and tubers were increased with the application of CCC. This is also in agreement with the work of Shah and Prathapasenan (1993) in *Vigna radiata* where CCC increased the nodulation.

The results obtained from the present study indicate that the CCC treatment increased the shoot length and decrease the petiole length, internodal length and number of leaves. This is in agreement with the early work in tomato (Islam, 1984) and hollyhock plants (Tezuka *et al.*,

1989) where CCC reduced the internodal length and the number of leaves. But it is not in agreement with the work in sunflower (Aboushoba et al., 1984) and Mustard (Sant Prasad and Din Shukla, 1991) where the leaf area increased with CCC concentration. The results were not in agreement with the early work in Linseed (Freer 1992), Barley (Ma and Smith 1991), Tomato (Arora et al., 1989), Phaseolus vulgaris (Rafique - Uddin 1984), Pelargonium zonale (Systema 1984) and Vicia faba (Winstel, 1985) where CCC reduced plant height.

The experimental results showed that CCC increased the pod length, pod circumference, pod weight, number of seeds/pod and weight of seeds/pod. As in the present study the yield was found to be increased in cotton (Bhatt, 1975), Groundnut (Sharma 1982), Phaseolus vulgaris (Rafique-Uddin, 1984), Cluster beans (Singh and Rajput, 1985), Soyabeans (Harshan Singh, 1987), maize (Kotting et al., 1988), Grape (Shikamany and Reddy, 1989), Mungbean (Shah and Prathapasenan, 1991), Mustard (Sant Prasad and Shukla, 1991), Lotus uliginosus (Tabora and Hampton, 1992), Vigna radiata (Wasnik and Bagga, 1992) and Wheat (Borner and Meinel, 1993).

Summary and Conclusion

SUMMARY AND CONCLUSION

INDOLE-3-ACETIC ACID

In the present investigation Indole-3-acetic acid increased the root length at 150 ppm. The number of leaves increased significantly at 100, 150 and 200 ppm. A slight reduction was noted in shoot length, petiole length, internodal length and number of nodules due to IAA treatment. However, the volume of the nodule increased at 100 and 150 ppm.

The concentration of IAA was directly proportional to the stimulation for the following characters, Pod length, Pod circumference, Pod weight, Number of seeds/pod and weight of seeds/pod. The stimulation was significant at all the concentrations.

INDOLE-BUTYRIC ACID

IBA treatment increased the length of the root significantly at all the concentrations. But the shoot length was reduced with IBA at all concentrations. IBA increased the petiole length, internodal length, number of leaves, number of nodules and the volume of nodules. The significant increase was noted in petiole length at 100, 150 and 200 ppm, in internodal length at 100 ppm and all the concentrations used increased the number of leaves and nodules significantly. The volume of the nodule showed a slight increase.

IBA treatments increased the length of pod, pod circumference, pod weight, number of seeds/pod and weight of seeds/pod significantly at all the concentrations.

2-CHLORO-ETHYL-TRIMETHYL AMMONIUM CHLORIDE

CCC treatments increased the length of the root significantly at all the concentrations. The petiole length, internodal length, number of leaves decreased due to CCC treatment. The shoot length, number and volumes of nodules increased in all the concentrations and it was directly proportional to the concentrations used.

Regarding the yield, all the concentrations of CCC significantly increased the pod length, pod circumference, pod weight, number of seeds/pod and weight of seeds/pod of the winged bean.

To conclude IAA, IBA and CCC increased yield by improving the characters of pod and seed in winged bean.

Bibliography

BIBLIOGRAPHY

Abdel Aziz, I.M., M.H. Mohmoud and M.A. Ashoub. 1985. Interactive effects of Indole acetic acid (IAA) and salinity on the germination and growth of soybean seedlings. Annals Agric. Sci. Ainshams University, 30: 1093-1108.

Aboushoba, L.M., N. Shahin and M.M. El-Afry. 1984. Physiological response of sunflower plants to foliar application of CCC and boron. Tropenlandwrit, Sakha Agric. Res. Sta., Kafr El-Sheik, Egypt, 32-40.

Ahmad, D.H. 1991. Multiplication of Acacia magnum by stem cuttings and tissue culture techniques. ACIAR proceeding series, 35 : 32-35.

Amitrani, A., F. Romani and A. Standardi. 1989. The effect of the time of indole - 3- butyric acid application and of darkness on the rooting of micropropagated M. 27 shoots. Agricoltura mediterranea, Italy, 119(4) 417-423.

Anon, 1981. Annual Report. All India coordinated project for the improvement of Tuber crops (Other than Potato). Subcentre, Jorhat. Assam Agri. Univ. Assam : 12.

Anshu Raghuwanshi, S.S. Dudeja and A.L. Khurana. 1992. Effect of NOD and growth regulators on nodulation of Pigeon pea (*Cajanus cajan* (L) Mill sp). Legume Research, 15 (2) : 91-96.

Arora, S.K., G.Kalloo and M.K. Banerjee. 1989. Effect of cycocel and alar on vegetative growth, flowering, fruit set, yield and disease incidence in tomato (*Lycopersicon esculentum* Mil.). Research and Development Reporter, 6 (1) : 65-71.

Balakrishnamurthy, G. and V.N.M. Rao. 1989. Influence of IBA and season on clonal multiplication of Edward rose (*Rosa bourboniana* Desp.). Research and Development Reporter, 6 (1) : 92-102.

Balboa, O., O.I. Cortes and J.P. Arce. 1987. Vegetative propagation of Prosopsis, research, Problems and Perspectives. Interciencia, From Abracts on Tropical Agriculture, 12 (1): 27-31.

Barbieri, P., C. Baggio, M. Bazzicalupo, E. Galli, G. Ranett and M.P. Nute. 1992. *Azospirillum gramineae* interactions. Effect of IAA. Field crop abstracts, 45(10) : 902.

Bassiri, A., A.E. Slinkard and F. Ahmad. 1985. Rooting of stem cuttings in Cicer. International chickpea Newsletter, 13 : 10-11.

Basu, D. and R.K. Chakravarthy, 1977. Chemical regulation of flowering an alternative approach to defloration in *Rauwolfia Serpentina*. Proc. 64th Indian Sci. Cong. : 111.

Behringer, F.J. 1991. Studies on light and hormonal regulation of stem growth in the garden pea. Dissertation Abstracts, International B. Sciences and Engineering, 52(2): 42-47.

Bhatt, J.G. 1975. Differential response of cotton to cycocel plant growth regulant, Turrialba, 25 (3) : 325-326.

Bhattacharjee, S.K. 1989. Influence of growth retarding chemicals on growth and flowering of *Jasminum grandiflorum* L., Indian Journal of Horticulture, 46(2): 240-243.

Bhattacharya, S., N.C. Bhattacharya and C.P. Malik. 1978. Synergistic effect of gibberellic acid and Indole-3 acetic acid on rooting in stem cuttings of *Abelmoschus esculentus* Moench. Planta, 138 : 111-112.

Bonner, J. and J. Thurlow. 1949. Inhibition of photoperiodic induction in Xanthium by applied auxin Bot. Gaz., 110: 613-624.

Borisenko, T.P. and V.A. Korneichuk. 1986. Evaluation of the effect of temperature, substrate moisture content and growth regulators on the rooting of *Chrysanthemum* cuttings. Referativnyi zhurnal, 12 : 860.

Borner, A. and A. Meinel. 1993. The effects of the growth retardant chloromequat (CCC) on plant height and yield in GA insensitive wheats. Plant Breeding, 110 (3) : 255-258.

Botia, J.M., A. Ortuno, F. Sabater, M. Acosta and J. Sanchez - Bravo. 1994.Uptake and decarboxylation of IAA during auxin induced growth in lupin hypocotyl segments. Influence of pH and Vanadate. Planta, 193 (2) : 224-231.

Cardi, T., F. Adamo and E. Filippone. 1991. In vitro of differentiated shoots in various genotypes of Pea. Journal of Genetics and Breeding, 45 (1) : 67-69.

Carpita, N.C. and K.N. Tarman. 1982. Promotion of hypocotyl elongation in loblolly pine (*Pinus taeda* L.) by Indole - 3 - acetic acid. Physiol. Plant, 55: 149-154.

Cathey, H.H. 1964. Physiology of growth retarding chemicals. Ann. Rev. Plant Physiol., 15 : 271-302.

Clifford, P.G., B.S. Pentland and A.D. Baylis. 1992. Effects of growth regulators on reproductive absicission in faba bean (Vicia faba cv. Troy). Journal of Agricultural Science, 119(1) : 71-78.

Coppola, V. and M. Forlani. 1985. Rooting trials on some grapevine rootstocks. Rivista di viticoltura e di Enologia, Italy, 38 (11) 566-575.

Daoud, D.A., J.T. Agha, K.H. Abu-Lebda and M.S. Al-khaiat. 1989. Influence of IBA on rooting of leafy olive cuttings. Olivae, Iraq, 6(27) 28-30.

Delvin, R.M. 1969. Plant Physiology. Affliated East West Press Ltd., New Delhi. 397-475.

Diethelm, R. 1986. Interactions between applications of plant growth regulators and the contents of IAA, ABA and GAS in fruit of the broad bean (Vicia faba L.) with special regard to the yield components. Dissertation Abstracts - C. 47: 606.

Edwardo, C. and S.H. West. 1980. The influence of IAA and GA hormones, on the germination and early seedling development of Leucaena. Leucaena Newsletter, 1 : 53.

Eliasson, L. and A.C. Nordstrom. 1985. Interactions between light, gibberellic acid, auxins and catechol in regulation of number of adventitious roots in pea stem cuttings. Acta universitatis Agriculture Brno A, 33 : 413-416.

Ellyard, R.K. and P.J. Ollerenshaw. 1984. Acacia flexifolia and its propagation from cuttings. Australian Horticulture, 82 (4) : 54-55.

Epstein, E. and A. Ackerman. 1993. Transport and metabolism of indole-3- butyric acid in cuttings of Leucodendron discolor. Plant Growth Regulation, 12 (1-2) : 17-22.

Fedorova, E.E., Z.K. Al'zhapparova, G.YA. Zhiznevskaya, E.N. Artemenko and S.F. Izmailov. 1992. Growth regulators in soyabean root nodules. Fiziologiya Rastenii, 39(2) 224-230.

Freer, J.B.S. 1992. Effect of nitrogen and plant growth regulators on lodging seed yield and quality in Linseed. Tests of Agrochemicals and cultivars. Annals of applied Biology, 13 : 70-71.

Friedman, A., Attman and E.Zamski. 1978. Adventitious root formation in bean hypocotyl cuttings in relationship to IAA transport and shoot anatomy. Isreal J. Bot., 27 : 36-41.

Gatut-Suprijadj. 1985. The influence of growth hormones on the rooting of Coffea arabica cuttings. Menara Perkebunan, Indonesia, 53 (3) : 77-80.

Gaward, T. 1986. Effects of seed soaking with chemicals on yield and nutrient uptake. J. Maharastra. Agri. Univ., 13 : 151-153.

Grzyb, Z.S. and A. Czynczyk. 1975. The effect of growth substances on the rooting of sour cherry and mahaleb softwood cuttings under mist. Prace Instytutu Sadownictwa W Skierniewi A, 19: 3-12.

Gurbakh Singh and B. Sharma. 1982. Effect of growth regulators on groundnut productivity. Indian Journal of Ecology, 9(2) : 281-285.

Hamner, K.C. and K.K. Nanda. 1956. A relationship between applications of IAA and high intensity light reaction at photoperiodism, Bot Gaz, 118 : 13-18.

Harb, E.Z. 1992. Effect of Soaking seeds in some growth regulators and micronutrients on growth, some chemical constitutents and yield of faba bean and cotton plants. Bulletin of faculty of Agriculture, University of Cairo, 43.

Harshan Singh, S. Chandra and R.S. Jolly. 1987. Effect of growth regulators in relation to time of souing and yield of soybean cultivars. Annals of Biology, 3(1) : 36-43.

Hartmann, H.T. and Kester De. 1983. Plant propagation, Principle and Practices. Prentice-Hall, Englewood cliffs, NJ, 298-342.

Hassan, M.M., A.A. Moustafa, M.A. Salama and Z.A. Ibrahim. 1993. Influence of IBA application on rooting ability of apricot stem cuttings. I. Responses of rooting criteria and endogenous regulators. Egyptian Journal of Horticulture, 18 (1) : 95-103.

Hicks, G.S. and A. Nair. 1986. Growth and morphogenesis in short term nodal cultures of an apple root stock in vitro. Can. J. Bot., 64: 2299-3304.

Hinchee, M.A.W. and T.L. Rost . 1986. The control of lateral root development in cultured pea seedlings. 1. The role of seedling organs and plant growth regulators. Bot Gaz., 147 : 137-147.

Hinchee, M.A.W. and T.L. Rost. 1992. The control of lateral root development in cultured pea seedlings. II. Root fasciation induced by auxin inhibitors. Botanica Acta, 105 (2) : 121-126.

Humphires, E.C. and O.W. Dysen. 1967. Effect of growth regulators CCC and B9 on same potato varities. Ann. Appl. Bil., 60 : 330-347.

Islam, M.T. 1984. Effect of cycocel on growth and development of tomato. Punjab Vegetable Grower, 19 : 51-56.

Jarvis, B.C. and A.H.N. Ali. 1984. Irradiance and adventitious root formation in stem cuttings of Phaseolus aureus Roxb. New Phytologist, 97 (1) : 31-36.

Kato, R., E. Nagayama, T. Suzuki, K. Uchida, T.H. Shimomura and Y. Harada. 1993. Promotion of plant cell division by an epidermal growth factor. Plant and cell physiology, 34 (6) 789-793.

Kaukovirta, E. 1969. Effect of growth retardants on the growth of bean seedlings 1. Relation to night temp and to method of application 2. Relation to night temp and to culture medium. F. Sci. Agric. Soc. Finland, 1 : 12-36.

Kaur, J. and G. Singh. 1987. Hormonal regulation of grain filling in relation to peduncle anatomy in rice cultivars, Indian J. Experi. Biol, 25 : 63-65.

Keshavachandran, R. and P.C.S. Nair. 1985. Standardisation of vegetative propagation in coca. Indian cocoa Arecanut and spices Journal, 9 : 29-34.

Kogl, F. and A. Haagensmith. 1931. Uberdie chemides wuchsstoffs proc. Kon. Akad. Wetensch, 34 : 1411.

Kogl, F. and C. Kostermans. 1934. Uberein neues Auxin (Hetero auxin) ausharn XI. Mitteiilkung, 2 - Physiolchem, 228: 90.

Kothari, S.L., N. Chandra and V.K. Chandra. 1991. Multiple shoot formation from cotyledonary node and shoot apex cultures of Glycine max. Soyaben Genetics Newsletter, 18 : 148-149.

kotting, K., K. Hofmann and W. Hofner. 1988. Possibilities of influencing the productivity of maize (Zea mays L.) by growth regulators Journal of Agronomy and Crop Science, 160: 64-71.

Kumari, S., S. Bharathi and M.I. Khan. 1990. Effect of cycocel on growth and metabolism of sunflower (Helianthus annus L.). Indian Journal of Agricultural Research, 24(2) : 87-93.

Kumar, S., G.Kumari and K.K. Dhir. 1984. Effect of IBA and adenosine monophosphate on rooting and sprouting of Ipomea fistulosa. Mart. Journal of Tree Sciences, 3 (1/2) : 63-66.

Leechong, T.L., J.J. Mc Guire and T. Kitchin. 1969. The relationship between rooting co-factors of easy and difficult root cuttings of three clones of Rhododendron. J. American Society. Hort. Sci., 94 : 45-48.

Lee, C.T. 1988. Effect of different rates of selected growth regulators on growth and production of winged bean. Proceedings of the Inter American Society for Tropical Agriculture. 32 : 104-115.

Liu, Q., K. Katou and H. Okamoto. 1992. Effects of exogenous auxin on regulation of elongation growth of excised on regulation of elongation growth of excised segments of Vigna hypocotyls under osmotic stress. Plant and cell Physiology, 33 (7) : 915-919.

Li, Y.L. and Lin, C.D. 1986. Study on the promotion of the development of roots of Castanopsis kawakamii Hay Seedlings. Journal of North-East Forestry University, China, 14 (2) : 48-54.

Ma, B.L., and D.L. Smith. 1991. Apical development of Spring barley in relation to Chloremequat and Ethephon. Agronomy Journal, 83 (2): 270-274.

Nagy, M., I. Tari and T. Buban. 1991. IAA distribution in the hypocotyls and Primary leaves of Phaseolus vulgaris L. treated with paclobutruzol in relation to their rooting capacity. Biochemic and physiologie der pflanzen. Hungary, 187 (6) : 447-451.

Naphade, K.T., B.N. Sagare and B.G. Joshi. 1986. Effects of seed soaking with chemicals on yield and nutrient uptake by Sun-flower. J. Maharastra Agri. Univ., 11 : 189-192.

Naylor, R.E.L. and N.H. Stephen. 1993. Effects of nitrogen and plant growth regulator chlormequat on grain size, nitrogen content and amino acid composition of Triticale. Journal of Agricultural Science, 120 (2) : 159 - 169.

Negi, K.S. and C.K. Tiwari. 1984. Vegetative propagation in cuttings of pongamia pinnata pierre by auxins. Indian Forester, 110 (7);655-659.

Nencki and Siebar. 1983. Response to growth substances of seed germination. Vegetable Science. 14 : 152-154.

Nordstrom, A.C. and L. Eliasson. 1991. Levels of endogenous IAA during adventitious root formation in pea cuttings. Physiologia plantarum. P. 29182 (4) Field Crop Abstracts, 45 (4) : 599-605.

Mcardle, R.N. and J.C. Bounkamp. 1985. The differential rooting response of 2 winged bean genotypes to IBA treatments under mist. Annals of Tropical Research, 7 : 21-26.

Meena, C. and C.L. Goswami. 1992. Effect of auxin on N_2 fixation and N_2 distribution in arhar (*Cajanus cajan* L. Mill. Sp.) Agricultural Science Digest, 12 (3) : 135-138.

Milthrope, F.L. and Moorby. 1966. The growth of the potato. Proc. 3rd Trienn. Conf. Bur. Ass. Potato Kes. 51-70.

Mudge, K.W. and B.T. Swanson. 1978. Effect of ethephon, IBA and treatment solution pH on rooting and on ethylene levels within mungbean cuttings. Plant Physiology, 61(2) 271-273.

Muthoo, A.K., F.A. Banday and V.K. Wali. 1992. Effect of IBA on rooting in Cherry clones by stooling. Advances in plant Sciences. 5(1) : 93-96.

Muthukrishnan, C.R. and S. Thamburaj. 1975. Tuber crops Research in Tamilnadu. Proc. In : Ann. Workshop on Tuber crops. Trivandrum, India. (ICAR).

Nagy, M. and Z. Tabi. 1982. The connection of retarded growth with endogenous gibberellin level in bean plants treated with CCC. Botanikai Kozlemenyek, 69(3/4): 179-186.

Nordstrom, A.C. and L. Eliasson. 1993. Interaction of ethylene with IAA in regulation of rooting in Pea cuttings. Plant growth Regulation, 12 (1-2) : 83-90.

Nordstrom, A.C., F.A. Jacobs and L. Eliasson. 1991. Effect of exogenous IAA and IBA on internal levels of the respective auxins and their conjugation with aspartic acid during adventitious root formation in Pea cuttings. Plant Physiology, 96 (3) : 856-861.

Oberholster, S.D., C.M. Peterson and R.R. Dute. 1991. pedicel abscission of Soyabeans, cytological and ultrastructural changes induced by auxin and ethephon. Canadean Journal of Botany, 69(10) : 2177-2186.

Ohta, K. 1980. Studies on root formation in cuttings 1. The effect of Indole-3-acetic acid on root formation in Pinus thungbergii parl, seedling cuttings. J. Jap. Forestry Soc., 62: 117-127.

Oota, Y. 1965. Effect of growth substances on frond and flower production in Lemna gibba G3. Pl. Cell. Physiol, 6 : 547-559.

Palaniswami, V., A.S. Hameed and M. Vijayakumar. 1985. Vegetative Propagation in cashew work done at Vridhachalam. Acta Horticulturae, 108: 67-70.

Pain S.K., B.K. Roy and S.P. Dey. 1983. Vegetative propagation by stem cuttings of Dalbergia sissoo Roxb. with IBA, NAA and Salicyclic acid. Geobi, France, 10(5) : 200-203.

Papenhagen, A. 1989. CCC Improves the habit of Pentas lanceolata. Lehr - und Versuchsanstalt fur Zierpflanzenbau und Floristik, 89(35) : 1707.

Pappiah, C.M. and S. Muthuswamy. 1976. A note on the effect of growth regulators on rooting of stem cuttings of Jasminum sambac. Ait Var Gundumalli South Indian Hort., 24 : 30-32.

Paul, K.B., J.C. Cryton and P.K. Biswas. 1976. Germination behaviour of Florida pulse seeds. Two effects of germination on stimulating chemicals. Weed Sci., 24 : 349-352.

Purushotham, K. and U.V. Sulladmath. 1985. Studies on the rooting of invigorated sucker cuttings of coffee. Journal of coffee Research, 15 (1/2) : 21-28.

Rabie, K.A.E., M.A. Bondok and H.M. El-Antably. 1991. Effect of Cycocel (CCC) on shedding of buds, flowers and immature pods in *Vicia faba* plants. Annals of Agricultural Science, 36(1) : 53-60.

Rafique - Uddin, M. 1984. Effects of cycocel on yield and yield contributing characters of *Phaseolus vulgaris*. Legume Research, 7 (1) : 43-47.

Rahman, M.M., M.A. Islam and M.R.K. Mondal. 1989. Effect of Wavelength of light and some phytohormones on the growth and yield of grass pea. Bangladesh Journal of Agricultural Research, 14 (1) : 19-23.

Ram, M. and P.K. Majumdar. 1983. Effect of IBA on stooling in litchi. Indian Journal of Horticulture, 40 (3/4) : 211-212.

Ramaswamy, N. 1991. Studies on effect of CCC, threl on the yield and quality of *Ipomea batatus* (L.). National seminar on use of plant growth regulators and stimulant to improve crop productivity.

Rangacharya, R.P. and P.R. Bawankar. 1992. Effect of growth regulators on N_2 uptake field and grain production in Pearl millet. Annual of plant physiology. Field crop Abstract, 45 (4) : 192.

Rao, L. and K.K. Dhir. 1991. Some biochemical aspects of N_2 fixation under salt stress in mung bean (Vigna radiata (L) Wilczek.). Proceedings National Symposium on growth and differentiation of Plants, 255-258.

Reicosky, D.A. and B.E. Brahnam. 1985. Plant growth regulators in intensive Cereal management for Michigan. In proceedings of the plant growth Regulator Society of America, Twelth annual meeting, 17.

Ruichi Pan and Zhijia Zhao. 1994. Synergistic Effect of Plant growth retardants and IBA on the formation of adventitious roots in hypocotyl cuttings of mung bean. Plant growth regulation, 14 : 15-19.

Sakr, R.A., Z.M. Sawan and M.A. Elkady. 1986. Response of 2 Egyptian cotton cultivars to IAA application. Tropenlandwrit, 87 : 133-142.

Sant Prasad and Din Shukla. 1991. Effect of N_2 and CCC on the seed yield and oil content of mustard. Journal of plant growth Regulation, 10(3): 52-55.

Shadeque, A., and M.L. Pandita. 1982. Effect of cycocel as foliar spray on growth yield and quality of potato. Journal of Research. Assam, 3 (1): 34-39.

Shah, T. and G. Prathapasenan. 1991. Effect of CCC on the growth and yield of mung bean. Journal of Agronomy and Crop Science, 166 (1) 40-47.

Shah, T. and G. Prathapasenan. 1993. Effect of CCC on shoot growth, nodulation, nitrogenase activity and contents of N_2, ureides, Sugars and Starch in mung bean. Biochemic and Physiologie der Pflanzen. 188 (6) : 373-384.

Sharma, P.K. 1980. Response of various growth regulators on seed germination and seedling growth of Brassica campestris Var. Varuna J. Indian hot. Soc., 59 : 132.

Sharma, A.K. and C.M. Govil. 1985. Response of growth substances of seed germination, seedling growth and hypocotyl anatomy in Momordica carantia L. Vegetable Science, 12 : 1-6.

Sharma, R. and K.K. Dhir. 1985. In vitro culture of axillary buds of Bougainvillae cultivar 'Marypalmer'. Indian Journal of Plant Physiology, 28 (2) : 169-176.

Shashikala Khanna, T.B. Dasaradhi and Abida Sultana. 1980. Effect of cycocel and ethrel on growth and yield of sweet potato. In : Proceedings of National Seminar on Tuber Crops. Coimbatore. 145-146.

Shikamany, S.D. and N.N. Reddy. 1989. Effect of growth retardants on growth, yield and quality in Grape CV. Thompson Seedless. Indian Journal of Horticultural Research, 46 (1) : 31-38.

Singh, J. and D.B. Singh. 1992. Effect of Plant growth regulator on yield of certain vegetable crops. JNKW Research Journal, 19, 20 and 21 : 96.

Singh, S.J.P. and C.B.S. Rajput. 1985. Effect of N_2, P and cycocel on physiochemical characters of cluster bean vegetable. Progressive Horticulture, 17 (3) : 181-184.

Singh, S.P. and V.S. Motial. 1982. Regeneration response of Callistemon lanceolatus cuttings to auxin and time of planting under intermittent mist. Bangladesh Journal of Scientific and Industrial Research, 17 (1/2) : 15-25.

Soleman, N.K., M.S. Mikhial, R.K. Harb and E.M. Khalil. 1988. Response of broad bean plants infected with Rhizoctonia Solani to application of growth regulators and Calcium. Egyptian Journal of Phytopathology, 20 (1) : 1-12.

Struve, D.K., R.D. Kelly and B.C. Moser. 1983. Promotion of root regeneration in difficult to transplant Sps. Combined Proceedings, International Plant propagation society, U.S.A. 33 : 433-439.

Sultan, S.M., A.O. Al-Atrachi and N.N. Fadhil. 1990(a). Effect of Planting dates and IBA acid on rooting and growth of hardwood cuttings of *Lagestroemia indica* L. Mesopotomia. Journal of Agriculture, 22 (4) : 63-72.

Sultan, S.M., T.M. Al-Lhalabi and A.O. Atrakchi. 1990 (b). Effect of planting media and IBA on rooting of *Ficus elastica* Var. Schryreriana. Mesopotomia Journal of Agriculture, 22 (4) : 45-51.

Sultan, S.M., M.D., Saleem and A.O. Al-Atrachi. 1990(c). Propagation of *Wisteria floribunda* DC. by hardwood cuttings. Mesopotomia Journal of Agriculture, 22 (4) 53-62.

Sunil Puri. 1990. Rooting of stem cuttings of *Casuarina equistifolia* and their nodulation. International tree crops Journal, 6 (1) : 51-57.

Systema, W. 1984. CCC Supresses the growth of *Polargonium zonale*. Vakblad Voor de Bloemisterij. 39 (8) : 31.

Tabora, R.S. and J.G. Hampton. 1992. Effects of cereals on growth and seed yield of *Lotus uligenosus* Seh K. CV. Grasslands maker. New Zealand Journal of Agricultural Research, 35 (3) : 259-268.

Tejbir Singh and V. Kumar. 1989. Nodulation and plant growth as influenced by growth regulators in some legumes. Acta Botanica India, 17 (2) 177-181.

Tezuka, T., C. Takahara and Y. Yamamoto. 1989. Aspects regarding the action of CCC in h ollyhock plants. Journal of Experimental Botany, 40 (215) : 689-692.

Tizio, R., J.C. Moyano and H. Morales. 1968. Inhibitor like substances in vine cuttings and their possible relationship to the rooting. Process. Phyton, 25 : 123-128.

Thimann, K.V. 1935. On an analysis of activity of two growth promoting substances on plant tissues. Proc. Kon. Med. Akad wet, 38 : 896-912.

Thimann, K.V. 1936. Auxin and growth of roots. Amer. J. Bot., 23 : 561-569.

Tovar, P. J.H. Dodds, R. Chandre and R.De. Arcaute. 1987. Effect of medium composition on in vitro tuberization. American Potato Journal, 64 (8) : 462.

Vazquez, A. and M.C. Mato. 1991. Effects of hydroxy - benzaldehydes on rooting and indole-3-acetic acid - oxidase activity in bean cuttings. Physiologia plantarum, 83 (4): 32-37.

Wareing, P.F. and I.D. Philips. 1978. In the control of growth and differentiation in plants, Pergamon press.

Wasnik, K.G. and A.K. Bagga. 1992. Effect of cycocel of nitrate reductase activity and grain yield in mung bean (*Vigna radiata* ; Wilczek). Indian Journal of Plant Physiology, 35 (1) : 104-107.

Wiesman, Z., J. Riov and E. Epstein. 1989. Characterisation and rooting ability of IBA conjugates formed during rooting of mung bean cuttings. Plant Physiology, 91(3): 1080-1084.

Winstel, K. 1985. Use of Agricultural chemicals in field beans. Gesunde Pflanzen, Germany, 37 (2) 68-72.

Wojtaszek, T., A. Libik and A. Bach. 1977. The effect of chormequat and Duraset on the growth and productivity of outdoor tomatoes. Zeszyty Naukowe Akademii Rolniczej W Krakowie, Ogrodnictwo, Poland, 125 : 29-46.

Yang, T., D.M. Law and P.J. Davies. 1993. Magnitude and Kinetics of stem elongation induced by exogenous IAA intact light grown pea seedlings. Plant Physiology, 102 (3) 717-724.