REGULATION OF FLOWERING AND FRUITSET IN CLUSTERED CHILLI THROUGH USE OF STIMULANTS, ANTI-TRANSPIRANTS AND REGULATORS

By

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THESIS

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DECLARATION

I hereby declare that the thesis entitled "Regulation of flowering and fruit set in clustered chilli through use of stimulants, antitranspirants and regulators" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Vellanikkara,
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CERTIFICATE

Certified that the thesis entitled "Regulation of flowering and fruit set in clustered chilli through use of stimulants, antitranspirants and regulators" is a record of research work done independently by Miss. Usha, P. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

Introduction

INTRODUCTION

Chilli is an important crop in India grown for fruits, used both as a vegetable and a spice. Its pungency, spicy taste and the appealing red colour makes it an indispensible adjunct in every household. Though an introduced crop, it is cultivated in almost all states of India. It is grown over an area of 8.26 lakh ha, with an annual production of 5.48 lakh tonnes (Sankaranarayana and Krishnamurthy, 1987). Seventy per cent of this area lies in Andhra Pradesh (1.48 lakh ha), Karnataka (1.43 lakh ha), Maharastra (1.40 lakh ha) and Tamil Nadu (0.62 lakh ha). India is the largest exporter of chilli in the world, exporting nearly 2.5-3% of the total production (Muthukrishnan et al., 1986). The average productivity in India (0.619 t/ha) is very low when compared to countries like Japan (42.32 t/ha), Italy (24.83 t/ha) and Egypt (15.89 t/ha). Among the various states in India, the maximum production per unit area (1.550 t/ha) is in Andhra Pradesh (Anon, 1985 a). The commercial value of the crop inspires chilli growers to emphasise on maximising the production per unit area. The agro inputs like high yielding cultivars, better plant nutrition, effective pest and disease control and improved agronomic practices have almost touched the potential production in many crops. Hence the scientists of the new era have to concentrate on the unexploited physiological aspects.

The major constraint in attaining higher yield in chilli is the heavy flower drop. The extent of flower fall varies from 5 to 95% depending on the season of cultivation. Among the many methods used to tackle this problem, plant growth regulation through application of exogenous chemicals is tried in the present experiment. Lack of pollination in conjunction with adverse weather conditions inflicts several internal changes in plants, including altering the levels of endogenous hormones. The external application of synthetic growth substances restores the hormonal balance.

Several plant growth substances are put to practical use in crop production to tailor growth and development of plants in the desired direction. Potentialities of an existing genotype can be brought to light through careful utilisation of specific growth substances. Triacontanols are of recent introduction consisting of a group of long chain fatty alcohols. They stimulate crop growth through increased uptake and translocation of nutrients and activation of enzymes involved in the metabolism. Possibility of their utilisation is emphasised in a number of commercial crops but remains untapped in chilli.

Naphthalene acetic acid is a growth regulator, already being used commercially in chilli for increased fruit set and yield. Its efficiency is to be worked out in relation to the array of new chemicals. 2,4-D is another synthetic growth regulator which at low concentrations is proved to be of immense value in reducing flower drop especially in tomatoes. Reports on its effect on chillies are seen contradictory.

The increased flower abortion reported under conditions of high temperature and severe soil moisture stress has led to the utilisation of antitranspirants to tackle the problem of reduced fruit set. ABA and CCC reduce plant size, there by reducing the area of transpiration. They also regulate the closure of stomata thus enhancing the effective utilisation of available water.

The efficiency of a chemical is a function not only of its own structure, but also of an innumerable number of factors like the concentration, time of application, plant species, part on which the chemical is applied and the prevailing weather conditions. This indicates the utmost necessity of finding out the best chemical along with its concentration to attain a specific effect in a plant species. The present studies are taken up with the objective of selecting the most suited chemical that regulates flowering and fruit set in chilli cv. KAU Cluster.

Review of Literature

REVIEW OF LITERATURE

A large number of flowers are produced in chilli, but the number of mature fruits obtained are much less. Considerable flower fall was reported in chilli by many workers, with extents varying depending on a number of external and internal factors. A fruit set of only 5% was reported by Gopalaratnam (1933) while it was 11% according to Nagarathnam and Rajamani (1963). Flower shedding commenced from the second fortnight after start of flowering and continued upto seventh fortnight with two distinct peaks at third and fifth fortnight (Suthanthira Pandian and Sivasubramaniam, 1978). Among the great number of factors influencing flower drop in chilli, the important ones are soil fertility, soil moisture status, soil temperature, photo period, incidence of pests and diseases and endogenous hormone levels (Hosmani, 1982).

Branching and production of flowers and fruits are influenced by fertility status of the soil. The highest number of fruits and yield were obtained when 0.32 g N was applied per kg of soil. Increasing doses of nitrogen resulted in increased flower fall (Boboshevska and Yacheval, 1975). Application of micro-nutrients like 0.08% Mo, 0.05% Mn, 0.1% B or 0.05% Zn as seed treatment and 0.03% Zn as foliar application by Butnaru et al. (1968), stimulated and with cloudiness prevalent during late August and September. In pepper (cv. California Wonder) more flowers were produced as a result of increased branching on plants exposed to low temperature (12°C) or low light intensity (800 ft. C). The low temperature increased number of nodes to first flower, while light intensity had no influence on either time of flowering or on number of nodes to first flower (Deli and Tiessen, 1969). Influence of temperature on fruit set, fruit shape and size in sweet pepper cv. California Wonder was reported by Rylski and Halvey (1974). Low temperature 8-10°C increased fruit set (%) and enhanced parthenocarpic fruit development. High day time temperature and low light intensity mainly at early stages of flower development promoted flower drop. Desired growth, development and productivity in capsicum were obtained at a soil temperature of 25°C. An increase or decrease in soil temperature had an adverse effect (Chermnykh _et al_., 1976). Song _et al_. (1976) noted increased flower and fruit abscission under short days ($<$ 12 hr) and high temperature (28-33°C) in chilli.

In capsicum, fruit set was not affected by relative humidity levels (55, 80 and 95%). Increasing RH enhanced seed set, growth, flower drop and fruit weight and reduced the time between pollination and harvest (Baer and Smeets, 1978).

plant growth and prevented flower abortion.

Cochran (1936) reported that the high temperature and low humidity at the time of flowering increased the transpiration pull resulting in abscission of buds, flowers and small fruits. In a trial conducted in South Korea, chilli plants grown in 10, 20 and 30% field capacity recorded maximum flower and fruit shedding in the driest treatment (Rhe and Park, 1975). Root flooding, tried as a measure to control flower abscission caused by deficient soil moisture did not show any effect (Song et al., 1976).

Incidence of insect pests, mites and disease causing organisms are known to increase flower and fruit drop in chilli. Occurance of leaf curl leads to stunting of plants, retards flower and fruit production and accelerates their drop. Effective control of this type of flower fall through both foliar as well as soil application of insecticides were reported by Sivaprakasam et al. (1976), Kareem et al. (1977), Singh et al. (1979), Sivaraj et al. (1979), Datar (1980) and Nair and Menon (1983).

Hamadeh (1967) attributed low fruit set caused by post anthesis abscission of flowers and young fruits in pepper to warm temperature during June-July and early August

Joen and Chung (1982) reported an increase in the number of days from sowing to flowering and percentage of fruit drop with increase in shade in red pepper cultivars. Low soil moisture content during blossom development and fruit formation resulted in abscission of buds, flowers and small fruits (Chauhan, 1983). The best fruit set in chilli was recorded at a temperature of 24°C and 70% RH (Van, 1986). Flower and fruit drop leading to considerable yield reduction was also recorded due to high temperature during early flowering stage in chilli by Arora et al.(1987).

A variation among varieties on extent of flower fall was also observed. Pet (1983) studied the growth and average number of fruits/plant in several capsicum hybrids and cultivars grown at day/night glass house temperature regime of 22°C/12°C, 20°C/14°C and standard, 23°C/20°C. With all hybrids and cultivars except Bruinsma Wonder, fruit set was better at 20°/14° than at 23°/20°. Bruinsma Wonder had the poorest fruit set, under all regimes. Sathyanarayana (1985) also reported variation among four cultivars tested for flowering, flower shedding and fruit production in some important chilli cultivars under rainfed condition.

Failure of pollination mechanism is often followed by the formation of a separation layer at the base of the pedicel (Phillips, 1971). Normally sufficient quantities of auxins reach the base of the pedicel from developing ovules which prevent flower abscission. The absence of auxins alone is not responsible for abscission. Other hormonal factors like ABA are also seen to be involved in abscission. In plant ABA synthesis is induced when subjected to water, salt and temperature stresses. Wright and Hiron (1969) suggested and enzymatic conversion from a precursor possibily the glycopyranoside of ABA. Though the actual role of various hormones in causing abscission is not fully understood, ABA produced changes in the activities of enzymes involved in N metabolism like protease and glutamate dehydrogenase which favours abscission were reported by Goswami et al. (1986). ABA content had a positive correlation with abscission while IAA content had a negative correlation.

Plant growth substances are used to control different developmental phases of plants, so as to improve seed germination (Hsuch and Lou, 1947, Choudhary and Singh, 1960, Adlakha and Verma, 1965), induce plant vigour (Choudhary and Singh, 1960), induce earliness in flowering and fruiting (Zimmerman and Hitchcock, 1944, Leopold and Scott, 1952, Gopalakrishnan and Choudhary, 1978) and increase yield (Singh and Choudhary, 1966, Verma and Choudhary, 1980).

In attempts to tackle the problem of increased flower fall and improved fruit set in chilli, almost all groups of plant growth substances were employed. Among the various auxins tried, NAA gave promising results. This led to extensive commercial use of the chemical (Hosmani et al. (1982).

Beneficial effects of ethylene, an easily available growth regulator were demonstrated by a number of workers (Lockwood and Vines, 1970 and Sims et al., 1970). Rylski (1972) found that when sweet pepper plants were treated with gibberellic acid and ethephon, gibberellic acid accelerated apical development resulting in abortion of flowers on lateral shoots, where as ethephon decreased growth of main axis and promoted sprouting of laterals. A high single concentration of ethrel (750 ppm) caused chlorosis, defoliation and fruit abscission (Danpel and Goodwin, 1975). Ethephon induced abscission was maximum in less matured fruits. Fruit retention was increased when ethephon was applied along with $Ca\ (OH)_2$. In field, ethephon without $Ca\ (OH)_2$ caused severe fruit and leaf abscission (Conrad and Sundstorm, 1987).

Many growth retardants like daminozide (1250-5000 ppm), chlormequat (1000 or 5000 ppm) etc. are also effective.

Combinations of various other growth substances have also been tried recently. Singh and Murthy (1984) reported that auxins in combination with abscission accelerants like GA, ethylene or ABA accelerates abscission as the effect of latter dominated. Increased number of fruits/plant and total yield due to application of a combination of Morphactin (1, 5 or 10 ml/litre) and/or GA_3 (50 mg/litre) applied at the beginning of flowering and a fortnight later were reported by Zayed et al. (1985).

Reports on effects of Triacontanol, a recently introduced plant stimulant, ABA and CCC, two growth retardants having antitranspirant properties and NAA and 2,4-D, two easily available growth regulators, on chilli are consolidated below.

Triacontanol

Triacontanol is a plant stimulant, getting popular now a days. This was first isolated from leucene wax by Chibnall et al. (1933) and from Alfalfa by Ries et al. (1977). A rapid increase in water uptake by plants treated with Triacontanol indicates that it affects transpiration. Utilisation of stored products in conjunction with water was reported by Bitterbender et al. (1978). The response of crops to triacontanol was positively correlated with temperature during germination and early growth (Ries, 1978). Effect of triacontanol on increasing heat resistance and photosynthetic rate of leaves and increase in root exudation and leaf protein and non protein nitrogen contents of rice was reported by Rao (1985). Vipul containing triacontanol 0.05% activates several enzymes or biological catalysts in the plant tissues. The cell wall becomes more permeable to absorb and translocate more nutrients and solutes. Vipul activates cell division (Anon, 1985 b).

In Korea, growth of chilli was increased consistently by seed treatment with triacontanol (10 g/l). Number of fruits/cluster were also increased (Lim, 1981).

In green house trials, triacontanol (0.001-1.0 mg/l) applied at 15 days after planting and 10 ml/38 cm pot, applied as soil drench 18 and 43 days after planting increased capsicum height as determined 71 days after planting. In field trials triacontanol (1.25 mg/l) applied as soil drench at 25 ml/plant at transplanting significantly increased early ripening, number of fruits and total yields (Mamat et al., 1983).

In chilli var. Pusa Jwala, the highest plant height of 105.86 cm against 90.72 cm in control was recorded when sprayed 3 times with vipul, containing triacontanol (0.05%)

(Anon. 1984). The same treatment increased average number of flowers/plant and yield (Annon. 1985 b).

Vipul (5 ppm) sprayed three times in Cv. LCA 235 resulted in the highest dry matter production. An increase in the number of chilli fruits/plant was observed when Vipul was sprayed (Rao, 1985). Vipul sprays increased the number of floral buds and flowers/plant due to triacontanol (Anon. 1987).

Rajamani (1987) also reported increase in plant height, plant spread, number of fruits, dry chilli yield and number of seeds/pod in chilli by application of triacontanol (1.25 ppm).

Antitranspirants

Growth retardants control transpiration, as the total surface area exposed to the atmosphere is reduced when plant growth is checked. The exploitation of this property of retardants like ABA and CCC is common among field crops (Chauhan, 1981). Reports on their use in chilli are limited.

The effects of ABA in causing stomatal closure and inhibiting transpiration were documented in a number of plant species. No case has been reported of the ineffectiveness of applied ABA in reducing transpiration in plants. Under conditions of stress, ABA is produced in plants and stomata closes slightly. The actual mechanism of ABA formation is unknown. Some suggestions are that phaseic acid, a compound closely related to ABA may be responsible for the closure of stomata (Bidwell, 1979). The retardant property of ABA was attributed to its action on inhibition of cell division and cell elongation as well as on synthesis of DNA and RNA (Walton, 1980).

Soaking capsicum seeds in 0.01% solution of abscissic acid resulted in reduction in plant height and increase in commercial yield and fruit vitamin C content (Samoshina and Abramova, 1979). Erkan and Bangertti (1980) tried 12 phytohormones and growth regulators and 3 out of them (ABA, IAA and ethephon) reduced stomatal aperture and water consumption of capsicum upto 12 days. Photosynthesis was also reduced by all the chemicals. El Abd, et al. (1986) reported that ABA at 10^{-4} M sprayed three times at 12 days interval increased root and shoot dry weight indicating reduction in plant size in capsicum Cv. Bell Boy.

Cycocel another growth retardant, used as an antitranspirant probably acts through it's interference with biosynthesis of gibberellic acid. A reduced level of gibberellic acid in treated plants could result in reduced stomatal opening and a lowered transpiration (Halvey and Kessler, 1963). Reduction in the endogenous GA content due to application of CCC was reported in tomatoes by Abdul et al. (1978). Its action on reduction of plant growth as well as enhanced flowering and fruit set can also be a result of this anti-gibberellin activity.

California Wonder capsicums when treated with cycocel (500, 1000 or 2000 ppm) during summer showed a decrease in plant height and increase in branch and leaf number. The doses of CCC that gave the highest dry weight in early summer planting was 1000 ppm (Nagdy et al., 1979 a). The highest increase in fruit set during summer was given at a dose of 2000 ppm. CCC (1000 ppm) as foliar application, following seedling dip increased early and total yield (Nagdy et al., 1979 b). When 50 days old seedlings were dipped in cycocel (2000 ppm), the resultant seedlings had epidermal cells which were thick and lignified. Leaf blades were thin with flattened midribs, leaf cells were smaller and leaf area was less in treated plants than in control.

In Cv. Ikeda, CCC (250 ppm) sprayed 14 days after transplanting and shading with black cloth from 2 true leaf stage had a beneficial effect on plant growth, development and productivity. The treatments also reduced the number of non marketable fruits by 29-31% (Correia _et al_., 1980).

Patil _et al_. (1985) also reported increased yield in chilli with an application of CCC (200 ppm).

Growth regulators

A number of reports are available on the use of the two easily available synthetic auxins, NAA and 2,4-D, on increasing fruit set and yield. The abscission preventing role of auxins has been exploited commercially even though the exact mechanism of action is not understood.

The most important effect of auxin is cell elongation. Leopold (1958) stated that the presence of a large amount of growth hormones at fruit set appears to be general and synthetic auxins substitute for pollination, suggesting that auxin itself is responsible for fruit set. This shows that the apparent stimulation of fruit set might have been a consequence of a retardation of abscission of flowers. He therefore stated that fruit setting by growth regulators is a function of their auxin activity.

Auxin compounds delay senescence through the maintenance of RNA synthesis and increased carbohydrate synthesis (Osborne, 1963). The auxin directed transport of nutrients, hormones and photosynthates also are seen to favour increased fruit set by their application (Krishnamurthi, 1981).

The supra optimal concentrations of 2,4-D cause a number of undesirable effects. The relatively high concentration of an auxin may result in inhibitory effects as a result of some of the auxin molecules securing all free positions on the protein component of the enzyme molecule (Mayer and Anderson, 1955). The reduction in the rate of photosynthesis as a result of its action of closing stomata also might be contributing to these effects (Mansfied, 1967).

NAA used as seed treatment and pre-bloom spray increased production of flowers and fruit set (Raghuveer and Shivraj, 1973, Chandra et al., 1976, Mote et al., 1975, Warade and Singh, 1977, Patil and Ballal, 1980, Menon, 1981).

Sivasubramaniam and Rajamani (1972) reported higher yield in chilli var. K-1 as a result of application of planofix (20 ppm). Chandramony and George (1976) also reported the same effect. According to them, an yield increase ranging from 5.8% in Cv. Local Blue to 132.9% in Cv. Kantari was possible. When different concentrations (10, 20, 30 or 40 ppm) were tried in chilli Cv. NP 46-A at 25, 50 and 75 days after planting, the lowest concentration of 10 ppm recorded the highest fruit set (80%). Increased plant height, fruit weight, size and yield also resulted from the application (Sharma et al., 1977). Warade and Singh (1977) tried a different range of concentration of NAA (0, 100, 200 or 300 ppm) as seed treatments as well as foliar application at 4-6 leaf stage, at first flower bud stage or at flowering. Earliest flowering followed the earliest application of 200 ppm. The same concentration applied at flowering gave maximum fruit set (70.5%) fruit volume (11.8 cm^2) and yield/plant (0.741 kg).

Devasabai (1974), reported effective control of flower fall when NAA was applied at full bloom stage. An increased production of short styled flowers, fruit set and yield in chilli was reported by the application of NAA (50 ppm) (Chattopadhyay and Sen, 1974). In four cultivars, Sankeshwari-32, Deglur, Walha and Dharmabad sprayed with NAA (10, 25 or 50 ppm) at full bloom and 20 days later effectively controlled flower drop in all cultivars except Dharmabad and yields increased upto 41%. The optimum concentration noted here also was 50 ppm (Mote et al., 1975). A foliar spray with urea (1%) along with NAA (10 ppm) increased both vegetative growth and yield of fruits (Rao and Rao, 1979).

Effects of NAA (10 ppm) and its formulations on the performance of four varieties of chilli were studied by Menon (1981). Significant difference for time to germination and seedling establishment, plant height, number of branches, fruit set and plant dry matter were noted among varieties. NAA was more superior than its formulations. Yield increase was a result of the action of auxin on fundamental processes like nucleic acid synthesis and enzyme synthesis or activation.

Increase in plant growth by NAA (100 ppm) through an increase in height and number of primary and secondary branches/plant, fruit set, fruits/plant, fruit size and ultimately early and total yields were reported by Singh (1982). In all the three concentrations of NAA (30, 50 and 70 ppm) used for seed treatment earlier germination (4-5 days) was noted. Fruit maturity was delayed by 7 days. Seed number markedly increased at 30 and 50 ppm of NAA but not in 70 ppm of NAA (Hariharan and Unnikrishnan, 1983).

Barooah and Baru (1983) reported increase in plant height accompanied by increased flower production and fruit set in chilli due to NAA application. Zhang et al., 1985 noticed an increased rate of photosynthesis in chilli plants treated with NAA (200 ppm) leading to an increase in dry matter production. Yamagar and Desai (1987) also reported early flowering and increased fruit production, less flower and fruit drop and higher yield in chilli plants treated with NAA.

Application of 2,4-D has both beneficial and deleterious effects in chilli. A reduction in plant height along with deformation in leaves from terminal buds was reported by Zanardi (1956) in chilli plants sprayed with 2, 4-D (6 ppm). Jakuskina and Kravcova (1957), observed malformed fruits with the application of chlorophenoxy compound at a concentration of 10 ppm. A canopy modification consisting of reduction in size, change in shape and lobbing of leaves was observed in chilli due to the application of 2,4-D at 5, 10, 50 and 100 ppm (Krishnamoorthi and Bhandari, 1957).

Contradictory reports are available on the effect of 2,4-D in increasing fruit set and yield in chilli. An increase in yield of chilli was observed by Singh (1962).

Short styled flowers were increased slightly by the application of 2,4-D (10 ppm) (Srivastava, 1964).

Wally et al. (1971) reported inhibition of flowering and reduction in yield by weight in sweet pepper during summer when 2,4-D (2 ppm) was applied where as, an increased production of flowers/plant and reduced flower shedding in chilli with the application of 2,4-D (10 ppm) was reported by Chandra and Shivraj (1973). Width of pods and seeds/pod were decreased by the application.

From the above review it is seen that the response of chilli to a plant growth substance depends on a number of factors. The efficacy of a chemical on a particular crop has to be tested under specific conditions as there are a number of problems like lack of sensitivity of effect and differences in varietal response. These factors may sometimes lead to undesirable side effects. So the best chemical and the best concentration on a particular variety of the plant species has to be standardised for different conditions. The present study was taken up with that objective.

Materia's and Methods

MATERIALS AND METHODS

The present experiment was conducted to find out effects of growth stimulants, antitranspirants and growth regulators on flowering and fruit set in chilli. The trials were laid out at the vegetable research plots, College of Horticulture, Vellanikkara, Trichur during February to June, 1987 (Summer), July to October, 1987 (Kharif) and January to April, 1988 (Summer). The chilli variety KAU Cluster developed at the Department of Olericulture, Kerala Agricultural University was used in the study. The research plot is located at an altitude of 23 m above mean sea level and at 10° 32' N latitude and 76° 16' E longitude. This region enjoys a typical warm humid tropical climate. The soil type is well drained sandy loam with pH 5.1. The metereological data during the period of experimentation are furnished in Appendix-I.

The experiment consisted mainly of four parts.

A. Quantification of flower fall and consequent loss in clustered chilli and observations on leaf abnormalities during summer.

B. Effect(s) of growth stimulants, antitranspirants and growth regulators on fruit set.

C. Effect(s) of exogenous chemicals on canopy morphology of chilli.

D. Estimation of net returns due to application of exogenous chemicals.

A. Quantification of flower fall and consequent loss in clustered chilli and observations on leaf abnormalities during summer.

1. Experimental materials

a) KAU Cluster (*Capsicum annuum* var. *fasciculatum*) (CA-33)

This is an erect, clustered fruited line, resistant to bacterial wilt (Goth *et al*., 1983) and collar rot (*Phytophthora capsicii*) (Peter *et al*., 1984). There is heavy flower fall in this line during summer.

b) Pant C-1 (*Capsicum annuum* var. *longum*) (CA-53)

This is an erect solitary fruited line released by the Central Variety Release Committee for high yield and resistance to leaf curl. This was used as a standard variety in the present experiment.

The seeds of the above varieties were collected from the Vegetable Seed Production Complex of the Department of Olericulture, College of Horticulture, Vellanikkara.

2. Lay out and experimental design

The seeds were sown during January, 1987 and transplanted during February. Fifty plants/genotype were transplanted. Five plants were randomly tagged from among the 24 observational plants after deleting the border rows. Following observations were recorded.

a) Days to fruit set
b) Index of earliness
c) Flower fall (%)
d) Incidence of leaf abnormalities (%)
e) Yield/plant (g)

Index of earliness for KAU Cluster was calculated from the formula

$$I = \frac{a_1 + a_2 \text{ .... } + a_n}{c_1 + c_2 \text{ .... } + c_n}$$

where,

ai = Yield of KAU Cluster on i^{th} day

ci = Yield of Pant C-1 on i^{th} day

n = 3

Flower fall in KAU Cluster was estimated by tagging the flower clusters formed on a particular day. The total number of flowers produced and the number of fruits set were counted. The number of flowers fallen were found out from the difference of these two values. The percentage of flower fall was then worked out.

$$F = \frac{Ff \times 100}{Tf}$$

Ff = Number of fallen flowers

Tf = Total number of flowers produced

Incidence of leaf abnormalities was estimated by counting the total number of leaves and the leaves with abnormalities on 30th and 60th day after transplanting. Percentage of leaf abnormalities was then worked out.

The influence of weather elements like maximum temperature, minimum temperature, maximum humidity, minimum humidity, soil temperature and sunshine hours on flower fall was worked out by simple correlation analysis.

B. Effect(s) of growth stimulants, antitranspirants and growth regulators on fruit set

1. Experimental material

Chilli var. KAU Cluster

2. Lay out and experimental design

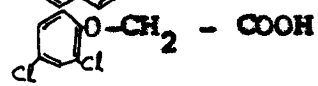
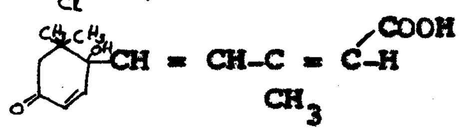
The experiment was conducted during February to June, 1987 (Summer and July to October, 1987 (Kharif). The experimental design was a randomised block design with four replications. There were five rows of ten plants each in each plot. The spacing was 60 x 45 cm. A distance of 1.5 m was given between plots to prevent drift of spray particles. During the cropping period various cultural operations and application of manures and fertilizers were carried out as per package of practices recommendations of Kerala Agricultural University (KAU, 1986). Twenty five tons of farm yard manure/hectare were applied at the time of land preparation. A fertilizer dose of 75 kg, 40 kg, 25 kg N, P_2O_5, K_2O/ha was applied. Half of Nitrogen, full Phosphorus and half of Potassium were applied as basal dose before transplanting, ¼ Nitrogen and half of Potassium was applied 20 to 25 days after transplanting. The remaining quantity of Nitrogen was applied one month after the first application. Earthing up of ridges were done after each fertilizer application. Inter-cultural operations to control weeds were done as and when necessary. Irrigation was carried out on alternate days to ensure sufficient moisture.

The various exogenous chemicals used in the experiment are given below along with their chemical name and formula (Table 1). There were six treatments during summer 1987 and seven treatments during *Kharif* 1987 excluding the control (water spray). The treatments are detailed below.

Treatments	Summer 1987	*Kharif* 1987
Control		
Growth stimutants	Three sources of tria contanol 2.5 ppm	
	1) Vipul (1 ml/2 l) (Godrej Soaps Pvt. Ltd.)	Vipul (1 ml/2 l)
	2) Miraculan (1 ml/5 l) (NOCIL)	Miraculan (1 ml/5 l)
	3) Paras photosynth (2.5 ml/l) (Hindustan Lever)	Paras photosynth (2.5 ml/l)
Anti-transpirants	Abscissic acid (25 ppm)	Abscissic acid (25 ppm)
		Cycocel (1000 ppm)
Growth regulators	Naphthalene acetic acid (15 ppm)	Nephthalene acetic acid (15 ppm)
	2,4-Dichlorophenoxy acetic acid (5 ppm)	2,4-Dichlorophenoxy acetic acid (5 ppm)

These chemicals were applied 15, 30, 45 and 60 days after planting

Table 1. The chemical name, and formula of the various exogenous chemicals used in the experiment

Common name	Chemical name	Chemical structure
Vipul	1 hydroxy triancontanol	$CH_3-(CH_2)_{28}\ CH_2OH$ 
Miraculan	1 hydroxy triacontanol	$CH_3-(CH_2)_{28} - CH_2OH$ 
Parasphotosynth	1 hydroxy triacontanol	$CH_3-(CH_2)_{28} - CH_2OH$ 
NAA	Naphthalene acetic acid	
2,4-D	2,4-Dichlorophenoxy acetic acid	
ABA	Abscissic acid	
CCC	2-Chloro ethyl trimethyl ammonium chloride	$Cl-CH_2-CH_2-N^+-CH_3Cl$ (CH_3)

Preparation of spray solutions

The spray solutions at desired concentrations were prepared taking into consideration the concentration of the active ingredient in the formulations and the quantity required for the treatment. A spray volume of 1.5 litres/ 6 m^2 was used.

Observations recorded

Five plants were randomly tagged from each plot and the following observations were recorded.

a) Earliness

1) Days to fruit set

2) Index of earliness

$$I = \frac{a_1 + a_2 + \dots\dots\dots\dots\dots\dots + a_n}{c_1 + c_2 + \dots\dots\dots\dots\dots\dots + c_n}$$

Where,

ai = Yield of treated plants on i^{th} day

ci = Yield of control plants on i^{th} day

n = 3

3) Bartletts rate index (BRI)

This was calculated from the formula

$$BRI = \frac{(P_1) + (P_1 + P_2) + (P_1 + P_2 + P_3)}{n\ (P_1 + P_2 + P_3)} \quad \text{(Saha, 1987)}$$

Where,

P_1 = Yield at first harvest

P_2 = Yield at second harvest

P_3 = Yield at third harvest

n = 3

b) Productive characters

1) F (Fruit set %) = $\frac{Fs}{N} \times 100$ (Saha, 1987)

Where,

N = Total number of flowers observed in that time

Fs = Number of flowers set from among N

2) Fruit yield/plant (g)

3) Fruit yield/plot (g)

Statistical analysis

Analysis of variance was done as for a randomised block design (Panse and Sukhatme, 1985).

C. Effect(s) of exogenous chemicals on canopy morphology of chilli

Experimental materials, layout and design were same as that of Experiment 2.

Observations recorded

The following observations were recorded from five randomly tagged plants.

1) Plant height (cm)
2) Plant spread (N - S)
3) Plant spread (E - W)

Plant height and spread were recorded on 90th day after transplanting.

4) Malformations; if any, on leaf, flower and fruit

Leaf abnormalities were estimated from total number of leaves and abnormal leaves. Percentage of leaf abnormalities was then worked out.

Flower malformations due to application of 2,4-D (5 ppm) was estimated from randomly picked 100 flowers. Following observations were made.

a) Pollen sterility (%)
b) Short styled flowers (%)
c) Ovules/cross section of ovary

Pollen sterility was counted as percentage of unstained pollen using acetocarmin stain. Ovules were counted from a cross section of ovary observed under ordinary microscope using safranin stain. Fine cross sections of ovaries collected from control plants and 2,4-D (5 ppm) sprayed plants were observed under microscope for anatomical modifications in the ovary. Changes observed were photographed.

Locules/fruit were counted from the cross sections of fruits. Fruit malformations were counted as percentage of malformed fruits in a fruit lot.

Statistical analysis

Analysis of variance was done as in a randomised block design (Panse and Sukhatme, 1985).

D. Estimation of net returns due to application of exogenous chemicals

The yield data from different treatments were transformed into monetary values based on current market price of green chillies (Rs.6/kg). Cost of exogenous chemicals were worked out separately for each treatment. The income after deducting the additional cost was estimated. Returns due to the application of different exogenous chemicals were then worked out.

A third crop of KAU Cluster was raised during summer 1988 to confirm the results from previous trials making use of the most effective treatments from the earlier two trials.

The treatments were

1. Control (water spray)
2. Vipul (1 ml/2 l). This was the most effective chemical during summer, 1987.
3. NAA (15 ppm). This was effective during <u>Kharif</u>, 1987.
4. CCC (1000 ppm). This was also effective during <u>Kharif</u>, 1987.

Lay out and design of experiment

The trial was laid out during January to April, 1988, in a randomised block design, with five replications. There were five rows of ten plants each/plot at a spacing of 60 x 45 cm. A higher dose of fertilizer was applied ie. 100 kg N, 40 kg P and 50 kg K/hectare. Full dose of P was applied as basal dose. Nitrogen and Potassium were applied in four split doses at 15 days interval.

Observations recorded

Observations on index of earliness, BRI and yield/ plant were recorded. Analysis of variance was carried out to test the significance of differences among treatments. Net return from each treatment were also worked out.

Results

RESULTS

Results of the present study to find out effect(s) of growth stimutants, antitranspirants and growth regulators are given under the following heads.

A. Quantification of flowerfall and consequent loss in clustered chilli and observations on leaf abnormalities during summer.

B. Effect(s) of growth stimulants, anti-transpirants and growth regulators on fruit set.

C. Effect(s) of exogenous chemicals on canopy morphology of chilli.

D. Estimation of net returns due to exogenous chemicals.

A. Quantification of flowerfall and consequent loss in clustered chilli and observations on leaf abnormalities during summer.

The performance of chilli var. KAU Cluster during summer and *Kharif*, 1987 are presented in Table 2. The *Kharif* crop of chilli was superior to summer crop in all aspects.

Table 2. Performance of chilli var. KAU Cluster during summer and *Kharif* 1987.

Characters	Summer (February-May, 1987)	*Kharif* (July-October, 1987)
Days to fruit set	84.75	80.25
Index of earliness	0.62	0.81
Bartletts rate index	0.70	0.54
Flower fall (%)	65.14	47.29
Yield/plant (g)	13.00	37.67
Incidence of leaf curl (%)	52.65	20.78

a) Days to fruit set

During summer, KAU Cluster took more days to set fruits (85 days) than that during Kharif (80 days). An earliness of 5 days was observed during Kharif.

b) Index of earliness

Index of earliness of KAU Cluster in relation to the standard variety Pant C-1 was 0.62 during summer, and 0.81 during Kharif, 1987. This shows that KAU Cluster did not give an early yield compared to Pant C-1, but during Kharif it performed better compared to summer.

c) Bartletts rate index

A high value of 0.7 was given by KAU Cluster during summer. It was only 0.64 in Pant C-1. During Kharif, KAU Cluster recorded a value of 0.54 and Pant C-1, 0.61. Pant C-1 did not show much variation during the two seasons.

d) Flower fall (%)

High flower fall was observed during summer (64.14%). During Kharif it was only 47.29%. A difference of 17.85% was observed between flower fall (%) during summer and Kharif.

e) Incidence of leaf abnormalities (%)

An increased incidence of leaf curl was observed during summer (52.65%). During Kharif the incidence was comparatively low (20.78%).

f) Yield/plant (g)

Yield/plant also varied considerably during the two seasons. During summer, yield/plant was very low (13 g). It was 37.67 g during Kharif.

g) Relation between weather elements and flower fall

The correlation coefficient between weather elements and flower fall (%) were worked out (Table 3). Among the many weather elements, maximum temperature alone had a high positive correlation with flower fall during both summer ($r = 0.89$) and Kharif ($r = 0.88$). Humidity did not have any significant correlation during summer, but during Kharif, it had a negative value. The other weather elements, minimum temperature, minimum humidity, soil temperature and sunshine hours did not show any relation with flower fall.

The analysis of variance for regression of flower fall with weather elements was done. The regression was significant only in case of maximum temperature. The actual flower fall along with the corresponding values estimated

Table 3. Correlation coefficient between flower fall (%) and weather elements

Weather elements	Correlation coefficient	
	Summer 1987	*Kharif* 1987
Maximum temperature (°C)	0.89*	0.88*
Minimum temperature (°C)	-0.85	0.42
Maximum humidity (%)	0.02	-0.79
Minimum humidity (%)	0.02	-0.48
Soil temperature (°C)	-0.59	0.78
Sunshine hours	0.31	-0.04

* Significant at $p = 0.05$

from the regression equations during specific periods are given in Table 4 and 5. The effect of maximum daily temperature on flower fall is presented pictorially (Fig. 1).

B. Effect(s) of growth stimulants, anti-transpirants and growth regulators on fruit set.

The general analysis of variance (Table 6) indicates that the 7 treatments during summer, 1987 (E_1) and 8 treatments during Kharif, 1987 (E_2) were significantly different for days to fruit set, index of earliness, Bartletts rate index, fruit set (%), yield/plant and yield/plot.

1) Days to fruit set

The response of chilli variety KAU Cluster to different exogenous chemicals for days to fruit set are presented (Table 7). During summer, 1987, among various treatments NAA induced the most earliness (9.00 days) followed by Vipul (5.75 days). Days taken for fruit set due to the application of these chemicals were highly significant when compared to control and 2,4-D. Miraculan and ABA were also superior to control and 2,4-D. The application of 2,4-D (5 ppm) delayed fruit set by 3.25 days. Decrease in days to set over control (%) was maximum for NAA followed by Vipul, ABA, Miraculan and Paras photosynth respectively.

Table 4. Actual and estimated values of flower fall during summer 1987

Periods	Mean maximum temperature	Flower fall (%)	
		Actual	Estimated
5-15 April	35.3	49.16	53.01
15-25 April	37.35	63.64	63.61
25 April-5 May	35.7	58.19	56.65
5-15 May	36.8	73.65	58.82
15-25 May	39.2	81.02	82.04

Regression equation $Y = -202.357 + 7.255^{*} x$

Table 5. Actual and estimated values of flower fall during *Kharif* 1987

Periods	Mean maximum temperature	Flower fall (%)	
		Actual	Estimated
23 Aug. - 1 Sep.	29.5	42.06	38.94
2 Sep. - 11 Sep.	30.8	42.77	50.18
12 Sep. - 21 Sep.	32.1	60.55	61.42
22 Sep. - 1 Oct.	31.6	57	57
2 Oct. - 11 Oct.	31.8	64.1	58.82

Regression equation $Y = -216.147 + 8.647^{*} x$

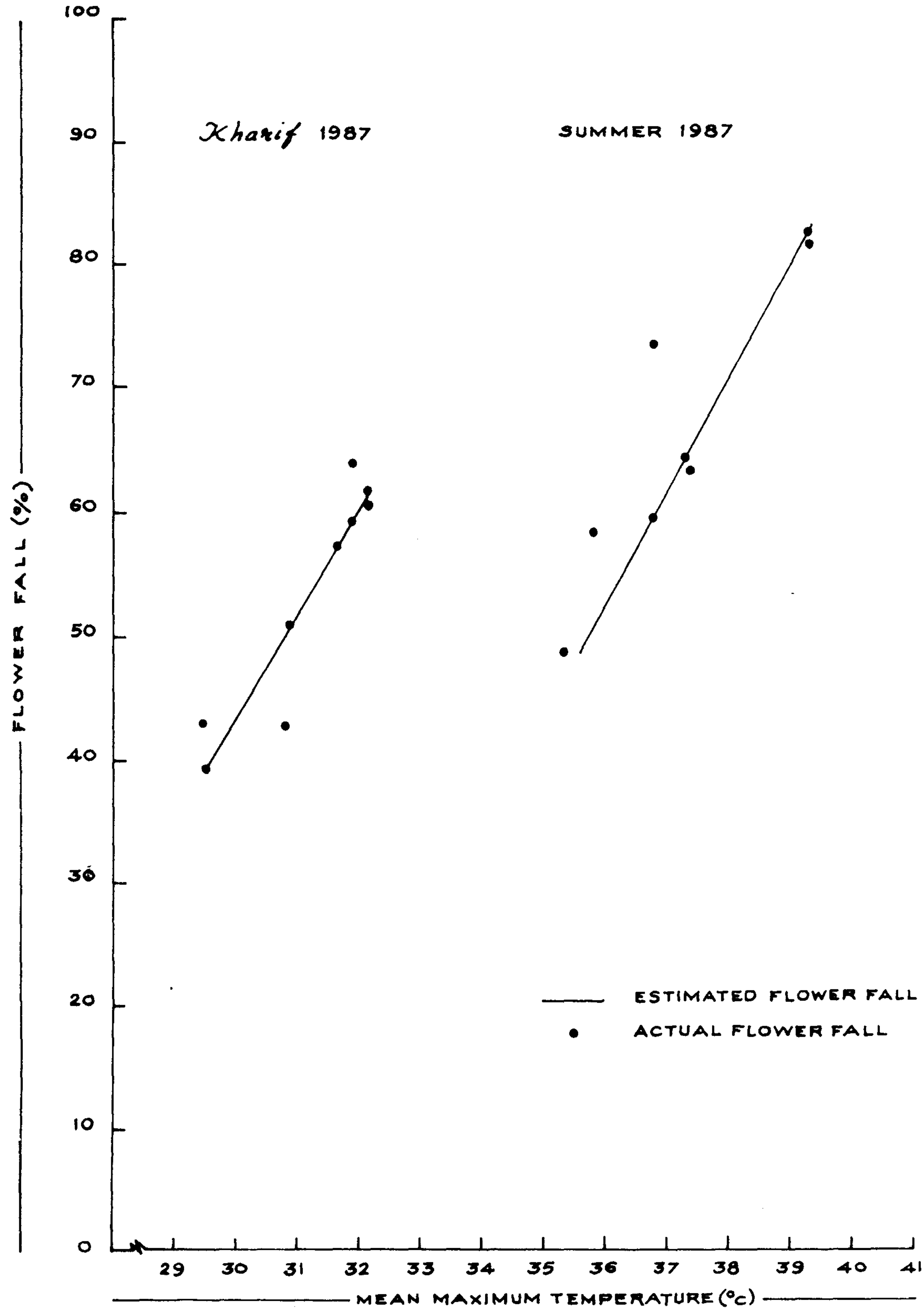


FIG. 1. EFFECT OF TEMPERATURE ON FLOWER FALL.

Table 6. General analysis of variance

Source of variance		df	M.S.					
			Days to fruit set	Index of earliness	Bartletts rate index	Fruit set (%)	Yield/plant	Yield/plot
Block	E_1	3	42.70	0.087	0	5.99	23.74	16395.00
	E_2	3	5.5	0.460	0.003	14.48	17.44	28376.00
Treatments	E_1	6 (5)$^+$	70.33**	0.432*	0.0057**	783.15**	40.46*	25987.00*
	E_2	7 (6)$^+$	34.14*	0.650*	0.23**	1317.09**	451.62*	421673.15*
Error	E_1	18 (15)$^+$	10.73	0.045	0.0014	13.83	5.06	5242.00
	E_2	21 (18)$^+$	9.62	0.113	0.005	12.21	60.71	56337.33

* p = 0.05
** p = 0.01
\+ degrees of freedom for index of earliness

Table 7. Response of chilli var. KAU Cluster to different exogenous chemicals
1. Days to fruit set

Treatments	Summer 1987		*Kharif* 1987	
	Days to fruit set	Increase or decrease over control (%)	Days to set	Increase or decrease over control (%)
Control	84.75	-	80.25	-
Vipul	78.00	-7.96	78.50	-2.18
Miraculan	79.50	-6.19	76.75	-4.36
Paras photosynth	80.00	-5.60	78.25	-2.49
ABA	79.25	-6.48	78.75	-1.85
CCC	-	-	74.25	-7.47
NAA	75.75	-10.61	73.75	-8.09
2,4-D	88.00	+ 3.83	82.50	+2.80
	CD (0.05) = 4.86		CD (0.05) = 4.56	

During *Kharif*, 1987 also NAA treated plots were the earliest (6.5 days) followed by CCC (6 days). The earliness induced by NAA was significant compared to Vipul, Paras photosynth and ABA. 2,4-D alone delayed fruit set by 2.25 days. Decrease in days to set over control was maximum for NAA (8.09%) followed by CCC (7.47%), Miraculan (4.36%), Paras photosynth (2.49%), Vipul (2.18%) and ABA (1.85%) respectively.

2. Index of earliness

The effect(s) of different growth regulators on index of earliness during summer and *Kharif* 1987 are given in Table 8. During summer, 1987 Vipul recorded the highest value of 1.28, which was highly significant over ABA and 2,4-D. Miraculan and Paras photosynth were also superior to 2,4-D and ABA.

During *Kharif* 1987, CCC recorded the highest value of 1.71, which was highly significant over 2,4-D, ABA, Vipul and Paras photosynth. All treatments except Paras photosynth were superior to 2,4-D.

3. Bartletts rate index

The earliness in yield calculated as Bartlett's rate index due to application of exogenous chemicals are given in Table 9.

Table 8. Response of chilli var. KAU Cluster to different exogenous chemicals
2. Index of earliness

Treatments	Index of earliness	
	Summer 1987	*Kharif* 1987
Vipul	1.28	1.32
Miraculan	1.19	1.40
Paras photosynth	1.14	0.89
ABA	0.81	1.03
CCC	-	1.71
NAA	1.10	1.42
2.4-D	0.40	0.50
	CD (0.05) = 0.32	CD (0.05) = 0.50

Table 9. Response of chilli var. KAU Cluster to different exogenous chemicals during summer and *Kharif* 1987

3. Bartlett's rate index

Treatments	Summer 1987	*Kharif* 1987
Control	0.70	0.54
Vipul	0.72	0.58
Miraculan	0.75	0.59
Paras photosynth	0.73	0.53
ABA	0.73	0.55
CCC	-	0.57
NAA	0.73	0.55
2,4-D	0.53	0.48
	CD (p = 0.05) = 0.11	CD (p = 0.05) = 0.05

During summer, 1987, Miraculan recorded the highest value of 0.75. The lowest value of 0.53 was recorded due to the application of 2,4-D (5 ppm). The highest value of index 0.59, during <u>Kharif</u> 1987 was also recorded by plants treated with Miraculan. This was followed by Vipul (0.58), CCC (0.57), NAA (0.55), ABA (0.55), Paras photosynth (0.53) and 2,4-D (0.48). The control has an index of 0.54. The value of 0.59 recorded by Miraculan alone was statistically superior to control.

4. Fruit set (%)

The response of clustered chilli to different exogenous chemicals on fruit set % and the increase or decrease (%) of each treatment over control were calculated (Table 10, Fig. 2). During summer fruit set increased considerably by the application of Vipul, Miraculan, Paras photosynth and NAA. Maximum increase in fruit set was observed for Vipul (27.08) closely followed by Miraculan (25.73). Application of 2,4-D adversely affected fruit set and that the fruit set was significantly lower than control. Decrease for 2,4-D over control was 18.58%. The percentage increase over control was maximum for Vipul (77.68%) followed by Miraculan (73.80), NAA (63.71), Paras photosynth (60.61) and ABA (6.48) respectively.

Table 10. Response of chilli var. KAU Cluster to different exogenous chemicals
4. Fruit set (%)

Treatments	Summer 1987		*Kharif* 1987	
	Fruit set (%)	Increase or decrease over control (%)	Fruit set (%)	Increase or decrease over control (%)
Control	34.86	-	52.71	-
Vipul	61.94	+77.68	74.55	+41.43
Miraculan	60.59	+73.80	77.09	+46.25
Paras photosynth	55.99	+60.61	69.97	+32.75
ABA	37.12	+ 6.48	67.07	+27.24
CCC	-	-	84.48	+60.27
NAA	57.07	+63.71	84.83	+60.93
2,4-D	28.38	-18.58	33.80	-35.80
	CD (0.05) = 5.52		CD (0.05) = 5.14	

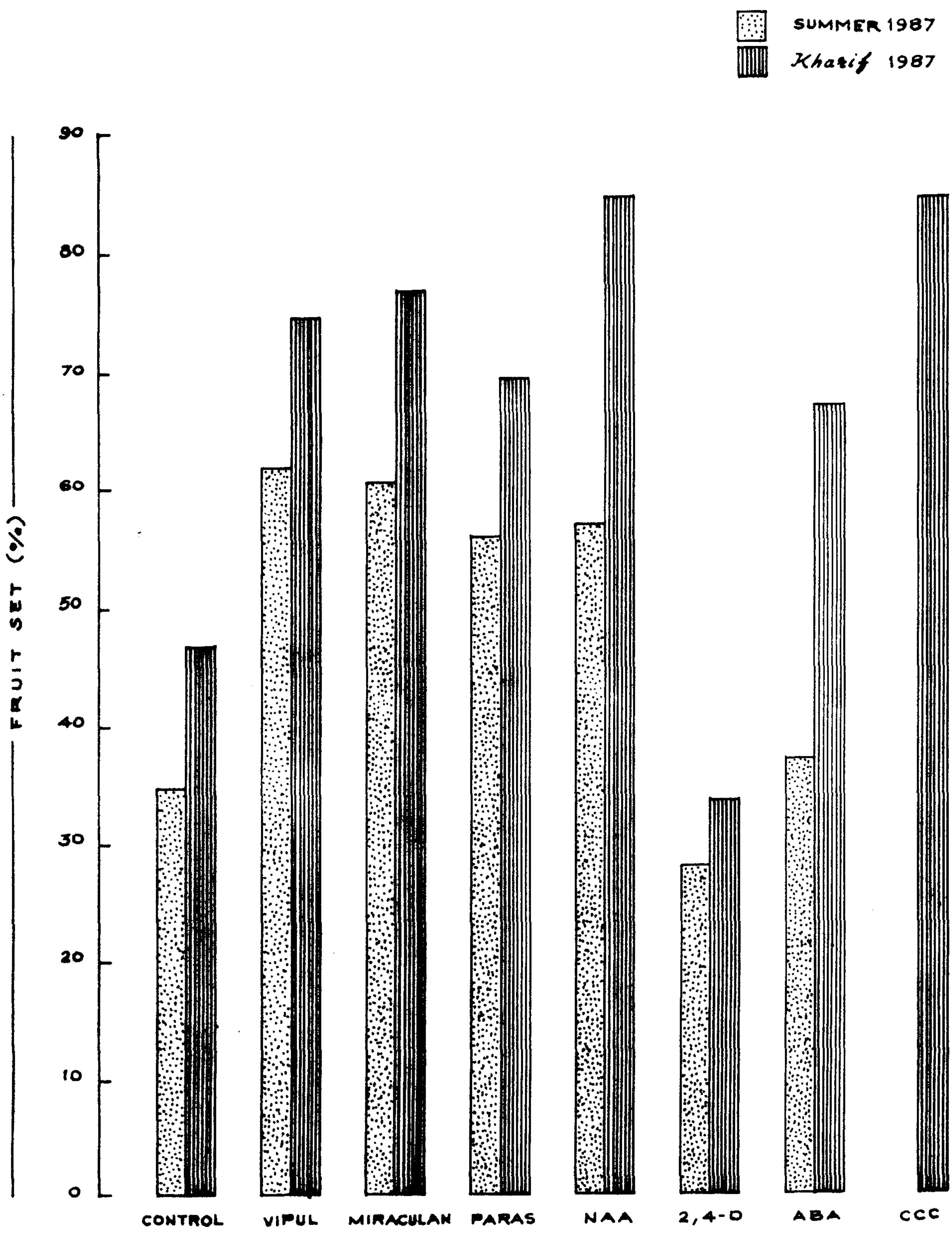


FIG. 2. EFFECT OF EXOGENOUS CHEMICALS ON FRUIT SET (%)

During *Kharif*, 1987, application of NAA resulted in higher fruit set (84.83%) followed by CCC (84.48%). Both the above treatments were superior to others. All treatments except 2,4-D increased fruit set. Increase in fruit set produced by NAA, CCC, Vipul and Miraculan were significantly superior to that induced by ABA. During *Kharif* also 2,4-D reduced fruit set significantly. Increase over control was maximum for NAA (60.93%) followed by CCC (60.27%), Miraculan (46.25%), Vipul (41.43%), Paras photosynth (32.75%) and ABA (27.24%) respectively. Decrease over control due to application of 2,4-D was 35.8%.

5. Fruit yield/plant

Table 11 indicates the fruit yield/plant during summer and *Kharif* 1987. During summer, 1987, yield/plant was maximum for Vipul (17.62 g), which was highly significant over control (13.00 g). Miraculan (16.40 g) and Paras photosynth (17.3 g) also were superior to control. NAA and ABA also showed an increase in yield/plant. 2,4-D sprays considerably reduced the yield. Percentage increase over control was maximum for Vipul (35.83) followed by Paras photosynth (33.07), Miraculan (26.15), NAA (24) and ABA (10.76) respectively. 2,4-D showed a decrease of 34.07% over control

Table 11. Response of chilli var. KAU Cluster to different exogenous chemicals
5. Yield/plant (g)

Treatments	Summer 1987		*Kharif* 1987	
	Yield/plant (g)	Increase or decrease over control (%)	Yield/plant (g)	Increase or decrease over control (%)
Control	13.00	-	37.67	-
Vipul	17.62	+35.53	50.08	+32.94
Miraculan	16.40	+26.15	49.97	+32.65
Paras photosynth	17.30	+33.07	37.67	0
ABA	14.40	+10.76	40.30	+ 6.98
CCC	-	-	53.40	+41.75
NAA	16.12	+24.00	52.70	+39.89
2,4-D	8.57	-34.07	22.37	-40.61
	CD (p = 0.05) = 3.34		CD (p = 0.05) 11.45	

During *Kharif*, 1987, CCC gave the maximum yield/plant (53.40 g) which was significantly greater than control (37.67 g). NAA, Vipul and Miraculan were also superior to control (Table 11). 2,4-D application significantly reduced the yield/plant (22.37 g). Increase over control was maximum for CCC (41.75%) followed by NAA (39.89%), Vipul (32.94%), Miraculan (32.65%) and ABA (6.98%) respectively. A decrease of 40.6% over control was observed due to 2,4-D application.

6. Fruit yield/plot (g)

Only Vipul gave a significantly superior yield (419.00 g) than control (303.75 g) during summer, 1987 (Table 12, Fig. 3). A reduction in yield was observed due to application of ABA and 2,4-D. Percentage increase over control was recorded for Vipul (37.94%), Miraculan (31.68%), Paras photosynth (30.34%), NAA (10.69%). Maximum decrease over control was observed for 2,4-D (36.70%) followed by ABA (6.74%).

During *Kharif*, 1987, CCC and NAA application gave significantly higher yields than control. 2,4-D, ABA and Paras photosynth yielded lower than control. Of these, decrease in yield was significant only in case of 2,4-D application. CCC, NAA, Vipul and Miraculan showed an increase of 48.11%, 46.74%, 30.16% and 30.19% respectively over

Table 12. Response of chilli var. KAU Cluster to different exogenous chemicals
6. Yield/plant (6 m^2)

Treatments	Summer 1987		*Kharif* 1987	
	Yield/plot (g)	Increase or decrease over control (%)	Yield/plot (g)	Increase or decrease over control (%)
Control	303.75	-	944.00	-
Vipul	419.00	+37.94	1228.75	+30.16
Miraculan	400.75	+31.68	1229.75	+30.19
Paras photosynth	395.00	+30.34	795.25	-15.75
ABA	283.25	- 6.74	936.50	- 0.79
CCC	-	-	1398.25	+48.11
NAA	336.25	+10.69	1385.25	+46.74
2,4-D	192.25	-36.70	457.50	-51.53
	CD (p = 0.05) 107.56		CD (p = 0.05) 349.09	

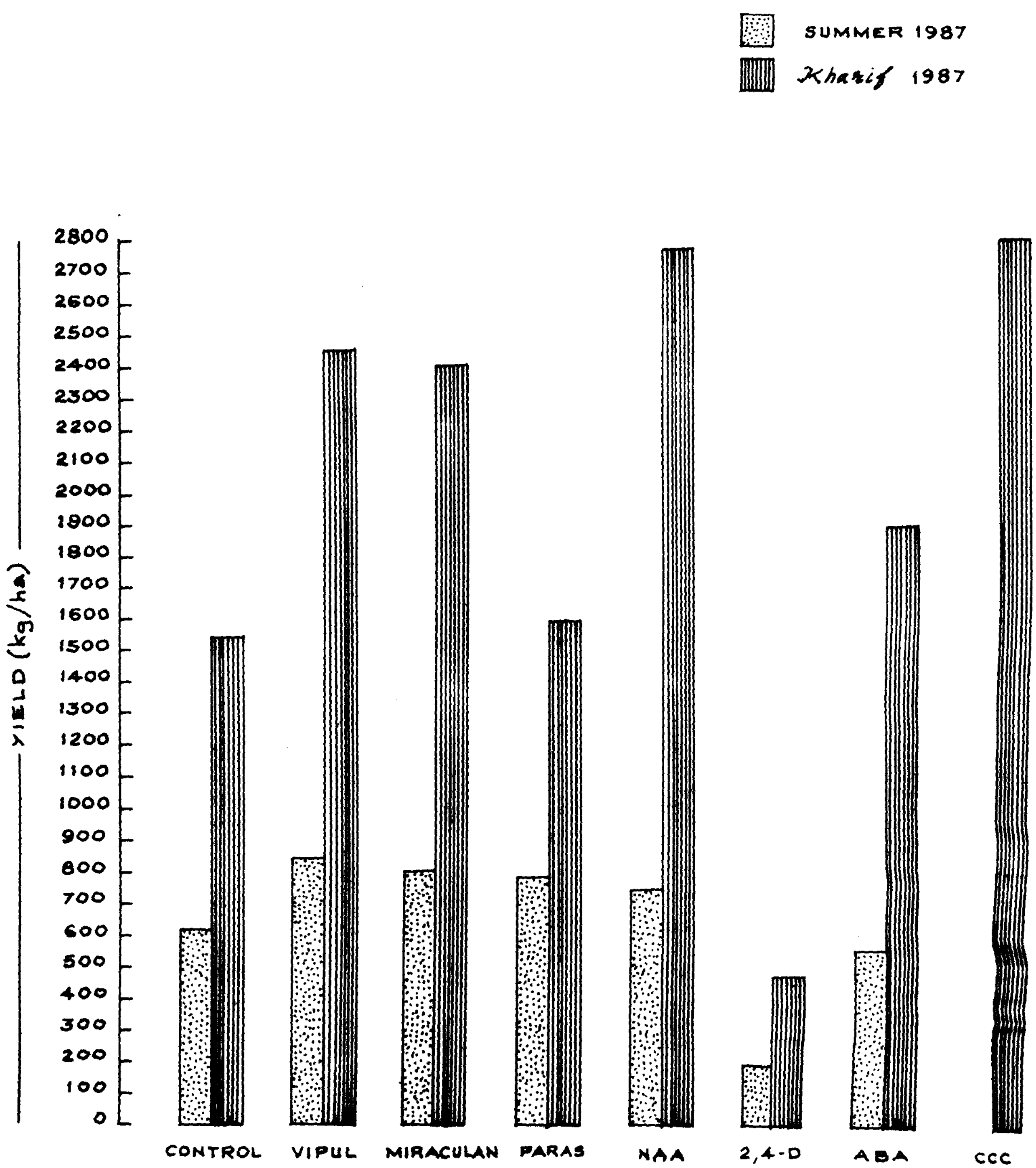


FIG. 3. EFFECT OF EXOGENOUS CHEMICALS ON YIELD (kg/ha).

Plate 1. KAU Cluster plants sprayed with Vipul (Summer 1987)

Plate 2. KAU Cluster plants sprayed with Miraculan (Summer 1987)

PLATE.1

PLATE.2.

Plate 3. KAU Cluster plants sprayed with NAA (*Kharif* 1987)

Plate 4. KAU Cluster plants sprayed with CCC (*Kharif* 1987)

PLATE.3.

PLATE.4

control. Percentage decrease over control was maximum for 2,4-D (51.53%) followed by Paras photosynth (15.75%) and ABA (0.79%).

C. Effect(s) of exogenous chemicals on canopy morphology of chilli

The general analysis of variance (Table 13) indicates that the 7 treatments during summer (E_1) and 8 treatments during Kharif (E_2) caused significant differences in plant height (cm) but not in plant spread either in North-South or East-West direction.

1. Plant height (cm)

During summer, 1987, Miraculan produced maximum height (42.35 cm) followed by NAA (42.2 cm) and Vipul (41.7 cm). A reduction in plant height was recorded due to application of Paras photosynth, 2,4-D and ABA. Of these, reduction in height caused by application of ABA only was significant. Percentage increase over control was maximum for Miraculan (3.90%) followed by NAA (3.55%) and Vipul (2.33%). Decrease over control was in the order of ABA (8.09%) followed by 2,4-D (5.52%) and Paras photosynth (1.84%).

Table 13. General analysis of variance

Sources of variation		df	M.S.				
			Plant height	Plant spread (N-S)	Plant spread (E-W)	Leaf abnormalities 30 d.a.p.	60 d.a.p
Block	E_1	3	13.27	5.30	7.27	65.96	74.72
	E_2	3	2.38	6.19	6.27	26.03	13.72
Treatments	E_1	6	14.21**	11.34	2.82	362.73**	751.73**
	E_2	7	50.16**	8.42	7.85	723.40*	1127.08*
Errors	E_1	18	3.39	10.37	12.95	42.75	33.95
	E_2	21	9.26	4.61	4.82	5.619	10.54

* $p = 0.05$
** $p = 0.01$
d.a.p. - days after planting

Table 14. Response of chilli var. KAU Cluster to different exogenous chemicals
1. Plant height (cm)

Treatments	Summer 1987		*Kharif* 1987	
	Plant height (cm)	Increase or decrease over control (%)	Plant height (cm)	Increase or decrease over control (%)
Control	40.75	-	37.75	-
Vipul	41.70	+2.33	44.00	+16.55
Miraculan	42.35	+3.90	39.27	+ 4.02
Paras photosynth	40.00	-1.84	36.95	- 2.11
ABA	37.45	-8.09	36.25	- 3.97
CCC	-	-	37.00	- 1.98
NAA	42.20	+3.55	44.30	+17.3
2,4-D	38.50	-5.52	34.80	- 7.81
	CD (p = 0.05)	2.73	CD (p = 0.05)	4.47

During *Kharif* 1987 maximum height was recorded by plants treated with NAA (44.3 cm). This was followed by Vipul (44 cm) and Miraculan (39.27 cm). Of these the increase in height due to application of NAA and Vipul were highly significant. CCC, ABA, 2,4-D and Paras photosynth caused a reduction in height. Maximum reduction was for 2,4-D (7.81%) followed by ABA (3.97%), Paras photosynth (2.11%) and CCC (1.98%) respectively.

2. Plant spread (N-S)

The treatments did not differ significantly during both the seasons (Table 15).

3. Plant spread (E-W)

The treatments did not differ significantly during both the seasons (Table 16).

4. Malformations on leaves, flowers and fruits

a) Leaf malformations

Leaf abnormalities were observed in plants treated with 2,4-D (5 ppm). The leaf size was reduced considerably (Table 17). There was severe lobbing of leaves thus changing leaf shape.

Table 15. Response of chilli var. KAU Cluster to different exogenous chemicals
2. Plant spread (N-S) (cm)

Treatments	Summer 1987		Kharif 1987	
	Plant spread	Increase or decrease over control (%)	Plant spread	Increase or decrease over control (%)
Control	36.10	-	27.60	-
Vipul	36.10	0	29.05	+5.25
Miraculan	32.75	- 9.27	27.80	+0.72
Paras photosynth	31.50	-12.74	27.45	-0.54
ABA	33.50	- 7.20	28.40	+13.58
CCC	-	-	26.65	-0.54
NAA	34.05	- 5.67	31.35	+2.89
2,4-D	33.60	- 6.92	27.45	-3.44
	CD (p = 0.05)	4.78	CD (p = 0.05)	3.15

Table 16. Response of chilli var. KAU Cluster to different exogenous chemicals
3. Plant spread (E-W) (cm)

Treatments	Summer 1987		Kharif 1987	
	Plant spread	Increase or decrease over control (%)	Plant spread	Increase or decrease over control (%)
Control	34.10	-	28.80	-
Vipul	34.20	+0.29	30.40	+5.55
Miraculan	34.35	+0.73	30.85	+7.11
Paras photosynth	32.85	-3.66	27.90	-3.12
ABA	33.95	-0.43	27.85	-3.29
CCC	-	-	26.70	-7.29
NAA	33.20	-2.63	28.70	-0.34
2,4-D	32.10	-5.86	27.75	-3.64

Table 17. Effect of different exogenous chemicals on leaf abnormalities (Summer 1987)

Treatments	30 d.a.p.		60 d.a.p.	
	Leaf abnormalities (%)	Increase or decrease over control (%)	Leaf abnormalities (%)	Increase or decrease over control (%)
Control	31.04	-	52.65	-
Vipul	12.42	-59.98	17.56	-66.6
Miraculan	15.46	-50.19	31.15	-40.83
Paras photosynth	17.66	-43.10	35.27	-33.01
ABA	27.39	-11.75	41.65	-20.89
NAA	24.96	-19.58	58.92	+11.90
2,4-D	40.63	+30.89	41.69	-20.81

d.a.p. = days after planting CD (p=0.05) 9.71 CD (p=0.05) 11.86

During summer, 1987, among the various exogenous chemicals, 2,4-D produced maximum abnormalities (40.63% on 30th d.a.p. and 58.92% on 60th d.a.p). Control plants showed severe symptoms of leaf curl (52.65%). Incidences of leaf curl symptoms were less pronounced in plants treated with triacontanol. The least incidence was for Vipul (17.56%) followed by Miraculan (31.15%) and Paras photosynth (35.27%). NAA and ABA recorded an incidence of 41.69% and 41.65% respectively. Percentage increase over control was maximum for 2,4-D (58.92%). Maximum percentage of decrease over control was noted for Vipul (66.6%) followed by Miraculan (40.83%) and Paras photosynth (33.01%). These three treatments differed significantly from control (Fig. 4).

The percentage of leaf abnormalities due to application of different exogenous chemicals during Kharif, 1987 are presented in Table 18 and Fig. 5. A maximum percentage of leaf abnormality was noted in case of 2,4-D (60.53%). Leaf curl symptoms in control plants were very low during the season (20.78%). The lowest incidence was recorded by Vipul (8.48%) and CCC (8.81%). Miraculan and Paras photosynth showed 14.92% and 15.15% incidence respectively. Percentage increase over control was maximum for 2,4-D (191.28%). Percentage decrease was maximum for Vipul (59.57%) followed by CCC (57.6%). Vipul, Miraculan, Paras photosynth and NAA

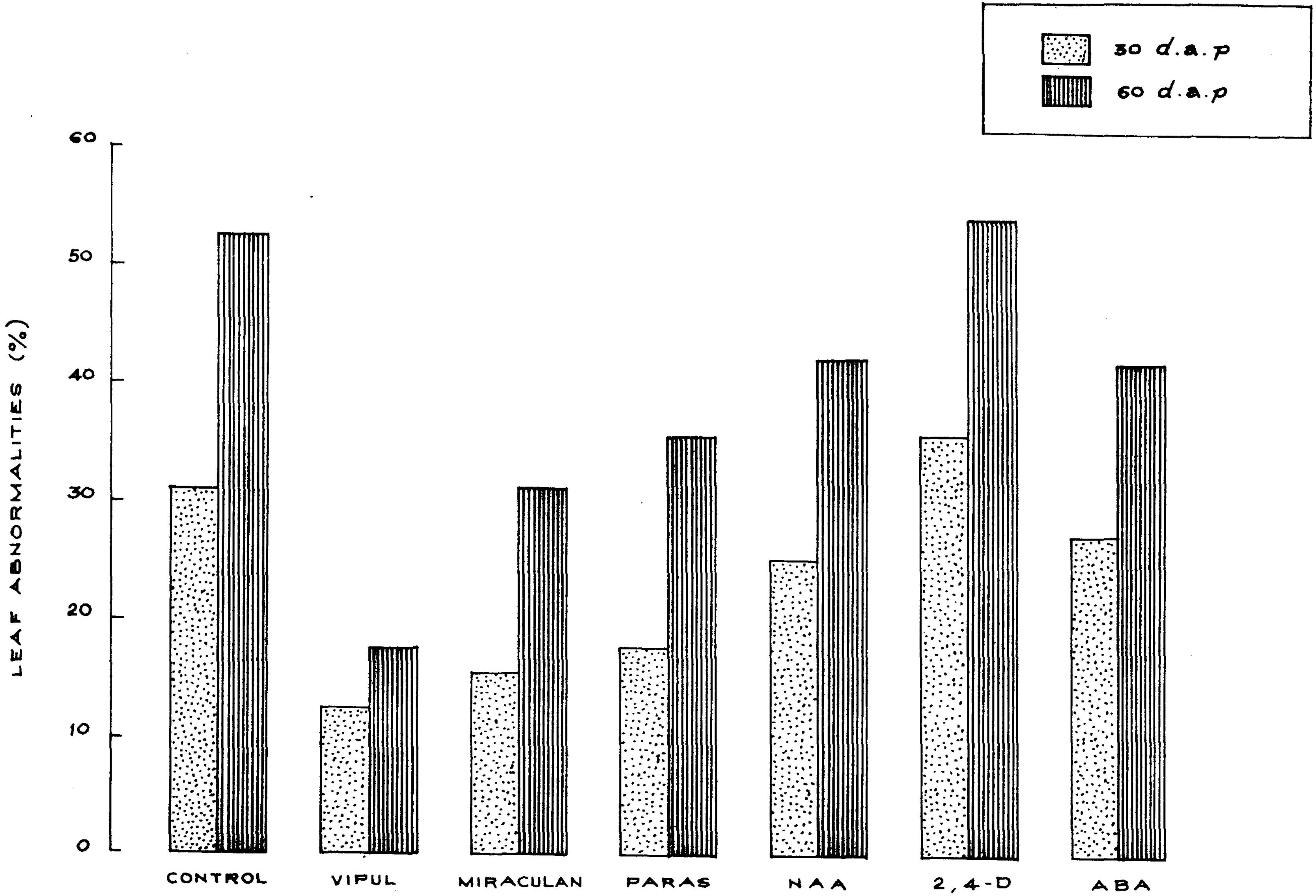


FIG. 4. EFFECT OF EXOGENOUS CHEMICALS ON LEAF ABNORMALITIES DURING SUMMER 1987.

Table 18. Effect of different exogenous chemicals on incidence of leaf abnormalities (*Kharif* 1987)

Treatments	30 d.a.p.		60 d.a.p.	
	Leaf abnormalities (%)	Increase or decrease over control (%)	Leaf abnormalities (%)	Increase or decrease over control (%)
Control	9.33	-	20.78	-
Vipul	3.92	-57.98	8.48	-59.57
Miraculan	4.83	-48.23	14.92	-28.20
Paras photosynth	6.26	-32.90	15.15	-27.09
ABA	7.19	-22.93	18.32	-11.83
CCC	3.41	-63.45	8.81	-57.60
NAA	3.76	-59.69	15.58	-25.02
2,4-D	43.13	+362.27	60.53	+191.28
d.a.p. - days after planting	CD (p=0.05) 3.49		CD (p=0.05) 4.77	

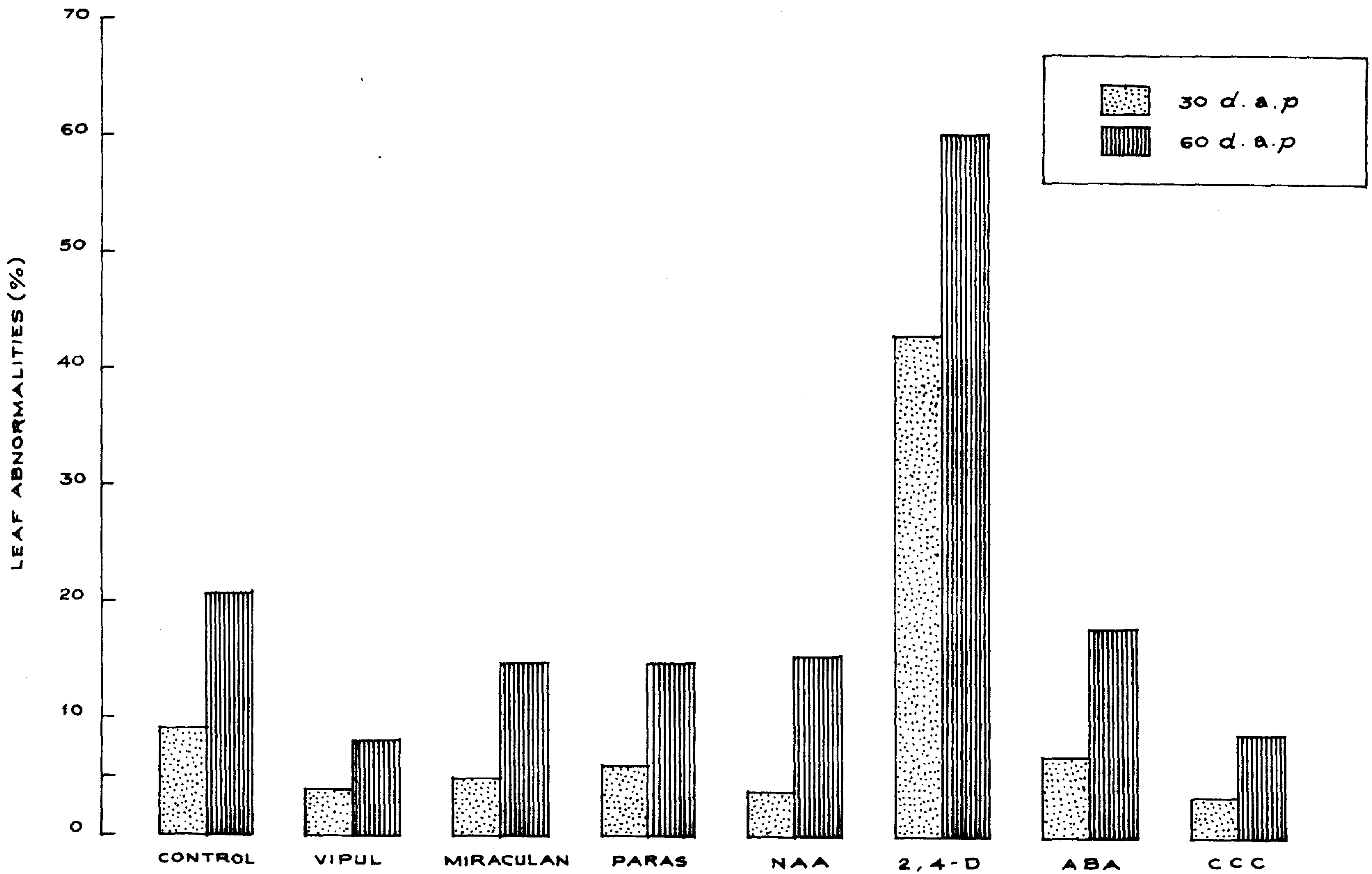


FIG. 5. EFFECT OF EXOGENOUS CHEMICALS ON LEAF ABNORMALITIES DURING *Kharif* 1987.

differed significantly from control. Vipul and CCC were significantly superior to all other treatments. The increase in the incidence of leaf abnormalities due to application of 2,4-D was significantly higher than control.

b) Flower malformations

Malformations on flowers were noted due to application of 2,4-D (5 ppm) (Table 19).

i) Pollen sterility

Pollen sterility increased due to 2,4-D application. A sterility of 45.09% was noted in flowers produced on plants treated with 2,4-D where as it was only 17.81% in control plants.

ii) Short styled flowers (%)

Percentage of short styled flowers also increased by about 10 due to 2,4-D application. The per cent of short styled flowers was 40 in plants treated with 2,4-D where as it was only 30 in control plants.

iii) Average number of ovules

Average number of ovules/cross section of ovary was much lower than control in plants treated with 2,4-D. An

Table 19. Effect of 2,4-D foliar spray (5 ppm) on chilli var. KAU Cluster

Characters	Control	2,4-D
Leaf abnormalities (%)	52.65	60.53
Pollen sterility (%)	17.81	45.09
Short styled flowers (%)	30	40
Average number of ovules	14.2	4.1
Average number of locules	3	2.10
Fruit malformations (%)	5	88.5

Plate 5. KAU Cluster plants exhibiting leaf, flower and fruit malformation due to 2,4-D application

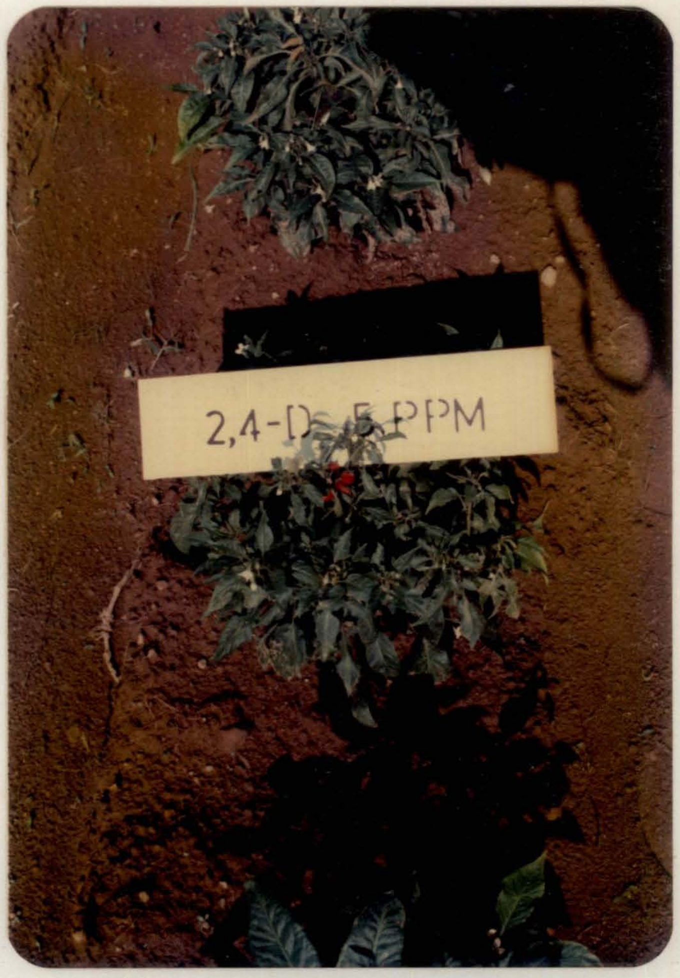


PLATE.5

Plate 6. Malformed fruits due to 2,4-D application

Plate 7. Cross sections of ovaries of (a) normal flower and (b) malformed flower due to 2,4-D foliar spray

PLATE.6.

PLATE.7.

average of 4.1 ovules/cross section of ovary was noted in 2,4-D treated plants where as it was 14.2 in control plants. Degeneration of placenta was observed in ovaries of 2,4-D treated plants at bud stage (Plate 7).

c) Fruit malformations

Severe malformations on fruit shape and size were observed due to 2,4-D application. Percentage of malformed fruits was 88.5. Average number of locules/fruit were also reduced on treating with 2,4-D (2.10 in 2,4-D and 3 in control).

D. Estimation of net returns due to the exogenous chemicals

Economics of application of various exogenous chemicals during summer 1987 were worked out (Table 20). Maximum income was obtained from Vipul (Rs.5040/-) followed by Miraculan (Rs.4800/-) and Paras photosynth (Rs.4740/-. The net income after deducting the additional cost due to application of chemical was maximum for Vipul (Rs.4905/-) followed by Miraculan (Rs.4740/-) and Paras photosynth (Rs.4140/-). Although NAA increased the yield slightly it gave an additional income of only Rs.276.00 over control. Percentage increase over control was maximum for Vipul

Table 20. Net return due to application of various exogenous chemicals during summer 1987

Treatments	Income (Rs./ha)	Cost of the chemicals (Rs.) (Additional cost)	Income after deducting the additional cost (Rs.)	Amount over control (Rs.)	Increase or decrease over control (%)
Control	3630.00	-	3630.00	-	-
Vipul	5040.00	135.00	4905.00	1275.00	+ 35.12
Miraculan	4800.00	60.00	4740.00	1110.00	+ 30.57
Paras photosynth	4740.00	600.00	4140.00	510.00	+ 14.04
ABA	3240.00	75000.00	-71760.00	-68130.00	-187.6
NAA	4020.00	114.00	3906.00	276.00	+ 7.60

Market prices of the various chemicals are given in Appendix-2.

followed by Miraculan, Paras photosynth and NAA respectively. Both ABA and 2,4-D reduced yield considerably. A net loss was observed due to application of the above two chemicals.

The economics of application of various exogenous chemicals during Kharif 1987 were also worked out (Table 21). During this season, maximum returns were obtained from CCC treated plants (Rs.16,770/-) and NAA treated plants (Rs.16,620/-). The income after deducting the additional cost due to the application of the chemical was maximum for NAA (Rs.16,506/-) followed by Vipul (Rs.14,565/-) and Miraculan (Rs.14,340/-). Although the returns were the highest for CCC treated plants, the cost of the chemical was very high, that the application resulted in a loss of Rs.12,420/ha. In case of ABA, although there was an increase over control, there was no advantage, when net returns were calculated due to high cost of the chemical. During this season, net income was maximum for NAA (Rs.7296/-). NAA gave an increase of 79.21% over control.

The data on index of earliness, Bartlett's rate index and yield/plot due to the application of the three most effective exogenous chemicals selected from previous trials are presented in Table 22. Vipul was the most effective treatment during summer, NAA and CCC during Kharif, 1987.

Table 21. Net returns due to application of exogenous chemicals (Kharif 1987)

Treatments	Income (Rs./ha)	Cost of the chemical (Additional cost) (Rs.)	Income after deducting additional cost (Rs.)	Amount over control(Rs.)	Increase or decrease over control (%)
Control	9210.00	-	9210.00	-	-
Vipul	14700.00	135.00	14565.00	5355.00	+ 58.14
Miraculan	14400.00	60.00	14340.00	5130.00	+ 55.70
Paras photosynth	9540.00	600.00	8940.00	-270.00	- 2.93
ABA	11220.00	75000.00	-63780.00	-54570.00	-592.5
CCC	16770.00	38400.00	-21630.00	-12420.00	-134.85
NAA	16620.00	114.00	16506.00	7296.00	+ 79.21

Market price of the chemicals are given in Appendix-2

Table 22. Effect of Vipul, NAA and CCC on index of earliness Bartletts rate index and yield/plot (6 m^2) during summer 1988.

Treatments	Index of earliness	Bartlett's rate index	Yield/plot (g)	
			Yield (g)	Increase or decrease over control (%)
Control	-	0.55	537.40	-
Vipul	1.95	0.55	960.20	78.67
CCC	1.96	0.57	955.80	77.85
NAA	2.04	0.53	925.20	72.16

This trial was conducted during summer, 1988.

a) Index of earliness

Index of earliness was maximum for NAA (2.04) followed by CCC (1.96) and Vipul (1.95). The three treatments did not differ significantly.

b) Bartlett's rate index

The maximum value was given by CCC (0.57) followed by Vipul (0.55). NAA recorded a value of 0.526, which was lower than control (0.55). None of the treatments differed significantly.

c) Fruit yield/plot

Yield was maximum from plants treated with Vipul (960.2 g). This was followed by CCC (955.80 g) and NAA (925.20 g). All the three treatments were significantly superior to control. The three treatments did not differ significantly. Maximum percentage increase in yield over control was for Vipul (78.67%) followed by CCC (77.85%) and NAA (72.16%) respectively.

d) Net returns

Maximum return of Rs.8888.88 was obtained for Vipul

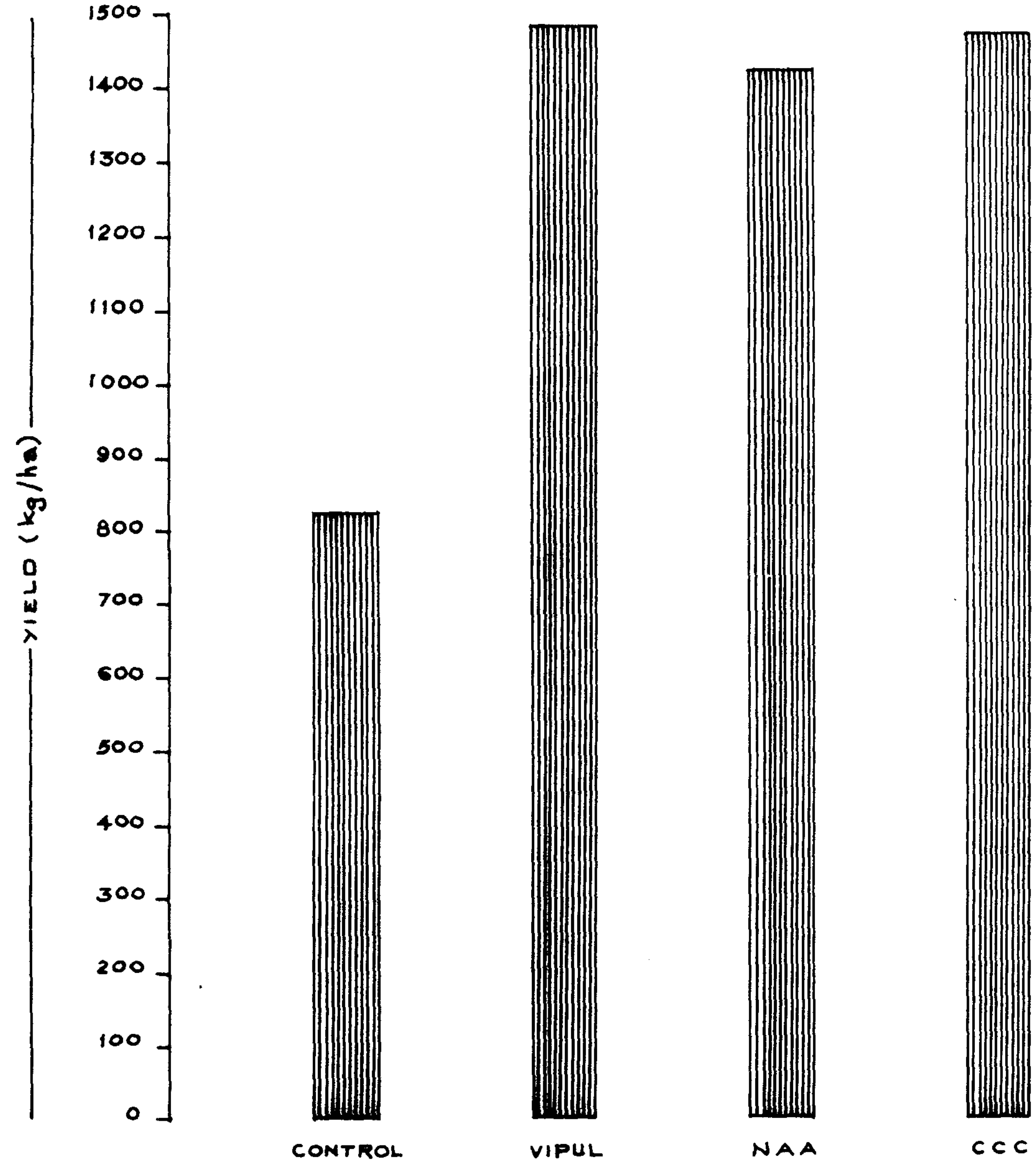


FIG. 6 . EFFECT OF VIPUL, NAA AND CCC ON YIELD (kg/ha)
DURING SUMMER 1988.

followed by Rs.8850.00 for CCC and Rs.8564.82 for NAA application (Table 23). when net returns were calculated, Vipul gave a return of Rs.3777.96 followed by Rs.3474.90 from NAA application. The high cost of chemical led to a net loss in case of CCC application.

Table 23. Net income due to application of Vipul, CCC and NAA during summer 1988

Treatments	Income (Rs/ha)	Cost of the chemical (Additional cost) (Rs)	Income after deducting the additional cost (Rs)	Amount over control (Rs)	Increase or decrease over control (%)
Control	4975.92	-	4975.92	-	-
Vipul	8888.88	135.00	8753.88	3777.96	+ 75.90
CCC	8850.00	38400.00	-29550.00	-24574.08	-493.00
NAA	8564.82	114.00	8450.82	3474.90	+ 69.8

Market price of the chemicals given in Appendix-2

Discussion

DISCUSSION

Enormous variations which can be brought about through judicious application of plant growth substances emphasise the significance of their discovery and usage in crop production. Availability of a number of naturally occuring and synthetic growth regulators opened up new vistas to look for substance(s) with specific actions. The synthetic growth regulators impart their effects by modifying plant growth and development through changes in the endogenous levels of naturally occuring hormones. Embellishing the content of endogenous growth substances by these external sources resulted in improving productivity in a number of commercial crops. In chilli, an increased productivity was made possible by use of chemicals like NAA and ethephon. If a reduction in flower fall, a major limitation in enhancing chilli production, can be effected through use of these substances, it would be highly welcomed. Results of the study conducted to find out extent of flower fall and the effect(s) of plant stimulants, antitranspirants and regulators in controlling it are discussed below.

The variations observed in extent of flower fall, incidence of leaf curl and yield/plant in chilli grown during summer and *kharif* are of a seasonal effect. The poor performance of summer crop resulted from high temperature prevalent during the season. A flower fall percentage of 65.14% was observed under a mean daily temperature of 36.87°C. Gopalaratnam (1933) reported a flower fall of 95% where as Nagaratnam and Rajamani (1963) reported a flower fall of 89%, under Tamil Nadu conditions. Rylski and Halvey (1974) and Song *et al*. (1976) also reported increased flower fall at high day temperature regimes of 20 to 24°C and 29 to 33°C. An increased incidence of leaf curl during summer due to high vector population was also reported earlier by Hosmani (1982) and Menon and Nair (1983). The humidity range of 50 to 90% did not influence the fruit set markedly, as reported earlier by Baer and Smeets (1978). No correlation was noted between flower fall and soil temperature. The temperature of more than 25°C inflicted an adverse effect on fruitset. This is similar to the reports of Chermykh *et al*. (1976). The reduction in early and total yields noted in the present study is the cumulative effect of all the above mentioned factors.

All the seven exogenous chemicals tried in the present experiment caused significant changes in earliness, fruit set (%) and yield. Earliness in flowering and fruit set is an indication of early transformation of plants to reproductive phase. Triacontanol, NAA, CCC and ABA induced earliness though their modes of action varied. In the present study the NAA treated plants were the most earliest. This result is in consonance with the findings of Warade and Singh (1977), Yamagar and Desai (1987). According to Menon (1981) NAA acts through fundamental processes like nucleic acid synthesis, ensyme synthesis and activation. Earliness induced by the three sources of triacontanol might be due to increased synthesis of cytokinin in the roots and their simultaneous translocation to the buds, there by triggering the metabolic processes and narrowing carbon nitrogen ratio (Ries, 1985 and Anon, 1987). In case of ABA and CCC the retardant property of the chemicals might have restricted the vegetative growth causing an early transformation to the reproductive phase. The reduction in the endogenous gibberellin content through application of CCC can also be a possible reason.

An increased fruit set was observed by application of triacontanol, NAA and CCC during both the seasons. This is a natural consequence of the effects of these chemicals in reducing flower abscission. The effect of a chemical to stimulate more number of ovaries and prevention of their subsequent abscission resulted in increased fruit set. Addicott and Lynch (1955) attributed the exhaustion of growth substances as the immediate cause of flower drop. Leopold (1964) proved that auxins are the agents which stimulate ovaries to develop. He also demonstrated that the synthetic auxins induce unpollinated ovaries to develop into full sized fruits. External application of NAA in the present study might have cointeracted the low levels of auxins, leading to increased fruit set through the development of more number of ovaries and retaining them till maturity. The increased fruit set observed due to application of triacontanol was through the stimulation of ovaries to develop, due to the chemicals, thus protecting the natural auxins from enzymatic destruction (Henry and Gordon, 1980). This increased content of native auxins might have prevented the flower abscission. In case of CCC, the retardant and antitranspirant property might have favoured the diversions of more assimilates and water for the reproductive development. This relieved the plants off water and carbohydrate stress which would otherwise have caused an increased flower drop as reported by Rudich (1986).

The yield increase by application of triacontanol, NAA and CCC is a corollary effect of the increased fruit set. Pandita _et al_. (1986) attributed increased synthesis of chlorophyll due to triacontanol application as the cause of increased yield. Increased chlorophyll content resulting from CCC application explains the yield increase due to the application of CCC. The auxin directed translocation of nutrients and photoassimilates as reported by Krishnamurthy (1981) might also have led to the increase in yield in NAA and triacontanol treated plants.

Though ABA acts both as a retardant and antitranspirant, its abscission inducing property dominated resulting in increased flower fall. The endogenous content is already high due to high temperature and water stress. The external application worsened the situation leading to the ultimate reduction in yield.

Studies on effect of exogenous chemicals on the canopy morphology of the plants indicate that the stimulants as well as the regulators increased plant height through their action on enhanced cell division and cell elongation of internodal region. Ries (1985) suggested the triggering of enzymes and secondary messengers by triacontanol resulting in increased plant growth. The growth regulator

(NAA) might have produced effect through its universally accepted property of cell elongation. The retardants ABA and CCC inhibited cell division and cell elongation through prevention of DNA and RNA synthesis resulting in reduced plant height.

The malformations exhibited on leaves, flowers and fruits due to application of 2,4-D during summer and kharif are in consonance with the reports of Zanardi (1956), Jakuskina and Kravcova (1957), Krishnamurthi and Bhandari (1957) and Srivastava (1964). This might be due to the fact that even the concentration of 5 ppm is supra optimal leading to inhibiting effects on the enzyme systems (Mayer and Anderson, 1955).

The relative effects of the various chemicals were worked out from the overall performance of the treated plants (Tables 24 and 25). Vipul was the best chemical during summer indicating that the response of crops to triacontanol is positively correlated with temperature during germination and early development (Ries, 1985). NAA treated plants had a significantly superior performance during kharif. Their poor performance during summer might be an after-effect of the increased incidence of leaf curl. In case of Vipul and CCC, the leaf curl incidence was much lower, due to insect repellent property of Vipul (Anon, 1978) and the production of leaves with thicker epidermal cells by CCC (Foud *et al*., 1977).

The observations and inferences mentioned above lead to the following conclusions. The overall performance of the *kharif* crop is better than the summer crop. Among the various exogenous chemicals, triacontanol Vipul was the best in reducing flower drop during summer. The overall performance of the plants treated with Vipul were the best during summer. Effectiveness of NAA was more pronounced during *kharif*. Application of 2,4-D even at 5 ppm produced deletereous effects. The exorbitant cost of the chemicals completely rules out the possibility of utilising ABA and CCC at high concentrations tried in the present study. This emphasise the need for finding out effective lower concentrations of the chemicals with in the limits of economic feasibility.

Table 24. Overall relative effectiveness of exogenous chemicals on chilli during summer 1987

Plant character → / Exogenous chemicals ↓	Days to fruit set	Index of earliness	BRI	Plant height	Fruit set %	Yield/ plant	Yield/ plot	% of effect- iveness
Vipul	2	1	5	3	1	1	1	66.7
Miraculan	4	2	1	1	2	3	2	64.30
Parasphotosynth	5	3	3	4	4	2	3	42.86
ABA	3	5	4	6	5	5	5	21.43
NAA	1	4	2	2	3	4	4	52.40
2,4-D	6	6	6	5	6	6	6	2.39

Table 25. Overall relative effectiveness of exogenous chemicals on chilli during *kharif* 1987

Plant characters → / Exogenous chemicals ↓	Days to fruit set	Index of earliness	BRI	Plant height	Fruit set %	Yield/ plant	Yield/ plot	% of effect-iveness
Vipul	5	4	2	2	4	3	4	51.03
Miraculan	3	3	1	3	3	4	3	59.20
Parasphotosynth	4	6	6	5	5	6	6	2.10
ABA	6	5	5	6	6	5	5	22.45
CCC	2	1	3	4	2	1	1	71.43
NAA	1	2	4	1	1	2	2	73.50
2,4-D	7	7	7	7	7	7	7	0

Summary

SUMMARY

The present investigation on "Regulation of flowering and fruit set in clustered chilli through use of stimulants, antitranspirants and regulators" were conducted at the vegetable research plots, College of Horticulture, Kerala Agricultural University, Vellanikkara, Trichur during February-May, 1987, July-October, 1987 and January-April, 1988. The experimental material was chilli var. KAU Cluster.

2) The performance of the variety during summer and *kharif* 1987 were compared and the extent of flower fall and incidence of leaf curl were observed. The *kharif* crop performed better than the summer crop with reduced flower fall (47.29%) and leaf curl incidence (20.78%) compared to 65.14% and 52.65% during summer.

3) Vipul, Miraculan and Paras photosynth, three sources of triacontanol, ABA and CCC, two antitranspirants and NAA and 2,4-D, two synthetic growth regulators were sprayed to chilli plants on 15, 30, 45 and 60th days after transplanting. The experimental design was randomised block design. observations were recorded on days to fruit set, index of earliness, Bartletts rate index, fruit set (%), yield/plant and yield/plot from the two trials.

4) The 7 treatments during summer and 8 treatments during _kharif_ 1987 showed significant variation in earliness, fruit set and yield. Among the various treatments, Vipul recorded the highest percentage of fruit set (61.94%) during summer. NAA and CCC recorded the highest fruit set, 84.83% and 84.48% respectively during kharif.

5) Among the vegetative characters considered the chemicals induced significant variation only in respect of plant height. The plant spread in North-South and East-West directions were unaffected.

6) A significant variation was also observed in the incidence of leaf abnormalities due to application of the chemicals. During summer 1987, all the three sources of triacontanol reduced the incidence significantly. This was most pronounced in plants treated with Vipul. Incidence of leaf abnormalities was comparatively low during _kharif_. In this season triacontanol as well as CCC reduced leaf abnormalities considerably.

7) 2,4-D (5 ppm) induced leaf, flower and fruit malformations during both the seasons. The plants were stunted in growth with curled and lobbed leaves. The malformed flowers had a reduced pollen fertility and their

ovaries had lesser number of ovules. Placenta was degenerated. The percentage of short styled flowers also increased due to the treatment.

8) The yield increase noted during summer was maximum for Vipul (37.94%). During *kharif* the maximum yield increase of 48.11% and 46.74% were recorded by CCC and NAA applications respectively. The additional dose of fertilizers applied during summer, 1988 showed a favourable effect towards increasing yields.

9) The efficiency of the chemicals were worked out from the overall performance of the treated plants. During summer Vipul recorded the highest efficiency of 66.7% where as NAA was the most efficient (73.4%) during *kharif*.

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* Originals not seen

Appendices

Appendix-I

Weather data during the period of experimentation

Period	Mean maximum temperature (°C)	Mean minimum temperature (°C)	Mean R.H. (%)	Mean soil temperature (°C)	Sunshine hours
February, 1987	35.6	22.8	57	35.6	10.3
March	36.4	22.2	55	36.2	10.2
April	36.2	25.3	64	37.5	7.97
May	36.1	24.7	66	35.9	8.68
June	30.7	23.7	83	27.6	4.53
July	30.3	23.5	84	25.4	5.67
August	29.6	23.5	87	28.6	3.66
September	31.5	23.9	79	31.1	6.72
October	31.9	23.9	79	30.2	7.66
November	31.6	22.8	77	29.3	8.11
December	31.6	23.3	70	29.3	7.81
January, 1988	32.4	22.0	56	30.4	9.2
February	35.8	23.1	56	36.2	9.8
March	35.7	24.35	67	35.8	10.1
April	35.06	24.28	70	36.8	8.3

Weather data during periods of flowering of summer and *kharif* 1987 (at 10 days interval)

Period	Mean maximum temper- ature(°C)	Mean minimum temper- ature(°C)	Mean maximum humidity (%)	Mean minimum humidity (%)	Soil temper- ature (°C)	Sunshine hours
Summer						
5-15 April	35.3	25.6	81	51.6	37.3	7.6
16-25 April	37.35	25.5	79.9	41.9	38.07	8
26 April-5 May	35.7	25.1	79	49.8	36.2	7.35
6-15 May	36.8	24.2	78.4	49.5	37	10.3
16-25 May	39.2	24.4	81.5	51.4	34.5	7.32
Kharif						
23 Aug-1 Sep	29.5	23.8	94.3	79.3	28.8	4.46
2 Sep-11 Sep	30.8	23.6	91.1	66.6	30.08	9.5
12 Sep-21 Sep	32.1	24.4	89.9	66.5	31.1	7.16
22 Sep-1 Oct	31.6	23.6	91.8	69.7	30.1	5.68
2 Oct-11 Oct	31.8	23.8	88	69.2	30.6	6.8

Appendix-II

Cost of various exogenous chemicals used

Chemical	Cost (Rs.)
Vipul (200 ml)	27.00
Miraculan (100 ml)	15.00
Parasphotosynth (125 ml)	15.00
Naphthalene acetic acid (25 g)	95.00
Abscissic acid (100 mg)	300.00
Cycocel (25 g)	960.00

REGULATION OF FLOWERING AND FRUITSET IN CLUSTERED CHILLI THROUGH USE OF STIMULANTS, ANTI-TRANSPIRANTS AND REGULATORS

By

USHA P.

ABSTRACT OF A THESIS

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Department of Olericulture
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ABSTRACT

Investigations were carried out at the vegetable research plots, College of Horticulture, Vellanikkara, Trichur, during February-May, 1987, July-October, 1987 and January-April, 1988, to find out the extent of flower fall and its possible control through the use of stimulant, triacontanol (Vipul, Miraculan and Paras photosynth), anti-transpirants (ABA and CCC) and growth regulators (NAA and 2,4-D) in chilli var. KAU cluster. The experiment was laid out in a Randomised block design. The various exogenous chemicals were sprayed on 15th, 30th, 45th and 60th days after planting.

Considerable variation was observed in extent of flower fall and incidence of leaf curl during summer and kharif 1987. The control plants recorded a flower fall of 65.14% during summer, where as it was only 47.29% during kharif. Triacontanol (2.5ppm) application resulted in a reduced flower fall during summer. The highest fruit set of 61.94% was recorded by Vipul. NAA (15 ppm) increased fruit set during both the seasons. The increase was more evident during kharif (84.83%). The antitranspirant, CCC

(1000 ppm) also caused an increased fruit set (84.48%) during *kharif*. 2,4-D (5 ppm) and ABA (25 ppm) significantly reduced fruit set.

The incidence of leaf abnormalities was more during summer than in *kharif*. Plants treated with triacontanols and CCC were more or less free of the incidence. 2,4-D application produced some deleterious effects through malformations in leaves, flowers and fruits of treated plants. The leaves were curled, lobbed and reduced in size. The treatment reduced pollen fertility ovule number and percentage of long styled flowers. It also led to degeneration of the placenta.

The highest efficiency of the chemical worked out from the overall performance of the treated plants was for Vipul (66.7%) during summer and NAA (73.5%) during *kharif*.