SOME PHYSICO-CHEMICAL TREATMENTS ON FLOWER INDUCTION IN MANGO

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By

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CERTIFICATE

This is to certify that the thesis entitled "Some Physico-Chemical treatments on the flavor induction in Mango" submitted in partial fulfillment of the requirements for the award of the degree of Master of Science in Agriculture (Horticulture) of the Orissa University of Agriculture and Technology is a faithful record of bonafide research work carried out by Smt Satyamachi Rath under my supervision and guidance and no part of the thesis has been submitted for any other degree or diploma, or published in any other form.

It is further certified that the help and assistance received by him during the course of the investigation have been duly acknowledged.

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CHAPTER I

Introduction

I N T R O D U C T I O N

Mango (Mangifera indica L.) is one of the most ancient fruits of India and is so popular among the people all over the country that it can undoubtedly claim to be the national fruiting of India. The famous fruit is acclaimed as the "king of fruits" as none can compete with it in area, production , nutritive value and popularity of appeal. Occupying an area of 0.75 million hectares with an estimated annual production of 6.9 million tonnes of fruit, mango has the top position among the cultivated fruits of India. It is grown in almost all the part of the country except the high mountainous range of the Himalayas.

Inspite of its topranking position among different fruits grown in the country the crop is unable to develop as a viable commercial concern because of its erratic bearing habit. Mango orcharding as a business therefore does not attract many farmers. Traders also lack confidence in this crop as during bumper year the price becomes very unremunerative and in the lean year there are very little crop for sale. The outstanding problem of the mango, therefore, is to

get a regular crop every year. A good crop of mango is usually obtained once in several years. The Indian mangoes for their wholesome qualities and taste promise a sure market all over the world. But for their irregular habit of cropping neither the growers go for intensive culture, nor the traders hope to develop a steady market.

Irregular cropping or Biennial bearing in Mango is a well known phenomenon needs hardly any explanation. As far back as 1590, Abulfazal, author of Aini-Akbari, while giving an account of this fruit in his treatise mentioned that some trees yielded in one year a rich harvest and less in the next while others have good yield in one year and produced no fruit at all in the following year. Similarly Hartless (1913) writes that he had never heared of any variety of Mango that flowered normally every year. Burns and Prayag (1920) have mentioned that records of Mango crop from 1903 to 1918 taken from Ganeshkhind botanical garden, on the whole, confirmed the belief that mango trees bear heavily only in every alternate years and that in the intervening year the crop is poor. According to them the bearing habit of the tree in alternate years is so regular that the off and on year can be anticipated with certainty, unless ofcourse it is altered by unforeseen circumstances. This

phenomenon is of great importance to the fruit growers as in the 'on' year, due to the abundance of the crop the market is glutted with fruits,while in the'off'year there is very little crop for sale.

The growth behaviour of Mango tree is rather peculiar, unlike many other fruits the growth in Mango in the course of season is periodic rather than continuous i.e. successive periods of growth alternating with quiscence. The appearance of new growth usually termed as flushes. The occurance of flushes during growing season in a year, the date on which they occur and the period over which they extend , vary with varieties, climatic conditions, cultural practices, age of the tree and the amount of crop borne by the tree previously. Each flush, after it is initiated, grows for some time, stops and breaks out again till it finally ceases. The amount of growth produced in one year is again very variable, in some years it is more while in other it is less.

The Mango flowers are borne in panicles at the terminal points of shoots. The terminal bud differentiates in to flowering bud if the subtended vegetative shoot has attained due maturity after making enough growth in the proceeding season. Again seasonal elongation of growth has a direct bearing on fruit bud differentiation.

(Introduction)

The process of growth and development of mango shoots has been recognised to undergo distinct stages (Roy 1953) before the terminal bud transforms in to a reproductive one during the flowering season. These stages are shoot elongation stage or rapid vegetative phase, growth cessation phase, shoot maturation phase, or ripeness to flower stage and then the flower initiations stage. Generally during the rapid vegetative stage the new shoots are produced as extension growth of the previous season shoots during the month of January and February under our conditions. The vegetative growth continues up to August and September though not in the form of shoot elongation but as increase in shoot thickness and then these shoots cease to grow in any manner which may be said as the growth cessation stage. Later on though there is no apparent change in the out ward appearance of the shoot yet the shoot under goes considerable physiological change within. Many workers have reported (Mallik 1953, Singh,L.B 1957 & 1959, Sen et al 1972) that during the period there is a good deal of accumulation in carbohydrate reserves of the shoot, mostly the starch contents and there is also depletion of soluble and non-soluble nitrogenous fractions leading to a build up of a high C/N ratio. This stage is otherwise called as the ripeness state or ripeness to flowering stage which seems to continue up to November and

December. This stage is considered very much essential as at the close of this period the resting bud transforms it-self and develops into flower primordia within and this phase is known as the flower initiation phase.

Many of the vegetative shoots of late occurence as of the July-August flush have been found not to flower during the following flowering season onaccount of missing the required resting and ripening time which seems to be very much essential from the view point of shoot maturity and the consequential accompaniment of the transformation of the vegetative to reproductive structure.

Such shoots do not flower during the spring producing what is called as the'off'year phenomena. later on these shoots get full time for rest and maturity to transform themselves into reproductive shoots in the coming spring, thus setting in the 'on' year phenomena.

The flowering and fruiting in the 'on' year continue to occupy the shoots terminal points till June to July and hence no vegetative flush can appear in them unless and untill these are shed. Thus the vegetative flush in such shoots can only appear by July to August at the earliest after the harvesting of fruits or there may not be any vegetative flush in such shoots till the next spring thus resulting in the 'off' year for the shoots.

(Introduction)

The 'off and on' year phenomena, as explained on the ground of shoot maturity or biochemically due to internal composition of low and high C/N ratio, may be changed by either physical manipulations such as ringing, knotching and defoliating of the current season shoots prior to the critical stage of transformation or by chemical treatments such as application of growth inhibitors or retardants or by both physical and chemical treatments.

Ringing and knotching as a practice for building up high C/N ratio in shoots has been in vogue for some of the biennial bearing varieties of apples. In mango, such studies have also been conducted. Yet the time of the operation, methods etc. have to be standardised after such a practice has been established to yield desired effect.

Application of growth retardants like B-nine, MH, Cycocel and Ethrel etc. has also been claimed to bring about retardation in growth and obtaining early physiological maturity in shoots. Maleic Hydrazide also have been employed to bring down the auxin level and induce flowering in some crop plants Wittwer (1954).

As such application of growth retardants or antiauxins may prove useful in mango causing flower induction. Some favourable results have also been indicated in case of mango (Sen,P.K (1968),S.C.Maity(1969),Das,G.C & Panda,S(1969).

The combination of physical and chemical methods may therefore be expected to produce the desired result in mango.

Although most of the mango varieties are biennial in habit yet none can be so defiant as Langra. This variety is very much popular for its fruits but for its pronounced biennial bearing habit its acreage is coming down. Langra has been studied in great detail with regards to its tree morphology and growth behaviour of flushes and so on where it has been exclusively proved that the shoots require definite rest period for transformation into flower bud.

Hence, there is a good scope to induce flowering in shoots of Langra by forcing same to rest and mature by application of growth retardants and by ringing and knotching of the shoots.

With the above objectives in view the investigation to study the effect of physical, chemical and physio-chemical treatments has been designed with a hope to induce flowering in mango.

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CHAPTER II

Review of Literature

REVIEW OF LITERATURE

Alternate bearing as a problem in Mango :

Alternate bearing in mango as a problem has been recognised and recorded as early as 1590, by Abul Fazal in his book 'Ain Akabari'. According to him, mangoes yielded more in one year and less in the next year, sometime there was a bumper crop followed by no crop at all. Hartless (1913) stated that she had never seen a mango tree which flowered normaly every year. From the 8years yield record taken at Saneshikhind Botanical garden since 1908 to 1916, Burn and Prayag (1920) concluded that the mango tree used to bear a heavy crop in every alternate years and usually poor crops in the intervening years. Wagle (1931) also like wise observed that mango trees were alternate bearers. Naik (1940) by keeping the records for four years of some locally important varieties like Neelum, Mulgoa and Andrews trees found that there were poor or no crops in three years out of four. This problem in mango was focused by a large number of workers (Singh and Khan 1939 ,Jan 1943, Singh1948, Roy 1953, Mallik 1953, Nacksono 1955, Singh 1957, 1960, Garg1960, Naik 1963.

Relation of growth flush to flowering :

According to Singh and Khan (1940) there seemed to be a strong antagonism existing between productivity and growth in the same shoot of the mango in the same year as mango used to bear terminally. There would not be any fruiting in a shoot in any particular year if sufficient vegetative growth had not taken place during the preceding year. They also found a direct relationship between early cessation of growth and fruitfulness. Naik and Rao (1942) held the view that a branch bearing fruit to maturity would not ordinarily putforth new vegetative growth before the next flower season.

Sen (1943) observed that a heavy fruiting in one year was accompanied by a light vegetative growth but if the flowering was prevented by some artificial means then these shoots might produce a heavey vegetative flush early. Importance of early cessation of growth as a precondition for flowering in mango was realised by Singh and Khan (1940), which was also supported by R.S.Roy (1953).

Roy stated that the shoots produced late in the season did not get sufficient time to mature and for that reason did not produce flowers in the following year.

In Hawaii studies carried out by Nakasone et al (1955) revealed that the biennial cycle may be the result of extremely long interval between the vegetative and flowering flushes. According to them an average of eighteen months was found to be necessary between vegetative flush and subsequent flowering and twelve months interval was considered to be an absolute minimum between vegetative and flowering flush.

B.S.Bajwa (1956) observed that the number of flushes appeared during a year differed from region to region and stated that the flushes which came earlier were useful andthey grew well to mature by the time of fruit bud differentiation. He concluded that the tree which put on a good growth early in summer was sure to flower profusely in the following year.

P.C.Mallik (1957) believed that the presence or absence of mixed panicles also affected the bearing habit. It was seen more number of mixed panicles were

present in the regular flowering varieties. The number of mixed panicles was the highest in Fazli, which showed an annual bearing tendency and lowest in Bombai and Langra, the alternate bearing varieties.

Singh,L.B. (1957) concluded that biennial bearing habit in mango was inherent and became more pronounced as the tree got older. He also observed fixed number of growth flushes in biennial varieties but found no such tendency in annual bearing varieties. In biennal bearing varieties fruiting was governed by 'on' and 'off' year conditions while in regular bearer fruiting was small but regular.

Singh R.N. (1959) hold the view that early initiation of flushes, early cessation of growth and definite quiescent period preceding flowering season were vital for fruit bud formation. But he (1959,b) failed to find any relation between the length, girth, and number of leaves per shoot and the fruit bud differentiation. According to him fruit buds could be formed on any new shoot irrespective of their emergence in the regular bearing Baramasia variety and fruit bud can differentiate and develop from any point in the tree irrespective of the size and nature of shoots.

Krishna Swami and Randhava (1961) stated to have observed five shoot growth cycles occuring between mid March and November in the varieties Bushera and Chousa under delhi conditions. Most extension growth was made during the first cycle lasting from March to May. Flowering shoots made most of their vegetative growth early in the season compared to shoots that remained vegetative.

Effect of Physical Treatments on Flower Induction :

Ringing and Knotching :

The importance of proper cultural practices to secure a regular crop has been stressed from very early times for mango. Nagle (1928) was able to increase the number of inflorescences by ringing and knotching in bearing trees but trees in vegetative state did not produce any response. Later in 1931 he was to some extent successful with ringing, manuring and pruning of October and November flush.

Singh and Khan (1940) advocated ringing and root pruning to stop the vegetative growth and promote fruitfulness. Sen (1944) reported that in the areas of

high rainfall, flowering could be induced by ringing provided the plant growth was favourable. Mallik(1951) tried ringing of bark so as to induce flowering. He found a significant increase in flowering in 20 years old Bombai, Langra, and Fazli trees following the removal of rings of bark, one and half inch wide from large branches in the month of August. Manuring without ringing was not much effective in increasing the flowering.

R.Singh and R.N.Singh (1972) reported that girdling might reduce the apical dominance. P.K.Sen, S.K.Maiti and S.C.Maiti (1972) mentioned that shoot decapitation with or without ringing treatment induced axillary flowering in alternate bearing mango cultivar Langra and a regular bearing cultivar Gulabkhas carried out in October, November and December. Gulabkhas was more responsive to the treatment and in Langra relatively more axillary flowering was induced in the 'off' year.

Defoliation :

Defoliation is said to cause delay or restrict flowering and on the other hand promote vegetative growth.

In case of mango Rao and Muthuswami (1953) demonstrated that changing of vegetative bud to flower

bud was possible by decapitation provided it was not accompanied by defoliation. The absence of leaves favoured vegetativeness.

L.B.Singh (1957) explaining the role of defoliation in mango stated that flowering substance seemed to be produced in the leaves but the vital substance might be detained by defoliation.

R.N.Singh and Majumdar (1962) observed that complete defoliation inhibited flowering but partial defoliation favoured flowering. In mango, defoliation studies, were verymuch less in number as compared to apple and other deciduous fruit crops and some of those works are cited below.

Roberts (1923) observed that leaf removal would reduce flower bud initiation in plums. In apples the same effect was noticed by M.H.Haller and Mangness J.R. (1933). In pear, Aldrich, and Work (1934) also observed similar effect but seen that the effect was restricted to the bud in the axil of removed leaf. Davis (1957) stated that on the ringed branches of both apples and Cherries flower formation did not occur until a certain number of leaves had been established. Minis, (1970) stated that

the part removal of Apricot leaves had a very pronounced effect in reducing initiation in leaf axil but more than 50% leaves had to beremoved for inhibition to occur. Automatic leaf shed caused less inhibition than induced leaf removal. It was also reported by Holmicke (1967) that the importance of leaf area played a great role in developing the flowering spurs as it gave rise to very weak spurs in apple which subsequently reduced flowering.

L.D.Singh (1961) reviewing critically different aspects of biennial bearing problem came to conclusion that biennial habit of mango could not be prevented by manuring, irrigation, pruning and control of the disease and pests nor it was affected by vigour of the varieties of major climatic factors like, rainfall, maximum and minimum temperatures. According to him the exact cause of biennial bearing is not known and no hit or miss method is likely to slove the problem.

Time of fruit bud differentiation :

The approximate time of fruit bud differentiation in mango is of utmost importance for planning cultural practices to regulate the extent and intensity of flowering.

Cytological studies carried out by Sen and Mallik (1941) demonstrated that flower bud differentiation under Sabour condition occured during October and November on shoots initiated in March and which ceased their growth in June - July. Mustard and Lynch (1945) also confirmed the above statement. There studies indicated that for most of the years floral bud differentiation began sometimes in September - October and the process steadily progresses without interruption till end of December.

According to studies carried out by Musahib-Ud-din and Dinsa (1946) at Lyllapur the period of fruit bud differentiation in mango ranged from middle of August until the end of October. It was found that the differntiation of flower bud in July flush occured in November. He also observed that flower buds continued to grow slowly through winter while vegetative buds did not.

R.N.Singh (1969) observed that December is the critical time for fruit bud differentiation. According to his report of 1969 fruit bud differentiation occured from middle of August to middle of December. Early cessation and definite period of dormancy were necessary for early fruit bud differentiation. However such typical behaviour used to be the chatacterstics of biennual bearers but not so in regular bearing varieties.

C/N ratio as related to growth and flowering :

That growth and flowering habit of trees are usually controlled by internal nutritional factors was first visualised by Klebs (1902). He believed that the course of plant development seemed to be determined by internal condition and these in turn may be governed by external factors. Further in 1910 his study revealed that the reduction in supply of nutritive salts led to fruitful condition provided there was adequate facilities for photosynthesis for the accumulation of carbohydrates. In 1905 Fisher also indicated that relative high carbohydrate in comparison to available nitrogen was necessary for fruit bud differentiation.

Chandler (1925) assumed that heavy crop resulted in exhaustion of one or more minerals and generally in the reduction of carbohydrates or some from of carbohydrates resulting in the inhibition of subsequent fruit bud formation. He also believed that inhibition of fruit bud formation might be due to the depletion of some essential elements present in minute quantities or might be due to the unfavourable chemical condition prevailing in the shoots like unfavourable carbohydrate content.

However studies conducted by potter and Phillips (1930) on the composition and fruit bud formation in the non bearing spurs of apple, revealed no relation between carbohydrate or nitrogen content to fruit bud formation but they found a steady rise in the starch content as the period for fruit bud differentiation approached, but they assumed that accumulation of starch was not an indication of favourable blossom bud differentiation.

Naik and Shaw (1937) worked on this line in mango. Their preliminary observations on determination of the seasonal variations of carbohydrate and nitrogen contents of Langra shoots couldnot however reveal any relation between the two.

Mallik (1953) working on the bio-chemical investigation in connection with fruit bud differentiation in mango stated to have noticed a sharp rise in the carbohydrate from October - November onwards in the shoots that were expected to flower in the following season. But after flowering during March the reserve carbohydrate used to drop down and continue in the depleted state till harvest. But no C/N ratio has been found to be the one that can favourable influence the folower bud formation.

Bajwa (1956) assumed that the quantity of reserved food in the tree generally effected growth and flowering in mango.

L.B.Singh, (1957) reviewing the literature on nitrition and biochemical factors as related to fruit bud formation in mango indicated that while high carbohydrate nitrogen ratio in mango shoots might be deemed a desirable factors for flowering, but these however, can not be taken as the very basis for inducing flowering in different flushes. Further he in 1959 analysed the chemical composition of shoots in 4 varieties over a 20 month period and indicated that the nutrients status of shoots could not be used as an aid in evaluating the biennial bearing habit of the mango. He concluded that biennial bearing in mango was initiated by some factors other than the concentration of the mineral nutrients. The concentration may only retard or accelerated the intensity of biennial bearing.

R.N.Singh (1960) working on the periodic changes in the chemical composition of shoot and their relation with fruit bud differentiation, revealed that all the mango varieties studied except Baramasia flower bud formation was favoured by high starch reserves and total carbohydrates in the shoot. His findings showing the starch playing an important part in fruit bud formation supported the view of Singh (1957).

Sen et al (1963) while assessing the charbohydrate and nitrogen content of mango shoots inrelation to fruit bud differentiation, indicated that irrespective of the

variety there was a general rise in carbohydrate content of the shoots for November to January i.e. during fruit bud initiation and development period.

Sen, Choudhuri and Basu (1972) reported that the carbohydrate and nitrogen contents of mango shoots in the biennial bearing cultivar Langra were higher in autumn and winter than in summer as was the C/N ratio.

EFFECT OF GROWTH INHIBITORS & RETARDANTS ON THE INDUCTION OF FLOWERING :

Of late, some growth regulants classed under growth retardants like Ethrel, B-nine, Cycocel have been recognised to influence the growth and flowering processes in plants. Growth inhibitors like MH (Maleic hydrazide) are also used now-a-days extensively for its profound influence on plant growth.

Effect of Ethrel on Growth of Crop Plants :

Ethrel has been observed to reduce the length of shoot internode. To this effect Sims and Micchelli (1969) applying Ethrel on pickling cucumber at 250 ppm. concentration observed reduction of internodes length. Iwahori, Lyons and Sims (1969) working with Ethrel reported that ethrel sprayed at 50-100 ppm on SMR-63

cucumber plants grown in glass house at the one leaf stage produced shorter internodes. Murray and Miller (1970) concluded that there was atleast shortening of internodes in eight cultivars of cucurbits by ethrel spray application at 240 ppm concentration. Coyne (1970) observed reduced internode length in squash with Ethrel applied at 250 ppm concentration. Splittstoesser (1970) stated that pumpkin plants treated with Ethephon produced short internode. Benoit (1972) sprayed cucumber cv. brittex with ethrel and observed production of shorter internodes. In 1972 Karchi and Amsko reported that ethephon applied at seedling stage of a monoecious and gynoecious cucumber reduced internode length.

Iwahori, Lyons and Sims (1969) spraying cucumber plants with ethrel produced smaller leaves than control just within one week of treatment. Benoit (1972) however noticed opposite effects. According to him spraying with ethrel on cucumber the leaf development was stimulated even after the first spray.

Vegetative growth in fruit crops such as apple and pear has been observed to be suppressed with foliar sprays of 250 to 1000 ppm of ethephon as reported by Edgerton and Blanpied (1968). Their observations were also supported by Ketchie (1970) who on vigorous grape vines, reduced vegetative growth after mid season foliar application of 1000 ppm ethephone which lowered the labour cost required for pruning and stimulated more uniform cluster maturity as a result of better light penetration.

Effect of B-Nine on Vegetative Growth :

Cathey and Stuart (1961 and Cathey 1963) found reduction in stem elongation of Horticultural plants by treating them with B-nine. Batjer and Williams (1964) observed that application of B-nine had a pronounced reduction in shoot growth. The degree of growth reduction was related but not proportional to the concentrations of the chemical. Similarly, inhibition of shoot elongation in Pea was observed due to the application of this chemical to shoot tips (Reed et al 1965). As per Edgerton and Hoffman(1965) foliar application of B-nine at 2000 to 5000 ppm applied to 3 year of old apple

trees in mid June reduced the growth by 40%. Joiner and Sheoran (1965) noticed shorter stems and smaller bracts in B-nine treated plants and found no growth differences in high and low level of the chemical. Luckwill and Weaver (1966) concluded from their experiment that B-nine was an inhibitor of extension growth in apple over concentration range of 200 to 2000 ppm, when applied 3 weeks after bloom. In cherries 2000 ppm B-nine sprayed in spring curtailed shoot elongation and induced early production of anthocyanin in fruits (Ryugo,K. 1966). Jonkers (1966) stated that earliest applications of 2500 ppm - 5000 ppm of B_9 at the time of flowering reduced twig length and leader shoot length in apple. It also reduced the overall dimensions of the tree. Cyuzo, Namori and Geissler (1970) in Hungary, reported that Alar reduced shoot growth by 40 to 60% and shortened the internodes and promoted flower initiation when applied at 3000 to 10,000 ppm to the trees on which yields were limited by insufficient blossoms. Sprays applied at higher concentration after harvest in 1965 delayed flowering in the following spring and caused mortality of fruit buds and individual flowers. Alar applied shortly after

full bloom in 1966 retarded shoot elongation more effectively than the post harvest sprays applied at the previous autumn. But both promoted fruit bud and differentiation. Stembridge and Forree (1969) and Barden (1968) reported that Alar suppressed the total growth increment in old stem approximately to equal extent as the decrease in new stem.

The growth inhibition induced by alar depend on both the concentrations and the time of application. The best growth inhibition induced by Alar was obtained with treatment when average shoot length was 20 to 25 cm. The average number of leaves per shoot declined as the degree of growth inhibition increased. (Schumacher and Frankhauser 1969). Malbro, S and Monson L.A. reported that alar reduced the shoot growth in the following spring when sprayed in apple tree in September at 0.1 to 0.2% concentration.

Wilde, and Edgerton reported in 1969 that Alar spray at 1000 ppm concentration caused histological abnormalities associated with extreme shortening of internodes.

Alar (B_9) reduced the terminal growth by reducing internode length but increased flower bud initiation when applied with 1000 to 8000 ppm to the

Cherry (Unrath, C.R et al 1969), Ranch and Mattestede reported that trees treated slightly after the flowering with Alar made only about half as much as terminal growth as unsprayed trees. In the year following Alar treatment however the growth of the treated trees was significantly greater than that of the control trees indicating that alar would have to be applied every year to control trees also effectively. High concentration of Alar, greatly increased the amount of bloom on these trees in the year following treatment. Williams and Schomer (1970) reported that Alar with Ethrel applied to non bearing trees reduced terminal growth and enhanced spur development in apple trees.

Effect of Cycocel (CCC) on Plant Growth :

Medliberska. I, reported in 1969 that the CCC was used for checking excessive vegetative growth and promoting cropping in pear and apple trees . Donna(1962) found that cycocel retarded stem elongation of both the bust and vine forms of cucumber and squash. Kuraishi and Muir (1963) recorded a reduction of 50% in stem length in CCC treated alaska pea plant at 1600 ppm.

Hill (1966) recorded 18% shortening of plants due to foliar spray and soil application of cycocel to tomato plants. The effect of the chemicals lasted for 3-4 weeks, after which the plant growth returned to returned to normal. Similarly Klapwijk (1966) observed inhibition of plant growth in tomato due to foliar application of CCC in pot culture trial.

Mirocka and Zobrowicki (1966) reported decreased growth rate of tomato plants when a soil application of 250 mg of CCC per plants was given after 15 days of sprouting under greenhouse. In bean, foliar spray of 250 ppm cycocel inhibited the growth of stem as reported by Michulewicz and Lamparska (1966).

Van Emden and Cockshull (1967) noticed that increasing CCC concentration progressively decreased the height of brussels sprout plants so that those treated with 2% CCC were only half as much as the height of the untreated plants at the end of the experiment. Lingraj and Srinivasan (1967) found soil applications of cycocel at 5000 ppm produced short, stocky and heavier bean plants as compared to control. Tolbert (1960) observed darker green foliage and increased leaf chlorophyll content in cycocel treated green house grown tomato plants. Tso. and Jeffrey(1961)

noticed smaller and darker green leaves in CCC treated tobacco plants. Tiesson (1962) found that soil drench application of CCC to tomato plants produced shorter darker compact plants with reduced foliage.

Repeated sprays of cycocel at 5000 ppm greatly reduced apical dominance in Langra Mango (Maiti, Mukhopadhay and Sen 1971).

Effect of MH on Growth of crop plants :

As per Schoene and Hoffman (1949) application of MH to young tomato plants resulted in their cessation of growth and inhibition of apical dominance. The length of inhibitory period appeared to be directly proportional to the concentration used and afterthe quiescent period growth resumed from lateral buds. It had also a temporary inhibiting effect both on vegetative growth and flowering in tomato, tobacco and the maize (Naylor 1950). Bose and Hamner (1960) opinedthat tomato plants treated with this compound exhibited temporary inhibition of growth. The root developments were affected and the plant height and

number of leaves were less than the control plant . Foliar application of 1000 . Mh to young tomato seedling resulted in the inhibition of vegetative and reproductive growth. Other effects that followed were retardation of shoot elongation, increase in stem diameter and reduction in number of leaves (Srinivasan and Hamner 1962).

The pyracantha hedge sprayed after clipping with 0.5% MH checked new shoot growth for a month and greatly reduced growth for several months (Knott, 1950). Macilrath (1950) spraying cotton plants with 2400 and 4800 ppm MH observed cessation of apical or terminal growth of the main stem and the growth renewed from developing vegetative laterals. Erickson et al (1952) reported that MH delayed the growth of orange and grape fruit trees at 1000 to 5000 ppm, reduced fruit diameter and produced more fruits per trees. Smygin (1954) concluded from his experiments that 0.4% MH inhibited growth of lemon seedlings for five months and increased frost resistance. In 1953, Hamner and Rol observed that application of 0.2 to 0.4% MH reduced growth in Honey Suckle, Red maple and chinese elm.

Spraying Mango trees with 0.4 to 0.6% MH in the 'on' year in December to January, Singh(1963) found that terminal buds were damaged and in the following March axillary buds sprouted and produced vegetative shoot. Working on lemon plants, Hield et al (1962) observed that 500 to 1000 ppm MH exhibited leaf epinasty and abscission of shoot tips. When 1.0% MH was sprayed on elm trees just after pruning, very little new growth appeared (Bell 1962) MH, also applied inhibited regrowth of lemon. (Aron 1962) Wear (1963) stated that MH inhibited growth of suckers at 5000 ppm when applied to lemon trees after top pruning. Okasha,Khalifa and Crane (1962) noticed that MH at 1000 to 2000 ppm applied in May on apricot and peach killed terminal of shoots. Higher concentrations killed tips of shoots and reduced growth by 40 to 60%.

Many workers have reported that MH inhibited apical dominance in plants. White D.C. (1952) observed that 0.3% MH sprayed to four years old apple trees in the spring inhibited terminal growth and forced lateral buds. This treatment produced dwarf

trees as compared to check. Whitter (1954) reported that MH spray inhibited terminal growth, stem elongation and apical dominance. On the other hand it stimulated lateral bud development in plants.

It had also been reported that MH sprays inhibited growth of terminals and development of apical buds in ivy when applied after trimming (North et al 1968).

Jankiewicz (1960) observed that application of 1200 ppm MH produced 4-6 branches in one year old apple trees. Jauhart and Prasad (1963) experimented the effect of 200 ppm, 400 ppm and 800 ppm of MH on 50 days old brinjal plants and confirmed that MH inhibits apical dominance.

Effect of Ethrel on Flowering :

Edgerton and Greenhagh (1968) reported that the new growth regulator ethrel when applied to apple and peach branches or young trees at several stages from pre-bloom to harvest, invariably checked vegetative growth and promoted flower bud formation in some cases. He also reported that fall and spring applications of 250 to 2000ppm of ethephon to apple and pear trees suppressed vegetative growth in some cases which was further supported by Katochio and Williams (1969) , William M.W. (1970)

and Cliftors and Porreyo (1970). They reported that ethephon treatments to induce flower bud formation also promoted earlier bearing or controlled biennial bearing habit.

Costa and Pillai (1973) stated that ethephon at 200 ppm applied one month before harvest appeared to reduce the number of mixed bud differentiated in the year of treatment but to raise it in the following year.

Chacko, Kohli and Randhawa, (1972) reported that varying concentrations of 200 to 2000 ppm ethrel tried on the 25 year old Langra tree induced early and heavey flowering. But Ethrel treatment produced the following abnormal effect such as flower in (i) production of 3 to 5 axillary panicles directly from last year fruiting stumps (ii) Large number of mixed leafy panicles (iii) emergence of large number of panicles from the dormant buds situated in woody branches. Nakata (1970) reported that ethephon promoted earlier flowering of mango which was also supported by Dutcher (1970).

Cooke, and Randall (1968) the evidence of the practical importance of ethrel and has reported that spraying pineapple plants with ethephon at rates of 1to4lb/A has generally induced 100% flower formation. The flowering response is hastend with the higher rates.

Stuart (1963) demonstrated that application B-nine caused suppression of vegetative growth and promoted initiation of flower buds. It also delayed flowering in petunia by 3-7 days and the response to dosage range of 0.5 to 5% was found to be without any toxic effect (Cathey and Malorin 1963). Edgerton and Hoffman (1965) found that foliar spray of B_9 at 2000 to 8000 ppm applied prior to flowering in mid June delayed bloom by 1 - 3 days in apple and resulted in higher fruit set as compared with control. Shutak (1966) opined that 500 to 8000 ppm of B-nine delayed blossoming and fruit drop, increased fruit color and reduced fruit size in apple. Dennis (1968) reported that B-nine retarded growth in both one year and two year old apple and pear seedlings and prompted flowering in the later.

In fruit trees such as apples, pears and sweet cherries more flowers are produced on trees sprayed with B_9 (Batjer and Williams 1963) Shanks and Link (1963) reported that foliar applications of B-nine to hydrangea increased inflorescence size. Foliar sprays of B-nine at 2000 to 8000 ppm applied to 3 years old apple trees in mid June promoted formation of flower buds and 15% of terminals flowered the next year as compared to 0.6% in

control and Edgerton et al (1965) and Maguire and Kitchin et al (1965) stated that all treatment of B-9 increased flower bud formations in Rhododendron. Rennix et al (1966) noticed an increased percentage of terminals with flowers due to two applications of B-nine.

Effect of Cycocel on Flowering :

Maiti, Mukhopadhyay and Sen (1971) stated that repeated sprays of cycocel at 5000 ppm greatly reduced and promoted flowering in Biennial bearing Langra mango. B_9 at the same concentration had similar but very slight effect. B-9 (500 - 1000 ppm) and cycocel (1000 - 2000ppm) applied in aqueous solution thrice at fort night intervals to the trees when they were in active state of growth during an off year, the result were very promising with all the 4 treatments. All of these increased the percentage of shoots flowering in the following spring but only cycocel at 2000 ppm increased the number of fruits harvested per treated limb (Maiti S.C and Sen,P.K; 1966), Seeman(1972) gave a comparative statement that CCC was more effective in retardation of growth in pear as Alar in apples. Early treatment was more effective than late treatment. Maiti, Basu and Sen (1972) reported that chloromequat and aminozide each at 1000,2000,4000 ppm were applied

to 4 and 21 year old mango cultivar Langra(Alternate bearing) and Baramasia (regular bearer). CCC treatment significantly reduced growth, irrespective of plant age or cultivar and promoted flowering in both cultivars but particularly in Langra. It had beneficial effect on fruit set and retention in young Langra plants only.

Effect of MH on Flowering :

MH at 0.005% delayed blossoming of raspberries by one week and at 0.2% flowering was delayed by a month, White (1950). According to Tukey and White (1950) application of this compound has also delayed flowering in berries, Peaches, Plums, and Cherries. Naylor and Davis (1950) reported that application of 0.025% to 0.2% MH solution delayed flowering to a great extent in wheat, maize, tobacco, tomato and cotton plants. Singh (1961) found that emergence of panicles in mango was delayed by almost a month but the fruits ripened at the same time as control. Investigation carried out by Jauhari and Prasad(1963) revealed that application of 400 and 800 ppm MH delayed flowering in Brinjal.

MH has been found to influence flowering in Peaches by arresting vegetative growth and nullifying

the inhibiting action of apical bud, Marth et al(1947). Mitchel and Cullinan (1951) and White (1950) reported inhibition of flowering for 4 - 8 weeks in black raspberry with MH sprayed before the flowers were visible.

Stuart (1962) noticed that application of MH, Cycocel and Phosphono -D caused suppression of vegetative growth and promoted initation of clusters of flower buds. Sen, Bhaduri and Lahiri (1962)stated that 50 to 5000ppm MH applied in November indicated a positive effect in inducing mixed panicles in Mango and these increased with increasing concentration of MH.

CHAPTER III

Materials and Methods

MATERIALS AND METHODS

The present investigation on the effect of physical, chemical and physico-chemical treatments for flower induction in mango was carried out in the Horticultural Research Station of the Orissa University of Agriculture and Technology during the year 1973-74. The various aspects of the study were to know the extent of retardation or check in growth, extent of flowering and earliness in the flowering time due to effect of such treatments.

LOCATION OF THE ORCHARD :

The orchard is located about 5 km. away from Bhubaneswar at a latitude of 20° 15'N and 80° 52' E. It is about 60 km. away from the Bay of Bengal having an altitude of 25.6 meters above the mean sea level.

The climate of the place is usually warm and humid. The summer months are unusually hot but the winter is comparatively milder. The data on weather conditions showing maximum and minimum temperature, maximum and minimum rainfall, sunlight hours, windvelocity and relative humidity etc. have been presented in the Table No.1.

Soil of the orchard is mostly sandy and sandy loam type with high iron content characteristic of red soil. The soil is deep, well drained and acidic with a pH of 4.7.

Table .. 1

Weather data from October 1973 to April 1974 at the Horticultural Research Station, OUAT., Bhubaneswar.

Sl.No.	Month	Rainfall in mm.	Relative Humidity in %	Mean Temperature °C	Wind Velocity km/hour
1	2	3	4	5	6
1	October	335.8	86.0	23.6	17.3
2	November	39.6	71.5	18.0	14.8
3	December	47.5	66.5	14.3	6.5
4	January	0.0	6.4	14.1	5.0
5	February	0.0	58.5	17.3	7.1
6	March	64.7	65.5	21.8	7.9
7	April	1.0	68.8	26.0	10.5

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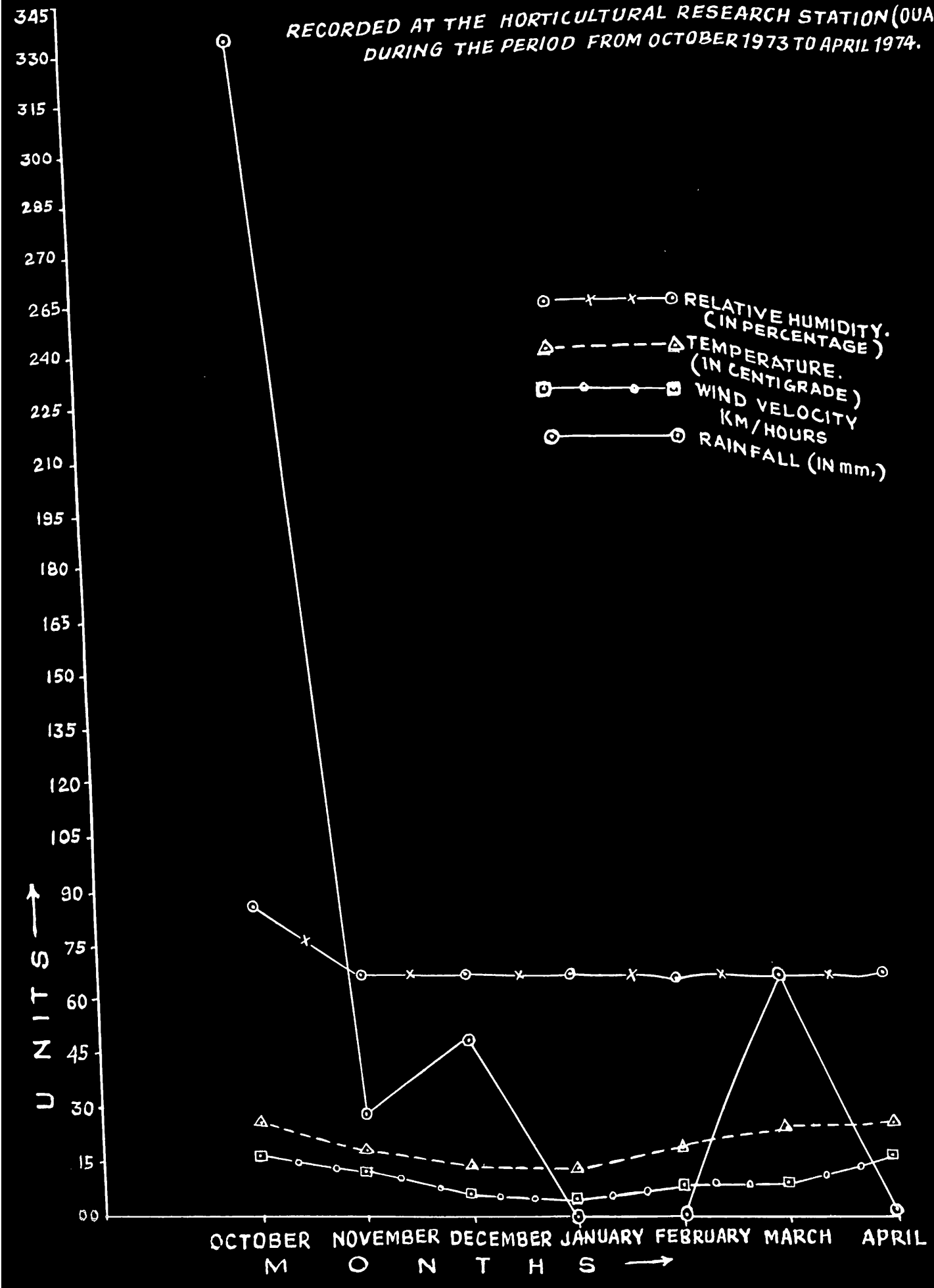
CLIMATOLOGICAL OBSERVATIONS

RECORDED AT THE HORTICULTURAL RESEARCH STATION (OUAT)
DURING THE PERIOD FROM OCTOBER 1973 TO APRIL 1974.



(Materials and methods)

SELECTION OF THE TREES :

Three Langra trees were selected for the above investigation. They were healthy and vigorous and were of the same age, size, shape and bearing performance. These trees were situated in the middle of the Orchard and as such were enjoying equal sunlight, wind velocity and uniform cultural treatments.

TREATMENT SCHEDULE :

Physical Treatments :

The Physical treatments were (i) Ringing (ii) Knotching and (iii) Defoliation of shoots.

(i) Ringing :

Ringing consisted of removal of bark, 3 to 5 cm. wide, in the form of a ring from the lower part of a stem representing one to two year old shoot as indicated by its greyish brown colour of the stem. The stem thickness at the point of ringing might be about 3-5 cm. also.

(ii) Knotching :

In knotching, a part of bark along with some amount of surface wood are to be removed so as to form a knotch. The length of knotch may be 3-5 cm. with a width of 3 cm. at the centre. The size and age of shoot in locating the knotching site are exactly the same as in ringing.

(Materials and methods)

(iii) Defoliation :

Defoliation consists of removal of leaves from the upper portion of the shoot representing the current season growth.

Experimental Design :

The experiment was conducted with four treatments, including control as one, in a randomised block design having five replications.

CHEMICAL TREATMENT :

Recently some growth retarding chemicals providing means for suppressing growth and inducing flowering in a wide variety of plants have been recognised. Among the most commonly used growth retardants the following chemicals were used for the present experiment.

(i) 2 Chloroethane phosphonic acid (Ethrel)
(ii) N dimethyl amino succinamic acid (Alar)
(iii) 2 chloroethyl trimethyl ammonium chloride(CCC)
(iv) 1,2 Hydropyridomine - 3, 6 - Mono (MH).

Ethrel was tried at concentrations of 200,400,600ppm. Alar was used in varying concentrations of 1000,3000 and 5000 ppm. The strength of cycocel used were 1000,3000 and 5000 ppm respectively. MH also was tried with 1000,1500 and 2000 ppm concentrations.

(Materials and methods)

Experimental design :

Randomised block design was followed in this experiment with 13 treatments, which included four chemicals and each of them were tried in three levels thus accounting for 12 treatments and the rest one was control where only distilled water was sprayed. There were five replications in all.

PHYSIO-CHEMICAL TREATMENTS :

These treatments were combinations of chemical applications with ringing. The mid concentrations chosen for the chemical treatments were selected to carry out this investigation. Therefore 400 ppm Ethrel, 3000 ppm each of Alar and Cycocel and 1600 ppm IAA were used on ringed shoots.

Experimental design :

The experiment was conducted with five treatments, including control as one, in a randomised block design having five replications.

SELECTION AND LABELLING OF THE SHOOTS :

For each of the three experiments, one tree was earmarked. Five limbs of uniform size per tree was selected at random covering the whole of tree surface.

Each limb was considered as one replication. Ten healthy shoots were selected from one branch of the limb to represent one treatment. Labels were prepared showing the experiment number, replication, treatment and shoot number.

SPRAY APPLICATION :

The required concentrations of aquous solutions were prepared from different chemicals by diluting the concentrated chemicals supplied by the respective firms. The shoots of different treatments were sprayed with required chemicals till the leaves were fully drenched shoots representing control were sprayed with distilled water only. The first spraying was undertaken on the 15th of October 1973 and the second spraying was given on the 1st November, just after a fortnight of the first spray.

OBSERVATIONS :

Observations on shoot length, basal diameter or thickness of shoot, number of leaves and cumulative leaf area of shoot time of flowering extent of shoots flowered and sex ratio etc. were recorded month wise beginning with 15th of October and ending on 15th April.

The extension in length was measured by a metre scale and the diameter of the basal portion of the shoot was measured by thickness gauge or dial. The cumulative leaf area of shoot was found out by measuring the length

and breadth of leaves with the help of a meter scale in pursuance of the "Length and width product method" of Ackley et al (1959). This length width product was multiplied by 0.76 to get the accurate leaf area. The factor was derived by determining the area of a sample number of leaves with the graph and planimeter and dividing the area by length width product of the leaves.

The effect of growth substances on sex expression in mango was studied by adopting the following procedure for finding out total number of flowers in an inflorescence.

From one of the selected trees, four panicles were selected at random and numbered serially by tagging. The total length of the flower bearing surfaces was measured and recorded on the main, secondary and tertiary rachii. In order to ascertain the total number of flowers daily count was taken from time to time when the flowers actually started opening on each panicle till the flowering was over. Counting was done in the evening between 4 to 5.30 P.M. by which time opening of flowers for the day were usually over. After each count the opened flowers were removed carefully. After the completion of counting the entire flowers in each panicle, the number of flowers per centimeter of flower bearing surface was calculated

by dividing the total number of flowers by the total length of the flower bearing surface. The sex ratio was calculated by dividing the number of male by perfect flowers.

BIOCHEMICAL STUDIES :

For biochemical studies of shoots under different treatments with regards to their total carbohydrate content, total nitrogen content and the C/N ratio were estimated thrice, the first being in the month of October, the second during January and the 3rd in the month of April.

The estimation of sugar was taken up as per Synogi (1945) method and the total nitrogen estimation was carried out as per microkjeldahl method given in I.C.A.R. (C.A.S). C/N ration was obtained by dividing the content of total carbohydrate with total nitrogen.

METHOD OF ESTIMATION SUGARS :

Somogyi's method (1945) was followed in the estimation of sugars in the plant material.

Somogyi's phosphate sugar reagent was prepared as described below. Two litres of the reagent contains -

(Materials and methods)

(a) 56 gms. of Anhydrous disodium hydrogen phosphate.

(b) 20 gms. of Rochelle salt (potassium-sodium tartarate) Hochcook, Hochcooks.

(c) 200 ml. of sodium hydroxide (N).

(d) 160 ml. of copper sulphate ($5H_2O$) (10% strength).

(e) 360 gms. of Anhydrous sodium sulphate.

(f) accurately weighed 0.1 N KIO_3 of 200 ml. (3.5670 of A.R. Salt per litre).

In about a litre of distilled water, 56 gms. of anhydrous disodium hydrogen phosphate and 20 gms. of Rochelle salt, were dissolved 200 ml. of NaOH were added to it, followed by a slow addition of 160 ml. of 10% $CuSO_4$ $5H_2O$. After the $CuSO_4$ is completely dissolved, 360 gms. of Anhydrous Sodium sulphate were added and brought into solution with vigorous stirring. The solution was transferred to a two litre volumetric flask and exactly, 200 ml. of 0.1 N KIO_3 (3.5670 gms. of A.R Salt/litre) were added. The KIO_3 solution was prepared with quantitative accuracy. After addition of iodate solution, the solution was made up to two litre mark. It was stored in a cool dark place for about 10 days, and then filtered through Buchner funnel using filter pump. The funnel and flask were washed and dried before hand. The first 50 ml. of the filtrate was discared. The reagent now ready for use and was stored in a

cool dark place. It was 0.01 N with respect to KIO_3.

ESTIMATION OF TOTAL SUGARS :

Extraction :

Extraction of sugars from dried material was carried out by cold extraction method. 250 mg. of dried material and 20 ml. of 80% alcohol was taken in a sample tube and kept on boiling water bath for half an hour. After 24 hours the supernatant liquid was decanted off. Then the cold extraction procedure was followed by 60% alchhol.The process was repeated allowing 24 hours of extraction in each grade of alcohol viz. 40%, 28% and distilled water. The final extraction was done to include fructosans which are insoluble in alcohol. The extracts were made upto a volume of 100 ml. from which an aliquot of 50 ml. was taken for subsequent process of clarification.

Clarification :

A 50 ml. aliquot was taken in a 100 ml. beaker and the alcohol was evaporated over a water bath. The beaker was however not allowed to dry out completely. After the alcohol was removed, 1 ml. of lead acetate

solution was added to precipitate the colloidal substances and the colouring matters. The content of the beaker were filtered down through Whatman No.1 filter paper into an another beaker containing 3 ml. of saturated solution of disodium hydrogen phosphate so as to precipitate the excess lead acetate in the form of lead phosphate. To remove the lead phosphate the content of the beaker was again filtered through Whatman No. 42 filter paper and the clear filtermate was collected and made up to the volume of 100 cc. in a volumetric flask.

Hydrolysis :

An aliquot of 20 ml. from the clarified solution was taken in a 50 ml. volumetric flask, 3.6 ml. of 2 Normal hydrochloric acid was then added in the volumetric flask and the flask was placed in a boiling water bath for half an hour for inversion of nonreducing sugars. After half an hour the flask was taken off and cooled andthe excess acid was neutralised with 0.5 N sodium hydroxide solution using a drop of methyl red indicator. The solution was made slightly acidic by adding a drop of 0.5 N acetic acid and then the volume was made up to 50 ml.

Titration :

10 ml. of sugar solution was taken in a test tube and 5 ml. of Somogyi's reagent was added. 5 ml. of distilled water was also added washing down the sides of the test tube. Blanks with 5 ml. Somogyi's reagent and 10 ml. distilled water were taken. The tubes were then kept in a hot boiling water bath for 15 minutes. After cooling, exactly 1 cc. of 2.5% KI and 3 ml. of 1.5 N. sulphuric acid were added so as to bring cuprous oxide to the solution. The excess iodide was titrated against 0.005 N. $Na_2S_2O_3$ using 1% starch solution as indicator. The amount of 0.005 N. sodium thiosulphate consumed by iodine was obtained by subtracting the volume of sodium thiosulphate of the sugar solution from that of blank.

The thiosulphate solution was prepared by dissolving 37.3 gms. of pure crystalline sodium thiosulphate in a litre of boiled and cooled distilled water. The stock solution was stored in a conical flask wrapped with black paper. 0.5 ml. of chloroform was added to the solution and then the rubber stoppered flask was placed in the refrigerator. After a week the solution was standardised according to the method described by Vogel (1951).

Reactions during the estimation of sugars :

At first the disaccharide sucrose is hydrolised to glucose and fructose by boiling with HCl. The reactions that take place during the estimation of sugars are as follows -

The $CuSO_4$ acting with NaOH produces the compound of cupric hydroxide, $Cu(OH)_2$ as shown below -

$CuSO_4 + 2\ NaOH = Na_2SO_4 + Cu(OH)_2$

$Cu(OH)_2$ reacts with reducing sugar when boiled to produce cuprous oxide.

$R{\cdot}CHO + 2\ Cu(OH)_2 = R{\cdot}COOH + Cu_2O + 2H_2O$

When KI and H_2SO_4 are added, the following reactions take place -

$3H_2SO_4 + 5KI + KIO_3 = 3K_2SO_4 + 3HI + HIO_3$

$5HI + HIO_3 = 3I_2 + 3H_2O$

The liberated iodine oxidises the Cu_2O as cupric iodide $2Cu_2O + 2I_2 = 4CuI + O_2$

Iodine reacting with $Na_2S_2O_3$ gives a quantitative value of sodium tetra thionate.

$2Na_2S_2O_3 + I_2 = 2NaI + Na_2S_4O_6$

When thereaction is going on, the starch indicator reacts with iodine giving a deep blue colour which disappears giving a pale green colour of cupric iodide.

Determination of starch :

Starch on acid hydrolysis gives a quantitative yield of D-Glucose, and thus the glucose can be estimated by Somogyi's reagent method.

The alcohol insoluble material left over in the sample tubes after the extraction of sugars was thoroughly washed and dried. 50 mgs. of the material were accurately weighed and taken in hard glass test tubes followed by 20 cc. of distilled water and 1 cc. of concentrated HCl. It was then boiled in water bath for two and half hours regularly stirring the content while boiling. Then the solution was cooled, filtered and neutralised with 2 N.NaOH and then rendered with 0.5 N. CH_3 COOH, then transferred to a 100 cc. volumetric flask and made up the volume of 100 cc.

Titration :

The same procedure as described earlier in the Somogyi's method of estimation of sugars was adopted in the estimation of starch.

Amount of reducing sugars multiplied with 0.90 gave the amount of starch present. The percentage of starch is expressed on dry weight basis.

Reactions :

$$CuSO_4 + 2NaOH = Na_2SO_4 + Cu(OH)_2$$

$$R.CHO + 2Cu(OH)_2 = R.COOH + Cu_2O + 2H_2O$$

$$3H_2SO_4 + 5KI + KIO_3 = 3K_2SO_4 + 5\ HI + HIO_3$$

$$5\ HI + HIO_3 = 3I_2 + 3\ H_2O$$

$$2\ Cu_2O + 2I_2 = 4\ CuI + O_2$$

$$2Na_2S_2O_3 + 2I_2 = 2\ NaI + Na_2S_4O_6$$

ESTIMATION OF NITROGEN :

The total nitrogen estimation was carried out as per microkjeldahe method given in I.C.A.R. (C. A. E).

Reagents required :

(a) Conc. H_2SO_4 (Sp.Gr. 1.84)

(b) Digestion mixture :- 10 parts of R.G. potassium sulphate and one part of A.R cupric sulphate were ground separately to fine powder from in a porcelain mortar and pestle. Those two chemical powders were thoroughly mixed on a clean butter paper andkept in a clean and dry wide mouthed bottle.

(c) Standard 0.02 N sulphuric acid.

(d) Mixed indicator :- To a 0.5 gm of bromecresol green 10 ml. of 0.1 N NaOH was added and this was made up to 500 ml. with distilled water. To 0.25 gm. of methyl red

1.5 ml. of 0.1N NaOH was added and the volume was made up to 250 ml. with distilled water, 150 ml. of methyl red bromocresol green solution was mixed with 50 ml. of methyl red solution and made up to 400 ml. with ethanol. This was stored in brown stoppered bottle.

(e) Boric acid solution (5%) :- 50 gms of reagent grade Boric acid was dissolved in 500 ml. of boiling water and was made up to 2500 ml. To this 50ml. of mixed indicator as mentioned above was added and stored in coloured bottle.

(f) NaOH 50% - one kg. of NaOH flakes was added slowly with stirring to 200 ml. of distilled water in a porcelain pot and this was allowed to cool. Then it was filtered through glass wool and stored in vinclaston bottle.

(g) Salicylated sulphuric acid :- 10 gm of R.G. salicylic acid was added to 500 ml. of conc. H_2SO_4 (Sp. gr. 1.840) and was stored till the same was dissolved.

Procedure :

About 0.1 gm. of dried and ground plant samples of mango leaves were taken into 30 ml. dise clean and dry pyrex made kjeldhal flask. To it a quarter ten

spoonful of digestion mixture was added. After that 3.4 ml. of salycilated sulphuric acid was added followed by the addition of Na_2-thiosulphate . At first the flask was heated slowly till the cessation of frothing and then it was strongly heated till the content of flask become clear, and bluish green. Heating was continued for another 15 minutes to insure complete digestion. Then it was collected and diluted with 15 ml. of distilled water. After this it was swirled and allowed to stand till the contents were cold. Then the whole digestion was transferred with two to three washings into the microkjeldhal distillation apparatus to it 10 - 15 ml. of 50% NaOH solution was added and then it was steam distilled for ammonia for 3 - 5 minutes. The evolved ammonia was led into 20 ml. boric acid solution contained in a 100 ml. conical flask. Then the resulting ammonia was titrated against standard 0.02 N H_2SO_4 solution to a pink end - point.

Calculations :

1 ml. of 0.02 N H_2SO_4 = 0.00028 gm of Nitrogen.

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CHAPTER IV

Experimental Findings

EXPERIMENTAL FINDINGS

(A) PHYSICAL TREATMENT :

There were four treatments in this experiment, such as Ringing, Knotching, Defoliation and control, which may be termed as T_1, T_2, T_3 and T_4 respectively for the sake of convenience.

Length of Shoot :

Observations on length of shoots in different treatments were recorded monthwise starting from the month of October and ending in April. The data pertaining to this character is recorded in the Table No. 3 and graphically illustrated in Figure II(a).

In the month of October the average length of shoots representing various treatments was almost comparable ranging between 19.34 cm. in the control to 20.72 cm. in the defoliation treatment (T_3). The shoots after October did not increase in length either in the month of November or December in all the treatments.

In the month of January increase in shoot length was again observed in all the treatments, though not equally. The respective average shoot length for

T_1,T_2,T_3 and T_4 were 20.65,21.33,22.62 and 20.93 cms. and the corresponding increase in shoot length were 0.80, 1.49,2.10 and 1.58 cms.

In the month of February, it was noticed that for the treatment T_1 the shoot length was 20.87 for T_2 it was 21.62 for T_3 it was 23.23 and for T_4 it was 21.61. Their increase over October was 1.12, 1.78,2.51 and 2.27 cms. respectively for T_1, T_2,T_3 and T_4 .

The shoot length as observed in March was 20.90,21.66, 23.37 and 22.06 cms. for T_1,T_2,T_3 and T_4 respectively. The corresponding increase over October were 1.15, 1.82, 2.65 and2.72 cms.

Final observation in April indicated that the shoot length were 20.95, 21.85,23.67 and 22.24cms. respectively for T_1, T_2, T_3, and T_4. The corresponding increase for these treatments were 1.25, 2.01,2.75 and 2.30 cms.

Thickness of Shoots :

Observation on the thickness of shoots recorded from October to April was shown in table No. 3 and graphically represented in the Figure III(a).

In the month of October the diameter of shoots at reference points for different treatments

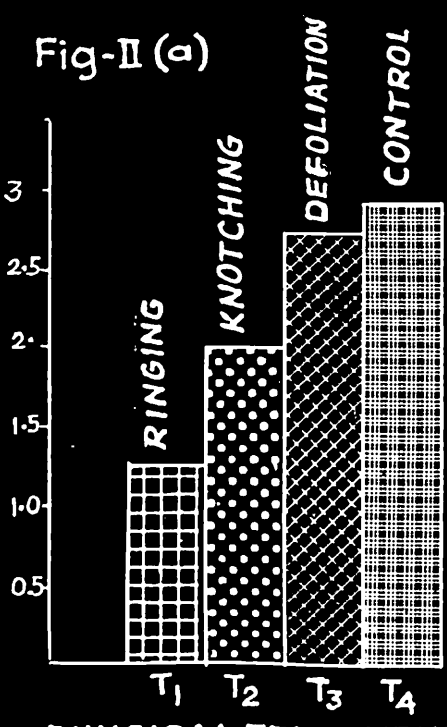
Table -2

Effect of Physical Treatments such as Ringing, Knotching and Defoliation on length of shoots (in cms.) and their increase over October (figures in brackets) shown monthwise from October - April, 1

Treatments		Oct. 1973	Nov. 1973	Dec. 1973	Jan. 1974	Feb. 1974	Mar. 1974	April 1974
Ringing	T_1	19.75	19.75	19.75	20.65	20.87	20.90	20.9
		-	-	-	(0.90)	(1.12)	(1.15)	(1.25
Knotching	T_2	19.84	19.84	19.84	21.33	21.62	21.66	21.8
		-	-	-	(1.49)	(1.78)	(1.82)	(2.01
Defoliation	T_3	20.72	20.72	20.72	22.82	23.23	23.37	23.4
		-	-	-	(2.10)	(2.51)	(2.65)	(2.75
Control	T_4	19.34	19.34	19.34	20.92	21.61	22.06	22.2
		-	-	-	(1.58)	(2.27)	(2.72)	(2.90
F 'Test'	...	N.S.	N.S.	N.S.	Sig.	Sig.	Sig.	Sig
S.E. (m)	...	-	-	-	0.0014	0.024	0.028	0.05
C.D.	...	-	-	-	0.18	0.112	0.136	0.25

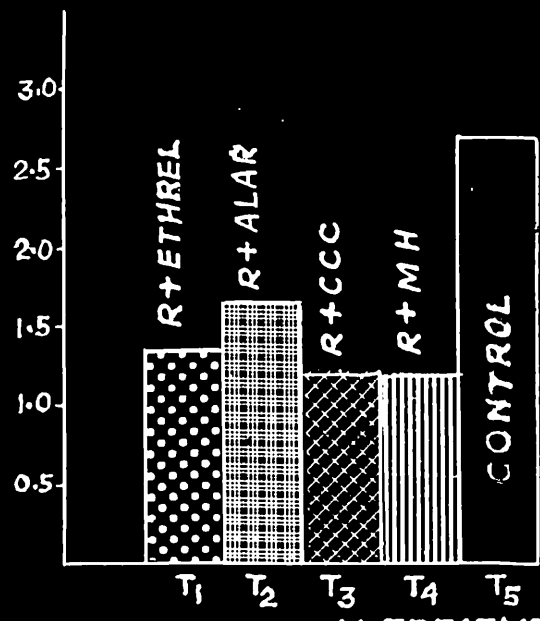
HISTOGRAMS SHOWING THE INCREASE IN LENGTH OF SHOOTS AS OBSERVED IN THE MONTH OF APRIL OVER THE MONTH OF OCTOBER [IN CENTIMETERS]

Fig-II (a)



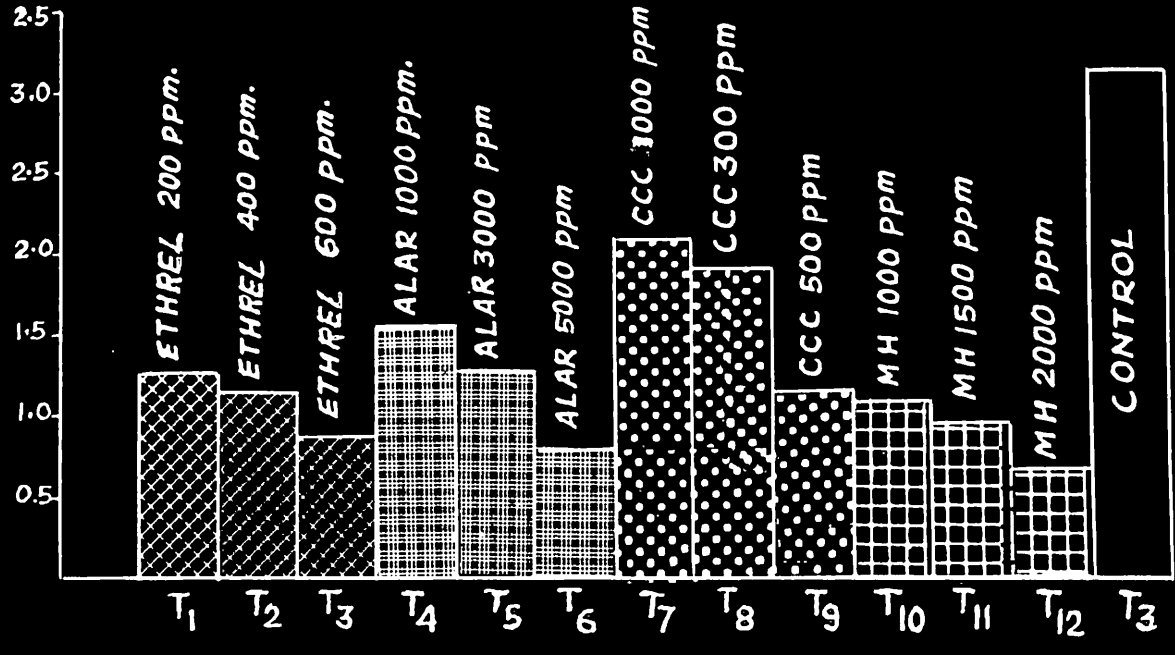
PHYSICAL TREATMENTS

Fig-II (c)



PHYSICO-CHEMICAL TREATMENTS.

Fig-II (b)



CHEMICAL TREATMENTS

were 0.216, 0.314,0.342 and 0.257 respectively for T_1,T_2,T_3 and T_4 and there were no further change in this attribute during the month of November, But in the month December again the thickness increased, the diameter at reference point were 0.218,0.315,0.343 and 0.257 inches for T_1,T_2,T_3 and T_4 respectively and the corresponding increase over October observation were 0.002,0.001,0.001,and 0.000 inches.

In the month of January, the thickness of sheets in T_1 were 0.242 with an increase of 0.026 in T_2 were 0.337 with an increase 0.023 , 0.368 with an increase of 0.016 inches for T_3 and 0.267 with an increase of 0.012 inches in T_4.

The thickness of sheets as observed during February for the treatment T_1,T_2,T_3,T_4 were 0.274, 0.348,0.367 and 0.275 inches respectively and the corresponding increases were 0.032 , 0.034, 0.026, and 0.018 inches over October observation.

For the month of March the respective thicknesses were 0.308,0.365,0.376 and 0.293 for T_1,T_2,T_3 and T_4 with the corresponding increase of 0.032,0.071,0.34 and 0.000 inches.

(Experimental Findings)

Table - 3

Effect of physical treatments such as ringing, knotching and defoliation on the thickness of shoots (in inches) and their increase over October (figures in the brackets) shown month wise from October to April.

Treatments	Oct. 1973	Nov. 1973	Dec. 1973	Jan. 1974	Feb. 1974	Mar. 1974	April. 1974
Ringing T_1	0.216	0.216	0.218	0.242	0.274	0.308	0.345
	-	-	(.002)	(.026)	(.058)	(0.092)	(.129)
Knotching T_2	0.314	0.314	0.315	0.337	0.348	0.385	0.389
	-	-	(.001)	(.023)	(.034)	(.071)	(.075)
Defoliation T_3	0.342	0.342	0.343	0.359	0.367	0.376	0.395
	-	-	(.001)	(.016)	(.025)	(.034)	(.053)
control. T_4	0.257	0.257	0.257	0.267	0.275	0.286	0.303
	-	-	-	(.012)	(.018)	(.029)	(.046)
F 'Test'	N.S	N.S	N.S	N.S	Sig.	Sig.	Sig.
S.E (m)	-	-	-	-	0.01	0.011	0.01
C.D	-	-	-	-	0.033	0.037	0.045

(Experimental Findings)

Final observation in April indicated that the increments in the thickness of shoots for the different treatments were 0.129, 0.085, 0.053 and 0.046 respectively for T_1, T_2, T_3, T_4 and at that time the corresponding thickness were 0.345 , 0.399, 0.395 and 0.303 inches.

Number of leaves :

The average number of leaves recorded in different treatments is shown in Table - 4 and illustrated in Figure -IV (a). The initial records as seen in the month of October were 8.08, 8.14, 8.36 and 7.60 representing T_1, T_2, T_3 and T_4 and the some average were maintained up to month of January. But in February the number of leaves in different treatments increased which were 14.13, 15.78, 9.98 and 15.60 respectively for T_1, T_2, T_3 and T_4 and the corresponding increases over October in those treatments were 6.06, 7.64, 0.98 and 8.00.

No further increase in number of leaves were seen in the month of March and April.

Extent of flowering :

The extent of flowering, expressed in percentage, as observed in different treatments during February to March is shown in Table -5 and the data graphically illustrated in Figure V(a).

Table -4

Effect of Physical treatments on number of leaves/shoot and their increase over October, shown monthwise from October to April. (Figures in brackets indicates increase in number over October)

Treatments.	Oct. 1973	Nov. 1973	Dec. 1973	Jan. 1974	Feb. 1974	Mar. 1974	April. 1974
Ringing T_1	8.08	8.08	8.08	8.08	14.13	14.13	14.13
	-	-	-	-	(6.05)	(6.05)	(6.05)
Knotching T_2	8.14	8.14	8.14	8.14	15.75	15.75	15.75
	-	-	-	-	(7.61)	(7.61)	(7.61)
Defoliation T_3	8.36	0.00	0.00	0.00	9.98	9.98	9.98
	-	-	-	-	(9.98)	(9.98)	(9.98)
Control. T_4	7.60	7.60	7.60	7.60	15.60	15.60	15.60
	-	-	-	-	(8.00)	(8.00)	(8.00)
F 'Test' ..	N.S.	N.S.	N.S.	N.S.	Sig.	Sig.	Sig.
S.E (m) ..	-	-	-	-	0.031	0.031	0.031
C.D. ..	-	-	-	-	0.152	0.152	0.152

(Experimental Findings)

The average values in percentage as recorded in different replications along with their corresponding angular values are also shown in the same table.

It may be seen that the average extent of flowering recorded T_1,T_2,T_3 and T_4 were 42.58,24.25, 5.14 and 4.53 percent respectively.

Sex-ratio :

Data pertaining to sex-ratio as observed under different treatments during the flowering period in February to March is presented in Table-17. The sex-ratioes were 1.921, 1.902, 1.286 and 1.945 for the treatments ringing,knotching, defoliation and control respectively, with the corresponding male flowers of 663, 742, 630 and 642, and the perfect flowers of 345, 390, 360 and 330.

Biochemical studies :

Biochemical observations relating to content of total carbohydrates, including reducing and nonreducing sugars and starch, total nitrogen and their ratioes in different physical treatments are recorded in Table-6.

Observations were taken thrice, first in October, second time in January and finally in the month of April. In different treatments reducing sugar content

Table -5

Effect of Physical treaments on the extent of flower induction in percentage shown in replication wise. (Figures in brackets indicates the respective angular values)

Treatments		Repl.I	Repl.2	Repl.3	Repl.4	Repl.5	Repl.6 Means
Ringing	T_1	32.9	38.0	46.0	46.3	49.7	42.58
		(35.00)	(38.06)	(42.71)	(42.88)	(44.83)	(40.69)
Knotching	T_2	22.8	17.4	22.7	37.8	30.4	24.22
		(22.52)	(24.65)	(22.45)	(31.82)	(33.46)	(29.38)
Defoliation	T_3	1.00	3.6	5.1	6.5	9.6	5.14
		(5.74)	(10.78)	(16.64)	(18.91)	(22.46)	(14.88)
Control.	T_4	1.20	3.2	3.25	6.25	8.15	4.53
		(7.71)	(10.31)	(10.47)	(14.42)	(16.84)	(11.69)
F 'Test'	..			Significant.			
S.E (m)	..	1.002					
C.D.	..	4.886					

varied within 3.391, to 3.492 in the month October. The same was seen to range between 2.921 and 4.312 in January and finally in April it is seen to vary from 3.127 to 3.262 for most of the period ringing had the highest content and defoliation had the lowest.

The non-reducing sugar content at the beginning was in between 0.842 to 0.873 in the month of October which increased in most of the treatments in January to above 0.9 except the defoliation where it decreased to 0.427. Again in April, all the treatment indicated lower values ranging between 0.792 and 0.799.

The total sugar content initially ranged in between 4.237 and 4.341 in October which increased in January ranging between 4.614 and 5.236 in all the treatments except defoliation where the value was 3.343. In April these values were seen to decrease which ranged between 3.926 and 4.011 , the former was seen in the defoliated treatment and the later was in ringing.

The starch content varied between 11.385 to 11.483 in the month of October while these ranged between 10.275 and 12.251 during January and the former was observed in defoliated shoots. Again in April the starch contents were seen to lower down and ranged between 10.532 and 10.737.

TABLE - 6

Biochemical Observations in leaves of physical treatments.

	Treatments		Reducing sugar.	Non-reducing sugar.	Total sugar.	Starch	Total Carbohydrate.	Nitrogen	C/N Ratio
OCTOBER	Ringing ..	T_1	3.455	0.873	4.328	11.438	15.766	2.388	6.602
	Knotching ..	T_2	3.492	0.849	4.341	11.385	15.726	2.421	6.495
	Defoliation	T_3	3.391	0.846	4.237	11.421	15.658	2.223	7.043
	Control ..	T_4	3.412	0.842	4.254	11.482	15.736	2.412	6.524
JANUARY	Ringing ..	T_1	4.313	0.924	5.236	12.251	17.487	2.113	8.275
	Knotching ..	T_2	4.125	0.917	5.042	12.179	17.221	2.102	8.192
	Defoliation	T_3	2.921	0.427	3.348	10.275	13.623	1.927	7.069
	Control ..	T_4	3.721	0.893	4.614	11.927	16.541	2.015	8.208
APRIL	Ringing ..	T_1	3.217	0.794	4.011	10.579	14.590	2.212	6.595
	Knotching ..	T_2	3.216	0.792	4.008	10.557	14.565	2.107	6.912
	Defoliation	T_3	3.127	0.799	3.926	10.727	14.653	2.112	6.937
	Control ..	T_4	3.242	0.793	4.035	10.532	14.567	2.109	6.907

(Experimental Findings)

The total carbohydrate content varied between 15.632 and 15.766 in the month of October which increased to range between 16.541 and 17.457 in the month of January except the defoliation sheet where the content actually decreased to 13.623. Again in April the carbohydrate contents decreased over January value which remained within the range of 14.565 to 14.683 .

In general the carbohydrate content was more in the ringed sheets during January but again in April defoliation indicated the highest level.

The nitrogen content of leaves ranged between 2.223 and 3.421 in the month of October which remained almost the same during January observation except the defoliation treatment which recorded a lower value of 1.027 against 2.223 as observed in October. The April observations also indicated almost identical figures as observed in October and January.

The C/N ratio ranged in between 6.496 and 7.043 in the month of October which increased invariably in January except the defoliated sheets where the value was seen to be the minimum (7.069). The April observation indicated a decreasing trend of C/N ratio over the findings of October.

(B) CHEMICAL TREATMENTS :

In this experiment, there were 13 treatments such as application of three levels each of Ethrel, Alar, Cycocel, MH and one control. These treatments were Ethrel 200 ppm (T_1), Ethrel 400 ppm(T_2),Ethrel 600 ppm (T_3) , Alar 1000 ppm (T_4), Alar 3000 ppm(T_5), Alar 5000 ppm (T_6),Cycocel 1000 ppm (T_7), Cycocel 3000 ppm (T_8) and Cycocel 5000 ppm (T_9), MH 1000ppm(T_{10}), MH 1500 ppm (T_{11}) and MH 2000 ppm (T_{12}) and control(T_{13}).

Length of Shoot :

The data obtained for the length of shoot indifferent treatments are shown monthwise in Table-7 and graphically illustrated in the Figure -II(b).

In the month of October the length of shoots were seen to range from 15.20 in T_{10} to 20.20 in T_9 . There were no increase in length of shoot for the month of November and also December.

In the month of January the length of shoot increased and it ranged between 19.96 (T_{10}) and 21.82(T_7) and the increase was the lowest in T_{12} indicating 0.5 cm increase only and the highest in control (T_{13}) showing an increase of 1.78 cm.

In the month of February the shoot length was ranging from 19.65 (T_{13}) to 22.12 (T_7) and the increase in shoot length was highest in T_{13} (control)

Table - 7 : Effect of Chemical Treatments on length of shoots (in cms.) and their increase over October(figures in the brackets) shown month wise from October -April.

Treatments	Oct. 1973	Nov. 1973	Dec. 1973	Jan. 1974	Feb. 1974	Mar. 1974	April. 1974
Ethrel 200 ppm T_1 ..	17.19 -	17.19 -	17.19 -	18.13 (.94)	18.18 (.99)	18.34 (1.25)	18.34 (1.25)
Ethrel 400 ppm T_2 ..	18.38 -	18.38 -	18.38 -	19.10 (.72)	19.14 (.76)	19.53 (1.15)	19.53 (1.15)
Ethrel 600 ppm T_3 ..	18.58 -	18.58 -	18.58 -	19.14 (.56)	19.19 (.61)	19.41 (.83)	19.41 (.83)
Alar 1000 ppm T_4 ..	19.30 -	19.30 -	19.30 -	20.58 (1.28)	20.73 (1.43)	20.83 (1.53)	20.83 (1.53)
Alar 3000 ppm T_5 ..	19.70 -	19.70 -	19.70 -	20.69 (.99)	20.72 (1.02)	20.95 (1.25)	20.95 (1.25)
Alar 5000 ppm T_6 ..	19.80 -	19.80 -	19.80 -	20.34 (.54)	20.40 (.60)	20.55 (.75)	20.56 (.75)
CCC 1000 ppm T_7 ..	20.10 -	20.10 -	20.10 -	21.88 (1.78)	22.13 (2.03)	22.25 (2.15)	22.25 (2.15)
CCC 3000 ppm T_8 ..	19.04 -	19.04 -	19.04 -	20.20 (1.16)	20.30 (1.26)	20.93 (1.89)	20.93 (1.89)
CCC 5000 ppm T_9 ..	20.80 -	20.80 -	20.80 -	21.76 (.96)	21.81 (1.01)	21.95 (1.15)	21.95 (1.15)
MH 1000 ppm T_{10} ..	15.80 -	15.80 -	15.80 -	16.54 (.74)	16.66 (.86)	16.85 (1.05)	16.85 (1.05)
MH 1500 ppm T_{11} ..	17.36 -	17.36 -	17.36 -	18.08 (.72)	18.18 (0.82	18.28 (.92)	18.28 (.92)
MH 2000 ppm T_{12} ..	16.14 -	16.14 -	16.14 -	16.64 (.50)	16.65 (.51)	16.79 (.65)	16.79 (.63)
Control T_{13} ..	17.74 -	17.74 -	17.74 -	19.52 (1.78)	20.06 (2.32)	20.89 (3.15)	20.89 (3.15)
F. 'Test' ..	NS	NS	NS	Sig	Sig	Sig	Sig
S.E.(m) ..	-	-	-	0.044	0.05	0.033	0.033
C.D. ..	-	-	-	0.103	0.209	0.097	0.097

having an increase of 2.32 cms.

The length of shoot varied from 16.79 in T_{12} to 22.25 in T_7 in March. The increase in length of shoot was the lowest in T_{12} showing an increase of 0.68 only as against 3.15 case of control. There were however no change in shoot length during April.

Thickness of shoots :

The data on thickness of shoots were tabulated, month wise from October to April and given in Table -5 and illustrated in Figure -III (b). The average thickness of shoots for October ranged in between 0.225 and 0.309 inches and for November there was no further increase in the shoot thickness, but during the month of December the thickness again increased which ranged in between 0.295 in T_{13} (Control) and 0.322 in T_{12} and the actual increase in thickness over October was 0.097 inches in T_{12} and 0.015 inches in T_{13}.

In January there was further increase in thickness which ranged from 0.021 in T_{13} to 0.016 in T_{12} and the corresponding shoot thicknesses were 0.301 inches in T_{13} and 0.331 inches in T_{12}.

In the month of February the thickness of shoots ranged between 0.290 in T_1 and 0.350 in T_{12}.

(Experimental Findings)

Table - 8

Effect of Chemical Treatments on the thickness of the sheet (inches) and their increase over October (figures in the brackets) shown month wise from October to April.

Treatments	Oct. 1973	Nov. 1973	Dec. 1973	Jan. 1974	Feb. 1974	Mar. 1974	April. 1974
Ethrel 200ppm T_1 ..	0.251 -	0.251 -	0.268 (.017)	0.275 (.024)	0.290 (.039)	0.294 (.043)	0.299 (.048)
Ethrel 400ppm T_2 ..	0.260 -	0.260 -	0.282 (.022)	0.286 (.026)	0.299 (.039)	0.308 (.048)	0.317 (.057)
Ethrel 600ppm T_3 ..	0.235 -	0.235 -	0.268 (.033)	0.268 (.033)	0.281 (.046)	0.314 (.079)	0.324 (.089)
Alar 1000 ppm T_4 ..	0.266 -	0.266 -	0.288 (.022)	0.293 (.027)	0.299 (.033)	0.301 (.035)	0.303 (.047)
Alar 3000 ppm T_5 ..	0.310 -	0.310 -	0.336 (.026)	0.341 (.031)	0.357 (.047)	0.364 (.054)	0.373 (.063)
Alar 5000 ppm T_6 ..	0.261 -	0.261 -	0.293 (.032)	0.297 (.036)	0.324 (.063)	0.337 (.076)	0.358 (.097)
CCC 1000 ppm T_7 ..	0.266 -	0.266 -	0.287 (.021)	0.290 (.024)	0.302 (.036)	0.304 (.038)	0.312 (.046)
CCC 3000 ppm T_8 ..	0.267 -	0.267 -	0.291 (.024)	0.298 (.031)	0.314 (.047)	0.319 (.052)	0.331 (.064)
CCC 5000 ppm T_9 ..	0.303 -	0.303 -	0.334 (.031)	0.341 (.038)	0.371 (.068)	0.379 (.076)	0.306 (.003)
MH 1000 ppm T_{10} ..	0.280 -	0.280 -	0.305 (.025)	0.310 (.030)	0.327 (.047)	0.338 (.058)	0.349 (.069)
MH 1500 ppm T_{11} ..	0.276 -	0.276 -	0.309 (.033)	0.318 (.042)	0.332 (.056)	0.338 (.062)	0.349 (.073)
MH 2000 ppm T_{12} ..	0.285 -	0.285 -	0.322 (.037)	0.331 (.046)	0.359 (.074)	0.370 (.085)	0.405 (.120)
Control T_{13} ..	0.280 -	0.280 -	0.296 (.015)	0.301 (.021)	0.311 (.031)	0.322 (.042)	0.323 (.043)
F 'Test' ..	NS	NS	Sig	Sig	Sig	Sig	Sig
S.E (m) ..	-	-	0.007	0.007	0.007	0.013	0.044
C.D ..	-	-	0.021	0.021	0.021	0.041	0.130

HISTOGRAMS SHOWING THE INCREASE IN THICKNESS OF THE SHOOTS AS OBSERVED IN THE MONTH OF APRIL OVER THE MONTH OF OCTOBER (DIA IN INCHES)

Fig III (a)

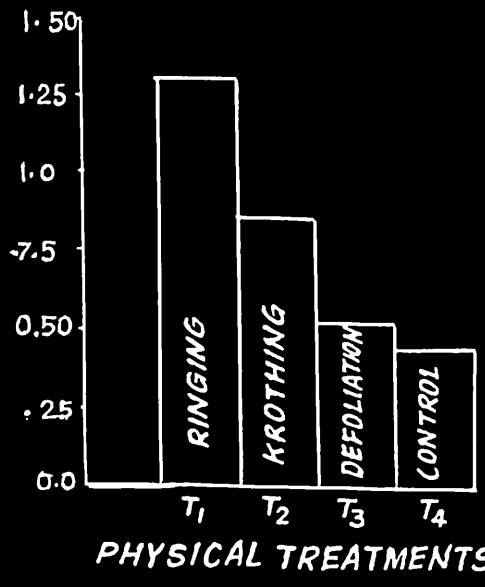


Fig-III (C)

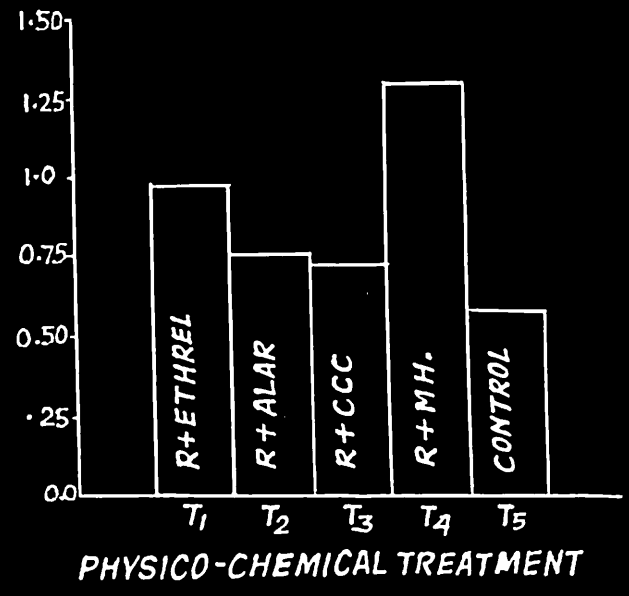
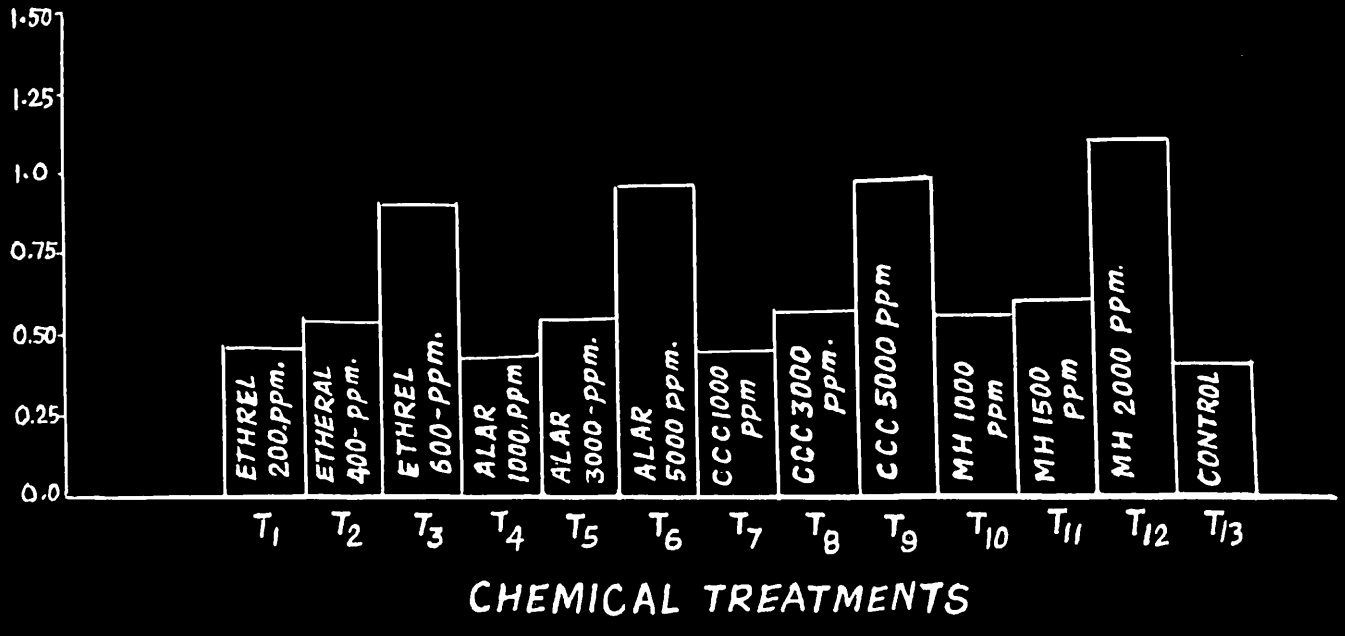


Fig-III (b)



(Experimental Findings)

The actual increase in the thickness over October ranged in between 0.039 in T_{13} and 0.074 in T_{12}.

Final observation in April showed that the thickness of shoots were distributed within the range of 0.323 in T_{13} (Control) to 0.405 in T_{12}, and the increase in thickness also were seem to range in between 0.043 in T_{13} to 0.120 in T_{12}.

Number of leaves :

Average number of leaves pershoot as recorded in different treatments are shown in the Table-9 and illustrated in the graph in Figure -IV(b).

In October the average number leaves recorded in different treatments found to vary within 8.96 in T_8 to 9.80 in T_5 and these number did not increase up to February. But in February the increase in average leaf number over October ranged between 2.93 in T_{12} and 7.6 in T_{13} and the average numbers of leaves recorded in different treatments varied from 12.54 (T_{12}) to 17.14(T_{13}). During March and April no further increase was observed.

Extent of flowering :

The extent of flowering in different treatments as recorded replication wise are presented in Table -10 and same was graphically illustrated in Figure V(b).

Table - 2 : Effect of chemical treatments on number of leaves and their increase over October(figures in the brackets) shown month wise from October - April.

Treatments		Oct. 1973	Nov. 1973	Dec. 1973	Jan. 1974	Feb. 1974	Mar. 1974	April. 1974
Ethrel 200 ppm T_1	***	9.50 -	9.50 -	9.50 -	9.50 -	15.48 (5.98)	15.48 (5.98)	15.48 (5.98)
Ethrel 400 ppm T_2	***	9.58 -	9.58 -	9.58 -	9.58 -	15.28 (4.7)	15.28 (4.7)	15.28 (4.7)
Ethrel 600 ppm T_3	***	9.80 -	9.80 -	9.80 -	9.80 -	13.40 (3.6)	13.40 (3.6)	13.40 (3.6)
Alar 1000 ppm T_4	***	9.54 -	9.54 -	9.54 -	9.54 -	15.14 (5.6)	15.14 (5.6)	15.14 (5.6)
Alar 3000 ppm T_5	***	9.90 -	9.90 -	9.90 -	9.90 -	14.24 (4.34)	14.24 (4.34)	14.24 (4.34)
Alar 5000 ppm T_6	***	9.64 -	9.64 -	9.64 -	9.64 -	12.68 (3.04)	12.68 (3.04)	12.68 (3.04)
CCC 1000 ppm T_7	***	9.82 -	9.82 -	9.82 -	9.82 -	15.84 (6.02)	15.84 (6.02)	15.84 (6.02)
CCC 3000 ppm T_8	***	8.96 -	8.96 -	8.96 -	8.96 -	13.60 (4.76)	13.60 4.74)	13.60 4.74)
CCC 5000 ppm T_9	***	9.70 -	9.70 -	9.70 -	9.70 -	13.20 (3.6)	13.20 (3.6)	13.20 (3.6)
MH 1000 ppm T_{10}	***	9.40 -	9.40 -	9.40 -	9.40 -	14.96 (5.56)	14.96 (5.56)	14.96 (5.56)
MH 1500 ppm T_{11}	***	9.76 -	9.76 -	9.76 -	9.76 -	13.84 (4.08)	13.84 (4.08)	13.84 (4.08)
MH 2000 ppm T_{12}	***	9.56 -	9.56 -	9.56 -	9.56 -	12.54 (2.98)	12.54 (2.98)	12.54 (2.98)
Control T_{13}	***	9.54 -	9.54 -	9.54 -	9.54 -	17.14 (7.6)	17.14 (7.6)	17.14 (7.6)
F Test	***	NS	NS	NS	NS	Sig.	Sig.	Sig.
S.E (m)	***	-	-	-	-	0.02	0.02	0.02
C.D	***	-	-	-	-	0.061	0.061	0.061

(Experimental Findings)

From the table it may be seen that there was minimum extent of flowering in the control (T_{12}) showing a percentage of 3.5 where as the maximum extent of 84.01 percent was recorded in T_9 where 5000 ppm of Cycocel was used.

Sex-Ratio :

The data on sex-ratio as observed in different treatments are presented in Table -17.

The sex-ratioes varied from treatment to treatment showing a minimum ratio of 1.866 in T_9 i.e. 5000 ppm of Cycocel and a maximum ratio of 2.216 in T_8 with 3000 ppm of Cycocel. The number of male flowers varied from 632 in T_{11} to 769 in T_{10} and the number of perfect flowers varied from 302 to 398 respectively in T_1 and together in T_9 and T_{10}.

Biochemical Studies :

Data on biochemical studies relating to reducing and non reducing sugars, starch and total carbohydrate and total nitrogen etc. in the leaves of different treatments taken during October, January and April are presented in Table -11.

It may be seen from the table that the level of reducing sugar content in all the treatment was almost identical in the month of October ranging

(Experimental Findings)

Table - 10

Effect of Chemical Treatments on the extent of flower induction (in percentage) shown replicationwise. Their respective angular values are presented in Table No.10(b).

Treatments	Repl. I	Repl. II	Repl. III	Repl. IV	Repl. V	Mean.
Ethrel 200ppm T_1 ..	35.90	36.00	36.40	30.90	31.67	34.17
Ethrel 400ppm T_2 ..	54.60	56.20	50.90	45.70	39.29	49.11
Ethrel 600ppm T_3 ..	58.90	61.80	58.30	60.40	60.50	58.96
Alar 1000ppm T_4 ..	25.80	26.10	26.80	26.20	21.20	25.22
Alar 3000ppm T_5 ..	31.50	31.60	30.10	34.00	27.10	30.86
Alar 5000ppm T_6 ..	54.10	57.50	52.20	60.70	47.70	54.24
CCC 1000ppm T_7 ..	55.90	56.30	56.60	64.00	36.80	51.92
CCC 3000ppm T_8 ..	63.90	67.10	60.60	60.00	53.90	62.66
CCC 5000ppm T_9 ..	82.70	85.60	80.85	85.60	82.06	84.01
MH 1000ppm T_{10}..	38.00	40.60	43.00	35.80	32.40	38.16
MH 1500ppm T_{11}..	46.80	47.15	47.20	43.60	37.50	44.60
MH 2000ppm T_{12}..	53.80	56.86	57.20	57.80	56.91	56.30
Control T_{13}..	3.20	4.35	3.00	3.40	4.00	3.50

Table - 10 (b)

Angles corresponding to percentages of flower induction as observed by the effect of Chemical treatments.

Treatments		Repl. I	Repl. II	Repl. III	Repl. IV	Repl. V	Mean.
Ethrel 200 ppm	T_1	36.81	38.67	37.11	33.77	34.37	36.15
Ethrel 400 ppm	T_2	47.58	47.98	45.62	42.63	38.62	44.48
Ethrel 600 ppm	T_3	53.13	51.47	46.89	51.00	51.06	50.11
Alar 1000 ppm	T_4	30.63	30.72	31.18	20.79	27.42	28.18
Alar 3000 ppm	T_5	34.14	34.20	33.27	35.67	31.37	33.73
Alar 5000 ppm	T_6	47.35	49.31	46.26	51.18	43.63	47.55
CCC 1000 ppm	T_7	48.39	48.63	62.79	47.29	37.35	46.09
CCC 3000 ppm	T_8	53.07	55.00	55.86	50.77	50.13	52.96
CCC 5000 ppm	T_9	65.42	77.89	64.08	83.45	68.95	71.95
MH 1000 ppm	T_{10}	38.59	39.52	40.98	36.76	34.70	38.10
MH 1500ppm	T_{11}	43.17	43.34	43.39	41.32	37.76	41.79
MH 2000 ppm	T_{12}	46.83	48.97	49.49	49.49	48.30	48.63
Control	T_{13}	10.31	11.97	10.04	10.03	11.64	11.07

F 'Test'	...	Significant.
S.E (m)	...	1.103
C.D	...	3.088

in between 3.412 to 3.432 again these values were seen to rise during January observation which ranged within 4.330 to 4.624. There were again receeding of the values in April which were within a range of 3.302 to 3.343 and slightly below the range observed in the month of October.

The levels of non reducing sugar content were almost uniform in all the treatments which were within the range of 0.865 to 0.877 during October. The values were seen to rise uniformly during January and remained within the range of 0.906 to 0.922. There were again reduction in the levels during April which were lower than the October values and these ranged in between 0.721 and 0.750.

Likewise the values of reducing and nonreducing sugars the total sugar content were some what more in October compared to April but in January the levels were the highest among the three observations.

Starch indicated the bulkiest fraction of the total carbohydrate which varied between 11.113 to 11.223 during October and these values increased during January to range between 12.140 to 12.197. During April the content decreased to a level within the range of

TABLE - 11

Biochemical Observation in the leaves in Chemical Treatments as Observed in October

Treatments	Reducing sugar.	Non - reducing sugar.	Total sugar.	Starch	Total Carbohydrate.	Nitrogen	C/N ratio
1	2	3	4	5	6	7	8
Ethrel 200 ppm	3.427	0.873	4.300	11.132	15.432	2.335	6.608
Ethrel 400 ppm	3.412	0.865	4.277	11.121	15.398	2.385	6.456
Ethrel 600 ppm	3.425	0.872	4.297	11.122	15.419	2.381	6.475
Alar 1000 ppm	3.438	0.877	4.315	11.123	15.438	2.352	6.097
Alar 3000 ppm	3.429	0.866	4.356	11.119	15.477	2.357	6.566
Alar 5000 ppm	3.427	0.872	4.299	11.123	15.422	2.382	6.474
CCC 1000 ppm	3.418	0.869	4.287	11.112	15.399	2.322	6.631
CCC 3000 ppm	3.425	0.872	4.297	11.123	15.420	2.357	6.542
CCC 5000 ppm	3.418	0.869	4.287	11.223	15.510	2.392	6.484
MH 1000 ppm	3.429	0.873	4.302	11.213	15.515	2.382	6.497
MH 1500 ppm	3.428	0.872	4.300	11.211	15.511	2.386	6.500
MH 2000 ppm	3.432	0.874	4.306	11.175	15.481	2.385	6.490
Control. ...	3.421	0.865	4.286	11.219	15.505	2.390	6.457

(To be continued)

TABLE - 11 (continued)

(Jemmary)

1	2	3	4	5	6	7	8
Ethrel 200 ppm	4.336	0.910	5.246	12.138	17.384	2.447	7.104
Ethrel 400 ppm	4.421	0.927	5.348	12.142	17.496	2.479	7.057
Ethrel 600 ppm	4.512	0.926	5.498	12.182	17.680	2.476	7.140
Alar 1000 ppm	4.337	0.886	5.323	12.147	17.470	2.462	7.095
Alar 3000 ppm	4.439	0.990	5.429	12.192	17.621	2.443	7.212
Alar 5000 ppm	4.523	0.992	4.515	12.197	17.655	2.467	7.156
CCC 1000 ppm	4.429	0.918	5.347	12.140	17.544	2.476	7.065
CCC 3000 ppm	4.576	0.929	5.505	12.192	17.697	2.482	7.130
CCC 5000 ppm	4.629	0.999	5.624	12.182	17.806	2.492	7.145
MH 1000 ppm	4.330	0.915	5.245	12.192	17.437	2.466	7.070
MH 1500 ppm	4.383	0.917	5.305	12.186	17.491	2.477	7.001
MH 2000 ppm	4.395	0.919	5.314	12.196	17.510	2.482	7.054
Control ...	4.357	0.906	5.263	12.187	17.450	2.442	7.145

(To be continued)

TABLE .. 11 (Continued)

Treatments	Reducing sugar.	Non-reducing sugar.	Total sugar.	Starch	Total carbohydrate.	Nitrogen	C/N ratio
Ethrel 200 ppm	3.321	0.721	4.042	10.135	14.177	2.337	6.066
Ethrel 400 ppm	3.319	0.723	4.042	10.122	14.164	2.337	6.056
Ethrel 600 ppm	3.342	0.732	4.074	10.098	14.172	2.322	6.077
Alar 1000 ppm	3.322	0.742	4.064	10.147	14.211	2.337	6.080
Alar 3000 ppm	3.321	0.729	4.050	10.157	14.207	2.346	6.053
Alar 5000 ppm	3.342	0.734	4.076	10.089	14.238	2.356	6.043
CCC 1000 ppm	3.319	0.723	4.042	10.162	14.218	2.346	6.060
CCC 3000 ppm	3.328	0.742	4.060	10.176	14.333	2.329	6.154
CCC 5000 ppm	3.343	0.769	4.120	10.273	14.208	2.317	6.157
MH 1000 ppm	3.319	0.742	4.061	10.196	14.257	2.322	6.139
MH 1500 ppm	3.321	0.739	4.060	10.227	14.287	2.337	6.126
MH 2000 ppm	3.339	0.733	4.072	10.128	14.200	2.332	6.076
Control ..	3.302	0.723	4.025	10.129	14.154	2.339	6.051

10.089 to 10.273 and the levels were lower than the levels observed in October.

Total carbohydrates indicated the same trend of results as total sugars and starch. During October the level of total carbohydrates varied within 15.398 to 15.515 andthese levels increased in January to remain within the range of 17.450 to 17.806. Again, the level decreased in April to the minimum ranging in between 14.154 to 14.298.

Total nitrogen content varied very slightly from treatment to treatments and period to period. However the minimum values were seen in April showing the range between 2.317 and 2.387 and maximum level in January which ranged between 2.442 to 2.492. The October level was in between the levels of January and April.

The C/N ratio ranged between 6.21 and 6.631 in October, 7.064 and 7.212 January and 6.043 and 6.157 in April. The highest average values of 7.111 was seen during January and the lowest value of 6.089 in the month of April. The October value of 6.486 was in between the January and April values.

(C) PHYSIO-CHEMICAL TREATMENTS :

In this experiment there were five treatments in all which were (i) Ringing + 400ppm Ethrel (T_1), (ii) Ringing + 3000ppm Alar (T_2), (iii) Ringing + 3000 ppm CCC (T_3), (iv) Ringing + 1500 ppm MH (T_4) and (v) Control (T_5).

Table - 12

Effect of Physico chemical treatments on length of shoots (in cms.) and their increase over October (figures in the brakkets) shown monthwise from October to April.

Treatments	Oct. 1973	Nov. 1973	Dec. 1973	Jan. 1974	Feb. 1974	Mar. 1974	April 1974
Ringing + Ethrel 400ppm T_1	18.72	18.72	18.72	19.82	19.96	20.09	20.09
	-	-	-	(1.10)	(1.24)	(1.37)	(1.37)
Ringing + Alar 3000 ppm T_2	18.62	18.62	18.62	19.08	20.18	20.18	20.18
	(-	-	-	(0.56)	(1.66)	(1.66)	(1.66)
Ringing + Cycocel 3000ppm T_3	18.80	18.80	18.80	19.60	19.91	20.00	20.00
	-	-	-	(0.70)	(1.11)	(1.20)	(1.20)
Ringing + MH 1500 ppm T_4	18.12	18.12	18.12	18.52	19.12	19.30	19.30
	-	-	-	(0.40)	(1.00)	(1.18)	(1.18)
Control. T_5	18.62	18.62	18.62	19.80	20.31	21.31	21.31
	-	-	-	(1.18)	(1.69)	(2.69)	(2.69)
F 'Test'	..	N.S	N.S	N.S	Sig.	Sig.	Sig.	Sig.
S.E.(m)	..	-	-	-	0.173	0.01	0.017	0.173
C.D.	..	-	-	-	0.079	0.06	0.079	0.079

xperimental Findings)

Length of Shoot :

The data on the average length of shoots in different treatments shoots as observed monthwise from October to April are presented in Table -12 and graphycally represented in Figure -II(c).

In the month of October the average length of shoots for the treatments T_1,T_2,T_3,T_4 and T_5 was 18.72, 18.52, 18.80,18.12 and 18.62 cms. respectively.

The length continued to remain unchanged during the month of November and December also.

But in January the length of shoots were seen to increase and attained 19.82, 19.58,18.80,18.16 and 19.80 cms. in T_1,T_2,T_3,T_4 and T_5 respectively. The increase in shoot length over October ranged between 0.40 in T_4 and 1.18 in T_5 (control).

In February, the average length of shoots were 19.86, 20.18, 19.91, 19.12, and 20.31 cm respectively for T_1, T_2, T_3, T_4 and T_5 and the respective increase were 1.24, 1.66, 1.11, 1.00 and 1.69 cms. respectively over the shoot length of October.

In March the change in shoot length was marked which ranged from 19.30 (T_4) to 21.31 in T_5 and the increases over October was in between 1.18 in T_4 and 2.69 in T_5.

perimental Findings)

Table - 12

Effect of physico-chemical treatments on the thickness of shoot (in inches) and their increase over October (figures in the brackets) shown month wise from October to April.

Treatments		Oct. 1973	Nov. 1973	Dec. 1973	Jan. 1974	Feb. 1974	Mar. 1974	April 1974
Ringing + Ethrel 400 ppm	T_1	0.245	0.245	0.281	0.300	0.313	0.330	0.339
		-	-	(.036)	(.055)	(.068)	(.085)	(.094)
Ringing + Alar 3000 ppm	T_2	0.273	0.273	0.301	0.316	0.328	0.342	0.352
		-	-	(.028)	(.043)	(.055)	(.069)	(.079)
Ringing + CCC 3000 ppm	T_3	0.270	0.270	0.294	0.312	0.322	0.333	0.342
		-	-	(.024)	(.042)	(.052)	(.063)	(.072)
Ringing + MH 1500 ppm	T_4	0.265	0.265	0.302	0.325	0.335	0.353	0.370
		-	-	(.037)	(.060)	(.070)	(.088)	(.105)
Control.	..	T_5 0.244	0.244	0.260	0.288	0.287	0.296	0.306
	..	-	-	(.016)	(.035)	(.043)	(.052)	(.062)
F 'Test'	..	..	N.S	N.S	Sig.	Sig.	Sig.	Sig.	Sig.
S.E (m)	..	..	-	-	0.01	0.013	0.01	0.01	0.004
C.D.	..	..	-	-	0.045	0.052	0.045	0.045	0.03

In the final observation during April the increase in shoot length was seen to vary between 1.18 in T_4 to 2.69 in T_5 and the average length of these shoots was found to range from 19.30 to 21.31 cms.

Thickness of Shoot :

Average thickness of shoots in different treatments as observed during October was 0.245, 0.273, 0.270, 0.265, 0.244 inches respectively for T_1, T_2, T_3, T_4 and T_5 and that shoot thickness remained unchanged during the month of November as shown in Table 13 and Figure -XXI (c).

In December the change in thickness was again marked which was in between 0.260 and 0.302 observed in T_5 and T_4 respectively and this increase in thickness of the shoot over October was seen to range between 0.016 and 0.037 inches.

In January the shoot thickness was ranging in between 0.289 and 0.325 inches as in T_5 and T_4 respectively and this seemed to have increased over October by 0.025 inches in T_5 and 0.060 inches in T_4.

During February the thickness ranged in between 0.287 and 0.335 respectively in T_5 and T_4 and the

Experimental Findings)

Table - 14

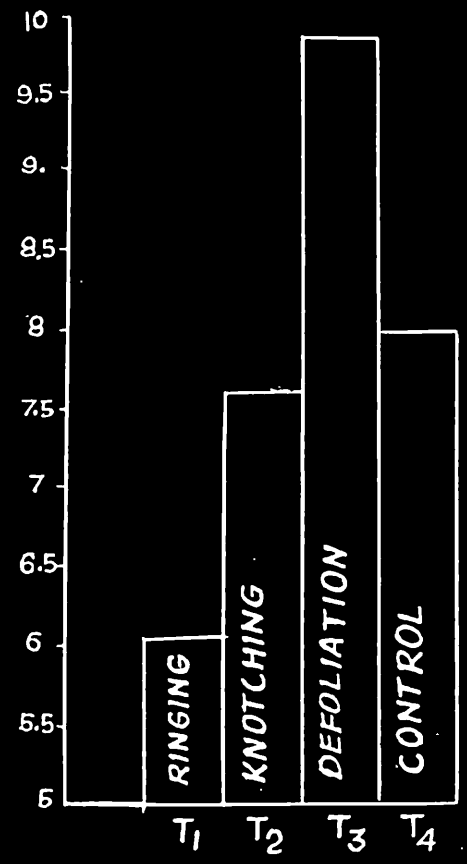
Effect of physico - chemical treatments on number of leaves and their increase over October (figures in brackets) shown month wise from October to April.

Treatments	Oct. 1973	Nov. 1973	Dec. 1973	Jan. 1974	Feb. 1974	Mar. 1974	April 1974
Ringing + Ethrel 400 ppm T_1	9.4	9.4	9.4	9.4	14.24	14.24	14.24
	-	-	-	-	(4.48)	(4.8)	(4.48)
Ringing + Alar 3000ppm T_2	10.3	10.3	10.3	10.3	14.79	14.79	14.79
	-	-	-	-	(4.49)	-	-
Ringing + CCC 3000 ppm T_3	9.9	9.9	9.9	9.9	14.87	14.87	14.87
	-	-	-	-	(4.97)	-	-
Ringing + MH 1600 ppm T_4	9.8	9.8	9.8	9.8	14.25	14.25	14.25
	-	-	-	-	(4.45)	(-	-
Control. T_5	10.2	10.2	10.2	10.2	12.72	12.72	12.72
	-	-	-	-	(2.52)	(-	-
F. 'Test' ..	N.S	N.S	N.S	N.S	Sig.	Sig.	Sig.
S.E (m) ..	-	-	-	-	0.01	0.01	0.01
C.D. ..	-	-	-	-	0.045	0.045	0045

TR-626

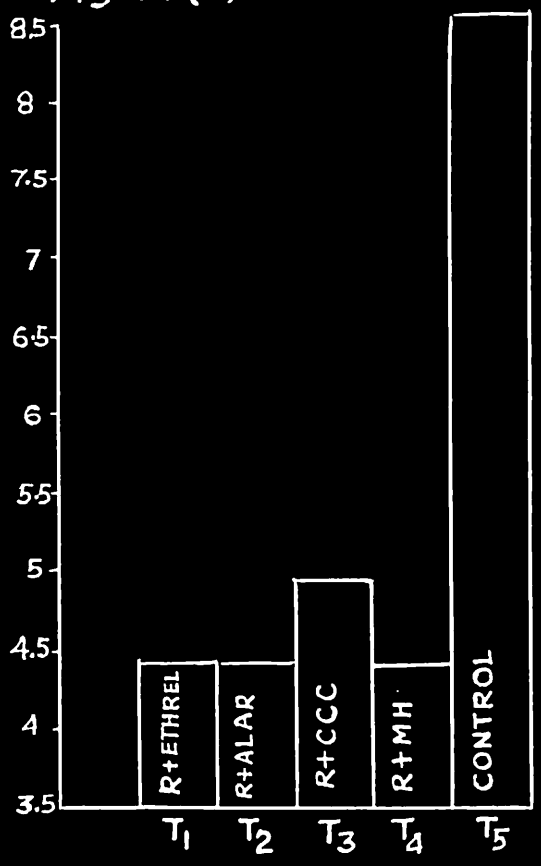
HISTOGRAMS SHOWING THE INCREASE IN NUMBER OF LEAVES AS OBSERVED IN THE MONTH OF APRIL OVER THE MONTH OF OCTOBER. (IN NUMBER)

Fig-IV (a)



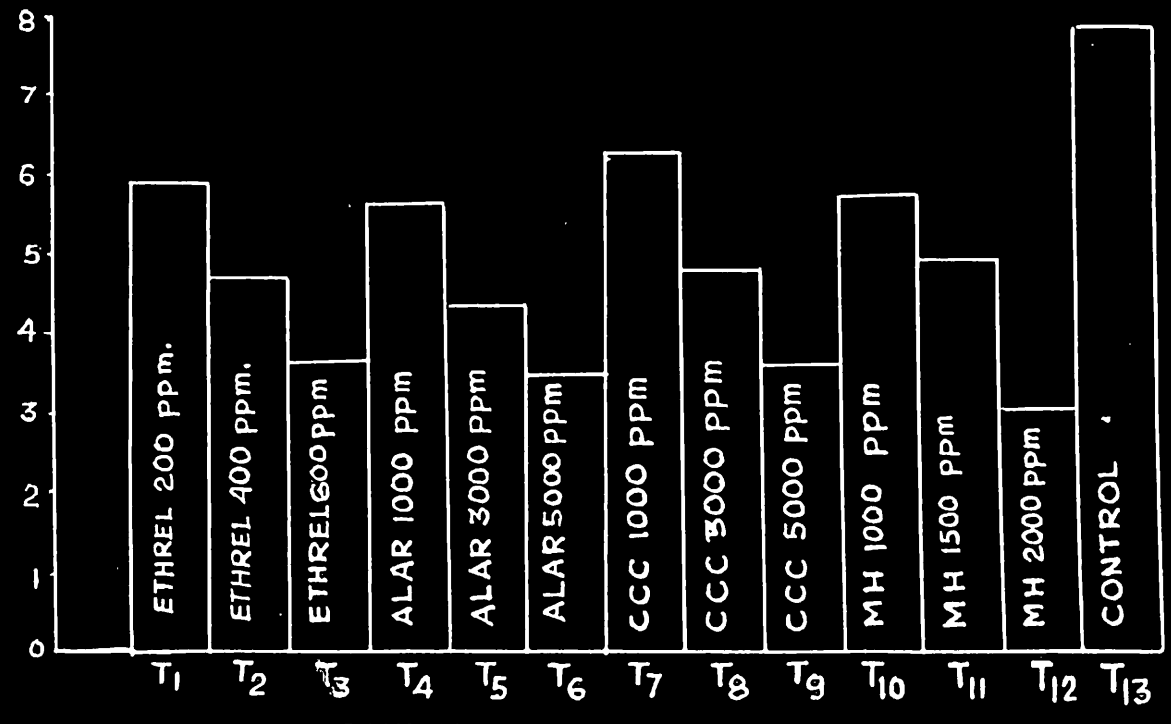
PHYSICAL TREATMENT

Fig-IV (c)



PHYSICO-CHEMICAL TREATMENT

Fig-IV (b)



CHEMICAL TRETMENTS

Corresponding increase of the thickness over October was 0.043 and 0.070 inches.

In March the average thickness of T_1, T_2, T_3, T_4 and T_5 was 0.330 , 0.342, 0.333, 0.353 and 0.296 respectively and the increase over October in each of these treatments was 0.025, 0.069, 0.063, 0.033 and 0.052 respectively.

In the final observation during April sheet thickness was ranging from 0.366 in T_5 to 1.315 in T_3 and the corresponding increase in thickness was from 0.022 to 1.050.

Number of leaves per shoot :

The data on average leaf number are presented in table -14 and graphically illustrated in figure -IV(e). In October the observed initial mean number of leaves 9.4, 10.3, 9.0, 9.8 and 10.2 respectively for the treatments T_1, T_2, T_3 and T_4 and T_5 and the number of leaves remained unchanged up to January. In February again their numbers increased to 14.24, 14.99, 14.87, 14.25 and 15.72 respectively. The corresponding increase of leaf number over October was 4.48 in T_1, 4.49 in T_2, 4.97 in T_3 and 4.45 in T_4 and 5.52 in T_5. There was no further change in the mean leaf number in April.

(Experimental Findings)

Table - 15

Effect of physico-chemical treatments on extent of flower induction (in percentage) shown in replication wise (figures in the brakkets indicated the respective angular values).

Treatments	Repl. I.	Repl. II.	Repl. III.	Repl. IV.	Repl. V	Mean
Ringing + Ethrel 400 ppm T_1	53.1 (46.76)	54.7 (47.70)	55.8 (48.33)	50.6 (45.34)	46.2 (42.82)	52.0 (46.19)
Ringing + Alar 3000 ppm T_2	31.6 (34.20)	33.2 (35.18)	30.6 (33.58)	36.2 (37.35)	30.6 (33.71)	34.0 (34.20)
Ringing + CCC 3000 ppm T_3	63.6 (52.89)	62.6 (52.34)	64.6 (53.33)	62.2 (52.06)	58.6 (49.95)	62.22 (52.11)
Ringing + MH 1500 ppm T_4	39.4 (38.20)	40.6 (39.58)	46.2 (42.82)	37.0 (38.00)	37.2 (37.58)	30.06 (38.65)
control. T_5	9.05 (17.46)	6.5 (14.77)	7.5 (15.50)	8.6 (17.00)	8.3 (16.76)	7.99 (16.32)

F 'T_{ent} '	..	Significant.
S.E (m)	..	0.233
C.D	..	3.63

CHAPTER V

Discussion

(Experimental Findings)

Extent of flowering & sex ratio :

The extent of flowering in percentages as observed in different treatments is presented in Table-15 and shown in Figure No V(a). The extent varied from treatment to treatment which was 52.0 in T_1, 34.01 in T_2, 62.28 in T_3, 39.06 in T_4 and 7.29 in the control. The corresponding male and perfect flowers were 665 and 346 for T_1, 695 and 349 for T_2, 670 and 350 for T_3, 677 and 360 for T_4 and 670 and 330 for T_5 showing the sex ratio of 1.933 , 1.991, 1.914, 1.920 and 1.861 respectively as may be seen from the Table No. 17.

Biochemical studies :

Data on biochemical studies relating to C/N ratio is presented in Table No. 16.

The level of reducing sugar varied within 3.463 to 3.490, 4.15 to 4.726 and 3.315 to 3.987 respectively during the month of October, January and April. The January level was the highest and the level in April was the lowest.

Similarly nonreducing sugar content varied from 0.917 to 0.921, 0.979 to 1.141 and 0.861 to 0.910 respectively for the month of October, January and April. The total sugar content also indicated similar trend of results as

TABLE - 16

(Biochemical Observations in leaves of Physico-chemical)

	Treatments	Reducing sugar.	Non - reducing sugar.	Total sugar.	Starch	Total Carbohy - drate.	Nitrogen	C/N r a t i o.
OCTOBER	Ringing + Ethrel	3.476	0.921	4.397	11.527	15.924	2.317	6.872
	Ringing + Alar	3.479	0.919	4.398	11.519	15.917	2.342	6.796
	Ringing + CCC	3.480	0.917	4.397	11.210	15.607	2.327	6.706
	Ringing + MH	3.469	0.920	4.389	11.217	15.606	2.332	6.692
	Control ..	3.468	0.919	4.387	11.222	15.609	2.321	6.725
JANUARY	Ringing + Ethrel	4.627	1.123	5.650	12.321	17.971	2.432	7.389
	Ringing + Alar	4.516	1.076	5.591	12.317	17.911	2.412	7.425
	Ringing + CCC	4.726	1.141	5.876	12.320	18.157	2.139	8.502
	Ringing + MH	4.482	1.059	5.541	12.317	17.858	2.421	7.376
	Control ..	4.135	0.979	5.114	11.928	17.042	2.327	7.328
APRIL	Ringing + Ethrel	3.321	0.872	4.193	10.721	14.914	2.218	6.724
	Ringing + Alar	3.342	0.879	4.221	10.527	14.748	2.298	6.417
	Ringing + CCC	3.318	0.861	4.179	10.017	14.196	2.273	6.248
	Ringing + MH	3.347	0.892	4.239	10.471	14.710	2.221	6.623
	Control ..	3.327	0.910	4.237	10.892	15.120	2.252	6.625

Table - 17

STUDIES ON SEX RATIO

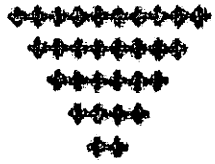
Physical Treatment	Male	Perfect	Total	Ratio
Ringing ..	663	345	1008	1.921
Knotching ..	742	390	1132	1.902
Defoliation ..	690	366	1056	1.885
Control ..	642	330	972	1.945
Chemical				
Ethrel 200ppm T_1 ..	665	302	967	2.201
Ethrel 400ppm T_2 ..	695	332	1027	2.093
Ethrel 600ppm T_3 ..	676	331	1007	2.042
Alar 1000ppm T_4	742	369	1111	2.010
Alar 3000ppm T_5	766	372	1137	2.056
Alar 5000ppm T_6	693	342	1035	1.994
CCC 1000ppm T_7	685	336	1021	2.038
CCC 3000ppm T_8	760	347	1116	2.316
CCC 5000ppm T_9	743	398	1141	1.866
MH 1000ppm T_{10}	769	398	1167	1.932
MH 1500ppm T_{11}	632	303	935	2.086
MH 2000ppm T_{12}	665	323	988	2.057
Control T_{13}	669	342	1011	1.956
Physico-chemical				
Ringing+Ethrel T_1	669	346	1015	1.933
Ringing+Alar T_2	695	349	1044	1.991
Ringing+CCC T_3	670	350	1020	1.914
Ringing+MH T_4	677	360	1037	1.880
Control T_5	670	330	1000	1.861

observed with the reducing and nonreducing sugars.

Starch content seemed to range in between 11.210 to 11.627, 11.928 to 12.331 and 10.017 to 10.823 respectively for the month of October, January and April. The total carbohydrate content indicated maximum value in January which ranged between 17.042 and 18.187 and the lowest levels in April which ranged in between 14.196 and 15.120. October levels remained in between the January and April levels.

Nitrogen content ranged from 2.317 to 2.342, 2.130 to 2.432 and 2.213 to 2.268 for the month of October, January and April respectively.

The C/N ratio indicated maximum figure in January where it ranged in between 7.323 and 8.502, the minimum figure was seen in April which was in between 6.248 and 6.724. The October figure was in between the two and indicated values ranging from 6.692 to 6.872.



DISCUSSION

The salient findings of the experiments, "Physical treatments, Chemical treatments and physicochemicals treatments on flower induction in mango" are discussed below experiment wise and comparative studies also made of the similar effects observed in all the three experiments. The data for various effects have been analysed statistically and their analysis of variance tables provided in the Appendix.

(A) PHYSICAL TREATMENTS :

Length of shoot :

From the table No. 2 and figure no. II-a it may be seen that comparble shoots have been taken at the beginning of the experiment during October and these have been subjected to different treatments such as ringing, knotching, defoliation and some are left as such to serve as control.

In general, the shoot length has not been seen to increase in all the treatments either during November or December.

(Discussion)

But then from January on wards the shoot length is seen to increase and it continued till the last observation in April. In general, the increase has been maximum in the defoliated shoot irrespective of the month or the cumulative growth at the final observation. From the analysis of variance table-1 and bar notations showing the comparison of treatment means it may be seen that the increase of shoot length during January in defoliation treatment is significantly superior to all other treatments such as ringing, knotching and untreated control. Control is also seen to be significantly better than knotching and ringing and knotching has been significant over ringing. The increase during February and March have shown the identical trend as observed in January. But in April though the trend of results remained the same yet no significant difference could be seen between ringing and knotching.

Thus ringing and to some extent knotching have produced almost no extension growth during the experimental period, where as maximum extension growth has been observed in the defoliated shoot. Many workers have reported earlier (Singh and Khan, 1940; Sen, 1943; Roy, 1953, and R.N.Singh, 1959) that by

ringing vegetative growth in mango could be suppressed. Again, there has also been reports that defoliation cause vegetativeness. Rao and Muthuswami (1953) reported that shoots use to continue vegetative growth instead of flowering in the season if those are defoliated. L.B.Singh (1957) explained the role of defoliation in mango by stating that flowering substance seems to be produced in the leaves but the vital substance might be detained by defoliation. R.N.Singh and Majumdar (1962) observed that complete defoliation inhibited flowering and led to vegetativeness.

Thickness of Shoot :

From the Table No. 3 and illustration No III(a) it may be seen that the shoot thickness observed in the month of October do not increase significantly in any of the treatment till the month of February. Then it continue to increase every month till the final observation taken in April. The increase during February has been found to be maximum in case of ringing and minimum in control. the analysis of variance table 3 indicated that there is significant difference among the treatments and ringing has been significantly

(Discussion)

superior over all other treatments, such as ringing, knotching and untreated control. Control is seen to be significantly better than knotching and ringing and knotching has been significant over ringing. The increase during February and March have shown the idential trend as observed in January. but in April though the trend of results remained the same yet no significant difference could be seen between ringing and knotching.

Thus ringing and to some extent knotching have produced almost no extension growth during the experimental period, where as , the increase during February has been found to be maximum in case of ringing and minimum in control. The analysis of variance table no. 3 indicates that there is significant difference among the treatments and ringing is significantly superior over all other treatments. Next in order of merits are knotching and defoliation and the last being the control.

The data for the month of March and April also indicate the same trend of result.

The highest increase in diameter due to ringing may be explained in the light of accumulation of

food reserve. Since there has been no extension growth for these categoris of shoots the accumulation of reserve material can only be accomodated by increasing the volume. Therefore the diameter increase in ringed shoot have been significantly higher incomparison to other catcories of shoots. Singh and Khan (1940) have pointed out that ringing causes cessation of longitudinal growth but diameter increases in such shoots. Sen (1943) observing on different flushed remarked that cessation of growth though began earlier in some shoots yet the growth in volume continued for long.

Number of leaves :

For the data showing effect of physical treatments on leaf number, table 4 and figure IV-a may be referred. The analysis of variance table for the data has been given in the table No. 4 of the appendix.

It may be seen from that table that number of leaves observed during October continued to remain as it is till February when new flush appeared and there has been significant increase in leaf number in the defoliation treatment in comparision to control knotching and ringing. control and knotching are also found to be significantly better than ringing but the difference observed in between

superior to either defoliation and control. Though control records the minimum percentage yet it is not found to be significantly differently from defoliation. As high as 42.56 percent of shoots turned flowering in the ringing treatment as compared to 5.14 and 4.53 percents in defoliated and control shoots respectively.

That ringing and knotching are capable of inducing flowering has been proved in this experiment. Previously Singh and Khan (1940) obtained beneficial results in mango through ringing and root pruning and they have observed that ringing and root pruning used to stop the vegetative growth and promote flowering. Sen (1944) also indicated that in areas of high rainfall, flowering could be induced by ringing provided the plant growth is favourable. Mallik (1951) tried ringing of bark in Gombai, Langra and Fazli trees of mango in the month of August and found that ringing in conjuction with manuring increased flowering.

Sen et al (1972) also observed that decapitation with or without ringing in Langra and Gulabkhas mangoes in October to December induced axillary flowering more so in Gulabkhas than in Langra but in the later more in the off year than the on year. Therefore our findings of significantly greater percentage of flowering observed

(Discussion)

in Langra on account of ringing are quite tenable from the results reported earlier by other workers.

It is also interesting to note that in ringed shoots more extra-axillary flower inflorescences appeared right from the barren stems of the treated shoots, especially below the ringing zone as may be seen from the photographs provided in the facing page. R.Singh and R.N.Singh (1972) seemed to hold good for the flowering also as Langra used to bear inflorescence panicles usually in the terminal positions.

Earliness in flowering ranging between 8 - 12 days has also been observed in the ringing treatment as compared to control and defoliated shoots. Such effect has not been reported earlier but this has a special significance from the point of view of escaping the damage from mango hoppers. Mango hoppers do a considerable damage to mango flowers produced late in the season and usually under local conditions the North Indian varieties produce flowers late in the season even as late as middle of March. Such flowers could be saved if flowering is induced earlier.

Sex ratio has been found to differ from treatment to treatment yet it is of very little significance are not very much distinguishable.

(Discussion)

Biochemical studies :

As per table no. 6 the results indicate that there has been increase of total sugar, starch, total carbohydrate, and C/N ratio in all categories of shoots in January over October and again these values are lowered in April. The maximum increase, however, has been seen in the ringing shoots and minimum with the defoliated ones. In corroborating these findings with extent of flowering it may be inferred that accompaniment of higher C/N ratio in ringing has been conductive for flower induction in this treatment as compared to control of defoliated shoots were lower values of C/N ratio have been registered. The importance of C/N ratio for flowering has been stressed by many workers like Klebs (1903), Chandler(1925), potter and Phillips (1930) and particularly in mango by Naik and Shaw (1937), Mallik (1953), Raju(1956), L.B.Singh (1957), R.N.Singh (1960), Sen et al (1963) and Sen, Choudhuri and Basu (1972).

(B) CHEMICAL TREATMENTS :

Length of Shoot :

The data in Table No. 7 reveal that the length of shoot observed in October remain unchanged till January irrespective treatments. From January

onwards the growth continued every month till the finalobservation recorded in April. Such have been the findings also in the physical treatment experiment. The monthwise increments of January to April have been found to be statistically significant as may be seen from the analysis of variance table no. 7 given in the appendix. The length of control sheets has been significantly greater in comparison to any of the other treatment under trial. The minimum length has been recorded with 2000 ppm MH which is the lowest among all treatments. Next higher effect to 2000 ppm MH has been shown by 5000 ppm Alar, 600 ppm Ethrel and 5000 ppm Cycocel. But there has been no significant difference among these treatments. It is interesting that all the highest concentrations used in different chemicals have exhorted maximum growth retarding effects. The lower concentrations of Cycocel such as, 1000 and 3000 ppm could not check the extension growth as competently as other treatments so that it occupied next below positions after control.

The objective of the experiment is to induce flowering and incidentally discourage vegetative growth prior to flowering since vegetative growth and flowering

process seem to be antagonistic in mango as per the observation of Singh and Khan (1940) , Naik and Rao (1942), and Sen (1943). The application of growth retardant not only caused cessation of growth prior to flowering but also the effect remained persistent beyond flowering until April which might not prove beneficial for the next season cropping. Since the effect of cycocel is not as persistent as others it may be preferred over other chemicals.

Of late, growth inhibitors and retardants as a class have been used extensively to check growth in plants and to produce dwarfing effect in annuals or in trees and in eliminating pruning required for wayside avenues and hedges.

Cathey and Stuart (1961), Cathey (1963), Batjer and Williams (1964), Reed et al (1965) , Edgerton and Hoffman (1965) and Dickhill and Weaver (1966) have reported growth retardation in apple and other horticultural crops with B-Nine. Similarly Sims and Micheli (1969), Ivahori, Lyon and Sims (1969), Murray and Miller (1970) , Coyne (1970), Splittstoesser (1970), Benoit (1972) and Edgerton and Blanpied(1968) have got suppression in stem elongation effect with ethrel. CCC also has been reported to cause retardation

(Discussion)

in shoot growth in pear and apple by Modlibovska(1962) in other crops by Deena (1962) , Kurdishi and Mulk (1963), Will (1966), Klapwijk (1966), Mracka and Zebrowski (1966), Van Eden and Cockshull (1962), Tolbert (1960) and Lingaraj and Srinivasan (1967) and for MH action the workers were Singh (1961) in mango, Field et al (1962), Knott (1956), Bell(1962), Crane (1963) and White (1962) in other crops.

Thickness of shoot :

Table No. 8 may be gided for the data on thickness of shoots. The thickness observed during October remained unchanged in November also. But further increase has been observed in all the treatments from January onwards till April. The increase observed in different treatments has been found to be significant every month since January as might be seen from the analysis of variance Table No 8. It may be generalised that the trend of effect as observed with different treatments in January the same trend in effect has also been observed in other months after January till April.

The highest increase in thickness has been observed with 2000 ppm MH which is significantly higher than any of the rest treatments. The next best increase after 2000 ppm MH has been the 5000 ppm CCC. Next inorder of

next are 5000 ppm Alar and 600 ppm Ethrel.So from all these findings it may be generalised that there has been maximum increase in shoot diameter only when it has been associated with the highest dose of all chemicals. MH has been found to be the most responsive and CCC, Alar and Ethrel are in the following order.

It is interesting to note that highest concentrations of different chemicals responsible for maximum retardation in the extension of shoot length as discussed earlier have also been found to be responsible to cause maximum increase in shoot diameter. It was also observed in the experiment with physical treatments that ringing caused maximum suppression of longitudinal extension but increased shoot diameter to a maximum extent.

Thus it is clear that retardation of longitudinal growth is inversely co-related with acceleration of transverse growth in Langra mango. Our previous works here with MH and Alar (Das and Panda) have also shown like wise effect in Langra and Bangenpalli.

Leaf number :

The table no. 9 may be referred for the data on leaf number.

It is seen that leaf number observed during

October irrespective of treatments remained unchanged in the following months of November, December and January.It increased in February after which there was no further increase till the final observation in April.

Maximum leaf number has been observed in the control shoots and it is significantly superior to any of the other treatments as per the analysis of variance table no. 9. The minimum leaf number is produced with 2000ppm MH and the next lowest was observed with 5000 ppm Alar. All higher concentrations of chemicals which checked growth to the maximum extent produced in few of their shoots new vegetative flush in the month of February thus the average leaf number is seen to be very much lowered in these treatments in comparison to control. The rest of the shoots in these treatments since flowered did not produce any vegetative growth. Hence flowered did not produce any vegetative phase antagonise each other is strong biennial bearers as in Langra. This has become very much evident here and is in conformity with the findings of earlier workers such as Singh and Khan (1940),Sen(1943) and Mallik(1957)

HISTOGRAMS SHOWING THE EXTENT OF FLOWERING
(IN PERCENTAGE)

Fig-V (a)

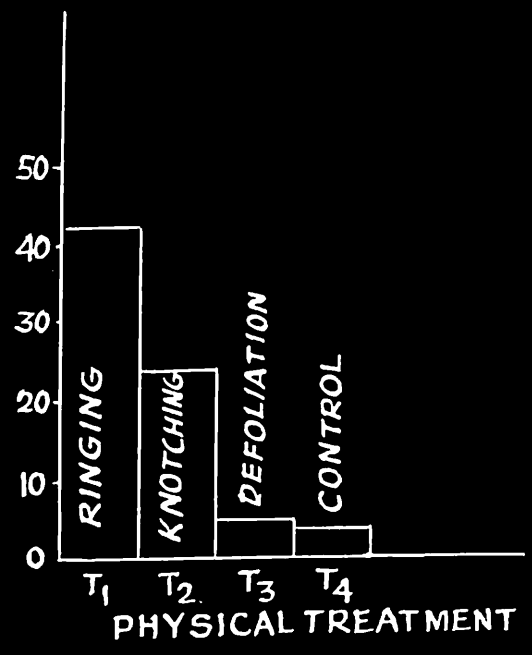


Fig-V (c)

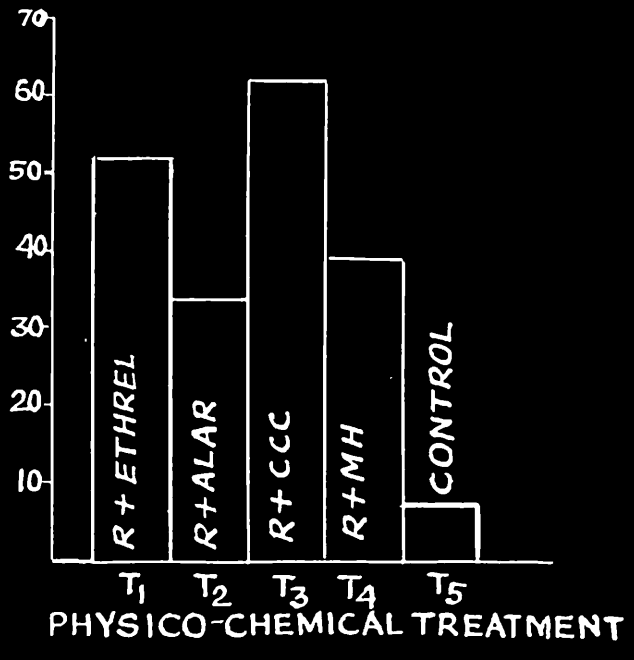
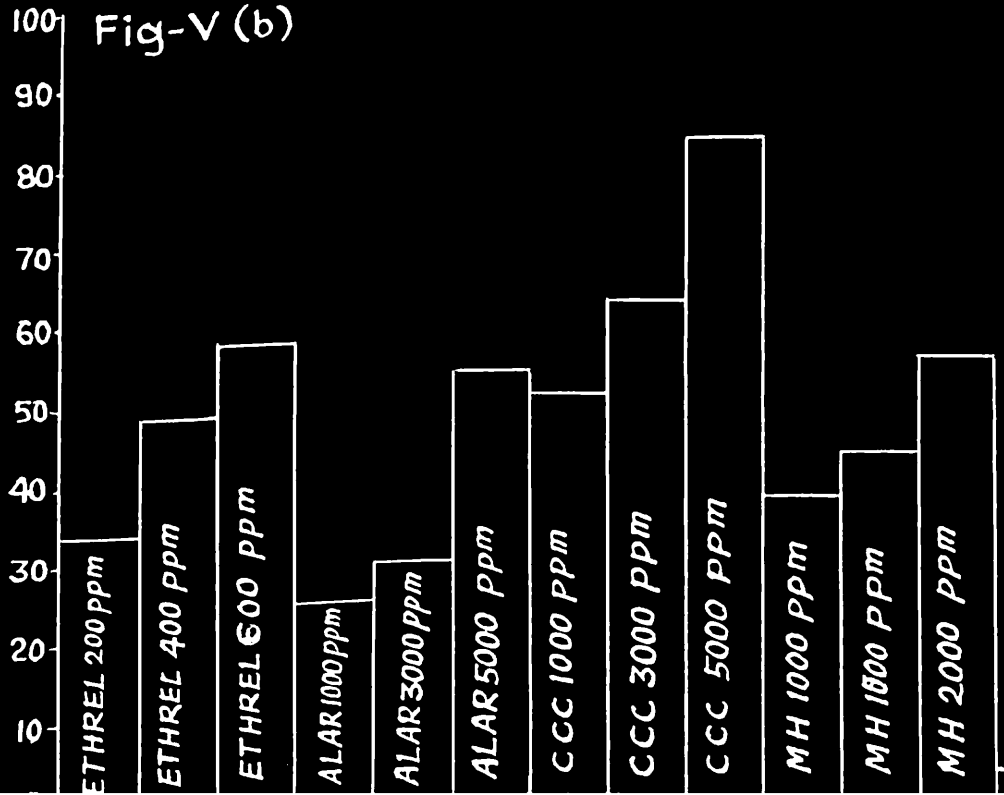


Fig-V (b)



(Discussion)

Extent of flowering :

For extent of flowering table No. 10 in the result chaper may be viewed .

From the table it may be seen that the minimum extent of flowering is found in the control which account for only 3.5% of shoots flowering in that treatment. The maximum extent of flowering of 24.1 percent has been observed in T_9 where 6000 ppm of Cycocel was used. Analysis of variance table no. 10 reveals that T_9 is significantly superior to all otherm treatments. T_8,T_3,T_{12}, T_6 and T_7 i.e. 8000 ppm Cycocel, 600 ppm Ethrel, 2000ppm MH, 6000 ppm Alar and 1000 ppm Cycocel have shown the next best percentages of flowering and there have no significant difference among themselves.

The percentage of flowering observed in those treatment ate seen to range between 51.92 and 63.63. T_4 is placed next higher to control inorder of merit showing 26.22 percent flowering but at the same time it is significantly different from control. T_5 and T_1 are also observed to be significantly superior to T_4 but have not exhibited any significant difference between them.

In general the effect of cycocel in all its concentrations have shown quite favourable result in bringing about higher percentage of flowering in comparison to other treatments.

(Discussion)

Ethrel and Maleic hydrazide has also seen to be par with lower concentration of cycocel. Since the highest concentration of cycocel produced the highest percentage of flowering at the same time all the concentrations of cycocel did not suppress the vegetative growth in the following spring it may therefore be concluded that CCC is the most effective chemical which can bring about both flower induction and subsequent vegetative growth for the next year flowering.

Effect of growth retardants on flower induction has been severally by manyworkers earlier. Maiti, Mukhopadhyay and Sen (1971) with repeated sprays of 8000 ppm Cycocel promoted flowering considerably in Langra mango.

They also reported that B_9 under similar concentrations induced flower but to a smaller extent in comparison to cycocel. Maiti, Basu and Sen also reported later in 1972 about the favourable effect of CCC on flower induction in Langra. Chadha et al (1972) studying on the effect of varying concentrations of ethrel in Langra mango reported that early and heavy flowering are caused on account of ethrel applications in Langra. They also reported the maximum extent of emergence of mixed leafy panicles and large number of

panicles from the dormant buds situated in the woody branches as a result of ethral application.

The other important effect of these chemicals has been the earliness in flowering especially with Ethrel in which the flowering could be noticed at least 15 days ahead of the regular flowering time. The advantage of earlier flowering in other wise late flowering varieties of North India under our conditions is quite immense from the point of view of getting higher fruit set and fruit yield because of the escape of the flowers from the damage of mango hopper for their earliness.

Comparing the extent of flowering observed between chemical and physical treatments it may be seen that the highest percentage of flowering observed in physical treatment is in ringing which comes only to 43.58 percent whereas the maximum percentage of flowering observed in chemical treatments is 84.1 as obtained with 5000 ppm Cycocel. The later is almost double of the ringing treatment. Even many other chemical treatments such as allconcentrations of cycocel, 2000 ppmH, 600 ppm Ethrel, 5000 ppm Alar etc. have also been found to surpass over the effect observed

Discussion)

with ringing treatment.

Sex ratio :

The extent of sex ratio varied between 1.266 and 2.216, the former is seen with 5000 ppm Cycocel and the later with 3000 ppm Cycocel as seen from the table no. 17. The lower sex ratio is considered more beneficial for fruit set because of higher number of perfect flowers in comparison to male flowers per panicle. Thus cycocel in addition to bringing about higher percentage of flowering cause also higher extent femaleness.

Biochemical studies :

The data in table no. 11 reveles that the content of reducing, non reducing and total sugar, starch, total carbohydrate, nitrogen and C/N ratio of shoots irrespective of treatments are higher in January than October and these are lowered further in April. Among the various treatments the lowest C/N ratio has been observed in the control shoots as observed in April and higher concentration is seen with 5000 ppm of Cycocel.

It is expected that high C/N ratio is associated with flowering condition and low C/N ratio with vegetativeness. Since cycocel has been observed to induce the highest percentage of flowering therefore correspondingly a higher C/N ratio has been reflected in its shoots. Again contro has produced very little flowering and

(Discussion)

(C) Physico-Chemical Treatments :

Length of shoot :

The results for the effect of physicochemical treatments on shoot length as given in table no. 12 reveal that the length of shoot has not been found to increase in the month of november and december over the initial length observed in October. However there has been increase in the month of January and in subsequent months of February and March, but in April there has been no further increase and the length remained what it was in the preceding month of March. The increase observed in each month is found to be significantly different from treatment to treatment as per the table no. 12 for the analysis of variance in January it is seen that there has been maximum increase in control which is significantly superior to any other treatment. Next to control, the increase has been more with 400 ppm ethrel plus ringing. The least increase has been seen with 1600 ppm CCC plus ringing and the next above it is seen with 3000 ppm Cycocel plus ringing. The similar trend of results is also observed for different treatments in the month of February and March.

(Discussion)

The suppression in extension growth owing to ringing alone or due to application of growth retardants has already been discussed in the experiments on physical treatment and chemical treatments. Therefore there is no doubt that the combination of physical and chemical treatments are bound to augen-in with the similar type of growth suppression as it has been observed either in physical or chemical treatments. Comparing the effect of ringing and chemical treatments also with physicochemical treatments it may be seen from table no. 2 and 7 that suppression due to ringing has been considerably lesser than the chemical treatments and physicochemical treatments has been almost identical with chemical treatments . Thus suppression has not been additive in physico-chemical treatments but more or less alike with chemical treatments. Since lower concentrations of growth retardants has been used in physico-chemical treatments that is the possible reason why the growth suppression could not surpass to that of chemical treatments.

Thickness of shoot :

From table no. 13 it may be seen that thickness of shoot registered increase from December unwards till April in all the treatments and there has been significant difference from treatment to treatment in each month which may be seen from the analysis of variance table no.13. The highest increase has been recorded with MH and ringing

and the lowest has been seen in the control. The other treatments as in descending order are ethrel, alar and cycocel.

Comparing the effect of ringing and chemical treatments from table no. 3, 8 and 13 it may be seen that the shoot diameter increase has been considerbly higher with ringing, although chemicals have imparted some effect. But in contrary to the expectation their combination has not shown an addivive effect similar to their suppression effect in shoot length. This anomaly may be expected to be due for the lower concentration of chemicals used in the physio-chemical treatments in comparision to the concentrations tried in the experiment with chemical treatments.

Number of leaves :

Data for number of leaves in table no. 14 and analysis of variance table no. 14 in the appendix indicated that irrespective of treatments, leaf number remained constant during October to January. Leaf number increased in the month of February in all treatments and the same number maintained till April when the final observation were recorded.

The maximum increase in leaf number is obtained in control which is significantly superior to rest others. The minimum increase has been seen

cussion)

with MH. the other treatment , Alar are also seen to be par with MH but it is significantly lower than the CCC and ethrel which are par with each other.

The effect of either ringing or chemical treatment alone has been almost the same as with the effect of ringing plus chemical. In all these cases maximum leaf number has been observed in the control and minimum with ringint or MH or their combination.

It has already been discussed earlier regarding the effect of growth retardants and ringing on suppression of vegetative growth, since in these treatments higher extent of flowering has been formed in contrast to vegetativeness it is but natural that the subsequent vegetative flush during flowering might be negligible in these treatments thus accounting for the lowest leaf number in the combined treatments of ringing and MH.Comparing MH with other growth retardants it may be visualised that MH singularly represents a class of growth inhibitors. Therefore its effecton suppression of vegetative growth is quite spectacular than the class of growth retardants like ethrel, alar and cycocel. Thus the least occurance of vegetative flush in MH is quite understandable as opposith to the effect of control and vis-a-vis with growth retardants.

(Discussion)

Extent of flowering :

The data on extent of flowering in physico-chemical treatments as given in table no. 15 and the analysis of variance table no. 15 of the appendix indicate that highest percentage of flowering occurs with 3000ppm CCC plus ringing which is significantly superior to rest others. Next in order of merit is ethrel plus ringing which is followed by MH and Alar. Each of these treatments are found to be significantly different from one another. The lowest percentage of flowering has been seen in the control sheets. the highest orcentage of flowering recorded in CCC which is 63.8 in contrast to the lowest percentage of 7.99 observed in the control.

Comparing the effects of physical, chemical and physico-chemical treatments from table no. 6,10 and 15 it may be seen that highest percentage of flowering has been observed in the experiment with chemical treatments which is 84.1%. But the combination of physical and chemical treatment does not record such a high percentage which shows only63.28 percent, possibly due to a lower concentration of chemicals used in this experiment as compared to the experiment with chemical treatments.

ng out in clusters
of ringing from the barren
stem

(Discussion)

Further no additive effect could be established in the combinations of ringing plus chemical as the girdling effect has possibly masked the effect of chemicals by blocking the desirable physiological change required for initiating the flowering process.

Earliness of flowering also has been observed to the extent of 15-20 days as a result of physiochemical treatments especially in combination of ethrel with ringing. Application of ethrel has also shown such type of earliness in the experiment with chemical treatments alone. Chacko and Kohli have obtained similar findings in different cultivars of mango with ethrel under Delhi conditions.

The other effect of physico-chemical treatments have been the occurance of large number of extra axillary inflorescences especially in the barren stem below the ringing region as shown in the photograph affixed in the facing page.

The induction of flowering below the ringing region suggest that flowering stimulus not necessarily accumulate in the shoot apex and cause flowering but is distributed all over the tree by way of translocation from branch to branch and might be stored in the wood of the tree trunk or translocated from the root region.

CHAPTER VI

Summary and Conclusion

discussion)

Sex ratio studies reveal that there has been difference in sex ratio from treatment to treatment as may be seen in Table No. 17.However, the difference is not conspicuously large among treatments. Maximum femaleness has been observed in Alar and the minimum in control.

Biochemical studies :

The table no. 16 showing the data of biochemical studies in the experiment with physio-chemical treatments reveals that contant of reducing, nonreducing and total sugar, starch and total carbohydrates, nitrogen and C/N ratio etc. increase to a maximum extent in January irrespective of treatments over the values of October which again fall below the level of October in the month of April.The highest C/N ratio has been recorded with cycocel plus ringing where the highest percentage of flowering has also been registered. Thus a high C/N ratio is associated with flowerness is evident from this finding. Again comparing the physical,chemical and physico-chemical treatments it may be seen that among all experiments maximum flowering has always been associated with the treatment showing the highest C/N ratio. Among all the high C/N ratioes registered in different experiments, thephysicochemical experiment with cycocel has shown the highest value but incidentally has not shown the highest percentage of flowering among all three experiments.

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SUMMARY & CONCLUSION

THE investigation on " Physical, Chemical and Physico-chemical treatments for flower induction in mango " has been undertaken in the Horticultural Research Station of the Orissa University of Agriculture and Technology, Bhubaneswar during 1973 - 74 in the cultivar Langra.

The physical treatment experiment comprised of four treatments such as ringing, knotching, defoliation and control which are tried in a randomised block design with five replications.

The experiment on chemical treatments consisted of thirteen treatments which are also tried in the randomised block design with five replications. Four chemicals, three of which are growth retardants like, Ethrel, Alar and Cycocel and one growth inhibitor such as Maleichydrazide (MH) are tried in three levels each to account for the twelve treatments and the thirteenth one is the untreated control. The respective

concentrations of these chemicals are 200,400, and 600ppm for Ethrel, 1000,3000 and 5000 ppm for Alar, 1000,3000 and 5000 ppm for Cycocel and 1000,1500 and 2000 ppm for MH.

The physico-chemical treatments are also tried in a randomised block design with five replications and these treatments consisted of general ringing of shoots to which any one of the chemicals like ethrel, Alar,Cycocel and MH is applied at concentration of 400,3000,3000 and 1500ppm respectively.

Treatments are given to the trees in the month of October and since then monthly observations on shoot length, shoot diameter and number of leaves etc. are recorded till the month of April when final observation was taken.

The time of emergence of panicles, extent of flowering and sex ratio etc. are recorded in different treatments during the flowering time.

Leaf samples are collected from different treatments during October,January and April to analyse the leaf content of sugar,starch, total carbohydrate,

Nitrogen and C/N ratio.

The salient findings observed in different experiments are summarised below.

Physical treatment :

In the experiment with physical treatments it is seen that ringing suppressed shoot extension growth to a maximum extent beyond the flowering season. Therefore the increase in shoot length in this treatment is significantly lower in comparision to other treatments especially over control which has shown the maximum increase in shoot length.

The shoot diameter increased considerably in all the physical treatments but it has been highest with ringing. control shoots have shown the lowest increase.

There is increase in leaf number during the month of February because of appearance of new vegetative growth irrespective of treatments but control has shown the highest increase and ringing has recorded the minimum increase.

There has been maximum extent of flowering in the ringing treatments showing 42.6% of its shoots flowered whereas, control registered flowering only in 4.53 percent of its shoots.

In ringing the flowering has been observed to have appeared 9 - 12 days earlier than the control shoots.

Biochemical studies reveals that there are higher leaf content of sugar, starch and total carbohydrate and C/N ratio in the ringing treatment as compared to other and especially so with control which indicated lowest values in all these constituents.

Chemical treatment :

In general , application of growth retardants reduced stem elongation considerably as compared to control. 2000 ppm MH induced the maximum inhibition.

Shoot thickness increased with the application of growth retardants and maximum increase is observed with 2000 ppm MH. in respect of

Leaf number has been seen to increase in all the treatments during the month of February,onaccount of new vegetative flush. Maximum increase however has been seen in the control which is significantly higher than any of the treatments with growth retardants. Minimum increase has been observed with 2000 ppm MH.

Flowering has been seen to be earlier by 15 - 20 days due to application of growth retardants especially with Ethrel application.

Extent of flowering has also substantially increased due to chemical treatments. Maximum extent of flowering has been observed with 5000 ppm CCC where 24.01 percent of the treated shoots flowered in contrast to 3.0% in the control.

Since cycocel has not substantically decreased vegetative growth and simultaneously have also induced maximum flowering therefore this may be the most desirable treatment from the point of view of balancing vegetative growth and flowering in the shoots inorder to make the tree bear regularly.

The biochemical studies reveal that in all cases of growth retardant the leaf carbohydrate content and consequently C/N ratio have become highest during January incomparision to october or April. Among all MH has shown the maximum C/N ratio and control shown the minimum.

Physico-chemical treatment:

Similar to the experimental findings recorded with physical and chemical treatments, the physico-chemical treatments have also shown suppression of shoot length, increase in shoot thickness, suppression of vegetative growth

at the time of vegetative flush and earliness and higher extent of flowering.

1500 ppm MH plus ringing has registered the maximum suppression in shoot length, maximum increase in stem diameter minimum number of leaves at the time of new vegetative flush and maximum C/N ratio.

The extent of flowering has been maximum with 3000 ppm CCC plus ringing. The combination of ethrel and ringing has shown the maximum earliness in flowering.

Contrary to exception non of the physico-chemical treatment could surpass in their effect over the chemical treatments possibly because of lower concentration of chemicals used or ringing has not been compatible with the chemical treatments.

Extra axillary flower panicles have been formed to larger extent in the physico-chemical treatments and in the physical treatments of ringing.

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Appendix

A P P E N D I X

A N O V A

Table -2

Month	Sources	D.F.	S.S.	M.S.	Variance ratio	Tf tant 5% .. 1%	
1	2	3	4	5	6	7	
~~Replication~~							
Oct.	Replication	4	1.07				
	Treatment	3	5.01	1.67	1.17	3.49	5.95
	Error	12	17.07	1.42		N.S	
Jan.	Replication	4	0.042				
	Treatment	3	3.634	1.21	173	Sig.	Sig.
	Error	12	0.105	0.007			
	S.E (m)		0.014	C.D.	0.013		
Feb.	Replication	4	0.04				
	Treatment	3	5.65	1.88	62.6	Sig.	Sig.
	Error	12	0.37	0.003			
	S.E(m)		0.024	C.D.	0.118		
May.	Replication	4	0.10				
	Treatment	3	77.76	2.68	616.0	Sig.	Sig.
	Error	12	0.05	0.004			
	S.E (m)		0.035	C.D	0.1364		
April.	Replication	4	0.4443				
	Treatment	3	8.0405	2.6801	167.46	Sig.	Sig.
	Error	12	2.069	0.0172			
	S.E (m)		0.058	C.D.	0.2511		
-		T_4	T_3	T_2	T_1		

Table -3

Oct.	Replication	4	0.07	.0207			
	Treatment	3	0.061	1.07 .04	1.07	N.S	N.S
	Error	12	0.53				

(to be continued)

1	2	3	4	5	6	7	8
Dec.	Replication	4.	0.0041				
	Treatment	3	0.005	0.001	0.037	N.S	N.S
	Error	12	0.0333	0.0027			
Jan.	Replication	4	0.006				
	Treatment	3	0.269	0.089	1.90	N.S	N.S
	Error	12	0.575	0.047			
Feb.	Replication	4	0.0025				
	Treatment	3	0.4710	0.157	314	Sig.	Sig.
	Error	12	0.007	0.0005			
	S.E (m)		0.01	C.D.	0.048		
Mar.	Replication	4	0.002				
	Treatment	3	1.357	0.452	64.57	Sig.	Sig.
	Error	12	0.008	0.0007			
	S.E (m)		0.011	C.D.	0.057		
April	Replication	4	0.0016				
	Treatment	3	2.149	0.0864	1278.5	Sig.	Sig.
	Error	12	0.0069	0.0005			
	S.E (m)		0.01	C.D	0.048		
		T_1	T_2 T_3	T_4			
Table -4 /							
Oct.	Replication	4	0.08				
	Treatment	3	0.09	0.01	0.33	N.S	N.S
	Error	12	0.39	0.03			
Feb.	Replication	4	0.073				
	Treatment	3	3.714	1.238	102.3	Sig.	Sig.
	Error	12	0.792	0.066			
	S.E (m)		0.031	C.D.	0.152		
		T_3	T_4 T_2	T_1			
Table -5 /							
	Replication	4	277.61				
	Treatment	3	2086.16	695.39	136.39	Sig.	Sig.
	Error	12	61	5.09			
	S.E (m)		1.008	C.D	4.966		
		T_1	T_2 T_3	T_4			

1	2	3	4	5	6	7	
Oct.	Replication	4	162.11			1.96	2.55
	Treatment	12	141.55	11.80	0.778	N.S.	N.S.
	Error	48	727.21	15.15			
Jan.	Replication	4	0.13				
	Treatment	12	10.38	0.86	86	Sig.	Sig.
	Error	48	0.57	0.01			
	S.E (m)		0.044	C.D,	0.123		
Feb.	Replication	4	0.051				
	Treatment	1 2	20.6628	1.713	127.83	Sig.	Sig.
	Error	48	0.0175	0.013			
	S.E.		0.054	C.D.	0.209		
Jan. & April	Replication	4	0.0116				
	Treatment	12	27.74	2.312	825.71	Sig.	Sig.
	Error	48	0.135	0.002			
	S.E(m)		0.023	C.D	0.067		
Table-8							
Oct.	Replication	4	0.0128				
	Treatment	12	0.247	0.002	1.3522	N.S	N.S
	Error	48	0.071	0.0014			
Dec.	Replication	4	0.0011				
	Treatment	12	0.2477	0.0206	68.66	Sig.	Sig.
	Error	48	0.0176	0.0003			
	S.E(m) 0.007		C.D. 0.031				
Jan.	Replication	4	0.0006				
	Treatment	12	0.3363	0.0280	93.33	Sig.	Sig.
	Error	48	0.0149	0.0003			
	S.E (m)		0.0077	C.D.	0.0318		
April	Replication	4	0.004				
	Treatment	12	2.6171	0.218	21.8	Sig.	Sig.
	Error	48	0.4944	0.0103			
	S.E (m) 0.044		C.D. 0.180				
Table-9							
Oct.	Replication	4	0.20	[illegible]			
	Treatment	12	0.17	0.014	0.212	N.S	N5.
	Error	48	3.31	0.066			
Feb.	Replication	4	0.01				
	Treatment	12	5.69	0.474	215.46	Sig.	Sig.
	Error	48	0.11	0.0022			
	S.E(m) 0.02		C.D.	0.061			

1	2	3	4	5	6	7	
Table No.10							
	Replication	4	154.4916				
	Treatment	12	12228.613	1019.501	142.984	Sig.	
	Error	48	342.103	7.127			
	S.E (m) 1.193 C.D. 3.953						
Table No.12							
Oct.	Replication	4	20.53			3.01	4.77
	Treatment	4	1.41	0.35	0.1	N.S.	N.S.
	Error	16	54.69	3.41			
	S.E.(m) 0.173						
Jan.	Replication	4	0.032				
	Treatment	4	4.9204	1.230	683.3	Sig.	Sig.
	Error	16	1.0294	0.0018			
	S.E. (m) 0.173 C.D. 0.079						
Feb.	Replication	4	0.19				
	Treatment	4	1.53	0.348	895.4		
	Error	16	0.103	0.33			
	S.E.(m) 0.01 C.D.0.06						
Mar & April							
	Replication	4	0.0173	0.0049			
	Treatment	4	0.075	1.99	12.45		
	Error	16	0.117	.0016			
	S.E.(m).0.173 C.D. 0.079						
			T_5 T_2 T_1 T_3 T_4				
Table No.13							
Oct.	Replication	4	0.001				
	Treatment	4	0.004	0.001	1.0	N.S.	N.S.
	Error	16	0.013	0.000			
Dec.	Replication	4	0.0016				
	Treatment	4	0.551	0.0367	77.4	Sig.	Sig.
	Error	16	0.0094	0.0005			
	S.E.(m) 0.01 C.D. 0.045						
Jan.	Replication	4	0.035				
	Treatment	4	0.3687	0.0921	54.17		
	Error	16	0.0283	0.0017		Sig.	Sig.
	S.E.(m) 0.010 C.D. 0.022						
Feb.	Replication	4	0.0116				
	Treatment	4	0.4006	0.1001	166.833		
	Error	16	0.0111	0.0006		Sig.	Sig.
	S.E.(m) 0.01 C.D. 0.045						
Mar.	Replication	4	0.0052				
	Treatment	4	0.6340	0.1309	818.166		
	Error	16	0.0110	0.0006			
	S.E.(m) 0.01 C.D. 0.045						
April.							
	Replication	4	0.004				
	Treatment	4	0.586	0.146	1460	Sig.	Sig.
	Error	16	0.002	0.0001			
	S.E.(m) 0.004 C.D. 0.020			T. T			

Table 14

ct.	Replication	4	0.12			
	Treatment	4	0.07	0.0175	0.2302N.S.	N.S.
	Error	16	1.23	0.076		

Feb.

	Replication	4	0.0031			
	Treatment	4	2.2956	0.5739	717.3750	S.E.
	Error	16	0.0136	0.0008		

S.E.(m) 0.01 C.D.0.0458

T_5 T_3 T_1 T_2 T_4

Table 15

	Replication	4	28.75			
	Treatment	4	3730.13	932.53	268.74	
	Error	16	55.62	3.47		

S.E.(m) 0.833 C.D. 3.63 31 S.

T_3 T_1 T_4 T_2 T_5