FRUIT SETTING IN CUCUMBERS AS INFLUENCED BY POLLINATION AND GROWTH REGULATORS

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I hereby recommend that this thesis prepared under my direction by Khalil Abu Ghannam titled FRUIT SETTING IN CUCUMBERS AS INFLUENCED BY POLLINATION AND GROWTH REGULATORS be accepted as fulfilling the thesis requirement for the degree of MASTER OF SCIENCE

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Final approval and acceptance of this thesis is contingent on the candidate's adequate performance and defense thereof at the final oral examination .

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INTRODUCTION

Cucumbers Cucumis sativus L. are grown in the Jordan Valley in the open field from mid February to late May and from August to December. The yield obtained is very low. Since the introduction of plastic culture to the Jordan Valley in 1970. Cucumber have been grown under plastic from early October to late May. The crop can be exported for a high price, and so it has become the major vegetable crop grown under plastic cover. The total area of vegetables grown under plastic during the season 1978/1979 was 675.6 hectares, of which 76% were planted to cucumbers (Steitieh and Musa 1979).

Farmers have been complaining about the large percentage of female flower abortion in cucumbers grown under plastic cover which resulted in lower fruit set and lower yield. Cucumber varieties grown in Jordan are mainly predominantly female and non parthenocarpic, so flower abortion may result from lack of pollination and/or lack of fertilization. Pollination in cucumbers is mainly accomplished by honey bees. However, the activity of honey bees is restricted under plastic cover. The structures are closed most of the time, and temperature, and relative humidity, are not favorable for honey bee activity (Bodenheimer and Ben-Nerya, 1937).

The amount of pollen available for pollination is low under low temperature and short days. The sub gynoecious varieties produce few male flowers. Conditions such as low temperature and short days prevailing during the cucumber growing season enhance the production

of female flowers, and ecourage the setting of parthenocarpic fruits from non parthenocarpic varieties (Nitsch et al., 1952).

Chlorflurenol, 4-CPA, 2,4-D, GA, IAA, Naptalam and many other growth regulators has been reported to induce parthenocarpic fruit set in tomatoes and cucumbers (Johnson, 1956, Homan, 1964, Cantliffe et al., 1972, Elasser et al., 1974a, b and Beyer and Quebedeaux , 1974). Chlorflurenol and 4-CPA were the growth regulators most used commercialy on fruit set .

The degree of parthenocarpy in the major varieties grown in the Jordan Valley has not been studied. The objectives of this study were :

1. To evaluate the intensity of parthenocarpy in ten cucumber varieties grown under plastic in the Jordan Valley .
2. To study the possibility of improving fruit set by the use of para chlorophenoxy acetic acid (4-CPA) and Methyl-2-chloro-9-hydroxy flurene-(9)- carboxylate(chlorflurenol).

As an outcome from this study we hope to find solutions for cucumber female flower abortion in plastic houses, by finding varieties that set fruits efficiently and/or by finding a suitable chemical treatment that would improve fruit setting .

REVIEW OF LITERATURE

Fruit set

Fruit set in cucumbers is the condition in the ovary when the signal to enlarge has been recieved. Experiments on cucumber flowers where styles were removed from the ovaries at intervals after pollination indicated that the signal for ovary enlargement was recieved 12 - 18 hr after pollination (Fuller and Leopold, 1975). The time required for the pollen tubes to reach the ovules was estimated to be 30 - 36 hr after pollination (Matlob and Kelly, 1973, and Fuller and Leopold, 1975). This indicated that the initial fruit set signal arose from an interaction between the pollen tubes and the pistillate tissue through which the tubes grow (Fuller and Leopold, 1975).Matlob and Kelly (1975) found that auxin like activity was increased in the styles of cucumber flowers while pollen tubes were growing, and that such auxin activity did not increase in the ovary until just before fertilization .

The endogenous levels of auxin, gibberellins, and cytokinins were found to be almost stable at the early stages of ovary growth in both pollinated and unpollinated tissue. The level of hormones in cucumber pollen also appeared to be inadequate for stimulating the growth of the ovary. Such results lead to the conclusion that hormones may not be controlling the initial fruit set mechanism in cucumbers even though they are capable of causing fruit growth (Fuller, 1974) .

Nucleic acid synthesis was found to be stimulated within 9 hr after pollination or, within 6 hr of auxin application. Such stimulation could be stopped by actinomycin-D if applied within 12 hr after pollination. Actinomycin-D also inhibited the ovary growth after auxin application. These results indicated that nucleic acid synthesis is necessary for fruit set. Later applications of such inhibitors were less effective (Fuller and Leopold, 1977). Powell and Krezdron (1977) found that Gibberellic acid application or self pollination, in Citrus madurensis Lour, resulted in considerabely stronger mobilization of C^{14} metabolites to the young ovaries and developing fruits than when flowers were emasculated. The movement of C^{14} metabolites after anthesis appeared to be essential for fruit set and development.

Pollination is necessary for cucumber fruit set. When pollination was prevented by using nets to exclude honey bees or, by capping the female flowers with gelatine capsules, fruit setting was dramatically reduced (Palevitch et al., 1972, Elassar et al., 1974 a, and Cantliffe, 1977 b).

Pollination in cucumbers is acomplished mainly by honey bees. However, the cucumber flower is not attractive to honey bees; and pollination may be reduced if honey bees find more attractive flowers growing nearby (Collinson and Martin, 1970; Free, 1970, cited in Ponti, 1976). Moreover, temperatures lower than 8 C, relative humidity higher than 80 %, and strong wind restricted bee activity(Bodenheimer and Ben-Nerya, 1937).

Fertilization in cucumbers is not always certain to take place, even with adequate pollination, if conditions are not favorable for pollen germination and pollen tube growth. Pollen germination and pollen tube growth are reduced at temperatures lower than 10 or higher than 43 C (Matlob and Kelly, 1973). Seed development in the early fruits was reported to restrict the development of additional fruits on cucumber plants (McCollum, 1934, cited in Cantliffe, 1977 b; Denna, 1973). In addition, the early fruit set resulted in a strong inhibition of vine growth and caused a reduction in fruit and seed production if left unharvested (Denna ,1973). Cucumbers for once-over harvest produced only one or two fruits per plant because the first set fruits inhibited the growth of subsequent fruits even if the female flowers were pollinated. The apical meristem may also inhibit fruit growth, since pinching the apical meristem of cucumber plants decreased the inhibitory effect on fruit growth, resulting in higher yield per plant (Baker and Dean, 1978 a).

Parthenocarpic fruit set.

Parthenocarpic fruit set in cucumbers is the ability to develop fruits without pollination, and it can be regarded as a qualitative character (Ponti, 1976). Cucumber plants which bear parthenocarpic fruits produce more fruits than do the nonparthenocarpic plants(Denna, 1973, Rudich et al., 1977, and Baker and Dean, 1978).

It was proposed that parthenocarpy in cucumbers is controlled by a gene pair expressing incomplete dominance with modifier genes(Pike

and Peterson, 1969). Hybrids resulting from crossing parthenocarpic and nonparthenocarpic lines were intermediate for parthenocarpic yield (Rudich et al.,1977). Ponti and Garretsen (1976) suggested that parthenocarpy in cucumbers is controlled by three independent isomeric genes with additive action, together with a non-allelic interaction of the homozygote-heterozygote type. Parthenocarpy is modified by various environmental factors. Short days and low temperatures, mainly low night temperature, enhanced parthenocarpic fruit development, and long days inhibited the development of parthenocarpic fruits in cucumber (Ponti, 1976, 1978, and Rudich et al., 1977), and in summer squash (Rylski, 1974). The general level of parthenocarpy in cucumbers was very low under poor light conditions (Ponti, 1978) .

Rudich et al.,(1977) suggested that the degree of parthenocarpy could be measured by either earliness of fruiting(measured by number of days to the first fruit or number of nodes to the first fruit) or the total number of parthenocarpic fruits, and Ponti , (1976) suggested parthenocarpic percentage as a measure. The latter also suggested that fruit number was too inexact to obtain satisfactory insight into parthenocarpic phenomena .

Effect of growth regulators on parthenocarpic fruit setting:

Parthenocarpic fruit set has also been reported to occur through the use of synthetic plant growth regulators .

Gibberellic acid (GA) at 0.2 µg applied to the pedicel of tomato flowers induced parthenocarpic fruit set(Homan,1964). GA_3 at

100 to 2000 ppm and GA_{4+7} at 50 to 200 ppm applied to cucumber flowers at anthesis caused parthenocarpic fruit set (Lingaraj , 1967, Elassar et al.,1974 a, and Ogawa and Aoki, 1977). The highest concentrations gave a higher parthenocarpic percentage .

At rates of one to ten µg, 2,4-Dichlorophenoxy acetic acid (2,4-D) applied once to the proximal region of the pedicel of tomato flowers was sufficient to induce parthenocarpic fruit set in 82 percent of the treatments. However, a continuous suply of 2,4-D was toxic to the ovary (Homan, 1964).

Indol acetic acid (IAA) applied to the tomato ovary at 0.1 to 0.2 mg/ml resulted in parthenocarpic fruit set in nearly all treatments, but it was ineffective when applied to the pedicel. The application of IAA to the pedicel of the cucumber was very effective in causing parthenocarpy (Homan, 1964). IAA at 10 to 100 ppm applied to cucumber flowers at anthesis also caused parthenocarpic fruit set (Elassar et al., 1974 a).

Naphthalene acetic acid (NAA) at 500, 1000, 1500, and 2000 ppm applied to cucumber flowers resulted in parthenocarpic fruit set (Lingaraj , 1967).

B-naphthoxy acetic acid (B-NOA) at 100 ppm applied directly to flowers at anthesis or to the entire plants of cucumbers and muskmelons caused parthenocarpic fruit development (Elassar et al.,1974 a, b).

The growth regulator 3-carboxy-1-(P-chloro phenyl)-4,6-dimethyl-2- pridone(CCDP) sprayed at concentrations of 50 to 100 ppm to the

entire cucumber plant increased the number of parthenocarpic fruits per plant (Cantliffe., 1972) .

The chemical 5,7-dichloro-4-ethoxycarbonyl methoxy-2, 1, 3-benzothiadiazole (PH 30.13) applied to the ovaries of non pollinated flowers of muskmelons, induced parthenocarpic fruit development (Risser, 1976).

Foliar sprays of N-1-naphthylphthalamic acid(naptalam) at 500 to 5000 ppm on cucumber plants at early flowering stage induced parthenocarpic fruit set (Quebedeaux and Beyer, 1974, Palevitch and Menagem, 1977). Naptalam sprayed on cucumber plant inhibited auxin transport from the ovaries and induced parthenocarpic fruit set (Beyer and Quebedeaux, 1972, 1973, 1974) .

2, 3,5-triiodobenzoic acid (TIBA) sprayed on cucumber plants, at 10 to 100 ppm when four to six flowers reached anthesis induced parthenocarpic fruit set (Cantliffe, 1972, Cantliffe et al., 1972a, Palevitch et al., 1972). This induction of parthenocarpy was attributed to inhibition of auxin transport from the ovaries (Beyer and Quebedeaux, 1972, 1973, 1974) .

Ethephon applied to cucumber plants at the two to three leaf stage increased the number of female flowers, and increased the early yield of marketable cucumbers (Churata and Awad, 1974).

3,3a-dihydro-2-(P-methoxyphenyl) 8H-pyrazolo [5,1-a] isoindol-8-one (DPX 1840) applied as a foliar application at early flowering stages induced parthenocarpic fruit set in the unfertilized pistillate flowers of cucumbers (Quebedeaux and Beyer, 1972). It was

found that DPX 1840 induced parthenocarpy by inhibiting auxin transport from the ovary (Beyer and Quebedeaux, 1972, 1973, 1974).

Maleic hydrazide (MH) applied to cucumber plants at 200 ppm at the one to two leaf stage, and again at the three to four leaf stage increased the number of female flowers, and increased the number of fruit and total weight of fruits per plant over the untreated control (Verma et al., 1969).

Chlormequat applied to cucumber plants at 2000 ppm at the two to three leaf stage increased the number of female flowers, and increased the early yield of marketable cucumbers (Churata and Awad, 1974).

4-CPA was reported many years ago to induce parthenocarpic fruit set in tomatoes (Singlitary and Warren, 1951, Johnson, 1956, Rudich and Rabinowitch, 1974); in muskmelons (Elassar et al., 1974 b); and in cucumbers (Palevitch et al., 1972, Elassar et al., 1974 a, and Matlob and Kelly, 1975). When applied to tomato influrescences , 4-CPA acted like an auxin and effectively prevented abscission by increasing the auxin level of the flower at the time it would normally be shed due to the low level of flower auxin (Johnson, 1956). Singlitary and Warren (1951) found that no significant difference resulted when 4-CPA was applied at bud, halfbloom, or fullbloom stages .No injury at any stage was caused by 4-CPA, but flowers sprayed at the full bloom stage developed and matured earlier, and the fruits were larger. Johnson (1956) also found that 4-CPA improved fruit set and increased yield of tomatoes when applied to the influrescences, or

to the foliage at the rate of 25 ppm at both low and high temperatures and light intensities. 4-CPA improved fruit set and increased the yield of tomatoes when applied at the rate of 200 ppm to the foliage when 12 flower clusters were present on the plant(Rudich and Rabinowitch, 1974). 4-CPA applied directly to cucumber and muskmelon flowers at the rate of 50 to 400 ppm caused parthenocarpic fruit development (Palevitch et al.,1972, Elassar et al., 1974 a,b, Matlob and Kelly, 1975), but few parthenocarpic fruits were produced at 38/27 C day / night temperatures.(Matlob and Kelly, 1975). When 4-CPA was applied as foliar spray to cucumber and muskmelon plants at the early anthesis stage, it induced parthenocarpic fruit development (Palevitch et al.,1972, and Elassar et al., 1974 a,b). Cucumber plants treated with a single spray of 50 ppm 4-CPA when there were approximately four open flowers seemed to be more effective than when there was one open flower (Palevitch et al.,1972). The seed coat was developed in all 4-CPA induced parthenocarpic fruits, but there was no embryo development (Elassar et al.,1974 a,b, and Matlob and Kelly, 1975). 4-CPA applied to the entire plants of cucumbers, muskmelons, and tomatoes at 25 to 400 ppm, caused epinasty and inhibition of plant growth. Growth was renewed later but with abnormally thick small leaves (Johnson, 1956, Elassar et al.,1974 a, b).

Chlorflurenol is one of the morphactins which were discovered for the first time as a new growth regulator in 1964(Schneider et al., 1965, Schneider, 1970). Morphactins are not transported and distributed in the plant in a polar manner. Translocation was reported to

be basipetal and acropetal. They inhibit and modify plant growth and development, especially that of the new growth. They are characterized by a remarkable low toxicity to animals, and they are not phytotoxic at a very wide range of concentrations. They are metabolized in plants rapidly, within a matter of days or weeks, so that actual residue problems need not be considered (Schneider , 1970). Chlorflurenol was reported for the first time to induce parthenocarpic fruit set in cucumbers in 1971 (Robinson et al.,1971) . Since then, it has been reported that it induced parthenocarpy and improved fruit set in cucumbers (Cantliffe, 1972, 1974 a,b, Cantliffe and Phatak, 1972, 1975, Cantliffe et al., 1972 a,b, Weibosch and Berghoef, 1974, Palevitch et al., 1976, Palevitch and Menagem, 1977,Slijkerman, 1977, Snyder and Fell, 1978, and Baker and Dean, 1978 b); in tomatoes (Rudich and Rabinowitch, 1974); in muskmelon(Elassar et al.,1974 b); and in beans(Gaithar, 1974). Chlorflurenol is considered as an auxin transport inhibitor. It inhibits auxin transport from the female cucumber flower through the peduncle within half an hour after treatment(Beyer and Quebedeaux, 1972, 1973, 1974). Beyer and Quebedeaux, (1974) measured the change in the amount of growth promoting activity in the extracts of ovaries after flower treatment with chlorflurenol, and proved that chlorflurenol inhibited auxin transport from the ovary, so they suggested that if the natural flow of auxin transport in the female flower is predominantly outward, then an auxin transport inhibitor would block this flow there by causing an accumulation of

auxin within the flower. This accumulated auxin could then trigger parthenocarpy. Cantliffe (1972) reported that chlorflurenol induced parthenocarpic fruit set when sprayed on cucumber plants when six to seven female flowers reached anthesis at concentrations ranging from 50 to 100 ppm, the higher concentration being more effective.Chlorflurenol at concentrations lower than 10 ppm promoted male flower development in the varieties Pioneer (predominantly female), and Galaxy(monoecious). Chlorflurenol at 10 to 100 ppm reduced male flower development in the monoecious cultivars (Robinson et al.,1971, Cantliffe, 1974 b, and Cantliffe and Phatak, 1975), but it did not affect female flower formation (Cantliffe, 1974 a). Shannon and Robinson (1976) found that the highest number of fruit set in cucumbers was realized in plots treated with 50 or 100 ppm higher and lower concentrations being less effective, and repeated applications were more effective than a single application. Chlorflurenol at 200 ppm induced the lowest number of fruits per plant and also resulted in the lowest yield of small fruits. This might indicate that this rate was too high, and might have inhibited fruit development. A gain of 7-11 fruits per plant was obtained by spraying cucumber plants with 40 to 60 ppm chlorflurenol at early flowering stage.BY atomizing the spray at the rate of 100 ppm, 13 fruits per plant were produced.(Weibosch and Berghoef, 1974). Robinson et al., (1971) reported that chlorflurenol was most effective in inducing parthenocarpy when applied at the flowering stage, and that only at the

rate of 40 ppm did chlorflurenol induce parthenocarpy when sprayed on cucumber plants at the four-leaf stage. When cucumber plants were sprayed with chlorflurenol till run off, fruit setting was limited to those flowers that reached anthesis within the period three days before and three days after spraying (Cantliffe, 1972). A single spray with chlorflurenol when there were approximately four open flowers seemed to be more effective than when only the first flower had opened (Palevitch et al., 1972). Cantliffe (1974 b) reported that yields of pickling cucumbers could be improved by increasing plant populations and then applying chlorflurenol at the fourth leaf stage in order to limit growth and promote fruit set. Chlorflurenol applied to cucumber plants when approximately 6 - 8 female flowers per plant had reached anthesis, resulted in markedly improved yield and returns (Cantliffe and Phatak, 1975; Snyder and Fell, 1976). Chlorflurenol did not have as great an effect on fruit set when fewer pistillate flowers had reached anthesis at the time of chlorflurenol application (Cantliffe et al., 1972 b, Weibosch and Berghoef, 1974, Shannon and Robinson, 1976). Plants treated with 50 ppm chlorflurenol five to eight days after the first flower had reached anthesis produced significantly more fruits per plant than did those plants treated only one day after anthesis. Chlorflurenol applied twice at 50 ppm, one day and three days after the first flower had reached anthesis, significantly increased the number of fruits per plant. Early applications of chlorflurenol often resulted in increasing the number of large fruits, but later applications resulted

in setting many small fruits and reduced the growth rate of the previous set fruits (Shannon and Robinson, 1976). Muskmelon plants sprayed with chlorflurenol developed fruits from flowers at the bud stage, but flowers at or past anthesis failed to set fruits(Elassar et al., 1974 b). The use of chlorflurenol on pollinated cucumber plants caused an increase in the number of fruit set as compared with the pollinated control plants. It caused a reduced fertilization or embryo abortion in the pollinated flowers; thus, the total number of seeds per fruit was reduced. The use of chlorflurenol precluded the necessity of pollination for fruit production in pickling and slicing cucumbers; However, pollination effectively increased the number of fruits per plant when chlorflurenol was used (Cantliffe, 1974 a, 1977 b). Chlorflurenol significantly lowered the node at which the formation of the first fruit took place in cucumbers (Cantliffe, 1972). The use of chlorflurenol on pollinated cucumber plants increased the range of nodes on which the fruits were located, but the average node number for all fruits was increased (Cantliffe, 1974 a). Baker and Dean (1978) studied the use of chlorflurenol with four experimental lines of MSU gynoecious hybrid cucumbers possessing varying degrees of parthenocarpy (none, weak , medium and strong). Their results indicated that the degree of genetic parthenocarpy in the hybrids contributed significantly to the total yield, and that when treated with chlorflurenol the medium and strong parthenocarpic hybrids produced the highest yields with the greatest number of fruit per plant .

Slijkerman (1977) suggested that the most ideal pickling cucumber variety is one which is partially genetically parthenocarpic , gynoecious, and which does not set fruits too quickly. Chlorflurenol can induce fruit setting in such a type at any time, so that successfull planning of harvest time can be achieved.

Chlorflurenol at all concentrations increased the proportion of small fruits, and it reduced the percentage of the off-shaped fruits (Robinson et al., 1971, Cantliffe et al., 1972 b, Weibosch and Berghoef, 1974, Cantliffe and Phatak, 1975, Palevitch et al., 1976, Shannon and Robinson, 1976, Palevitch and Menagem, 1977, Slijkerman, 1977, and Baker and Dean, 1978). However, Palevitch et al., 1972 found that chlorflurenol treatments did not affect fruit weight, instead, it modified fruit shape, and all parthenocarpic fruits were recorded as slightly irregular .

Chlorflurenol inhibited the main shoot growth, reduced the leaf area, stimulated the basal branching, and resulted in darker green coloring of the new growth in cucumbers (Schneider et al., 1977) , in muskmelons (Elassar et al., 1974 b), in potatoes (Schneider, 1970), and in beans (Gaithar, 1974). Schneider et al., (1977) reported that applications of chlorflurenol to cucumber plants at early stages in the greenhouse resulted in compact young plants with shortened vines, improved branching, improved female flowering, and increased rate of anthesis. Applications of chlorflurenol to older plants induced parthenocarpic fruit setting, even in the very young female buds. Application of chlorflurenol to cucumber plants at 100 ppm stopped growth in all cultivars (Cantliffe, 1974 b) .

MATERIALS AND METHODS

Experiment I. Effect of pollination on cucumber fruit set.

The experiment was conducted in a plastic house located at the University Farm in the Jordan Valley in 1979. Three pollination treatments were applied to ten cucumber varieties in a split plot experiment .

The main plots were the pollination treatments, and the varieties were the subplots. The three pollination treatments were: preventing pollination by clipping the corolla, hand pollination in order to ensure pollination, and open pollination or leaving the flowers for natural pollination .

The varieties were: BA_{11} ; BA_1 ; Beitalpha F_1Z 152; and Beitalpha F_1 Z151 from Sluis and Groot; Special F_1 and Damascus F_1 from Peto seed; Dalelah F_1 from Hezra; Flora more # 3 from Hurst;Marbella from Elite Zaden; and Maram from Brunisma. The main treatments were replicated three times .

In the plastic house mono super phosphate (17 % P_2O_5) at the rate of 210 kg P_2O_5 per hectare was applied . The amount was spread and mixed into the soil before planting. Ammonium sulphate(20.5 %N) was added with the irrigation water. A total of 100 kg nitrogen per hectare was applied in six applications, the first application was applied one week after seed germination, and the rest were applied subsequently at two week intervals .

The plots were drip irrigated at weekly intervals. Three seeds were planted in hills 30 cm apart on February 7th, 1979. The rows were 3m long and 60 cm apart. Each variety was represented by one row per replicate. Missing hills were replanted when necessary. The plants were thinned to one plant per hill when they were at the two to three leaf stage. The plastic house was kept weed free by cultivation and hand weeding. The plants were sprayed with the following pesticides: a mixture of chlorothalonil 75% WP(Dachonil) and Zenib(80 % WP) was sprayed weekly at 0.175 % and 0.2 % respectively for the control of downy mildew; tridimefon 25 % WP(Bayleton) at 0.025 % was sprayed twice in order to control powdery mildew; mevinphos 24% EC(Phosdrin) at 0.1 % was sprayed once in order to control aphids and propargite 57% EC(Omite) was sprayed once at 0.075% in order to control mites.

Two plants from each sub plot were chosen at random for detailed study. These plants were observed for the number and kind of flowers and number of fruits that developed at each node. The data then were used to calculate the percent of fruit set and the intensity of parthenocarpy according to the following equations .

$$\text{Percent of fruit set} = \frac{\text{number of fruits per plant}}{\text{Total number of female flowers per plant}} \times 100$$

$$\text{Intensity of parthenocarpy} = \frac{\text{number of parthenocarpic fruits per plant}}{\text{Total number of female flowers per plant}} \times 100$$

The data were analysed statistically. Duncan's Multiple Range Test was used for mean separation .

Experiment II. Effect of 4-CPA and chlorflurenol on cucumber fruit set.

This experiment was conducted in a plastic house located on a farmer's field near Maadi in the Jordan Valley .

Chlorflurenol and 4-CPA each at 0, 50, 100, 150, and 200 ppm concentrations, were applied to cucumber plants cv. Dalelah F_1 in a split plot experiment. The growth regulators were the main plots and the concentrations were the sub plots. The main treatments were replicated four times. Each subplot consisted of three rows with 12 plants in each row. The ten plants in the center of the middle row were used as the sampling area, leaving the outer rows as borders in order to minimize drift hazard.

Soil samples to a depth of 30 cm were taken and analysed at the Agricultural Research and Extension Department Laboratory. The soil analysis is presented in table (1) .

Table (1). Analysis of soil samples taken from a plastic house near Maadi .

$CaCO_3$	27.1 %
Organic matter	1.1 %
PH	7.7 - 7.9
EC at 25 C	4.3 mmhos
N	0.15 %
P	26.5 ppm
K	1121.5 ppm

Chicken manure at the rate of 40 m^3 per hectar was added and mixed into the soil. The soil was flood irrigated then plowed after two weeks. The soil was sterilized by Ditrapex (20 % methylios thiocyanate and 80 % mixture of dichloro propenes and dichloro propanes and other related compounds) at the rate of 500 liters per hectar.

Phosphorous fertilizer in the form of mono super phosphate (17 % P_2O_5) was added at the rate of 250 kg P_2O_5 per hectar, at the time of planting as a band application. Nitrogen fertilizer was added in the form of ammonium sulphate (20.5 % N). A total of 200 kg nitrogen per hectar were added in two applications. The first application was added at the time of planting as a band; the second was added at early flowering as a side dressing. On January 7th, 1979 , three cucumber seeds were planted in hills 35 cm apart . The rows were 4.2 m long, and 90 cm apart. Missing hills were seeded one week after seed germination, and the plants were thinned to one plant per hill at the second or third leaf stage .

The plants were furrow irrigated weekly. The plastic house was kept weed free by cultivation and hand weeding. The plants were trained to a string. The laterals and flowers were pruned from the first and second nodes. The plants were sprayed with the following pesticides: a mixture of Dachonil(75 W.P) and Zenib (80 WP) was sprayed weekly at the rate of 0.175% and 0.2 % respectively for controlling downy mildew; a mixture of Benomyl 50 WP(Benlate) and Zenib

(80 WP) was sprayed twice at the rate of 0.05% and 0.2% respectively in order to control Schlerotinia ; Bayleton(25 % WP) was sprayed at the rate of 0.03% in order to control powdery mildew; and Phosdrin (24 % EC) was sprayed twice at the rate of 0.1 % in order to control aphids. The soil was drenched twice with a mixture of Benlate and Zenib at the rate of 0.05% and 0.2% respectively in order to control wilting caused by soil born fungi .

Acqueous solutions of the growth regulators were applied to the whole plants till run off when approximately 6-8 female flowers per plant had reached anthesis. The treatments were made in the afternoon. The plants were irrigated the second day after the treatments had been applied .

Five plants were chosen at random from each subplot in order to record the following observations; Vine length per plant , number of nodes developed per plant during the period from after the treatment till the last female flower appeared, number and kind of flowers at each node, and number of fruits set. Visual observations were also recorded on leaf size, color and shape, and stem branching. Fruit numbers and weights were recorded from the sampling area .

The data of total yield, percent early yield[1)], percent fruit set, number of nodes developed per plant, and the average internode length were analysed statistically, and Duncan's Multiple Range Test was used for mean separation .

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1) Percent earlyyield= $\frac{\text{Yield harvested in 5pickings of the treatment}}{\text{Total yield of the same treatment}} \times 100$

RESULTS

Experiment I.

1. Percentage of fruit set .

The pollination treatments had a pronounced effect on cucumber fruit set among the varieties used in this experiment (Table 2). Hand pollination induced the highest percentage of fruit set whereas clipping the corolla induced the lowest percentage. The differences between the pollination treatments were highly significant, and hand pollination being the best suited for most varieties. However, the varieties differed significantly in their ability to set fruits.Marbella had the highest percentage of fruit set; the fruit set in the variety BA_1 was significantly higher than in the varieties: BA_{11} , Beitalpha F_1Z 152, Special F_1, Dalelah F_1, and Maram, but there were no significant differences in fruit set among the rest of the varieties .

The interactions between the varieties and the different pollination treatments were highly significant. The varieties Beitalpha F_1Z 151, Special F_1, and Flora more # 3 gave a high percentage of fruit set with hand pollination that ranged from 58% to 65.3% , but open pollination resulted in intermediate percentage of fruit set that ranged from 39.1 % to 43.3 %, while clipping the corolla resulted in the lowest percentage of fruit set that ranged from 2.7% to 9.1% . The

Table 2. Effect of hand pollination, open pollination, and clipping the corolla on the percentage of fruit set in ten cucumber varieties .

Variety	Treatment			
	Hand Pollination	Open pollination	Clipping(no pollination	Variety mean
BA_{11}	51.4 [1] abcG	39.6 aG	3.6 cdH	31.5 r
BA_{1}	46.5 bcG	48.7 aG	27.1 bH	40.8 Q
Beitalpha F_1Z 152	57.5 abcG	42.5 aG	2.6 dH	34.2 r
Beitalpha F_1Z 151	65.3 aG	43.3 aH	2.7 cdI	37.1 Qr
Special F_1	58 abG	39.1 aH	4.2 cdI	33.8 r
Dalelah F_1	53.8 abcG	42 aG	4.9 cdH	33.6 r
Flora more # 3	60.1 abG	40.6 aH	9.1 cI	36.6 Qr
Damascus F_1	59.8 abG	44.5 aG	5.6 cdH	36.6 Qr
Marbella	53.5 abcG	55.2 aG	59.8 aG	56.2 P
Maram	40 cG	23.5 bG	24.4 bG	29.3 r
Treatment mean	54.6 X	41.9 Y	14.4 Z	

1. Means in rows or columns followed by the same letter do not differ significantly at the 5% level of probability according to Dancan's Multiple Range Test. Letters X-Z were used for comparision between pollination treatments, letters P-r were used for comparision between varieties, letters a-d were used for comparision between varieties for the same pollination treatment, and letters G-I were used for comparision between varieties for different main plots .

varieties BA_{11}, Beitalpha F_1 Z 152, Dalelah F_1, Damascus F_1 and Maram gave equal percentage of fruit set with hand pollination and open pollination, but gave a significantly lower percentage of fruit set with clipping the corolla. The variety Marbella gave high percentage of fruit set with all pollination treatments. The varieties BA_1 and Maram gave a relatively high percentage of fruit set with clipping the corolla, but hand and open pollination resulted in higher percentages of fruit set.

2. Number of fruits per plant.

Hand pollination induced the greatest number of fruits per plant among all cucumber varieties (Table 3), but clipping the corolla resulted in the lowest number of fruits per plant. The variety Marbella produced the largest number of fruits per plant among all pollination treatments as compared with other varieties, and the difference was significant statistically. The variety BA_1 also produced a significantly larger number of fruits than did the variety Maram. There was no significant differences in the number of fruits per plant among the rest of the varieties.

The interaction between the varieties and pollination treatments was significant. The varieties BA_{11}, Beitalpha F_1 Z 151, Flora more # 3 and Maram produced more fruits per plant with hand pollination than with open pollination or clipping the corolla which resulted in the lowest number of fruits per plant in the varieties mentioned. The varieties Beitalpha F_1

Table 3. Effect of hand pollination, open pollination, and clipping the corolla on the number of fruits developed per plant in ten cucumber varieties .

Variety	Treatment			
	Hand Pollination	Open pollination	Clipping(no pollination	Variety mean
BA_{11}	11 [1] bG	6.8 bH	0.7 cI	6.2 S
BA_1	10.7 bGH	12 aG	7.2 bH	9.97 Q
Beitalpha F_1Z 152	6.3 cG	5.0 bG	0.3 cH	3.9 t
Beitalpha F_1Z 151	10.0 bG	4.8 bH	0.7 cI	5.2 St
Special F_1	10.0 bG	7.0 bG	0.7 cH	5.9 S
Dalelah F_1	10.0 bG	7.3 bG	1.2 cH	6.4 S
Flora more # 3	11.7 bG	5.8 bH	1.7 cI	6.4 S
Damascus F_1	10.0 bG	7.3 bG	0.8 cH	6.0 S
Marbella	14.5 aG	14.0 aG	11.8 aG	13.4 P
Maram	11.7 bG	6.7 bH	5.7 bH	8.0 r
Treatment mean	10.7 X	7.7 Y	3.1 Z	

1. Means in rows or columns followed by the same letter do not differ significantly at the 5 % level probability according to Duncan's Multiple Range Test.
   Letters X-Z were used for comparision between pollination treatments.
   Letters P-t were used for comparision between varieties.
   Letters a-S were used for comparision between varieties for the same pollination treatment.
   Letters G-I were used for comparision between varieties for different pollination treatment.

Z 152, Special F_1, Dalelah F_1 and Damascus F_1 produced equal numbers of fruits per plant with hand and open pollination, but an extremely low number with clipping the corolla . The variety BA_1 produced a high number of fruits per plant with clipping the corolla, but open and hand pollination increased the number significantly .

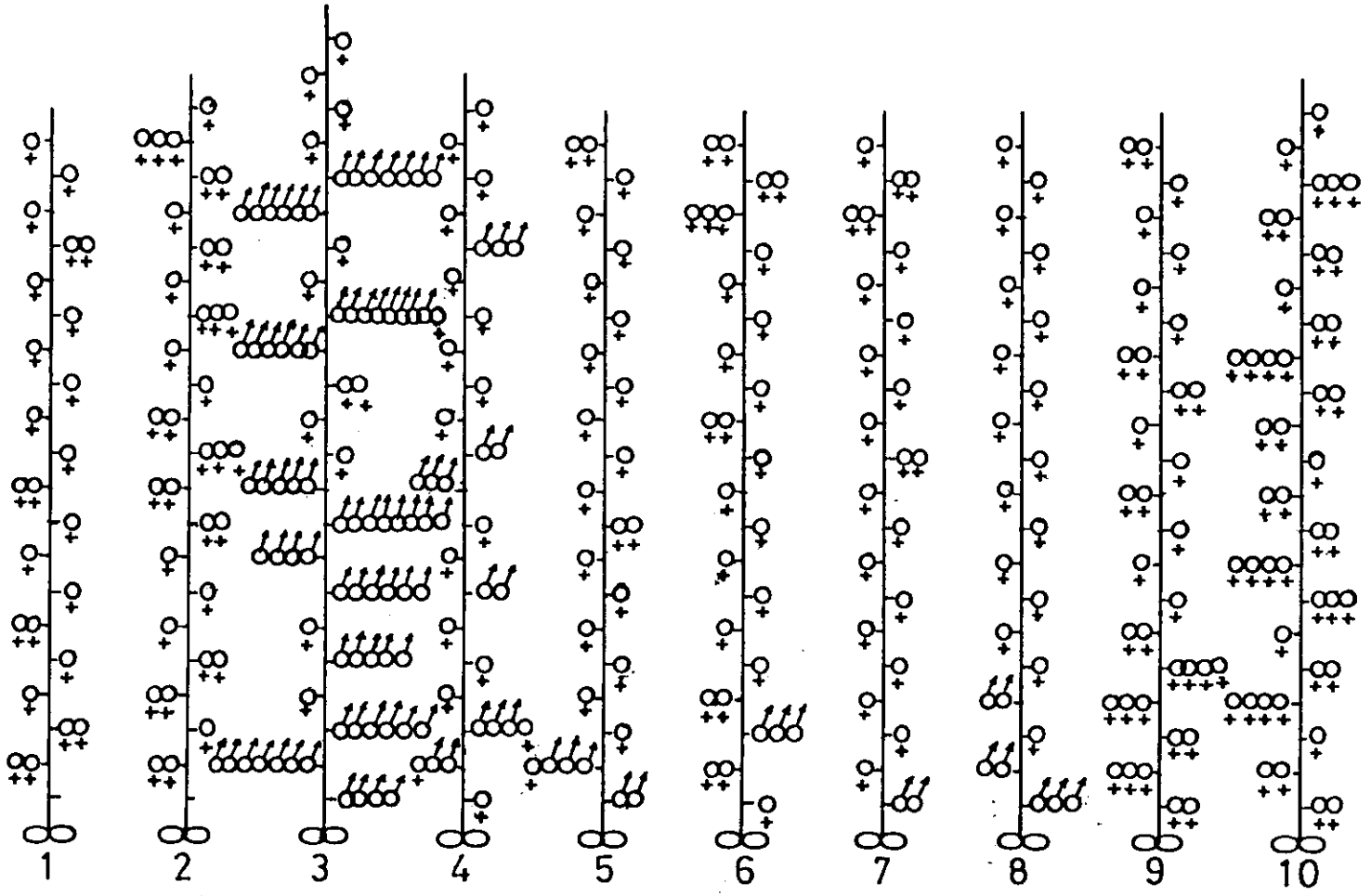
3. Sex expression.

Flowering patterns along the main stem of the ten varieties indicated that the varieties Beitalpha F_1Z 151 and Beitalpha F_1Z 152 were monoecious because they produced a large number of male flowers on the lower nodes, and continued to develop male flowers on the higher nodes (Fig. 1). The varieties Special F_1, Dalelah F_1, Flora more # 3, and Damascus F_1 produced few male flowers on the lower nodes, So they can be considered as predominantly female varieties. The varieties BA_{11}, BA_1, Marbella, and Maram were strongly gynoecious developing all female flowers on all nodes .

Experiment II.

1. Effect of 4-CPA and chlorflurenol on percent of fruit set, percent of early yield, and total yield of cucumbers.

The results of treating cucumber plants with 4-CPA and chlorflurenol are presented in table 4. Chlorflurenol induced a significantly higher percentage of fruit set than did 4-CPA. Both chemicals applied at concentrations ranging from 50 to



1-BA11. 2-BA1. 3-Beitalfa F_1 Z152 DMT, PMR. 4-Beitalfa F Z151 PMR. 5-Special F_1. 6-Beitalfa(Dalelah). 7-Flora more #3. 8-Damascus F_1. 9-Marbella. 10-Maram.

Fig. 1. Flowering pattern along the main stems of ten cucumber varieties

♀ = female flower.

o = male flower .

Table 4. Effect of the foliar application of 4-CPA and chlorflurenol on the percentage of fruit set, Percent of early yield, total yield, number of nodes developed in 30 days after treatment, and average internode length in Cucumis sativus L. cv. Dalelah F_1

Growth regulator	Rate ppm	Percent of fruit set	Percent of & early yield	Total yield kg/plot	number of nodes	Avr. internode length cm
	Control 0	45.865 d [1]	54.2075 b	19.0125 ab	16.2 a	5.65 a
Chlor-flurenol	50	62.21 ab	69.705 a	18.9125 ab	10.425 bc	1.99 d
	100	63.28 a	77.865 a	18.7125 ab	8.325 bc	1.88 d
	150	63.42 a	71.865 a	18.13 ab	9.1125bc	1.91 d
	200	65.215 a	75.7975 a	14.55 b	7.5875 c	1.71 d
Mean of o,r	Chlorflure-nol	59.995 y	69.8425 z	17.8975 z	10.330 z	2.628 z
	0	47.94 d	50.5 b	23.0375 a	15.9 a	5.99 a
4-CPA	50	55.435 bc	65.1 a	22.5375 a	11.975 b	4.91 b
	100	54.55 c	69.24 a	21.5 a	8.9 c	3.65 c
	150	48.46 cd	70.34 a	18.875 ab	8.35 c	3.615 c
	200	54.16 c	71.6275 a	20.6375 a	8.5 c	3.2 c
Mean for 4-CPA		52.109 z	65.3615 z	21.3175 y	10.725 z	4.273 y

1. Means in colums followed by the same letter do not differ significantly at the 5% level probability according to Duncan's Multiple Range Test. Letters y-z were used for comparision between chemicals, letter a-d were used for comparision between concentrations for the same chemical .

200 ppm induced a significantly higher percent of fruit set than did the untreated control. There were no significant difference between the effects of chlorflurenol and 4-CPA on the percentage of early yield, but both chemicals induced significantly higher percentages of early yield than that of the untreated control. Chlorflurenol and 4-CPA at concentrations ranging from 50 to 200 ppm did not induce yields higher than that of the untreated control. Chlorflurenol at 200 ppm reduced total yield sharply .

2. Effect of 4-CPA and chlorflurenol on growth of cucumber plants.

There was no significant difference between the effect of chlorflurenol and 4-CPA on the number of nodes that developed 30 days after treatment(Table 4).Both chemicals applied at 50 to 200 ppm induced signficantly fewer nodes than did the untreated control. The number of nodes was reduced as the concentration increased from 50 to 100 ppm. In addition, both chemicals induced significantly shorter internodal length than that of the untreated control at all concentrations. Chlorflurenol was more effective in inducing shorter internodes at 50 ppm than did any of the 4-CPA concentrations. There were no significant differences among the chlorflurenol concentrations on internodal length. 4-CPA at 50 ppm was less effective than the higher 4-CPA concentrations in inducing shorter internodes. The chlorflurenol treatments increased early branching and the new leaves that developed after treatment were smaller in size, thicker, and darker green in

color. 4-CPA treatment inhibited the plant growth for two weeks after which the growth was resumed abnormaly. The new leaves were small, thick, and were pale green in color.

3. Effect of 4-CPA and chlorflurenol on female flower production.

Chlorflurenol and 4-CPA reduced the number of female flowers per plant that developed after they were applied (Table 5). But chlorflurenol was more effective in reducing the number of female flowers per plant compared to 4-CPA treatment.

Table 5. Effect of 4-CPA and chlorflurenol on the number of female flowers produced per plant after treatment.

Treatment	Rate of application ppm	No.of female flowers per plant ($\bar{X} \pm SD$)
Chlorflurenol	50	16.69 ± 3.54
	100	13.83 ± 4.28
	150	13.69 ± 3.09
	200	10.11 ± 2.76
4-CPA	50	20.8 ± 5.3
	100	17.07 ± 4.46
	150	17.4 ± 5.62
	200	16.11 ± 1.62
Control	--	24.0 ± 3.59

DISCUSSION

Experiment I.

Clipping the corolla as a means of preventing pollination , reduced the percentage of fruit set and number of fruits per plant in most varieties. However, fruits were produced in all varieties in spite of clipping the corolla. Such fruit would have to be parthenocarpically set. The percentage of fruit set that resulted after clipping the corolla could be used to measure the parthenocarpic intensity (Ponti, 1976). Our results indicated that Marbella had a high parthenocarpic intensity, while BA_1 and Maram had a weak parthenocarpic intensity. The other varieties were non parthenocarpic. A few fruits were set on the non parthenocarpic varieties in spite of clipping the corolla. This result might be due to the effect of the environmental conditions such as low light intensity, low temperature, and short days which favor parthenocarpic fruit set.This was reported for cucumbers (Nitsch et al., 1952).

Open pollination increased the percentage of fruit set in the non parthenocarpic as well as in the weakly parthenocarpic varieties. This result could be due to chance pollination by bees. The varieties developed fruits during March and April when the temperature was relatively high (Appendix 9). Thus bees were more active(Bodenheimer and Ben-Nerya, 1937). Besides, the plastic house was opened during the day time for ventillation allowing access for the bees to move inside the house .

Hand pollination ensured a high percentage of fruit set in all non parthenocarpic varieties . Pollination seemed to be necessary for fruit set in these varieties as was reported earlier for cucumbers Palevitch et al.,(1972). Elassar et al.,(1974 a), and Cantliffe (1977 b), and for muskmelons Elassar et al.,(1974 b). Hand pollination improved fruit set in the weakly parthenocarpic varieties (Maram and BA_1) because they were only moderately efficient in setting parthenocarpic fruits. Pollination improved the total fruit set percentage. Hand pollination and open pollination did not increase the percentage of fruit set in the strongly parthenocarpic variety Marabella, because the variety can set fruits with or without pollination .

Sex expression plays no role in increasing fruit set when pollination is restricted, the gynoecious variety BA_{11}, the monoecious varieties Beitalpha F_1Z 151 and Beitalpha F_1Z 152, and the predominantly female varieties Flora more # 3, Damascus F_1, Special F_1, and Dalelah F_1 responded in the same way to the corolla clipping treatment by producing few fruits per plant. The parthenocarpic varieties Marbella, Maram, and BA_1 produced significantly more fruit per plant because they have the genetic make up to do so .

Experiment II.

Chlorflurenol and 4-CPA increased the percentage of fruit set in cucumbers. Chlorflurenol, an auxin transport inhibitor (Beyer and

Quebedeaux, 1972, 1973, 1974), inhibited auxin transport from the female flowers which led to the accumulation of auxin in sufficient amounts to cause fruit set .

4-CPA applied to the female flowers moves rapidly through the pedicel and accumulates inside the flower causing fruit set, fast fruit growth, and preventing abscission(Johnson, 1956; Homan,1964).

Chlorflurenol induced a significantly higher percentage of fruit set than did 4-CPA. Cantliffe et al., (1972 b) and Rudich and Rabinowitch (1974), obtained results comparable to results obtained in this study . 4-CPA was less effective although more female flowers were produced on the branches that developed after treatment, it enhanced the abscission of female flowers that reached anthesis at the time of treatment (Elassar et al., 1974 a) .

Chlorflurenol and 4-CPA did not increase the total yield over the control but they did increase the percent of early yield. Early in the season pollination may be restricted due to the reduction in bee activity(Bodenheimer and Ben-Nerya, 1937), which resulted in low fruit set on the control plants and reduced the early yield. In contrast, the 4-CPA and chlorflurenol treatments induced fruit set and thus increased the early yield. Robinson et al.,(1971), Cantliffe et al.,(1972 b), Elassar et al.,(1974 b). Schneider et al., (1977), and Baker and Dean (1978) found that chlorflurenol was an effective means of increasing earliness and yield, especially when bee pollination was limited. Elassar et al.,(1974 b) reported that 4-CPA might

improve the early yield of muskmelons especially when bee pollination is limited. Rudich and Rabinowitch (1974) found that 4-CPA increased tomato yield significantly for once over harvest. After the second week of the harvest period the untreated plants continued to grow normally and produced more female flowers. At the same time the temperature was relatively high, the plastic house was opened most of the day time for ventilation, and the bees were more active in pollinating the female flowers. Which may have resulted in setting more fruits on the control plants. 4-CPA and chlorflurenol caused a reduction in the number of the nodes and this was associated with the reduction in the number of the female flowers produced.

Chlorflurenol increased early branching and the new leaves were smaller in size, thicker and darker green in color. Comparable results were obtained by Gaithar (1974), Rudich and Rabinowitch (1974), Elassar et al.,(1974 b), Shannon and Robinson (1976), and Schneider et al.,(1977). 4-CPA inhibited the growth for two weeks after which the plants recovered. Johnson (1956) and Elassar et al., (1974 b) reported comparable results .

CONCLUSIONS

1. Preventing pollination by clipping the corolla of the female flowers sharply reduced fruit set in the non parthenocarpic cultivars BA_{11}, Beitalpha F_1Z151, Beitalpha F_1Z152, Special F_1 Dalelah F_1, Flora more # 3, and Damascus F_1, regardless of their sex type .
2. The parthenocarpic cultivar Marbella produced a high percentage of fruit set and more fruits per plant with or without pollination .
3. The varieties Beitalpha F_1Z151 and Beitalpha F_1Z152 were monoecious. The varieties Special F_1, Dalelah F_1 Flora more # 3, and Damascus were predominantly female. The varieties BA_{11}, BA_1, Marbella and Marem were strongly gynoecious .
4. The open pollinated non parthenocarpic cultivars produced very low percentages of fruit set during the cold period because pollination was prevented, but it produced higher percentage of fruit set when temperatures warmed up because the plastic house was ventilated more often and bees were able to visit the flowers more often accomplishing, pollination .
5. Chlorflurenol and 4-CPA increased the percentage of fruit set, but they did not increase the total yield, because they checked the growth and reduced the number of the female flowers produced.
6. Chlorflurenol and 4-CPA increased the percentage of early yield because they increased fruit set under conditions of reduced pollination due to low temperature, low light intensity, and low insect activity .

SUMMARY

Three pollination treatments, hand pollination, open pollination, and clipping the corolla to prevent pollination, were used to pollinate ten cucumber cultivars. Hand pollination induced the highest percentage of fruit set in all cultivars and clipping the corolla resulted in the lowest percentage of fruit set. Marbella produced the largest number of fruits and the highest percentage of fruit set in response to all pollination treatments. Hand pollination or open pollination were necessary for fruit setting in the cultivars BA_{11}, Beitalpha F_1Z151, Beitalpha F_1Z152, Special F_1, Dalelah F_1, flora more # 3, and Damascus F_1. Marbella showed strong parthenocarpic tendency, Maram and BA_1 showed moderate parthenocarpic tendency , while BA_{11}, Beitalpha F_1Z152, Beitalpha F_1Z151, Special F_1, Dalelah F_1, Flora more # 3, and Damascus F_1 were non parthenocarpic. Beitalpha F_1Z151 and Beitalpha F_1Z152 were monoecious, Maram, BA_1, and Marbella were gynoecious, and Special F_1; Dalelah F_1, Flora more #3, and Damascus F_1 were predominantly female .

Chlorflurenol and 4-CPA at 50, 100, 150, and 200 ppm were applied to Cucumis sativus cv. Dalelah F_1 when approximately 6-8 female flowers reached anthesis. Chlorflurenol at all concentrations induced significantly higher percentages of fruit set than did 4-CPA. Both chemicals induced a higher percentage of fruit set than occurred in the control. Both chemicals increased significantly the early yield but total yield was not increased. Both chemicals at all concentrations reduced the number of nodes produced within 30 days after treatment and reduced the internode length .

ملخص بالعربيـــــــه

اثر التلقيح والهرمونات على عقد الثمار في الخيـــــــار

تم اجراء تجربتين لدراسة اثر التلقيح والهرمونات على عقد الثمار في الخيار في التجربة الاولى استعملت ثلاث طرق تلقيح هي - التلقيح اليدوى ، التلقيح المفتوح بواسطة الحشرات ، وعدم التلقيح باغلاق الزهرة المؤنثة بواسطة سلك مغطى بالبلاستيك لمنع وصول حبوب اللقاح - لتلقيح الازهار في عشرة اصناف خيار . وقد اعطت معاملـــــة التلقيح اليدوى اعلى نسبة في عقد الثمار بينما اعطت معاملة عدم التلقيح اقل نسبة فـــي عقد الثمـــــــار .

أما بين الاصناف المستعمله فقد اعطى الصنف Marbella أعلى نسبة في عقـــد الثمار وكذلك في عدد الثمار للنبات الواحد ضمن جميع معاملات التلقيح ، وقد تبين مـــن النتائج التي حصلنا عليها ان التلقيح سواء كان يدويا أو بواسطة الحشرات ضروريا للاصناف Special F_1 , Beitalpha F_1 Z152 , Beit alpha F_1 Z151, BA_{11}, Dalelah F_1, Flora more # 3 , Damascus F1 .

بين ان الصنف Marbella يعقد الثمار عقدا بكريا بدرجة عالية والصنفيـــــــن BA_1 , Maram ذى درجة متوسطة بينما لم تظهر باقي الاصناف اى ميل لعقد الازهار عقد بكريا .

وقد تبين من الدراسة ان الصنفين Beit alpha F_1 Z 152 , Beit apha F_1 Z152 هي اصناف احادية المسكن monoecious حيث اعطت نسبة كبيرة من الازهار المذكـــره على الجزء السفلى من الساق وازهارا مؤنثة على الاجزاء العلوية ، في حين تبين ان الاصناف BA_1 , BA_{11}, Maram وماربيلا هي اصناف انثوية حيث اعطت ازهارا مؤنثة فقط . بينما كانت الاصناف سائدة الانوثة Damascus, Flora more # 3 , Dalelah F_1 , Special F_1 (Predominantly female) حيث تكونت عليها بعض الازهار المذكره خصوصا على الجزء السفلي من الســـــاق .

أما التجربة الثانية فقد تم رش نباتات الخيار صنف Dalelah F_1 بالهرمونـــات 4-CPA , Chlorflurenol بالمعدلات: صفر ، ٥٠ ، ١٠٠ ، ١٥٠ ، ٢٠٠ جزء في المليون عند تواجد عدد من ٦ - ٨ ازهار مؤنثة في مرحلت التفتح لكل نبـــات

أدت معاملات الرش بالهرمونين الى زيادة واضحة في نسبة عقد الثمار عنها فـــي النباتات غير المعاملـــــــه .

وكذلك أدى استعمال ال Chlorflurenol في جميع التركيزات الى زيادة عقـــد الثمار زيادة ملموسة ومؤثرة عن معاملات ال 4-CPA

كما وان استعمال الهرمونين المذكورين أدى الى زيادة المحصول المبكر (المقطوف خلال الاسبوعين الاولين) بينما لم يتأثر اجمالى المحصول بهذا الاستعمال . كما أدى الرش بالهرمونين ايضا الى تقصير طول السلاميه وانقاص عدد العقد المنتجة بواسطة النبات خلال الثلاثين يوما التي تلت الـــرش .

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Appendix (1). Percentage of fruit set in ten cucumber cultivars pollinated with different pollination treatments .

Pollination treatment	variety	Percentage of fruit set			Angle=Arcsin Proportion		
		Block I	II	III	BlockI	II	III
Hand pollination	BA_{11}	53.65	52.63	48.00	47.12	46.49	43.85
	BA_1	51.45	45.80	42.30	45.80	42.53	40.57
	Beitalpha F_1Z152	42.85	76.90	52.63	40.92	61.27	46.49
	Beitalpha F_1Z151	66.66	64.28	65.00	54.76	53.31	53.73
	Special F_1	46.15	57.14	70.59	42.82	49.08	57.17
	Dalelah F_1	56.00	48.15	57.14	48.45	43.97	49.08
	Flora more # 3	62.07	59.09	59.09	52.00	50.24	50.24
	Damascus F_1	57.14	56.25	65.00	49.08	48.62	53.73
	Morbella	62.50	45.71	52.24	52.24	42.53	46.26
	Maram	37.50	41.94	40.63	37.76	40.34	39.58
Open pollination	BA_{11}	38.70	38.09	41.99	38.47	38.12	40.40
	BA_1	46.15	45.83	54.17	42.82	42.59	47.41
	Beitalpha F_1Z152	52.00	49.10	26.31	46.15	44.48	30.85
	Beitalpha F_1Z151	30.77	57.14	41.93	33.71	49.08	40.34
	Special F_1	41.94	37.50	37.78	40.34	37.76	37.94
	Dalelah F_1	41.12	45.00	40.00	39.87	42.13	39.23
	Flora more # 3	38.46	50.00	33.33	38.35	45.00	35.24
	Damascus F_1	51.85	51.42	30.01	46.09	45.08	33.27
	Marbella	52.00	61.45	52.00	46.15	51.65	46.15
	Maram	24.48	24.14	21.87	29.67	29.40	27.90
Clipping the female flower	BA_{11}	0	5.88	5.00	0	14.06	12.92
	BA_1	26.09	29.63	25.42	30.72	32.96	30.26
	Beitalpha F_1Z152	0.00	0.00	8.00	0.00	0.00	16.43
	Beitalpha F_1Z151	0.00	0.00	11.76	0.00	0.00	20.09
	Special F_1	6.25	0.00	6.45	14.54	0.00	14.77
	Dalelah F_1	0.00	8.69	6.12	0.00	17.16	14.30
	Flora more # 3	7.14	17.65	2.63	15.45	24.88	9.28
	Damascus F_1	7.14	6.66	2.94	15.45	15.00	9.81
	Marbella	48.00	63.64	67.86	43.85	52.89	55.49
	Maram	26.32	24.14	22.73	30.85	29.40	28.45

Analysis of variance for appendix (1) .

Source of variation	d.f	S.S	MS	F	F tabular 5%	F tabular 1%
Subplots	89	22789.17				
Main plots	8	14286.53				
Block	2	80.53	40.26	0.71	6.94	18.00
Factor (A)	2	13982.01	6991.00	124.84**	6.94	18.00
Error (A)	4	223.98	55.99			
Factor (B)	9	2207.15	245.23	7.79**	2.054	2.756
Interaction	18	4596.06	255.33	8.11**	1.769	2.297
Error (B)	54	1699.42	31.47			

Appendix (2). Number of fruits that developed on ten cucumber cultivars pollinated with different pollination treatments.

Treatments		Blocks		
Pollination	Variety	I	II	III
Hand Pollination	BA_{11}	11	10	12
	BA_1	9	12	11
	Beitalpha F_1 Z152	3	6	10
	Beitalpha F_1 Z151	8	9	13
	Special F_1	6	12	12
	Dalelah F_1	7	13	12
	Flora more # 3	9	13	13
	Damascus F_1	8	9	13
	Marbella	10	16	17.5
	Maram	9	13	13
Open pollination	BA_{11}	6	8	6.5
	BA_1	12	11	13
	Beitalpha F_1Z 152	6.5	6	2.5
	Beitalpha F_1Z 151	2	6	6.5
	Special F_1	6.5	6	8.5
	Dalelah F_1	7	9	6
	Flora more # 3	5	8	4.5
	Damascus F_1	7	9	6
	Marbella	13	16	13
	Maram	6	7	7
Clipping the female flower	BA_{11}	0	1	1
	BA_1	6	8	7.5
	Beitalpha F_1 Z152	0	0	1
	Beitalpha F_1 Z151	0	0	2
	Special F_1	1	0	1
	Dalelah F_1	0	2	1.5
	Flora more # 3	1	3	1
	Damascus F_1	1	1	0.5
	Marbella	12	14	9.5
	Maram	5	7	5

Analysis of variance for appendix (2) .

Source of variation	d.f	S.S	MS	F	F tabular	
					5%	1%
Subplots	89	1867.40				
Main plots	8	1008.64				
Block	2	68.86	34.43	2.16	6.94	18.00
Factor (A)	2	876.21	438.10	27.56**	6.94	18.00
Error (A)	4	63.56	15.89			
Factor (B)	9	608.67	67.63	35.95**	2.054	2.756
Interaction	18	148.50	8.25	4.38**	1.769	2.297
Error (B)	54	101.57	1.88			

Appendix(3).Effect of foliar application of 4-CPA and chlorflurenol on the percentage of early yield in *Cucumis sativus* L. cv. Dalelah F1 .

Chemical	Rate of application	Block I	Block II	Block III	Block IV	Total
Chlorflurenol	50 PPM	61.86	66.06	76.61	74.29	278.82
	100 PPM	75.89	80.00	80.57	75.00	311.46
	150 PPM	75.87	83.28	72.75	54.00	286.55
	200 PPM	79.92	79.30	78.97	65.00	303.19
	Control	52.50	51.61	59.05	53.67	216.83
Total main plot		346.04	360.25	367.95	322.61	1396.85
4-CPA	50 PPM	55.93	60.45	72.77	71.25	260.40
	100 PPM	59.77	75.20	67.75	74.24	276.96
	150 PPM	74.16	72.66	72.96	61.58	281.36
	200 PPM	69.85	83.29	68.63	64.74	286.51
	Control	55.97	44.17	51.65	50.19	202.00
Total main plot		315.68	335.77	333.78	322.00	1307.23
Total block		661.72	696.02	701.73	644.61	2704.08

Analysis of variance for appendix (3).

Source of variance	d.f	S.S	MS	F obsered	F tabular	
					5%	1%
Subplots	39	4316.47				
Main plot	7	494.10438				
Blocks	3	225.20829		3.307	9.28	29.46
Chemicals	1	200.79367		8.8455	10.13	34.12
Error (a)	3	68.1	22.7			
Concentrations	4	2534.1253	633.531	12.339**	2.78	4.22
Chemical X concentration	4	56.0356	14.0089		2.78	4.22
Error (b)	24	1232.20472	51.342			

Appendix(4) Effect of foliar application of 4-CPA and chlorflurenol and on the percentage of fruit set in Cucumis sativus L. cv. Daleiah F_1.

Chemical	Rate of application	Block I	BlockII	Block III	BlockIV	Total
Chlorflurenol	50 PPM	60.00	57.88	66.54	64.41	248.83
	100 PPM	62.09	57.14	66.95	66.94	253.12
	150 PPM	60.87	65.00	65.38	62.44	253.69
	200 PPM	63.41	67.02	64.91	65.52	260.86
	0 PPM	52.71	40.56	42.96	47.19	183.42
Total main plots		299.08	287.6	306.74	306.50	1199.92
4-CPA	50 PPM	55.17	52.31	60.41	53.85	221.74
	100 PPM	57.94	52.94	53.43	53.90	218.21
	150 PPM	47.92	45.59	51.15	49.16	193.82
	200 PPM	55.29	54.22	53.74	53.39	216.64
	0 PPM	42.24	52.69	48.27	48.57	191.77
Total main plots		258.56	257.75	267.00	258.87	1042.18
Total blocks		557.64	545.35	573.74	565.37	2242.1

Analysis of variance for appendix (4)

Source of variance	d.f	S.S	MS	F	F tabular	
					0.05	0.01
Subplots	39	2193.959				
Main plots	7	681.749				
Blocks	3	43.672	14.557	2.724	9.28	29.46
Chemicals	1	622.048	622.048	116.4229	10.13	34.12
Error (a)	3	16.029	5.343			
Concentration	4	903.075	225.7687	18.9511	2.78	4.22
Chem. X Conc.	4	323.218	80.8045	6.7827	2.78	4.22
Error (b)	24	285.917	11.9132			

Appendix(5) Effect of foliar application of 4-CPA and chlorflurenol on the total yield(kg/plot)of *Cucumis sativus* L. cv. Dalelah F_1 .

Treatment	Block I	Block II	Block III	Block IV	Total treatment
Chlorflurenol 50PPM	15.6	16.35	20.95	22.75	75.65
Chlorflurenol 100PPM	16.8	17.75	19.3	21.00	74.85
Chlorflurenol 150PPM	18.65	15.25	17.25	22.05	73.200
Chlorflurenol 200PPM	11.95	15.7	13.55	17.00	85.20
Control	25.05	15.5	15.75	19.75	76.05
Total main plot	88.05	80.55	86.8	102.55	357.95
4-CPA 50 PPM	20.65	26.55	22.95	20.00	90.15
4-CPA 100 PPM	26.10	18.55	20.00	21.35	86.00
4-CPA 150 PPM	14.90	15.25	25.70	19.65	75.50
4-CPA 200 PPM	26.20	20.35	17.85	18.15	82.55
Control	18.85	26.60	21.00	25.70	92.15
Total main plot	106.70	107.30	107.50	104.85	426.35
Total block	194.75	187.85	194.30	207.40	784.30

Analysis of variance for appendix (5)

Source of variation	d.f	S.S	MS	F observed	F.tabuler 5%	F.tabuler 1%
Subplots	39	585.02775				
Main plot	7	169,79775				
Blocks	3	20.08125			9.28	29.46
Chemical	1	116.964	116.964	10.7134*	10.13	34.12
Error (a)	3	32.7525	10.9175			
Concentrations	4	68.819625	17.2049	1.3456	2.78	4.22
Chem. X conc.	4	32.035375	8.00884	0.6114	2.78	4.22
Error (b)	24	314.375	13.09895			

Appendix (6) Effect of foliar application of 4-CPA and chlorflurenol on the number of nodes that developed on the main stem of Cucumis sativus L. cv. Beleiah F1 within 30days after treatment.

Chemical	rate of application	Block I	Block II	Block III	Block IV	Total
	50 PPM	12.2	10.25	9.05	10.2	41.7
Chlorflurenol	100 PPM	6	10.8	8.2	8.3	33.3
	150 PPM	8.4	7.45	11.6	9.0	36.45
	200 PPM	6.4	6.8	9.75	7.4	30.35
	Control	18	15	16	15.8	64.8
Total main plot		51.0	50.3	54.6	50.7	206.6
	50 PPM	14.7	12.2	9.2	11.8	47.9
	100 PPM	9	8.9	8.8	8.9	35.6
4-CPA	150 PPM	7.4	7.4	10.2	8.4	33.4
	200 PPM	9	7.6	9.6	7.8	34.0
	Control	15.8	15.4	16.2	16.2	63.6
Total main plot		55.9	51.5	54.0	53.1	214.5
Total block		106.9	101.8	108.6	103.8	421.1

Analysis of variance for appendix (6)

Source of variance	d.f	S.S	MS	F observed	F tabular 5%	F tabular 1%
Subplots	39	422				
Main plots	7	5.952				
Blocks	3	2.795			9.28	29.46
Chemicals	1	1.5605	1.5605	2.932	10.13	34.12
Error (a)	3	1.597	0.532			
Concentrations	4	352.104	88.026**	37.048**	2.78	4.22
Chem. X Conc.	4	6.92	1.730	0.728	2.78	4.2
Error (b)	24	57.376	2.376			

Appendix (7) Effect of foliar application of 4-CPA and Chlorflurenol on the average internode length in Cucumis sativus L cv. Dalelah F_1 .

Treatment		Block I	Block II	Block III	Block IV	Total treatment
Chlorflurenol	50 PPM	1.88	1.96	2.21	1.92	7.97
	100 PPM	1.89	1.94	1.87	1.82	7.52
	150 PPM	1.87	1.87	1.89	2.01	7.64
	200 PPM	1.58	1.76	1.69	1.82	6.85
Control		5.63	5.73	5.88	5.44	22.68
Total main plot		12.85	13.26	13.54	13.01	52.66
4-CPA	50 PPM	5.41	5.34	4.1	4.8	19.65
	100 PPM	3.69	3.64	3.91	3.37	14.61
	150 PPM	3.72	3.54	3.71	3.49	14.46
	200 PPM	3.14	3.19	3.06	3.42	12.81
Control		6.49	5.83	5.72	5.92	23.96
Total main plot		22.45	21.54	20.5	21.00	85.49
Total block		35.30	34.80	34.04	34.01	138.15

Analysis of variance for eppendix (7)

Source of variation	d.f	S.S	MS	F observed	F tabulär 5%	F tabulär 1%
Subplots	39	96.45034				
Main plot	7	27.41762				
Blocks	3	0.11761			9.28	29.46
Chemicals	1	26.945225	26.945225	227.843**	10.13	34.12
Error (a)	3	0.354785	0.11826			
Concentrations	4	60.7165	15.179	248.51**	2.78	4.22
Chem. X Conc.	4	6.85	1.7125	28.037**	2.78	4.22
Error (b)	24	1.4660775	0.061087			

Appendix 6. Temperature and relative humidity in the plastic house at Maadi and open field during Jan. - March, 1979.

Appendix 9. Temperature and relative humidity in the plastic house at the University Farm during March - April , 1979 .