I. INTRODUCTION

Sweet pepper (Capsicum annuum L.) is of an economical importance all over the world due to its high nutritional and medical values. It is the richest source of vitamin C among different vegetables and also a good source of vitamin A. It is considered as one of the most important vegetables grown in A.R.E. for both export and local consumption. It is used in a great variety of ways. Pepper plants are cultivated as summer, fall and winter crops. Most of the area,however, is planted for summer harvest due to the favourable climatic conditions of summer season for the growth and development of pepper plants. As mentioned by Department of Agricultural Economic and Statistics, Ministry of Agriculture, A.R.E. (1983), acreage planted with pepper was 18302, 4044 and 3107 feddans with a production of 126154, 24364 and 16203 tons for the summer, fall and winter harvests,respectively, in the 1981/1982 season.

Several problems arose in the winter harvest due to its high sensitivity to the climatic fluctuations, particularly the temperature as stated by Cochran (1936). Moreover, low yield of small oblate unattractive fruits are produced in winter plantings, this is due to the unfavourable climatic conditions. The winter crop is mainly produced for export beside the local consumption with high prices. A sum of 344 tons of green sweet peppers of the winter harvest was exported to foreign markets in the 1981/1982 season.

Any treatment that is capable to increase the yield and improve fruit quality will be of considerable importance.

In the past few years, great attention has been focussed on the possibility of using foliar application of some growth regulators and micronutrients in order to improve both yield and quality of many vegetables.

Nowadays, it is quite clear that several regulators play an important rôle in modifying many physiological processes, as flowering, fruit setting and shedding, by which the yield of fruit crops is greatly determined.

The micronutrients seem to be not less important than the growth regulators. Although micronutrients are needed in relatively very small quantities for adequate plant production, their deficiences cause a great disturbance in the physiological and metabolic processes involved in the plant. The insufficient supply of these elements to horticultural plants is considered to be one of the most important nutritional problems especially after the decrease of these elements in the Nile water (Nabhan, 1966).

This work was aimed to study the effect of cycocel, ethrel and naphthalin acetic acid foliar sprays on growth, chemical composition, yield and quality of winter pepper. Moreover, comparing such treatments with other ones commonly practised; i.e., plastic cover, sucrose spray or seed chilling to avoid bad effect of low temperatures or light frost during winter season, was one of the aims of this work.

An attempt to improve both yield and quality of summer sweet pepper through B, Zn, Mn, Fe, Irral or Bayfolan foliar nutrition was another aim of this work.

2. REVIEW OF LITERATURE

The literature concerning the effect of some growth regulators and micronutrients as well as the control treatments on growth, chemical composition, yield and quality of sweet pepper will be reviewed under the following headings:

1. Plant growth characteristics.
2. Chemical composition of vegetative parts.
3. Flowering, fruit-setting and shedding.
4. Yield components.
5. Fruit quality.

2-1. Plant Growth Characteristics:

A) Effect of some growth regulators:

It is quite clear now that plant growth characteristics expressed as number of leaves and branches, stem length and diameter as well as fresh and dry weights are governed by different natural and synthetic regulators. Among those growth regulators, however, some are of special interest for this study as follows:

I. Effect of Cycocel.--Application of cycocel produced shorter pepper plants (Greener, 1968; Wahdan, 1973; Abdalla _et al._, 1979; and Nagdy _et al._, 1979).

Stem dwarfism was found to be accompanied with an increase in the stem diameter as a result of cycocel treatment (Wittwer and Tolbert, 1960 as well as Marisiddaiah and Gowda, 1978).

Concerning number of branches and leaves, each of Torfs (1966), Bryan (1970), Abdel Maksoud _et al._ (1975) and Nagdy _et al._ (1979) reported that the cycocel treatment was of stimulating effect in this respect.

With regard to dry matter content, Ashour and El-Fouly (1970), working on tomatoes, and Nagdy _et al._ (1979), working on pepper, reported that cycocel spray increased dry matter/plant.

On the other hand, Tiessen (1962) as well as Mishra and Pradhan (1969) found that cycocel had no effect on pepper growth. However, Abdalla _et al._ (1979) found that different cycocel used rates; _i.e._, 500, 1000, 1500 ppm., significantly inhibited morphological growth characters and seemed to lower dry matter content in different plant parts of eggplant and pepper plants grown as summer crops.

Conflicts data obtained by different workers suggest that CCC is not necessary a growth retardant; but rather it can be thought as a growth regulator which may have a positive effect on growth. This hypothesis is in good agreement with the findings of Fadl et al. (1973) who studied the effect of CCC on the relative concentrations of different promotors and inhibitors present in winter and summer pepper plants and concluded that CCC acts as a growth regulator in winter plants and as a growth retardant in summer ones.

II. Effect of Ethrel.--The effect of ethrel has been the subject of extensive research work on different plants and in different aspects of plant growth. Garica and Campo (1972) reported that ethrel is readily absorbed by plant organs, breaks down within the tissues producing ethylene gas, phosphorus and chlorine. Bargstrom (1939) interpreted his early observations on the effect of ethylene on plants, to that ethylene causes a lateral transfer of growth hormones.

Concerning the effect on plant height, Burg (1968) and Burg et al. (1971) mentioned that ethrel inhibits stem elongation and attributed its inhibiting effect on elongation, to inhibition of cell devision. Whereas, John and Hanon (1975) mentioned that ethylene inhibits stem elongation by redirecting growth in a lateral rather than longitudinal direction. Moreover, Campel

(1976) found that ethephone reduced stem elongation and stimulated root development in tomato plants. Khademi and Khosh-Khui (1977) reported that ethephone reduced plant height but increased the number of lateral branches in ornamental pepper. Nagdy et al. (1979) indicated that application of ethrel produced shorter pepper plants.

With regard to effect on stem diameter, Nagdy et al. (1979) added that shortening of stem as a result of ethrel treatment was accompanied with increasing in stem diameter. Moreover, Jaworski et al. (1980) reported that ethephone caused thickening of tomato stem.

Concerning the effect on number of branches and leaves, Nagdy et al. (1979) found that number of both branches and leaves as well as average dry weight of vegetative organs in pepper plants were increased by ethrel treatment. However, Knavel and Kemp (1973) stated that ethrel reduced total leaf number of pepper plant.

III. Effect of NAA.--Auxins participate in a number of different aspects of plant development. The most characteristic action of auxins is to promote cell enlargement which induces stem elongation of plants (Leopold, 1964; and Wilkins, 1969).

Takahashi and Nakayama (1961) reported that plant height was increased as a result of spraying tomato plants with 50 ppm. NAA. Chhonkar and Ghufran (1968) indicated that treating roots of tomato seedlings with 0.1 or 0.2% NAA enhanced plant growth. Amer (1981) found that using 100 or 200 ppm. NAA enhanced vegetative growth expressed as stem length, leaf number as well as dry weight per plant.

On the other hand, Saito and Ito (1966) showed that increasing NAA concentration from 0.01 up to 10 ppm. restricted plant growth of tomato. Moreover, Singh and Upadhyay (1967) indicated that foliar application of NAA at 0.5, 15 or 20 ppm. significantly reduced plant height.

B) Effect of sucrose:

Growth responses to sucrose applied to tomato plants have been described by Went and Carter (1948) who demonstrated that when plants were grown under certain unfavourable environmental conditions, those receiving sucrose applications showed more rapid terminal growth than the untreated controls. Sucrose spray was reported to be effective in increasing the growth of tomato plants (Berrie, 1960). The growth of different organs of pepper plants was stimulated by 2.5 or 10% sucrose spray and 10% sucrose was the best treatment to induce plants with more leaves as well as higher dry weight (Abdel Maksoud et al., 1975).

C) Effect of plastic cover:

Pepper plant growth was stimulated and plant height was increased by 10-20 cm. as a result of plastic cover (Kapitany, 1971). Vegetative growth of tomatoes was increased by plastic mulch treatments (Vandenberg and Tiessen, 1972; and Cornillon, 1974). Somos (1973) stated that growing pepper plants under plastic covers gave very good results concerning growth characters.

D) Effect of seed-cold treatments:

Madzarova (1962) indicated that exposure of tomato seeds to low temperature resulted in the development of fewer leaves and more flowers. Moreover, Belousova (1972), working on eggplant, and Belousova (1973), working on pepper, reported that when seeds were kept at -1 to -2°C. for 24-36 hours, growth, development and branching were hastened; but number of leaves per plant was decreased. Gireko and Emmerikh (1975) also indicated that exposing seeds to low temperature speeded up plant development; but reduced leafiness in endive.

E) Effect of some micronutrients:

Intensive research work concerning the rôle of micronutrients has been being accomplished. The need for supplying vegetable crops with micronutrients is sometimes very much essential. Among those micronutrients, however, some are of special interest for this study as follows:

I. Effect of B.--Zagorodnys and Sultanov (1956) as well as Spithost (1969) reported that B enhanced growth of tomato plants. Increasing B concentration up to 3 ppm. increased plant height and leaf number of tomato plants (Verma et al., 1973). Abdel Maksoud et al. (1974) found that growth of pepper plants, expressed as plant height and leaf number, was stimulated by 1.5% boric acid.

With regard to dry matter content, it was found to be increased due to spraying plants with B (Gjurov et al., 1965; Majewski et al., 1969; Spithost, 1969; working on tomato; and Abdel Maksoud et al., 1974; working on pepper).

II. Effect of Zn.--Foliar application of Zn stimulated the growth of tomato and pepper plants (Schmidt, 1963; Pais, 1969; and Bojeenko, 1970). Foliar sprays with Zn at 1.12 up to 4.48 kg. $ZnSO_4$/h increased plant height of tomatoes (Mohaptra and Kibe, 1971). Treatment with 100 ppm. $ZnSO_4$ improved vegetative growth of tomatoes (Ashour, 1973).

III. Effect of Mn and Fe.--El Labodi *et al.* (1976) indicated that foliar sprays with Mn and Fe increased dry matter content in tomatoes.

IV. Effect of Mixture of Micronutrients.--Abutalybov and Mardanov (1957) mentioned that adding Zn, Mn and Cu in the form of sulphate as well as B as borax to the mixture, used for making nutrient solution for pots, improved seedling growth and increased dry matter content of tomato plants. In another study, conducted by Stolyarov (1971), it was found that application of Mn and Zn showed a stimulatory effect on dry matter content of tomato plants. Amer (1981) indicated that applications of micronutrients; *i.e.*, B, Mn and Zn separately or in their combinations significantly enhanced stem length, number of leaves as well as fresh and dry weight per plant in tomatoes. El-Husseni (1982) demonstrated that some positive increments in plant vigour were noticed when pepper plants were sprayed with Zn, Mn and B.

2-2. Chemical Composition of Vegetative Parts:

A) Effect of some growth regulators:

With regard to the effect of CCC foliar spray on the chlorophyll content of plant, Knavel (1969) found that tomato leaves of cycocel treated plants contained more total chlorophyll than in leaves of the untreated plants. Lyedovs'kii (1974) indicated that treating tomato seedlings with CCC at 0.3-0.5% increased leaf chlorophyll content. Similar results were also obtained by Mitwally et al. (1979) working on tomato plants.

Concerning the effect of ethrel on the chlorophyll content of plants, Khademi and Khosh-Khui (1977) showed that ethephone increased chlorophyll content of ornamental pepper leaves.

Regarding the effect of NAA on plant chlorophyll content, Sedlovesku (1973) found that NAA increased leaf chlorophyll contents in cucumber. However, Metwally et al. (1979) noticed that NAA showed no constant effect on either chlorophyll or carotenoids percentage in tomato.

Concerning the indoles content, it was reported that CCC application reduced their contents in plants (Kuraishi and Muir, 1963, working on pea; Norris, 1966, working on wheat seedlings; Casper and Lacoppe, 1968, working on barley seedlings; and Runkova et al., 1972, working on some ornamental plants). On the other hand, Bekhit (1981) reported that CCC or IBA had no significant effect on the indolic compounds in tomatoes.

With respect to the effect of growth regulators on the phenol plants content, Fadl and Hortmann (1967) found that there was an antagonism between auxin and phenols. Moreover, El Ghandour (1969) showed that 2,4-D treatment reduced growth inhibiting levels, whereas IBA application increased promoting activity in winter pepper leaf extract. Fadl et al. (1973), working on winter pepper plants, found that the inhibitors such as phenolic acid disappeared due to CCC spray. On the other hand, Bekhit (1981) obtained fluctuated results concerning the effect of CCC on auxin and total phenol in tomatoes.

Concerning the effect of growth regulators on NPK contents of vegetative parts, it was reported that nitrogen content was significantly increased in both leaves and stems of tomato plants by CCC spray (Knavel, 1969; and Abdalla and Verkark, 1970). Knavel (1969) and Powlowski *et al.* (1970) stated that CCC increased P content but decreased K content in tomato leaves. Moreover, Abdel Maksoud *et al.* (1975) indicated that spraying pepper plants with CCC increased N content in stems and P content in leaves, while K was not affected in leaves. Amer (1981) showed that foliar application of NAA at 100 or 200 ppm. led to an increase in N, P and K contents of both leaves and stems of tomato plants.

B) Effect of Sucrose:

With regard to the effect of sucrose on chlorophyll formation, Ahmed *et al.* (1965) mentioned that carbohydrate substances are one of the factors affecting chlorophyll formation in the plant. These authors demonstrated that experiments showed that when yellow leaves were immersed in a sugar solution, they quickly turned green as a result of chlorophyll formation.

With regard to the effect of sucrose foliar spray on the N, P and K contents of pepper plants, Abdel Maksoud *et al.* (1975) found that percent of P and K in stems or N & P in leaves are increased when plants were sprayed with 5 or 10% sucrose, respectively, while K in leaves was not affected by sucrose spray.

C) <u>Effect of Plastic Cover:</u>

Concerning the effect of plastic cover on N, P and K contents, Carolus and Downes (1958) indicated that plastic cover increased soil temperature and moisture which increased nutrients availability, and which in-turn increased N, P and K contents in plants.

D) <u>Effect of Seed-Cold Treatments:</u>

Concerning the effect of chilling treatments on phenol plants content, Briggs (1960) as well as Fadl and Hortman(1967) stated that reduction in inhibitory substances, such as phenols, in response to chilling are common in plants.

With regard to the effect of seed-cold treatments on N content of plants, Higazy <u>et al.</u> (1976) reported that exposing pea seeds to low temperatures produced plants of higher nitrogen content.

E) <u>Effect of Some Micronutrients:</u>

Spraying plants with micronutrients may affect their chemical content either by direct means or indirect ones.

Chlorophyll level in different vegetable crops was found to be closely correlated with some micronutrients.

Iron is closely concerned with chlorophyll molecule formation but not a constitute of it (Holmes and Brown, 1957). Rutland and Bokovak (1968) showed the beneficial effect of Fe on chlorophyll formation. Jungk *et al.* (1972) reported that chlorophyll content of the leaves increased with increasing Fe concentration from 0.003 to 0.30 ppm. Amberger (1974) stated that the rôle of iron in chlorophyll synthesis is universal. Zen El Abdeen and Metwally (1979) indicated that foliar sprays with 0.05% Fe or 0.05% Mn + 0.05% Fe increased leaf chlorophyll content by 20 and 21%, respectively, in tomatoes. Pandev *et al.* (1981) indicated that Fe deficiency reduced leaf chlorophyll A content by 69.48%, Chlorophyll B content by 64.45% and caused smaller reduction in carotenoid content than in chlorophyll content in pepper plants.

Manganese is also closely correlated with chlorophyll formation. It stimulated its formation (Lesina, 1966; Gilfillans, 1968; Albegov, 1972; El Labodi *et* al., 1976; and Zen El Abdeen and Metwally, 1979).

With regard to effect of boron and zinc on chlorophyll formation, Pandev *et al.* (1981) indicated that B