STUDIES ON THE INFLUENCE OF MEPIQUAT CHLORIDE ON PHYSIOLOGICAL ACTIVITIES AND YIELD OF WHEAT

THESIS

Submitted in Partial Fulfilment of the Requirements for the Degree of M.Sc. in Botany (Plant Physiology)

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بسم الله الرحمن الرحيم

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DEDICATION

I would like to dedicate this work to my husband Mr. AHMED ABD EL-HAMEED and my family for their support and patience.

ACKNOWLEDGMENT

(Firstly my unlimited thanks to God)

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Beside the work carried out in this thesis, the candidate has attended and passed successfully the following post graduate courses as a partial fulfilment of the requirements for the degree of Master of Science during the academic year 1986-1987.

1- Plant physiology
2- Methodology
3- Biostatistics
4- English Language
5- German Language

" DECLARATION "

This thesis has not been previously submitted for any degree at this or at any other university.

Signed

SALWA A. ALI

INTRODUCTION

Wheat (*Triticum aestivum,* L.) is one of the main cereal crops in the world as well as in Egypt. Improvement of its yield is the primary concern of plant physiologists, plant breeders and soil experts.

Wheat occupies about 1.5 million feddan which represent about 27% of the total cultivated area during winter season (Ministry of Agriculture of Egypt). Over the last two decades, the average production of wheat increased from 1.2 to 1.8 t./f. However, efforts aiming for further increase in wheat production are still going on.

At present, the production of wheat in Egypt is about 2.2 million tons per year (Ministry of Agriculture of Egypt). Thus more efforts should be directed towards increasing wheat yield. In order to fill the gap between production and consumption, new areas outside the Nile Valley and the Delta were reclaimed, supplied with water (either from the Nile or from other sources such as wells and canals) and devoted for wheat production.

Increasing plant productivity, either in the form of dry weight or yield, is one of the main targets in Egypt's agricultural policy, this could be achieved through fertilization and/or growth regulators including promotors and retardants. The characteristic effect of the latter group is the inhibition of vegetative growth (manifested by reduction in the height of plant and its individual internodes) resulting as compact and sturdy plants; so, growth retardants were employed to reduce crop lodging (Jung and Rademacher, 1983). It has been found that growth retardants may also promote tillering and increase the number of ear-bearing tillers (Hill *et al.*, 1982, Koranteng and Matthews, 1982; Child *et al.*, 1983).

For the economical value of wheat, the present investigation was carried out as a trial to increase its yield by using different concentrations of a growth retardant as foliar spray at early and late stages of growth. A relatively newly manufactured plant growth retardant, 1,1-dimethyl piperidinium chloride [commercially known as Mepiquat chloride (MC) or pix produced by BASF Company Ltd. and having the structure illustrated in Fig. (1)] was choosen for this study. Interactive effects of this growth retardant and gibberellic acid (GA_3) at the seedling stage) on the level of endogenous gibberellin-like substances was also investigated.

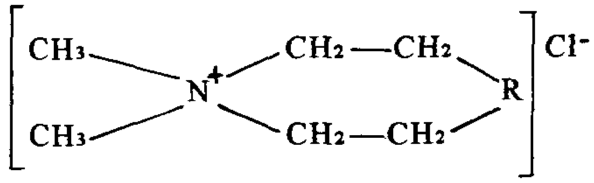

Fig. (1) Chemical structure of mepiquat chloride.
(1,1-dimethyl piperidinium chloride)

REVIEW OF LITERATURE

1. Effect of mepiquat chloride on vegetative growth:

Mepiquat chloride is a relatively new plant growth regulator principally used for limiting undesired vegetative growth in cotton plants(Schott and Rittig, 1982).

Lodging is a problem in intensive cereal management systems, especially under high rainfall conditions. Jung and Rademacher (1983) reported that, out of approximately 60 commercially available substances having growth regulating activity, only three (chloremequate chloride, mepiquat chloride and ethephon) are used mainly for lodging control.

Lodging resistance is very important especially at the time of anthesis and at the early grain filling period as these growth stages are very sensitive to lodging (Pinthus, 1973); therefore, an improved lodging resistance is very important. However, anti-lodging chemicals were not intended to be yield enhancers when they were applied by Caldwell *et al.* (1988) to barley plants, rather they were yield protectors by reducing yield losses caused by early lodging and allowing for faster, more economic harvesting by preventing late season lodging.

Application of mepiquat chloride shows a high retarding effect on the growth of some cotton varieties (Cappy and Cothren, 1980; Barbosa and Costro, 1983; Khafaga, 1983; Sing and Sahay, 1989). In addition, several investigators - through their researches on some plant species and varieties - came to the conclusion that application of mepiquat chloride results in a decrease in plant height [Morandi *et al.*, (1983) on soybean; Prusakova, *et al.*, (1986) on barley; Giordani *et al.*, (1989) on wheat].

Application of mepiquat chloride increases the number of tillers of barley [Cartwright and Waddington, 1982; Woodward and Marshall, 1988; Waddington and Cartwright, 1988] as well as branching of egg plants (El-Zawily *et al.*, 1985].

Concerning the effect of mepiquat chloride on the dry weight of the shoot system constituents (leaves and/or stems), Wu *et al.*, (1985) and Khasanov *et al.*, (1986) found that the application of mepiquat chloride to cotton plants at concentrations of 100 ppm and 1 litre/ha. at the squaring stage and the flowering stage respectively, increased the dry weight of the leaves. Morandi *et al.* (1984) on studying the effect of mepiquat chloride (MC) and cycocel (CCC) on soybean plants grown under green-house and outdoor conditions, found that MC was more active than CCC in decreasing stem dry weight. Wendt *et al.* (1984) stated that the addition of 50 g mepiquat chloride/ha. to cotton plants significantly lowered shoot dry weight.

On the other hand, Morandi *et al.* (1983) applying mepiquat chloride to soybean (cv. Halesoy, 71) found that concentration of 500 or 1000 mg/pot increased dry weight of stem.

Response of the root system to mepiquat chloride was studied by some investigators. Cappy and Cothren (1980) found that when 22.25 g active ingredient (a.i.) MC/ha was applied to cotton plants 10 days prior to mid-bloom, root density at the bloom stage was 33% higher than at the vegetative stage, compared with 12.5% increase in the root density of untreated plants. Urwiler and Oosterhuis (1986) reported that treating cotton plants with a mixture of mepiquat chloride and indole buteric acid at a concentration of 1 mg and 2 or 4 mg/pot respectively, increased root growth.

The effect of mepiquat chloride on the dry weight of plants was studied by some investigators, for example, Morandi *et al.* (1983) using soybean plants grown in green-house or under outdoor conditions, found that there was no difference in aerial dry weight of the plants.

Concerning the chlorophyll content of the plants treated with mepiquat chloride, Wu *et al.* (1985) stated that application of the chemical at a concentration of 100 ppm to cotton plants during the squaring stage, increased the chlorophyll content of the leaves compared to control plants. Zayed *et al.* (1985) treated 5-weeks old okra plants with solutions of mepiquat chloride at concentrations of 100, 250 or 500 mg/litre and found that all the treatments increased the pigments content (chlorophyll-a plus -b and carotenoids) of the leaves. Abdel-Al *et al.* (1986) applied mepiquat chloride (50 g a.i./litre) at concentrations of 500, 750 or 1000 cm^3/feddan to *Gossypium barbadense* (cv. Giza 75) at the beginning and the peak of flowering and they found that the chemical generally increased the total chlorophyll content of the treated plants compared to the control. Eid *et al.* (1986 b) also applied mepiquat chloride at concentrations of 0, 500, 750 or 1000 cm^3/feddan to cotton plants at the beginning of flowering and repeated the application at the peak of flowering. They found that the chlorophyll content of the leaves tended to be increased.

2. Effect of mepiquat chloride on some chemical constituents:

Some of the plant constituents e.g. total nitrogen, protein, carbohydrates and nucleic acids, are noticably affected by mepiquat chloride, the effect differ with the different plant species or varieties.

Concerning the nitrogen content of the plants, Zayed *et al.* (1985) found that treating 5-weeks old okra plants with mepiquat chloride at concentrations of 100, 250 or 500 mg/litre increased the nitrogen contents of their leaves.

On the other hand, Cothren (1986) when sprayed cotton plants at early flowering with mepiquat chloride at concentration of 49.4 g/ha, found no significant differences in the nitrogen content of the leaves of the treated plants compared to the control.

On the other hand, Stein *et al.* (1983) stated that application of mepiquat chloride to cotton plants at the 7th leaf stage decreased the protein content of the leaves, the decrease was directly proportional to the concentration used.

The effect of mepiquat chloride on nucleic acids content was studied by few investigators, e.g. the study of Stein *et al.* (1983) who reported that application of mepiquat chloride to cotton plants (grown in a growth chamber) at the 7th leaf stage, decreased nucleic acids content in the leaves compared to control plants, the decrease was directly proportional to the concentration used.

Concerning the effect of MC on the endogenous auxins. Kochhar *et al.* (1972) found that morphactin completely inhibited de novo formation of roots on stem cutting of *Salix tetrasperma*. They attributed this inhibition in rooting to the low level of endogenous auxin content induced by

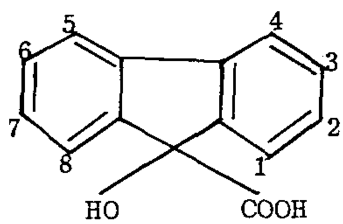

Fig. (2) chemical structure of chlorflūrenol CF_{125}

(morphactin)treatment. Moreover, Smolinski *et al.* (1981) observed that the effect of morphactin was probably caused by an inhibition of basipetal auxin transport and by the disturbance of general cell polarity during cambial divisions El-Kady *et al.* (1982) working on six-month old decapitated coffee seedlings which were sprayed twice with morphactin, found that bud dormancy was broken by morphactin which reduced the IAA content of the sprouting shoot by about 50%.

With respect to increasing the growth inhibitors particularly abscisic acid as a result of treating with mepiquat chloride, He *et al.* (1990) recorded increment in the level of abscisic acid in cotton plants treated with mepiquat chloride.

In addition, El-Greadly (1993) found that treating Globe artichoke plants with the combination of mixture of trace elements plus alar at concentration of 6000 ppm gave the highest inhibitor activity and the lowest promotor activity when compared with the combination of mixture of trace elements plus alar at concentration of 400 ppm and untreated plants.

Concerning the effect of MC on the endogenous gibberellins (the literature available dealing with this point is very limited as far as our knowledge extends; so, the effect of other growth retardants especially those of antigibberellin nature will be referred to here).