

17

1742-11

4758

**PHYSIOLOGICAL RESPONSE OF
TOMATO PLANT TO SOME
GROWTH REGULATING
SUBSTANCES**

By

GALAL MOHAMED SAID FARRAG

THESIS

Submitted in Partial Fulfilment of the
Requirements for the Degree of

MASTER OF SCIENCE

in

Plant Physiology

Ain Shams University
Faculty of Agriculture
Plant Pathology Dept.



4758



1971

APPROVAL SHEET

This Thesis for the M.Sc. Degree
has been Approved by :

W. A. Ashour

H. Hamawin

M. Kady

Date : 6 / 11 / 1971

...oo0oo...



A C K N O W I D G M E N T

This work has been carried out under the supervision of Dr. M. El-Kedi, Assoc. Prof. of Plant Physiology, Dr. M.A. Abdel-Halim, Assoc. Prof. of Plant Physiology , Dr. A.I. Gebr, Assoc. Prof. of Plant Physiology and ex-supervision of Dr. A. Rasfat Prof. of Plant Physiology of the Plant Pathology Dept., Faculty of Agriculture, Ain-Shams University, Egypt. To them, the writer wishes to express his deepest gratitude and indebtedness for their supervision, progressive criticism and encouragement throughout this work.

The writer is also very grateful to Dr. H. El-Hamawi, Head of Cotton Physiology Section, Cotton Dept., Ministry of Agriculture for his generous help and counsel.

Thanks are also due to all members of the Plant Pathology Dept. for their assistance and kindness.

...ooOoo...

C O N T E N T S

	Page
INTRODUCTION	1
REVIEW OF LITERATURE	3
Effect of growth regulators on growth characters	9
Effect of growth regulators on flowering and fruit setting	18
Effect of growth regulators on the yield	24
Effect of growth regulators on the chemical constituents	29
MATERIALS AND METHODS	33
RESULTS AND DISCUSSION	40
A. Growth characters	40
1. Plant height	40
2. Number of lateral branches	45
3. Number of leaves	48
4. Total leaf area	52
5. Number of flowers	55
6. Number of fruits	58
7. Dry weight of stems	60
8. Dry weight of leaves	63
9. Dry weight of roots	67
10. Fresh weight of fruits	69
B. Chemical constituents	76
1. Nitrogen content	76
a. Stems	76
b. Leaves	82
c. Roots	85
2. Phosphorus content	89
a. Stems	89
b. Leaves	93
c. Roots	95

	Page
3. Potassium content	99
a. Stems	99
b. Leaves	103
c. Roots	105
4. Sugar content in ripe fruits	107
SUMMARY	110
APPENDIX	114
REFERENCES	138
ARABIC SUMMARY.	

...ooOoo...

INTRODUCTION

Tomato, *Lycopersicon esculentum* Mill., is one of the most important vegetable crops grown in Egypt. This crop is produced for local consumption as well as for exportation. According to the Statistical Hand Book of Egypt, 1970 a total area of about 241,098 fedden was cultivated by tomato in 1969. The government as well as the farmers try hard to increase the yield of this crop and to facilitate to a large extent the occurrence of fruits to meet the request of consumers all over the year round.

It has been repeatedly shown that environmental and internal factors are responsible for differences in growth behaviour and yield of various plant species. Growth, flowering, fruit setting and chemical constituents are of vital importance contributing in yield control. Investigations dealing with the effect of general agricultural practices on tomato yield are plenty. On the other hand, those dealing with modifying different phases of growth by using plant growth regulators are somewhat rare. Results obtained differ greatly according to several factors such as the nature of these substances, concentration, time of application, number of sprays and others.

This investigation was carried out aiming to study the physiological response of tomato plants to a group of growth regulators namely GA, CCC, IBA and B-9. These substances were selected according to the previous literature indicating that two of them are growth promoters, while the others are growth retardants.

It is hoped that this work may throw some light on the possibilities of adjusting the pattern of plant development by using growth regulators and accordingly improve the yield of tomato plants.

REVIEW OF LITERATURE

It is almost a century since Julius Sachs in 1880 proposed that root-forming and flower-forming substances are manufactured in different plant parts and by moving in very low concentrations through the plant, cause the development of these organs (Addicott, 1957).

Auxins :

Auxins are defined according to the American Society of Plant Physiologists (Tukey et al, 1954) as compounds characterized by their capacity to induce elongation in shoot cells. They resemble indole-3-acetic acid in physiological action. Auxins may, and generally do, affect other processes beside elongation, but elongation is considered critical. Auxins are generally acids with an unsaturated cyclic nucleus or derivatives of such acids.

A general relationship of auxin to growth has been shown in different tissues in a variety of ways. It was shown by Hatcher (1959) and Vegis (1964), that auxin content in apple twigs rises in the spring as growth gets underway, and it subsequently declines through the growing season following the decline in growth rate until autumn.

Furthermore, Leopold (1964) indicated that auxins often occur most abundantly in the most actively growing tissues. He reported that in Lens roots, for instance , auxin was most abundant in the area of the most active growth (2 mm from tip).

An extensive study on the metabolism of indole acids done by Fawcett et al (1961) indicated that the growth-regulating activity shown by these acids in wheat and pea tissues was due to the break-down of the side chain of each acid through β -oxidation to yield either the highly active ~~acetic~~ or propionic acid as end product.

Gibberellins :

Since 1926 a series of investigations have been made in Japan by Kurosawa on the biology of the fungus , Gibberella fujikuroi which attacks rice, causing long pale spindly growth. Eventually in 1938, a group of characteristic metabolic products called gibberellins were isolated from this fungus by Yabuta & Sumiki (1938), and were later shown to accelerate greatly the growth in length of seedling stems of a number of plant species when applied in lanolin paste (Kato, 1953). These observations were later extended to a closely related product, gibberellic acid , which produces similar responses in the many species tested. An important characteristic of these new substances is that

They apparently accelerate extension growth in aerial organs (shoots and coleoptiles) only, and possess none of the other growth-regulating activities of the auxins

According to ICI Bull., 1970 about 24 well chemically identified compounds belonging to gibberellins have been recognized and their mode of action in plants have been tackled.

Not only Gibberellins are produced as a product of the fungus Gibberella fujikuroi, but they are also found naturally in so many plant species. These substances are probably common in higher plants and may play direct or indirect roles in almost every physiological process (Phinney and West, 1960).

The diverse responses by plants due to the application of gibberellins were explained on the basis of the differences in configuration between different applied gibberellins, (Wittwer and Bukovac, 1962), mode of application, dose, time and multiplicity of sprays, air temperature, intensity and spectral composition of the light , presence of the natural auxins in the cell and the mineral nutrition of the plants (Avenisyan, 1966).

Interactions of gibberellins with other exogenous and endogenous promoters and inhibitors controlling plant growth and flowering were discussed by many investigators

Whitton, 1957; Bradford and Hemming, 1961; Kato, 1961; Boyard et al., 1962; Vagin, 1964; Valdovinos and Ernest, 1967; Valdovinos and Sastry, 1968; Anderson and Sair, 1969).

Nitsch (1957) indicated that the beneficial effect of gibberellins on some woody plants was due to an increase in their auxin content. Gibberellin-Indoleacetic acid synergism has been proposed for the elongation of sections from light-grown pea seedlings and in stowed etiolated sections.

Furthermore, GA treatment led to the production of an inhibitor which retarded auxin destroying system, namely the IAA-oxidation enzyme system (Housley and Deverall, 1961).

Based on the reaction site of GA in plant tissues which is different from that of auxin, Kato (1961) emphasized that GA is a growth promoting substance quite different in nature from auxin and its growth regulating effect is not due to a change in auxin level of the affected tissues.

However, the antagonistic effect of GA to root forming activity of IAA has been also emphasized (Overbeek, 1966).

Studying the effect of GA on the elongation of the Avena coleoptile, Valdovinos and Sastry (1968) found that the rate of tryptophane metabolism in the presence of

IAA, was increased by approximately 120 per cent. On the other hand, Anderson and Muir (1969) did not find any effect of GA on the enzymatic conversion of tryptophan to tryptamine to IAA.

Growth Retardants :

New types of organo-synthetic chemicals, which could retard stem elongation and indirectly affect flowering and yield without causing malformations in plants have been extensively studied. The term "growth-retarding chemicals" or growth retardants was used to refer to such chemicals.

A new group of quaternary ammonium compounds were reported by Tolbert (1960). The most active compound , 2, chloroethyl trimethylammonium chloride, is an analog of choline known as Cycocel. Its trivial name is chlorocholine chloride and usually abbreviated to CCC.

This chemical retards the growth of a large number of plant species to much higher extent than any of the earlier compounds (Tolbert, 1961; Cathey, 1964).

Shorter internodes, darker green foliage, and increased leaf chlorophyll content were observed in treated greenhouse - grown tomato plants (Wittwer and Tolbert , 1960).

Tolbert (1960) observed that CCC and GA, produced

opposite growth effects on plants. However, he indicated that CCC is not an "antigibberellin" because CCC is not structurally alike gibberellins. Meanwhile, specific competition between GA and the growth retardant for one or several reaction sites in the plant did not exist.

Cath^ey (1964) referred to growth retardants as "antimetabolites" rather than antigibberellins, implying a more general interference with cellular metabolism.

Kuraishi and Muir (1963) conducted experiments with CCC and IAA on Alaska pea plants (Pisum sativum). Their findings suggested that retardation of stem growth by CCC was due to lack of IAA and was independent of gibberellins. These investigators concluded that the growth retardant interacted directly with IAA to cause a decrease in the level of diffusible auxin.

Almost similar findings were reported by Halevy(1963), who suggested that the growth retardant CCC interacts with gibberellins or IAA-oxidase (or its cofactors and inhibitors) to lower the auxin level of plant tissues.

On the other hand, the action of growth retardants on plants was caused through their inhibitory effect on the biosynthesis of endogenous gibberellins (Cathey, 1964 ; Paleg et al., 1965; Zeevaart, 1965).

Knypl and Rennert (1967) showed that CCC did not affect the synthesis of IAA oxidase and furthermore, the delayed growth of the treated cucumber hypocotyl sections was not dependant on the accelerated destruction of the endogenous auxin

The effect of the growth retardant N-dimethylamine succinamic acid (B-995 which sometimes known as B-9 or Alar) on the development of various plants are given by Cathy^e (1964). Fruit trees such as apple and cherry also respond to B-9. Trees sprayed in 1962 with B-9 produced more flowers in 1963 than unsprayed trees. B-9 sprays suppressed further vegetative growth of Asaleas and induced flower buds to form earlier than in untreated plants. Moreover, sweet corn produced more ears per plant with increasing dosages of B-9.

Effect of Growth Regulators on Growth Characters :

Auxins :

As has been indicated earlier by definition, auxins promote vegetative growth in numerous plants.

In (1953) Von Abrams indicated that intact dwarf and tall etiolated pea seedlings, variety Telephone, exhibit a differential response to applied IAA. Spray application of IAA solution (2 mg /l.) to plants of six days age