Turkish Journal of Botany

Volume 24 | Number 4 Article 1

1-1-2000

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Turk J Bot
24 (2000) 215-219

Research Article

Effect of Some Growth Regulators and Commercial Preparations on the Chlorophyll Content and Mineral Nutrition of *Lycopersicum esculentum* Mill

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Received: 28.05.1996
Accepted: 21.01.2000

Abstract: The effect of some growth regulators and commercial preparations on N, P, K and chlorophyll contents *Lycopersicum esculentum* Mill. were examined. Tomato seedlings were grown in sand and after four weeks they were transferred to Hoagland hydroponic culture solution. Growth regulators and commercial preparations were applied to these plants twice, one week and three weeks after transferral, at room temperature. 10 or 20 ppm IAA, GA_3 , ABA; 20 ppm Berelex and 15 or 30 ppm Cytozyme were pulverized during the applications.

After an eight-week experimental period, not only were morphological observations made, but analyses of chlorophyll for primary productivity and N, P, and K for mineral nutrition were carried out as well.

The chlorophyll contents of ABA and cytozyme-treated plants were found to be higher than those of the others. N and K contents were found to increase with cytozyme application, whereas ABA and Berelex applications increased the P content. Morphological changes such as decrease in the growth rate and leaf size in ABA-treated plants, unhealthy growth in GA_3-treated plants and healthy growth and leaf size increase in cytozyme-treated plants were observed.

Key Words: *Lycopersicum esculentum*, abscisic acid (ABA), gibberellin (GA_3).

Bazı Büyüme Düzenleyici Maddeler ve Ticari Preparatların *Lycopersicum esculentum* Mill'in Mineral Beslenme ve Klorofil İçerikleri Üzerine Etkileri

Özet: Bu çalışmada, bazı bitki büyüme düzenleyici maddeler ve ticari preparatların, Lycopersicum esculentum Mill. bitkisinde N. P. K ve klorofil içerikleri üzerine etkileri incelenmiştir. Kum içinde yetiştirilen domates fideleri dört haftalık iken Hoagland su kültür ortamına alınmıştır. Oda koşullarındaki bu bitkilere, büyüme düzenleyici madde ve ticari preparatlar, bir hafta ve üç hafta sonra olmak üzere iki kez uygulanmıştır. Uygulamalarda 10 ve 20 ppm IAA, GA_3, ABA; 20 ppm Berelex ile 15 ve 30 ppm Cytozyme püskürtülmüştür. Sekiz haftalık deneme süresi sonunda, uygulamalı ve kontrol bitkilerde morfolojik gözlemlerin yanısıra, primer verimlilik için klorofil ve mineral beslenme açısından da N, P ve K analizleri yapılmıştır.

Elde edilen sonuçlara göre, ABA ve Cytozyme uygulanan bitkilerde klorofil miktarı diğerlerinden yüksektir. Cytozyme uygulaması bitkilerde N ve K içeriğinde artışa neden olurken; ABA ve Berelex uygulanan bitkilerde P içeriğinin yüksek olduğu bulunmuştur. Diğer yandan, ABA uygulanan bitkilerde zayıf gelişme ve yaprak küçülmesi; GA_3 uygulanan bitkilerde sağlıksız gelişme ve Cytozyme uygulanan bitkilerde ise, sağlıklı bir gelişme ile yapraklarda genişleme gibi morfolojik değişimler gözlenmiştir.

Anahtar Sözcükler: *Lycopersicum esculentum,* Absisik Asit (ABA), Gibberellin (GA_3).

Introduction

Growth and development events in plants are controlled by growth regulators [1]. These can be found in the plant naturally or they may be manufactured [2, 3]. As production of the natural material known as plant hormones is not economically feasible and as the determination of the optimum conditions under which they function is difficult, they have to be manufactured. Due to health and environmental pollution problems, reaction against artificial growth regulators directed the institutes interested in this subject to search for new preparations. The main objective is the application of macro and micro nutrients together with some amino acids and enzymes by leaf fertilizing methods. These materials are being widely used in Turkey and in the rest of the world. Many cytozyme studies have been carried out on crops such as rice, barley, corn and cotton [4, 5, 6].

Plant culture type, climate and soil, as it contains nutrients, affects the advantages. The aim of this study is the investigation of the effect of Cytozyme Crop Plus, a biotechnological preparation, Berelex and plant hormones on the tomato plant.

Materials and Method

Tomato seedlings were grown in sand under greenhouse conditions and were transplanted for the trial series to be carried out under water culture conditions.

Lycopersicum esculentum seeds were grown in sand and were transferred into Hoagland water culture medium after four weeks when they were 10 cm in height [7].

Two subsequent applications were done, one and three weeks after the transferral of the seedlings into the water culture medium. Ten and 20 ppm IAA: 10 and 20 ppm ABA: 10 and 20 ppm GA_3; 20 ppm Berelex and 15 and 30 ppm Cytozyme Crop Plus were pulverized onto 16 plants until the leaves were completely wet.

At the end of the four-week trial period, the seedlings were first weighed in order to determine the fresh weight, and samples for chlorophyll analysis were taken. Seedlings were then put in the autoclave at 60ºC for N. P and K analyses. For N determination the Kjeldahl technique [8] was employed and the wet combustion technique was used for K and P determinations [9]. In chlorophyll analysis, the method developed by Kirk [10] was applied.

Standard error and standard deviation calculations were made for the results obtained, and the t-test was performed [11].

Results and Discussion

Studies for increasing plant yield have great importance for mankind. The primary plant hormones, regulating growth and development of plants growing on diverse and variable land mediums are auxins, gibberellins, cytokinins, abscisic acid and other growth inhibitors and ethylene, and theoretically vernalins, florigens and antesins [1].

According to the information currently available, many artificial compounds that can regulate the growth and development of plants are being produced by chemical industries. These compounds are even found to be more effective than their natural equivalents and therefore able to replace natural phytohormones in general [5, 12]. For this reason, research for new plant growth regulators continues today. According to Tietz [13], in Europe approximately 100,000 substances are being tested every year for this purpose.

According to the results of our study concerning the application of various growth regulators in different concentrations on tomato seedlings grown in water culture, a maximum increase of 5.99% in N content is obtained for cytozyme when control and treated plants are compared in terms of N content. There is no significant effect of other applications on the N content of plants. For example, with respect to the control plant, a decrease of 0.87% for the application of 10 ppm IAA, an increase of 2% for the application of 20 ppm GA_3 and a decrease of 3% for the application of 10 ppm ABA were observed. The decrease in both concentrations of cytozyme application might be due to the fact that cytozyme, which is rich in micro-feeders, increases N-uptake by the plant.

When the effects of growth regulators on K content aer compared with the control plant, the K content of the plant is seen to increase 25% for the application of 15 ppm Cytozyme whereas there is a decrease of 19% for the 20 ppm ABA application. The effects of other growth regulators on the K content of the plant are summarized below. There is an increase of 6% for the application of 10 ppm IAA and 10 ppm GA_3. There is an increaes of 5% for the application of 10 ppm ABA. There is an increase of 0.7% for the applicaiton of Berelex. It is claimed that the reason for the decrease in K content as a result of the 20 ppm ABA application, is the prevention of water and mineral uptake due to the ABA.

In comparison with the control plant, it is seen that the growth regulators, except for ABA applied to the tomato plant, generally decrease the P content. In this regard, there are decreases of 13%, 16.8% and 5.5% in mineral phosphor content, with respect to the control, for cytozyme applications of 10 ppm IAA and GA_3, 30 ppm and 15 ppm respectively. Since the mineral determined by the analysis is phosphor, plant growth stimulators such as IAA, GA_3, cytozyme and Berelex support the addition of uptaken phosphor to the structural elements. However, it is seen that ABA, which is a growth inhibitor, prevents this function (Figures. 1, 2 and 3). LSD test results of these figures are shown in the Table.

In terms of primary productivity, the amount of chlorophyll a, chlorophyll b and a+b are increased by 93%, 78% and 87% in 10 ppm ABA applicaiton respectively; in 15 ppm cytozyme application by 51%, 49.5% and 50.5% respectively; and in 30 ppm cytozyme application by 57%, 137.5% and 87% respectively. In the Berelex application the corresponding increases in the above-mentioned chlorophylls are 51%, 90% and 62% respectively (Figure 4).

As seen in Figure 5, 10 ppm gibberellin-treated plants showed a 17% increase when compared to the control.

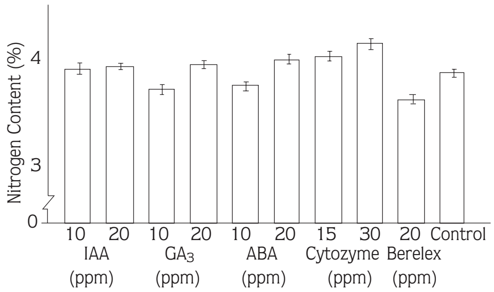

Figure 1. Effects of Different Concentrations of IAA, GA_3, ABA, Cytozyme and Berelex on N Content.

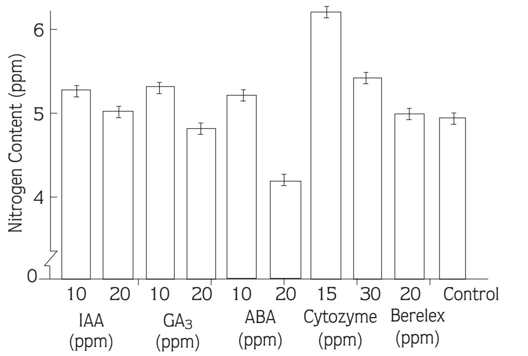

Figure 2. Effects of Different Concentrations of IAA, GA_3, ABA, Cytozyme and Berelex on K Content.

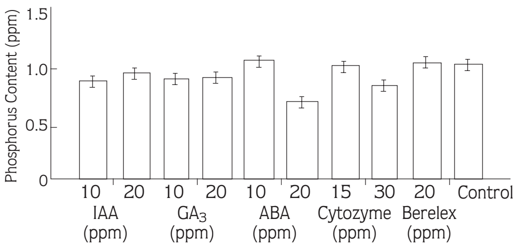

Figure 3. Effects of Different Concentrations of IAA, GA_3, ABA, Cytozyme and Berelex on P Content.

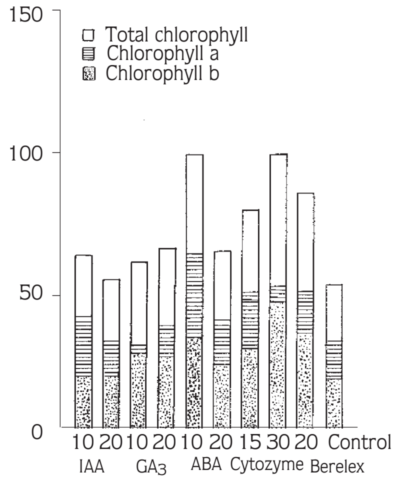

Figure 4. Effects of Different Concentrations of IAA, GA_3, Cytozyme and Berelex on Chlorophyll Content (a, b and total).

Also in the 20 ppm ABA application, stem height decreased by 17.5%. This value varies by the order of 0.1 according to the t-test.

In the case of root length, in 10 ppm IAA and 10 ppm GA_3 applications root development varies on the order of 0.1 and 0.01 in 20 ppm GA_3-treated plants. Leaf number varies on the order of 0.01 in 10 and 20 ppm ABA applications and is decreased by 37% in the former (Figure 6).

In comparison to the control, fresh weight was found to increase by 16% in 30 ppm cytozyme application (Figure 7). The 14% increase as a result of 10 ppm IAA does not show any change statistically; however in the 20 ppm IAA application the 66% decrease varies on the order of 0.05. Ten and 20 ppm ABA cause 65% and 90% decreases respectively. Both decreases vary on the order of 0.05. Nevertheless, the weight reduction in 10 ppm GA_3 and 20 ppm Berelex is statistically invariant.

When dry weight is considered, 20 ppm ABA application caused a 41% weight reduction in comparison to the control. However, cytozyme applications increased dry weight by 10.5%.

The nitrogen content of the plants is not influenced by any of the applications. This is due to the water culture used, which contains sufficient nitrogen.

Phosphorus content is constrained in IAA, GA_3, ABA and Cytozyme applications. As IAA elongates cells, gibberelling increases the height of the plant and cytozyme affects the vegetative growth similarly to IAA and GA_3, and phosphorus uptake, which is an indication of reproductive growth, is observed.

As 15 ppm cytozyme application increases the dry weight, it also increases the uptake of potassium, which

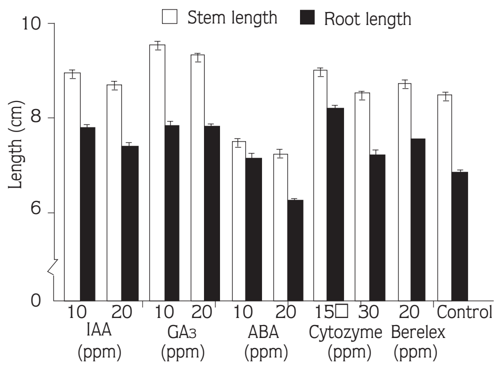

Figure 5. Effects of Different Concentrations of IAA, GA_3, ABA, Cytozyme and Berelex on the Stem and Root Length of *L. esculentum* Mill.

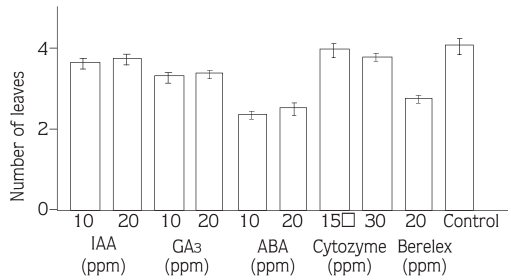

Figure 6. Effects of Different Concentrations of IAA, GA_3, ABA, Cytozyme and Berelex on the Number of Leaves of *Lycopersicum esculentum* Mill.

Table. The means of the 10 groups were compared by single-way variance analysis in terms of N, P, K, and then examined by LSD test. Those with significant differences are shown in the table (α=0.05).

	A	B	C	D	E	F	G	H	I	J
A	-	*		*		*	*•	*	*	
B	*	-	*		*		*	*		*
C			-		*	*	*	*	*	
D	*		*	-	*		*	*		*
E		*	*	*	-	*	*	*	*	*
F	*		*		*	-	*•	*		*
G	*•	*	*	*	*	*•	-	*	*	*•
H	*	*	*	*	*	*	*	-	*	*
I	*		*		*		*	*	-	*
J		*		*	*	*	*•	*	*	-

(*) = K
(.) = P
Groups are not significantly different at the α=0.05 level = N
A = Control B = 10 ppm IAA C = 20 ppm IAA D = 10 ppm G_3
E = 20 ppm GA_3 F = 10 ppm ABA G = 20 ppm ABA H = 15 ppm Cytozyme
I = 30 ppm Cytozyme J = 20 ppm Berelex

is the co-factor of enzymes, by accelerating the metabolism. ABA increase in the plant is correlative to potassium, leading to a decrease in potassium content.

A 93% increase in chlorophyll a content when 10 ppm ABA is applied revealed that cyclic photosynthetic electron transfer is preferred. Similarly, when Berelex and 30 ppm cytozyme is applied chlorophyll b content increased by 90% and 137.5%, respectively. Hence in this case acyclic electron transfer is preferred to the cyclic one.

15 ppm cytozyme application balances the increases in chlorophyll a and b contents. Cytozyme, which is a product of microbial fermentation, is determined to include substances from auxin, gibberellin and cytokinin groups (which are also products of microbial fermentation [14, 1]). From this point of view, it can be stated that there is no difference between Berelex and cytozyme applications.

Stimulation of increased plant height by Gibberellin and inhibition by ABA are defined characteristics of these

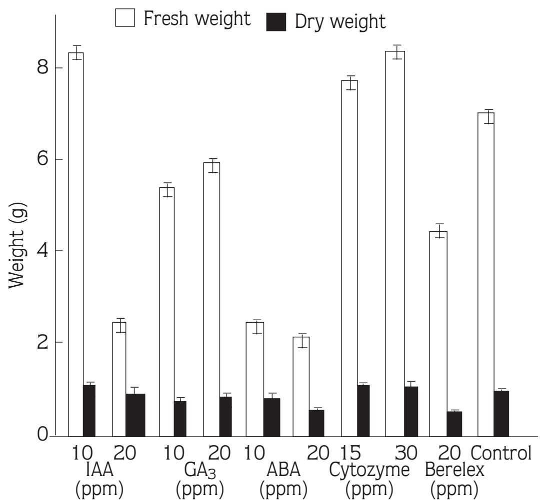

Figure 7. Effects of Different Concentrations of IAA, GA_3, ABA, Cytozyme and Berelex on Fresh and Dry Weight of *Lycopersicum esculentum* Mill.

hormones [15]. Similarly, inhibition of root elongation is an effect of ABA [15]. Stimulation of root elongation in 30 ppm cytozyme application supports the idea that this application influences the growth by increasing the mitotic index in the root.

Decrease in the number of leaves is also typical for ABA [15]. Statistically the increase in fresh weight in plants subject to 10 ppm IAA is invariant, whereas the decrease in the same property in 20 ppm IAA, and in 10 and 20 ppm ABA applications can be explained with the inhibition of water uptake.

The decrease in fresh weight as an outcome of Berelex application is also not statistically variant on the order of 0.10, 0.05 and 0.01 according to the results of t-test. The increase in the 30 ppm cytozyme application can be explained by growth of the plant due to an increase in dry weight.

In light of all the results, 15 ppm Cytozyme Crop Plus was found to be suitable for tomato cultivation as it is conducive to balanced and correlative growth.

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