RESPONSE OF COTTON PLANTS TO SOME POLYPHENOLS APPLICATION

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Abstract

The present investigation was carried out to study the effect of the application of polyphenolic compounds i.e. Pyrogallic, P.coumaric acid and Tanic acid, at concentrations of 50 and 100 ppm of each, on the development of the cotton variety Giza 81.

The application of the studied compounds had no significant influence on growth characters in both seasons, except number and length of internodes in 1990 season, where the maximum of both characters was obtained when the plants were treated with Tanic acid (50 ppm) and Pyrogallic acid (100 ppm), respectively. The compounds increased number of open bolls/plant, seed cotton yield per plant and per feddan, while the other characters were not clearly affected. The highest values were obtained from the application of P.coumaric acid when applied at 50 ppm in both seasons. Treated plants were earlier in maturity. Micronaire and Pressley index were not affected. The foliar spray of the compounds increased auxin content, ratio of poly to total phenols in leaves and seed protein content, while seed oil content was not affect-

INTRODUCTION

The cotton plant (Gossypium spp.) produces many natural polyphenolic compounds such as Vanillic acid, Sinapic, P-coumaric acid, Perulic acid, P-coumaric acid, Salicylic acid and Caffeic acid (Hanny 1980). Polyphenols and other derivatives from Shikimate metabolism play an important role in decreasing IAA degradation by 30 percent in healthy cotton tissue besides these compounds might contribute to the increase of 1AA and decrease of IAA decarboxylation (Wiese and De Vay 1970). Schwentner and Morgan (1966) found that certain monophenols enhanced abscission in cotton plants, and they also reported a role of phenols in the abscission process, besides, phenolic substances were found to influence the activity of IAA oxidase.

Polyphenols and orthodihydroxy phenols inhibit the action of IAA oxidase and monophenols enhance its activity (Zink and Muller, 1963).

Tomasweska (1968) found that polyphenols encouraged the abscission retardation by IAA and monophenols antagonized the retardation. Polesika (1973) found that the phenol compounds (Ferulic, Vanillic and Coumaric acid) in different organs of cotton at different growth stages have given the high contents of coumaric acid derivatives in the young organs of the plants and protected them from shedding.

Brzozowska *et al.* (1973) found that phenolic compounds present in leaves of the cotton plant at the time of flowering constituted about 3.52% of dry matter. El-Hamawi *et al.* (1974) showed that the total phenols content reached its maximum and dropped sharply to a very low level before the end of first 15 days of the young bolls after anthesis. This result indicates that there is a relation between the phenolic content of young growing bolls and shedding. Abdel-al (1981) reported that coumarin spray at higher concentration caused an increase in number of bolls and yield of seed cotton, while it reduced the shedding percentage. The highest yield was obtained when coumarin was applied a week from start of flowering. He also found that the hormonal content (IAA, GA3, Cytokinin and total phenols) of bolls was generally higher in plants treated with coumarin.

MATERIALS AND METHODS

This investigation was carried out at the Agricultral Research Center's Farm at Giza in 1989 and 1990 seasons. Giza 81 cotton variety was used as an experimental material in randomized complete block design with four replicates. Polyphenols were applied as foliar sprays as follows: Zero ppm (control), 50 ppm Pyrogallic acid, 100 ppm Pyrogallic acid, 50ppm P-coumaric acid, 100 ppm P-coumaric acid, 50ppm Tanic acid, and 100ppm Tanic acid.

The plot consisted of five rows, four meters long, 60cm, apart, with a distance between hills of 20cm. The planting date was on March 23, and March 30 in 1989 and 1990 seasons, respectively. Ammonium nitrate (33%) and Calcium Superphosphate (15.5% P_aO_5) at the rate of 60 kg N and 16 kg P_2O_5 per feddan were applied. All cultural practices were done according to common practices. Pyrogallic acid, P-coumaric acid and Tanic acid were applied as foliar spray after one week from the start of flowering. The middle row was used for chemical analysis in which leaf samples were obtained from the upper fourth node from the apex, after 2 weeks

from the treatment application, and the following constituents were determined in ethanolic extract: total and polyphenols (according to Simons and Ross, 1971) and auxins (according to Flisson 1969).

Twenty five plants were labeled at random in each plot and at the end of each season the following traits were recorded: 1-Plant height cm, 2-No of internodes, 3-Length of internode cm, 4-No. of sympodia/plant, 5-No. of open bolls/plant, Boll weight in grams. 7-Seed cotton yield per plant in grams, 8-Seed index (weight of 100 seeds in grams), 9-Lint percentage.

Yield in cantar per feddan was estimated on the basis of the yield per plot. Earliness was measured as a percentage of seed cotton yield of the first pick to the total seed cotton yield. Oil and protein contents in seeds were determined using A.O.A.C., 1970. Micronaire value and Pressley index were measured at the Laboratories of Cotton Research Institute, under the standard conditions of test (65±2% relative humidity and 70±2°C F temperature). The differences between treatments were tested as described by Snedecor and Cochran (1971), using L.S.D. at 5%.

RESULTS AND DISCUSSION

I- Growth :

It is revealed from data presented in Tables 1, 2 that the foliar spray of coton plants with phenol compounds (i.e. Pyrogalic acid, P. coumaric acid and Tanic acid) did not exert any significant influence on plant growth traits in 1989 season. In 1990 season the treatments of Pyrogallic acid at 50 and 100 ppm and P-coumaric acid at 100 ppm significantly decreased the number of internodes, while the treatments of Pyrogallic acid at 100 ppm increased the length of internodes significantly.

The effect of such compounds on the growth and development of cotton plants may be due to their effect on hormone activity within the plants (Abdel-al, 1981), thus these materials may exert its effect on cell division and/or its elongation. However additional studies are very important to give satisfactory explanation for the effect of such compounds on cotton plant growth.

II-Yield and yield components :

The results in Tables 1 and 2 reveal that, seed cotton yield and number of open bolls/plant were significantly affected in both seasons. The increase in yield caused by the phenols application was more clear in 1990 season, where all the treatments significantly increased seed cotton yield compared to the control. The

Table 1. Effect of polyphenols on growth, yield, yield components and lint properties of cotton plants during 1989 season.

Treatments	ppm	Plant height (cm)	No. of interno-des/ plant	Length of internode (cm)	No. of sympodia /plant	No. of open bolls /plant	Boll weight (gm)	Seed cot-ton yield/ plant (gm)	Seed index	Lint (%)	Yield in Cantar per fed-dan	Micro-naire reading	Press-ley index	Ear-liness
Control	0	144.6	32.0	4.52	16.9	8.2	2.63	21.6	10.0	36.3	5.88	4.5	10.5	59.0
Pyrogallic acid	50	149.2	33.2	4.49	17.2	10.0	2.67	26.7	10.3	36.5	6.69	4.6	10.8	67.0
	100	143.4	31.4	4.57	17.8	11.8	2.61	30.8	10.1	36.3	7.29	4.3	10.9	67.9
P-coumaric acid	50	150.6	34.8	4.33	18.0	12.1	2.67	32.3	10.7	36.6	8.07	4.6	10.8	65.4
	100	148.4	32.6	4.55	16.7	11.4	2.57	29.3	10.1	36.8	7.15	4.5	10.8	66.2
Tanic acid	50	142.6	32.6	4.34	17.4	10.4	2.62	27.2	10.3	36.1	7.23	4.7	109	61.2
	100	147.8	31.8	4.65	17.8	10.6	2.59	27.5	10.1	36.3	7.34	4.5	10.5	67.0
L.S.D. 5%		N.S.	N.S.	N.S.	N.S.	1.5	N.S.	3.8	N.S.	N.S.	1.31	N.S.	N.S.	4.9

Table 2. Effect of polyphenols on growth, yield, yield components and lint properties of cotton plants during 1990 season.

Treatments	ppm	Plant height (cm)	No. of interno-des/ plant	Length of internode (cm)	No. of sympodia /plant	No. of open bolls /plant	Boll weight (gm)	Seed cot-ton yield/ plant (gm)	Seed index	Lint (%)	Yield in Kentar per fed-dan	Micro-naire reading	Press-ley index	Ear-liness
Control	0	148.2	33.3	4.45	17.5	8.3	2.83	23.5	10.7	36.0	6.43	4.3	10.8	54.5
Pyrogallic	50	151.2	31.3	4.83	18.0	10.1	2.84	28.7	10.9	36.4	7.45	4.7	10.9	63.4
acid	100	147.0	28.8	5.10	18.6	11.9	2.82	33.6	10.7	36.5	8.21	4.5	10.5	64.0
P-coumaric	50	152.7	32.3	4.73	18.1	12.0	2.86	34.3	10.9	36.7	8.90	4.6	10.9	62.1
acid	100	150.0	29.8	5.03	18.5	11.7	2.80	32.8	10.6	36.7	8.12	4.5	10.5	63.0
Tanic acid	50	145.2	34.0	4.27	17.9	10.5	2.79	29.3	10.6	36.0	7.76	4.5	10.8	55.0
	100	144.3	32.0	4.51	18.3	10.8	2.75	29.7	10.7	36.5	7.96	4.7	10.8	61.5
L.S.D. 5%		N.S.	1.6	0.40	N.S.	1.4	N.S.	2.9	N.S.	N.S.	1.02	N.S.	N.S.	5.4

other yield components such as boll weight, lint percentage and number of sympodia/plant were not significantly affected. The increase in yield of seed cotton is attributed to the increase in boll production, this means that these substances may exert its effect on vegetative growth and increase boll setting percentage. These substances may play an important role in the regulation of the production of endogenous hormones and consequently increase flower production and decrease shedding percetage of young bolls. Zinck and Muller (1963), Tomasweska (1968) and Abdel-al (1981) found that polyphenols antagonized the retardation by IAA which caused increases in number of bolls and yield of seed cotton. Spray applications significantly increased earliness percentage except the treatment of Tanic acid at the lower rate in both seasons. This effect could be due to that these substances have a stimulating effect on boll maturation.

III- Lint quality :

The data in Tables 1 and 2 reveal that the application of phenolic compounds to cotton plants had no significant influence on micronaire and Pressley index in both seasons .

IV- Chemical constituents :

A- Leaves:

It is clear from the data in Table 3 that the foliar spray of polyhenolic cmpounds on cotton plants increased auxin content in plant leaves as compared to the control. It is also evident that plants treated with P-coumaric acid with a concentration of 50ppm had the highest auxin content in their leaves, followed by those treated with Pyrogallic acid with a concentration of 100 ppm. In general, the data revealed that P-coumaric application increased auxin content with a higher degree than those plants treated with the other two compounds especially Tanic acid. This means that the effect of such compounds on plant metabolism especially auxin and its related compounds depends on the concentration of each compound as well as the type of polyphenol applied (Tomasweska (1968), Wiese and De vay (1970) found that polyphenols encouraged the abscission retardation by IAA and mopophenols antagonized the retardation. They found also that polyphenols and other derivatives from Shikimate metabolism play an important role in decreasing IAA degradation by 30 percent in healthy cotton tissues.

Concerning the effect of phenolic compounds on the ratio of polyphenol to total

Table 3. Effect of polyphenols on some chemical contents in leaves and seeds during 1989 and 1990 seasons.

		1989				1990			
Treatment	ppm	Auxin mg/g D.Wt.	Polyphenols Total phenols (%)	Seed oil (%)	Seed protein (%)	Auxin mg/g D.Wt.	Polyphenols/ Total phenols (%)	Seed oil (%)	Seed protein (%)
Control	0	2.12	71.3	23.33	21.36	2.18	73.4	24.10	20.31
Pyrogallic	50	2.28	75.8	24.00	22.60	2.31	77.2	24.20	22.38
acid	100	3.67	88.2	24.33	23.55	2.60	89.1	24.75	24.44
P-coumaric	50	3.83	90.5	24.33	23.65	3.95	93.0	24.30	23.75
acid	100	3.18	85.2	25.66	23.35	3.10	87.0	25.75	23.25
	50	2.48	80.1	24.33	21.20	2.51	80.8	24.90	20.94
Tanic acid	100	2.61	82.6	23.00	22.10	2.79	83.2	24.10	21.75
L.S.D. 5%		0.12	2.1	N.S.	0.51	0.11	2.2	N.S.	0.56

phenols as presented in Table 3, the data revealed that the application of such compounds to cotton plants increased this ratio as compared to the control plants, and the highest value was obtained when P-coumaric acid was applied at 50 ppm while the lowest was obtained when Pyrogallic acid was sprayed at a concentration of 50 ppm. In general, the data revealed that the application of Tanic acid and Pyrogallic acid to cotton leaves increased this ratio by increasing its concentration, while the reverse was true for P-coumaric acid in which the lower concentration increased this ratio in both seasons. In this respect, Polesika (1973) found that the phenol compounds: Ferulic, Vanillic, and Coumaric acids in different organs of cotton plant at different growth stages show the high contents of Coumaric acid derivatives in the young organs of the plant and protect them from shedding.

B- Seed :

The data in Table 3 reveal that application of polyphenol compounds to cotton leaves had no significat influence on oil content in cotton seeds in both seasons, however, the application of P-Coumaric acid produced the highest oil percentage when applied at 100 ppm. This may be due to the fact that these compounds did not exert its effect on the metabolism and biosynthesis of oil and its related compounds.

On the other hand, protein content in seeds of treated plants was higher when compared to control plants, except those plants treated with Tanic acid with a concentrajon of 50 ppm. in 1989. It is clear from these data that the application of Pyrogallic acid to cotton plants increased protein content when applied at 100 ppm as compared to those treated with 50 ppm, while the reverse was true for P-coumaric acid. It is obvious that there was a similar trend in the effect of such compound on auxin, ratio of polyphenol to total phenols and protein content in seeds.

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استجابة نباتات القطن للمعاملة ببعض الفينولات العديدة

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مركز البحوث الزراعية ، معهد بحوث القطن ، قسم بحوث فسيولوجيا القطن .

اجرى هذا البحث لدراسة المعاملة ببعض المركبات الفينولية العديدة وهى حامض البيروجاليك - حامض الباراكيوماريك وحامض التانيك بتركيزات ٥٠، ١٠٠ جزء فى المليون من كل منها وتأثيرها على نمو صنف القطن جيزة ٨١ خلال موسمى ١٩٨٩ ، ١٩٩٠ بمزرعة مركز البحوث الزراعية بالجيزة.

لم يكن للمواد تحت الدراسة تأثير معنوى على صفات النمو فى كلا الموسمين فيما عدا عدد واطوال السلاميات فى الموسم الثانى فقط حيث كانت اكبر القيم المتحصل عليها فى هاتين الصفتين عند المعاملة بتركيز ١٠٠ جزء فى المليون على الترتيب.

أدت المعاملة بهذه المركبات (الفينولات العديدة) الى زيادة فى متوسط عدد اللوز المتفتح على النبات ومحصول النبات من القطن الزهر وكذلك المحصول للفدان، بينما لم يكن لها تأثير على بقية الصفات تحت الدراسة.

وأعطت معاملة النباتات بحمض الباراكيوماريك بتركيز ٥٠ جزء فى المليون أعلا قيم لمحصول النبات الواحد ومحصول الفدان فى كلا الموسمين.

وأدت المواد تحت الدراسة الى زيادة مؤكدة فى صفة التبكير بالنسبة للمقارنة، بينما لم يكن لها تأثير على صفتى نعومة ومتانة التيلة.

وقد كان لرش النباتات بالمركبات الفينولية العديدة تأثير واضح على زيادة المحتوى الاكسينى فى الاوراق وكذلك النسبة المئوية للفينولات العديدة الى الفينولات الكلية.

كما أدت معاملة النباتات بهذه المركبات الى زيادة المحتوى البروتينى للبذور ولم يكن لها تأثير على محتوى البذور من الزيت.