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PHYSIOLOGICAL RESPONSE OF WHEAT (*Triticum aestivum* L.) TO SPERMIDINE AND ETHRYL

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ABSTRACT

This work was carried out to study the effect of spermidine and ethryl on growth, yield and chemical composition of wheat (*Triticum aestivum* L.) plants grown in sandy soil at Kafr-Hakim, Giza, Egypt, during two successive seasons 1997/98 and 1998/99.

The data indicated that spraying wheat plants with spermidine or ethryl had a positive effect in most cases on growth parameters, the maximum values were obtained with spermidine at 150 and 200 ppm.

Spraying wheat plants with the spermidine at 150 and 200 ppm gave the highest economic yield of grain and 1000-grain weight. Spraying plants with spermidine at 100 and 150 ppm attained significant increases in straw yield.

Application of spermidine or ethryl treatments in general decreased protein content and total soluble sugars, while increased total sugars and non soluble sugars. On the other hand, using spermidine at 150 and 200 ppm and ethryl at 100 g/fed had an obvious stimulating effect on phosphorus percentage in wheat grains. The results has been interpretted by the correlation coefficient between wheat plants characters under spermidine treatments which indicated that grain yield was positively and significantly correlated with plant height and spike weight, while positively nonsignificantly correlated with tillers number, spike length, flag leaf area and 1000-grain weight. Under ethryl treatments grain yield was negative and nonsignificantly correlated with tillers number, spike length, straw yield and total soluble sugars. On the other hands positive and nonsignificant, correlations of grain yield was obtained with other characters under ethryl treatments.

INTRODUCTION

Plant growth regulators effects on crop growth and productivity are widely varied. Spermidine stimulates many aspects of plant growth and development. Ethryl known to inhibit some aspects of plant development. Smith (1985) reported that polyamine fulfil led important functions and this was substantiated their behavior in relation to hormones, senescence, it's stimulation and modulating growth in a higher plants. Tipirdamaz *et al*. (1995) found that polyamine application significantly increased alpha amylase activity. Yang *et al*. (1996) indicated that grain fillings and 100 seed weight of rice were positively correlated with polyamine contents particularly with spermidine and spermine. In addition, those growth regulators were good grain plumpness.

Fluglsang (1986) found that crop treated with ethephon showed a reduction at straw, length and lodging but it increased seed yields. Norberg, *et al*. (1988) reported that ethephon application under high density conditions decreased corn grain yield and reduced plant height and lodging when applied at tasselling or post tasselling, while increased the protein concentration of the grain. On the other hand, Mohamed *et al*. (1990) showed

that the application of ethephon on wheat did not affect yield or grain protein. In addition, ethephon application at intensification of cultural practices was not effective for increasing grain yield and grain protein content.

The objectives of the present study was to reveal the effect of foliar application of spermidine and ethryl on growth, yield and it's components of wheat and their effect on some chemical constituents of produced grains.

MATERIALS AND METHODS

The present work was conducted in two successive seasons 1997/98 and 1998/99 on sandy soil at Kafr-Hakim, Giza, Egypt, to investigate the effect of Spermidine and Ethryl on growth, yield and chemical constituents of produced grains of wheat (*Triticum aestivum* L.) Row planting method was used, grain rate was 60 kg/fed. in both seasons. Wheat grains, variety Sahka 69 were sown on 15 and 17 of November in 1997 and 1998 seasons, respectively. Plot area was 12 m^2 (4 x 3m), in rows 4 meters long and 25 cm apart. During the previous years, calcium superphosphate (15.5 P_2O_5%) was added presowing at 100 kg/fed, ammonium nitrate (33.5% N) at 100 kg/fed was applied at three equal doses at the first (seedling stage), third and fiveth (tillering stage) irrigations. Potassium sulfate (48-52% K_2O) at the rate of 50 kg/fed. was added at two equal doses at the first and third irrigations.

The treatments consisted of four concentrations of spermidine ($NH_2(CH_2)_3 NH (CH_2)_4NH_2$); 50, 100, 150 and 200 ppm and three concentrations of ethryl 100, 200 and 300 g/fed and the control (distilled tap water).

In both seasons, foliar application of spermidine, as well as ethryl were sprayed at twice, with the abovementioned concentrations on the overground parts (leaves and stems). The first spray was applied at tillering stage (30 days after sowing) and the second spray at grain milky stage (140 days after sowing).

Measurments of growth characteristics were taken for plant height, tillers number/m^2, spike length (cm), spikes number/m^2, fresh and dry spike weight at the heading and harvest stages, grain yield (g/m^2), 1000-grain weight (g), straw yield (kg/fed.), crop index and harvest index at harvest stage.

Some chemical constituents analysis of produced grains:

Grains samples from all treatments were dried at 70°C for constant weight and ground to determine the following chemical constituents. Nitrogen and protein percentage according to the method of A.O.A.C. (1970) and protein percentage was calculated by multiplying the value of total nitrogen content by 5.70. Phosphorus percentage was determined according to the method described by Chapman and Pratt (1978). Total sugars and total soluble sugars were determined colorimetrically according to the method described by Dubois *et al*. (1956).

The experiment was arranged as a randomized blocks design with three replicates. Combined analysis for data of the average the two seasons was carried out and the values of LSD. were calculated as described by

Snedecor and Cochran (1980). Simple correlation coefficients between grain yield and growth and yield components characters, were determined according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth characteristics:

Some concentrations of either spermidine or ethryl resulted in significant increases in some growth parameters of wheat plants such as plant height, tillers number, spikes number, spike length, spike weight and flag leaf area. It is evident from the data presented in Table (1), that foliar spermidine application showed the highest value of plant height at heading stage comparing with the other treatments of ethryl and control. While, at the harvest stage, the concentrations of either spermidine at 150 and 200 ppm and ethryl at 100 and 200 g/fed. resulted in significant increases in plant height. Spermidine at treatment 200 ppm realized the maximum value in this character wherther at heading or harvest stages.

Table (1): Effect of spermidine and ethryl on some growth characteristics of wheat plants (Average of two seasons, 97/1998 and 98/1999).

Treatments	Plant height (cm)		Tillers number/m^2		Spike number/m^2		Spike length (cm)		Spike weight at harvest (g)		Flag leaf area (cm^2)
	Heading	Harvest	Heading	Harvest	Heading	Harvest	Heading	Harvest	Fresh	Dry	
Spermidine 50 ppm	86.7	94.7	668.5	768.2	550.1	763.0	10.9	15.0	1.52	0.88	15.72
100 ppm	86.7	97.3	690.3	868.2	581.3	763.1	12.5	15.8	1.68	0.93	16.67
150 ppm	90.0	103.3	982.5	891.3	768.2	864.2	12.5	15.9	1.76	0.96	17.92
200 ppm	93.0	105.4	840.6	914.3	795.6	872.6	11.2	16.7	1.94	0.98	19.83
Ethryl 100 g/fed	80.0	105.3	745.9	862.8	602.2	796.2	11.8	12.0	1.45	0.70	15.20
200 g/fed	78.3	103.7	868.4	912.9	767.8	852.3	11.9	12.7	1.00	0.55	15.38
300 g/fed	75.0	99.7	906.2	874.0	798.2	824.1	12.0	12.2	0.96	0.52	9.17
Control	83.3	91.7	617.4	901.2	533.2	835.5	10.8	14.5	1.44	0.88	15.33
L.S.D. at 5%	8.72	7.85	235.4	N.S	N.S	N.S	1.34	1.7	0.47	0.16	4.77

Regarding tillers number of wheat plant, data in Table (1) showed that tillers number per plant was increased as a result of spermidine and ethryl at heading and harvest stages. However the maximum values in this respect were obtained with spermidine at treatments of 150 and 200 ppm and ethryl at treatments of 200 and 300 g/fed. At heading stage, spermidine at treatment of 200 ppm and ethryl at treatment of 200 g/fed. at harvest stage were the most effective treatments for increasing the tillers number.

The results tabulated in the same Table indicated clearly that spermidine and ethryl had no significant effect on spikes number at heading and harvest stages, spraying with spermidine and ethryl caused increases in spikes number over the control at heading stage, especially at spermidine treatments of 150 and 200 ppm and ethryl at treatments of 200 and 300

g/fed., respectively. While, the slight increases were observed with treatments of 150 and 200 ppm of spermidine at harvest stage.

It is evident from the data presented in Table (1) that all concentrations of spermidine and ethryl led to increase in spike length at the heading and harvest stages, except with ethryl at harvest stage led to significant decrease in spike length. The most significant effect was noticed with spermidine treatment 200 ppm being 16.67 cm at harvest stage, while, that of control was 14.5cm.

The data also indicated that spermidine treatments increased fresh or dry weight of spike and flag leaf area with increasing the concentration, over ethryl treatments and control. On the other hand, spraying with ethryl decreased these characters than their corresponding of the controls.

Many investigators found a positive relationship between the application of spermidine and the increment in many growth characters of some plants as *Triticum aestivum*, (Anguillesi *et al,* 1990 and Reggiani *et al,* 1994) on rice and (Bonneau *et al.,* 1994). While, the present results for the effect of spermidine could be interpretted as Galston (1983) reported that polyamines are senescence inhibitors. They inhibited the rise in RNAase, protease and peroxidase; reduced the rate of senescence of leaf protoplasts; induced DNA synthesis and mitoic activity; promoted the synthesis macromolecules; stabilized thylakoid membranes; maintained high protein content, and prevented the loss of chlorophyll in leaf disks. Concerning the effect of ethryl, the abovementioned results are in agreement with those of Gaska and Oplinger (1988), Kasele *et al.* (1994) and Abdrabou (1995) on *Zea mays*.

The results of simple coefficients between some characters of wheat plant under sperimidine treatments are presented in Table (4). It is clear that the increases in grain yield were due to significant positive correlation with plant height and spike weight, as well as positive and nonsignificant correlation with other growth characters. Plant height significantly had a positive correlation with spike length, spike weight, flag leaf area and 1000-grain weight.

The decreases in grain yield under ethryl treatments, as show in Table (5) were due to nonsignificant positive correlation with plant height, spike weight, flag leaf area and 1000-grain weight. However, nonsignificant negative correlations were obtained with tillers number, spike length and straw yield. This interpreted metabolites accumulation in straw.

Chemical Constituents:

Data presented in Table 3 showed the percentage of nitrogen, protein and phosphorus in dry produced grains as affected by spermidine and ethryl treatments. It is clear that different levels of spermidine or ethryl caused pronounced decreases in nitrogen and protein compared with control. The lowest values in this respect were observed at treatment 100 g/fed ethryl which recorded 81% and 80% relative to control for nitrogen and protein, respectively. Regarding phosphorus percentage, it is clear that using spermidine at 150, 200 ppm and ethryl at 100 g/fed. had an obvious stimulating effect on the phospherus percentage which was increased as

compared with other treatments and control. The highest value in this respect was obtained at level 200 ppm spermidine which recorded 125% relative to control.

Concerning the contents of total sugars and non soluble sugars, in the grains of wheat plant, (Table, 3)the results indicated that, their content increased due to spray the plants with spermidine and ethryl at all concentrations. The maximum increases of total soluble sugars and non soluble sugars in this respect were 164 and 171% relative to control, respectively, resulted at treatment of spermidine 100 ppm. On the other hand, total soluble sugars in grains was decreased due to application of spermidine or ethryl spray compared with control. Whereas, the plant which treated with foliar spray of ethryl at 300 g/fed. gave the best results compared with other treatments. In general the increases in total sugars were followed by increasing nonsoluble sugars and decrease soluble sugars. These results could be interpretted on the basis of the results of Angelini *et al* (1995), Hu (1999), Preety, *et al* (1999) and Lopez (2000).

Yield and it's components

The obtained data in Table 2 indicated that there were significant differences among the various treatments. Spraying wheat plants with spermidine at 150 and 200 ppm caused significant increases in grain weight (g/m^2) as well as grain yield (kg/fed.) as compared with the control. However, spraying with these concentrations had no significant effect on 1000-grain weight.

Table (2): Effect of spermidine and ethryl on yield components of wheat plants (Average of two seasons, 97/1998 and 98/1999).

Treatments	Grain weight (g/m^2)	1000-grain weight (g)	Grain yield Kg/fed	Straw yield Kg/fed	Crop index	Harvest Index
Spermidine 50 ppm	497.86	40	2091	3334	62.72	38.54
100 ppm	543.10	40	2281	4274	53.37	34.80
150 ppm	605.24	41	2542	4595	55.32	35.62
200 ppm	561.19	43	2357	3619	65.13	39.44
Ethryl 100 g/fed	508.81	38	2137	3409	62.69	38.53
200 g/fed	477.86	38	2007	3977	50.47	35.94
300 g/fed	468.57	37	1968	4241	46.40	31.70
Control	474.52	39	1993	3212	62.05	38.29
L.S.D. at 5%	73.98	N.S	312.15	554.55	8.50	5.48

It is evident from the data presented in the same Table that all concentrations of spermidine and ethryl led to increases in straw yield kg/fed. of wheat plants, being more significant at 100 , 150 ppm of spermidine and at treatments 200 and 300 ethryl as compared with the control. The maximum values of straw yield in this respect recorded 4274 and 4595 kg/fed at spermidine 100 and 150 ppm, respectively, while the control was 3212 kg/fed.

Table (3): Effect of spermidine and ethryl on nitrogen, protein, phosphorus, total sugars, soluble sugars and non soluble sugars percentage in wheat grains (Average of two seasons, 97/1998 and 98/1999)

Treatments	Nitrogen	Protein	Phosphorus	Total sugars	Total soluble sugars	Non soluble sugars
Spermidine						
50 ppm	2.08	11.86	0.36	51.76	1.95	49.81
R	86	86	75	121	61	126
100 ppm	2.24	12.77	0.46	69.88	2.25	67.63
R	93	92	96	164	71	171
150 ppm	2.13	12.14	0.50	51.55	2.33	49.22
R	88	88	104	121	73	125
200 ppm	2.11	12.03	0.60	45.26	2.42	42.84
R	88	88	125	106	76	109
Ethryl						
100 g/fed	1.94	11.06	0.53	53.39	1.11	52.28
R	81	80	110	125	35	132
200 g/fed	2.05	11.69	0.48	51.35	1.12	50.23
R	85	85	100	120	35	127
300 g/fed	2.11	12.03	0.45	51.08	2.83	48.25
R	88	88	94	120	89	122
Control	**2.41**	**13.74**	**0.48**	**42.66**	**3.19**	**39.47**
	100	**100**	**100**	**100**	**100**	**100**

R = Relative to control.

Regarding crop and harvest index of wheat plants, data in Table 2 show that, spraying with spermidine at 50 or 200 ppm and ethryl at 100 and 300 g/fed. caused increases in crop and harvest index compared with other treatments and control. Similar positive effect of spermidine on yield components was mentioned by several investigators Bharti (1995) and Gniazdowska *et al*. (1995) on wheat and Zhu *et al.* (1997) on rice. On the other hand, some workers reported that grain yield of miaze tended to decrease with increasing rate of ethephon Gaska and Oplinger (1988) and Kasele *et al.* (1994).

Simple coefficients between grain yield its components and chemical constituents under spermidine treatments are calculated and presented in Table (4). It is evident that increasing grain yield was due to nonsignificant positive correlation with phosphorus, total sugars and nonsoluble sugars. However in Table (5) the decrease in grain yield under ethryl treatments could be interpretted by nonsignificant negative correlation with spike length and nonsignificant positive correlation with spike weight, flag leaf area, 1000-grain weight, nitrogen, total sugars and nonsoluble sugars.

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الاستجابة الفسيولوجية لنبات القمح لكل من الإسبرميدين والإيثريل

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أجرى هذا البحث بمنطقة كفر حكيم بالجيزة خلال موسمين متتالين 1998/97و 1999/98 لدراسة تأثير كل من الإسبرميدين والإيثريل على النمو والمحصول والتركيب الكيميائى لنبات القمح.

وقد أظهرت النتائج أن الرش بالإسبرميدين والإيثريل أعطت نتائج إيجابية فى معظم قياسات النمو وأعطى الرش بالإسبرميدين بتركيز 150 و 200 جزء فى المليون أعلى نتائج بالنسبة لقياسات النمو المختلفة.

وكذلك أعطى الرش بالإسبرميدين عند تركيز 150 و 200 جزء فى المليون أحسن نتائج لمحصول وكذلك وزن الألف حبه ، بينما الرش بالإسبرميدين بتركيز 100 و 150 جزء فى المليون أعطى زيادة معنوية فى محصول القش. ولقد كان لاستخدام كل تركيزات الإسبرميدين أو الإيثريل أثره الفعال فى نقص محتوى البروتين فى حبوب القمح والسكريات الذائبة، بينما زادت السكريات الكلية والسكريات غير الذائبة، ومن ناحية أخرى زاد محتوى الفوسفور نتيجة المعاملة بالإسبرميدين بتركيز 150 و 200 جزء فى المليون والمعاملة بالإيثريل بتركيز 100 جرام/فدان.

أظهرت الدراسة وجود أرتباط موجب معنوى تحت تأثير الاسبرميدين بين محصول الحبوب وكل من طول النبات ووزن السنبلة ، وكذلك إرتباط موجب مع عدد الأفرع وطول السنبلة ومساحة الورقة ووزن الألف حبة. وكان الارتباط تحت تأثير الايثريل سالبا وغير معنوى بين محصول الحبوب وعدد الأفرع، طول السنبلة، محصول القش والسكريات الكلية الذائبة بينما كان موجبا وغير معنوى مع الصفات الأخرى.

Table (4): Simple correlation coefficients between wheat plants characters under spermidine treatments.

Characters	1	2	3	4	5	6	7	8	9	10	11	12
Grain yield	0.889*	0.373	0.784	0.882*	0.751	0.653	0.864	-0.542	0.497	0.231	-0.386	0.242
1-Plant height		0.431	0.933*	0.969*	0.964*	0.926*	0.556	-0.636	0.708	-0.023	-0.346	-0.008
2- Tillers number			0.399	0.593	0.522	0.356	0.262	0.418	0.891*	-0.242	0.652	-0.265
3- Spike length				0.948*	0.945	0.908*	0.514	-0.583	0.694	0.202	-0.403	0.215
4- Spike weight					0.956*	0.875	0.615	-0.456	0.803	0.069	-0.209	0.076
5- Flag leaf area						0.974*	0.372	-0.534	0.824	-0.123	-0.212	-0.112
6- 1000-grain weight							0.224	-0.650	0.728	-0.186	-0.316	-0.168
7- Straw yield								-0.270	0.196	0.583	-0.347	0.584
8- N %									0.030	-0.010	0.875	-0.135
9- P %										-0.313	0.366	-0.322
10- Total sugars											-0.514	0.999*
11- T. Soluble sugars												-0.545
12- Non S.S.												-

Correlation coefficient at 5% : 0.878

Table (5): Simple correlation coefficients between wheat plants characters under ethryl treatments.

Characters	1	2	3	4	5	6	7	8	9	10	11	12
Grain yield	0.587	-0.548	-0.408	0.197	0.494	0.135	-0.485	0.625	0.969*	0.492	-0.677	0.548
1-Plant height		-0.346	-0.893	-0.658	0.035	-0.538	0.385	-0.988	0.450	0.966*	-0.901	0.991*
2- Tillers number			0.603	0.097	0.416	0.477	0.007	0.482	-0.360	-0.495	0.061	-0.429
3- Spike length				0.783	0.398	0.830	-0.591	0.942	-0.191	-0.979	-0.085	-0.945
4- Spike weight					0.571	0.891	-0.948	0.659	0.375	-0.063	0.377	-0.710
5- Flag leaf area						0.820	-0.729	0.069	0.686	-0.215	-0.458	-0.091
6- 1000-grain weight							-0.875	0.609	0.369	-0.723	-0.059	-0.636
7- Straw yield								-0.394	-0.648	0.521	-0.075	0.454
8- N %									-0.442	-0.988	0.836	-0.997
9- P %										0.306	-0.643	0.384
10- Total sugars											-0.759	0.992*
11- T. Soluble sugars												-0.571
12- Non S.S.												

Correlation coefficient at 5% : 950