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Influence of planting patterns and exogenous ethylene application on fruit and seed in squash (*Cucurbita pepo*)

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ABSTRACT

In order to evaluate the distance cultivation effects and ethylene spray on fruit and seed production in squash, a field experiment was conducted in spring and summer, 2007. The factors were three dose of ethylene (0, 50 and 100 ppm of 2-Chloro-ethylphosphonic acid) and three density of planting (100*50 cm, 150*50cm and 200*50 cm). Evaluated characters in this research were seed yield and yield components including number of fruit per plant, number of seed per fruit, 100-seed weight. Although the combinations of 100ppm ethylene*100*50cm and 0ppm ethylene*100*50cm made the most number of fruit in area but the most of the weight of fruit (2831.4 kg/ha), weight of fresh seed (998.7kg/ha) made by 100ppm ethylene and 200*50cm density. Results showed that 100 ppm of ethylene and 200*50Cm density was the best combination. Correlations between weight of fruit and weight of seed and number seed per fruit were positive and between weight of fruit and number fruit was negative.

Key words*:* Squash (*Cucurbita pepo*), planting density, Ethylene(2-Chloro-ethylphosphonic acid), yield.

INTRODUCTION

Percentages of seed germination immediately after seed extraction were similar to those observed after 2 years of storage (Nerson, H., 2005).

Excessive seed leakage and a relatively low ratio of embryo weight to seed coat weight were associated with poor germination (Nerson and Harry., 1987). Length of period of sowing to harvesting for this plant is 4.5 month therefore is summer crop. Mean of yield is 600-1500 kg/ha. Now farmers planting by rows that distance between rows are 1-2 meter but not appear that what linkage of number fruit and seed yield, is few fruit with more weight or farther fruit with few weights has more yields? Density of planting by effect of competition between plants is effective in fruit production and seed yield and therefore could show to farmers the best density in this plant. In the other hand Ethylene is one of the hormones that increase the female flowers and then increase yield. In this research evaluate the effect of different densities and various concentrations of ethylene.

MATERIAL AND METHODS

Field experiment was conducted at Shahrekord (latitude 50°51′N, 32°17′E, 2049 m asl), located at about 500 Km of capital town of Iran on spring and summer 2007. The medial annual rainfall is about 337.2-mm per year. Average annual temperature is 11.2°C. Soil texture was Loam. Pervious year of culture was fallow. C, N, P and K content, EC, pH and percentage of sand, silt and clay were determined (Table 1). Total N was measured calorimetrically following Kjeldahl

digestion. Also, soil pH and electrical conductivity (EC) were estimated using a glass electrode pH meter and an EC meter in 1:1 soil water suspension. Organic carbon was determined by modified Walkley and Black method (Mckeague, 1987).

The experiment was arranged in a randomized complete block design with a split plot layout and three replications. The factors were three concentration of ethylene (0, 50 and 100 ppm) as main plots and three density of planting (50*100 cm, 50*150cm and 50*200 cm) as the sub plots. Each block consisted of three main plots. The main plots had three subplots that consisted of four rows spaced 150 cm apart and 8m length. 24 hours before planting, seeds were soaked and disinfected by Carboxin Tiram (100-150 gr per 100 Kg seed). Sowing was achieved in 22May. Spry of ethylene was conducted in V_2 stage and weeding and thinning 20 days after the plants had four true leaves.

Topsoil of the experimental plot area was kept moist throughout the growing season when necessary.The characteristics under investigation were weight of fruit, number fruit per area, weight of 100 seed, number seed per fruit and yield of fresh and dry seed. Plants after deletion of 50cm of head and endrows were sampled on full maturity and with several machines, properties were calculated. All data were subjected to ANOVA using the statistical computer package SAS_9 and treatment means separated using Duncan's multiple range test at $P \leq 0.05$ level. For drawing the picture,tables and graphes $Excel_{2003}$ software was used.

RESULTS

Weight of fruit per hectare

In this factor significant difference ($P \leq 0.01$) was observed among seeds were cultivated with different density. Density of 50*200Cm showed higher weight of fruit per area (Table 3). The results of analysis of variance indicated that there were significant differences between concentrations of Ethylene in this character that 100 ppm ethylene in this character is the best than others. 50*200 density-100 ppm ethylene combination produced the most weight of fruit per hectare (33333.33 kg/ha table 2-3).

Number fruit per area

There is significant difference ($P \leq 0.05$) in number fruit per area was observed among seeds were cultivated with different density. Seeds cultivated by 50*200Cm showed higher in number fruit than other treatments, and differences between interactions (density of cultivation* ethylene) was significant too (Tables 2-3). The results of analysis of variance indicated that there were high significant differences between ethylene treatments in this character. Results showed most of the number fruit per area (10333.33 per ha) was achieved in 50*200 cm-100ppm ethylene combination (Tables 2-3).

Fresh seed yield

Differences between various densities, concentrations of ethylene and combinations in this character were significant.100 ppm ethylene and in the other hand 50*200Cm density, were the best treatments. 4135.02 kg/ha was achieved in the 50*200Cm-100ethylene combination (Tables 2,4).

Dry seed yield

In this factor significant difference in weight of fruit per area was observed among seeds were cultivated with different density. The results of analysis of variance indicated that there were significant differences between concentrations of Ethylene in this character. Also in Duncan's multiple range test at $P \leq 0.05$ level, density of 50*200 Cm showed higher weight of fruit per area and 100 ppm ethylene in this character is the best too, therefore 50*200 density and 100 ppm ethylene combination produced the most dry seed yield (1560.36 kg/ha table 2,4).

Weight of 100 seed

Neither differences between various densities nor differences between concentrations of ethylene were significant, even by Duncan's multiple range test at $P \leq 0.05$ level, there were no separable divisions between combinations (Tables 2,5).

Number seed per fruit

In this character concentration of 100ppm ethylene in the various treatments of ethylene and density of 50*200cm in several densities were significant that the most of number seed per fruit (600.88) was achieved in 50*200Cm -100ppm Ethylene combination (Tables 2-3).

Table 1: Physical and chemical characteristics of the experimental farm soil

pH	O.C	E.C	Zn Available	Fe Available	Mn Available	Cu Available	K Available	P Available	Total Nitrogen	Texture	depth
8.33	0.79 %	0.47 ds/m	1.136 ppm	3.453 ppm	9.79 ppm	1.108 ppm	245 ppm	2.8 ppm	0.065 %	Loam	0-30 Cm

Table 2: Analysis of variance of weight of fruit, fresh seed yield, dry seed yield, number fruit, weight of 100seed and number seed per fruit in squash plants that affected by several densities and concentrations of ethylene

10	Degree of freedom	Weight of fruit (Kg/ha) mean of square	P<α	Fresh seed yeild (Kg/ha) mean of square	P<α	Dry seed yeild (Kg/ha) mean of square	P<α	Number fruit mean of square	P<α	Weight of 100 second mean of square	P<α	Number seed mean of square	P<α
Block	2	10769500.6	-	1659054.3	-	313820.204	-	14333333.3	-	2.267	-	25113.99	-
Ethylene	2	210845924.6	0.05	10151418.58	0.05	1898408.59	0.05	73444444.4	0.05	1.795	ns	208152.7	0.05
Error a	4	22884552.4	-	1409028.27	-	263783.955	-	8444444.4	-	1.335	-	13597.88	-
Density	2	216402758.5	0.001	2769209.19	0.01	126787.777	0.01	105444444.4	0.01	1.456	ns	83050.69	0.01
Density	4	7397344.3	ns	43552.67	ns	1689.28	ns	20555555.6	0.05	2.344	ns	10721.88	0.1
Error b	12	5869555	-	20695.78	-	3308.37	-	6018518.5	-	1.494	-	4665.68	-
Ethylene													
Coefficient Variation			9.26	6.61	6.19	15.12	5.18	25					

Correlation between characters

Evaluation of several characters showed significant effects between them that correlation between fruit weight in contrast of number seed in fruit, dry and fresh yield is positive and in the other hand between weight of fruit and number fruit is negative. Increase of number fruit, Redounded to increase of competition and therefore fruit weight decreased. Correlation between dry and fresh seed yield to number fruit is negative and between weight of 100 seed and number seed per fruit in contrast of number fruit is negative that by increase of number fruit, number seed per fruit and weight of 100 were decreased (Tables 6).

DISCUSSION

Fruit yield in squash can increase by concentrations of ethylene but correlation between this increase and more density, is negative. In this

Table 3: Weight of fruit and number fruit on squash that affected with several densities and concentrations of ethylene. Numbers in this table are mean of 3replication ± Sd

Ethylene	Weight of Fruit (kg/ha) Density			Mean	
treatment	50*100	50*150	50*200	Ethylene	
0 ppm	13838.33±2935.28	21063±4685.81	27010±6070.85	20637	B
50 ppm	24016.66±1701.77	27443.33±2501.92	32764.66±3279.35	28075	A
100 ppm	2583±1041.47	30000±1000	33333.33±1527.52	29722	A
Mean of density	21229 C	26169 B	31036 A	26144.67	
Ethylene	**Number Fruit (ha) Density**			**Mean**	
treatment	**50*100**	**50*150**	**50*200**	**Ethylene**	
0 ppm	21000±4358.89	22666.66±2886.75	14666.66±2081.66	14000	B
50 ppm	16333.33±3214.55	13000±1000	12666.66±2081.66	15222	B
100 ppm	20666.66±3055.05	14666.66±2081.66	10333.33±2516.61	19444	A
Mean of density	12556 C	16778 B	19333 A	16222	

Table 4: Weight of fresh seed and Dry seed on squash that affected with several densities and concentrations of ethylene. Numbers in this table are mean of 3replication ± Sd

Ethylene	Weight of fresh seed (kg/ha)			Mean of
treatment	50*100	50*150	50*200	Ethylene
0 ppm	919.46±56.09	1293.08±118.6	1853.23±149.93	1355.26 C
50 ppm	1374.99±89.03	1617.96±183.15	2380.46±411.4	1791.14 B
100 ppm	2847.49±1153.67	3138.18±1181.85	4135.02±1274.01	3373.57 A
Mean of density	1713.98 C	2016.41 B	2789.57 A	2173.32
Ethylene	**Weight of fresh seed (kg/ha)**			**Mean of**
treatment	**50*100**	**50*150**	**50*200**	**Ethylene**
0 ppm	437.85±26.7	587.76±53.91	699.33±56.58	574.98 C
50 ppm	654.73±42.4	735.43±83.24	898.26±55.23	762.81 B
100 ppm	1355.93±49.3	1426.43±37.21	1560.36±80.79	1447.58 A
Mean of density	816.17 C	916.54 B	1052.66 A	928.45

Table 5: Weight of 100 seed and number seed per fruit on squash that affected with several densities and concentrations of ethylene. Numbers in this table are mean of 3replication ± Sd

Ethylene treatment	Weight of 100 seed (gr) Density			Mean of
	50*100	50*150	50*200	Ethylene
0 ppm	23.66±0.11	23.01±0.07	23.15±0.35	23.277 A
50 ppm	23.23±0.32	23.53±0.05	23.23±0.28	23.33 A
100 ppm	23.36±0.32	23.2±0.17	25.66±3.66	24.07A
Mean of density	23.25 A	23.42 A	24.01 A	23.559
Ethylene treatment	**Number seed per fruit Density**			**Mean of**
	50*100	**50*150**	**50*200**	**Ethylene**
0 ppm	89.85±13.07	112.98±3.76	207.29±16.13	136.71 C
50 ppm	177.36±38.59	242.74±45.96	307.78±54.41	242.63 B
100 ppm	274.03±66.81	434.86±13.89	600.88±51.92	436.59 A
Mean of density	180.42 C	263.53 B	371.99 A	271.97

Table 6: Correlation between characters on squash that affected with several densities and concentrations of ethylene

	Weight of fruit	Weight of fresh seed	Weight of dry seed	Number fruit	Weight of 100 seed	Number seed per unit
Weight of fruit	1					
Weight of fresh seed	0.601**	1				
Weight of dry seed	0.52**	0.97**	1			
Number fruit	-0.69**	-0.39*	-0.27	1		
Weight of 100 seed	0.192	0.58**	0.502**	-0.27	1	
Number seed per fruit	0.672**	0.91**	0.86**	-0.64**	-0.5*	1

* Significant in α=5% and ** significant ant in α=1%

research in more characters by increase of density in 50*100Cm to 50*200Cm, number seed per fruit, dry and fresh seed yield and total yield increased and number fruit per area decreased. Squash is one of the indeterminate plants and in these plants if don't heading result that at the end of growth season, produced vegetative and reproductive organs and competition between these organs were appeared. This competition was ingenerated for water and mineral materials. In some investigations period of irrigation of squash was reported every 5day (Ahmed Ertek *et al.,* 2003). In this research for investigation the results for farmers and not input the other factor in the research, heading not conducted and permit the plants to maximum growth and development. Because by augment of density, interact specific competition was increase and therefore competition between plants was increase. Ethylene was used but for competition in dense of plants, yield is decreased.

Nerson (2005) in research that conducted on plant density and affects it on squash seed yield reported that by increase of number fruit per plant, Seed weight was decreased. There was near relationship between number fruit and seed yield.

The most seed yield and fruit yield made by 4plant per m^2. But in another research that prepared by Sant parkash (1995) in India, there was significant differences between interaction factors as the best density and date of planting were 90*60Cm and 10march respectively.

Reiners and Riggs (1999) to evaluate the effect of different density in squash in two places for determine the value of purchase, revealed that increase of plant number in2990 to 8960per hectare made the further number fruit and yield in places and varieties and yield was increased of 49ton/ha to 61.4 ton/ha. Increase rows distances of 1.8 to 3.6 meter made the significant effect of decrease of number fruit per area but no effect of yield components.

Naghdi *et al* (2004) in other research for determine the effect of distance of planting and time of harvesting on *Thymus vulgaris* L., reported that in 3 distance (15, 30,45Cm) and 3time (beginning of blooming, full blooming and fruit set), the most yield, fresh herbage (6.4ton/ha), oil yield (2.1% in dry herbage) made in distance of 15 Cm and beginning of blooming also maximum thymol content was observed in the beginning of blooming and 45 cm space. However, 15 cm spacing and harvesting in the beginning of blooming was the best treatment in respect of yield of dry matter, oil and thymol per unit area.

Ganjali *et al* (2007) in the evaluation of the effect of different time of planting (6, 20 March and 4 April) and several densities (5, 10 and 15 Kg/ha) on *Nigella sativa* L. reported that there were significant differences as the most yield of black cumin was made by 6march-15kg/ha. The effect of density on height is significant but time of planting on this character is not effective. Filippo D'Antuono *et al* (2001) in same research showed that essential oil composition was very stable in N. *damascena*, but markedly affected by sowing date in N. *sativa*. Oil yield of N. *sativa* decreased with delayed sowing. As a whole, the two species had positive agronomic traits, such as short growing cycle, low seed shattering and low susceptibility to diseases. This, together with different possible options for direct utilization or industrial processing, may determine an interest in further considering the two species as potential new multi-purpose crops.

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