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Response of some Egyptian sweet melon (*Cucumis melo* var. *Aegyptiacus* L.) cultivars to water stress conditions

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Abstract

Drought is a wide-spread problem, seriously influencing sweet melon (*Cucumis melo* var. *Aegyptiacus* L.) production and quality. Therefore, identification or development of tolerant genotypes is of immense importance for sweet melon production in drought prone areas. Two field experiments were conducted in clay loam soil at Baramoon Experimental Farm, Dakahlia Governorate, Egypt during the two summer seasons of 2008 and 2009, to evaluate five sweet melon cultivars (Shahd El-Dokki, Ananas El-Dokki, Ismaelawi, Kahera-6 Improved, Albasosi) under regular irrigation and stress conditions (drought conditions were imposed after first irrigation and created by reducing the frequency of irrigation by one half to that of irrigated crop, *i.e.*, missing alternate irrigation) using a split plot design with three replicates. Drought susceptibility index, relative yield reduction and relative yield values were used to describe yield stability and yield potential. Results indicated that exposure of sweet melon cultivars to water stress lead to significant decrease in fruit weight, fruit length, fruit width, fruit flesh thickness and total yield per plant. Whereas, water deficit caused significant increase in total soluble solids. The tested cultivars markedly varied among them in all estimated characters. The interaction between irrigation levels and cultivars had significant effects on all traits under study in both seasons. Cultivars with the highest yield and yield components under non-stress conditions had the highest yield and yield components under stress conditions. On the basis of the drought resistance indices, Kahera-6 Improved was relatively stress susceptible, whereas Albasosi was more tolerant and stable cultivar therefore detailed studies are warrented for validating its drought tolerance characterstic.

Key words: *Cucumis melo*, sweet melon, cultivars, water stress, drought resistance.

Introduction

Sweet melon (*Cucumis melo* var. *Aegyptiacus* L.) is considered as one of the most important vegetable crops grown in Egypt. Fruits are consumed in the summer season and are popular because the pulp of the fruit is very refreshing, highly nutritional and sweet with a pleasant aroma (Melo *et al*., 2000).

The shortage of water availability has become a worldwide problem; therefore, there has been an intense interest in studying plant water stress interactions in arid and semi-arid environments. In Egypt, under limited water supply conditions, the farmers tend to increase the irrigation interval, which creates water stress. Water stress is one of the most important factors affecting every aspect of plant growth. Many irrigation experiments have shown that melon is sensitive to water stress (Faberio *et al*., 2002; Sensoy *et al*., 2007). Fruit yield and its components were highly influenced by the total volume of irrigation water at different crop stages in a semi-arid climate (Faberio *et al*., 2002). Water deficit produces smaller fruits (Fabeiro *et al*., 2002; Long *et al.*, 2006) and lower yields (Cabello *et al.*, 2009; Dogan *et al.*, 2008; Kirnak *et al*., 2005; Sensoy *et al*., 2007; Zeng *et al.*, 2009).

Although considerable variation for drought resistance has been identified among muskmelon cultivars (El-Kassas and ElSebsey, 1998), very little work has been done to study the effects of water stress on sweet melon cultivars in Egypt. In future years breeding programs must consider and select from newly released varieties with improved water use efficiency. In this regard, screening for more drought tolerant sweet melon varieties, which are able to produce an acceptable yield under water stress, is an important component in melon breeding research programs. Thus, it is important to identify sweet melon genotypes with high yield potential and stability under drought stress.

This study was an attempt to measure some effects of moisture stress levels on five sweet melon cultivars and to screen them for yield potential and stability under water stress conditions to identify cultivars that can adapt to water deficit conditions.

Materials and methods

Two field experiments were performed during the two summer seasons of 2008 and 2009 at Baramoon Experimental Farm, Dakahlia Governorate, Egypt, where the soil is clay-loam. Five sweet melon cultivars (Shahd El-Dokki, Ananas El-Dokki, Ismaelawi, Kahera-6 Improved and Albasosi) were used for this study.

A split plot design with three replicates was used for experimental layout. The main plots were assigned to two irrigation levels (regular irrigation and stress conditions). Drought conditions were imposed after first irrigation and created by reducing the frequency of irrigation by one half to that of irrigated crop, *i.e.*, missing alternate irrigation. Sub plots were used for five sweet melon cultivars. Each experimental unit area was consisted of four ridges (5 m in length and 1.5 m in width) and plants were spaced 50 cm apart.

Seeds were sown on 7th and 6th April in both study seasons, respectively. Except irrigation, recomended cultural practices for sweet melon were followed.

At the harvesting time, a random sample of 12 plants was taken from each experimental unit and data were recorded for fruit weight (g), fruit length (cm), fruit width (cm), flesh fruit thickness (cm), total yield per plant (g) and total soluble solids (TSS). Total soluble solids were determined using a hand refractometer.

The data were statistically analyzed according to Snedecor and Cochran (1982). Comparisons among means of treatments were tested using LSD values at 5% level.

Evaluation of drought resistance: Based on average of two seasons, the results were used to evaluate the effect of drought stress. Drought resistance indices were defined by following formula:

Stress susceptibility index = (1-Ys/Yw)/D (Fisher and Maurer, 1978)
Relative yield reduction = 1-Ys/Yw (Hiller and Clark, 1971)

Where Ys is the mean of yield under drought, Yw is the mean of the same character under well-watered conditions, and D is the environmental stress intensity = 1-(mean yield of all varieties under drought/mean yield of all varieties under well-watered conditions). The relative yield under drought was calculated as the yield of a specific genotype under drought divided by that of the highest yielding genotype in the population.

Results and discussion

Effect of irrigation levels: Data illustrated in Table 1 reveals that the drought stress significantly decreased the fruit weight, fruit length, fruit width, flesh fruit thickness and total yield per plant in both the seasons. Under water deficit, low crop yield obtained may be due to infrequent application of water resulting in a lack of moisture in active crop root zone, inadequate moisture conservation, and poor nutrient utilization (Frank and Viets, 1967). Therefore, it was concluded that if irrigation water is available, the sweet melon plants must be irrigated regularly to obtain higher yield. Whereas, water deficit caused significant increase in total soluble solids in both seasons. This result may be attributed to the decrement in the water content of the plant which caused a remarkable increase in the cell sap concentration. TSS is an important parameter for drought. A similar effect of drought on TSS was also observed by Fabeiro *et al*. (2002), Long *et al*., (2006), Sensoy *et al.* (2007) and Zeng *et al.* (2009).

Effect of sweet melon cultivars: Table 2 reveals that sweet melon cultivars exhibited significant differences for all characters in both the seasons. Albasosi cultivar gave the highest fruit weight, fruit length, fruit width, flesh fruit thickness and total yield per plant, and had the lowest values of TSS than other cultivars in both seasons. While, Shahd El-Dokki cultivar gave the lowest values of fruit weight, fruit width, and total yield per plant in both seasons. The lowest values of fruit length and flesh fruit thickness were recorded in cv. Kahera-6 Improved, however, fruits of Kahera-6 Improved had the highest values of TSS. These findings were similar in both experimental seasons. Some investigators concluded that the genotypic variation between cultivars of Egyptians sweet melon might result in variation in yield and yield components (El-Dweneny 1978; El- Shimi and Ghoneim, 2006).

Table 1. Effect of irrigation levels on sweet melon yield and its components during summer 2008 and 2009 seasons

Irrigation levels	Fruit weight (g)	Fruit length (cm)	Fruit width (cm)	Flesh fruit thickness (cm)	TSS (%)	Total yield / plant (g)
2008 season						
Normal	2429	23.08	15.02	3.88	9.93	5779
Stress	1896	20.68	13.30	3.45	11.71	4170
LSD 5%	61	0.39	0.64	0.19	0.26	204
2009 season						
Normal	2304	22.02	14.13	3.67	9.50	5642
Stress	1809	20.15	12.99	3.20	11.44	4091
LSD 5%	172	1.38	0.15	0.10	1.23	47

Table 2. Effect of sweet melon cultivars on yield and its components during summer 2008 and 2009 seasons

Cultivars	Fruit weight (g)	Fruit length (cm)	Fruit width (cm)	Flesh fruit thickness (cm)	TSS (%)	Total yield / plant (g)
2008 season						
Shahd El-Dokki	1354	19.21	11.66	3.30	10.48	3280
Ananas El-Dokki	1540	17.11	13.32	3.37	11.48	3867
Ismaelawi	2292	27.50	12.91	3.45	9.95	5135
Kahera-6 Improved	1675	17.06	15.95	3.16	12.95	4292
Albasosi	3952	28.53	16.96	5.05	9.23	8298
LSD 5%	185	1.45	1.17	0.35	0.82	223
2009 season						
Shahd El-Dokki	1279	18.24	11.31	3.16	10.10	3219
Ananas El-Dokki	1435	16.46	12.77	3.26	11.32	3833
Ismaelawi	2167	26.53	12.40	3.32	9.58	5025
Kahera-6 Improved	1571	16.55	15.10	3.05	12.40	4203
Albasosi	3831	27.65	16.20	4.88	8.94	8054
LSD 5%	155	1.07	1.00	0.19	0.49	139

Effect of the interaction between irrigation levels and cultivars: The interaction between irrigation levels and cultivars had significant effects on all studied traits in both the seasons (Table 3). The results clearly show that for all sweet melon cultivars, the effect of drought stress resulted in reduction in all studied traits except TSS. Cv. Albasosi, watered regularly, gave the highest values for fruit weight, fruit length, fruit width, flesh fruit thickness and total yield per plant, but it gave lowest value for TSS in comparison with other treatments in both seasons (Table 3). While stressed plants of cv. Shahd El-Dokki exhibited reduction in fruit weight, fruit width, and total yield per plant in both seasons. Highest values of TSS was recorded in stressed plants of cv. Kahera-6 Improved. These results were in agreement with El-Kassas and ElSebsey (1998) on muskmelon.

Evaluation of drought resistance: Water stress induced yield decline is useful indicator for assessing drought resistance. Results in Table 4 implied that the highest yield reduction occurred for Kahera-6 Improved (29%). The lowest yield reduction was for Ananas El-Dokki (26 %).

The stress susceptibility index (SSI) appeared to be a suitable selection index to distinguish resistant cultivars. Genotypes with

Table 3. Effect of the interaction between irrigation levels and cultivars on sweet melon yield and its components during summer 2008 and 2009 seasons

Treatments		Fruit weight (g)	Fruit length (cm)	Fruit width (cm)	Flesh fruit thickness (cm)	TSS (%)	Total yield / plant (g)
Irrigation	Cultivars						
2008 season							
Normal	Shahd El-Dokki	1519	20.39	12.50	3.48	9.53	3813
	Ananas El-Dokki	1712	18.01	14.13	3.56	10.71	4485
	Ismaelawi	2587	28.87	13.66	3.68	9.15	5995
	Kahera-6 Improved	1875	18.04	16.87	3.31	12.01	5044
	Albasosi	4453	30.11	17.93	5.37	8.25	9558
Stress	Shahd El-Dokki	1189	18.03	10.82	3.12	11.43	2747
	Ananas El-Dokki	1368	16.20	12.51	3.19	12.24	3248
	Ismaelawi	1997	26.13	12.16	3.23	10.75	4274
	Kahera-6 Improved	1474	16.08	15.03	3.00	13.89	3540
	Albasosi	3450	26.95	15.98	4.72	10.22	7038
LSD 5%		68	2.06	1.66	0.50	1.16	316
2009 season							
Normal	Shahd El-Dokki	1404	19.11	11.78	3.25	9.22	3701
	Ananas El-Dokki	1572	16.95	13.21	3.36	10.19	4367
	Ismaelawi	2451	27.53	12.86	3.47	8.68	5849
	Kahera-6 Improved	1756	17.45	15.87	3.11	11.25	4907
	Albasosi	4337	29.07	16.93	5.14	8.14	9385
Stress	Shahd El-Dokki	1153	17.36	10.84	3.06	10.98	2737
	Ananas El-Dokki	1298	15.97	12.32	3.15	12.46	3298
	Ismaelawi	1883	25.54	11.95	3.17	10.48	4200
	Kahera-6 Improved	1386	15.66	14.34	2.98	13.56	3498
	Albasosi	3324	26.24	15.47	4.62	9.74	6723
LSD 5%		219	1.51	1.41	0.27	0.69	197

Table 4. Average yields of five sweet melon cultivars under normal (Yw) and stress (Ys) conditions, stress susceptibility index, Relative yield reduction and relative yield under water stress (RY_S)

Cultivars	Total yield / Plant (g)		Relative yield reduction	Stress susceptibility index	RY_S
	Yw	Ys			
Shahd El-Dokki	3757	2742	27	0.98	0.40
Ananas El-Dokki	4426	3273	26	0.95	0.47
Ismaelawi	5922	4237	28	1.03	0.61
Kahera-6 Improved	4976	3519	29	1.06	0.51
Albasosi	9472	6931	27	0.99	1.00
Mean	5711	4140	-	-	0.60

low SSI values (less than 1) can be considered to be drought resistant (Bruckner and Frohberg, 1987), because they exhibited smaller yield reductions under water stress compared with well-watered conditions than the mean of all genotypes.

The cultivars Kahera-6 Improved and Ismaelawi were relatively drought susceptible (SSI > 1), while the cultivars Shahd El-Dokki, Ananas El-Dokki and Albasosi were relatively drought resistant (SSI values < 1). However, the low SSI values may not necessarily give a good indication of drought resistance of a genotype. Low SSI values of a variety could be due to lack of yield production under well-watered conditions rather than an indication of its ability to tolerate water stress. Therefore, a stress tolerant genotype as defined by SSI, need necessarily not to have a high yield potential. Cultivar Albasosi was relatively high yielding under water stress (RY > mean RY), while Shahd El-Dokki, Ananas and El-Dokki were relatively low yielding (RY < mean RY).

It is concluded that Albasosi is a more tolerant variety among the studied varieties and could be further tested for other drought conferring characteristics. Kahera-6 Improved with the highest SSI and relative yield reduction with low relative yield under water stress condition was identified as sensitive cultivar.

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