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Original scientific article

FIRST EVALUATION OF MELON (*Cucumis melo*. L) LANDRACES UNDER HIGH TUNNEL CONDITION IN SISTAN

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In order to evaluate a number of agro-morphological characteristics in 10 melon population, an experiment based on randomized complete block design with three replications was carried out in two years (2017-2018) at high tunnel condition at Zahak Agriculture Research Station. The relationships among the related traits evaluated using by statistical methods. The combined analysis of variance revealed highly significant differences among landraces in evaluated traits. A highly and significant correlation was observed between fruit width and yield (0.81**). Mean comparison using Duncan's multiple rang test revealed that maximum yield belonged to landrace Zardeivanaki with 29160 kg/ha. Factor analysis was used for understanding the data structure and trait relations. The factor analysis showed that five factors explained 84% of the total variation among the traits. Therefore, the selection may be done according to the first component and it was helpful for a good breeding program for development of high yielding genotypes also landraces Dargazi, Zardeivanaki and Sabzsooski were placed very closely indicating that the responses of these landraces to be similar to high tunnel cultivation condition.
Keyword: landrace, melon, high tunnel, Sistan

INTRODUCTION

Due to its ability to provide a protected growing environment without the cost of fossil fuels, the high tunnel can provide several opportunities for the grower, there is growing interest in high tunnels for both organic and conventional production (CONNER *et al.*, 2009). Farmers grow a different of crops and rely on season extension technologies, such as high tunnels, row

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covers, and greenhouse-grown transplants, to supply customers' needs for fresh local produce during the year (SASSENRATH *et al*., 2010). Important tool like Plasticulture, including row covers and high tunnels as well as plastic mulch, could be effective for crop diversification and season extension as it enables farmers in sistan to create microclimates for cropping such as muskmelon (NAROUI RAD *et al*., 2018b). One of the strategies for increasing yields involves the use of plastic covers, which are designed to modify the environmental conditions in order to prolong the harvest period, increase early crops, increase yields, improve quality, reduce the mechanical damage caused by hail and/or strong rain, and reduce the incidence of phytopathogenic fungi, among others (JIANG *et al*., 2003). The open-field system is the predominant melon production method in Sistan (NAROUI RAD *et al*., 2017). High-tunnel system, which, when compared to greenhouses, is low-cost and provides a viable alternative due to its favorable technical/ economic optimization ratio (LAMONT, 2009). Consumer demand for fresh fruit as organic produce are increasing and markets for this healthy production are on the rise (ZEPEDA and DEAL, 2009). There are few studies on high tunnels farming and evaluated as organic production, high tunnel systems for production well known recently and this method is efficient and improve yield of vegetables than farm grown system (LAMONT *et al*., 2003). High tunnels play an important role to reduce direct exposure of sun and as a microclimate biotic and abiotic stresses better could be controlled, frequently, temperature changes will occur less, soil temperature increased and carbon dioxide levels also soil moisture have positive association with tunnel production (MARY and WSZELAKI, 2012; MILLNER *et al*., 2009). The objective of this study was to determine the impacts of high tunnel production for first time on melon genotypes and aimed to evaluate the yield and its relationship with the vegetative and reproductive components of melon established under high tunnel systems.

MATERIALS AND METHODS

Research was conducted during the growing seasons (December through May) of 2018 and 2019 at the Agriculture and Natural Resource Research Station of Zahak, located in Sistan and Baluchestan, southeast Iran, at 61°41′ S and 30°54′ E at 482 m above mean sea level, with a yearly rainfall of 59 mm. Average temperature is 23°C. Seeds of landraces received from vegetable research institute, Ten muskmelon genotypes (1- Jajoo2- Dargazi 3- Sabz Sooski 4- Jajadraisa 5- Zardzavareh 6- 482 7- Mohaligilan 8- Zardeivanaki 9- Sefidak 10- Tilmagasisabz) were selected for inclusion in the trial. The high tunnel treatment was located within one Quonset-style, tunnel structure was with a round roof with slightly shorter and curved sidewalls measuring 30 m long · 9 m wide, with 1.2-m-high sidewalls and a height of 4 meter the peak, Frame for high tunnel was galvanized steel. The tunnel was arranged in an east–west orientation and was covered by Polyvinyl chloride (PVC) used as a framing material for high tunnel. Sidewalls were 1.5 meter in height to maximize ventilation. During severe weather, the sidewalls were closed. A randomized complete block design was used with 3 replications and planting beds were covered with 0.025-mm-thick embossed black plastic mulch also irrigated using drip tape with 30-cm emitter spacing, characteristics of the irrigation water: pH was 7.20 and EC was 2.12 ds $m^{-}1$, seeds were spaced 0.5 m apart in the row with 2 m between rows and the ten plants per plot was the same for all genotypes. Melons grow in a well-drained, sandy loam soil. Melons plants are trained to a single stem and tied up a wire by pruning out the lateral shoots and wrapped the stems around the string, Insects normally pollinated the flowers. They support each other. Premium 20-20-20+TE, 100 % water soluble drip fertilizer was used as 100 – 150 g in 100 liters of water in two stages flowering and fruit setting. To determine yield, fruit were graded into marketable and then counted and weighed, total soluble solids measured with a handheld refractometer. The first three crown fruits to ripen in each plot were used for soluble solids testing. The data were analyzed by ANOVA and means comparison was done by Duncan's at $P \leq 0.05$. Data analysis was done using SAS version 9.2 (SAS Institute, Cary, NC). Seventeen traits were evaluated at the ripening of the fruits. They were selected to characterize yield and yield components. For autumn and winter, maximum average temperature was around 25°-27°and the average minimum temperature was around 15°-18°.

RESULTS AND DISCUSSION

Table1. Combined ANOVA for 10 landraces in two years

SOV	DF	Day to male flower appearance	Day to female flower appearance	Day to fruit setting	Day to maturity	Distance of fruit to main stem	Distance of fruit from the base	Fruit weight	Flesh diameter
Year	1	4.26	0.26	8.8	0.81	0.81	3.7	16733	0.08
Error	4	10.13	17.9	10.08	8.2	6.31	14.7	13193	0.08
Genotype	9	105.2**	92.1**	59.7**	143.7**	137.9**	351.4**	1543723**	1.46**
Genotype× Year	9	3	56.9	18.3	3.52	1.18	3.89	4597	0.023
Error	36	5.11	28.6	43.5	2.99	2.55	30.3	6293.4	0.23

**significant at 1% statistical level

Table 1. Continued

SOV	DF	Cavity diameter	TSS	Seed weight	Number of seed	Fruit length	Fruit width	Plant length	Number of fruit	Yield
Year	1	0.14	0.01	17.58	2829	0.45	0.66	0.81	0.003	1651700
Error	4	0.12	0.05	2.73	6962	6.05	0.58	1535.2	0.005	1433174
Genotype	9	6.05**	15.27**	431.9**	120503**	116.4**	11.55**	4533**	3.6**	29464985**
genotype× Year	9	0.03	0.07	9.1	457	0.35	0.09	52.4	2.05	60590
Error	36	0.55	0.4	6.12	6724	4.81	53.2	970.5	1.08	783531

**significant at 1% statistical level

Variability plays an important role in crop breeding. An insight into the magnitude of variability present in crop species is of utmost importance as it provides the basis for selection. The mean squares of 10 landraces of melon are presented in Table 1. The analysis of variance showed that the mean squares for the genotypes were highly significant ($P<0.01$) for all the traits. Similar results were obtained by some researchers (CONNER *et al.*, 2009*;* NAROUI RAD *et al*., 2018b; NAROUI RAD *et al.*, 2017). Effect of year and its interaction with genotypes were not significant.

According to (JONES and SINGH, 2000; NAROUI RAD *et al*., 2010; OLESEN *et al*., 2000) factors like weather and soils are important causes for crop yield variability but for this study due to invariable condition it couldn't be effective for making variation. Means were compared with Duncan's Multiple Range Test (Table 2). The genotype "sabz sooski and Zardeivanaki" had the highest average fruit weight.

Table 2. Means values and ranking order for different characters of the 10 landraces.

Landrace	Day to male flower appearance	Day to female flower appearance	Day to fruit setting	Day to maturity	Distance of fruit to main stem	Distance of fruit from the base	Fruit weight	Flesh diameter
Jajoo	64.8 D	72D	85.3E	111 C	20 ABC	35.6C	792EF	2.33D
Dargazi	72.3AB	77CD	87.3 CDE	119 B	21 AB	28.3 D	1537 B	2.86CD
Sabz Sooski	70.1B	77.5CD	86 DE	123 A	19 BC	38.6 BC	2121 A	4.1A
Jajadraisa	64.6 CD	77.5CD	86.9 CDE	110 C	21.5 A	37.17C	1418 C	3.05BC
Zardzavareh	71.8 B	79.6 BC	91.5 B	122 A	21.1AB	47.5 A	885 E	2.63 CD
482	66.6C	79.4BC	89.1BC	112 C	33.9 E	28.3D	761 F	76.2 CD
Mohaligilan	71.6 B	80.3 BC	81.89BC	119 B	20.8 AB	39 BC	1523 B	3.2 BC
Zardeivanaki	70 B	87.2B	88.5CD	119 B	18.3 CD	45.17AB	2187 A	3.56AB
Sefidak	74.6 A	89.6A	96 A	121 AB	17.1D	34.5 CD	1537 B	2.73CD
Tilmagasisabz	62.1 D	77.6 CD	86.6 CDE	121 AB	8.66E	51.5 A	1110 D	2.71CD

Means followed by the same letter (s) are not significantly different at 5 % level of probability

Table 2. Continued

Landrace	Cavity diameter	TSS	Seed weight	Number of seed	Fruit length	Fruit width	Plant length	Number of fruit	Yield
Jajoo	7.33B	6.17 DE	15.9E	421 EF	16.8 D	12 B	216 BC	2AB	10570G
Dargazi	8.9 A	10.3A	32.5 B	527 D	23.5A	13AB	230 ABC	2AB	20490C
Sabz Sooski	7B	6.6 CD	31.4B	640 BC	24.9A	13.1AB	214 C	1B	14140 F
Jajadraisa	8.4 A	6.3 CD	22.4 CD	528 D	18.5 CD	13.7AB	239 ABC	2AB	18910D
Zardzavareh	5.9 C	4.5F	21.3CD	524 DE	22.1 AB	9.8C	243 ABC	1B	5900H
482	7.16 B	5.5E	15.4 E	408 F	11.6 E	12.1B	170 D	3A	15230 E
Mohaligilan	8.95 A	7.8B	18.9 E	500 DEF	20.1BC	14.4A	257 AB	1B	10160 G
Zardeivanaki	8.7 A	6 DE	25.3 C	582 CD	22.4 AB	14.4 A	215 C	2AB	29160 A
Sefidak	8.4 A	7.8 B	40.3 A	884 A	20.08BC	13.7AB	268 A	1B	10240 G
Tilmagasisabz	7.5 B	7 C	34.3B	700 B	12.9E	12.1 B	220BC	3A	22190 B

Means followed by the same letter (s) are not significantly different at 5 % level of probability

Table 3. Phenotypic correlation coefficients of studied traits

	Day to male flower appearance	Day to female flower appearance	Day to fruit setting	Day to maturity	Distance of fruit to main stem	Distance of fruit from the base	Fruit weight	Flesh diameter	Cavity diameter	TSS	Seed weight	Number of seed	Fruit length	Fruit width	Plant length	Number of fruit	Yield
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	1																
2	.638*	1															
3	.679*	.915**	1														
4	.577	.329	.345	1													
5	.450	-.059	-.012	.032	1												
6	-.234	-.055	-.049	.474	-.115	1											
7	.431	.251	-.026	.444	.328	.094	1										
8	.267	-.002	-.210	.368	.191	.108	.874**	1									
9	.226	.273	.035	-.126	.221	-.315	.497	.197	1								
10	.331	.089	-.016	.182	.167	-.431	.324	.051	.722*	1							
11	.346	.467	.345	.626	-.113	.135	.468	.195	.247	.530	1						
12	.343	.689*	.551	.581	-.153	.261	.421	.167	.181	.275	.907**	1					
13	.700*	.124	.092	.533	.786**	.013	.697*	.561	.175	.276	.305	.191	1				
14	.189	.313	-.016	-.085	.164	-.223	.720*	.549	.865**	.470	.217	.263	.220	1			
15	.510	.464	.505	.371	.571	.199	.225	-.065	.345	.340	.417	.521	.464	.220	1		
16	-.736*	-.368	-.425	-.484	-.732*	-.049	-.394	-.320	.002	-.062	-.176	-.288	-.771**	-.112	-.711*	1	
17	-.290	-.120	-.387	-.058	-.267	.147	.73*	.65*	.71*	.211	.225	.068	-.042	.81**	-.350	.571	1

** Significant at 5% statistical level; ** Significant at 1% statistical level*

The minimum fruit weight was noted for the genotype 482 with 761gr. The highest TSS (10.3°Brix) recorded for Dargazi. LONG *et al*. (2004) revealed that number of fruits per plant affect TSS in melon. The highest yield were recorded for Zardeivanaki and Dargazi 29160 and 2490 kg/ha respectively. Moderate and high positive correlations were observed among all the 17 measured traits (Table 3). Knowledge of the interrelationship between yield and its component may assist the breeder to decide upon the intensity and direction of the selection pressure to be given on related traits for the simultaneous improvement of yield-contributing traits. NAROUI RAD (2018) reported that fruit diameter exhibited a strong positive correlation with yield per plant. The highest significant positive correlation was observed between time to female flower appearance and time to fruit setting (0.91**), showing that simultaneous selection for these characters would result in the early maturity fruits. Significant positive correlations were also seen between fruit width and yield (0.81**) as well as yield with flesh diameter (0.65*) and cavity diameter (0.71*). This proves that genotypes with high flesh and cavity diameter help to keep more yields. Moreover, significant negative correlations were found between traits, for example fruit length and the number of fruit (-0.71*). These findings are consistent with ZALAPA *et al*. (2008) who reported a positive and significant correlation between yield and fruit size. The diversity of and relationship between traits are essential information in crop improvement programs, and the success of plant-breeding programs relies heavily on the existence of genetic and phenotypic variability for particular traits (NAROUI RAD *et al*., 2018a).

Factor analysis revealed mainly five underlying factors for studied traits (Table 4 and Figure 1). Factor 1 explained 34.38% of the total variance and had maximum loadings on

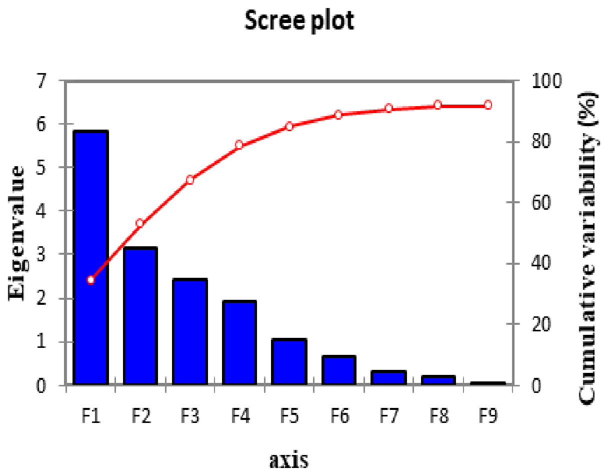

Fig 1. Scree plot diagram for studied traits of 10 landraces of melon

Table 4. Factor analysis for the estimated variables of melon landraces using the principal component procedure.

Trait	F1	F2	F3	F4	F5
Day to male flower	**0.789**	0.278	0.138	0.162	0.113
Day to female flower	**0.645**	0.313	-0.507	0.233	0.418
Day to fruit setting	0.525	**0.614**	-0.403	0.261	0.298
Day to Maturity	**0.630**	0.240	-0.115	-0.546	-0.187
Distance fruit to main stem	0.454	0.067	**0.756**	0.222	-0.120
Distance of fruit from the base	0.019	0.148	-0.098	**-0.595**	-0.045
Fruit weight	**0.738**	-0.548	0.136	-0.313	0.197
Flesh diameter	0.463	**-0.488**	0.278	-0.469	0.318
Cavity diameter	0.462	**-0.647**	-0.122	0.543	-0.031
TSS	0.469	-0.409	-0.127	0.414	**-0.520**
Seed weight	**0.665**	-0.066	-0.535	-0.231	-0.384
Number seed	**0.675**	0.112	-0.590	-0.213	-0.105
Fruit length	**0.750**	-0.027	0.562	-0.178	-0.100
Fruit width	0.500	**-0.689**	-0.059	0.274	0.275
Plant length	**0.681**	0.299	0.053	0.205	-0.226
Number of fruit	**-0.739**	-0.433	-0.499	0.002	-0.050
Yield	-0.016	**-0.780**	-0.274	-0.223	0.044

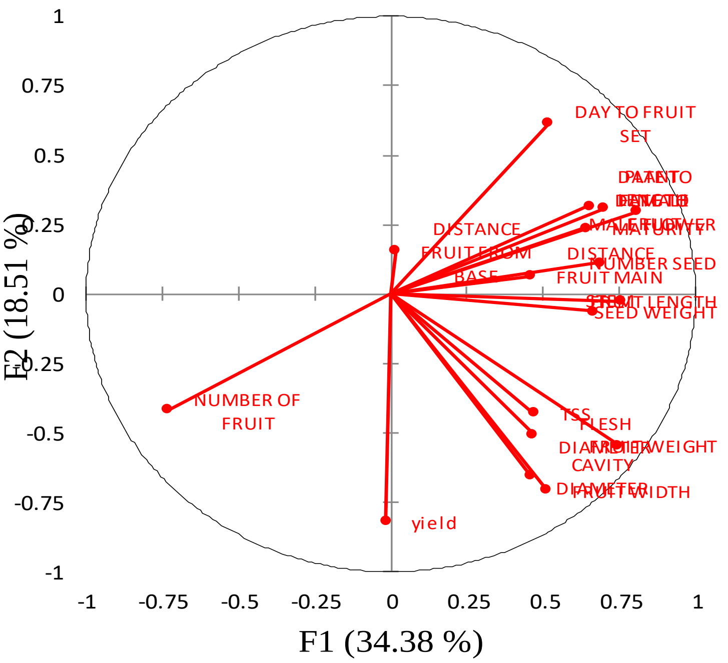

Fig 2. Factor analysis projections on axes 1 and 2

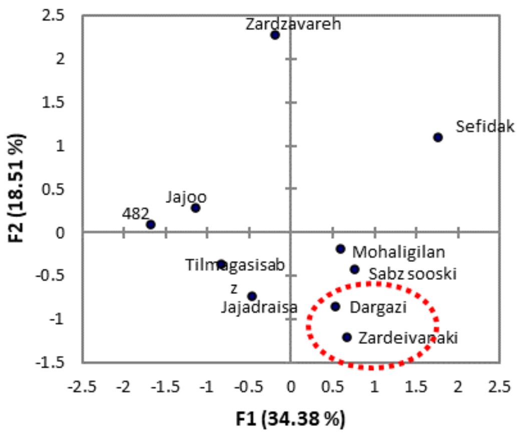

Fig 3. Factor analysis of 10 studied cultivars and landraces based of phenotypic traits

Factor analysis is one the most important multivariate analysis that show us how much the traits have main role in variation. NAROUI RAD *et al*. (2017) indicate factor analysis could help breeder to understand which components are effective in final fruit yield. Day to male flower appearance, day to female flower appearance, day to maturity, fruit weight, seed weight, number of seed, plant length and number of fruit. Factor 2 accounted for 18.5% of the total variance and had maximum loadings on day to fruit setting, flesh diameter, cavity diameter, fruit width and yield. 14.3% of the total variance was explained by factor 3 which had maximum loadings on distance of fruit from main stem, factor 4 explained 11.3% of the total variance and had maximum loading on distance of fruit from the earth surface and finally Factor 5 explained 6.12% of the total variance and had maximum loading on TSS. SARABI *et al*. (2016) by PCA analysis revealed variations among the traits and determined four main factors that explained 97.53% of the total variance. One interesting interpretation of the factor score plot (Figure 3) is that the Dargazi, Zardeivanaki and Sabzsooski landraces were placed very closely indicating that the responses of these landraces to be similar to somewhat, it can be concluded that the same climate and environmental conditions in this geographical area had similar effects on their reactions. NAROUI RAD *et al*. (2018a) reported through PCA of 14 morphological variables of the 36 melon accessions, 7 principal components were determined with 84.72% cumulative contribution and the two major principal components covered 14 characteristics and explained 40% of the results. TRIMECH *et al*. (2013) reported the PCA plot according to the two first components, accounting to 49.68 % of the total variation and second component was correlated to the fruit length. In a factor scatter plot, accessions located near each other are considered to have a similar contribution with respect to the different variables studied. Based on the factor analysis and biplots and scatter plot (Figure 2 and figure 3), genotypes sefidak, zardzavareh and 482 had the maximum variability for studied traits and can be used in breeding programs successfully.

CONCLUSION

In this experiment, results revealed that high tunnel cultivation is very suitable for arid region because of better utilizing, especially for water consumption, Dargazi and Zardeivanaki were the landraces by good performance as yield. Flesh diameter, cavity diameter and fruit width were the most important traits which have main role for high yield.

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PRVA EVALUACIJA POPULACIJA DINJE (*Cucumis melo*. L) GAJENIM U TUNELU U SISTANU

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Izvod

Da bi se procenio niz agromorfoloških karakteristika u populaciji od 10 dinja, u dve godine (2017-2018) u visokim tunelima na Poljoprivrednoj istraživačkoj stanici Zahak izveden je eksperiment zasnovan na randomiziranom kompletnom blok dizajnu sa tri ponavljanja. Odnosi između srodnih osobina procenjeni su statističkim metodama. Kombinovana analiza varijanse otkrila je izuzetno značajne razlike među lokalnim populacijama u procenjenim osobinama. Primećena je visoka i značajna korelacija između širine ploda i prinosa (0,81 **). Poređenje sredina primenom Duncan-ovog testa otkrilo je da je maksimalni prinos pripadao populaciji Zardeivanaki sa 29160 kg / ha. Za razumevanje strukture podataka i odnosa osobina korišćena je faktorska analiza. Faktorska analiza pokazala je da je pet faktora objasnilo 84% ukupnih varijacija među osobinama. Prema tome, selekcija se može izvršiti prema prvoj komponenti, što je bilo korisno za dobar program oplemenjivanja za razvoj visoko rodnih genotipova, populacije Dargazi, Zardeivanaki i Sabzsooski takođe su bile pozicionirane veoma blizu, što ukazuje na to da su odgovori ovih populacija slični uslovima gajenja u visokim tunelima.

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