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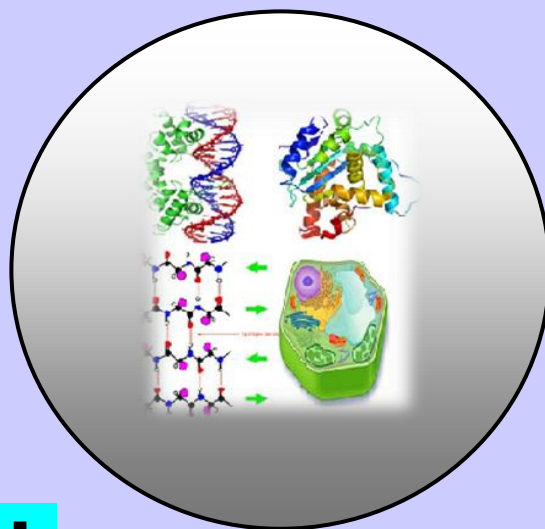
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Evaluation of Some Varieties of Sweet Pepper under Irrigated Field Condition of Uzbekistan

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ABSTRACT

*The growth potentials of some sweet pepper (*Capsicum annuum* L.) varieties grown in Uzbekistan have been evaluated with respect to their seed germination, plant height, the number of leaves, the number of stem, bush diameter, the time of the flower buds, fruit maturity, fruit length, fruit diameter, fruit yield per plant, total yield. The experimental trials were conducted in greenhouse and open field of the Institute of Plant Production, Uzbekistan. The results of full vegetation stage (from germination till harvest) showed that shorter period observed for genotypes 39822, 39823, 0038-9155-1, C05820, 0237-7011, and 0038-9155-1. The number of pepper chambers was similar in accessions PBC 762 sel, ISPN08-05, and check variety "Dar Tashkenta". In this study sweet pepper accessions showed differences in plant development, vegetation period and fruit yield. During selection process high yielded two varieties were selected namely 0437-7061 and ISPN 08-04. These varieties showed best performance in growing stages, fruit development and vegetation period and registered in Uzbekistan. These varieties are best adapted to local conditions and recommended for farmers for market production.*

Keywords: Sweet Pepper, Genotypes, Arid Land, Physiology and Yield.

INTRODUCTION

Sweet pepper (*Capsicum annuum* L.) is considered as important vegetable worldwide for human nutrition after tomato. It contains many mineral elements including ascorbic acid, phenols and vitamin C which are important for human health (Olufolaji and Makinde 2004; Balasundram et al. 2006). Sun-Hwa Ha et al. (2007) reported pigments identified in pepper fruits including lycopene, lutein, zeaxanthin, β -cryptoxanthin, violaxanthin, antheraxanthin and β -carotene, capsanthin, and cryptocapsin. It has been estimated that annual trade of sweet pepper is 17% worldwide (Singh et al. 2004). The variations on fruit type, shape,

colour and test were found among the available sweet pepper varieties (Ghasemnezhad et al. 2011; Savita and Mantri 2009). The abiotic stress factors affect sweet pepper growth and development, reducing yield and fruit quality (Navarro et al. 2003). Peppers require higher nutrients for normal growth and development, thus the application organic and mineral fertilizers increase their yield and water holding capacity (Maroto and Borrego 2008). However, the plant growth and development of pepper was affected by abiotic stresses such as salinity and drought cause yield reduction and In many coastal areas of the Mediterranean, vegetable crops. The selection and development new varieties are necessary to obtain high yielded and suitable parental line for local environmental conditions, considering climatic constraints (Thul et al. 2009). In recent years, the production of sweet pepper in Uzbekistan was also increased, and registered varieties consist of thirty one genotypes.. There is growing demand in Uzbekistan for developing local varieties which are adapted to local climatic conditions such as drought and salinity with high yield. Therefore, as an attempt to produce local good fruit quality and high yield sweet pepper varieties, this study was conducted to select suitable lines for Uzbekistan condition.

MATERIAL AND METHODS

A total of 24 sweet pepper (*Capsicum annuum* L.) genotypes namely Dar Tashkenta, PBC 142, PBC 271, PBC 762- sel, ISPN08-01, ISPN08-02, ISPN08-03, ISPN08-04, ISPN08-05, C01141, C01413, C01649, C05007, C05820, 0237-7011, 0237-7645, 0037-7645, 0038-9155-1, 0437-7031, 0537-7061, 0636-6018-2, 0736-6001, 39822, 39823 were acquired from World Vegetable Center was used in this experiment. Only "Dar Tashkent" variety developed locally was used as a check variety. The experimental trials were conducted in greenhouse and open field of the Institute of Plant Production, Uzbekistan during 2008 – 2015 years. The climate of the area is continental with an annual average rainfall of 200+36 mm and more than 90 percent of the total rain falling between October and May. The average minimum monthly air temperature is 0°C in January, the maximum of 37°C in July, and the soil temperature ranges between -2 to 35°C. The average highest relative humidity is slightly more than 70% in January and the minimum is less than 35% in June. The soil is calcareous serozem with 2.4% organic matter, N 0.1%, P 1.34%, K 7.1%. The pH is 7.8. The experiment was carried out in a randomized complete block design (RCBD) with four replications. The seedling were transplanted in the experimental plots on May in 14 m² plots at 70x30 cm spacing. Fertilizers and other cultivation practices were applied as per recommendation of the "Methodical Guidelines on the sweet pepper study, AVRDC, Taiwan" (2006). At harvest, six plants randomly selected from the plots of each replication, washed and analyzed for plant morphological characteristics. The measurements included seed germination, plant height, the number of leaves, the number of stem, bush diameter, the time of the flower buds, fruit maturity, fruit length, fruit diameter, fruit yield per plant, total yield.

RESULTS AND DISCUSSIONS

The results of our experiments showed that there were differences in the duration of the seedling growth stages among the cultivars. The seed germination of cultivars of ISPN08-01, C05820, 0038-9155-1, PBC 142, PBC 271, PBC 762- sel was earlier (18-19 days) compared to other varieties (Table 1).

The morphological characteristics are given in Table 1. The flowering stage was shorter for genotypes C05820, 0038-9155-1, 39823, and PBC 142 (58-61 days). The flowering stage of variety "Dar Tashkenta" was ranged from 75 to 78 days and was earlier for 2-8 days for accessions of 0037-7645, 0537-7061 and C05007. The ripening stage of genotypes 0537-7061, 0736-6001, C01141, PBC 762- sel, ISPN08-02, ISPN08-03, and 0437-7031 was around 130 -135 days. Vegetation period from mass germination to first fruit harvest in "Dar Tashkenta" variety was 90-101 days and it refers to mid ripening group. Genotypes with the period 86-88 days were belong to group of early ripening (PBC 271, 0537-7061 and 0736-6001) and the following genotypes were belong to group of mid ripening (0037-7645, ISPN08-04 and ISPN08-05).

Table 1. Mean performance for germination, flowering, ripening and full vegetation stage of 16 sweet pepper accessions.

Accession	Germination, days		Flowering, days		Fruitmaturity, days		Fullvegetatio, days
	10%	75%	10%	75%	10%	75%	
Dar Tashkenta	17	21	69	77	133	139	114
PBC 142	15	19	52	61	144	149	112
PBC 271	16	19	68	76	128	136	114
PBC 762-sel	16	19	70	78	129	135	118
ISPN08-01	15	18	70	78	135	142	116
ISPN08-02	18	23	70	77	130	135	118
ISPN08-03	16	20	69	76	130	135	119
ISPN08-04	17	24	71	78	135	141	121
ISPN08-05	18	24	71	78	134	139	122
C01141	18	24	71	78	124	130	127
C01413	18	22	70	78	142	148	119
C01649	20	25	66	82	145	154	127
C05007	18	22	59	67	125	139	125
C05820	14	18	50	58	119	132	110
0237-7011	16	20	70	77	143	148	109
0237-7645	16	20	65	73	130	137	119
0037-7645	16	21	65	73	130	137	116
0038-9155-1	16	19	52	59	118	132	106
0437-7031	18	23	69	76	130	135	125
0537-7061	16	20	63	71	123	130	119
0636-6018-2	18	22	65	73	134	141	113
0736-6001	16	20	64	72	125	133	118
39822	19	23	60	67	143	148	106
39823	17	21	55	60	145	150	109
Mean	16.8	22.6	36.8	72.9	132.3	139.2	118.5
LSD	0.85	1.02	1.87	2.11	2.73	3.46	1.68

There is also late ripening group, and following genotypes C01649 and C05007 are belong to that group. The results of full vegetation stage (from germination till harvest) showed that shorter period observed for genotypes 39822, 39823, 0038-9155-1, C05820, 0237-7011, and 0038-9155-1. Those observations are important when selecting varieties that adapted in local conditions such as semi-arid and higher temperature.

Table 2. The plant height, bush diameter, number of lateral stems and number of leaves of sweet pepper accessions.

Accession	Plant height		Bush diameter		Number of lateral branches		Number of leaves	
	cm	% to check	cm	% to check	St.	% to check	St.	% to check
Dar Tashkent check	43.1	100.0	18.1	100.0	2.8	100.0	113	100.0
PBC142	31.2	73.3	18.3	98.9	3.0	107.1	142	119.3
PBC271	37.1	87.2	22.6	122.2	3.0	107.1	138	116.0
PBC762 sel	32.8	77.1	23.5	127.0	3.3	117.9	129	108.4
ISPN08-01	39.3	92.4	23.0	124.3	3.3	117.9	135	113.4
ISPN08-02	41.3	97.1	22.8	123.2	3.5	125.0	129	108.4
ISPN08-03	42.5	99.9	22.5	121.6	3.5	125.0	126	105.9
ISPN08-04	45.3	106.5	23.5	127.0	3.6	128.6	144	121.0
ISPN08-05	37.2	87.4	23.5	127.0	3.6	128.6	133	111.8
C01141	39.3	92.4	18.7	101.1	3.8	135.7	129	108.4
C01413	44.3	107.4	19.3	106.0	2.8	100.0	125	100.8
C01649	36.5	88.5	19.2	105.5	3.0	107.1	125	100.8
C05007	41.7	101.1	23.1	126.9	3.0	107.1	128	103.2
C05820	30.1	73.0	18.4	101.1	2.9	103.6	132	106.5
0237-7011	40.0	97.0	23.4	128.6	3.0	107.1	119	96.0
0237-7645	47.7	105.9	17.3	95.1	3.3	117.9	109	87.9
0037-7645	27.1	65.7	17.5	96.2	3.3	117.9	109	87.9
0038-9155-1	23.6	57.2	14.6	80.2	2.8	100.0	102	82.3
0437-7031	39.8	96.5	21.5	118.1	3.3	117.9	132	106.5
0537-7061	30.0	71.9	18.5	106.9	3.6	128.6	123	100.0
0636-6018-2	43.3	103.8	17.9	103.5	3.0	107.1	114	92.7
0736-6001	38.1	91.4	20.1	116.2	2.7	96.4	111	90.2
39822	37.6	90.2	18.9	109.2	3.0	107.1	110	89.4
39823	38.6	92.6	19.4	112.1	3.0	107.1	100	81.3
Mean	38.1	-	20.1	-	3.15	-	123.3	-
LSD	1.18		1.48		0.07		8.35	

In Table 2 are documented the mean plant height and number of leaves of pepper accessions. The genotypes 0038-9155-5-1, 0537-7061, 0736-6001, C05820, PBC 271 and ISPN 08-05 were 4.3-5.6 cm high, whereas 0037-7645, 0237-70-11, C01141, C01649, C05007, PBC 142 accessions were around 6.0-6.6 cm high, and highest genotypes were (6.9 cm) "Dar Tashkenta", 0437-7031 and ISPN08-04 (Table 2).

Table 3. The fruit yield, fruit diameter, number of peppers chamber, and fruit wall thickness of sweet pepper accessions.

Accession	Fruit length		Fruit diameter		Number of chambers in the fruit	Thickness of fruit flesh, mm
	cm	%to check	cm	% to check		
Dar Tashkenta. check	8.6	100.0	4.95	100.0	3-4	4.6
PBC142	9.3	109.4	4.20	87.0	4	2.0
PBC 271	8.45	99.4	6.65	137.7	3	4.0
PBC 762 sel	10.9	128.2	5.70	118.0	3-4	3.5
ISPN08-01	9.8	115.3	5.10	105.6	3	4.5
ISPN08-02	15.4	18.2	4.30	89.0	3	4.5
ISPN08-03	13.4	157.6	5.30	109.7	3	4.8
ISPN08-04	10.0	117.6	5.15	106.6	2-3	5.0
ISPN08-05	9.4	110.6	5.95	123.2	3-4	4.0
C01141	8.0	94.1	7.15	148.0	3	3.5
C01413	10.9	126.7	5.20	102.0	3	3.0
C01649	7.0	81.4	4.90	96.1	4	3.0
C05007	9.7	112.8	4.90	96.1	3	2.0
C05820	6.1	70.9	4.90	96.1	4	3.0
0237-7011	10.9	126.7	4.75	93.1	4	2.0
0237-7645	7.2	83.7	5.50	107.8	2	2.5
0037-7645	8.4	97.7	5.50	107.8	2	2.0
0038-9155-1	9.0	104.7	4.20	82.4	3	2.0
0437-7031	8.9	103.5	4.95	97.1	3	4.0
0537-7061	8.4	96.6	4.55	87.5	3	3.0
0636-6018-2	14.7	169.0	4.70	90.4	2-3	3.0
0736-6001	6.8	78.2	5.60	107.7	3	6.0
39822	8.4	96.6	4.10	78.8	3	2.0
39823	8.7	100.0	4.20	80.8	3	3.0
Mean	9.5	-	6.82	-	3.1	3.46
LSD	0.34		0.12		0.07	0.45

Check variety Dar Tashkenta had 18,1 cm in the bush diameter and eight accessions PBC 762 sel, ISPN08-01, 0237-7011, C05007, ISPN08-03, ISPN08-04, ISPN08-05 и 0237-7011 had higher indicators then check variety. A correlation between plant height and diameter was positive and the average ($r = 0.61 \pm 0.22$).

The number of lateral stems was higher in accessions ISPN08-04, ISPN08-05, C01141 and 0537-7061 (128.6-135.7%). At the end of vegetation period, the higher number of leaves was observed in accessions PBC 142, PBC 271, ISPN08-01, ISPN08-04 and ISPN08-05 (111.8-121.0%). The correlation coefficient between the number of lateral branches and the number of leaves per plant was higher ($r = 0.85 \pm 0.15$).

Table 4. The number of fruits, weight and yield of pepper accessions.

Accession	Number of fruits		Fruit weight		Yield	
	St.	%to check	g/St	%to check	g/plant	%to check
Dar Tashkenta, check	6.35	100.0	79.8	100.0	500	100.0
PBC142	5.4	85.0	51.4	61.6	281	56.3
PBC271	7.95	125.2	66.0	79.1	410	82.2
PBC762 sel	5.5	86.6	57.0	68.3	399	80.0
ISPN08-01	5.4	85.0	108.1	129.6	585	117.2
ISPN08-02	5.6	88.2	94.8	113.7	536	107.4
ISPN08-03	7.7	121.3	89.3	107.1	687	137.7
ISPN08-04	7.0	110.2	79.4	95.2	710	142.3
ISPN08-05	5.4	85.0	114.7	137.5	627	125.7
C01141	6.0	94.5	90.3	108.3	526	105.4
C01413	6.8	106.3	113.8	139.2	769	150.2
C01649	8.2	128.1	94.9	116.2	772	150.8
C05007	6.6	103.1	58.9	72.1	395	77.1
C05820	6.2	96.9	55.0	67.3	341	66.6
0237-7011	6.85	107.0	73.8	90.3	524	102.3
0237-7645	5.5	85.9	77.5	94.9	444	86.7
0037-7645	6.1	95.3	75.4	92.3	460	89.8
0038-9155-1	6.8	106.3	53.8	65.9	366	71.5
0437-7031	6.75	105.5	96.9	118.6	638	124.6
0537-7061	7.0	110.2	77.8	94.1	552	109.7
0636-6018-2	6.4	100.8	108.1	130.7	649	129.0
0736-6001	5.8	91.3	80.3	97.1	502	99.8
39822	6.0	94.5	69.5	84.0	418	83.1
39823	6.3	99.2	66.8	80.8	421	83.7
Mean	6.4	-	80.5	-	520	-
LSD	0.31		2.79		67.4	

Table 3 show the fruit characteristics of pepper accessions including fruit length, diameter, fruit index, number of chambers in the fruit and the wall thickness of the fruit. The length of fruit of the sweet pepper check variety Dar Tashkenta ranged from 8.5 to 8.7 cm. The accessions PBC 762 sel, ISPN08-01, ISPN08-02, ISPN08-03, ISPN08-04, C01413, C05007, 0237-7011 and 0636-6001 had longer fruit compared to check variety (12-28%) whereas shorter fruit was observed in accessions C01649, C05820, 0237-7645 and 0736-6001.

Fruit diameter of check variety Dar Tashkenta ranged from 4.6 to 5.2 cm. Several accessions PBC 271, ISPN08-05, and C01141 had higher diameter (23 -48%) compared to check variety. However, the accessions PBC 142, ISPN08-02, 0038-9155-1, 0537-7061, 39822 and 39823 showed reduced diameter of fruits compared to check variety. Between the length and diameter of the fruit the correlation coefficient was positive ($r = 0.23 \pm 0.27$).

The number of pepper chambers was similar in accessions PBC 762 sel, ISPN08-05, and check variety "Dar Tashkenta". Thickness of fruit flesh in check variety ranged from 4.3 to 4.8 mm and similar observation recorded for accessions ISPN08-01, ISPN08-02, ISPN08-03, and 0437-7031. ISPN08-04 (5 mm) and 0736-6001 (6 mm) belong among varieties with thick fruit wall. The correlation was observed between the fruit diameter and the thickness of fruit flesh ($r = 0.46 \pm 0.25$). It has been reported that selection of pepper genotypes for their plant growth, yield and fruit quality depends on amount of positive heterosis (Hatem and Salem 2009; Khalil and Hatem 2014).

Table 4 shows differences of accessions in number of fruits and yield of pepper. The number of fruits per plant for check variety Dar Tashkenta was 6.3-6.4, whereas significantly higher fruits were observed in accessions PBC 271, ISPN08-03 and C01699. The fruit weight of accessions was also differ, being higher for lines ISPN08-02, C01649, ISPN08-01, ISPN08-05, C01413 and 0636-6018-2 (113.6-139.2%). The average weight of fruit of check variety Dar Tashkenta ranged between 76.1-82.7 g. There were correlation between the number of fruits per plant and weight of fruits ($r = 0.47 \pm 0.24$). The yield of pepper was shown in Table 4. The accessions ISPN08-01, ISPN08-05, 0437-7031, ISPN08-03, ISPN08-04, C01413 and C01649 showed high yield (17-50%) compared to check line "Dar Tashkenta". It has been also reported that the differences in fruit yield and plant development traits of the evaluated accessions are mainly due to the varying extent of genetic diversity between the parents of different crosses (Thul et al. 2009).

The large fruit cultivars of pepper are important for global market, including shape, quality of fruit. Such demand requires selecting cultivars which are adapted to local climatic conditions and adapted to various abiotic and biotic stresses (Crosby 2008).

CONCLUSION

Selection of improved pepper accessions that are adapted to local climatic conditions can often produce high yielding and better quality genotypes. In this study sweet pepper accessions showed differences in plant development, vegetation period and fruit yield. During selection process high yielded two varieties were selected namely 0437-7061 and ISPN 08-04. These varieties showed best performance in growing stages, fruit development and vegetation period and registered in Uzbekistan. These varieties are best adapted to local conditions and recommended for farmers for market production.

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