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IMPROVEMENT OF SOME ECONOMIC TRAITS OF SWEET PEPPER (EL-BALADY CV.) BY RECURRENT SELECTION

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ABSTRACT

Recurrent selection has been used as a breeding method to improve traits having low heritability such as earliness, fruit yield and fruit weight. The objective of this study was to measure the progress of two cycles of recurrent selection in increasing the productivity of sweet pepper (*Capsicum annuum* L.). To realize this objective, interest was also given for the estimation of the variability in the original population and the correlation coefficients among the studied characters.

Most studied characters especially plant height, number of branches / plant, early yield and total yield reflected high variability in the original population. The estimation of phenotypic correlation among the possible pairs of studied characters showed that significant or highly significant and positive correlation between early and total yield with number of fruits / plant, average fruit weight, fruit length, fruit diameter and fruit wall thickness. Total yield exhibited positive and highly significant correlation with early yield, number of fruits / plant and average fruit weight. Highly significant, but negative correlation between number of fruits / plant and average fruit weight. Highly significant positive correlation between average fruit weight, fruit length and fruit diameter.

After two successive cycles of recurrent selection, the improvement over the base population (Co) were 60.3, 67.5, 27.3 and 13.6% for total yield per plant, number of fruits per plant, average fruit weight and fruit diameter, respectively. Therefore, the successive cycles of the recurrent selection seem to have an obvious effect on improving such characters.

INTRODUCTION

Sweet pepper (*Capsicum annuum* L.) is one of the most popular vegetable crops grown in Egypt. In spite of introducing several new hybrids, substantial amount of sweet pepper in Egypt is currently still produced using a local highly heterogenous cultivar. Growers use this cultivar due to its adaptation to prevailing environmental conditions and it is also favourable for the local consumers, who use its fruits both as fresh vegetable and as pickle.

Because of the high percent of outcross, in pepper (George, 1985; Todorov and Csillery, 1990), this crop can be considered as a mixture of heterozygous genotypes originated in the past from intervarietal crosses occurred in the grower's farms, where they produce their own seeds without adequate isolation and no practising for plant roguing.

Differences between pepper landraces due to genotype, environment or genotype-environment interaction were also reported (Zewdie and Bosland, 2000).

Heritability estimates in narrow sense were low for early and total fruit weight, indicates that a major part of total phenotypic variances are due to dominance, or over dominance and the environmental factors affect on the inheritance of these characters (Ahmed and Hurra, 2000). Recurrent selection can be used to improve quantitative traits having low heritability,

permitting the accumulation of yield gains from each cycle of selection. Recurrent selection has been used in many vegetable crops to improve fruit yield (Cramer and Wehner, 1998).

The objective of this study was to measure the improvement of pepper plants (El-Balady cv.) after two successive cycles of recurrent selection.

MATERIALS AND METHODS

This work was carried out during four successive summer seasons from 2001 to 2004 at El-Baramon Horticulture Research Farm, Dakahlia Governorate.

The plant material:

The sweet pepper (*Capsicum annuum* L.), El-Balady cultivar used in these studies, is well known and successfully grown and cultivated in A.R.E., especially in El-Behira Governorate. The seed was collected from different farms and local seed retailers.

Estimation of variability and phenotypic correlation coefficients of some characters in original population:

The experiment was carried out during the season of 2001. Fifty-days from sowing the seeds in the nursery, the seedlings were transplanting in the field on April 15th 2001. The experimental area consists of 200 ridges, each ridge was 5 meters long and 70 cm wide, the spacing between plants was 50 cm apart and the agricultural practices were followed according to the general program of pepper cultivation . A population of 2000 plants was obtained to estimate the following parameters, i.e, range, mean, standard deviation, standard error and coefficient of variation as well as phenotypic correlation among characters. The following formula was used in calculating the phenotypic correlation coefficient (r) among all combinations of the studied characters:

$$r = \frac{M_{12}}{\sqrt{M_{11} \cdot M_{22}}}$$ Where

M_{12} = Covariance of the two variables 1 and 2.
M_{11} = Variance of the first variable.
M_{22} = Variance of the second variable.

The following measurements were determined on a number of individual plants (taken at random), plant height, number of branches per plant (after 90 days from transplanting), number of days to first open flower (earliness), early yield as weight of fruits per plant in the first three harvests, total yield per plant in all harvests. number of fruits per plant, average fruit weight, fruit length, fruit diameter and fruit wall thickness.

Recurrent selection program:

The simple recurrent selection program was carried out during the seasons of 2002, 2003 and 2004.

On April 20th, 2002 fifty-days from seed sowing, seedlings from the original collection (Co) were transplanted in the field. The initial population of cycle (1) consisted of 2150 plants were obtained as mentioned before. Sixty plants were visually selected on the basis of earliness, which was associated with high total yield and its components. These selected plants were selfed to produce selfed seeds (C_1). At the end of the growing season, the superior ten plants from the sixty plants were selected based on the early yield, total yield, fruit weight and number of fruits per plant. These selected ten plants were considered as the parental material for cycle (1).

On August 5th, 2002, the selfed seeds produced from each of the ten plants mentioned above, were sown separately in nursery. On September 20th, 2002, the seedlings were transplanted separately in the greenhouse as families. Each family was represented by at least one row, 70 cm wide and five m long and the spacing between plants were 30 cm. During the flowering stage, all possible intercrosses among the families were made by hand. All the seeds produced from these crosses were bulked and used for the production of a new population for the next cycle of selection and to measure the improvement of the previous selection cycle, compared with both the original population (Co) and the next cycle (C_2).

On February 20th, 2003, the stock of bulked seeds were sown in nursery and then transplanted into the field on April 10th, 2003, to produce cycle 2 population. The same method of selection, mentioned in cycle 1, was also practiced to end up with ten superior plants for high total fruit yield and its components. Seeds obtained from intercrossing the ten families were harvested and bulked as before.

During 2004, an experiment was carried out in order to estimate the obtained improvement from the previous cycles over the original population (Co). On February 30th, 2004, the seeds obtained from cycles 0, 1 and 2 were sown in seedling trays and then the seedlings were transplanted into the field on April 15th, 2004. A randomized complete block design with three replicates was used. Each replicate contained the three populations; cycles 0, 1 and 2. Each population was represented by three rows, per plot. The row was 70 cm wide, 5 m long and contained 15 plants. All cultural practices were performed exactly the same as were done in the previous experiments. The data were recorded from five random plants in each plot and the average was obtained except for earliness and yield. Earliness was measured as the average number of days from transplanting and up to opening of the first flower in all plants in the plot. Total yield per plant was recorded as the average total weight of all fruits harvested from all plants in the plot and divided by the number of the plants.

The statistical analysis of the recorded data was carried out using the usual method of the randomized complete block design. In the analysis of the data, population means for each character were calculated and compared, using the Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Estimation of variability in the original population:

The variability in each of the various studied characters in the original population of recurrent selection was studied and the data are presented in Table 1.

The mean value of plant height was 52.18 cm with a wide range from 32 to 85 cm. Variation in each plant height was noticed to be highly pronounced. The estimated values for the standard deviation, standard error and the coefficient of variation, appeared to be 16.92, 2.185 and 32.43%, respectively.

Table 1: Estimation of variability of the studied characters in the original population of El-Balady cultivar of sweet pepper

Characters	Range	Mean $\bar{x}$	Standard deviation S	Standard error SE	Coefficient of variation CV%
Plant height (cm)	32 - 85	52.18	16.92	2.185	32.43
No. of branches / plant	3 - 14	6.78	3.52	0.455	51.94
N. of days to first open flower (earliness)	32 – 47	38.33	3.80	0.493	9.96
early yield / plant (gm)	20 – 720	328.67	187.91	24.262	57.17
Total yield / plant (gm)	160 – 1165	698.43	237.75	30.696	34.10
No. of fruits / plant	13 – 63	30.60	11.27	1.455	36.80
Average fruit weight (gm)	11.4 – 34.0	23.16	4.50	0.581	19.44
Fruit length (cm)	4.9 – 10.5	8.37	1.36	0.176	16.24
Fruit diameter (cm)	3.3 – 5.2	4.11	0.41	0.053	10.01
Fruit wall thickness(cm)	0.2 – 0.5	0.302	0.075	0.009	24.83

Estimating the variability of the number of branches per plant. Data reflected high variability of this character. The range was noticed to be from 3 to 14 branches per plant with a mean value of 6.78 branches. The high variability was illustrated by the high estimated values for the standard deviation, standard error and coefficient of variability, their values were 3.52, 0.455 and 51.94%, respectively.

The earliness (number of days from transplanting to the opening of the first flower) ranging from 32 to 47 days, with a mean value of 38.33 days. The standard deviation, standard error and the coefficient of variation were estimated by the values 3.80, 0.493 and 9.96%, respectively.

Original population differed greatly in their earliness and gave early yield values ranging from 20 to 720 g/plant. The mean value was 328.67 g/plant. The high variability was illustrated by the high estimated values of S, SE and CV%. These estimated values were 187.91, 24.262 and 57.17%, respectively.

Total yield was recorded from the original population. These plants differed greatly in their productivity and gave total yield values ranging from 160 to 1165g. The mean value was 698.43 g/plant. The estimated values for the S, SE and CV% were found to be 237.75, 30.696 and 34.10%, respectively.

Number of fruits per plant in the original population ranging from 13 to 63, while the mean value was 30.60 fruits/plant. The values of the S, SE and CV% were 11.27, 1.455 and 36.80%, respectively.

Concerning fruit quality, data in Table 1 showed that average fruit weight ranging from 11.4 to 34g, fruit length ranging from 4.90 to 10.51 cm, fruit diameter ranging from 3.3 to 5.2 cm and fruit wall thickness ranging from 0.2 to 0.5 cm, while the mean values for average fruit weight, length, diameter and fruit wall thickness were 23.16g, 8.37 cm, 4.11 cm and 0.302 cm, respectively. Values of standard deviation were 4.50, 1.36, 0.41 and 0.075, values for standard error were 0.581, 0.176, 0.053 and 0.009 and values for CV% were 19.44, 16.24, 10.01 and 24.83% for the average fruit weight, length, diameter and fruit wall thickness, respectively.

Most studied characters especially plant height , number of branches / plant, early and total yield reflected high variability in the original population. The estimated values of the range and the standard deviation reflected also the continuous variability that seemed to be present for these traits.

Such a continuous variation may suggest that these characters were quantitatively inherited and recurrent selection program was so suitable to select plants having desire characters. A similar conclusion was reported by Abou-El-Fadl (1979), Venkata Rao and Chhonkar (1984) and Mohamed (2004).

The high variability mentioned in most of the studied characters might be related to the fact that the natural cross-pollination in pepper is relatively high, it was noticed to vary from 9.1 to 31 8% by Obland and Porter (1941). In addition to cross-pollination, most of these characters are suggested to be treated as being under polygenic control.

Phenotypic correlation among studied characters:

Phenotypic correlation (r), between 45 pairs of the 10 characters under investigation, were estimated The data are given in Table 2, showed that highly significant and positive correlation between plant height and number of branches per plant (r = 0.666) and fruit diameter (r = + 0.362). Significant and positive correlation between number of branches per plant and fruit wall thickness (r = + 0.224) was noticed Highly significant and positive correlation between early flowering and early yield (r = + 0.277) and fruit wall thickness (r = + 0.223). Significant or highly significant and positive correlation between early and total yield (r = +0.679), number of fruits per plant (r = + 0.458), average fruit weight (r = + 0.324), fruit length (r = + 0.223), fruit diameter (r = + 0.230) and fruit wall thickness (r = + 0 364).

In the present study, total yield exhibited positive and highly significant correlation with early yield (r = 0.679), number of fruits per plant (r = + 0.849) and average fruit weight (r = + 0.253), suggesting that these characters are the most important yield components and that effective was important in total fruit yield which it could be achieved through selection based on these component characters. Thus, improvement aimed at any one of these characters (early yield, number of fruits per plant and average fruit weight) will automatically lead to improvement in the total yield.

Highly significant but negative correlation between number of fruits per plant and average fruit weight (r = - 0.241) as shown in Table 2. Highly significant positive correlation between average fruit weight and fruit length (r = + 0.265) and fruit diameter (r = + 0.284) are shown in Table 2. Data also showed that, significant and highly significant with positive correlation between Fruit wall thickness and fruit length (r = + 0.422) and fruit diameter (r = + 0.207), respectively. These results are in agreement with that reported by Ahmed *et al.* (1997), Ahmed and Hurra (2000), Mamedov and Pyshnaja (2001) and Leaya and Abdul Khader (2002), who found similar association in pepper plants.

Efficiency of the simple recurrent selection program:

Data presented in Table 3 show that the differences between the plants resulted after two cycles of recurrent selection (C_2) and original population plants (Co) were not statistically significant for plant height, number of branches per plant, number of days to flowering, early yield per plant, fruit length and fruit wall thickness. Therefore, two successive cycles of recurrent selection were not enough for inducing the improvement in such characters.

The effect of two cycles of recurrent selection on the other character; i.e., total yield per plant, number of fruits per plant, average fruit weight and fruit diameter are shown in Table 3. These data illustrated the efficiency of the successive cycles of recurrent selection in improving the individual plant performance. The first cycle of recurrent selection was able to raise the productivity of the individual plants by 47.8, 65.0, 2.1 and 5.5% for total yield / plant, number of fruits / plant, average fruit weight and fruit diameter over the base population (Co), respectively.

However, after the second cycle of recurrent selection, the improvement over the base population (Co) were 60.3, 67.5, 27.3 and 13.6% for total yield / plant, number of fruits per plant, average fruit weight and fruit diameter. Therefore, the successive cycles of the recurrent selection seem to have an obvious effect on improving such characters.

Table 2. Phenotypic correlations among the studied characters in El-Balady cultivar of sweet pepper in 2001 season.

Characters	No. of branches / plant	No. of days to first open flower	Early yield / plant (g)	Total yield / plant (g)	No. of fruits / plant	Average fruit Weight (g)	Fruit Length (cm)	Fruit diameter (cm)	Fruit wall thickness (mm)
Plant height	0.666**	0.119	0.062	- 0.11	- 0.081	0.004	0.001	0.362**	0.006
No. of branches / plant		0.141	0.143	- 0.001	- 0.056	0.111	0.131	0.130	0.224*
No. of days to first open flower			0.277**	0.104	0.079	0.075	0.076	0.123	0.223**
Early yield / plant				0.679**	0.458**	0.324**	0.223*	0.230*	0.364**
Total yield / plant					0.849**	0.253**	0.070	0.098	0.064
No. of fruits / plant						- 0.241	- 0.025	- 0.016	- 0.019
Average fruit weight							0.265**	0.284**	0.161
Fruit length								0.013	0.422**
Fruit diameter									0.207*
Fruit wall thickness									

* significant at 5% level. ** Significant at 1% level.

Table 3. The effectiveness of the successive cycles of selection program on each of the various studied characters.

Recurrent selection cycles	Plant height (cm)		No. of branches / plant		No. of Days to flowering		Early yield / plant (g)		Total yield / plant (g)		No. of fruits / plant		Average fruit weight (g)		Average fruit length (cm)		Average fruit diameter (cm)		Fruit wall thickness. (mm)	
	$\bar{x}$	% of Co	$\bar{x}$	% of Co	$\bar{x}$	% of Co	$\bar{x}$	% of Co	$\bar{x}$	% of Co	$\bar{x}$	% of Co	$\bar{x}$	% of Co	$\bar{x}$	% of Co	$\bar{x}$	% of Co	$\bar{x}$	% of Co
Co	55 0 b	100	7 0 a	100	40.0 a	100	345 a	100	968 b	100	40.9 b	100	23.8 b	100	8.6 a	100	3.7 b	100	3.3 a	100
C_1	53.2 b	96.7	5.9 a	84.3	38.7 a	96.8	263 b	76.2	1431 b	147.8	67.5 a	165.0	24.3 b	102.1	6.9 b	80.2	3.9 b	105.4	2.6 a	78.8
C_2	60 2 a	109.5	6.7 a	95 7	38.4 a	96.0	353 a	102.3	1552 a	160.3	68.5 a	167.5	30.3 a	127.3	8.2 ab	95.3	4.2 a	113.5	2.9 a	87.8

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تحسين بعض الصفات الإقتصادية للفلفل الحلو (البلدى) بالإنتخاب المتكرر

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أجريب هذه الدراسة بهدف معرفة كفاءة الإنتخاب المتكرر البسيط فى تحسين بعض الصفات الإقتصادية للفلفل الحلو (الصنف البلدى) ولقد وجه الإهتمام لذلك لتقدير كمية الإختلافات الموجودة فعلا داخل هذا الصنف بالنسبة لبعض الصفات الهامة ، وقد قدرت أيضا قيم معامل الإرتباط بين أزواج هذه الصفات وذلك للإعتماد عليها فى تسهيل عملية الإنتخاب بالحقل على أساس الصفات المورفولوجية ، وبعد إجراء الإنتخاب لدورتين قيست التحسينات التى أمكن الوصول إليها فى الصفات المدروسة وذلك بالمقارنة بالعشيرة الأصلية ، ولقد تم ذلك من خلال تصميم تجربة قطاعات كاملة العشوائية ، ولقد إستغرقت هذه الدراسة أربعة سنوات من ٢٠٠١ – ٢٠٠٤ م وأجريت بمزرعة البرامون بالمنصورة.

وكانت أهم النتائج المتحصل عليها:-

- معظم الصفات المدروسة وخاصة طول النبات – المحصول المبكر – المحصول الكلى – أظهرت درجة عالية من الإختلافات فى المجتمع الأصلى.
- أظهر تقدير قيم معامل الإرتباط بين أزواج الصفات المدروسة الاتى:-

١- إرتباط موجب معنوى أو عالى المعنوية بين المحصول المبكر وكل من المحصول الكلى / النبات – عدد الثمار / النبات – متوسط وزن الثمرة – طول الثمرة – قطر الثمرة – سمك جدار الثمرة .

٢- إرتباط موجب عالى المعنوية بين المحصول الكلى / نبات وكل من المحصول المبكر / نبات – عدد الثمار / النبات – متوسط وزن الثمرة.

٣- إرتباط سالب عالى المعنوية بين عدد الثمار / النبات ومتوسط وزن الثمرة.

٤- إرتباط موجب عالى المعنوية بين متوسط وزن الثمرة وكل من طول الثمرة – قطر الثمرة.

بعد دورتين من الإنتخاب أظهرت تجربة تقييم مدى التحسينات التى أمكن الحصول عليها الاتى:-

١- بلغت نسبة التحسين فى المحصول الكلى للنبات ٦٠,٣% بالنسبة للعشيرة الأصلية.

٢- نسبة التحسين فى عدد الثمار / النبات بالنسبة للعشيرة الأصلية بلغت ٦٧,٥%.

٣- بلغت الزيادة فى متوسط وزن الثمرة ٢٧,٣% وقطر الثمرة ١٣,٦% بالنسبة للعشيرة الأصلية.

٤- كان تأثير دورتى الإنتخاب طفيفا وغير معنوى بالنسبة لباقى الصفات المدروسة.

نستنتج من هذه الدراسة أن الإنتخاب المتكرر البسيط لدورتين كان ذا فاعلية فى زيادة المحصول الكلى للنبات – عدد الثمار / النبات – متوسط وزن الثمرة – قطر الثمرة. ولهذا فالدورات المتتالية من الإنتخاب المتكرر لها تاثير ملحوظ على تحسين هذه الصفات.