CLONAL SELECTION FOR IMPROVING SOME IMPORTANT CHARACTERS OF SWEET POTATO (*Ipomoea batatas* (L), Lam)

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ABSTRACT

The present investigation was carried out in two consecutive summer seasons of 2005 and 2006, in order to determine the magnitude of variability among the different studied agronomic traits of sweet potato "Abies" cultivar viz. vine length, number of branches plant^{-1}, number of roots plant^{-1}, roots weight plant^{-1}, root fresh weight, root dry matter and root dimensions (root length and root diameter), some chemical compositions of roots such as total sugars, starch, carbohydrates and carotene. Moreover, study the efficiency of the used clonal selection program for improving sweet potato "Abies" cultivar was conducted.

The obtained results reflected that the estimated coefficient of variation (C.V. %) values for the agronomic characters of the original population showed enough variability for the purposes of selection and improvement. Generally, the results indicated that the original population (O.P.) was characterized with a high variability for most of considered traits. The estimated (C.V. %) values were ranged from 14.94% (for roots starch content) up to 56.89% (for weight of roots plant^{-1}). The remarkable variation revealed, by most investigated characters, that the original population can support the high possibilities of conducting successful and efficient selections to introduce new clones, with better general performances than their original population. The results illustrated, generally, that the estimated values of the ranges and coefficients of variation for the different studied characters; vegetative growth, roots yield and its components; showed narrower and lower variability magnitudes after using the clonal selection technique. Such achieved improvements may be related to, relatively, high amount of variability in the original population. Accordingly, most of the variability, detected among the (O.P.) individuals could be related to genetic variability. Also, the results reflected, generally, that using clonal selection method increased, significantly, the chemical contents of each total sugars, starch, carbohydrates and carotene contents in most selected clones compared with the (O.P.). Since, the general performances of all tested clones were varied, indicating the presence of genotypic differences among the evaluated clones. Among the selected clones of sweet potato, the clones (clone-9) and (clone-10) produced superior values for the studied characters than those of the other clones and their original population.

Key words: *Agronomic traits, clonal selection, root quality, sweet potato, variability.*

INTRODUCTION

Sweet potato [(*Ipomoea batatas* (L), Lam, 2n= 6x= 90); Ozias-Akins and Jarret (1994)] is the seventh most important food crop in the world, particularly, in many of the developing countries. Asia and Africa countries account for 95% of the world's sweet potato production. Since; it considered as a major source of food for its containing carbohydrates, starch, protein, vitamins A and C, β-carotene and some essential minerals (Woolfe, 1992; Morrison *et al.* 1993; Onwueme and Charles, 1994; Tseng *et al.* 2002 and Katayama *et al.* 2006). In addition, sweet potato roots and vines can be processed into animal feed ingredients. Furthermore, roots can be used as industrial raw materials such as starch, which transformed into sugar, alcohol and acid. In the recent years, it was noticed that the average production per faddan of sweet potato in Egypt is low (Division of Vegetables and Fruits Statistics, General Administration of Agric. Econo. and Stati.; Min. Agric., Egypt). However, this could be due to using old local varieties of sweet potato, which have a relatively low productivity level, and deterioration of its production and roots quality. Also, the great magnitude of variability presented among the individual plants of any commercially grown population. Therefore, it is vital to start via using an effective breeding program for improving sweet potato. So, the clonal selection method is suitable for this purpose, since it is well know that sweet potato is one of the most important crop belong to asexual group that are usually propagated by the usage of two vegetative organs; i.e., vine cuttings and rooted sprouts "slips". Accordingly, using clonal selection, superior clones may be isolated from the mixed population of asexually propagated species. Selection in such mixed population is based on the phenotype of the individual plants. The genotype of the superior clone is then maintained through asexual propagation.

Regarding the estimated values of variability, several investigators estimated the magnitude of variability among sweet potato genotypes for some economic and important agronomic traits (e.g. Jones 1969; Jones *et al.* 1969; Thamburaj and Muthukrishnan 1978; Zheng *et al.* 1985; Chen. *et al.* 1989; Alam *et al.* 1998; Anshebo *et al.* 2004 and Tsegaye *et al.* 2006 and 2007). Their results revealed considerable variability among the genotypes for the traits under consideration. This in turn is more useful for exploitation in selection programs leading to the identification of superior genotypes. Hence, selection for desirable traits based on the highly variable characters would be effective in sweet potato improvement programs.

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Several investigators studied the effects of clonal selection method on some important asexual vegetable crops, such as potato (Brown and Caligari, 1986; Holm, 1988 and Siddique, 1991), garlic (Egorlykskii, 1986; Galaeva, 1991; Gvozdanovic *et al.* 1994 and Sakr, 1996), and artichoke (Habib, 2001). Since, their results indicated, generally, that using clonal selection in improving the studied characters of these crops was an effective technique or improvement method. Accordingly, evaluation programs of the selected– and developed– new clones in comparison with different genotypes became an important way in identifying and selecting new superior genotypes, which have good general performances. So, evaluation studies of the developed new sweet potato clones and/or cultivars were realized by several workers like Tawfik, 1974; Huett, 1976; Thamburaj and Muthukrishnan, 1978; Watley and Phills, 1978; Nassar *et al.*, 1982; Bourke, 1984; Lee *et al.*, 1985; Liao *et al.*, 1985; Sen *et al.*, 1988; Nagi *et al.*, 1992; Shalaby *et al.*, 1993-a; Babu, 1994; Saleh, 1997; Omran *et al.*, 2002-a; Wanas, 2002; Anshebo *et al.*, 2004; Katayama *et al.*, 2006. These evaluation work recorded significant differences among the selected clones or genotypes of sweet potato in their studied characters.

Therefore, this study was undertaken to estimate and determine the magnitude of variability for different agronomic traits of sweet potato, which help the breeder in improving such crop. Moreover, the clonal selection breeding program was used to select some clones of the commercial population of local sweet potato "Abies" cultivar in addition to compare and evaluate the selected clones to determine the best ones in growth, yield and quality characters.

MATERIALS AND METHODS

The experiments of the current study were carried out through two successive summer seasons of 2005 and 2006 at the Experimental Station Farm, at Abies region, the Faculty of Agricaulture, Alexandria University, Alexandria Governorate, A.R.E.

Original genetic material

The original genetic material used in this investigation was the common commercial "Abies" cultivar, which considered as the most and widely cultivar grown in Alexandria and other Governorates in Egypt. Clonal selection method of breeding was practiced on this cultivar in the present study, due to this method is well known has a high efficiency for improving asexually propagated crop, through the isolation of clones with better characteristics than the original used population. The successive steps of the used program were as follows:

Growing of the original population

The breeding program started with commercial population consisting of about 4500 stem cuttings of sweet potato "Abies" cultivar. Stem cuttings, 25-35 cm long were taken from the apical growth of mature plants. Then, they were prepared by removing the bottom leaves and transplanted on one side of the row on April 17th, 2005. The experimental area included 240 rows, 5 m long and 70 cm wide, and the spacing between plants within rows was 25 cm. The cultural practices; such as fertilization, irrigation and pests control were performed as usually recommended for sweet potato's commercial production whenever they appeared necessary.

Data recorded and variability estimates

Studied characters were measured on the basis of individual plants. The time to record data on two vegetative growth characters; i.e., vine length and number of branches plant^{-1}; was at about 90 days from transplanting when the plants were totally grown. At the harvesting stage (tuberous or storage roots formation) after about 135 days from transplanting, storage roots were, carefully, dug up of each hill, collected by hand and attention was paid to obtain whole tuberous roots as complete as possible. Then, the following data were recorded; number of roots plant^{-1}; roots weight plant^{-1} (kg); root fresh weight (g); root diameter (cm) and root length (cm). Directly after harvesting, three storage roots samples from each plant were randomly bulked, washed, cut into small and thin slices, then, 30 grams roots sample from each plant, were dried in a forced air oven at 70^{0}C for three days, till a constant weight was accomplished, then the samples reweighed to estimate the percentage of root dry matter content. Sub–samples of three hundred dried roots were taken, ground into fine powder with a grinder to determine tuberous roots quality, represented by roots chemical constituents; *viz.* total sugar, starch, carotene and carbohydrates contents. These different chemical compositions were determined and analyzed as follows; total sugars content using the procedure of Association of Official Analytical Chemists (A.O.A.C., 1980); starch content as described by Malik and Singh (1980); carotene content according to Davies (1976) and carbohydrates were estimated by the summation of both total sugars and starch contents.

The mentioned characters were used to calculate the statistical parameters; mean ($\bar{x}$), range (R), and coefficient of variation (C.V. %) for each character.

Initial selection and first clones generation production

At the beginning of the storage roots formation, the best 200 plants from the growing original population were primarily selected on the basis of the general performances of their visual vegetative growth characters. At harvest stage, after tuberous roots formation, a second selection, according to the previously mentioned characters of the roots yield and its components, was conducted within the initially selected plants for further investigation. The number of second selected plants came out to be only 70. In such stage, the stem cuttings of each selected plants (clones) as well as samples of original population were cut, prepared and, separately, transplanted in the nursery on September 10, 2005, for the next season to evaluate these genotypes. A third and more severe selection; on the basis of roots quality characteristics; i.e., chemical compositions as expressed by total sugars, starch, carbohydrates and carotene contents, was conducted within the second selected plants. Accordingly, number of finally selected clones came out to be, only, sixteen plants.

The selection criteria used in this study were based on the ranges of the following desirable characters; a long vine length (from 135–200 cm); a more number of branches (from 12 -19); a medium root's diameter (from 5-8 cm); a medium root's length (from 12-20 cm); high number of roots plant^{-1} (from 6-12); a medium root's weight (from 175-250 g); a high dry matter content (from 23-32%); a medium roots weight plant^{-1} (from 1.200-2.500 kg); as well as high contents of the chemical compositions of roots; namely, carotene (0.381–0.520 mg.g.$^{-1}$d.w.), total sugars (170.00 – 220.00 mg.g.$^{-1}$d.w.); starch (230.00-270.00 mg.g.$^{-1}$d.w.) and carbohydrates (420.00- 500.00 mg.g.$^{-1}$d.w.).

Evaluation of the derived clones

On the basis of the general performances of the final selected entries in all studied vegetative growth, yield and its components, and roots quality characters; the best sixteen selected clones, in addition to representative samples of the original sweet potato population of "Abies" cultivar, were evaluated in summer season of 2006.

Good stem cuttings of each clone and original population were transplanted on April 14th , 2006, using a randomized complete blocks design with three replicates. Each plot consisted of four rows, 4 m long and 70 cm wide. The planting was done on one side of the rows at 25 cm spacing. All recommended cultural practices for commercial sweet potato production were followed.

Statistical analyses

All collected data of the previously mentioned characters were recorded, statically analyzed according to the used design and as illustrated by Al-Rawi and Khalf-Allah, (1980), using Co-Stat Software (2004), computer program for statistics. The differences among the various means were tested, using Duncan's multiple range test (L.S.R.). Also, the statistical parameters; i.e., mean ($\bar{X}$), range (R) and coefficient of variation (C.V. %) for each studied character were calculated.

RESULTS AND DISCUSSION

Variability estimates in original population

The results of the estimated values for the statistical parameters; means ($\bar{X}$), ranges and coefficients of variation (C.V.); for all the studied characters of the original population of the sweet potato "Abies" cultivar are presented in Table 1.

Table 1: Means ($\bar{X}$), ranges and coefficients of variations (C.V.%) estimates for all the studied characters of the original population of the sweet potato "Abies" cv. in 2005 season.

Parameters / Characters	$\bar{X}$	Range	C.V.%
Vine length (cm)	136.12	85.00-200.00	55.57
No. of branches plant^{-1}	13.22	6.00-20.00	33.37
No. of roots plant^{-1}	5.28	3.00-13.00	46.15
Weight of roots plant^{-1} (Kg)	1.07	0.610-3.200	56.89
Root fresh weight (g)	197.30	85.00-510.00	43.00
Root dry matter (%)	22.88	19.20-35.01	29.15
Root length (cm)	20.06	11.30-26.23	30.31
Root diameter (cm)	7.99	3.50-11.52	29.03
Total sugars (mg.g^{-1} d.w)	179.81	163.10-232.21	20.64
Starch (mg.g^{-1} d.w)	238.05	220.00-297.31	14.94
Carbohydrates (mg.g^{-1} d.w)	407.44	410.50-508.11	33.19
Carotene (mg.g^{-1} d.w)	0.397	0.321-0.565	21.16

The obtained results, clearly, indicated that the original population (O.P.) was characterized with a high variability for most considered characters as appeared from the estimated coefficients of variation values that ranged from 29.03% (for root diameter) up to 56.89% (for weight of roots plant^{-1}). On the other hand, the starch content of storage roots showed the lowest variation (14.94%) among all studied characters. However, total sugars and carotene contents showed relatively high variation with estimated values of 20.64% and 21.16% for their C.V%, respectively. Such results seemed to be due to that "Abies" cultivar is considered old enough and has been commercially grown for a long period without any purification and improvement. The tremendous variation reflected by most investigated characters of the original population supported the high possibilities of conducting successful and efficient selections to introduce new clones, with better general performances than their original population. Such an opinion is agreed completely with ideas of Kustarev (1980), Holm (1988) and Siddique (1991), who mentioned that the existence of high variation of characters, within the population wanted to be improved, is the first and the important key for achieving the successful expectation of improving superior cultivar. Moreover, the highest detected extreme values, noticed in the reflected wide ranges by most of the studied characters, which reached more than double of the population mean in particular characters, clearly, suggested the high potentialities for improving such characters in sweet potato. These results are in conformity with the results obtained by many investigators such as Jones *et al.* (1969) for different storage root traits; Thamburaj and Muthukrishnan (1978), Anshebo *et al.* (2004) and Tsegaye *et al.* (2006) for number of branches plant^{-1}, weight of single tuber root, tuber root length and girth, tuber roots weight plant^{-1} and vine length; Zheng *et al.* (1985) for vine length; Chen *et al.* (1989) for tuber root weight and tuber roots yield plant^{-1}; Alam *et al.* (1998) for vine length, number of storage roots plant^{-1}, individual root weight and storage fresh roots yield plant^{-1}; Tsegaye *et al.* (2007) for vine length, storage roots number plant^{-1}, root length and diameter, root weight, roots yield plant^{-1} and root dry matter content. These authors found considerable variabilities among genotypes for the traits under consideration, which in turn is more useful for exploitation in selection program. Accordingly, it was expected that all studied characters could be improved through selection, but with varying degrees, depending on the amount of variation present in the population, the selection intensity, and the heritability of the concerned character.

The results concerning the comparisons among the means, ranges and coefficients of variation of the studied characters of the seventeen different populations; i.e, populations derived from the clonal selection cycle (clone-1 to clone-16), and the original population (O.P.); are listed in Table 2.

Regarding vine length; the comparisons among the means of the seventeen different populations indicated that all selected populations were characterized with, significantly, longer vines, than that of the original population (O.P.). The results showed, also, that the coefficient of variation values and ranges of the derived populations were found to be lower and narrower, relative to those of the (O.P.). Among the selection clones of sweet potato clones (clone-9) and (clone-10) produced significantly long vines than those of the other clones. These results indicated, clearly, that the practiced clonal selection was able to increase, significantly, the vine length from 132.53 cm in (O.P.) to more obvious (from 139.66 cm to 188.06 cm) in the selected clones. The results illustrated, also, that using clonal selection method reduced the (C.V.) values from 52.83% in (O.P.) to < 26.54 in the different selected clones (Table, 3). This result might be expected, since vine length character seemed to be simply inherited. The successful selection for long vine could be related to the type of gene action involved in the inheritance of this character, that seemed to be additive as reported by Jones (1969).

Pertaining number of branches plant^{-1}; Table 2 illustrated that using the clonal selection method reflected significant increases in a half of the selected clones compared to the (O.P.) in this character. This result was noticed from the comparisons among the mean values of the (O.P.) with the means of each of selected clones (clones number 3, 6, 7, 9, 10, 11, 12, and 15), which appeared to be significant. The results illustrated, also, that the general performances of all tested genotypes varied in this respect, indicating the presence of genotypic differences among the evaluated genotypes.

This result seemed to agree with the finding of Shalaby *et al.* (1993-a) who detected significant differences among some sweet potato genotypes for the trait number of lateral branches plant^{-1}. The estimated values of the ranges and coefficients of variation reflected, also, lower and narrower variability magnitudes after the clonal selection technique. Such achieved improvements may be related to, relatively, high amount of variability in the original population. Such a result, clearly, indicated that most of the variability detected among the original population individuals could be related, in a sound part of its magnitude, to genetic variability. Therefore, this genetic component of variation was reflected on the progenies of initially selected clones.

Table 2: Means ($\overline{X}$), ranges and coefficients of variations (C.V.%) estimates for the vine length and number of branches characters of the selected clones and the original populations (O.P.) of the sweet potato in 2006 season.

Characters	Vine length (cm)			No. of branches plant^{-1}		
Parameters / Clones	$\overline{X}$	Range	C.V.%	$\overline{X}$	Range	C.V.%
Clone -1	139.66 g	135.00-168.00	26.54	13.21 f	12.00-14.00	16.68
Clone -2	167.68 d	163.50-171.20	19.64	14.14 ef	13.00-15.0	17.01
Clone -3	175.56 bc	170.60-180.70	22.11	16.07 c-e	12.00-16.00	17.11
Clone -4	140.68 g	135.70-145.20	19.52	13.57 f	12.00-14.00	15.86
Clone -5	144.48 fg	143.00-145.70	17.82	14.55 d-f	12.00-15.00	19.15
Clone -6	178.97 b	156.90-170.70	16.11	16.14 c-e	14.00-16.00	14.73
Clone -7	164.33 d	166.30-192.00	22.31	16.11 c-e	14.00-17.00	17.16
Clone -8	178.01 b	165.00-192.00	18.00	13.19 f	14.00-16.00	14.81
Clone -9	188.06 a	170.30-189.30	14.22	19.09 a	12.00-20.00	12.91
Clone -10	188.02 a	172.70-196.20	14.63	18.34 ab	13.00-19.00	12.98
Clone -11	141.31 g	138.90-140.00	18.91	16.97 bc	15.00-19.00	19.17
Clone -12	148.34 f	145.90-150.50	15.17	16.56 b-d	12.00-18.00	21.11
Clone -13	158.26 e	156.30-161.30	19.82	15.14 c-f	13.00-19.00	20.22
Clone -14	169.97 cd	160.60-172.70	17.73	14.56 d-f	13.00-19.00	18.11
Clone -15	181.53 b	171.00-185.00	16.18	16.00 c-e	14.00-18.00	14.31
Clone -16	179.30 b	186.70-191.90	24.31	13.88 f	12.00-16.00	15.32
(O.P.)	132.53 h	89.90-202.00	52.83	13.34 f	8.00-19.00	32.72

Values having similar alphabetical letter (s) do not significantly differ, using Duncan's multiple range test (L.S.R.) at 0.05 level of probability.

The results concerning number of roots plant $^{-1}$, roots weight plant^{-1}, root fresh weight and root dry matter content (Table 3) indicated, clearly, that all selected clones reflected different degrees of superiority over the original population. These results seemed to be in accordance with the results obtained by several investigators like Tawfik (1974) and Bourke (1984) for root weight and Nagi *et al.* (1992), Velmurgan *et al.* (1999) and Wanas (2002) for number of roots plant^{-1} and roots yield plant^{-1} characters; Saleh (1997); Brabet *et al.* (1998); Ma *et al.* (1997) and Omran *et al.* (2002-b) for roots dry matter content; when they compared some sweet potato genotypes for these characters. Since, they concluded that the evaluated genotypes were varied in their characters. The highest value in this respect appeared to be in the clone number (clone-9), followed by the clone (clone-10). These two clones reflected, significantly, the highest mean values of number of roots plant^{-1}, roots weight plant $^{-1}$ (kg), root fresh weight (g) and root dry matter content (%); that were estimated by 9.01, 2.31, 255.45, 30.20 in the case of clone (clone-9), and 8.76, 2.12, 240.81 and 30.17 in the case of clone (clone-10), respectively. The relative increments of these two clones (clone-9 and clone-10) on their number of roots plant^{-1}, weight of roots plant^{-1}, root fresh weight and root dry matter contents, were estimated by 83.88%, 148.22 %, 35.94% and 30.28%, respectively, in the case of clone (clone-9), and 78.77%, 127.94%, 28.15% and 26.76% for such four characters, respectively, in the case of clone (clone-10). These particular clones were noticed to have the best vine length and number of branches plant^{-1}, as previously mentioned.

The estimated values of the ranges and coefficients of variation for these characters reflected a lower variability magnitudes after using clonal selection method, since, the (C.V.%) values of all selected clones were, severely, reduced to reach the range from 11.00%, to 22.63% for number of roots plant^{-1}; 14.01% to 23.18% for weight of roots plant^{-1}; 12.60% to 20.50% for root fresh weight and from 13.30% to 22.30% for root dry matter content, compared with those of 45.77%, 55.18%, 41.17% and 28.73% of the original population (O.P.), respectively (Table, 3). Generally, the great amount of variability noticed in the original population gave good chances for efficient selection for such characters. These results, generally, indicated that practiced clonal selection appeared to be efficient in isolating particular clones with better characteristics than the original population, form which they were selected. These results reflect also that the differences detected among the clones concerning these characters involved some genetic effects upon which the selection worked out and reflected its positive efficiency. In this respect, several investigators studied the influences of clonal selection in some economic vegetables such as potato (Brown and Caligari, 1986; Holm, 1988; Siddique, 1991), garlic (Egorlykskii, 1986; Galaeva, 1991; Gvozdanovic *et al.* 1994; Sakr, 1996) and artichoke (Habib, 2001). Their results indicated that using clonal selection method in improving these important vegetables was an effective technique for crop improvement.

Table 3: Means ($\overline{X}$), ranges and coefficients of variation (C.V. %) estimates for roots yield and its components characters of the selected clones and the original populations (O.P.) of sweet potato in 2006 season.

Characters	No. of roots plant^{-1}			Weight of roots plant^{-1} (kg)			Root fresh weight (g)			Root dry matter (%)			Root length (cm)			Root diameter (cm)		
Parameters / Clones	$\overline{X}$	Range	C.V %	$\overline{X}$	Range	C.V %	$\overline{X}$	Range	C.V %	$\overline{X}$	Range	C.V %	$\overline{X}$	Range	C.V %	$\overline{X}$	Range	C.V %
Clone -1	7.89 a-d	4.00-9.00	22.63	1.705 c	1.370-1.860	18.10	216.18 de	175.00-240.00	16.11	29.51 ab	23.50-32.22	16.22	13.68g	11.68-15.31	14.15	6.03 c-e	5.00-7.30	16.15
Clone -2	7.99 a-c	4.00-8.00	18.61	1.640 c-e	1.280-1.840	17.01	205.67 ef	180.00-220.00	14.12	27.52 cd	25.70-28.18	14.18	14.51fg	11.00-16.11	12.16	6.76 bc	5.20-8.10	15.31
Clone -3	7.96 a-c	3.00-9.00	17.22	1.504 c-e	1.250-1.640	18.31	188.90 h	170.00-250.00	20.50	27.71 cd	27.00-32.22	18.18	17.03bc	12.23-18.00	15.17	5.68 ef	4.50-7.30	18.19
Clone -4	8.60 a-c	5.00-10.00	18.12	1.637 c-e	1.370-1.860	20.32	190.64 h	175.00-210.00	19.00	29.40 ab	25.00-33.50	21.17	16.44c	13.00-17.16	16.81	6.30 b-e	4.60-8.30	22.22
Clone -5	8.60 a-c	6.00-9.00	16.18	1.855 bc	1.750-1.850	15.50	213.92 de	185.00-240.00	18.11	28.47 bc	24.60-31.00	18.22	15.48de	12.22-20.10	17.09	5.59 b-d	5.10-8.20	19.33
Clone -6	5.37 fg	5.00-8.00	22.33	1.108 fg	0.900-1.300	16.18	206.19 ef	190.00-215.00	15.11	28.51 bc	22.20-30.23	19.12	16.60c	15.00-18.86	22.52	5.86 d-f	4.40-7.50	20.62
Clone -7	8.10 a-c	6.00-9.00	13.10	1.644 c-e	1.450-1.825	18.11	202.64 fg	190.00-235.00	19.09	29.90 ab	23.50-31.00	17.11	14.03fg	12.70-15.11	19.32	5.11 f	4.30-6.30	16.17
Clone -8	6.12 d-g	5.00-10.00	20.22	1.301 d-f	1.100-1.550	20.10	209.70 d-f	198.00-225.00	18.11	27.38 cd	25.00-30.85	16.32	15.51de	12.00-17.00	18.51	6.33 b-e	4.20-7.30	13.10
Clone -9	9.01 a	7.00-10.00	11.00	2.301 a	1.800-2.450	14.01	255.45 a	205.00-275.00	12.60	30.20 a	26.91-32.23	13.30	16.32c	14.50-17.12	11.13	7.05 b	5.50-8.20	11.10
Clone -10	8.76 ab	5.00-11.00	19.01	2.113 ab	1.900-2.600	19.00	240.81 b	210.00-250.00	17.17	30.17 a	24.00-30.60	15.50	17.76b	13.00-18.22	14.31	6.62 b-d	5.10-8.10	15.22
Clone -11	7.09 b-e	6.00-11.00	16.50	1.521 c-e	1.100-1.800	26.00	214.49 de	195.00-250.00	19.10	27.17 c-e	23.50-29.58	16.17	14.23fg	13.12-16.21	16.36	5.66 ef	5.00-6.45	14.33
Clone -12	5.68 e-g	4.00-10.00	12.00	1.103 fg	0.900-1.750	23.18	193.96 gh	185.00-235.00	20.11	22.47 i	20.00-25.70	17.50	14.48fg	13.00-16.11	13.93	6.16 c-e	5.86-7.50	13.21
Clone -13	6.90 c-f	5.00-12.00	22.40	1.283 ef	1.00-1.450	17.32	186.11 h	180.00-215.00	18.22	24.28 gh	23.34-29.50	22.30	14.78ef	11.00-17.22	19.09	6.39 b-e	5.68-7.50	18.11
Clone -14	8.29 a-c	4.00-12.00	21.30	1.546 c-e	1.100-1.900	22.81	185.78 h	180.00-220.00	15.16	26.75 d-f	24.80-30.12	18.17	14.67f	10.00-18.50	20.10	6.05 c-e	4.83-7.60	19.01
Clone -15	7.63 a-d	5.00-11.00	19.50	1.666 cd	1.200-1.950	20.91	218.51 cd	195.00-260.00	17.17	25.73 ef	24.80-29.50	19.30	16.99bc	12.00-18.60	18.18	5.55 ef	4.90-6.20	17.19
Clone -16	7.14 b-e	4.00-9.00	12.51	1.624 c-e	1.300-1.900	19.16	227.95 c	175.00-265.00	20.21	25.47 fg	24.80-31.00	20.20	16.24cd	11.50-21.00	21.82	6.09 c-e	5.11-7.95	20.09
(O.P.)	4.90 g	3.00-12.00	45.77	0.927 g	0.645-3.400	55.18	187.91 h	85.00-560.00	41.17	23.18 hi	1900-35.50	28.73	19.06a	10.66-27.11	30.92	8.04 a	3.11-11.76	29.87

Values having similar alphabetical letter (s) do not significantly differ, using Duncan's multiple range test (L.S.R.) at 0.05 level of probability.

With respect to root length and diameter characters, the comparisons among the means of the different evaluated populations in Table 3 indicated, generally, that all selected clones were characterized with, significantly, shorter and thinner roots, than that of the original population. The results showed, also, that the coefficients of variation values and ranges of the derived clones were found to be lower and narrower, relative to those of the (O.P.). These results indicated, clearly, that the practiced clonal selection was able to reduce, significantly, the root length within the ranges of 13.68 to 17.76 cm for root length; and 5.11 to 7.05 cm for root diameter for all the slected clones; compared with those of the original population 19.06 cm and 8.04 cm, respectively. From breeding aspect, the results of the current study can suggest that medium values for root dimension traits are desirable for consumer. This result reflects the efficiency of clonal selection method as an essential step for sweet potato improvement.

Concerning the determined chemical compositions; *viz.* total sugars, starch, carbohydrates and carotene; the results in Table 4 reflected, relatively, high variation within their original population, as those noticed for the other considered characters. Since, the estimated values of coefficients of variation (C.V.%) for the total sugars, starch, carbohydrates and carotene contents were 20.16%, 15.32%, 32.92% and 22.12%, respectively, in the (O.P.). Accordingly, the efficiency of selection on improving these chemical components of sweet potato roots would expected in the selected clones. So, the variability magnitudes were reduced in all derived clones for the chemical contents of sweet potato roots. The comparisons among the means of each total sugars, starch, carbohydrates and carotene contents illustrated, generally, that using clonal selection method increased, significantly, these chemical contents in most selected clones. The results observed, also, that the general performances of all tested genotypes were varied in their chemical composition, indicating the presence of significant differences among the sweet potato genotypes. The obtained results appeared to agree with the findings of Hammett (1974) on carbohydrates content; Bradbury and Holloway (1988); Babu (1994); Saleh (1997); Wanas (2002) on total sugars content, Liao *et al.*, (1985) and Shalaby *et al.*, (1993-b) on carotene content and Saleh (1997); Brabet *et al.* (1998); Omran *et al.* (2002-b); Wanas (2002) on starch. They concluded that the differences among the evaluated genotypes of sweet potato seemed to be significant. From chemical constituent's aspect, the best clone that showed the highest mean values for these four previous chemical components was found in clone clone-9. These results mean that increasing the chemical compositions in sweet potato roots may be related to increasing in most vegetative and yield characters.

Such result illustrated, generally, that the clone clonal-9 reflected superiority in all studied characters, with only two exceptions, than the original population or than all other clones. Therefore, it may be concluded that clonal selection method was found to be highly efficient, in the present breeding program in isolating good clones of sweet potato "Abies cultivar". Clone-9 appeared to be the best one among the all selected clones under consideration, followed by clone- 10.

Table 4: Means ($\overline{X}$), ranges and coefficients of variations (C.V. %) estimates for the chemical compositions; total sugars, starch, carbohydrates and carotene; of the selected clones and original populations (O.P.) of sweet potato in 2006 season.

Characters	Total sugars (mg.g.$^{-1}$ d.w.)			Starch (mg.g.$^{-1}$ d.w.)			Carbohydrates (mg.g.$^{-1}$ d.w.)			Carotene (mg.g.$^{-1}$ d.w.)		
Parameters / Clones	$\overline{X}$	Range	C.V %	$\overline{X}$	Range	C.V %	$\overline{X}$	Range	C.V %	$\overline{X}$	Range	C.V%
clone-1	214.51 ab	200.70-225.53	12.50	268.98 c	260.82-273.13	14.30	483.49 ab	480.50-488.63	17.33	0.513 b	0.495-0.531	13.12
clone- 2	214.72 ab	195.30-220.00	12.00	251.44 de	240.00-259.12	11.50	466.16 cd	463.18-469.67	20.00	0.451 c-f	0.436-0.462	16.21
clone- 3	200.57 cd	195.42-215.30	13.18	268.28 c	260.86-276.73	12.10	468.83 c	461.53-479.46	18.50	0.479 c	0.461-0.493	18.10
clone- 4	190.77 d-f	180.57-195.40	10.11	272.17 bc	260.50-273.70	11.00	462.94 cd	460.80-466.12	19.10	0.438 ef	0.432-0.446	15.31
clone- 5	180.41 f-h	178.41-189.86	11.17	267.78 c	265.60-275.13	12.11	448.19 ef	446.17-451.99	12.10	0.518 b	0.511-0.530	12.82
clone- 6	170.01 h	168.76-175.43	13.12	247.84 e	240.50-256.03	7.50	417.86 i	416.26-437.25	15.11	0.396 g	0.381-0.415	16.22
clone- 7	216.10 ab	210.69-220.60	15.13	238.36 f	235.85-240.50	11.00	454.46 de	410.00-456.40	17.31	0.437 ef	0.420-0.450	11.18
clone- 8	205.27 bc	200.50-209.50	12.18	278.43 ab	275.80-28.50	9.10	483.70 ab	476.30-487.30	13.31	0.471 cd	0.460-0.483	11.11
clone- 9	220.16 a	210.60-230.36	9.05	281.74 a	280.58-285.86	6.50	495.34 a	486.95-501.51	11.82	0.550 a	0.533-0.573	10.32
clone- 10	179.47 gh	175.50-182.50	11.51	275.18 a-c	275.80-289.20	12.21	461.20 cd	430.00-461.97	12.71	0.523 ab	0.511-0.533	16.16
clone- 11	213.97 ab	210.10-220.12	13.51	257.60d	250.74-260.34	13.32	471.60 bc	466.81-475.86	14.05	0.461 c-e	0.451-0.471	14.18
clone- 12	192.94 de	189.60-195.50	12.00	229.76 g	225.35-233.80	15.11	422.69 hi	410.90-427.60	16.50	0.477 c	0.473-0.480	11.22
clone- 13	190.47 d-g	185.90-195.70	13.50	250.51 de	247.70-259.42	14.12	440.90 fg	433.60-446.12	18.00	0.420 fg	0.403-0.437	12.13
clone- 14	186.94 e-g	182.13-191.80	11.20	245.0Q e	240.30-251.21	10.19	431.94 gh	425.63-442.39	22.10	0.443 d-f	0.426-0.467	13.32
clone- 15	201.08 cd	195.03-210.20	9.33	270.40 c	268.80-272.63	9.07	471.48 bc	460.29-478.50	19.00	0.540 ab	0.525-0.568	15.32
clone- 16	217.47 a	210.09-230.60	13.80	250.57 de	240.80-252.50	8.09	468.04 c	464.41-479.10	20.22	0.518 b	0.450-0.560	14.19
(O.P.)	182.25 e-g	163.00-251.00	20.16	236.44 f	218.50-295.13	15.32	418.70 i	405.50-509.30	32.92	0.342 h	0.321-0.567	22.12

Values having similar alphabetical letter (s) do not significantly differ, using Duncan's multiple range test (L.S.R.) at 0.05 level of probability.

RFERENCEES

Alam, S., B. D. Narzary and B. C. Deka.1998. Variability, character association and path analysis in sweet potato (*Ipomoea batatas* L. Lam.). J. Agric . Sci. Soc. N. E. India.11:77-78.

Al-Rawi, K. M. and A. M. Khalf-Alah.1980. Desigin and analysis of agricultural experiments. Text book. El-Mousl Univ. Press. Ninawa. Iraq .pp. 487 (In Arabic).

Anshebo, T., D. Veeraragavathatham and M. Kannan. 2004. Genetic variability and correlation studies in sweet potato (*Ipomoea batatas* L. Lam.). Madras Agric. J. 91(7-12): 420-424.

A.O.A.C. 1980. Official Methods of Analysis Association Official Analytical Chemists. 13th ed., Washington, D. C., USA.

Babu, L. 1994. Changes in carbohydrate fractions of sweet potato tubers on processing. Trop.Agric.71(1) :71-73. (c.a. Pl. Breed. Abst. 64, 12957).

Bourke, R. M. 1984. Growth analysis of four sweet potato (*Ipomoea batates*) cultivars in papua New Guinea. Tropical Agriculture (1984); 61 (3): 177-181. (c.a.Pl. Breed. Abst., 1985, 55(3), 1869).

Brabet, C., D. Reynose, D. Dufour, C. Mestres, J. Arrdondo and G. Scott. 1998. Starch content and properties of 106 sweet potato clones from the world germplasm collection held at CIP, Peru. International Potato Center (CIP). Lima, Preu, program Report 1997-1998. pp. 279-286.

Bradbury, J. H. and W. D. Holloway. 1988. Chemistry of tropical root crops: significance for nutrition and agriculture in the pacific, ACIAR Monograph Ser. No.6. Canberra.

Brown, J. and P. D. S. Caligari. 1986. The efficiency of seedling selection for yield and components in a potato breeding programme . J. Pl Breed. 96: 53-62.

Chen, F. X, J. W. Xie and X. Z. Zhang.1989. Heritability tendency of tuber yield, dry chip percentage and bacterial wilt resistance in sweet potato. J. Fujian – Agric. College. 18(1): 133-138. (c.a. Pl. Breed. Abst., 60:1684).

Co-State Software. 2004. User's manual version. Cohort Tusson, Arizona, USA.

Davies, B. H. 1976. Analysis of carotenoid pigment. In: T. W. Goodwin (ed.), Chemistry and Biochemistry of Plant Pigments. Academic Press, London and New York.

Egorlykskii. A. 1986. A new introduced garlic cultivar through clonal selection. Kartofel -i-ovoshchi. 37(3). (c.a. Pl. Breed. Abst. 57(9): 4339, 1987).

Galaeva, M. F. 1991. Garlic Zimnii. Kartofel -i-ovoshchi. 8(6). (c.a. Pl. Breed. Abst. 62 (5), 7188, 1992).

Gvozdanovic, V. J, A. Takac and M. Vasic. 1994. New clones of spring garlic. Noviklonovi Jarog Belog Luka. Selectijai Semenarstvo. 1(1): 65-68 (c.a. Pl. Breed. Abst. 65(8), 8705, 1995).

Habib, R. M. E. 2001. Efficiency of clonal selection on improving characteristics of artichoke (*Cynara scolymus* L.). M. Sc. Thesis, Fac. of Agric. Alexandria Univ., Egypt.

Hammett, H. I. 1974. Total carbohydrate and carotenoid content of sweet potatoes as affected by cultivar and area of production. Hort. Sci. 9(5): 467-468.

Holm, D. G. 1988. Sanger selection studies I. Selection and comparative trials. Amer. Potato. J. 65(1): 21-26.

Huett, D. O.1976. Evaluation of yield, variability and quality of sweet potato cultivars in sub-tropical Australia. Expl. Agric. 12: 9-16.

Jones, A.1969. Quantitative inheritance of ten vine traits in sweet potatoes. J. Amer. Soc. Hort. Sci. 94: 408-411.

Jones, A., C. E. Steinbauer, and D. T. Pope. 1969. Quantitative inheritance of ten root traits in sweet potatoes. J. Amer. Sco. Hort. Sci. 91: 271-245.

Katayama, K., K. Kotnae, S. Tamiya, K. Khoyama, M. Nakatani and K. Komaki. 2006. Review: Studies on the breeding for improving starch properties in sweet potato. JARQ 40(2): 115-122.

Kustarev, A. I., V. I. Krasnostanova and F. E. Antoshchenko. 1980. Role of clonal selection. Kartofel-i- Ovoshchi. 11(10). (c.a. Pl. Breed. Abst. 54(13): 6038, 1984).

Lee, L., C. H. Liao, M. L. Chung and S. F. Yen. 1985. A new sweet potato variety Tainung-68. Taiwan Agric. Bimonthly. 21(6): 45-60. (c.a. Pl. Breed. Abst. 57, 2156).

Liao, C. H, H. Wong, Lee, M. L. Chung and S. F. Yen. 1985. A new sweet potato variety, Tinung – 67. Taiwan Agric. Bimonthly, 21(6): 40-44. (c.a. Pl. Breed . Abst. 57, 427).

Ma, D. F., H. M. Li and I. G. Mok. 1997. Introduction and use of exotic germplasm in the Chinese sweet potato breeding program. CIP Program Report, 98: 311-316.

Malik, C. P. and M. B. Singh. 1980. Plant enzymology and histoenzymology. A Text Manual – Kalyani Publishers, New Delhi.

Morrison, T. A, R. Pressey and S. J. Kaks. 1993. Changes in alpha and beta amylase during storage of sweet potato lines with varying starch hydrolysis potential. J. Amer. Soc. Hort. Sci. 118(2): 236-242.

Nagi, M.W., R. M. Emara and A. S. Foda. 1992. A new released sweet potato cultivar for table consumption in Egypt. J. Agric. Res. 70: 297-303.

Nassar, S. H., S. A. Fouda, M. R. Omarah and S. M. Moustapha.1982. Appraisal of some new sweet potato in Egypt. Annals of Agricultural Science, Moshtohor, 17: 227-240. (c.a. Field Crop Abst ., 1983; 3, 2526).

Omran, A. F., R. M. Khalil, N. M. Wanas and Afaf A. M. Salim. 2002-a. Average degree of heterosis in sweet potato. Minufiya J. Agric. Res. 27(3): 637-655.

Omran, A. F., R. M. Khalil, N. M. Malash, M. M. El-Sayed, N. M. Wanas and Afaf A. M. Salim. 2002-b. Behavior of some breeds sweet potato lines and their F_1 crosses. Minufiya J. Agric. Res. 27(3): 621-635.

Onwueme, I. C. and K. Charles. 1994. Tropical root and tuber crops: Productives and future prospects. FAO. Plant production and protection paper (126) FAO, Rome, pp: 115-135.

Ozias-Akins, P. and R. L. Jarret. 1994. Nuclear DNA content and amplified polymorphic DNA marker data for fingerprinting sweet potato (*Ipomoea batatas,* L.) genotypes. Theor. Appl. Genet. 88: 332-336.

Sakr, A. M. M. 1996. Efficiency of clonal selection in Egyptian and Chinese garlic cultivars. M. Sc. Thesis, Fac. of Agric. Alexandria Univ., Egypt.

Saleh, M. 1997. Yield test and tuber quality of pentaploids sweet potato. Suletin Budidaya pertanian (Indonesia), 2:35-42. (c.a. Computer search).

Sen, H., N. Roychoudhury and S. K. Mukhopadhyaya. 1988. Performance of different sweet potato (*Ipomea batatus*) entries in the alluvial soil of west Bengal. Environment and Ecology 6(2): 430-438. (c.a. Pl. Breed. Abst. 58(12): 10500, 1988).

Shalaly, G. I., S. A. Abdel Aal, A. M. Damarany and A. M. Abd El-Salam. 1993-a. Evaluation of some cultivars and breeding lines of sweet potato under Assiut conditions. Assuit J. Agric. Sci. 24 (1): 315-327.

Shalaby, G. I., S. A. Abdel-Aal, A. M. Damarany and A. M. Abd El-Salam. 1993-b. Evaluation of some cultivars and breeding lines of sweet potato under Assiut conditions .II. Chemical composition and storage ability of storage roots. Assiut J. Agric. Sci. 24(1): 329-344.

Siddique, M. A. 1991. Yield potential of indigenous potato varieties and their future in Bangladesh. Proc. of the first National Workshop on Tuber crops. 12-27. (c.a .Pl. Beed. Abst . 58(4): 2087, 1988).

Tawfik, M. A.1974. Qualitative and qualitative evaluation of some sweet potato lines under Egyptian condition. M. Sc. Theses, Faculty of Agric. Caire Univ. Egypt.

Thamburaj, S. and C.R. Muthukrishnan. 1978. Association of metric traits and path analysis in sweet potato (*Ipomoea batatas*, (L) Lam.). Madras Agric. J. 63: 1-8.

Tsegaye, E., E. V. D. Sastry and N. Dechassa. 2006. Correlation and path analysis in sweet potato and their implications for clonal selection. J. Agron. 5(3): 391-395.

Tsegaye, E.; N. Dechassa and E. V. D. Sastry. 2007. Genetic variability for yield and other agronomic traits in sweet potato. J. Agron. 6(1): 94-99.

Tseng, Y-T.; H-F. Lo and S-Y. Hwang. 2002. Genotyping and assessment of genetic relationships in elite polycross breeding cultivars of sweet potato in Taiwan based on SAMPL polymorphisms. Bot. Bull. Acad. Sin. 43: 99-105.

Velmurgan, K., S. Thamburaj and M. Kanna. 1999. Variability in the open pollinated progenies of sweet potato (*Ipomea batatus*, (L) Lam.) at three stages of harvest. South Indian Horticres. 47: 220-221. (ca. Computer research).

Wanas, N. M. 2002. Evaluation of some new potato varieties under Egyptian condition. Minufiya J. Agric. Res. 27. 4(2): 1009-1016.

Watley, B. T. and R. B. Phills. 1978. "Carver" sweet potato. Hort. Sci. 12(3): 266.

Woolfe, J. A. 1992. Sweet potato – An untapped food resource. Published in collaboration with the Internat. Potato Center, Peru, Cambridge, UK. pp. 643.

Zheng, J. Z., G. W. Zheng, J. L. Huang and W. T. Liu. 1985. Preliminary study of genetic variation in the main characters of backcross progenies of sweet potato, Fujian Nongye Keji (Fujian Agric .Sci. and Technology), No.2: 30-33. (c.a. Pl. Breed. Abst., 56: 3932).

الملخص العربي

الإنتخاب بالسلالة الخضرية لتحسين بعض الصفات الهامة في البطاطا

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أجريت هذه الدراسة فى محطة البحوث الزراعية بمنطقة أبيس والتابعة لكلية الزراعة – جامعة الإسكندرية فى الموسمين الصيفيين لعامي ٢٠٠٥ و ٢٠٠٦ ، بغرض معرفة مدي كفاءة إستخدام دورة واحدة من إنتخاب السلالة الخضرية من خلال معرفة مقدار وحجم الإختلافات الموجودة فى العشيرة الأصلية لنباتات البطاطا صنف أبيس، وذلك على بعض الصفات الاقتصادية الهامة.

واشتملت الصفات المدروسة والتي تم الإنتخاب لها على طول العرش ، عدد الأفرع لكل نبات ، عدد الجذور لكل نبات ، وزن الجذور للنبات ، متوسط وزن الجذر ، النسبة المئوية للمادة الجافة للجذور ، طول وقطر الجذر ، محتوى الجذور من السكريات الكلية ، النشا ، الكربوهيدرات والكاروتين. حيث تم زراعة حوالي ٤٥٠٠ نبات في الموسم الصيفي ٢٠٠٥ وذلك لتقدير مقدار وحجم الاختلافات فى الصفات المدروسة على أساس النباتات الفردية وذلك من خلال تقدير المتوسط و المدى بالإضافة إلى معامل الاختلاف. تبين من الدراسة وجود اختلافات كبيرة وكافيه لإجراء الإنتخاب والتحسين علي هذا المحصول الأقتصادى الهام.

أجرى الانتخاب بين النباتات علي أساس الشكل المظهري للصفات السابق تحديدها على عدة مراحل خلال فترة النمو الخضري وفترة تكوين الجذور كذلك تم زيادة شدة الانتخاب بعد الحصاد وتقدير بعض المكونات الكيميائية الموجودة بالجذور (السكريات الكلية ، النشا ، الكربوهيدرات ، الكاروتين) ، ولقد إنتهى الإنتخاب بأفضل ستة عشر سلالة خضرية والتى تم زراعة العقل الساقية (العرش) لكل سلالة على حدة بالإضافة الى العشيرة الأصلية .

تم تقييم كفاءة طريقة الانتخاب بالسلالة الخضرية وذلك على تحسين الصفات المدروسة خلال الموسم الصيفى لعام ٢٠٠٦ بإستخدام تصميم القطاعات العشوائية الكاملة وذلك لمقارنة العشائر المنتخبة وهى ستة عشر سلالة خضرية بالإضافة إلى العشيرة الأصلية وأظهرت النتائج بصفة عامة أن إستخدام طريقة التربية بإنتخاب السلالة الخضرية أدى إلى تحسين ملحوظ ومعنوي فى كل الصفات المدروسة مقارنة بالعشيرة الأصلية. كما حدث إنخفاض بدرجات مختلفة فى مقدار الإختلافات بالنسبة لجميع الصفات موضع الدراسة مقارنة بالعشيرة الأصلية.