Minufiya J. Agric. Res. Vol. 34 No.1(1): 107-126 (2009)"http://www.mujar.net"

STUDIES ON THE INHERITANCE OF SOME CHARACTERS ON OKRA [*Abelmoschus esculentus* (L.) Moench].

A.K. Hatem; M.K. Hatem and S.M.A. Mohamed
Hort., Res. Institute, Agric. Res. Center, Giza, Egypt
(Received: Dec , 17 , 2008)

ABSTRACT: ***The present investigation was carried out at Barrage, Horticulture Research Station, during three successive summer seasons 2006, 2007 and 2008. The genetic materials used in this study were four parental lines of okra [Abelmoschus esculentus (L.) Moench] viz, Green Velvet (GV), Clemson Spineless (CS), Balady (Ba) and Punjab Podmini (PP). Seeds of the parents of each cross and F_1's were sown in summer season of 2007 to obtain F_2 of their F_1 hybrids. Seeds of the eight populations viz, four parents, two F_1's and two F_2 for these crosses were planted in field experiment in summer season of 2008 for evaluation and studying the inheritance of some traits viz, number of days to flowering, early and total edible pods yield and total carbohydrates in pods. The results indicated that the inheritance of number of days to flowering was found to be simple with complete dominance for earliness of flowering , and obtained heritability (h^2_b) ranged from 83.14% to 88.916% for this trait. The number of pods and weight for early yield was found to be controlled by more than three pairs of genes with mostly additive gene action and partial dominance for the high yield of pods. Furthermore, the presence of many minor genes were required for the expression of the high number of pods. Obtained data indicated that the inheritance of the total pods yield is controlled by more than three pairs of genes with mostly additive gene action and partial dominance for the high yield and presence of many minor genes. The heritability for total pods yield ranged from 43.900% to 64.043%. The relatively low value heritability indicates that the total yield is affected by environmental conditions. The inheritance of total carbohydrates was found to be simple, it is controlled by one pair of genes with mostly additive gene action and partial or complete dominance for the high content.***

Key words: ***Heterosis, Heritability, Potence ratio, Inbreeding depression, Genetical variance.***

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is one of the most popular vegetable crops in Egypt. It is a multipurpose crop valued for its tender and delicious pods, which can be used either fresh, dried, frozen or canned after cooking. In Egypt, the cultivated area of okra in 2007 According to statistics

of the Ministry of Agriculture, reached about 17949 feddans and its production reached, nearly 117944 tons with an average of 6.60 ton/fed.

Increasing yield, to meet the requirement of increasing population can be achieved by developing, selection and releasing new yielding cultivars or hybrids with good pods quality through breeding and selection programs.

Regarding average degree of heterosis, dominance and over-dominance was observed for number of days from planting to the first flower anthesis, early and total yield in okra were mentioned by Shukla *et al.* (1989), Singh and Mandal (1993), Ragaa *et al.* (1997), Neeta *et al.* (2004) and Hatem *et al.* (2008).

In this respect, Bhalekar *et al.* (2004), found that the heterosis in desirable direction was evident for pods yield and its component characters, except for average pod weight. They added that, significant heterosis was found for pods weight per plant. Saeed *et al.* (2004), reported that additive gene action for fresh pods yield per plant and days to first flower, suggested effective of selection in early segregating generation for these traits. However, over-dominance for fresh pods yield per plant indicated the feasibility of heterosis through breeding for this trait.

On the other hand, Adeniji and Olawale (2007), showed that the additive-dominance model was adequate in explaining the inheritance of pods yield. The results of generation mean analysis indicated that the additive genetic effects significantly accounted for a large proportion of variability observed for pods yield resulted in evaluated crosses. They added that partial dominance and over dominance revealed an intermediate performance and the possibility of developing hybrids for pods yield. Narrow sense heritability estimates were low to moderate. An additive genetic effect suggests that selection among segregating population could provide an average improvement in the performance of pods yield in subsequent generations, they reported that the inheritance of pods yield was polygenic, thus safeguarding against genetic loss of pod yield in selection process.

Therefore, the present investigation was carried out to evaluate the mode of inheritance and genetic control of some economic useful characters, heritability and heterotic estimates for this traits in okra.

MATERIALS AND METHODS

The present investigation was carried out at Barrage Horticulture Research Station, during three successive summer seasons 2006, 2007 and 2008. The genetic materials used in this study were four parental lines of okra (*Abelmoschus esculentus* (L.) Moench) viz, Green Velvet (GV), Clemson Spineless (CS), Balady (Ba) and Punjab Podmini (PP) received from

Vegetable Research Department, Hort. Res. Institute. The main characteristics of these lines are presented in Table (1).

Table (1): Main characteristics of the parental lines.

Parental lines	Pod characteristics
1. Green Velvet (GV)	Light green up to 15 cms. long, thin and medium spiny pods , early maturity .
2.Clemson Spineless (CS)	Dark green up to 12 cms. long and medium spiny pods , medium maturity .
3.Balady (Ba)	Dark green up to 10 cms. long , thick and hard spiny pods , early maturity .
4.Punjab Podmini (PP)	Medium to light green up to 15 cms. long , thick and medium spiny pods, late maturity.

These parental lines were at a high degree of homozygosity since they were previously selfed subjected to selfing and selection for two generations.

The four parents were planted in the field in summer 2006 and possible crosses between GV x CS and Ba x PP were made to obtain the F_1 crosses.

The F_1's of the two crosses viz, Gveen Velvet (GV) x Clemson Spineless (CS) and Balady (Ba) x Panjab Podmini (PP) whose parents were widely differed in their pod characteristics were sown in summer season of 2007 to obtain the F_2 population .

Seeds of the eight populations viz, 4 parents, two F_1's, and two F_2 for these crosses, were planted in the field on March 3th of 2008 season for studying the inheritance of the some traits. A randomized complete block design with three replicates was adopted. Each replicate included 12 plants of each parent and F_1's and 48 plants of F_2 were planted at 30 cm apart between plants.

The cultural practices were carried out according to the recommendations reported by Ministry of Agriculture .

Harvesting period started from May and continued up to Sept., pods were picked with their peduncles in the morning at three days intervals during the entire season.

The studied traits were :

[1] Number of days from planting to the first flower anthesis per plant.

[2] Early edible pods yield by number and weight/plant in the first 21 days of starting harvesting.

[3] Total edible pods yield (gm./plant): It was calculated by the total edible weight of pods during the entire season.

[4] Total carbohydrates (%): Sample of 100 g of fresh pods were taken at random in the middle of the season and then dried for total carbohydrates determination according to the method described by A.O.A.C. (1990).

Statistical Procedures :

[1] Analysis of variance was made in order to test the levels of significance among the mean values of the tested populations for all trait, using least significance differences (L.S.D.), according to Steel and Torrie (1990).

[2] Estimates of genetic parameters were calculated according to Warner *et al.* (1980), as follows:

a) Average degree of heterosis (ADH%), was expressed as perecent increase or decrease of the performance above the mid-parents (MP) value and the high parent (HP) value as follows:

$$\text{ADH \% (based on MP)} = \overline{F}_1 - MP/MP \times 100.$$

$$\text{ADH \% (based on HP)} = \overline{F}_1 - \overline{HP}/\overline{HP} \times 100.$$

b) Potence ratio (PR) = $F_1 - \overline{MP}/½ (\overline{P}_2 - \overline{P}_1)$

c) Inbreeding depression (ID%) = $\overline{F}_1 - \overline{F}_2/\overline{F}_1 \times 100$.

d) Environmental variance (E) = $V_{P1} + V_{P2} + V_{F1} /3$.

e) Genetical variance (G) = $V_{F2} - E$.

f) Heritability (h^2_b) = V_G/V_E.

g) Predicted gain (GS) = (K0.05) ($\sqrt{V_{F2}}$) (h^2_b) .

where, $\overline{P}_1$, $\overline{P}_2$, $\overline{F}_1$, $\overline{HP}$ and $\overline{F}_2$ are the means of P_1, P_2, F_1, high parent and F_2, respectively, while V_{P1} , V_{P2}, V_{F1} and V_{F2} are the variances of P_1, P_2, F_1 and F_2 respectively. (MP) is the mid-parental value. $K_{0.05}$ is the selection differential and equals 2.06 for 5% selection intensity (Johanson *et al.* 1955).

[4] Chi square test was used to compare the observed and the theoretical ratios (Steel and Torrie, 1960) in the studied populations .

[5] The minimum number of gene pairs responsible for various characters differences between parents of different crosses was calculated by the following methods:

a) Castle and Wright (1921) formula:

$$N = D^2/_8 (V_{F2}-V_{F1})$$

Where : N = minimum number of gene pairs by which the parents differ.

D = differences between the parental means.

V_{F2} = variances of F_2 population.

V_{F1} = variances of F_1 population.

b) Burton (1951) formula :

$$N = \frac{0.25\,(0.75 - h + h^2)\,D^2}{(V_{F2} - V_{F1})}$$

Where : N = minimum number of gene pairs.

$h = \overline{F_1}\text{-}\overline{P_1} / \overline{P_2}\text{-}\overline{P_1}$

Frequency distribution tables were also prepared for populations of each studied trait. These tables were used in preparing histograms showing the percentage of plants in various levels of the trait.

RESULTS AND DISCUSSION

There were no differences among replications for the non-segregating populations (parents and F_1). Therefore, the data were pooled for genetic analysis.

[1] Inheritance of number of days from planting to the first flower anthesis:

The crosses Green Velvet (GV) x Clemson spineless (CS) and Balady (Ba) x Punjab Podmini (PP), were used in studying the mode of iheritance of number of days from planting to the first flower anthesis.

Data presented in Figure 1 showed highly significant difference between the two parental lines for each cross in this trait. The parental lines Green Velvet and Balady were significantly less than Clemson Spineless and Punjab Podmini in number of days to flowering by about 4.055 and 6.583 days, respectively, indicating that the parents Green Velvet and Balady were earlier than the parents Clemson Spineless and Punjab Podmini in flowering . The parental lines for each cross had distinct non-overlapping ranges .

The average degree of heterosis (ADH%) was estimated as -6.876% and -12.438% based on MP and HP, respectively, in the cross GV x CS and as -7.460% and -15.377%, based on MP and HP, respectively, in the cross Ba x PP, suggesting dominance for the earlier parents. The estimated potence values (-1.082 and -0.797, respectively) for the two crosses was in accordance with the suggested dominance hypothesis of the earlier parent

(Table 2) is noticed that the parent showed fewer number of day is considered as HP .

The distribution of F_1's plants clearly reveals complete dominance of the earlier parents for this trait. Most plants covered the range exhibited by the earlier parents (Green Velvet and Balady) for the two crosses. However, non of the F_1's plants was similar to the late

Table (2) : Estimates of genetic parameters for the studied characters.

A: Number of days from planting to the first flower anthesis

Early number edible pods yield / plant

Genetic parameters	Number of days from planting to the first flower anthesis		Early number edible pods yield / plant	
	GC x CS	Ba x PS	GC x CS	Ba x PS
ADH % :-				
- based on MP	- 6.876	-7.460	4.394	11.698
- based on HP	- 12.438	-15.377	-6.145	0.684
Potence ratio (PR)	-1.082	-0.797	0.391	0.572
Inbreeding depression (ID)	-2.407	0.491	4.294	2.956
Environmental variance (E)	0.610	1.016	0.790	2.491
Genetical variance (G)	3.008	8.148	1.686	3.570
Heritability in broad sense (h^2_b %)	83.140	88.916	68.100	58.907
Predict gain (GS %)	325.789	554.482	220.715	298.737
Minimum number of genes:-				
-Castle and Wright formula	0.683	0.678	3.343	3.544
- Burton formula	1.082	0.893	3.599	4.125

B: Early weight edible pods yield / plant
Total edible pods yield / plant

Genetic parameters	Early edible pods yield / plant		Total edible pods yield / plant	
	GC x CS	Ba x PS	GC x CS	Ba x PS
ADH % :-				
- based on MP	5.154	7.500	6.344	9.110
- based on HP	-5.113	-6.057	-3.029	-3.691
Potence ratio (PR)	0.476	0.520	0.656	0.685
Inbreeding depression (ID)	0.337	0.449	0.038	0.554
Environmental variance (E)	27.270	22.732	307.348	267.280
Genetical variance (G)	16.668	31.346	240.511	476.047
Heritability in broad sense (h^2_b %)	37.936	57.965	43.900	64.043
Predict gain (GS %)	518.010	878.100	2116.738	3596.888
Minimum number of genes:-				
-Castle and Wright formula	3.711	3.724	3.017	3.169
- Burton formula	4.133	4.227	3.667	3.914

C: Total Carbohydrates in pods

Genetic parameters	Total Carbohydrates in pods	
	GC x CS	Ba x PS
ADH % :-		
- based on MP	3.400	7.788
- based on HP	-4.409	-1.504
Potence ratio (PR)	0.416	0.826
Inbreeding depression (ID)	-1.280	1.364
Environmental variance (E)	0.017	0.015
Genetical variance (G)	0.141	0.205
Heritability in broad sense (h^2_b %)	89.138	93.109
Predict gain (GS %)	72.967	89.935
Minimum number of genes:-		
-Castle and Wright formula	1.284	1.117
- Burton formula	1.395	1.497

parental lines (Clemson Spineless and Punjab Podmini), for the two crosses, as shown in Figure 1.

About 84.722% of the F_2 plants for the cross (GV x CS) convered the range exhibited by P_1 (GV) and F_1 population. The remaining F_2 plants (15.278%) covered the range exhibited by P_2 (CS). Meanwhile, about 79.861% of the F_2 plants for the cross (Ba x PP) convered the range exhibited by P_1 (Ba) and F_1 population but the remaining F_2 plants (20.139%) covered the range exhibited by P_2 (PP), the recessive parent. These distribution fit a 3 : 1 ratio using X^2 test with probability of 0.9 – 0.75. These distribution leads to suggest that number of days from planting to the first flower anthesis in these crosses is controlled by a single pair of gene with dominance of the earlier parents.

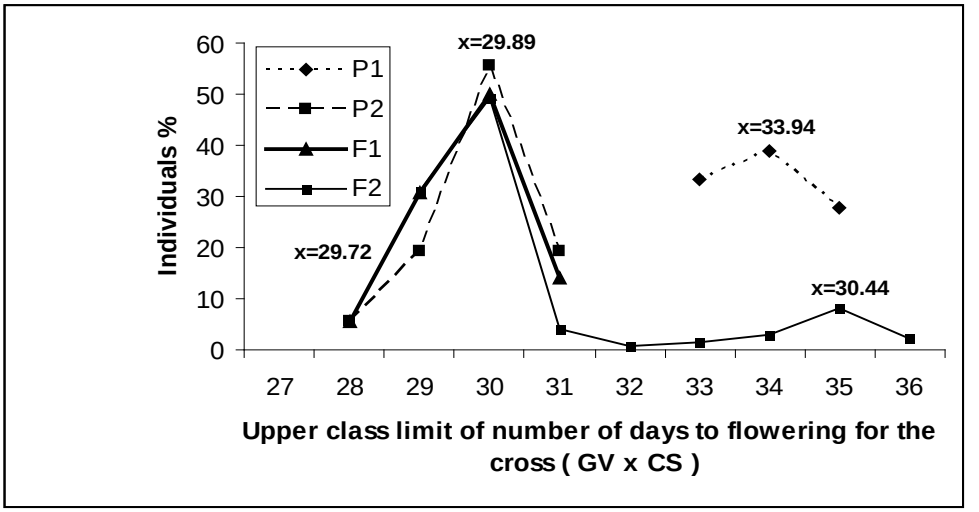
Expected F_2 means for the two crosses were calculated according to the monogenic inheritance of the character and the dominance of few number of days to flowering using Powers (1955) formula : $F_2 = P_1$ (¾) + P_2 (¼), where P_1 and P_2 are the means of dominant and recessive parents, respectively. This expected means (30.903 and 33.535, respectively) for the two crosses and the actual means (29.722 and 32.556, respectively) for the crosses GV x CS and Ba x PP, support the hypothesis presented.

Heritability in broad-sense (h^2_b) for the crosses "GV x CS" and "Ba x PP" was relatively high (83.140% and 88.916%, respectively). These values is in accordance with the monogenic inheritance of the character. However, (h^2_b) values suggested that progress could be made in changing number of days to flowering in okra by selection within segregating progenies. Considerable progress of this trait by breeding and selection was also verified by the calculated gain (GS) which was estimated as 325.789% and 554.482%, respectively. The calculated inbreeding depression ID were -2.407% and 0.491%, respectively in the two crosses.

The present results confirms previous reports of Shukla *et al.* (1989), Singh and Mandal (1993), Ragaa *et al.* (1997) and Neeta *et al.* (2004), who found that dominance was observed for this trait. In this respect, Moualla *et al.* (2005) found high heritability value (92%) for early in flowering.

[2] Number of pods for early yield:

Data presented in Fig. (2) revealed significant difference between the two parental lines in number of pods of early yield in the two studied crosses . The parents Clemson Spineless and Balady,



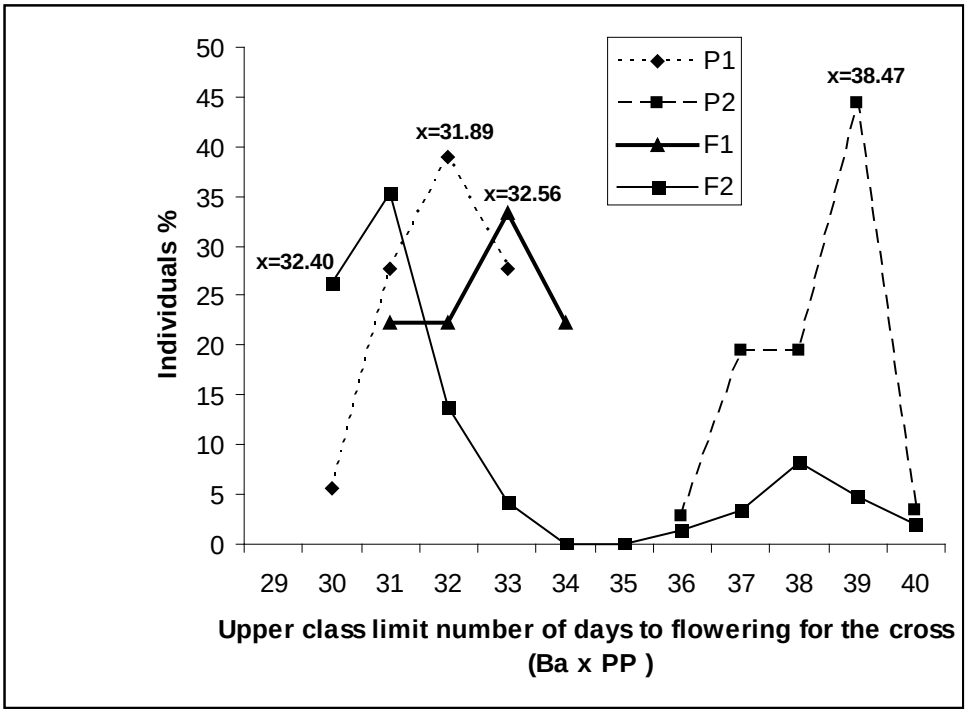


Fig. (1) : Distribution of number of days to flowering in parental lines , F_1 and F_2 plants for the crosses (GV x CS) and (Ba x PP) .

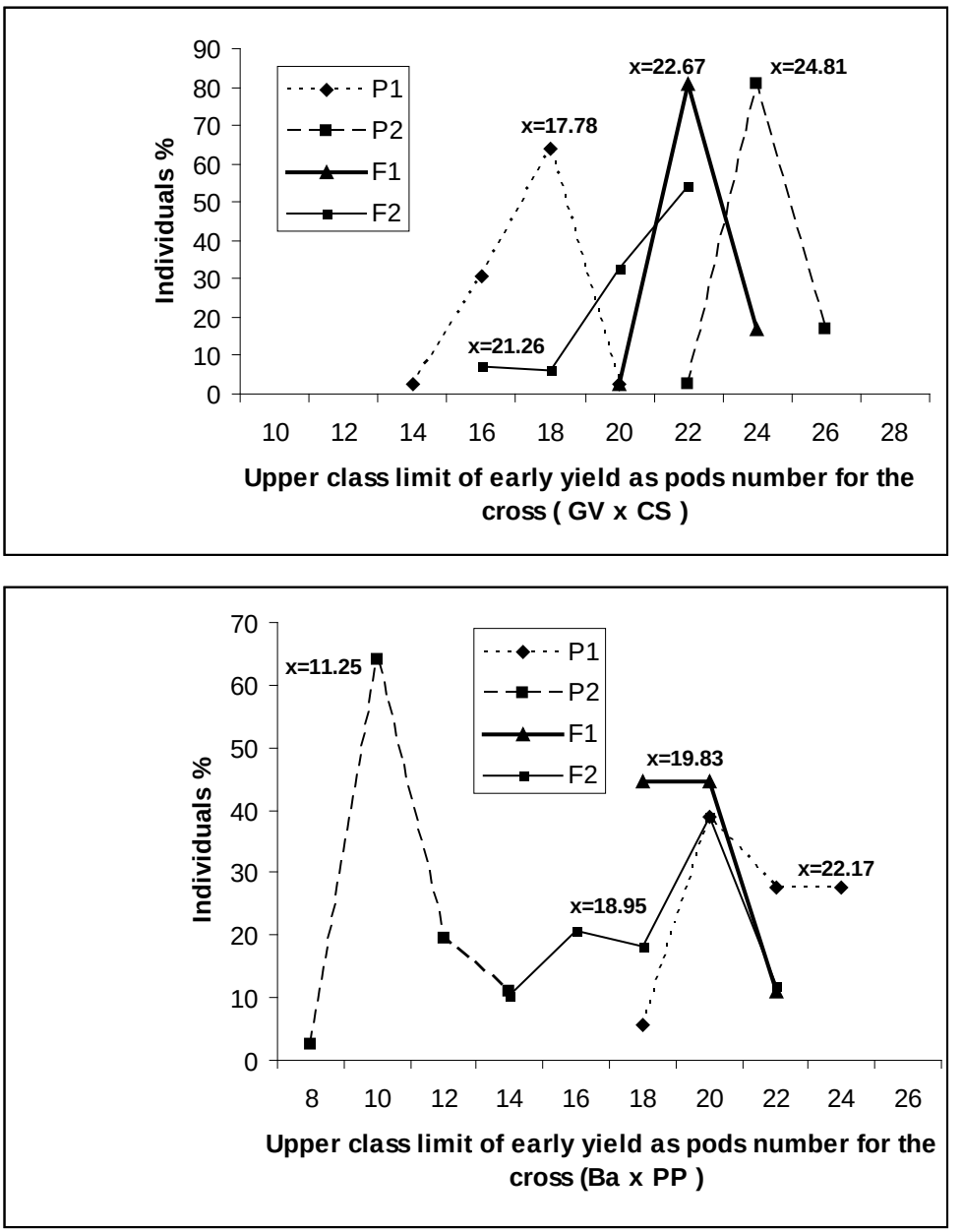


Fig. (2) : Distribution of early yield as pods number /plant in parental lines , F_1 and F_2 plants for the crosses (GV x CS) and (Ba x PP) .

significantly exceeded the Green Velvet and Punjab Podmini by about 7.028 and 10.917 pods/plant, respectively. The two parents for each cross had distinctly non-overlapping ranges.

Significant differences were observed between the means of the two F_1 crosses (GV x CS) and (Ba x PP), (22.667 and 19.833 pods/plant, respectively) and their expected means (21.292 and 16.709 pods/plant, respectively). The ADH%, based on the mid-parental values for the crosses (GV x CS) and (Ba x PP), was estimated as 6.455% and 18.702%, respectively, indicating dominance towards the high parents (CS and Ba). The obtained significantly negative ADH% values (-8.623% and -10.526%) for the two studied crosses, in relation to the high parents (HP), suggested partial dominance for the high number of pods. The estimated potence values (0.476 and 0.520, respectively) for the two crosses were in accordance with the suggested partial dominance and additive effects hypothesis (Table 2).

The F_1's frequency distribution for the two studied crosses were skewed towards the high parents, as expected when the characters supporting partial is controlled by partial dominance genes .

The distribution of the F_2 plants for the two studied crosses were stretched over a wide range for the number of pods, indicating that the character may be controlled by many genes. Slight skewness towards the low parents is observed. This unexpected skewness may be due to one or more of the following cases : (1) Apparent of some F_2 plants with an average number of pods for early yield within the range of the low parent due to some overlapping of the phenotypes. (2) It is possible that some plants appeared lower in number of pods due to some environmental factors. (3) Expression of high number of pods apparently influenced by modifying genes and environment.

The minimum number of genes was estimated as 3.343 and 3.599 according to Castle & Wright, and Burton formulae, respectively in the cross (GV x CS), and 3.544 and 4.125 in the cross (Ba x PP). The heritability (h^2_b) was estimated as 68.100% and 58.907%, in the two crosses respectively. The (h^2_b) indicates that earliness is relatively affected by environmental conditions.

The observed significant difference between the actual means of the F_1 and F_2 in the two crosses support the partial dominance of the high number of pods for early yield (Table 2) .

It appears from the examination of data presented that the number of pods for early yield is controlled by more than three pairs of genes with mostly additive gene action and partial dominance for the high number of

pods . Furthermore, the present results confirms previous findings of many workers, among them, Hussein *et al.* (1994), Ragaa *et al.* (1997), Moualla *et al.* (2005) and Hatem *et al.* (2008).

[3] Weight of pods for early yield :

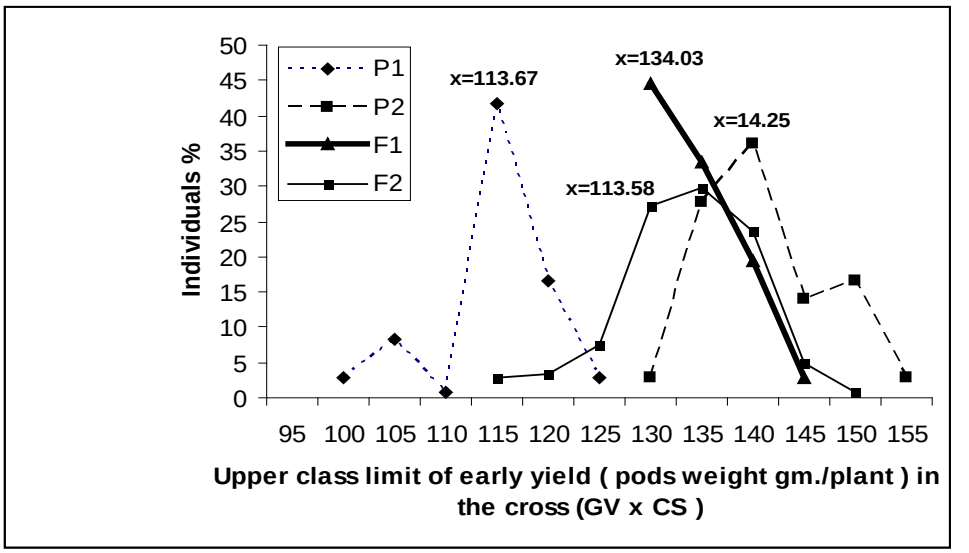
Data presented in Fig. (3) revealed significant difference between the two parental lines for each cross in this trait. The parents Clemson Spineless and Balady significantly exceeded the parents Green Velvet and Punjab Podmini by about 27.583 and 35.278 gm./plant, respectively. The two parents for each cross had distinctly non-overlapping ranges.

Significant differences were observed between obtained (134.028 and 130.799 gm./plant) and expected (127.459 and 122.222 gm./plant) arithmetic means of the F_1's populations for the two studied crosses. The ADH%, based on the MP values was estimated as 5.154% in the cross "GV x CS" and 7.500% in the cross "Ba x PP", indicating dominance towards the high parents. Partial dominance for the high weight of pods for early yield was detected in these crosses, since it showed significant negative ADH values in relation to high parents.These values were (-5.113% and -6.057%, respectively) for the two crosses. The estimated potence values (0.476 in the cross GV x CS and 0.520 in the cross Ba x PP) was in accordance with the suggested partial dominance and additive effects hypothesis (Table 2). Similar results were obtained by Ragaa *et al.* (1977) and Olawale (2007).

The F_1's frequency distribution was skewed towards the high parents, due to the partial dominance of the high parents . Significant difference between the actual means of the F_1 and F_2 supporting the partial dominance of the high weight (Table 2) .

The distribution of the F_2 plants for the two crosses streached over a wide range as weight of pods for early yield .The minimum number of genes was estimated as 3.711 and 4.133 according to Castle & Wright and Burton formulae, respectively, for the cross "GV x CS", and 3.724 and 4.227, respectively for the cross "Ba x PP". The BSH was estimated as 37.936% in the cross "GVxCS" and 57.965% in the cross Ba x PP. Predected gains (GS) as 518.010% and 878.100% for the two crosses. The relatively low BSH obtained indicates that early yield is controlled by many genes and accordingly affected by environmental factors .

It could be concluded that the early yield is controlled by more than three pairs of genes with mostly additive gene actions and partial dominance for the high weight.



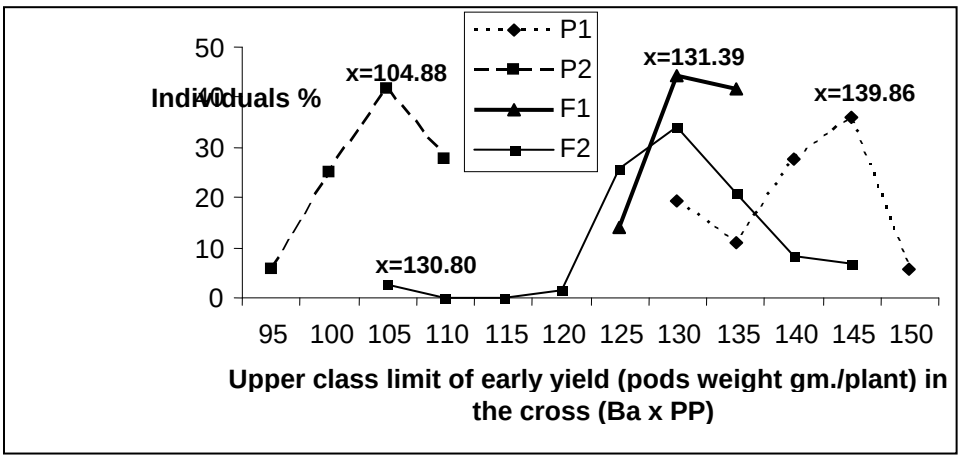


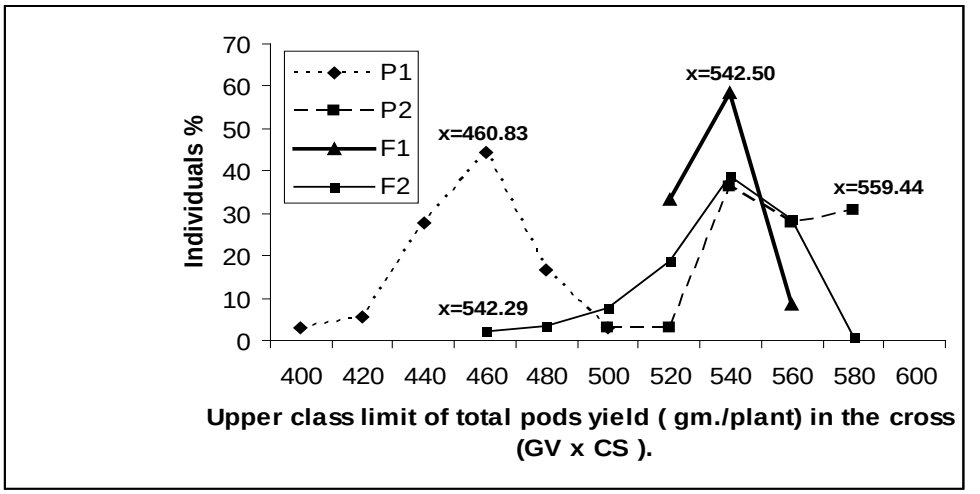
Fig. (3): Distribution of early yield (pods weight/ plant) in parental lines , F_1 and F_2plants for the crosses (GV x CS and Ba x PP) .

[4] Total yield (weight of pods):

Data presented in Fig. (4) showed highly significant difference between the two parental lines in each studied cross in total pods weight. The parent Clemson Spineless (CS) exceeded Green Velvet (GV) by about 98.611

gm./plant, but the parent Balady (Ba) exceeded Punjab Podmini (PP) by about 123.612 gm./plant.

Significant difference was observed between both obtained (542.500 gm./plant) and expected (483.139 gm./plant) arithmetic means of the F_1 population (GV x CS), but observed between both obtained (507.361 gm./plant) and expected (465.000 gm./plant) arithmetic means of F_1 population for the cross (Ba x PP).



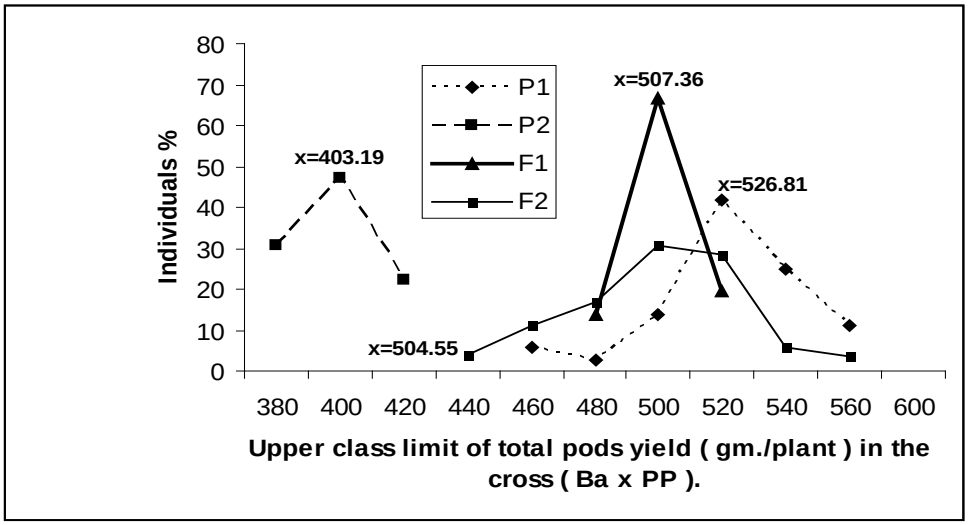


Fig. (4) : Distribution of total pods yield (gm./plant) in parental lines , F_1 and F_2 plants for the crosses (GV x CS) and (Ba x PP) .

The ADH% was estimated as 6.344% and 9.110% based on MP for the crosses "GV x CS" and "Ba x PP", respectively. These values -3.029% and -3.691% based on HP for the two crosses, respectively, suggesting partial dominance for the high yield, with additive gene action. The estimated potence values (0.656 and 0.685, respectively for the two crosses) is in accordance with the suggested partial dominance and additive effects hypothesis (Tables 2).

The F_1's frequency distribution was skewed towards the high parents, supporting the partial dominance of the high total yield.

The distribution of the F_2 plants in the two crosses were stretched over a wide range of the total pods weight scale without distinct classes, indicating that the character may be controlled by many genes. The minimum number of genes for the crosses "GVxCS" and "Ba x PP" was estimated as 3.017 and 3.667 according to Castle-Wright and Burton formulae, respectively, for the first cross and 3.169 and 3.914, respectively, for the second cross. The heritability (h^2_b) was estimated as 43.900% for the first cross and 64.043% for the second cross and (GS) as 2116.738 and 3596.888% respectively. The relatively low (h^2_b) obtained is in accordance with the continuity distribution of F_2 plants and the estimated minimum number of genes. Moualla *et al.* (2005) who found heritability estimated as 69.0% for the total pods weight.

Data presented in Fig. (4) showed that the means of F_1 and F_2 in the two crosses did not significantly differ, indicating that the F_2 populations could be used in commercial production of okra regarding these crosses .

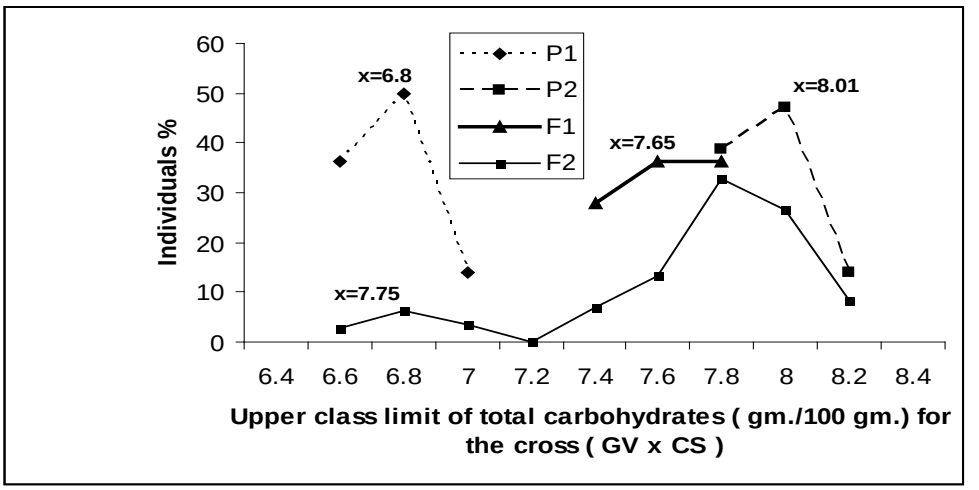
It appears from the examination of data presented that this trait is controlled by more than three pairs of genes with mostly additive gene action and partial dominance for the high yield. The present results confirms previous reports of Ragaa *et al.* (1997), Bhalekar *et al.* (2004), Neeta *et al.* (2004) Olawale (2007) and Hatem *et al.* (2008), who found that the total pods yield was partial dominance for the high yield and additive gene effects.

[5] Total carbohydrates:

Data presented in Fig. (5) showed highly significant differences between the two parental lines in the two studied crosses in total carbohydrates content in pods. The total carbohydrates content of Green Velvet ranged from 6.60 to 7.0 gm./100 gm. with average of 6.797 gm./100gm. Meanwhile, it ranged from 7.800 to 8.200 gm./100gm. with average of 8.001 gm./100g., in the pods of Clemson Spineless, for the first cross (GV x CS). In this respect, it ranged from 7.600., to 8.200 gm./100gm., with average of 7.911 gm./100gm., in Balady and ranged from 6.400 to 6.800 gm./100gm., with average of 6.547

gm./100gm., in Punjab Podmini for the second cross (Ba x PP). The two parents for each cross had distinctive non-overlapping ranges (Fig. 5).

Significant differences were observed between the obtained and expected F_1 means of the two crosses "GVxCS" and "Ba x PP" . The



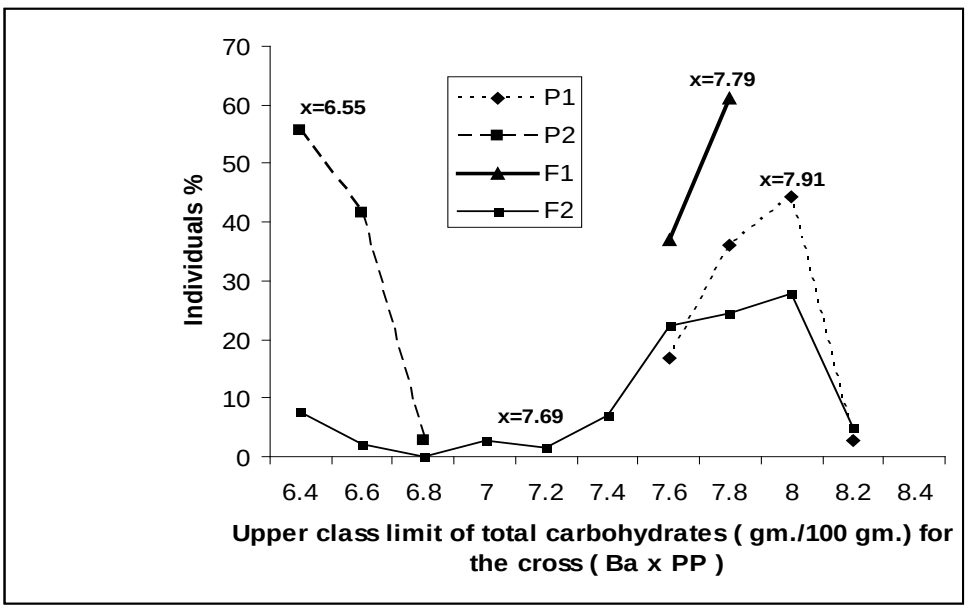


Fig. (5): Distribution of total carbohydrates content (gm. /100gm. Dry weight) for pods in parental lines , F_1 and F_2 plants for the crosses (GV x CS) and (Ba x PP) .

obtained means were (7.653 and 7.792 gm./100g., respectively) while the expected means were (7.40 and 7.229 gm./100gm., respectively). The ADH% was estimated as 3.400% and 7.788%, respectively, based on MP and as -4.409% and -1.504%, respectively, based on high parents content, in the two crosses. This results suggesting partial dominance for the high content for the first cross and complete dominance for the second cross . The estimated potence values (0.419 and 0.826, respectively) for the two crosses is in accordance with this suggestion (Table 2).

The F_1's frequency distribution for the two crosses was skewed towards the high parental lines, supporting the partial and complete dominance of the high total carbohydrates content in pods (Fig. 5).

About 67.361% of the F_2 plants for the cross GV x CS and 79.167% for the cross Ba x PP were convered the range exhibited by the high parents content (Clemson Spineless and Balady) for the two crosses, and F_1 populations. The remaining F_2 plants (32.639% and 20.833%, respectively) for the two crosses covered the range exhibited the recessive parents (Green Velvet and Punjab Podmini). This distribution fit a 3 : 1 ratio using x^2 test with probability of 0.9 – 0.75. This distribution leads to suggest that total carbohydrates content in pods of okra in these two crosses is controlled by a single pair of genes with partial or complete dominance of the high content.

Heritability in broad-sense (BSH) in the studied crosses (GV x CS and Ba x PP) were 89.138% and 93.109%, respectively. These high values suggested that progress could be made in total carbohydrates in pods of okra by selection within segregating progenies. Considerable progress of this trait by breeding and selection was also verified by the calculated predicted gain (GS) which was estimated as 72.967% and 89.935%, respectively for the two studied crosses. Meanwhile, the calculated inbreeding depression ID was -1.279% and 1.364%, respectively for the two crosses.

The minimum number of genes was estimated as 1.284 and 1.393 according to Castl-Wright and Burton formulae, respectively for the cross Ba x PP.

It appears from the examination of data presented that this trait was simply inherited. It is controlled by one pair of genes with partial or complete dominance for the high content.

It seems that, this was the first attempt to study the inheritance of total carbohydrates in pods of okra. From the available it can be stated that critical review of literature on the subject failed to reveal any report of this nature.

REFERENCES

Adeniji, O. and T. Olawale (2007). Heritability and Number of Genes Governing Pod Yield in West African Okra *Abelmoschus caillei* (A. chev) Stevels. Agric. J. 2, (4): 483-486.

Association of Official Analysis Chemists (1990). Official and tentative methods of analysis. The A.O.A.C., Washington D.C., U.S.A.

Bhalekar, S.G., U.T. Desai and C.A. Nimbalkar (2004). Heterosis studies in okra. J. of Maharashtra Agric. Univ., 29, (3): 360-362.

Burton, G.W. (1951). Quantitative inheritance in pearl millet, (*Pennisetum glaucum*). Agron. 43: 409-417.

Castle, W.E. and S. Wright (1921). An improved method of estimating the number of genetic factors concerned in cases of blending inheritance. Sci., 54: 223.

Hatem, A.K., M.K. Hatem and Seham M. Aly (2008). Behaviour of some economic characteristics in Okra (*Abelmoschus esculentus* (L.) Moench). Minufiya J. Agric. Res. 33, (6): 1525-1541.

Johanson, H.W., H.F. Robinson and R.E. Comstock (1955). Estimates of genetic and environmental variability in Soyabean. Agric. J. 47: 314-318.

Neeta, S.; P. Ganesh, J.R. Yadav and B. Singh (2004). Heterosis and inbreeding depression in okra. Progressive Agric., 4, (1): 63-65.

Ragaa, A. Grawish, M.A. Fatthallah, R.M. Khalil, W.S. Ragheb and S.M. Mansour (1997). Combining ability and heterosis for some characters in okra. Minufiya J. Agric. Res. 22, (6): 1613-1632.

Saeed, A., A.J. Malik, M. Abid, M.B. Kumbhar and K. Abdul (2004). Inheritance studies in okra under drought conditions. Sarhad J. of Agric., 20, (1): 57-65.

Shukla, A.K., N.C. Gautam and A.K. Yiwari (1989). Heterosis and combining ability in okra (*Abelmoschus esculentus* (L.) Moench). Vegetable Sci. 16, 191-196. (C.F. Plant Breed. Abstr. 60: 10574).

Singh, R.K. and G. Mandal (1993). Studies on heterosis in okra (*Abelmoschus esculentus* (L.) Moench). Annals Agric. Res. 14, 429-433 (C.F. Plant Breed. Absetr. 65: 5359).

Steel, R.G.D. and J.H. Torrie (1960). Pricipal and procedures of statistics. McGraw, N.Y. 481 p.

Warner, R.A., D.C. Sanders and W.R. Henderson (1980). Inheritance of tolerance to Rhizoctonnia Fruit Rot of Tomato. J. Amer. Soc. Hort. Sci. 105: 819-822.

دراسات وراثية لبعض الصفات على الباميا

أحمد قطب حاتم . محمود قطب حاتم . سيد محمود أحمد محمد

بحوث الخضر . معهد بحوث البساتين . مركز البحوث الزراعية

الملخص العربى

أجريت هذه الدراسة بمزرعة محطة بحوث البساتين بالقناطر الخيرية خلال المواسم الصيفية لأعوام ٢٠٠٦ ، ٢٠٠٧ ، ٢٠٠٨ بهدف الحصول على المزيد من المعلومات الخاصة بوراثة بعض الصفات في الباميا حيث تفيد هذه المعلومات المربى في وضع وتنفيذ برامج التربية لتحسين هذا المحصول .

واستخدمت في هذه الدراسة أربعة سلالات أبوية من الباميا وهى جرين فلفيت ، وكلمسون سباينلس ، والبلدى ، وبانجاب بودمين . وقد أجريت لهذه السلالات التربية الداخلية لعدة أجيال لتنقيتها وراثيا . وقد أجرى التهجين في موسم ٢٠٠٦ لإنتاج الجيل الأول . وتم اختيار الهجينين (جرين فلفيت × كلمسون سبانيلس) و (والبلدى × بانجاب بودمين) وذلك على حسب الاختلافات في الصفات المراد دراستها بين الأباء .

وفى موسم ٢٠٠٧ زرعت بذور الأباء الأربعة والهجينين اللذان تم اختيارهما وتم إنتاج الجيل الأول بين الأباء والجيل الثانى من التلقيح الذاتى لنباتات الجيل الأول .

وفى موسم ٢٠٠٨ زرعت الأباء والهجن والجيل الثانى في تجربة مصممة بطريقة القطاعات الكاملة العشوائية في ثلاث مكررات . والصفات التي تناولتها هذه الدراسة هى:- عدد الأيام اللازمة لظهور أول زهرة على النبات ، وعدد ووزن المحصول المبكر ، ووزن المحصول الكلى ، ومحتوى القرون من الكربوهيدرات الكلية . وقد أخذت البيانات على النباتات الفردية .

وكانت أهم النتائج المتحصل عليها هى :

[١] كانت صفة وراثة عدد الأيام من الزراعة حتى الازهار صفة بسيطة التوريث مع وجود سيادة تامة للتبكير في الإزهار .

[٢] أظهرت النتائج أن كلا من صفة المحصول المبكر والكلى يتحكم فيها أكثر من ثلاث أزواج من الجينات مع وجود التفاعل المضيف للجينات ووجود عدد من الجينات المحوره لظهور صفة التبكير وارتفاع المحصول . وكانت السيادة جزئية في كل من هذه الصفات . وكان تأثير الظروف البيئية على هذه الصفات ملحوظاً .

[٣] كانت صفة محتوى القرون من الكربوهيدرات الكلية صفة بسيطة التوريث مع وجود سيادة جزئيه للمحتوى العالى في وجود التفاعل المضيف للجينات ، أو سيادة تامة للمحتوي العالي .