Multiple trait selection in Egyptian variety Giza 90

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SUMMARY

The present study was carried out at Shandaweel Res. Sta. Sohag, Cotton Res. Inst., ARC during the three summer seasons of 2013-2015. The basic materials were seeds of 60 single plants selected from the breeding nursery of renewing and maintenance of Giza 90 (G. 90) according to field evaluation and laboratory determinations in 2012 season. The selfed and open pollinated (natural) bolls of each plant were picked and ginned separately (the same materials used to produce G. 90 nucleolus). G. 90 is traced back to a cross between Giza 83 × Dandara, and released commercially in season 2000. G. 90 is a commercial Egyptian cotton cultivar (*G. barbadens* L.) cultivated at Upper and Middle Egypt regions and characterized by high yielding ability, high ginning out turns (more than 120 pounds), and early maturity with staple length of about 31 mm.

These materials were subjected to evaluate three methods of pedigree selection as follows:

1. Single trait selection for lint yield/ plant (LY/ P)
2. Thirteen selection models of modified desired gain selection index (Pesek and Baker 1969&1970)
3. The traditional method followed by Cotton Maintenance Res. Sec. for renewing and maintenance of Egyptian cotton varieties, represented by the check strain (the newest nucleolus of Giza 90) in the experiments every year.

In season 2013 selfed seeds of each of the 60 selected plants along with the check strain were planted on March 28th, 2013 in a plot in the breeding nursery. Each plot included five rows 7.0 m long, 60 cm apart and 70 cm between hills within a row (10 plants in a row). The middle row was left without planting to facilitate plant screening and selfing. At

flowering, self-pollination was done for the best plants in the breeding nursery, and days to first flower (DFF) were recorded for each plant (the total number of selfed plants were 847). Before picking ten open sound bolls were picked from each plant to measure boll weight (BW; g), seed index (SI; g), and lint index (LI; g). After picking at the end of the season the characters recorded for each single plant were seed cotton yield/ plant (SCY/ P; g), lint yield/ plant (LY/ P; g), lint percentage (Lint %), number of bolls/plant (NB/ P), number of seeds/ boll (NS/ B), Micronaire reading (Mic), fiber strength as Pressley Index (PI) was measured by the H.V.I instrument and Upper half mean length (UHM, mm) was measured by the H.V.I. instrument.

Selection procedures

1. Single trait selection for LY/P

   Selfed seeds of the best 20 single plants in LY/P were saved for season 2014.

2. Selection index models

   Selfed seeds of the 20 superior plants for each model were saved for next season.

In the second season of 2014, the selected plants covered single trait selection for LY/ P and selection index models were planted by selfed seeds on April 1st, 2014. A randomized complete blocks design of three replications was used. The plot was single row 4m in length, 60cm apart and 40 cm between hills within a row. One row was left without planting between each two rows to facilitate selfing and plant screening. After full emergence the hills were thinned to one plant/ hill. The recommended cultural practices for cotton production were adopted throughout the growing season. The same studied characters were recorded as in the previous season. The selfed seeds of the best 10 plants for each selection procedure were saved for evaluation in the next season

(2015) as in season 2014. The experimental design, plot size, and agricultural practices were as in the previous season. The results could be summarized as:

A. Description of the base population; season 2013.

Mean seed cotton yield/ plant (150.77 g), lint yield/ plant (58.69 g), number of bolls/ pant (47.83) accompanied with high coefficients of variation of 39.81, 39.74 and 39.45%, respectively. Mean boll weight (3.15 g), number of seeds/ boll (30.0) showed medium coefficients of variation of 8.40 and 8.67%, respectively. Otherwise, the coefficients of variability in seed index, lint index, days to first flower and technological properties were very low and ranged from 2.49 for days to first flower to 7.40% for Micronaire reading. It should be recalled that the observations were taken on 847 plants out of about 2000 plants or more. Weak plants were excluded. These results reflect the method of renewing strains and varieties of Egyptian cotton. The breeder devotes his effort to insure technological properties, fineness, strength and fiber length, and select the plants matched Giza 90 type in fiber properties irrespective of their yield and its components. Therefore, the coefficients of variability of Micronaire reading, Pressely index and upper half-mean length were low, reflecting the great similarity of the plants in fiber properties. Likewise, the coefficients variability in seed index, lint index and days to first flower were low as in all the Egyptian cottons. The high coefficients of variability of seed cotton yield/ plant, lint yield/ plant, number of bolls/ plant and boll weight indicate to the feasibility of selection for these traits with good preservation of fiber properties.

B. Season 2014 (First cycle selection)

1. Mean squares of the genotypes of the selected traits and other correlated traits after one cycle of selection were significant ($P \leq 0.05$ to $P \leq 0.01$) except few cases. Mean squares of genotypes for boll

weight were significant in index 2 and index 9, and for DFF in indices No. 2, 3, 5, 7, 8 and 13.

2. Phenotypic coefficients of variability of LY/ P decreased rapidly from 39.74 in the base population to 7.05% after one cycle of selection for LY/ P *per se*. However, it ranged from 12.15 to 15.93% for the same trait; LY/ P in all the indices included LY/ P. This indicates that selection indices were better than single trait selection in preserving variability for more cycles of selection.
3. Generally, it could be concluded that after one cycle of selection for different selection indices, the coefficients of variation were high for SCY/P, LY/P and NB/P, medium to low for BW and low for the other traits.
4. It should be indicated that genotypes mean squares was not significant for some cases meaning that the genetic variance was an estimate of zero. Therefore, the GCV%, PCV% and heritability were not calculated.
5. The completely depletion of genetic variance was found for DFF in index 3, index 5, index 7, index 8, index 11, and index 13, for NS/ B in index 1 and index 11, and for lint and seed indices for index 11.
6. Broad sense heritability estimates of the traits under selection pressure were mostly high. It ranged for LY/P from 61.40% (single trait selection for LY/P) to 97.78% in index 11, for NB/P from 80.81 to 90.06%, for LI from 64.29 to 73.53 and from 46.59 to 64.69% for NS/ B.
7. Means LY/P of the 20 selected families ranged from 31.80 to 45.00 with an average of 37.88g. The average of the 20 selected families significantly ($p \leq 0.01$) out yielded the check strain by 20.87%. The best ten families in LY/P saved for the next cycle of selection out yielded the check strain by 21.57 to 43.59%.

8. Index 1 involved lint yield/ plant and number of bolls/ plant. The overall means of all traits did not differ significantly from the check strain. However, eight families were significantly ($P \leq 0.05$ to $P \leq 0.01$) better than the check strain in LY/P, and two families for number NB/ P. Likewise, six, five, four, and one families showed significant increase compared to the check strain for SCY/ P, Lint%, BW and seed index; respectively.
9. Selection index 2. The observed gain after one cycle of selection of the individual families indicated that 12 families showed significant ($P\leq 0.05$ to $P\leq 0.01$) genetic gain in SCY/P and LY/P, which ranged from 15.28 to 40.90% for SCY/P, and from 17.53 to 38.80% of the check strain for LY/ P.
10. Selection index 3. Selection index 3 involved LY/P and NS/B. The significant observed genetic gain ranged from 17.86 to 43.53% for SCY/P, from 20.08 to 95.41% for LY/P, from 15.06 to 86.83%, for NB/P, from 9.63 to 16.97% for BW and from 8.48 to 16.37% for SI.
11. Selection index 4. Involved LY/ P and LI. The significant observed genetic gain ranged from 18.33 to 39.53% for SCY/P, from 1934 to 40.40% for LY/P, from 2.84 to 5.53% for lint %, from 29.38 to 31.08% for NB/P, and from 10.71 to 23.83% of the check strain for BW.
12. Selection index 5. Included LY/P and DFF. The observed genetic gain in percentage of the check strain indicated that 8, 9, 4, 4, 6, 4, and 3 families exceeded the check strain in SCY/P, LY/P, lint%, NB/ P, BW, SI and NS/ B; respectively.
13. Selection index 6. Involved LY/P, Micronaire reading, Pressely index and upper half-mean length. This index was omitted because the three fiber tests could not be determined in the second season.

14. Selection index 7.Involved NB/P and NS/B. The observed genetic indicated that 6, 8, 1, 5, 4, 3 and 2 families significantly (P≤ 0.05 to P≤ 0.01) exceeded the check strain for SCY/P, LY/P, LINT%, NB/P, BW, SI and NS/B; respectively.
15. Selection index 8. Families NO. 13, 12, 5, 7, 7 and 5 were significantly (P≤ 0.05 to P≤ 0.01) better than the check strain for SCY/P, LY/P, lint%, NB/P, BW and NS/B; respectively.
16. Selection index 9. Twelve families showed significant observed genetic gain in yields ranged from 12.86 to 38.68% for SCY/P, and from 14.23 to 43.59% for LY/P. Five families, 6, 9, 2 and 3 showed significant observed genetic gain in Lint%, NB/ P, SI, NS/ B and DFF; respectively.
17. Selection index 10.Involved LI and NS/ B. Numerous individual families showed significant improvement over the check for SCY/P (8 families), LY/P (8 families), NB/P (5 families), BW (3 families), SI (5 families) and one family for each of NS/ B and DFF.
18. Selection index11.Incorporated LY/P, NB/P and NS/B. Ten selected families showed significant (P≤ 0.05 to P≤ 0.01) observed gain ranged from 17.70 to 43.12% for SCY/ P, and from 17.53 to 38.59% of the check strain for LY/P. Eight families for NB/ P and two families for each of SI and NS/B significantly exceed the check strain. Likewise, three families were earlier in flowering than the check strain.
19. Selection index12. Involved LY/P, NB/P and LI. Eight families showed significant (P≤ 0.05 to P≤ 0.01) genetic gain in seed cotton yield/ plant ranged from 18.33 to 39.53% of the check. Likewise, 13 families out yielded the check in LY/P, ranged from 16.68 to 40.71%. Three, eight, five, one and two families exceeded the check in lint%, NB/P, BW, NS/B and DFF.

20. Selection index13. Involved LY/P, LI and NS/ B. The significant (P≤ 0.05 to P≤ 0.01) observed genetic gain was recorded for 8 families for both of SCY/P and LY/P. The significant observed genetic gain ranged from 17.74 to 43.12% for SCY/P, from 16.46 to 38.59% for LY/P, from 15.06 to 36.37% for NB/ P, from 16.73 to 16.97% for BW, and from 10.32 to 16.73% of the check for SI. One family was earlier in flowering than the check strain.
21. Selection index14. Included NB/P, LI and NS/B. The significant (P≤ 0.05 to P≤ 0.01) observed genetic gain ranged from 18.33 to 39.53% for SCY/P, from 19.34 to 40.40% for LY/P, from 15.39 to 31.08% for NB/P, and from 12.88 to 16.61% of the check strain for BW. One family exceeded the check strain for SI (12.70%) and DFF (-3.54%).

C. Season 2015 (Second cycle selection).

1. The analysis of variance indicates that the genotypes mean squares (families) were not significant for LY/P, SCY/P and NB/P when selection practiced for LY/ P. However, mean squares of genotypes of the other traits were significant.
2. The phenotypic coefficient of variation in LY/P dropped from 39.74% in the base population to 4.78% after two cycle of selection. However, selection indices which included LY/P showed GCV % larger than that of selection for LY/P *per se*. The genetic coefficient of variation in LY/P was 10.35, 9.75, 5.65, 12.35, 12.32, 0.0, 7.61 and 0.0 for indices No. 1, No. 2, No. 3, No. 4, No. 5, No. 11, No. 12 and No. 13; respectively. It could be concluded that the genetic variability after selection indices in general was larger than that after single trait selection.
3. Single trait selection for lint yield/ plant: Nine out of ten individual families showed significant increase in yields than the check strain. The observed genetic gain indicated that 9, 1, 6, 2, 1, 1, 2, 1 and 4

families significantly ($P \leq 0.05$ to $P \leq 0.01$) exceeded the check strain in yields, lint%, NB/P, BW, SI, LI, NS/B, PI and UHM length, respectively. The significant genetic observed gain in the selection criterion LY/ P ranged from 14.59 to 27.19% of the check strain.

4. Selection index 1 (LY/P and NB/P): The observed genetic gain in LY/ P (Table 38) indicates that nine families and their mean significantly ($P\leq 0.05$ to $P\leq 0.01$) out yielded the check strain. The significant observed gain in LY/P ranged from12.32 to 33.77%. Six families and the average of selected families showed significant ($P\leq 0.01$) observed genetic gain in NB/P ranged from 11.32 to 35.48 %.
5. Selection index 2 (LY/ P and BW): Four selected families showed significant observed genetic gain in LY/P ranged from 20.51 to 38.84%. Likewise, four families showed significant observed genetic gain in BW ranged from 10.67 to 20.0 %.
6. Selection index 3 (LY/P and NS/B): The observed genetic gain indicates that 8, 8, 3, 2, 2, 6,4 and 5 families showed significant observed genetic gain in SCY/P, LY/P, lint%, NB/P, BW, SI, PI, and UHM length; respectively. The significant observed genetic gain in LY/P ranged from 17.60 to 35.46 %.
7. Selection index 4 (LY/P and LI): Four selected families showed significant increase in LY/P than the check strain. However, index 4 failed to increase LI. The significant observed genetic gain in LY/P ranged from 19.94 to 34.88 % of the check strain. The overall average of selected families showed significant observed genetic gain in LY/ P of 15.05%. The same four families (No. 372, No. 93, No. 265, and No. 143) which showed significant observed genetic gain in LY/P showed significant observed genetic gain in SCY/ P and NB/ P.
8. Selection index 5 (LY/ P and DFF): The observed genetic gain showed a significant average of 12.95, 14.06 and 6.33% for SCY/P,

LY/P and PI. The significant observed genetic gain in five individual families ranged from15.76 to 32.90% for SCY/ P and from 17.51 to 33.76 % for LY/ P. Significant observed genetic gain in PI of four families ranged from 9.16 to 16.11 %. Three families showed significant genetic gain in UHM length ranged from 3.08 to 5.58 %.

9. Selection index 7 (NB/P and NS/B): The observed genetic gain indicated that 6, 6, 5, 2, 6, 3 and 6 families showed significant genetic gain for SCY/P, LY/P, Lint%, BW, SI, PI and UHM length; respectively. The significant genetic gain in LY/P ranged from 19.94 to 35.45 %. Index 7 recorded the best average of LY/P (43.13) and ranked the first in improving LY/P respect to the 14 selection index models.
10. Selection index 8(NB/P and LI): Four families showed significant increase in NB/ P over the check. Otherwise, index 8 failed to improve LI. Seed cotton yield/plant of the selected families ranged from 88.63 to 121.43 with an average of 105.35 compared to 91.85 gm for the check strain. Lint yield/plant of the selected families ranged from 34.53 to 47.83 with a significant average of 40.80 compared to 35.46 gm for the check strain. Seven families showed significant genetic gain in both of SCY/P and LY/P. Two, five and one families showed significant genetic gain ($P \leq 0.01$) in lint %, NB/ P and Micronair reading, respectively. The three superior families in LY/P were No. 372 (34.88%), No. 143 (23.52%) and No. 819 (20.33 %). These families showed significant differences in fiber properties with the check strain. However, family No. 766 showed significant genetic gain in LY/P of 12.32 %, and -15.38 % in Micronaire reading with significant increase in PI of 10.84 %. Family No. 766 could be considered a promising family because it was significantly out yielded Giza 90 nucleolus and showed the finest fiber which was less

than Giza 90 by -15.38 % in Micronaire reading. It is a great success to decrease Micronaire reading of Giza 90 from 3.90 to 3.3 in the selected family No. 766.

11. Selection index 9 (NB/P and SI): The observed genetic gain indicated that families (No. 565, No. 673 and No.737) showed significant observed genetic gain of 16.13, 19.35 and 19.35 % in NB/ P, respectively. Furthermore, seven families showed significant observed genetic gain ranged from 15.34 to 40.81% for LY/P and from 17.72 to 36.71 % for SCY/P. All the seven families which showed significant observed genetic gain in LY/P except one (No. 148) showed favorable significant observed genetic gain in one or two of the fiber properties. The best family in LY/P (No. 565) was late in maturity. Family No .673 showed genetic gain of 28.60 % for LY/P and 10.21 % for PI. Family No. 737 showed increase of 27.66 % in LY/ P, 10.84 and 5.20 % for PI and UHM length; respectively.
12. Selection index 10 (LI and NS/ B): Data of the observed genetic gain indicates that 4, 5, 3, 2,3, 1, 4 and 2 families showed significant observed genetic gain in SCY/P, LY/P, lint %, BW, SI, DFF, PI and UHM length; respectively. The significant genetic gain in LY/P ranged from 20.90 to 35.45%.
13. Selection index 11 (LY/P, NB/P and NS/B): Mean LY/P ranged from 40.80 to 45.90 with a significant average of 42.59 gm compared to 35.46 gm/ plant for the check strain. Mean of NB/P ranged from 33.00 to 37.67 with a significant average of 35.50 compared to 31.0 bolls/ plant for the check strain. Likewise, NS/B ranged from 17.33 to 19.0 with an average of 18.40 compared to 19.60 for the check strain. Mean observed genetic gain was significant for LY/P (21.11%). But, in SCY/ P and NB/ P was insignificant with the check strain. One family showed significant observed genetic gain in SCY/ P), LY/ P

and NB/P. This family is No. 73. The significant genetic gains in SCY/P, LY/P and NB/P were 26.15 %, 29.44% and 19.35%.

14. Selection index 12 (LY/P, NB/P and LI): Mean observed genetic gain was significant for SCY/P (16.54 %), LY/P (17.21%) and NB/P (12.90%). Six families showed significant observed genetic gain in SCY/P and LY/P. The significant genetic gain in LY/P ranged from 16.84 to 34.88 %. The best family was No. 372 which showed significant genetic gain of 32.20, 34.88, 2.05 and 22.58 % for SCY/P, LY/P, Lint % and NB/P; respectively. Furthermore, this family showed insignificant differences with the check strain in fiber properties. Family No. 803 showed significant genetic gain of 25.72, 29.81, 3.26, 16.13, 9.18, 8.24, and 6.52 % for SCY/P, LY/P, Lint %, NB/P, SI, LI and UHM length; respectively.
15. Selection index 13 (LY/P, LI and NS/P): Some superior families were detected by index 13. The observed genetic gain indicates that family No. 540 showed the highest significant genetic gain of 31.12, 35.45, 3.24, 14.33, 6.43 and 2.98 % for SCY/P, LY/P, Lint %, BW, SI and UHM length, respectively. Family No. 73 showed significant ($P \leq 0.01$) genetic gain of 29.44% without effects on fiber properties of Giza 90. Family No. 437 showed significant genetic gain of 25.49 % for LY/ P and 14.42 % for Pressley index. Families No. 590 and No. 586 showed significant genetic gain in LY/P of 21.83 and 20.90 and in PI of 8.11 and 22.84 %; respectively.
16. Selection index 14 (NB/P, LI and NS/P): The genetic gain indicated that six families showed significant genetic gain in NB/ P ranged from 12.90 to 19.35% with a significant average of 9.68 %. The improvement in NB/P accompanied with improvements in SCY/P and LY/P. Seven families showed significant genetic gain in LY/P ranged from 18.64 to 29.81%.

D- Comparison between selection procedures

Selection procedures were subjected to two ranks. In the first rank, the number of detected families showed significant genetic gain in LY/P was implemented. Meanwhile, in the second rank v implemented the number of detected families showed significant genetic gain in LY/P ≥25% of check strain. The observed genetic gain of the detected families was summed to give total genetic gain. In the first rank index 1 (LY/P and NB/ P) ranked the first and scored total gain of 206.97% followed by index 3(LY/P and NS/B), selection for LY/P *per se*, index 9 (NB/P and SI) and selection index7 (NB/P and NS/ B). In the second rank selection index 7 ranked the first, index 9 ranked the second, index 1 ranked the third, index 3 ranked the fourth, and selection for LY/P per se ranked the ninth. It could be concluded that selection index was better than single trait selection in detecting the superior families in LY/P.

Results indicate that many models of selection index were superior to single trait selection for LY/P. Furthermore, 15 promising elite strains characterized by high yielding ability with significant improvement in one or more of the three main fiber properties. Generally, it could be concluded that the present program for maintenance and renewing Egyptian cotton varieties is a precise and perfect program to preserve the fiber quality. But, this program should be modified to allow the isolation of superior high yielding off types from the breeding nursery characterized by improvement in one or more fiber quality.