LINE X TESTER ANALYSIS FOR SOME ECONOMICAL USEFUL CHARACTERS IN KENAF (*Hibiscus cannabinus* L.)

AMANY M.M. EL-REFAIE

Fiber Crops Res. Section, Field Crops Res . Inst., ARC, Giza

(Manuscript received 23 May 2011)

Abstract

This study was conducted with the objective of estimating combining ability and gene action for some economical useful traits in kenaf. This was achieved via evaluating 15 progenies of the line x tester analysis consisting of five females (P_1=S,13, P_2= S.114, P_3= S.119, P_4= S.98/205 and P_5= S.38) and three males (P_6=Giza3, P_7=S.105/2, and $P_{8=}$S.112). In 2010, the eight parents and their 15 F_1's progenies were evaluated in a randomized complete block design with four replications at Ismailia Agric. Res. Station Farm, Ismailia Governorate, Egypt. The predominant role of additive gene action was involved in the expression of all studied characters except for each of plant height, technical stem length and fiber length. Therefore, selection can be performed followed in the F_2 and subsequent generations for all studied characters, except for the previous three traits. P_3 and P_7 exhibited significant and positive GCA effects for green weight and most of its components as well as P_6 for three important components (green weight/plant, fiber weight/plant and fiber percentage), indicating that the use of these parents in kenaf breeding programs could increase green weight and consequently increasing fiber yield. Concerning, seed weight per plant results indicated that the P_7 followed by P_3 and P_5 exhibited high best combiners for seed weight. The cross $P_3 \times P_7$ exhibited significant positive SCA effects for green weight and most components (plant height, technical stem length, fiber length, fiber weight and seed weight per plant). This cross involved high x high general combiners for these traits. Also, $P_4 \times P_6$ (high x high) for fiber percentage. Whereas, $P_4 \times P_6$ exhibited significant positive SCA effects as well as high x low general combiner parents for green weight/plant and most important components. Phenotypic (rp) and genotypic (rg) correlation coefficients concluded that the green stalk weight, plant height, technical stem length, fiber percentage and fiber length are the major components contributing to fiber weight/plant in kenaf. Therefore, selection for these traits will improve the fiber yield in kenaf.

Key words: *Kenaf, Line x tester, Combining ability, Gene action,.*

INTRODUCTION

Kenaf (*Hibiscus cannabinus* L) is one of the most important fiber crops in the world. It has been cultivated and used as cordage crop to produce twine, rope, gunny-bag and sackcloth. Many produces from kenaf have been developed, such as pulping and papermaking, oil absorption and potting media, board making, filtration media and animal feed (Sellers and Reichert, 1999, Cheng, 2001). In Egypt, Kenaf is cultivated to produce bast fiber, which is used alone or mixed with jute fiber to manufacture bags, twine, ropes and other products. Also as a raw material it can be used an alternative to wood fiber in pulp and paper industry. Moreover, kenaf seeds contains similar oil to that extracted from cotton seeds but free from gossypol (poison material) as edible for human consumption.

One of the most important objectives of kenaf breeding in Egypt is to improve, simultaneously, fiber yield, green stalk yield and high technical stem length. To select high-yielding genotypes in kenaf, information on f the combining ability and the type of gene action for yield and its components of the entries of the reference population is of great importance. If additive gene action is predominant, then the breeder can effectively succeed in getting progress by selection at various levels of inbreeding, since additive effects are readily transmissible from one generation to another.

The concept of line x tester analysis was developed by Kempthorne (1957), it is a modified from of top cross scheme. Singh and Narayanan (1993) concluded that the line x tester mating design provides almost the same genetic information as the diallel analysis. As well as, this technique like diallel and partial diallel, and also help in the identification of good general combiners and specific cross combinations as well as in the choice of breeding procedure for genetic improvement of various polygenic characters. A knowledge of relative magnitude of additive and non-additive gene effects would be very useful in designing efficient breeding program. Such information in kenaf is limited. Diallel analysis of yield and its components in kenaf was studied by Mourad *et. al.,*(1989), Abo-Kaied (2007) and El-Refai (2007). On the other hand, many investigators studied the differences between kenaf genotypes e.g., Osman and Momtaz,1982, Xiao *et. al.,*1993, and Webber,1993. Many correlation studies indicated that basal stem diameter, green plant weight, fiber length and plant height were the major components contributing to fiber weight in kenaf (Mourad *et. al.,*1987, Padmaja,1989, El-Shimy *et. al.,*1990, Subramanyam *et. al.,*1995, Abo-Kaied, 2007 and El-Refaie, 2007).

Owing to the small kenaf cultivating area annually in Egypt by reason of the great competition with the other summer crops in the ancient valley land, therefore, the biggest challenge in breeding new varieties has been to produce a variety that is adapted to the sandy soil conditions in the new areas. For this reason, this study aimed to estimate the combining ability of eight parents and their crosses as well as to estimate the type of gene action for yield and yield components under sandy soil conditions, in addition to estimate the phenotypic and genotypic correlation coefficients between fiber yield and related characters.

MATERIALS AND METHODS

The materials used for the present study consisted of 23 kenaf genotypes (8 parents, 15 F_1,s). Genotype characteristics of the material used according to their pedigree, origin and year released are presented in Table 1. The parents from 1 to 5 were used as female (line) and from 6 to 8 as male (tester) parents in a line x tester mating design**.** These eight parents represent a wide genetic variability for yield, yield component and other related characters of kenaf.

Table 1. Identification of eight kenaf genotypes used, pedigree, origin and year released.

Genotypes	Pedigree	Origin	Year released*
1-S.13	S.36/64/3 x S.8/61/2	Advanced strain	1975
2- S. 114	S.16/63/2 x S.29/145	" " " " " " "	1993
3- S.119	Giza 4 x S.16/63/2	" " " " " " "	1995
4-S.98/205	S.77/68/1 x S.87/68/1	" " " " " " "	1992
5- S.38	Giza 3 x S.4/59-27	" " " " " " "	1976
6- Giza 3	Selected from farmer fields	Local cultivar	1961
7- S.105/2	Giza 5 x S.87/68-1	Advanced strain	1994
8-S.112	H.27/127 x H.27/130	" " " " " " "	1994

* Year released, selected as promising line.

In 2009 season, each of the 3 male parents was crossed to the 5 female parents to obtain 15 F_1 crosses at Giza Res. Station Farm. In 2010 season, the eight parents and their 15 F_1,s were planted in a randomized complete block design with four replications at Ismailia Agric. Res. Station Farm, Ismailia Governorate, Egypt. The soil type was sandy soil with coarse sand 64.45%, fine sand 28.14%, silt 5.12%, clay 1.28%, organic matter 0.50 %, available nitrogen 7.01 ppm and pH value of 7.13. Seeds of each parent and F_1 were sown in single rows. The rows were 3 m long and 50 cm apart. The distance between hill was 25 cm and planting date was the first week of May 2010. The seedling were thinned after four weeks from sowing to leave two plants per hill. The recommended cultural practices for kenaf were applied. Ten random guarded plants were chosen from each row, by means that ten plants for each parent and for each F_1 from each replication were used for measuring data. The following traits were recorded:

1) green weight (g)/ plant, as weight in grams of kenaf stalk plant after 48 hours from harvesting, 2) plant height (cm), 3) technical stem length in cm, 4) fiber length (cm), 5) fiber weight (g)/plant, as the weight in grams of the air-dried fibers extracted from retted green stalk weight of kenaf plant, 6) fiber percentage = (fiber weight/plant ÷ green weight/plant) x 100, 7) fruiting zone length in cm, 8) stem diameter in mm and 9) seed yield per plant (g).

STATISTICAL ANALYSIS

Analysis of variance of the data was performed on plot means bases. Line x tester design is employed for studying genetic variation in a fifteen-family population for F_1 generations .The variation among families within generation is further divided into genetic variation components attributable to general (GCA) and specific combining ability (SCA) following the method suggested by Singh and Chaudhary (1985). Variances due to general (GCA) and specific (SCA) combining ability and due to combining ability variances and effects were estimated according to line x tester analysis as per Kempthorne (1957).

Phenotypic (rp) and genotypic (rg) correlation coefficients were calculated according to the formula suggested by Al-Jibouri *et. al.,* (1958).

RESULTS AND DISCUSSION

1- Analysis of variances:

Variances due to entries (parents and F1,s) are highly significant for green weight/plant and its related characters (Table2). This indicates that those parental genotypes and their crosses showed a reasonable degree of variability for these traits. Also, mean squares due to parents and crosses were highly significant for all traits. Such variability among different kenaf genotypes in green stalk weight and its components was also reported by Osman and Momtaz,1982, Xiao *et. al.,*1993, Webber,1993, Abo-Kaied, 2007 and El-Refai, 2007. Mean squares of parents vs. crosses as an indication to average heterosis over all hybrids was significant, revealing that heterotic effect was pronounced for these characters, while parents vs. crosses for seed weight/plant was non-significant. Mean squares due to males were significant for all characters under study. On the other hand, the variances due to females were non significant for all traits except for both of stem diameter and seed weight/plant. The difference in genetic variance between male and female was probably due to random chance in sampling of parental genotypes. Dominance gene effects, as indicated by male x female interactions were significant for all studied characters except stem diameter.

The partitioning of genetic variance into general (GCA) and specific (SCA) combining ability variances is shown in Table (3). GCA variances were significant for all studied characters. On the other hand, SCA variances were non significant for only five characters i.e., green weight/plant, fiber weight/plant, fiber percentage, stem diameter and seed weight/plant. Whereas, GCA variances were larger than the corresponding SCA variances except three traits, plant height, technical stem length and fiber length. Also, the values of additive and dominance as well as, the ratio of GCA/SCA variances for all studied characters were exhibited in the same direction, except the GCA/SCA ratio for the previous three traits (plant height, technical stem length and fiber length). These results indicate the predominant role of additive gene action involved in the expression of these characters. Therefore, selection should be possible in the F_2 and subsequent generations for all studied characters, except for the previous three traits. Abo-Kaied (2007) found that the additive effects were more important than non-additive effects for plant height, technical stem length, fiber weight, fiber percentage, fiber length, seed weight, and fruiting zone length. On the other hand, for both of stem diameter and green weight per plant showed that the non-additive effects were more important than additive effects.

2- GCA effects:

The estimates of general combining ability effects of female and male parents are shown in Table (4). P_3 (S.119) and P_7 (S.105/2) showed highly significant and positive general combining ability effects for all studied characters except for fiber percentage and fruiting zone length due to only P_3. The parents, P_2 (S.114) exhibited significant positive GCA effect for green weight/plant and P_6 (Giza 3) revealed significant positive GCA effects for the three important traits, green weight/plant, fiber weight/plant and fiber percentage. Whereas P_4 (S.98/205) exhibited significant and positive GCA effect for fiber percentage, fruiting zone length and stem diameter and P_5 (S.38) for stem diameter and seed weight/plant.

In general, P_3 (S.119) and P_7 (S.105) exhibited significant and positive GCA effects for green weight and most of its components as well as P_6 (Giza 3) for three important components (green weight/plant, fiber weight/plant and fiber percentage), indicating that the use of these parents in kenaf breeding programs could increase green weight and consequently increasing fiber yield. Concerning, seed weight/plant results indicated that the P_7 followed by P_3 and P_5 showed significant positive general combining ability effects. Therefore, it could be concluded that these three parents (P_7, P_3 and P_5) exhibited the best combiners for seed weight.

3- SCA effects:

Table (5) shows specific combining ability effects for green weight/plant and its related characters. Out of the 15 F_1 crosses, only one cross, $P_3 \times P_7$ exhibited significant positive SCA effects for green weight and most components (plant height, technical stem length, fiber length, fiber weight and fruiting zone length). Also, P_4xP_6 showed significant positive SCA effects in the desirable direction for green weight/plant, fiber length, fiber weight/plant, fiber percentage and stem diameter. Whereas, P_5xP_7 exhibited SCA effect for each of plant height, technical stem length and fiber length as well as P_4xP_8 for only green weight/plant in addition P_5xP_8 for fiber percentage. Also, P_1xP_6 showed significant positive SCA values for plant height and fiber length as well as P_1xP_8 for plant height, technical stem length, fruiting zone length, seed weight/plant and fiber length in addition P_2xP_8 for plant height, technical stem length, fiber length, fiber weight, fiber percentage and fruiting zone length.

In general, cross, $P_3 \times P_7$ exhibited significant positive SCA effects for green weight and most components (plant height, technical stem length, fiber length, fiber weight, stem diameter and seed weight/plant). This cross involved high x high general combiners for these traits. $P_4 \times P_6$ (high x high) for fiber percentage and $P_4 \times P_7$ (high x high) for fiber percentage, fruiting zone length and stem diameter. Whereas, $P_4 \times P_6$ exhibited significant positive SCA effects as well as high x low general combiner parents for green weight/plant and most important components viz., fiber length, fiber weight and fruiting zone length. Also, $P_5 \times P_7$ involved high x low general combiner parents for plant height, technical stem length and fiber length as well as $P_4 \times P_7$ (high x low) for plant height and technical stem length. On the other hand, the residual crosses ($P_1 \times P_6$, $P_1 \times P_8$, $P_2 \times P_8$, $P_4 \times P_8$ and $P_5 \times P_8$) that exhibited desirable SCA values (positive and significant) involved (low x low) general combiner parents. Therefore, the crosses $P_3 \times P_7$, $P_4 \times P_7$ and $P_5 \times P_7$ are likely to throw good segregates for these traits if the allelic genetic systems are present in good combination and epistatic effects present in the crosses act in the same direction as to maximize the desirable characteristics.

4- Mean performance:

Mean performance regarding green stalk yield, fiber yield, seed yield per plant and their related characters for 23 kenaf genotypes (8 parent and 15 F1's crosses) are presented in Table (6). The two local strains 105/2 and 119 gave the highest means for each of green stalk weight/plant (441.53, 398.93 g), plant height (288.8, 284.53 cm), technical stem length (216.70, 236.85 cm), fiber length (212.45, 230.33 cm), fiber weight / plant (34.43, 31.85 g), fiber percentage (7.80, 7.99%), fruiting zone length (72.13, 47.68 cm), stem diameter (14.95, 14.60 mm) and seed weight/plant (6.48, 5.33 g), respectively. On the other hand, the highest means for crosses were recorded by cross P_3xP_7 for green weight/plant and most related characters, followed by each of P_2xP_7 P_4xP_7 and P_5xP_7 for some important yield components.

In general, the local strain 105/2 was superior the other parents for most important characters i.e., green stalk weight, plant height, fiber weight, fruiting zone length, stem diameter and seed weight/plant. In the same time, the highest means for crosses were recorded by cross P_3xP_7 for green weight/plant and most economic related characters.

5- Correlation studies:

Phenotypic (rp) and genotypic (rg) correlation coefficients among 9 characters for 23 kenaf genotypes (8 parents and 15 F_1's crosses) are shown in Table (7). These results indicated that fiber weight/plant was significantly positively correlated with each of green weight, plant height, technical stem length, fiber length, fiber percentage, fruiting zone length, stem diameter and seed weight/plant. These results are in agreement with those obtained by Mourad *et. al.,*1987*,* Padmaja,1989*,* El-Shimy *et. al.,*1990*,* Subramanyam *et. al.,*1995, Abo-Kaied, 2007 and El-Refaie, 2007.

In general, it can be concluded that green stalk weight, plant height, technical stem length, fiber percentage and fiber length are the major components contributing to fiber weight/plant in kenaf. Therefore, selection for these traits will improve the fiber yield in kenaf.

T2

T3

T4

T5

T6

T7

REFERENCES

1. Abo-Kaied, H. M. H. 2007. Combining ability and gene action for yield and yield components in kenaf (*Hibiscus cannabinus* L.). Egypt. J. Agric. Res., 85(2): 535-549.
2. Al-Jibouri, H. A., P. A Miller and H. F. Robinson. 1958. Genotypic and environmental variances and covariances in an upland cotton cross of interspecific origin. Agron.J.50: 633-636.
3. El-Reffaie, Amany M. M. 2007. Diallel analysis for some quantitative characters in kenaf (*Hibiscus cannabinus* L.). J. Agri. Sci. Mansoura Univ., 32(3) : 1649-1658.
4. El-Shimy, G. H., S. M. Gaafar and A. M. Hella. 1990. Morphological and anatomical studies in some kenaf cultivars. Egypt. J. Appl. Sci., 5(7): 585-600.
5. Kempthorne, C. 1957. An Introduction to Genetical Statistics, PP.468-71.John-Wiley & Sons,New York.
6. Mourad, N. K. M., A. I. Sahsah and G. H. El-Shimy. 1987. Studies on correlation and path coefficient analysis of components of fiber and seed yield in kenaf (*Hibiscus cannabinus* L.). Minufiya J. Agric. Res., 12: 89-104.
7. Mourad, N. K. M., A. M. A. Hella and E. A. F. El-Kady. 1989. Heterosis and combining ability studies for some quantitative characters in kenaf (*Hibiscus cannabinus* L.). J. Agric. Res.Tanta Univ., 15: 383-398.
8. Osman, R. and A. Momtaz. 1982. A comparative study of oil content, fatty acid composition and agronomic characters of five kenaf cultivars. Agric Res. Rev., 60(8). 127-139.
9. Padmaja, P. 1989. Heterosis studies in Roselle (*Hibiscus sabdariffa* L.). M.Sc. Ag. Thesis APAU, Hyderabad. (C.F. Subramanyam *et. al.,* 1995).
10. Sellers, T. and N. A. Reichert. 1999. Kenaf properties, processing and products. Mississippi State University, MS.
11. Singh P. and S. S. Narayanan. 1993. Biometrical techniques in plant breeding. Second Edition, Kalyani Publishers, New Delhi, 1000 002.
12. Subramanyam, D., P. V. Rama Kumar, B. Krishnamurthy and S. Ismia. 1995. Heritability and correlation studies in kenaf. Indian J.Genet., 55 (3):279-282.
13. Webber, C. L. 1993.Yield components of five kenaf cultivars. Agron. J., 85(3): 533-535.
14. Xiao, A. P., X. L. Tian and J. Leng. 1993. Analysis of kenaf seed composition. Bast fiber Res. Inst. CAAS, Yuanjiang, China's Fiber Crops 15(3): 16-17.

تحليل الأب الكشاف × سلالة لبعض الصفات الاقتصادية الهامة في التيل

أماني محمد محي الدين الرفاعي

معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية – الجيزة

أجريت هذه الدراسة بهدف تقدير القدرة علي الائتلاف والفعل الجيني لبعض الصفات الاقتصادية الهامة في التيل باستخدام تحليل الأب الكشاف في السلالة من خلال تقييم 15 هجين ناتجة من التهجين بين خمسة تراكيب وراثية (1 =س13 ، 2 =س3،114 = س119 ، 4 = س 205/98، 5 =س38) استخدمت كأمهات ، وثلاثة تراكيب وراثية (6=جيزة3 ، 7 = س2/105، 8 =س112) استخدمت كآباء كشافة. في موسم 2009 تم إجراء التهجينات بين الآباء الكشافة مع الأمهات وذلك بمحطة البحوث الزراعية بالجيزة. وفي موسم 2010 تم تقييم الـ8 آباء ، 15 هجين في الجيل الأول في محطة البحوث الزراعية بالإسماعيلية في تجربة قطاعات كاملة العشوائية ذات الأربعة مكررات .

تشير النتائج إلى أن تأثير العوامل الو راثية المضيفة أكبر من غير المضيفة في توريث كل الصفات المدروسة باستثناء الطول الكلى، الطول الفعال وطول الألياف للنبات، لذلك من الممكن ممارسة الانتخاب اعتبارا من الجيل الثاني والأجيال التالية له باستثناء تلك الصفات. كما تشير النتائج أن الأبويين س 119، س 2/105 أظهرا قدرة عامة علي الائتلاف لصفات محصول الساق الأخضر للنبات ومعظم مكوناته، كما أظهر الأب جيزة 3 هذه القدرة لأهم ثلاث مكونات (وزن الأخضر للساق، ووزن الألياف والنسبة المئوية للألياف)، لذلك يمكن استخدام هذه الآباء في برنامج تربية التيل لتحسين محصول الساق الأخضر وبالتالي محصول الألياف، كما تشير النتائج الخاصة بوزن البذور للنبات أن الأباء س 119، س 38، س 2/105 أظهرو قدرة عامة عالية علي الائتلاف، لذلك يمكن استخدام هذه الآباء لتحسين محصول البذور للنبات. كما تشير النتائج الخاصة بالقدرة الخاصة علي الائتلاف أن الهجين (س119 ×س2/105) أظهر قدرة خاصة علي الائتلاف لوزن الساق الأخضر وأهم مكوناتة (الطول الكلي، الطول الفعال، وطول الالياف ووزن الالياف ووزن البذور للنبات) وهذا الهجين يمتلك أبوية قدرة عامة عالية علي الإتلاف (عالي×عالي). أيضا الهجين (س205/98×جيزة 3) كان أيضا أبوية (عالي×عالي) بالنسبة لصفة النسبة المئوية للألياف وكن نفس الهجين (عالي×عالي) بالنسبة لصفة النسبة المئوية للألياف وكان (عالي×منخفض) لصفة وزن الساق الأخضر وأهم مكوناتة.

كما تشير النتائج الخاصة بالارتباط الظاهري والو راثي بين الصفات إلى أن محصول الساق الأخضر والطول الكلي والطول الفعال والنسبة المئوية للألياف وطول الألياف أظهرت ارتباط موجب ومعنوي مع محصول الألياف/نبات لذلك يمكن الانتخاب لتلك الصفات لتحسين محصول الألياف في التيل.