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SHORT NOTE [NOTA CORTA]

MODE OF INHERITANCE OF POD SPININESS IN OKRA (*Abelmoschus esculentus* (*L.*) Moench)

[MECANISMO DE HERENCIA DEL CARACTER DE ESPINA EN VAINA DE LA OKRA (*Abelmoschus esculentus* (*L.*) Moench)]

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SUMMARY

The mode of inheritance of spininess in okra was investigated. Two okra cultivars, namely 'Khartoumia spiny' and the Indian cultivar 'Pusa Sawani' were used in this study. The two parents were self pollinated for three successive generations to fix the character under study. Crosses were made between 'Khartoumia spiny' and 'Pusa Sawani', and reciprocal F_1's, F_2's and all possible backcrosses were derived from the initial crosses. No reciprocal differences were found between F_1 and F_2 generation for pod spininess. Segregation in the crosses between the local cultivar 'Khartoumia spiny' and the Indian cultivar 'Pusa Sawani' indicated that the presence of spines on pods was controlled by single gene, with incomplete dominance.

Key words: Gene action; inheritance studies; okra plants; maternal effects; fruit spininess.

RESUMEN

Se estudió el mecanismo de herencia de las espinas de la vaina de la okra empleando el cultivar Khartoumia espinosa y el cultivar indú Pusa Sawani. Las líneas parentales fueron autopolinizadas por tres generaciones sucesivas para fijar el carácter de intéres. Se realizaron cruzas entre los dos cultivares y cruzas recíprocas F_1 y F_2 y todas las retrocruzas posibles. No se encontró efectos recíprocos entre las generaciones F_1 y F_2 para este caracter. La segregación en las cruzas del cultivar Khartoumia espinosa y Pusa Sawani indican que la presencia de espinas en las vainas fue controlado por un único gen, con dominancia incompleta.

Palabras clave: Acción génica; herencia, okra; efectos maternos; espinosidad del fruto.

INTRODUCTION

The cultivated okra (*Abelmoschus esculentus* (L.) Moench) is an important vegetable crop throughout tropical and subtropical regions of Asia and Africa (Bisht and Bhat, 2006). It originated in tropical Africa (Purseglove, 1974); also it presumably originated in tropical Asia (Grubben, 1977).

Okra is a tender plant and grows well in hot weather. In the Sudan, okra is extensively grown especially where there is irrigation. As a wild plant it grows all over the rainfed areas of the Sudan. The crop is one of the most popular vegetables and its association with the native food in the different regions of the country created a great stable demand for it.

The immature tender pods are used in stews or cut into slices, sundried, then ground as a powder and used as a favourite Sudanese dish called "Weika". Similarly, the older immature pods which start to develop fiber are also cut into slices, sundried, ground and cooked. Even the young leaves are used as a vegetable and also may be dried. In other countries the pods are used in stews and soups.

The potential of the seeds as a new protein source was emphasized by Karakoltsides and Constantinides (1975). Protein content of the seed is 20 percent or more and oil content 14 percent or more. Thus, it would appear that okra seed can be used as a protein and oil crop (Martin *et al*., 1981; Martin, 1982).

Okra flowers are self fertile, but usually up to 20% cross pollination occurs by insects (Gurbben, 1977). On the other hand, in Putero Rico, Martin (1983) recorded a broad range of variation with levels varying from 0 to 60%.

In the Sudan, a number of local mixed cultivars, Indian and American introductions are grown in the irrigated areas. The local cultivars are known as "Baladi" and each cultivar is named after the area from which it is collected, some of these cultivars are characterized by the presence of spines and stickiness of pods. The presence of spines in some local cultivars, make picking an unpleasant job, although preferred by consumers, because they contain high percentage of mucilage (Abdalla, 1969).

Few studies have been reported on the inheritance of spininess in okra. Kalia and Padda (1962), Nath and Dutta (1970) reported that fruit spininess was monogenically controlled with the absence of complete dominance of one allele over the other. Furthermore, Markose and Peter (1990) and Hamon and van Sloten (1995) reported monogenic and dominant inheritance for pod spininess. Similar results were obtained by Jambhale and Nerkar (1985) and Jassim (1967) in the hybrids of *Hibiscus esculentus* and *Hibiscus manihot*. On the other hand, Miller and Wilson (1937) mentioned that the strains producing fruit free of spines in the early part of the season have been found to produce spines on the pods late in the season; a factor that has prevented any conclusion on the mode of inheritance of this character.

Though improved crop cultivar is one of the pre-requisites for high yield, little breeding has been done on okra in the Sudan, with this consideration in mind; this study was carried out to fulfill the following objectives:

1. To study the mode of inheritance of spininess.
2. To determine if "maternal effects" influence for this character.

MATERIAL AND METHODS

The experiment was carried out at the Demonstration Farm of the Faculty of Agriculture, Shambat, Sudan (Latitude 15° 40' N and Longitude 32° 32' and 380 meters above sea level altitude). The soil is heavy cracking clay (43% to 48% clay) with an EC of 0.7 dS m^{-1} and pH 8.0. Throughout out the experiment, average maximum temperatures were 37.9 °C and minimum temperature of 26.1 °C and annual rainfall of 32.73 mm. The experimental site is categorized as hot dry region, which could be represents a suitable region for the production of okra. Hence, the test genotypes could express their full genetic potentials for the character investigated here.

Two okra cultivars were selected as parental material namely 'Khartoumia spiny' (Kha) and the Indian cultivar 'Pusa Sawani' (PU) spineless to study the mode of inheritance of spineness. Ten healthy plants of each parental line were chosen randomly and selfed by bagging the floral buds in the afternoon prior to their opening the following morning i.e at 4 p.m. for three successive generations i.e. June 1996, October 1996 and March 1997 to produce pure inbred lines and to fix the character under investigation.

The two parental inbred lines viz, (PU) and (Kha) were reciprocally crossed generating F_1 populations F_1 PU, and F_1 Kha. (PU) and (Kha) designate the female parent in the cross from which later generations were derived. The two reciprocal F_2's and the eight possible backcrosses were obtained.

In July 1998, the following generations were planted, namely parents, F_1, F_2, backcrosses and their reciprocals in a randomized complete block design with two replicates, using 5-ridges plots of 4x4 meters with 75 cm between the ridges and 30 cm between plants, 3-4 seeds were sown per hole. Two weeks from sowing the plants were thinned to two plants / hole. All the necessary cultural practices and protection measures were adopted for raising good crop.

A minimum number of two fruits from the lower, middle and upper part of each individual plant were examined individually under low power magnification of Hand-lens at maturity and scored for presence or absence of spines on the pods surfaces. The fruits skin showed three categories: uniform spines, intermediate spines intensity and smooth or glabrous pods.

Statistical analysis

To study the mode of inheritance of spininess in two okra inbred cultivars, the procedure of the chi-square test was applied. The okra fruits surface were classified into three classes namely uniform spines, intermediate spines intensity and smooth. Segregation ratios for phenotypic classes were summarized and checked for expected ratios with chi-square good-of-fit test (Gomez and Gomez, 1984).

RESULTS

With regard to the cross between the two inbred lines 'Khartoumia spiny' and 'Pusa Sawani' (Table 1), the plants of the parent 'Khartoumia spiny' bear pods with uniform dense spines while the plants of the parent 'Pusa Sawani' bear glabrous pods. This cross gave F_1 plants bearing pods with spines but in decreased density than the parent 'Khartoumia spiny' in the direct as well as the reciprocal cross. Segregation took place in the F_2 plants giving three phenotypic classes, namely plants bearing pods with dense spines, plants bearing spiny pods but in less density than the first class, and plants bearing glabrous pods. The F_2 consisted of 86 plants bearing dense spiny pods, 156 plants bearing pods with intermediate intensity of spines, and 71 plants bearing glabrous pods. This is very close to 1:2:1 ratio. As shown in Table 1, the P-

value of χ^2 is (P = 0.50-0.30) indicating that the deviation from the expected frequencies is not significant i.e. there is a good fit to a 1:2:1 ratio. In other words, there is a monogenic difference between the two parents in the study, but with incomplete dominance of spininess over spineless.

Backcrosses two plants bearing glabrous pods segregated into 154 plants bearing pods with intermediate spines and 137 plants bearing glabrous pods. Examination of values obtained from the backcrosses to the recessive parents suggested a 1:1 ratio. Chi-square analysis for goodness of fit (Table 2) showed a P- value of 0.50 - 0.30 suggesting good agreement. Thus, spininess in this cross appears to be controlled by one major gene pair, with incomplete dominance.

DISCUSSION

The presence of spines on the plant and the pods of okra in the present leading local varieties make picking an unpleasant job, especially during the hot climate. This problem can be solved by the improvement of the already existing local cultivars or to find cultivars better than the presently grown. Firstly it is important to study the mode of inheritance of this important character.

In the present study, a single gene was found to be responsible for the inheritance of spines on pods but with incomplete dominance. i.e. the character of spiny pods is partially dominant over the glabrous pods. This result is in accordance with that reported by Kalia and padda (1962), Jassim (1967), Nath and Dutta (1970) and Jambhale and Nerkar (1985) who reported that fruit spininess was monogenically controlled with the absence of complete dominance of one allele over the other. On the other hand, these results were at variance with those reported by Miller and Wilson (1937) who observed that the strains producing fruits free of spines in the early part of the season have been found to produce spines on the pods late in the season i.e. a factor that has prevented any conclusion on the mode of inheritance of this character. Kalia and Padda (1962) further reported that the nature of hairiness was influenced by the environment as well as by the age of the fruit, but in this study the spines became very prominent by the marketable fruit size. Therefore, the desirable spineless fruits with other desirable characters can be attained through hybridization and selection in the segregating generations. Further experiments are needed at early and late season to confirm the mode of inheritance of this character.

Mather and Jinks (1974) stated that maternal effects arise where the mother makes a contribution to the phenotype of her progeny over and above that resulting from genes she contributes to the zygote. Furthermore, Stansfield (1991) mentioned that some attributes of progeny are not expressions of their own genes, but rather those of the maternal parent. Such effects may be ephemeral or may persist throughout the life-span of the individual. The substances which produce maternal effects are not self-perpetuating, but must be synthesized a new for generation of progeny by the appropriate maternal genotype.

In the present study, in all generations, for spininess character, no reciprocal differences were detected, indicating the absence of maternal influence for it. This finding are more or less similar to the results obtained by Lee *et al*. (1968) who reported that, in *Gossypium*, maternal effect appears to be fairly rare, which means that maternal effects could be true for gossypol and spininess characters.

Table 1. Phenotypic expression of fruit spininess in parents, F_1 and F_2 generations in okra.

Generation	Plants bearing dense spiny pods	Plants bearing pods with intermediate spines	Plants bearing glabrous pods	Total	Expected phenotypic ratio	χ^2	P-value
'Khartoumia Spiny' (Kha)	145	-	-	145			
'Pusa Sawani' (PU)	-	-	167	167			
Kha x PU F_1	-	139	-	139			
PU x Kha F_1	-	164		164			
Pooled F_1	-	303	-	303			
Kha x PU F_2	46	80	40	166	1:2:1	0.619	0.80-0.70
PU x Kha F_2	40	76	31	147	1:2:1	2.037	0.50-0.30
Pooled F_2	86	156	71	313	1:2:1	1.441	0.50-0.30

Table 2. Phenotypic expression of fruit spininess in the backcrosses generations in okra.

Generation	plants bearing dense spiny pods	plants bearing pods with intermediate spines	plants bearing glabrous pods	Total	Expected phenotypic ratio	χ^2	P-value
F_1Kha x Kha BC_{11}	89	69	-	158	1:1:0	2.532	0.20-0.10
F_1PU x Kha BC_{11}	70	60	-	130	1:1:0	0.769	0.50-0.30
Pooled BC_{11}	159	129	-	288	1:1:0	3.125	0.10-0.05
F_1PU x PU BC_{12}	-	80	70	150	0:1:1	0.667	0.50-0.30
F_1 Kha x PU BC_{12}	-	74	67	141	0:1:1	0.348	0.70-0.50
Pooled BC_{12}	-	154	137	291	0:1:1	0.993	0.50-0.30

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