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Inheritance of number of capsules per leaf axil and hairiness on stem, leaf and capsule of sesame (*Sesamum indicum* L.)

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Abstract

This investigation was carried out to study the inheritance of stem, leaf and capsule hairiness and number of capsules per leaf axil in sesame. For hairiness, Muganli-57 (♀) which is hairless was crossed with ACS 82 (♂) with high hairiness on capsules, leaves and stem. For number of capsules per leaf axil, Muganli-57 (♀) with one capsule per leaf axil was crossed with ACS 114 (♂) and ACS 139 (♂), which were providing three capsules per leaf axil. The results in the F_1 generation of the cross made for hairiness revealed that hairiness in sesame was controlled by a single dominant gene and it was dominant over hairless. Similar result was obtained for the crosses of number of capsules per leaf axil that one capsule per leaf axil character was dominant to three capsules and this character was controlled by one single gene. Chi-square values obtained for all the crosses in F_2 progeny showed a good fit for a monogenic inheritance with the F_2 phenotypic ratio of 3:1. Three capsules per leaf axil and hairiness are the important characters for providing more seed yield and natural defense mechanism for some biotic and abiotic factors, respectively. Therefore these two characters could be assessed as a part of ideal plant type. The information presented in this investigation was beneficial for the genetic improvement of sesame and reaching to appropriate plant type.

Keywords: Sesame, inheritance, dominancy, plant type, seed yield.

Introduction

Sesame (*Sesamum indicum* L., *Pedaliaceae*) is one of the oldest crops known to humans and it was a major oilseed in the ancient world because of its ease of extraction, great stability, and drought resistance (Langham and Wiemers, 2002). Recently it has been assessing as nutritional and anti-aging feature with high quality of vegetable oil (50-60%) (Arslan et al., 2007; Uzun et al., 2007, 2008; Chayjan, 2010). Since its oil is highly resistant to oxidative deterioration by containing antioxidant lignans such as sesamin and sesamolin (Yoshida and Takagi, 1997; Moazzami and Kamal-Eldin, 2006; Erbas et al., 2009) and also includes of a high percentage unsaturated fatty acids (Yermanos et al., 1972; Were et al., 2006). On the contrary of these profits, sesame production is limited due to low seed yield (Ashri, 1989; Yol et al., 2010: Pham et al., 2010), diseases (El-Bramawy, 2006), stress factors (Sarwar et al., 2007) and unmechanized features (Uzun et al., 2003; 2004; Uzun and Cagirgan, 2006; 2009), basically. Therefore, breeding efforts have mainly concentrated on development of high yielding and disease resistant varieties. One of the important ways for increasing seed yield is using plants with an extra numbers of capsules per leaf axil (Baydar et al., 1999) because sesame generally has one capsule per leaf axil. Theoretically, if plants provide more than one capsule in each leaf axils, more capsules are then acquired and consequently more seed yield might be provided. Extra numbers of capsules per leaf axil can therefore be assessed as a part of appropriate sesame plant type. In struggle with biotic and abiotic stress factors, hairiness is a natural defense mechanism since hairy plants could be identified to more tolerant to some insects (Ghafoor et al., 2001; Furat and Uzun, 2010). Hairiness is correlated with resistance to leaf-curl as well as drought tolerance in sesame (Rheenen, 1972). Hairy plants may therefore be preferable for securing healthy plants. The basic prerequisite in adopting a suitable breeding method is a sound understanding of the genetic behavior (Hossain et al., 2010), therefore, success in development of genotypes with desired characters depends on the knowledge of genetic makeup of the characters and their behavior in different genetic backgrounds (Sumathi and Muralidharan, 2009). For developing the plants with three capsules per leaf axil and hairiness on stem, leaf and capsule, a detailed understanding of the genetics of these characters and easy means of describing the character are required. In this point of view, this article describes the genetic behavior of number of capsules per leaf axil and hairiness on stem, leaf and capsule of sesame.

Materials and methods

Experimental area

The study was carried out at the West Mediterranean Agricultural Research Institute's fields of Antalya (36°52'N. 30°50'E. 15 m elevation) which has coastline to Mediterranean Sea and it has 1060 mm annual average precipitation and 18 °C annual average temperature (TSMS, 2010).

Table 1. Inheritance of number of capsules per leaf axil and hairiness characters in sesame

Crosses	Experimental		Theoretical		χ^2	P	Ratio
Number of capsules per axil	One capsule per leaf axil	Three capsules per leaf axil	One capsule per leaf axil	Three capsules per leaf axil			
Muganli-57 x ACS 139	68	18	75	25	0.76	0.35-0.45	3:1
Muganli-57 x ACS 114	76	20	75	25	0.89	0.30-0.40	3:1
Crosses	Experimental		Theoretical		χ^2	P	Ratio
Hairiness	Hairy plants	Hairless plants	Hairy plants	Hairless plants			
Muganli-57 x ACS 82	54	21	75	25	0.36	0.50-0.60	3:1

Plant materials

For inheritance of hairiness in sesame, registered cultivar, Muganli-57 (♀) with no hairiness and long hairiness on stem, leaf and capsules, ACS 82 germplasm (♂) were the genetic materials of the study. For inheritance of number of capsules per leaf axil, Muganli-57 with one capsule per leaf axil (♀) was crossed with ACS 114 (♂) and ACS 139 (♂) with three capsules per leaf axil, separately.

Genetic study

All the crosses were made in the growing season of 2008. At maturity, crosses were made between two genotypes using flower buds emasculated just before anthesis and pollinated the second day with pollen grains from freshly dehisced anthers of the male parents, ACS 82, ACS 114, and ACS 139 (Falusi and Salako, 2003). F_1 and F_2 generations were grown at the same location in 2009 and 2010 growing seasons, respectively. All the materials were grown in 70 cm row and 10 cm plant spacing. Fertilizer was applied at rates of 60 kg N, 60 kg P_2O_5 and 60 kg K_2O per hectare prior to sowing. Weeds were controlled by hand.

Statistical analyses

A chi-square ($\chi2$) goodness of fit test was performed on the F_2 populations against a possible theoretical segregation ratio using the formula: $\chi2 = \Sigma (O - E)^2 / E$, where O and E are the observed and expected values, respectively (Steel and Torrie, 1980).

Results and discussion

Following to Muganli-57 (♀) x ACS 114 (♂) and Muganlı-57 x ACS 139 (♂) crosses, all the F_1 plants of both crosses had one capsule per leaf axil indicating that this character was dominant over three capsules per leaf axil. In F_2 progeny, the ratios of one capsule to three capsules per leaf axil were 76:20 and 68:18 for Muganli-57 x ACS 114 and Muganli-57 x ACS 139, respectively (Table 1). As phenotypic, 68 and 76 plants indicated one capsule per leaf axil (Figure 1.a), 20 and 18 plants indicated three capsules per leaf axil (Figure 1.b), respectively. Chi-square values obtained for both crosses showed a good fit for a monogenic inheritance with the F_2 phenotypic ratio of 3:1. These crosses indicated that number of capsules per leaf axil in sesame was under the control of a single gene and one capsule per leaf axil was dominant over three capsules per leaf axil. Ashri (2007) indicated a symbol "*T*" for one capsule to three capsules per leaf axil. The gene symbols and dominancy were proposed as *T* for one capsule and *t* for three capsules and $T > t$. Theoretically, extra capsule ability per leaf axil in sesame is an important advantage in the efforts to increase seed yield per plant because genotypes with three capsules per leaf axil has potential to provide more capsules per plant in comparison to those of one capsule per leaf axil (Baydar, 2005). On the other hand, several investigations proposed that the varieties with three capsules per leaf axil have not had their potential for securing maximum seed yield (Baydar, 2005; Van Rheenen, 1981). This contrast could be explained by the production of the photosynthates and not the number of capsules (Ashri, 1998). Nevertheless, high yield potential in genotypes with three capsules should be assessed because they appeared to be ideal for improving seed yield productivity in sesame (Kang et al., 1985). All the F_1 plants from the cross Muganli-57 x ACS 82 had strong hairs on their stems, leaves and capsules showing dominant character of hairy on hairless. In F_2 generation, the ratio of hairy to hairless progenies for the cross between Muganli-57 (♀) and ACS 82 (♂) were 54:21. Phenotypically, 54 plants showed hairiness (Figure 2.a) and 21 plants showed no hair on stem, leaves and capsules (Figure 2.b) (Table 1). The F_2 segregation ratios in this cross indicated that hairiness character is monogenic and the calculated χ^2 values for the cross exhibited a good fit for a monogenic inheritance for an F_2 phenotypic ratio of 3:1. This cross denoted that hairiness is under the control of a single gene and hairy is a dominant character on no hair. Closely our study, Falusi et al. (2002) studied inheritance of stem and petiole hair density and they found many medium hairs which were dominant over few long hairs. This result showed strong hairiness had dominancy over light hairiness and he found 3:1 ratio. Similarly, we found that 3:1 ratio indicating that strong hairiness is dominant over no hairiness. Rather than stem and petiole hairiness as pointed out by Falusi et al. (2002), our study demonstrated that leaf and capsule hairiness in sesame were also controlled by a single dominant gene. Hairiness is a typical character of sesame and can be seen many parts of plant such as stem, leaf, corolla and capsules (Weiss, 1983). Strong hairiness character could be evaluated as advantages for insect pests and diseases of sesame. However, strong hair genotypes were limited in sesame collections as pointed by Bisht et al. (1998), Furat and Uzun (2010), Xiurong et al. (2000). They reported only few genotypes with hairiness in their entire sesame collections. Therefore, the data belongs to inheritance of hairiness in this investigation is valuable for the usefulness of genetic improvement of strong hairiness in sesame. The results of the study showed that one capsule per leaf axil and hairiness characters are dominant over three capsules per leaf axil and no hair, respectively. These two characters showed monogenic inheritances. The information about inheritance of three capsules per leaf axil could be beneficial for genetic improvement of sesame targeting higher seed yield. Hairiness could also be evaluated for

Fig 1. A view of number of capsules per leaf axil in sesame. a: Shoot of one capsule per leaf axil, b: Shoot of three capsules per leaf axil.

Fig 2. A view of hairiness in sesame. a: Shoot of the hairy plant, b: Shoot of the hairless plant.

breeding programs for obtaining plants with moderate resistance to biotic and abiotic stress factors.

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