Potential Use of Non-Shattering in Sesame for Breeding and Yield Improvement in Thailand

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Kasetsart University (KU) Sesame Breeding Project had been developed sesame lines with high seed retention after the capsules are dry in 2003. These sesame lines are divided into two types: (1) The capsules open at the tip when they are dry, but the seed remained in the capsules more than 70% after the capsules are inverted. This capsule type is called shatter resistance (Langham,1996) and (2) The capsules are closed when they are dry, it is called non – shattering (Wongyai and Chowchong, 2003a). Both shatter resistance and non – shattering are easily threshing by rice or soybean thresher machine. Seeds do not damage by machine. The improved non – shattering is not controlled by recessive indehiscent gene (*id*). The original indehiscent plant was reported by D.G. Langham (1946) and the capsules of the *id/id* indehiscent plant proved too difficult to thresh (Ashri, 1998). However, the further research on inheritance of shatter resistance and non – shattering in sesame are needed for understanding.

In April 2004 the two superior non – shattering lines with white seed color have been released namely C plus 1 and C plus 2. These two lines were developed from the cross KUds6111/ Sesaco 20. KUds6111 is delayed shattering which it was developed by KU Sesame Breeding Project. Sesaco 20 is shatter resistance which it was developed by Sesaco Corporation, San Antonio, Texas, USA (Wongyai and Chowchong, 2003b).

The shattering in sesame remains the problem of sesame production in the world. Seed loss may reduced yield by 60% (Boyle and Oemcke, 1995) Sesame could not grow in a large area and it could not mechanically harvest. In Thailand sesame production areas are reduced year by year. It is due to seed shattering and it is costly at harvest and manual labor is becoming scarce. The new varieties of non – shattering would be potential for increasing seed yield per unit area and the mechanical production system would accept by grower as the major crops such as rice and maize.

KU18, the black seed sesame variety was developed by KU Sesame Breeding Project in 1992. KU18 is unique quality for taste and flavor for edible seed (Takada and Uno, 2001). In addition the local varieties of Thailand namely Loie, Mae Hongson , Kok Samrong and Saraburi are higher lignans content (Katsuta *et al.*, 2001). Thus, the shatter resistance and non – shattering lines have been employed for KU Sesane Breeding Project. There are three programs as follow: 1) To develop high yielding cultivar, 2) To improve black seed sesame with good taste and flavor and 3) To

develop high seed retention with high lignans content.

The crosses of these three breeding programs were made in 2002. The selected F_4 and F_5 lines of these breeding programs will be tested for their yielding ability and will evaluate for seed quality and lignans content.

Introduction

Current sesame (*Sesamum indicum* L.) crop yield are poor in relation to many other crops. Average yields ranged from 394 to 1,225 kg/ha in countries around the world (FAO, web site as of March, 2003). Almost sesame varieties are indeterminate growth habit and capsules dehisce when mature. The indeterminate nature of sesame leads to produce leaves, flowers and capsules as long as the weather conditions and soil moisture permit. Thus, any harvest date is a compromise and some seed are lost either to early capsules shattering or the late capsules being immature. Generally sesame is required mach manual labor at the harvest season. In some developing countries, the manual labor is becoming scarce and its costs are high. Thus, sesame is a typical small holder. The need for the development of productive non – shattering cultivars is critical to successful cultivation of sesame in more advanced, mechanized agriculture (Ashri, 1998).

In 1943 D.G. Langham (1946) found the indehiscent mutant. It was controlled by a recessive allele called the indehiscent gene (*id*). It exhibited many undesirable and probably pleiotropic effects, including lower seed set and reduced seed quality. Despite continuous breeding efforts it has not yet been possible to separate the indehiscence from the undesirable traits, so that no indehiscent commercial cultivar. The best indehiscent *id/id* lines developed by D.M. Yermanos, the capsules are so difficult to thresh that yield losses and damaged seed result (Ashri, 1998; D.R. Langham and Wiemers, 2002).

Sesame Production in Thailand

Sesame is the cash crop in Thailand. All sesame acreage is grown under rainfed conditions. Thus, the production in any given year can vary up and down depending on rainfall. In 2003 the planting area is 62,720 ha, and the amount of seed produced is 38.8 tonnes for an average of 619 kg/ha. Sesame growing seasons in Thailand are early rainy and late rainy seasons. In early rainy season sesame is grown before planting rice in February and middle April. In February the main growing areas are in the northeastern region. Black seed sesame is the major production. The planting areas in the middle April are in the lower northern region and the central plain. The major of sesame production come from the lower northern region. The local black – red seed

variety is grown in this region. The black seed and black – red seed varieties are grown in the central plain. Sesame production areas in early rainy season are 65% while it is 30% in late rainy season.

In late rainy season sesame is grown after majors crops, rice or corn in July to middle August. The main production areas are in the western and the lower northern regions. Black seed sesame is produced in the western while the local black – red seed is produced in the lower northern. In addition the local white seed sesame varieties, Loie or Nga Kai Pla and Mae Hongson are grown in rainy season (middle May to June) in the northern region. Both Loie and Mea Hongson varieties are photosensitive. They are small seed size but they are high lignans antioxidant (Katsuta *et al.*, 2001).

The popular varieties of black seed sesame are the local one, Nakornsawan and KU 18 which it developed by Kasetsart University Sesame Breeding Project. It has been promote to farmer since 1992. It is good quality of flavor and taste, seed size and seed color for edible seed in Japan (Takada and Uno, 2001). At present the acreage of KU 18 is increasing in the northeast and western regions.

Shattering characteristics in sesame

The five terminology of shattering characteristics in sesame are as follow (Wongyai, and Chowchong, 2003a):

Shattering : When capsules are ripen and dry the tip of capsule open and split from top to bottom along the suture and seeds come out of capsules. Normally seeds loss due to capsule shattering are higher than 90%.

Indehiscence : The ripening capsules are dry and they do not open. This capsule character was discovered by D.G. Langham in 1943. It is controlled by single recessive gene, *id.* But the sesame lines with indehiscent capsules are not suitable for commercial grown. Because the capsules are difficult to thresh and seeds were damaged.

Delayed shattering : All capsules on the plant are ripen but they do not open. Sesame plants can leave in the field for few days and then the capsules open and seed come out of capsules. The improved delayed shattering KU lines gave the days after capsules ripening and begin to open range from 5 to 30 days.

Shatter resistance : When the ripening capsules are dry the tip of capsules open. But the

seeds remain in the capsules after the capsules are inverted. Seeds loss depend on the degree of shatter resistance.

Non – shattering : The dry capsules do not open and they are easily to thresh by machine. Also seeds are easy release from the cepsules and seeds do not damage. This non – shattering character is not controlled by *id* gene.

Non – shattering lines of KU Ssesame Breeding Project

Kasetsart University Sesame Breeding Project had attempted to develop sesame lines for better seed retention since 1988. The determinate sesame lines was developed but it still have a problem of seed shattering. However, the delayed shattering line, KU 3113 was obtained from the cross between determinate sesame lines (KUdt4043/KUdt4041) in 1990. Then, the project had focused on development of delayed shattering. The promising delayed shattering lines were obtained in 1993. They had number of days from capsule maturation to capsule open ranged from 3 to 30 days. But they are double husk and seed color are black and buff. These characters are not suitable for commercial grown. The project also considered to develop shatter resistance in 1991. The *id* gene of indehiscent lines (UCR – ns) developed by D.M. Yermanos were crossed with the improved KU lines. Selection of better seed retention in capsules had been emphasized. But it could not be successful. Until in 1995 the KW – lines were obtained from Mr. Takada, Katagi Food CO., LTD. In 2000 the non – shattering and shatter resistant capsules were obtained from the cross Kuds6111/KW14 and Kuds6105/KW16. KW14 and KW16 are known later in 2000 that they are the shatter resistant varieties of S20 and S21, respectively. These two varieties were developed by Sesaco Corporation. San Antonio, Texas, USA.

The results of yield trials and evaluation of seed remained in capsules after inverted capsules eight promising lines were obtained. Average seed yield and some agronomic character of these lines are shown in Table 1.

However, the improved non – shattering lines still have shatter resistant capsules at 1 – 8 percent per plant (Fig.1). Also, the non – shattering capsules will open when the plants were damaged by diseases. This phenomenon is similar to indehiscent lines. The threshing of non – shattering and shatter resistant capsules were evaluated by using soybean and sorghum threshing machines. KUsr6662 gave the highest seed come out of capsules (> 90%) and seeds did not damage. The second rank is KUrs6660. The results suggest that the threshing machine of rice, sorghum and soybean could be used for threshing sesame. These threshing machines should be adjust for efficiency use in sesame. KUsr6662 and KUsr6660 have been released namely C plus 1

and C plus 2, respectively in April 2004.

Potential use of non – shattering in breeding and yield improvement in Thailand

Seed loss is a major problem for sesame production around the world. Boyle and Oemcke (1995) reported that seed loss may reduced yield by 60%. Only Sesaco Corporation has been developed shatter resistant capsules. The shatter resistant varieties are available for grower who contract to Sesaco Corporation in Texas and Oklahoma. In Thailand the area grown has reduced by lower seed yield due to seed shattering and scare of manual labor at harvest. In addition the lack of support from government compares to the other crops. Since 2002 the National Research Concil of Thailand has mainly policy to support budget for research in rice, casava, sugar cane, medicinal plant and para rubber. In addition most of extention projects involve to promate growing para rubber, rice, sugar cane, and cessava. But the major crops such as soybean, maize, vegetable and horticultural crops receive more budget than cesh crop such as sesame, castor and cowpea. Thus, there are few researchers both in breeding and crop production in sesame.

The improved non – shattering and shatter resistant lines will be increased the seed yield of sesame per unit area and the mechanization would be potential use in sesame production as well as rice and maize. The KU Sesame Breeding Project has considered to improve non – shattering

Table 1. Means of seed yield and some agronomic characters in the seven non-shattering and one shatter resistant lines grown at Suwan Farm in August 2002

Line	Pedigree	Days to Flowering	Days to maturity	FP	Branches per plant	Plant Height	GF	Capsules per plant	1,000 seed weight	Yield	Seed color
		--- d ---				--- cm ---				g	kg/ha
KUsr6660	KUds6111×S20-1-1-2	39	101	30	2	116	60	61	3.40	1,925	White
KUsr6661	KUds6111×S20-1-1-1	36	98	30	2	115	69	51	3.50	1,372	White
KUsr6662	KUds6111×S20-3-1-5	36	98	30	2	118	62	56	3.40	1,534	White
KUsr6663	KUds6111×S20-3-1-1	36	98	30	3	123	34	55	3.40	1,691	White
KUsr6607	Kuds6111×S20-1-10	39	101	31	5	110	67	50	3.80	1,725	White
KUsr6637	KUds6111×S20-1-11-3	39	106	35	4	108	59	72	3.40	2,053	White
KUsr6697	KUds6111×S20-1-1-5	34	97	31	3	113	61	49	3.70	1,501	White
KUsr6040 1/	KUds6105×S21-5-1	34	90	35	4	113	54	47	3.60	1,564	Black

Source : Wongyai and Chowchong, 2003a.

1/ Shatter resistant line; FP = flowering period ; GF = growth during flowering

Fig. 1. Segregation of non-shattering and shatter-resistant capsules within plant.

with high yield and seed quality. As above mentioned that KU 18 is good quality of black seed sesame for edible seed especially for Japanese. And the local varieties such as Loie, Mae Hongson, Koksamrong and Saraburi are high lignans content. The three breeding programs has been begun in 2002 as follow: 1) To develop high yielding cultivar, 2) To improve black seed sesame with good taste and flavor and 3) To develop high seed retention with high lignans content. The non – shattering and shatter resistance were crossed to improved lines, KU18, and local high lignans in 2001. The selection of characters to be improved has been done in F_2 populations and in successive generations of each program.

The F_4 and F_5 lines of each program will be tested for their yielding ability and shatter resistance in August 2004. The quality of black seed sesame of F_6 lines will be evaluated by Katagi Food Co. Ltd. F_6 seeds of lignans improved lines will be sent to Dr. Katsuta at National Institute of Crop Science, Tsukuba, Japan for evaluation of sesamin and sesamolin content.

The improvement of sesame production system in Thailand the project had three training courses for fermers in October and November 2003. The course included the demostration field of C plus 1 and KU 18, planting, harvesting and threshing by machine. This training would be gave an opportunity to farmers to learn about growing sesame for high yield and good quality. Farmers

were happy to see the non – shattering capsule. They hope that they would be get more seed yield per unit area and received more money too.

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