

Effect of Some Threshing Parameters on Sesame Separation

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ABSTRACT

The threshing section on combine harvester or thresher machine affects grain and stalk separation performance. In this study, effect of some threshing parameters such as drum speed, feed rate and concave open on closed capsules sesame straw sieve in developed threshing unit. Threshing drums used were a rasp bar with tooth type. Three threshing drum speeds of 500, 700 and 900 min⁻¹ (6.5, 9.1, 11.7 m/s) were used to investigations. Three feed rate as 90, 180 and 270 kg/h and three concave open as 20, 35 and 50 mm were used in this study. Four sieves were used for separation of straw. Their mesh numbers are 7, 10, 14 and 18. Results show that the best performance for separation of sesame straw were gave at the maximum drum speeds, minimum feed rates and concave opens experienced in this study.

Keywords: Sesame; *Sesamum indicum* L., separation, sieve, threshing, Turkey

1. INTRODUCTION

The separation is very sensitive to variation in the physical properties of grain, straw and chaff (Strivastava et al., 1990). Threshing materials size give from threshing units effected to design the separation unit. Working conditions of threshing units play a part in for material size and separation (Kanafojski and Karwowski, 1976). Majority threshing material separate in the sieve on combine harvester or thresher machine because of this, selection of sieves is very important.

Separation process studies and selection of the sieves used separation units have gone on for a long time for different crops. However, there is not enough knowledge about separation of sesame crop. Alferov and Braginec (1972) studied on threshing and grain separation in threshing units as a uniform probability- conditioned process. Sudajan et al. (2002) determined the effect of drum type, drum speed and feed rate by sunflower threshing. The rasp bar drum type showed reduction in the proportions of material other than grain (MOG) passing thought the concave. Maertens and Baerdemaeker (2003) investigated to different feed rates on separation. Kutzbach (2003) exposed the separation parameters of separation units. Wacker (2003) showed that influences of crop properties on the separation of cereal crops.

Sesame (*Sesamum indicum* L.) is one of the oldest cultivated plants in the world. It was a highly prized oil crop of Babylon and Assyria at least 4 000 years ago. Today, India and China are the world's largest producers of sesame, followed by Burma, Sudan, Mexico,

Nigeria, Venezuela, Turkey, Uganda and Ethiopia (Oplinger et al., 1990). Sesame is one of the important oilseed crops and producing 2 585 400 tones from approximately 1 954 000 ha in the world (FAO, 2005). It is grown in the warmer areas of Africa, Asia and Latin America for seeds. Sesame seed contains about 50% oil, which has excellent cooking quality, flavor, and stability.

This study was conducted to determine effect of some threshing parameters such as drum speed, feed rate and concave open to selection of sieve used in separation units at the developing threshing machine for closed capsule sesame crop.

2. MATERIAL AND METHODS

Closed capsule mutants, cc6 which is described by Cagirgan (2001) were grown following regular farmer practices and harvested manually in the field of Mutation Research Group at Akdeniz University, Agriculture Faculty, Antalya, Turkey. These plants of the 2007 harvest season were used for all the experiments in this study. The moisture content of the sesame was determined by the oven-drying method (ASAE, 1982). The average moisture content of closed capsules sesame mutant was 11% on w.b.

The closed capsules sesame-threshing unit was to be developed new one operates on the principle of axial flow movement of the material (Figure 1). The threshing mechanism consisted of a threshing drum, which rotates inside a two-section concave. The threshing drum was a rasp bar type. A rasp bar with peg tooth, closed threshing drum had four equidistionary bars built on the periphery of the parallel orientation. Peg tooth on the rasp bar provided to catch the material into the threshing unit. Developed threshing drum diameter and length were 250 and 300 mm, respectively. Because sesame is typically threshed at very low drum speed, three threshing drum speeds of 500, 700 and 900 min^{-1} (6.5, 9.1, 11.7 m/s) were experienced. The thresher was powered by electric motor and speed was set by speed control device.

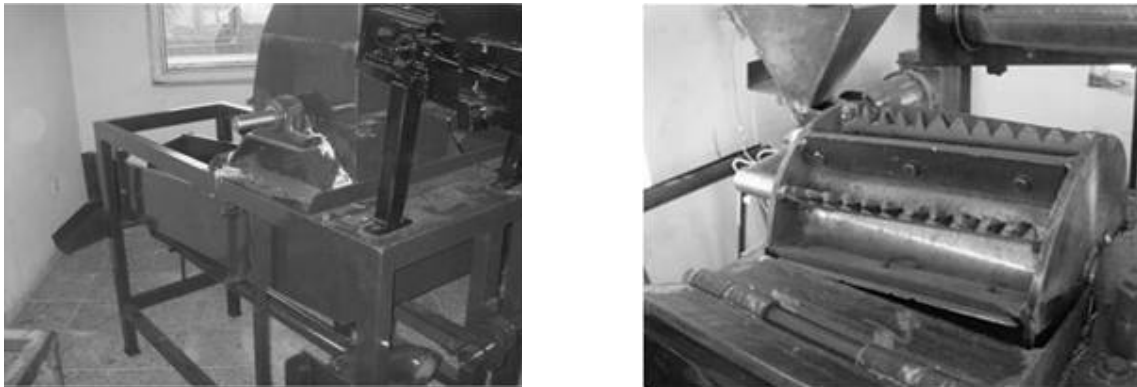


Figure 1. Closed capsules sesame threshing unit

The three feed rates were as 90, 180 and 270 kg/h. The independent variables studied were feeding belt speed and feed rate. The wideness and length of the feeding belt were 400 mm and 3000 mm, respectively. Feeding belt was divided into three sections by 1000 mm. The speed of feeding belt was 0.5 m/s. After the material had weighed by electronic scales, material loaded on the belt conveyor and fed into the hopper as an axial type.

The concave was made of steel plate. The length of the concave of threshing unit was 0.30 m. The concave of threshing unit was pure steel plate. In this study, three concave open was selected as 20, 35 and 50 mm, respectively. A plastic container was used to collect the material ejected from the straw outlet. Collected straw was weighted by electronic scales and put on the sieves box. Sieves box consisted of four sieves used for separation of straw sieve (Figure 2).



Figure 2. Sieve box and sieves used in the experiments

Their mesh numbers are 7, 10, 14, and 18. The holes of mesh were round. For determined the straw size, sieves box was shocked with ten minutes and materials that were on the sieves were weighted. Material into the each sieve was rated to the total material. The size of the straw was analyzed against different threshing drum, feed rates and concave open by using a randomized complete block design (RCBD) of 3 by 3 by 3 factorial experiments with three replications. Comparison between treatment means by the least significant difference at the 1% and 5% level.

3. RESULTS and DISCUSSION

Straw size is very important parameter for selection of the separation and cleaning unit. There has not been any information of sesame stalk size so far. Collecting material from the threshing unit included sesame grain. Sesame grain should not be broken.

Percentage of separation on the first sieves (7 mesh number) was given in Figure 3. Average values of material including straw and grain on the first sieve were found to be 61.2, 62.4 and 65.6% for drum speed of 500 min^{-1} , 700 min^{-1} and 900 min^{-1} respectively. According to analysis of Duncan's multiple test, effect of the drum speed on stalk size on the first sieve was significant ($p < 0.01$). Therefore, average straw values on first sieve were found to be 66.5, 60.1 and 62.6% for feed rate of 90 kg/h, 180 kg/h and 270 kg/h. Effect of feed rate on stalk size on the first sieve was significant ($p < 0.01$).

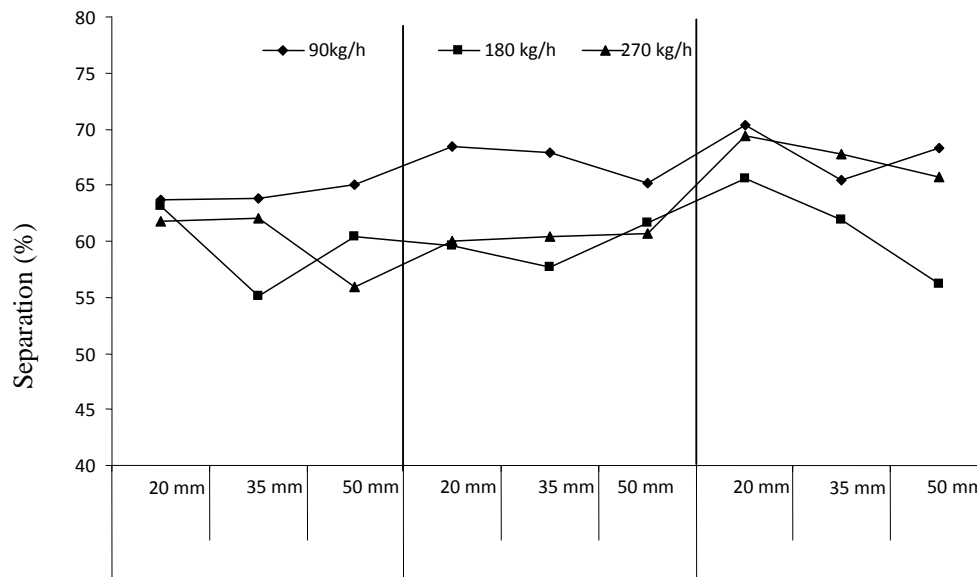


Figure 3. Separation on the first sieve

Effect of the concave open on the stalk size of first sieve was significant ($p < 0.05$). Average values of stalk size on the first sieve were determined to be 62.0, 62.4 and 64.6% for 50 mm, 35 mm and 20 mm, respectively. The results indicated that the highest values of the stalk size on the first sieve was found as 70.4 % in 900 min^{-1} drum speed, 90 kg/h feed rate and 20 mm concave open. The lowest values of the stalk size on the first sieve was found as 55.0 % in 500 min^{-1} drum speed, 180 kg/h feed rate and 35 mm concave open.

Mesh number of the second sieve in the sieve box was 10. Its profile was smaller than the first sieve's. Percentage values on the second sieve were given in Figure 4 for different drum speed, feed rates, and concave open.

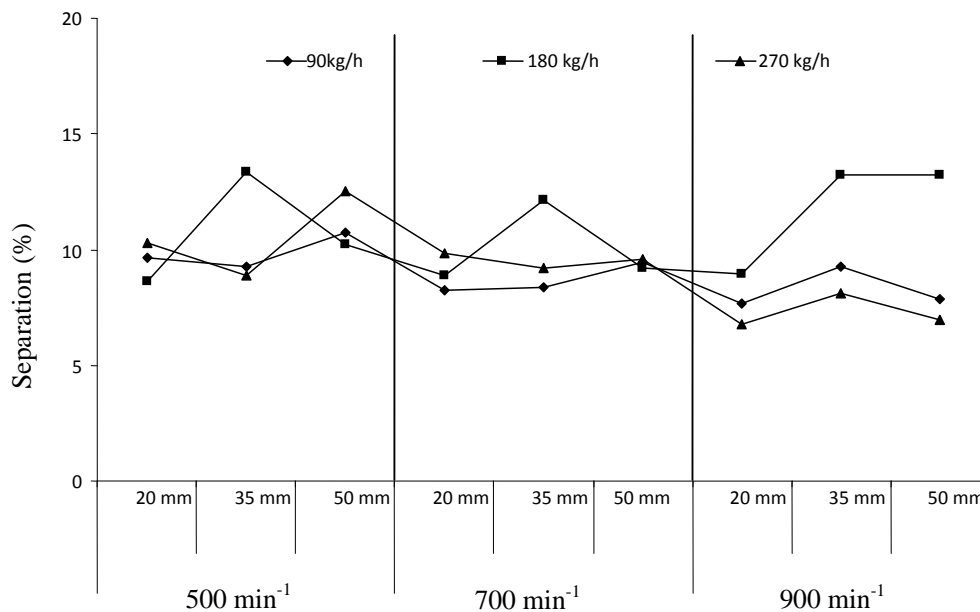


Figure 4. Separation on the second sieve

Average values of collecting straw on the second sieve were found to be 10.3, 9.4 and 9.1 % for drum speed of 500 min^{-1} , 700 min^{-1} and 900 min^{-1} respectively. According to analysis of Duncan's multiple test, effect of the drum speed was not significant on stalk size on the second sieve. Average straw values on second sieve were found to be 8.9, 10.8 and 9.1% for feed rate of 90 kg/h, 180 kg/h and 270 kg/h. Stalk size on the second sieve was significantly influenced by feed rate ($p < 0.01$).

Effect of the concave open on the stalk size of second sieve was significant ($p < 0.05$). Average values of stalk size on the second sieve were determined to be 9.9, 10.2 and 8.7% for 50 mm, 35 mm and 20 mm, respectively. The results indicated that the highest values of the stalk size on the second sieve was found as 13.3% in drum speed of 500 min^{-1} , feed rate of 180 kg-mat/h and concave open of 35 mm. The lowest values of the stalk size on the second sieve was found as 7.6 % in drum speed of 900 min^{-1} , feed rate of 90 kg/h and concave open of 20 mm. If you select the second sieve for separation of the sesame stalk, 77% of the harvesting material will have been taken.

Percentage of separation of the third sieve was given in Figure 5. Mesh number was 14. It was smaller than the second sieve. Effect of drum speed was significant ($p < 0.05$) on the stalk size of the third sieve. The lowest value was determined as 17.4 % at the drum speed of 900 min^{-1} feed rate of 270 kg/h and concave open of 20 mm. The highest value was 27.3 % at the drum speed of 700 min^{-1} , feed rate of 180 kg/h and concave open of 20 mm. Average values of percentage of separation for the drum speeds of 500 min^{-1} , 700 min^{-1} and 900 min^{-1} were 23.9, 23.5, and 20.3%, respectively.

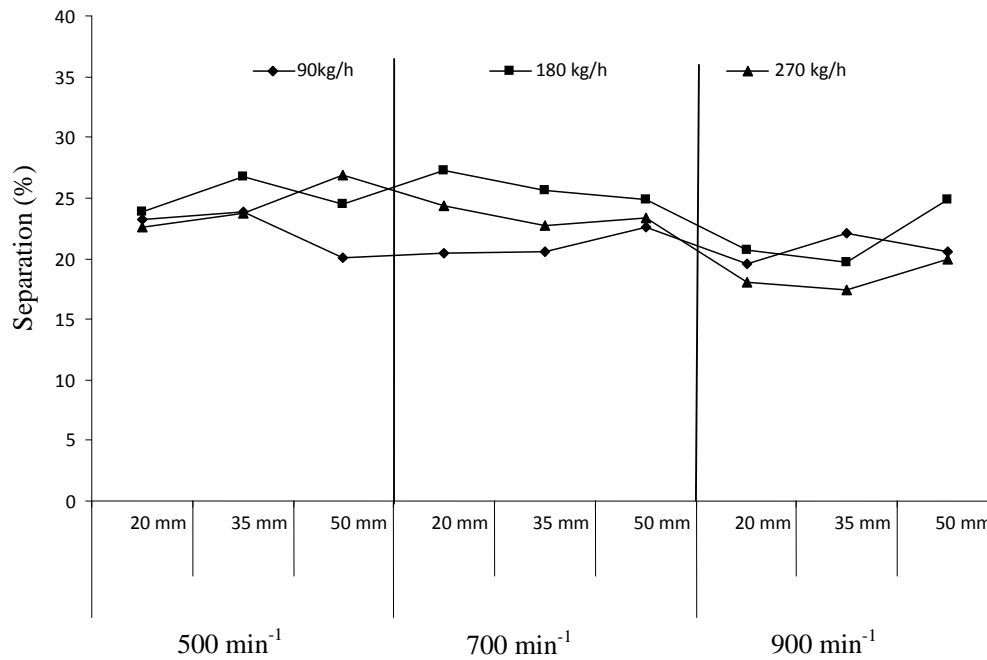


Figure 5. Separation on the third sieve

Average straw values on third sieve were found to be 21.4, 24.2 and 22.1 % for feed rate of 90 kg/h, 180 kg/h and 270 kg/h. Effect of feed rate was significant ($p < 0.01$) on stalk size on the third sieve. Effect of the concave open was not significant on the stalk size of third sieve. Average values of stalk size on the third sieve were determined to be 23.0, 22.5, and 22.2 % for 50 mm, 35 mm and 20 mm, respectively.

Forth sieve was used to acquire for sesame grain. Sesame grain have to clean and not break on the forth sieve. 18-mesh number sieve was used for grain. After the experiment, there was some stalk piece on the forth. It must include only grain, not other materials. Average values on the fourth sieve were given in Figure 6. Their values were changed between 2.3 % and 7.6 % at different working condition of threshing unit. When 2.3 % value was determined in the 900 min^{-1} drum speed, 90 kg/h feed rate and 20 mm concave open, material in the sieve was quiet clear. On the other hand, material, at the 700 min^{-1} drum speed, 270 kg/h feed rate and 35 mm concave open, included too much stalk and other than material. This situation is not desired to determine of separated parameters.

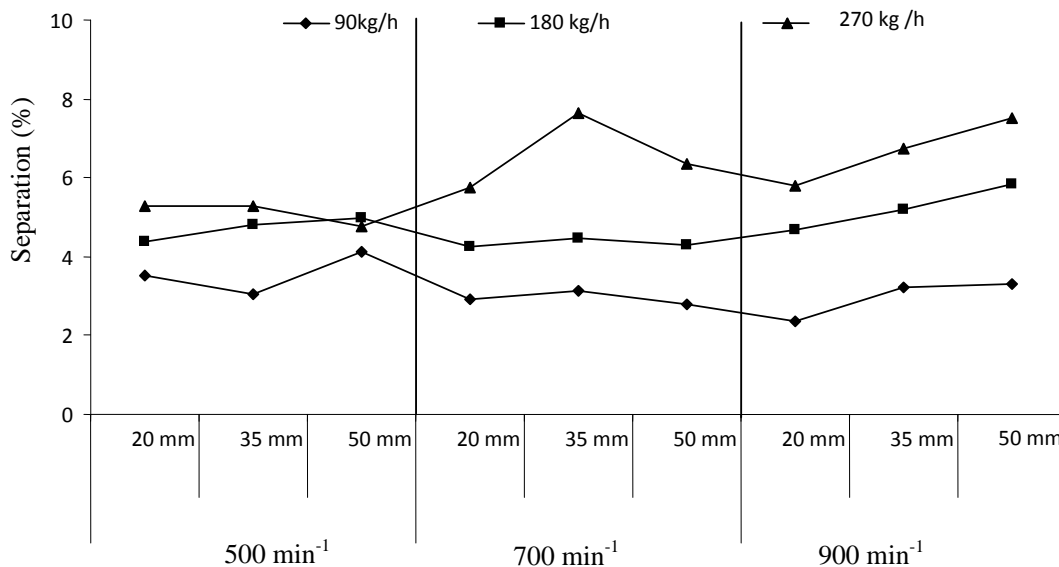


Figure 6. Separation on the fourth sieve

Average values of collecting straw on the fourth sieve were found to be 4.4, 4.6 and 4.9 % for drum speed of 500 min⁻¹, 700 min⁻¹ and 900 min⁻¹ respectively. According to analysis of Duncan's multiple tests, the drum speed, and feed rate were not significant on the material in the fourth sieve. Therefore, average values on fourth sieve were found to be 3.1, 4.7 and 6.1 % for feed rate of 90 kg/h, 180 kg/h and 270 kg/h. For 50 mm, 35 mm and 20 mm concave open, average values of material on the fourth sieve were determined to be 23.0, 22.5, and 22.2 % for 50 mm, 35 mm and 20 mm, respectively.

4. CONCLUSION

Separation parameters have been very important to develop a new separation system. Sieves have been used separation systems but selections of them are mostly important for new plants and new threshing unit.

In this study, effect of some threshing parameters such as drum speed, feed rate and concave open were investigated to sesame. The highest drum speed gave the claim performance to separation of straw size at all sieve. Drum speed of 900 min⁻¹ should be proposed to determine of the sieve used for separation of sesame stalk.

The lowest feed rate was better than other feed rate because feed rate unit was manufactured small and material pressed together in the threshing unit. Unless the material pressed together, separation of straw sizes can be easily. The best results were determined at 90 kg/h feed rate for selection of sieve used in the straw size separation.

Concave open of 20 mm should be used for selection of the sieves. When concave open has been increased, the material will be founded to be too much time in the threshing unit. In addition, stalk size might be seemed like under the threshing unit.

As a result of the experiment, 10, 14 and 18 mesh number sieves should be used for separation of sesame stalk and grain. Design of separation unit should be depend on these sieves. The best performance of the sieves gave at 900 min^{-1} drum speed, 90 kg/h feed rate and 20 mm concave open for separation of the sesame stalk and grain

5. ACKNOWLEDGEMENTS

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