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Full Length Research Paper

Improving the traditional sesame seed planting with seed pelleting

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The aim of this study is to determine the effect of seed pelleting in a variety of sesame types on yield and yield factors. In this study, it is suggested that with the help of seed pelleting, it will be possible to achieve a better planting, and subsequently, to acquire an increase in the yield and its elements. In this research, Muganli-57, Ozberk-82 and Golmarmara type seeds were used, which are all officially registered and commonly used seed kinds in Turkey. Two types of planting were utilized: 1- the traditional planting method used worldwide, 2- alternative sensitive method. In the sensitive method, the pelleted sesame seeds treated with a special pelleting mixture had a diameter of 3 mm or larger. These pelleted sesame seeds were planted with a pneumatic spacing planter. This study was done in Adnan Menderes University, Agricultural Faculty, Research and Practice Centers located in Menderes Plain and in the field of the plant production center of Dalaman. The arable field trials were done in two locations with a split plot trial method with three replications. In this study, the height of the plants (cm), number of lateral branches (lateral branches plant^{-1}), number of capsules per plant (capsule plant^{-1}), height of first capsule (cm), number of plants harvested per square meter, yield (kg ha^{-1}) and thousand kernel weight (g) were analyzed for both pelleted and nonpelleted sesame seeds. As a result, the pelleted sesame seeds improved the yield significantly compared to the normal sesame seeds. It was found that the pelleted sesame seeds had a mean yield value of 1976.3 kg ha^{-1}, whereas the non-pelleted sesame seeds had a mean yield value of 1243.2 kg ha^{-1}. Statistically significant differences exist between the pelleted and non-pelleted seeds in terms of the height of the plants (cm), number of lateral branches per plant (branch plant^{-1}), number of capsules per plant (capsule plant^{-1}), height of first capsule (cm), number of plants harvested (plant/ m^2), yield values (kg ha^{-1}) and thousand kernel weight (g).

Key words: Sesame, *Sesamum indicum* L, seed pelleting, mechanization of sesame planting, yield.

INTRODUCTION

Sesame holds a special importance in the world's oil production due to its high quality. 40-60% of sesame seeds are composed of oil. Because of its high production cost and limited production, it is not commonly used in meals in Turkey, instead it is mostly used in tahin and halva production (Langham and Wiemers, 2002). The production is far below the need of the country. Annually, approximately 450-600.000 tones of oil are imported.

Most imported oil industry plants in Turkey are sunflower, cotton seed, sesame, soya bean and peanut. According to FAO (2003), the reserved area for sesame planting in the world was 6.57 million hectometer, the production rate was 3.096 million tones/year and the yield was 471.2 kg ha^{-1} (FAO, 2004). In Turkey, reserved area for sesame planting was 50.000 ha, the production rate was 22.000 tones year^{-1} and the yield was 440 kg ha^{-1} in the same period. Although the yield in Turkey is higher than the world average, it is not satisfactory (Demir et al., 1992; Marquard et al., 1992). The main reasons for this condition are: planting sesame as a secondary crop,

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insufficient fertilizer usage and insufficient watering with broadcast seeding.

In China, hybrid sesame varieties are produced and as a result of the usage of fertilizers, sprays, hormones, mulching and mechanization, the yield increased to 2,573.488 kg ha^{-1} (Dingxuan and Jinxiang, 1991). This development may mean that sesame production will have an increasing popularity in oil industry in a few years (Mulkey et al., 1987).

As a hoeing plant, sesame has an important place in planting period. Nevertheless, due to manual harvesting, the workforce and the production costs increase considerably. Because of small size of the seeds, planting mechanization is difficult and hence broadcast seeding is common in Turkey and worldwide. The lack of mechanization in cultural practices exists in the areas of broadcast seeding. In those areas of broadcast seeding, seed rate is not well adjusted and the maintenance is not pursued by mechanization. This negatively affects the yield and cost of production. Therefore, increasing the yield and expanding the usage of mechanization in planting areas is a necessity. In sowing plants with seed drill, one of the major factors in obtaining high yield is the sound cultural practice. For example, if seed drill is used in the fields of broadcast seeding, more yields are obtained in wheat agriculture in Turkey. As it is known, the biggest obstacle in planting sesame by seed drill is the fact that the seeds are too small. With the help of seed pelleting, it will be possible to enlarge the diameters of the seeds and plant them with a pneumatic spacing planter.

In a study conducted in National Honam Agricultural Experiment Station (NHAES) in Korea, where sesame is planted manually, sesame seeds were pelleted with organic and inorganic materials\substances in order to develop an integrated mechanization system, to reduce labor cost. In this study, the diameter of pelleted seeds is reported to be 3 mm and seed number in each pellet is approximately 1.9 (NHAES, 1998). In the same study, it is emphasized that the applied system is a more advanced technique than the traditional method, which makes use of tractor, attached P.E film mulcher and spot sower. This mechanization system is integrated with ridge formation, P.E film mulching and sowing. It is stated that pelleted seed applications are lower in terms of seed yield, have higher value in terms of number of capsules in plants, the height of first capsule, length of plant and the number of plants harvested/harvested plants (anonymous).

In the same study, the height of the plants grown from pelleted seeds is reported to be higher than plants derived from normal seeds. The plant height is 113 cm with the traditional sowing method, 112 cm with hoeing, and 119 cm without hoeing, the thousand-kernel weight is 2.3, 2.21 and 2.25 g, respectively. In this study, the pelleted seeds have a decreased seed yield. The seed yield is 632 kg ha^{-1} with the traditional sowing method, 631 kg ha^{-1} with hoeing and 581 kg ha^{-1} without hoeing. This may be due to the differences between the soil conditions and the variants used in the study. The height of first capsule is 47 with the traditional sowing method cm, 36 cm with hoeing and 56 cm without hoeing. Pelleted seeds have a higher harvested plant number compared to normal seeds. The harvested plant number is 18 $plantm^{-2}$ with the traditional sowing method, 16 m^{-2} with hoeing and 25 m^{-2} without hoeing. In the plot of mechanical seeding, the time for emergence is delayed, but on the other hand the number of capsules per plant increases. The number of capsules in plant is 50 number $plant^{-1}$ with the traditional sowing method, 56 number $plant^{-1}$ with hoeing and 50 number $plant^{-1}$ without hoeing.

In this study, our aim was to increase the sesame yield by means of pelleting and to make the seeds appropriate for planting with a pneumatic spacing planter.

MATERIALS AND METHODS

In this study, 3 kinds of sesame that are widely planted in Turkey (Muganli-57, Ozberk-82 and Golmarmara) are used. The sesame seeds were pelleted in the University's Agricultural Department with two inorganic materials (clay mineral and silicate compound). The pelleted sesame seeds had a diameter of 3 mm or larger (Dogan et al., 2005).

The study area in Aydin has alluvial soils of the Kademe series (Calcaric Fluvisol (FAO); Oxaquic Xerofluvent (USDA)) (Bilgehan Aydin et al., 1999). The site in Dalaman is an alluvial soil of the Adakoy series (Typic Xerofluvent, USDA).

There are corn, maize and cotton fields and fruit plantations in Adnan Menderes University Faculty of Agriculture experimentation fields and corn and cotton fields in Dalaman fields.

The studies are conducted in 2004-2005 sesame growing season. The data for heat, humidity, rainfall and land heat of both locations are given in Table 1.

Pelleted seeds were planted with a pneumatic spacing planter (Hassia-made in Germany), which had a plate with 30, Ø3 mm holes.

The trials were carried out in Aydin Adnan Menderes University Agricultural Faculty arable fields and in arable fields of Dalaman Agricultural main division, in divided plots with three replications. In the trials varieties and planting technique constitute the main and sub plots, respectively. The dimensions of the prepared plots were 2.8 x 25 m. Inter-row width was 0.70 m and in each plot four rows were planted with the pneumatic spacing planter. Manual planting (broadcast seeding) was carried out in the plots subjected to traditional method.

The soil tillage was done with three body-mounted-type tractor ploughs shaving continental bodies. Seedbed preparation was done with mounted tandem disc harrow (four gangs), and a float was used to preserve soil moisture. Plantings were carried out in main product conditions and normal seeds were planted with a planting rate of 10 kilograms per hectare with traditional (manual broadcasting) seeding methods. The pelleted seeds were planted with a pneumatic spacing planter with a planting rate of 0, 6 kg per hectare. The pelleted seeds drilled in 2, 5-3 cm depth. After broad-casting, the seeds were mixed into the soil with a mounted tandem-disc harrow and then sealed with scrubbers. According to soil moisture and calculated water requirement of plants, irrigation applications were done once in the Aydin location and four times in

Table 1. The climate input for Aydin and Dalaman locations.

Parameter	Location	May	June	July	August	September	October	November
Heat (^oC)	Aydın	20.3	26.4	29	27.3	23.9	20.6	13.6
	Dalaman	19.60	24.74	27.24	26.31	24.80	21.36	15.36
Humidity (%)	Aydın	60.8	52.0	50.4	55.8	59.3	63.1	69.4
	Dalaman	59.86	62.50	62.49	60.11	65.02	65.37	66.71
Rainfall (mm)	Aydın	6.6	0.6	0.0	0.0	7.3	0.2	74.7
	Dalaman	13.3	1.1	0	0	0	42.4	170.9
Soil temperature in 5 cm depth (^oC)	Aydın	24.6	31.30	35.4	33.5	23.50	23.2	14.3
	Dalaman	17.81	22.69	25.05	25.16	22.12	16.90	10.59

Table 2. Germination rates of the sesame seeds in the field.

Sample	Traditional seeding (%)	Pelleted seed planting (%)
Muganlı	61.15	73.3
Özberk	63.14	75.8
Gölmarmara	52.44	83.3

the Dalaman location. In both locations 130 kg ha^{-1} DAP (18-46) and 180 kg ha^{-1} ammonium sulphate fertilizer was used. Planting took place on 20 May 2005 in Aydın and on 10 June 2005 in Dalaman. Harvesting was done in 4 Sept. 2005 in Aydın and in 21 Oct. 2005 in Dalaman. Inter-row hoeing and on-row hoeing was done once in sensitive planting plots. Harvesting was done manually at the time capsules split open and led dry down. Approximately three weeks later threshing was done manually. The compared values were the average values calculated by selecting 10 plants randomly from each plot. The yield values were calculated by harvesting plants from an area of 1.4x 10 m^2 (14 m^2) within each plot.

RESULTS AND DISCUSSION

In broadcast planting and planting with/by pneumatic sensitive planting machine, rates of emergence in the field of planted seeds differ (Table 2). In general, planting pelleted seeds with a pneumatic spacing planter leads to highest rate of emergence. In broadcast planting, low germination value depends on the planting method. Ozberk kind seeds have the highest rate of emergence at broadcast seeding (63.14%). Pelleted seeds of Golmarmara have the highest field germination rate in planting by machine with 83.3% followed by Ozberk (75.8%) and Muganli (73.3%).

When the bare seed planting and pelleted seed planting are compared to one another, planting pelleted seeds with a pneumatic spacing planter is shown superior performance than bare seeds.

The results of combined analysis of variance with respect to the analyzed properties in two locations can be seen in Table 3. As seen in the table, there is a significant difference with respect to plant height, the capsule number per plant, the harvested plant number, and yield between pelleted and normal seed planting ($p<0.005$).

Mean values of plant height, capsule number per plant, number of lateral branches, height of first capsule, number of plants harvested, seed yield and thousand kernel weight are compared .

According to the analysis of mean values at both locations, locations, pelleting, location x pelleting factors were found to be significant determinants in respect to yield (Table 4). With pelleted seeds, the mean seed yield was 1605 (kg ha^{-1}) in Dalaman location, and 2346 (kg ha^{-1}) in Aydin location. With normal seeds, the results were 1197 (kg ha^{-1}) and 1288 (kg ha^{-1}), respectively. It is possible to say that the yield differences between locations result from the time of planting, because planting was carried out in Aydin location earlier than Dalaman location. However, it is observed that the responses each kind gives to different environments vary significantly (e.g. Golmarmara kind) according to the effect of the environment. According to the mean values of both locations, pelleted seeds had an increased yield (1976 kg ha^{-1}) when compared to normal seeds (1243 kg ha^{-1}). At a similar study done in South Korea by National Honam Agricultural Experiment Station (NHAES), pelleted seeds had a decreased seed yield in contrast to our study. This may be due to the differences between the soil conditions and the variants used in the study (NHAES, 1998). When the yield results obtained in the study are examined it is clearly seen that using pelleted seeds will provide significant contributions to increase the yield in sesame planting/agriculture. Because when pelleted seeds are used it is possible to do planting with seed drill and to make the plants grow in appropriate planting norms. This

Table 3. The results of analysis of variance according to the analyzed properties of seed types (F value).

	S.D.	Plant height (cm)	Lateral Branches (branch/plant)	Number of capsule per plant (capsule/plant)	Height of first capsule (cm)	Number of plants harvested (plant/m^2)	Yield (kg/ha)	Thousand cornel weight (g)
Location	1	1288.2*	2.25*	8810.9*	1760.5**	69.44*	15583.3*	1.42**
ReplicationxLocation	4	522.170*	0.280ns	1403.927ns	238.911**	14.028ns	4497.277ns	0.050ns
Pelleting	1	1955.851**	1.000ns	7580.604*	23.603ns	69.444*	48368.618**	0.029ns
Locationxpelleting	1	1.228ns	0.111ns	233.071ns	46.353*	58.778*	9524.849*	0.052ns
Error1	4	65.690	0.174	504.650	3.877	3.694	878.315	0.021
Type	2	1083.796*	0.333ns	816.588ns	225.373**	1.694ns	203.541ns	0.132ns
Locationxtype	2	291.905*	0.760ns	836.954ns	20.584ns	2.528ns	3148.698ns	0.074ns
Pelletingxtype	2	48.676ns	0.493ns	289.614ns	30.901ns	6.194ns	279.612ns	0.030ns
Locationxpelletingxtype	2	148.763ns	0.271ns	390.281ns	19.001ns	3.028ns	1147.670ns	0.034ns
Error	16	69.037	0.325	403.667	10.973	6.486	1095.476	0.024
Total	35	281.360	0.403	1010.985	101.969	11.406	3487.596	0.077

provides the opportunity for the cultural processes to be carried out more effectively and healthily, and therefore increases the yield.

When the yields of the three types of seeds, calculated with and without pelleting are compared, the results showed that all of them had an increased yield with pelleting of the seeds. So it is concluded that this method may be a potential alternative in increasing the yield in sesame planting. Furthermore, the yield results obtained by some researchers that tried to increase the sesame yield are lower than our pelleted yield results (Kandasamy et al., 1989; Manivannan et al., 1993; Rao et al., 1992; Velanquez et al., 1993; Yadava et al., 1981; Osman and Khıdır, 1984; Narayan and Redy, 1982; NHAES,1998b).

The mean height of the plants can be seen in Table 5. When the results of the three types of seeds, planted with and without pelleting, are compared, all of them had a significantly increased mean height with pelleting of the seeds. With pelleted seeds, the mean height of the plants in Dalaman location was 129.56 cm and in Aydin it was 141.2 cm. There had also been an observable difference between locations with normal seeds. The mean heights of the normal seeds were 114.4 and 126 cm, respectively. The difference between pelleted and non pelleted seeds may have originated from the optimal living area supplied to the pelleted seeds by using row seeding. These findings are in concordance with some of the other studies about the height of the sesame plants (Vyans, 1981; Demir et al., 1992; Marquard et al., 1992). In a study done in South Korea, the height of the plants grown from pelleted seeds is reported to be higher than plants derived from normal seeds (NHAES, 1998; NHAES, 1998b; NHAES, 1998c).

The number of lateral branches can be seen in Table 6. Only location factor had a significant effect on the number of lateral branches per plant. In the pelleted seeds group, the mean number of branches per plant was 3.39 (branch plant^{-1}) in Dalaman and 3.77 (branch plant^{-1}) in Aydin. For normal seeds the number of branches per plant was 2.94 (branch plant^{-1}) and 3.55 (branch plant^{-1}), respectively. These results are in concordance with some of the other studies (Vyans, 1981; Demir et al., 1992; Marquard et al., 1992).

With respect to the number of capsules per plant, pelleted seeds had a mean value of 139.9 capsules per plant in Dalaman location and 166.1 capsules per plant in Aydin location. With normal sesame seeds, the results were 105.8 and 142.2 capsule plant^{-1} respectively. These results are summarized in Table 7. When the mean value of Aydin and Dalaman locations with and without pelleted seeds are compared, the pelleted seeds had a significantly higher capsule per plant number (152.9 versus 124.6). A similar result has also been ob-tained in South Korea by NHEAS (NHAES, 1998; NHAES, 1998c).

The factors having significant effect on the height of first capsule were location, replication x location and the type of the seed (Table 8). The height of first capsule with pelleted seeds in

Table 4. The seed yield values (kg ha^{-1}) of varieties analyzed in this study.

Type	Pelleted seed			Control		
	Dalaman	Aydin	Mean	Dalaman	Aydin	Mean
Mugani-57	1670	2102	1885	1253	1235	1244
Ozberk-82	1753	2206	1979	1230	1282	1255
Golmarmara	1393	2733	2063	1110	1349	1229
Mean	1605	2346	1976	1197	1288	1243
LSD	57.32	57.32		57.32	57.32	

Table 5. The mean height of the plants (cm).

Type	Pelleted seed			Control		
	Dalaman	Aydin	Mean	Dalaman	Aydin	Mean
Muganlı-57	137.7	142.2	139.95	122.7	131.2	126.95
Ozberk-82	139.7	139.2	139.45	121.3	133.8	127.55
Golmarmara	111.3	142.0	126.65	99.3	115.3	107.30
Mean	129.56	141.2	135.38	114.4	126.0	120.20
LSD	Ns	ns		Ns	ns	

Table 6. The mean number of lateral branches per plant (branch plant^{-1}).

Type	Peletted seed			Control		
	Dalaman	Aydin	Mean	Dalaman	Aydin	Mean
Muganlı-57	3.07	4.23	3.65	3.13	3.90	3.52
Ozberk-82	4.03	3.60	3.82	2.83	3.20	3.02
Golmarmara	3.07	3.50	3.28	2.87	3.57	3.22
Mean	3.39	3,77	3.58	2,94	3.55	3.25
LSD	0.987	0.987		0.987	0.987	

Table 7. Number of capsules per plant (capsule plant^{-1}).

Type	Peletted seed			Control		
	Dalaman	Aydin	Mean	Dalaman	Aydin	Mean
Muganlı-57	136.0	173.8	154.9	105.3	163.9	134.6
Ozberk-82	150.0	172.8	161.3	118.3	125.1	121.7
Golmarmara	133.7	151.7	142.6	93.7	137.5	115.6
Mean	139.9	166.1	152.9	105.8	142.2	124.61
LSD	34.7	34.7		34.7	34.7	

Dalaman location was 27.56 cm and in Aydın location it was 39.2 cm. With normal seeds it was found to be 23.67 and 32.60 cm, respectively. When the mean value of Aydın and Dalaman locations with and without pelleted seeds were compared, it was found that the pelleted seeds had a significantly higher first capsule length than the normal seeds. A similar result has also been obtained in South Korea by NHEAS (NHAES, 1998).

Location, replication x location and pelleting process were the factors that have been found to have a significant effect on harvested plant number (Table 9). The mean harvested plant number with pelleted seeds in Dalaman location was 11.00 (plant m^{-2}) and in Aydin location it was 16.33 (plant m^{-2}). With normal seeds it was found to be 10.78 (plant m^{-2}) and 11.00 (plant m^{-2}), respectively. A similar result has also been obtained in

Table 8. The height of first capsule (cm).

Type	Pelleted seed			Control		
	Dalaman	Aydin	Mean	Dalaman	Aydin	Mean
Muganlı-57	26.33	38.92	32.62	23.00	33.17	28.05
Ozberk-82	32.33	41.70	37.01	28.67	36.63	32.65
Golmarmara	24.00	37.20	30.60	19.33	28.02	23.67
Mean	27.56	39.27	33.41	23.67	32.60	28.13
LSD	ns	ns		ns	ns	

Table 9. The numbers of harvested plant (plant m^{-2}).

Type	Pelleted seed			Normal seed		
	Dalaman	Aydin	Mean	Dalaman	Aydin	Mean
Muganlı-57	10.33	15.67	13.00	12.33	10.67	11.50
Ozberk-82	11.00	15.33	13.17	10.00	11.33	10.67
Golmarmara	11.67	18.00	14.83	10.00	11.00	10.50
Mean	11.00	16.33	13.67	10.78	11.00	10.89
LSD	4.41	4.41		4.41	4.41	

Table 10. Thousand kernel weight according to seed types (g).

Type	Pelleted seed			Normal seed		
	Dalaman	Aydin	Mean	Dalaman	Aydin	Mean
Muganlı-57	3.84	4.10	3.97	3.67	4.30	3.98
Ozberk-82	3.47	3.93	3.70	3.58	4.17	3.87
Golmarmara	3.69	3.93	3.81	3.70	3.90	3.80
Mean	3.67	3.99	3.83	3.65	4.12	3.89
LSD	0.268	0.268		0.268	0.268	

South Korea by NHEAS. Pelleted seeds had a higher harvested plant number compared to normal seeds (NHAES, 1998).

Location was the only factor that has been found to have a significant effect on the mean thousand kernel weight (Table 10). Mean thousand cornel weight with pelleted seeds in Dalaman location was 3.69 g and in Aydın location it was 3.93 g. With normal seeds it was found to be 3.70 and 3.90 g, respectively. With normal seeds it was found to be 3.70 and 3.90 g, respectively. These values are higher than the NHEAS study's (NHAES, 1998).

Conclusion

When the mean yield of Aydin and Dalaman locations with and without pelleted seeds was compared, the pelleted seeds had a significantly higher yield compared to the normal seeds. Pelleted seeds had a positive effect on important criteria in yield such as the height of the first capsule, the height of the plant and number of capsules per plant (values). It can be clearly seen that the type of seeds used in this study are appropriate seeds for pelleting and the yield can be increased by using these seeds with mechanization of sesame planting. Furthermore, since the mixture materials used in pelleting are cheap, this method can be practiced all over the world easily.

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