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Full Length Research Paper

The effects of seed coating treatment on yield and yield components in some cotton (*Gossypium hirsitum* L.) varieties

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The use of delinted cotton seeds in cotton planting instead of fuzzy cotton seeds has spread recently. Cotton planting area of the world was 32,150,000 ha in 2003 - 2004. Approximately 45 - 50% of the planting seed in the world is delinted. This signifies that nearly 16,000,000 ha cotton area is planted by delinted cotton seed. In this study, coating fuzzy cotton seeds is proposed as an alternative to delintation. Coating makes fuzzy cotton seeds more suitable for the pneumatic spacing planter. Also, unlike delintation, sulphuric acid is not used for coating and this eliminates the problems associated with its usage such as seed loss, pollution and threats to human health. The results show that the cultivation of coated cotton seeds has no disadvantage regarding the agronomic and technological characteristics of cotton seed; coating may even improve the characteristics of the seeds. Also, no significant difference exists in terms of yield. Hence, seed coating has the potential to expand organic cultivation of cotton, as the coated seeds can be easily planted with pneumatic spacing drills and as organic seed procurement would be provided with the seed coating method.

Key words: Fuzzy cotton seed, seed coating, yield components.

INTRODUCTION

The use of delinted cotton seeds in cotton planting instead of fuzzy cotton seeds has spread recently. Cotton planting area of the world was 32,150,000 ha in 2003 - 2004 (ICAC, 2003). Assuming that most of the seed planted in rows is delinted, approximately 45 - 50% of the planting seed in the world is delinted. Sulphuric acid (H_2SO_4) is used for delintation and this leads to seed losses, increases pollution and threatens human health. Of course, mechanically delinted seed, which is common in West African countries, is used too but this area is only 2,208,000 ha (ICAC, 2003). Such a big share of delinted seed is obtained by using sulphuric acid (H_2SO_4).

In recent years, the utilization of delinted cotton seeds has spread in Turkey. The rate of delinted planting seed is around 90%, particularly in the Aegean Region. The two different kinds of cotton seeds (fuzzy and delinted seeds) require different planting methods. Sulphuric acid (H_2SO_4) is used for delintation to produce delinted seeds and at the end SO_2 is let out. In general, to prepare 1 kg of delinted seeds, approximately 12 or 15 g of concentrated H_2SO_4 is used. However, pollution stemming from the evaporation of the acid used in delintation, the increases in cost and seed losses is the negative effects of delintation. Generally, at the end of delintation, Nazilli 84-S cotton variety loses 10 - 15% of its seeds, and Nazilli M-503 and Nazilli 143 cotton varieties lose 15 - 25% of their seeds.

In this study, coating fuzzy cotton seeds is proposed as an alternative to delintation, which was not done before. The aim of this study was to make fuzzy cotton seeds suitable for the pneumatic spacing planter by coating the fuzzy seeds with a special coating mixture (two inorganic natural material: clay mineral and silicate compound) instead of planting delinted seeds, the utilization of which

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causes pollution and increases cost. Also, it was aimed to determine the effects of coating treatments on cotton yield and yield components. In India, farmers have used termit clay and cow dung to cover the seed. This not only incorporates natural fungicide, but also eases sowing and stops the seeds from sticking together (Elzakker, 1999). In addition, as the amount of zinc in the soil is very low in the Aegean region, zinc (2.4%) was added to the coating material; therefore a second coating treatment was examined in the trials.

Seed cotton yield, plant height, boll number, seed cotton weight per boll, hundred seed weight, gin turnout, fiber fineness and fiber length were examined in the study.

MATERIALS AND METHODS

Fuzzy and delinted seeds of Nazilli 84-S, Nazilli M-503 and Nazilli 143 cotton varieties of *Gossypium hirsitum L.* developed by Nazilli Cotton Research Institute were used as materials in the study (Soyler et al., 2000; Gulyasar et al., 2000). At the beginning of the study, physical properties of the soil in the research plots: loam, total salt (%) 0.0113, pH 8.02, $CaCO_3$ (%) 7.46, organic material (%) 1.69 (Aksoy et al., 1998) were determined.

The study was conducted in the research plots of the Faculty of Agriculture in Adnan Menderes University, located in Aydin province, Turkey in 2002, 2003 and 2004. The study area has alluvial soils of the Kademe series (Calcaric) Fluvisol (FAO); Oxaquic Xerofluvent (USDA) (Aydin et al., 1999). The study was carried out using three different cotton varieties, four different types of seeds and randomized complete block design with three replications in 36 plots each of which has a row spacing of 0.70 and 25 m row length. The plots were ploughed with a 3 body mounted tractor plough at the beginning of April and then the plots were ploughed with a trailed tandem disc harrow, that is widely used in the region three times to prepare the seedbeds. For planting delinted and coated seeds (Dogan et al., 2003), a mounted *Hassia* brand pneumatic spacing drill was used. The pneumatic spacing drill consisted of four plates. Diameter of each plate is 220 mm and has 30 holes having a diameter of 3 mm. For planting fuzzy seeds, a mounted *Dundar* brand mechanical cotton planter, which makes seed drilled in rows, was used. At the end of the experiments, it was determined that the most suitable plant spacing is 15.7 cm and the most suitable forward velocity is 1 m/s, and these values were applied to the field tests. The soil was sealed with scrubbers before and after the planting to maintain the tilth. The cotton seeds were coated in the lab of the Agricultural Machines Department of College of Agriculture in Adnan Menderes University.

The properties examined are: seed cotton yield (kg ha^{-1}), plant height (cm), boll number (num. $plant^{-1}$), seed cotton weight per boll (g), hundred seed weight (g), gin turnout (%), fiber fineness (micronaire) and fiber length (mm). The technological properties of fiber were studied in the laboratory of Cotton Research Institute in Nazilli with HVI spectrum 1.

Evaluations

The values obtained from this study were applied to the analysis of variance using the randomized complete block design with the help of Tarist statistic package program developed by Açıkgöz et al. (1994) and then least significant difference (LSD) test was carried out to determine the level of significance of the differences between the treatments.

RESULTS AND DISCUSSION

Agronomic and technological characteristics

Table 1 display the mean squares of seed cotton yield (kg ha^{-1}), boll number (num. $plant^{-1}$), seed cotton weight per boll (g), gin turnout (%), fiber fineness (micronaire) and fiber length (mm). When the results of the analysis of variance of the year 2002 was looked at, it was clear that the differences between the varieties are statistically significant considering all the characteristics except for seed cotton yield (kg ha^{-1}), fiber fineness (micronaire) and fiber length (mm) (Table 1). In 2003, differences between the varieties are statistically significant for all the characteristics except for seed cotton yield (kg ha^{-1}). The results showed that in 2004, only seed cotton yield (kg ha^{-1}) and gin turnout (%) characteristics are statistically important. Table 1 show that the differences between the treatments are insignificant statistically for all the characteristics in all three years. When the variety x treatment interaction was examined, it was obvious that only the boll number (num. $plant^{-1}$) in 2002 and the fiber length (mm) in 2003 are significant (Table 1).

Seed cotton yield

Table 2 shows that the differences between the varieties and the variety x treatment interaction are statistically insignificant in 2002 and 2003. In 2004, the differences between the varieties are statistically significant, but the variety x treatment interaction is statistically insignificant.

Scrutiny of the average of varieties showed that varieties in the same group follow Nazilli 84-S in 2004 (Table 2). When the variety x treatment interaction was examined, it was observed that among the treatments done with Nazilli 84-S, coating (5638.3 kg ha^{-1}) and delinted planting seed (5275.0 kg ha^{-1}) treatments produce significantly high yield.

When the values obtained in 2002, 2003 and 2004 was examined; it is possible to state that although yields of the varieties are not influenced by different seed planting treatments, coating treatments may cause the yield to decrease. Nonetheless, in 2004, coating treatment gives the maximum yield among the treatments done with Nazilli 84-S, and this indicates that factors like environment and time (year) may have influence on yield; though, this influence is little.

That Nazilli 84-S gives less yield in 2002 and 2003 is an unexpected situation since the yield potential of this cotton variety is higher than the other two cotton varieties, as it is in 2004. Studies conducted at Nazilli Cotton Research Institute have shown that Nazilli 84-S variety gives more yield than Nazilli M-503 and Nazilli 143 varieties (Eksi et al., 2000; Gulyasar et al., 2000; Cagirgan et al., 2002). Delayed planting dates in 2002 and 2003 may account for the situation.

Table 1. Mean squares of some characteristics in 2002, 2003 and 2004.

Source of variation	DF	Seed cotton yield (kg ha^{-1})	Boll Number (num plant^{1})	Boll weight (g)	Gin turnout (%)	Fiber fineness (mic.)	Fiber length (mm)
2002							
Replication	2	2283642.7*	17.28*	3.42**	8.61**	0.173	3.179*
Variety	2	211000.1	21.99**	1.35**	37.77**	0.041	0.450
Treatment	3	813822.8	6.14	0.23	0.75	0.042	0.826
Variety x Treatment	6	168843.7	9.17*	0.13	0.85	0.035	0.482
Error	22	436052.3	3.21	0.13	1.03	0.062	0.766
Total	35	515341.9	6.36	0.40	3.51	0.061	0.842
2003							
Replication	2	30721.5	178.31**	0.996*	5.91	0.617**	1.315
Variety	2	184854.8	75.87*	1.223**	72.60***	0.478*	4.417**
Treatment	3	440336.6	44.40	0.443	1.98	0.142	1.100
Variety x Treatment	6	7800.6	6.43	0.102	0.64	0.033	2.366**
Error	22	143606.1	21.95	0.176	4.07	0.097	0.588
Total	35	141665.7	33.23	0.293	7.32	0.142	1.197
2004							
Replication	2	69769.2	7.289	0.723	1.457	0.355*	1.848
Variety	2	1453267.7*	2.235	0.821	30.523***	0.276	2.812
Treatment	3	181910.2	0.954	0.443	0.115	0.118	0.577
Variety x Treatment	6	416272.1	6.872	0.225	0.846	0.050	1.523
Error	22	196231.4	5.554	0.250	0.803	0.085	0.834
Total	35	297329.4	5.295	0.322	2.487	0.108	1.101

*, **, ***Significant at 5, 1 and 0.1%, respectively.

Table 2. Average seed cotton yield of the varieties (kg ha^{-1}) as to the seed treatments examined and the groups.

Variety	Treatments				Mean varieties
	Fuzzy	Delinted	Coated	Zinc + Coated	
Means and groups in 2002					
Nazilli 84-S	4067.0	3850.0	3798.7	3446.7	3790.6
Nazilli M-503	4339.3	4375.3	3396.3	3921.3	4008.1
Nazilli 143	4117.3	4461.0	3753.7	3791.0	4030.8
LSD	1118.947				559.473
Means and groups in 2003					
Nazilli 84-S	3476.5	3327.1	2951.5	3035.9	3197.7
Nazilli M-503	3613.5	3590.2	3138.5	3370.7	3428.2
Nazilli 143	3567.2	3568.0	3169.6	3266.4	3392.8
LSD	642.135				355.614
Means and groups in 2004					
Nazilli 84-S	4361.0 b*	5275.0 a	5638.3 a	5044.0 ab	5079.6 a
Nazilli M-503	4777.0	4473.7	4343.0	4384.3	4494.5 b
Nazilli 143	4471.3	4540.3	4516.7	4314.0	4460.6 b
LSD	750.627				375.314

*Values with the same letters are significantly different at the 0.05 level of probability.

Table 3. Average boll number of the varieties as to the seed treatments examined and the groups.

Variety	Treatments				Mean varieties
	Fuzzy	Delinted	Coated	Zinc+ Coated	
Means and groups in 2002					
Nazilli 84-S	16.63 a*	13.57 b	13.23 b	15.43 ab	14.72 b
Nazilli M-503	16.83	15.97	16.97	17.80	16.89 a
Nazilli 143	14.70 c	16.13 bc	19.80 a	18.17 ab	17.20 a
LSD	3.037				1.519
Means and groups in 2003					
Nazilli 84-S	13.00	12.30	15.43	15.97	14.18 b
Nazilli M-503	19.10	14.63	22.03	18.13	18.48 a
Nazilli 143	19.70	14.80	19.40	20.43	18.58 a
LSD	7.938				3.969
Means and groups in 2004					
Nazilli 84-S	16.73	16.23	18.83	20.00	17.95
Nazilli M-503	18.37	19.00	17.23	19.23	18.46
Nazilli 143	18.43	18.17	17.57	16.23	17.60
LSD	3.993				1.997

*Values with the same letters are significantly different at the 0.05 level of probability.

Boll number

When the average boll number of the treatments and varieties examined in 2002 (Table 1) was scrutinized, it was seen that both the differences between the varieties and the variety x treatment interaction are statistically significant. Among the treatments done with Nazilli 84-S, while fuzzy planting seed treatment has the maximum boll number of 16.63 (num. plant^{-1}), coating and delinted planting seed treatment had the minimum boll number (13.23 num. plant^{-1} and 13.57 num. plant^{-1}, respectively) (Table 3). However, in Nazilli M-503, zinc added coating treatment has the maximum boll number (17.80 num. plant^{-1}), and in Nazilli 143, coating treatment has the maximum boll number of 19.80 (num. plant^{-1}) and zinc added coating treatment comes after this with a boll number of 18.17 (num. plant^{-1}).

It can be shown that the differences between the varieties are statistically significant in 2003 (Table 3), and Nazilli 143 and Nazilli M-503 varieties have the maximum boll number (18.58 num. plant^{-1} and 18.48 num. plant^{-1}, respectively). Variety x treatment interaction was statistically insignificant in 2003 and also in 2004. Differences between the varieties are statistically insignificant in 2004 as well (Table 3).

The results (Table 3) show that boll number changes depending on the varieties. The boll number results of Nazilli 84-S variety are in accordance with the results reported by Simsek (2004). In addition, generally we can say that coating and zinc added coating treatments increase boll number prominently.

Seed cotton weight per boll

When the average seed cotton weight per boll of the treatments was looked at and varieties examined in 2002 and 2003 (Table 1), it was seen that the differences between the varieties are statistically significant, and the variety x treatment interaction is statistically insignificant. When the average of varieties was examined, Nazilli 143 and Nazilli M-503 had the maximum cotton seed weight per boll (6.79 and 6.64 g, respectively) in 2002 (Table 4). A similar case was observed in 2003. In both years, Nazilli 84-S had the minimum seed cotton weight of 6.15 and 5.27 g per boll, respectively (Table 4).

Table 1 shows that both the differences between the varieties and the variety x treatment interaction are statistically insignificant in 2004. Although the average of varieties is statistically insignificant, group has existed and Nazilli 143 had the maximum seed cotton weight of 6.92 g per boll while Nazilli 84-S had the minimum seed cotton weight of 6.41 g per boll like 2002 and 2003 (Table 4).

The results show that (Table 4) seed cotton weight per boll changes depending on the varieties as it was also the case for boll number. These results are in accordance with the results reported by Cagirgan et al. (2002). In addition, when we look at the treatments on the basis of varieties, it is possible to say that coating treatments positively influence seed cotton weight per boll in a way that the weights increase (Table 4).

Gin turnout

Table 1 shows that the differences between the varieties are statistically significant, and the variety x treatment interaction is statistically insignificant. When the average of varieties is examined (Table 5), it is clear that Nazilli 84-S has the maximum gin turnout for all three years with

Table 4. Average seed cotton weight per boll of the varieties as to the treatments examined and the groups.

Variety	Treatments				Mean varieties
	Fuzzy	Delinted	Coated	Zinc + Coated	
Means and groups in 2002					
Nazilli 84-S	6.48	6.14	6.08	5.90	6.15 b
Nazilli M-503	6.66	6.66	6.65	6.59	6.64 a
Nazilli 143	6.75 ab*	7.23 a	6.71 ab	6.48 b	6.79 a
LSD	0.615				0.308
Means and groups in 2003					
Nazilli 84-S	4.97	5.18	5.53	5.41	5.27 b
Nazilli M-503	5.59	5.62	6.15	6.27	5.91 a
Nazilli 143	5.30	5.71	5.59	5.53	5.53 b
LSD	0.710				0.355
Means and groups in 2004					
Nazilli 84-S	6.23	6.68	6.54	6.20	6.41 b
Nazilli M-503	6.70 ab	7.10 a	6.42 ab	5.94 b	6.54 ab
Nazilli 143	6.98	6.94	6.80	6.95	6.92 a
LSD	0.848				0.424

*Values with the same letters are significantly different at the 0.05 level of probability.

Table 5. Average gin turnout (%) of the varieties as to the treatments examined and the groups.

Variety	Treatments				Mean varieties
	Fuzzy	Delinted	Coated	Zinc+Coated	
Means and groups in 2002					
Nazilli 84-S	41.66	43.14	42.27	42.10	42.29 a*
Nazilli M-503	38.88	39.00	38.96	39.70	39.13 b
Nazilli 143	39.27	38.78	39.16	40.04	39.31 b
LSD	1.715				0.857
Means and groups in 2003					
Nazilli 84-S	45.06	45.35	46.28	44.67	45.45 a
Nazilli M-503	41.27	40.32	41.94	41.98	41.38 b
Nazilli 143	41.26	40.42	41.24	41.19	41.03 b
LSD	3.417				1.709
Means and groups in 2004					
Nazilli 84-S	42.24	42.74	43.29	43.58	42.96 a
Nazilli M-503	41.21	41.75	41.33	41.51	41.45 b
Nazilli 143	40.25	39.83	39.85	39.17	39.78 c
LSD	1.518				0.759

*Values with the same letters are significantly different at the 0.05 level of probability.

42.29, 45.45 and 42.96%, respectively. Other varieties come after Nazilli 84-S (Table 5).

When we look at all the results, it is obvious that coating treatment has no negative or positive influence on gin turnout. If, however, we pay attention to the gin turnouts in some years, we can say that coating treatment might increase gin turnout. Average results for the varieties show that Nazilli 84-S variety has higher gin turnouts. This is due to the characteristics of the variety as also reported by Cagirgan et al. (2002), Cagirgan and

Table 6. Average fiber fineness of the varieties (micronaire) as to the treatments examined and the groups.

Variety	Treatments				Mean varieties
	Fuzzy	Delinted	Coated	Zinc+Coated	
Means and Groups in 2002					
Nazilli 84-S	5.40	5.27	5.30	5.43	5.35
Nazilli M-503	5.37	5.17	5.40	5.10	5.26
Nazilli 143	5.33	5.37	5.50	5.27	5.37
LSD	0.421				0.211
Means and Groups in 2003					
Nazilli 84-S	5.11	5.28	5.27	4.94	5.15 a*
Nazilli M-503	4.65	5.02	5.09	4.79	4.89 ab
Nazilli 143	4.71	4.76	4.82	4.75	4.76 b
LSD	0.528				0.264
Means and Groups in 2004					
Nazilli 84-S	5.03	5.24	5.17	5.05	5.12 a
Nazilli M-503	5.02	5.04	4.70	4.60	4.84 b
Nazilli 143	5.05	5.13	5.19	4.93	5.07 ab
LSD	0.493				0.246

*Values with the same letters are significantly different at the 0.05 level of probability.

Barut (2000), Goktepe and Goktepe (2000).

Fiber fineness

Table 6 shows that both the differences between the varieties and the variety x treatment interaction are statistically insignificant in 2002. The data of 2003 and 2004 show that (Table 6) differences between the varieties are statistically significant but the variety x treatment interaction is insignificant. When the average of varieties in Table 6 was examined, it was seen that Nazilli 84-S has the thickest fibers in 2003 and 2004 (5.15 micronaire and 5.12 micronaire, respectively). In 2003, Nazilli 143 (4.76 micronaire) and in 2004 Nazilli M-503 (4.84 micronaire) had the finest fibers (Gulyasar et al., 2000; Goktepe and Goktepe, 2000).

These results are important since they show that coating treatments may positively influence fiber fineness in a way which makes fibers thin, despite the fact that statistically, treatments do not influence fiber fineness.

Fiber length

It is seen from Table 1 that both the differences between the varieties and the variety x treatment interaction are statistically insignificant in 2002 and 2004. But in 2003, both the differences between the varieties and the variety x treatment interaction are statistically significant (Table 1). Examination of fiber length values obtained in 2003 (Table 7) showed that coating treatment has the tallest fibers in all three varieties. Here, it is crucial to state that in 2002 and 2003, coating treatments have taller fibers too. These results are important because they show that coating treatments do not negatively influence fiber length (Gulyasar et al., 2000; Goktepe and Goktepe 2000).

Conclusion

When the tables were examined, it is possible to say that the cultivation of cotton seeds by coating bears no disadvantage regarding the agronomic and technological characteristics of cotton. Coating treatments may positively influence some characteristics of cotton. Even though it is observed that coating treatment may dec-rease seed cotton yield, the result obtained from this study is statistically insignificant. That zinc has no important influence on yield and other characteristics indicate that the soil in the research fields had no problems with zinc.

As the delintation can be eliminated in the coating treatment (in the regions where the intensity of pink bollworm is low), pollution, which is an important problem, will be prevented to some extent. As we all know, sulphuric acid, which is used for producing delintation, threatens human health and environment. Seeds' treat-ment with acid is not a desired process in delintation operations. Seed coating will play an important role in the expansion of organic cultivation of cotton, as the coated seeds can be easily planted with pneumatic spacing drills Also, organic seed procurement, which is also an important problem in organic agriculture, would be provided with the

Table 7. Average fiber length (mm) of the varieties as to the treatments examined and the groups.

Variety	Treatments				Mean varieties
	Fuzzy	Delinted	Coated	Zinc+Coated	
Means and Groups in 2002					
Nazilli 84-S	30.25	30.67	31.08	30.83	30.71
Nazilli M-503	30.58	31.25	30.17	30.67	30.67
Nazilli 143	29.58	30.50	30.58	30.75	30.35
LSD	1.483				0.741
Means and Groups in 2003					
Nazilli 84-S	27.21 ab*	26.70 b	28.28 a	27.31 ab	27.38 b
Nazilli M-503	26.56 b	27.77 b	27.82 b	29.22 a	27.84 b
Nazilli 143	29.27 a	28.49 ab	27.88 b	28.68 ab	28.58 a
LSD	1.299				0.649
Means and Groups in 2004					
Nazilli 84-S	29.19 a	28.74 ab	28.65 ab	27.38 b	28.49 b
Nazilli M-503	29.02	29.80	29.50	29.19	29.38 a
Nazilli 143	28.54	29.72	28.82	30.00	29.27 a
LSD	1.548				0.774

*Values with the same letters are significantly different at the 0.05 level of probability.

seed coating method. This will also positively influence human health and environment.

The significance of the study comes in the form of generating an environmentally and economically sound seed coating technique for organic agriculture. Moreover, the finding that there is no significant difference between the yield values of delinted cotton seeds and coated cotton seeds is important due to the need of eliminating very costly delintation plants.

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