Losses Incurring During Cotton Mechanical Harvesting, in Central Greece

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ABSTRACT

An investigation on the losses incurring during cotton mechanical harvesting was undertaken during the last five years within a programme to assess the performance of cotton pickers in the area. The investigation was on commercial fields as well as experimental fields. Losses were defined as pre-harvest (the cotton that fell on the ground before the picker entered the field), losses of seed-cotton and bolls on the ground after the first picking, losses of seed-cotton and bolls on the ground after the second picking, losses of cotton left on the plants after the second picking. Losses, especially preharvest losses, had a wide variation depending on weather conditions, on field topography, on varieties used (varieties requiring higher force to pull seed cotton locks had lower losses on the ground but a tendency for higher losses on the plants) and on cultivation technique (twin rows had higher losses than single). Losses in many cases are high, indicating that there is a potential to reduce them by appropriate management of the fields and of the machines.

Introduction

Cotton is the most important Greek arable crop. It covers the 15% of the total cultivated area and the 30% of the irrigated. Crop production is almost fully mechanized. Harvesting is usually done during October and November, when the wet season starts. Therefor it is important to harvest the crop as soon as possible. Cotton is harvested mainly by horizontal spindle drum type two row pickers. There are still working some old one row harvesters and some four row were imported lately. The usual practice is to complete picking in two passes of the machine. The first pass picks the largest part of the yield, about 80% while the second picks the remaining 20% or less. The timing of harvesting is very important. Early harvesting, when a lot of bolls are not open causes higher losses as spindles pull the bolls and drop them on the ground. This is especially important for varieties with large bolls like Zeta 2 (Gemtos and Mygdakos, 1996). Delay of harvesting increases preharvest losses as well as lint damage due to adverse weather conditions.

Recently, a lot of new developments has taken place in cotton cultivation techniques. A lot of new varieties were imported mainly from the USA and Israel, that a require longer growing period. Some new varieties were also developed by the Greek Cotton Institute. Modified irrigation techniques with earlier water application were used to produce higher fruiting and facilitate mechanical harvesting. Increased plant populations were used either by reduced spacing in the row or by planting in twin rows to produce higher fruiting and hasten full canopy.

Abernathy (1965) compared cotton harvesting losses by hand and machine. Cotton losses on ground were 14.7 and 19.8% for the machine compared to 0.5 to 2.5% for hand picking. Lint losses on the plant were similar (2.1 and 2.6%). In another experiment with varying plant populations 75,000 plants/ha gave the lower losses at 9.6% with range 10.7% for 25,000 pl/ha to 16.8% for 225,000pl/ha. He referred to data showing that defoliation did not affect harvesting efficiency, yields and lint properties but reduces cotton m.c. and increases machine working hours. Kepner *et al.* (1976) defined harvesting losses by cotton pickers as :preharvest losses, cotton dropped on the ground by the spindles and cotton left on the plant. Smith and Wilkes (1976) referred to data on cotton varieties performance in machine harvesting. Harvesting efficiency ranged from 90% down to 75%. Barker (1982) has developed an equation to predict preharvest cotton losses. He referred to measurements on the force to remove a lock to vary between 0.097 to 1.31 N. He stated also that rainfall less than 14.5 mm and wind movement less than 129 km/day had not effect on preharvest losses. Shaw *et al.* (1968) conducted research on the effects of cotton varieties on harvesting efficiencies. On ground and on plant losses ranged from 4.7 to 11.9% while preharvest losses form 1.3 to 3.7% and overall efficiencies from 88.2 to 91.6% They measured the peak remoal force of locks which ranged from 0.773 to 1.827 N and carpal angles from 143.7^{o} and 176.5^{o}. Colwick *et al.* (1984) stated that losses in the USA ranged from 5-15% with an annual average of 11%. They refer to a research by Corley in which harvesting losses are related to the energy required for lock removal. Chatzilakos (1968) has studied cotton harvesting losses in Greece when the first pickers were imported. He found 2% preharvest losses, 3.09% on the ground and 6.88% on the plant. Gemtos and Mygdakos (1996) reported machine losses from 7.5 to 14.9% in 13 different varieties in Greece. They found that plant population did not have a significant effect on losses in the conditions studied. An assessment of the losses during mechanical harvesting under the new conditions is important to improve crop management. In this paper, the results of an investigation on cotton losses in Thessaly, Greece, during years 1992-95 is reported.

Material and methods

The measurements were carried out in commercial fields during the harvesting period or in experimental fields where comparison of different varieties or cultivation techniques were tested. The measurements started before the machine entered the field. Lengths of rows from 5 to 10 m were selected at random in the field. Fifty cm at each side of the row were defined. All cotton on the ground was picked to clear the soil and weighted. This part expressed as a percentage of the yield was the preharvest losses. After the machine passage, seed cotton and the bolls fallen on the ground were collected. Seed cotton was weighted, the bolls were left in a barn to open and then the seed cotton was weighted. The sum of the two represent cotton losses on the ground from the first pass. During the second pass of the machine and before the machine enters the field, the ground of row lengths of 5 - 10 m were cleared from cotton. After the machine passage, seed cotton and bolls were collected from the ground. The same procedure as for the first pass was followed and the sum of the two represent cotton losses on the ground from the second pass. In the same rows length after the last passage of the machine all cotton and bolls on the plant were collected. The bolls were left in a barn for 10 days and the cotton of the opened ones was weighted. The total weight of seed cotton and cotton from the bolls is the loss on plants after the second pass of the machine.

Several measurements of losses in commercial fields were carried out in several places in Thessaly, central Greece from 1992 till 1995 under different conditions such that before or after rain or wind for preharvest losses, in plantations with different varieties, and in single and twin rows of cotton. Comparison of different varieties was made in the experimental fields of the Hellenic Cotton Board in Palama, Karditsa. The results of 1993 were presented by Gemtos and Mygdakos (1996). In the two later years measurements of the force needed to pull the cotton lock out of the kernel was measured to find any correlation between them. The measurements were carried out in the laboratory. The open boll was secured in a vice. One lock was clipped and weights were added till the lock was removed. Then the weights caused the removal were weighted and recorded. In an experiment which studied the effect of two levels of irrigation, two levels of pant populations, two levels of fertilization on three cotton varieties the losses were measured. In an experiment comparing two varieties and single and double rows of cotton at 1 m spacing between rows, the losses during mechanical harvesting were measured to compare the two systems.

Results and Discussion

A summary of the results obtained during the three years is shown in Table 1. The data show that a wide variation of losses depending on the variety used (Korina generally presents higher losses) and the configuration of the plantation (twin rows caused higher preharvest losses). Measurements of preharvest losses after the heavy rain of 1994 gave losses up to 15%.

The results of the losses estimation in the variety experiment of 1994 as well as the lock removal force are shown In Table 2. In this year the weather condition were ideal at the beginning of the harvesting period and preharvest losses were negligible. But after the first picking a rainfall of more than 175 mm caused excessive flooding in the area and the cotton left on the plants was washed out. A regression analysis of the results showed a negative correlation between cotton seed lost and the lock removal force. A linear model fitting, gave a non significant correlation coefficient of 0.32. The results of 1995 season are shown in Table 3. A regression analysis of the results showed a negative correlation between total harvesting loss and lock removal force for a linear or multiplicative model (about r_2=-60.3%) Fig. 1. Similar results were obtained for preharvest losses as well as on the ground from the first picking and second picking. A regression analysis of the relationship between seed cotton loss on the plant and the lock removal force showed a positive tendency (Fig. 2) although the model was not statistically significant.

Preharvest losses were higher in plots with high fertilization, high plant population and in the variety KORINA that had the minimum lock removal force. Total machine losses (without preharvest losses) were affected only by variety with the minimum lock removal force giving the higher losses.

Conclusions

From the results presented, it was shown that:

- Losses during mechanical harvesting varied widely and it is possible to reduce them.
- Varieties present different degrees of adaptation to mechanical harvesting.
- Varieties with high lock removal force present lower losses.
- Twin rows and denser populations cause higher harvesting losses.

- Increased N fertilization causes increased harvesting losses

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Table 1. Percent cotton harvesting losses in commercial fields: Mean values.

Variety	Plantation	Loss on Soil			Loss on	Total
		Preharvest	1st Pass	2nd Pass	Plant	Loss
ACALA	Normal	1.410	2.810	2.400	6.03	12.64
Range	Normal	0.53-2.22	1.92-3.73	1.52-3.40	4.62-7.11	
KORINA	Normal	1.550	5.820	7.000	6.980	18.35
Range	Normal	0.55-2.65	3.57-7.07	2.45-6.20	5.93-8.02	
ACALA	Single rows	0.82	1.9	4.4	2.5	9.6
ACALA	Twin rows	0.93	2.3	3.3	4.1	10.6
KORINA	Single rows	0.095	2.0	5.3	3.6	11.9
ACALA	Twin rows	1.05	2.76	5.16	3.75	12.72

Table 2. Percent cotton harvesting losses for different varieties in 1994.

Variety	Yield	Seed-cotton	1st Pass Losses on Ground		Lock Removal
	kg/ha	w.c.	Seed-cotton	Bolls	Force N
ST 506	3000	8.09	2.71	2.03	0.51
CREMA 111	3000	7.93	1.84	3.41	0.79
K Ó 1	4200	8.74	1.56	2.15	0.76
Z 2	4080	8.84	2.25	1.49	0.67
D P-50	3760	8.75	2.25	1.10	0.84
COKER	4000	8.57	0.82	1.10	0.70
MAX-9	3740	10.03	1.12	2.34	0.72
HAZERA	3900	8.20	1.27	3.25	0.84
ALEGRIA	3000	7.52	3.51	2.63	0.71
ARIA 324	4360	8.76	0.88	2.08	0.70

Table 3. Percent cotton harvesting losses for different varieties in 1995.

Variety	Loss on Soil		Loss	Total	Lock Removal
	1st Pass	2nd Pass	on Plant	Loss	Force N
ACALA SJ2 AM	4.7	1.9	1.2	7.8	0.8
ARIA ST 324	6.6	2.1	2.5	11.2	0.9
KORINA	8.4	3.4	1.8	13.8	0.5
KS1	5.8	2.1	1.0	8.7	0.9
macnair	6.4	3.7	1.5	11.6	0.7
VULCANO DP 50	1.9	1.8	2.5	6.2	1.0
ZETA 2	2.5	1.0	2.7	6.2	0.9

Figure 1. Effects of locule removal force to the total cotton losses in 1995.

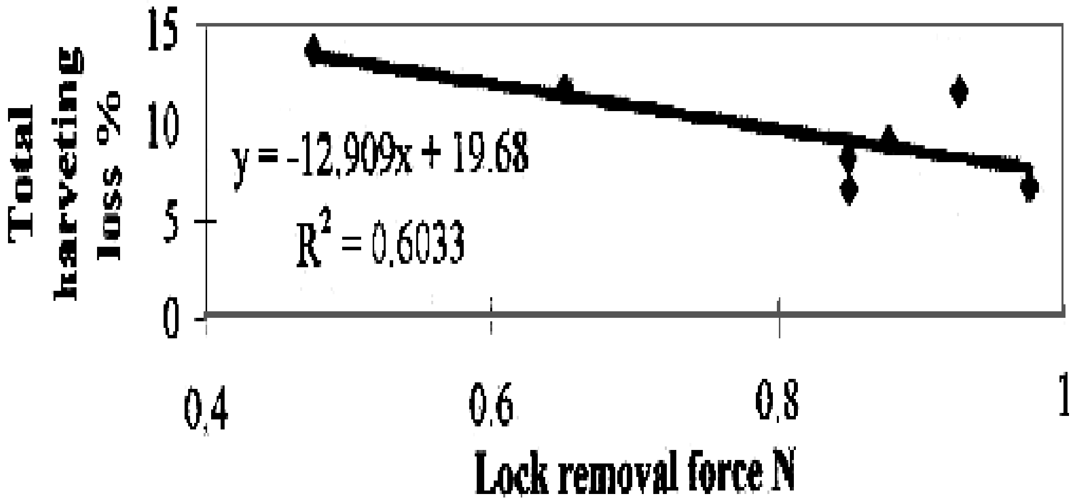

Figure 2. Effects of locule removal force to the cotton losses on the plants.