TITLE: 1635 Harvesting Performance of a Tractor Mounted Mechanical Cotton Picker

DISCIPLINE: Harvesting and Ginning

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ABBREVIATIONS: **W=** White; **LSP**= Light Spotted; **SM**= Strict Middling; **M**= Middling; **SLM**= Strict Low Middling; **LM**= Low Middling

ABSTRACT

In this study, two narrow row mechanical pickers manufactured by Uzel Corp., which is the one of the biggest tractor manufacturers of Turkey, were used in situ tests in order to determine their qualitative and quantitative performance.

The study was conducted at five different locations in the Western and Southeastern region of Turkey where the two American (St 393, St 457) and one Australian (Carmen) cotton varieties were planted at a 0.76 m row spacing. Cultural operations from planting to harvest such as thinning, hand hoeing, machine hoeing, fertilizing, spraying and furrow irrigation were performed by the farmers. Ground sprayers were used for defoliant application in all locations.

The results obtained from the study indicated that the ground losses showed a variation between 1.4% and 5.0% while the stalk losses were found to be between 1.7% and 7.8% according to field and plant conditions. The losses were found in the acceptable range as

suggested by Turkish national standards. The average field capacity of the picker was measured as 0.26 ha/h.

The gin turnout was 1%-2% lower in the machine picked samples. Trash content was found to be higher in the machine picked samples due to pre-cleaning not being applied before ginning. No other adverse effect on the fiber properties caused by the picker was observed.

KEYWORDS

Cotton, cotton harvesting, cotton picker, tractor mounted picker

INTRODUCTION

Cotton is mainly grown in the western, southern and south eastern part of Turkey and its production system has a labor-intensive structure. Hence, hand picking is still a common labor force requirement and the unit cost for hand harvesting is considerably high. On the other hand, there are not enough local workers for picking in the western and southern part of the country since these regions are more industrialized as compared to the other regions. Therefore, in these regions farmers tend to meet the additional labor requirement by employing seasonal workers migrating from eastern and south eastern Anatolia. This seasonal labor force was the case until agricultural production partially started in the Southeastern Anatolia Project (GAP) region.

The GAP is an integrated project and aims to improve living standards, income levels and employment opportunities for about 3.8 million regional people. With the project, it has been planned to irrigate 1.7 million hectares which includes 8 different cities in the east and the southeast. The Southeastern region covers approximately 10% of the total land of Turkey and 20% of the irrigable land of the country.

With the effects of an increasing trend in production and partial starting of irrigation in the GAP region, where the suitable area for cotton production is about 1.2 million hectare, the number of migrant workers in the south and west part of the country has dramatically decreased. This decrease has caused the unit costs of hand harvesting to increase to about 25% - 35% of the total crop value in the last decade. Unfavorable conditions for hand picking have also accelerated the transition to mechanical picking. Some farmers, since 1998, have started using American originated, self propelled, narrow row spindle pickers to harvest their crops.

Although they have good technology and capacity, these pickers are not widespread enough mainly because of unsuitable farm structures as well as considerably high initial sales prices and the high price of spare parts are beyond the reach of the average income of a Turkish farmer. Evcim (2000) stated that it is possible to pick cotton economically by spindle type pickers if the land size of the farm is more than 150-200 hectares. However, the ratio of the farms with more than 50 ha is about 17% and the average farm size does not exceed 95 ha in this group in Turkey (Anonymous, 2005a). Although, cooperation among the farmers who have larger farms can be a solution to overcome this problem, it is difficult to put into practice in Turkey. There are several reasons for the difficulty such as the fragmented structure of the land, an excessive number of land parcels due to inheritance laws, insufficient harvest planning and some disagreements among farmers.

Since 2002 the unsuitable situation for economical cotton picking by the spindle pickers has caused small scale farmers to look for a cheaper alternative. As a result, power-takeoff driven, four narrow row tractor mounted type mechanical pickers have been imported from Uzbekistan by some entrepreneurs and modified before being presented to Turkish farmers. In spite of their suitability for small areas, difficulties in attaching to the tractor and an unsuitable position of the picking units have brought some restrictions to the Uzbek

originated pickers. By 2005, a new and different tractor mounted, two narrow row mechanical picker has been presented by the Uzel Corp. which is the one of the biggest tractor manufacturers of Turkey.

The objective of this study was to determine the performance of the Uzel Corp. two narrow row (0.76 m) tractor mounted type cotton picker on the basis of quantitative performance (such as field losses and harvest efficiency) and qualitative performance (effect on lint quality) in situ tests.

MATERIALS AND METHODS

The study was conducted at five different locations in the Western and Southeastern region of Turkey where the two American (St 393, St 457) and one Australian (Carmen) cotton varieties were planted at 0.76 m row spacing. Cultural operations from planting to harvest such as thinning, hand hoeing, machine hoeing, fertilizing, spraying and furrow irrigation were performed by the farmers. Ground sprayers were used for defoliant application in all locations and an Uzel CottonCraft model, tractor mounted type, two narrow row (0.76 m) mechanical cotton picker was used for harvesting.

The picker consists of a tractor, picking units and a basket. A view of the picker is depicted in Figure 1. A tractor has been constituted as a main power source for the picker. It was equipped with a backward driving system for moving in a backward direction when picking.

The picking units are attached to the tractor from the three point hitch and driven by a hydraulic motor attached to the tractor's power takeoff. A picking unit has four vertical drums located in line as a group of two. Every drum has vertical bars with sharp ended - spirally rounded metal sheets for removing seed cotton from the bolls (Figure 2). Removal of seed cotton from these bars after picking was performed by four rotating brushes which are located as a group of two on both sides of the drums (Figure 3). Seed cotton is conveyed by air to the basket located right above the tractor's engine block with four conveying pipes. Some specifications of the picker used during the tests are given in Table 1.

Performance of the picker was determined according to the methods as described by Ministry of Agriculture and Rural Affairs of Turkey (Anonymous, 2006a)

Evaluation of the harvesting performance included the quantitative and qualitative measures stated earlier. To determine the quantitative performance, two rows, each 3 m long, were selected randomly from three different areas. In these rows, seed cotton samples (will subsequently refer to as *Ref.*) were picked carefully by hand and the field yield was determined. The following 3 m of each row was then marked and the pre-harvest loss was determined by collecting seed cotton that had fallen to the ground by natural causes. These 3 m sections were then harvested by the picker.

After the picker passed, ground loss was determined by quantifying the amount of seed cotton that had fallen to the ground by picker action and stalk loss was determined by that amount that remains on the plant. These two losses were determined as a percentage of total yield. In addition to these two measurements, the picker field capacity was determined as the amount of seed cotton picked by the picker in an hour.

To determine the qualitative performances, machine picked seed-cotton samples were taken from the basket during unloading operations (will subsequently refer to as *Mach. Picked*). All seed cotton samples were ginned in order to determine to gin turn-out ratio. This ginning was achieved in a special laboratory that has a roller-gin without a cleaning unit.

Measurements for the lint quality factors such as trash content, fiber length, strength, micronaire and color grade were performed on the lint samples according to USDA (1995) classification at the HVI (Ulster HVI Spectrum) laboratory located at Commerce Exchange of Manisa All tests were replicated five times.

RESULTS AND DISCUSSION

Table 2 shows the quantitative performance of the picker. The quantitative performance of the cotton picker included the ground and stalk loss. Ground loss is the main indicator of successful harvest and it is affected by different factors such as field conditions, appropriate variety, picker adjustments and experienced operators.

National standards indicate that ground loss should not exceed 5% of the total field yield in appropriate field and plant conditions while pre-harvest losses can not be more than 2%.

Ground loss values can vary between 2% - 4% of the field yield in mechanical picking in Turkey if all conditions are suitable (Oz and Evcim, 2002a, Oz, 2005, Simsek and Ozkan, 2005). The results obtained from the study showed that the picker has very good performance from a ground loss point of view. The relationship between field yield and ground loss was not found to be significant. The effect of boll opening ratio on the ground losses was found to be not significant. Slightly higher ground loss values were obtained in the province of Adiyaman when compared with other locations that is probably due to the variety although variety was not found to have a significant effect on the values. Generally, the results indicated that the ground loss can be held about 2.5% of the field yield if all other conditions suitable.

Stalk loss (also expressed as picking efficiency) was found to vary over a wide range compared to the ground loss (Table 2). Stalk loss is related to variety characteristics; especially the suitability of the bolls for picking, as well as plant and field conditions. It is also affected by the picker's adjustments. Although stalk loss may not be accepted as a real loss because of a chance for a second picking, it is another indicator of successful harvesting.

The results indicated that field and physical plant conditions were dominant for the picking performance values rather than variety characteristics. The variety, Carmen, had different results depending on its growing location rather than its varietal characteristics (Table 2). Insufficient weed management and too many lodged plants caused more stalk loss for the Menemen1 than other locations where planted Carmen variety. In Adiyaman location where ST 457 variety was planted uncompleted growing pattern probably due to very late planting (beginning of June) has restricted the suitability of the bolls for picking. High pre harvest losses and very low defoliant rates (about 27%) were measured in this location. Harvesting was performed with higher loss values as compared to the other region since the farmer did not want to wait until the maturity period for fall due to possible rains.

According to national standards, stalk loss should not exceed 5% of the total field yield for appropriate field and plant conditions and if the boll opening ratio is more than 95%. Previous studies showed that stalk loss can vary between 3% and 5% if all of the conditions are suitable (Oz and Evcim, 2002b, Oz, 2005, Simsek and Ozkan, 2005). Results indicated that stalk loss can be held to about 3%-4% of the total field yield if all appropriate conditions are present. Therefore, it is possible to conclude from this test that the performance of the picker was satisfactory from the point of stalk loss under appropriate conditions.

Field capacity of the picker being tested was calculated to be between 0.35 and 0.40 ha/h. This capacity is quite low as compared to the self propelled spindle pickers on the market and is due to the test picker's small basket size and low ground speed. No significant relationship was found to exist between the picker field capacity and the field yield or boll opening ratio.

The field capacity values are instantaneous and they were calculated by ignoring the time spent for unloading, turning and etc. ASABE (2006), reports that the field efficiency for cotton pickers is between 60%-75% and averages 70%. In this case, the field capacity of the experimental picker with an average field efficiency of 70% would be 0.26 ha/h. The daily capacity, assuming 10 working hours a day, was estimated to be between 9.2 and 13.1 metric

tons excluding the results obtained from the province of Adiyaman. This mechanical picking capacity is equal to the hand harvest capacity of 113 to 227 workers a day by considering that a seasonal worker can hand pick 60 to 80 kg of seed cotton/day.

Table 3 shows the commercially important ginning and fiber values for the qualitative performance of the picker. Gin turnout was found to be slightly lower for the machine picked samples. This was caused by the different action of hand picking as compared to machine spindle picking. Since the hand picker picks cotton by pulling and the machine by spinning, the machine picker causes more bracts and other thrash to break off and come with the seed cotton. The machine picking increases the amount of bracts and other trash in the seed cotton and, as a result, the gin turnout ratio goes down for machine picker harvest. In general, the decrease in gin turn out caused by mechanical picking was not large. The important parameter to consider in cotton harvest is the amount and quality of lint cotton harvested by hectare that is actually baled and not the percentage of trash that might come in with the harvested seed cotton.

The trash content of the machine picked samples was found to be higher as expected. No-cleaning was applied to the seed cotton samples taken and the trash particles remained in the lint. It was observed that the trash content was mostly formed from lots of fine particles. There was no significant relationship between variety and seed cotton trash content after harvest. The effect of defoliant effect was found to be not significant, although slightly lower trash values were observed with Finish in the province of Mardin. Using a herbicide as a defoliant did not create an adverse effect on the values of seed cotton trash content obtained in Menemen1.

One or two-full lower Color Grades were obtained on the average for the machine picked samples versus hand picked. This was mainly the result of ginning all of the machine picked samples by a roller-gin without using a pre-cleaning unit. The color grade was decreased since fine trash was not removed from the lint prior to ginning.

Although the trash content was higher and the color grade was lower for the machine picked samples, the results are acceptable because the lower color grade and higher trash content can be eliminated by proper pre-cleaning and ginning.

Small differences were measured between the reference (hand picked) and machine picked samples for all of the other lint quality factors except for fiber length (Table 4). A slightly higher fiber length was measured on the machine picked samples. Other parameters such as average fiber length uniformity, strength and micronaire were found to be in acceptable ranges.

CONCLUSIONS

The picker used in the study was one designed to be suitable for small scale farms. Its overall performance was found to be quite satisfactory.

No significant differences in field loss values were found between the self propelled spindle pickers and the experimental picker used in this study. The results obtained in the study indicated that the field losses were mostly related to the physical field and plant conditions rather than the design of the picker itself.

Using the ground loss as the main indicator of successful harvesting, it was found to be in the range as suggested by Turkish national standards under the appropriate field and plant conditions. The results of the experimental picker in this study were not different than the results obtained in previous picker studies. The stalk loss followed the same trend as the

ground loss.

The field capacity of the experimental picker was found to be lower than self-propelled spindle pickers due to small size of the machine. According to these test results, it is possible to state that the experimental picker is suitable for small farms of between 100 to 150 hectares of land. It is believed that the capacity of the experimental picker can be increased with better harvesting organization.

The differences between hand and machine picking were not significant although there was a small decrease in some factors due to the machine picking. The gin turnout ratio has a great importance for the Turkish farmer since cotton trade is based on harvested seed cotton. It is important that accurate trash levels in machine picked seed cotton be measured or established in order that the Turkish farmer is not unfairly penalized for machine picking.

All of the machine picked seed cotton samples ginned without using a seed cotton pre-cleaning unit had a higher trash content than was measured for hand picked samples. On the other hand, the seed cotton samples picked by hand for the test were picked more carefully than a migrant cotton picker would do. Therefore, it is possible to say that the actual differences between hand and machine picked samples would be much lower in practice and can be removed by proper seed cotton pre-cleaning and ginning. Saw-ginning also will help to eliminate adverse effects in color grade.

The picker does not adversely affect the other fiber properties such as fiber length, fiber strength, length uniformity, micronaire and elongation. It was found that the fiber property changes depended upon the cotton variety and not on harvesting or defoliant application.

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Figure 1 General view of the picker in situ.

Figure 2 General view of the metal sheets on drum.

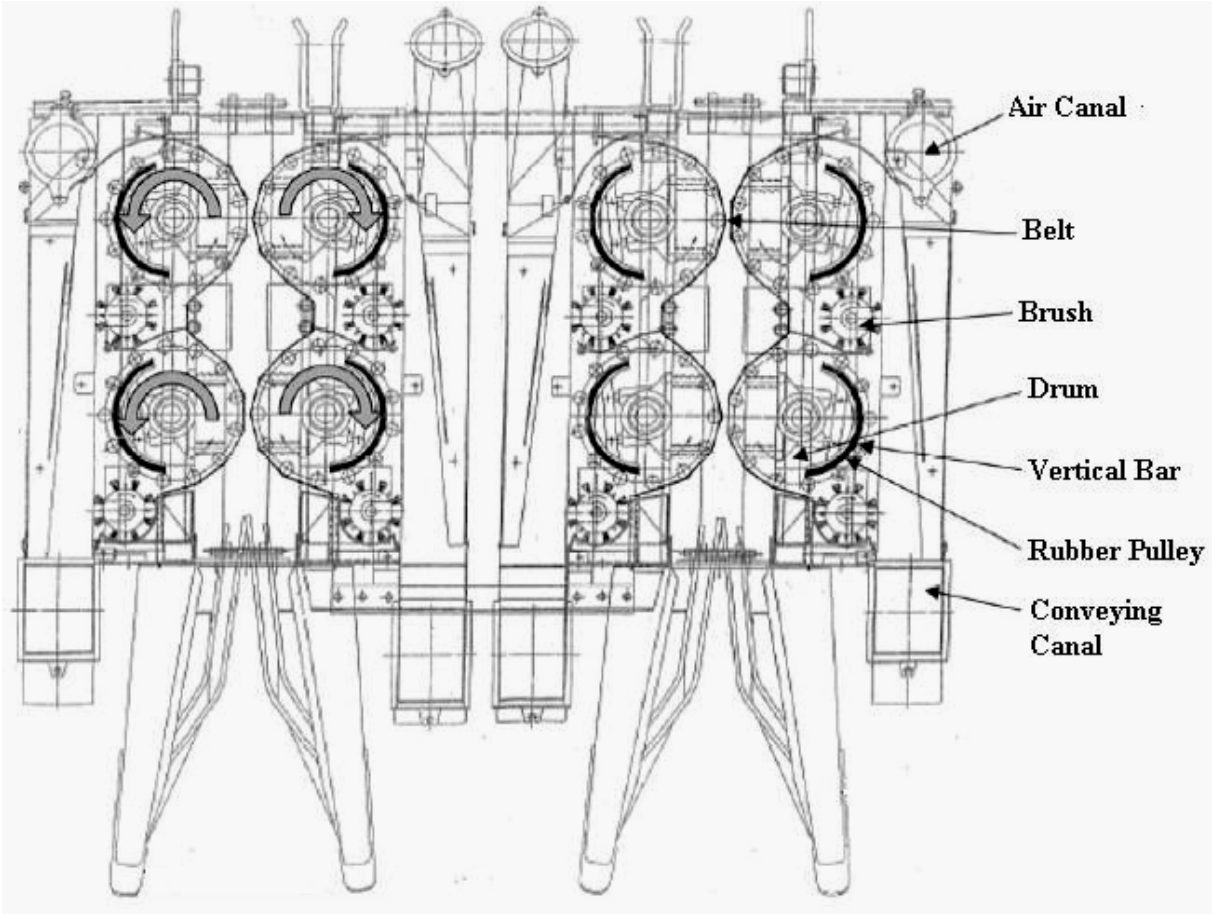

Figure 3 Detailed view of the picking units

Table 1. Some specifications of the picker. (Anonymous, 2006)

Energy Source	***Tractor (min. 55 kW)***
Ground Speeds	***0-3.1 km/h – 1st picking*** ***0-4.7 km/h – 2nd picking***
Picking Units	
Number of rows	***2***
Row Spacing	***0.76 m***
Picking style	***Vertical***
Picker Orientation	***In-line***
Number of drums	***4 (per unit)***
Number of bars	***13 (per drum)***
Drum drive system	***Gear***
Drum height control	***Hydraulic***
Doffer Type	***Brush (polyethylene)***
Conveying	
Fan Type and Speed	***Induced air @ 3800 rpm***
Basket	
Capacity	***9 m3***
Unloading Type	***Vertical, backward unloading***
Compactor	***Roof-mounted, rail type***
Dimensions	
Overall Length	**7.1 m**
Width	**2.1 m**
Height	**4.0 m**
Wheelbase	**1.6 m**

Table 2. Average quantitative performance values of the picker

Locations	Variety	Plant-Field Conditions	Field Yield (kg/ha)	Boll Opening (%)	Pre Harvest Loss (%)	Ground Loss (%)	Stalk Loss (%)
Soke ***(West)***	**Carmen**	**good-good**	**5034**	**91**	**0.3**	**2.2**	**1.7**
Menemen1 ***(West)***	**Carmen**	**average-average**	**4833**	**91**	**0.3**	**3.3**	**7.8**
Mardin ***(Southeast)***	**St 393**	**good-good**	**3544**	**90**	**0.2**	**3.1**	**3.1**
Menemen2 ***(West)***	**Carmen**	**good-good**	**4942**	**97**	**0.0**	**1.4**	**4.3**
Adiyaman ***(Southeast)***	**St 457**	**average-bad**	**2448**	**95**	**2.6**	**5.0**	**5.1**

Table 3. Average variation of gin turnout, trash content and color grade

Locations	Variety	Defoliant	Gin Turnout (%)		Trash Content (%)		Color Grade	
			Ref.	Mach. Picked	Ref.	Mach. Picked	Ref.	Mach. Picked
Soke ***(West)***	**Carmen**	**Dropp Ultra**	**41.8**	***40.5***	**0.80**	***2.81***	**W-M** **W-SLM**	***LSP-SLM*** ***LSP-LM***
Menemen1 ***(West)***	**Carmen**	**Appeal %EC***	**42.2**	***39.7***	**0.75**	***2.27***	**W-M** **W-SLM**	***LSP-SLM*** ***LSP-LM***
Mardin ***(Southeast)***	**St 393**	**Finish**	**41.9**	***41.3***	**0.27**	***1.88***	**W-M**	***W-SLM*** ***W-LM***
Menemen2 ***(West)***	**Carmen**	**D. Ultra& Finish**	**43.5**	***41.6***	**0.43**	***2.21***	**W-SM** **W-M**	***W-SLM*** ***W-LM***
Adiyaman ***(Southeast)***	**St 457**	**D. Ultra& Finish**	**43.6**	***40.5***	**0.38**	***2.36***	**W-SM** **W-M**	***LSP-SLM*** ***LSP-LM***

* *Herbicide*

Table 4. Average variation of other lint quality factors

	Soke		Menemen1		Mardin		Menemen2		Adiyaman	
	Ref.	*Mach. Picked*	Ref.	*Mach. Picked*	Ref.	*Mach. Picked*	Ref.	*Mach. Picked*	Ref.	*Mach. Picked*
Length (mm)	**28.89**	***29.41***	**29.11**	***29.45***	**27.61**	***28.14***	**29.56**	***29.77***	**27.01**	***27.18***
Length Uniformity (%)	**84.32**	***83.86***	**85.17**	***83.98***	**82.90**	***82.70***	**87.62**	***86.80***	**82.37**	***84.10***
Strength (g/tex)	**32.63**	***30.38***	**34.45**	***30.67***	**27.00**	***27.25***	**36.30**	***36.19***	**29.86**	***29.91***
Micronaire	**4.60**	***4.63***	**4.37**	***4.93***	**3.81**	***3.96***	**4.46**	***4.45***	**5.01**	***5.35***