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Comparison of Different Thinning Applications in Cotton Farming

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Abstract: The aim of this study was to investigate the alternative applications on thinning based upon excessive manual labour in cotton production in Turkey's field conditions. For this purpose, two different thinning systems were studied as alternative to conventional thinning system. Hand thinning, which is one of these systems, was applied through sparse sowing in low sowing norm using the pneumatic spacing drill. In the other system, thinning procedure was done with the rotary thinner after conventional sowing. The results were compared according to the parameters of emergence degree, working time requirements, cost and seed cotton yield. Finally, no differences were observed among the emergence degree values related to the systems applied. However, according to time requirements the lowest value (112.86 h ha^{-1}) was obtained in the system which involved the use of rotary thinner. In terms of cost rotary thinner was 23.18 and 30.99 \$ ha^{-1} cheaper when compared to sparse sowing and conventional system, respectively. Thus, it was more economical than the other systems. Similarly, the highest value of seed cotton yield (4720.95 kg ha^{-1}) was observed when the rotary thinner system was used.

Key words: Cotton, thinning applications, rotary thinner, mechanisation management

INTRODUCTION

Emergence degree changes depend on quality of seed, conditions of climate, insects, methods of seedbed preparation, type and content of soil etc. In these conditions, farmers keep reserved plant on the field by use the more excessive sowing norm and in this way decrease the risk on emergence. On the other hand, farmers are obligated to remove excess plant by thinning. The cotton plant has a tolerance for uniformity on plant distribution down the row. The plant density can be changed without decreasing production in the wide limits[1]. This case offers advantage by reducing or removing of manual labour for hoeing in cotton production.

Hoeing and thinning must be done in the course, otherwise, it will cause the fall of produce. In the period of hoeing and thinning, because of the difficulty on ensuring of worker and unsuitable climate conditions, labour can not finish the job in time.

Three major cultivation techniques are applied in row crops production. These are thinning with hand hoe, mechanised thinning and production without thinning. Hand hoeing keeps its importance on cotton production in Turkey. Manpower requirement on hoeing of cotton has a portion approximately 33% in total[2]. Cultural applications cost has a mean portion 20% in total production costs on cotton farm.

Cotton field can be thinned by thinning machine without decreasing production and saving in cost. Saving in manpower was 13.427 h da^{-1} (56.6%) on thinning by machine compare to conventional thinning by hand hoe[3].

Emergence degree, weed population and technical possibility of country determine the mechanisation degree of thinning on cotton production.

Cotton production without thinning is possible by means of continuous suitable conditions of climate, suitable seedbed preparation, using of delinted cotton seed with high emergence capacity, using of precision seed drill with high capability, applying chemical or thermal weed control. However, bad conditions of weather during sowing period and probability of appearance of disease and insect increase the risk on precision sowing without thinning.

In this study, it was aimed that the alternative applications on thinning based on excessive handwork in cotton production, were investigated on field conditions in Turkey.

MATERIALS AND METHODS

This study was conducted at the fields of Adnan Menderes University, Research and Production Farm during to 2001-2002 cotton production period. The

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structure of the land soil on which the research was carried out consisted of sandy-loam characteristics with 20.8% clay, 19.2% silt and 60% sand.

It was used a device which is also used by Yalçin[4] to measure the fuel consumption of tractor in the experiments. A digital chronometer, measures in 1/100 second, was used in the time consumption measurements.

The equipment series were used which is dominant on cotton farming in Aydin Region in this research[5]. Mouldboard plough, disc harrow, field sprayer, broadcaster, field scrubber were used to soil tillage and seedbed preparation.

Randomised Blocks Experiment Design with three replications was used in this research[6]. The plot length was 30 m and each plot was sowed 32 rows. Three systems were examined after the soil tillage and seedbed preparation (Table 1).

The rotary thinner with 9 thinning units and total working width in 3 m used in System 3 was an alternative application to conventional thinning (Fig. 1).

In the sowing application on the plots, the row spacing was 0.7 m. Nazilli 84 delinted cotton seed, a regional cotton cultivar, was used throughout the sowing applications. In the sowing application, 50 kg ha^{-1} cotton seeds were sowed using a mechanical cotton seed drill. Single seed was sowed by pneumatic spacing drill in 0.07 m of sowing space.

In order to determine the average shoot number, counting were done everyday after the beginning of the germination. The degree of emergence was calculated according to the following equation by using the values for each plot[7].

$$ED = \frac{m}{n} \cdot 100$$

Where ED is emergence degree in %, m is the average number of emerged shoot in one meter and n is the number of sowed seed in one meter.

In finding out the time requirements results the analytical method was used, because it was thought to be the most convenient to the purpose of the research. The effective working time of the machines used in this research consists of three parts, the foundation time, turn time and lost time. The effective working time of systems were obtained by addition the time requirement values of the each equipment in systems[8].

The time requirement was measured to determine the time consumption of workers in thinning applications. The time measurements were achieved in 20 m length in the plots thinned by hand hoe. The obtained data were transformed to the time consumption on hand thinning on the basis of hectare.

Fig. 1: Rotary thinner

In this research the elements constituting the machine use costs were analysed in two major groups as fixed costs (Amortisation, Interest, Insurance, Tax, Protection cost) and variable costs (Maintenance, Repair, Labour, Fuel and oil cost). By analysing the costs, total machinery and systems costs were calculated[5]. To calculate the conventional thinning by hand hoe cost, $ 0.35 were considered per one hour working time.

The results of the time requirements and costs were evaluated on the basis of the standard plot used in research by Uçucu[9] which has 150 m length, 66.67 m width and 1 ha size.

To determine the total seed cotton yield, plots were harvested. The seed cotton yield of plots were transformed to hectare (kg ha^{-1}).

All data were analysed according to Randomized Blocks Experiment Design and the differences of average were evaluated by LSD (probability of 0.05).

RESULTS AND DISCUSSION

Emergence degree, working time and seed cotton yield values were analysed in this study. The differences of applications were found significant for working time and seed cotton yield but non-significant for emergence degree (Table 2).

The mean of emergence degree was 54.09% in the System 1 plots. According to this value, 108190 plant ha^{-1} was reached after germination. The average value of emergence degree was 55.79% on the plots System 2 was applied. On these plots, 310857 plant ha^{-1} in total was found. The emergence degree was calculated 54.22% on the plots the mechanical thinning was applied (System 3). According to this value 302095 plant ha^{-1} was found in total. This value shows that more than 70000 plant ha^{-1} aimed at the beginning was achieved. Therefore, on these

Table 1: Procedural stages of the applications in the research

Groups of Applications	System 1	System 2	System 3
Pre-thinning	Sowing (Pneumatic Spacing Drill)	Sowing (Mechanical Seed Drill)	Sowing (Mechanical Seed Drill)
	Soil Concentration (Field Scrubber)	Soil Concentration (Field Scrubber)	Soil Concentration (Field Scrubber)
	Inter Row Hoeing (IRHE*)	Inter Row Hoeing (IRHE*)	Inter Row Hoeing (IRHE*)
	Insect Application (Field Sprayer)	Insect Application (Field Sprayer)	Insect Application (Field Sprayer)
	Inter Row Hoeing (IRHE*)	Inter Row Hoeing (IRHE*)	Inter Row Hoeing (IRHE*)
Thinning	1. Thinning (Hand Hoe)	1. Thinning (Hand Hoe)	Mechanical Thinning (Rotary Thinner)
	2. Thinning (Hand Hoe)	2. Thinning (Hand Hoe)	1. Thinning (Hand Hoe)
			2. Thinning (Hand Hoe)

*IRHE : Inter Row Hoeing Equipment

Table 2: Variance analysis according to the characteristics studied in the methods

		Mean Squares			
Source of Variance	Df	Emergence Degree (%)	Working Time of First Thinning (h ha^{-1})	Working Time of Second Thinning (h ha^{-1})	Seed Cotton Yield (kg ha^{-1})
Blocks	2	8.50	184.94	262.29	68382.56
Systems	2	2.69	3627.06**	2417.53*	973647.16*
Error	4	4.74	139.55	222.79	135195.84

*=significant probability at 0.05 level, **= significant probability at 0.01 level

Table 3: Time requirements of the systems

	Time Requirements (h ha^{-1})					
		Thinning Applications				
Systems	Pre-thinning Applications	Mechanical Thinning	First Thinning	Second Thinning	Total Thinning	Total
1	4.05	-	74.60A	105.29B	179.89B	183.94
2	3.89	-	119.17B	107.27B	226.44B	230.33
3	4.07	0.99	50.66A	57.14A	108.79A	112.86
LSD			26.78	33.84	5581.0	

System 1: Pneumatic spacing drill (0.07 m sowing space)+ Conventional thinning (by hand hoe)
System 2: Mechanical seed drill (50 kg ha^{-1} sowing norm)+ Conventional thinning (by hand hoe)
System 3: Mechanical seed drill (50 kg ha^{-1} sowing norm)+Mechanical thinning (by rotary thinner)

Table 4: Cost of the systems

	Cost ($ ha^{-1})					
		Thinning Applications				
Systems	Pre-thinning Applications	Mechanical Thinning	First Thinning	Second Thinning	Total Thinning	Total
1	65.41	-	28.35	40.01	68.36	133.77
2	55.54	-	45.28	40.76	86.04	141.58
3	58.45	11.18	19.25	21.71	52.14	110.59

Table 5: Values of seed cotton yield in the systems

Systems	Seed cotton yield (kg ha^{-1})
1	3614.28B
2	4402.38AB
3	4720.95A
LSD	833.54

plots the adequate plant population for different thinning applications was obtained. Similar results were reported by Kerby *et al.*[10].

According to these results, the effects of sowing machinery were non-significant on the emergence degree values. Similarly, Bayat *et al.*[11], found that the emergence degree values were above 40% on all plots using mechanical seed drill and pneumatic spacing drill in various norms. Moreover, Yalçin and Özarslan[12], found 47.87% emergence degree values on the plots sown by using mechanical seed drill.

Time measurements were done in order to find out the most advantageous thinning technique in terms of time consuming,. Based on the data gathered out of the calculations, time requirements were found in each thinning application. In addition to these, time requirements related to sowing and cultural procedures pre-thinning application and the total time requirements related to the analysed systems were found (Table 3).

Among the time requirements of the pre-thinning procedures, no differences were observed at all. This might be due to the equal speed of the sowing machinery and the similar cultural procedures applied in the systems.

When the thinning applications were taken into consideration, the highest value of time requirement of the first thinning (119.17 h ha^{-1}) was obtained from the plots when System 2 was applied. The lowest value (50.66 h ha^{-1}) was found on the plots which the mechanical

thinning with the rotary thinner (System 3) was applied. On the basis of the first-hoeing, in System 3, relatively 3.21 and 57.5% less working time was required than System 1 and System 2, respectively. When time requirement results of the second thinning were examined, not considerable differences exist statistically between values of the System 1 and System 2. Yet, the lowest time requirement value in the second hoeing was observed in System 3. When compared to the other systems, in the second hoeing of System 3, approximately 46.2% time saving was observed. In comparison to the other systems, the first and second hoeing procedures in System 3 was found advantageous in terms of time requirements due to decreasing the plant population by using the rotary thinner. According to total time requirements in thinning applications, the most advantageous value (108.79 h ha^{-1}) was achieved in System 3. It is obvious that the level of mechanisation in thinning application must be increased in order to save time in cotton production. Likewise, Önal[3] emphasised that in thinning application through mechanical process was saved human labour up to 134.27 h ha^{-1} (56.6%) in comparison to the conventional thinning applications.

To find out the most economical thinning application method in terms of cost, the application cost of rotary thinner involved in System 3 was taken into consideration and the total costs in thinning applications were determined. Considering the costs of pre-thinning applications, the working time costs of systems were determined (Table 4).

When the costs related to pre-thinning applications were analysed, the cost of System 1 was found to be meanly 8.42 \$ ha^{-1} higher than the other systems due to the fact that the cost of acquiring the pneumatic spacing drill is higher than that of the mechanical seed drill. As parallel to the working time requirements in those applications, the cost of first and second thinning applications varied. The first and second thinning applications in System 3 were realised in less cost. This result was also observed in total thinning costs and the same result was obtained. On the other hand, the highest cost was observed in System 2. When the total system costs were analysed, System 3 decreases the cost 23.18 and 30.99 \$ ha^{-1} when compare to System 1 and 2, respectively. Considering the costs of thinning applications, mechanical thinning applications can be applied in cotton production.

To determine the seed cotton yield values, the total harvested values of two times were taken as the base (Table 5). Among the yield values of the systems applied on the plots, differences were observed statistically. Because of the significant differences of Systems (Table 2), statistical groups related seed cotton yield were evaluated. The highest value (4720.95 kg ha^{-1}) was significantly obtained from the plots in System 3. When compared to System 1 and System 2, 30.6 and 7.2% more seed cotton yield was obtained in System 3, respectively. Additionally, Yalçin *et al.*[13] found that conventional tillage method had average 4206 kg ha^{-1} seed cotton yield.

The effects of different applied sowing techniques on emergence degree were non-significant, and the reserved plant population to cause the need for thinning could be obtained. Application of mechanised thinning resulted that working time requirement was approximately 40% less in comparison to hand hoeing, and 52% less in comparison to sparse sowing. According to variations in total thinning cost, mechanised thinning helped savings, up to 16.22 \$ ha^{-1} compared to hand thinning and 33.9 \$ ha^{-1} compared to sparse sowing. The fact that mechanisation applications in agricultural procedures lessen the working time and costs was emphasised in this study, as well.

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