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Full Length Research Paper

Effect of different harvest methods on olive yield and work capacity

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In this research, olives were harvested by four different methods (wood rake, wood stick, mechanical bough shaker + wood stick and electronic harvesting rake + wood stick) and an effort was made to determine their effect on olive yield. From the data obtained during a two year period, the method with the highest work capacity was determined to be the third method (mechanical bough shaker + wood stick), and the lowest work capacity was obtained from the first method (wood rake). When the average work capacities for two years are examined, the highest work capacity was obtained for the 3rd method (51.53 kg/man hour), followed by the 2nd method (31.43 kg/man hour), 4th method (28.01 kg/man hour) and the 1st method (19.19 kg/man hour), respectively. When the yield averages for two years are examined, the highest yield was obtained for the 3rd method (21.64 kg), followed by the 4th method (14.06 kg), 2nd method (13.64 kg) and 1st method (19.19 kg), respectively.

Key words*:* Olive, harvesting tool, yield, work capacity.

INTRODUCTION

Olive is accepted by world health organizations as an important source of nutrition, makes a significant contribution to the economy and the agriculture of olive cultivating nations. Olives are grown on around 10 million hectare area containing 800 million trees. It has been determined that over 90% of the harvested olives are used for making oil and that the annual olive oil production in the world is over 2.5 million tons (Wiesman, 2009). According to the International Olive Oil Council (IOOC) 97% of the worlds olive production occurs in Mediterranean countries.

Turkey is an important olive producer like Spain, Italy, Greece and Tunisia, produces 8.5% of the world olives, 5% of world olive oil production and 11.5% of worlds table olive production (Anonymous, 2004). The total olive cultivation area in Turkey is 600,000 hectares and it represents 2% of the total agricultural land and 22% of all fruit and vineyard producing lands. The employment of approximately 400 thousand families means not only the utilization of the family work capacity but also represents 2% of all agricultural employment (Yapici, 2006; Aksu et al., 2003).

In olive harvesting, as in many other agricultural crops, the requirement for labor and the cost are higher than that required for other processes in olive production. In all olive production processes, harvesting is the process that requires the most labor. The work carried out in Turkey has shown that, olive harvesting takes up 40 to 80% of the total labor time and that it represents 30 to 60% of the total production cost (Anonymous, 2002, Saracoglu, 2006). In olive production, 50 to 65% of the total labor requirements are attributable to the harvesting phase (Caran, 1998; Saracoglu, 2006).

Currently, olive harvesting is carried out by both traditional methods and using harvesting machines. The use of machines in harvest has resulted an increase in yields. On the other hand, completion of the harvest within the optimum period of time which varies according the crop differences is an other important factor for a succesful harvest operation (Say, 2009). Mechanized harvest in olive production allows timely operations. Therios (2009) indicated that 10 to 15 trees/h or more can be harvested using harvesters with two or three

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operators. However, the equipment and the machines used in harvesting can cause various types of damages to the olive trees. Peeling and even breakages were observed at the points where the bough shakers are tied to the trees. Breakages also occur in shaking and raking methods. The olive tree should not be damaged to be able to obtain the best quality of olives.

On the other hand, Wiesman (2009) indicated that damage to olive trees were caused by traditional methods in many regions. Thus the yield is low, the trees are severely damaged, and the cost of the harvesting operation is high. Different mechanical harvesting methods were proposed and developed instead of hand harvest. Keeping in views of the above fact the present investigation was undertaken to study the effect of different harvest methods on olive yield and work capacity.

MATERIALS AND METHODS

The study was carried out in an olive grove in Burhaniye (Turkey) where olive cultivation is quite common. The trees with the same attributes were identified (age, yield, applied agricultural treatments) for the trials of the four different machine harvesting methods. The method of harvesting applied for the first year was repeated for the second year as well. For each method three repeats were carried out. Randomized plots design was applied for selection of the trees for the repeats.

Olives were harvested with workers using wood rakes in the first method (harvesting with wood rake). Olives were harvested with workers using wood sticks in the second method (harvesting with wood stick).

In the third method (mechanical bough shaker + wood stick) olives were harvested by employing experienced workers in the use of the mechanical bough shaker. The hook at the end of the machine was hooked onto the boughs and the vibration from the engine enabled the harvesting of the olives. Olives remained in the tree after machine harvest was harvested using wood sticks.

The fourth method (electronic harvesting rake + wood stick) used the electronic harvesting rake machine. This machine was applied to all the boughs of individual trees by an experienced worker and as in the previous method the remaining olives were harvested using a wood stick. Working time was measured using a chronometer and the weights of the olives were determined for each method. Work capacity and the weight of the harvested crop were determined for the obtained (ASAE, 2006).

The collected olives were weighed using an electronic sensitive weighing device. In all the methods 5 to 8 canvas fabrics in the size of 10×10 m were used to prevent the loss of olives and also the damages that occur when the olives fell on the ground.

The harvesting methods given above were repeated for the trees in each application in the following year. The data were statistically analyzed using analysis of variance and DUNCAN multiple comparison test. The effect of different harvesting methods on olive yield was investigated for two years.

RESULTS AND DISCUSSION

Work capacity data

Work capacities that were determined for four different harvesting methods are given in Table 1 for the 1st and 2nd years.

From the harvesting data acquired, it was observed that there was an increase in work capacity in methods 1 and 2 where wood rake and wood stick were used. In methods 3 and 4, in which machines were used for harvesting, there was a decrease in work capacity used and an increase in work capacity when wood sticks were used.

In the third method when only mechanical bough shaker was used the two year average for the work capacity was 161.27 kg/man hour. Although having to use a wood stick after the machine to harvest the remaining olives results in a decrease in work capacity, the overall best result was obtained from this method. Wiesman (2009) and Therios (2009) indicated that 10 - 15 trees/h or more can be harvested using harvesters with two or three operators.

The same situation applies to the 4th method. When electronic harvesting rake is used on its own, the two year average work capacity was 72.61 kg/man hour, and using the wood stick after electronic harvesting rake to bring down the remaining olives decreased the work capacity to 28.01 kg/man hour.

During the 1st year the highest work capacity was obtained from the 3rd method (34.52 kg/man hour) among the harvesting methods. The second highest work capacity was obtained from the 4th method (28.01 kg/man hour) which was followed by the 2nd method (20.29 kg/man hour) and the 1st method (14.3 kg/man hour), respectively.

During the 2nd year the highest work capacity was obtained from the 3rd method (68.54 kg/man hour), while the second highest work capacity was obtained from the 2nd method (42.58 kg/man hour), followed by the 4th method (32.05 kg/man hour) and finally the 1st method (24.09 kg/man hour). There was a high statistical significance between the changes in the 1st and the 2nd year's variances (r: 0.91). The use of the same harvesting method on the some tree in two succeeding years did not affect the work capacity (Table 2).

The work capacities of the different methods increased for all of the methods from 1st year to the second. The highest increase was determined for to the 2nd method (109.81%), which was followed by the 3rd method (98.56%), the 1st method (68.49%) and the 4th method (33.71%), respectively (Table 2). Saracoglu (2003) obtained the highest work capacity with mechanical bough shaker in olive harvest.

The average work capacities for two years associated with the harvesting methods are given in Table 3. When the average work capacities for two years were examined, the highest work capacity was obtained for the 3rd method (51.53 kg/man hour), followed by the 2nd method (31.43 kg/man hour), 4th method (28.01 kg/man hour) and the 1st method (19.19 kg/man hour), respectively. The effect of applied harvesting methods on

Table 1. The work capacities of different methods used (kg/man hour).

	Wood rake			Shaker			Electronic rake			Wood stick		
	Year 1	Year2	%	Year 1	Year 2	%	Year 1	Year 2	%	Year 1	Year 2	%
Method 1	14.3	24.09	68.49									
Method 2										20.29	42.58	109.81
Method 3				169.74	152.8	-9.97				10.98	18.75	70.82
Method 4							87.3	57.91	-33.66	8.44	12.22	44.91

Table 2. The work capacity of different methods (kg/man hours) and the associated variation ratios (%).

	Method 1	Change	Method 2	Change	Method 3	Change	Method 4	Change
Year 1	14,3	68.49	20.29	109.81	34,52	98.56	23,97	33.71
Year 2	24,09		42.58		68.54		32.05	

Table 3. Average work capacities for two years for the harvesting methods (kg/man hour).

	Average work capacity (kg/man hour)
Method 1	19.19 ± 5.54
Method 2	31.43 ± 12.73
Method 3	51.53 ± 19.61
Method 4	28.01 ± 5.48

use of bough shaker. The increase in work capacity due that experience of the operator is important during the quantities. The use of inexperienced labor for machine harvesting for the 2nd year has resulted in a reduction in work capacity (Table 1). Friedley et al. (1973) indicated work capacities had a statistical significance of ($P < 0.01$).

The use of different labor in the 1st and 2nd years may be the source of the variance between the harvest to the use of wood sticks after machine harvesting was reflected in the average work capacity for all methods. There were statistically significant differences in work capacities for all of the methods (Table 3).

Crop quantity data

The 1st and 2nd year crop quantities and the change rates obtained from the four different harvesting methods are given in Tables 4 and 5. In the 1st year, the highest yield was obtained using the 3rd method (16.49 kg). While the second highest crop yield was obtained from the 4th method (14.05 kg), which were followed by the 2nd method (9.58 kg) and the 1st method (6.09 kg). The different values obtained in the first year may be attributed to the differences in the trees.

In the 2nd year the highest yield was obtained from the 3rd method (26.78 kg). The second highest yield was obtained from the 2nd method (17.69 kg), which was followed by the 4th method (14.08 kg) and 1st method (11.35 kg), respectively. It can be seen that there was an increase in the yield for the first three methods for the second

Table 4. The crop quantities obtained from four different harvesting methods (kg).

	Wood rake			Shaker				Electronic rake				Wood stick	
	Year 1	Year 2	%	Year 1	Year 1	Year 2	%	Year 1	Year 1	Year 2	%	Year1	
Method 1	6.09	11.35	86.46										
Method 2										9.58	17.69	84.66	
Method 3				11.98	22.2	85.31				4.51	4.58	1.55	
Method 4							10.08	11.08	9.92	3.97	2.99	-24.51	

Table 5. The crop quantities (kg) and the variances (%) obtained.

	Method 1	Change	Method 2	Change	Method 3	Change	Method 4	Change
Year 1	6.09	86.46	9.58	84.66	16.49	62.40	14.05	0.21
Year 2	11.35		17.69		26.78		14.08	

year, while there was no change for the fourth method. This reduction results from bough breakages during harvesting with wood sticks after the machines in the first year. Erdogan et al. (2003) indicated that bough shakers do not damage trees and its bark.

When the variances between the crop quantities for the 1st and the 2nd years were examined, it was determined that there was a reduction in crop quantities using the 4th method while there was an increase using other harvesting methods. The increase was the highest in the 1st method (86.46%), while it was 84.66% for the 2nd method, 62.4% for the 3rd method and 0.21% for the 4th method, respectively (Table 4). There was a high statistical significance between the changes in the 1st and the 2nd year's variances (r:+0.75). However, the reduction in the crop harvested by the 4th method cannot be attributed to method differences. As was stated previously, the bough breakages are responsible for the crop reduction in the second year.

When the yield averages of two years were examined, the highest yield was obtained from the 3rd method (21.64 kg), followed by the 4th method (14.06 kg), 2nd method (13.64 kg) and 1st method (19.19 kg), respectively. There was a statistical significant ($P<0.01$) difference between the yield based on different harvesting methods. When viewed from a statistical perspective there was no yield difference between the 2nd and the 4th methods (Table 6).

When the variances in average work capacities of two years and the total yields were compared, high correlation (r: +0.78) between the two variables can be observed (Table 7). As was stated previously, the variance in work capacity may be attributed to the use of different workers for machine harvesting, and the variance in yield results from bough breakages. When the differences are ignored, a correlation coefficient was obtained between 0.90 and 1. Thus, it can be seen from the two year data that the crop quantities have a positive influence on work capacity.

Conclusıon

Although many studies in the olive industry, mechanical harvesting technology is still not fully developed. Yield changes have been similar to one another in the trees which were harvested by different methods. The highest increase occurred in the first and the second methods. Bough breakages were seen during harvesting with wood sticks. Bough breakages cause decline in yield in the following year.

The use of wood stick after machines results in a reduction of the work capacity. The use of machines for olive harvesting at a maximum rate will ensure that more crops are harvested in a shorter time. The pruning method of the olive trees

Table 6. The two year yield averages of the harvesting methods (kg).

	Yield average (kg)
Method 1	8.72 ± 3.04
Method 2	13.64 ± 4.49
Method 3	21.64 ± 5.96
Method 4	14.06 ± 0.82

Table 7. Variances of the average work capacity and the total yield (%).

	Method 1	Method 2	Method 3	Method 4
Average work capacity	68.49	109.8	98.56	33.71
Total yield	86.46	84.66	62.4	0.21

determines the harvesting period. Pruning method applicable for machine harvesting should be preferred. In accordance with the data obtained from this study, it can be seen that the use of suitable equipment during harvesting and repeating the appropriate technique every year, will eliminate negative influences such as bough breakages and bark peelings, reducing costs and olive losses from trees. There fore, there will be an increase in the work capacity and yield.

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