

A Survey on some date palm orchards parameters applicable in date palm mechanization

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Abstract: This work was conducted to determine some important information related to date palm gardens and trees to be utilizable in designing of a date palm service machines. Different parameters were collected from 37 farms in Biskra province, due its importance in Algerian dates production, such as: height of trees (to crown), circumferences of trees and position of the dates bunch in the tree, number of tractor, irrigation mode. According to the results of this survey, several points were defined applicable in date palm mechanization, such as the variety cropped in all orchards visited is, only, Deglet Nour, 84% of farms visited don't exceed 3 ha of size, the machine work height must reach up 8 m higher, in minimum, the irrigation channels and the intercropping are, generally, along the rows which facility the displacement of wheeled machine and the number of tractor stays insufficient to develop a tractor-mounted date palm tree service machine.

Keywords: Date palm, mechanization, height of tree, irrigation mode, service machine

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1 Introduction

The date palm is one of the most important crops in Algeria. It is a source of revenue for about 3.5 million inhabitants in the Saharan regions of the country. According to Benziouche et al. (2012), there are more than 18 million palm trees spread over an area of 160,000 hectares and the total production reaches 6 million qtx/year. Algeria is famous for the production of Deglet Nour from Biskra Province.

Date palm requires particular care especially at the level of the crown, such as de-thorning, pollination, spraying, thinning, pruning, clusters arrangement and positioning of anti-breakage-supports, covering and, finally, harvesting. All these operations are still carried out manually, which requires a lot of time and cost, as

well the danger of palm climbing. For these reasons, mechanization of these farms operations is very important, consequently, it is necessary to determine some characteristics of palm date tree and orchards that would help the designer in palm date machines.

Several researches have been developed to survey on some parameters to be used in palm date mechanization such as, Ahmed et al. (1992) provided as many of the date palm properties including: age, tree height, crown height, trunk diameter, palm distribution and cutting resistance of the leaves. The overall size, reach, ground clearance and power required by a machine was decided after a survey of date farms carried out in 19 farms to determine the range of tree heights, spacing between trees and bunch disposition, ground profiles and soil strength (Al-Suhaibani et al., 1988). Keramat Jahromi et al. (2007) determined some important physical properties of date palm tree based on age of palm. In order to design a climber service machine, a research has been developed by Keramat Jahromi et al. (2008) to determine some

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engineering properties of date palm trunk applicable in designing of this machine.

The objective of this research is to survey on several date palm related-information applicable in date palm mechanization. No detailed studies about the irrigation mode used and the number of tractor existed have been performed up to now. Also, this kind of studies was conducted for the first time in Algeria. The data were collected from Biskra province due its importance in Algerian dates production.

2 Materials and methods

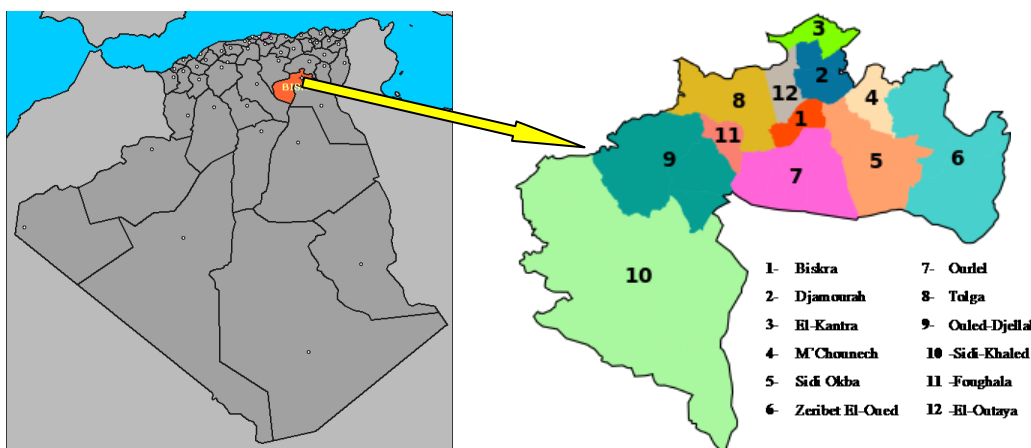


Figure 1 Biskra province situation

2.2 Survey

In this study, a survey of typical date palm farms was carried out on 37 orchards from end of December 2013 until end of February 2014. These palm date orchards were chosen to be representative of the conditions likely to be most often found in the field. The regions visited were the Eastern region (Zeribet El-Oued and Sidi-Okba), centre region (Biskra, Tolga, Ourlet and Foughala) and western region (Ouled-Djellal and Sidi-Khaled).

Using a structured questionnaire, with one interview, the following variables were collected:

- **Data for date palm orchards:** Location, arrangement of trees, surface, existence of intercropping.
- **Data for palm-trees:** number of trees and the space between the palms and ranks.
- **Data for tree measures:** height of trees (to crown), circumferences of trees and evaluation space between the

2.1 Presentation of the study area

Biskra province produces 31% of Algerian dates, (Benziouche et al., 2012) for this we select it to carry out our survey. The study area is located in the southeastern of country, the gateway to the Sahara. The height above sea level is 112 m which makes it one of the lowest cities. The chief town of the province is located at 400 km of the capital, Algiers. She has surface area of 21671 km² divided to 12 administrative districts (Figure 1). Biskra has a hot desert climate, with very hot and dry summers and mild winters with annual rainfall averaging between 120 and 150 mm / year. The average annual temperature is 20.9 °C.

dates cluster and the trunk. Note here that, so as to apply these measures, we select from each palm garden 5% of total productive trees using a simple random selection.

In order to evaluate the height of tree, we used dendrometer Blum-Leiss. Likewise, determination of space between the trees and the circumference of tree were measured with a tape.

- **Irrigation mode and the ground profile**
- **Number of tractor**

3 Resultants and discussion

According to this survey, we found that no machine is used specially in the crown-related operations. The decreasing availability of skilled labor (climbers) in face of the increasing number of trees and the high cost of the harvesting operation is considered a most constraint for

the farmers. The variety cropped in all orchards visited is, only, DegletNour.

orchards visited. These orchards were randomly selected in a way to browse the entire of the areas which are the leading date-producing.

3.1 Data for date palm orchards and palm trees

Table 1 shows general information for 37 date palm

Table 1 Data for date palm orchards

N°	Name	Location by district	Trees arrangement	Intercropping	size (ha)	N°	Name	Location by district	Trees arrangement	Intercropping	size (ha)
1	M'lili (1)	Ourlet	rows	fruit tree	1	20	El Ghrous (1)	Foughala	rows	fruit tree	2
2	M'lili (2)	Ourlet	rows	fruit tree	2	21	El Ghrous (2)	Foughala	rows	fruit tree	2
3	M'lili (3)	Ourlet	Scattered	fruit tree	1,5	22	El Ghrous (3)	Foughala	rows	fruit tree	4
4	M'lili (4)	Ourlet	rows	None	2,5	23	El Ghrous (4)	Foughala	rows	fruit tree	1,5
5	Bochagroune	Tolga	Scattered	None	1,5	24	Doucen (1)	Ouled-Djellal	rows	None	2
6	Lichana	Tolga	rows	None	12	25	Doucen (2)	Ouled-Djellal	rows	None	1
7	El-Hadjeb	Biskra	rows	None	1	26	Doucen (3)	Ouled-Djellal	rows	None	6
8	Tolga (1)	Tolga	rows	None	6	27	Doucen (4)	Ouled-Djellal	rows	None	2,5
9	Tolga (2)	Tolga	rows	Vegetable, Cereal, forage	2	28	Doucen (5)	Ouled-Djellal	rows	None	10
10	Tolga (3)	Tolga	rows	None	1	29	Ouled-Djellal	Ouled-Djellal	rows	None	6
11	Bordj Ben Azzouz	Tolga	rows	None	2	30	Sidi Khaled (1)	Sidi Khaled	rows	fruit tree	0,5
12	Sidi-Okba (1)	Sidi-Okba	rows	fruit tree	2	31	Sidi Khaled (2)	Sidi Khaled	rows	fruit tree, forage	0,5
13	Sidi-Okba (2)	Sidi-Okba	rows	None	3	32	Sidi Khaled (3)	Sidi Khaled	rows	Cereal	0,5
14	Sidi-Okba (3)	Sidi-Okba	rows	fruit tree	3	33	Sidi Khaled (4)	Sidi Khaled	rows	fruit tree, forager	1
15	A ñ Naga (1)	Sidi-Okba	rows	None	3	34	Sidi Khaled (5)	Sidi Khaled	rows	Cereal, fruit tree)	0,5
16	A ñ Naga (2)	Sidi-Okba	Scattered	None	3	35	Sidi Khaled (6)	Sidi Khaled	rows	Vegetable, fruit tree)	0,75
17	Khenguetsidi Nadji (1)	Zeribet El-Oued	Scattered	None	2	36	Sidi Khaled (7)	Sidi Khaled	rows	Cereal	1
18	Khenguetsidi Nadji (2)	Zeribet El-Oued	Scattered	fruit tree	1,5	37	Sidi Khaled (8)	Sidi Khaled	rows	Cereal, fruit tree)	2
19	Khenguetsidi Nadji (3)	Zeribet El-Oued	Scattered	None	1,5						

Figure 2 shows the different category of farms according to the size, intercropping and trees arrangement.

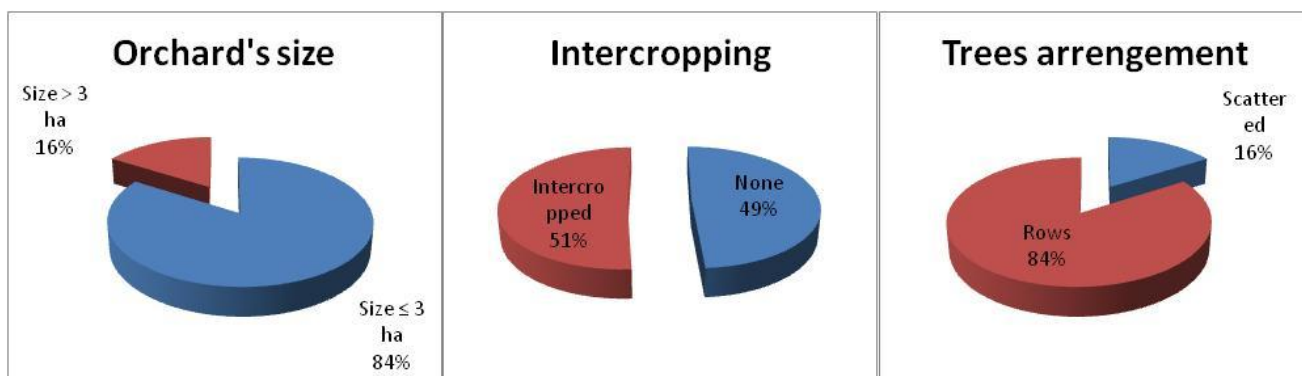


Figure 2 diagram of percentage for the size, intercropping and trees arrangement parameters

According to this table, in 84% of palm orchards, the distribution pattern of palm trees is rows. Likewise, the intercropping is absent in 49% of orchards, while in the

rest of orchards, the farmers intercrop, mostly, the fruit tree such as: apricot, apple, lemon. As shown in Figure 3, the plantation of fruit trees is aligned with the rows of

palm trees. These results give confidence to the farmers to introduce a large palm date service machines, intercropping will hinder such encouragement.

Us show in Figure 2 the 37 farms ranged in size from 0.5 ha to 12 ha, where 84% of these farms don't exceed 3 ha. This result shows that the majority of orchards in the region are a family farms, that's mean the yield is not very important to make the investment in expensive machinery financially feasible.



Figure 3 Date palm orchard intercropped with fruits trees
The following table summarizes data collected for palm date trees distances, number and density of each site.

Table 2 Data for palm-trees

N°	Name	Number trees	Trees distance (m)	rows distance (m)	N°	Name	Number trees	Trees distance (m)	rows distance (m)
1	M'lili (1)	100	8	8	20	El Ghrous (1)	140	8	8
2	M'lili (2)	150	8	8	21	El Ghrous (2)	150	8	8
3	M'lili (3)	109	Scattered	Scattered	22	El Ghrous (3)	500	8	8
4	M'lili (4)	300	7	7	23	El Ghrous (4)	200	8	8
5	Bochagroune	50	Scattered	Scattered	24	Doucen (1)	230	9	9
6	Lichana	400	6	6	25	Doucen (2)	120	9	9
7	El-Hadjeb	90	8	8	26	Doucen (3)	600	8	8
8	Tolga (1)	700	7	8	27	Doucen (4)	300	6	8
9	Tolga (2)	200	7	7	28	Doucen (5)	1000	6	7
10	Tolga (3)	140	8	8	29	Ouled-Djellal	600	6	7
11	Bordj Ben Azzouz	250	7	8	30	Sidi Khaled (1)	50	8	8
12	Sidi-Okba (1)	200	9	9	31	Sidi Khaled (2)	54	8	8
13	Sidi-Okba (2)	450	5	5	32	Sidi Khaled (3)	55	8	7,5
14	Sidi-Okba (3)	450	8	7	33	Sidi Khaled (4)	116	8	8
15	A ñ Naga (1)	270	4	5	34	Sidi Khaled (5)	53	8	8,5
16	A ñ Naga (2)	300	Scattered	Scattered	35	Sidi Khaled (6)	70	8	7,5
17	KhenguëtSidiNadji (1)	100	Scattered	Scattered	36	Sidi Khaled (7)	120	8	7,5
18	KhenguëtSidiNadji (2)	100	Scattered	Scattered	37	Sidi Khaled (8)	240	8	8
19	KhenguëtSidiNadji (3)	100	Scattered	Scattered					

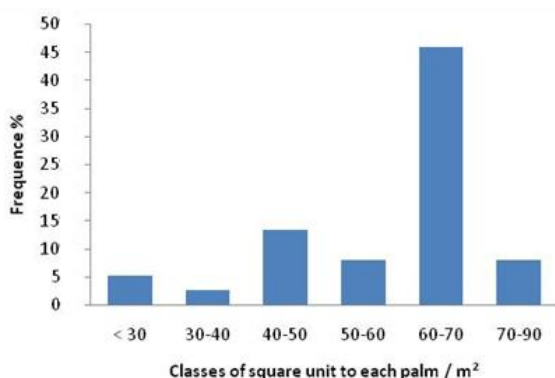


Figure 4 Frequency distribution of square unit to each palm

The data illustrate that, the spaces between trees don't much correspond to the dimension of modern palm trees plantation proposed by Zaid et al. (2002) and from Figure 4, which illustrates the frequency distribution of different classes of square unit to each palm tree, we found that 46% of squares unit vary from 60 to 70 m² but in fact, the planting density also depends on ecological factors.

Although, the trees distances may see spacious in majority of cases, which would encourage using an engine similar to the one developed by Al-Suhabani (1990). Besides, the farmers apply these distances according to their point of view, not as recommended by the Ministry of Agriculture.

The variations in tree height (minimum and maximum and means values with the corresponding values of standard deviation) are given in Table 3, as well as the variation in tree circumference (minimum and maximum and means values).

Table 3 Measures on trees

N°	Name	Height of tree (m)				Circumference (m)			N°	Name	Height of tree (m)				Circumference (m)		
		Min	Max	Moy	Ec-t	Min	Max	Moy			Min	Max	Moy				
1	M'lili (1)	4	7	5,5	2,12	1,00	2	1,5	20	El Ghrous (1)	5	9	7	2,83	1,75	1,88	1,815
2	M'lili (2)	6	8	7	1,41	0,80	1	0,9	21	El Ghrous (2)	2,2	7	4,6	3,39	1,44	1,94	1,69
3	M'lili (3)	9	14	11,5	3,54	1,00	2	1,5	22	El Ghrous (3)	3	10	6,5	4,95	1,57	2,04	1,805
4	M'lili (4)	4	7	5,5	2,12	1,20	1,6	1,4	23	El Ghrous (4)	0,7	1,2	0,95	0,35	1,88	2,51	2,195
5	Bouchagroune	4,5	7,8	6,15	2,33	1,60	1,9	1,75	24	Doucen (1)	3,6	6,8	5,2	2,26	1,65	1,9	1,775
6	Lichana	1	4,8	2,9	2,69	1,50	1,6	1,55	25	Doucen (2)	3,6	5,2	4,4	1,13	1,69	1,94	1,815
7	El-Hadjeb	2,2	5	3,6	1,98	1,50	1,8	1,65	26	Doucen (3)	5,8	9,5	7,65	2,62	1,72	2,1	1,91
8	Tolga (1)	0,6	2	1,3	0,99	1,40	1,8	1,6	27	Doucen (4)	2,2	15	8,6	9,05	1,50	1,88	1,69
9	Tolga (2)	7,8	12	9,9	2,97	1,40	1,8	1,6	28	Doucen (5)	1,5	3	2,25	1,06	1,57	1,88	1,725
10	Tolga (3)	8	9	8,5	0,71	1,60	2	1,8	29	Ouled-Djellal	0,8	2,2	1,5	0,99	1,50	2	1,75
11	Bordj Ben Azzouz	10	14	12	2,83	1,60	1,8	1,7	30	Sidi Khaled (1)	6,3	6,7	6,5	0,28	1,90	2,13	2,015
12	Sidi-Okba (1)	2,2	5	3,6	1,98	1,70	2,1	1,9	31	Sidi Khaled (2)	5,93	6,18	6,055	0,18	1,80	2	1,9
13	Sidi-Okba (2)	3	7	5	2,83	1,80	2,3	2,05	32	Sidi Khaled (3)	6	6,5	6,25	0,35	1,00	0,9	0,95
14	Sidi-Okba (3)	1	4	2,5	2,12	1,70	2,2	1,95	33	Sidi Khaled (4)	4	5	4,5	0,71	1,93	2,3	2,115
15	A ñ Naga (1)	2,4	6,8	4,6	3,11	1,55	2,3	1,925	34	Sidi Khaled (5)	6,15	6,45	6,3	0,21	1,90	2,2	2,05
16	A ñ Naga (2)	3,2	8	5,6	3,39	1,20	2,4	1,8	35	Sidi Khaled (6)	4,9	5,3	5,1	0,28	1,90	2,13	2,015
17	KhenguetSidiNadji (1)	8	13	10,5	3,54	1,50	2	1,75	36	Sidi Khaled (7)	5	7	6	1,41	1,00	1,2	1,1
18	KhenguetSidiNadji (2)	4	12	8	5,66	1,50	2	1,75	37	Sidi Khaled (8)	2,43	2,7	2,565	0,19	1,93	2,51	2,22
19	KhenguetSidiNadji (3)	4	10	7	4,24	2,00	2,2	2,1									

We found that the height of trees ranges from 0.6 m to 15 m, while according to Al-Suhaibani et al. (1988) the maximum and minimum values of tree height are 17.43 and 1.00m, Ahmed et al. (1992) measured height of palms ranges from 1.1 to 10.2m and Keramat et al (2007) found that the average of tree height range from 1.51 m to 10.32 m. Consequently the machine work height should reach up to this higher. Also, the maximum tree circumference is 2.51 m corresponding to 0.80 m of diameter and the minimum is 0.8m which means 0.25m. Al-Suhaibani et al. (1988) found the circumference varies from 2.56 and 0.90m, Ahmed et al. (1992) found that tree circumference ranges from 1.16 to 1.72m and Keramat et al (2007) estimated that the average values of mid and top circumference varied from 1.28 to 2.40m, with average value of 1.72m, respectively. This variable used in designing a climber date palm machine and a lifting machine which has a platform in the form of "U" to elevate an operator to perform the crown related-operations.

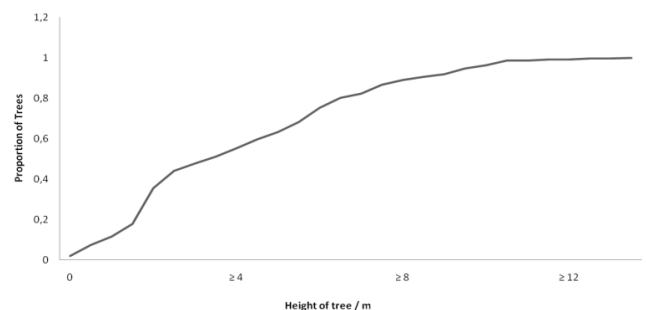


Figure 3 The cumulative frequency distribution of height of 546 palm trees from 37 farms

Figure 3 shows cumulative frequency distribution of height of 546 palm trees from 37 farms. 86% of productive palm trees don't exceed 8m and Al-Suhaibani et al (1988) found that for 86% the maximum height of palm trees is 10 m. As a result, the machine work height must reach up to this higher, in minimum; we can consider this as a referential height to our machine in order to reduce the production cost for some service machines.

3.2 Irrigation mode and the ground profile

The irrigation modes used in date palm orchards visited are the channels (the local name is Sagya), large ditches and localized. The average size of irrigation channels was 40 cm of depth and 50 cm of width, while for the ditches, the average size was 50 cm of depth and 180 cm of width. Furthermore, we found that, there is

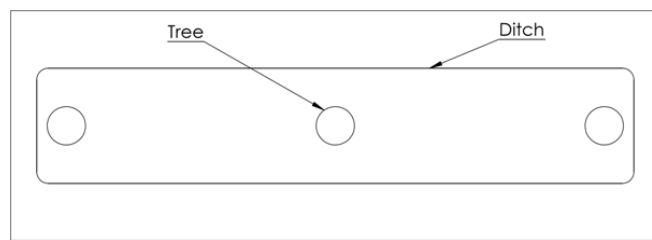


Figure 6 Ditch irrigation mode

Table 4 Irrigation modes

N°	Orchards	Sagya	ditches	Localized	N°	Orchards	Sagya	ditches	Localized
1	M'lili (1)			X	20	El Ghrous (1)			X
2	M'lili (2)			X	21	El Ghrous (2)			X
3	M'lili (3)		X		22	El Ghrous (3)	X		
4	M'lili (4)	X			23	El Ghrous (4)			X
5	Bouchagroune	X			24	Doucen (1)	X		
6	Lichana		X		25	Doucen (2)	X		
7	El-Hadjeb	X			26	Doucen (3)	X		
8	Tolga (1)		X		27	Doucen (4)	X		
9	Tolga (2)	X			28	Doucen (5)	X		
10	Tolga (3)	X			29	Ouled-Djellal	X		
11	Bordj Ben Azzouz	X			30	Sidi Khaled (1)	X		
12	Sidi-Okba (1)		X		31	Sidi Khaled (2)	X		
13	Sidi-Okba (2)	X			32	Sidi Khaled (3)	X		
14	Sidi-Okba (3)	X			33	Sidi Khaled (4)	X		
15	A ñ Naga (1)	X			34	Sidi Khaled (5)	X		
16	A ñ Naga (2)	X			35	Sidi Khaled (6)	X		
17	KhenguetSidiNadji (1)	X			36	Sidi Khaled (7)		X	
18	KhenguetSidiNadji (2)	X			37	Sidi Khaled (8)			X
19	KhenguetSidiNadji (3)	X							

awateringhole,with different forms (carry or circle) and sizes, around each tree which make the space between trees smaller. The following figures illustrate the diagrams of each irrigation mode founded.

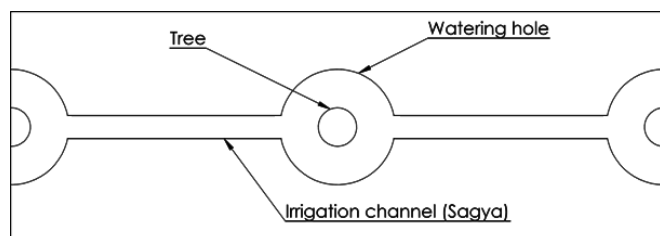


Figure 4 Traditional irrigation mode (Sagya)

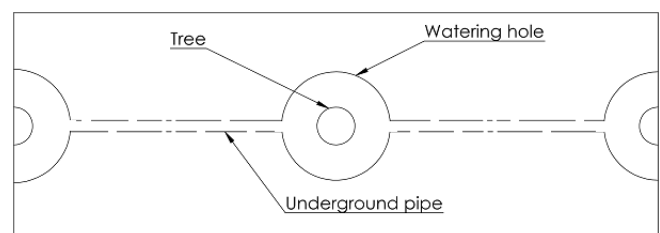


Figure 5 Localized irrigation mode

As shown in Table 4, the percentage of use a localized, traditional channels (Sagya) and large ditches mode irrigation are 16%, 73% and 11%, respectively. Therefore, 84% of ground sites restrict the free movement of the vehicles with wheels. This finding leads us to prevent the building a wheeled service machine or to construct a tool to facilitate the passage of these vehicles. For this reason, a pair of a portable bridge unit has been developed by Al-Suhabani et al. (1993) to be used to enable the engine to cross over irrigation channels.

Generally, we observed in all sites that the soil kinds were sandy and hard with some grass and weed. On some sites the land was completely flooded by the irrigation water but still firm to walk on, similar to founded by Al-Suhaibaniet al (1988).

3.3 Bunchposition on palm tree

In all orchards visited, the operation of bunches arrangement and positioning of anti-breakage-supports is considered very important, especially for cultivars with high commercial value. In this operation, the bunches have to be arranged under the leaves so, when growing up in size; fruits will not get caught in the foliage or damaged by thorns. When arranging the bunches, it's often necessary to support them with leaves, since they are not self-sustained. This operation facilitates the rest of the farmer operation like the coverage and harvesting of bunch (Garbati, 2008).

Due the moment of the survey, the majority of orchards had been harvested but on the some sites the bunch positions on a palm tree that have been examined. The distance (A) ranged from 0.7 to 1.5 m and (B) ranged from 0.3 to 0.7m with (A) the distance between (C) and the tree, (B) the distance between (C) and closest leaf and (C) the node of covering bag in yellow color on the Figure 6. These measures help in determining the operation diameter and angles for the harvester machines which carried out the operation without climbing the tree.



Figure 7 Bunches positions on palm tree

3.4 Number of tractor

This parameter allows us to make a decision about the construction a tractor-mounted date palm tree service machine such as those was developed by Moustafa (2005). Hence, for the total of orchards surveyed, there are 5 tractors which have the same puissance (45 kW) and two wheels drives. Consequently, the number of tractor stays insufficient to develop such as machines.

4 Conclusions and Suggestions

Determination on some parameters date palm orchards should enable the designer to develop a service machine to perform the necessary cultural tasks on date palm trees in Algeria. The present survey has concluded the following:

- a- The machine work height must reach up 8 m higher, in minimum in order to service a greater part of date palm trees.
- b- The irrigation channels and the intercropping are, usually, along the rows which facilitate the displacement of wheeled machine, with 4x4 wheels drive in preference.
- c- The trees spacing encourages using of a wider machine but in the designing, we must take into consideration the existing of watering hole because it reduce these spaces.
- d- The variation in bunch spacing is encouraged to design a harvester aid. Besides, the farmer can arrange the bunches in accordance with the operation diameter and angles of his harvester machine.
- e- The number of tractor is insufficient to develop a tractor-mounted date palm tree service machine. Although, this kind of elevator merits encouraging, since it's likely to be less expensive than the elevator motorized.
- f- The cost of this machine should be not expensive, because the majority of farmers don't have important returns to make the investment in expensive machinery financially feasible.

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