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Olive Harvesting in Syria

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SUMMARY - In the period 2005-2006, in the framework of the Italian cooperation project "Technical Assistance for the Improvement of Olive Oil Quality in Syria", demonstrative trials to evaluate the effectiveness of hand-held machines to harvest the fruits of some of the main olive Syrian cultivars were carried out.

At the present time, almost all the olives produced in Syria are harvested by hand from the trees (sometimes also using sticks to beat the crown), because manpower cost is relatively low. The olives are often collected in not specialised cloths spread under the trees. Often the olives naturally fallen to the ground are harvested and mixed with the olives harvested from the trees. The worker productivity with manual harvesting is relatively low: 6-20 kg/h/worker. Harvested olives are put in bags made of hemp or plastic fibres and stored, in the farm and in the mill, often for a total of 1-2 weeks. Frequently, the olives are not stored in suitable places (aerated and cool rooms).

In mid November 2005, two hand-held machines, a pneumatic comb (Olistar Evolution, Campagnola, Bologna, Italy) and an electric whipper (Oliviero, Agritec, Grosseto, Italy), were compared with one another and with manual harvesting, on adult trees, trained to the globe system, of the two main Syrian olive cultivars: Sorani (Idleb area) and Zaity (Aleppo area). The harvesting yield (percentage of olives harvested with respect to total production) was 96-97% with manual harvesting and ranged from 92% to 95% with the machines. With respect to manual harvesting, working productivity (kg of olives detached by one worker in one hour) increased about 3.5-4 times with the cultivar Zaity and 4.5-5 times with the cultivar Sorani using the electric whipper and pneumatic comb. The results were good and promising, considering that the two regions and cultivars taken into account represent about 60% of the total surface area cultivated with olives in Syria. In November 2006, these interesting results were substantially confirmed in demonstrative trials carried out with pneumatic combs, in Homs, Salamieh and Hama areas, on the cultivars Doebli and Kaissy.

Suggestions are given in order to improve the impact of olive harvesting on the quality of the product and on the economical revenue of olive cultivation in Syria.

Keywords: *Olea europaea* L., olive mechanical harvesting, pneumatic comb, electric whipper

RESUME *- Pendant les années 2005 et 2006, dans le cadre du projet de la coopération italienne intitulé: «Assistance technique pour l'amélioration de la qualité de l'huile d'olive en Syrie», un diagnostique concernent la récolte des olives et des démonstrations pratiques ont été organisées pour évaluer l'efficience et la réelle applicabilité des systèmes de récolte mécaniques sur les variétés les plus répandues en Syrie.*

Actuellement la récolte manuelle est la plus commune et traditionnelle, parfois avec l'aide des bâtons pour frapper les rameaux; cette pratique trouve une justification dans le coût réduit de la main d'œuvre. Les olives sont amassées dans des tapis de fortune au-dessous de l'arbre. Environ le 50% des agriculteurs mélange les olives récoltées de l'arbre avec les olives qui se trouvent sur le terrain depuis longtemps; celle-ci est une pratique commune. La productivité de la récolte manuelle est assez baisse: 6-20 Kg par ouvrier par heure. Les olives sont placées dans des sacs en fibre naturelle ou en plastique et ne sont pas gardées dans des lieux souhaitables (chambres ventilées et fraîches).

A midi novembre 2005, 2 machines manuelles, un peigne pneumatique (Olistar évolution, Campagnola, Bologna, Italy) et un fouet électrique (Oliviero, Agritec, Grosseto, Italy) ont été comparés avec la récolte

manuelle sur des oliviers adultes des deux variété syriennes principales: la Sourani (Région d' Idleb) et la Zaity (Région d' Alep) conduits en gobelet.
L'efficience, exprimée en pourcentage des olives récoltes sur la production totale a été du 96-97% avec la récolte manuelle et du 92-95% avec les machines. Si on compare l'efficience de récolte (Kg récoltés par ouvrier en 1 heure) celle-ci a augmentée de façon importante pour la variété Zaity (3,5 4 fois) lorsque pour la variété Sourani ce valeur a augmenté de 4,5-5 fois utilisant le fouet électrique et le peigne pneumatique respectivement. Les résultats ont été très positifs et promettant, surtout si on considère que les variétés étudiées représentent le 60% des arbres d'oliviers cultivés en Syrie.
Ces mêmes résultats ont été confirmés pendant des autres essais exécutés dans les régions de Homs, Salamyeh, Hama, sur les variétés Doeibli et Kaissy.
Des considérations qui concernent l'amélioration de l'impacte de la récolte mécanique et la qualité du produit avec les aspects économiques de la récolte en Syrie ont été reportées dans ce travail.

Mots-clès: *Olea europaea* L.*, Récolte mécanique, rateaux pneumatiques, fouet électrique*

Introduction

Harvesting is one of the most important practices in olive cultivation. The choice of time and the way of doing it can greatly affect the quantity and quality of the oil, the production the following year and the economical return (Famiani et al., 2004). Theoretically, the optimal time to harvest is when the maximum quantity and quality of oil can be obtained. However, maximum quantity and quality do not always coincide and in this case it has to be decided to favour quantity or quality. The time chosen for harvesting also affects the length of time needed to detach the olives (because olive detachment force decreases during ripening), which influences the effectiveness of manual and mechanical harvesting.

At the present time, according to an investigation carried out as part of the Italian cooperation project "Technical Assistance for the Improvement of Olive Oil Quality in Syria" (see the chapter "The Olive Oil Sector in Syria" in this book) almost all the olives produced in Syria are harvested by hand from the trees (sometimes also using sticks to beat the crown), because manpower costs are relatively low. The olives are often collected in unspecialised cloths spread under the trees. Often the olives naturally fallen to the ground are harvested and mixed with the olives harvested from the trees. Harvested olives are put in bags made of hemp or plastic fibres and stored, in the farm and in the mill, often for a total of 1-2 weeks. Only in the areas of Daraa and Damascus about 40% of the farmers use plastic boxes instead of bags. Frequently, the olives are not stored in suitable places (aerated and cool rooms). The worker productivity with manual harvesting is relatively low: 6-20 kg/h/worker. Moreover, manual harvesting is tiring and the use of ladders gives rise to high risks of workers falling. In Syria, olive harvesting is, generally, carried out from the beginning of October to the end of November in the coastal areas, and from the end of October to the end of December, up to January with late cultivars, in the inland areas. Collecting olives naturally fallen to the ground and mixing them with olives harvested from the trees has to be avoided because it greatly decreases oil quality. Moreover, also the use of bags to transport and store olives and the excessive length of storage (more than 2 days) cause a progressive decrease of oil quality (decrease of fruity aroma and taste, increase of free acidity, oxidation and organoleptic defects). As far as the efficiency of manual harvesting is concerned, improvement could be obtained by using manual combs to detach the olives and nets of suitable size spread under the trees to collect the olives. In this way a 10-20% increment of harvesting productivity could be obtained.

In the last decades, the overall situation of olive growing in Syria has changed remarkably. As a matter of fact, a large number of new olive orchards have been planted (about 57% of the olive trees in Syria are less than 20 years old) and so olive production should increase remarkably (Al Ibrahem, 2006). As a result, the manpower requirements for olive harvesting will also increase and it may become difficult to find sufficient workers to harvest the olives. Moreover, the increase of production should also provide more oil for export. This oil has to be of high quality to better meet the qualitative standards demanded by the international market. In this regard, the use of machines to increase the harvesting productivity makes it easier to concentrate the harvest in the period of maximum oil quality and reduce the risk of excessive olive storage since, at the farm level, the amount of olives needed for processing can be reached in a shorter time. Likewise, it is also predicted that manpower costs will increase in the coming years. Overall, this situation has caused increasing interest in the mechanization of olive

harvesting in Syria and in obtaining oils with good qualitative characteristics. In this last regard, the time in which harvesting is carried out is critical to obtain high quality oil. Within the Italian Cooperation project “Technical Assistance for the Improvement of Olive Oil Quality in Syria”, studies to determine the best harvesting time of the main Syrian cultivars were carried out and the results, that give indications for selecting the best harvesting time for each variety, are reported in the book “Characterization of the main Syrian olive cultivars”, produced within the same project.

Up to now, in several olive producing countries, a number of studies have been carried out to mechanize fruit harvesting and as a result several machines are now available on the market (Michelakis, 2002; Panaro et al., 2003). Among them, the most common are the trunk shakers and hand-held machines. Trunk shakers are usually very effective for harvesting in intensive olive groves, characterised by gentle slopes, trees having a single trunk, rising branches, planted according to a regular spacing and able to give a high production, but their price is relatively high (Famiani et al., 2004). Hand-held machines are small, versatile devices that can easily fit the different training systems of the trees, be used on sloping terrain and with irregularly spaced trees and their price is relatively low (Famiani et al., 2004). Being held directly by the workers, they cause some fatigue and cannot be used efficiently on trees taller than 4-4.5 m.

The real effectiveness of the different machines has to be evaluated with specific trials in different environmental and cultural conditions. In Syria, trials to determine the effectiveness of machines to harvest olives have been very limited and so very little is known about the suitability of Syrian cultivars for mechanical harvesting.

Project related activities

Use of hand-held machines for olive harvesting

Within the Italian Cooperation project “Technical Assistance for the Improvement of Olive Oil Quality in Syria”, some demonstrations were carried out in order to evaluate the effectiveness of two hand-held machines, a pneumatic comb and an electric whipper, for the harvesting of the two main Syrian olive cultivars, Sorani and Zaity, which together cover about 60% of Syrian olive orchards. Hand-held machines were studied because, with respect to larger machines, they have a much lower price which makes them more suitable for the economic and social (availability of manpower) conditions of Syria.

Demonstration trials were carried out in mid November 2005 in two different olive orchards, one located in the Idleb area, where the cultivar Sorani is the main cultivar, and the other in the Aleppo area, where the cultivar Zaity is the most important. Both olive orchards were private and representative of a large part of olive growing in these areas where olive harvesting is normally concentrated in November. The Sorani trees were about 30 years old and the Zaity ones were about 40 years old; they were trained according to the globe system.

The two hand-held machines evaluated were a pneumatic comb (Olistar Evolution, Campagnola, Bologna, Italy) and an electric whipper (Oliviero, Agritec, Grosseto, Italy). They were compared with one another and with manual harvesting. Both machines were fastened to a stake and had a total length (stake + harvesting device) of 2.5 m. The weight of the stake + harvesting devise was of 2.2 kg for the electric whipper and 2.5 kg for the pneumatic comb. The pneumatic comb was run by an air motor-compressor. The electric whipper was run by a 12 V battery. For each harvesting system three replicates (3 trees) were used.

In both of the olive orchards, tree size was determined by measuring the diameter and the height of the crowns and the total height of the trees. Before harvesting, fruit detachment force was determined by using a dynamometer. With all the harvesting systems, detached olives were collected in a net spread under the trees. The time required for the harvesting of each tree was determined and the harvested olives were weighed. At the end of harvesting all olives remaining on the crown were harvested manually and weighed in order to calculate the percentage of totally harvested olives (harvesting yield). Samples of olives were taken to determine fruit weight, pigmentation and water and oil content. Details on methods used for evaluation of fruit characteristics can be found in Abdeen et al. (2006).

Photo 1: Manual Harvesting

Photo 2: Mechanical harvesting with the electric whipper

Photo 3: Mechanical harvesting with the pneumatic comb

Manual harvesting was carried out by five people both in Idleb and Aleppo. Mechanical harvesting was performed by one worker. The working productivity was calculated only considering the time required for detaching the fruit from the trees (by hand or with machines) but not the time needed to spread the nets under the trees and collect olives from the nets. This was not done because it should be the same for all the harvesting systems and so it should not make any difference in their comparison. The working productivity is expressed as kg of olives detached (harvested) by one worker in one hour.

Results

The trees of the cultivar Sorani in the Idleb area were average sized and they were relatively low in height (Table 1). The production per tree was relatively high. Fruit detachment force and olive weight were medium (Table 2). The oil content was high. The pigmentation regarded only the surface of the olives and, on average, did not cover the whole surface. The harvesting yield (percentage of olives harvested with respect to the total production) was 97% with manual harvesting and around 95% and 92% with the pneumatic comb and electric whipper, respectively (Table 3). With respect to manual harvesting, working productivity was 4.5-5 times higher using the machines.

Table 1: Tree characteristics of the cultivars Sorani and Zaity. Average values ± Standard error.

Cultivar	Crown diameter (m)	Crown height (m)	Total tree height (m)	Olive production (kg/tree)
Sorani	4.5 ± 0.2	3.5 ± 0.1	3.7 ± 0.1	25.7 ± 2.9
Zaity	4.9 ± 0.2	4.1 ± 0.1	4.4 ± 0.1	42.6 ± 3.5

The trees of the cultivar Zaity in the Aleppo area were average to large sized and were not excessively tall (Table 1). The production per tree was high. Fruit detachment force was quite low and olive weight was medium (Table 2). The oil content was high. The pigmentation regarded only the surface of the olives and, on average, did not cover the whole surface. The harvesting yield was 96% with manual harvesting and around 92% with the two harvesting machines (Table 3). With respect to manual harvesting, working productivity was about 3.5-4 times higher using the machines.

In both of the regions and cultivars, the size of trees was suitable to use hand-held machines, particularly the Sorani cultivar that was less than 4 m tall. However, trees of the cultivar Zaity were less than 4.5 m which is considered the height beyond which there are problems in using these machines. The results showed that in both cultivars, the use of the pneumatic comb or electric whipper could significantly enhance the working productivity with respect to manual harvesting, with the pneumatic comb always showing slightly higher values than the electric whipper. Also the harvesting yields obtained with the machines were good considering that they were only slightly lower than those obtained with manual harvesting. The results are in agreement with those obtained in studies conducted with the same machines in Italy (Tombesi et al., 1996; Famiani et al., 2004), whereas with pneumatic combs, poor results were reported in experiments carried out in Turkey and Tunisia (Caran, 1997; Benthaer and Rouina, 2002). The good results obtained in Syria are probably due to the the not excessive height of the trees, the high fruit load, the good weight of olives and the medium or low detachment force, all factors that have a positive influence on machine efficiency (Famiani et al., 2004). With respect to Sorani, the

higher harvesting working productivity in Zaity with all the harvesting systems is probably a result of the low detachment force. In both the cultivars, the slightly lower harvesting yields obtained with the machines with respect to manual harvesting can be attributed, at least in part, to the fact that the crowns of both cultivars were relatively dense and so it was not easy to work with the machines in all parts of the crown. In this regard some improvements could be made by slightly prolonging the use of the machines and by pruning the trees according to the requirements of these machines for their optimal use (avoid excessive vegetative density, favour lateral development of the canopy and limit tree height, but also maintaining good canopy volume in order to not reduce the production per tree).

Table 2: Fruit characteristics of the cultivars Sorani and Zaity. Average values ± Standard error.

Cultivar	Fresh weight (g)	Detachment force (N)	Pigmentation index (0-7)	Water content (%)	Oil content (%f.w.)	Oil content (%d.w.)
Sorani	3.0 ± 0.1	3.4 ± 0.1	2.1 ± 0.1	35.4 ± 0.5	32.5 ± 0.6	50.4 ± 0.7
Zaity	2.3 ± 0.1	1.7 ± 0.1	2.4 ± 0.2	41.8 ± 1.2	28.5 ± 1.2	48.4 ± 1.7

Table 3: Harvesting yield and working productivity obtained with the cultivars Sorani and Zaity. Average values ± Standard error.

	Cultivar Sorani		Cultivar Zaity	
Harvesting system	Harvesting yield (%)	Harvesting working productivity (kg/h worker)	Harvesting yield (%)	Harvesting working productivity (kg/h worker)
Manual	97.0 ± 1.6	8.8 ± 0.6	96.0 ± 1.8	19.6 ± 0.3
Pneumatic comb	95.3 ± 3.2	47.2 ± 3.3	92.4 ± 2.5	79.3 ± 3.1
Electric whipper	92.1 ± 3.7	40.9 ± 3.8	92.0 ± 2.2	71.1 ± 4.8

The results obtained in the demonstration trials are good and promising, considering that the two regions and cultivars taken into account represent about 60% of the total surface area cultivated with olives in Syria. This means that there is a large number of olive orchards potentially suitable to be efficiently harvested with hand-held machines. The use of such devices allows the harvesting working productivity to increase and thus reduce the amount of labour needed to harvest olives. This can be useful in Syria to face the impact of the remarkably increased surface area cultivated with olives and to concentrate harvesting in the best period in order to obtain the best possible balance between the quantity and quality of the oil. These interesting results were confirmed by successive trials carried out in November 2006 in other areas and with other cultivars (Table 4). The best results obtained with Doebli in Homs and with Kaissy are probably due to the high fruit load of the trees and to the high weight of the fruit, respectively.

Table 4: Tree and fruit characteristics and harvesting working productivity obtained with the use of pneumatic combs*.

Area	Cultivar	Tree dimension	Olive weight	Olive detachment force (N)	Olive pigmentation index (0-7)	Harvesting working productivity (kg/h worker)
Homs (Al Hadeda)	Doebli	medium	medium	5.0	3	125
Salamieh	Doebli	medium	medium	4.5	3	40
Hama (Neop demo plot)	Kaissy	medium	high	7.0	2	73

* 2 operators with 2 combs

Further studies would be useful to evaluate the efficiency of these machines in other olive ripening stages (primarily earlier stages to evaluate the impact of higher detachment forces) and on other Syrian cultivars.

Concerning the economical feasibility of using hand-held machines for olive harvesting in Syria, some simulations have been carried out. Considering a cost to purchase an air motor-compressor + 2 pneumatic combs + all the required accessories of about 3,800.00 € (euro), a manpower cost of 6 €/day, a motor-compressor fuel cost of 5-6 €/ha, a harvesting yield (percentage of detached olives) similar to that of manual harvesting and an increase of working productivity of 2-3 times with respect to manual harvesting, an olive farm larger than 7-8 ha would be necessary to make the use of hand-held machines more economical than manual harvesting. Obviously, such farm size would decrease if the increase in working productivity was higher than 2-3 times. With the use of electrical devices the purchase cost of all the equipment (machine + battery + charger device) is reduced to 600-700 € and, consequently, the farm size that makes it economically feasible to use such machines would be around 1-2 ha.

When pneumatic devices are used for olive harvesting, the air motor-compressor can also be used to run devices to mechanize tree pruning (i.e. pneumatic scissors and saws). In the case where the farm owns a tractor, a compressor activated by the tractor (that is cheaper than a motor-compressor) could be used. This condition or the availability of an air compressor used for other purposes in the farm make the introduction of machines for olive harvesting easier and more feasible.

In general, hand-held machines can cause some injuries to trees (to shoots and small branches), above all with early harvesting when it is more difficult to detach the olives, but usually such injuries do not cause significant negative effects on tree health. However, in case of significant damage to cultivars sensitive to *Pseudomonas savastanoi* a treatment with copper compounds (oxychlorure, bordolese, etc.) soon after harvesting could be advisable.

Hand-held machines cause a certain amount of fatigue of the workers. However, it should be taken into account also that the use of ladders is tiring and, furthermore, could be a risk for accidents.

As seen before, trunk shakers allow full mechanisation of harvesting in intensive olive groves, characterised by gentle slopes, cultivars which produce average/large size fruit (> 2 g), trees with a single trunk (1-1.2 m high), rising branches, planted according to a regular spacing and able to give a high production (> 15 kg), but their price is relatively high. With the use of trunk shakers it is possible to harvest from 80% to 95% of the olives on the trees (Famiani et al., 2004). The productivity of workers, with respect to manual harvesting, can be increased 5-20 times; the latter value when the trunk shaker is combined with mechanical collection of the olives (Famiani et al., 2004). Some trials to evaluate the efficiency of trunk shakers in Syria were carried out several years ago. New investigations on the use of modern trunk shakers should be done in order to evaluate the influence of Syrian cultivars, tree structure and harvesting time on the efficiency of such machines and thus to optimize the conditions for their use. Considering that in the future, as a result of the development of the olive sector, the use of trunk shakers will probably increase in Syria, it is very important, in new plantations, to train young trees to give them a structure that is suitable for the use of such machines. Particular attention should be paid to obtaining a single free trunk 100-120 cm high. Trees with more than one trunk and trunks too short are difficult to correct.

Conclusion

In conclusion, taking into account the modalities with which olive harvesting is currently carried out in Syria, the results of the demonstration trials that have been carried out to mechanize such practice and the predicted future development of the olive sector and of the general economical situation in Syria, some suggestions can be given in order to improve the impact of olive harvesting on the quality of the product and the economical revenue of olive cultivation.

(i). Harvesting has to be performed at the right stage of ripening in order to obtain an optimal oil quantity and quality. In particular, it has to be remembered that overly ripened olives are very soft and so are easily damaged with a consequential negative influence on oil quality. Moreover, they give an oil with lower fruit aroma/taste and antioxidant content. Indications to establish the optimal harvesting time for the main Syrian olive cultivars are given in the book “Characterization of the main Syrian olive cultivars”, produced by the Italian cooperation project “Technical Assistance for the Improvement of Olive Oil Quality in Syria”, in which a characterization of the main Syrian olive cultivars is reported.

(ii). Greater use of manual combs to detach the olives and of nets of suitable size spread under the trees to collect the harvested olives should be promoted in order to improve the harvesting productivity of the workers (+10-20%) and the working conditions in terms of fatigue.

(iii). Olives harvested from the ground, which usually give oil with defects, must be kept and milled separately from those harvested from the trees which can give virgin or extra virgin oils.

(iv) The use of aerated plastic boxes instead of bags (made of hemp or plastic fibres) to transport and store olives before processing should be greatly encouraged, along with reduction in the length of storage, which should not exceed 48 hours, and the use of aerated and cool rooms to store the olives.

(v) The introduction of hand-held machines for olive harvesting should be promoted in order to reduce the manpower requirement that is not always easily available and also to be able to concentrate harvesting in the best period to obtain high oil quantity and quality. In this regard, it has to be considered that in Syria there is a large number of olive orchards with trees potentially suitable in terms of structure and height for the use of hand-held machines for olive harvesting. However, to use such machines and to obtain the best results, the trees need to be pruned to meet the requirements of these machines (avoid excessive vegetative density, favour lateral development of the canopy and limit tree height, but also maintain good canopy volume in order to not reduce the production per tree).

(vi). It is strategically important to train trees in new plantations by giving them a structure that is suitable for the use of trunk shakers considering that in the future, as a result of the development of the olive sector, the use of such machines will probably increase in Syria. In this regard, particular attention has to be paid to obtaining a single free trunk 100-120 cm high. Trials to evaluate the effectiveness of trunk shakers to harvest olives in Syria should be promoted.

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