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# Impact of pre-harvest irrigation on fruit yield and oil contents of olive (*Olea europaea* L.) cv. Coratina

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**Key words:** Coratina, Fruit yield, Irrigation, Oil contents, Pickling, Olive.

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## Abstract

Field experiment was carried out in olive (*Olea europaea* L.) orchard at two places "Barani Agriculture Research Institute, Chakwal" and "Izhar Olive Farm, Kallar Kahar" located in Punjab, Pakistan on cultivar ''Coratina" to analyze the impact of pre-harvest irrigation on fruit weight, fruit moisture contents and oil contents. 9-10 years old fruiting trees of uniform plant canopy and similar fruit load were selected for research purpose. Other than control treatment ($T_0$), two different irrigation treatments ($T_1$; 100 liters of water/ plant and $T_2$; 200 liters of water/ plant) were applied in three splits at six days interval to till eighteen days before fruit harvesting. Different yield parameters i.e. fruit weight, fruit moisture contents and oil contents were measured after irrigation application. It was determined that irrigated plants with 200 liters of water had more fruit yield in term of more individual fruit weight. Furthermore, it was also found that irrigation had little effect on fruit size. However, oil contents generally decreased with increase in volume of irrigation water. Water contents (fruit moisture) were found more in plants irrigated with 200 liters of water followed by 100 liters of water. Fruit weight was more in irrigated olive plants with 200 liters of water followed by 100 liters of water. Hence, results would be amazing if irrigation is applied sharply before harvesting that facilitates more return to olive growers if they sale fruit of olive for pickling or other fresh fruit consumption purposes.

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**Introduction**

Olive is thought to be the most extensively grown fruit crop in Mediterranean climatic conditions. Although, olive is one of the drought tolerant fruit tree but for commercial production it needs to be irrigated (Sofo *et al.*, 2007). Misfortunately, water scarcity has been found in arid and semi-arid regions for irrigated commercial olive production. Hence, wise utilization of existing water is a key for long term commercial olive growth and production. Furthermore, currently irrigated olive cultivation is expanding with the passage of time in spite of being known that water scarcity decreases size and yield of olive fruit (Costagli *et al.*, 2003; Grattan *et al.*, 2006). It has been reported that two top olive producing countries i.e. Italy and Spain in the world has 28% and 26 % irrigated olive orchards (E.U., 2012). While application of irrigation water in reduced volume showed narrow effect on production of olive (Grattan *et al.*, 2006; Lavee *et al.*, 2007). However, olive plants can be cultivated in annual low rainfall areas and give profitable crop but irrigation application is necessary for achieving high yield in olive trees. Moreover, it has been reported that irrigation application is a factor which enhances number of fruits, fruit weight and fruit size of olive trees, hence ultimately increasing profit for growers (Ingles *et al.*, 1996; Lavee *et al.*, 2007).

Research report on physiological mechanism of olive has proved that olive is drought tolerant and can be cultivated in unfavorable environmental conditions (Chartzoulakis *et al.*, 1999; Connor and Fereres, 2005). Misfortunately, influence of irrigation water volume on olive oil contents and compositional factors has been studied rarely. However, few studies have been conducted recently on this subject but findings of these studies, most of the time, are not uniform and acceptable. It has been found that oil contents are mostly affected with the irrigation water volume and time of application (Salas *et al.*, 1997; Gómez-Rico *et al.*, 2006).

Irrigation volume and time of application has its effect on oil contents and fruit yield (in term of individual fruit weight) of olive (Gucci *et al.*, 2007). However, convenience of irrigation for quality oil production is ambiguous as most of the trials have resulted that irrigation status of olive orchard have a very little effect on peroxide value, free acidity and ultraviolet light absorbing parameters (Tognetti *et al.*, 2007). In research trials, Ben-Gal *et al.*, (2011) found that free acidity in olive oil was more in irrigated olive oil as compared to the non-irrigated olive trees. Hence, data analyzed showed that free acidity values were high in irrigated olive trees up to 0.8% in extra virgin oil (Dag *et al.*, 2008). However, trials conducted by Inglese *et al.*, (1996) in Italy and Spain showed that there was no effect of soil moisture on fatty acids of extra virgin oil. Furthermore, oleic acid contents were found higher in trees irrigated with low water volume (341 L/ tree) as compared to those who were irrigated with more water volume in Arbequina cultivar (Berenguer *et al.*, 2006).

Other than this, varietal impact was noted in cv. Souri which exhibited enhancement of fruit size and oil contents with the increase in irrigation levels in both off and on year but cv. Barnea exposed this impact only in off year (Ben-Gal *et al.*, 2011). It was reported interestingly by Motilva *et al.*, (2000) that irrigation is the factor in olive which affects the phenolic contents at maximum level (phenolic contents mitigates with increase in irrigation volume) in extra virgin olive oil. These results were also supported by another research managed by Servili *et al.*, (2007) which denoted that more irrigation caused decrease in hydrophilic phenols and diphenols in cv. Leccino. Moreover, these results also assembled with the results of Romero *et al.*, (2002) who found that oil from irrigated trees of Arbequina cultivar expressed low phenolic contents in comparison with deficit irrigated trees.

However, generally moisture contents have been observed higher in fruits of irrigated olive trees (Gomez-Rico *et al.*, 2006). Effect of irrigation is cultivar dependent as well when different moisture contents were exposed in oils of Arbequina, Koroneiki and Coratina cultivars at same irrigation level

(Dabbou *et al*., 2011b). Hence, main objective of recent study was to observe the changes and impacts in quantity of olive fruit and oil contents induced with the irrigation application at different levels in "Pothohar region" in Pakistan as previously no research has been conducted on this issue which would prove remarkable for farmers in term of increase in their output and ultimately profit.

**Materials and methods**

*Plant materials and environmental conditions*

For recent trials, olive plants (*Olea europaea* L.) cv. "Coratina" was planted in field in 2009-10 at "Barani Agriculture Research Institute, Chakwal" and "Izhar Olive Farm" Pakistan in Northern Punjab. Soil utilized for this purpose was sandy loam soil. Olive trees were planted at population density of 193 plants per acre (P*P= 15 ft & R*R= 15 ft). However, these olive trees were used for experimental trial in 2019. For experimental layout, two olive trees against each treatment were chosen in three alternate rows at each location. Olive trees selected were similar in size, canopy and equal yield load. After that fruits from three alternate rows were picked manually eighteen days after irrigation application and collected in individual baskets for further analysis and data observation. The collected fruit was sent to Barani Agricultural Research Institute, Chakwal for oil extraction purpose (Turkish Olive Oil Extraction Unit "*Pieralisi Machine Olearrie*"). Moreover, data of different yield and oil contents parameters was noted by using respective methods and instruments.

*Irrigation treatments and experimental design*

The irrigation was applied in three splits at six days intervals through buckets in measured quantity of water eighteen days before fruit harvesting. Control treatment ($T_0$) contained without irrigation of water application while treatment ($T_1$) contained 100 liters of water applied to each tree and treatment ($T_2$) consisted of 200 liters of water for each olive plant. All treatments contained three replications while each replication contained six olive plants. Experiment was laid out in randomized complete block design in field. In addition, all the care (weeding, pruning, fertilization and other cultural practices) were followed in same way for all the treatments. Furthermore, environmental conditions were same for all plants in whole growing season and during research trials. However, climatic conditions of the area are arid to semi-arid with annual rainfall of 770 mm, minimum average temperature during January (1.7°C) and maximum average summer temperature was (36-38°C). The dry period was from May to June while from July to September area got monsoon season with annual rainfall of 408 mm. The detail of metrological data was measured with the help of weather station installed at Soil and Water Conservation Research Institute, Chakwal. The detailed graph of metrological data is as follows (Fig. 1).

*Fruit weight (g)*

Fruit weight was measured in term of fruit grams against three different irrigation treatments. In order to analyze the impact of pre-harvest irrigation, fifty fruits were chosen randomly from the fruit harvested for oil extraction purpose from each replication of all treatments (150 fruits in one treatment). Then average fresh fruit weight was calculated with the help of digital weight balance.

*Fruit moisture contents (%)*

To find out the impact of irrigation treatment on ripened fruit water content just eighteen days before fruit harvesting, five hundred gram of purple fruits were crushed by using hammer mill method. Sample was mixed completely and then 30 g of semi-solid paste were shifted to petri dish. Petri dish was placed in fan forced oven at 80 $C^0$ for 24 hours. Then sample was uninvolved from the fan forced oven and kept in dry desiccator and cooled down to ambient room temperature. After cooling to room temperature, dry weight of the sample was calculated and fruit water contents were calculated in term of percentage of fruit weight.

*Oil contents (%)*

For oil extraction purpose fruit was sent to BARI (Barani Agriculture Research Institute) on very next

day after harvesting in Pieralisi olive oil extraction machine imported from Italy. This oil extracting machine follows the principal of solvent extraction. Fruit of each treatment was used for extraction separately. Total of 150 Kg of fruit of each treatment was collected and sent for oil extraction. Fruits were first washed and cleaned in washer drum. Then fruit was conveyed to crushing drum of the extraction unit. For two hours it remained in crushing drum.

After that the crushed material was forwarded to centrifugal machine which rotates at the rate of 6000 rpm. This unit is used to extract almost all oil contents from olive fruit. So, it's the best method to make comparison of different cultivars oil contents. The oil quantity was measured with the help of scaled beaker after extraction. However, oil contents were calculated in term of percentage of weight of olive fruit.

**Results and discussion**

*Fruit weight (g)*

Results declared that olive fruit weight was found highest (2.19 g) in treatment $T_2$ at location-1 followed by fruit weight (2.17 g) of same treatment $T_2$ at location-2. However, minimum fruit weight (2.08 g) was expressed by treatment $T_0$ at location-1 proceeded by fruit weight (2.04 g) of treatment $T_0$ at location-2. Hence, fruit weight fluctuated between 2.19 g and 2.04 g as a result of irrigation water application in different doses (Fig. 2). Furthermore, results of $T_2$ at both locations and result of $T_1$ at location-1 were found statistically similar while results of other treatment at both locations were not statistically similar. These results are similar with the study of Moriana *et al.*, (2007) who found that fruit weight decreased radically in response to water deficiency and fruit load.

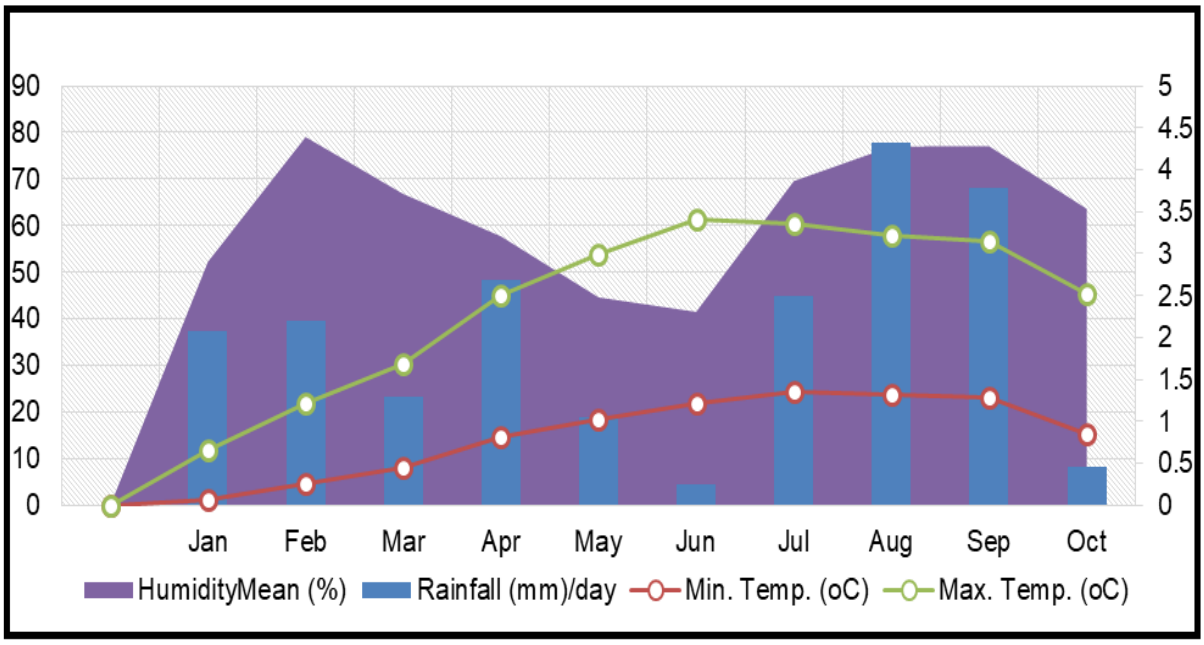


**Fig. 1.** Metrological data of year 2019 in Chakwal Region, recorded with weather station installed at Soil and Water Conservation Research Institute, Chakwal.

*Fruit moisture contents (%)*

While discussing about the fruit moisture contents, it was found that treatment $T_0$ showed minimum moisture contents (46.93 %) in fruit at location-1 followed by moisture contents (49.93 %) in treatment $T_0$ at location-2. While maximum moisture contents (56.63 %) were observed in treatment $T_2$ at location-2 followed by moisture contents (55.70 %) in same treatment at location-1 (Fig. 3). Hence, statistical data expressed that results of all treatments are not statistically similar.

Moisture content is an important aspect at harvesting stage as it has a strong impact on extraction efficiency during processing. It also has several effects on fruit and oil quality.

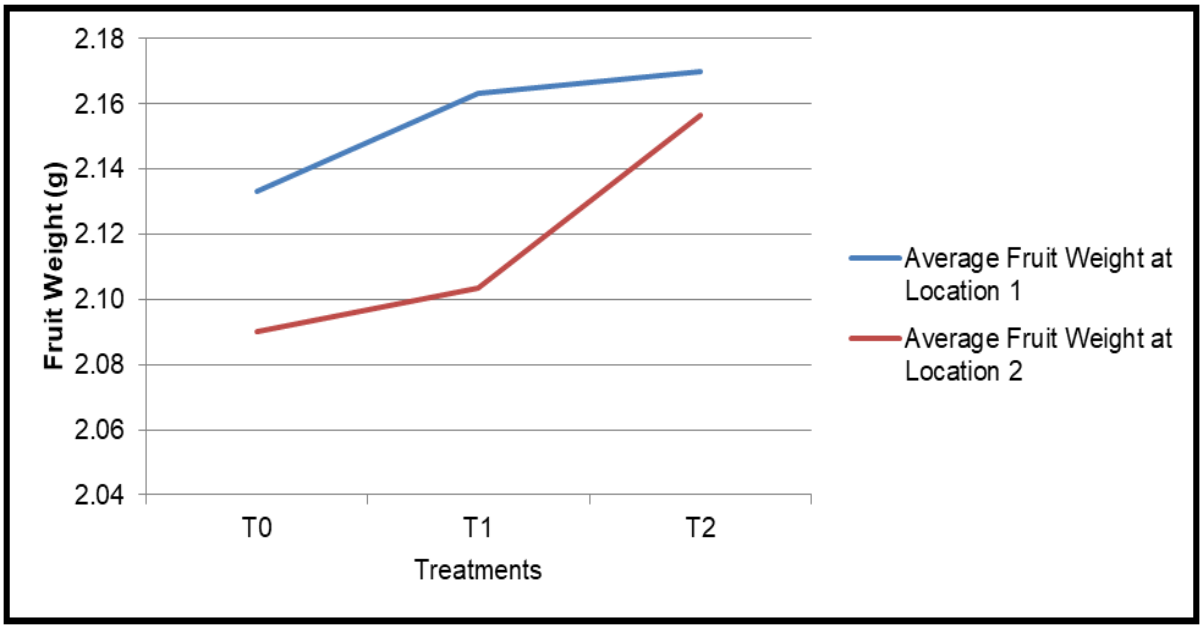


**Fig. 2.** Effect of different pre-harvest irrigation treatment with respect to both locations on individual olive fruit weight of cv. Coratina.

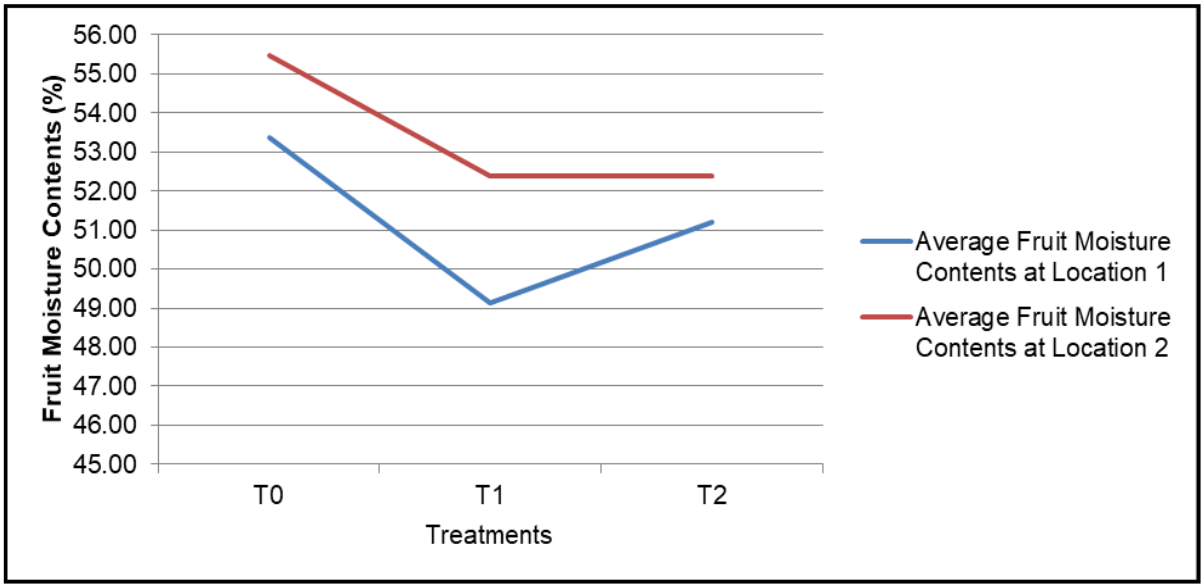


**Fig. 3.** Effect of different pre-harvest irrigation treatment with respect to both locations on olive fruit moisture contents of cv. Coratina.

All the varieties showed a decreasing trend in moisture content during the maturation period although the rate of decrease in moisture content differed between the varieties. These results are resembled with the study of Mailer and Ayton (2009).

*Oil contents (%)*

Results drawn from the data showed that irrigation application decreases the oil contents in both cultivars as maximum oil contents (14.13 %) were observed in treatment ($T_0$) with no pre-harvest irrigation at location-1 followed by same treatment (13.1 %) at location-2. While oil contents decreased to 10.73 % in treatment T2 at location-2 followed by same treatment (11.26 %) at location-1. Moreover, it was expressed from the results that oil contents fluctuated from 14.13 % to 10.73 % with pre-harvest irrigation application (Fig.4). It was interesting to find that results of treatment $T_0$ at location-2 and results of $T_1$ at both locations were statistically

similar. Treatment $T_2$ also showed statistically similar results at both locations. The results of previous studies of individual cultivars showed that oil content was generally either slightly affected (Gomez-Rico *et al.,* 2007; Lavee *et al.,* 2007) or not affected (Motilva *et al.*, 2000; Patumi *et al.*, 2002) by irrigation. The results of Toplu and Yildiz, (2009) showed that significantly lower fruit size, lower fruit weight, higher maturity index and higher oil content effect of irrigation and harvest time on olive quality. The study of Tognetti *et al.* (2006) showed that two varieties of olive ('Frantoio' and 'Leccino') irrigated at 66% ETc throughout the season had similar oil yield to those irrigated at 100% ETc.

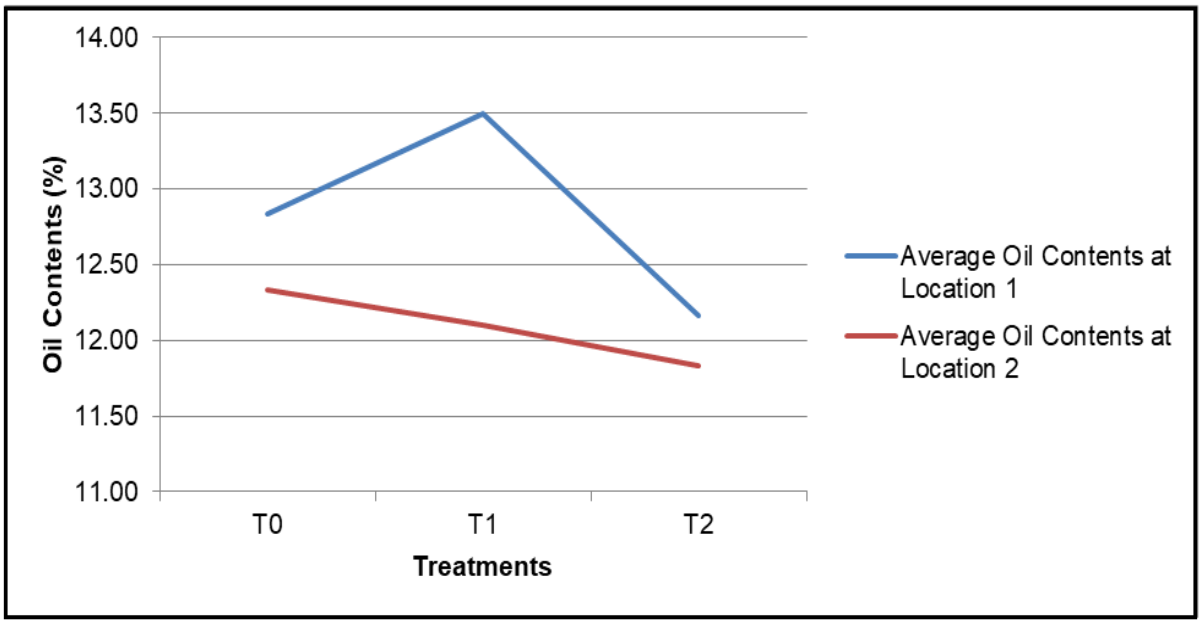


**Fig. 4.** Effect of different pre-harvest irrigation treatment with respect to both locations on olive oil contents of cv. Coratina.

## Conclusion

It was concluded that irrigated plants with 200 liters of water had more fruit yield in term of more individual fruit weight. Furthermore, it was also found that irrigation had little effect on fruit weight. However, oil contents generally decreased with increase in volume of irrigation water. Moisture contents were found more in plants irrigated with 200 liters of water followed by 100 liters of water. Fruit weight was more in irrigated olive plants with 200 liters of water followed by 100 liters of water. Hence, results would be amazing if irrigation is applied sharply before harvesting that facilitates more return to olive growers if they sale fruit of olive for pickling or other fresh fruit consumption purposes.

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