Research Article

Evaluation of Some Promising Varieties of Olive (*Olea europaea* L.) for Growth and Yield under Pothwar Regions of Punjab, Pakistan

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Abstract | The consumption and production of olive is attaining great importance day by day in Pakistan. The table olive varieties with large sized fruit have great attraction for olive growers and consumers. The last three-years (2017-2019) study was conducted with the objective to evaluate varietal performance of table olives i.e. Ascolana, BARI Zaitoon-1, Earlik, Gemlik, Hamdi, Hojiblanca, Manzanilla and Picual at Barani Agricultural Research Institute (BARI), Chakwal. Eight olives varieties were evaluated for their growth and yield under Pothwar region of Punjab, Pakistan. The trial was conducted with experimental design following randomized complete blocks design (RCBD) with three replications. The results exhibited morphological trait differences among the olive varieties. Maximum fruit yield (22.66 Kg), fruit weight (6.29 g) and oil recovery percentage (24.66%) were recorded in Ascolana, Earlik, Gemlik, and Hamdi varieties. Based on growth and yield performance four varieties namely, Ascolana, Earlik, Gemlik, and Hamdi were found most suitable and potential varieties for mass scale cultivation in Pothwar region. The proposed varieties can be grown for commercial processing and product development.

Introduction

Olive is getting popularity among all spheres of society due to its medicinal and dietary value. Previously, Olive was considered as a crop of the Mediterranean countries. The Mediterranean region is the main olive producing area including Syria, Turkey and Israel (Trujillo *et al.*, 2014). Presently many other regions of the world are adapting olive cultivation in their cropping system due to its economic value, comparatively easy production technology and wider adaptability. During last couple of decades, consumption and cultivation of olive also started in many countries other than Mediterranean

basin like Australia, India, China, Pakistan and the American southern part (Awan *et al.*, 2011). Olive plant have an adaptive mechanism to grow well and produce fruit under rain fed conditions (Ahmed *et al.*, 2009; Giuffre, 2017; Lorite *et al.*, 2018).

According to International Olive Council (IOC), global virgin olive oil was 3207,000 tons in which maximum oil was produced by Spain (1125, 300 tons), Italy (366,000 tons), Tunisia (350, 000 tons), Greece (275, 000 tons), Turkey (225, 000 tons), Morocco (145, 000 tons) and Portugal (140,500 tons). The total Olive Oil production of the IOC member countries in 2020/21 was 2,999,500 tons comprising

of 93.8% of the world total production, a decrease of 0.3% compared to the last year. Olive fruit production for 2019-20 amounted to 3,057,500 tons, an increase of 5.5% compared to the last year. Among the IOC member countries, Spain stands out for its weight in world production (15%), despite a 22.5% drop. Egypt's production has increased by 25% compared to the 2018-19 campaign, contributing 24.5% of the world total. According to estimates for the 2020-21 campaign, production could increase by 2.5% compared to 2019-20, reaching 3,134,000 tons, and consumption would increase by 0.4% (Anonymous, 2020-21).

Awareness of olive cultivation among farming community of Pakistan shows economical survival of olive in Pakistan. The increasing demand of Olive oil and its value-added products like Olive pickles, jam, squash, murabah, candies and other sweet products encouraging farmers to produce more and more fruit. Total plantation in Pakistan is now 29,48,780 by Pakistan Agricultural Research Council (PARC) source (Khaliq et al., 2020). Olive is being cultivated in Pothwar region of Punjab, Pakistan but Chakwal district's contribution is highest. In Chakwal 3285 acre area is under olive cultivation. Overall Area under olives in Pothwar is 8615 acres there is an increasing trend in the area of olive groves in Pakistan. In BARI, according to the development programs i.e. Developing Pothwar into Olive Valley and Public Sector Development Program (PSDP) projects olive plantation in Punjab Pakistan was 1,77,4019 and 75,250 respectively. Olive can play its essential role in our country's economy. It is evaluated that Pakistan's aggregate household edible oil use is around 2.9 million tons. Approximately, 67% of this consumption is met through import (Azmat et al., 2020).

It is crucial to known olive varietal performance under sub mountainous agro climatic conditions for successful olive cultivation and development of economical olive industry in the area. Vegetative and reproductive growth characters in olive tree strongly respond to light availability, canopy differences, and architecture of different cultivars (Schneider *et al.*, 2012; Cherbiy-Hoffmann *et al.*, 2013; Rousseaux *et al.* 2020). Olive varieties to compare the leaf area distribution, canopy architecture, leaf anatomical characteristics and production efficiency of Arbequina, Coratina and Frantoio are currently considered as best varieties for olive production under Mediterranean climate (Tous, 2010; Neri *et al.*, 2020).

Olive varieties like Nevadillo, Manzanilla and Lechín, showed a less percentage changes in adequate area, as for Verdial and Picual. Different researchers suggested that the difference in stem girth of olive varieties might be due to inhabitant suitability occur both inside and outside the species´ distribution range (Rosati *et al.*, 2017). In areas of Tunisia, Methamem *et al.* (2015) reported highest oil contents in Picholine and Fougi as compared to Dahbia and Lucques. In case of Pakistan climatic conditions, Gemlik variety is one of the dominant varieties regarding oil recovery %. Among few olive varieties like Dolce agogia, Moraiolo, Coratina, Leccino, Uslu and Gemlik. Arbequina and Frantoio contained the significant amount of olive oil (Khaliq et al., 2020).

Olive cultivation history of the Punjab province is not very long. Throughout the last one-decade, olive gained much popularity as a result of its great socio-economic importance. During the past ten years, Olive was cultivated on area of more than 4494.36 hectares in the Pothwar region (Anonymous, 2020; Anonymous, 2018). Pakistani agro-climatic conditions are not exactly like the Mediterranean countries. Various olive varieties are being cultivated in Pothwar region and the provinces of Baluchistan and Khyber Pakhtunkhwa (Awan *et al.*, 2014; Pulido-Fernández *et al.*, 2019).

Olive varieties do not perform uniformly in all climatic conditions in olive producing countries. Every climatic zone has to select suitable varieties of olive for adaptability and profitability through local research system. A lot of research was done at BARI Chakwal for performance evaluation of different table varieties of olive to ensure the maximum profitability from olive cultivation. Eight varieties having promising results were compared to find the most suitable variety for economical production in particular conditions of olive growers. The present study was conducted to select the most suitable olive varieties for cultivation in sub mountainous area of the Punjab Province. Olive variety having maximum fruit yield and good oil recovery along with uniform, thin distribution of leaves and balanced tree canopy is required for cultivation in extreme cold and hot temperatures during summer and winter season. The main objective of the this study was to compare and evaluate the performance of some promising olive

varieties for growth and production potential under local agro climatic conditions for general cultivation in sub mountainous area of the Punjab.

Materials and Methods

The current experiment was conducted at the research area of Barani Agricultural Research Institute (BARI), Chakwal, Pakistan. BARI is located on 72° longitude, 32° latitude and 575m altitude. The Climate of BARI Chakwal area is arid to semi-arid, having annual rainfall of 772 mm annually. The area having lowest temperature during January is -4.00°C and maximum 36.00 – 38.00 °C during summer. Maximum rainfall (408 mm) is received during the months of July to September.

Experimental plants of olive varieties i.e. Ascolana, BARI Zaitoon-1, Earlik, Gemlik, Hamdi, Hojiblanca, Manzanilla and Picual selected with uniform canopy having age of 9 to 10 years. Soil texture was sandy loam which was measured by hydrometer method, organic matter (OM) 0.89 % which was calculated through wet oxidation method, EC= 1.5 d Sm^{-1}, which was calculated by using EC meter (DDS-307A), pH of 8.1 which was calculated by using pH meter (Mettler Toledo Delta 320), CaCO$_3$= 4.23% calculated through titration method. Planting geometry of 6.00×6.00 meter was established for experimental layout. The cultural practices like weeding, hoeing, fertilization and irrigation were kept same to get maximum precision and accuracy. The aforementioned olive varieties were selected for their better performance regarding vegetative growth and production behavior in local agro climatic conditions. Plant height was measured with the help of measuring tape from ground level to apex of the plant (cm). Stem girth was measured by calculating average annual growth rate of the stem girth (cm) and inter nodal distance was measured with meter rod (cm). Average fruit weight (g) was calculated from fifty fruits randomly selected from all canopy of the tree from all directions. Fruit sample was randomly selected regarding fruit size and maturity stage. Fruit yield (kg) was calculated by weighing the whole harvested fruit from each experimental unit (24 plants). Oil recovery (%) was calculated after 1st press of fruit harvested from each experimental unit. Olive oil was extracted by commercial extraction unit having centrifugal technology with fruit crushing capacity of 600 Kg/hour (Model Pieralisi, Italy).

Statistical analysis
The mean data regarding vegetative, productive and oil recovery were analyzed statistically. Least significance difference (LSD) calculated at the *P*< 0.05 (Steel *et al.*, 1997).

Results and Discussion

Morphological characteristics of olive
Plant height: Plant height is not a permanent trait that should be same among the all varieties, but it varies according to genetic makeup, climatic conditions and cultural practices. Olive cultivars were evaluated for plant height. Maximum plant height (258.30 cm) was recorded in Earlik variety while minimum plant height (192.50 cm) was observed in Manzanilla olive variety (Figure 1).
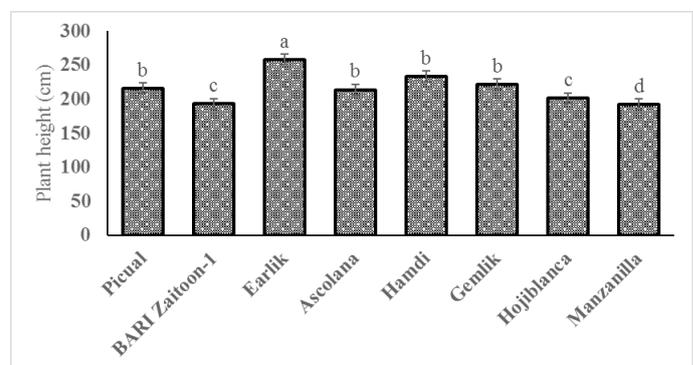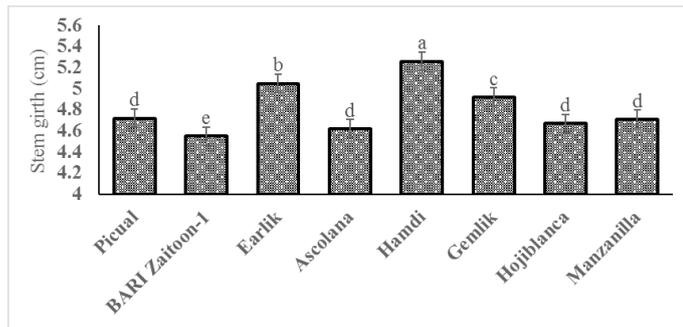

Figure 1: *Plant height of different olive varieties under Pothwar climatic conditions.*

Numerous distinguishing techniques used in olive trees to evaluate its diversity. There are various techniques for evaluation of olive tree diversity. Among those, morphological characteristics are most important. There are different quantitative and qualitative characteristics that can be studied through physical observations like plant height. Plant height actually determine the growth and development of a tree according to its existing climate (Kareem *et al.*, 2018; Sharief *et al.*, 2019; Nafees *et al.*, 2020). A variation in plant height among the olive varieties actually results due to the effect of environmental conditions and genetic makeup of the variety which perform differently in specific climatic conditions (Hammami *et al.*, 2011). The current results are also in line with the findings of Mnasri *et al.* (2017) and Bartoli *et al.* (2020) who reported that plant height is an important tool for evaluating the olive varieties.

Stem girth: Maximum plant girth (5.26 cm) of olive tree was recorded in Hamdi variety while minimum

girth (4.55 cm) of olive tree was observed in BARI Zaitoon-1 olive variety (Figure 2).

Figure 2: *Stem girth of different olive varieties under Pothwar climatic conditions.*

Genetic varietal make up and environmental conditions results into growth rate of stem girth which ultimately strengthen the plant existence (Naqvi *et al.*, 2015; Akram *et al.*, 2019). Olive trees having better stem girth are stronger and more resistant against wind storms and helpful in better management of tree canopy. These results are in conformity with the results obtained by some other researchers (Moriondo *et al.*, 2013; Viola *et al.*, 2013; Olesen and Wirthensohn, 2020; Ponti *et al.*, 2014; Fraga *et al.*, 2019; Arenas-Castro *et al.*, 2020).

Internodal distance: Inter nodal distance of olive varieties determines the canopy shape and porosity of the branches favoring for light and air permeability. Maximum intermodal distance (5.26 cm) of olive tree was recorded in Earlik variety while minimum intermodal distance (4.55 cm) of olive tree was observed in Hamdi olive variety (Figure 3).
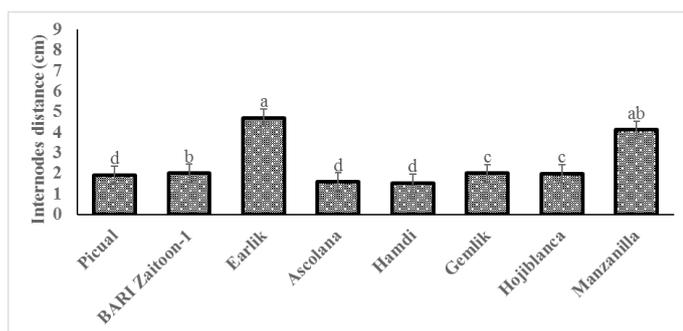

Figure 3: *Internodal distance of different olive varieties under Pothwar climatic conditions.*

Olive branches internodal distance variation actually resulted due to its higher number of primary branches, conical canopy and a reproductive ability equivalent to cuttings. Some other researchers also reported the same findings in case of internodal distance (Neri *et al.*, 2020). Internodal distance variation was also in

consistent to other investigators (Hannachi *et al.*, 2008; Poljuha *et al.*, 2008). These findings were like those of Fayek *et al.* (2014) who reported similar results while comparing Egyptian olive clones with the international genotypes.

Fruit weight: Fruit weight is the main trait that should be consider for yield estimate of Olive tree. In the current study, Olive varieties like Ascolana, Earlik and Gemlik having a fruit with more pulp which ultimately impact the fruit size. Maximum fruit weight (4.12 g) of olive tree was recorded in Earlik variety while minimum fruit weight (1.52 g) of olive tree was observed in Manzanilla olive variety (Figure 4).
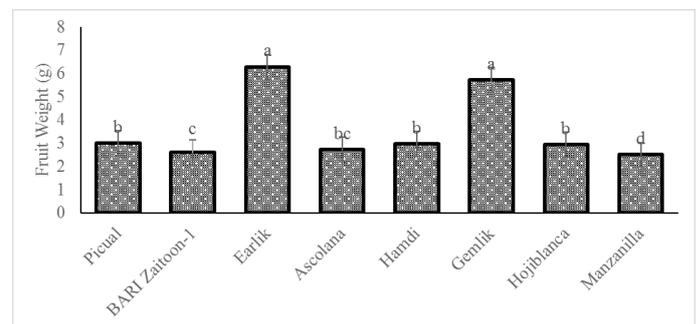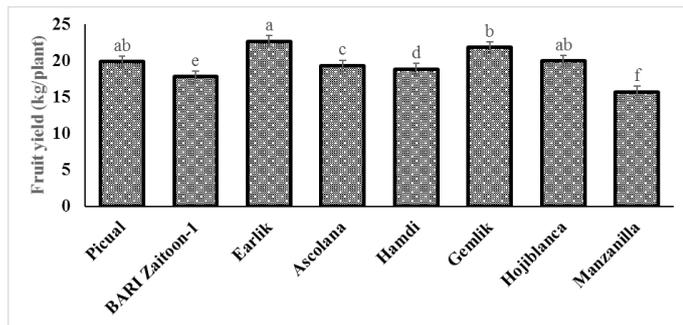

Figure 4: *Fruit weight of different olive varieties under Pothwar climatic conditions.*

Average fruit weight of a variety indicates the productivity potential of the specific variety. Fruit weight of a variety reflects its yield and multiple use of fruit for developments of olive products. Similar results in case of fruit weight also reported by other researchers (Shahzad *et al.*, 2013; Mahmood *et al.*, 2014; Marino *et al.*, 2019; Rosati *et al.*, 2018; Proietti et al., 2015).

Fruit yield: Fruit yield per plant indicates economic potential of the variety along with its adaptability with olive growers. Maximum fruit yield (22.66 Kg plant^{-1}) of olive tree was recorded in Earlik while minimum fruit yield (15.71 Kg plant^{-1}) of olive tree was observed in Manzanilla olive variety (Figure 5).

Olive varieties have a varietal variation keeping in view oil and fruit production some have dual purpose. In the current experiment mostly table varieties were studies. Earlik was the prominent one as compared to other varieties. In the previous studies of Pothwar region of Pakistan, "Nocellara" was the only genotype which was used for table purpose while another genotype "Sorani" was used for both table and oil

(dual) purpose (Qureshi *et al.*, 2020). The table varieties have a bold fruit size as compared to oil varieties which ultimately increased the fruit yield Trentacoste and Puertas (2011).

Figure 5: *Fruit yield of different olive varieties under Pothwar climatic conditions.*

Oil recovery (%): Oil recovery from an olive variety is main tool for its acceptability among olive growers and processors. Maximum oil recovery (24.66 %) from olive fruit was recorded in Earlik variety while minimum oil recovery (14.36 %) was observed in BARI-Zaitoon-1 (Figure 6). In a previous study, it was found that every cultivar have a variation in oil contents which is actually due to its genetic trait besides of this some management factors like soil, temperature and climate have a significant impact but the temperature is the dominant factor which effect the oil contents (Oteros *et al.*, 2014). Oil contents variation of fruit also correlate with fruit size that affected from exogenous and endogenous factor (Hammami *et al.*, 2011).
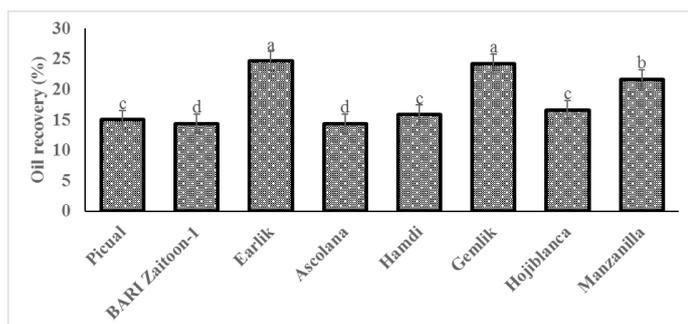
Figure 6: *Oil recovery (%) of different olive varieties under Pothwar climatic conditions.*

Highest fruit weight, pit weight and concentration of fatty acid directly correlate with oil recovery percentage. (Mehri and Mehri, 2007; Hannachi and Marzouk, 2012). Qureshi *et al.* (2020) also observed similar observation in their study of olive adaptation in Pothwar climate of Pakistan, they reported maximum oil recovery from olive verity "Mariania".

Conclusions and Recommendations

Olive varieties respond differently regarding the growth and yield parameters. All the varieties showed a different response according to Pothwar climate. The table varieties like Ascolana, Earlik, Gemlik and Hamdi performed well under the climatic condition of Pothwar area. The findings of present study led us to conclude that various olive varieties performed differently for growth, yield and quality parameters under sub-mountainous climate condition. The olive varieties like Ascolana, Earlik, Gemlik, and 'Hamdi' found as most suitable varieties of olive with potential growth and high yield potential. The proposed selected olive varieties can be recommended for commercial cultivation in Pothwar region and the adjoining areas of Punjab for better yield and oil recovery.

Acknowledgments

Novelty Statement

The current experiment is the first one which highlighted the adaptation of Olive varieties in the Pothwar climate because being a tree it require huge time for its adaptation especially to study its yield and growth parameters. BARI Chakwal is the one designated institute who working in the Olive sector in Pakistan.

Author's Contribution

Muhammad Ashraf Sumrah conducted this experiment and data were collected and analyzed by Muhamad Jan and Azhar Hussain who designed this experiment. The first draft of the article was prepared by Muhammad Ashraf Sumrah and Muhammad Jan. Final draft was also prepared by Shoaib Akhtar and Humara Umar after a proof reading of Hussain Nawaz and Muhammad Afzal.

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