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ECONOMICAL OLIVE CULTIVATION BY SELECTION OF SUITABLE VARIETY IN POTHWAR REGION OF PAKISTAN

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ABSTRACT

Olive (*Olea europaea*) is very popular for producing premium quality edible oil, though it is the main crop of the Mediterranean region, playing a pivotal role in the economies of those countries. Its cultivation is increasing in other countries, including Pakistan, due to its wide adoptability and easy propagation technology. The very wide genetic variability of the plant is a reason for its popularity. Olive varieties behave differently in different climatic zones of the world. Pakistan has adopted various varieties for their cultivation in different olive production pockets. These studies were conducted in the Centre of Excellence for Olive Research & Training (CEFORT), Chakwal, to prioritize suitable olive varieties for Pakistan's economical olive oil business. The highest yield (2652 Kg/acre), Net Profit/acre (Rs. 271386), Oil Recovery/acre (331.7652Ltr.), and Oil income (331765.2) was observed in BARI Zaitoon-I while Average Oil Recovery (13.48%), Total Expenditure /Acre (61335.01) was observed in Arbiquina olive variety. BARI Zaitoon-1, BARI Zaitoon-2, Arbequina, and Koroneiki proved most suitable for cultivation in sub-mountainous areas of Pakistan. These varieties are recommended for olive cultivation in the Pothwar region due to their growth behavior, olive oil content, and good economic return. The difference in the fruit ripening period among these varieties results in the prolonged supply of raw material to the olive oil extraction industry.

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INTRODUCTION

Olive (*Olea europaea*) is the main crop of the world's Mediterranean region for producing premium quality edible oil with omega-3 and other essential phenols necessary for better human health (Allaq et al., 2022). This tree is being grown in different regions of the world to increase edible oil production. It plays a vital role in the economy of Turkey, Spain, Purtagal, Israeal, and other Mediterranean countries (Ballus et al., 2014). It is becoming popular out of the Mediterranean region due to its wide adoptability and availability of different varieties, which can be grown in various types of climatic conditions of those areas (Piroddi et al., 2017).

The economy of olive oil and products is also dependent on climate, variety of genetic variability, extraction method, and duration of fruit harvesting. All these factors ultimately affect the benefit-cost ratio (Schifani et al., 2018; Berbel and Posadillo, 2018). Different from previous studies, which examined literature systematically to outline a general framework for the agri-food sector, the present study adopts a scoping review approach to provide specific insights on how the olive economy can be operationalized into a particular agri-food system, i.e., the olive oil supply chain (Nikkhah et al., 2021; Moreno-Maroto et al., 2019; Zabaniotou et al., 2015).

Comprehensive research activities were envisaged in Pakistan for the cultivation of olives to increase edible oil production. Centre of Excellence for Olive Research & Training (CEFORT), Chakwal established an olive germplasm unit comprising 86 varieties of olive to check the adoptability and performance of different olive varieties in the Potowar region (Sumrah et al., 2021). A comprehensive research program was designed to study different production aspects of olives, and complete data was compiled and analyzed for performance evaluation of different olive varieties. Many olive varieties were compared for their performance and adoptability potential based on production data and final economic return (Akhtar et al., 2021). Oil varieties, dual purpose, and table varieties of olive were selected and registered for establishing the olive production industry in Pakistan. Selected olive varieties were registered with Federal Seed Certification and Registration (FSC&RD).

Olive varieties BARI Zaitoon-1, BARI Zaitoon-2, Picual, Arbequina, Chemlali, Ottobratica, Koroneiki, and Pendolino, were recommended oil varieties for cultivation in Potowar Region. Prioritization of these varieties was made based on performance data to produce economical olive oil and better

income for the olive growers. This research effort was necessary for olive growers to select a suitable olive variety for cultivation on their farms according to their technical skills and available resources.

METHODOLOGY

Olive trees of age 9-11 years were selected as research material. Four plants of each variety were selected as the experimental unit for recording data regarding production and yield. Standard cultural practices recommended for olive cultivation in Potowar region were adopted to maintain the experimental units. Performance data of selected varieties for three years from 2019-2021 was recorded to achieve the target of studies. Following performance data of selected varieties (BARI Zaitoon-1, BARI Zaitoon-2, Picual, Arbequina, Chemlali, Ottobratica, Koroneiki, and Pendolino) was recorded and analyzed to prioritize the olive varieties.

Tree Canopy (cm3)

The tree canopy of selected olive varieties was measured, and the canopy size of competitive varieties was compared to assess the olive field's covered area.

Fruit Ripening Period (Days)

Fruit ripening time is an important characteristic of the olive variety for its adoption. In these studies, fruit ripening time was calculated from the petal drop stage of the fruit to the fully ripened (Black colour) stage of the fruit.

Fruit Yield/plant (Kg)

Fruit yield was calculated by weighing fresh fruit harvested from each tree, and means were used for reporting yield data.

Operational Cost/acre (Rs.)

Operational cost/acre was calculated for pruning, harvesting, and oil extraction from fruit for comparison of the economic performance of the selected olive varieties, while other management costs remained standard for all varieties.

The pruning cost was calculated based on pruning intensity and labour used for the open-head system of pruning in all experimental units. The harvesting cost of fruit was calculated based on contract labour charging 15-20 rupees/kg of fruit. Oil extraction cost was calculated on the base of labour and operational cost of the oil extraction unit for crushing of 01-ton fruit.

Economic Status of Competitive Varieties

The economic output of olive varieties compared in the studies was recorded on the basis of income received from extracted olive oil from relevant varieties, and net income was calculated by deduction of variable expenses from the gross income of the oil. These calculations were made on the recommended plantation geometry (18 x 18 ft) and 135 plants/acre. The olive oil produced from each variety was sold at the rate of Rs.1000/ltr.

RESULTS AND DISCUSSION

Tree Canopy (cm^3)

Tree canopy is a very important factor in olive cultivation for the judicial use of resources. The data revealed that the maximum tree canopy (549.33) was recorded in BARI Zaitoon-II, and the minimum tree canopy (529.66) was recorded in Koroneiki (Table 1). This difference in tree canopy is due to their growth habit and the genetic makeup of the varieties. Olive trees with smart canopies provide better light penetration and air circulation, essential for producing quality fruit. However, trees with big canopy may be helpful for more yield and better utilization of land resources. Similar findings were also reported by Mansouri et al. (2018) and Usanmaz et al. (2019), as they reported that plant canopy is the main factor for oil production because proper pruning for plant canopy maintenance has a critical role.

Table 1. Comparison of Tree Canopy (cm^3) for competitor olive varieties.

Varieties	2019	2020	2021	Mean
Arbiquina	535 ± 2.30	536± 2.05	544± 2.12	538.33 BC
Koroneiki	518 ± 2.09	531± 2.14	540± 2.20	529.66 D
Pendolino	481 ± 2.10	521± 2.19	567± 2.35	523.00 C
Picual	536± 2.18	548± 2.00	555± 1.98	546.33 B
Chemlali	525± 2.16	538± 2.04	563± 2.09	542.00 B
BARI Zaitoon- I	523± 2.05	548± 1.90	565± 2.18	545.33 B
BARI Zaitoon- II	531± 2.22	546± 2.32	571± 2.35	549.33 A
Ottobratica	516± 2.17	544± 2.11	575± 2.37	545.00 B

Fruit Ripening Period (Days)

The data given in Table 2 depicted that the maximum fruit ripening period was recorded in Ottobratica (186 days), and the minimum fruit ripening period was observed in Picual (124 days). A greater fruit ripening period results in maximum oil accumulation in fruit while reducing the oil quality by reducing the polyphenols level of the olive oil. Olive varieties having shorter fruit ripening periods may reduce olive oil quantity, with better quality oil having maximum polyphenols. Wang et al. (2018) reported similar findings among eight olive cultivars. According to their findings, Olive verities, i.e. Empeltre, Hojiblanca, and Koroneiki are among more oil and have taken more days as compared to others. Pardo et al. (2019) also reported that as the ripening process progresses, Oil accumulation increases, but oil will lose fruitiness, bitterness, pungency, and stability, and some organoleptic defects appear to the point of lowering the category (from extra virgin to virgin) in Castellana olive variety.

Table 2. Comparison of Fruit Ripening Period (Days) for competitor olive varieties.

Varieties	2019	2020	2021	Mean
Arbiquina	143± 2.16	136± 2.07	141± 2.00	140 B
Koroneiki	145± 2.25	137± 2.11	139± 2.09	140 B
Pendolino	185± 2.20	180± 2.17	187± 2.04	184A
Picual	131± 2.19	117± 2.34	124± 2.29	124 D
Chemlali	147± 2.06	136± 2.13	145± 2.03	143 B
BARI Zaitoon- I	145± 2.02	137± 2.03	139± 2.05	140 B
BARI Zaitoon- II	138± 2.16	131± 2.10	134± 2.34	134 C
Ottobratica	187± 2.30	183± 2.18	188± 1.90	186 A

Table 3. Comparison of Yield/Plant (kg) for competitor olive varieties.

Varieties	2019	2020	2021	Mean
Arbiquina	20.88± 0.60	22.75± 1.16	21.20± 1.27	21.61 C
Koroneiki	22.16± 1.10	18.34± 1.90	19.81± 1.16	20.10 D
Pendolino	22.15± 1.80	21.85± 1.36	21.50± 1.26	21.83 B
Picual	22.45± 1.25	19.73± 1.20	25.20± 1.23	22.46 B
Chemlali	20.88± 1.10	22.75± 0.90	20.32± 2.05	21.64 C
BARI Zaitoon- I	23.92± 1.03	22.45± 2.16	24.20± 1.27	23.52 A
BARI Zaitoon- II	20.56± 1.11	20.75± 1.23	23.30± 1.29	21.53 C
Ottobratica	21.55± 1.18	22.10± 1.56	20.90± 1.50	21.51 C

Fruit Yield/plant (Kg)

Data shown in Table 3 reflected that maximum yield was recorded in BARI Zaitoon-I (23.52 kg/plant) while minimum yield was observed in Koroneiki (20.10kg/plant). Fruity yield estimation is important when a grower plans his business on selling fruit instead of olive oil. Olive varieties may behave differently in different production zones with various environmental conditions. The difference in olive fruit yield is due to genetic and environmental factors for each variety. Borges et al. (2019) also reported similar findings in their two-year experiments as in the case of Arbiquina and Hojiblanca olive varieties.

Variable Operational Cost/acre (Rs.)

Data reveals that BARI Zaitoon- I showed the minimum cost of production (Rs. 45163.95), and Chemlali showed the maximum cost of production (75211.8). Variable operational cost is a crucial factor for selected olive varieties' economic benefits. Olive growers usually select an olive variety with minimum production cost and maximum returns. This difference in the cost-benefit ratio is due to the olive variety's genetic potential, the area's agro-climatic conditions and the grower's expertise. Mesano et al. (2021) evaluated olive cultivars production on the basis of economic sustainability through economic indicators, taking into account all of the cost and revenue factors of olive cultivation in each management system. The results showed, overall, a suitable level of profitability of different scenarios, except for the Partially Irrigated treatment, as the investment costs of the irrigation system are not economically sustainable with regard to the revenue obtained. Olive cultivation is an important agro-industrial sector (Hamam et al., 2021; Ponti et al., 2014; Pergola et al., 2013). The olive sector represents a considerable economic, agricultural and ornamental concern whilst also playing a role in the maintenance of biodiversity, showing a link with some wild crop relatives of considerable conservation value (Di Vita et al., 2013; De Gennaro et al., 2012) and benefit in the economic and social dimensions in rural areas. Despite the economic importance of this product in many countries, olive production is associated with several negative effects on the environment, with consequences on resource depletion, soil degradation, air emissions and waste generation. The impacts can vary significantly due to the practices and techniques employed in olive growing and production (Falcone et al., 2020; Testa et al., 2014).

Table 4. Comparison of Variable Operational Cost/acre (Rs.) for competitor olive varieties.

Name of variety	Pruning Cost (Rs.)/Acre/ Year	Harvesting Cost (Rs.)/Acre/ Year	Oil Extraction Cost (Rs.)/ton	Total Operational Cost (Rs.)
Arbiquina	2103.80	47779.71	11451.50	61335.01
Koroneiki	2324.90	46399.3	11655.00	60379.2
Pendolino	2177.50	46371.82	11562.50	60111.82
Picual	1936.30	43613.38	9953.00	55502.68
Chemlali	2262.00	43646.3	11303.50	75211.8
BARI Zaitoon- I	1842.50	33849.45	9472.00	45163.95
BARI Zaitoon- II	1902.80	44199.15	9620.00	55721.95
Ottobratica	1842.50	39500.3	11396.00	52738.8

Economic Status of Competitive Varieties

Data showed that BARI Zaitoon 1 gave a maximum profit (Rs. 271386/acre) while Ottobratica gave a minimum net profit (Rs. 130853.7/acre). This difference in the economic performance of olive varieties is due to genetic potential, agro-climatic conditions and the grower's business plan. The highest yield (2652 Kg/acre), Net Profit/acre (Rs. 271386), Oil Recovery/acre (331.7652 Ltr.) and Oil income (331765.2) was observed in BARI Zaitoon-I while Average Oil Recovery (13.48%), Total Expenditure /Acre (61335.01) was observed in Arbiquina olive variety.

Table 5. Comparison of Variable Operational Cost/acre (Rs.) for competitor olive varieties.

Name of variety	Yield (kg/acre)	Average Olive Oil Recovery %	Total Oil Recovery/acre (Ltr.)	Oil Income/Acre (Rs.)	Total Expenditure/acre (Rs.)	Net Profit/acre (Rs.)
Arbiquina	1696	13.48	228.6208	228620.8	61335.01	167285.79
Koroneiki	2358	11.46	270.2268	270226.8	45163.95	225062.85
Pendolino	2225	9.61	213.8225	213822.5	60111.82	153710.68
Picual	2193	12.02	263.5986	263598.6	55502.68	208095.92
Chemlali	2056	10.15	208.684	208684	57211.8	151472.2
BARI Zaitoon- I	2652	12.51	331.7652	331765.2	60379.2	271386
BARI Zaitoon- II	2500	10.8	270	270000	55721.95	214278.05
Ottobratica	1883	9.75	183.5925	183592.5	52738.8	130853.7

CONCLUSIONS AND RECOMMENDATIONS

It was concluded that every olive variety performed differently under field conditions regarding morphological and agronomical attributes and economic parameters. So the study reflects that the growers having the sale of raw fruit as the business plan may select olive varieties resulting in good fruit yield per unit area, and growers having a business plan for the sale of olive oil may select olive varieties having maximum olive oil production potential even with low fruit yield. Hence it is recommended that overall, BARI Zaitoon-I and Arbiquina are the best olive variety which produced the highest yield, net profit, oil recovery and income.

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