

Valorization of Olive Pomace for the Breeding of Young *Quercus suber* L. Plants in the Guerbes Soilless Nursery (Northeast Algeria)

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Article Details: Received: 2025-07-23 | Accepted: 2025-12-01 | Available online: 2026-03-31

<https://doi.org/10.15414/afz.2026.29.01.74-80>



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This study aims to investigate the possibility of using olive pomace in the preparation of growing substrates for the cultivation of young *Quercus suber* L. plants in nurseries. It was performed in Guerbes (Skikda, Algeria) where three substrates made from olive pomace, forest humus and a control (forest soil alone) were tested. The obtained results revealed that the S2 substrate (50% olive pomace + 50% humus), by its balanced physicochemical properties (pH = 7.436; EC = 0.17 mmhos/cm; CEC = 79 meq/100 g; Organic matter = 6.46 and water retention capacity = 28.66) represents the best substrate because the young plants raised in this substrate for four months recorded the best results in terms of height (16.136 cm), diameter (0.249 cm), fresh weight of the aerial part (2.090 g), fresh weight of the root part (10.23 g), dry weight of the aerial part (0.960g) and dry weight of the root part (3.930 g).

Keywords: olive pomace, substrate, *Quercus suber*, guerbes

1 Introduction

The accumulation of organic waste is a major environmental problem in olive production areas (Azbar et al., 2004). Olive pomace, a residue from olive crushing, represents more than 35% of the initial weight of the fruit and poses management problems due to its high organic load and slow biodegradability (Mekki et al., 2013; Roig et al., 2006). In Algeria, there are no statistics on the quantities of olive pomace. However, the annual olive production which reached last year over 9 million quintals of olives, with 6 million destined for olive oil (Ministry of Agriculture, Rural Development and Fisheries [MARDF], 2024), gives us an idea about the large quantities of olive pomace discharged annually into the environment. Several studies have highlighted its agronomic potential when used as an amendment or growing medium (Bougnom et al., 2009; Makan et al., 2014). Few studies have addressed the effects of olive pomace on the growth of *Quercus suber* L. seedlings, notably the studies of Bouchaour-Djabeur Merabet (2015) and Belaidi (2010). This Mediterranean

species, which has great environmental and economic importance, often faces difficulties in producing seedlings in nurseries due to its low germination rate and nutritional requirements (Pausas et al., 2002). Consequently, the present research aims to evaluate the effectiveness of substrates based on olive pomace mixed with humus for the production of *Quercus suber* L. plants, analyze their physicochemical characteristics and check their impact on the morphological parameters of young plants grown in a soilless nursery for four months.

2 Material and Methods

2.1 Presentation of the Study Station

The study was conducted at the Guerbes soilless nursery, located in the Guerbes Sanhadja wetland, northeast of the department of Skikda. It covers an area of 12 hectares and stands on a plain at an altitude of 38 meters with a slope of 0 to 3%. The climate of the region is subhumid with mild winters. Pedologically, the soils of the area have a clay-silt ratio and are based on coastal dunes and

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quaternary alluvium. The general exposure of the site is oriented towards the north and northeast.

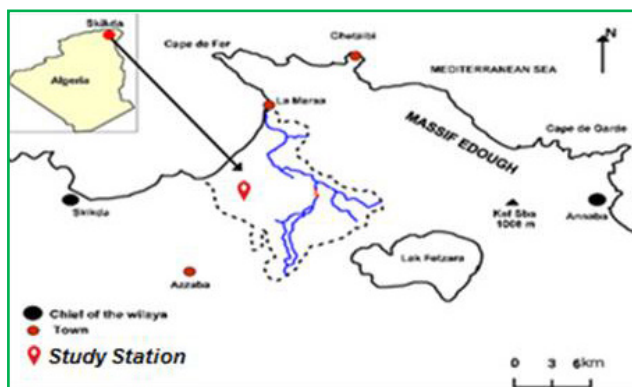


Figure 1 Localization of the Study Station

2.2 Plant Material

The *Quercus suber* L. acorns studied (Figure 2) were harvested in the Collo forest massif in December 2017.



Figure 2 *Quercus suber* L. acorns used in the experiment

2.3 Olive Pomace

The olive pomace used was collected from olive mills in the same region of Skikda, which minimizes variability between batches, and the good mixing allows relatively homogeneous substance. This waste is composted for three years in the nursery to reduce its acidity, eliminate any toxic compounds, and lower the high nitrogen content through mineralization. Its size varies between 1 and 4 mm.

2.4 Substrate Preparation

In this experiment, the retention element used was forest humus combined with an aerator (olive pomace). However, the control was composed solely of forest humus (table 1).

Table 1 Composition and name of the substrates tested

Substrate	Olive pomace	Forest humus
	%	
S1	60	40
S2	50	50
S3	40	60
T	0	100

2.5 Experimental Protocol

Since the experimental conditions are relatively homogeneous, the chosen design is a completely randomized trial with four treatments, and 80 repetitions. The entire design comprises a total of 320 acorns. The boxes are elevated 60 cm above the ground to allow the roots to self-girdle.

2.6 Seedling Breeding Management

The acorns were sown on January 10th, 2018, using one pre-germinated acorn with an exposed radicle. They were irrigated by misting depending on the condition of the substrate. Weed control was performed manually whenever necessary.

2.7 Plant Measurements and Observations

After four months in the nursery, and in order to study the effect of the substrate on plants growth, we measured the following parameters: height, diameter at the collar, number of leaves and branches, biomass of the aerial part and biomass of the underground part.

2.8 Statistical Analysis

ANOVA followed by Tukey's HSD test aim to detect whether there was at least one significant difference between the means and if so, to determine the location of this difference. The principal component analysis aims to simplify complex data while retaining essential information. The statistical analysis was implemented in IBM SPSS Statistics 25 at a significance level of $\alpha = 0.05$.

3 Results and Discussion

3.1 Physicochemical Analyses of Substrates

The analysis of some physicochemical properties of the tested substrates allowed us to observe that the pH of the substrates ranges from 7.33 (S1) to 8.09 (T). The S1 and S2 substrates have a neutral pH, which remains within the desirable range for soilless cultivation, i.e. 5 to 8 (Argillier et al., 1991). And favorable to the bioavailability of essential nutrients (Gruda, 2012).

Table 2 Results of physicochemical analyses of substrates

Substrate	S1	S2	S3	T
pH	7.33	7.43	7.90	8.09
EC (mmho/cm)	0.20	0.17	0.14	0.11
CEC (meq/100g)	85.00	79.00	67.00	53.00
Organic matter	7.58	6.46	6.90	2.91
Organic carbon	4.40	3.75	4.01	1.69
Water retention capacity	30.43	28.66	26.37	20.00

Table 3 Analysis of variance table for the measured parameters

Parameter	P-value	Significance	Treatment	Mean
Height	0.000	***	T	11.80 ^a
			S3	12.13 ^a
			S1	15.42 ^b
			S2	16.13 ^b
Diameter	0.582	n.s	S3	0.22 ^a
			T	0.24 ^a
			S1	0.24 ^a
			S2	0.24 ^a
Number of leaves	0.340	n.s	T	13.83 ^a
			S2	14.50 ^a
			S3	15.30 ^a
			S1	16.06 ^a
Number of branches	0.147	n.s	T	1.32 ^a
			S3	1.46 ^a
			S2	1.56 ^a
			S1	1.83 ^a
Fresh weight of the aerial part	0.013	*	S3	1.39 ^a
			T	1.47 ^{ab}
			S1	2.05 ^b
			S2	2.09 ^{cb}
Fresh weight of the root part	0.000	***	T	4.59 ^a
			S3	7.04 ^b
			S1	7.49 ^b
			S2	10.23 ^c
Dry weight of the aerial part	0.272	n.s	S3	0.70 ^a
			T	0.79 ^a
			S1	0.96 ^a
			S2	0.96 ^a
Dry weight of the root part	0.000	***	T	2.07 ^a
			S3	3.05 ^b
			S1	3.22 ^{bc}
			S2	3.93 ^c

*** highly significant ($p < 0.001$); ** significant ($p < 0.05$); (n. s) – not significant ($p \geq 0.05$)

Electrical conductivity (EC), an indicator of salinity, remains low for all substrates (< 0.2 mmho/cm), thus excluding any osmotic stress on the young plants (Abad et al., 2001). Cation exchange capacity (CEC) ranges from S1 (85%) to S1 (53%) and increases with the olive pomace content in the substrate. This improvement is explained by the richness of olive pomace in colloidal compounds (Raviv et al., 2008). Similarly, the organic matter content is remarkable in substrates enriched with olive pomace. This organic matter stimulates microbial activity and supports balanced growth of young plants without causing the negative effects associated with excess unstabilized organic matter (Verdonck & Gabriels, 1988). Water retention capacity is high in substrates containing olive pomace, and varies from 30.43 in S1 to 26.37 in S3. These values allow better moisture regulation without compromising substrate aeration, a fundamental element for root development in woody species (Bunt, 1988). The olive pomace used in this test as an aerator also acts as a retainer.

3.2 Measurements Taken on the Plants

The analysis of variance (Table 3) made it possible to highlight the differential effect of the various substrates made from olive pomace and forest humus on the different measurements and observations made on the young plants of *Quercus suber* L. After four months in the nursery. This analysis shows that the height of the aerial part of the young plants is significantly influenced by the substrate factor. The Post Hoc analysis identified two homogeneous groups. The second group composed of the two substrates S1 and S2 enriched respectively by 60% and 50% in olive pomace allowing to obtain the tallest heights with values of 15.42 cm and 16.14 cm respectively. According to Mekki et al. (2013) and Ben Ahmed et al. (2009), this is explained by good aeration, good nutrient availability and the improvement of water retention of these two substrates by the presence of olive pomace. Also, the substrate has a non-significant effect on the diameter ($p = 0.582$), the number of branches ($p = 0.340$) and the number of branches ($p = 0.147$). At this stage of growth, the parameters are insensitive to

variations in the substrate and there is always sufficient time to reveal marked differences.

Concerning the root biomass, the results obtained show that the substrate has a significant effect on the fresh weight of the roots and the dry weight of the roots. The Post Hoc test identified three homogeneous groups, group 3 of S2 (50% pomace + 50% humus) gave the highest fresh and dry root weights of around 10.25 and 3.93g respectively. These results demonstrate the value of olive pomace for root development, perhaps due to its richness in organic matter, lignin, as well as the structure of the substrate, improving the porosity which favors root growth for better absorption of water and nutrient components. Finally, substrates containing olive pomace, particularly in equal proportions or even more (S1 and S2), were favorable to the growth of young *Quercus suber* L. plants, mainly in height and root biomass. These results are in line with the study on the valorization of agro-industrial by-products for horticultural substrates and demonstrate the agronomic and environmental interest of this practice (Mekki et al., 2013; Ben Ahmed et al., 2009). In the same context, Bouchaour-Djabeur & Merabet (2015) and Belaidi (2010) have shown that olive pomace has a positive effect on the germination and growth of young *Quercus suber* plants. In the other hand Pires et al. (2025) found that the substrate made from olive pomace compost gave less good germination results for two oak species (*Quercus faginea* and *Quercus coccifera*), probably due to its physical and chemical properties which limited moisture retention.

3.3 Principal Component Analysis

The principal component analysis (figure 4) reveals interesting relationships between the different morpho-biometric variables measured. Biomass-related variables, such as fresh weight and dry weight of the aerial part, as well as those of the root part, are highly correlated with each other and aligned in the same direction as plant height. In contrast, stem diameter and leaf number appear weakly correlated with the other variables.

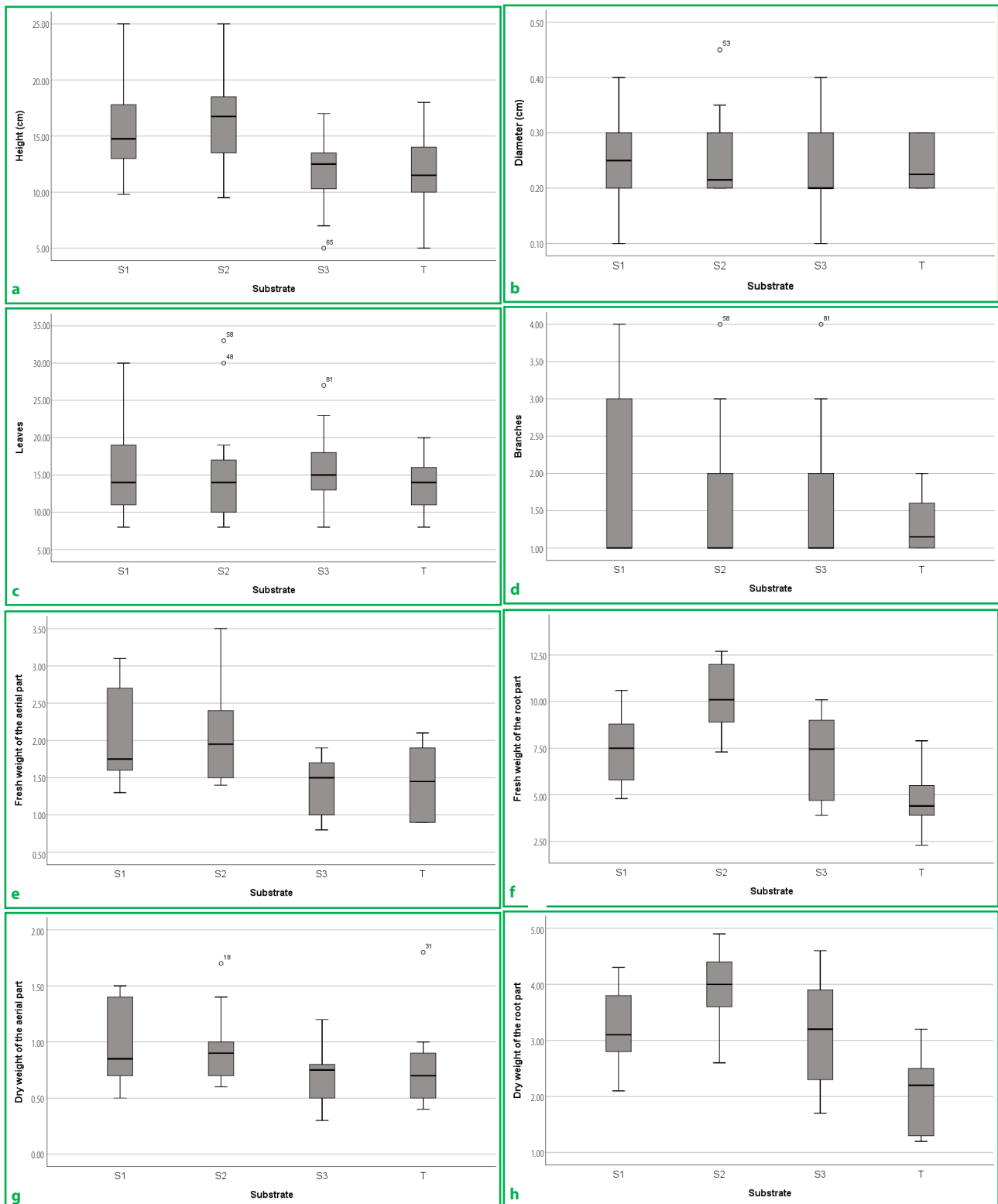


Figure 3 Effect of culture substrate on some morphological parameters of young *Quercus suber* L. plants: (a) height, (b) diameter, (c) Number of leaves, (d) Number of branches, (e) Fresh weight of the aerial part, (f) Dry weight of the root part, (g) Dry weight of the aerial part, (h) Dry weight of the root part

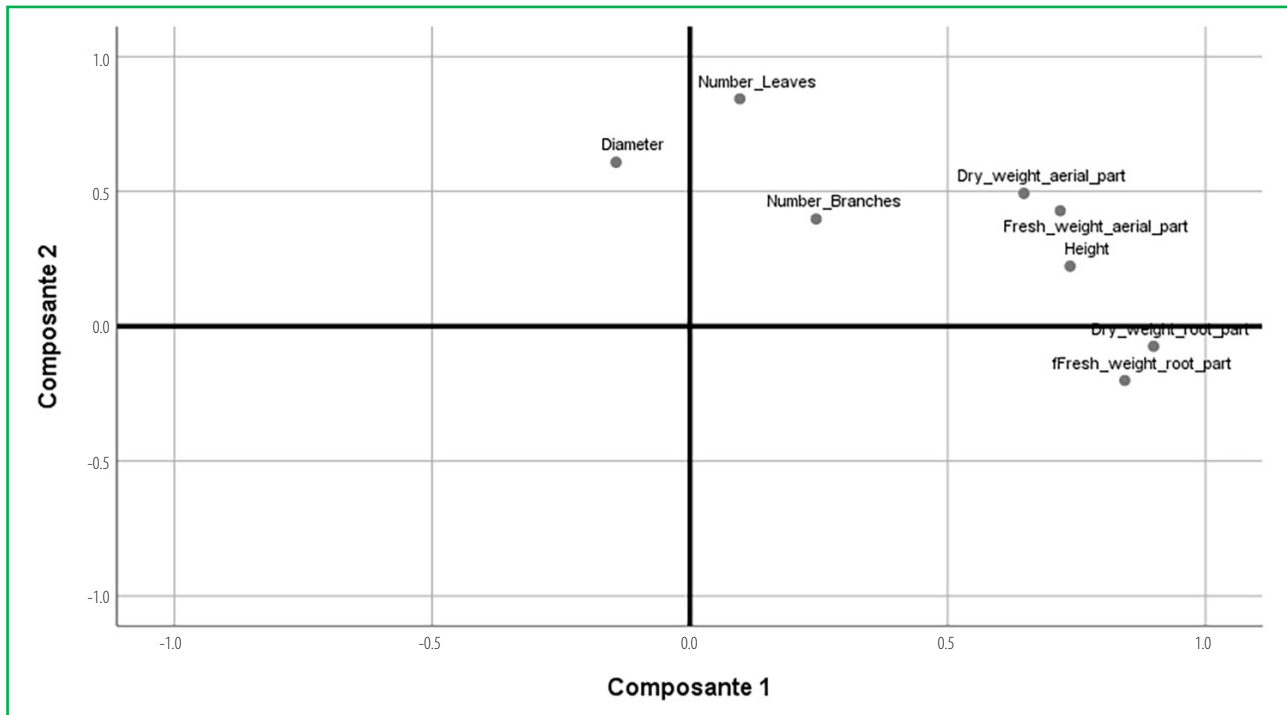


Figure 4 Principal component analysis of the parameters studied

4 Conclusion

This study was undertaken in the hors-sol nursery of Guerbes (North-East of Algeria) and based on the comparison between three substrates made from olive pomace with different percentages and a control (forest humus alone) to valorize pomace and study the possibility of its integration into the cultivation substrates used for the breeding of young plants of *Quercus suber* L. The results obtained showed that substrate 2 (50% olive pomace and 50% forest humus), due to its physicochemical qualities, represents the best olive pomace/humus balance. Plants grown in this substrate for four months recorded the best results, especially in terms of height (16.136 cm), diameter (0.249 cm), fresh weight of the aerial part (2.090 g), fresh weight of the root part (10.230 g), dry weight of the aerial part (0.960 g), and dry weight of the root part (3.930 g). Therefore, the integration of olive pomace into nursery substrates constitutes a sustainable and effective solution for recovering abundant organic waste while improving the production performance of forest seedlings. It constitutes a remarkable sustainable amendment, which not only improves organic waste but also the quality of forest plants produced in nurseries.

Acknowledgments

My thanks go to all the staff at the Guerbes nursery for their help and assistance.

Conflict of Interest

The authors declare that they have no conflict of interest.

Author Contributions

Belaidi Abdelouahab: conceptualization, formal analysis, methodology, visualization, writing – original draft preparation, writing – review & editing; Bouakba Nourelhouda, Chekired Dounia: funding acquisition, investigation, resources; Francisco Maria Vázquez Pardo, Francisco Marquez Garcia: correction of the manuscript.

AI and AI-Assisted Technologies Use Declaration

No generative AI tools or AI-assisted technologies were used in the preparation of the manuscript.

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