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Competition between Seedlings of *Pinus pinea* L. and *Ceratonia siliqua* L. on Their Growth

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ABSTRACT

Competition is reflected in the strength of plant growth, production, leaf area, and depth of the root total. Over time, the number of dead individuals may increase or be reflected in the production and vitality of individuals where competition arises as a result of the similarity of the species' food, water, and light needs. The competition within and between *Ceratonia siliqua* and *Pinus pinea* trees has been measured at the rate of four treatments (1 to 5) within the species, and 5 treatments between the two species. We measured the total dry weight, dry total weight, dry root weight, seedlings diameter, and high seedlings. The results of the measurement of the competition between seedlings showed moral differences in dry total weight, dry total vegetable weight, and high seedlings, while no moral differences in dry root weight and diameter were shown. Similarly, the value correlation coefficient values of measured quantity properties of seedlings had a strong direct relationship with dry total weight. Also, the results of measurements of competition between the two species indicated significant differences in dry total weight, dry vegetable weight, and dry root weight, the mean values of all traits were higher in *Ceratonia siliqua* than that of the *Pinus pinea*, while there were no differences in the diameter and height of the seedlings. Mixing tree species is better than pure forests and may enhance growth in mixed forests.

INTRODUCTION

Competition among forest trees is a common natural phenomenon where different tree species vie for resources such as sunlight, water, and nutrients to thrive and survive in their ecosystem. This competition plays a vital role in shaping the structure and composition of forest communities. Trees may compete for space, light, and access to soil nutrients, with taller trees often overshadowing smaller ones and limiting their access to sunlight. In some cases, trees may release chemicals into the soil to inhibit the growth of nearby plants, a process known as allelopathy. However, competition among forest trees is a complex and dynamic process influenced by various factors such as species diversity, soil conditions, climate, and disturbances like natural disasters or human activities. Ultimately, competition among trees contributes to the overall biodiversity and resilience of forest ecosystems. Due to its ability to alter the vegetation cover in new sites, competition is important. It impacts the relationships between light and water, making it a specific and direct factor. Competition can arise at any point in the life cycle of a plant, from germination to seedling development, with the first year being particularly important (Goor *et al*, 1976). The stage of life that seedlings occupy is crucial and delicate for all plants. If certain environmental factors remain unchanged, the early dominance of one or more species in a given area enhances the likelihood that these species will persist in that area (Abdullah, 1988). As a component of a plant's life cycle, germination is an irreversible biological process. The embryo commits to either growing or dying once germination begins (Baskin and Baskin, 2014). As a biotic factor, plant-plant competition can impact species abundance and distribution, community composition, and growth (Pierik *et al.* 2013). Plants can adapt to changes in resource availability and the presence of neighboring plants through adjustments to their morphological and physiological traits, which are the primary means of increasing their competitive ability (Anten *et al*. 2005). Plant-plant competition is frequently influenced by abiotic variables, such as the availability of resources (Yu *et al*. 2017). Given that mixed pine forests can yield higher yields than pure forests, research on the competition between *Pinus sylvestris* L. and *Fagus sylvatrica* L. in two climatically distinct regions led to the conclusion that species mixing may promote mixed forest growth (Andres *et al*, 2017).

Degroote *et al*. (2018) studied the importance of competition and the age of trees on the growth volume at the level of *Quercus robur* and between trees. They found that there is no relationship between tree abundance and forest productivity due to the variation in growth between the trees as a result of the variation in competition. This understanding is necessary to understand the relationship between tree diversity and the

productivity of the surrounding forest. To predict growth for sustainable forest management, it is crucial to evaluate the competition between trees in the study of growth at the individual tree level (Mary and Oluremi, 2019).

Yu *et al.* (2019) examined the competitive dynamics between *Abies faxoniana* and *Picea purpurea*. They discovered that both species grew under both intra- and inter-species competition and that there were notable variations in several physiological processes, the most significant of which are the accumulation of dry matter, the capacity for photosynthesis, the absorption of nutrients, the contents of carbohydrates, and the microstructure of leaves in high-temperature environments.

The study aimed to understand the competition between different species and their effects on seedling growth, as understanding the ecological processes that lead to changes in seedling communities by studying competition within and between the two species of important forest trees that grow in the AL-Jabel AL-Ahkder east, Libya region.

MATERIAL AND METHODS

Two species of forest tree seeds were selected is growth at different altitudes on the Al-Jabel Al-Akhder region, *Pinus pinea* and *Ceratonia siliqua* (fig.1), according to (1991, Vidokvic). the three field experiments were conducted one season the year 2019 to study the effect of competition on the growth of pine and carob seedlings within the same and between species by estimating some characteristics total dry weight (TDW), vegetative dry weight (VDW), root dry weight (RDW), height (H) and diameter (D) of the seedling. *P. pinea* seeds were soaked in water for 24 h, while *C. siliqua* seeds were treated with concentrated sulfuric acid for 30 min and washed. Planting took place in spring 2019, with irrigating every two days and weekly thereafter. The study analyzed competition between *P. pinea* seedlings and *C. siliqua* seedlings, measuring eight trials within one species and 13 trials between two different species. The seedlings were measured at varying numbers, with a total of 13 treatments. After planting, the seedlings were measured for height and diameter and dried in a drying oven at 69 °C for 24 h. The dry weight of each sample was calculated separately.

Statistical analysis:

The study utilized a complete randomization design (C.R.D), Duncan's test, T-test, and Pearson correlation analysis to analyze the results and compare the mean between the measured variables.

Table 1: Planting seedlings within each treatment

Ceratonia siliqua L.(C) Pinus pinea (P) P.C		**Pinus pinea (P)**		**Ceratonia siliqua L. (C)**	
Treatments T	**Number of seedlings in each treatment**	**Treatments T**	**Number of seedlings in each treatment**	**Treatments T**	**Number of seedlings in each treatment**
T1	C	T5	P	T9	C.P
T2	C.C	T6	P. P	T10	C.C. P
T3	C.C.C	T7	P.P. P	T11	C.C.C.P. P
T4	C.C.C.C.C	T8	P.P.P.P. P	T12	P.P.C
				T13	P.P.P.C.C

Pinus pinea

Ceratonia siliqua

Figure 1: Species of forest tree growth at different altitudes on the Al-Jabel Al-Akhder

RESULTS AND DISCUSSION

Competition between similar species seedlings:

Measurements were performed for *C. siliqua* seedlings, where the mean values of the dry root weight (DRW) and diameter (DI) showed that there were no significant differences between the seedlings, while there were significant differences in the mean of total dry weight, where the highest mean is 3.3150 for the second treatment, followed by 2.7033, 2.0833, and 2.0307 for the treatments First, third and fourth, respectively. (Table 2). Additionally, there is a significant difference between the treatments of vegetative dry weight (VDW) This is a result of the intense competition that developed as a result of the seedlings being crowded inside the pot. This is also consistent with the statement made by Goore and Barney (1976) that the seedlings should not be diluted in pots inside the nursery because preventing even one seedling from developing will result in intense competition amongst them. Table (3) shows the mean traits that were measured for *P. pinea* seedlings, as the results indicate that there were no significant differences between the treatments in all traits except for the height of the seedlings, where the height of the seedlings differed, the highest height was 23.71 cm and the lowest height was 20.03 cm. This indicates that there is no intense competition between the seedlings of *P. pinea*, which indicates that the nutritional, water and light requirements was available our results contradict with Weaver and Frederick (1929), who stated that competition between individuals of the same species is always intense.

Table 2: Mean values of traits of *Ceratonia siliqua* (C) seedlings:

Treatments	Total dry weight	Vegetative dry weight	Root dry weight	Height	Diameter
T1	2.703[a]	2.256[a]	0.780	20.233[a]	3.100
T2	3.315[a]	2.358[a]	1.070	22.433[b]	3.233
T3	2.083[b]	2.358[a]	0.523	17.106[c]	3.063
T4	2.030[b]	1.173[b]	0.656	17.753[d]	3.100
F	10.541**	2.250*	n.s	2.55*	n.s

* significantly different at 0.05 level of significance, ns: no significant difference at 0.05 level of significance, T1:C, T2:C.C, T3:C.C.C, T4: C.C.C.C.C

Table 3: Mean values of traits of *Pinus pinea* (P) seedlings

Treatments	Total dry weight	Vegetative dry weight	Rootdry weight	Height	Diameter
T5	1.440	1.010	0.450	23.166[a]	2.666
T6	1.716	0.963	0.586	23.033[a]	2.833
T7	1.533	1.003	0.533	20.686[b]	2.720
T8	1.423	1.054	0.506	23.715[a]	2.606
F	n.s	n.s	n.s	2.263*	n.s

* significantly different at 0.05 level of significance, ns: no significant difference at 0.05 level of significance, T1:P, T2: P. P, T3: P. P. P, T4: P.P.P.P.P

One the other hand, Table (4, 5) shows the Pearson correlation coefficients between the measured variables for *C.siliqa* and *P.pinea* seedlings. For *C.siliqa* traits we note that all the coefficients have a strong direct relationship with the TDW with the highest correlation coefficient of 0.947 VDW, followed by the RDW of 0.92, then the height with a correlation coefficient of 80.0 with HI. On the other hand, The traits of *P.pinea* seedlings. a strong direct relationship with the TDW with the RDW 0.947, followed by VDW and DI.

Table 4: Correlation of the Pearson coefficient for the measured quantitative characteristics of *C.silliqa* seedlings.

	TDW	VDW	RDW	DIA	HI
TDW	1				
VDW	** 0.947	1			
RDW	** 0.920	**0.784	1		
DIA	** 0.698	**0.680	**0.586	1	
HI	** 0.809	**0.767	** 0.768	** 0.641	1

TDW total dry weight, VDW: vegetative dry weight, root dry weight (RDW), height(H) and diameter(D)

Table 5: Correlation of the Pearson coefficient for the measured quantitative characteristics of *P.pinea* seedlings.

	TDW	VDW	RDW	DIA	HI
TDW	1				
VDW	**0.833	1			
RDW	**0.906	**0.605	1		
DI	**0.703	**0.602	**0.624	1	
HI	**0.666	**0.661	** 0.498	**0.834	1

TDW total dry weight, VDW: vegetative dry weight, root dry weight (RDW), height(H) and diameter(D)

Competition between *P.pinea* and *C. siliqua:*

Competition was measured between the seedlings, where the mean of the t-test shows that there are significant differences in the characteristics that were measured the mean of TDW of *C.siliqua* is 2.65, which is higher than *P.pinea* 1.24. (Fig., 2) Also, the results of (VDW) indicated that there were significant differences in the mean of *C. siliqua* 1.7763 it was higher than of *P.pinea* 0.8119, and the t-test value of 4.765 with a probability value of 0.001 that there is a significant difference between the mean vegetative weight of the two species, Fig. (3) shows that the mean of VDW of *C. siliqua* was higher.

The study was to understand the competition between different species and their effects on seedling growth, as well as the ecological processes that lead to changes in seedling communities by studying competition within and between the two species of important forest trees in the canopy of the AL-Jabel AL-Ahkderzone.

The results showed significant differences in some traits, the most important of which are (TDW), (VDW), (RDW), (HI), and (D) where indicated. The species grow under competition within and between species, *C.Silliqua* seedlings excelled in all measured traits. This is attributed to the fact that the nutritional needs of conifers are less than that of broadleaf, and this confirms that competition may occur at all stages of germination and during seedling development, especially during the first year of growth, and this plays an important role in determining the number of individuals that occupy a specific site at each stage in the vegetative succession and these results are consistent with what was mentioned by (Yu *et al*., 2019).

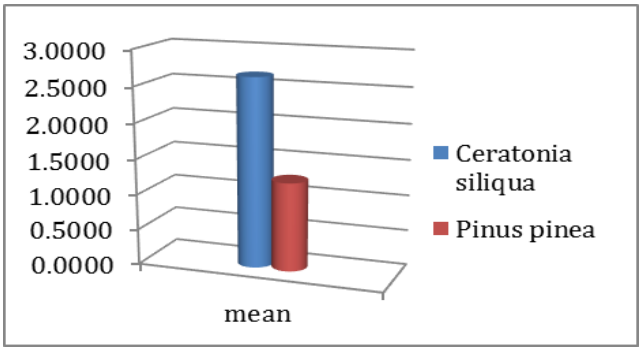

Figure 2: Mean of Total dry weight

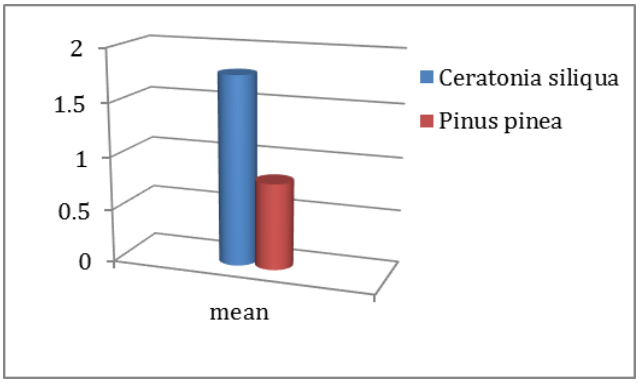

Figure 3: Mean of vegetative dry weight

Moreover, this indicates that *Ceratonia siliqua*, after the seedling and establishing stage, is able to grow due to its ability to withstand and resist the stressful conditions prevailing in the semi-arid regions, especially drought, and salinity and this coincides with Correia *et. al.,*(2010) stated that *C. siliqua* seems to be a salt as well as a drought-tolerant species.

Although most of the characteristics considered were in favor of *C. siliqua, P. pinea,* constitutes one of the principal members of the canopy in the zone, and that means that he possesses the ability to cope with harsh conditions, especially fire, and that coincides with (El-Barasi and Saeed, 2008) as well as with (Sidari, 2008), who stated that *P. pinea* is a species able to regenerate in the Mediterranean area under constraints conditions as fire and salinization.

It can also be said that mixing species may enhance growth in mixed forests, and this confirms what was indicated by Andres *et al*., (2018) who stated that mixed pine forests are more productive than pure forests. However. mixed forests are more resistant and resilient, in the effort to reduce forest vulnerability in the face of climate change and carbon dioxide accumulation, productivity and species diversity (De Prado 2022). Taking in consideration, that these species under test, *C. siliqua* and *P. pinea* constitute in several places the dominant species of the canopy in El-Jebel Al-khdar zone, (El-Barasi and Saeed 2013; Saeed *et al.* 2019). This type of research along with those that focus in the same direction is important and urgent, to save what can be saved in several habitats in El-Jabal al–Akhdar areas, due to the presence of large areas of vegetation dominated by *Juniper sp.* suffering from dieback (Al-Shaikhy*et al.*2023), and (Camareo, *et al.*2020) who studied the drought-induced dieback of *Juniper sp.* Throughout the Mediterranean basin ecosystems. At the same time, other species are considered possible alternative candidates to replace *Juniper sp.* and are dominant in many areas among them *Ceratonia siliqua* and *Pinus pinea.*

CONCLUSION

It recommends encouraging the cultivation of mixed *Ceratonia siliqua* seedlings and *Pinuspinea* in the afforestation program of natural forests in the Al Jabal Al-Akhdar zones. Additionally, providing appropriate environmental conditions is crucial to increasing their survival rate during the first two years of cultivation, at least. Furthermore, conducting thinning operations by removing some trees underneath the prevailing trees can help reduce competition for soil water and thus increase tree growth. Finally, it is crucial to study the surrounding factors affecting the growth of forest trees and attempt to improve the environmental conditions as much as possible to benefit the growth of the tree cover.

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الملخص العربي

تأثير التنافس بين شتلات الصنوبر الثمرى والخروب على نموها

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ينعكس التنافس على قوة النبات وانتاجه ومساحة أوراقه وعمق المجموع الجذري ومع الوقت قد يزيد عدد الأفراد الميتة او ينعكس على إنتاج الأفراد وحيويتها حيث ينشأ التنافس نتيجة لتشابه افراد النوع في احتياجاتها الغذائية والمائية وكمية الضوء. تم قياس التنافس داخل وبين شتلات الخروب *Ceratonia silliqua* والصنوبر الثمري *Pinus pinea* بمعدل أربع معاملات لكل نوع عدد الشتلات فيها (١ إلي ٥) داخل النوع الواحد، و٥ معاملات بين النوعين، تم قياس الوزن الكلي الجاف، وزن المجموع الخضري الجاف، الوزن الجذري الجاف، قطر الشتلات وارتفاع الشتلات، كذلك تم قياس معامل ارتباط بيرسون بين المتغيرات. أظهرت نتائج قياس التنافس بين شتلات الخروب فروق معنوية في الوزن الكلي الجاف ووزن المجموع الخضري الجاف وارتفاع الشتلات ،بينما لم يظهر اي فروق معنوية في الوزن الجذري الجاف والقطر، كذلك كانت قيم معامل الارتباط للخصائص المقاسة لشتلات الخروب ذات علاقة طردية قوية مع الوزن الكلي الجاف. من ناحية اخرى، لم تظهر تحاليل قياسات التنافس بين شتلات الصنوبر أي فروق معنوية في جميع الخصائص التي تم قياسها بينما كانت قيم معامل الارتباط بيرسون ذات علاقة طردية قوية مع الوزن الكلي الجاف. أيضا، أشارت نتائج قياسات التنافس بين النوعين فروق معنوية في الوزن الكلي والخضري والجذري الجاف حيث كان قيم متوسط كل الصفات اعلى لشتلات الخروب من الصنوبر بينما لم تظهر أي فروق معنوية في قطر وارتفاع الشتلات للنوعين الخلط بين الأنواع الشجرية يعتبر أفضل من الغابات النقيه وقد يعزز من النمو في الغابات المختلطة.

الكلمات المفتاحية: التنافس، الخروب، الصوبر الثمري، غابة مختلطة.