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Experimental Study of the Behavior of Aleppo Pine Seedlings in Pots Growing and Effect of Natural Litter (Monospecific and Mixed) on Growth, Biomass and Nutrient Content

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ABSTRACT

A study was carried out on small Alep pine plants behaviour using vegetation pots in order to test a hypothetic litter forest effect allelopathy on this species regeneration. It revealed favourable litter action, i.e. best growth and development plant. So, it shows best monospecific litter effect (Alep pine) on plants behaviour compared to mixed litters (Alep pine and holm oak). This best plant behaviour which consisted of greatest radial and vertical growth, great biomass, great volumic index and best chemical nutrition (chemical mass) was caused by the fact that Alep pine monospecific litters, with acid character, induced best nutritious elements dynamic (N, P, K) and great microbial groups activity (mineralisators fungi, myccorhiza) in soil.

Key words: Litters, small alep pine plants, growth, soil, biomass, chemical mass

INTRODUCTION

In forest ecosystems, regeneration of settlements has often been a serious problem for foresters in temperate (Drapier, 1983; Becker and Drapier, 1985; Messaadia, 1987; Andre *et al*., 1987) Mediterranean areas (Abourouh, 1983; Derridj, 1990; Malki, 1992; Boukerker, 1997 and Fernandez *et al*., 2008). This phenomenon is proportionally dangerous , especially in areas where climatic and soil conditions are not always conducive to good plant cover dynamics, in addition, a decline is observed in some subjects even if they are old (Nahal, 1975; Kadik 1983 and Vicente-Serrano *et al*., 2010).

In Mediterranean semi-arid Aleppo pine (*Pinus halepensis*. Mill) is no exception to this state of affairs since its renewal and sustainability in some of its traditional habitats appear to compromise (Kadik, 1983; Fernandez, *et al*., 2006). This author believes that the causes of degradation are also pine forests in climate and soil. In terms of climate, lack of moisture in summer causes the degeneration of young seedlings from natural regeneration. The problem of soil renewal essence consists, besides the lack of water in the soil, of impairment in terms of mineral nutrition. This would be due to causes of quantitative, qualitative and evolving forest litter as highlighted Rapp (1967) and Bensid (1996) in their work on the dynamics of organic matter from the pine-covered. These biological effects, consisting of organic debris of any nature (leaves, needles, branches, twigs) form the surface layers and play an important role in retaining water in the runoff and blocking in the running cycle Biogeochemical nutrient. In addition, they provide humus to the ground after processing by the telluric microflora, improves certain physical properties of soil structure, porosity and water holding capacity (Nahal, 1975; Duchaufour, 1988).

However, some studies (Drapier, 1983; Messaadia, 1987; Andre *et al.*, 1987) have pointed out, in temperate zones, a causal relationship between, on one hand the type of humus, nature and mode biological effects of recycling (rainfall-leachates, litter) in contact with soil and secondly the behavior of populations during the different phases of their life cycle (germination, growth and development). Among the driving factors, these studies implicate dysfunction of the biogeochemical cycling of elements, linked to a turn-over slow organic matter and/or allelopathy that might result, either by the nature of these materials by themselves depressive effect of these substances on soil microflora. These two phenomena are powerful factors inhibiting the regeneration of species in forest sites (beech, spruce and fir).

The present work is meant to test the hypothesis "allelopathic" in the difficulties of regeneration of Aleppo pine and relates to the study of potted plants of the effect of the nature of the litter (mono or mixed) on the behavior seedlings of Aleppo pine under glass. Sprayed with a solution simulating the rainfall-Aleppo pine leachates, these seedlings will-they suffer from an allelopathic phenomenon that could upset the smooth development of Aleppo pine seedlings in the pine woods?

MATERIAL AND METHODS

Study material

Soil: The soil used was taken from the A_1 horizon, in a young pine forest located on the northern slope of Jebel Sekrine near Ain Azel (Setif). This is actually a mull limestone, brown, silty texture, fine crumb structure, moderately humic and characterized by good biological activity.

The analytical study of this substrate was performed on a sample dried in the open air and sieved to 2 mm and gave the results shown in Table 1.

In taxonomically, this soil belongs to the class of soil calcined magnesia, CA profile, medium humus-rendzina forest type (Duchaufour, 1988).

Litter:

Origins of the litter: Litters we used were taken from a station in Aleppo pine forest mixed with oak. We chose two different types of litter in terms of their nature:

- Litter in Aleppo pine (litter monospecific pine stand)
- Mixed litters (Aleppo pine and holm oak, mixed stand)

Fashion collection bedding: Litter were collected under the feet of pine and oak in the upper soil components to include fresh young of the year (leaves, needles). In layers under-lying, we collected items older decomposed more or less advanced (stage fermentation and humification).

Chemical composition of litter: After the sorting of litter, the fraction consisting exclusively of Aleppo pine needles and leaves entire and ancient oak is dried at 105°C in an oven and is then crushed and sieved 2 mm to conduct various tests, whose results are presented in Table 2.

Table 1: Results of soil analysis

Granulometry (%)													
					Lime stone (%)		pH		Elements (%)				
Clay	Limon thin	Limon great	Fine sand	Coarse sand	Total	Active	H_2O	KCl	C (%)	Mo (%)	N (%)	P (%)	Electric conductivity Meq/100
2.04	12.19	68.20	9.04	8.53	52	22.5	7.1	6.9	1.45	2.49	0.32	0.003	11.20

Table 2: Analysis of litter

	Analysis type (%)						
Litter type	N	C	C/N	P	K	Ca	Mg
Aleppo pine	1.03	27.30	26.50	0.01	0.21	6.55	0.20
Mixed litter	0.99	25.50	25.76	0.07	0.20	6.10	0.20

Table 3: Analysis of soluble needles of Aleppo pine

Analysis type	pH	C(%)	N (%)	NH_4 (ppm)	NO_3 (ppm)	C/N	P (%)	K (%)	Ca (%)	Mg (%)
Results	5.62	1.46	0.04	4.55	27.44	36.50	0.05	0.02	0.89	0.008

Table 4: Mineralomass plants before the experiment

	Elements (%)		
Parts	N	P	K
Aerial	6.9	1.32	0.52
Underground	2.9	1.39	1.64

Water soluble pine needles

Extraction technique (soaking in cool water): To simulate rainfall-leachates Aleppo pine, we used the technique of soaking in cool water and the plant material to extract soluble litter. This extraction was done using a mixture of distilled water and bedding not crushed and dried at room temperature (T = 20°C). In our experimental conditions, the extraction ratio litter/ distilled water was fixed at 1/10, getting close to that used in the work of Becker and Draper (1985).

Chemical composition of water-soluble: After stirring for one hour and incubated overnight, the aqueous extracts were filtered through millipore membranes and then subjected to chemical analysis whose results are shown in the Table 3.

pH measurement of water soluble (aqueous extracts) was performed by a pH meter. An organic carbon solution is determined by the method of Walkley-BLACK. This method is based on carbon oxidation by potassium dichromate (K2Cr2O7) in sulfuric acid.

Total nitrogen was determined by Kjeldahl method, while the inorganic nitrogen was determined by the technical and Gouny Drouineau (extracted with KCl solution M). Chemical elements (Ca, Mg, K) were determined by atomic absorption spectrophotometry and phosphorus by the method JORET - HEBERT (Ghanem, 1997).

Pine seedlings: In this experiment, we used young Aleppo pine seedlings raised in nurseries at the Institute of Agronomy of Batna and from seeds selected and processed at the nursery near Ain Touta Tamarins (wilaya of Batna).

At the start of the experiment, the age of these seedlings was 45 days. The analysis of plant material for the determination of the nutrient content of air and root systems was carried out before planting and at the end of the experimental period (5 months). The analytical results of the seedlings before experiments are shown in Table 4.

METHOD OF STUDY AND ANALYSIS

Planting technique: Potting vegetation: For this experiment, we used plastic pots. To differentiate them easily, we took them in different colors. Their dimensions are as follows:

- **Depth:** 21.5 cm
- **Diameter from the top:** 22.8 cm
- **Diameter of the bottom:** 13 cm

EXPERIMENTAL PROTOCOL

Modes of treatment: To promote a healthy pace of plant development, conduct regular observations of practice and monitoring of growth, we placed the plants in a greenhouse. These were divided into 3 lots, a witness and two treatments corresponding to the effect of two different litters. In each pot we brought 5 kg of soil sieved to 2 mm and 4 were transplanted seedlings of Aleppo pine. The treatments employed were:

- **Treatment 1:** Ground (no litter)-Aleppo pine seedlings-distilled water
- **Treatment 2:** Soil-litter Aleppo pine-pine seedlings-soluble pine needles
- **Treatment 3:** Soil-mixed litter (pine and oak)-pine seedlings-soluble pine needles

The experiment was spread over a period de150 d ays and each treatment resulted in 5 repetitions.

Fashion watering plants: To simulate the effect of vegetation cover in this experiment, we watered the seedlings into the soil-litter leachates with pine needles, whereas in the control systems we used distilled water. Watering frequency was set at an irrigation per week and the amount of water applied in each pot was 600 mL per irrigation which corresponds to a moisture content equivalent to 80% capacity retention soil water.

ANALYSIS AND MEASUREMENTS

Soil analysis: To assay the total elements (Na, K, Mg and Ca), we used a hydrolysis triacid consisting of a ground attack by a mixture of sulfuric acid (H2SO4), hydrochloric acid (HCl) and perchloric acid (HClO4).

As for the determination of total phosphorus, we used a diacid hydrolysis with nitric acid (HNO3) and perchloric acid (HClO4) with a ratio of 1/5.

The total calcium content is achieved by calcimeter BERNARD. As for the exchangeable cations and CEC, their analysis was performed after removal of these bases (Ca, Mg, K and Na) with a solution of ammonium acetate (pH 7).

Analysis of litter: For analysis of total nitrogen, we used the Kjeldahl method, whose principle is to transform, through mineralization, organic nitrogen to ammonium sulfate (Duchaufour, 1970).

The determination of mineral elements (K, Mg, Ca) was done using the atomic absorption spectrophotometer, after calcination of samples at the muffle furnace. These same samples were used to determine phosphorus by the method of JORET-HEBERT.

Analysis of nutrient content: The study of nutrient content (N, P, K) was performed on samples of seedlings previously dried in an oven (105°C). This analysis also required a calcination of these samples in muffle furnace and was followed by a mix of these different chemical elements using the same methods as those used for the analysis of litter.

Measurement of seedling growth and biomass: The vegetative parameters that we have quantified the dry weight of aerial part, dry weight of the underground part, the collar diameter and stem length. These measurements were performed on both seedlings developed in the presence of monospecific litter in the presence of mixed litters.

After a follow-up period of growth and development of seedlings which lasted five months, was taken to the separation of the aerial part of the underground part and drying plant material obtained in an oven (T = 105°C). This material has subsequently been the subject of several weighings to determine the dry weight of aerial systems and underground systems of pine seedlings.

RESULTS AND DISCUSSION

Effect of the nature of bedding on the behavior of Aleppo pine seedlings

Effects on seedling growth: We see from the results shown in Table 5 that the pine seedlings, subjected to single-species litter, have a better shoot growth compared to those developed on mixed litter (pine, oak) with respective results of 11.84 and 11.27 cm. However, this growth was significantly lower in the control soils, not subject to the effect of organic matter.

Measurements of collar diameter also revealed differences in radial growth with 1.96 cm for litter monospecific pine and 1.89 cm for the mixed litters.

This difference in growth, although slightly lower, could be due either to the acidic nature of organic compounds including pine leaching is faster and seem to favor a better solubilization of chemical elements in the soil surface or the amount of nutrients contained in the water-soluble. This phenomenon of growth can also be related to action myccorhises whose development is favored in acidic organic medium (Boullard, 1968; Dommergues and Mangenot, 1970; Mangenot and Toutain, 1980).

This may also be due to the synthesis of phytohormones by the microflora whose metabolism is intensified by the contribution of single-species litter.

Effects on biomass and volume index: The effect of the nature of the litter results in obtaining a higher biomass in the presence of monospecific pine litter. Thus, the weight of the aerial part (stems) reached as a result of litter and litter mixed monospecific, respectively 1.8842 g and 1.6656 g, while that of underground parts (roots) is respectively 0.8849 g and 0.5488 g (Table 6).

Volume for the index, we note a greater value of this parameter under the effect of single-species litter (0.4018 and 0.4548 cm^3). In soil systems alone, these two parametersshow lower values than those obtained in the soil-litter (Table 6). This increase in biomass would be related to greater metabolic activity of the plant, itself driven by the accumulation of nutrients as easily assimilable organic debris from having undergone leaching by water or microbial decomposition. These nutrients can also be the result of microbial synthesis in the soil.

The relative importance of the influence of litter on the behavior of seedlings (growth and biomass), statistical analysis, based on the Newman-Keuls test, allowed the following classification:

- Monospecific litter in Class 1 which is higher than the mixed litter in Class 2. There would be an effect "nature of the litter" very significant on the behavior of plants

Table 5: Growth of Aleppo pine seedlings in different systems

	Traitement type		
Measure	Soil (witness)	Soil-litter of Aleppo pine	Soil mixed litter of Aleppo pine and Holm oak
Collar diameter (cm)	0.13	0.196	0.189
Stem length (cm)	8.33	11.84	11.25

Table 6: Biomass and volume indices of Aleppo pine seedlings in different systems

	Traitement type		
Measure	Soil (witness)	Soil-litter of Aleppo pine	Soil-mixed litter of Aleppo pine and Holm oak
Dry weight of the aerial part (g)	0.8845	1.8842	1.6656
Dry weight of underground part (g)	0.6271	0.8849	0.5488
Volumic index (cm^3) $D^2.L$	0.1090	0.3510	0.3120

Table 7: Content of mineral elements of Aleppo pine seedlings

	Seedlings					
	Air system (stems)			Underground system (roots)		
Litters	N (%)	P (%)	K (%)	N (%)	P (%)	K (%)
Witnes soil (no litter)	3.9	0.04	0.11	3.15	0.14	0.10
Soil-litter of Aleppo pine (monospecific)	4.1	0.17	0.11	3.40	0.26	0.12
Soil-mixed litter (Aleppo pine + Holm oak)	4.4	0.06	0.09	3.60	0.15	0.09

Effects on nutrient content: Concerning the parties mineralomass root and stem, the analysis in Table 6 shows that single-species litter induce better mineral nutrition of plant phosphorus, potassium and magnesium compared to mixed litters that seem to favor better nutrition plant nitrogen and calcium.

Thus, the nitrogen content of stems grown in soil-litter monospecific reached 4.1, against 4.4% in shoots developed in the soil-litter combined (Table 7). In roots, the nitrogen content is 3.4% for the ground system-monospecific litter and 3.6% for the ground system-mixed litter. This relative decrease in nitrogen retention by the plantlets developed on monospecific litter is probably due to a somewhat reduced nutrition could be related to inhibition of nitrifying bacteria from soil by water-soluble extracts of the litter of coniferous (pine). In contrast, mixed litter, because it contains compounds derived from deciduous species (oak), promotes improved dynamics of the element nitrogen in the soil.

For phosphorus, we note a better fixation of this element seedlings found in the soil-pine litter. This is due to better nutrition, phosphorus, itself promoted by high solubilization of this element, either by water-soluble acidic litter (Haddouche, 1999) or by the telluric microflora.

CONCLUSION

This study examined the influence of forest litter on the behavior of young seedlings of Aleppo pine in order to clarify the interaction aspect bioédaphiques factors - regeneration of forest stands, using growing pot technique as an experimental model.

First, it is clear from this study that the effect litter translates, in general, behave better in the aspects of seedling growth, biomass production and mineral nutrition.

Secondly, it is noted an increased effect of monospecific litter Aleppo pine on the radial and vertical growth (height), biomass density and the index of seedlings. This influence is also reflected in better nutrition and greater plant nutrient content, particularly for phosphorus and potassium. However, nitrogen and calcium appear to be better absorbed by the seedlings developed in the soil-mixed litters (pine and oak). This demonstrates that in the monocultures, there may be a better nutrient dynamics and biological activity, mainly fungi in soils, promoting better behavior of seedlings and thus a larger stand regeneration.

Following this study, it is clear that allelopathic effect in relation to the nature of forest stands (coniferous or mixed) does not seem to occur in the pine forest ecosystem type or oak pine forest. It would be wise to consider in future work, the effects of age of forest litter on the behavior of seedlings.

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