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SUMMARY

Since fire is an important factor in the Mediterranean regions and *Ceratonia siliqua* a dominant plant, we decided to study three aspects of their relation i. e. the germination of its seeds after fire, the possibility of toxins presence in the soil under *C. siliqua* before and after fire and its flammability.

Results showed that: the thick and hard seed-coat is not an adaptation to fire, there are no toxins under *C. siliqua* trees. Flammability is mainly influenced by two factors: moisture content, and branch-age during the growth period.

INTRODUCTION

Fire is integrally connected with mediterranean type ecosystems. This is easily understood by observing the very efficient adaptations that plants living in such ecosystems have developed and by which they survive after fire (SHANTZ, 1947).

We can discern two main types of such adaptations. The first type occurs in plant species that after fire regenerate only by resprouting (obligatory resprouters), the second in plant species that after fire regenerate by abundant germination of their seeds. The stimulation of seed germination by fire in the second type of regeneration does not exclude the possibility of regeneration by resprouting; this is the reason why these plants are referred also as facultative resprouters.

The evergreen sclerophylls that dominate in the maquis ecosystems belong to the first type (obligatory resprouters), while in the second type (facultative resprouters) belong all the plant species that bear adaptations for the summer stress of water scarcity, by means of seasonal dimorphism. These plants dominate in phryganic ecosystems.

The activation of seed germination by fire is attributed to the following reasons (MARGARIS, in press):

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(2) Laboratory of Ecology, University of Thessaloniki, Greece.

1. Fire scarifies the seed-coats resulting in their imbibition with water.
2. Inactivation of heat-sensitive germination inhibitors present in the soil.
3. Increase of the Red/Far Red ratio due to the elimination of the leaf canopy by fire.

Ceratonia siliqua as an evergreen sclerophyllous plant, regenerates after fire by resprouting. The presence, however, of hard seed-coat in its seeds show probably an adaptation by which this plant makes an increasing germination after fire. The presence or not of toxins in the soil under *C. siliqua* before and after fire is a problem which has not yet been answered. Also nothing is known about the flammability of this plant.

In the present contribution we are trying to give an answer in the previous questions.

MATERIALS AND METHODS

The seeds of *C. siliqua* were collected in April 1978 at the campus of the Athens University near mount Hymettus, from the plants and from the ground under the plants. At the same time we collected soil and litter under *C. siliqua* and we transported it to the laboratory.

For the germination experiments *C. siliqua* seeds were put after treatment with fungicide, into petri dishes (10 cm diameter) on two sheets of filter paper, covered with another one, and imbibed with 8 ml of tap water.

Soil and seeds were heated at a Gallenkamp oven. For the experiments of *Zea mays* cultivation on heated and unheated soil, we used the hybrid I.S. 400.

Zea mays seeds were planted in plastic pots of 17 cm diameter and 9 cm height; each pot contained heated or unheated soil to the 7 cm height. All the germination experiments were run in a long day room (day: 16 hrs, $27 + 2°$ C, night: 8 hrs, $23 + 2°$ C).

For the flammability experiments was used a Thermolyne, type 1500, furnace. Time was measured in seconds, from the moment the branch was put in the furnace till the appearance of flame.

RESULTS AND DISCUSSION

1. The effect of fire on seeds

As it is mentioned in the introduction, the thick and impermeable to water, seed coat of *C. siliqua* makes us think, that it probably is an adaptation to the frequent fires. To test this hypothesis in the first series of experiments we cut the tip of the seeds, and then we checked their germination.

We observed a dramatic increase in the germination percentage from 20 % to 90 %. It is sure therefore that the non-germination of *C. siliqua* seeds is mainly due to the thick, non permeable to water seed coat. But in the following series of experiments where the seed coat was scarified by heating there was no activation of germination (Table I).

We conclude therefore that the hard, thick seed-coats of *C. siliqua* are not an adaptation to fire.

TABLE 1 — Germination percentage of C. siliqua seeds under various treatments

<table>
<tr><th>Temp °C / Time min</th><th>60</th><th>80</th><th>100</th><th>120</th><th>140</th><th>UNTREATED SEEDS</th><th>SEEDS WITHOUT TIP</th></tr>
<tr><td>30′</td><td>5</td><td>0</td><td>0</td><td>0</td><td>0</td><td rowspan="2">20</td><td rowspan="2">90</td></tr>
<tr><td>60′</td><td>20</td><td>5</td><td>0</td><td>0</td><td>0</td></tr>
</table>

2. Toxins in the soil under *C. siliqua* and their inactivation by fire

To test this hypothesis we conducted two series of experiments. In the first the soil was heated at 120° C for 30 min. and then planted with *Zea mays* seeds. In the following days we measured the height of the above ground parts of *Zea mays* seedlings and thereafter we compared it with that of seedlings grown on soil taken under *C. siliqua*.

Results are shown in Fig. 1. Using the t-test, we conclude

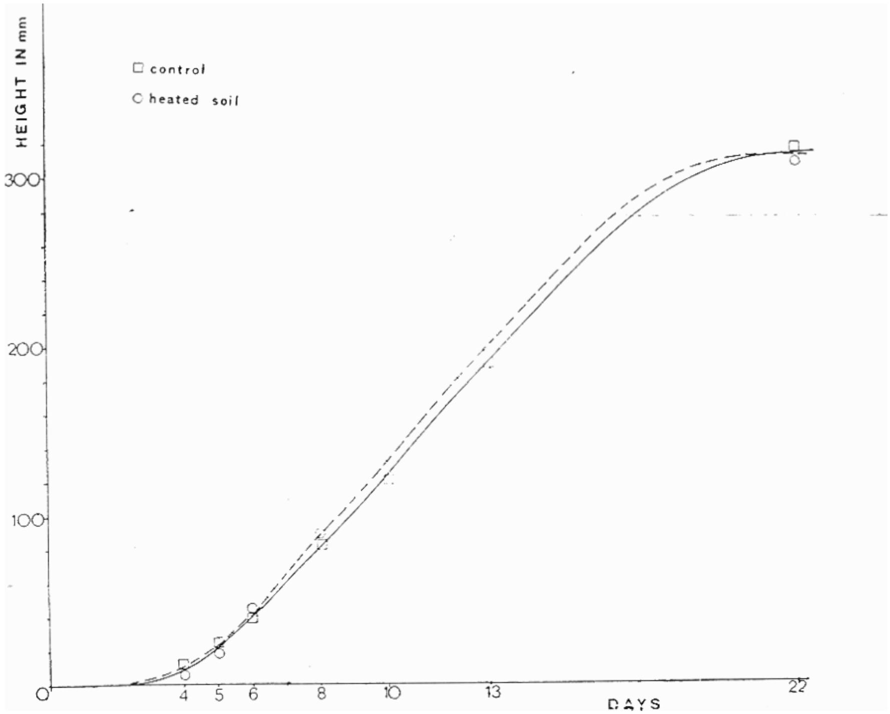

Fig. 1 — Growth response of *Zea mays* seedlings in heated soil.

that there are not significant differences between the growth of *Zea mays* seedlings in the two differently treated soil samples at the 0.05 level.

The second series of experiments was conducted in order to test the possible presence of toxins in the litter of *C. siliqua*. In these experiments we measured the growth of *Zea mays* seedlings on soil in which we had added pulverised litter of *C. siliqua*. The results are shown in Fig. 2, from which we conclude, again using the t-test that there are no differences in the growth between the seedlings grown in soil with litter and those grown in a heated mixture of soil and litter.

The above mentioned data show that there are no toxins in the soil under *C. siliqua* which are inerted by fire, at least when using *Zea mays* for the bioassay.

TABLE 2 — Ignition times (in seconds) for new and old branches at the two seasons for the three humidity levels

°C	APRIL					
	FRESH		OVEN DRIED		WATER SATURATED	
	NEW	OLD	NEW	OLD	NEW	OLD
450	char.	char.	char.	char.	char.	char.
500	char.	char.	2.7	4.9	char.	char.
540	char.	15	1	3	11.9	14.3 2 charred
580	7.7	9.1	-	1.9	11.3 2 charred	7.8
650	6	7.1	-	1	6.7	7.4
700	3.5	4.1	-	-	3.9	5.4
750	3.1	3.4	-	-	3.6	4.1
AUGUST						
450	23	27.67	char.	24.5	char.	char.
500	11	11	6.5	3.5	char.	14
550	8.6	6.8	2.5	3.12	11.5	12
600	7.8	6.7	1.9	1.8	10	8.5
650	5.1	4.6	-	-	8.5	7.2
700	4.1	3.3	-	-	6	4.7
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

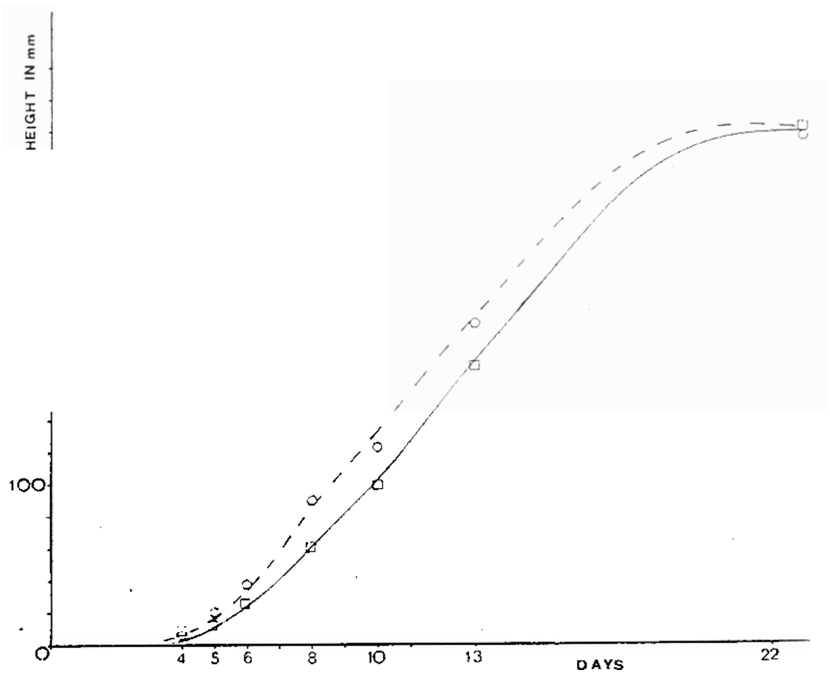

Fig. 2 — Growth response of *Zea mays* seedlings in heated soil with litter. Squares, control. Circles, heated soil and litter.

3. Flammability

C. siliqua is found in the hot regions of the Mediterranean climate. For this reason we decided to study its flammability during the warm and humid month of April and the hot and dry August, at three moisture levels:

1. Immediately after cutting the branches when the moisture content is the normal one of the tree.
2. After water saturation of the branches for 24 hrs. at room temperature.
3. After 24 hrs. of oven drying at 60° C

The experiments concerning flammability were carried on both old and new branches.

Results are inserted in Table II. From these we conclude the following:

1. In each treatment there are no statistically significant differences at the 0.05 level between the ignition times of April and August branches; a fact which can be attributed to the same moisture level into which the samples are brought.

   The only exception is exhibited by the old branches, tested immediately after cutting. In this case the ignition time of April is longer than that of August, probably because of the high water content during April.

2. When we compare the ignition times of the new and old branches of the same month, under the three different treatments, we conclude that:

a) In August there are statistically significant differences between the ignition times of fresh and water saturated branches. This is due to the water stress to which the tree is subjected at this period.

b) The difference between the ignition times of new and old branches of the same month is statistically significant at the 0.05 level only in April, both in «fresh» and «oven-dried» conditions; this phenomenon is not observed in August probably because the new branches have matured.

Although it could be expected for the ignition time of the old branches to be shorter than that of the new ones, because of their low ash content (MONTGOMERY and CHEO, 1969), results show the opposite. This fact can be attributed either to their low content in ether soluble substances (MUTCH, 1964) or to their high mineral content (PHILPOT, 1967, 1970).

From these two hypotheses we can retain only the second because other workers (KING and VINES, 1969, TRABAUD, 1976) claim that essential oils (part of ether soluble substances) influence the combustion behaviour but not the ignition time.

ACKNOWLEDGEMENTS

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