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STUDIES REGARDING THE INFLUENCE OF SOME ESSENTIAL OILS ON MAIZE CROP DEVELOPMENT

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Abstract: Maize crop (*Zea mays*), within most of agricultural areas in Romania, does not meet favorable climatic conditions. The main abiotic problems encountered by maize crop are related to the low soil temperatures during germination and reduced amount of rainfall during the formation and maturation of caryopses. In order to mitigate the negative impact of these factors, in this study it was investigated the possibility of corn seed treatment with essential oils dispersion of *Ocimum basilicum*, *Thymus vulgaris*, *Rosmarinus officinalis* and *Anethum graveolens*. The evolution of maize crops from sowing to harvesting highlighted the beneficial role of essential oils treatments, increasing crop yield with approximately 650 kg grains per hectare, by using 20-40 ml of essential oil for 20 kg of seed.

Key words: *Zea mays, essential oil, sub-optimal, germination*

INTRODUCTION

The climatic conditions for Romania, beginning with 1950 to the year 2000, were not very favorable in terms of temperature during maize seeds germination and the precipitation level during July and August. The optimal minimum temperature according to FAO (Ecocrop, data sheet) data for maize crop is 18ºC and the annual precipitation level should exceed 600 millimeters. These requirements are also reflected in the statistics of the National Institute of Statistics (INS, 2015, 2016) where the average yield per hectare is 3600 kg/ha. There are examples where almost 10000 kilograms were obtained per hectare (Agrointel, Elsit farm, 2016) under non-irrigated conditions, using imported hybrids with high germination under sub-optimal temperatures and drought-resistant. But these crops cannot be sustainable without crop rotation with plants that have low water requirements. By using corn hybrids with highly developed radicular system, which can penetrate the soil up to 200 cm depth (Borg & Grimes, 1986), it can be obtained high yields, but with a significant decrease of the water reserve for the next crop.

In this study it was assessed the possibility of intervention on seeds obtained from the autochthonous breeding programs with essential oils (EO) based treatment before sowing in order to accelerate the germination and the metabolism orientation to achieve a more vigorous root system.

MATERIALS AND METHODS

For this experiment it was used the double hybrid corn Turda 200 (FAO 290), which is early maturing plant. The experiment was placed in the experimental field of Research-Development Institute for Plant Protection Bucharest after a previous culture of *Helianthus*

tuberosus. The experimental model was composed of three test variants and two control variants in four replications and had the following timeline of the agro-technical works:

1. 10.04.2017 - plowing at the depth of 25 cm and tilling,
2. 12.04.2017 - seed treatment in the laboratory,
3. 13.04.2017 - sowing at 25 cm per row and 70 between rows,
4. 02.05.2017 - assessment of the emergence,
5. 21.07.2017 - evaluation of the plant height,
6. 31.07.2017 - measurement of the chlorophyll content index,
7. 13.09.2017 - harvest evaluation.

Throughout the experiment, the relative air temperature and precipitation were recorded at one-hour intervals with the T707 weather station (VAISALA WXT-510 combined transducer). Seed treatments were performed with a dispersion of 95% water and 5% essential oil, together homogenized with 0.2% agar (Remmal et al., 1993). Commercially essential oils of the following species have been used: *Ocimum basilicum* (8LOT16031), *Thymus vulgaris* (9LOT160205), *Rosmarinus officinalis* (1LOT160310) and *Anethum graveolens*. The amount of essential oil used in the seed treatment was calculated by reference to the mass of dry corn seed. The administered doses were 1000µl of EO/kg corn kernels. Seed treatment was performed in Petri dishes loaded with 50 seeds previously untreated. For experimental variants treated with essential oil, were added 253.4 µl of EO-water dispersion/50 seeds and 4ml of water for homogenization and soaking, and for water treated control only 4ml of water. The treatment duration was 24 hours. Measurement of stem height was performed with a laser telemeter from the tip of tassel to the ground. The total chlorophyll content index (CCI) determination was performed with the CCM-200 plus device on the third leaf from the tassel in the middle of the leaf and on the right side of the primary vein.

RESULTS AND DISCUSSIONS

The corn emergence (Figure 1) was favored mostly by the use of *Anethum graveolens* essential oil as a result of the antimitotic effect at values ranging between 500 and 1500 ppm (Khaldi et al., 2015). The high corn emergence percentage for the water-treated control may be due to optimal soak within 24 hours at 20°C before sowing. The reduced size of plants (Figure 2) treated with essential oils could be a result of induced effect of these extracts, which favor the development of the radicle at the expense of the hypocotyl in the first germination phases. The total chlorophyll content index (Figure 3) was highest at emerged plants from water treated seed, the other variants, including untreated control, had close values. However, it can be noticed that the chlorophyll content index is slightly higher in variants with a lower percentage of emergence. This indicates the appearance of a limiting element in the soil. Grain yields per hectare (Figure 4) were higher for each variant compared to the untreated control. The highest yield was recorded in the control treated only with water, exceeding the untreated control by almost 1000 kilograms per hectare. The yield of the untreated control was in agreement with the level of precipitation (Figure 5) collected by the soil during the sowing-harvesting period, so for 420 L/m^2, the forecast production was around 4431 kg/ha according to the following formula: Maize kg/ha = (available water x 10.55 x soil nutritional favorability)/100. Regarding the relative air temperature (Figure 6), maize culture started around an average of 14°C and ended around the average of 20°C. By calculating the soil temperature at a depth of 10 cm depending on the air temperature using the formula of Khandaker et al. (2015): $T_{soil\ 10\ cm} = 6.224 + 0.842 * T_{air}$, the value of 18ºC was determined. This temperature corresponds to the optimal minimum temperature indicated by the Ecocrop parameters.

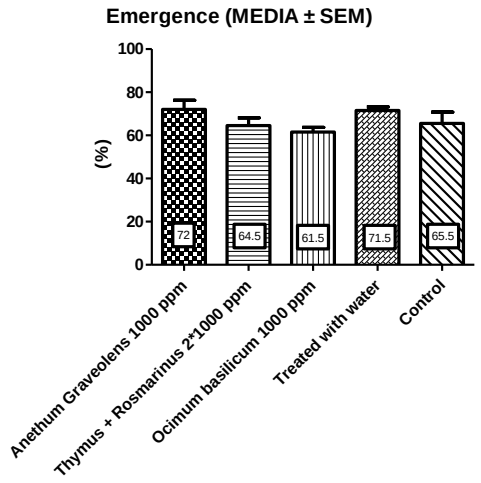

Figure 1. Emergence at 19 days

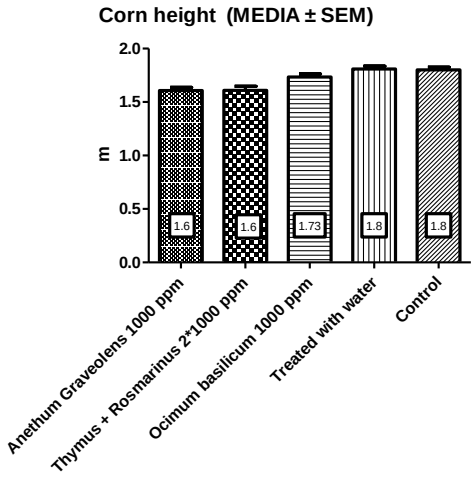

Figure 2. Corn height at 99 days

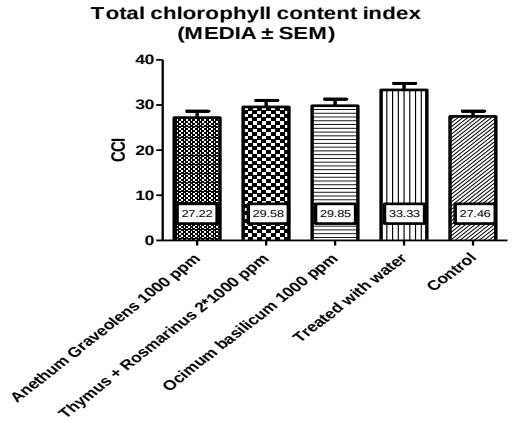

Figure 3. Total chlorophyll content index at 109 days

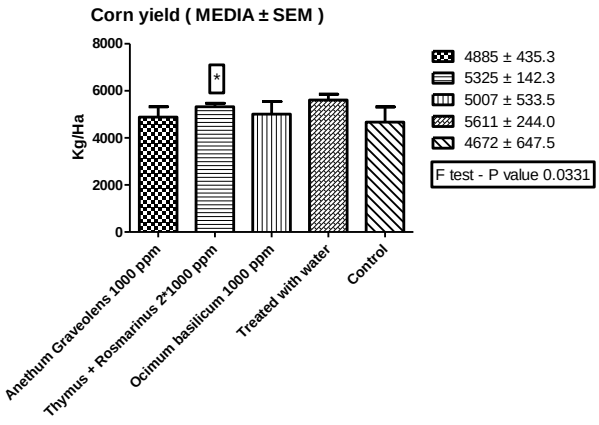

Figure 4. Corn yield at 153 days

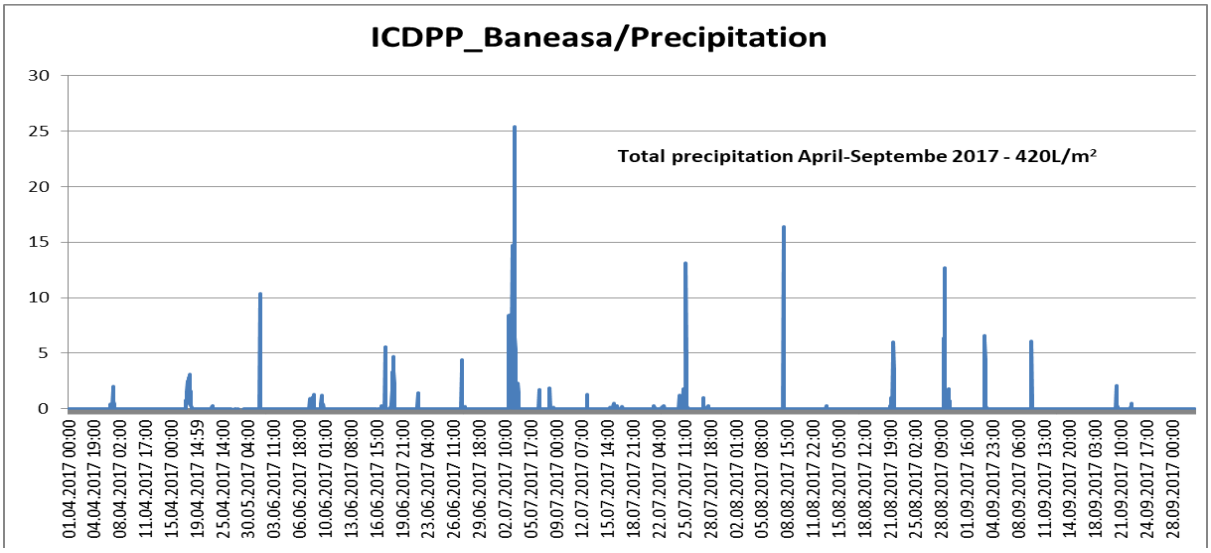

Figure 5. Total precipitation during agricultural season of corn

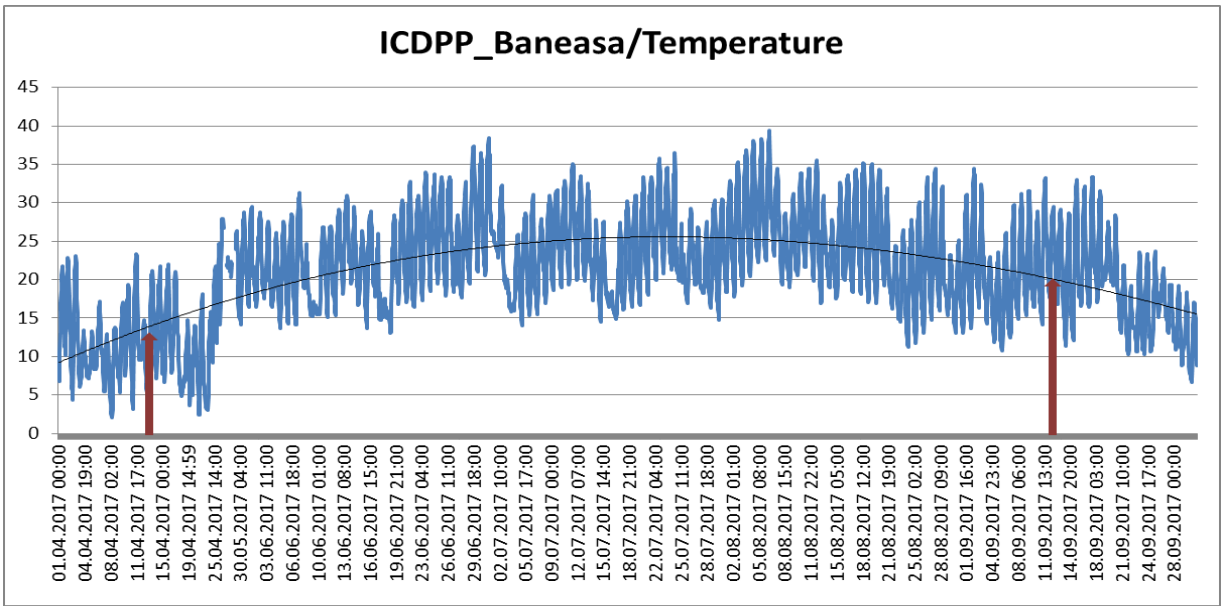

Figure 6. Temperature during agricultural season of corn (left arrow – sowing, right arrow- harvest

CONCLUSIONS

The use of essential oils in the treatment of corn kernels before sowing has produced changes in germination, which have propagated during the entire vegetative period. Seed treatment with water alone produced good yield (5611 ± 244 kg grains per hectare), but had a frequency of *Ustilago maydis* attack of 4%. Using 20 ml of thyme essential oil and 20 ml of essential oil of rosemary to treat 20 kg of maize seeds, a harvest of 5325 ± 142.3 kg grains per hectare can be obtained, which represents a 14% production increase compared with untreated controls. The low yield obtained in this experiment compared with Turda 200 hybrid performance it may be due to the *Helianthus tuberosus* precursor culture, the lack of autumn plowing and low potassium level in the arable layer 0-25 cm (36.83 kg K^+/ha).

Using the specific consumption of K^+ (33.2 kg/1000 kg of corn) and the potassium soil content in the 0-25 cm layer, it can be concluded that the root system in the case of untreated control penetrated the soil up to a depth of approximately 100 cm, and 120 cm in the case of sample treated with a mixture of thyme and rosemary essential oils.

Analyzing the low average standard error in the case of the tests in which the mixture of essential oils was used, it can be concluded that this treatment induce a character of uniformity and can substitute antifungal treatments prior sowing seeds.

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