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The effect of some organic acid and plant-derived material treatments on the germination and emergence of lettuce

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Abstract The research was carried out to investigate the effect of plant materials which are used as an alternative to the synthetic chemicals in organic farming (thyme, mint, basil and garlic oil, hot pepper, and neem tree seed extract) and some organic acids (salicylic and jasmonic acid) on the germination, emergence, and seedling characteristics in lettuce (*Lactuca sativa* L.) cv Arapsaçı. The seeds of lettuce treated with these materials were subjected to germination and emergence tests at temperature 20±1 °C and 60±5 % RH in autumn period. After that, all seeds (including untreated) were kept at 5±1 °C and again checked for germination, emergence, and seedling characteristics in spring period. Thyme oil affected negatively the germination and emergence, and also, the infected seed ratio increased. Although the infection ratio was 1 % in untreated seeds, it was 7.8 % in the seeds treated with thyme oil. After the storing period, infection ratio of thyme oil was 8.5 % which was higher than other treatments. There was no significant effect of treatments on seedling characteristics.

Keywords *Lactuca sativa* · Seed · Organic treatments

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Introduction

Lettuce is widely grown both in the field and greenhouse as salad vegetable in all over the world also in Turkey. On the other hand, the size of organically cultivated area in Turkey has reached 614,000 ha and Turkey is one of countries which have the highest increases to the area of organic farming all over the world (Willer and Lernoud, 2013).

Because synthetic-chemical use is forbidden in organic agriculture, some physical and biological methods aimed at the control of seed-borne pathogens are being investigated. There are some physical seed treatment methods like hot water, hot (humid) air, and electron beam, but they are required special equipments and have the potential to damage the seed if they are not applied at an appropriate dose (Nega et al. 2003; Wolf et al. 2008). The potential alternative seed treatments (microorganism, plant extract, and inducer of resistance) have been developing against the different seed-borne pathogens and for mitigating the impact of stress conditions (Groot et al. 2004; Hammer et al. 1999; Klessig and Malamy 1994). However, limited information is currently available dealing with their effect on germination and seedling quality. The aim of this research was to evaluate the effect of these materials on germination, emergence, and seedling quality of lettuce.

Material and methods

The essential oils and plant extracts which were used in this research were selected on the basis of their reported

Table 1 Effect of different seed treatments on germination percentage (GP) and mean time germination (MTG) in autumn and spring periods

	GP (%)		MTG (days)	
Treatments	Autumn	Spring	Autumn	Spring
Thyme oil	92.00	85.75b	4.55b	3.71a
Mint oil	92.00	93.50a	4.20c	3.67a
Basil oil	93.25	94.50a	4.13cd	3.48b
Garlic oil	91.75	95.50a	4.05cd	3.49b
Hot pepper extract	97.50	93.50a	4.10cd	3.37cd
Neem seed extract	94.75	94.50a	4.08cd	3.31d
Salicylic acid	92.25	94.25a	4.01d	3.38bcd
Jasmonic acid	94.75	97.00a	4.86a	3.71a
Non-treated	94.50	96.25a	4.11cd	3.47bc
Significance	ns	*	**	**

There is no statistical difference between the averages with the same letter

ns not significant

Significant at *$P \leq 0.05$, **$P \leq 0.01$ (according to *t* test)

antimicrobial properties against a number of pathogens (Blum et al. 2006; Hammer et al. 1999). These natural agents are allowed in organic agriculture. The lettuce seeds had not been treated with any chemicals.

The essential oils were provided from local seller of herbs. The aqueous extracts of hot pepper and neem seed were prepared. For this, neem tree seeds were firstly separated from the fruits. Then, seeds were crushed and mixed with an equal amount of deionized water (*w*/*w*) and the mixture was filtered. One liter of deionized water was added to 10 ml of filtrate. Prepared aqueous extract derived from hot pepper fruits were used at 10 ppm dosage. The organic acids were obtained from Sigma-Aldrich (Interlab Inc. İstanbul). A suspension of essential oils was prepared by dispersing 10 ml amount of essential oil in 1 l of sterile deionized water. The seeds were soaked in water including 10 ml/l oil, extract, or acid for 0.5 h at room temperature except jasmonic acid (1 ml/l). After treatment, seeds were dried for 1 day on a clean cloth under laboratory conditions.

For emergence test, seeds were sown into multi-cell plastic pot (each cell having 30-ml growing media). The properties of peat used as growing medium were as follows: 100–300 ppm N, 100–300 ppm P_2O_5, 150–400 ppm K_2O, pH 5.4–5.9, and electrical conductivity 350 μS/cm. For germination test, each combination of four replicates of 100 seeds was placed on two pieces of Whatman 1 filter paper moistened with distilled water into a 9-cm glass petri dish. petri dishes were placed in incubator at 20±1 °C, 60±5 % RH with a photoperiod of 16:8 h (light/dark). Radicle protrusion to 1 mm was scored as germination. Seed germination was recorded

Table 2 Effect of different seed treatments on emergence percentage (EP), mean time emergence (MTE), and infected seedling ratio (ISR) in autumn and spring periods

	EP (%)		MTE (days)		ISR (%)	
Treatments	Autumn	Spring	Autumn	Spring	Autumn	Spring
Thyme oil	84.00	85.75	7.69ab	9.94	7.75a	8.50a
Mint oil	71.00	80.50	7.43bc	8.99	2.00b	3.50b
Basil oil	79.00	90.25	7.40bc	8.60	1.00b	3.25b
Garlic oil	81.00	87.50	7.37bc	8.32	1.33b	2.25b
Hot pepper extract	90.00	84.50	7.07c	9.11	1.50b	4.25b
Neem seed extract	95.00	88.75	7.09c	7.87	1.00b	2.75b
Salicylic acid	82.50	90.00	7.57bc	8.40	2.00b	2.75b
Jasmonic acid	75.50	87.50	8.17a	9.04	1.66b	4.00b
Non-treated	76.50	90.25	7.69bc	8.32	1.00b	2.00b
Significance	ns	ns	*	ns	**	*

There is no statistical difference between the averages with the same letter

ns not significant

Significant at *$P \leq 0.05$, **$P \leq 0.01$ (according to *t* test)

at 24-h intervals, and germinated seeds were removed from the petri dishes. The seeds were stored at 5±1 °C for 6 months. Afterwards, the experiment was repeated to determine the efficacy of different treatments after storage in spring growing season.

The diagnosis of diseases was made by Prof. Dr. Nuray Özer (Department of Plant Protection, Namık Kemal University) during trials. The experiment was arranged to completely randomized design with four replicates. Arcsine transformation of germination or emergence percentage values was used to stabilize variance. The values were analyzed using analysis of variance followed by a LSD mean separation tests.

Results

There was no statistically significant difference among treatment regarding germination percentage in the autumn period, but seed treated thyme oil had the lowest germination percentage in spring and the seeds treated with other materials responded similarly (Table 1). The thyme oil led to the lowest germination percentage with 85.75 %, while other treatments took part in the same important group (ranged from 97.00 to 93.50 %).

In autumn, the mean time germination/emergence was significantly increased after treatment with jasmonic acid compared to other materials (Tables 1 and 2). Significant differences among treatments were not observed in terms of mean time emergence in spring. The seedling quality properties like seedling length, seedling weight, and vigor index were not adversely affected by any of the treatments (data not shown).

The seeds treated with thyme oil have the highest percentage of infected seed. When taking into account the germination, emergence, seedling properties, and infection ratio, best results were obtained from seeds treated with neem tree extract (Tables 1 and 2).

Discussion

As similar to results concerning mean germination time, Blum et al. (2006) stated that there was no indication of a positive effect of seed treatment with plant strengtheners on parsley or dill concerning a better germination rate of emergence.

Although thyme oil, among essential oils tested, exhibited the highest in vitro inhibitory activity against seed-borne pathogens (Wolf et al. 2008), in this research, the seeds treated with thyme oil have highest percentage of infected seed, while infection ratio changed between 1 and 4 % in others. This may be due to high concentration and/or the lack of sufficient purity. Wolf et al. (2008) reported that cinnamon oil at a concentration of 3.3 % was damaged the cabbage seeds. Although neem is generally known to be effective against insects, it was reported by Foerster et al. (2001) that neem can be used for Fusarium wilt.

Suggestions

Based on these results, it can be stated that thyme oil extract increased the rate of infected seedling in both periods, and the neem seed extract used as an insecticide can be used against diseases without loss of quality characteristics of seedlings.

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