SEEDS GERMINATION AND SEEDLINGS GROWTH OF MAIZE IN RESPONSES TO COGERMINATION, AQUEOUS EXTRACTS AND RESIDUES OF BASIL

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Abstract

Aromatic plants are intensely explored for their potential use as allelopatically active crops. The current series of laboratory experiments was conducted to assess the allelopathic potential of basil on maize. The effect of plants was evaluated through: seed cogermination in Petri dishes, effect of aqueous extracts from fresh and dry plant biomass in three concentrations (5; 10 and 20%) in Petri dishes, and effect of dry plant residues in rates of 10; 20 and 30 g/kg of soil in the pots. The cogermination of basil seeds had non- significant effect on germination and seedlings length of maize. The aqueous extracts of basil had various effects, in higher concentration (20%) significantly reduced, while lower concentrations extracts (5 and 10%) showed stimulatory effect on maize root and shoot length. The effect of incorporation of basil residues was stimulatory effect for root length of maize.

Key words: *allelopathic effect, cogermination, basil (Ocimum basilicum L.), maize (Zea mays L.)*

INTRODUCTION

Allelopathy is an interference mechanism between receptor and donor plants and may exert either positive or negative effects [6]. The interactions that are mediated by allelochemicals and signalling chemicals take place both belowground and aboveground [14]. These activities are concentration dependent and might inhibit the growth of one plant at one concentration and might stimulate the growth at other concentration [2].

Recently, many researches around the world show their keen interest on aromatic and medicinal plants for searching new novel compounds [2, 9, 20].

Species of the family Labiatae possess strong allelopathic activity against other plant species [17].

Ocimum basilicum L. is an annual plant, member of family Labiatae (Lamiaceae), popular known as common basil or sweet basil and belongs to worldwide cultivated aromatic and medicinal plants. It contains several chemical constituents such as polyphenols, flavonoids and terpenes [24].

The main phenolic compounds in basil are rosmarinic acid, vanillic acid, lithospermic acid, coumarinic acid, caffeic acid, hydroksibenzoacid, syringic acid, ferulic acid, protocatheuic acid [13]. According to [16], phenolic compounds are but one category of the many secondary metabolites implicated in plant allelopathy.

Many workers reported allelopathic activity of *O. basilicum*. [8] found that seed germination of hoary cress was reduced when it germinated with seeds of basil, but germination of quack grass (*Agropyron repens*) was stimulated. [10] reported that water extract of *O. basilicum* up to 100 g/l inhibited dry weight of *Centaurea depressa, Abutilon theopharasti* and *Chenopodium album*.

Maize (*Zea mays* L.) is one the most important cereal crops grown in Romania and it is used as food, fodder and also utilized as a raw material in industries.

The inclusion of species with allelopathic activity in crop rotation systems, intercropping or for mulching may have benefits for crop management.

Utilization of allelopathy in cropping systems, however, will depend on better understanding of the chemical or chemicals involved and their behaviour in natural and agricultural ecosystems [17].

Due to the economic value of maize, this study was undertaken to evaluate the allelopathic effects of *O. basilicum* on *Z. maize* through seed cogermination, use of aqueous extracts and plant residues.

MATERIALS AND METHODS

Laboratory experiments were carried out the Faculty of Agronomy, University of Craiova, in 2019.

Seeds of basil (Company AGROSEL, Romania) and seeds of maize hybrid Olt (NARDI Fundulea, Romania) were used in the experiments.

All seeds were sterilized according to [23].

The effect of cogermination was investigated according to [8], in the first laboratory experiment.

Thirty seeds of basil and thirty seeds of maize (V2) were placed in Petri dishes lined with double layer of filter soaked with distilled water. Control treatments (V1) consisted of seeds of a single species (thirty seeds of maize). The Petri dishes were kept at laboratory temperature (23 °C ± 2) for 7 days.

In the second laboratory experiment, in order to obtain the basil aqueous extracts, fresh and dry aboveground biomass was ground and then mixed with distilled water according to the modified formula of [19]. This extract was filtered and diluted with distilled water to give three final concentrations of 5%, 10% and 20% (V2, V3 and V4).

Twenty seeds of maize were placed in Petri dishes lined with double layer of filter soaked with these aqueous extracts, while distilled water was used as the control (V1).

Petri dishes were maintained under laboratory conditions (temperature 23 °C ± 2) for 7 days.

This laboratory experiment was composed of four variant treatments with three replications.

In order to evaluate the effect of basil residues on maize, the third laboratory experiment was carried according to the modified method of [19].

Dry plant residues of basil in rates of 10; 20 and 30 g/kg of the soil were incorporated into the commercial substrate (V2, V3, and V4). The soil free basil residues were used as control (V1). Thirty maize seeds were sown in the each pot filled with soil.

This experiment was arranged in a randomized design with four variant treatments in three replicates, and was maintained under laboratory temperature (23 °C ± 2) for 15 days.

The roots and shoots growth elongations (cm) were recorded at the end of each experiment.

The germination percentage G (%) was calculated as:

$$G\% = \text{Germinated seeds/Total seeds X } 100$$

The inhibitory or stimulatory percent (IR) was found according to the adapted formula of Williamson and Richardson (1988):

$$\text{IR (\%)} = \frac{\text{C} - \text{T}}{\text{C}} \text{ X } 100$$

where: C – the mean value of control; T – the mean value of treatment.

IR < 0 indicates inhibition, IR > 0 indicates stimulation, and the magnitude of IR values reflects the intensity of the allelopathic effect.

All collected data was analysed statistically with ANOVA and means were compared at significant 5% level by Duncan's multiple range test.

RESULTS AND DISCUSSIONS

Statistical analysis of the data showed that the cogermination of basil and maize seeds had non-significantly affect ($p \leq 0.05$) on the studied parameters (Table 1).

The aqueous extract of basil significantly ($p \leq 0.05$) affected the root and shoot length of maize and the basil residues significantly ($p \leq 0.05$) affected only the root length of maize (Table 1).

There are no previous experimental results presenting cogermination effect of basil seeds on the germination and growth in maize seedlings.

According to [22] basil seeds reduced germination of hoary cress, but promoted shoot and root length.

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Table 1. ANOVA of studied traits of maize at cogermination and aqueous extracts of basil

Traits	Df	MS	F test
COGERMINATION			
Germination (%)	1	16.66	0.06^{ns}
Root length (cm)	1	2.40	2.23^{ns}
Shoot length (cm)	1	0.20	0.14^{ns}
AQUEOUS EXTRACTS			
Germination (%)	3	100.8	0.43^{ns}
Root length (cm)	3	13.76	4.59*
Shoot length (cm)	3	2.87	4.31*
RESIDUES			
Germination (%)	3	22.22	0.33^{ns}
Root length (cm)	3	126.61	19.99*
Shoot length (cm)	3	23.59	1.68^{ns}

MS = mean square; * = Significant at $p \leq 0.05$; ns = non-significant
Source: Own calculation.

Table 2. Effect of basil seed cogermination on germination and seedlings growth of maize

Variant	Treatment	Germination		Root length		Shoot length	
		(%)	IR	(cm)	IR	(cm)	IR
V1	Control	63.33	-	6.97	-	3.73	-
V2	Cogermination (basil + maize seed)	66.67	+5.3	8.23	+18.1	3.37	-9.6

IR = the inhibitory or stimulatory percent
Source: Own calculation.

Table 3. Effect of basil aqueous extracts on germination and seedlings growth of maize

Variant	Treatment	Germination		Root length		Shoot length	
		(%)	IR	(cm)	IR	(cm)	IR
V1	Control (0%)	63.33	-	6.97^{a}	-	3.73^{bc}	-
V2	5%	66.67	+5.3	8.10^{a}	+16.2	4.23^{ab}	+13.4
V3	10%	63.33	0	8.67^{a}	+24.4	5.00^{a}	+34.0
V4	20%	53.33	-15.8	3.87^{b}	-44.5	2.67^{c}	-28.4

IR = the inhibitory or stimulatory percent;
Different letters means significant differences at 5% probability level by Duncan's test
Source: Own calculation.

In our study, a slight stimulatory effect of cogermination was observed for germination and for root length by 5.3% and 18.1%, respectively, while shoot length was slightly reduced by 9.6% compared to control (Table 2).

[3, 5] found that sage and dill seeds in cogermination with maize showed non-significant effects on germination, but they significantly reduced maize seedlings.

On the contrary, cogermination of sweet marjoram has significantly stimulated the germination and growth of maize seedlings [4].

Aqueous extracts of basil had non-significant effect on germination of maize seeds (Table 3).

A slight effect also has been observed: the lowest concentration V2 (5%) stimulated germination by 5.3%, while the highest concentration V4 (20%) inhibited germination by 15.8%.

According to [11], germination indices are generally used to detect potential stimulatory or inhibitory allelopathic activity of the test plant, but the results of present study revealed that early seedling growth is influenced to great degree by extracts tested. [7] also reported that aqueous extract of aboveground parts of sweet basil significantly reduced germination of sorghum, millet, maize and wheat. [21] found that *Ocimum* extract at 1% inhibition germination of *Amaranthus* by 80%.

Basil aqueous extracts influenced significantly the growth of maize seedlings (Table 3).

Lower concentrations of basil extract showed stimulatory effect on roots and shoots elongation. The stimulation effect of roots ranged from 16.2% at V2 (5% concentration) to 24.4% at V3 (10% concentration), and the stimulation effect of shoots ranged from 13.4% at V2 to 34.0% at V3, compared to the control. The inhibition of maize root elongation by the higher concentration extracts (20%) was of 44.5% and the inhibition of maize shoot elongation was of 28.4%.

Thus, the lengths of roots showed more inhibition than the lengths of shoots. A possible explanation is that the permeability of allelochemicals to root is greater than to shoot [18].

These results are in accordance with other studies which reported that lower concentrations of allelochemicals generally have lesser or stimulatory effect on the plant growth, while negative effect increases with the increase in concentration [15].

According to [21], the roots and hypocotyls of chick pea, black gram, moth bean and cow pea, shows the stimulatory effect under *Ocimum* 1% leaf extract treatment, but at 10% concentration of leaf extract treatment shows inhibition for the same legumes.

Incorporated basil residues showed non-significant effect on germination and shoot length, but had a significant stimulatory effect on root length (Fig. 1, Table 4).

Fig. 1. Effect of basil residues on root and shoot seedlings
Source: Original, obtained through the laboratory experiment.

Root length was stimulated from 35.2% at V4 (30 g/kg) to 106.1% at V2 (10 g/kg) compared to the control treatment (V1).

However, basil residues slightly stimulated shoot length from 15.3% at V3 (20 g/kg) to 20.3% at V2 (10 g/kg).

On the contrary, [1] showed that reduction in weed seed emergence and growth was recorded when dry basil plant residues were incorporated in the soil, in rates of 10 and 20 g/kg.

Table 4. Effect of basil residues on germination and seedling growth of maize

Variant	**Treatment (g/kg)**	**Germination**		**Root length**		**Shoot length**	
		(%)	IR	(cm)	IR	(cm)	IR
V1	Control (0)	70.00	-	14.67^{c}	-	26.10	-
V2	10	70.00	0	30.23^{a}	+106.1	31.40	+20.3
V3	20	73.33	+4.76	22.67^{b}	+54.5	30.10	+15.3
V4	30	66.67	-4.76	19.83^{b}	+35.2	30.27	+16.0

IR = the inhibitory or stimulatory percent;
Different letters means significant differences at 5% probability level by Duncan's test
Source: Own calculation.

CONCLUSIONS

This study indicated that the basil had allelopathic potential on maize development, which varied according to how the basil was used and concentrations used. Cogermination with basil seeds had non-significant effect on maize germination and seedlings growth.

The highest inhibition of maize seedlings was observed in 20% aqueous extracts of basil.

Low concentrations (5 and 10%) of basil aqueous extracts had stimulatory effect on maize seedlings growth.

Basil residues promoted root length of maize.

As a result, the stimulating potential of lower concentrations of basil aqueous extracts and basil residues could be exploited to promote maize crop growth, but field studies should be achieved to complement the information obtained in the laboratory.

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