Scientific Papers. Series A. Agronomy, Vol. LXV, No. 1, 2022
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

EFFECTS OF APPLICATION OF VERMICOMPOST AND EXTRACT OF VERMICOMPOST IN MAIZE CULTURE IN THE EARLY STAGES OF DEVELOPMENT

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Abstract

Romania is one of the largest maize producers in the European Union. It is a crop that can be very profitable if certain requirements related to the cultivation and care of the crop. The aim of the present study was to evaluate the effect of vermicompost and vermicompost extract, on seed germination and root development of maize seedlings. Effective concentration range and the degree of stimulation varied significantly between the treatments. The obtained results show that the dose of 1 litter of vermicompost extract at 20 l/water positively influences the seed germination. Regarding the development of the roots, the dose of 1l extract of vermicompost at 5l/water recorded the best results. Regarding the use of vermicompost, the best results in terms of seed germination were the best for the incorporation into the soil of doses of 10 and 20 t/ha. The best results were obtained using the amount of 20 tons of vermicompost/ha, the corn roots having a much stronger and more developed root system compared to the other variants.

Key words*: vermicompost, extract of vermicompost, biofertilizer.*

INTRODUCTION

Traditional agriculture today is characterized by excessive inputs of chemical fertilizers, pesticides and herbicides, while the application of organic fertilizers is insufficient. Excessive use of chemical pesticides and pesticide fertilization and loss determine negative effects on the environment, soil and food pollution with waste, degradation of soil quality (Ju et al., 2009) and agricultural biodiversity (Minuto et al., 2006; Gill and Garg., 2014). According to Fred (1991), agriculture has had both positive and negative effects, and the use of synthetic fertilizers leads to the loss of the soil's natural nutrients when used on its surface. According to Katsunori (2003), inorganic fertilizers that are applied to the soil are more resistant to the environment than natural fertilizers, because they are mixed with chemicals and therefore harmful and also pose a threat to the environment, and the effects are felt on soil fertility. With the current price of chemical fertilizers and declining production of organic fertilizers due to changes in the number of animals, it is necessary to pay attention to other suitable alternatives to create this situation.

Corn can be defined as the "grain god" because of its productivity potential when compared to other grains (Umesha et al., 2014). Romania is one of the largest corn producers in the European Union. It is a crop that can be very profitable if certain requirements related to the cultivation and care of the corn crop are met. Maize is in fact a crop that requires high nutrition and also its productivity depends on proper nutrient management. Nutrient management is a vital factor affecting corn yield, as reported by Verma (2011).

Vermicompost is an organic fertilizer that can be obtained from the recovery of decomposed household waste with the help of earthworms. The process of recycling food waste ensures a natural, black, strong-smelling fertilizer, which has an extremely beneficial effect on the process of growing plants.

Vermicompost extract or aerated compost tea is considered a very good option for conventional and organic growers (Kim et al., 2015), because it increases crop productivity by introducing

microorganisms from the extract into the soil and the plant that helps maintain moisture in the plant as well as in the soil, the assimilation of nutrients from the soil, as well as the population of the soil with microorganisms.

MATERIALS AND METHODS

Preparation of plant material

The potted maize experiment was carried out in the greenhouse at the Research and Development Institute for Plant Protection Bucharest (RDIPP). The experiment took place in July 2021. 20 pots 38 cm long and 15 cm wide were used and a total of 160 kg of soil (8 kg/pot) was added to the pots. Fourteen Furti CS (360 FAO) corn seeds from 2020 were added to each pot.

For RDIPP maize experiment on the effect of applying vermicompost extract on seed germination and root length, 25 corn seeds were added to each petri dish. Maize seeds were weighed both before application of the extract and 3 days after seed germination. They stood at 23 degrees in the dark. Blue laboratory paper was used to soak them in different doses of extract.

Preparation of vermicompost and vermicompost extract

The vermicompost was obtained in 2020. Sheep, goat and horse manure one year old was used, to which were added in 2019 the worms of the species *Eisenia fetida*. After an interval of 12 months, the separation between the worms was made and vermicompost obtained by ingesting manure and excreting it by earthworms. The method of separation was through sieving.

The vermicompost extract was obtained in May 2021. The same vermicompost was used in 2020. At 10 litters of distilled water, 1 kg of vermicompost was used, to which was added an aquarium pump to aerate the extract for a period of 24 hours. Subsequently, the extract was strained through a fine sieve and used in the laboratory experiment.

RESULTS AND DISCUSSIONS

Effects of vermicompost extract on maize germination and root development

The experience consists of 6 variants with 8 repetitions each. 25 maize seeds were used for each replicates (Tables 1, 2).

Table 1. Agrochemical characteristics of vermicompost extract

Material	pH	N mg/l	P mg/l	K mg/l	Ca mg/l	Mg mg/l	Zn mg/l
Vermicompost extract	7	2023.05	60	792	70	42	87

Table 2. Vermicompost extract doses used in each variant

V1	Control – distilled water – 0%
V2	1L to 40l distilled water - 5ml to 200 ml water 2.5%
V3	1L to 30l distilled water – 6.67ml to 200 ml a water – 3.3%
V4	1L to 20l distilled water - 10ml to 200 ml water – 5%
V5	1L to 10l distilled water - 20ml to 200 ml a water – 8.3%
V6	1L la 5l distilled water - 40ml to 200 ml water– 20%

The seeds mass was determined for each variant and repetition, the results being the Table 3.

Table 3. Biomass of seeds after treatment

Biomass of seeds after treatment	V1 - 0%	V2 - 2.5%	V3 - 3.3%	V4 - 5%	V5 - 8.3%	V6 - 20%
R1	7.92	7.81	7.6	7.84	8.13	7.97
R2	7.9	7.8	7.67	7.9	7.96	7.87
R3	7.91	7.93	7.76	7.89	7.62	7.93
R4	7.82	7.75	7.73	7.66	7.72	7.86
R5	7.7	7.53	7.33	7.69	7.82	7.85
R6	8.02	7.76	7.81	7.77	7.68	7.77
R7	7.45	7.83	7.87	7.93	7.86	7.84
R8	7.92	7.43	7.74	7.76	7.97	8.07
Average - Seed Mass/g	7.83	7.73	7.68	7.80	7.84	7.89

After determining the mass of the seeds, the doses of the extract were prepared, for each petri dish 3 disks of blue laboratory paper were used which was soaked in the mixture of water and vermicompost extract which was distributed according to alternative. The seeds were kept at 23 degrees Celsius in the dark. The germination of the germs was done after 3 days, as well as the germination of the seeds and the measurement of the roots.

In Table 4 we notice that the vermicompost extract has no effect on the seed biomass, the control, respectively, variant 1 registering the highest average of 12.18 g, and variant 3 where the dose of 1L extract at 30 l water respectively was used, 6.67 ml of vermicompost extract recorded the lowest average, respectively 11.61 grams.

The low percentage can be clearly seen compared to the control (Table 5). Variant 2 with a weight 3% lower than the control, variant 3 with a percentage of 4.73% less than the control, variant 4 with a percentage with 2.43% less than the control, variant 5 with a percentage of 3.12% lower than the control and variant 6

registering the closest percentage to the control by 0.19% less.

Table 4. Germinated seed biomass

Biomass of germinated seeds	V1 - 0%	V2 - 2.5%	V3 - 3.3%	V4 - 5%	V5 - 8.3%	V6 - 20%
R1	11.79	11.6	11.37	12.27	12.5	11.92
R2	12.25	12.26	12.29	12.32	11.33	11.78
R3	12.79	12.19	11.39	11.49	11.47	12.36
R4	12.6	11.62	12.26	11.2	12.06	12.46
R5	11.57	12.34	11.03	11.4	11.3	12.54
R6	12.4	11.71	11.48	12.29	11.38	11.93
R7	11.69	11.63	11.7	12.23	11.96	12
R8	12.4	11.13	11.36	11.92	12.45	12.31
Biomass of germinated seeds/g	12.18	11.81	11.61	11.89	11.81	12.16

Table 5. Seed germination - percentage

Germination percentage	V1 - 0%	V2 - 2.5%	V3 - 3.3%	V4 - 5%	V5 - 8.3%	V6 - 20%
R1	88	96	84	76	80	92
R2	88	100	92	92	76	92
R3	84	100	88	88	84	100
R4	96	68	92	92	100	84
R5	88	96	96	96	88	88
R6	88	84	88	100	92	100
R7	88	88	100	92	96	84
R8	100	84	92	100	96	88
Average of seed germination percentage	90	89.5	91.5	92	90	91

The 4 variant recorded the highest value in terms of germinated seeds, respectively 184 seeds out of 200, the average being 23 seeds per repetition. These results show that the dose of 11 to 20 l/water positively influences the seed germination. Variant 2 recorded the lowest values, respectively 179 germinated seeds, the average being 22.3, lower than the control.

The rootlets were measured individually and then collected resulting in a total of each repetition and variant (Table 6).

Table 6. Rootlets length

Medium length rootlets	V1 - 0%	V2 - 2.5%	V3 - 3.3%	V4 - 5%	V5 - 8.3%	V6 - 20%
R1	2.40	2.87	2.53	2.83	2.61	3.13
R2	2.69	3.88	3.89	3.48	2.07	2.52
R3	3.18	3.60	1.60	2.32	2.89	3.51
R4	3.16	1.40	3.44	2.48	3.69	3.12
R5	3.23	3.60	2.78	2.55	1.64	3.51
R6	2.14	3.26	2.48	3.49	1.56	3.24
R7	3.12	2.54	3.12	3.10	3.41	2.59
R8	3.28	2.46	2.77	3.28	2.93	2.95
Avarage - Medium length rootlets cm	2.90	2.95	2.83	2.94	2.60	3.07

Regarding the development of the rootlets, variant 6 registered the highest value, respectively 3.07 cm, proving that the dose of 1 l to 5 l/water is much more effective than the control variant where only water was used.

Effects of vermicompost on maize germination and root and leaf development

The experience was established on June 5, 2021 within the Research-Development Institute for Plant Protection Bucharest.

The pots were kept in a mini greenhouse inside the institute.

The average temperature in this range was 30°C. 14 maize seeds were added to each pot. The doses used for each variant are Tables 7, 8.

Table 7. Doses of vermicompost administered

V2	36.4 g/pot	6.5 t/ha
V3	56 g/pot	10 t/ha
V4	84 g/pot	15 t/ha
V5	112 g/pot	20 t/ha

Table 8. Agrochemical analysis of vermicompost and vermicompost extract

Material	pH	N mg/l	P mg/l	K mg/l
Vermicompost	7.1	2	1.8	4
Soil	6	0.8	0.1	0.3

The first reading was made 3 days after sowing the seeds in pots. The results are in the Table 9.

Table 9. First reading - seed germination

	Control	6.5 t/ha	10 t/ha	15 t/ha	20 t/ha
R1	0	4	4	3	3
R2	3	4	5	6	5
R3	2	6	7	7	5
R4	4	4	6	5	9
TOTAL Seeds germinated and come out at the first observation	9	18	22	21	22

After the first reading we can see that the impact of the vermicompost is considerable. Variant 3 and variant 5 recorded the most germinated seeds, respectively a total of 22 seeds, which means 39% of 56 seeds, compared to the control which recorded a total of 9 seeds, respectively a percentage of 16%.

The use by incorporation of doses of 10-20 t/ha offers a good yield for the germination of corn seeds.

Table 10. Second reading - seed germination

	Control	6.5 t/ha	10 t/ha	15 t/ha	20 t/ha
R1	13	13	13	14	14
R2	14	14	14	14	14
R3	13	13	14	14	14
R4	13	14	14	14	14
TOTAL Germinated seeds and second observation	53	54	55	56	56

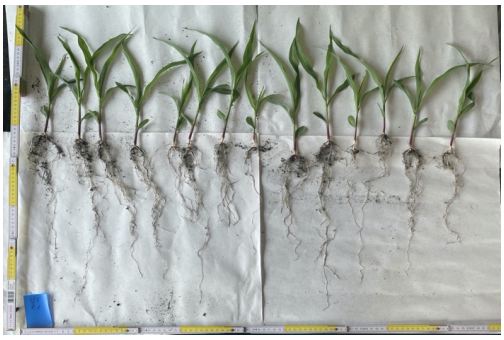
The second reading was performed 3 days after the first reading, respectively 6 days after sowing the seeds, variant 5 as in the first observation, registering a germination of 100% compared to the control (94%), as well as variant 4 registering a germination of 100%, the control remaining with the lowest percentage and number of germinated seeds (Tables 10, 11).
The next determinations were made at 6-day intervals, when the plants reached the stage of 3-4 true leaves, respectively on the 13-14 BBCH scale.

Table 11. Average root length of maize shoots

	Control	6.5 t/ha	10 t/ha	15 t/ha	20 t/ha
R1	21.61	21.89	27.02	27.39	35.52
R2	21.91	20.43	25.24	25.04	32.88
R3	24.73	19.16	25.96	23	24.79
R4	24.17	23.4	26.93	27.14	24.12
The average length of the root of the corn shoots	23.11	21.22	26.29	25.64	29.33

The best results were obtained in variant 5 where the dose of 20 t/ha was used, the corn roots having a much stronger and more developed root system compared to the control. The percentage compared to the control being 27% higher. Variant 2 registered much lower values than the control (these low values must be due to the damage of the roots when separating them from the soil and pots). The percentage compared to the control was 8% lower.
Regarding leaf development, the dose of 15 t/ ha of vermicompost helped the maize shoots to develop the leaves much faster than the control (Table 12). Their development is significant both in length and width, this aspect is found in Tables 13 and 14. A much more developed foliage in both length and width, helps a lot against plants pests such as *Tanymecus dilaticollis* and *Opatrum sabulosum* that attack maize shoots in the 1-4 leaf stage causing serious damage to the crops in our country. Plants with much more developed leaves are much more resistant to these pests, so that their attack is not so strong.
Another important aspect regarding the nutrients is that when applying liquid fertilizers, a larger foliage results and a stronger absorption of nutrients.

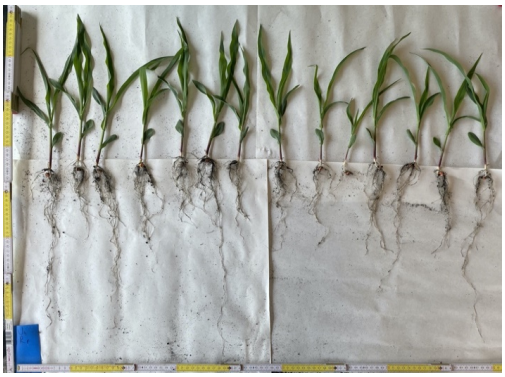
Picture 1. Root length - Control Variant 1 Replicate 2



Picture 2. Root length - Variant 5 Replicate 1

Table 12. Leaf length

	Control	6.5 t/ha	10 t/ha	15 t/ha	20 t/ha
R1	37.12	41.69	45.3	54.55	52.48
R2	36.45	40.17	39.88	56.24	57.68
R3	32.58	32.24	40.32	48.12	52.69
R4	32.78	45.11	44.09	55.42	46.16
Average leaf length (cm)	34.56	39.80	42.40	53.58	52.25



Picture 3. Root length - Variant 4 Replicate 1

Table 13. The width of the maize leaves

	Control	6.5 t/ha	10 t/ha	15 t/ha	20 t/ha
R1	1.37	1.44	1.44	1.56	1.74
R2	1.46	1.44	1.44	1.49	1.7
R3	1.27	1.24	1.31	2.22	1.52
R4	1.22	1.36	1.29	1.54	1.41
Average maximum leaf width (cm)	1.33	1.37	1.37	1.70	1.59

Tabel 14. Average length of shoots

„	Control	6.5 t/ha	10 t/ha	15 t/ha	20 t/ha
R1	26.86	27.01	30.1	31.27	31.1
R2	29.04	29.84	28.44	33.21	34.29
R3	23.12	25.23	30.49	31.1	31.84
R4	25.36	31.78	29.8	32.77	30.89
Average length of shoots	26.10	28.46	29.71	32.09	32.03

Regarding the length of the shoots, also variant 4 with the vermicompost dose of 15 t/ha registered the best values as well as the highest percentage of 18.67%, the control remaining with the lowest values. From the table and graph it can be seen that in the other variants where vermicompost was added, the yield was higher.
From the results obtained determining the leaf area in all 5 variants, we observe that variant 4 with a dose of 15t / ha offers the best yield in terms of foliar development in maize.

CONCLUSIONS

Regarding the vermicompost extract, we cannot say that it positively influences the corn seeds, due to this fact, this experiment must be repeated with other doses and other hybrids, instead, the vermicompost applied in the soil gave a very good yield. Due to the bacteria and nutrients in the vermicompost, the maize at a dose of 15t / ha registered the best yield both in terms of root and foliar development. A very important aspect is the pests *Tanymecus dilaticollis* and *Opatrum sabulosum* which attack the corn shoots in the 1-4 leaf stage causing serious damage to the crops in our country, the maize being very well developed at this stage, the damage will be considerably lower. This aspect is also demonstrated by the leaf area index, which means a stronger photosynthesis and a higher production of sugars essential for the growth and feeding of the plant. It should also be noted that a strong root system means better plant nutrition and strong resistance to external factors such as drought. The bacteria in the vermicompost not only help the plant to assimilate nutrients much faster, but also improve the soil microflora.
According to the new CAP and its goal of reducing chemical fertilizers by 20% by 2030, the use of vermicompost is a cheap and effective alternative for farmers, given the growing growth of chemical fertilizers and the need to use more and more every year, due to soil degradation, and negative effects on the environment and atmosphere and soil biodiversity.

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