EVALUATION OF THE BIOLOGICAL EFFECT OF DIFFERENT VERMICOMPOST AND PEAT MIXTURES ON ROCKET (*ERUCA SATIVA* MILL.) SEEDLING PRODUCTION

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Abstract: The vermicomposting process can improve the quality of horticultural substrates. The main aim of this work was to evaluate the phytotoxicity and Dickson quality index (DQI) of some vermicomposts used as fertilizers. These vermicomposts were obtained from food scraps digestate mixed with shredded paper waste (DWV) and vineyard wastes such as grape marc and dry shoots (VWV). These vermicomposts were applied as 3.2% and 5.0% on a commercial peat substrate. When aqueous dilutions (1:10 w/v and 1:20 w/v) were made from these vermicompost substrates, the normalized residual germination index (NRGI) showed low phytotoxicity for both DWV and VWV treatments in the dilution 1:10 (w/v), while in dilution 1:20 (w/v) the NREI showed normal development for both vermicompost treatments (VWV and DWV). The Dickson quality index (DQI) calculated for *Eruca sativa* Mill. seedlings treated with vermicompost from vineyard wastes (VWV 3.2%) demonstrate positive influence on rocket seedlings compared to untreated peat, with significant differences at $p < 0.01$.

Key words: *vermicompost, grape marc, digestate, rocket.*

INTRODUCTION

In Romania, timid steps are being taken in the implementation of some methods of valorization of plant residues from courtyards, farms and gardens, predominantly in rural environments, as well as wet fractions from household waste, predominantly in urban environments. According to Eurostat, in 2021, Romania recycled 11.3% of municipal waste. In Romania, during 2022, 301 kg of municipal waste per person was generated compared to 349 kg of waste per person in 2024, while the year has not ended (Eurostat, ec.europa.eu). The Romanian Parliament adopted the Law 181/2020 (Ministry of Justice, legislatie.just.ro, code 229273) regarding the management of non-hazardous compostable waste, defined by the Commission Regulation (EU) 1357/2014 of 18 December 2014 (European Union, european-union.europa.eu), which prohibits the disposal by burning of plant residues, with a predominant application in rural areas. Then there is the Law 132/2010 (Ministry of Justice, legislatie.just.ro, code 120275) updated in 2024 on the selective collection of waste in public institutions and the Law 101/2006 (Ministry of Justice, legislatie.just.ro, code 71304) on the sanitation service of localities, republished in the Official Gazette of Romania, no. 920 of October 12, 2023 and subsequently amended by Government Ordinances no. 58/2016, 172/2020 and 30/2023 (Ministry of Justice, legislatie.just.ro, codes 181898, 231238 and 267397) involving the separate collection of waste fractions (Ministry of Justice, www.just.ro). These fractions produce a considerable amount of waste that must somehow be reintroduced into the economic circuit. For the urban wet fraction, as well as for the rural plant residues, composting is a welcome process (Karimi et al, 2024). In addition, vermicomposting is a cheaper and faster process compared to organic matter conversion into compost (Gomes-Brandon & Domingues, 2014). Vermicomposting represents a good technological action for the recovery of agricultural, domestic and industrial waste (Enebe & Erasmus, 2023). Vermicomposting in Romania is at a beginning level (Petre et al., 2018). On the other hand, the cultivation of plants in an ecological system has gained in popularity, and many farmers prefer optimal fertilizers (Dimitri & Greene, 2002). Nutrient management plays an important role in increasing crop yields and maintaining soil fertility for sustainable production (Kann et al., 2013). Currently, there is an interest for environmentally friendly waste management methods that have an impact with effectively low cost and produces immediate results (Srivastava et al., 2019), and vermicomposting has demonstrated the presence of humic substances from compost and vermicompost, a fact that improves soil fertility (Kumar et al., 2015). *Eruca sativa* Mill. is a plant used in salads with commercial importance in many areas of the world (Elmaardy, 2020). It has the ability to grow in many types of climatic conditions and in soils with low fertility (Backhshandeh et al., 2020; Garg & Sharma, 2014).

The purpose of this study is to evaluate some vermicomposts obtained from vegetal wastes with the help of earthworms (*Dendrobaena hortensis* M.), in greenhouse conditions, in order to produce valuable seedlings substrates for horticulture applications.

MATERIALS AND METHODS

The experiments were focused on the influence of several vermicomposts applied as fertilizer, in two different proportions, to a commercial peat substrate used for seedlings production.

Two of the vermicomposts used in this study, vineyard waste vermicompost (VWV) and digested waste vermicompost (DWV), were locally obtained at the Faculty of Biotechnologies. The VWV vermicompost was generated by recycling vineyard waste, namely grape marc and dry shoots of Tămâioasă Românească variety collected from the Research and Development Station for Viticulture and Winemaking Pietroasa, Buzău County. The DWV vermicompost was derived from digested household waste, obtained from the canteen of UASVM Bucharest, mixed with shredded paper waste, from the administrative office of the Faculty of Biotechnologies. A commercial biological enzyme formulation was used to start the composting process of DWV. For both VWV and DWV, the vermicomposting process was mediated by the *Dendrobaena hortensis* Mill. earthworm. The composts were maintained for 8 weeks under a minimum humidity of 85% and an average temperature of 23°C. The vermicomposts were lyophilized to decrease their moisture at 8%, and then were ground and sieved in the laboratory. Their pH averaged 6.5. A commercial vermicompost (CV), with similar pH and moisture characteristics, was used for comparative analysis.

All three vermicomposts were tested in two proportions, 3.2% and 5.0% (Table 1), added to a commercial peat (P). The same peat, without any added vermicompost, was use as control. Seven variants were tested as seedling substrate, according to the established protocol, in three replicates (Table 1).

Table 1. Experimental variants

Experimental variants	Peat	Grape marc and shoots vermicompost	Digestate vermicompost + shredded paper waste	Commercial vermicompost
VWV 3.2%	**96.8%**	**3.2%**	**-**	**-**
VWV 5%	**95.0%**	**5.0%**	**-**	**-**
DWV 3.2%	**96.8%**	**-**	**3.2%**	**-**
DWV 5%	**95.0%**	**-**	**5.0%**	**-**
CV 3.2%	**96.8%**	**-**	**-**	**3.2%**
CV 5%	**95.0%**	**-**	**-**	**5.0%**
P	**100%**	**-**	**-**	**-**

Two types of experiments were performed on *Eruca sativa* Mill. (rocket), one conducted in laboratory conditions to evaluate the liquid phase of the substrate mixtures, and the another performed in greenhouse conditions to evaluate the fertilizer effect of the vermicomposts.

The liquid phase of the substrate mixtures was tested on rocked seeds, in the Environmental Biotechnologies laboratory, at the Faculty of Biotechnologies. According to Zucconi et al. (1981) protocol, seeds were mounted in Petri dishes on a filter paper support, moistened with 5 ml of the substrate solutions in two dilutions (D1 and D2), prepared as 1:10 (w/v) and 1:20 (w/v) in distilled water. To prepare these solutions 5.0 g of each tested substrate were diluted in 50.0 ml of distilled water for dilution D1, and other 5.0 g of each substrate were diluted in 100.0 ml of distilled water for the D2 dilution. Distilled water (DW) was used as control. The infusions were prepared in Erlenmeyer flasks and subjected to agitation for one hour at a temperature of 20°C and 150 rpm in the Daihan Labtech co. Ltd. shaking incubator. Then the solutions were centrifuged for 10 minutes at 9000 rpm with Hermle Z 306 equipment from Hermle Labortechnik GmbH and then filtered using Whatman filter paper 1. The resulting liquid phase of the substrate mixtures were used for the germination test.

The evaluated parameters included seed germination (%), radicel length (cm) and various indices, such as: the relative percentage of germinated seeds (RSG %), the rate of relative root elongation (RRG %), and the germination index (GI %) (Hoekstra et al., 2002; Walter et al., 2006). The GI was calculated based on the relative percentage of germinated seeds (%) and the relative growth rate of the root (cm). The germination index is directly influenced by different physico-chemical characteristics of the moistening solution used (e.g.: electrical conductivity, total nitrogen, NH_4^+ ions and heavy metals traces) that explain possible phytotoxic actions on seeds germination. (Hoekstra et al., 2002). The interpretation of GI value ranges is in accordance to Matei et al. (2017) protocol (Table 2).

Table 2. Interpretations of the ranges of GI (%) values (Matei et al., 2017)

Ranges of values	Interpretations of the ranges
GI > 80.0%	There are no phytotoxic elements, or they are in very low concentration
50.0% ≤ GI ≤ 80.0%	There is a moderate presence of phytotoxic substances
GI < 50.0%	There is a strong presence of phytotoxic substances

In establishing the degree of phytotoxicity, the following were calculated: the normalized residual germination index (NGI) and the residual normalized elongation index (NEI), both depend on the percentage of germination (%) and root length (cm). (Bagur-Gonzáles et al., 2002). Both NGI and NEI indices determine the toxicity of solutions if negative values are achieved (Table 3), according to Bagur-Gonzáles et al. (2011).

Table 3. Interpretations of NGI and NEI ranges (Bagur-Gonzáles et al., 2011)

Ranges of values	Interpretations of the ranges
> ±0.00	Normal degree of root development or hormesis effect
−0.25 ÷ ±0.00	Low degree of toxicity
−0.50 ÷ −0.25	Moderate degree of toxicity
−0.75 ÷ −0.50	High degree of toxicity
−1.00 ÷ −0.75	Very high degree of toxicity

To obtain the phytotoxicity indices the seeds were incubated for 72 h at 25°C at the FTC 90E incubator from Velp Scientifica. The experiment was also performed in three repetitions. Statistical analyzes were calculated using Microsoft Excel 2010.

The greenhouse experiments were carried out between January and March 2024, in the UASVM Bucharest greenhouse, under controlled conditions, with an average temperature of 23°C. Alveolar trays, having 0.064 L/alveolus, were used in the experiments. Rocked treated seeds were sown in these trays. Irrigation was carried out at intervals of three days in the watering trays, in order to maintain a constant moist in the substrate, with an average humidity of 60.0%. The emergence curve and appearance of the first true leaf in the rocket plants were evaluated. Plants were harvested and analyzed 35 days after sowing. Several biometric parameters were evaluated to determining rocket seedling quality: the number of leaves, root length (cm), diameter of the root collar (mm), hypocotyl length (cm), leaf rosette diameter (mm), height of the epigeal zone of the plant (cm), and leafs area (cm^2) (Pandey & Singh, 2011), and the index of chlorophyll content. Several other parameters were performed within the Environmental Biotechnologies laboratory, at the Faculty of Biotechnologies. The fresh and dry weights (g) of the plants, and three relevant quality indices of the plants growth were calculated: the root-stem index (RSI) (Iverson, 1984), the elongation index (EI) (Schmidt-Vogt, 1981), and Dickson quality index (DQI) (Dickson et al., 1960).

RESULTS AND DISCUSSIONS

Analyzing the liquid phase extracted from various vermicompost added substrates, several parameters were determined on treated rocked seeds. The experimental data on the plant's biological response to the treatments in both tested dilutions are presented in Table 4. According to the results, both dilutions (D1 and D2) induced a germination percentage similar to the control (DW), thus suggesting no inhibitory effects on rocket germination. The variant VWV5.0% recorded the highest value of the germination percentage in D1 (94.1 %), but which was not reflected in a significant root length (2.4 cm) compared to the DW control (2.6 cm). The lowest germination values were recorded for the treatments VWV3.2% and DWV3.2% (80.4%), in correlation with the lowest values of the root length (2.3 cm). Regarding the root length in both tested dilutions, there were mostly significantly positive results of the treatments compared to the DW control (2.6 cm), with the highly significant value (3.7 cm) for the CV3.2% variant and distinctly significant for P variant in dilution D2 (3.4 cm). Similarly, according to Hoekstra et al. (2002) both germination percentage and root length decrease while increasing the concentration of aqueous vermicompost extract treatments.

Tabel 4. Biologic response of *Eruca sativa* germination (%) and root length (cm) to the aqueous dilutions (D1 and D2) of various growth substrates

Variants		VWV 3.2%	DWV 3.2%	CV 3.2%	VWV 5.0%	DWV 5.0%	CV 5.0%	P	Control (DW)	AVERAGE	DL 5%
Germination (%)	D1	80.4 ºº ±3.4	80.4 ºº ±6.8	90.2 ±12.2	94.1 ±0.0	84.3 º ±3.4	90.2 ±3.4	90.2 ±3.4	92.2 ±8.9	87.8 ±5.3	6.3
	D2	88.2 ±5.9	94.1 ±5.9	96.1 ±3.4	92.2 ±8.9	90.2 ±8.9	90.2 ±3.4	84.3 ºº ±3.4	92.2 ±8.9	90.9 ±3.6	4.3
Root length (cm)	D1	2.3 ±0.2	2.3 ±0.9	3.1* ±0.4	2.4 ±0.4	3.0 * ±0.7	3.4 ** ±0.2	3.1 * ±0.5	2.6 ±0.1	2.88 ±0.4	0.5
	D2	3.2 * ±0.6	3.2 * ±0.5	3.7*** ±0.2	3.0 ±0.8	2.6 ±0.5	3.1 * ±0.6	3.4 ** ±0.7	2.6 ±0.1	3.1 ±0.4	0.5

Legend. Values are presented as Mean values ± Standard deviation; Different asterisk symbols (* to ***) are attributed to positive differences, at $p < 0.05$, $p < 0.01$, and $p < 0.001$ respectively; Different ring point symbols (º to ºº) are attributed to negative differences, at $p < 0.05$ and $p < 0.01$; D1 - dilution 1:10 (w/v); D2 - dilution 1:20 (w/v).

The relative percentage of germinated seeds (RSG) recorded distinctly significant negative values on dilution D1 of VWV3.2% and DWV3.2% variants (87.2%), and dilution D2 of P variant (91.5%), as can be seen in Table 5.

Table 5. Evaluation of rocket biological response to various aqueous extracts

Variants	Dilutions	VWV 3.2%	DWV 3.2%	CV 3.2%	VWV 5.0%	DWV 5.0%	CV 5.0%	P	Control (DW)	Average	DL 5%
RSG (%)	D1	87.2 ºº ±10.5	87.2 ºº ±5.8	97.9 ±7.4	102.1 ±10.4	91.5 º ±7.0	97.9 ±7.6	97.9 ±9.6	100.0 ±0.0	95.2 ±5.8	6.84
	D2	95.7 ±16.2	102.1 ±13.3	104.3 ±10.1	100.0 ±19.6	97.87 ±20.1	97.9 ±9.6	91.5 ºº ±8.9	100.0 ±0.0	98.7 ±3.9	4.66
RRG (%)	D1	89.4 ±8.9	91.5 ±33.0	121.7 * ±11.9	94.3 ±15.7	118.9 ±23.6	132.6 ** ±5.8	119.9 * ±17.2	100.0 ±0.0	108.6 ±16.6	19.4

	D2	126.2 * ±26.0	126.2 * ±18.6	144.8*** ±9.9	117.4 ±32.5	100.0 ±20.3	120.5 * ±20.9	132.3 ** ±28.9	100.0 ±0.0	120.9 ±15.3	18.2
GI (%)	D1	78.0 ±15.6	79.8 ±23.2	119.1 ±18.6	96.3 ±23.1	108.8 ±15.2	129.8 * ±4.9	117.4 ±5.1	100.0 ±0.0	103.7 ±18.6	22.1
	D2	120.9 * ±46.7	128.9 * ±8.8	150.9*** ±23.5	117.4 ±52.9	97.9 ±28.0	117.9 ±10.1	120.9 * ±29.4	100.0 ±0.0	119.4 ±16.6	19.7

Legend. Values are presented as Mean values ± Standard deviation; Different asterisk symbols (* to ***) are attributed to positive differences, at $p < 0.05$, $p < 0.01$, and $p < 0.001$ respectively; Different ring point symbols (º to ºº) are attributed to negative differences, at $p < 0.05$ and $p < 0.01$; D1 - dilution 1:10 (w/v); D2 - dilution 1:20 (w/v); RGS – relative germinated seeds; RRG – relative root germination; GI – germination index; DW-distillated water.

On the other hand, the relative root elongation rate (RRG) showed highly significant positive result (144.8%) for the CV3.2% treatment in dilution D2, leading to highly significant positive germination index (GI) values (150.9%). Significant positive values of GI were also registered when using D2 aqueous extracts of VWV3.2%, DWV3.2%, and peat (P), which translates into a lack of phytotoxicity. In dilution D2, a lower percentage of vermicompost added to peat led to better results in root growth rate than a higher percentage: CV3.2% > CV 5.0%, VWV3.2% > VWV5.0% and DWV3.2% > DWV% 5.0. For the germination index (GI) there were similar responses. It was also noted that the germination index for the CV3.2% treatment in dilution D2 showed distinctly significant values compared to the CV5.0% treatment in dilution D1. All results of the variants in dilution D2 for the germination index (GI) showed the lack of toxicity of the treatments or very low toxicity of the physico-chemical elements characteristic of the substrates, according to (Matei et al., 2017). The lowest value (97.9%) was recorded in the DWV5.0% variant, but with an insignificant result compared to the Control (DW). A correlation in most cases was directly proportional to the positive significance of the relative elongation rate of the root, translated into a significant result also for the germination index (GI).

According to Bagur-Gonzáles et al. (2011) algorithm, in dilution D1 low phytotoxicity values were recorded. The lowest results being for the variants VWV3.2% and DWV3.2% (-0.128) for the normalized residual germination index (NRG) (Table 6), correlated with the relative percentage of germinated seeds and obviously with the germination percentage. Identical situation for the DWV5.0% variant with a significantly negative result (-0.085). In dilution D2 the value of the DWV3.2% variant was positive compared to the same variant in dilution D1. Only for P variant there was a distinctly significant negative result (-0.085) in D2, with regard to this index. Regarding the normalized residual elongation index (NEI), only in dilution D1 positive values were recorded for the variants VWV3.2% < DWV3.2% < VWV5.0% showing no phytotoxicity. In dilution D2 for the NEI index, only positive values were recorded that converge towards a normal degree of development or correlated with the other values from dilution D1, respectively the NGI index can present a hormesis effect. It was observed that although CV3.2% and CV5.0% variants were negative for the NGI index. Results showed significant positive values for the NEI index in the two dilutions correlated with root length. Also, the P variant presented negative values in both dilutions for NGI, but significant positive values for NEI. In dilution D2, variants VWV3.2% and DWV3.2% had significant positive results for NEI index developing normal root growth positively correlated with germination index (GI). According to Zucconi et al. (1981) it is worth noting the situation in which the NEI index for the CV3.2% variant recorded very significant results and the variant CV5.0% distinctly significant result compared to the distilled water (DW) as a control. Similar significance values for CV3.2% dilution D1 and CV5.0% dilution D2 for the normalized residual elongation index are expected.

Table 6. Phytotoxicity index evaluations of various treatments on *Eruca sativa*

Variants	Dilutions	VWV 3.2%	DWV 3.2%	CV 3.2%	VWV 5.0%	DWV 5.0%	CV 5.0%	P 100%	Control (DW)	Average	DL 5%
NRG	D1	-0.128 ºº ±0.11	-0.128 ºº ±0.06	-0.021 ±0.07	0.021 ±0.10	-0.085 º ±0.07	-0.021 ±0.08	-0.021 ±0.10	0.000 ±0.00	-0.048 ±0.06	0.07
	D2	-0.043 ±0.16	0.021 ±0.13	0.043 ±0.10	0.013 ±0.20	-0.021 ±0.20	-0.021 ±0.10	-0.085 ºº ±0.09	0.000 ±0.00	-0.012 ±0.04	0.05
NEI	D1	-0.106 ±0.09	-0.085 ±0.33	0.217 * ±0.12	-0.057 ±0.16	0.189 ±0.24	0.326 ** ±0.06	0.200 * ±0.17	0.000 ±0.00	0.086 ±0.17	0.20
	D2	0.262 * ±0.26	0.262 * ±0.19	0.448*** ±0.10	0.174 ±0.32	0.002 ±0.20	0.205 * ±0.24	0.322 ** ±0.29	0.000 ±0.00	0.209 ±0.15	0.18

Legend. Values are presented as Mean values ± Standard deviation; Different asterisk symbols (* to ***) are attributed to positive differences, at $p < 0.05$, $p < 0.01$, and $p < 0.001$ respectively; Different ring point symbols (º to ºº) are attributed to negative differences, at $p < 0.05$ and $p < 0.01$; D1 – dilution 1:10 (w/v); D2 – dilution 1:20 (w/v); NRG – normalized residual germination index; NEI – normalized residual elongation index; DW – distillated water.

In the greenhouse experiments, rocket growth parameters were analyzed when grown in peat substrate fertilized with various vermicomposts.

Those 21 plants sown for each variant represent 100% and the most germinated seeds were recorded for variants VWV3.2% and DWV3.2% with 20 plants emerged, representing 95.24% and CV5.0%, respectively DWV5.0% with 19 germinated seeds for a percentage of 90.48%. The P control variant had a percentage of 85.71% with 18 plants similar to the VWV5.0% variant, the lowest emergence percentages were recorded for the CV3.2% with 71.43%, meaning 15 germinated seeds.

In the greenhouse conditions, the morphological characters of interest presented significant values in all criteria of the DWV3.2% and CV3.2% (Table 7). Thus, for the number of leaves, the highest value was for the CV3.2% variant with 5.4 leaves per plant, the root length of the DWV3.2% variant with 9.5 cm, respectively diameter of the root collar with the value of 1.2 mm. The highest epigeal zone was recorded for the CV3.2% variant with a value of 13.8 cm. The same variant presented the largest leaf surface with the value of 14.0 cm².

Table 7. The physiological characteristics of *Eruca sativa* plants grown in various substrates

Variants	VWV 3.2%	DWV 3.2%	CV 3.2%	VWV 5.0%	DWV 5.0%	CV 5.0%	Control (P)	AVERAGE	DL 5%
Leaves number	5.0 * ±2.4	5.1 * ±2.4	5.4 ** ±2.9	3.5 ±1.7	4.3 ±1.6	3.8 ±1.7	3.9 ±1.9	4.4 ±0.7	0.9

Variants	VWV 3.2%	DWV 3.2%	CV 3.2%	VWV 5.0%	DWV 5.0%	CV 5.0%	Control (P)	AVERAGE	DL 5%
Root length (cm)	7.7 ±4.5	9.5 ** ±5.3	8.1 * ±4.9	3.6 ±1.8	5.1 ±2.9	4.1 ±2.2	5.2 ±3.6	6.2 ±2.2	2.6
Diameter of the root collar (mm)	1.2 ±0.6	1.2 ** ±0.5	1.4 * ±0.8	0.8 ±0.4	0.9 ±0.4	0.7 ±0.4	0.7 ±0.3	1.0 ±0.3	0.3
Epigeal zone (cm)	13.2 * ±6.9	13.5 * ±6.0	13.8 ** ±7.7	10.9 ±5.1	11.5 ±4.1	10.2 ±5.1	10.4 ±5.1	11.9 ±1.5	2.3
Total plant high (cm)	20.9 * ±11.2	22.9 ** ±10.4	21.9 * ±12.4	14.5 ±6.8	16.6 ±6.3	14.3 ±6.9	15.7 ±7.9	18.1 ±3.7	4.7
Leaf area (cm^2)	11.9 * ±7.5	11.1 * ±5.2	14.0 ** ±8.9	6.14 ±3.3	8.4 ±3.5	6.3 ±4.4	5.6 ±3.3	9.1 ±3.3	4.7

Legend. Values are presented as Mean values ± Standard deviation; Different asterisk symbols (* to ***) are attributed to positive differences, at p <0.05, and p < 0.01, respectively.

Depending on the biometric data analyzed on the rocket plants, the fresh and dry weights of the plants were analyzed, both for the root, as well as for the aerial part of the plants, respectively the dry/fresh weight ratio of the plants, obtaining the results of interest in establishing the quality indices (RSI, EI, DQI) of the rocket seedlings on the peat substrate fertilized with vermicompost in the two levels and their specific meanings (Table 8).

Table 8. The main indices (RSI, EI, DQI) **evaluating of *Eruca sativa* seedling qualities when grown in various substrates**

Variants	VWV 3.2%	DWV 3.2%	CV 3.2%	VWV 5.0%	DWV 5.0%	CV 5.0%	P Control	Average	DL 5%
Dry/fresh weight ratio of plants	0.114	0.132*	0.200***	0.061	0.068	0.072	0.068	0.102	0.05
RSI	23.295ºº	29.255º	46.030**	17.313ºº	38.818	57.167	49.833	37.387	16.88
EI	11.186ºº	11.441ºº	10.000ººº	14.533	13.372	13.973	14648	12.736	2.02
DQI	0.035**	0.024	0.039**	0.009	0.008	0.006	0.006	0.018	0.01

Legend. Values are presented as Mean values ± Standard deviation; Different asterisk symbols (* to ***) are attributed to positive differences, at p < 0.05, p < 0.01, and p < 0.001 respectively; Different ring point symbols (º to ºº) are attributed to negative differences, at p < 0.05 and p < 0.01; RSI – Root-Stem index; EI – Elongation index; DQI – Dickson Quality Index.

It was observed that, in agreement with the biometric results, the responses of the quality indices (RSI, EI and DQI) are similar for p < 0.01. For dry/fresh weight plants ratio a very significant result with a value of p < 0.001 was recorded by the CV3.2% variant.

The root-stem index, calculated according to Iverson (1984), recorded a distinctly significant value of 46,030 units for the CV3.2% variant and the lowest value was present for the VWV5.0% variant for a negative p < 0.01 value compared to the P control variant.

According to May (1984), the shoot-root index (RSI) indicates that the plant has better quality when the aerial part is relatively smaller than the root, a situation that guarantees better development due to the fact that plant's transpiration is lower compared to its absorption capacity.

Another important index in seedlings evaluation is the elongation index (EI) (Schmidt-Vogt, 1981). This index correlates plant resistance with photosynthetic capacity (Toral, 1997). High positive values of EI translate as good seedling transplantation capacity (Toral, 1997). In Table 8, CV3.2% variant revealed highly significant negative differences ($p < 0.001$) in EI compared to the control variant (P), while VWV3.2% and DWV3.2% variants revealed significant negative differences ($p < 0.01$) compared to the control variant (P). The highest positive result in EI, was registered in VWV5.0%, although insignificant compared to P control variant.

The Dickson Quality Index (DQI) (Dickson et al., 1960) correlates RSI and EI indices, revealing the seedling quality on the tested substrates (Oliet, 2000). Significant distinctive values were obtained in variants CV3.2% > VWV3.2% compared to the control (P), thus indicating the importance of adding vermicomposts as fertilizers to conventional peat substrate (Herrera et al., 2009). The other tested variants did not significantly influence the seedlings quality compared to the control.

CONCLUSIONS

Significant positive results ($p < 0.05$) were seen on root length of *Eruca sativa* when seeds were moist with aqueous dilutions 1:20 w/v of peat supplemented with vermicomposts VWV3.2% and DWV3.2%, compared to control.

Regarding the germination index (GI), the same VWV3.2% and DWV3.2% variants showed significance differences ($p < 0.05$) compared to the control.

Looking at phytotoxicity indices (NRG and NEI), the dilutions (1:20 w/v) of VWV3.2% and DWV3.2% substrates showed significant results compared to the control and normal root growth compared to VWV5.0% and DWV5.0% variants, which did not show phytotoxicity, but were not significant compared to the control. The VWV3.2%, DWV5.0%, CV5.0% and P variants had negative values for the NGI index, showing reduced phytotoxicity to rocked seedlings.

Aqueous dilutions (1:10 w/v) of VWV3.2%, DWV3.2%, VWV5.0% and DWV5.0% showed low phytotoxicity values towards *Eruca sativa*.

Regarding the percentage of rocket emergence in greenhouse conditions, variants VWV3.2% and DWV3.2% presented the best percentage (92.24%).

Significant different values ($p < 0.01$) were revealed in DWV3.2% variant compared to the control, regarding root length, diameter of root collar, and total height of the plant. The CV3.2% variant presented significant results regarding the number of leaves, epigeal height and leaf area at $p < 0.01$, as well as leaves number, height of the epigeal zone, total height plant and leaf area at $p < 0.05$.

The VWV3.2% and CV3.2% substrates showed significant differences regarding Dickson Quality Index (DQI) at $p < 0.01$, compared to the peat control, without vermicompost fertilisation.

From both laboratory and greenhouse experiments, on rocket grown under the influence of vermicompost fertilized substrates, can be concluded that lower treatments of vermicompost, meaning 3.2% compared to 5.0%, leads to superior values in seed germination and plant growth compared to the untreated peat used as control.

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