

VARIATION OF SOME PHYSIOLOGICAL INDICES IN *Tagetes erecta* L. ACCORDING TO GROWTH SUBSTRATE

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Abstract. The study evaluated the influence of some growing substrates with variable content of compost from biodegradable waste on some physiological indices and growth parameters in the *Tagetes erecta* L. species. Different components were used to prepare the growth substrates, and depending on the weight of participation, the experimental variants resulted: V1 – garden soil 100%; V2 – compost 100%; V3 – compost 20% + peat 70% + vermiculite 10%; V4 – compost 30% + peat 60% + vermiculite 10%; V5 – compost 40% + peat 50% + vermiculite 10% (each variant in four repetitions). The biological material was represented by the *Tagetes erecta* L. species. The genotype "Tagetes erecta F1 Discovery Orange" was cultivated. Physiological indices and biometric parameters were evaluated, considered representative to quantify the plants response to growth substrates: plant height (Ph), shoots number (Sn), plant diameter (Pd) and shoots diameter (Sd). Several determinations were made during the vegetation period, at different times: April 22 (T1), May 22 (T2), June 18 (T3), July 21 (T4) and August 27 (T5). A strong, positive correlation was recorded between plant height (Ph) and shoot diameter (Sd), $r=0.881^{***}$. Moderate correlations were recorded between plant height (Ph) and shoot number (Sn), $r=0.715^{***}$, between plant height (Ph) and plant diameter (Pd), $r=0.754^{***}$, between shoot number (Sn) and shoot diameter (Sd), $r=0.700^{***}$, and between plant diameter (Pd) and shoot diameter (Sd), $r=0.781^{***}$. Weak correlation was recorded between shoot number (Sn) and plant diameter (Pd), $r=0.669^{***}$ ($^{***} p < .001$). In the PCA evaluation, PC1 explained 83.581% of variance, and PC2 explained 10.035% of variance. The cluster analysis, in relation to the important parameters considered (Ph, Pd) facilitated obtaining a dendrogram of association of the variants (Coph.corr.=0.881). The dynamics of the plants main parameters (Pd, Ph) on the experimental variants in relation to time, was described by polynomial equations of the 2nd degree under differentiated conditions of statistical certainty. A variable increase (Δ) in the evaluated parameters (positive and negative values) was recorded in the experimental variants (V2 – V5) in relation to the control variant (V1) and the moments of determination during the study period.

Keywords: compost, growth substrate, models, physiological indices, *Tagetes*, variability

INTRODUCTION

The amount of waste resulting from different socio-economic activities is growing rapidly, with estimates for the immediate future of up to 6 million tons per day (WEC, 2016; Uddin et al., 2021). The selective collection of waste represents the first step and a major concern in order to effectively manage different categories of waste and reduce environmental pollution (Campos-Alba et al., 2021; Latosińska et al., 2021). Within the circular economy, biological waste occupies an important place, considered as part of the "key flows" of waste for selective collection (Brás et al., 2022). Different studies have addressed biological waste in relation to their sources (producers of this waste), with their typology, the resulting quantities, and other important criteria for different management strategies (Brás et al., 2022).

The need for the selective collection of waste is already increasingly promoted, although regulated by laws and regulations, the achievement of this objective is done with variable steps, from one country to another, from one human community to another, through different implementation methods and levers.

Various methods and techniques have been and are used to induce people to do selective collection (e.g. color of containers, location, visual messages, information, certain bonuses). Gallardo et al. (2021) communicated, in some pilot studies (Castelló de la Plana, Spain) progress in the rate of selective waste collection of up to 90%, in relation to the applied strategy, with the registration of a positive evolution of the experience of selective collection for citizens.

Within the residual flows, solid organic waste of municipal origin represents an intensively studied subject, as a result of their specificity - large quantities, continuous flow over time, varied physical and biochemical characteristics (e.g. high variability in terms of categories, quantities and composition), which involves extensive operations of collection, handling, temporary storage - selection, processing. Over time, some solutions were found, but new challenges were identified, in the context of the circular economy, energy resources, environmental quality, quality of life (Policastro and Cesaro, 2022).

Within solid waste, organic waste occupies a high share, and composting is an efficient way to capitalize on it in the form of fertilizers, but the adoption and use of this category of fertilizers is determined by certain

factors, such as sufficient information on the fertilizing quality (content of nutrients, metals, pathogens, salinity, etc.), the recovery price in relation to other fertilizers, regulations on the fertilizer market etc. (Chen et al., 2020).

Biodegradable organic waste, a category within waste, has been studied for valorization through different methods (e.g. compost and digestate) (Saveyn and Eder, 2014; Esercizio et al., 2021; Vinci et al., 2021). The composting process of different categories of biodegradable organic waste was studied in relation to influencing factors of the composting process (moisture content, reaction medium, C:N ratio, temperature) but also in relation to the content of the main nutrients, N, P, K in order to exploit these potential resources for agriculture (Kadir et al., 2016).

For the evaluation of some composts (results from biodegradable solid municipal waste) different compost quality indices were analyzed (e.g. TOC - total organic carbon; TN - total nitrogen), and the results confirmed the quality of the compost for use as an organic amendment from the perspective of carbon capture, of sustaining and diversifying soil biodiversity, as well as the balance of organic matter in the soil (Bekier et al., 2022). In order to improve the biological and chemical properties of the composts obtained from the fermentation of solid organic waste, in some studies the addition of different salts (carbonates; phosphates; sulfates; sources of carbohydrates) was tested with favorable results (García Molano et al., 2021).

Studies on the use of compost resulting from methane fermentation of some organic food waste, mixed with different organic fertilizers from animals (manure from horses, cows, and chickens) have confirmed the favorable effect on plants, in order to train the compost in the process of agricultural production, and for supporting soil fertility (Santi et al., 2021).

The purpose of this study was to evaluate the possibility of valorizing a compost resulting from fermentation processes of biodegradable organic waste for the purpose of growing plants, the way in which it influences the growth and development of plants based on vegetation indices and parameters, as well as the development of description models of the plants' response in time to the growth substrates.

MATERIAL AND METHODS

The study was carried out in controlled conditions, protected space, modular solar, in the municipality of Salonta, Bihor County, Romania.

The biological material was represented by the *Tagetes erecta* L. species. The genotype "*Tagetes erecta* F1 Discovery Orange" (*Tagetes erecta* F1 - term used in the article) produced by the company Benary, Germany, was cultivated. It is a hybrid form, showing a dwarf and compact habit, orderly, plant height of about 23 cm, orange inflorescence. An aspect of the plants on the experimental variants is presented in figure 1.



Figure 1. Aspect from the experiment, *Tagetes erecta* F1 on different growth substrates (original figure)

In relation to the objectives of the study, five experimental variants were organized, using different growth substrates. Different components were used to prepare the growing substrates: garden soil, compost, peat, vermiculite. The garden soil was taken from the local source and was thermally treated for disinfection (hot water, controlled conditions), crushed and sieved (0.5 cm sieve) for use. The compost was purchased from the composting station of the county ecological platform (Oradea municipality), made by fermentation processes of

selectively collected biodegradable organic waste. The compost was disinfected by treating it with hot water, similar to garden soil. The peat (from Latvia) was with a grain size of 0 – 20 mm, acid reaction (pH = 3.5 – 4.5), without wetting agent, produced by Agaris company. Vermiculite (natural mineral silicate), presented a neutral reaction, 2-3 mm granulation. The growth substrates were prepared based on the presented components: V1 - garden soil 100%; V2 – compost 100%; V3 – compost 20% + peat 70% + vermiculite 10%; V4 – compost 30% + peat 60% + vermiculite 10%; V5 – compost 40% + peat 50% + vermiculite 10%. The experiment was organized in four repetitions.

Sowing for the seedlings production was done on February 28, 2022 (uniform substrate for the production of seedlings). On March 26, planting was done on experimental variants (uniform plants provided from seedlings), respectively on differentiated substrates (V1 – V5). Through the maintenance works, the humidity of the growth substrates and the plants, as well as the phytosanitary status of the plants, was uniformly ensured.

In relation to the purpose of the study, certain parameters of the plants were evaluated, considered representative as the response of the plants to the experimental substrates: plant height (Ph), shoot number (Sn), plant diameter (Pd), and shoot diameter (Sd). Several determinations were made during the vegetation period, respectively on April 22 (T1), May 22 (T2), June 18 (T3), July 21 (T4) and August 27 (T5). On August 27, the drying of the plants was already found in some variants, and the observations were completed.

The experimental data were analyzed by appropriate mathematical and statistical methods, in order to test the safety of the data, the presence of variance, as well as the interdependence between the determined parameters, and the description of the behavior of the data in relation to the experimental variants and the moments of determination in time, during the study period (Hammer et al. 2001; Wolfram Alpha 2020; JASP, 2022).

RESULTS AND DISCUSSIONS

The evolution of *Tagetes erecta* F1 plants was analyzed in relation to the experimental variants, in the April 22 - August 27 interval, experimental year 2022. A hundred determinations were made for each parameter considered, and the values resulting from the statistical analysis are presented in table 1. On throughout the study period, the values of the analyzed parameters varied between 0 and various other values, depending on the specifics of each parameter; 40.5 cm in the case of Ph; 80 in the case of Sn; 35 cm in the case of Pd; 18 mm in the case of Sd. The Anova test confirmed the presence of variance within the series of recorded experimental values, as well as the safety of the data, under conditions of Alpha=0.001, table 2.

Table 1. Descriptive statistics - recorded values for studied parameters under experimental conditions, *Tagetes erecta* F1

Statistical parameters	Ph	Sn	Pd	Sd
Valid	100	100	100	100
Missing	0	0	0	0
Median	28	17	22	10
Mean	24.65	23.79	19.89	9.155
Std. Error of Mean	1.188	2.201	0.887	0.457
Coefficient of variation	0.482	0.925	0.446	0.499
Variance	141.068	484.228	78.72	20.887
Skewness	-0.743	0.958	-0.544	-0.44
Std. Error of Skewness	0.241	0.241	0.241	0.241
Kurtosis	-0.725	-0.075	-0.305	-0.8
Std. Error of Kurtosis	0.478	0.478	0.478	0.478
Shapiro-Wilk	0.883	0.881	0.951	0.942
P-value of Shapiro-Wilk	< .001	< .001	< .001	< .001
Minimum	0	0	0	0
Maximum	40.5	80	35	18
25th percentile	10.5	6	14.25	5
50th percentile	28	17	22	10
75th percentile	34	38	27	13

Table 2. Anova test

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	15203.14	3	5067.714	27.96351	2.02E-16	5.527887
Within Groups	71765.48	396	181.226			
Total	86968.62	399				

The correlation analysis led to the values presented in figure 2. A strong, positive correlation was recorded between plant height (Ph) and shoot diameter (Sd), $r=0.881^{***}$. Moderate correlations were recorded between plant height (Ph) and shoot number (Sn), $r=0.715^{***}$, between plant height (Ph) and plant diameter (Pd), $r=0.754^{***}$, between shoot number (Sn) and shoot diameter (Sd), $r=0.700^{***}$, and between plant diameter (Pd) and shoot diameter (Sd), $r=0.781^{***}$. Weak correlation was recorded between shoot number (Sn) and plant diameter (Pd), $r=0.669^{***}$ ($^{***} p < .001$). Figure 2 also shows the density of the distribution of the values of each determined parameter, as well as the safety, 95% confidence, and prediction intervals.

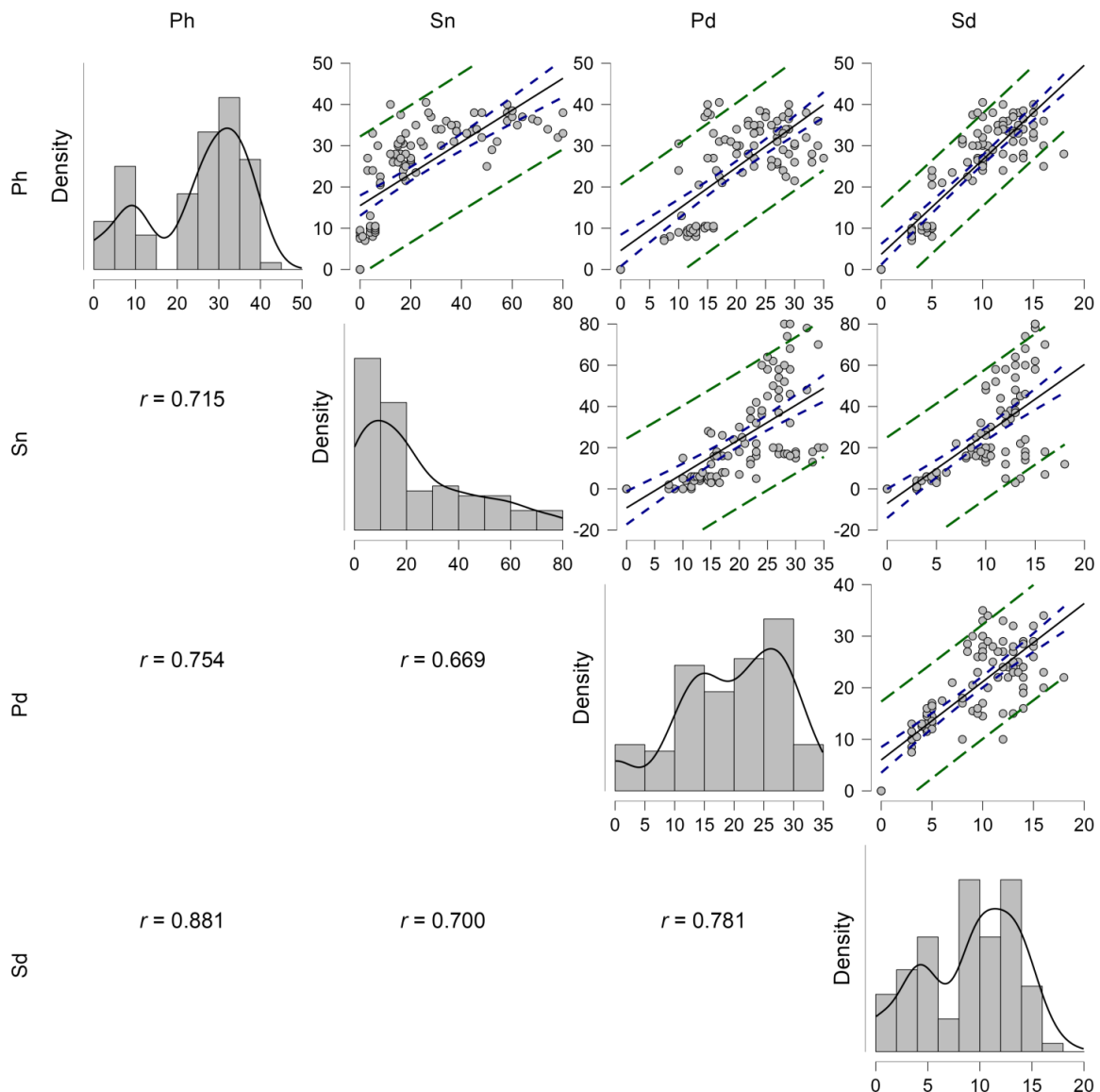


Figure 2. The graphic representation of the correlations between the parameters studied in *Tagetes erecta* F1, under the experimental conditions

According to PCA, the diagram in figure 3 was obtained, in which the experimental variants are distributed in relation to the determination time of the studied parameters (V-T combination; V1 to V5 - growth substrates; T1 to T5 determination moments). The independent positioning of all the variants associated with the

moment of T1 determination, in relation to determined parameters, was found. In the case of the other moments of determination (T2 to T5), the experimental variants and combinations of variants - moment of determination (V-T) were positioned differently in relation to determined parameters. The variants V2, V3, V4 and V5 were associated with the Pd parameter at time T2. The variants at the moments T3, T4 and T5 were associated with the parameters Ph, Sd and Sn, with the exception of the variant V2 at the moment T5 (V2-T5) which presented an independent position. In PCA, PC1 explained 83.581% of variance, and PC2 explained 10.035% of variance.

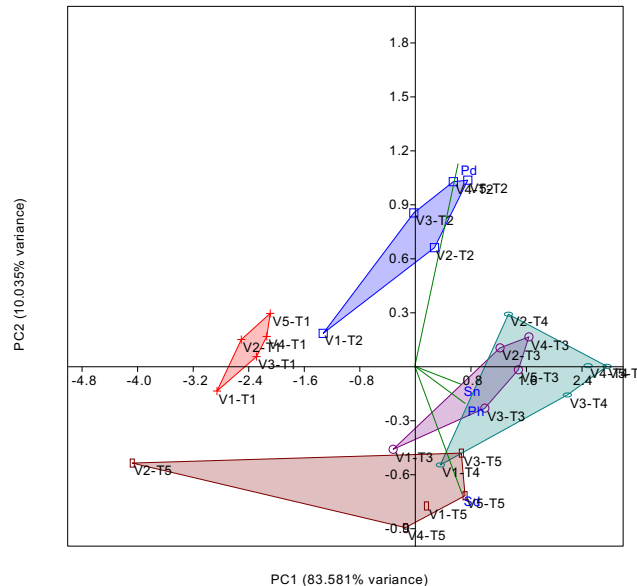


Figure 3. PCA diagram regarding the distribution of experimental variants associated with the moments of parameter determination in *Tagetes erecta* F1 (average values)

The cluster analysis in relation to more important parameters (Ph, Pd) led to the dendrogram in figure 4, in which the variants were associated on the basis of similarity according to the contribution to the values of the indices considered, under conditions of Coph.corr.=0.881.

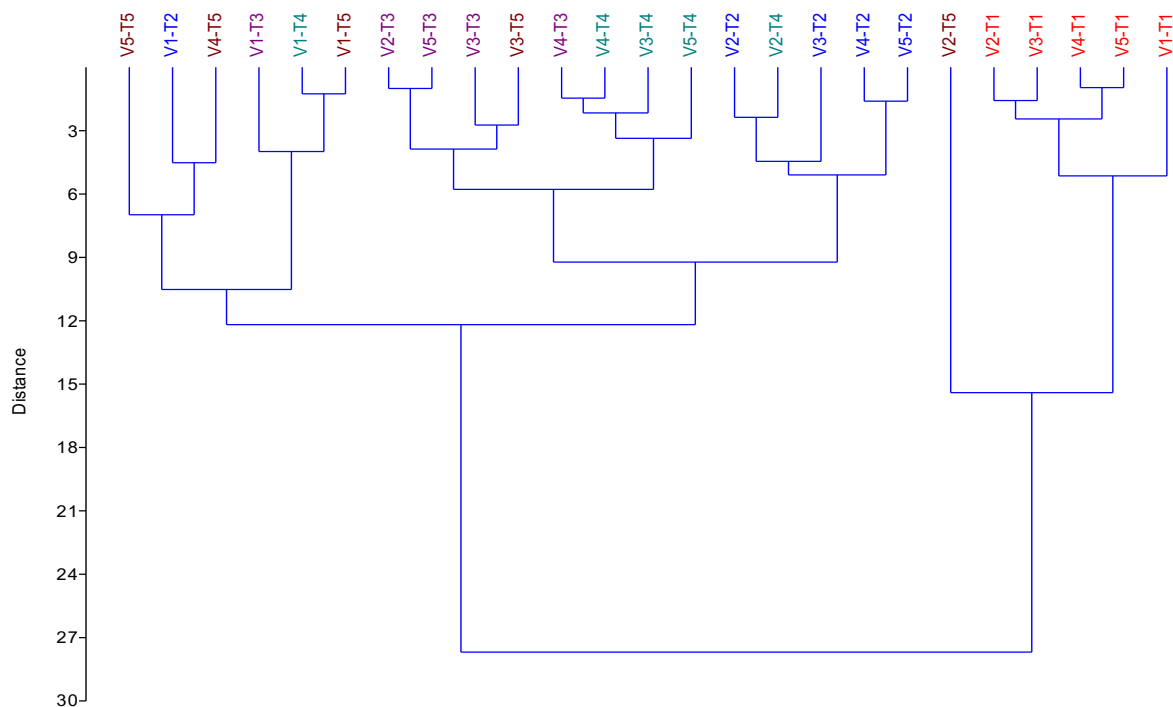


Figure 4. Dendrogram of variants grouping in relation to Ph and Pd, *Tagetes erecta* F1 (average values)

The formation of two distinct clusters, with several sub-clusters each, was found. A cluster included all the variants in relation to the T1 moment of determination, as well as the V2-T5 variant, with low values for the considered parameters. The second cluster included the other variants in several sub-clusters.

The variation of Ph in relation to Sd (analysis on average values) was described by equation (1) under conditions of $R^2=0.881$, $F=51.832$, $p<0.001$, and the variation of Ph in relation to Pd was described by equation (2) under conditions of $R^2=0.669$, $F=14.152$, $p<0.001$. The graphic distribution of Ph values in relation to Sd and Pd respectively is presented in figure 5 (a), (b).

$$Ph = -0.01853x^3 + 0.2823x^2 + 2.14x - 0.5889 \quad (1)$$

$$Ph = -0.00427x^3 + 0.1601x^2 + 0.07949x - 1.334 \quad (2)$$

where: x – shoot diameter (Sd, mm) in equation (1); x – plant diameter (Pd, cm) in equation (2)

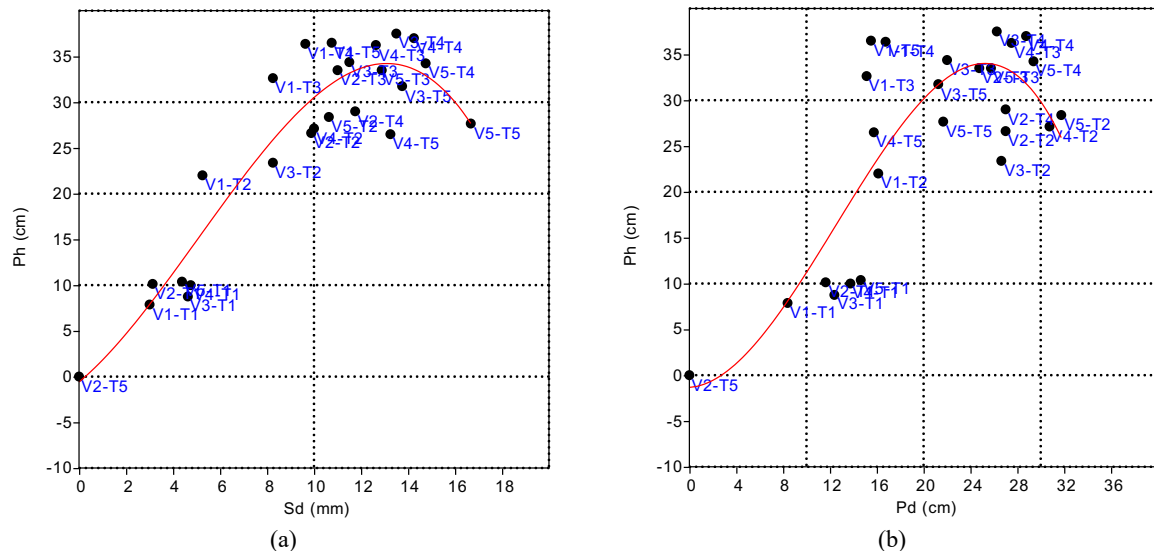


Figure 5. Graphical distribution of Ph values in relation to Sd (a) and in relation to Pd (b), *Tagetes erecta* F1 (average values)

The variation of important parameters in the overall description and characterization of the plants, *Tagetes erecta* F1, in relation to the experimental variants (growth substrate) and the moment of determination, was made by regression analysis.

The variation of Pd in relation to Sd and Sn, as a direct and interaction effect, was described by equation (3), under conditions of $R^2=0.967$, $p<0.001$, $F=117.6889$. The graphic representation of Pd values in relation to Sd (x – axes) and Sd (y – axes) is presented in figure 6 (a), (b).

$$Pd = ax^2 + by^2 + cx + dy + exy + f \quad (3)$$

where: Pd – plant diameter (cm); x – shoot diameter (Sd, cm); y – shoot number (Sn); a, b, c, d, e, f – coefficients of the equation (3); a= -0.179128; b= -0.002187; c= 3.839841; d= -0.130685; e= 0.029890; f= 0.

The variation of Ph in relation to Sd and Sn, as a direct and interaction effect, was described by equation (4), under conditions of $R^2=0.983$, $p<0.001$, $F=235.2208$. The graphic representation of Ph values in relation to Sd (x – axes) and Sn (y – axes) is presented in figure 7 (a), (b).

$$Ph = ax^2 + by^2 + cx + dy + exy + f \quad (4)$$

where: Ph – plant height (cm); x – shoot diameter (Sd, cm); y – shoot number (Sn); a, b, c, d, e, f – coefficients of the equation (4); a= -0.133339; b= -0.007494; c= 3.422782; d= 0.220078; e= 0.034746; f= 0.

The dynamics of the main parameters of the plants (Pd, Ph) under the influence of the experimental variants, was evaluated in relation to time, during the evaluation period (128 days) and the moments of determination.

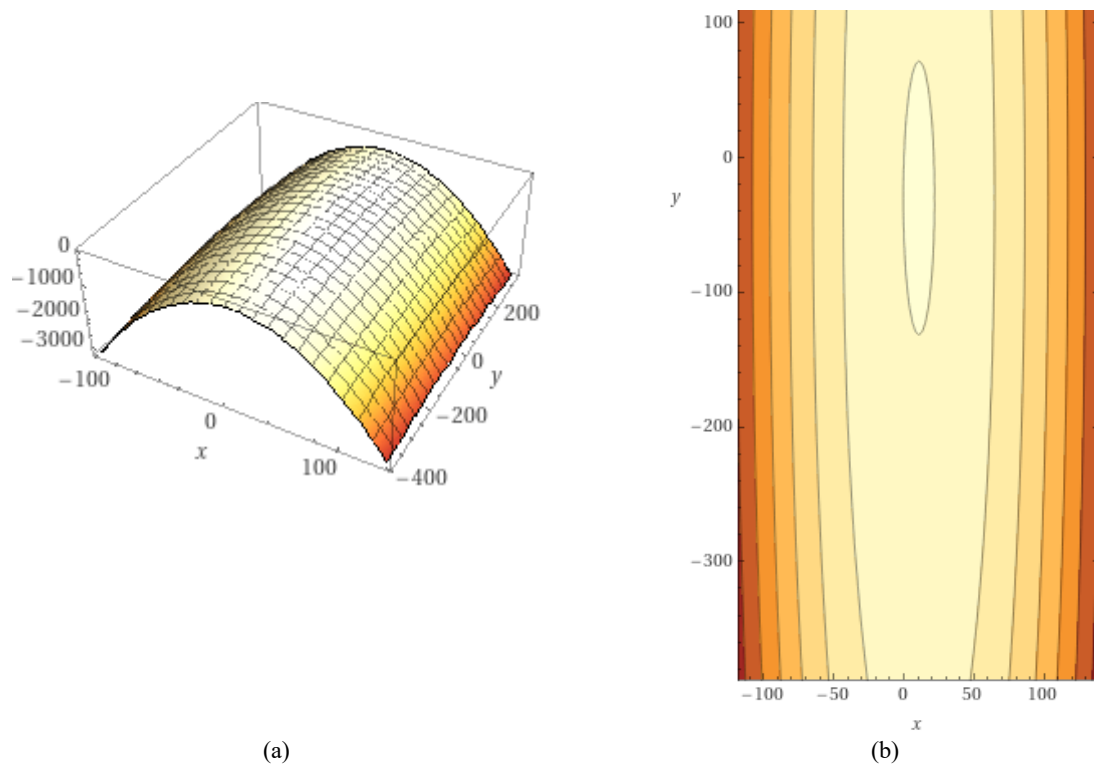


Figure 6. The graphic variation of Pd values in relation to Sd (x – axes) and Sn (y – axes), *Tagetes erecta* F1

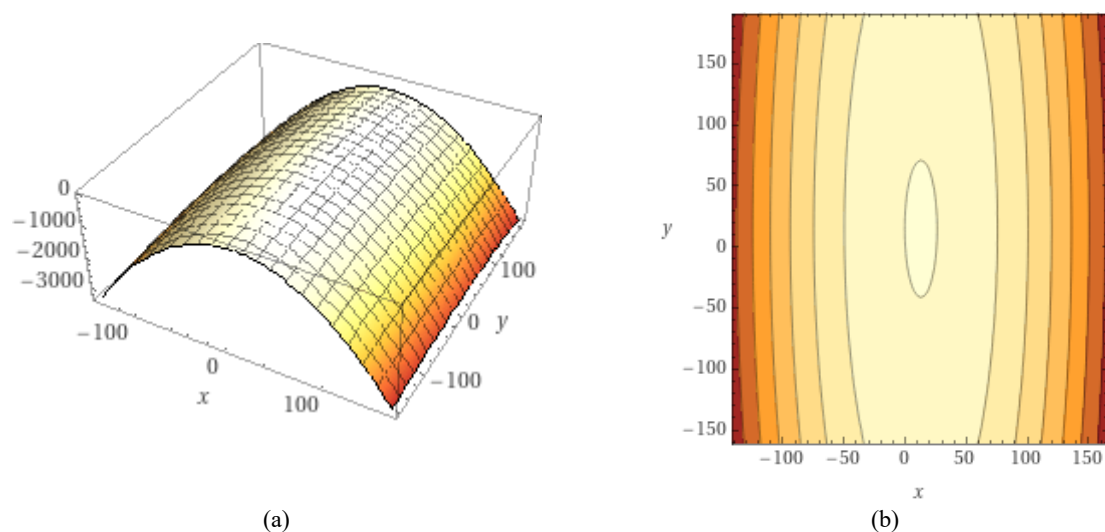


Figure 7. Graphic variation of Ph values in relation to Sd (x – axes) and Sn (y – axes), *Tagetes erecta* F1

Thus, the plants diameter (Pd) variation in relation to time, was described on the experimental variants by polynomial equations of the 2nd degree, equations (5) to (9), under statistical safety conditions, table 3, with graphical distribution in figure 8.

Table 3. The equations that described the Pd variation in relation to time on the experimental variants, <i>Tagetes erecta</i> F1					
Experimental Variant	Equations	Eq No.	p	R ²	F test
V1	$Pd = -0.001124x^2 + 0.1915x + 9.062$	(5)	0.162	0.837	5.1692
V2	$Pd = -0.005617x^2 + 0.6435x + 10.87$	(6)	0.072	0.928	12.838
V3	$Pd = -0.002137x^2 + 0.3295x + 13.73$	(7)	0.293	0.706	2.4069
V4	$Pd = -0.003891x^2 + 0.5044x + 14.69$	(8)	0.122	0.877	7.1319
V5	$Pd = -0.002833x^2 + 0.4007x + 16.3$	(9)	0.304	0.696	2.2873

x in equations (5) to (9) – the time (t, days) during the study period

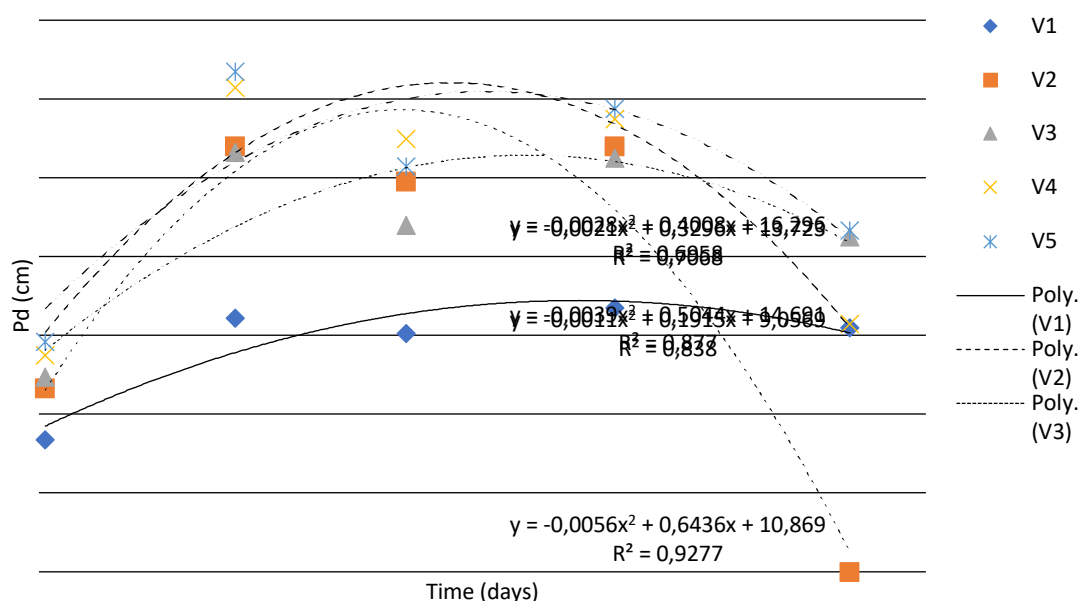


Figure 8. The graphic representation of the Pd values distribution on experimental variants in relation to time, *Tagetes erecta* F1 (average values)

The dynamics of the Ph parameter on experimental variants, in relation to time during the evaluation period, was described by polynomial equations of the 2nd degree, equations (10) to (14), under statistical safety conditions, presented in table 4. Graphical representation of the values Pd distribution on experimental variants, in relation to time, and the response curves, is given in figure 9.

Table 4. The equations that described the Ph variation in relation to time on the experimental variants, *Tagetes erecta* F1

Experimental Variant	Equations	Eq No	p	R ²	F test
V1	$Ph = -0.002753x^2 + 0.5794x + 7.236$	(10)	0.0034	0.996	289.37
V2	$Ph = -0.007159x^2 + 0.8565x + 8.427$	(11)	0.0092	0.991	107.54
V3	$Ph = -0.003694x^2 + 0.6626x + 7.618$	(12)	0.0044	0.995	224.66
V4	$Ph = -0.004656x^2 + 0.7308x + 9.207$	(13)	<0.001	0.999	2400.6
V5	$Ph = -0.003898x^2 + 0.6271x + 10.69$	(14)	0.0184	0.981	53.155

x in equations (10) to (14) – the time (t, days) during the study period

From the analysis of the two parameters Pd and Ph in relation to the time during the study period and the moments of intermediate determinations, a more accurate description was found for Ph than for Pd. In the case of Pd, the structural elements of the plant (the degree of branching, the number of shoots, the lateral distribution of the shoots) had a much more pronounced influence on the values regarding the diameter of the plants, and the obtained equations described with a lower precision and statistical certainty the variation of Pd.

In the case of Ph, the equations obtained more accurately described the variation of plant height in relation to time, on the experimental variants and the intermediate moments of determination.

In the case of variant V2 (compost, 100%), the course of vegetation was affected by the composition of the growing substrate, so that at T5 the recorded values confirmed the stopping of plant vegetation, a fact expressed in the graphical representations for Pd and Ph, in relation to time during the study period (figures 7 and 8). The high concentration of compost led to a vegetation stress that favored the premature cessation of vegetation at T5, after 128 days.

In order to comparatively evaluate the differences between the variants, in relation to the control variant (V1), the growth increment (Δ) was calculated for each determined parameter.

In the case of Ph, the increase recorded variable values in relation to the variants and determination time: $\Delta Ph = 0.88 - 2.50$ cm (T1), $\Delta Ph = 1.38 - 6.38$ cm (T2), $\Delta Ph = 0.88 - 3.63$ cm (T3), $\Delta Ph = -7.38 - 1.13$ cm (T4), $\Delta Ph = -36.50 - -4.75$ cm (T5). The negative values recorded showed that over time, the *Tagetes erecta* F1 plants grown on the substrate with compost showed certain deficiencies of the vegetation, associated with the

concentration of compost and the time factor.

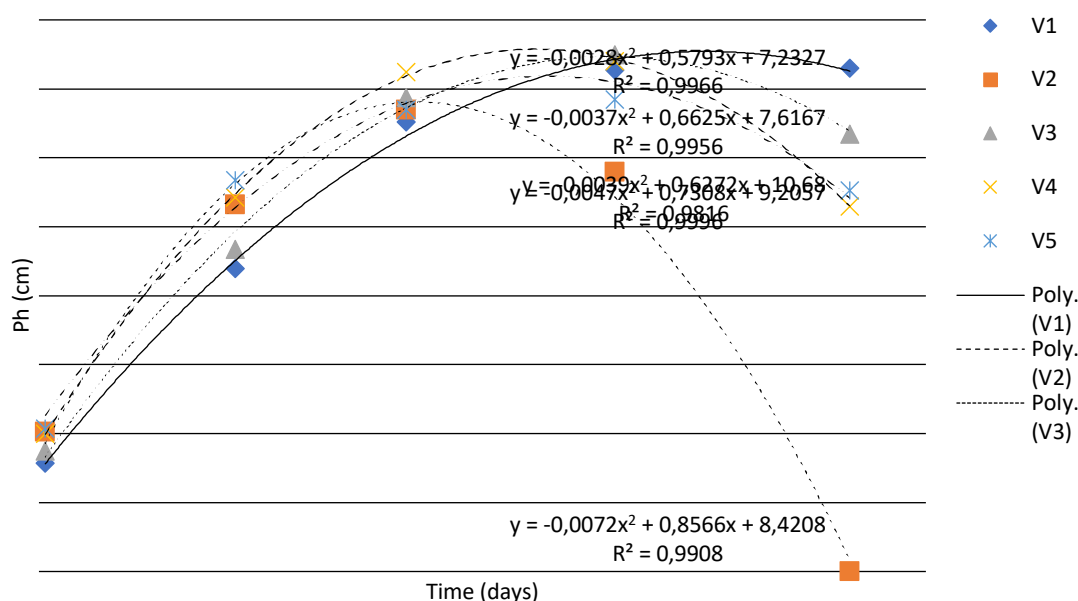


Figure 9. Graphic representation of the Ph values distribution on experimental variants in relation to time, *Tagetes erecta* F1 (average values)

In the case of the Sn parameter, the calculated growth increment, compared to the control variant, showed variable values, associated with the experimental variants and the evaluation time: $\Delta S_n = 1.75 - 5.50$ (T1), $\Delta S_n = 9.50 - 12.50$ (T2), $\Delta S_n = 20.25 - 27.25$ (T3), $\Delta S_n = 21.75 - 51.50$ (T4), $\Delta S_n = -15.00 - 2.25$ (T5). It was found that the values of ΔS_n showed positive values for all variants, during the T1 - T4 determination moments, and negative values for the V2, V4 and V5 variants at the T5 determination moment.

In the case of the Pd parameter, the calculated growth increment (ΔP_d) compared to the control variant, presented variable values on the experimental variants and the evaluation time: $\Delta P_d = 3.25 - 6.25$ (T1), $\Delta P_d = 10.50 - 15.53$ (T2), $\Delta P_d = 6.88 - 12.38$ (T3), $\Delta P_d = 9.50 - 12.63$ (T4) si $\Delta P_d = -15.50 - 6.17$ (T5). In the case of the Pd parameter, negative values of the calculated increase (ΔP_d) were recorded only in the case of the V2 variant at the moment T5.

In the case of the Sd parameter, the calculated increase in growth (ΔS_d) compared to the control variant, showed variable values, on the experimental variants and the evaluation period: $\Delta S_d = 0.13 - 1.75$ (T1), $\Delta S_d = 3.00 - 5.38$ (T2), $\Delta S_d = 2.75 - 4.63$ (T3), $\Delta S_d = 2.13 - 5.13$ (T4), $\Delta S_d = -10.75 - 5.92$ (T5). Negative values were found only in the case of the V2 variant at the time of T5. Also, in the case of variant V2, a gradual decrease of the calculated increase (ΔS_d) was observed during the study period, from $\Delta S_d = 4.62$ (T2), to the value $\Delta S_d = 2.75$ (T3), to the value $\Delta S_d = 2.13$ (T4), and to the value $\Delta S_d = -10.75$ (T5).

Artificial growth media, based on different solid components (mineral or organic) have been of interest for a long time in order to obtain, characterize and use them as growth substrates in controlled environments (greenhouses, solariums, phytotrons, etc.), for different crop plants for the purpose of research and production (Sala, 2011; Mourad et al., 2018; Nerlich and Dannehl, 2021).

The concerns for solid substrates, obtained from different categories of biodegradable organic waste, were presented in the introductory chapter of this study, with reference to some of the many studies and articles communicated in the scientific community, especially regarding the quality and use of these composts (e.g. Kadir et al., 2016; García Molano et al., 2021; Santi et al., 2021; Bekier et al., 2022).

In Romania, the Compost Law (Legea nr. 181, 2020) established the legal framework for the development of non-hazardous compostable waste management activities, by recycling and valorizing them using the composting/anaerobic digestion option in order to protect human health and the surrounding environment.

Based on the legal regulations, both internationally and in Romania, and the favorable results communicated by the specialized literature regarding the valorization of composts resulting from the fermentation of biodegradable organic waste for the purpose of growing plants, the present study evaluated the

valorization of compost for the purpose of cultivating the species *Tagetes erecta* L., plants of interest both for ornamental purposes and for raw material for the pharmaceutical and medicinal industries.

The results recorded in this study highlighted the possibility of using compost in different concentrations for plant growth substrates, and the data obtained contribute to completing the information in the field of valorization of biodegradable organic waste.

CONCLUSIONS

The growing substrates used facilitated the comparative evaluation of the influence of compost from the fermentation of some biodegradable organic waste on the growth of “*Tagetes erecta* F1 Discovery Orange” plants, based on the indices and parameters evaluated during the vegetation period of the plants.

Compared to the control variant, with garden soil substrate, the variants based on mixtures with variable weight of compost, or integral compost, ensured better values of the indices and parameters determined in plants (Ph, Sn, Pd and Sd) on a considerable interval of the vegetation period.

From the PCA and CA analyses, the differentiated positioning and association of the variants in relation to the main parameters of the plants (Ph, Pd) and the moments of determination during the study period resulted; it was obvious the positioning and association of the V1 variants at all determination moments (T1 to T5) and the V2 variant at the T5 moment (V2–T5), with low values of the determined parameters compared to the other variants.

The safety of the results was confirmed by the Anova test, and the PCA and Ca analyzes led to statistically safe results; PCA, PC1 explained 83.581% of variance, and PC2 explained 10.035% of variance, Coph.corr.=0.881.

In the case of variant V2 (integral compost), the growth period was influenced by the composition of the growth substrate, and there were negative increases in the determined parameters (ΔPh , ΔSn , ΔPd , ΔSd) at the time of T5 determination (at 128 days during vegetation), compared to the control variant.

The variation of the parameters determined in relation to time on the experimental variants was described by polynomial equations of the 2nd degree, under conditions of statistical safety for the parameter Ph (p , R^2) and under conditions confirmed only by R^2 for Pd.

3D models and as isoquants described the variation of the main parameters Pd and Ph in relation to Sd and Sn, under conditions of $R^2=0.967$, respectively $R^2=0.983$, $p<0.001$).

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