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VARIATION OF SOME PARAMETERS IN EARLY CABBAGE IN RELATION TO FERTILIZERS - COMPARATIVE EVALUATION

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Abstract

The variation of some morphological parameters and physiological indices in cabbage (Brassica oleracea var. capitata) in relation to fertilization was evaluated. The experiment was carried out under greenhouse conditions, agricultural year 2023-2024. The early cabbage hybrid 'Gazelle F1' was cultivated. Fertilization was done with Natur Complet G (12.5 kg/400 m^2) by incorporation into the soil, respectively Terranova (500 ml/400 m^2) and Naturamin WSP (10 g/10 L water), with fertigation application. A control variant was considered for comparison. Total plant biomass (TPW, g), head fresh biomass (HFB, g), leaf fresh biomass (LFB, g), leaf dry biomass (LDB, g), leaf ash content (LAC), root fresh biomass (RFB, g), root dry biomass (RDB, g), and root ash content (RAC, g) were determined. The comparative analysis showed differences with statistical safety generated by fertilization for TPB and HFB ($p<0.001$), LFB ($p<0.01$), and LDB ($p<0.05$). Multivariate analysis showed positive action of parameters, and variable level of intensity in relation to the principal components. The positioning of plant parameters changed in the structure of the principal components, in relation to the fertilization variants.

Key words: *early cabbage, fertilizers, greenhouse, morphological parameters, multivariate analysis.*

INTRODUCTION

Vegetables represent a comprehensive plants category with multiple uses, and cabbage (*Brassica oleracea* var. *capitata*), in Brassicaceae family, is a very popular vegetable plant, cultivated throughout the world (Ionescu & Roman, 2015; Moreb et al., 2020; El-Dkeshy et al., 2022). Cabbage is an important vegetable plant, with a high content of water, fiber, mineral elements, vitamins and active principles (e.g. antioxidants, phyto-chemicals), with high popularity in diets around the world, and high importance for human nutrition in various forms of preparation (Moreb et al., 2020; Daniel et al., 2023; Mulțescu et al., 2024). Plants of the Brassica genus represent a group of vegetables important for the diversity and improvement of diets and human health, as a result of the nutritional balance they provide (Zhang et al., 2025). Cabbage is considered an important plant in the vegetable category, with economic advantages and nutritional and human health benefits (Bute et al., 2024).

Various studies have highlighted the pharmacological properties of cabbage, with beneficial effects in nutrition and in the nutritional therapy of certain diseases, as a result of its effect on oxidative stress (Yang, 2018). The biochemical and nutritional composition of cabbage depends largely on the genotype, environmental conditions, and agronomic conditions, respectively on the interaction of these factors (Moreb et al., 2020). Due to its high content of bioactive compounds and their profile, cabbage has been classified as a functional food, with an important role in nutritional therapy (Uuh-Narvaez & Segura-Campos, 2021).

The influence of soil and some mineral elements (phosphorus, zinc) was analyzed on red cabbage under greenhouse cultivation conditions (Pongrac et al., 2019). The study authors reported variations in some agronomic parameters in plants and in the content of mineral elements in red cabbage in relation to different soil types and applied fertilizers, with implications for the quality of cabbage in human nutrition.

In relation to environmental factors, cabbage was classified as "intermediately sensitive" to water stress, and different irrigation methods were studied in relation to water efficiency in cabbage cultivation (Bute et al., 2021). Variation in some agronomic parameters and reduction in head yield in white cabbage were recorded in relation to drought stress and the water regime provided by irrigation (Seidel et al., 2017). Water is an important resource for sustainable cabbage cultivation, and irrigation methods contribute differentially to water use efficiency (Demir et al., 2024). The authors recorded effects on agronomic parameters, yield and quality indices in cabbage in relation to different water supply methods. Variable levels of correlation were found between marketable yield and agronomic parameters of cabbage plants, in relation to the methods and irrigation regime used (Demir et al., 2024). The growth and development of cabbage plants in early stages of vegetation have been studied to understand and explain the complexity of morphology in plant dynamics, the accumulation of photosynthetic pigments, and the influence of some technology elements (e.g. density) in cabbage cultivation (Bute et al., 2024).

Agronomic and morphological parameters were studied in cabbage in relation to different categories of pyroclastic materials and applied doses (Tetsopgang & Fonyuy, 2019). Cabbage culture was studied in relation to different types of fertilizers, organic and mineral, by evaluating some agronomic parameters of plants and yield (El-Dkeshy et al., 2022). Based on the determined morphological and agronomic parameters, and the yield, the authors identified fertilizer products and experimental variants that generated positive effects on cabbage crop, under the study conditions. The influence of some organic wastes was studied on red cabbage and broccoli within the framework of ecological cultivation technologies (Maffia et al., 2024). The authors of the study identified composts (fermented organic waste) with favorable effects on the soil and red cabbage and broccoli crops, under experimental conditions, which can be promoted for ecological technologies. Cabbage yield and certain soil properties were analyzed in relation to different organic fertilizer resources (Wang et al., 2024). The authors recorded the influence of organic fertilizers on the organic matter and nutrient content of the soil, and selected the effective products for agricultural practice. The authors also selected the fertilization variant that showed a favorable effect on cabbage yield, and which can be promoted for sustainable agriculture.

Economic cabbage production has been analyzed in relation to various potentially limiting factors, ecological, economic and social (Daniel et al., 2023). Different methods and techniques for improving the quality of cabbage production have been studied, through biotechnological, genetic and agronomic approaches (Zhang et al., 2025).

This study comparatively analyzed the cabbage crop in relation to fertilization based on morphological parameters and physiological indices, and quantified the differentiated positioning of the parameters in relation to the main components, as a result of the applied fertilization.

MATERIALS AND METHODS

The research was conducted at the "Young Naturalists' Resort", University of Life Sciences "King Mihai I" from Timisoara, in the agricultural year 2023-2024. The experiment was done in a protected space (greenhouse) figure 1. The soil was prepared by mechanical work with a tiller. Two crop variants were created by fertilization. The control variant was considered without fertilization. In the fertilized version, the product Natur Complet G was applied and incorporated into the soil, at a dose of 12.5 kg/400 m^2. The early cabbage hybrid 'Gazelle F1' was cultivated. The crop was established by planting seedlings, 40 days old, on December 28, 2023. The planting distances was 80 cm between rows and 30 cm between plants per row, with a density of 40000 plt/ha (Figure 1).

By fertigation, the product Terranova (two fertigations) and the product Naturamin WSP (three fertigations) were applied. The product Terranova was applied in a dose of 500 mL/400 m^2 after transplantation (8.01.2024) and in a dose of 750 mL/400 m^2 during the plant growth period (26.01.2024). The Naturamin WSP product was applied at a dose of 10 g/10 L of water, through three fertigations; during the vegetative growth period of the plants (25.01.2024), at the beginning of head formation (14.02.2024), and during the head formation period (01.03.2024). The greenhouse conditions during the experiment were characterized by temperatures of 14-16°C, and humidity of 80-85%.

Figure 1. Aspects in cabbage crop during the experimental period, greenhouse within “Young Naturalists Resort”, University of Life Sciences “King Mihai I” from Timişoara

On March 28, 2024, at the stage of harvesting for market of cabbage, samples were collected for determinations. From each experimental variant, ten whole plants (plants with roots) were randomly collected. The plant samples were placed in individual plastic bags, in boxes and transported to the laboratory for determinations. The determinations were made at the Environmental Biology and Biomonitoring Research Center, West University of Timişoara.

Several plant morphological parameters were determined: total plant biomass (TPW, g), head fresh biomass (HFB, g), leaf fresh biomass (LFB, g), leaf dry biomass (LDB, g), leaf ash content (LAC), root fresh biomass (RFB, g), root dry biomass (RDB, g), and root ash content (RAC, g). For the determination of the TPW parameter, the whole plants were considered, with the root (root cleaned of soil by washing and drying), the basal leaves and the head. For the determination of the HFB parameter, the head (commercial head) was detached from each plant. For the LDB parameter, the first three leaves wrapped in the head were taken. The determination of the fresh mass was carried out by weighing with a technical balance (KERN), accuracy ±0.005 g. The plants were dried in an oven (MEMMERT), at 105°C. The determination of the ash content was carried out with a calcinations (Nabertherm) oven 450-550°C.

General statistical analysis of the data was performed to certify statistical reliability and the presence of variation. Comparative analysis was performed for each parameter, between the experimental variants. Multivariate analysis was used to explain the position and mode of action of each parameter in relation to the principal components on the experimental variants. PAST v.4.17 software (Hammer et al., 2001), and JASP v.0.16.4 software (2022) were used for data analysis and processing and the generation of specific graphs.

RESULTS AND DISCUSSIONS

The plant samples (ten whole plants per variant, randomly harvested) were analyzed according to the experimental protocol for the purpose of the study. The experimental data obtained based on the determinations were analyzed for statistical characterization (Descriptive Statistics), and the results are presented in Table 1, and Table 2. The general analysis of the experimental data through the ANOVA Test (Alpha = 0.001) confirmed the statistical reliability of the results, and the presence of variance in the data set (Table 3).

Table 1. Statistical data of early cabbage parameters, hybrid 'Gazelle F1', unfertilized variant

Statistical parameters	TPB	HFB	LFB	LDB	LAC	RFB	RDB	RAC
N	10	10	10	10	10	10	10	10
Min.	774.12	482.78	23.04	1.18	0.28	14.62	2.61	0.35
Max.	1415.06	996.21	32.14	2.09	0.60	27.69	4.73	0.91
Sum	12239.90	8008.40	290.61	16.38	3.80	202.80	36.88	5.32
Mean	1223.99	800.84	29.06	1.64	0.38	20.28	3.69	0.53
Std. error	63.57	47.21	0.88	0.09	0.03	1.28	0.20	0.06
Stand. Dev.	201.02	149.28	2.79	0.30	0.10	4.04	0.62	0.18
Median	1262.17	843.05	29.58	1.65	0.36	19.44	3.61	0.49
25 prcntil	1122.46	703.24	27.54	1.44	0.29	17.44	3.27	0.38
75 prcntil	1408.49	892.48	31.25	1.85	0.44	23.84	4.32	0.64
Skewness	-1.316	-1.120	-1.150	0.015	1.158	0.558	0.118	1.231
Kurtosis	1.822	1.246	1.282	-0.445	1.501	-0.374	-0.121	1.256
Geom. mean	1206.682	786.207	28.932	1.613	0.369	19.929	3.640	0.509
Coeff. Var.	16.42	18.64	9.61	18.19	26.52	19.91	16.94	33.14

Table 2. Statistical data of early cabbage parameters, hybrid 'Gazelle F1', fertilized variant

Statistical parameters	TPB	HFB	LFB	LDB	LAC	RFB	RDB	RAC
N	10	10	10	10	10	10	10	10
Min.	1264.03	908.68	25.00	1.51	0.36	12.62	2.56	0.27
Max.	1897.05	1328.83	36.61	2.36	0.64	23.79	5.53	0.61
Sum	15631.02	11104.67	322.47	19.04	4.33	197.10	38.56	4.76
Mean	1563.10	1110.47	32.25	1.90	0.43	19.71	3.86	0.48
Std. error	67.59	46.71	1.13	0.10	0.03	1.02	0.28	0.03
Stand. Dev.	213.73	147.72	3.58	0.31	0.09	3.22	0.88	0.10
Median	1525.14	1096.79	31.86	1.80	0.40	20.22	3.64	0.49
25 prcntil	1381.83	977.66	30.59	1.64	0.37	18.22	3.39	0.42
75 prcntil	1783.78	1244.46	35.23	2.27	0.46	21.65	4.26	0.55
Skewness	0.141	0.190	-0.735	0.466	1.763	-1.027	0.944	-0.719
Kurtosis	-1.111	-0.980	0.464	-1.426	2.933	1.843	0.755	0.818
Geom. mean	1549.940	1101.646	32.058	1.882	0.426	19.441	3.771	0.464
Coeff. Var.	13.67	13.30	11.10	16.26	20.62	16.32	22.85	21.77

Table 3. ANOVA Test results

Source of Variation	SS	df	MS	F	P-value	F crit.
Between Groups	42656285	7	6093755	416.001	1.03E-95	3.703
Within Groups	2226561	152	14648.43			
Total	44882847	159				

The interdependence between the parameters determined in cabbage plants was analyzed within each experimental variant. In the case of the control variant (Table 4) the HFB parameter presented a very strong positive correlation with TPB (r = 0.947***). Strong, positive correlation was recorded between LDB and LAC (r = 0.812**), between LDB and RFB (r = 0.832**) and respectively between RFB and RDB (r = 0.833**). Weak correlation was recorded between RDB and RAC (r = 0.675*). In the case of the fertilized variant (Table 5), the TPB parameter showed a very strong, positive correlation with HFB (r = 0.950***). A strong, positive correlation was recorded between TPB and LFB (r = 0.817**), between RFB and RDB (r = 0.869**). A moderate correlation was recorded between HFB and LFB (r = 0.773**), and a weak correlation was recorded between LFB and RFB (r = 0.647*) and between LDB and LAC (r = 0.642*). At the level of the other parameters, a correlation without statistical safety was recorded.

Table 4. Correlation matrix between cabbage plant parameters, hybrid 'Gazelle F1', control variant

Variable	Statistical parameters	TPB	HFB	LFB	LDB	LAC	RFB	RDB	RAC
TPB	Pearson's r	-							
	p-value	-							
HFB	Pearson's r	0.947***	-						
	p-value	< .001	-						
LFB	Pearson's r	0.501	0.552	-					
	p-value	0.140	0.098	-					
LDB	Pearson's r	0.287	0.347	0.374	-				
	p-value	0.422	0.326	0.287	-				
LAC	Pearson's r	0.136	0.300	0.233	0.812**	-			
	p-value	0.709	0.400	0.518	0.004	-			
RFB	Pearson's r	-0.138	-0.020	0.247	0.832**	0.640	-		
	p-value	0.704	0.956	0.492	0.003	0.046	-		
RDB	Pearson's r	-0.231	-0.156	0.223	0.688*	0.445	0.833**	-	
	p-value	0.521	0.666	0.535	0.028	0.197	0.003	-	
RAC	Pearson's r	-0.306	-0.096	0.292	0.165	0.206	0.403	0.675*	-
	p-value	0.389	0.792	0.412	0.648	0.567	0.248	0.032	-

Table 5. Correlation matrix between cabbage plant parameters, hybrid 'Gazelle F1', fertilized variant

Variable	Statistical parameters	TPB	HFB	LFB	LDB	LAC	RFB	RDB	RAC
TPB	Pearson's r	-							
	p-value	-							
HFB	Pearson's r	0.950***	-						
	p-value	< .001	-						
LFB	Pearson's r	0.817**	0.773**	-					
	p-value	0.004	0.009	-					
LDB	Pearson's r	-0.016	-0.162	0.178	-				
	p-value	0.965	0.656	0.622	-				
LAC	Pearson's r	0.285	0.219	0.312	0.642*	-			
	p-value	0.424	0.543	0.380	0.045	-			
RFB	Pearson's r	0.414	0.524	0.647*	-0.018	-0.144	-		
	p-value	0.234	0.120	0.043	0.960	0.690	-		
RDB	Pearson's r	0.034	0.182	0.243	0.061	-0.283	0.869**	-	
	p-value	0.926	0.616	0.499	0.868	0.428	0.001	-	
RAC	Pearson's r	-0.412	-0.326	-0.256	-0.111	-0.491	0.048	0.329	-
	p-value	0.237	0.359	0.476	0.761	0.150	0.895	0.353	-

The comparative analysis was performed for each parameter of the cabbage plants, between the two experimental variants, and the results obtained are presented in Table 6. In the case of TPB and HFB parameters, the fertilized variant generated positive differences compared to the unfertilized variant, at the p<0.001 level (***). In the case of the LFB parameter, positive differences were recorded at the p<0.01 level (**), and in the case of the LDB parameter, a positive difference was recorded at the p<0.05 level (*) between the two variants. In the case of the other parameters, the differences did not present statistical safety (Table 6). The recorded results showed that the ash content in the leaf samples (LAC) did not present significant differences between the two variants.

At the level of the root system, also by fertilization, under the study conditions, no differences were generated in conditions of statistical safety.

Table 6. Difference between parameters in cabbage hybrid 'Gazelle F1' and significance level

Plants parameter	Recorded values and confidence interval			Difference and confidence interval		Statistical parameters		
	Given mean: V2 (Fertilized)	Sample mean: V1 (Unfertilized)	95% conf. interval:	Difference:	95% conf. interval:	t :	p (same mean):	Sig
TPB	1563.10	1224.00	(1080.2 1367.8)	339.11	(195.31 482.91)	-5.3347	<0.001	***
HFB	1110.47	800.84	(694.05 907.63)	309.63	(202.84 416.42)	-6.5588	<0.001	***
LFB	32.25	29.06	(27.064 31.058)	3.19	(1.1921 5.1859)	-3.6126	0.006	**
LDB	1.90	1.64	(1.4249 1.8511)	0.26	(0.048888 0.47511)	-2.7811	0.021	*
LAC	0.433	0.380	(0.30815 0.45245)	0.053	(-0.019451 0.12485)	-1.6523	0.133	ns
RFB	19.71	20.28	(17.391 23.169)	-0.57	(-2.3191 3.4591)	0.4463	0.666	ns
RDB	3.86	3.69	(3.2412 4.1348)	0.17	(-0.27484 0.61884)	-0.8708	0.407	ns
RAC	0.480	0.532	(0.4059 0.6581)	-0.052	(-0.074101 0.1781)	0.9328	0.375	ns

Principal Component Analysis (PCA) was applied to explain the positioning, intensity and action of the determined parameters in relation to the principal components on the two experimental variants. Chi-squared Test confirmed the reliability of the analysis model (Table 7).

Table 7. Chi-squared Test

Experimental Variant	Value	df	p
V1 (Control)	22.112	7	0.002
V2 (Fertilized)	16.815	7	0.019

In the case of the control variant, three parameters with positive action were loaded in PC1, very strong intensity LDB (r = 0.943) and strong intensity RFB (r = 0.874), and LAC (r = 0.864).

In PC2, three parameters with positive action and very strong intensity were loaded, HFB (r = 0.950), TPB (r = 0.938) and moderate intensity, LFB (r = 0.736).

In PC3, one parameter (RAC) was loaded with positive action and very strong intensity (r = 0.922). The RDB parameter was positioned with multiple actions. The loading of the components is presented in Table 8, with a graphic representation in Figure 2.

Table 8. Component Loadings, control variant

Parameters	PC1	PC2	PC3	Uniqueness
LDB	0.943			0.027
RFB	0.874			0.103
LAC	0.864			0.221
HFB		0.950		0.069
TPB		0.938		0.054
LFB		0.736		0.195
RAC			0.922	0.121
RDB				0.100

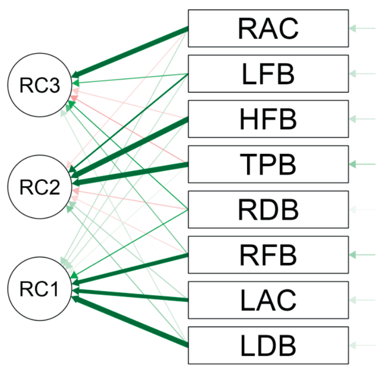

Figure 2. Path diagram for control variant

In the case of the fertilized variant, in PC1 three parameters with positive action were loaded, very strong intensity TPB (r = 0.964), HFB (r = 0.954), and strong intensity LFB (r = 0.840).
In PC2 two parameters with positive action were loaded, very strong intensity, RDB (r = 0.960), and strong intensity, RFB (r = 0.846).
In PC3 two parameters were loaded, with positive action of very strong intensity, LDB (r = 0.950) and strong intensity, LAC (r = 0.831). The RAC parameter was positioned with multiple actions. The loading of the components is presented in Table 9, with graphic representation in Figure 3.
The characteristics of the components are presented in Table 10 (control variant) and Table 11 (fertilized variant), with the graphical distribution of the Eigenvalue - component relationship in Figures 4 and 5, respectively.
The applied fertilization generated changes in the cabbage plants, but in a differentiated way in the aerial part compared to the root part.

Table 9. Component Loadings, fertilized variant

Parameters	PC1	PC2	PC3	Uniqueness
TPB	0.964			0.070
HFB	0.954			0.068
LFB	0.840			0.145
RDB		0.960		0.076
RFB		0.846		0.055
LDB			0.950	0.071
LAC			0.831	0.121
RAC				0.399

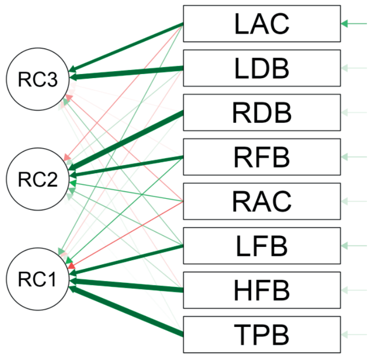

Figure 3. Path diagram for fertilized variant

Table 10. Component characteristics, control variant

Component	Unrotated solution			Rotated solution		
	Eigenvalue	Proportion var.	Cumulative	SumSq. Loadings	Proportion var.	Cumulative
Component 1	3.564	0.446	0.446	2.914	0.364	0.364
Component 2	2.493	0.312	0.757	2.477	0.31	0.674
Component 3	1.052	0.131	0.889	1.718	0.215	0.889

Table 11. Component characteristics, fertilized variant

Component	Unrotated solution			Rotated solution		
	Eigenvalue	Proportion var.	Cumulative	SumSq. Loadings	Proportion var.	Cumulative
Component 1	3.397	0.425	0.425	3.154	0.394	0.394
Component 2	2.218	0.277	0.702	2.106	0.263	0.657
Component 3	1.380	0.172	0.874	1.735	0.217	0.874

More extensive changes were recorded at the level of the TPB, HFB, LFB and LDB parameters which presented statistically significant differences compared to the root part. In the case of the RFB and RDB parameters, the differences between the variants did not present statistical safety. Also, the ash content in the leaf and root samples (LAC, RAC) did not record statistically significant differences between the two variants.
In the control variant, high variability was recorded for the RAC parameter (CV = 33.14), moderate variability for the LAC parameter (CV = 26.52) and low variability for the other parameters. In the fertilized variant, moderate variability was recorded for the LAC (CV = 20.62), RDB (CV = 22.05) and RAC (CV = 21.77) parameters.
Variability in cabbage has also been reported by other studies, at the level of some morphological parameters of slopes in relation to plant density (Bute et al., 2024). The accumulation and concentration of mineral elements in the cabbage has been analyzed in

relation to genetic variability (Chura et al., 2021). Morphological variability has been analyzed in relation to hybrid and parental forms in cabbage, based on a large number of morphological characters (Kibar et al., 2016). Differentiated variability has been recorded in red cabbage for phenotypic and genotypic parameters, in relation to different characters and quality indices (Deep et al., 2024).

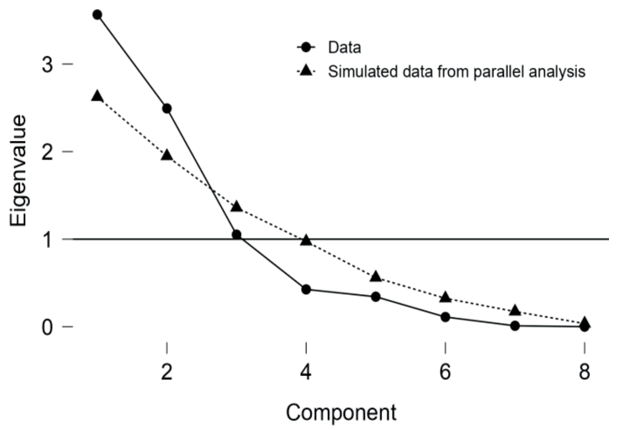

Figure 4. Scree plot for control variant

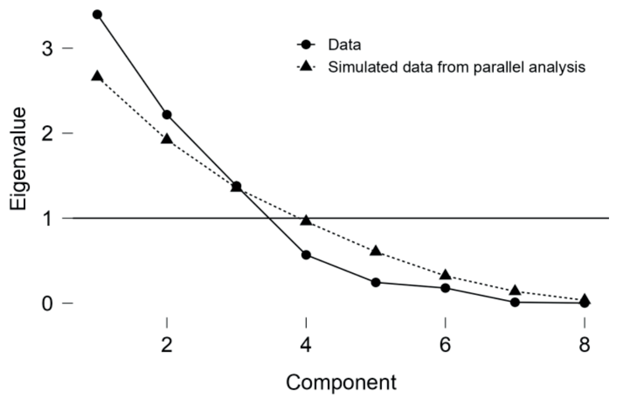

Figure 5. Scree plot for fertilized variant

Cabbage is an important crop and has been studied under different environmental conditions, crop structure and rotations (Kutova et al., 2020).
Commercial yield is important in cabbage and has been analyzed in comparison to total plant yield in relation to different cropping systems and technology factors (Paranhos et al., 2016).
The yield of cabbage head (HFB parameter) recorded an increase in growth by fertilization, which justifies the technological sequence under the study conditions, in early cabbage, the 'Gazelle F1' hybrid. The variation of some agronomic parameters and the yield of cabbage head in relation to different mineral or organic resources, fertilizers, and technology elements, have been reported in other studies (Tetsopgang & Fonyuy, 2019; Maffia et al., 2024; Tejashwini et al., 2024; Wang et al., 2024). Also, the variation in cabbage head yield was recorded in relation to the water factor (Seidel et al., 2017), which showed that cabbage clearly registers at the head level the positive or negative effect of vegetation factors. The positive, very strong correlation was maintained between the HFB and TPB parameters, both in the fertilized variant ($r = 0.950$) and in the unfertilized variant ($r = 0.947$), at a level close to intensity. This showed the balanced growth of the plants in relation to the available nutritional resources, with the increase in the head yield associated with the level of available nutritional resources, but maintaining the proportionality of the plants. In the case of the unfertilized variant, the HFB/TPB = 0.65 ratio was recorded, and in the case of the fertilized variant the HFB/TPB = 0.71 ratio was recorded.

CONCLUSIONS

The early cabbage crop, the 'Gazelle F1' hybrid, specifically capitalized on the conditions experimentally provided by differentiated fertilization, in a greenhouse culture environment. The fertilization provided, by fertilizers applied to the soil, and by fertigation, generated changes in the cabbage plants parameters compared to the control variant, but in a differentiated way, in the root part, compared to the aerial part of the plants.
Larger changes were recorded in the aerial part of the plants, compared to the root part of the plants. At the level of the TPB, HFB, LFB and LDB parameters, values with significant differences were recorded in the fertilized variant, compared to the control variant, at the level of $p<0.001$ (TPB, HFB), at the level of $p<0.01$ (LFB) and at the level of $p<0.05$ (LDB). In the case of the parameters from the root part (RFB, RDB) the differences between the fertilized variant and the control variant did not present statistical safety. In the case of the ash content in the leaf samples (LAC), and in the root samples (RAC), the differences did not present statistical safety.

A very strong, positive correlation was recorded between HFB and TPB parameters, both in the fertilized version (r = 0.950) and in the unfertilized variant (r = 0.947), at a level close to intensity, which showed balanced plant growth and development in relation to nutritional resources.

Multivariate analysis (PCA) highlighted the positive action of the determined parameters, with variable intensity level, in relation to the principal components. Morphological parameters of the plants were positioned differently in the structure of the principal components, in relation to the fertilization variants, but in both variants a positive action of the parameters was recorded.

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