Scientific Papers. Series B, Horticulture. Vol. LXIX, No. 2, 2025
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

STUDY OF THE POSSIBILITIES OF USING COMPOST AS A SUBSTRATE FOR GROWING *BRASSICA OLERACEA* L. VAR. *CAPITATA* L.

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Abstract

The present study aimed to trace the change in microbial communities and the degree of cabbage formation under different variations of the growth medium. Five variants were studied: control - soil, V1 - 10% compost and 90% soil, V2 - 25% compost and 75% soil, V3 - 50% compost and 50% soil, V4 -100% compost. Samples were taken on 15, 30 and 60 days. The amount of total microflora in all variants slightly decreased over time, but the mineralization rate remained almost the same. Throughout the experiment, the main share in the composition of the total microflora was occupied by non-spore-forming bacteria and bacillus, and actinomycetes and micromycetes were less represented. The total amount of microorganisms was higher in the variants with compost compared to the control, highest in the variant with 100% compost content.

***Key words**: microorganisms, compost, Brassica oleracea L. var. capitata L.*

INTRODUCTION

Composting converts raw organic materials into a biologically stable, humic-like product called compost (Ceglie & Abdelrahman, 2014; Graves and Hattemer, 2000). Compost mixtures with an optimal carbon/nitrogen ratio of around 30:1 of the input materials shows a higher microbial number and better physicochemical characteristics of the finished product. (Grigorova-Pesheva et al., 2024). Given the deteriorating state of soils across Europe, both in terms of physical characteristics and nutrient content (Ferreira et al., 2022; Lawrence & Melgar, 2023), the possibility of using compost as a basis for growing certain crops is of interest for developing agriculture and meeting the needs for ever higher productivity. The composition and quality of the finished compost varies greatly depending on the starting substrates used in the composting process. (Miyamoto et al., 2023). Furthermore, composting is essentially a biological transformation of organic matter under the action of microorganisms (Rastogi et al., 2020). Different groups of microorganisms participate in the composting process, and their distribution and abundance affect the quality of the finished product (Silva & Naik, 2007). As a result, when using compost as a base for seedlings, the characteristics of the finished compost, its organic matter content, fractional composition, as well as acidity, have a strong influence on the development and formation of crops (Chaudhuri et al., 2016). It is for this reason that the present study aimed to evaluate different combinations in percentage terms of compost and soil. The production of vegetable seedlings worldwide is enormous. As noted by Carmona et al. (2012) in their article, given the limited volume of seedling containers, the quality of the substrate is of key importance.

In their study, although related to decorative plants, the team of Giuffrida (2017) found that certain compost mixtures can completely or partially replace the soil substrate used until now. This suggests the possibility of using certain compost mixtures as an alternative to soil substrate, which will lead to significant economic benefits for agriculture and mainly for vegetable production.

In this study, the experiments were carried out with cabbage (*Brassica oleracea* L. var. *capitata* L.), given the large percentage it occupies in vegetable production in Bulgaria. In addition, cabbage crops are classified as undemanding in terms of soil type, but are particularly demanding on soil fertility

(Daskalov & Kolev, 1958). Namely because of this, cabbage is a suitable test subject for transplanting in containers with different variants of soil-compost mixture. Moreover, given the low acidity levels preferred by cabbage seedlings (Daskalov & Kolev, 1958), as well as the need for high levels of organic matter (Kolev, 1963; Manolova, 2012), the soil-compost mixture appears to be a potential alternative for their production, including as a lower budget option. The great economic importance of cabbage has also led to various scientific developments related to its cultivation in combination with other crops. A comparative study of root and soil microbiological activity in individual and intercropping cultivation of cabbage (*Brassica oleracea* L. var. *capitata* L.) was carried out, and the influence of different mixed crops on the microbial abundance of the cabbage rhizoplane was also studied. (Mladenova et al., 2023; Mladenova et al., 2024a; Mladenova et al., 2024b).

The main goal of this study is to investigate the potential for using different variants of soil-compost mixtures for growing cabbage seedlings, based on microbiological indicators, as well as on the degree of seedling development.

MATERIALS AND METHODS

In our study, cabbage was used as an experimental seedling. Cabbage is a major representative of the Brassicaceae family, an extremely commonly used vegetable in Bulgaria, which is also very suitable for intercropping (Mladenova & Yordanova, 2023). For the purpose of this study, cabbage was also chosen, given that it ranks second in production in Bulgaria for 2023 with 44,963 tons per year. (Ministry of Agriculture and Food, Bulgaria, report 437, 2024). For the experimental part, five variants were prepared: control - soil, V1 - 10% compost and 90% soil, V2 - 25% compost and 75% soil, V3 - 50% compost and 50% soil, V4 - 100% compost. Mature compost obtained from the transformation of potatoes, wood chips, green leafy vegetables and starter soil in a ratio of 20/2.5/10/7.5 was used, with the initial C:N ratio of 31:1. The compost was previously analyzed for the presence of pathogens above the maximum permissible levels, which were not detected. The finished compost used in this scientific work has the following characteristics: C:N - 14:1, pH - 7.2, suitable structure of the formed aggregates, N - 1.76%, C - 24.64%. The soil used is from the Vrazhdebna farm, where the experiment was conducted. The soil has the following characteristics: $pH_{(H_2O)}$ - 6.9, organic carbon (Corg.) - 1.72% P_2O_5 - 15.96 mg/100 g, K_2O - 22.91 mg/100 g, N - 0.11%.

In each of the variants, seedlings of *Brassica oleracea* L. var. *capitata* L. were planted. The microbiological status of the different mixtures and the control was studied, as samples were taken on 15, 30 and 60 days. The amount of *Bacillus*, non-spore-forming bacteria, micromycetes and actinomycetes was determined. For the determination of *Bacillus*, the samples were previously pasteurized, with subsequent inoculation on Nutrient agar at 24°C for 48 hours. For non-spore-forming bacteria, nutrient agar was used, and the cultivation was done at 24°C for 48 hours. The cultivation of actinomycetes was carried out on Starch ammonia agar at 35°C for 7 days, and of fungi on Čapek doxa agar, for 7 days, at 30°C. Based on the quantities of individual groups of microorganisms, the total microbial count was determined. Each inoculation was repeated five times, and the average value was given. The results are presented in column-forming units (CFU) x 10^5 per gram of absolutely (abs.) dry mass. In addition to the microbiological parameters, the external signs of development of the product part - cabbage - were also examined. The only treatment applied was watering.

RESULTS AND DISCUSSIONS

The results of the experiments are presented in CFUx10^5/g dry mass. The reported values for microbial abundance expressed as the total microbial number of the individual variants by day are presented in Figure 1.

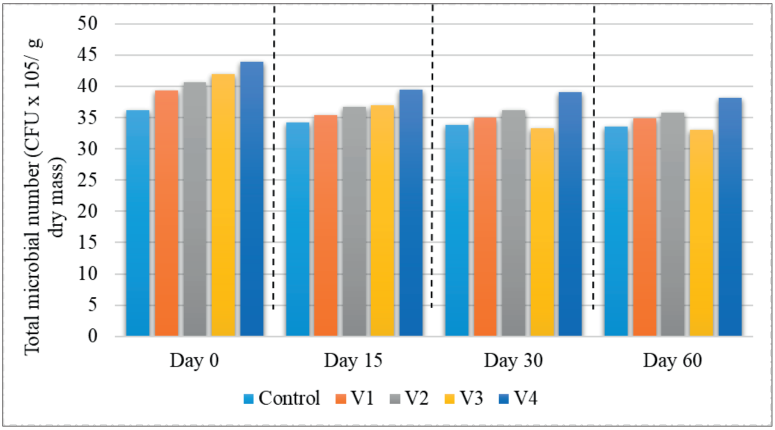

Figure 1. Total microbial number (CFU*10^5/dry mass)

The data from analyses of the total microbial number show a slight decrease in microbial abundance as time progresses. At the beginning of the experiment (day 0) the highest total amount of microorganisms was found in the compost sample (V5). The lowest number of microorganisms is expected for the soil sample (100% soil, V1). In the other variants, as the percentage of compost increases, the amount of microflora also increases. Given that the increased amount of microflora leads to a faster transformation of organic components into forms suitable for plants (Chen et al., 2024), we believe that variants with a higher percentage of compost will provide a greater amount of nutrients to the grown seedlings. As time progresses, microbial abundance in all variants decreases. The difference between day 0 and day 15 is the largest. Between day 30 and day 60, almost no difference is observed, as the system has reached equilibrium. Compared to the baseline data, microbial abundance decreased most significantly in V4, which is equal parts compost and soil. The reduction in total microbial number compared to the baseline data is as follows: Variant 1: 7.34%, Variant 2: 11.39%, Variant 3: 11.84%, Variant 4: 21.35% and Variant 5: 13.06%. Similar data show the specificity of using soil-compost mixtures. The main risk is the reduction of microbial abundance, respectively the reduction of the transformation of the available organic matter. Thus, in the initial sample with only soil, the microorganisms decreased almost two times less compared to the sample of simple compost (V5). Of interest are the data that show a higher decrease in microbial abundance with increasing percentage of compost, as in sample 4, the total microbial number decreased by 21.35%. More than in the variant with compost (V5). Apart V5, which is just compost, V3 stands out (compost 25%, soil 75%) which has the highest total number of microbes.

Figures 2-5 show the quantities of individual microbiological groups in the studied samples in dynamics.

The data on the studied quantities of individual microbiological groups show a dominant presence of the group of non-spore-forming bacteria regardless of the variant and the number of days of reporting. Given that, these are the microorganisms that predominate in the final phases of organic matter transformation, the data show a stable state of the compost mixtures and similar microbiological characteristics to the soil.

After non-spore-forming bacteria, the most common is the bacillus group, followed by the micromycetes and actinomycetes groups, which are almost equally represented.

The data from the microbiological analyses on day 15 show a slight change in the distribution of microbial groups. Thus, the amount of non-spore-forming bacteria decreases slightly at the expense of the slightly increased amount of *Bacillus*. In all samples, an increase in the amount of micromycetes compared to the amount of actinomycetes was observed.

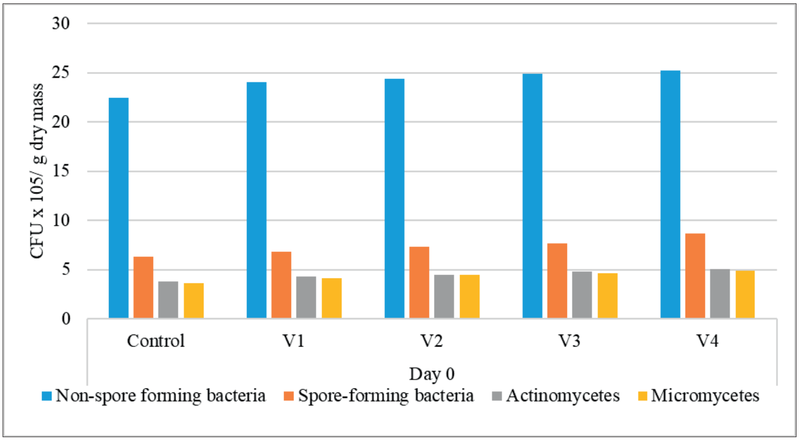

Figure 2. Microbial number of main microbial groups at Day 0 (CFU*10^5/ dry mass)

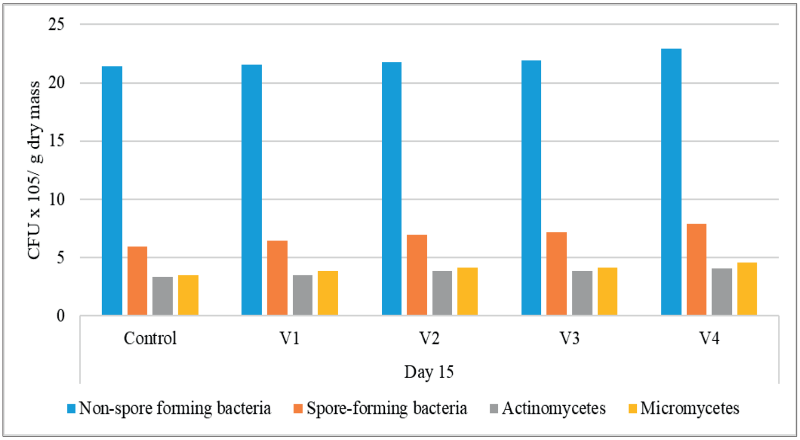

Figure 3. Microbial number of main microbial groups at Day 15 (CFU*10^5/ dry mass)

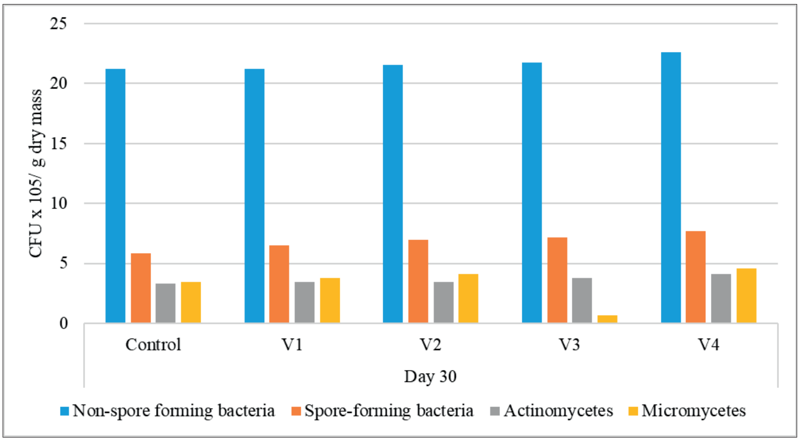

Figure 4. Microbial number of main microbial groups at Day 30 (CFU*10^5/ dry mass)

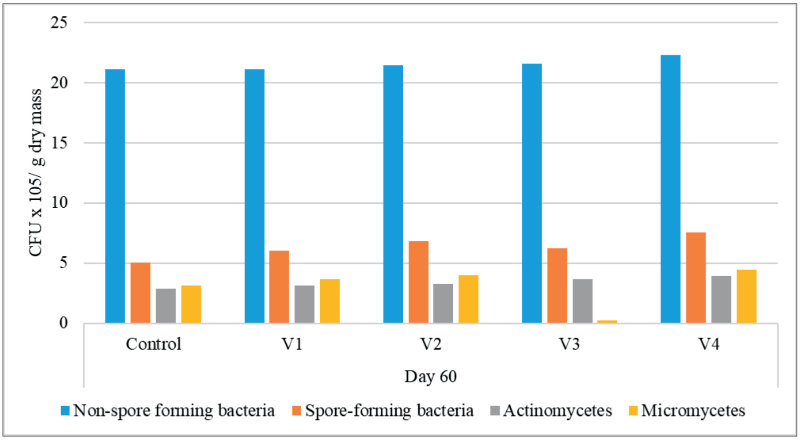

Figure 5. Microbial number of main microbial groups at Day 60 (CFU*10^5/ dry mass)

The values reported for day 30 show the occurrence of certain changes in V4. In the other variants, there is no significant dynamics in the results. In V4, the amount of fungal microflora has greatly decreased, constituting only 6% of the total microflora. In the other variants, this percentage is around 27%. Similar data indicate a certain suppression of the fungal microflora, probably as a result of the greater participation of the compost mass, in which there is a specific development of microorganisms that can exhibit a certain competition with the soil ones. There are studies that show that when materials are mixed, microorganisms that are autochthonous to both mixtures appear allochthonous to the mixed material, which leads to a certain competition between the groups, which continues until equilibrium is reached, often by displacing one species over the other (Boehme et al., 2004).

The data on the microbiological characteristics at day 60 maintain the trends from the previous samplings. However, in V4 we observed an almost complete absence of the fungal group. In this variant, when mixing the two starting materials used, specific settling in places and non-formation of a soil-like structure of the mix were observed. We assume that the increased compost content leads to a certain change in the formation of the structural aggregates of the mix, which changes the water-air regime. These data are also explained by the higher levels of anaerobes reported in this variant. This is probably one of the reasons for the strong reduction of the fungal microflora, which is known to be highly aerophilic.

During each reading of the microbiological parameters of the seedling production variants, the external development of the cabbage seedlings used was observed. For the purpose of the experiment, equally developed seedlings were introduced on day 0. In order to track their development and the potential development of cabbage, the tracking was carried out within 60 days. At each sampling, the development of the stem and leaf mass was recorded. At the beginning, the variant with 100% compost showed much faster stem development and leaf formation compared to the other variants. The development of the stem was about 37% greater. The variant with 100% soil (V1) also had very good initial development. It is interesting that at the initial reading on day 15, V2 (10% compost, 90% soil) stood out with the weakest development.

Measurements on day 30 showed that all variants had similar characteristics, with a delay in the development of Variant 5, with pure compost. Development and formation of cabbage was observed in all variants. On day 60, the data indicated that the variant with pure compost had the weakest development of cabbage, despite the initial rapid growth. Variant 2, with 25% compost and 75% soil, stood out with the best-formed and fresh cabbage. Similar data showed that soil-compost mixtures are suitable not only for growing cabbage seedlings, but also for the entire vegetative cycle. Given the generated results, we believe that when building appropriate beds with a base of soil-compost mixture, the entire cultivation until harvesting of cabbage can be carried out on them.

CONCLUSIONS

The present study was conducted to investigate the possibility of using compost as a potential substrate for the development of *Brassica oleracea* L. var. *capitata* L. The present work examined four variants of compost mixture and one control. For each of the variants, the total microbial count and the amount of individual microbial groups were determined at the beginning of the experiment, on day 15, day 30 and day 60. The state of seedling development was also assessed. As time progressed, a decrease in the total number of microorganisms in all samples was found. In all samplings, V5, with only compost, and V3, with 25% compost and 75% soil, was characterized by the highest microbial abundance. For all variants, the group of non-spore-forming bacteria predominated. In general, the variants have similar microbiological characteristics, with the exception of V4. In this variant, a strong suppression of the fungal microflora was observed, which almost disappeared at the end of the experiment.

When analyzing the external signs of the seedlings on day 15, its more rapid development is clearly evident in V5, with compost. After it, the best development is observed in V1 (100% soil). On day 30, the seedlings have almost similar signs, which emphasizes the slowdown in the rapid development of V5. At the end of the experiment, V3 stands out with the best development, which has the best-formed cabbage.

The present experiment proved that the use of a soil-compost mixture is suitable for growing cabbage seedlings.

Such a way of growing seedlings would reduce financial costs, especially for mixed farms that generate large quantities of compost. However, it is important to take into account that each compost has specific characteristics in relation to the starting materials used.

Based on the conducted research, we recommend that if rapid seedling development and subsequent sowing is required, the variant with 100% compost or with 25% compost should be used. However, if the seedling is kept for a longer period of time, the variant with 100% compost is not applicable and it is necessary to resort to the option with 25% compost. In all cases, we recommend using compost mixtures when growing cabbage, even in open areas, given this crop's need for a sufficient amount of organic matter in the environment.

This study can serve as a basis and foundation for future in-depth research on the topic. The findings of this study represent a basic platform for the future use and utilization of compost mass generated on farms.

ACKNOWLEDGEMENTS

The current study was performed in the framework of ‘Investigating interrelationships in different variations of organic waste composting, by creating dynamic compost mixtures with the addition of ameliorants and tracking microbiological and enzyme activity - variants for applying a quality organic-mineral compost-based improver in agricultural practice’ – КП-06-Н66/10” funded by Research Fund of Ministry of Education and Science in Bulgaria.

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