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Morphological factors in no-till cabbage production

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Abstract

The no-till system promotes benefits that extend not only the characteristics of soil improvement, interfering in the quality and productivity of the plants, thus improving physical, chemical, and biological attributes of the crop and resulting in profitability to the producer. The present study evaluated the agronomic development of cabbage according to different cover plants. The experiment was performed in the field, in the Vegetable sector of the University of Rio Verde - UniRV, Rio Verde, GO. The cover plants used were millet (*Pennisetum americanum* (L)), sunflower (*Helianthus annuus*), brachiaria (*Brachiaria decumbens),* and crotalaria (*Crotalaria* juncea). The studied greeneries were cabbage *(Brassica oleracea*), Astrus plus hybrid. The parameters evaluated to analyze the physiological development were: the plants' height, number of leaves, and cabbage diameter. The results were submitted to the descriptive statistical method with analysis of means, covariances, and correlations, using the Matlab program. Plant growth data were submitted to the analysis of variance, and when significant, the cover plant factor was compared by Fisher's test, and the factor days after planting was analyzed by regression. The cabbage showed a higher mean height (cm), leaves, and diameter with the sunflower covering plant. The millet was the best plant to increase the cabbage's mean productivity.

Keywords: greenery, management, plant cover, production

Introduction

Brassicas worldwide provide the most remarkable diversity of manufactured products derived from a single genus. Leafy vegetables, flowers, and roots can be consumed fresh, cooked, and processed. The production of these vegetables in Brazil has been growing exponentially in the last decades, due to its economic importance, with significant production volumes in different states and a rapid monetary return for producers in small-sized areas (Melo et al., 2019).

Plant cover improves the soil's physical and chemical aspects, accumulating a high amount of dry matter in the system, forming straw layers in the soil, avoiding erosion, leaching, and being optimal weed suppressants (Araújo et al., 2015).

Among the management techniques that change the dynamics of weeds communities, the dead straw cover stands out, affecting the weeds emergence, nutrient dynamics of the nutrients returning to the soil, and consequently, the crop growth and productivity (Correia et al., 2006).

These brassicas with high nutritional and commercial value have a high capacity to extract nutrients from the soil (Silva et al., 2012). Studies have shown that brachiaria, crotalaria, millet, and fallow (spontaneous vegetation) provide substantial nutrients to the soil after the coverings management (Assis et al., 2013).

These changes are more pronounced in conventional soil preparation systems than conservationist systems such as no-tillage (SPD), which appear as soil density, volume and pore size distribution, and stability of soil aggregates, influencing water infiltration and plant development (Castro et al., 2011). Cover plants increase the amount of phytomass on the soil surface, reduce erosion and increase water infiltration in the soil (Guedes

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Filho et al., 2013).

This phytomass, after decomposition, increases microbial activity, nutrients accumulation, and organic matter in the soil surface layers and, consequently, favors the soil aggregates increased stability (Lima Filho et al., 2014).

In tropical regions, a significant challenge for the maintenance of no-till is the high decomposition rates of the vegetal material, demanding large quantities of straw (Chioderoli et al., 2012). Therefore, annual or semi-perennial grasses and legumes should be considered for this purpose (Carneiro et al., 2008).

This work evaluated the cabbage culture development according to different cover plants.

Material and Methods

The experiment was performed at the University of Rio Verde - UniRV, Rio Verde, GO. The area is located at 545 meters altitude, latitude 23° 25' south, and 51° 25' west longitude. The soil is classified as latosol red/ dystrophic (Embrapa, 2013).

The experimental design was randomized blocks with five treatments and five repetitions. Each repetition consisted of 6 meters long and 3 m wide plot, totaling 18 m^2. The plants were spaced 0.5m between plants and 0.50m between lines, summing 72 plants per plot. The treatments consisted of different covering plants: sunflower (Helianthus *annus),* crotalaria (*Crotalária ochroleuca),* brachiaria *(Brachiaria brizantha),* millet *(Pennisetum glaucum),* and fallow *(weeds)*. The seeding density of the cover plants was 50,000, 300,000, 200,000, and 200,000 plants/ha-1 for sunflower, crotalaria, brachiaria, and millet, respectively. Plants were sowed according to the technical recommendations of each species (Carvalho et al., 2018).

At 45 days after the cover plants emergence, the area was dried, using the herbicides glyphosate (960 g/ha) and 2.4-D (720 g/ha), following Valente et al. (2000) and Alves (2019). There was no fertilization during the cover plants growth of nor weeds removal by mechanical, chemical, or manual means.

The cabbage variety was the Astrus Plus hybrid. The seedlings were acquired from breeders in trays with a substrate. The transplant was performed as the seedlings presented four definitive leaves and 25 days after desiccation of the area, using a 0.5 m spacing between plants and 0.70 m between lines. The irrigation was performed by sprinkling twice a day: at 9:30 to 10:00 and 16:00 to 17:00.

Irrigation was carried out daily at the beginning and the end of every day for one hour. The harvest was performed 92 days after the seedling planting.

Productivity metrics analyzed: plant height, number of leaves, and head diameter.

The plant height was measured by a graduated ruler, considering the neck of the plant until the apex of the oldest fully expanded leaf. The leaf number per plant was measured by counting their number before the head closure. Finally, the diameter was defined by measuring the width of the head of the cabbage by a caliper.

The vegetative cycle of the cabbage culture is divided into phenological phases. These phases comprise a growing or vegetative period of the culture, the leaves' closure, and the head's formation for harvesting and maturation (head rigidity) (Figure 1).

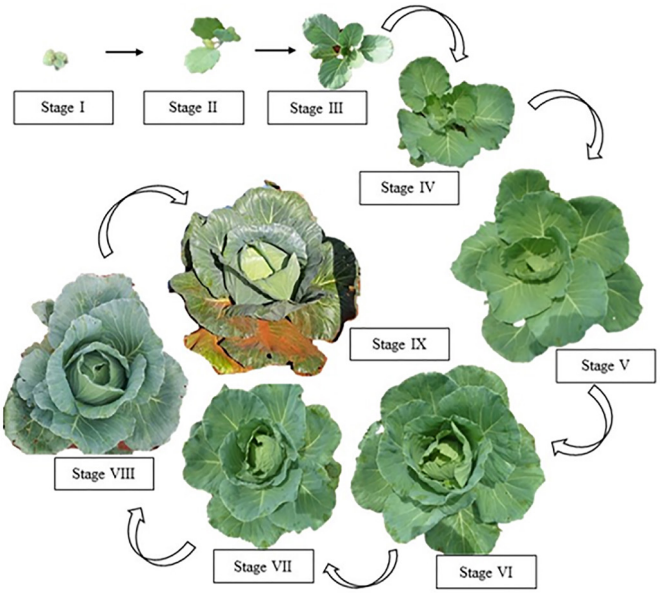

Figure 1. Phenological *phases of the Brassica* oleracea culture. (Source: Marasca et al., 2022.

The collected data on plant growth were submitted to analysis of variance. If the analysis of variance displayed significant results, the factor "covering plant" was compared by the Fisher Test, and the factor "days after planting" was analyzed by regression. In addition, data on plant height, number of leaves per plant, head diameter, and productivity were submitted to the analysis of variance and, when significant, compared by the Fisher test (P<0.05) processed by the Sisvar® statistic program (Ferreira, 2011).

Results and Discussion

The "covering plant" factor in the days after planting produced no difference among the treatments for the plant growth variable. However, the regression test indicated plant growth as a quadratic behavior as studying the factor days after planting within each cover plant (Figure 2).

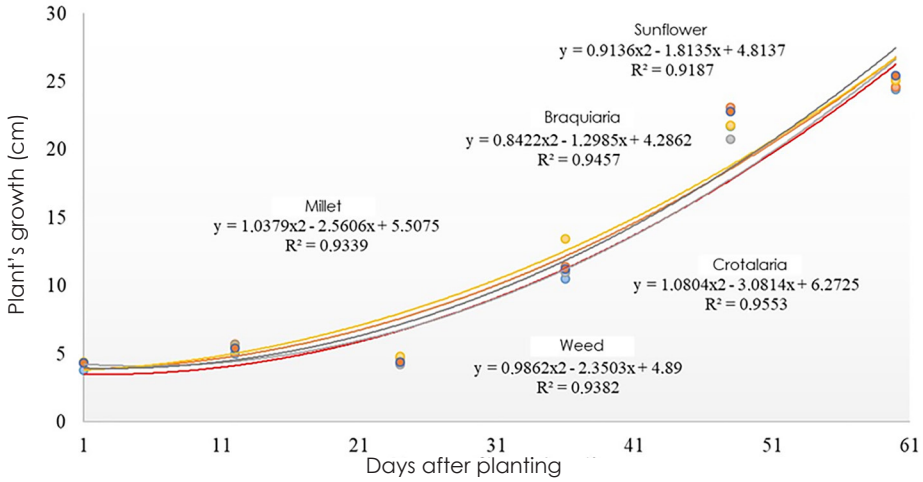

Figure 2. Growth of cabbage grown in association with different cover plants.

The quadratic behavior of plant growth on dry mass production suggests that the production time of the cover plants was sufficient to reach the plants' maximum production.

The rates of elongation and leaf onset, lifetime, and the philochronous displayed a quadratic behavior. There was an increase in the tillers' number and the dry matter production as the plants were fertilized. However, nitrogen utilization efficiency and apparent recovery linearly decreased as nitrogen increased (Abreu et al., 2020).

As displayed in the table 1, the type of soil cover over successive cabbage cultivation did not influence plant height, head diameter, and fresh head mass. However, the number of leaves per plant was higher when cultivating cabbage after using millet and brachiaria, compared to sunflower and fallow, which did not differ statistically from the crotalaria.

Productivity per area was higher when using millet as a cover plant prior to the cabbage planting when compared to fallow and sunflower, not differing statistically from brachiaria and crotalária.

Table 1. Plant Height (PH), Number of Leaves per Plant (LoP), Head Diameter (HD), Fresh Head Mass (FHM), Productivity (PROD) and Cultivated Cabbage bred in Succession to different cover plants.

Treatment	PH (cm)	LoP (Unit)	HD (cm)	FHM (kg)	PROD (kg ha^{-1})
Sunflower	24.61^{nf}	14.87 b	16.12^{nf}	1.06^{nf}	5513 c
Millet	25.47	17.70 a	13.14	1.21	18928 a
Brachiaria	25.10	17.45 a	16.53	0.99	15648 ab
Crotalaria	25.25	15.87 ab	14.54	0.89	14305 abc
Pousio (weed)	24.41	14.82 b	16.18	0.95	6959 bc
CV (%)	4	8	18	32	53

As assessing the rational integrated and organic production systems in the culture of onions in conventional and no-till cultivation, the no-till system increased the total commercial productivity of conventional soil management. Furthermore, the formation of upper-class bulbs (bulbs with a cross diameter greater than 50 mm) is observed only in conventional and rational treatments, is higher in no-till in the bulbs and diameter (Menezes Júnior et al., 2020).

The association with millet, brachiaria, and

crotalaria produced the highest number of leaves per plant, and the highest dry mass of the cover plants, providing the development of vegetables in higher numbers than fallow and sunflower.

The association with millet produced the highest productivity compared to the other cover plants used. Millet is one of the most used cover plants in the cerrado of Goiás, and the species has adapted quickly to the region's climate.

The no-till system for the cabbage culture, even in the initial implantation phase, can interfere in the dynamics and maintenance of soil organic matter and increase the values of light organic matter, C, N, C stock, organic particulate, and associated minerals, humic and oxidizable fractions compared to conventional planting and grazing (grass family) (Melo et al., 2016).

Phytomass production, decomposition, and nutrient release of black oats (*Avena strigosa* Schieb) related to cauliflower productivity *(Brassica oleracea* var. Botrytis) under different soil management systems. Furthermore, the researchers observed that black oats (cv. Embrapa 139) are adapted to the climate of the mountainous region of the Rio de Janeiro state and can serve as a soil cover plant for cultivation in autumn/winter. Therefore, cauliflower production in the no-till system in succession to the cultivation of black oats is an option to improve crop productivity rates in the Rio de Janeiro Mountain region and preserve soil and water (Schultz et al., 2020).

The millet haystack presented an accentuated decomposition rate (29%) in the first 17 days after the haystack management. After this, the decomposition rate slowed down, reaching 82% at 82 days, mainly due to the higher lignin and cellulose content (Perin et al., 2015).

The use of different soil covers and seedling planting on their decomposing residues is promising in vegetable cultivation. Besides improving the agronomic indicators proven in this study, the soil maintenance of residues preserves humidity for a more extended period, decreases the irrigation cost, minimizes the mineral fertilizer due to nutrient cycling, and provides other benefits, such as the control of erosion and weeds (Torres et al., 2015).

Conclusions

The association with millet provided the highest cabbage productivity compared to the other cover plants used in this experiment.

The cabbage (*Brassica oleracea*) did not show significant plant height, cabbage diameter, and fresh head mass for all cover plants.

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