EFFECTS OF MALT BAGASSE UTILIZATION ON KALE GERMINATION USING DIFFERENT SUBSTRATES AND SHADINGS

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3 ## Abstract

4 Malt bagasse is an important waste from breweries, with high potential of usage in various animal and human food areas. Nonetheless, there are few studies of its *in natura* usage as soil conditioner for various vegetables seedings production. Thus, this works objective was evaluate the interaction among different substrate compositions, using brewery waste as component, and different shading levels at Georgian cabbage germination. For that, the experiment was made in five different shading levels (50%, 70%, 90%, 70% with plastic and full sun) and three different substrates moistures with distinct compositions: S1 (33,33% of manure; 33,33% of sandy soil; 33,33% of clayish soil), S2 (83% of earthworm humus; 15% of fine glyceride charcoal; 2% of mammon dumpling), S3 (33,33% of brew waste; 33,33% of sandy soil; 33,33% of clayish soil), in an completely randomized design, with five repetitions for each shading level and substrate concentration. Germination beginning occurred in the third day after sowing (DAS) and lasted until the tenth DAS. The S2 substrate stood out, followed by S1, with similar results in height, roots length, germination percentage, and germination speed index. On the other hand, the substrate composed of malt bagasse obtained the worst results in all shading conditions, being not indicated to kale seedings production.

Keywords: Brassica oleracea var. acephala; malt bagasse; horticulture; luminosity

INTRODUCTION

5 The malt bagasse has gained importance due to the great volume yearly produced by brew industries (CORDEIRO, 2011). Brewery wet waste, according with Brochier e Carvalho (2009), is resultant from the initial stage of brew production process, presenting itself in husk or bran forms, with approximately 80% of humidity. According with Lopes et al. (2015), at the processing end subproducts are generated and the most present waste, corresponding to 85% of the total, is from the malt bagasse. Countless studies point the ruminants feeding as an alternative usage for the waste (GOMES, 2010). Besides that, the malt bagasse utilization as soil conditioner is still an incipient research area.

6 The city of Niterói invests on the creation of the sustainable brewers seal with the intention to encourage the region's brewer pole through 3288/217 law, which encourages the craft breweries creation, prioritizing the correct destination of its wastes. That way, this works objective was to evaluate the interaction of different substrate compositions, using the brewery waste and different shading levels on the Georgian kale germination.

MATERIALS AND METHODS

7 The experiment was carried out on the experimental site of Campus Gragoatá, of Universidade Federal Fluminense, Niterói, RJ, which coordinates are: latitude of 22º 54′ 00′′S, longitude of 43º 08′ 00′′W and altitude of 8m. The region has climate Aw, following Köppen classification, e.g., tropical weather with dry winter and rainy summer, with average annual temperature of 23 Celsius degrees, and average annual precipitation of 1200mm, occurring on the period from 2021 August 14th until 2021 September 10th.

8 The treatments consisted of different substrate compositions and different shading levels (50%, 70%, 90%, 70% with plastic, and full sun), using kale (*Brassica oleracea var. acephala*) seedings from ISLA®, which sowing was made in 2021 August 31st.

9 For the different substrate compositions to seedings production, the following soils were used: Planossolo Háplico e Argissolo Vermelho-Amarelo (EMBRAPA, 2018), collected from UFRRJ in Seropédica – RJ, along with tanned bovine manure or the craft brewery malt bagasse waste from Niterói – RJ. The substrate 2 was provided by Fazendinha Agroecológica (Table 1):

10 **Table 1** – Description of substrate treatments based on the percentage volume ratio of each component

11

Treatment	Substrate composition % (v/v)
S1	33.33% manure; 33.33% of sandy soil; 33.33% clay soil
S2	83% earthworm humus; 15% fine charcoal of gliricidia; 2% castor cake
S3	33.33% brewery waste; 33.33% of sandy soil; 33.33% clay soil

12 According with the soil chemical analysis, it was necessary to correct its pH according to Manual de Calagem e Adubação do Estado do Rio de Janeiro (2013).

13 The substrates were added in polystyrene trays with 200 cells, and then allocated in distinct green houses with different shading levels, being the irrigation made a day before sowing. After, kale seeds were sown by cells, each treatment of different compositions having 50 units and each experimental unit having 1 seed.

14 The germination ratio was daily measured until the tenth day after the germination beginning, when all treatments stabilized. The germination percentage and germination speed index (IVG) was then determined. The germination percentage was calculated through the proposed formula of Regras para Análise de Sementes (BRASIL, 2009), and the IVG according to the equation proposed by Maguire (1962) adapted from Moraes et al. (2012).

15 After germination counting, in the tenth day, the kale physiological data as seedling height and roots length were measured with a graduated ruler.

16 All response variables were subjected to Shapiro-Wilk test, in order to verify if the variables came from a normally distributed population. After, data significance determination was made with ANOVA, and the average values comparation test using the Turkey model, with 5% probability, with SISVAR® software.

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RESULTS AND DISCUSSION

19 The germination percentage data presented in figures 1, 2 and 3 shows each substrate behavior in the distinct shading levels. That way, it can be seen that S1 substrates stabilization occurred until the seventh DAS, with lower percentage (68%) occurring in full sun situation, due higher temperatures and higher daily irrigation need. Being the 90% shading level the most efficient with 86% of germination, due to lower climate conditions variation and better humidity maintenance in the substrate (Figure 1).

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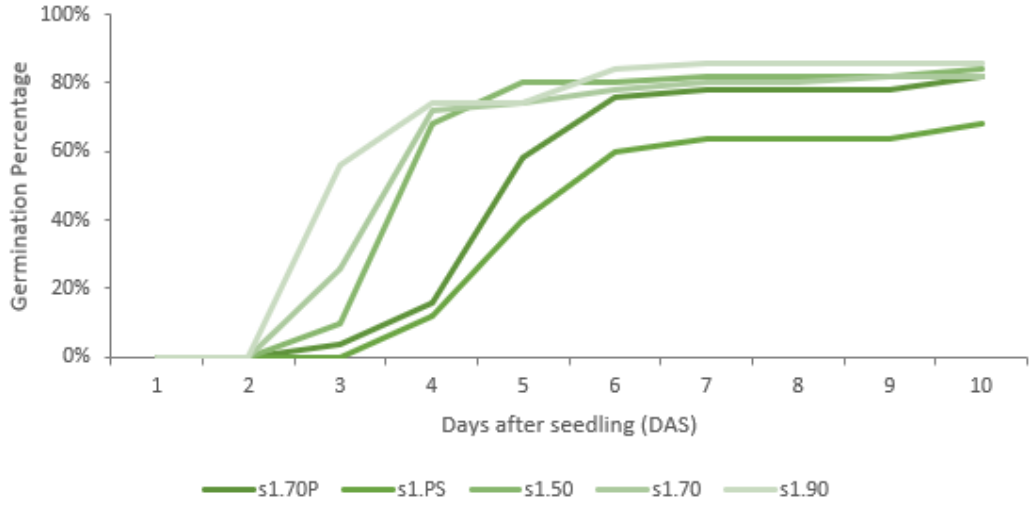

21 Figure 1: Percentage of germination of substrate S1 at different shading levels: 50% (50), 70% (70), 90% (90), 70% with plastic (70P) and full sun (PS).

22 The S2 substrate, from Fazendinha Agroecológica, showed very similar results independent of shading levels, with stabilization values between sixth and seventh DAS (Figure 2). For this substrate, the greater germination occurred with shading 50, with 84%, and the lower value in shading 90, with 72%.

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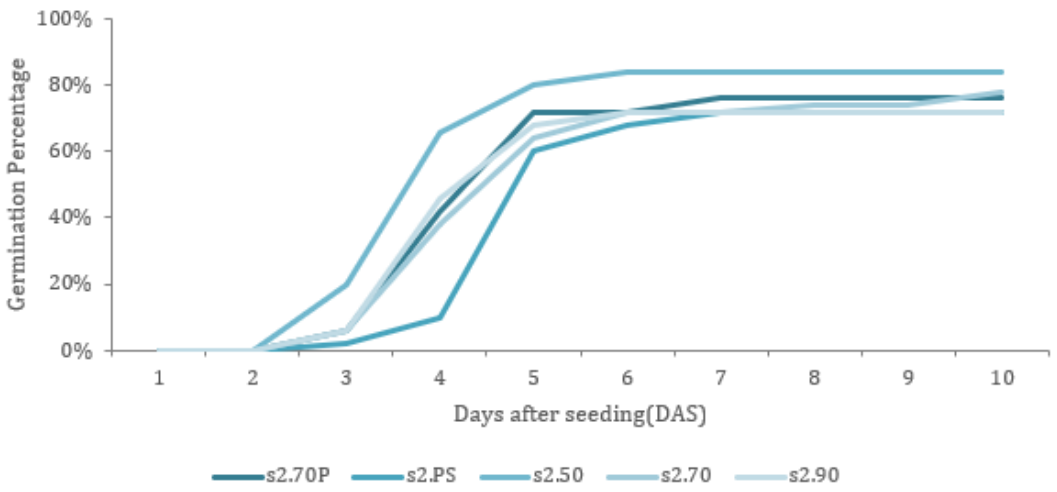

24 Figure 2: Percentage of germination of substrate S2 at different shading levels: 50% (50), 70% (70), 90% (90), 70% with plastic (70P) and full sun (PS).

25 The substrate containing the malt substrate (S3) showed worst germination results, occurring lately and with vary poor values. The better situation occurred in shading 90 with 76% of germination, and for full sun only 10% of germinative capacity. (Figure 3)

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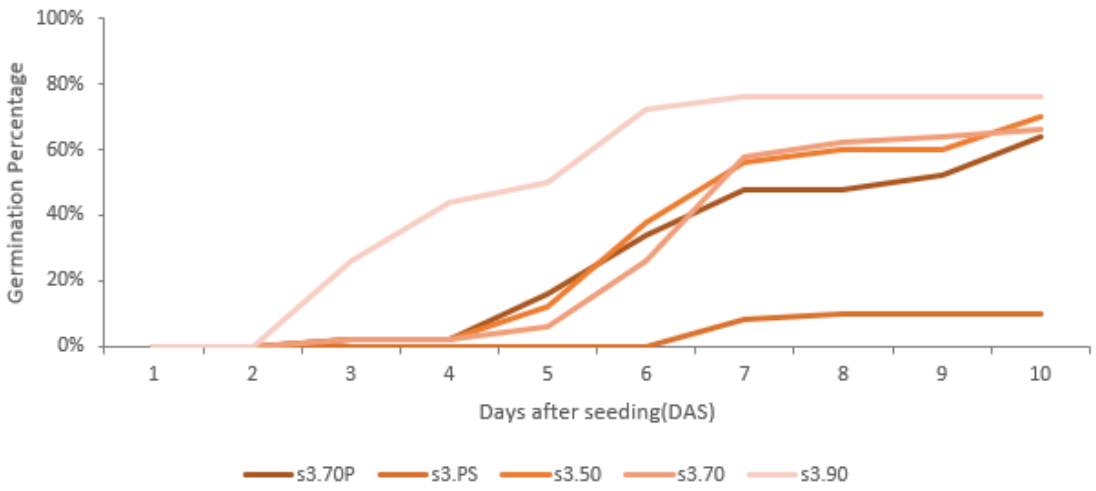

27 Figure 3: Percentage of germination of substrate S3 at different shading levels: 50% (50), 70% (70), 90% (90), 70% with plastic (70P) and full sun (PS).

28 These results shows that each substrate obtained better results in different climate conditions, pointing the brew waste usage, generally for greater shading level conditions, as it has better results over other shading levels.

29 About the IVG, it can be seen that the S2 substrate showed the best results considering the different shading levels, followed by S1. The substrate that contained brew waste (S3) did not stood out in any condition. It is highlighted that the best combination occurred with S1 substrate in 90% shading level, being 1794% higher then the worst combination, that occurred with S3 substrate in full sun condition.

30 Table 2 - Description of the Germination Speed Index (IVG) for the different substrates and shading

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Substrate	Shading				
	50	70	90	70P	Full Sun
S1	10,36 Bc	10,87 Ab	12,56 Aa	8,21 Bd	6,45 Be
S2	10,82 Aa	8,59 Bc	8,53 Cd	8,79 Ab	7,29 Ae
S3	5,54 Cb	5,15 Cc	9,30 Ba	5,06 Cd	0,70 Ce

Uppercase letters compare substrate averages and lowercase letters compare shadings. Means followed by the same letters do not differ statistically from each other by the Tukey test (P<0.05).

32 The treatment height (Table 3), showed generally very similar values between S1 and S2 substrates for each different shading levels, being statistically similar, not differing between each other. Nonetheless, it is highlighted the low values for S3 substrate.

33 Table 3 - Description of height data in cm for different substrates and shading

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Substrate	Shading				
	50	70	90	70P	Full sun
S1	0,94 Aa	1,02 Aa	0,78 ABab	0,94 Ba	0,46 Ab
S2	1,02 Aab	0,96 Aab	1,06 Aab	1,42 Aa	0,70 Ab
S3	0,44 Bb	0,44 Bb	0,54 Bb	1,04 ABa	0,00 Cc

Uppercase letters compare substrate averages and lowercase letters compare shadings. Means followed by the same letters do not differ statistically from each other by the Tukey test (P<0.05).

35 Table 4 - Description of root length data in cm for different substrates and shading

36

Substrate	Shading				
	50	70	90	70P	Pleno Sol
S1	4,78 Aab	6,80 Aa	3,60 Abc	2,08 ABc	3,24 Abc
S2	4,48 Aa	4,94 Aa	4,26 Aa	4,00 Aa	4,34 Aa
S3	1,60 Ba	0,98 Ba	2,52 Aa	7,72 Ba	0,00 Bb

Uppercase letters compare substrate averages and lowercase letters compare shadings. Means followed by the same letters do not differ statistically from each other by the Tukey test (P<0.05).

37 The presented results points to the no utilization of malt bagasse as seeding production component. It can be occurred due to the quantity of sugars composed in the waste, leading to fungi and bacteria proliferation, interfering in the production.

CONSIDERATIONS

38 The malt bagasse did not showed effectiveness in substrate formation to kale seedings production in different shading levels.

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