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Propagation and Vegetative Development of *Portulaca oleracea* Linn. in Different Substrates

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Abstract

UFP's are unconventional food plants, which can be included in food and feed, but underutilized because they are few known and/or researched. Portulaca oleracea Linn, known as a wigworm, is considered a weed due to its easy spread in different places, has potential to be included in the diet of people, so that they can take advantage of its medicinal, nutritional and landscape benefits. In view of the above, the objective of this research was to evaluate the vegetative development of the bollworm cultivated in different substrates to obtain a better production of green mass besides adding higher medicinal and/or nutritional contents. The experimental design was a completely randomized design with 6 treatments: 1-Barranco soil (Witness), 2-Soil + Bovine manure, 3-Soil + Commercial substrate, 4-Soil + Charred rice straw, 5-Soil + Bovine manure + Charred rice straw, 6-Soil + Bovine manure + Commercial substrate and 5 replicates. The seed germination rate was evaluated at five, ten and 15 days after sowing (DAS). At 70 DAS the total fresh mass of the plants and total dry mass in grams, plant height, main root length and number of leaves were evaluated. The substrate composed of ravine soil + bovine manure + charcoal rice straw provided the best indices of development of the bollworm plant. The combination of three components for the formation of a substrate favored fresh and dry biomass.

Keywords: *Portulaca oleracea*, PANCs, organic waste

1. Introduction

Weeds are extremely important in the agricultural context, being responsible for losses that occur in the productivity and quality of products of economic interest derived from crops. Some species considered invasive have potential food, medicinal and ornamental use still unknown by a large part of the Brazilian population (Viana et al., 2015).

Portulaca oleracea is considered a weed due to its easy propagation and dissemination. It can be observed in many environments, good or bad, as an example in rocky, sandy soils, corners of walls, abandoned land, cracks in sidewalks, but prefers soil rich in organic matter and is indicated as an indicator of soil fertility (MAPA, 2010).

This vigorous development can be explained according to Carneiro and Smiljanic (2016), who report that the bellhop has C4 metabolism, due to the presence of a second sheath around the radially arranged vascular bundle in the leaf, so they are tolerable for long periods of deficit water.

There have been reports of this species since ancient Egyptian times, but their peculiarities are only having greater relevance in the field of research today, mainly because of their medicinal properties (Okafor et al., 2014). In this way allied to this important function, this plant can be included in human food and still be used as ornamental, since it produces enough flowers, conditions that must be considered.

P. oleracea is an annual plant of the family Portulacaceae (Cros et al., 2007), which is worldwide disseminated (Santos, 2014). They are herbaceous plants, with generally prostrate stem, with dichotomous branching, subsseiling leaves, spatulate, evident central rib; attenuated base; apex rounded to obtuse; whole margin; glabrous; inflorescence with 2-6 flowers. Sessile flowers, flower buds flattened laterally; yellow petals; sessile, with about 20-30 black or opaque seeds per fruit (Coelho & Giulietti, 2010). It multiplies sexually and is very prolific. A single plant can produce 10,000 seeds (MAPA, 2010).

According to Lorenzi and Matos (2008), and Mangoba (2015), this species deserves attention of the researchers of several areas of knowledge. There have been reports in the literature of its interesting nutritional and medicinal characteristics, including high levels of omega-3s among green leafy vegetables, some fish oils, algae and linseed seeds, as well as vitamins and minerals. This high content of omega-3 fatty acid, an important substance for the prevention of heart attacks and the strengthening of the immune system, makes the insertion of this plant into the food routine very interesting to be studied.

Due to its medicinal qualities, it is listed by the World Health Organization (WHO) (Lorenzi & Matos, 2008). Even given the excellent qualities indicated, this plant is not consumed by the majority of Brazilians, probably due to the lack of research, incentives and knowledge related to its benefits. The purslane can be consumed in the form of salads, soups, sauteed or in green juices. To be inserted in the eating habits of the people, initially should be studied the forms of reproduction and growth, as well as their response in different substrates, with the objective of obtaining better production of green mass and mainly to add higher levels of the medicinal principles and or (Zorzeto et al., 2014).

Nature and the agricultural industry provide us with many types of organic waste, which must be reused in plant production systems as a way of recycling nutrients and reducing the negative impacts caused by the large accumulation of nutrients in the environment in which they are introduced. As examples we have residues from crop residues and by-products derived from companies such as sugar cane, husks (rice straw), feedlots (animal manure), among others (Mota et al., 2009).

In soil terms, the bollworm is a plant that does not present great demands, having capacity to grow in arid, saline and poor soils, but preferring nutrient rich soils with good water availability (Yazici et al., 2007). Probably, the cultivation of this vegetable in substrate without competition with other plants may favor a higher growth, leafy ones and greater weight in foliar mass.

The addition of organic materials to the soil, as it is well known, improves its physical (texture, density), chemical (nutrients, pH) and biological characteristics (microorganisms, mycorrhizae), favoring a lesser need for application of chemicals, fertilizers and pesticides, can also reduce the vegetative period of cultivated plants (Fermino & Kampf, 2003). Degradation of organic matter and the slow availability of nutrients promote good nutritional support during all phases of plant development (Santos et al., 2011).

Although it is an extremely rustic and easily proliferated plant, the prosecutor prefers soils rich in organic matter (MAPA, 2010). The cultivation in these soils can increase characteristics related to green mass productivity, increase nutrient content and pharmacological properties, as well as improve the visual quality of the plants, providing better attraction to consumers and probably greater chances of being accepted (Araújo Neto et al. 2009). Studies on the best way to propagate the bollworm and on the best substratum for its sowing and vegetative development are quite scarce in the literature.

The use of unconventional food plants (UFP's) should be included in research activities, since these plants may present alternatives to combat hunger and malnutrition of the most needy populations, as well as being used as ingredients in the most sophisticated naturalistic cuisine, many of them unknown by the population (MAPA, 2010).

The prostitute follows as an example of a UFP's, with good indications of nutrition, medicinal and ornamental properties, but which has not yet aroused commercial interest on the part of producers and/or companies (MAPA, 2010), leading one to believe that the lack of research more specific is the main obstacle. In view of the above, the objective of this research was to evaluate the vegetative development of the bollworm (*Portulaca oleracea* Linn.) grown on different substrates.

2. Method

The experiment was conducted in the experimental area of the Evangelical Faculty of Goianésia, located in the city of Goianésia, Goiás, Brazil. According to the classification of Köppen, the climate of the São Patrício Valley region is tropical, where it is basically defined by high rainfall indices in the summer and dry in winter, reaching an average annual rainfall of 1502 mm and an annual average temperature of 24.4 °C.

The invasive plant used for this research was *Portulaca oleracea* Linn., popularly known as bollwort. The seeds of the species were obtained in commercial vegetable garden, located in the city of Goianésia, Goiás, where there was great infestation of the same in the beds. The sowing of the pedigree was carried out in August 2017 on a polyethylene tray with 200 cells. In each cell three bare seeds were added, where it was then thinned one week after emergence, leaving one plant per cell. After the seedlings acquired size and firmness, they were transplanted with an average of 3 cm in height and 8 leaves per plant for the plastic bags filled with the appropriate treatments, around 30 days after germination.

In order to set up the experiment, the ravine soil was removed from the B horizon of a yellow latosol with the aid of a manual hoe in a field cut. The bovine manure was acquired in the same garden in which the bollworm seeds were collected. The rice straw was acquired in local commerce (in natura), where later the carbonization was carried out and the commercial substrate was the Tropstrato. The vegetables were also obtained in the local commerce of the municipality of Goianésia, Goiás, Brazil. The proportion of components in the mixture was 1:1.

The experimental design was completely randomized, with 6 treatments and 5 replicates (Table 1).

Table 1. Substrates used in the cultivation of bollworms. Goianésia, Goias, Brazil, 2017

	Treatments
T1	Barranco soil (Witness)
T2	Soil + Bovine manure
T3	Soil + Commercial substrate
T4	Soil + Charred rice straw
T5	Soil + Bovine manure + Charred rice straw
T6	Soil + Bovine manure + Commercial substrate

The trays containing the seedlings and the sachets containing the plants after transplanting remained in the open area, at full sun throughout the experiment period (70 days). The water was supplied manually with the aid of a watering can.

In the evaluations the germination rate was determined, counting the number of germinated seedlings. To obtain these data, germination of the seeds in the tray of 200 cells containing three seeds each was considered. Seedlings were counted in three periods, five days after sowing (DAS), 10 DAS and 15 DAS.

Seedlings development analyzes were performed 70 days after emergence (DAE). The mean plant height (PH) in cm was determined from the base of the stem (neck) to the apex of the youngest leaf and the main root length in cm, determined from the neck of the plant to the last root extension (RL), with the aid of a graduated ruler. The number of leaves (NL) per plant was also performed.

The analyzes of green and dry biomass were carried out at the Technological Center of the Evangelical Faculty of Goianésia. For these analyzes, the total fresh mass (TFM) and total dry mass (TDM) in grams were determined. The total fresh mass was obtained by weighing the whole plant in a precision scale, where they were later placed in previously identified paper bags and placed in an oven at 70 °C, which remained for 72 hours to obtain the total dry mass (TDM). The data were submitted to analysis of variance, and the means were compared by the Tukey test ($p = 0.05$).

3. Results

Figure 1 shows the emergence percentage of *P. oleracea* seeds at 5 DAS, 10 DAS and 15 DAS.

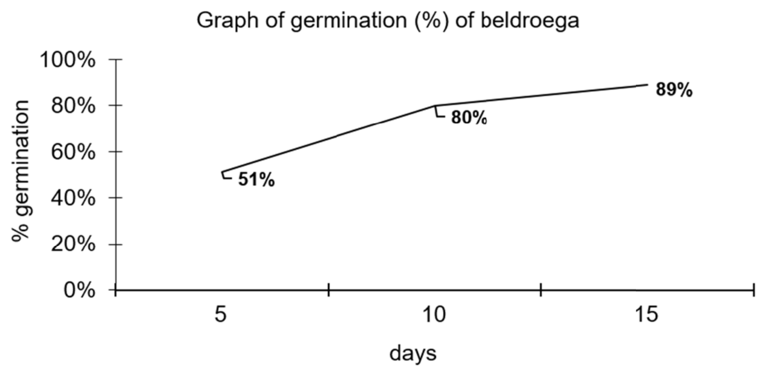

Figure 1. Seed germination rate, at 5 DAS, 10 DAS and 15 DAS of the pedigree in Goianésia, Goiás, Brazil, 2017

Table 2 shows the average data on number of leaves (NL), plant height (PH), root length (CR), total fresh mass (TFM) and total dry mass (TDM) of cultivated *P. oleracea* on different substrates.

Table 2. Mean data of number of leaves (NL), plant height (PH), root length (RL), total fresh mass (TFM) and total dry mass (TDM) of *P. oleracea* submitted to different substrates in Goianésia, Goiás, Brazil, 2017

Treatments	NL	PH (cm)	RL (cm)	Total mass (g)	
				TFM	TDM
Witness	313.8 b	28.8 b	36.2 a	40.6 b	6.68 c
Soil + Bovine manure	366.8 b	32.8 ab	34.6 a	54.6 b	8.18 bc
Soil + Commercial substrate	339.2 b	32.6 ab	33.6 a	44.4 b	7.44 c
Soil + Charred rice straw	348.2 b	32.4 ab	40.0 a	44.0 b	7.74 bc
Soil + Bovine manure + Charred rice straw	701.6 a	39.4 a	37.0 a	100.8 a	12.06 a
Soil + Bovine manure + Commercial substrate	464.8 ab	28.8 b	32.0 a	68.5 b	9.78 b
LSD (0.05)	34.04	11.69	14.98	32.26	12.46

Note. Means followed by the same letter in the column do not differ statistically by the Tukey test at the 5% probability level.

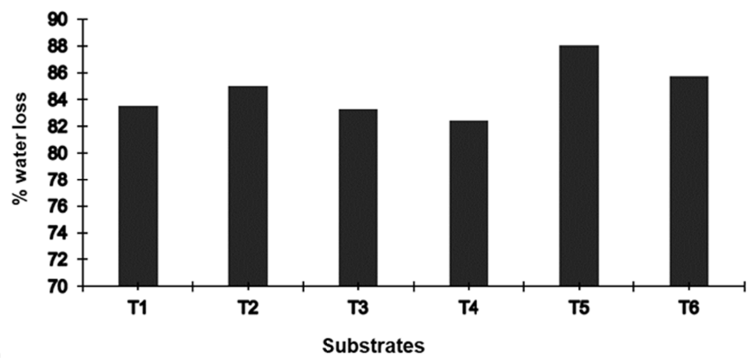

Figure 2. Mean values of water loss (%) of the *P. oleracea* cultivated on different substrates. T1: Witness, T2: Soil + Bovine manure, T3: Soil + Commercial substrate, T4: Soil + Charred rice straw, T5: Soil + Bovine manure + Charred rice straw, and T6: Soil + Bovine manure + Commercial substrate

4. Discussion

Fifty days after planting, 51% of the seeds were germinated, at 10 days 80% and at 15 days 89%. At 15 DAS, there was still a great disparity between the germination of the seedlings, since some were already with larger size and more developed leaves, while others were still in the process of germination (Figure 1). According to Brighenti and Oliveira (2011), weeds have characteristics of unevenness in the germination process, which guarantees their survival over time and is therefore difficult to control. This is due to seed distribution in the soil profile or dormancy mechanisms of each invasive species.

In relation to the number of leaves, the substrate T5 (Soil + bovine manure + rice straw) contributed significantly to obtain the highest number of leaves in the plant when compared to the substrates T1, T2, T3 and T4, but was not statistically different from the substrate T6 (Soil + bovine manure + commercial Substrate). The percentage change in the number of leaves was 313.8 to 701.6 leaves per plant (Table 2). The number of leaves was directly related to the increase of the fresh matter and total dry matter in the plants of sorrel. Arrigoni-Blank et al. (2003), in evaluation of jasmine-orange seedlings submitted to full sun and cultivation with substrates containing bovine manure in the mixture, found larger numbers of leaves per plant.

There was a difference in plant height of T5 treatments compared to treatments T6 and T1 (Witness), where again, the first one stands out with higher plants (Table 2). The stature has a role in the competition between plants, favoring the higher ones due to the better capture of the radiation, transformation in photoassimilates and conversion in fresh and dry mass.

No statistical differences were obtained between the substrates for the root length variable, this result can be attributed to the packing of the seedlings in plastic sachets with capacity for only two liters of substrates, which provided an environment limited to their growth. However, in the treatments in which carbonized rice straw was used as components, larger roots were obtained with 37 cm and 40 cm, respectively, in T4 and T5 (Table 2).

Rice husk in both natural and charred form provides excellent characteristics for root growth in seedling production, mainly because of the spaces it promotes in the soil, raising aeration of the substrate. Other characteristics described as favorable are resistance to decomposition, relative structure stability, low density and pH close to neutrality, and fast and efficient drainage that generates good oxygenation to the roots (Mello, 2006).

Measures of linear dimensions such as plant height and diameter, root length and number of structural units as number of leaves, flowers, fruits and etc., are considered useful in evaluating the development of a plant, often sufficient to detect differences between treatments (C. P. Peixoto & M. F. S. P. Peixoto, 2004).

The fresh mass is directly related to the number of leaves and branches present in a particular species, in this study heavier plants were acquired when grown on the T5 substrate, which was statistically different from the other substrates (Table 2). Cavalcanti et al. (2002), evaluated imbuzeiro plants, and as for the other variables, again the best results of fresh and dry mass were favored by bovine manure.

The total dry mass variable was the most statistically significant difference between treatments, with values varying from 6.68 grams (Witness) to 12.06 grams (T5), with average losses of 88.04% of water in the plants T5, as can be observed in Figure 2, where the percentages of water loss of the treatments submitted to the drying process are highlighted.

Water is the primary constituent of the botanical plant, which can be present in up to 90% of its composition (Santos, 2014). The lower levels of water loss in T3 and T4 (Figure 2) may have been due to the lower density provided by commercial substrate and rice straw, which provide rapid drainage of water, leaving no water available for longer periods of time, to leave the plant fully turgid. Guerrini and Trigueiro (2004) states that charcoal rice husk is a lightweight material with low water retention, with high porosity when added in higher dosages in the substrate mixtures, raising its percentage of macropores.

Bovine manure and rice straw are components with potential for use in buckwheat production. Steffen et al. (2010) in lettuce research also showed good results in the production of seedlings using different concentrations of rice husk and bovine manure. The chemical analysis of the substrates evaluated in this experiment could have aided in the interpretation of the obtained results.

During laboratory analysis, three interesting facts were observed: the first was the presence of earthworms only in the substrates that contained cattle manure, which certainly contributed to the better degradation of the organic matter. The second fact was the tenacity of the branches and branches of the plants submitted to these substrates T2, T5 and T6, which were shown to be firmer and thicker, different mainly from the plants cultivated in the soil (T1), which became thinner and brittle. The third was in relation to the amount of flowers emitted during the evaluation period, was also higher in these treatments.

Araújo Neto et al. (2009) in an evaluation of pepper seedlings production found similar results to the present work, where the soil containing bovine manure and charcoal rice husk was also the best treatment for the variables of plant height, dry mass and fresh mass.

At 15 days after seed emergence, the germination rate was 89%. The substrate composed of soil + bovine manure + charred rice straw provided the best indices of development of the bollworm plant, characterized by the measurement of linear dimensions: plant height and root length and structural units as the number of leaves. The combination of three components for the formation of a substrate favored fresh and dry biomass.

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