Is it Possible to Produce Healthy Organic Herbal Plug Seedlings through Different Proportions of Organic Materials?

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Abstract

Producing healthy herbal plug seedlings is a challenge among organic growers. Most of the organic nutrition studies were done on finish crops in greenhouse or field planting. There is an urgent need to produce organic plugs or seedlings. Establishing uniform healthy plug seedlings is critical for early start in field plantings. The general time frame to produce plugs ranges from 5 to 6 weeks depending on species. Most of the recommended organic substrate or fertilizers do not contain complete elemental nutrients for seedling establishment. Plugs are sensitive to environmental factors from sowing to transplant. They are sensitive to pH, EC, substrate buffer, N form and concentration. Therefore, the study was conducted to investigate the effect of different types of organic substrates suitable for plug production. Two experiments were conducted. The treatments consisted of peat, perlite, coir, feather, blood meal, soy meal and/or compost. They were mixed at different proportions to provide all the macro and micronutrients. Herbal plants, basil, coriander, and rosemary, were grown in a polycarbonate greenhouse. Germination percentage of all the treatments, including the one amended with 40% compost, was above 97% in basil and 91% in coriander. On the whole, coir substrate amended with 20% – 40% compost in basil and 10% – 20% compost in coriander produced better transplants. The shoot and root fresh weights of organic seedlings were greater than the conventionally grown seedlings. The organic rosemary cuttings' root zone pH was 6.7 to 7.3 and EC was 1.3 to 1.8 $S \cdot m^{-1}$, in both coir and peatlite amendments. Rooting performance of rosemary cuttings grown in coir amended with soy meal was as good as the conventionally grown cuttings. Cuttings planted in coir amended with feather and blood meal rooted better than the cuttings planted in peatlite amended with soy meal, feather or blood meal.

INTRODUCTION

Herbs are being used to enhance flavor of foods and are believed to have medicinal values. As a result, the trend of growing organic herbs is gaining popularity among consumers. This perception of herbs and organic production has rooted in people's minds, and consequently there is a huge demand for organically grown herbs. Growers have been growing and venturing into producing organic herbs through trial and error by experimenting with various organic substrates that they have access to. Formulating organic substrates and combining organic nutrients for organic herb production can be a challenging issue, partly due to non-uniformity, inconsistency, bulky nature and source of organic materials (Raviv, 2005). Moreover, limited information is available on how to grow and produce transplants of organic herbs in a greenhouse environment using substrates listed by Organic Materials Review Institute (OMRI).

Container substrates for growing plants, whether organic or inorganic, have to conform to the standard physical properties (water holding capacity, air capacity, total porosity, uniformity, stability, drainage and moisture retention), chemical properties (pH, EC, CEC and buffering capacity), thermal properties (temperature fluctuations) and biological properties (free from pathogens and support ideal biological root environment). Other issues related to organic substrates are the availability and the logistics of receiving and handling.

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Properties of organic materials selected as organic substrates and nutrients for this study include: feather meal - 14N:0.2P:0.1K; bone meal - 4N:21P:0.2K; soy meal - 6.5N:1.5P:2.4K; blood meal - 15.8N:0.1P:0.1K; and compost - 4N:0.7P:2K. The nutrient release rate of these organic nutrients is slow in feather and bone meal; slow to medium in soy meal, and medium to fast in blood meal (Hartz and Johnstone, 2006).

Although seedlings require essential elements for normal growth, the required amount somewhat differs from finish crops. Seedlings are more sensitive to fluctuations in the root zone environment that include water stress, aerations, pH and EC (Leskovar and Stoffella, 1995; Nelson, 2005). Organic matter is added to the substrate to improve the necessary physical and chemical properties and at the same time to act as a slow release reservoir of nutrients. The study was conducted to investigate the influence of pH and electrical conductivity (EC) on herb transplants grown in coir substrate amended with compost, and to evaluate various organic substrates (coir and peat) and organic fertilizers (feather, blood and soy meal) on organic transplant establishments.

MATERIALS AND METHODS

The experiments were carried out in a polycarbonate greenhouse at Raker, Litchfield, Michigan from August 2006 to December 2006. Coir and peat were used as the main organic substrates for this study to provide an ideal root zone environment for the organic transplants. Some of the properties of substrates used in these experiments are as follows: Coir with a pH of 6.0 - 6.2 and EC of 1.2-1.8 $S{\cdot}m^{-1}$; peat with a pH of 3.0 - 3.5 and EC of 0.1- 0.2 $S{\cdot}m^{-1}$; and compost with a pH of 6.9 – 7.1 and EC of 3.5 – 4.0 $S{\cdot}m^{-1}$. Specially formulated conventional substrate for greenhouse transplants with peat (80%), perlite (20%), dolomitc lime and micronutrients was used as control. The Organic materials used were OMRI certified and they were feather and blood meal (The Fertrell® Company, Bainbridge, PA); compost (Longwood Plantation, Newington, GA); peat, and perlite (Sun Gro Horticulture, Bellevue, WA); and soy meal (Litchfield Mill, MI). The organic substrate components and organic nutrients used in the experiments were mixed dry in a plastic bin and water was added to moisten the substrates before filling the trays.

The first experiment was a randomized complete block design consisting of six treatments - five treatments with coir substrate mixed with different proportions of compost (0, 5, 10, 20, and 40% by volume), and one treatment with conventional substrate as control. The test plants were basil *(Ocimum basilicum* L.*)* and coriander *(Coriandrum sativum).* The treatments were randomized along the length of the bench. The seeds were sown and grown with a day temperature settings at 22 to 23ºC, and the night was cooler by 4 to 5ºC. The seeds were sown in a 12 × 24-cells tray with cells 3.18 cm deep, 2.06 cm wide at the top, and 1.30 cm wide at the bottom. The seedlings were irrigated using boom irrigation with reverse osmosis (RO) water. The time between irrigations varied according to the need of treatments and species.

The second experiment was a factorial arrangement of treatments with coir and peatlite (70:30 by volume) as two main factors. The sub-factors were combinations of three different organic fertilizers which included feather meal (10 g L^{-1}), soy meal (15 g L^{-1}) and blood meal (15 g L^{-1}) giving a total of seven treatments, including the control (conventional production). The test plants were rosemary *(Rosmarinus officinalis)* cuttings. Each treatment had four replications, and each replication consisted of a 36-cell strip tray (Cell dimensions – 50 mm deep, cells are 54 mm × 61 mm on top and volume per cell is 175 ml). The trays were placed in propagation unit benches with bottom heat (25ºC), and during the first week were misted for 5 s at 20 and 60-min intervals, during day and night, respectively. From the second week onwards they were misted for 5 s at 30 and 60-min intervals during day and night, respectively. Visual observations were done on a daily basis. The pH and EC measurements were done using the squeeze extraction technique (Huang et al., 2001), and shoot and root fresh weight were done by destructively harvesting 20 transplants from each replication. Pesticides or plant growth regulators were not used during the entire transplant production cycle. The statistical analysis was performed using the Sigma Stat program.

RESULTS

Experiment 1: Basil and Coriander

1. pH. In basil, the pH value of coir substrate increased with an increase in compost from 0 to 10% and declined with further increase in compost from 20 to 40%, by day 10 (Fig. 1A). The pH value declined and it remained at 6.7 - 6.8 in all treatments, even in 40% compost, by day 20. On the other hand, in coriander the pH declined with an increase in compost except at 40%, by day 10 (Fig. 1B). The pH dropped further by 1.2, 0.5, 0.3, 0.2 and 0.3 at 0, 5, 10, 20, and 40% compost, respectively by day 20. The standard conventional substrate pH remained at 5.0 to 5.7 at day 10 and 20 for basil and coriander seedlings.

2. EC. On day 10, the EC value of basil substrate increased from 0.6 to 1.4 $S \cdot m^{-1}$ with increasing percent compost, except in treatment amended with 40% compost. On the other hand, on day 20 (Fig. 2A), the EC value dropped drastically with values between 0.4 to 0.65 $S \cdot m^{-1}$ in all treatments, more so in treatment with 20% compost. The EC value of coriander substrate also increased with increasing percent compost (from 0.4 to 0.95 $S \cdot m^{-1}$) on day 10 (Fig. 2B), and dropped with values between 0.4 and 0.7, more so in treatments with 20 and 40% compost, on day 20. The EC values of conventional substrate were between 0.50 and 0.55 $S \cdot m^{-1}$ on days 10 and 20, in both crops.

3. Germination Percentage. In both species the percent germination declined with increased percent compost on day 10 and 20 (Fig. 3A and 3B). Germination of coriander declined linearly from 89% at 0% compost amended substrate to as low as 70% at 40% compost amended substrate, on day 10. However, by day 20, percent germination of all the treatments including the one amended with 40% compost was above 97% in basil and 91% in coriander.

4. Fresh Weight. Shoot and root fresh weight increased with increased percent compost in basil (Fig. 4A). On the other hand, in coriander, the shoot fresh weight increased quadratically and then declined at 40% compost amended substrate, whereas, the root fresh weight declined with increased percent compost in all treatments (Fig. 4B). The shoot and root fresh weight of seedlings grown in standard conventional substrate was less than the compost amended treatments in both basil and coriander.

Experiment 2: Rooting of Rosemary Cuttings

1. pH and EC. In rosemary, the pH values of coir-based substrate amended with feather, soy or blood meal were 7.2, 7.3 and 7.3, respectively, whereas, the pH values of peatlite substrate amended with feather, soy or blood meal were 6.8, 6.8 and 6.7, respectively (Fig. 5). The EC values of coir amended with feather, soy or blood meal were 1.63, 1.3 and 1.4 $S \cdot m^{-1}$, respectively, and the EC values of peatlite substrate amended with feather, soy or blood meal were 1.8, 1.3 and 1.4 $S \cdot m^{-1}$, respectively (Fig. 6). The conventional substrate pH and EC values were 5.8 and 0.5 $S \cdot m^{-1}$, respectively.

2. Rooting Percentage. Ninety nine percent of rosemary cuttings planted in coir-based substrate amended with soy meal rooted successfully as similar to the ones grown in standard conventional substrate (Fig. 7A). Rooting percentages was 57 and 45 in coir amended with feather or blood meal, respectively. On the other hand, the rosemary cuttings rooted poorly in peatlite based substrate with not more than 8% and 7% in substrate amended with soy meal or feather meal, respectively, and none at all in blood meal-amended substrate (Fig. 7B).

DISCUSSION

Experiment 1

The basil seedlings had the tendency to elevate root zone pH (between 6.7 and 7.3) and EC. However, there were no visual signs of nutrient deficiency symptoms in this herb. On the other hand, just a slight variation of pH and EC has not only delayed germination but also lowered the germination percentage in coriander. This indicates that coriander is more sensitive to root zone pH and EC factors. The gain in the shoot and root fresh weight of basil transplants grown in 20% and 40% compost indicates it is more responsive to high nutrient availability. The coriander transplants attained optimum shoot fresh weight at 20% compost and declined at 40% compost-amended coir substrate. However, the shoot and root fresh weights of both crops were greater than or equal to the seedlings grown in conventional substrate. The organic substrate and nutrient may reduce the need to provide constant fertigation during transplant production.

Experiment 2

Although organic nutrients with different particle size had somewhat impacted the rooting in rosemary cuttings, the main factor seems to be the organic substrate itself. Higher air capacity of coir substrate (Noguera et al., 1997; Abad et al., 2002; Nelson et al., 2004) may have contributed to greater rooting performance, irrespective of the organic nutrients, and higher water holding capacity of peatlite substrate may have provided an unfavorable root zone environment for rooting, more so in a propagation environment with regular misting. It is even more critical in shallow transplant cells (Bilderback and Fonteno, 1987).

In both coir and peatlite substrate, rooting was more successful in granular soy meal amended substrate than in feather or blood meal-amended substrates. Cuttings planted in granular type soy meal-amended coir substrate rooted successfully, similarly as cuttings grown conventionally. This suggests that granular soy meal has minimal impact on the overall air capacity of the substrate. On the other hand, feather and blood meals, with finer particle size, may have further accentuated water holding capacity in peatlite substrate and lowered air capacity in coir substrate. Plants' response to root physical environment is as important as the type, quantity and quality of organic substrates and organic nutrients used in formulation process of substrates for producing healthy organic transplants. The physical properties of substrates have an overriding effect on rooting of rosemary cuttings than the chemical properties such as pH and EC.

CONCLUSION

On the whole, coir substrate amended with 20% – 40% compost in basil and 10% – 20% compost in coriander produced better transplants. Rosemary cuttings rooted well in coir substrate amended with soy meal. Substrate aeration was a significant component for the rooting success in rosemary cuttings. In-between fertilizer applications during the production period could be avoided by diligently selecting and incorporating appropriate organic substrates and nutrients according to the needs of the herbs. Further research needs to be focused on the specific pH and EC requirement for each and every herb. There is no single organic substrate formulation that works best for all herbs.

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Figures

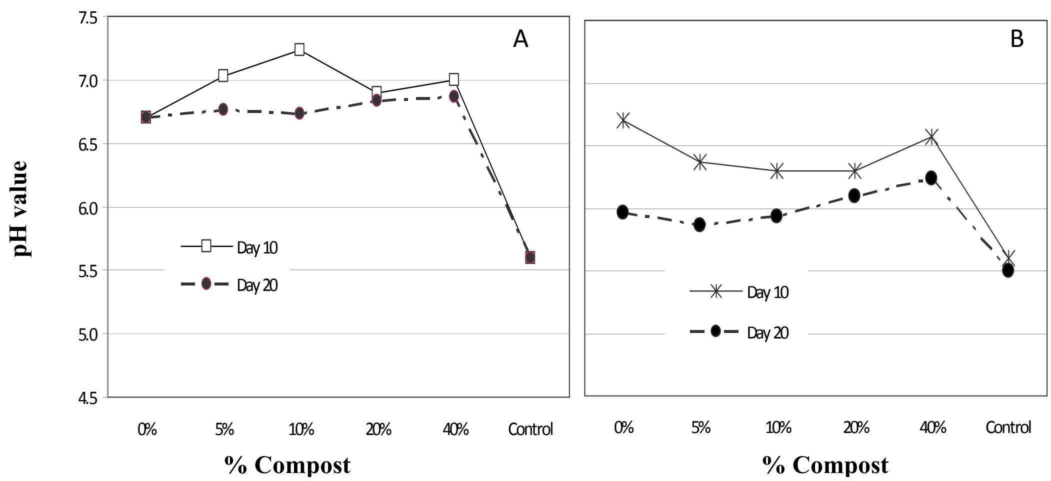

Fig. 1. pH of basil (A) and coriander (B) coir substrate amended with various proportions (% by volume) of compost on day 10 and 20.

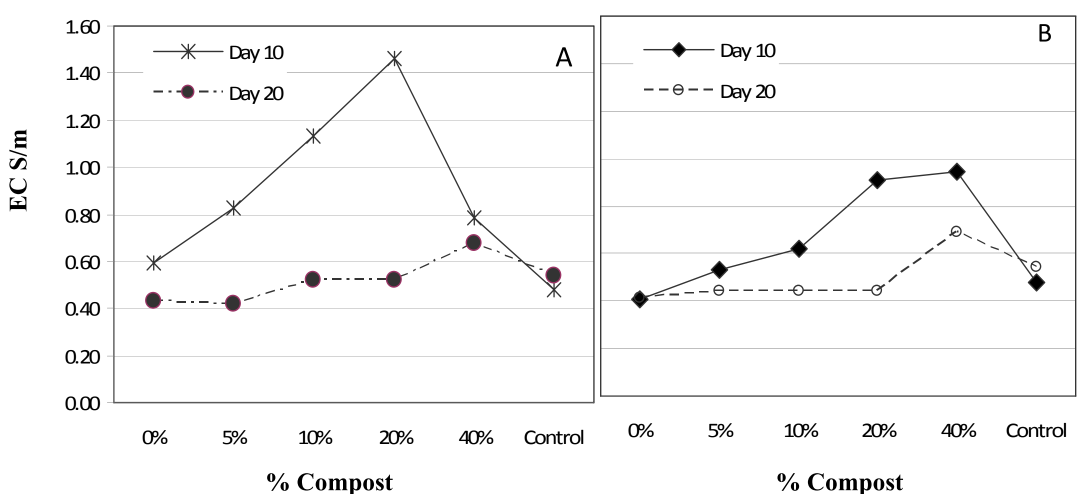

Fig. 2. EC of basil (A) and coriander (B) coir substrate amended with various proportions (% by volume) of compost on day 10 and 20.

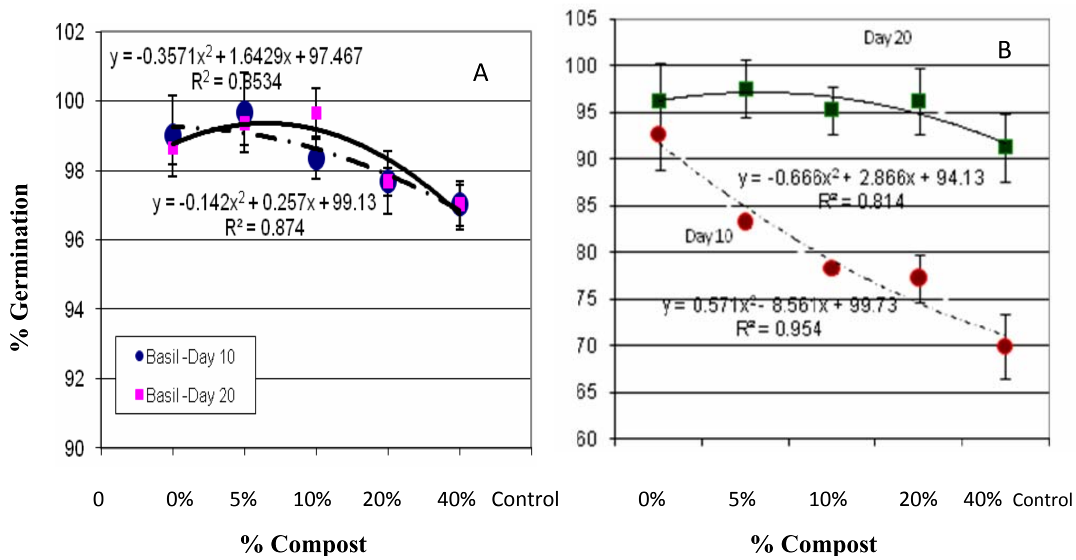

Fig. 3. Percent germination of basil (A) and coriander (B) seedlings grown in coir substrate amended with various propotions (% by volume) of compost on day 10 and 20.

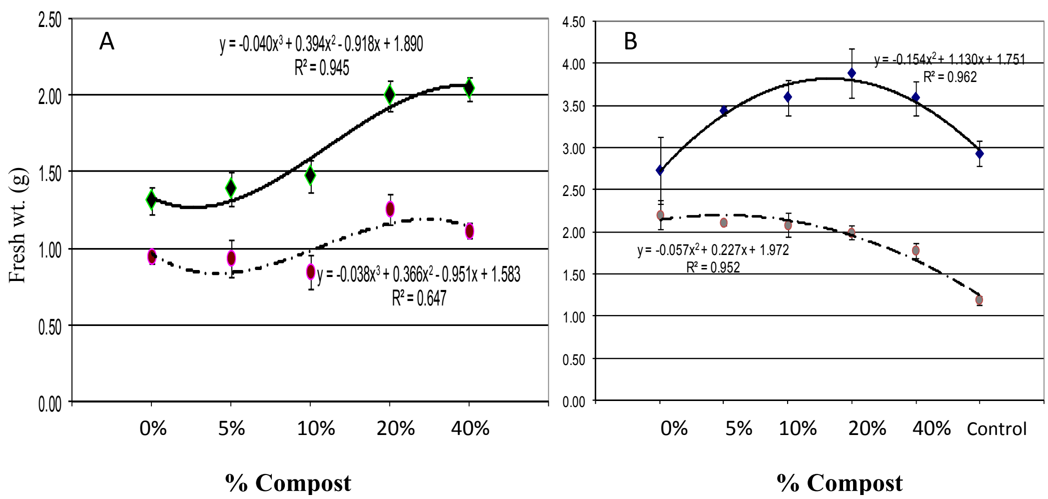

Fig. 4. Shoot and root fresh weight of basil (A) and coriander (B) grown in coir substrate amended with various proportions (% by volume) of compost.

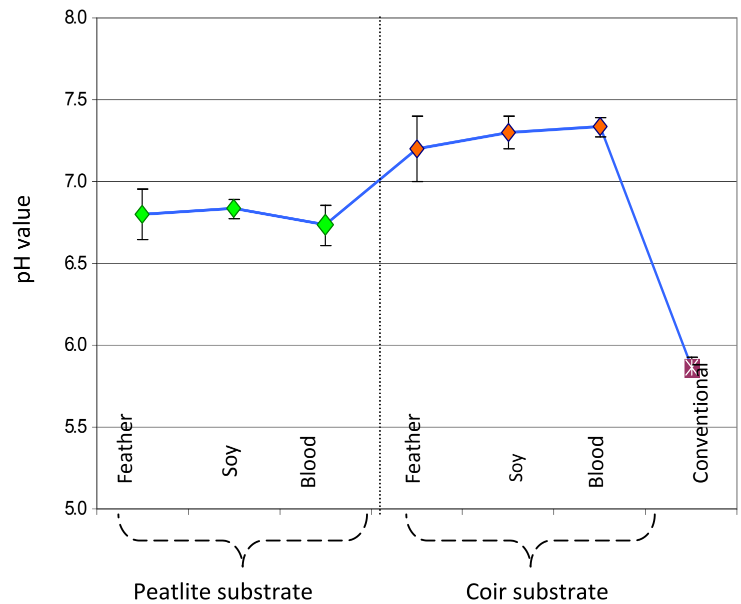

Fig. 5. pH of rosemary grown substrates (coir or peatlite) amended with feather meal, soy meal or blood meal.

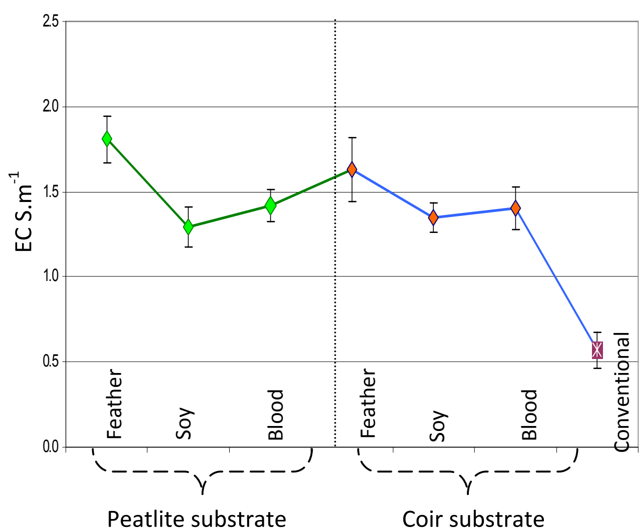

Fig. 6. EC of rosemary grown substrates (coir or peatlite) amended with feather meal, soy meal or blood meal.

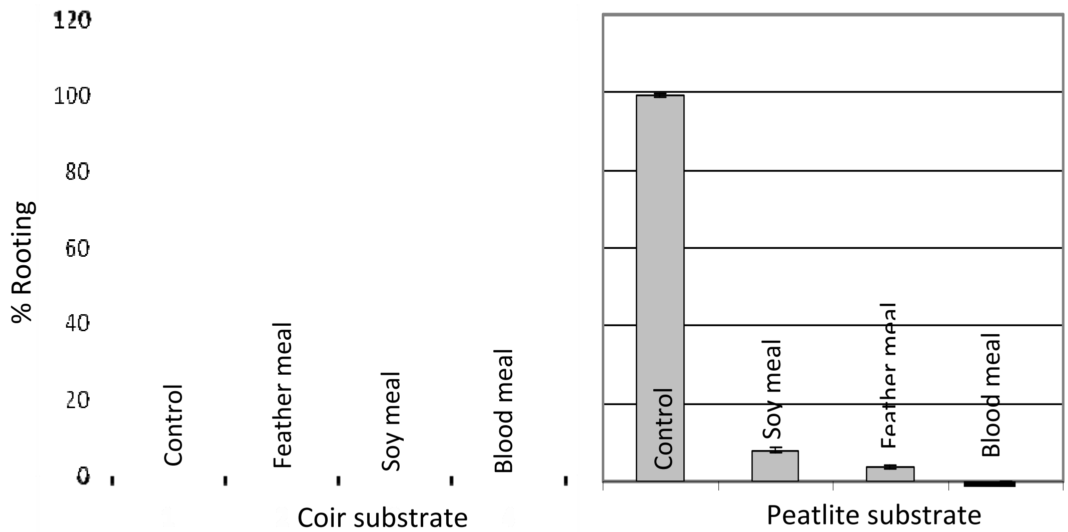

Fig. 7. Rooting % of rosemary cuttings grown in substrates (coir or peatlite) amended with feather meal, soy meal or blood meal.