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Effects of organic foliar nutrient application on lettuce production in Central Vietnam

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ABSTRACT

A field experiment was conducted in spring-summer season in Central Vietnam to investigate the effect of different application levels (e. g. 25, 50, 75 and 100 l/ha) of organic foliar nutrient solution named BD1 which was mixed from molasses, watermelon extract and aglutamic solution on the growth and yield of lettuce plants. Growing time, plant height, number of leaves per plant, canopy diameter, biomass and yield were investigated. The results indicated that the plant treated with high levels of 50, 75 and 100 l/ha had a positive effect on the development, growth and yield of lettuce. Spraying at the level of 100 l/ha was an optimal level which gained highest growth and yield. As a result, farmers are recommened to use the BD1 as a nutrient supplement to lettuce in organic agricultural production.

Key words : Growth parametter, lettuce, organic foliar, Vietnam, yield

INTRODUCTION

Vegetables are important sources of many nutrients, including fiber, mineral and vitamin. Despite having many types of vegetables with different production methods in the market, there are some products unsafe for consumer's health due to the abuse of agrochemicals (Basumatary *et al.*, 2017; Bayat *et al.*, 2019). Therefore, organic farming systems are becoming more and more focused on many countries worldwide, especially in developing countries. Organic farming is a non-chemical cultivation system and organic sources are reused (Willer and Lernoud, 2019). Organic agricultural products increasingly meet consumer demand because of the food safety as well as benefits for environmental protection.

Lettuce (*Lactuca sativa* L.) is a leafy vegetable and widely used in people's daily meals. Lettuce brings many nutrients, namely, vitamin, protein, lipid, fiber and minerals that provide a relatively high-calorie intake for the human body (Van Duyn and Pivonka, 2000). Lettuce helps in stimulating digestion, treating cough, neurasthenia, constipation, etc. Lettuce determines the quality of the vegetable mix and builds a good appetite. Thus, this makes lettuce a favourite vegetable having the high consumption all the year round. It is usual for lettuce to be grown on the soil and fertilized. Nevertheless, to increase the yield and quality of lettuce as well as ensure food safety, one usually applies foliar nutrient spray (Fawzy, 2010; Mohsen *et al.*, 2016; Pollyana *et al.*, 2016; Abdel-Salam, 2018; Al-Taey *et al.*, 2018).

Foliar nutrients are mobilized directly into a plant leaf, which is the goal of fertilization to begin with, increasing the rate of photosysthesis in the leaves, and by doing so stimulate nutrient absorption by plant roots (Barel and Black, 1979). A great attention has been directed to the use of some extracts from plants and animals as a foliar spray to minimize mineral fertilizer, decrease the polution of the agricultural environment and produce healthy food for human.

Thua Thien Hue province has a large area of lettuce growing in the central region of Vietnam. In order to sufficiently meet the needs of using lettuce, apart from cultivar, plant protection, seasonality, density, it is essential to proper use of organic nutrients as a foliar spray. Consequently, how to spray organic nutrients with reasonable concentration leading to the best growth and development of plants is an important issue (Jun *et al.*, 2006; Peiris and Weerakkody, 2015). The objectives

of this study were to determine the effect of BD1 organic nutrient solution on the growth and development, yield of organic lettuce production. The research results provide a full understanding of using the organic nutrient solution for lettuce without compromising on human health and the environment.

MATERIALS AND METHODS

The field experiments were conducted in spring season from January to May, 2019 at Huong An commune, Huong Tra town, Thua Thien Hue province, Central Vietnam (N16°28'0962"; E107°30'45 31") with four application levels such as 25, 50, 75 and 100 l per hectare) of the organic nutrient solution named BD1. The experiments were arranged as randomized complete block design (RCBD) with three replications. The area of each plot was 10.0 m^2 (5.0 × 2.0 m). The lettuce was individually planted in rows of 20 × 18 cm spacing. Fertilizer for all experiments was only basic application of 500 kg lime and 12 tonnes manure/ha.

The BD1 was blended molasses, watermelon extraction and aglutamate solution in equal proportions. Nutrient concentration of the BD1 is shown in Table 1. Three sprays of BD1 nutrient solution on the leaves of lettuce plants were sprayed weekly by using power-pack hand sprayers with the first pray was conducted at one week after transplanting. The spray volume was calibrated to 450 l/ha. As a control, pure water was applied in the same as BD1.

Ten plants in each plot were randomly selected to record agronomic traits. *Canopy diameter* was *measured* at the widest part of the bush at 32 days after transplanting. One day before harvesting, plant height was determined by measuring the distance from the soil surface to the end of the longest leaf. At harvest, these 10 plants were harvested, their roots were removed, and then the number of leaves per plant was counted; the aboveground biomass and edible parts of each plant were measured. Aboveground biomass of plants was bagged individually and dried at 105°C to determine dry matter.

Table 1. Nutrient concentration of BD1 organic nutrient solution (ppm)

Parameter	Concentration (ppm)
N	1403.6±3.25
P	423.5±5.23
K	1665.8±6.52
Ca	140.2±8.36
Mg	32.6±9.28
S	42.0±6.65
Fe	3.58±1.25
pH	5.8
EC (dS/m)	3.5

Data were analyzed using Statistix 10.0 (Analytical Software, Tallahassee, FL, USA). To compare the differences in agronomic traits and yield per plant among treatments, we conducted one-way ANOVA. In all cases, $P<0.05$ was considered to be significant.

RESULTS AND DISCUSSION

Plant Growth

The growth duration of crop plants depends on cultivar, season, environmental conditions and field practices. In particular, cultivar is the decisive factor to a total growth time of rice. This indicator helps farmer to arrange cultivated timing to avoid the unsuitable conditions and to meet market's requirement. However, Table 2 shows that the growth duration was not different among tested levels of BD1 solution. The total growth time of

Table 2. Effect of BD1 on plant height, leaf number and growth time of lettuce

Treatment (l)	Plant height at harvest (cm)	No. of leaves/ plant	Canopy diameter (cm)	Total growth time (days)
25	21.4^{a}	21.1^{ab}	27.0^{ab}	40
50	23.8^{bc}	23.1^{bc}	28.5^{bc}	40
75	25.0^{cd}	24.1^{bc}	29.4^{cd}	40
100	26.1^{cd}	24.3^{cd}	29.2^{cd}	40
Water	21.1^{a}	20.4^{a}	25.2^{a}	40
LSD (P=0.05)	1.53	2.06	2.34	-

Figures in a column followed by same superscripts do not differ significantly by one-way ANOVA, $P<0.5$.

lettuce was 40 days. Our results are in agreement with the results of some authors who reported that organic foliar fertilizer was not affected on the growth duration of plants (Randall *et al.*, 1975; Rumbidzai and Justin, 2014).

Plant height is one of the indicators evaluating the growth and productivity, reflecting the ability to synthesize and accumulate organic matter. Lettuce will grow well if it has an appropriate and balanced height for each period. Table 2 shows that foliar spray of BD1with differnt levels had significant effect on plant height of lettuce. The plant treated with high levels of 50, 75 and 100 l had higher height, without significant difference among them. Mohsen *et al.* (2016) also indicated that spray of different levels of two cyanobacterial extracts for lettuce plants significantly increased the plant height.

Plant leaf plays an extremely important role in the growth and development of vegetable crops. It participates in photosynthesis and synthesizes organic matter. Furthermore, the leaf is responsible for evaporating and regulating heat. Especially for leafy vegetables such as lettuce, leaf plays a decisive part in productivity and vegetable qualities. Table 2 shows the number of leaves of lettuce plants, gererally, ranging between 20.4 and 24.3 leaves/plant and the canopy diametter, ranging between 25.2 and 29.4 cm. The higher number of leaves and larger canopy diametter were obtained by 100, 75 and 50 l treatments. On contrary, the low number of leaves and small canopy diametter were found in case of 25 l and the control treatments. These results may be due to the physiological roles of vitamin and amino acid in the solution which increased the metablic process role and levels of indogenous hormones e. g. IAA and GA_3 (Chaliakhyan, 1957).

Plant Biomass

There was a significant difference on fresh biomass, edible biomass and dry biomass among treatments (Table 3). The non-treated plants showed the lowest fresh biomass, edible biomass and dry biomass of 48.0, 26.7 and 3.9 g/plant, respectively, which increased by addition of BD1. The highest fresh biomass, edible biomass and dry biomass were found in case of 100 l with 76.3, 48.3 and 7.4 g/plant, respectively. This finding is in agreement with the results reported by other authors for plant biomass of lettuce treated by foliar nutrient solution (Mohsen *et al.*, 2016; Abdel-Salam, 2018).

Table 3. Effect of BD1 on plant biomass of lettuce

Treatment (l)	Biomass (g/plant)	Edible biomass (g/plant)	Dry biomass (g/plant)
25	58.7^{c}	35.0^{b}	5.2^{c}
50	62.3^{bc}	37.0^{b}	6.6^{b}
75	64.0^{b}	40.0^{b}	6.2^{b}
100	76.3^{a}	48.3^{a}	7.4^{a}
Water	48.0^{d}	26.7^{c}	3.9^{d}
LSD (P=0.05)	5.3	5.48	0.72

Figures in a column followed by same superscripts do not differ significantly by one-way ANOVA, P<0.5.

Plant Yield

Yield is the main trait targeted to improve rice productivity; therefore, it was the key trait used to evaluate the performance of lettuce to foliar nutrient solution of BD1. Yield is the productivity that obtains in the production process, reflecting the adaptability of the cultivar to the external conditions, resistance to pests and other adverse conditions. Practices obtained higher yields indicating that they were more likely adapting the farming conditions. There were significant differences in the biological and economic yields of lettuce among different treatments (Table 4). The biological and economic yields ranged between 12.7 and 21.2 tonnes, and 8.0 and 14.3 tonnes per hectare, respectively. The highest yields were obtained by 100 l, then 75 and 50 l treatments. On the contrary, the low yields were found in case of 25 l and the control treatments.

Previous studies indicated that organic foliar application had a positive effect on total

Table 4. The effect of BD1 on yield of lettuce

Treatment (l)	Biological yield (t/ha)	Economic yield (t/ha)
25	15.8^{b}	10.3^{c}
50	16.9^{b}	11.0^{bc}
75	17.4^{b}	12.3^{b}
100	21.2^{a}	14.3^{a}
Water	12.7^{c}	8.0^{d}
LSD (P=0.05)	1.64	1.79

Figures in a column followed by same superscripts do not differ significantly by one-way ANOVA, P<0.5.

yields of lettuce (El-Shinawy and Gawish, 2006; Fawzy, 2010; Mohsen *et al.*, 2016; Pollyana *et al.*, 2016; Abdelgawad *et al.*, 2018). Ahmed *et al.* (1997) stated that the positive effect of applying foliar nutrient solution (e.g. dry yeast) was attributed to its own contents of different nutrients, high percentage of protein, large amount of vitamin and natural plant growth regulators such as cytokinins.

It was concluded from this study that the BD1 organic nutrient solution which was mixed with molasses, watermelon extraction and glutamate solution had a positive effect on the development, growth and yield of lettuce. Spraying at the level of 100 l/ha was an optimal level which gained highest growth and yield. As a result, farmers are recommened to use the BD1 as a nutrient supplement to lettuce in organic agricultural production.

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