Potential of vermitea and SNAP as nutrient solution for lettuce (*Lactuca sativa*) under non-circulating hydroponics system

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ABSTRACT

The present study was carried out to evaluate potential of vermitea and simple nutrient addition programme (SNAP) on the growth performance and profitability of lettuce production. Gathered, organized and tabulated data were analyzed through completely randomized design (CRD) programmed Microsoft Excel. Three hundred fifteen (315) lettuce plants were used in the study and distributed in fifteen experimental units with each replicate having seven treatments viz T_1 [100% SNAP (Control)], T_2 (25% SNAP +40 ml/l vermitea), T_3 (25% SNAP + 30 ml/l vermitea), T_4 (25% SNAP + 20 ml/l vermitea), T_5 (40 ml/l vermitea), T_6 (30 ml/l vermitea) and T_7 (20 ml/l vermitea). The type of fertilizer solutions used had a substantial impact on the plant growth parameters. With a mean of 10.30, lettuce grown in 100 per cent SNAP solution produced the maximum number of leaves. This treatment also resulted in highest leaf length of 16.77 cm which was at par with the treatment 25 per cent SNAP + 40 ml per l vermitea (14.30 cm). The treatment 100 per cent SNAP solution produced largest canopy measuring 24.50 cm and highest plant weight of 51.23 g.

Keywords: Vermitea; lettuce; hydroponics; growth; SNAP; synthetic fertilizer

INTRODUCTION

To sustainably feed the world's growing population, methods for growing sufficient food have to be evolved. Modification in growth medium is an alternative for sustainable production and to conserve fast depleting land and available water resources. In the present scenario, soilless cultivation might be commenced successfully and considered as alternative option for growing healthy food plants, crops or vegetables (Butler and Oebker 1962). In smart agriculture, plant culture in soilless condition is one of the growing technologies in some parts of the world like Africa and Asia which includes the growing of crops with or without a soil media or using a recirculating and non-recirculating nutrient solution (Li et al 2018). Agriculture without soil includes hydro agriculture (hydroponics), aqua-agriculture (aquaponics) and aerobic agriculture (aeroponics) as well as substrate culture.

Soilless plant cultivation in an almost completely controlled environment is a relatively modern cultivation technology and is used almost exclusively in greenhouses (Khan 2018). Hydroponics, a soilless cultivation system, is gaining interest as it reduces the dependency on agricultural land and pesticides and can be implemented in areas with poor soil quality, thus mitigating the negative effects of extreme weather events (Rajendran et al 2024). Soilless farming has the capacity of addressing the problems in soil degradation, limited water supply and to reduce pests and diseases; it is a key solution while promoting sustainability in agriculture production (Sambo et al 2019).

Hydroponics is a method of growing plants in nutrient solutions with or without the use of an inert medium to give mechanical support, such as gravel, vermiculite, rockwool, peat moss, saw dust, coir dust, coconut fiber and so on. The phrase hydroponics comes from the Greek terms 'hydros' which means water and 'ponos' which means labour and literally translates to 'water work'. Professor William Gericke invented the term hydroponics in the early 1930s (Jan et al 2020).

The majority of hydroponic systems work automatically to regulate the amount of water, nutrients and photoperiod based on the needs of various plants (Resh 2022).

According to Resh (2022), hydroponics is an alternative technique in which the soil is replaced by an aqueous solution by containing only mineral elements required for vegetable production. The hydroponics system is widely used for the production of seedlings of leafy vegetable species since the quality is severely affected by pre and postharvest treatments. More importantly, leafy vegetables, such as lettuce, cultivated in hydroponics system, showed uniformity in seedlings development and plant growth and consequently in transplanting and harvesting time (Gonnella et al 2001).

The present study was conducted to evaluate the growth performance of lettuce on SNAP solution in combination with different vermitea treatments.

MATERIAL and METHODS

Styro box of fruits, styro cup, bamboo slats, scissors, cutter knife, tin can, nails, polyethylene (PE) plastics, seeds of lettuce, SNAP solution, aerator, 60 liter capacity container, ruler, weighing scale, calipers, beakers and pH meter were used in the study. Additionally, the study used different farm animal manures (goat, rabbit, cow and sheep) for vermicast production.

Seedling trays were filled with garden soil and organic material in the ratio of 1:1 and one seed per hole was sown. The trays were placed under partial shade for 15 days before transplanting to reduce moisture loss and induce germination.

Production of vermicast: A site that was shaded, flood-free and accessible to water supply to source of compost materials was selected. Animal manure, Kakawate and banana trunk were used in the ratio of 2:2:1. Vermin beds were prepared which were well pulverized and freshly-cut grass was shredded on them. Water was added to materials that had less than 60 per cent moisture and the materials were thoroughly mixed while watering. The materials were placed in outdoor beds measuring 1 meter in width to any convenient length. The beds were covered with plastic film to start anaerobic process (1-2 weeks). One kilogram of earthworms for every square meter of vermin bed having 100-200 kg of compost materials was stocked.

The moisture level in the beds was maintained at 60 per cent. The earthworms were protected from predators. The vermicompost was harvested within 30-45 days by separating the vermin from the vermin compost by handpicking or by using screen. The vermicast was properly packed and the vermicompost was stored in a dry place.

Preparation of vermitea: A 60-liter container with aerator was prepared. Fifty litres of un-chlorinated water was poured into the container. The water was aerated for 30 minutes. Three kilograms of vermicast (sourced out from the different farm animals) was put inside a tea bags and placed hanging inside the container. Mollases (500 ml) were poured in the aerated container followed by addition of 50 ml IMO after 30 minutes. Harvesting was done after 24 h of aeration.

Preparation of seedling plugs: Seeds of lettuce (green span) were sown in coco coir as the growing medium. Styrofoam cups were used for the seedling plugs. Serrated knife was used to make 4 to 6 slits (about 2-inch long on the side and including about 0.5 inch at the bottom). Cups were filled with the growing media (about 0.5 inch thick). Seedlings sown in coco coir were transplanted into the cups.

Preparation of growing boxes: Styrofoam fruit boxes measuring 24" × 16" × 9" were used as growing or culture pots containing the nutrient solution. The bottom part of the boxes was lined with plastic to prevent the nutrient solution from draining out. On the lid or box cover, 8 holes, equidistant from one another, were cut out. Each hole could hold the seedling plug in place by its neck. Lids of the boxes had prefabricated vents or openings which allowed the passive aeration of the roots. Plastic liner was used to close all the open slits of the lid/cover to prevent entry of mosquitoes.

The experiment was laid out in a complete randomized design with seven treatments and three replications at 15 plants per treatment. The treatments used were: T_1 [100% SNAP (Control)], T_2 (25% SNAP + 40 ml/l vermitea), T_3 (25% SNAP + 30 ml/l vermitea), T_4 (25% SNAP + 20 ml/l vermitea), T_5 (40 ml/l vermitea), T_6 (30 ml/l vermitea) and T_7 (20 ml/l vermitea).

The seedling plugs were transplanted in the installed hydroponic boxes according to the assigned treatments. Fifteen seedling plugs were transferred per box which made 15 plant samples per treatment. A total of 315 plant samples were transplanted in total. The seedling plugs were installed in the boxes and submerged 2.5 cm deep in the nutrient solutions.

The nutrient solution to water ratio was maintained to fifteen (15) liters of water and certain percentage of nutrient solution per box. Maximum protection against insect pests and diseases was done. Daily visit to the experimental area was conducted to observe the presence of insect pests and diseases.

Harvesting was done 28 days after transplanting. Uprooting of the whole plant was done manually. Thereafter, the stems were cut off just below the lower leaves of the plants with pruning shear.

Data collection

Number of leaves at harvest: The leaves of the plants were counted for all the samples per treatment at harvest. The total number of leaves of the sample plants was divided by ten to get the average number of leaves per plant.

Leaf blade length (cm): The leaf length was measured from the base to the tip of the largest, medium-size and smallest leaf from three randomly selected fully expanded leaves per plant using a standard ruler at harvest.

Canopy diameter (cm): Canopy diameter was taken by measuring the widest vegetable canopy diameter position from a canopy edge on one side to the edge of the other side at harvest (Wiangsamut and Koolpluksee 2020).

Total fresh weight per sample plant at harvest (g): The weight of ten sample plants with the roots was taken using digital weighing balance.

Programmed Microsoft excel of randomized complete block design was used to organize, tabulate and analyze the data. Least significant differences were used to compare treatment means.

RESULTS and DISCUSSION

The data on the effect of different treatments on growth parameters of lettuce are given in Table 1.

Number of leaves at harvest

The type of fertilizer solutions used had a substantial impact on the number of leaves per plant. With a mean of 10.30, lettuce grown in 100 per cent SNAP solution (T_1) produced the maximum number of leaves followed by T_2 (25% SNAP + 40 ml/l vermitea), T_4 (25% SNAP + 20 ml/l vermitea) and T_3 (25% SNAP + 30 ml/l vermitea) with means of 6.87, 6.47 and 6.07 respectively, the latter three being at par. The lower number of leaves was recorded in T_5 (40 ml/l vermitea) and T_6 (30 ml/l vermitea) with 4.53 and 4.93 leaves per plant respectively, which were, on the other hand, at par with T_7 (20 ml/l vermitea) (5.00) and T_3 (6.07).

Leaf length

The average leaf length varied between 16.77 and 6.40 cm. Treatment T_1 resulted in maximum leaf length of 16.77 cm which was at par with T_2 (14.30 cm). However, T_2 was at par with T_4 (12.00 cm) and T_3 (11.60 cm). Treatments T_5, T_6 and T_7 resulted in lower leaf length of 6.40, 6.47 and 6.93 cm respectively and were at par with one another.

Canopy diameter

The nutrient solution had significant effect on plant canopy diameter. In comparison to the other treatments, T_1 produced a largest canopy measuring 24.50 cm followed by T_3 (19.67 cm), T_2 (19.37 cm) and T_4 (17.83 cm), the three being at par. Lowest canopy diameter was obtained in treatments T_5 (7.90 cm), T_7 (9.23 cm) and T_6 (9.53 cm), the three being at par.

Total sample plant fresh weight at harvest

The type of organic nutrient solution had a highly significant effect on the total fresh weight per plant of lettuce. T_1 resulted in highest plant weight of 51.23 g followed by T_2 (23.07 g), T_4 (17.44 g) and T_3 (17.33 g), the three being at par. The lowest plant weight was observed in T_5 (6.73 g) which was at par with T_7 (13.25 g).

Borres (2022) reported that in lettuce, the highest number of leaves (9.13) and mean leaf length (14.18 cm) were recorded under treatment SNAP solution and 300 ml vermitea followed by SNAP solution

Table 1. Effect of different treatments on plant growth parameters of lettuce

Treatment	Number of leaves/plant	Leaf length (mm)	Canopy diameter (cm)	Weight/plant (g)
T_1: 100% SNAP (Control)	10.30[a]	16.77[a]	24.50[a]	51.23[a]
T_2: 25% SNAP + 40 ml/l vermitea	6.87[b]	14.30[ab]	19.37[b]	23.07[b]
T_3: 25% SNAP + 30 ml/l vermitea	6.07[bcd]	11.60[b]	19.67[b]	17.33[bc]
T_4: 25% SNAP + 20 ml/l vermitea	6.47[bc]	12.00[b]	17.83[b]	17.44[bc]
T_5: 40 ml/l vermitea	4.53[d]	6.40[d]	7.90[c]	6.73[d]
T_6: 30 ml/l vermitea	4.93[d]	6.47[d]	9.53[c]	14.34[c]
T_7: 20 ml/l vermitea	5.00[cd]	6.93[d]	9.23[c]	13.25[cd]
F-value	-	-	-	-
CV (%)	11.70	16.91	12.81	13.52
LSD	1.79	4.38	4.80	6.73

Means in a column bearing common alphabets do not differ significantly

with 8.67 number of leaves and 13.18 cm long leaves. The lettuce in the vermitea with SNAP and the solution that used only SNAP (control) gave best results in terms of number of leaves. They found that lettuce in treatments with tea manure had better response compared to treatments that used the fermented juice. This might be due to characteristics of biofertilizer extracts, mostly manures undergone decomposition before the application compared to the fermented juice extracts. The heaviest plant with 138.13 g was recorded in SNAP solution (control) followed by 129.58 g in treatment SNAP solution and 300 ml vermitea. This might be due to the optimum nutrient content of SNAP and characteristics of vermicast.

Solis and Denzo (2024) reported that using commercially available nutrient solution for lettuce production produces taller plants, broader leaves, longer leaf blade, wider canopy and a greater number of leaves as compared to the organic nutrient source Biovolt which produced narrower leaves, shorter leaf blade, narrower canopy and lesser number of leaves. Borres et al (2021) conducted a study to evaluate the potential of lettuce in a non-recirculated hydroponics system using SNAP using different levels of SNAP solution. The application of SNAP solution did not have a significant effect on the length and width of lettuce leaves. However, it had a significant effect on the height, number of leaves and yield.

Uy et al (2021) observed that the lettuce plants grown in SNAP solution consistently produced the tallest plants, highest number of leaves, longest roots and the heaviest fresh weight per plant.

Gonzales et al (2020) determined the growth and yield performance of different lettuce varieties using SNAP through hydroponic technology for enterprise development and revealed significant differences in all the treatments in terms of plant height while length of roots, number of leaves, weight of the plant and biomass perceived to be equal which showed no significant differences.

Solis and Magaret (2022) revealed that among organic nutrient solutions, Ramils and Healthynest showed comparable results to conventional inorganic fertilizer and SNAP in terms of horticultural characteristics, root development, survival rate, yield and sensory quality attributes and cost and return analysis.

The direct use of organic fertilizers in hydroponic systems may limit plant growth due to high biological oxygen demand in the root zone caused by the presence of dissolved organic carbon molecules (Ezziddine et al 2021, Durell 1941). Furthermore, most nutrients in organic sources, such as agricultural and aquacultural waste, are not in ionic forms and hence are not directly available to the plants. To optimize the utilization of organic waste for hydroponic plant development, a solubilization stage is required to break down organic matter and mobilize nutrients.

CONCLUSION

In the present study, it was found that the type of fertilizer solutions used had a substantial impact on the plant growth parameters of lettuce. With a mean of 10.30, lettuce grown in 100 per cent SNAP solution produced maximum number of leaves. This treatment also resulted in maximum leaf length of 16.77 cm which was at par with the treatment 25 per cent SNAP + 40 ml per l vermitea (14.30 cm). The treatment 100 per cent SNAP solution produced largest canopy measuring 24.50 cm and highest plant weight of 51.23 g. Thus it was concluded that 100 per cent SNAP solution was best treatment for enhancing the plant growth parameters of lettuce. Significant results were obtained for growth parameters but treatments that utilized organic nutrient solution solely is not recommended as it resulted in poor growth. Combining vermitea with SNAP solution had comparable results with SNAP solution though there was considerable increase in growth and yield.

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