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Effect of Natural Farming Inputs as Nutrient Source Applied at Different Levels on Hydroponically Grown Lettuce

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Abstract

Nutrient solution concentration is one of the most practical and effective ways of controlling and improving the yield and nutritional quality of crops for human consumption. The study was conducted to determine the effect of natural farming inputs as nutrient source applied at different levels on hydroponically grown lettuce. It was conducted at Cagayan State University – Piat Campus from September to October 2019. The Completely Randomized Design (CRD) with four replications was used to test the following treatments: T_1–25ml SNAP solution (Control), T_2-5grams Master Blend (Control), T_3–10ml SNAP+5ml FFJ+5ml FPJ+15ml KAA, T_4-10ml SNAP+5ml FFJ+5ml FPJ+15ml KAA, T_5–10ml SNAP+5ml FFJ+5ml FPJ+20ml KAA, T_6-10ml SNAP+5ml FFJ+5ml FPJ+20ml FAA, T_7–20ml KAA and 20ml FAA. The plants are grown in T_1 (SNAP solution) consistently produced the tallest, number of leaves, longest roots and the heaviest fresh weight per plant. Master Blend can also be used as a nutrient solution for hydroponics since they are not significantly different from each other. Plants in T_7 applied with 20ml KAA and 20ml FAA can also be used as a nutrient solution. However, only there was a delay of one week in maturity which is 37 days as compared with commercial (SNAP and Master Blend) having 30 days maturity. In the absence of SNAP solution and master blend, the fermented Fish Amino Acid (FAA) and Kuhol Amino Acid (KAA) as organic is a potential culture media for hydroponically lettuce production.

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Introduction

Lettuce (*Lactuca sativa*) is one of the most commonly grown hydroponic vegetables in the Philippines. It is the most popular among salad vegetable crops and in demand or need by the local markets throughout the year. Hydroponics is a modern and developed crop production technique where crops are grown in a restrained environment in solid or liquid media without any soil by providing fundamental and essential nutrients. Plants may be grown in a nutrients solution only (liquid culture) or they may be supported by an inert medium (aggregate culture).

Hydroponic technology produces many benefits that it is highly productive and it conserves water and land. These systems have been shown to save 70-90% of water usage when compared by the crop to conventional agriculture systems (Raviv and Leith, 2008). Normally, with hydroponics, plants grow inside enclosures that control temperature, light, water and nutrition. Through this system of production, it is a cleaner way to grow plants and is useful when land and natural resources are scarce. The plants produced are of better quality than plants that come from soil because the soil contains impurities and bacteria.

The progress of hydroponics has been rapid and results obtained in various countries have proved that this technology is thoroughly practical and has definite advantages over conventional methods of crop production. One of the importance of hydroponics over growing in soil is the speed of growth by the plant. It needs less nutrient material to feed the plants and these exist within a self-contained environment that can easily control the waste products.

Today farmers are slowly increasing their use of hydroponics, and researchers are looking more closely at how it could solve future food problems. Since the population is growing, the land to be used is becoming scarce and hydroponic cultivation can help us solve some future problems. However, hydroponic production is largely dependent on the commercial nutrient solution which is costly i.e. shipping of the product and also its availability in the market. Considering this problem, there is a need to look for an alternative way of producing the nutrient solution for hydroponics production. Thus, extraction of natural farming inputs like Fermented Fruit Juice (FFJ), Fermented Plant Juice (FPJ), Fish Amino Acid (FAA) and Kuhol Amino Acid (KAA) can be used as the source of nutrients for hydroponically grown vegetables like lettuce. Hence the study.

Generally, the study aimed to determine the effects of natural farming inputs as the nutrient source at different levels on hydroponically grown lettuce. Specifically, the study aimed to; (1) evaluate the theoretical nutrient composition of the different natural farming inputs as a nutrient source for hydroponics production; (2) determine which of the different natural farming inputs would give the best in terms of agronomic parameters of lettuce in hydroponics production; and (3) compare the economic and profitability of the different treatments.

Materials and methods

The following materials were used in the study: lettuce seeds, SNAP solution, coco-coir, fruit-styro box, plastic styro cup, measuring device (graduated cylinder and ruler) cutter, water and fermented natural farm inputs (NFI's).

Preparation of fermented natural farming inputs

Fermented Plant Juice (FPJ)

The plant material were collected early in the morning while they are fresh and the macro-organisms are still present. Do not wash the plant materials. Cut the plant materials into small pieces so that the juice can easily be extracted. Put 2 kg chopped materials in a pail, add 1 kg molasses, then mix thoroughly with your hands. Make sure that all plant materials are mixed with molasses so that juice can be extracted easily. After mixing the plant materials used and the molasses, cover with paper or cloth, and secure with a rubber or string. Manila paper was used as a cover to allow some air to get inside the pail and for the gas that is being produced during the fermentation process to escape. On the cover, write the date of processing and the expected date or harvest. Store the fermented plant juice in a safely chosen room.

Fermented Fruit Juice (FFJ)

Collect the fruit materials needed in extracting fermented fruit juice except for citrus fruit. Cut the materials into small pieces so that the juice can be easily extracted. Put 1 kg of chopped materials in a pail, add 1 kg of molasses, and then mix thoroughly with your hands. Make sure that all fruit materials are mixed with molasses so that juice can be easily extracted. After mixing the fruit materials used and the molasses, cover with paper or cloth and secure with a rubber or string. Manila paper was used as a cover to allow some air to get inside the pail and for the gas that is being produced during the fermentation process to escape. On the cover, write the date of processing and the expected date harvest. Store the fermented fruit juice in a safely chosen room.

Kuhol Amino Acid (KAA)

Collect a mollusk needed in extracting kuhol amino acids. Crush the mollusk till it turns into tiny pieces so that the amino acids can be extracted easily. Put 1 kg of crushed mollusk in a pail, add 1 kg of molasses, then mix thoroughly with your hands in a manner way to avoid incidence. Make sure that all crashed mollusk mix with molasses so that the juice can be easily extracted. Cover the pail with paper or cloth, and secure with a string or rubber. Manila paper was used as a cover to allow some air to get inside the pail for the gas that is being produced during the fermentation process to escape. On the cover, write the date of processing and the expected date harvest. Store the fermented kuhol amino acids in a safely chosen room.

Fish Amino Acid (FAA)

Collect the materials needed in extracting fish amino acid, here are: Head or entrails of fresh fishes can be used because of the nutrients present on it. Crush the materials chosen into pieces so that the amino acids can be easily extracted. Put 1 kg of chosen material in a pail, add 1 kg of molasses, and then mix thoroughly with your hands in a manner to avoid incidence. Make sure that all crushed mollusk mixed with molasses so that the juice can be easily be extracted.

Cover the pail with paper or cloth, and secure with a string or rubber. Paper or cloth is used as a cover to allow some air to get inside the pail for the gas that is being produced during the fermentation processing and the expected date of harvest. Store the fermented fish amino acids in a safely chosen room.

Preparation of seedlings and growing boxes

Establishing the seedlings

Fill the sowing tray with a layer of the growing media at 1 inch thick and level the media. Scatter the small seeds of lettuce uniformly and thinly and water liberally every day until the seeds will germinate at 3-5 days. Grow the seedlings under the sun for 7 to 14 days before transferring to individual growing cups (seedling plugs).

Preparing the Growing boxes

Make 8 holes on the lid or cover of the box using the tin can borer. Use the plastic bag as the liner of the bottom half of the box to make it fit to hold the nutrient solution. Use packaging tape to close all the open slits of the lid/cover to prevent the entry of mosquitoes as shown in Fig. 1.

Preparing the seedling plugs

Prepare the Styrofoam cups. Use the serrated knife or saw to make 4 – 6 slits (about 2 inches long on the side and including about ½ inch at the bottom). Fill in the holding cups with the growing media (about 1 inch thick). Transplant a seedling from the sowing tray. "Dig" a hole in the middle of the growing media in the cup. Use the bamboo stick to uproot the seedlings from the sowing tray with care. Transfer only one (1) seedling per cup (Fig. 2). Lightly press the media around the base of the transplanted seedling. Water carefully the seedling plugs. Put 10 liters of water in a growing box and add nutrients based on the treatment formulation.

Methods of analyzing the nutrient composition

The samples of extracts were collected and submitted to the Cagayan Valley Integrated Agricultural Laboratory at Tuguegarao City as the basis for nutrient formulation.

Table 1 shows the mineral composition and concentration of the nutrient solution and they were analyzed using the different methods: Nitrogen – *Kjeldahl Jauber - Gunning*, Phosphorus - *Vanadomolybdate*, Potassium – *Flame Atomic Emission* while micronutrients were analyzed using *Atomic Absorption Spectrophotometric*.

Experimental design and treatments

The Complete Randomized Design (CRD) was used and it was replicated 28 times using the 28 boxes with 8 plants in each planting box to test the following treatments: T_1 – 25 ml SNAP Solution (Control),T_2 - 5 grams Master Blend (Control), T_3 – 10 ml SNAP + 5 ml FFJ + 5ml FPJ + 15 ml KAA, T_4 - 10 ml SNAP + 5 ml FFJ + 5ml FPJ + 15 ml KAA, T_5 – 10 ml SNAP+ 5 ml FFJ + 5 ml FPJ + 20 ml KAA, T_6 – 10 ml SNAP + 5 ml FFJ + 5 ml FPJ + 20 ml FAA, T_7 – 20 ml KAA and 20 ml FAA. The Table 2 shows the theoretical amount of nutrients contributed of the different treatments per 10 Liters of water.

Care and management of the crop

The nutrient solution to water ratio remained consistent. The pH was monitored for every replacement of the solution. Daily monitoring of the occurrence of insect pests was strictly monitored.

Harvesting

Harvesting was done at 30 days after transplanting. Plant samples were tag just at harvest to avoid intermixing of samples.

Data gathered

Plant height

Eight representative sample plants were used to measure the height of the plants at harvest. The total plant height was divided by eight to get the average height per plant.

Number of leaves

The leaves of the plants were counted at harvest. The total number of leaves of the sample plants was divided by eight to get the average number of leaves per plant.

Root length

The length of roots of the sample plants was measured from the base to the tip using the foot rule.

Fresh weight per eight sample plants

The sample plants were immediately weighed after harvesting.

The PH of the nutrient solution

The pH of the nutrient solution was observed at weekly intervals using the pH meter.

Statistical tool

The data were analyzed using STAR, version 2.0.1 2014. Biometrics and Breeding Informatics, PBGB Division, International Rice Research Institute, Los Baños, Laguna following procedures for analysis of variance (ANOVA) for Complete Randomized Design (CRD) to test the significant differences among treatments. The Least Significance Difference (LSD) test was also used to analyze the mean comparisons.

Result and discussion

Plant Height (cm)

The plant height as affected by different organic solutions is presented in Table 3. Results showed significant variation among treatment means.

The plants are grown in SNAP solution (T_1) produced the tallest plants with a mean of 26.3 centimeters. It was followed by the plants grown in Master Blend solution (T_2), T_7, T_5, T_6 and T_4 with a mean value of 22.65, 18.48, 17.21, 14.51 and 13.86 centimeters, respectively. The plants cultured in (T_3) produced a mean of 11.04 centimeters recorded as the shortest plants. Analysis of variance shows highly significant differences among treatments. Such differences in plant height were attributed to the effect of organic nutrient solution as a growing medium.

Table 1. Mineral composition and concentration of the nutrient solution used in Different Treatments.

Materials	Nutrient content						
	N (%)	P (%)	K (%)	Zinc (ppm)	Copper (ppm)	Manganese (ppm)	Iron (ppm)
SNAP Solution A	0.07	0.64	3.84	1	2.5	17.5	1
SNAP Solution B	0.04	1.89	0.01	12.5	10	3225	160
Master Blend	0.88	1.28	5.19	3.0	10	550	65
Fermented Fruit Juice (FFJ)	0.35	0.10	1.05	7.5	5	612.5	4.5
Fermented Plant Juice (FPJ)	0.37	0.11	0.91	2.3	5	330	82.5
Kuhol Amino Acid (KAA)	2.23	0.58	2.82	7.5	3	413	30
Fish Amino Acid (FAA)	1.90	0.33	1.03	7.5	1	442.5	195

This means that the availability of all essential nutrients and their presence in appropriate ratios, and favorable external conditions as cited by Resh (2012); Sonneveld and Voogt 2010).

Number of Leaves

The average number of leaves as affected by different organic solutions is presented in Table 3. The plants are grown in SNAP solution (T_1) produced the most number of leaves with a mean of 19.04. It was followed by the plants grown in Master Blend (T_2) with a mean value of 17.45. The least number of leaves was produced from T_6 with a mean of 6.6. Analysis of variances reveals highly significant differences among treatments used in this study.

This result is attributed to the nutrients composition of the solution that can stimulate the growth and development of plants which can compensate for the toxic effects of other elements or may replace essential nutrients in a less specific role Trejo-Téllez *et al.*, (2007).

Table 2. Theoretical amount of nutrients contributed of the different treatments per 10 Liters of Water.

Materials	Nutrient content						
	N (ppm)	P (ppm)	K (ppm)	Zinc (ppm)	Copper (ppm)	Manganese (ppm)	Iron (ppm)
T_1 – 25 ml SNAP Solution	1.31	1.17	2.19	.03	0.01	0.01	0.01
T_2 – 5 grams Master Blend	1.73	0.65	0.25	.09	0.01	0.01	0.01
T_3 - 10 ml SNAP + 5 ml FFJ + 5ml FPJ + 15 ml KAA	2.63	1.12	1.3	0.4	0.01	0.01	0.01
T_4 - 10 ml SNAP + 5 ml FFJ + 5ml FPJ + 15 ml KAA	2.63	1.24	1.29	0.03	0.01	0.01	0.01
T_5 – 10 ml SNAP+ 5 ml FFJ + 5 ml FPJ + 20 ml KAA	3.06	0.25	1.31	0.04	0.01	0.01	0.01
T_6 - 10 ml SNAP + 5 ml FFJ + 5 ml FPJ + 20 ml FAA	2.63	0.97	1.39	0.3	0.01	0.01	0.01
T_7 - 20 ml KAA and 20 ml FAA.	3.5	1.28	1.18	0.4	0.01	0.01	0.01

Table 3. Summary of statistical analysis on the eeffect of natural farming inputs as nutrient source applied at different levels on hydroponically grown lettuce.

Treatments	Gathered data				
	Plant Height (cm)	Number of Leaves	Root Length (cm)	Fresh Weight (g)	pH
T_1 – 25 ml SNAP Solution	26.30	19.04	34.99	193.53	8.20
T_2 – 5 grams Master Blend	22.27	17.45	30.53	180.27	8.19
T_3 - 10 ml SNAP + 5 ml FFJ + 5ml FPJ + 15 ml KAA	11.04	8.46	16.49	88.01	8.43
T_4 - 10 ml SNAP + 5 ml FFJ + 5ml FPJ + 15 ml KAA	13.86	7.31	18.65	95	8.36
T_5 – 10 ml SNAP+ 5 ml FFJ + 5 ml FPJ + 20 ml KAA	17.22	8.72	19.49	86.36	8.41
T_6 - 10 ml SNAP + 5 ml FFJ + 5 ml FPJ + 20 ml FAA	14.51	6.6	20.47	89.31	8.39
T_7 - 20 ml KAA and 20 ml FAA.	18.48	12.85	30.01	151.55	8.34
CV%	2.16	8.27	4.23	0.93	8.64
RESULT	**	**	**	**	**

ns-not significant

*significant at 1%

**highly significant at 5%

Length of Roots (cm)

The average length of roots as affected by different organic solutions is shown in Table 3. Results revealed significant differences among treatment means. The plants are grown in SNAP solution (T1), Master Blend solution (T2) and T7 solution produced the longest roots with a comparable mean value of 34.99, 30.53 and 30.01 centimeters respectively.

Fig. 1. Packaging tape to close all the open slits.

The shortest was recorded at T3 with a mean of 16.49 centimeters. The differences of the study may be attributed to the growing solutions that contain several enzymes, plant growth hormones, vitamins along with micro and macronutrients that enhance the growth and productivity of crops Zambare *et al.*, (2008); Hatti *et al.*, (2010).

Fig. 2. Transfer only one (1) seedling per cup.

Fresh Weigh per Plant (g)

The fresh weight per plant as affected by the growing solution is shown in Table 3. The plants are grown in the SNAP (T_1) solution produced the heaviest plant with a mean value of 193.53 grams followed by the Master Blend solution (T_2) with 180.26 grams and the lightest in fresh weight was produced in (T_5) solutions with a mean value of 86.36 grams. Analysis of variance reveals highly significant differences among treatments tested. The differences in yield may be attributed to the growing medium which is essential to the yield of the crop. According to Santiago 2019, reported in his study that plants are grown in SNAP solution consistently produced the tallest, number of leaves, longest roots and the heaviest fresh weight per plant. An important feature of the nutrient solutions is that they must contain the ions in solution and in chemical forms that can be absorbed by plants according to Tyson *et al.*, (2007). The most basic nutrient solutions consider in their composition only nitrogen, phosphorus, potassium, calcium, magnesium and sulfur and they are supplemented with micronutrients (Trejo-Téllez *et al.*, 2007).

pH of Nutrient Solution

The average weekly pH of the growing solution is shown in Table 3. All the growing medium solutions obtained pH values of alkaline which means that the availability of nutrients from the growing solution is dependent on the pH of the solution. The alkalinity is an important water quality parameter that needs to be closely monitored in hydroponic systems (Timmons and Ebeling, 2013; Reed, 2006).

Conclusions and recommendations

Based from the result of the study, the following conclusions were drawn: The plants grown in T_1 (SNAP solution) consistently produced the tallest, number of leaves, longest roots and the heaviest fresh weight per plant., master blend can also be used as nutrient solution for hydroponics since they are not significantly different with each other and plants in T_7 applied with 20ml KAA and 20ml FAA can also be used as nutrient solution. However, only there was a delay of one week in maturity which is 37 days as compared with commercial (SNAP and Master Blend) having 30 days maturity. In the absence of SNAP solution and master blend, the fermented Fish Amino Acid (FAA) and Kuhol Amino Acid (KAA) as organic is a potential culture media for hydroponically lettuce production. A follow-up study on the palatability test is recommended.

References

Hatti SS, Londonkar RL, Patil SB, Gangawane AK, Patil CS. 2010. "Effect of Eisenia fetida vermiwash on the growth of plants." Journal of crop Science **1(1),** 6. Retrieved on November 13, 2020 from https://bit.ly/2tTUND3

Resh HM. 2016. Hydroponic food production: a definitive guidebook for the advanced home gardener and the commercial hydroponic grower. CRC Press. Retrieved on November 13, 2020 from http://bit.ly/31ccNEA

Santiago RT. 2019. Performance of Hydroponic Lettuce Using Organic Medium Solutions. International Journal of Ecology and Conservation, **29(1),** 56-82. Retrieved on November **13,** 2020. https://ejournals.ph/issue.php?id=1217

Sonneveld C, Voogt W. 2009. Nutrient management in substrate systems. In Plant nutrition of greenhouse crops (p 277-312). Springer, Dordrecht. Retrieved on November 13, 2020 from http://bit.ly/2S3kzwC

Trejo-Téllez LI, Gómez-Merino FC, Alcántara, G. 2007. Elementos benéficos. Nutrición de cultivos. G. Alcántar, L. I. Trejo-Téllez (eds.). México, DF: MundiPrensa y Colegio de Postgraduados, 59-101. Retrieved on November 13, 2020. http://bit.ly/2RHZWqR

Tyson RV, Simonne EH, Davis M, Lamb EM, White JM, Treadwell DD. 2007. Effect of nutrient solution, nitrate-nitrogen concentration, and pH on nitrification rate in perlite medium. Journal of plant

nutrition **30(6)**, 901-913. Retrieved on November 13, 2020 from
http://bit.ly/37EMg5o

Zambare VP, Padul MV, Yadav AA, Shete TB. 2008. Vermiwash: biochemical and microbiological approach as ecofriendly soil conditioner. ARPN Journal of Agricultural and Biological Science **3(4),** 1-5. Retrieved on November 13, 2020 from
https://go.aws/37MMZSo