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Formulation of organic liquid fertilizers and their effects on germination of selected seeds and growth and yield of chilli (*Capsicum frutescens* L.)

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Abstract

The present study was aimed to formulate organic liquid fertilizers using banana pseudostem and to assess their potential use in the germination of selected seeds (i.e., chilli, curry chilli, lettuce, and water spinach), and growth and yield of chilli (*Capsicum frutescens* L.), in combination with either organic (cattle manure - CM) or inorganic fertilizers (IF). The formulations were banana pseudostem extract with decomposed solution (banana formulation- BF) and banana pseudostem extract with 2% Panchagavya (BP). The nutrient content (NPK) of formulations were analyzed. In the germination test, control (distilled water T1) was compared with BF (T2) and BP (T3). The pot experiment was conducted in a complete randomized design with six treatments and four replicates. The treatments were T1 (100% IF), T2 (100% CM), T3 (50% IF + 50% BF), T4 (50% CM + 50% BF), T5 (50% IF + 50% BP) and T6 (50% CM + 50% BP). The liquid formulations were applied at the rate of 250 Lha^{-1}. Growth

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parameters namely the number of leaves per plant, plant height and yield were measured. Results of nutrient analysis of formulations indicate that BF had 365 ppm N, 1320 ppm P, and 8097 ppm K, while BP had 601 ppm N, 1930 ppm P, and 8619 ppm K. The results indicated that the highest germination percentage was recorded in T2 (BF) in all selected seeds. Vigour index was higher in T2 (BF) and T3 (BP) treatments than in the control. Significant differences among treatments in plant height of chilli were only observed at the second and sixth week. However, the number of leaves showed significant differences during the second, fourth and sixth weeks. Among the treatments, the highest yield was recorded in T6. Moreover, all foliar treatments T3, T4, T5, and T6 performed better than T1.

Keywords: banana formulation, banana pseudostem extract, *Capsicum frutescens*, Panchagavya

INTRODUCTION

The current farming system mostly depends on chemical fertilizers, which may negatively affect soil health, soil organisms, environment, and human health. The Sri Lankan government spends almost US$ 13,200 for the importation of inorganic fertilizer (Central Bank of Sri Lanka, 2020). In the present agricultural system, improving crop production on a sustainable basis is a quite challenging issue. To address this problem, integrated nutrient management is an attractive alternative where organic and inorganic nutrients are applied in combination to get ecological as well as economic benefits in farming systems (Gruhn *et al*., 2000).

The availability of organic fertilizers is very limited in the local market. However, the organic sources (i.e., plant residues and animal wastes) are abundantly available in the environment. With increasing environmental awareness, agricultural wastes can be used for efficient conversion into biomaterials. Using fresh animal waste as fertilizer may cause undesirable effects because it can damage the plants and environment (Millner *et al*., 2014). Therefore, it is advisable to add partially decomposed waste in the form of decomposed solution and Panchagavya. It has been reported that decomposed solution of cow dung and cow urine was an effective nutrient source when used in combination with other organic sources (Thamilini *et al.*, 2020).

Another waste material that is underutilized in Sri Lanka is banana Pseudostem. Banana is one of the important tropical fruit crops widely grown all-around the country. The banana tree is a non-seasonal crop and their cultivated extent in Sri Lanka is around 45,497 ha (Department of Census and Statistics, 2017). In addition to the banana fruit, a large volume of biomass in the form of pseudostem is generated as waste. Banana pseudostem consists of macronutrients, micronutrients, and growth hormones such as cytokinin and gibberellins (Kolambe *et al.*, 2013). Using pseudostem, products like fibre, fabrics, paper, organic liquid fertilizer, candy, vermi-compost, etc., have been developed in other countries, especially in India (Mohapatra *et al*., 2010). In the northern region of Sri Lanka where banana is commonly cultivated, however, the pseudostem is underutilized. Currently the challenges faced by the farmers and households is the disposal of pseudostem. Huge amount of pseudostems are dumped in roadsides, which leads to environmental problems. As banana pseudostem is rich in macro and micronutrients, it can be incorporated to enhance the quality of organic fertilizer.

Meanwhile, Panchagavya comprises five products obtained from cow, namely dung, urine, milk, curd, and ghee. When the above five bovine products are reasonably blended and utilized, these have an inexplicable positive influence on crops (Swaminathan *et al.*, 2007). Panchagavya plays a vital role in organic agriculture. It consists of almost all the macronutrients, micronutrients, and growth hormones, and also numerous kinds of microorganisms which would help to improve soil quality (Maheshwari *et al*., 2007). The use of these organic inputs can be helpful to obtain higher nutrient content and uptake by crop and good soil health for the subsequent crops.

Foliar fertilization provides benefits when absorption by the plant root is not to the required level, or soil nutrient level is less than the optimum for plant growth. Foliar application is also recommended when soil pH is either highly acidic or alkaline which limits the nutrient uptake by roots, high weed invasion, or nematode infestation. Foliar application is also useful as a preventive method to avoid nutrient deficiencies, especially, micronutrients by using a minute amount of fertilizer (Patil *et al*., 2010). In addition, it is also possible to combine fertilizers with other agrochemicals which could reduce the cost of application (Oosterhuis, 2009).

The importance of organic fertilizers has long been realized, however, very few research has been conducted in Sri Lanka to study the usage

of different underutilized nutrient sources. In Sri Lanka, a strong move towards organic farming has been taken. However, the availability of organic fertilizers is not adequately available in the market. Therefore, it is important to find alternative organic sources of nutrients and fertilizer products. Though banana pseudostem, has high potential as a nutrient source, no study has been reported in Sri Lanka regarding this. Therefore, this experimental study was conducted at the Department of Agricultural Chemistry, Faculty of Agriculture, University of Jaffna to formulate different types of liquid fertilizers using Banana pseudostem extract, panchagavya, and decomposed solution and compare their effects on the performance of chilli (*Capsicum frutescens* L.). Chilli was selected as a test crop because it is one of the important cash crops grown in Sri Lanka. It is a main spice yielding plant and belongs to the family Solanaceae. It is a valuable and important spice in our daily diet. Though the potential yield of green chilli is approximately 12-15 t/ha, the national average yield is only 4.74 t/ha in 2015 (Department of Agriculture, 2015). The overall objective of this study was to assess the suitability of banana pseudostem sap enriched formulations in enhancing crop productivity and role as an organic fertilizer. The specific objectives were

- to assess the nutrient composition of banana pseudostem sap, decomposed solution, and panchagavya.
- to formulate the organic liquid fertilizer in combination with different levels of banana pseudostem sap, decomposed solution, and panchagavya solution.
- to study the efficiency of liquid fertilizer formulation in germination of selected seeds.
- to assess the efficiency of different levels of formulated liquid fertilizer on the growth and yield of green chilli.

MATERIALS AND METHODS

Study location

This study was conducted at the Faculty of Agriculture, University of Jaffna, Kilinochchi from January 2020 to July 2020. The pot experiment was conducted in the net house of the JICA training farm. Laboratory analysis was carried out at the Department of Agricultural Chemistry, Faculty of Agriculture, University of Jaffna.

The raw materials used for liquid fertilizer were banana pseudostem, cow dung, cow urine and panchagavya solution. Banana pseudostems were collected from farmer's field at Inuvil. Fresh cow dung and cow urine were collected from the Animal Farm, Faculty of Agriculture, University of Jaffna.

Two organic liquid fertilizers were prepared namely Banana formulation and Banana pseudostem extract with 2% Panchagavya. The banana formulation was prepared by using banana pseudostem extract and decomposed solution.

Preparation of banana pseudostem extract

About 75 cm of pseudostem was cut from a bottom part of the banana tree (variety: *Itharai*) after the harvest of the bunch. It was cleaned using a cloth to remove dirt materials on the surface. Blades and the inner core of the pseudostem were separated carefully. They were chopped into small pieces by using stainless steel liquidizer and strained through a clean muslin cloth to obtain the extract. During this process, from 100 grams of chopped outer blade banana pseudostem, 75 mL of extract was obtained, while from 100 grams of chopped inner core banana pseudostem 90 mL of extract was obtained. Outer blade banana pseudostem extract and inner core extract were mixed in one is to one ratio. This extract was considered as 100% level. The extract was diluted according to the treatments.

Preparation of banana formulation

Ten kilograms of fresh cow dung and 500 mL of cow urine were taken and it was mixed with ten liter of water (Thamilini *et al.*, 2020). This mixture was allowed to decompose for two weeks, filtered and preserved in refrigerator.

Ten liters of banana formulation was prepared by mixing 2 L of decomposed solution, 650 mL banana pseudostem extract, and 7.35 L of water. One liter of the banana formulation was prepared by mixing 200 mL of the above decomposed solution, 65 mL banana pseudostem extract, and 735 mL of water.

During the preparation of banana pseudostem extract with 2% Panchagavya formulation, 2% of panchagavya solution was replaced for decomposed solution of above mentioned banana formulation. Two

milliliters of panchagavya solution was diluted with 98 mL of distilled water. One liter of banana pseudostem extract with 2% Panchagavya solution was prepared by mixing 200 mL of diluted panchagavya solution, 65 mL banana pseudostem extract, and 735 mL of water.

Chemical analysis of raw materials

Nutrient contents such as N, P, and K were analyzed for making a liquid fertilizer mix recipe. Total nitrogen was estimated by Kjeldhal method, as explained by Haluschak (2006). Phosphorus content was determined by Vanadomolybdate method as described by Kalra (1971), and potassium content was measured by using flame photometer as described by Kalra (1971).

Efficiency of liquid fertilizer in germination of different seeds

Three different treatments were applied to four different seeds to assess the efficiency of fertilizer formulation of organic sources in germination. In the germination test, control (distilled water T1) was compared with BF (T2) and BP (T3). Table 1 shows the treatment schedule for soaking.

Table 1: Treatment schedule for soaking

Seed name	30 SW (mg)	100 SW (mg)	Volume needed (mL)
Lettuce	32.20	107.33	3.22
Green chilli	170.00	566.67	1.70
Water spinach	1410.40	4701.33	1.41
Curry chilli	193.00	643.33	1.93
Sugar graze	1210.00	4033.33	1.21

SW- Seeds weight

Thirty seeds were soaked in different fertilizer formulations for 3 hours. Seeds were soaked in 1/10 times volume of seed's weight (Arancon *et al.,* 2012). Thereafter selected seeds (curry chilli, lettuce, green chilli) were placed in filter paper on petric dish and other type of seeds (water spinach) was placed on pots with sand. The day onward growth parameters including the percentage of germination, seedling height were measured.

Vigour index value was calculated using the following formula proposed by Abdul-Baki and Anderson (1973).

Vigour index = Germination (%) x Total seedling length (cm)

Preparation of pots

Black polythene bags were used as pots and ten kilograms of air-dried, sieved (<2 mm) soil was added to each pot. According to the treatment schedule, inorganic fertilizers were mixed with the topsoil one day prior to transplanting. Organic Fertilizer (Cow manure) was applied two weeks before transplanting. The pots were labeled according to the number of treatments and number of replicates. *Capsicum frutescens* L. KA-2 (Karadhiyan Aru-2) variety was used as a test crop. One seedling was transplanted in each pot.

Treatments and experimental design

The experiment was arranged in a completely randomized design with four replicates. Six different treatments were applied to pots. Table 2 shows the treatment schedule.

Table 2: Treatments in experiment

Treatment number	Fertilizer formulation
T1	100% IF
T2	100% CM
T3	50% IF + 50% BF
T4	50% CM + 50% BF
T5	50% IF + 50% BP
T6	50% CM + 50% BP

BF: Banana formulation BP: Banana extract + 2% Panchagavya CM-Cattle manure IF-Inorganic fertilizer

For organic treatments cow manure was applied to the soil at the rate of 10 tons/ha. For inorganic treatments, fertilizers were applied according to the department of agriculture recommended rates. Urea (475 kg/ ha) at top dressing was applied in four splits at 2, 4, 8, 12 weeks after planting. MOP at the rate of 50 kg/ha was applied with the third top dressing (Department of Agriculture, 2015). Table 3 shows the amount of fertilizers applied to a pot. The liquid fertilizer formulations were applied as foliar spray at every two weeks at the rate of 250 liters/ha (Salunkhe *et al*., 2013).

Table 3: Inorganic Fertilizer Recommendation

	Urea	TSP	MOP
Basal	-	2.700 g	1.350 g
Top dressing 100% (Per pot)			
2 WAP	3.375 g	-	-
4 WAP	2.565 g	-	-
8 WAP	3.645 g	-	1.350 g
12 WAP	3.240 g	-	-
Top dressing 50% (Per pot)			
2 WAP	1.688 g	-	
4 WAP	1.283 g	-	
8 WAP	1.823 g	-	0.675 g
12 WAP	1.620 g	-	

WAP – Weeks After Planting, TSP - Triple Super Phosphate, MOP - Muriate of Potash

Data collection and statistical analysis

Plant height and leaf number per plant were recorded every two weeks. In each treatment height of four plants was recorded in two weeks intervals. Measurements were made from ground level to extreme growing tip using a meter scale. The matured pods were harvested from the 17th of April to 7th of July at 10 - 14 days intervals. Harvested pods were measured separately as per treatments. An electronic scale balance was used to

measure the weight of harvested pod of each pot. After 180 days plants were uprooted and final fresh and dry weights were quantified. The data were statistically analyzed using a statistical analytical system (University version) and Duncan's multiple range test was used to compare means at significance level of 0.05.

RESULTS AND DISCUSSION

Physico chemical properties of soil

Collected soil had 6.77 pH, sandy clay loam in texture and was non-saline (EC: 67.37 **µ**S/cm). The organic matter content of the soil was 0.82% and the bulk density was 1.55 g/cm^3. Soil has 25 ppm of available nitrogen, 31.8 ppm of available phosphorus, and 61.3 ppm of available potassium.

Nutrient content of raw materials and formulations

Table 4: Nutrient content of raw materials and organic fertilizer formulations

	Nitrogen	Phosphorus	Potassium
Banana pseudostem extract	3600 ppm	450 ppm	9696 ppm
Panchagavya	7500 ppm	2976 ppm	7576 ppm
Decomposed solution	1025 ppm	4899 ppm	4445 ppm
Cattle manure	2770 ppm	24010 ppm	4862 ppm
Banana Formulation	365 ppm	1320 ppm	8097 ppm
Banana sap with 2% Panchagavya	601 ppm	1930 ppm	8619 ppm

Table 4 displays the total nutrients available in raw materials and total nutrient availability in organic liquid fertilizer formulations. Panchagavya

had the highest N content (7500 ppm) while the lowest was recorded in decomposed solution (1025 ppm). The highest and lowest P was observed in cattle manure (24010 ppm) and banana pseudostem extract (450 ppm), respectively. On the other hand, the highest K was found in banana pseudostem extract. The decomposed solution had the lowest K (4445 ppm). Table 4 shows that the BP formulation had comparatively much higher N and P content than BF, however, both formulations had similar P contents.

Germination test and vigour index

Figure1 displays the effect of different organic liquid fertilizer formulations on the germination of selected seeds. Among all seeds, the highest germination percentage was recorded in T2 (Banana Formulation). In water spinach T2 (Banana Formulation) and T3 (Banana pseudostem extract with 2% Panchagavya) were higher in germination than T1 (Control). In Lettuce T2 (Banana Formulation) had the highest germination percentage among the treatments. In chilli and curry chilli, T2 (Banana Formulation) was higher in germination than T1 (Control).

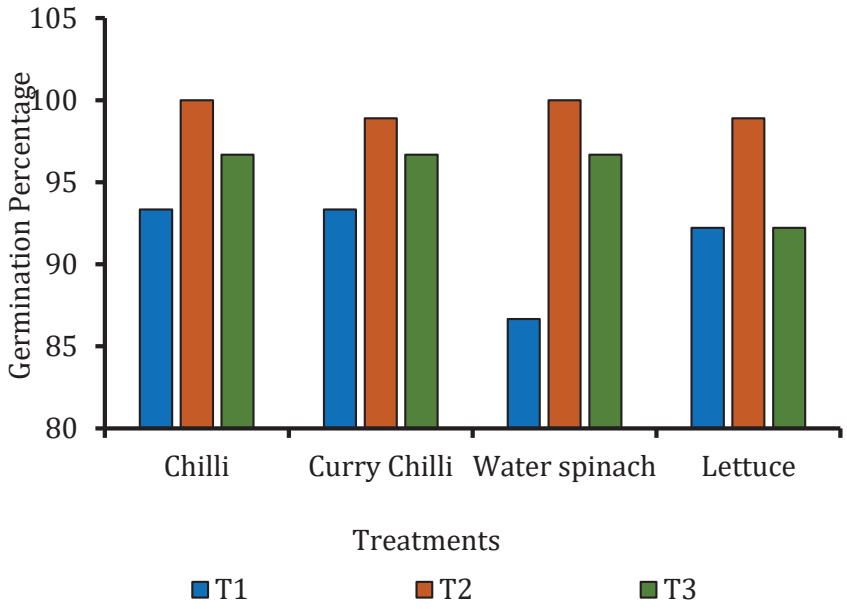

Figure 1: Germination percentage of selected seeds. T1-Control, T2-Banana Formulation, T3-Banana pseudo stem extract with 2% Panchagavya.

Organic liquid fertilizers (Cow dung slurry, Banana pseudostem sap) contain macro and micro-nutrients and growth promoting substances like Indole Acetic Acid (IAA), Giberrilic Acid (GA), etc. These growth hormones help in the germination of seeds and improve cell growth (Natarajan, 2007). It was reported that application of enriched sap to the nursery of eggplant and chilli, advanced the seedlings to transplantable stage 8 to 9 days earlier than the control, however, when the sap was applied as foliar spray to the nursery, advancement was only 3 days (Kolambe *et al*., 2013). Figure 2 shows the effect of different organic liquid fertilizer formulations on the vigour index of selected seeds.

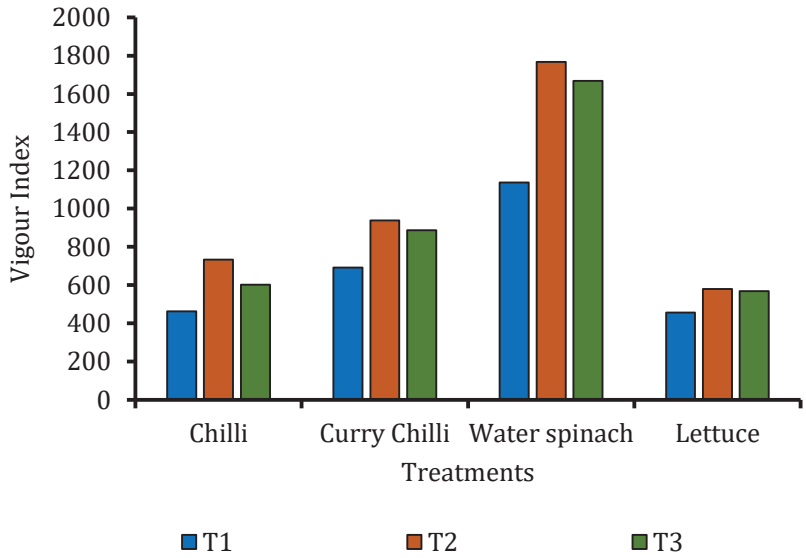

Figure 2: Vigour Index of selected seeds. T1- Control, T2 - Banana Formulation, T3 - Banana pseudo stem extract with 2% Panchagavya.

Vigour index in T2 (Banana formulation) was significantly higher than the other treatments in chilli and water spinach. In all seeds, vigour index of T2 (Banana formulation) and T3 (Banana pseudostem extract with 2% Panchagavya) were higher than T1 (control).

Growth parameters

Table 5 displays the effect of different organic liquid fertilizer formulations on plant height. At the second week after transplanting, the highest height

Table 5: Plant height with different treatments

Treatments	On transplanting	After 2 weeks	After 4 weeks	After 6 weeks	After 8 weeks	After 10 weeks
100% IF	8.50[a]	12.63[a]	26.20[a]	48.98[ab]	65.08[a]	72.40[a]
100%CM	7.50[a]	10.50[ab]	23.13[a]	47.95[ab]	70.23[a]	83.83[a]
50% IF+ 50%BF	7.95[a]	11.38[a]	23.50[a]	45.50[ab]	67.50[a]	80.68[a]
50%CM+ 50%BF	8.40[a]	7.75[b]	21.95[a]	41.00[b]	62.75[a]	83.83[a]
50% IF+ 50%BP	7.63[a]	11.13[a]	22.75[a]	44.50[ab]	73.50[a]	86.98[a]
50%CM+50%BP	7.88[a]	9.63[ab]	22.25[a]	51.68[a]	70.60[a]	89.98[a]

IF - Inorganic fertilizer, CM-Cattle manure, BF-Banana Formulation, BP-Banana pseudostem extract with 2% Panchagavya. Means followed by the same letter in each column are not significantly different at the 5% level.

was recorded in T1 (100% IF), however, it was not significantly different with other treatments except T4 (50% CM + 50% BF). At 4th week after transplanting, there was no significant difference in height among the treatments. However, the height of T1 (100% IF) was higher than the other treatments. Six weeks after transplanting, the highest height was recorded in T6 (50% CM+50% BP) while the lowest in T4 (50% CM+50% BF). There were no significant differences in height between T1 (100% IF), T2 (100% CM), T3 (50% IF + 50% BF) and T5 (50% IF + 50% BP). At eighth and tenth weeks after transplanting there was no any significant difference in plant height among the treatments.

According to Misal *et al.* (2015), the application of two sprays of banana pseudostem enriched sap (2%) increased the plant height in fenugreek compared to no sap application. The noticeable influence of liquid organics on growth aspects of fenugreek might be due to their rapidly available form of nutrients, which are easily absorbed, leading to faster growth and development of fenugreek components. Salunkhe *et al.* (2013) reported that the application of banana pseudostem sap at 2000 L/ha through a micro-irrigation system to onion gave significantly higher plant height. However, in the present study, plant height was not significantly increased than fertilizer treatment, possibly due to the dilution of the extract.

Table 6: Number of leaves per plant with different treatments

Treatments	On transplanting day	After 6 weeks	After 4 weeks	After 6 weeks
100% IF	6[a]	15[a]	52[a]	157[a]
100% CM	6[a]	11[b]	41[b]	140[a]
50% IF+50% BF	6[a]	11[b]	38[b]	114[b]
50% CM+50% BF	6[a]	12[b]	43[b]	143[a]
50% IF+50% BP	6[a]	10[b]	36[b]	108[b]
50% CM+50% BP	6[a]	10[b]	40[b]	117[b]

IF - Inorganic fertilizer, CM-Cattle Manure, BF-Banana Formulation, BP-Banana pseudostem extract with 2% Panchagavya. Means followed by the same letter in each column are not significantly different at the 5% level.

Table 6 displays the effect of different organic liquid fertilizer formulations on the number of leaves per plant. The number of leaves per plant in T1 (100% IF) was significantly higher than other treatments until four weeks after transplanting. However, there was no any significant difference in the number of leaves per plant when transplanting.

Crop yield

The weight of green chilli was recorded in 7-14 days intervals. The crop yield of each treatment at different time interval is illustrated in Table 7. First harvesting was done after 100 days from transplanting. The yield of first harvest for a treatment ranged between 196 g (T4-50% CM + 50% BF) to 256 g (T2- 100% CM). The average Yield from T2 (100% CM) was significantly higher than other treatments. However, there was no any significant difference in yield among T3 (50% IF + 50% BF), T5 (50% IF + 50% BP) and T6 (50% CM + 50% BP). All other treatments, except T4 (50% CM + 50% BF) gave a significantly higher yield than T1 (100% IF).

In the second picking, no significant difference was observed in yield among the treatments. T5 (50% IF +50% BP) had the highest yield (220 g) compared to all other treatments. The lowest yield (100 g) was obtained from T3 (50% IF + 50% BF). In third picking, the highest and lowest yield were obtained from T6 (50% CM + 50% BP) and T2 (T2- 100% CM) respectively. The yield of T6 (50% CM + 50% BP) was significantly higher than other treatments. There was no significant difference in yield among T1 (100% Inorganic) T3 (50% IF + 50% BF) T4 (50% CM + 50% BF) and T5 (50% Inorganic + 50% BP). The yield of T2 (100% CM) treatment had the lowest yield from third picking. However, the yield of T5 (50% IF + 50% BP) and T1 (100% IF) were significantly higher than T2 (100% CM).

In the fourth picking, the yield from T5 (50% IF +50% BP) was significantly higher than the yield from T1 (100% IF). Yield ranged from 58 g (T1 -100% IF) to 280 g (T5- 50% IF +50% BP). The yield of foliar applied treatments was higher than the yield of T1 (100% IF). In fifth picking, the highest yield and lowest yield were obtained from T6 (50% CM + 50% BP) and T1 (100% IF) respectively. Yield ranged from 18.5 g (T1- 100% IF) to 231 g (T6-50% CM + 50% BP). There was no significant difference in yield among T1 (100% IF), T2 (100% CM), and T3 (50% IF + 50% BF). However, the yield from all these three treatments (T1, T2, and T3) were significantly lower than the T6 (50% CM + 50% BP).

Table 7: Weight of green chilli pods in different pickings

Treatments	First picking	Second picking	Third picking	Fourth picking	Fifth picking	Sixth picking
100% IF	50.75±1.35^{c}	27.50±15.55^{a}	18.50±9.95^{b}	14.50±9.00^{b}	4.63±4.61^{b}	7.12±7.23^{c}
100% CM	64.00±1.35^{a}	42.50±22.17^{a}	10.45±0.42^{c}	21.25±26.31^{ab}	7.50±2.80^{b}	18.12±4.93^{bc}
50% IF+ 50% BF	57.50±1.61^{b}	25.00±19.15^{a}	16.50±1.29^{bc}	29.25±1.50^{ab}	18.00±15.71^{b}	23.30±3.12^{b}
50% CM+ 50% BF	49.00±4.43^{d}	41.25±15.48^{a}	13.75±4.79^{bc}	37.00±0.65^{ab}	38.75±17.35^{ab}	40.44±1.16^{a}
50% IF+ 50% BP	50.75±1.00^{b}	55.00±20.41^{a}	18.75±1.90^{b}	70.00±68.43^{a}	38.75±34.01^{ab}	9.88±7.27^{c}
50% CM+ 50% BP	55.725±2.03^{b}	42.50±33.04^{a}	39.00±1.31^{a}	57.00±34.05^{ab}	57.75±40.03^{a}	17.99±15.55^{bc}

Means with the same letter within a given column are not significantly different at the 5% level.

In the sixth picking, yield ranged from 28.47 g (T1- 100% IF) to 161.75 g (T4- 50% CM + 50% BF). Yield from T4 (50% CM + 50% BF) was significantly higher than all other treatments. However, there was no significant difference in yield among T1 (IF), T3 (50% IF + 50% BF) and T5 (50% CM + 50% BP). Total yield from T6 (50% CM + 50% BP) was significantly higher than T1 (100% Inorganic), T2 (100% CM) and T3 (50% Inorganic + 50% BF). The yield of T4 (50% CM + 50% BF) and T5 (50% Inorganic + 50% BP) were higher than T1 (100% Inorganic), however, a significant difference was not observed. Total yield for the treatments ranged from 491.97 g (T1- 100% Inorganic) to 1079.87 g (T6- 50% CM + 50% BP). The total yield variation is shown in Figure 9. It is interesting to note that total yield was higher in T6 (50% CM + 50% BP) than the T1 (100% Inorganic). However, the vegetative parameters were high in T1 (100% Inorganic). Through the foliar application of organic liquid fertilizers, plants utilized the maximum amount of macro and micronutrients. Nutrient leaching losses are also less in foliar application compared to the soil application (Fageria *et al*., 2009).

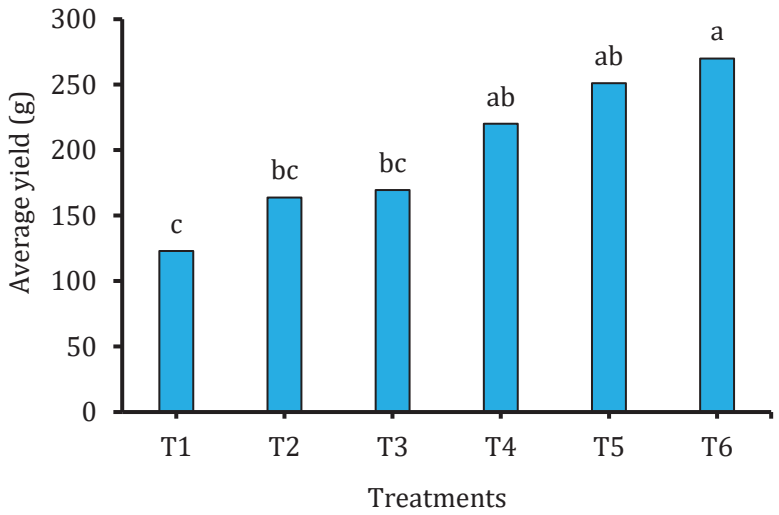

Figure 3: Total yield of chilli. T1- 100% IF, T2- 100% CM, T3- 50% IF + 50% BF, T4- 50% CM + 50% BF, T5- 50% IF +50% BP, T6- 50% CM + 50% BP. Means with the same letter within a given treatment are not significantly different at p= 0.05.

Organic formulations used in this study consist higher amount of phosphorus and potassium. It has been reported that phosphorus enhances the synthesis and translocation of carbohydrates, roots development and growth. Phosphorus induces earliness in flowering and fruiting including seed formation (Brady and Weil, 2008). In addition, the application of higher amount of K increased vitamin C content in chilli (Mary and Balakrishnan, 1990). Fruit weight of pomegranate was significantly increased in treatments applied with enriched banana pseudostem sap at 1% (Rathod *et al*., 2017) which was possibly due to the higher nitrogen and potassium in the sap improved the metabolic process enhanced the growth. In the same study, 1% enriched banana pseudostem sap reported significantly lower fruit drop (16.22%), early harvesting, highest fruits/plant, fruit set percentage, percentage fruit retention, and fruit yield. Similar findings of higher yield were reported in garlic (Patil *et al.*, 2014). In another study in chilli foliar application of a novel organic liquid fertilizer at 2% gave the highest fruit weight (Deore *et al*., 2010). Liquid organic manures contain macro and micro-nutrients, many vitamins, essential amino acids, numerable microorganisms, and growth promoting substances like IAA, GA etc. (Natarajan, 2007) which could have contributed to the positive response in plants.

CONCLUSIONS

The results of the study revealed that the highest germination percentage was recorded in T2 (Banana Formulation), in selected seeds namely, chilli, curry chilli, water spinach, and lettuce. In water spinach T2 (Banana Formulation) and T3 (Banana pseudostem extract with 2% Panchagavya) showed a higher germination percentage than T1 (Control). In all the crops tested, the seedling vigour index of T2 (Banana Formulation) and T3 (Banana pseudostem extract with 2% Panchagavya) were higher than the control. Considering both germination percentage and seedling vigour, T2 is the best treatment to enhance seedling quality. Among six different fertilizer treatments, the highest total yield was recorded in T6 (50% CM + 50% Banana pseudostem extract with 2% Panchagavya), which was significantly higher than T1 (100% IF), T2 (100% CM), and T3 (50% IF + 50% BF). Moreover, all foliar sprayed treatments T3 (50% IF + 50% BF), T4 (50% CM + 50% BF), T5 (50% IF + 50% BP) and T6 (50% CM + 50% BP) performed equal or better than T1 (100% IF). By substituting 50% of inorganic fertilizer with enriched Banana formulation, yield of chilli was increased by 46%. This study has verified that the quality organic liquid fertilizer can be produced from Banana pseudostem sap with decomposed

solution and panchagavya. The use of organic liquid fertilizer helps to decrease the inorganic fertilizer usage without affecting the yield of chilli.

DECLARATION OF CONFLICT OF INTEREST

Authors have no conflict of interest to declare.

REFERENCES

Abdul-Baki, A.A. and Anderson, J.D. 1973. Vigor determination in soybean seed bymultiple criteria 1. Crop science, 13(6): 630-633.

Arancon, N.Q., Pant, A., Radovich, T., Hue, N.V., Potter, J.K. and Converse, C.E. 2012. Seed germination and seedling growth of tomato and lettuce as affected by vermicompost water extracts (teas). HortScience, 47(12): 1722-1728.

Brady, N.C. and Weil, R.R. 2008. The nature and properties of soils, Upper Saddle River, NJ: Prentice Hall, 13, pp 662-710.

Central Bank of Sri Lanka. 2020. Press Release Issued by Date. Available at: https://www.cbsl.gov.lk/sites/default/files/cbslweb_documents/press/pr/press_20200515_externl_sector_performance_february_2020_e.pdf [Accessed 9 Aug. 2020].

Department of Census and Statistics, 2017. Agriculture and environment statistics division, Department of Census and Statistics, Sri Lanka.

Department of Agriculture, 2015. [online] Available at: https://doa.gov.lk/FCRDI/index.php/en/crop/34-chilli. [Accessed 9 Jun. 2020].

Deore, G.B., Limaye, A.S., Shinde, B.M. and Laware, S.L. 2010. Effect of novel organic liquid fertilizer on growth and yield in chilli (*Capsicum annum* L.). Asian journal of experimental biological sciences, 2010:15-19.

Fageria, N.K., Filho, M.B., Moreira, A. and Guimarães, C.M. 2009. Foliar fertilization of crop plants. Journal of plant nutrition, 32(6): 1044-1064.

Gruhn, P., Goletti, F. and Yudelman, M. 2000. Integrated nutrient management, soil fertility, and sustainable agriculture: current issues

and future challenges. Internatioal Food Policy Research Institute, Washington, pp 3-18.

Haluschak, P. 2006. Laboratory methods of soil analysis. Canada-Manitoba soil survey, pp.3-133.

Kalra, Y.P. 1971. Methods used for soil, plant, and water at the soils laboratory of the Manitoba-Saskatchewan region, Edmonton, Alta.: Canadian Forestry Service, Department of the Environment, pp 57-68

Kolambe, B.N., Patel, K.K., Pawar, S.L., Patel, J.M. and Prajapati, D.R. 2013. A novel organic fertilizer of banana pseudostem. WIPO patent No. WO/2013/001478, ICAR.

Maheshwari, M., Dhevagi, P., Udayasoorian, C. and Natarajan, S.P. 2007. A commercial input in agriculture. Proceedings of National Conference Glory Gomatha, S.V. Veterinary University tirupati: 41-45.

Mary, S.S. and Balakrishnan, R. 1990. Effect of irrigation, nitrogen and potassium on pod characters and quality in chilli (*Capsicum annuum* L.) cv. K. 2. South Indian Horticulture, *38*(2):86-89.

Millner, P., Ingram, D., Mulbry, W. and Arikan, O.A. 2014. Pathogen reduction in minimally managed composting of bovine manure. Waste management, 34(11):1992-1999.

Misal, N.B., Patil, R.G., Shirgire, S.T. and Kulkarni, M.V. 2015. Effect of growing conditions and fertilizer scheduling with and without application of Banana pseudostem sap (enriched) on Biomass yield of fenugreek. Ecology, Environment & Conservation, 21: 351-356.

Mohapatra, D., Mishra, S. and Sutar, N. 2010. Banana and its by-product utilisation: An overview. Journal of Scientific and Industrial Research, 69:323-329.

Natarajan, K. 2007. Panchagavya for plant. Proceedings of National Conference. Glory Gomatha, S.V. Veterinary University Tirupati, 1-3.

Oosterhuis, D. 2009. Foliar fertilization: mechanisms and magnitude of nutrient uptake. In: Proceedings of the fluid forum, 2: 15-17.

Patil, B.C., Hosamani, R.M., Ajjappalavara, P.S., Naik, B.H., Smitha, R.P. and Ukkund, K.C. 2010. Effect of foliar application of micronutrients on growth and yield components of tomato (*Lycopersiconesculentum* Mill.). Karnataka Journal of Agricultural Sciences, 21: 428-430.

Patil, T.D., Kolambe, B.N., Patil, R.G. and Bafana, A.M. 2014. Effect of rates of castor cake and banana psuedostem sap on yield and yield attributing characters of organically grown garlic (*Allium sativum* L.) (CV GG-2). BIOINFOLET-A Quarterly Journal of Life Sciences, 11(1a): 100-104.

Rathod, M.J., Ramdevputra, M.V., Nurbhanej, K.H. and Patel, M.S. 2017. Effect of Ethrel and banana pseudostem sap on fruit yield and yield attributes of pomegranate (*Punica granatum* L.) cv. Bhagwa. International journal of Chemical Studies, 5(5): 392-396.

Salunkhe, J.R., Patel, A.M., Patil, R.G. and Pisal, R.R. 2013. Effect of banana pseudostem sap as liquid fertilizer in onion. Indian Journal of Agricultural Research, 47(3): 258-262.

Swaminathan, C., Swaminathan, V. and Vijayalakshmi, K. 2007. Panchagavya Boon to Organic Farming, First edition, International Book Distributors Lucknow, pp. 20-63.

Thamilini, R., Gnanavelrajah, N., Arasakesary, S.J. and Amirthalojanan, A. 2020. An innovative liquid fertilizer to promote growth and yield responses of tomato (*Lycopersicon esculentum* Mill.). Proceedings of 9th YSF Symposium held on 13th November 2020:197-201.