EFFECT OF NUTRIENT SOLUTION AND FOLIAR APPLICATION OF ORGANIC FERTILIZER ON GROWTH AND YIELD OF CAPSICUM IN SOILLESS SYSTEM

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*This is to certify that thesis entitled, "**EFFECT OF NUTRIENT SOLUTION AND FOLIAR APPLICATION OF ORGANIC FERTILIZER ON GROWTH AND YIELD OF CAPSICUM IN SOILLESS SYSTEM**" submitted to the, Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of **MASTER OF SCIENCE IN HORTICULTURE,** embodies the result of a piece of bona fide research work carried out by **SONCHITA ROY** Registration: 18-09048 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma in any other institution.*

I further certify that any help or source of information received during the course of this investigation has duly been acknowledged.

Dated: JUNE, 2020
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EFFECT OF NUTRIENT SOLUTION AND FOLIAR APPLICATION OF ORGANIC FERTILIZER ON GROWTH AND YIELD OF CAPSICUM IN SOILLESS SYSTEM

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ABSTRACT

The growth and yield of Sweet pepper in response to the effect of nutrient solution and foliar application of Cow dung leachate as liquid organic fertilizer was evaluated at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka-1207, during the period from September, 2018 to March 2019. Four types of foliar application of CDL viz. FA_0= Control (no application), FA_1= 100 g/L leachate of cow dung, FA_2= 150g/L CDL, FA_3= 200 g/L CDL, and four types of Solution addition of liquid organic fertilizer, NS_0: Control (standard nutrient solution as Rahman and Inden), NS_1= 100 g/L CDL + standard nutrient solution, NS_2= 150g/L CDL+ standard nutrient solution, NS_3= 200 g/L leachate of CDL + standard nutrient solution. The experiment was conducted in a Randomized Complete Block Design (RCBD) with three replications. Physical properties, yield contributing parameters, yield, and physiological properties were measured in this experiment. The highest plant height (97.20 cm), early flowering, early fruiting, fruit length (12.56 cm), fruit breadth (7.33 cm), fruit diameter (7.65 cm), fruit pericarp thickness (6.04), fruit volume (189.36), no. of fruits/plant (8.56), individual fruit weight (112.12 g), yield/ plant (959.76 g) were found in NS_3FA_3 which was similar to NS_2FA_2. Physiological parameters viz. leaf area (LA), leaf area ratio (LAR) was also found in NS_3FA_3 and lower leaf mass ratio (LMR) and root weight ratio (RWR) was acceptable for good result and NS_3FA_3 shows lower result. So, NS_3FA_3 showed best combination in this experiment.

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ABBREVIATIONS AND ACRONYMS

ANOVA	= Analysis of variance
BBS	= Bangladesh Bureau of Statistics
CDL	= Cow dung leachate
cm	= Centimeter
cm^2	= Centimeter squares
CV%	= Percent Coefficient of variation
DAF	= Days After Flowering
DAT	= Days After Transplanting
DMRT	= Duncun’s Multiple Range Test
df	= Degrees of freedom
et al.,	= And others
e. g.	= exempli gratia (L) for example
g	= Gram (s)
i.e.	= id est (L), that is
L	= Littre
LSD	= Least Significant Difference
mL	= mililitre
RCBD	= Randomized Complete Block Design
Wt.	= Weight
%	= Percentage

CHAPTER I
INTRODUCTION

CHAPTER I

INTRODUCTION

The geographical land area of Bangladesh is 14.3 million hectares (m. ha.).Cultivated area of Bangladesh is only 8.577 m. ha. The cultivable land of Bangladesh is decreasing day by day and the historical trend of cultivated area shows limited scope of horizontal expansion. In Bangladesh, 46.61% family is dependent on agriculture .With the help of modern technology, innovations, modern equipment etc. Bangladesh is now a unique epitome in food grain production, in spite of decreasing arable land, population growth, flood, drought, salinity induced by climate change and adverse climate. This is done by adopting various improved technologies, hydroponic is one of technique which will help in future to contribute the national economy by producing and exporting good quality food.

Hydroponics or Soilless culture is a method of growing plants in nutrient solutions (water containing fertilizers) with or without the use of an artificial medium (sand, gravel, vermiculite, rock wool, perlite, peat, moss, coir or sawdust) to provide mechanical support to the plant. Aggregate systems have a solid medium of support. It does not harm our environment as runoff fertilized soil and very little water is lost due to evaporation (Linden *et al.*, 2000). It is the intensive culture system by which all the resources are used efficiently and yielding maximum crops in a unit of area. However, quality of horticultural crops grown through soilless culture improves significantly compared to conventional soil culture. Furthermore, hydroponic production increase crop quality and productivity which results in higher competitiveness and economic incomes (Savvas, 2003). Hydroponic culture is becoming increasingly popular all over the world (Avidan, 2000). The person who lives in urban areas have no cultivable land but want to cultivate crops can be easily cultivate in hydroponically. By this technique, individual can cultivate high valued crops like Sweet

Pepper, Strawberry, Cherry Tomato, Lettuce, Melon, Rock Melon, Cucumber, Bitter Gourd, Eggplant, Bean, Beat, Cabbage, Cauliflower etc. In this method, there is no need of arable land where production is possible through the year round (Rahman *et al*., 2019). The accurate control of nutrient supply to the plant represents the main advantage of soilless culture. It has some disadvantages also- the initial cost is very high, the price of nutrient solution is also high, daily attention is necessary, skilled knowledge and trained person is also required.

Research on foliar fertilization was possibly started in the late 1940s and early 1950s, (Fritz, 1978 ; Haq and Mallarino, 2000 ; Girma *et al.,* 2007). Foliar fertilization is a widely used practice to correct nutritional deficiencies in plants caused by improper supply of nutrients to roots (Ling and Silberbush, 2002). Foliar fertilization is a system of feeding plants by applying liquid fertilizer directly to the leaves, bark etc. of the macro and micro nutrients are more effective in terms of getting maximum yield and reduce losses (Rahman *et al.,* 2014). No leaching out of nutrients occurs through foliar fertilization.

Liquid organic nutrient solution is one of the important alternative addition in hydroponic system which can mitigate the cost of nutrient solution. The production of vegetables in organic nutrient solution is a feasible alternative to obtain free-chemically agents produce with a high antioxidant capacity, which is an indicator of the nutraceutical value of fruits and vegetables (Singh *et al.*, 2012). These organic fertilizer solutions contain a high amount of mineral nutrients, beneficial microorganisms (Edwards *et al.*, 2010) and growth promoting agents such as folic and hemic acids (Arancon *et al.*, 2007). Moreover, the production costs of organic nutritive solutions are lower compared to those of traditional inorganic fertilizer solutions (Wrzodak *et al.,* 2012). Organic fertilizers are effective in promoting environmental sustainability and plant growth after long term use (Sum *et* *al*., 2014 and Atiyeh *et al.,* 2001). The use of liquid organic fertilizer as a replacement or supplement to chemical fertilizer is an attractive solution for hydroponic planting. Moreover, according to the researchers organic fertilizers are generally insoluble in water, nutrient are available slowly as they are converted to soluble form by microorganisms. Because the plenty of macro and micro nutrients for plant growth is in liquid organic fertilizer, it has been widely applied to hydroponic plants. Plants can efficiently absorb components dissolve in the liquid fertilizer as growth nutrients.

A nutrient solution for hydroponic systems is an aqueous solution containing mainly inorganics ions from soluble salts of essential elements for higher plants and also some organic compounds such as iron chelates may be present (Steiner, 1968). Plants require 17 essential elements to grow and reproduce. Nutrient solution contains all the nutrient which is required for plants growth and development. From nutrient solution electrical conductivity, P^H, Temperature and osmotic potential of the solution can be measured.

Sweet pepper (*Capsicum annuum* L.) is an economically important crop belonging to the family Solanaceae. It is a year round international vegetable crop used in various ways for home consumptions, catering and industries (Obidiebube *et al.,* 2012). It was originated in the Mexico and Central America region Christopher Columbus encountered it in 1493. Pepper is grown as an annual crop but it is generally herbaceous perennial plant and will yield for several years in tropical climates. Sweet peppers are rich in vitamins particularly vitamin A and vitamin C and hundred gram of peppers provides 4.3 g of carbohydrates, 1.3 g of protein and 24 kcal of energy and other nutrients (Farooq *et al.,* 2015). Sweet peppers has various taste such as sweet, mild or strongly pungent. The fruit contain capsaicinoids which is responsible for pungency. They are various types of color such as green, red, yellow etc. The level of carotene like lycopene, is nine times higher in red pepper. The sweetness of capsicums is due to their natural sugars (green capsicums have less sugar than red capsicums).Red peppers have twice the vitamin C content than green peppers. Growing capsicum in the field is a laborious work because it is very prone to virus disease. That why it is cultivated in the net house.

Objectives of the study:

a. To identify the suitable does of organic nutrient solution (cow dung leachate) for capsicum cultivation.

b. To investigate the effect of the foliar application on growth and yield of capsicum.

CHAPTER II
REVIEW OF LITERATURE

CHAPTER II
REVIEW OF LITERATURE

Sweet pepper (*Capsicum annuum* L.) is a common, popular, and internationally important vegetable crop which is commercially cultivated in our country. Many research works have been done in various parts of the world on growth and yield of capsicum. But very few studies on the growth and yield of capsicum in hydroponic or soilless culture system have been studied in our country. Therefore, the research work about capsicum is not adequate in Bangladesh. Nowadays, different types of variety of capsicum and leafy vegetables can be successfully grown in hydroponic systems. A suitable organic nutrient solution is necessary to produce a high quality crop.

Phibunwatthanawong, T., and Riddech, N., (2019) found that the ranges of chemical parameters as follows: pH 4.5–7.8, EC 25–33 dS/m, total N 0.14–0.33%, total P2O5 0.002–0.017%, total K2O 0.81–11.8%, OM 0.26–3.25%, OC 0.26–3.20% and C:N ratio 6.14–17.92. Microbiological analysis indicated total microorganism of 9.99–9.05 log CFU/ml. Nitrogen fixers, phosphate and potassium solubilizing agents were found in all formulas. IAA concentration was 1.13–59.53 mg/l. The fertilizers produced after 30 days of fermentation and used at a dilution of 1:100 gave more than 100% germination index showing non-phytotoxicity characteristics. The results for the hydroponic system showed that liquid fertilizer formula 3 (distillery slop: sugarcane leaves: filtrate water 1:0.1:0.25 v:w:v) and formula 5 (distillery slop: sugarcane leaves 1:0.25:0.25 v:w:v) demonstrated the best growth performance, which was similar to plants treated with liquid chemical fertilizer.

Souri *et al.* (2018) found that Nutrient profile of plant leaves and pods were significantly increased by foliar applications of organic fertilizer, only for

N and K and also by NPK soil application.

Souri M. k. and Aslani M. (2018) found that plant growth, pod yield (79%) and pod quality were improved by application of chelate fertilizers. Growth parameters as plant height, number of leaves and lateral shoots, shoot dry weight, pod number and pod length were significantly increased by foliar application of the chelate fertilizers. The concentrations of nitrogen, potassium and iron in pods and above all in leaves were increased by foliar application of chelate fertilizers compared to control and soil applied NPK. Pod pH and TSS were not influenced by treatments; however, foliar application of the chelate fertilizers resulted in higher titratable acidity (40%), vitamin C (112%) and protein (35%) content of pods. The results indicate that organic-based chelate fertilizers can be effective safer alternatives for simple chemical salts in calcareous soils.

Dasgan *et al.* (2017) reported that using bio-fertilizers in organic soilless tomato production did not influence the plant vegetative growth, nutrient uptake and fruit properties of tomato plant.

Azam *et al.* (2016) found that the effect of foliar applied different concentrations (5, 10 and 15 mM) of calcium chloride and potassium chloride to alleviate drought stress in bell pepper plants. Both experiments were conducted according to CRD (completely randomized design). Calcium and potassium significantly improved all parameters, i.e., photosynthesis rate, transpiration rate, leaf free proline, leaf osmotic potential, fruits weight, etc. Calcium chloride at 10 mM showed better results than other treatments under normal irrigation while calcium chloride at 15 mM showed better results under drought conditions. So, it may be concluded that drought tolerance in bell pepper could be improved by foliar application of calcium and potassium chlorides.

Lopez *et al.* (2016) conducted an experiment to evaluate the effect of organic nutrient solutions over yield, quality and antioxidant capacity of hydroponic cucumber (*Cucumis sativus* L.) fruits produced under greenhouse conditions. The organic solutions used were compost and vermicompost teas, and the Steiner nutrient solution was used as control. Evaluated variables were: yield, quality, and antioxidant capacity of cucumber fruits. Nutritive solutions affected yield and antioxidant capacity of the produce. Steiner solution obtained a higher yield (41.8 - 44.4%) than organic nutritive solutions; however organic cucumber samples had higher antioxidant capacity. Compost tea treatment obtained the highest antioxidant capacity among all treatments, resulting 42% higher than inorganically fertilized produce. Compost tea is a viable alternative as a nutrient source in the production of hydroponic cucumber under greenhouse conditions with an improved nutraceutical quality.

Chinta *et al.* (2015) found that using organic nutrient solution made from corn steep liquor not only made successful *Lactuca sativa* (Lettuce) production, but also reduced root rotting.

Peiris *et al. (*2015) found that the effect of organic liquid fertilizers on the average fresh weights of leaves (LFW) and roots (RFW).Average dry weight of leaves (LDW) and roots (RDW), average leaf area (LA) of Lettuce grown in hydroponics were statistically significant.

Peiris P. U. S. and Weerakkody W. A. P. (2015) conducted an experiment to study the plant growth in terms of fresh weight (FW, g/ plant), dry weight (DW, g/plant), total leaf area (LA, cm2/plant), maximum root length (RL, cm), specific leaf weight (SLW, g/cm2) and number of leaves at harvest (NL) in leaf lettuce of variety „Grand Rapid in three different organic based liquid fertilizers. The highest FW was observed in T3 (Glliricidia leaf extract) where the average EC and average pH were maintained at 0.43 dS/m and 5.85, respectively throughout the growing period. The highest NL and LA were also found in T3, resulting a higher production of photosynthetic tissues; where the lowest NL and LA were observed in T1 (Compost tea liquid). The highest DW, partitioned to leaves (LDW) and roots (RDW) were recorded in T3. T1 and T2 (Poultry manure liquid) showed significantly lower dry matter partition to leaves and roots eventhough the highest EC (0.77dS/m) during the study period was recorded in T2. Although EC is an indirect indication of the strength of nutrient solution, T2 did not show significant yield advantage due to some reason. The SLW, was not significantly different. The highest RL was also found in T3; owing to its higher dry matter partitioning. But, the highest growth of root hairs was observed in T1; which encourages nutrient absorption for plant survival, even at low EC levels. The study revealed that Glliricidia leaf extract as the most favourable organic based liquid fertilizer for best growth performance of leaf lettuce while Compost tea liquid was the lowest. Poultry manure was an intermediate performer in case of vegetative growth in leaf lettuce.

Liang *et al.* (2014) reported that traditionally, organic nutrient solution for hydroponics has not been feasible, despite the similarities in plant growth when either conventional or organic fertilizer is applied on soil. It was not until the early 1990s when liquid organic nutrient solutions for hydroponics were introduced. Challenges with these liquid nutrient solutions emerged, such as organic fertilizer being unsuitable to plant growth because nitrogen in organic sources is predominantly organic, hence unusable by plants. The forms of nitrogen absorbed by plants are nitrate and ammonium. Therefore, the nitrogen in manure requires to be mineralised prior to use by plants hydroponically.

Rahman *et al.* (2014) reported that foliar spraying of micronutrients (B+ Mo + Zn) as combined application significantly increased the plant height, number of branches plant^{-1}, number of pods plant $^{-1}$, number of seeds pod $^{-1}$, biological and seed yields, while control (H_2O spray 2 alone) gave the minimum value in all the traits. The study also suggested that foliar application of micronutrients (B+ Mo + Zn) is beneficial to get the maximum seed yield of common bean.

Akbari *et al.* (2013) found that Zn + Fe foliar application in cumin had significantly effects on yield and yield components such as number of umbels per plant, number of umbellets per umbel and 1000 seed weight. Zn + Fe foliar application had significant effect (a > 0.05) on most physiological traits in dry farming such as relative water content (RWC), and protein content. The results indicated that the foliar application of macronutrients caused a significant and/or highly significant effect on some of growth parameters and yield components during the two growing seasons. In addition, some nutrient of wheat grains content i.e. Potassium, Zinc, Manganese and Cupper were significant and or highly significant increased due to foliar application of macronutrients (El-Ghany, 2013).

Ali *et al.* (2013) conducted a field experiment to evaluate the possible effect of some macro and micro nutrients with different concentration levels as a foliar application on the vegetative growth, flowering, and yield of tomato cv „Roma. All the treatments showed a positive effect on growth, flowering, and yield but, T5 (nitrogen 5.5 g/100 mL + Boron 5 g/100mL + Zinc 5 g/mL) and T3 (Boron 5 g/mL), revealed most significant influence on all parameters under study as compared to T1 (control).

Kazemi (2013) showed that high Zn (100 mg/L) and Fe (200 mg/L) and their combination significantly promoted vegetative and reproductive growth in tomato. Foliar application of Zn (100 mg/L) + Fe (200 mg/L) resulted in the maximum plant height (124.14 cm), branches per plant (8.36), flowers per cluster (18.14), fruits per cluster (8), fruits per plant (90.14), fruit weight (95.14 g), chlorophyll content (22.14 SPAD)and yield (25.14 t ha^{-1}). Results showed that in the cultivars stem diameter, number of seeds per plant, number of bolls, plant height and harvest index. Mn spraying and Zn + Mn spraying had maximum grain yield, biological yield, 1000- seeds weight, stem diameter, number of seeds per plant and plant height (Rajabi *et al.* 2013).

Farahi *et al*. (2013) conducted an experiment to evaluate the effect of humic acid on quantitative and qualitative characteristics of strawberry (Fragaria ananasa cv. □Aromas□). The rooted daughter plants of □Aromas□ strawberry were planted in pots containing perlite and cocopeat (1:1). Humic acid were sprayed on the plants when they were completely established. The treatments consisted of different concentrations of humic acid (Greenhum containing 13% humic acid) (0, 1.5, 3.0 and 4.5 mg l-1). Certain traits were measured including leaf chlorophyll index; the weight, length, width and length/width ratio of the fruits; number of fruit in plant; yield of single plant in a 2months period; malformed fruit percent; total soluble solid percent and fruit firmness. Results indicated that the application of humic acid had positive influence on fruit number, total yield of plant, TSS, fruit firmness and chlorophyll content. Generally, foliar application of humic acid led to the improvement of quantitative and qualitative characteristics of this cultivar of strawberry. Consequently, the application of 1.5-3 mg l-1 humic acid is recommended in hydroponic culturing of strawberry.

Younis *et al.* (2013) reported that plants treated with foliar application of micro nutrients along with NPK showed significant increase in the growth characteristic like plant height, number of flowers plant^{-1}, bud diameter, flower diameter, fresh and dry weight of flower, flower quality, flower stalk length compared to the application of NPK alone and untreated plants (control). It was concluded that application of micronutrients along with NPK could improve flower yield and quality of roses.

Shehata *et al*. (2012) showed that foliar application with yeast and chitosan increased significantly the vegetative growth, yield and its quality of cucumber. Results also found that foliar application with chitosan at rates of 4 ml L^{-1} recorded the best treatment to obtain the highest vegetative growth, yield and quality of cucumber plants.

Khosa *et al.* (2011) reported that plant height, number of branches per plant, length of branches per plant, number of leaves per plant, leaf area, flower diameter and flower quality increased with increasing fertilization level and began to turn down when fertilization level exceed beyond the above given levels of macro and micro nutrients. Foliar fertilization influenced the days to first flower emergence as compared to control where no foliar spray of macro and micro nutrients was applied. It took 85.55 days in T3 treatment as compared to control i.e. 105.55 when macro nutrients spray applied and in case of micro nutrients it took 81.88 days in flower emergence as compared to control i.e 100.88.

Shinohara *et al.* (2011) reported that using organic nutrient solutions made from fish-based fertilizer or corn steep liquor hydroponically, produced tomato yield similar to those produced from conventional nutrient solutions. From the same organic nutrient solutions, Shinohara *et al.* (2011) further established that when *Lactuca sativa* (Lettuce) was grown, the organic system produced significantly greater and fresh *Lactuca sativa* (Lettuce) head weight than in the conventional system.

Bozkoylu *et al.* (2010) investigated that the effects of organic and Synthetic conventional fertilization on soilless growing tomato. They report that organic fertilization gave rise to decrease in plant growth, yield and fruit size properties in comparison to synthetic fertilization. Total soluble solids and titrable acidity of tomato juice were not significantly different in organic and synthetic inorganic fertilized plants.

Nasiri *et al.* (2010) showed that flower yield increased by foliar application of Fe and Zn compared with control (untreated). The highest flower yield (1963.0 kg ha-1),was obtained for Fe + Zn spray treatment with about 46.4, 24.64, and 81.77% improvements in comparison with control, respectively. The results showed that flower yield and yield increased by foliar application of Fe and Zn compared with control (untreated). The highest flower yield (1963.0 kg ha^{-1}) was obtained for Fe + Zn spray treatment with about 46.4, 24.64, and 81.77% improvements in comparison with control, respectively.

Habib M. (2009) found that foliar application of Zn and Fe increased seed yield of wheat and its quality, compared with control. Among treatments, application of (Fe + Zn) obtained highest seed yield and quality.

Natesh *et al.* (2005) observed that foliar spray of micronutrients at flowering stage increased the plant growth. However, foliar spray of ZnSO4 (0.1%) recorded more plant height (82.8cm), higher number of branches per plant (25.6) and also observed the influence organics (mycorrhiza, vermicompost and FYM) influenced the growth parameters significantly. Maximum plant height (73.7cm) and maximum number of branches per plant (21.3) was recorded in FYM (10 t ha-1) followed by mycorrhiza (2.5 t ha^{-1}) (70.1 cm) and vermicompost @ 2.5 t ha^{-1} (69.3 cm and 20.9 cm) over control (68.9cm and 19.2cm). Foliar spray of micronutrients at flowering stage increased the growth and yield of chilli (*Capsicum annuum* L.) cv. Byadagi kaddi. Foliar spray of ZnSO4 (0.1%) recorded higher yield (248.26 kg/ha) and quality parameters followed by borax and MgSO4 (0.1% each).

Katkar *et al.* (2002) conducted an experiment to study the effect of foliar sprays of nutrients and chemicals on yield and quality of cotton. Results indicated that the foliar application of different nutrients and chemicals significantly increased seed cotton yield by 38.7, 37.1, 31.3 and 21.2% over control.

Tumbare *et al.* (1999) applied NPK at recommended rate as solid fertilizer and as liquid fertilizer; the yield and yield component values increased with increasing fertilizer rate by liquid as compared to conventional application. After 1980s, the application of foliar fertilizers is the quickest way to deliver nutrients to the tissues and organs of the crop, and is proved that application of these micronutrients is beneficial to correct certain nutrient deficiencies.

Bhonde *et al.* (1995) evaluated the effect of zinc, copper and boron on onion crop. Bulb size and yield as well as quality of bulb were enhanced when micronutrients were applied in combination instead of alone. The foliar application of zinc 3 ppm, copper 1 ppm and boron 0.5 ppm were found to give maximum net return to the growers. Foliar spray of most of micronutrient treatments significantly increased the uptake of N, P, K, S, Zn, Fe, Cu, Mn and B in fruits and shoots of tomato.

Several studies including Garland *et al.* (1993) and Shinohara *et al.* (2011) have since demonstrated that using microorganisms to degrade organic nitrogen in organic sources such as manure results in nitrates and ammonium production which in turn are used for plant production. Recently, there have been successful hydroponic production of tomato and other vegetables using organic nutrient solutions processed by microorganisms.

Verdonck *et al.* (1982) found that the use of different organic and inorganic substrates allows the plants the best nutrient uptake and sufficient growth and development to optimize water and oxygen holding.

CHAPTER III
MATERIALS AND METHOD

CHAPTER III
MATERIALS AND METHOD

3.1 Experimental site

The experiment was conducted in the semi-net house at the Horticulture Farm of Sher-e Bangla Agricultural University, Dhaka 1207, and Bangladesh during September 2018 to March 2019. The location of the experimental site is situated in 23º 74/ N latitude and 90º 35/ E longitude. The altitude of the location was 8 m from the sea level (The Meteorological Department of Bangladesh, Agargaon, Dhaka).

3.2 Seed and other materials

The seeds of capsicum cv. California Wonder, Tokyo and Red Army were used in the experiment. The packets of seed were collected from Siddik Bazar, Gulistan, Dhaka. The styrofoam, coco peat, plastic pot, plastic tray, wood, broken bricks, polythene sheet etc. were collected from Town Hall, Mohammadpur, Dhaka. Experimental chemicals were bought from Tikatolli, Dhaka.

3.3 Experimental Design and treatments

The experiment was conducted in a completely randomized design (CRD) with three replications. Two factors were considered as treatments denoted as NS (Nutrient Solution) and FA (Foliar application) of liquid organic fertilizer.

Factor - A: Solution addition of liquid organic fertilizer

NS_0: Control (standard nutrient solution as Rahman and Inden)

NS_1: 100 g/L leachate of cow dung + standard nutrient solution

NS_2: 150g/L leachate of cow dung + standard nutrient solution

NS_3: 200 g/L leachate of cow dung + standard nutrient solution

Factor - B: Foliar application of liquid organic fertilizer (Once a week for all treatments)

FA_0: Control (no application)

FA_1: 100 g/L leachate of cow dung

FA_2: 150g/L leachate of cow dung

FA_3: 200 g/L leachate of cow dung

3.4 Collection of Cow dung

Cow dung was collected from SAU animal farm where the manure was stored in an open storage. Cow dung was chosen because plenty of cow dung is available due to dominance of cattle farming in all over of our country.

3.5 Preparation of organic nutrient solution from Cow dung leachate

5 kg of cow dung were placed into a jar with 50 L tap water. The mixture was stired continuously for through mixing. Then the mixture was kept in room temperature and stired regularly. After four weeks of decomposition, undiluted extracts were filtered using a cotton cloth and subjected to nutrient analysis.

3.6 Experimental environment

The seeds were sown in the seed bed prepared by the media mixtures of coco peat, broken bricks and rice husk. Two weeks old seedlings were transferred into the 250 mL plastic pots. Eight different wooden boxes (180cm × 25cm × 25cm) were prepared for culturing the seedlings. Polythene sheet was placed in the inner side of box so that the nutrient solution could not pass through the wooden box. Boxes were filled with different media mixtures of coco peat, broken bricks and rice husk. The experiment was conducted in a semi-net house under intensive care. The room was kept neat and clean during the time of the experiment.

3.7 Growing media preparation

The mixture of coco peat, broken bricks and rice husk are used as growing media. Coco peat was soaked in a big drum for 24 hours. Then they are mixed with broken bricks and rice husk properly. This mixer was placed in a Styrofoam sheet box for planting capsicum plant.

3.8 Nutrient solution

Rahman and Inden (2012) nutrient solution was used in the treatment. The ratio of Rahman and Inden (2012) solution were NO_3-N, P, K, Ca, Mg and S of 17.05, 7.86, 8.94, 9.95, 6.0 meq./L respectively. The rates of micronutrients were Fe, B, Zn, Cu, Mo and Mn of 3.0, 0.5, 0.1, 0.03, 0.025 and 1.0 mg/L respectively for both the nutrient solutions.

3.9 Seed sowing

The seeds were soaked in water for 24 hours and then wrapped with a piece of thin cloth. The socked seeds were then dispersed over polythene sheet for 2 hours to dry out the surface water. After that seeds were shown in plastic tray and covered with newspaper under room temperature for raising.

3.10 Transplanting of capsicum seedling

Two weeks old capsicum seedlings were transferred to plastic pot contains the mixture of coco peat, broken bricks and ash. Regular water and ½ strength of Rahman and Inden (2012) solution were given. After four weeks these seedlings were transplanted to the main box (plate 2). The seedlings were transplanted carefully so that roots were not damaged. After transplanting of capsicum plant in the box light watering was done with sprayer.

3.11 Intercultural operations

3.11.1 Pruning

Three weeks after transplanting, the flower which are arise on the node of each stem were removed, so that plants gets enough time to develop an adequate vegetative stage before fruit set. Starting four weeks after transplanting, plants are trained with “V” trellis system. In the “V” trellis system, the lateral shoot (the smaller shoot of the pair that bifurcated on a node) were prune.

3.11.2 Insect and pest management

Capsicum plants were grown in net house i.e. controlled environment. So, no insecticides were given in the experiment.

3.11.3 Diseases management

Capsicum plants were cultivate in controlled environment in soilless system. All the nutrients required for plant growth are given artificially. The growing environment was neat and clean, so that no disease attacked to the plant during the experiment.

Plate1: Growing stage of capsicum

Plate2: Growing stage of capsicum

Plate3: Flowering stage of capsicum

Plate4: Fruiting stage of capsicum

Plate 5: Fruits of capsicum

3.12 Data collection

Data on the following parameters were collected from the plants during the whole experiment. Data were collected from each plant. Data were collected on different growth and yield parameters viz., plant height at different days after planting, 1^{st} flowering date, 1^{st} fruiting date, fruit length, fruit diameter, fruit volume, number of fruits per plant, individual fruit weight, fruit yield per plant; physiological parameters , viz., leaf area (LA), leaf area ratio, leaf mass ratio and root weight ratio. Growth and yield contributing parameters have recorded and discussed in the result and discussion section, but physiological parameters will be collected at the end of the experiment.

3.13 Plant Growth and Yield parameters

3.13.1 Plant height

Plant height was measured by a meter scale in centimetre (cm at 0, 30, 60, 90, 120, 150 and180 DAT (days after transplanting) from the attachment of growing media up to the tip of the longest leaf.

3.13.2 First flowering date

The experimental plot was observed daily to collect data. The plants when bloom the first flower, the date of the days were recorded.

3.13.3 First fruiting date

The plants when produce the first fruit set, the date of the days were recorded.

3.13.4 Number of fruits per plant

Number of fruits per plant were counted at 75 (First harvesting), 120 (Second harvesting) and 180 (Third harvesting) DAT. All the fruits of each plant were counted separately. Only the younger fruits at the growing stage of the plant were excluded from the counting and the average number was recorded.

3.13.5 Individual fruit weight

The individual fruit weights were measured by electric balance at the

Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka 1207.

3.13.6 Individual fruit length

The length of individual fruit was measured during harvesting with the help of a large scale in centimeter unit.

3.13.7 Individual fruit breadth

The breadth of individual fruit was recorded during harvesting with the help of a large scale in centimeter unit.

3.13.8 Individual fruit volume

The volume of individual fruit was measured during harvesting with the help of a 500ml beaker in centimeter cube (cc) unit. Another name of cc unit is ml.

3.13.9 Dry weight of 100 g fruit

100 g fruit was collected from each treatment, the fruit was sliced by sharp knife and dried at sun for 2 days separately, after that these was transferred to oven of central laboratory, Sher-e-Bangla Agricultural University to dry properly. It was collected and weighted by electric balance after 72 hours.

3.13.10 Fresh weight of plant

One plant was uprooted from each treatment at 180 DAT. Leaf was detached from the plant and root was cut at the junction of stem and root. Root was washed by tap water to remove growing media and sun dried to remove attaching water. All these three part of plant was weighted separately by electric balance.

3.13.11 Dry weight of plant

Stem, leaf and root was dried separately by sun for 3 days, after that these was send to Central laboratory, Sher-e-Bangla Agricultural University for oven dry. Then it was collected and weighted by electric balance after 72 hours.

3.14 Growth parameter analysis

Growth parameters (fresh and dry weights of stem, leaf and root), and different physiological parameters [Leaf area (LA), leaf area ratio (LAR), leaf mass ratio (LMR), root weight ratio (RWR)] were determined in the experiments. The parameters were measured as described below:

$$\text{LAR} = \frac{LA}{PDW}$$

Where, LAR = leaf area ratio, LA = Leaf area (cm^2), PDW = plant dry weight (g).

$$\text{LMR} = \frac{LDW}{PDW}$$

Where, LMR = leaf mass ratio, LDW = leaf dry weight (g).

$$\text{RWR} = \frac{RDW}{PDW}$$

Where, RWR = root weight ratio, RDW = root dry weight (g)

3.15 Statistical analysis of data

The data in respect of yield and yield contributing characters were statistically analysed to find out the statistical significance for the experimental results statistic 10. The means for all the treatments were calculated and analyses of variance for all the characters were performed by F test.

CHAPTER IV
RESULTS AND DISCUSSION

CHAPTER IV
RESULTS AND DISCUSSION

The results of the experiment observed under semi net house conditions were presented in table 1 to table 14 and figure 1 to figure 14. The experiment was conducted to study the growth and yield of hydroponic Capsicum as influenced by liquid organic nutrients. The results were presented and discussed under the following sub heading.

4. 1 Vegetative growth and yield parameters

4.1.1 Plant height (cm)

Plant height of Sweet pepper is an important character which varies according to varieties. The plant height at different days such as 0, 30, 60, 90, 120, 150 and 180 days after transplanting (DAT) are measured (Table 1). Plant height was not significant at 0 DAT, but it was significantly differed at 30, 60, 90, 120, 150 and 180 DAT due to application of standard nutrient solution with different doses of leachate of cow dung (Appendix I). In case of 0 DAT, the highest plant (13.13 cm) was found in NS_2 and the shortest plant (13.08 cm) was found in NS_0. At 30, 60, 90, 120, 150, 180 DAT, the highest value of plant height (34.22 cm, 53.42 cm, 69.11 cm, 78.33 cm, 84.38 cm, 88.55 cm) respectively was found in the treatment of NS_3 standard nutrient solution + 200g/L leachate of cow dung and the shortest value of plant height (29.28 cm, 45.78 cm, 58.66 cm, 67.27 cm, 72.19 cm, 76.21 cm) respectively was found in the treatment of NS_0 standard nutrient solution + 100g/L leachate of cow dung. The results revealed that the maximum plants heights at all dates were found in plants grown in treatment NS_3 which was statistically similar to that of NS_2. Cow dung contains nitrogen which helps to increase the height of the plant. It was revealed that with the increase of organic nutrient solution plant height is also increased.

Plant height was significantly changed by different levels of foliar application of leachate of cow dung at different growth stage at different DAT (Table 1). Foliar application of cow dung leachate influence plant height of capsicum (Appendix I).

Plant height was not significant at 0 DAT, but it was significantly differed at 30, 60, 90, 120, 150 and 180 DAT due to foliar application of leachate of cow dung. At 0 DAT, the highest plant was found in FA_2 and the shortest was found in FA_0. At 30, 60, 90, 120, 150, 180 DAT, the highest value of plant height (33.72 cm, 53.85 cm, 69.50 cm, 79.79 cm, 85.93 cm, 89.91 cm) respectively was found in the treatment of FA_3 foliar application of 200g/L leachate of cow dung and the shortest value of plant height (30.05 cm, 45.09 cm, 57.91 cm, 65.43 cm, 70.99 cm, 75.41 cm) respectively was found in the treatment of FA_0 i.e, foliar application of 100g/L leachate of cow dung. Narkhede *et al.* (2011) found that significant increase in plant height of pepper plants treated with Vermicompost. The present results are consistent with this findings.

In case of interaction effect of standard nutrient solution and foliar application of cow dung leachate, the insignificant variation was found at 0 DAT, whereas the significant variations were found at 30, 60, 90, 120, 150 and 180 DAT (Table 2). The highest combination of plant height was found in the treatment of NS_3FA_3 and the shortest was found in NS_0FA_0.

Table 1. Main effect of nutrient solution and foliar application of cow dung leachate on plant height of capsicum at different days after transplanting

Treatment	Plant height at different days after transplanting (DAT) (cm)					
	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
Nutrient solution (NS)						
NS_0	29.28 c	45.78 c	58.66 c	67.27 c	72.19 c	76.21 c
NS_1	31.80 b	50.29 b	64.24 b	74.24 b	80.62 b	85.01 b
NS_2	33.96 a	53.27 a	68.68 a	77.79 ab	83.80 a	87.82 a
NS_3	34.22 a	53.42 a	69.11 a	78.33 a	84.38 a	88.55 a
Foliar Application (FA)						
FA_0	30.05 c	45.09 c	57.91 c	65.43 c	70.99 c	75.41 c
FA_1	31.88 b	50.21 b	64.76 b	73.86 b	79.84 b	84.01 b
FA_2	33.60 a	53.61 a	68.53 a	78.56 a	84.21 a	88.25 a
FA_3	33.72 a	53.85 a	69.50 a	79.79 a	85.93 a	89.91 a
Level of significance (P)						
NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
FA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

P represents the level of significance of one-way ANOVA. NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution , and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

Table 2. Interaction effect of nutrient solution and foliar application of cow dung leachate on plant height of capsicum at different days after transplanting

Treatment	Plant height (cm)					
	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
NS_0FA_0	28.10 f	39.22 j	52.25 h	60.31 g	64.99 g	69.12 f
NS_0FA_1	28.83 ef	45.34 i	57.62 g	66.33 fg	71.17 f	75.35 e
NS_0FA_2	30.46 de	49.81 f-h	63.63 ef	75.05 b-e	79.46 d	83.48 d
NS_0FA_3	29.74 d-f	48.75 gh	61.14 fg	67.42 e-g	73.13 ef	76.88 e
NS_1FA_0	30.64 de	44.72 i	60.29 fg	71.88 d-f	78.59 de	83.01 d
NS_1FA_1	31.05 cd	50.39 e-g	63.71 ef	72.80 d-f	79.43 d	83.83 d
NS_1FA_2	32.65 bc	53.29 c-e	65.83 de	73.47 c-f	78.80 de	83.39 d
NS_1FA_3	32.83 bc	52.78 c-f	67.15 de	78.79 a-d	85.64 bc	89.81 bc
NS_2FA_0	30.65 de	49.38 gh	60.13 fg	67.23 e-g	72.92 ef	77.52 e
NS_2FA_1	33.23 b	51.26 d-g	67.78 c-e	75.07 b-e	80.89 cd	84.65 cd
NS_2FA_2	35.91 a	55.82 a-c	72.38 a-c	82.77 ab	89.68 ab	93.36 ab
NS_2FA_3	36.04 a	56.61 ab	74.44 ab	86.09 a	91.71 ab	95.74 a
NS_3FA_0	30.81 d	47.04 hi	58.97 fg	62.29 g	67.47 fg	72.00 ef
NS_3FA_1	34.42 ab	53.87 b-d	69.94 b-d	81.24 a-c	87.87 ab	92.22 ab
NS_3FA_2	35.37 a	55.51 a-c	72.28 a-c	82.93 ab	88.89 ab	92.78 ab
NS_3FA_3	36.26 a	57.25 a	75.26 a	86.87 a	93.27 a	97.20 a
Level of significance (P)						
NS×FA	<0.0342	<0.0215	<0.0452	<0.0047	<0.001	<0.001

P represents the level of significance of one-way ANOVA. NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution , and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

4.1.2 Flowering of plant

Significant dissimilarity was found in days to first flowering due to standard nutrient solution + different doses of cow dung leachate treatment (Appendix II). Flowering of any crop is the preliminary stage of being fruit. Earliest flowering was appeared in NS_3 at 38.06 DAT which was statistically similar to that of NS_2 treatment. On the other hand late flowering was appeared in NS_0 at 41.78 DAT (Table 3). This was because proper management of liquid organic fertilizer increases nitrogen that enhances the protein synthesis, which allows plant to grow faster, rate of metabolism, cell division, cell elongation and thereby stimulated apical growth.

The foliar application of different doses of cow dung leachate have shown significant difference on growth characters like flowering of the Capsicum (Appendix II). Flowering of capsicum were significantly affected by foliar application (Table 3). Earliest flowering was appeared in FA_3 at 38.67 DAT which was statistically similar to that of NS_2 treatment. On the other hand, FA_0 showed late flowering at 42.33 DAT. The amount of vermicompost had a significant effect on plant height, flowering, shoot and root biomass and diameter of the flowers of the Marigold plants (Pritam *et al.,* 2010). However, the effects of vermicompost on flowering and fruiting of strawberry might be attributed to the fact that higher doses of vermicompost have resulted in to better growth of plants and consequently took lesser days to flowering and produced higher fruit yield than those receiving inorganic fertilizers (Atiyeh *et al.*, 2001; Arancon *et al.,* 2004, 2006).

Significant influence was noted on flowering influenced by combined effect of liquid organic fertilizer and foliar application. Earliest flowering was recorded from the treatment combination NS_3FA_3 (35.89) and the late flowering were found in NS_0FA_0 (43.89).

4.1.3 Fruiting of plant

Fruiting of capsicum were significantly affected by foliar application of liquid organic fertilizer (Table 3). Early fruit setting was appeared in NS_3 at 16.64 DAF which was statistically similar to that of NS_2 treatment. On the other hand late fruit setting was appeared in NS_0 at 18.36 DAF. This was because proper management of organic fertilizer increases nitrogen that enhances the protein synthesis, which allows plant to grow faster, rate of metabolism, cell division, cell elongation and thereby stimulated apical growth.

The foliar application of cow dung leachate have shown significant difference on growth characters of the capsicum (Appendix II). Fruiting of capsicum were significantly affected by foliar application of cow dung leachate (Table 3). Frist fruiting was appeared in FA_3 at 16.81 DAF. On the other hand, FA_0 showed late fruiting of the plant at 17.89 DAF.

Significant effect was noted on fruiting influenced by combined effect of liquid organic fertilizer and foliar application. Early fruit setting was recorded from the treatment combination NS_3FA_3 (15.56) and the last fruit setting were found in NS_0FA_0.

Table 3. Main effect of nutrient solution and foliar application of cow dung leachate on flowering and fruiting of capsicum

Treatment	First flowering (DAT)	First fruiting (DAF)
Nutrient solution (NS)		
NS_0	41.78 a	18.36 a
NS_1	41.39 a	18.22 a
NS_2	39.58 ab	17.81 a
NS_3	38.06 b	16.64 b
Foliar Application (FA)		
FA_0	42.33 a	17.89 a
FA_1	40.56 ab	18.42 a
FA_2	39.25 b	17.92 a
FA_3	38.67 b	16.81 b
Level of significance (P)		
NS	<0.0036	<0.001
FA	<0.0063	<0.001

P represents the level of significance of one-way ANOVA. NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

Table 4. Interaction effect of nutrient solution and foliar application of cow dung leachate on flowering and fruiting of capsicum

Treatment	First flowering (DAT)	First fruiting (DAF)
NS_0FA_0	43.89 ab	17.44 c-g
NS_0FA_1	42.00 a-d	19.78 a
NS_0FA_2	42.78 a-c	19.67 ab
NS_0FA_3	38.44 c-e	16.55 gh
NS_1FA_0	46.22 a	18.89 a-c
NS_1FA_1	42.56 a-d	18.89 a-c
NS_1FA_2	37.78 de	18.33 a-d
NS_1FA_3	39.00 c-e	16.78 e-h
NS_2FA_0	43.33 a-c	17.67 c-g
NS_2FA_1	37.00 e	18.22 b-e
NS_2FA_2	39.33 b-e	18.11 c-f
NS_2FA_3	38.67 c-e	17.22 d-g
NS_3FA_0	38.56 c-e	17.56 c-g
NS_3FA_1	40.67 b-e	16.78 e-h
NS_3FA_2	37.11 e	16.67 f-h
NS_3FA_3	35.89 e	15.56 h
Level of significance (P)		
NS×FA	<0.0066	<0.0015

P represents the level of significance of one-way ANOVA. NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

4.2.1 Fruit length

Fruit length of capsicum were significantly affected by standard nutrient solution and Cow dung leachate application (Appendix III). The highest fruit length was found in NS_3 (11.67 cm) which was statistically similar to that of NS_2 (11.47 cm) treatment. On the other hand NS_0 (9.48 cm) showed shortest fruit length. This occur due to more vegetative growth and development of the plant at later stage of plant growth. For that reason increasing dose of organic fertilizer increased fruit length. Nanotechnology liquid fertilizers significantly ($p < 0.001$, $p < 0.01$ and $p < 0.05$) affected the fruit length and dry matter statistically in cucumber (Melek *et al.*, 2014) like *Hibiscus esculentus* (Vanmathi and Selvakumari, 2012).

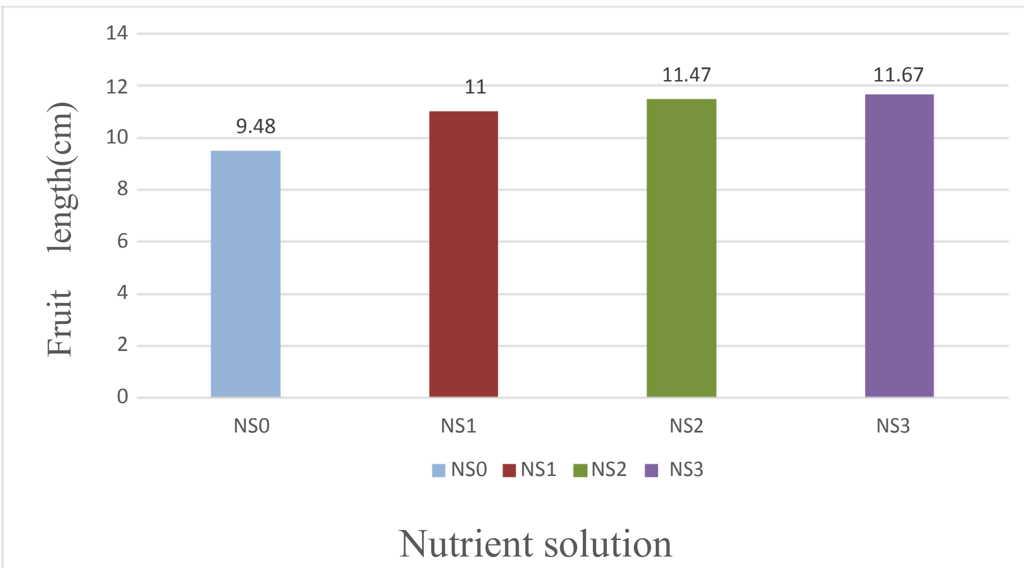

Figure1. Effect of different doses of Cow dung leachate + nutrient solution on fruit length (cm)

NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution).

Fruit length of capsicum were significantly affected by foliar application of different doses of Cow dung leachate (Appendix III). The highest fruit length was found in FA_3 (11.48 cm) which was statistically similar to that of FA_2 (11.31 cm). On the other hand FA_0 (10.12cm) showed shortest fruit length in the dose of foliar application of 100g/L cow dung leachate.

Significant effect was noted on length influenced by combined effect of liquid organic fertilizer and foliar application. The highest fruit length was recorded from the treatment combination NS_3FA_3 (12.56) and the lowest fruit length were found in NS_0FA_0 (9.26).

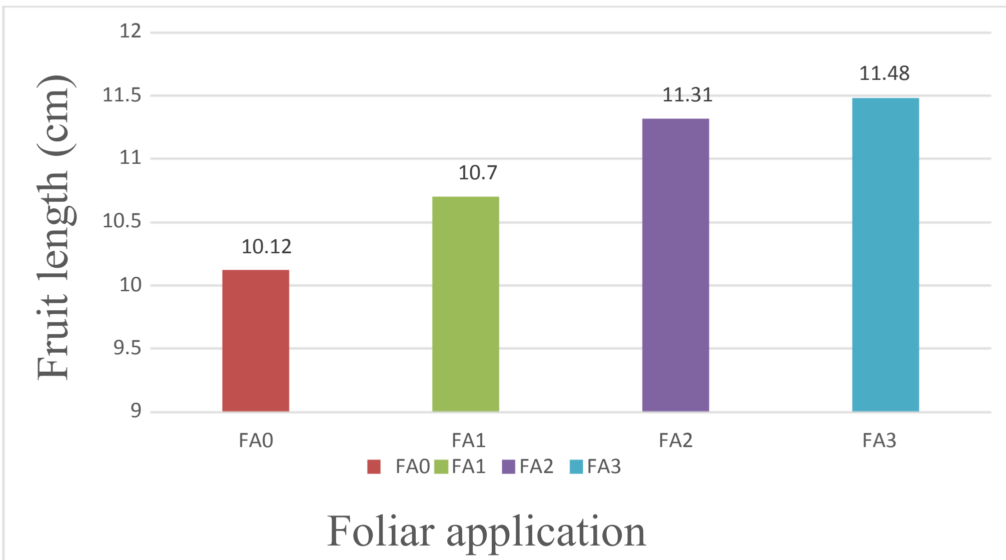

Figure 2. Effect of foliar application of Cow dung leachate on fruit length (cm)
FA = Foliar application FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

4.2.2 Fruit breadth

Fruit breadth of Capsicum were significantly differed by standard nutrient solution and Cow dung leachate application (Appendix III). The highest fruit breadth was found in NS_3 (6.64 cm) which was statistically similar to that of NS_2 (6.58 cm) treatment. On the other hand NS_0 (5.52 cm) showed shortest fruit breadth. This occur due to more vegetative growth and development of the plant at later stage of growth. For that reason increasing dose of cow dung increased fruit breadth.

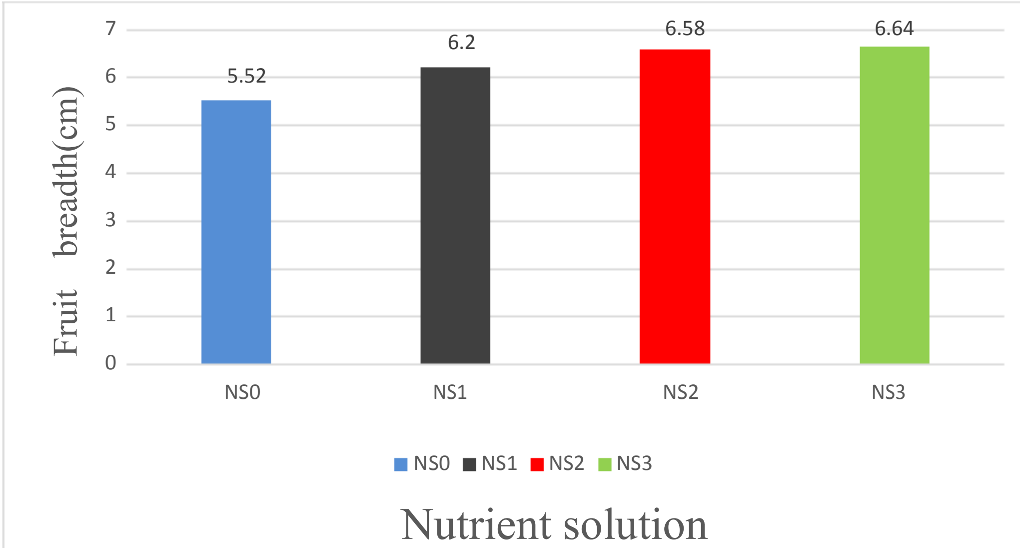

Fig.3. Effect of different doses of cow dung leachate + nutrient solution on fruit breadth (cm)

NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution).

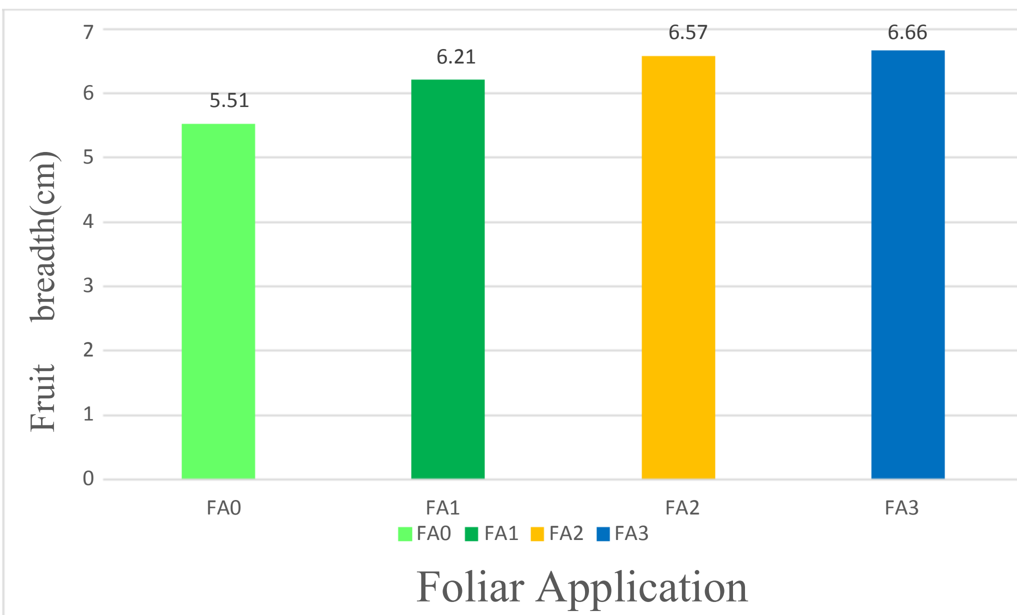

Fig. 4. Effect of foliar application of cow dung leachate on fruit breadth (cm)

FA = Foliar application FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

Fruit breadth of Capsicum were significantly differed by foliar application of different doses (Appendix III). The highest fruit breadth was found in FA_3 (6.66 cm) which was statistically similar to that of FA_2 (6.57 cm). On the other hand FA_0 (5.51 cm) showed shortest fruit breadth.

Significant effect was observed on breadth influenced by combined effect of nutrient solution and foliar application. The highest fruit breadth was recorded from the treatment combination NS_3FA_3 and the lowest were found in NS_0FA_0.

4.2.3 Fruit Diameter

Fruit diameter of Capsicum were significantly affected by standard nutrient solution and Cow dung leachate application (figure 5). The highest fruit diameter was found in NS_3 (7.12 cm) which was statistically similar to that of NS_2 (6.99 cm) treatment. On the other hand NS_0 (4.23 cm) showed lowest fruit diameter.

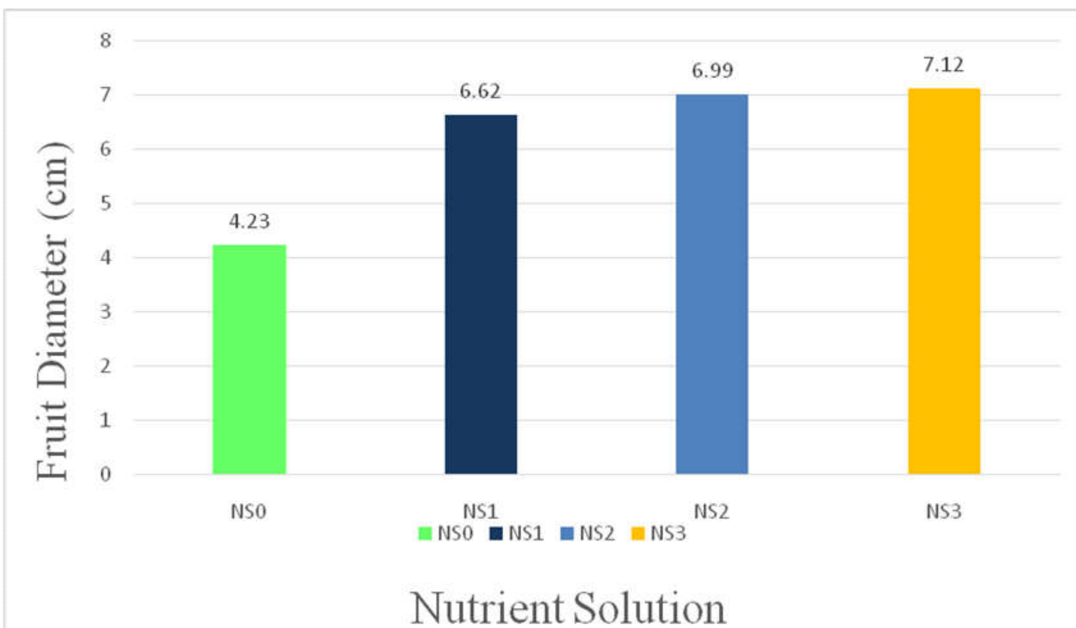

Fig. 5. Effect of different doses of cow dung leachate + nutrient solution on fruit diameter (cm)

NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution , and NS_3 =200g/L leachate of cow dung + standard nutrient solution).

Fruit diameter of Capsicum were significantly affected by foliar application of different doses of Cow dung leachate (figure 6). The highest fruit length was found in FA_3 (6.57 cm) which was statistically similar to that of FA_2 (6.47 cm). On the other hand FA_0 (5.81 cm) showed lowest fruit diameter.

Significant influence was noted on diameter influenced by combined effect of liquid organic fertilizer and foliar application. The highest fruit diameter was recorded from the treatment combination NS_3FA_3 and the lowest were found in NS_0FA_0.

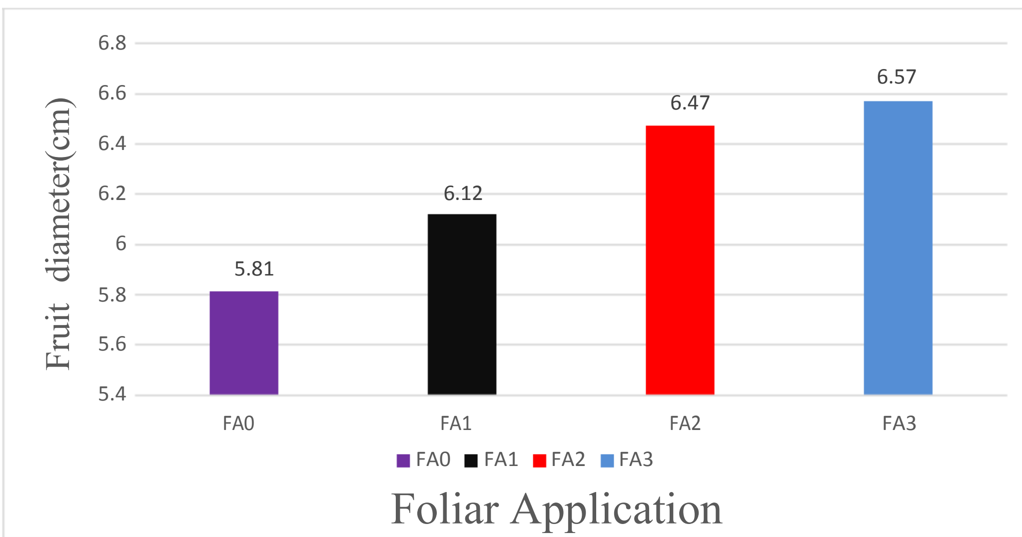

Fig. 6. Effect of foliar application of cow dung leachate on fruit diameter (cm)

FA = Foliar application FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

Table 5. Interaction effect of nutrient solution and foliar application of cow dung leachate on fruit length, breadth and diameter of capsicum

Treatment	Fruit length (cm)	Fruit breadth (cm)	Fruit diameter (cm)
NS_0FA_0	9.26 f	4.84 i	4.17 g
NS_0FA_1	9.37 f	5.45 gh	4.20 g
NS_0FA_2	9.93 ef	6.20 d-f	4.36 g
NS_0FA_3	9.37 f	5.58 f-h	4.20 g
NS_1FA_0	10.44 de	6.01 d-g	6.32 f
NS_1FA_1	10.89 cd	6.12 d-f	6.49 ef
NS_1FA_2	11.00 cd	6.16 d-f	6.78 c-e
NS_1FA_3	11.67 a-c	6.51 b-d	6.89 cd
NS_2FA_0	10.33 de	5.83 e-h	6.34 f
NS_2FA_1	11.00 cd	6.36 c-e	6.69 d-f
NS_2FA_2	12.22 ab	6.93 a-c	7.40 ab
NS_2FA_3	12.33 ab	7.21 a	7.53 a
NS_3FA_0	10.44 de	5.36 hi	6.40 ef
NS_3FA_1	11.56 bc	6.90 a-c	7.11 bc
NS_3FA_2	12.11 ab	6.98 ab	7.33 ab
NS_3FA_3	12.56 a	7.33 a	7.65 a
Level of significance (P)			
NS×FA	<0.0346	<0.0030	<0.001

P represents the level of significance of one-way ANOVA. NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

4.2.4 Fruit Volume

Fruit volume of capsicum were significantly affected by standard nutrient solution and cow dung leachate application (Appendix III). The highest fruit volume was found in NS_3 (164.78) which was statistically similar to that of NS_2 treatment. On the other hand NS_0 (129.73) showed lowest fruit volume.

Fruit volume of capsicum were significantly affected by foliar application of cow dung leachate (Table 6). The highest fruit volume was found in FA_3 (167.63) which was statistically similar to that of FA_2. On the other hand FA_0 (124.73) showed lowest fruit volume.

Significant influence was observed on volume influenced by combined effect of nutrient solution and foliar application of cow dung leachate. The highest volume was recorded from the treatment combination NS_3FA_3 and the lowest were found in NS_0FA_0.

4.2.5 Fruit Pericarp

Fruit pericarp of capsicum were significantly affected by by standard nutrient solution and cow dung leachate application (Appendix 3). The highest fruit pericarp was found in NS_3 (5.64) which was statistically similar to that of NS_2 treatment. On the other hand NS_0 (5.30) showed lowest fruit pericarp (Table 6). Shehata et al. (2004) observed that the treatments receiving NPK +chicken manure+ compost at the rate of (1/3 + 1/3 + 1/3) increased fruit length, weight of fruits, total yield, flesh thickness and increased concentration of N, P and K in leaves and stems of sweet pepper plant.

Fruit pericarp of capsicum were significantly affected by foliar application of cow dung leachate (Table 6). The highest fruit pericarp was found in FA_3 (5.67) which was statistically similar to that of FA_2. On the other hand FA_0 (5.31) showed lowest fruit pericarp.

Significant influence was observed on pericarp on fruits influenced by combined effect of nutrient solution and foliar application of cow dung leachate. The highest pericarp thickness was recorded from the treatment combination NS_3FA_3 and the lowest were found in NS_0FA_0.

Table 6. Main effect of nutrient solution and foliar application of organic nutrient on volume and pericarp thickness of capsicum

Treatment	Fruit volume	Pericarp thickness
Nutrient Solution (NS)		
NS_0	129.73 c	5.30 b
NS_1	147.79 b	5.53 a
NS_2	161.77 a	5.63 a
NS_3	164.78 a	5.64 a
Foliar Application (FA)		
FA_0	124.73 c	5.31 b
FA_1	148.41 b	5.52 a
FA_2	163.30 a	5.64 a
FA_3	167.63 a	5.67 a
Level of significance (P)		
NS	<0.001	<0.0035
FA	<0.001	<0.0041

P represents the level of significance of one-way ANOVA. NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

Table 7. Interaction effect of nutrient solution and foliar application of organic nutrient on volume and pericarp thickness of capsicum

Treatment	Fruit volume	Pericarp thickness
NS_0FA_0	112.40 g	5.07 e
NS_0FA_1	126.68 e-g	5.37 c-e
NS_0FA_2	142.75 c-e	5.63 a-c
NS_0FA_3	137.09 d-f	5.13 de
NS_1FA_0	138.01 d-f	5.59 a-d
NS_1FA_1	143.90 c-e	5.50 b-e
NS_1FA_2	150.77 b-d	5.48 b-e
NS_1FA_3	158.49 bc	5.55 b-d
NS_2FA_0	142.75 c-e	5.63 a-c
NS_2FA_1	137.09 d-f	5.13 de
NS_2FA_2	138.01 d-f	5.59 a-d
NS_2FA_3	143.90 c-e	5.50 b-e
NS_3FA_0	150.77 b-d	5.48 b-e
NS_3FA_1	158.49 bc	5.55 b-d
NS_3FA_2	179.21 a	5.57 b-d
NS_3FA_3	189.36 a	6.04 a
Level of significance (P)		
NS×FA	<0.0051	<0.0230

P represents the level of significance of one-way ANOVA. NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

4.2.6 Number of Fruit

Number of fruits of capsicum were significantly affected by nutrient solution and Cow dung leachate application (Appendix 4). The highest fruit number was found in NS_3 (7.67) which was statistically similar to that of NS_2 (7.47) treatment. On the other hand NS_0 (6.33) showed lowest fruit number (figure 7). Samawat et al. (2001) reported in 100% Vermicompost treatment, fruit weight and fruit number was three, five and nine times more than the control treatment. Patil et al. (2004) observed that significantly highest numbers of fruits (42.07 per plant) were recorded in the plants supplemented with 3 % of liquid organic fertilizers in tomato.

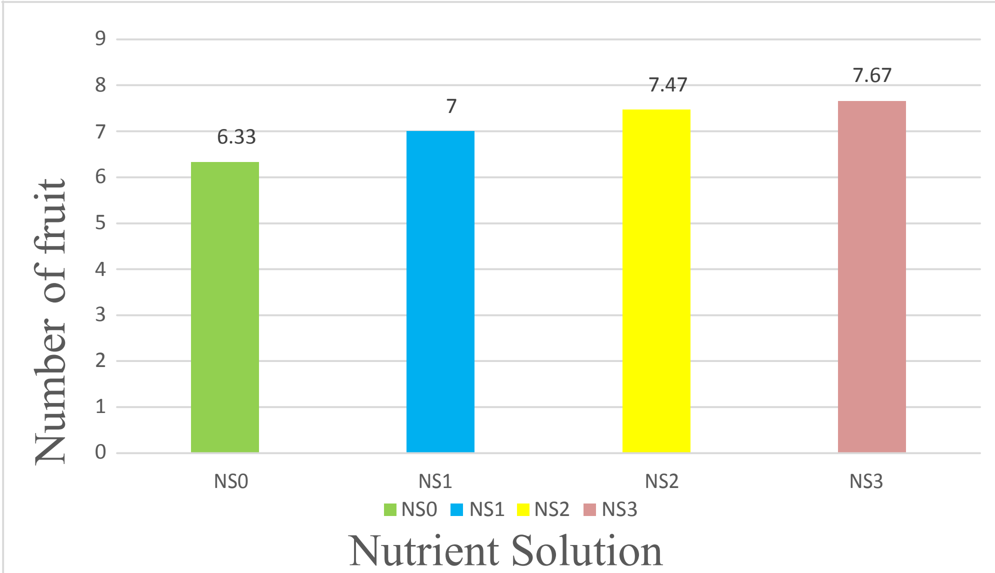

Fig.7. Effect of different doses of cow dung leachate + nutrient solution on number of fruit

NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution , and NS_3 =200g/L leachate of cow dung + standard nutrient solution)

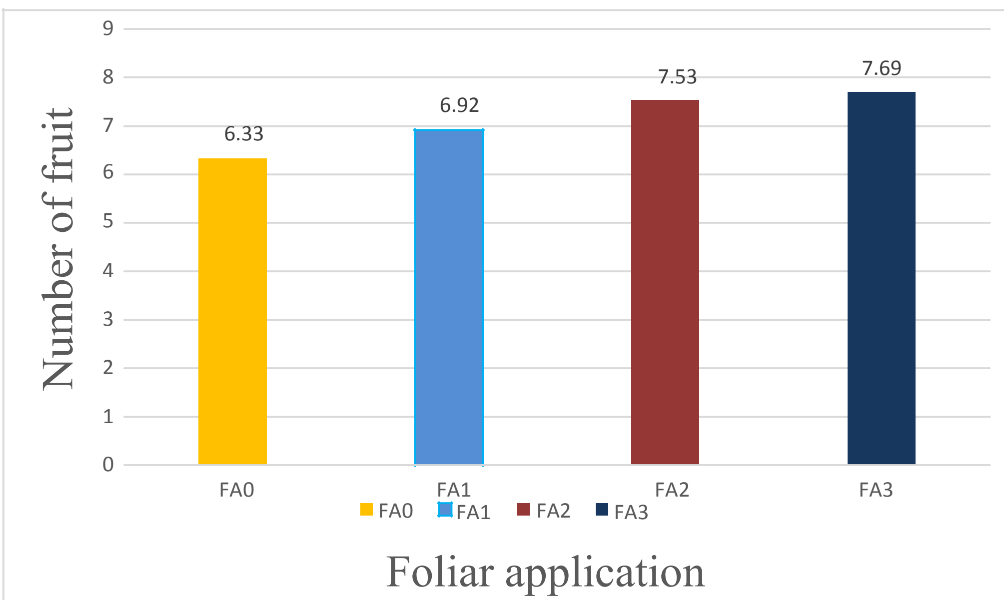

Fig.8. Effect of foliar application of different doses of cow dung leachate on number of fruit

FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

Fruit number of capsicum were significantly affected by foliar application of different doses of Cow dung leachate (Figure 8). The highest fruit number was found in FA_3 (7.69) which was statistically similar to that of FA_2 (7.53). On the other hand FA_0 (6.33) showed lowest fruit number.

Significant influence was noted on number of fruit influenced by combined effect of liquid organic fertilizer and foliar application (table 8). The highest fruit number was recorded from the treatment combination NS_3FA_3 and the lowest were found in NS_0FA_0.

4.2.7 Individual fruit weight

Individual fruit weight of capsicum were significantly affected by nutrient solution and cow dung leachate application (Figure 9). The highest fruit weight was found in NS_3 (105.25 g) which was statistically similar to that of NS_2 (104.32 g) treatment. On the other hand NS_0 (94.01) showed lowest fruit weight. Attarde *et al.,* (2012) found that fruit weight of okra increases due to the amplification of nutrient content through the application of vermicompost.

Individual fruit weight of capsicum were significantly affected by different levels of foliar application (Figure 10). The highest fruit weight was found in FA_3 (105.30 g) which was statistically similar to that of FA_2. On the other hand FA_0 (94.28 g) showed lowest fruit weight. Salas and Ramirez (2001) observed maximum fresh fruit weight in capsicum treated with organic manure like chicken manures, compost and vermicompost treatment than inorganic fertilizers**.**

Significant influence was noted on Individual fruit weight influenced by combined effect of liquid organic fertilizer and foliar application (Table 8). The highest individual fruit weight was recorded from the treatment combination NS_3FA_3 and the lowest were found in NS_0FA_0.

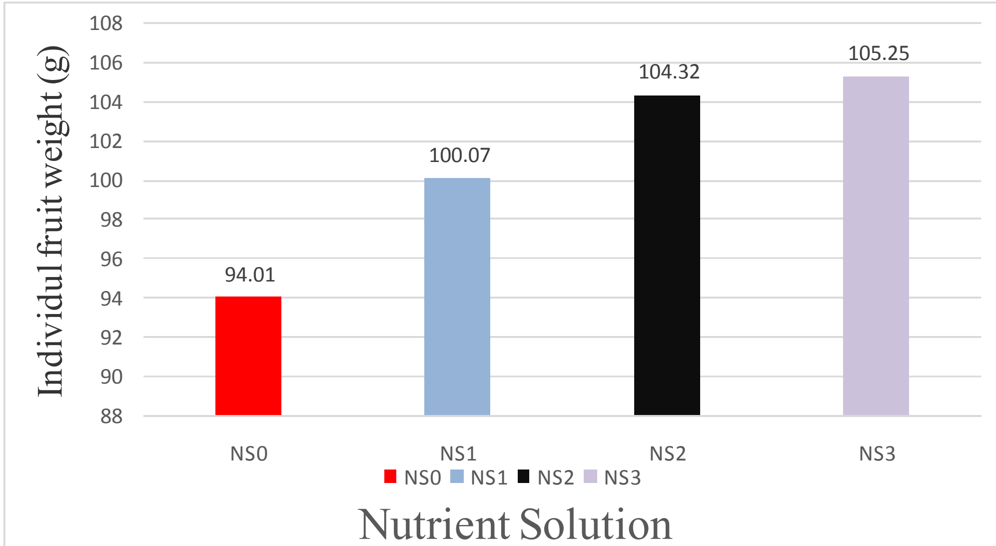

Fig. 9. Effect of different doses of cow dung leachate + nutrient solution on individual fruit weight (g)

NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution , and NS_3 =200g/L leachate of cow dung + standard nutrient solution).

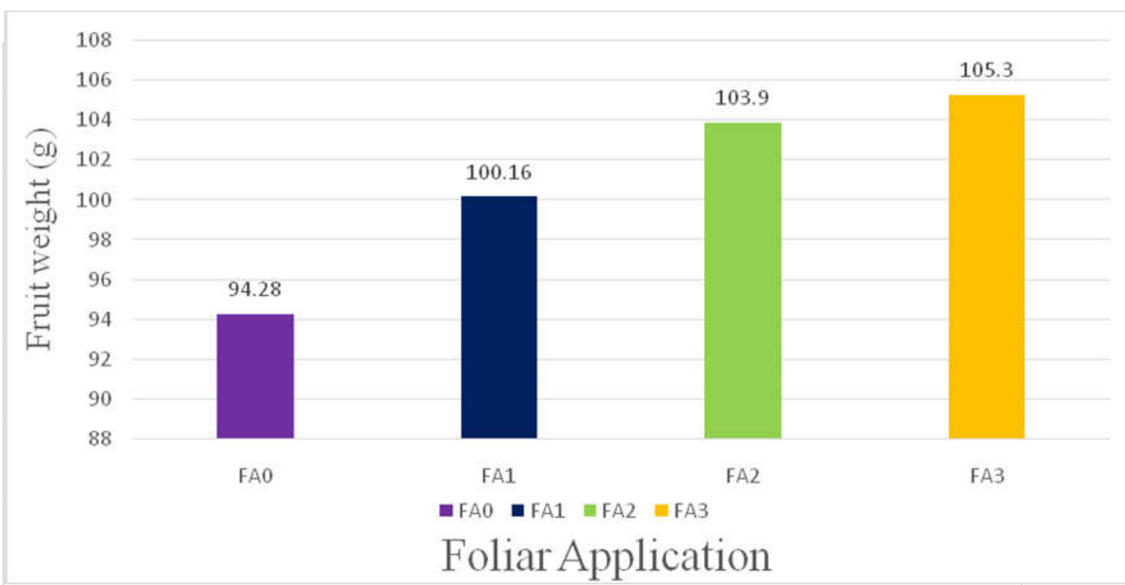

Figure 10. Effect of foliar application of cow dung leachate on individual fruit weight (g)

FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

4.2.8 Fruit dry weight

Fruit dry weight of capsicum were significantly affected by nutrient solution and cow dung leachate application (Figure 11). The highest fruit dry weight was found in NS_3 (9.77 g) which was statistically similar to that of NS_2 (9.63 g) treatment. On the other hand NS_0 (7.67 g) showed lowest fruit dry weight. Souri, M. K. and Aslani M. (2018) found that Plants produced significantly higher pod dry weight, although application of all the organic chelates significantly increased pod dry weight.

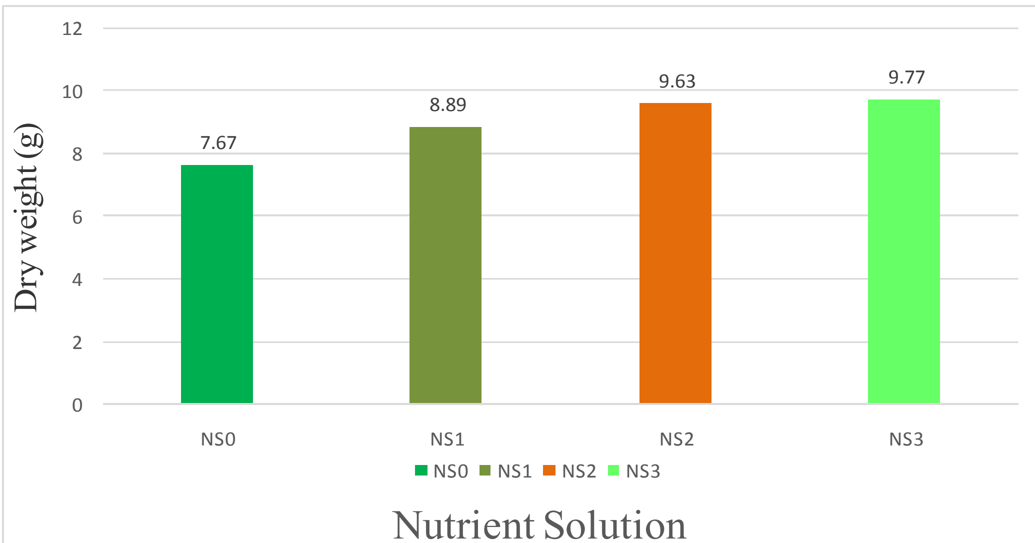

Fig.11. Effect of different doses of cow dung leachate + nutrient solution on fruit dry weight (g)

NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution , and NS_3 =200g/L leachate of cow dung + standard nutrient solution).

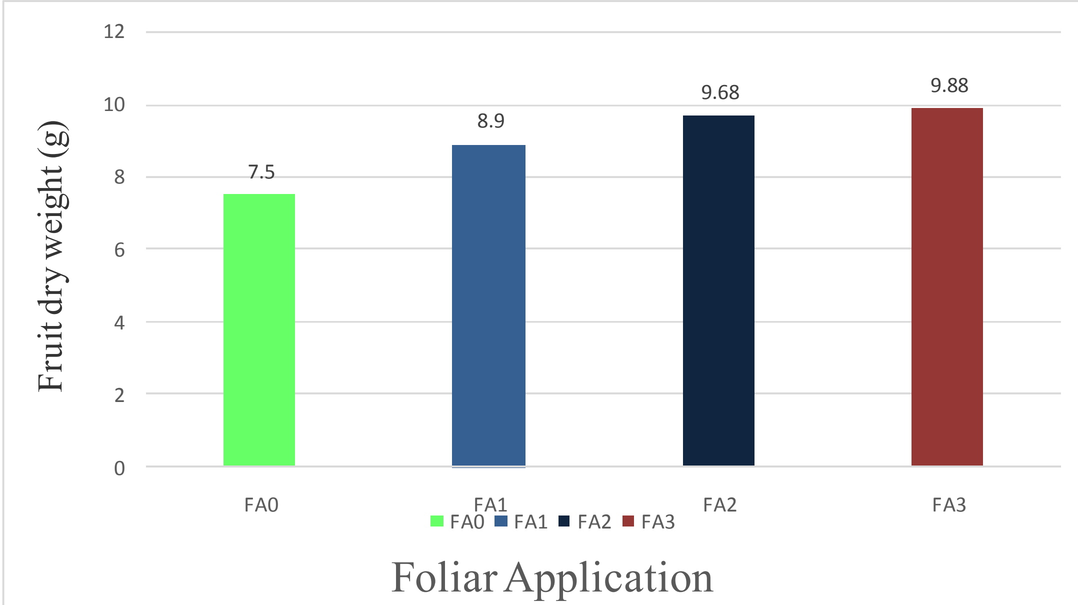

Figure 12. Effect of foliar application of cow dung leachate on fruit dry weight (g)

FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

Fruit dry weight of capsicum were significantly affected by foliar application of cow dung leachate (Figure 12). The highest fruit dry weight was found in FA_3 (9.88 g) which was statistically similar to that of FA_2. On the other hand FA_0 (7.50 g) showed lowest fruit dry weight.

Significant difference was noted on fruit dry weight influenced by combined effect of liquid organic fertilizer and foliar application (Table 8). The highest individual fruit weight was recorded from the treatment combination NS_3FA_3 and the lowest were found in NS_0FA_0.

4.2.9 Yield/Plant:

Marketable yield was affected by nutrient solution and Cow dung leachate application (appendix 4). The highest yield (812.75 g yield/plant) was found in NS_3 treatment while, lowest yield (597.39 g yield/plant) was found in NS_0 treatment (figure 13). This might be due to higher number of fruit by application of NS_3. Doss *et al.* (1981) reported that average yields from the lower nitrogen rate were greater than the higher nitrogen rate in the two driest years and were similar or higher from the higher nitrogen rate in year of more average rainfall. The effects of vermicompost on flowering and fruiting of strawberry might be attributed to the fact that higher doses of vermicompost have resulted in to better growth of plants and consequently they took lesser days to flower and produced higher fruit yield than those receiving inorganic fertilizers only (Brown, 1995; Atiyeh *et al.,*2000, 2001; Arancon *et al.,*2006.

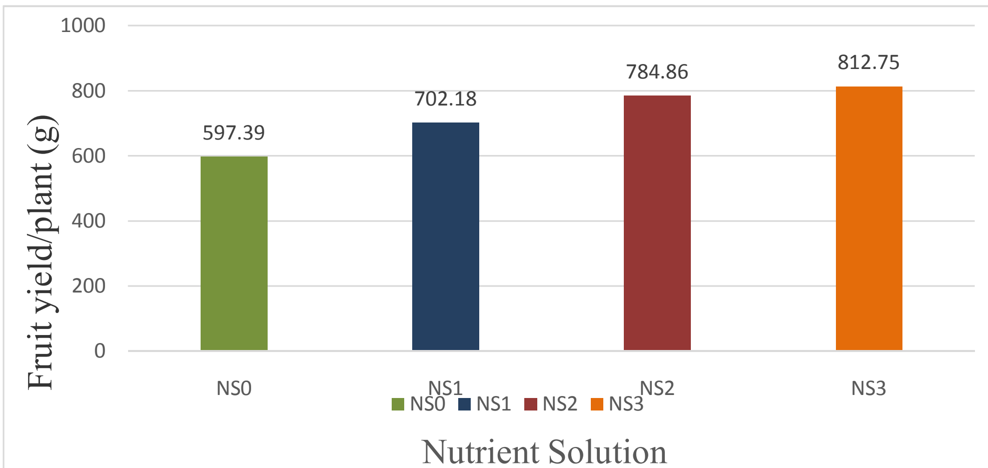

Fig. 13. Effect of different doses of cow dung leachate + nutrient solution on fruit yield/plant (g)

NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution , and NS_3 =200g/L leachate of cow dung + standard nutrient solution).

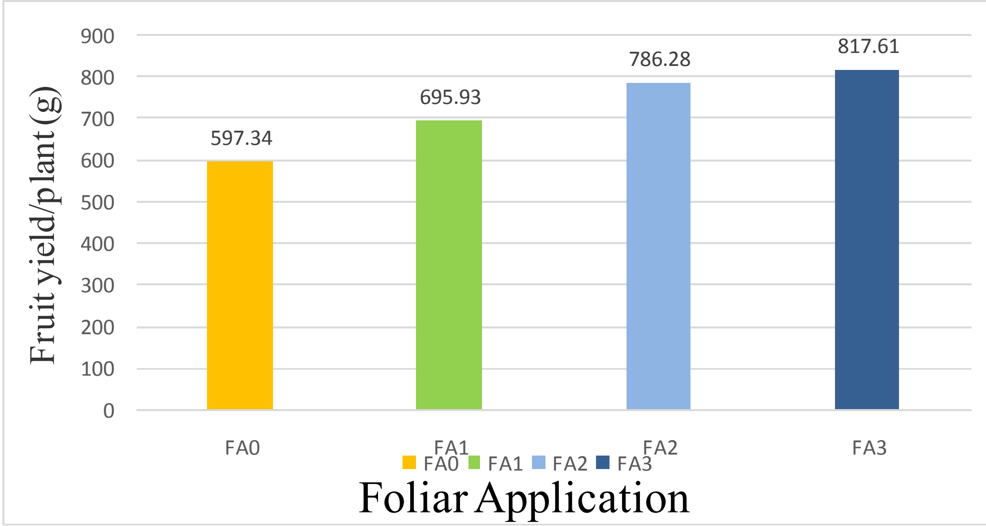

Figure 14. Effect of foliar application of cow dung leachate on fruit yield/plant (g)

FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

The yield contributing characters of the capsicum has significance due to different foliar application. Marketable fruit yield/plant of capsicum were significantly affected by foliar application of cow dung leachate (Figure 14). The highest fruit yield/plant was found in FA_3 (817.61 g) which was statistically similar to that of FA_2. On the other hand FA_0 (597.34 g) showed lowest fruit yield/plant.

Significant difference was noted on fruit yield/plant which influenced by combined effect of nutrient solution and foliar application of Cow dung leachate. The highest individual fruit yield/plant was recorded from the treatment combination NS_3FA_3 and the lowest were found in NS_0FA_0.

Table 8. Interaction effect of nutrient solution and foliar application of organic fertilizer on fruits/plant, individual fruit weight and fruit dry weight of capsicum

Treatment	Fruits/plant (No.)	Individual fruit weight (g)	Fruit dry weight (g)	Fruit yield/plant (g)
NS_0FA_0	6.11 d	91.16 f	6.61 h	557.42 f
NS_0FA_1	6.22 d	92.68 ef	7.46 f-h	577.17 ef
NS_0FA_2	6.78 cd	96.13 d-f	8.69 c-e	651.79 ef
NS_0FA_3	6.22 d	96.07 d-f	7.91 e-g	603.15 ef
NS_1FA_0	6.44 d	98.59 d-f	8.35 d-f	635.24 ef
NS_1FA_1	6.89 cd	99.08 c-f	8.73 c-e	684.35 d-f
NS_1FA_2	7.00 cd	100.51 c-e	8.94 cd	705.42 de
NS_1FA_3	7.67 a-c	102.11 b-d	9.54 bc	783.71 cd
NS_2FA_0	6.33 d	94.85 d-f	7.83 e-g	601.19 ef
NS_2FA_1	7.00 cd	101.86 b-d	9.18 cd	713.27 de
NS_2FA_2	8.22 ab	109.65 ab	10.59 a	901.13 a-c
NS_2FA_3	8.33 ab	110.90 a	10.92 a	923.83 ab
NS_3FA_0	6.44 d	92.54 ef	7.20 gh	595.53 ef
NS_3FA_1	7.56 bc	107.02 a-c	10.22 ab	808.91 b-d
NS_3FA_2	8.11 ab	109.30 ab	10.51 a	886.80 a-c
NS_3FA_3	8.56 a	112.12 a	11.15 a	959.76 a
Level of significance (P)				
NS×FA	<0.0346	<0.0474	<0.001	<0.0114

P represents the level of significance of one-way ANOVA. NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

4.3 Plant fresh weight

4.3.1 Leaf fresh weight:

Leaf fresh weight of Capsicum at 180 DAT varied significantly by different treatment of nutrient solution and different doses of cow dung leachate (Appendix 5). Result revealed that topmost result ((67.84 g) was recorded from NS_3 treatment whereas NS_0 treatment was scored as the lowest (58.54 g).

Leaf fresh weight of capsicum were significantly affected by different levels of foliar application (Table 9). The highest leaf fresh weight was found in FA_3 (68.54 g) which was statistically similar to that of FA_2 whereas FA_0 treatment was scored as the lowest (57.18 g).

Significant influence was noted on leaf fresh weight influenced by combined effect of liquid organic fertilizer and foliar application of nutrient solution. The highest leaf fresh weight was recorded from the treatment combination NS_3FA_3 the lowest were found in NS_0FA_0.

4.3.2 Stem fresh weight:

Stem fresh weight of capsicum at 180 DAT varied significantly by nutrient solution and Cow dung leachate application (Appendix 5). Result revealed that topmost result (73.02 g) was recorded from NS_3 treatment whereas NS_0 treatment was scored as the lowest (61.29 g) after final harvest.

Stem fresh weight of capsicum were significantly affected by different levels of foliar application (Table 9). The highest stem fresh weight was found in FA_3 (75.07 g) which was statistically similar to that of FA_2 whereas FA_0 treatment was scored as the lowest (57.42 g).

Significant influence was noted on stem fresh weight influenced by combined effect of liquid organic fertilizer and foliar application of nutrient solution. The highest stem fresh weight was recorded from the treatment combination NS_3FA_3 the lowest were found in NS_0FA_0.

4.3.3 Root fresh weight:

Root fresh weight of capsicum at 180 DAT varied significantly by nutrient solution and cow dung leachate application (Appendix 5). Result revealed that topmost result (32.09 g) was recorded from NS_3 treatment whereas NS_0 treatment was scored as the lowest (31.06 g) after final harvest.

Root fresh weight of capsicum were significantly affected by different levels of foliar application (Table 9). The highest root fresh weight was found in FA_3 (34.02 g) which was statistically similar to that of FA_2 and the lowest root fresh weight was found in FA_0 (26.85).

Significant influence was noted on root fresh weight influenced by combined effect of liquid organic fertilizer and foliar application of nutrient solution Table 10). The highest root fresh weight was recorded from the treatment combination NS_3FA_3 the lowest were found in NS_0FA_0.

Table 9. Main effect of nutrient solution and foliar application of organic fertilizer on leaf fresh weight, stem fresh weight and root fresh weight of capsicum

Treatment	Leaf fresh weight (g)	Stem fresh weight (g)	Root fresh weight (g)
Nutrient Solution (NS)			
NS_0	58.54 c	61.29 c	31.06 ab
NS_1	63.21 b	67.20 b	30.03 b
NS_2	67.05 a	72.12 a	31.78 a
NS_3	67.84 a	73.02 a	32.09 a
Foliar Application (FA)			
FA_0	57.18 c	57.42 c	26.85 c
FA_1	63.51 b	67.55 b	30.86 b
FA_2	67.41 a	73.59 a	33.22 a
FA_3	68.54 a	75.07 a	34.02 a
Level of significance			
NS	<0.001	<0.001	<0.0159
FA	<0.001	<0.001	<0.001

P represents the level of significance of one-way ANOVA. NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

Table 10. Combined effect of nutrient solution and foliar application of organic fertilizer on leaf fresh weight, stem fresh weight and root fresh weight of capsicum

Treatment	Leaf fresh weight (g)	Stem fresh weight (g)	Root fresh weight (g)
NS_0FA_0	52.88 g	52.99 g	27.77 fg
NS_0FA_1	57.75 f	60.72 d-f	30.39 d-f
NS_0FA_2	62.61 d-f	67.25 cd	34.60 ab
NS_0FA_3	60.91 ef	64.21 c-e	31.49 c-e
NS_1FA_0	59.73 f	63.32 de	28.86 e-g
NS_1FA_1	62.27 d-f	65.50 c-e	29.33 e-g
NS_1FA_2	64.73 c-e	68.12 b-d	29.34 e-g
NS_1FA_3	66.10 cd	71.84 bc	32.58 b-d
NS_2FA_0	58.44 f	58.77 e-g	26.57 gh
NS_2FA_1	65.28 c-e	68.57 b-d	30.15 d-f
NS_2FA_2	71.45 ab	79.60 a	34.75 ab
NS_2FA_3	73.05 ab	81.54 a	35.64 a
NS_3FA_0	57.67 f	54.58 fg	24.19 h
NS_3FA_1	68.76 bc	75.40 ab	33.59 a-c
NS_3FA_2	70.85 ab	79.40 a	34.19 a-c
NS_3FA_3	74.10 a	82.71 a	36.39 a
Level of significance(P)			
NS×FA	<0.0415	<0.0026	<0.001

P represents the level of significance of one-way ANOVA. NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

4.4 Plant dry weight

4.4.1 Leaf dry weight:

Leaf dry weight of capsicum at 180 DAT varied significantly by nutrient solution and cow dung leachate application (Appendix 6). Result revealed that topmost result (11.37 g) was recorded from NS_3 treatment whereas NS_0 treatment was scored as the lowest (9.34 g) after final harvest.

Leaf dry weight of capsicum were significantly affected by foliar application of cow dung leachate (Table 11). The highest leaf dry weight was found in FA_3 (11.63 g) which was statistically similar to that of FA_2. FA_0 treatment was scored as the lowest (9.00 g) after final harvest. Foliar application of vermicompost leachate produce significantly higher leaf area and dry weight of plants than control (Singh *et al*. 2010).

Significant influence was noted on leaf dry weight influenced by combined effect of liquid organic fertilizer and foliar application of nutrient solution. The highest leaf dry weight was recorded from the treatment combination NS_3FA_3 the lowest were found in NS_0FA_0.

4.5.2 Stem dry weight:

Stem dry weight of capsicum at 180 DAT varied significantly by nutrient solution and cow dung leachate application (Appendix 6). Result revealed that topmost result (12.21 g) was recorded from NS_3 treatment whereas NS_0 treatment was scored as the lowest (9.65 g) after final harvest.

Stem dry weight of capsicum were significantly affected by different levels of foliar application (Table 11). The highest stem dry weight was found in FA_3 (12.37 g) which was statistically similar to that of FA_2. FA_0 treatment was scored as the lowest (9.44 g) after final harvest.

Significant influence was noted on stem dry weight influenced by combined effect of liquid organic fertilizer and foliar application of nutrient solution. The highest stem dry weight was recorded from the treatment combination NS_3FA_3 the lowest were found in NS_0FA_0.

4.3. Root dry weight:

Root dry weight of capsicum at 180 DAT varied significantly by nutrient solution and cow dung leachate application (Appendix 6). Result revealed that topmost result (5.23 g) was recorded from NS_3 treatment whereas NS_0 treatment was scored as the lowest (4.43 g) after final harvest.

Root dry weight of capsicum were significantly affected by different levels of foliar application (Table 11). The highest root dry weight was found in FA_3 (5.24 g) which was statistically similar to that of FA_2. FA_0 treatment was scored as the lowest (4.45 g) after final harvest. The effective results in terms of plant dry weight as a result of application of organic fertilizer (Singh and Hussain, 2015).

Significant influence was noted on root dry weight influenced by combined effect of nutrient solution and foliar application of cow dung leachate (Table 12). The highest root dry weight was recorded from the treatment combination NS_3FA_3 the lowest were found in NS_0FA_0.

Table 11. Main effect of nutrient solution and foliar application of organic fertilizer on leaf dry weight, stem dry weight and root dry weight of capsicum

Treatment	Leaf dry weight (g)	Stem dry weight (g)	Root dry weight (g)
Nutrient Solution (NS)			
NS_0	9.34 c	9.65 c	4.43 c
NS_1	10.55 b	11.11 b	4.87 b
NS_2	11.23 a	12.05 a	5.16 a
NS_3	11.37 a	12.21 a	5.23 a
Foliar Application (FA)			
FA_0	9.00 c	9.44 c	4.45 c
FA_1	10.48 b	11.14 b	4.86 b
FA_2	11.37 a	12.09 a	5.14 a
FA_3	11.63 a	12.37 a	5.24 a
Level of significance (P)			
NS	<0.001	<0.001	<0.001
FA	<0.001	<0.001	<0.001

P represents the level of significance of one-way ANOVA. NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 =

100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

Table 12. Interaction effect of nutrient solution and foliar application of organic fertilizer on leaf dry weight, stem dry weight and root dry weight of capsicum

Treatment	Leaf dry weight (g)	Stem dry weight (g)	Root dry weight (g)
NS_0FA_0	8.22 g	8.18 h	4.20 f
NS_0FA_1	9.11 fg	9.50 fg	4.31 ef
NS_0FA_2	10.43 cd	10.95 c-e	4.61 c-f
NS_0FA_3	9.58 d-f	9.99 e-g	4.59 c-f
NS_1FA_0	10.06 d-f	10.54 d-f	4.73 c-e
NS_1FA_1	10.29 c-e	10.86 c-e	4.80 c-e
NS_1FA_2	10.49 cd	11.13 c-e	4.92 b-d
NS_1FA_3	11.37 bc	11.93 bc	5.03 bc
NS_2FA_0	9.26 e-g	9.95 e-g	4.49 d-f
NS_2FA_1	10.64 cd	11.43 cd	4.99 b-d
NS_2FA_2	12.34 ab	13.18 a	5.54 a
NS_2FA_3	12.68 a	13.63 a	5.62 a
NS_3FA_0	8.46 g	9.09 gh	4.37 ef
NS_3FA_1	11.87 ab	12.76 ab	5.34 ab
NS_3FA_2	12.23 ab	13.09 ab	5.51 a
NS_3FA_3	12.90 a	13.91 a	5.70 a
Level of significance(P)			
NS×FA	<0.001	<0.0006	<0.0265

P represents the level of significance of one-way ANOVA. NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

4.4 Physiological growth traits

The physiological growth parameters of capsicum plants were significantly influenced by different cow dung leachate application (APPENDIX 7). Cow dung leachate increased leaf area. In case of leaf area (LA), the higher leaf area (LA) was found NS_3 treatment (575.69 cm^2) and the lower was found in NS_0 (523.15 cm^2). Leaf area is an important factor of light interception and consequently of transpiration, photosynthesis and plant productivity (Dufour, L. and Guérin, V. (2005). In case of Leaf Mass Ratio (LMR), the higher Leaf Mass Ratio (LMR) was found in NS_0 treatment (0.399) and the lower was found in NS_3 treatment (0.394). Higher LMR is one of the important criteria for producing higher metabolites. Prieto et al. (2007) reported that increased LMR gave the plants an increased ability to intercept light. In case of Leaf Area Ratio (LAR), the lower Leaf Area Ratio (LAR) was found in NS_3 (20.25) while the higher was found in NS_0 (22.47). Lower LAR is one of the important criteria for producing higher metabolites. Decreased LAR was found by Starck (1983) in tomato, which agreed with our findings.

The physiological growth parameters of capsicum plants were significantly influenced by different foliar application of cow dung leachate (Table 13). In case of leaf area (LA), the higher leaf area (LA) was found in FA_3 (576.13) and the lower was found in FA_0 (513.77). Foliar application of vermicompost leachate produce significantly higher leaf area and dry weight of plants than control (Singh et al. 2010). In case of Leaf Mass Ratio (LMR), the higher Leaf Mass Ratio (LMR) was found in FA_3 (0.398) and the lower was found in FA_0 (0.393). In case of Leaf Area Ratio (LAR), the lower Leaf Area Ratio (LAR) was found in FA_3 (19.84) while the higher was found in FA_0 (22.60). Decreased LAR was found by Starck (1983) in tomato, which agreed with our findings. In case of root weight Ratio (LAR), the lower root weight Ratio (RWR) was found in FA_3 (0.183) while the higher was found in FA_0 (0.190).

In case of leaf area, Leaf Area Ratio (LAR), the significant variation was found in combination NS_3FA_3 (Table 14). In case of Leaf Mass Ratio (LMR), root weight ratio (RWR) significant variation was found in NS_0FA_0.

Table 13. Main effect of nutrient solution and foliar application of Cow dung leachate on leaf area, leaf mass ratio, leaf area ratio and root weight ratio of capsicum

Treatment	Leaf area (cm^2)	LMR ($g\ g^{-1}$)	LAR ($cm^2 g^{-1}$)	RWR ($g\ g^{-1}$)
Nutrient solution (NS)				
NS_0	523.15 b	0.399 a	22.47 a	0.190 a
NS_1	538.79 b	0.397 a	20.33 b	0.184 b
NS_2	563.08 a	0.395 b	19.93 b	0.182 b
NS_3	575.59 a	0.394 b	20.25 b	0.183 b
Foliar Application (FA)				
FA_0	513.77 c	0.393 b	22.60 a	0.195 a
FA_1	540.90 b	0.396 ab	20.55 b	0.184 b
FA_2	569.81 a	0.398 a	19.99 c	0.180 c
FA_3	576.13 a	0.398 a	19.84 c	0.180 c
Level of significance(P)				
NS	<0.001	<0.0029	<0.001	<0.0186
FA	<0.001	<0.0060	<0.001	<0.001

P represents the level of significance of one-way ANOVA. NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

Table 14. Interaction effect of nutrient solution and foliar application of organic cow dung leachate on leaf area, leaf mass ratio, leaf area ratio and root weight ratio of capsicum

Treatment	Leaf area (cm^2)	LMR ($g\ g^{-1}$)	LAR ($cm^2 g^{-1}$)	RWR ($g\ g^{-1}$)
NS_0FA_0	509.42 e	0.399 a-c	24.76 a	0.204 a
NS_0FA_1	516.17 e	0.398 a-c	22.53 bc	0.188 b
NS_0FA_2	545.74 c-e	0.401 a	21.01 de	0.177 c
NS_0FA_3	521.25 de	0.397 a-c	21.59 c-e	0.190 b
NS_1FA_0	519.67 de	0.397 a-c	20.52 ef	0.187 b
NS_1FA_1	531.99 de	0.396 a-d	20.51 ef	0.185 b
NS_1FA_2	542.98 c-e	0.395 b-d	20.48 ef	0.186 b
NS_1FA_3	560.50 b-d	0.401 ab	19.83 fg	0.178 c
NS_2FA_0	514.65 e	0.391 de	21.74 cd	0.189 b
NS_2FA_1	535.43 de	0.393 cd	19.79 fg	0.184 b
NS_2FA_2	595.74 ab	0.397 a-c	19.18 g	0.178 c
NS_2FA_3	606.50 a	0.397 a-c	18.99 g	0.176 c
NS_3FA_0	511.33 e	0.386 e	23.36 b	0.199 a
NS_3FA_1	580.00 a-c	0.396 a-d	19.38 fg	0.178 c
NS_3FA_2	594.75 ab	0.397 a-d	19.30 g	0.179 c
NS_3FA_3	616.26 a	0.397 a-c	18.95 g	0.175 c
Level of significance				
NS×FA	<0.0241	<0.0214	<0.001	<0.0314

P represents the level of significance of one-way ANOVA. NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

CHAPTER V
SUMMARY AND CONCLUTION

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The experiment was conducted in the net house at the Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka 1207, Bangladesh during September 2018 to March 2019 to determine the effect of nutrient solution and foliar application of liquid organic fertilizer in hydroponic or soilless system. Treatments considers two factors. The experiment was conducted in a randomized completely block design with two replications. The summary of the experiment was described here.

In case of growth parameters of capsicum, maximum plant height was at 180 DAT. The highest plant height (88.55 cm) was recorded from plant grown in NS_3 treatment whereas the shortest plant height (76.21 cm) was recorded from NS_0 treatment. The early flowering from the plant grown was recorded in NS_3 treatment at 38.06 DAT which was statistically similar to that of NS_2 at 39.58 DAT and late flowering was recorded from the plant grown in NS_0 at 41.78 DAT. The early fruiting was recorded from the plant grown in NS_3 at 16.64 DAF and late fruiting was recorded from the plant grown in NS_0 treatment at 18.36 DAF. In case of fruit length, the highest fruit length (11.67 cm) was recorded from plant grown in NS_3 treatment which was statistically similar to that of NS_2 (11.47 cm) and lowest fruit length (9.48 cm) recorded from plant grown in NS_0 treatment. In case of fruit breadth, highest fruit breadth (6.64 cm) was recorded from plant grown in NS_3 which was statistically similar to that of NS_2 (6.58 cm) and lowest fruit breadth (5.52 cm) recorded from plant grown in $NS_{0.}$ The highest fruit diameter (7.12 cm) was recorded from plant grown in NS_3 treatment which was statistically similar to that of NS_2 (6.99 cm) and lowest fruit diameter (4.23 cm) recorded from plant grown in NS_0 treatment. The higher fruit volume (164.78) was recorded from plant grown in NS_3 treatment which was statistically similar to that of NS_2 (161.77) and lower fruit volume (129.73) recorded from plant grown in NS_0 treatment. In case of number of fruit per plant, the maximum (7.67) number of fruit per plant was recorded from plant grown in NS_3 which was statistically similar to that of NS_2 (7.47) while the minimum number of fruit/plant (6.33) was recorded plant grown in NS_0. In case of individual fruit wt., the highest (105.25 g) individual fruit wt. was recorded from plant grown in NS_3 treatment which was statistically similar to that of NS_2 (104.32 g) while the lowest individual fruit wt. (94.01 g) was recorded plant grown in NS_0 treatment. In case of dry wt. of 100g fresh wt. of Capsicum, the higher fruit dry wt. was found in NS_3 (9.77 g) which was statistically similar to that of NS_2 (9.63 g) and the lowest fruit dry wt. was found in NS_0 (7.67 g) treatment. In case of plant fresh wt. at 180 DAT, the highest leaf wt. (67.84 g) was recorded from NS_3 treatment whereas NS_0 treatment was scored as the lowest (58.54 g), the highest stem fresh wt. (73.02 g) was recorded from NS_3 treatment whereas NS_0 treatment was scored as the lowest (61.29 g), the highest root fresh wt. (32.09 g) was recorded from NS_3 treatment whereas NS_0 treatment was scored lowest (31.06 g). In case of plant dry wt. at 180 DAT, the highest leaf dry wt. (11.37 g) was recorded from NS_3 treatment whereas NS_0 treatment was scored as the lowest (9.34 g), the highest stem dry wt. (12.21 g) was recorded from NS_3 treatment whereas NS_0 treatment was scored as the lowest (9.56 g), the highest root dry wt. (5.23 g) was recorded from NS_3 treatment whereas NS_0 treatment was scored as the lowest (4.43 g). In case of yield/plant, the highest yield (812.75 g) was recorded from NS_3 treatment whereas NS_0 treatment was scored as the lowest (597.39 g).

Results showed that foliar application of cow dung leachate of capsicum had significant effect on growth and yield of Capsicum. In case of growth parameters of Capsicum, highest plant height (88.55 cm) was recorded from plant grown in FA_3 while the shortest plant height (76.21 cm) was recorded from FA_0. The early flowering was recorded from the plant grown in FA_3 at 38.06 DAT and late flowering was recorded from the plant grown in FA_0 at 41.78 DAT. The early fruiting was recorded from the plant grown in FA_3 at 16.64 DAF and late fruiting was recorded from the plant grown in FA_0 at

18.36 DAF. The highest fruit length (11.67 cm) was recorded from plant grown in FA_3 treatment which was statistically similar to that of FA_2 (11.47 cm) and lowest fruit length (9.48 cm) recorded from plant grown in FA_0 treatment. The highest fruit breadth (6.64 cm) was recorded from plant grown in FA_3 treatment which was statistically similar to that of FA_2 (6.58 cm) and lowest fruit breadth (5.52 cm) recorded from plant grown in FA_0 treatment. The highest fruit diameter (7.12 cm) was recorded from plant grown in FA_3 treatment which was statistically similar to that of FA_2 (6.99 cm) and lowest fruit diameter (4.23 cm) recorded from plant grown in FA_0 treatment. The highest fruit volume (164.78) was recorded from plant grown in FA_3 treatment and lower fruit volume (129.73) recorded from plant grown in FA_0 treatment. In case of number of fruit/plant, the maximum (7.67) number of fruit/plant was recorded from plant grown in FA_3 treatment which was statistically similar to that of FA_2 (7.47) treatment while the minimum number of fruit/plant (6.33) was recorded plant grown in FA_0 treatment. The highest individual fruit wt. (105.25 g) was recorded from plant grown in FA_3 treatment which was statistically similar to that of FA_2 (104.32 g) while the lowest individual fruit wt. (94.01 g) was recorded plant grown in FA_0. In case of dry wt. of 100g fresh wt. of Capsicum, the higher fruit dry weight was found in FA_3 (9.77 g) which was statistically similar to that of FA_2 (9.63g) and the lowest fruit dry wt. was found in FA_0 (7.67 g). In case of plant fresh weight at 180 DAT, the highest leaf wt. (67.84 g) was recorded from FA_3 treatment whereas FA_0 treatment was scored as the lowest (58.54 g) the highest stem fresh wt. (73.02 g) was recorded from FA_3 treatment whereas FA_0 treatment was scored as the lowest (61.29 g), the highest root fresh wt. (32.09 g) was recorded from FA_3 treatment whereas NS_0 treatment was scored and the lowest (31.06gm). In case of plant dry weight at 180 DAT, the highest leaf dry wt. (11.37 g) was recorded from FA_3 treatment whereas FA_0 treatment was scored as the lowest (9.34 g), the highest stem dry wt. (12.21 g) was recorded from FA_3 treatment whereas FA_0 treatment was scored as the lowest (9.56 g), the highest root dry wt. (5.23g) was recorded from FA_3

treatment whereas FA_0 treatment was scored as the lowest (4.43 g).In case of yield per plant, the highest yield (812.75 g) was recorded from FA_3 treatment whereas FA_0 treatment was scored as the lowest (597.39 g).

Different physiological parameters; viz. in case of leaf area (LA), the higher leaf area (LA) was found in the plants grown in NS_3 and the lower was found in NS_0, in case of Leaf Mass Ratio (LMR), the higher Leaf Mass Ratio (LMR) was found in NS_3 and the lower was found in NS_0, in case of Leaf Area Ratio (LAR), the higher was found in NS_0 while the lower Leaf Area Ratio (LAR) was found in NS_3, in case of Root Weight Ratio (RWR), the lower Root Weight Ratio (RWR) was found in NS_3 while the higher was found in NS_0. Best result was found from plant grown in NS_3 followed by NS_2.

Different physiological parameters; viz. in case of leaf area (LA), the higher leaf area (LA) was found in the plants grown in FA_3 and the lower was found in FA_0, in case of Leaf Mass Ratio (LMR), the higher Leaf Mass Ratio (LMR) was found in FA_3 and the lower was found in FA_0, in case of Leaf Area Ratio (LAR), the higher was found in FA_0 while the lower Leaf Area Ratio (LAR) was found in FA_3. Best result was found from plant grown in FA_3 followed by FA_2.

CONCLUSIONS

According to the findings of the present experiment, the following conclusions were drawn.

1. The growth and yield of capsicum were high in the NS_3 treatment of standard nutrient solution + 200 g/L cow dung leachate.

2. Higher vegetative growth and fruit yield parameters and physiological traits of capsicum were found in FA_3 treatment of foliar application of 200g/L cow dung leachate.

The application of Standard nutrient solution + 200 g/L cow dung leachate and foliar application of 200g/L cow dung leachate independently as well as in combination produced the highest growth and yield of capsicum.

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APPENDICES

APPENDICES

Appendix 1. Analysis of variances of plant height at different days after transplanting of capsicum

Source of variation	Degrees of freedom (df)	Mean squares of plant height at different days after transplanting (DAT) (cm)						
		0 DAT	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
Nutrient solution (NS)	3	0.013	63.107	153.398	284.503	311.032	379.126	385.469
Foliar Application (FA)	3	0.048	35.718	200.297	331.654	508.689	535.462	504.367
NS×FA	9	0.534	2.650	14.795	13.517	67.539	75.520	73.501
Error	30	0.578	1.100	2.792	6.522	19.364	11.003	9.973

NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

Appendix 2. Analysis of variances of yield contributing characters and yield of capsicum

Source of variation	Degree of freedom (df)	Mean square of yield contributing character	
		First flowering (DAT)	Firstfruiting (DAF)
Nutrient solution (NS)	3	35.529	7.333
Foliar Application (FA)	3	31.719	5.540
NS×FA	9	20.891	2.647
Error	30	6.344	0.636

NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

Appendix 3. Analysis of variances of fruit length, breadth, diameter, volume and pericarp of capsicum

Source of variation	Degree of freedom (df)	Mean square of yield contributing character				
		Fruit length (cm)	Fruit breadth (cm)	Fruit diameter (cm)	Fruit volume	Fruit pericarp
Nutrient solution(NS)	3	11.712	3.217	22.088	3073.72	0.338
Foliar Application (FA)	3	4.624	3.247	1.450	4498.20	0.327
NS×FA	9	0.576	0.418	0.202	398.432	0.157
Error	30	0.238	0.111	0.046	115.696	0.060

NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

Appendix 4. Analysis of variances of fruits/plant, fruit weight, fruit dry weight and yield of capsicum

Source of Variation	Degree of freedom (df)	Mean square of yield contributing character			
		Number of fruits/plant	Individual fruit weight (g)	Fruit dry weight (g)	Fruit yield/plant
Nutrient Solution (NS)	3	4.215	314.807	11.123	112347.52
Foliar Application (FA)	3	4.624	290.708	14.023	117889.03
NS×FA	9	0.576	43.777	1.420	14851.660
Error	30	0.240	19.557	0.302	4957.454

NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

Appendix 5. Analysis of variances of fresh weight of leaf, stem and root of capsicum

Source of Variation	Degree of freedom (df)	Mean square of yield contributing character		
		Leaf fresh weight (g)	Stem fresh weight (g)	Root fresh weight (g)
Nutrient solution (NS)	3	217.888	348.800	10.018
Foliar Application (FA)	3	315.671	771.362	124.340
NS×FA	9	16.021	65.882	16.480
Error	30	6.941	17.231	2.479

NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

Appendix 6. Analysis of variances of dry weight of leaf, stem and root of capsicum

Source of variation	Degree of freedom (df)	Mean square of yield contributing character		
		Leaf dry weight (g)	Stem dry weight (g)	Root dry weight (g)
Nutrient solution (NS)	3	10.312	16.557	1.591
Foliar Application (FA)	3	16.979	20.971	1.499
NS×FA	9	1.985	2.130	0.186
Error	30	0.346	0.455	0.073

NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.

Appendix 7. Analysis of variances of physiological growth parameters of capsicum

Source of variation	Degrees of freedom (df)	Mean square of physiological parameters			
		Leaf area (cm^2)	LMR ($g\ g^{-1}$)	LAR ($cm^2 g^{-1}$)	RWR ($g\ g^{-1}$)
Nutrient solution (NS)	3	6690.370	0.0001	16.294	0.0001
Foliar Application (FA)	3	9881.182	0.0001	19.423	0.001
NS×FA	9	1334.071	0.0001	2.290	0.0001
Error	30	514.120	0.0001	0.390	0.0001
Level of significance					
NS		<0.001	<0.0029	<0.001	<0.0186
FA		<0.001	<0.0060	<0.001	<0.001
NS×FA		<0.0241	<0.0214	<0.001	<0.0314

NS = Nutrient solution (NS0 = control (standard nutrient solution as Rahman and Inden), NS_1 = 100 g/L leachate of cow dung + standard nutrient solution, NS_2 =150g/L leachate of cow dung + standard nutrient solution, and NS_3 =200g/L leachate of cow dung + standard nutrient solution). FA = Foliar application (FA_0 = Control (no application), FA_1 = 100 g/L leachate of cow dung, FA_2 = 150 g/L leachate of cow dung, FA_3 =200 g/L leachate of cow dung.