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Postharvest quality of bell pepper (*Capsicum annuum* L.) in soilless media with fertigation of organic amendments

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ABSTRACT— Bell pepper (*Capsicum annuum* L.) is well known for its high content of bioactive compounds, strong antioxidants, and high levels of Vitamin C. The use of different organic amendments on soilless culture is very promising to address issues in producing organic vegetables worldwide. This study was conducted to evaluate the effect of fertigation frequency and different concentrations of organic amendments under soilless production on the postharvest quality of bell pepper. The study was laid out in a split-plot design with the frequency of fertigation as the main plot and organic amendments as sub-plot factors. Higher fertigation frequency at 16 times compared to 8 times daily and the application of organic amendments, effective microorganism (EM), and humic acid (HA) significantly improve quality, specifically Vitamin C, chlorophyll a/b, total Chlorophyll, total carotenoids, and free radical scavenging activity (FRSA).

KEYWORDS: bell pepper, fertigation, EM, HA

1. INTRODUCTION

The cultivation of peppers (*Capsicum annuum* L.) is considered an important issue in human food consumption. The world's fresh pepper production in 2020 was at about 36.09M [13]. In the Philippines, the quantity of capsicum (bell pepper) shipped in 2020 was 392 metric tons [15]. Bell peppers belong to the family Solanaceae and originated from Central and South America. Numerous species were used centuries before Columbus landed on the continent (Manrique, 1993); they are grown for fresh and processed markets. It is an excellent source of Vitamin A, Vitamin C, and fiber, and its high antioxidant properties help reduce the risk of cardiovascular diseases and cancer. [9] reported that the consumption of pepper fruit has increased because it is a source of nutrients and antioxidants. Adequate plant nutrition is vital in vigorous plant growth, increased yield, and high fruit quality. [3] added that attention had been given to the effects of preharvest factors on nutritional and bioactive compounds (such as pigments, phenolic compounds, and antioxidant compounds), which play a role in human health.

Pre-harvest factors such as agricultural practices, irrigation, and fertilization could influence the fruit quality of pepper [8]. Fertigation, or the application of fertilizer and water together along a drip irrigation system, is one way to minimize environmental risk. According to (Nunes et al., 2017). It is one of the leading technologies adopted in the vegetable production sector, especially in fruit vegetables and cultivation under a protected environment. Sabi (2012) reported that fertilization technology remarkably increases fertilizer and water use efficiency, reducing production costs and lessening the potential of environmental pollution due to fertilizer leaching.

Effective Microorganisms (EM) was developed at the University of the Ryukyus, Okinawa, Japan, in early 1980 by a distinguished professor Dr. Teruo Higa. EM are mixed cultures of beneficial naturally occurring organisms that can be applied as inoculants to increase the microbial diversity of the soil ecosystem. It increases the beneficial microbial population in the soil for sustainable crop production [7]. The different species of organisms in effective microorganisms complement each other and are in a mutually beneficial relationship with the roots of plants in the soil ecosystem. Plants would, therefore, grow exceptionally well in soils inhabited and dominated by these effective microorganisms [12]. Effective microorganisms enhance soil fertility and promote crop growth, flowering, fruit development, and crop ripening. It can increase crop yields, improve crop quality, and accelerate the breakdown of organic matter from crop residues [4]. EM are mixed cultures of beneficial naturally occurring organisms that can be applied as inoculants to increase the microbial diversity of the soil ecosystem. Evidence suggests that EM inoculation to the soil can improve soil quality, plant growth, and yield (Han et al., 2006). EM promotes germination, flowering, fruiting, and ripening in plants, improves the physical, chemical, and biological environments of the soil and suppresses soil-borne pathogens and pests, enhances the photosynthetic capacity of crops, ensures better germination and plant establishment, and increases the efficacy of organic matter as a fertilizer, due to the beneficial effects of EM, crop yields and quality can be enhanced [2]. A study by Devasinghe and Kularathna (2016) showed that EM was more suitable to enhance the yield and quality of hydroponically grown lettuce than growing with inorganic fertilizers alone. Previous studies have also demonstrated a positive response to using effective microorganisms in crop production. They indicate this technology's potential to increase crop yield and quality (Higa, 1991).

Humic acid (HA) is an excellent natural resource to be utilized as an alternative for increasing crop production. It is a naturally occurring polymeric organic compound produced by the decay of organic materials and is found in soil, peat, and lignites [11]. HA, which originates from different materials, has many beneficial effects on various aspects and parameters of plant growth, such as yield and root growth, including that of strawberry (*Fragaria × ananassa* (*Duchesne ex Rozier*)), pepper (*Capsicum annuum* L.) [10], maize (*Zea mays* L.) [5], lettuce (*Lactuca sativa* L.) [6], and gerbera (*Gerbera jamesonii Bolus* ex. *Hook f*.) [1], among others. According to [14], in lettuce, HA applications positively affect dry matter productivity and the nutrient mechanism of lettuce plants. With the increasing dose of HA, the usage of phosphorus by plants is increased. He added that in tomatoes, results showed the highest stem diameter, leaf number of branches, total plant yield, and root weight were obtained from soil+foliar Ca-humate and B-human application. Soil+foliar B-humate application increased body diameter, the number of branches, and plant B content to 37%, 50%, and 84%, and soil + foliar Ca-human application increased the root weight, plant weight, and plant Ca content to 62% by 29%, and 70% respectively, when compared to control.

Different organic amendments to soilless culture will address issues in producing organic vegetables worldwide. Applying organic amendments like the effective microorganism (EM) and humic acid (HA) in soilless culture through fertigation would be very promising in the postharvest quality of bell pepper. This study was conducted to evaluate the effect of fertigation frequency and different concentrations of organic amendments under soilless production on the postharvest quality of bell pepper.

2. Methodology

The study was conducted under a protective structure at the Vegetable Area of the College of Agriculture and Food Science, Department of Horticulture, Visayas State University, Visca, Baybay City, Leyte, through soilless culture and fertilizer application which was fed through drip irrigation or fertigation from September 2017 – April 2018.

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Volume 19, Issue 03, March, 2023

The study was laid out in split-plot design; Main plot – fertigation frequency (8 and 16 times daily) of VSU-LNF and Sub-plot – drenching of different organic amendments (7 Treatments; Fig. 3). The treatments were as follows; T1-Water, T2-EM 1L:400L, T3-EM 1L: 500L, T4-EM 1L:600L, T5-HA 150g:100L, T6-HA 100g:100L, and T7-HA 50g:100L. The basis of the different treatments as per the recommendation of the product and with low and high concentrations against its product recommendations.

Bell peppers were harvested early in the morning, 55 days after transplanting at a mature green stage of the fruit, and were pre-treated by washing, air dried, and stored under ambient conditions. The conduct of postharvest quality of bell pepper was set up at the Department of Horticulture Postharvest Laboratory. There were ten samples per treatment/replication set-up in the laboratory.

Postharvest data were fruit weight (g) color, shriveling, visual quality assessment (VQR), firmness, percent titratable acid (TA), pH, total soluble solids (TSS), carotenoids, chlorophyll a/b, Vitamin C and Free radical scavenging activity (FRSA). Statistical analyses used were Statistical Tool for Agricultural Research (STAR) and Statistics 10 to compare means and their level of significance.

3. Results and Discussion

Table 1 shows significant differences in treatments on percent weight loss during the fourth day of storage at ambient conditions, with a significant decrease in the weight of stored bell pepper at an average of 5.54%. The highest percent weight loss was observed in Treatment 2 (6.53%) and lowest in Treatment 6 (4.76%). No significant differences were observed among fertigation frequency. The application of different concentrations of organic amendments has influenced the weight loss of bell pepper during postharvest storage in ambient conditions. Weight loss in a bell pepper is attributed to the function of different metabolic processes, such as respiration and other oxidative processes (Wilson, 2017). Respiration is the process of breaking down food reserves, specifically the stored carbohydrates, to produce energy used in different physiological activities in the cell resulting in the reduction of the fruit weight during storage. No significant differences were observed in the bell pepper's percent decrease in polar length and equatorial diameter.

Table 1. Percent weight loss and decrease in polar length and equatorial diameter of bell pepper during storage at the ambient condition as affected by fertigation frequency and organic amendments.

Fertigation Frequency	Weight Loss (%) Day 4	Weight Loss (%) Day 7	Decrease in Polar length (%) Day 7	Decrease in Equatorial Diameter (%) Day 7
A – 8 times daily	5.72	11.68	5.06	8.21
B – 16 times daily	5.35	11.55	5.40	7.08
Organic Amendments				
T1-Water	5.71ab	11.91	4.67	8.48
T2-EM 1L:400L	6.53a	13.25	4.36	7.10
T3-EM 1L:500L	5.50ab	11.32	3.96	8.11
T4-EM 1L:600L	5.52ab	11.68	3.92	6.52
T5-HA 150g:100L	5.31ab	11.34	6.26	7.85
T6-HA 100g:100L	4.76b	11.04	6.21	7.75
T7-HA 50g:100L	5.42ab	10.74	7.22	7.71
CV (%) A	14.18	1.34	27.68	39.21
CV (%) B	12.63	11.18	48.39	29.29

Means in a column with the same letter designation is not significantly different from each other based on the 5% level of Tukey's Honest Significant Difference (HSD) Test.

According to Ahmed et al. (2010); Singh et al. (2013), respiration was higher at the start of the experiment and gradually decreased with time upon storage. Hence, weight loss was already experienced at the early stage of storage of bell pepper in ambient storage. Wills et al. (1998) reported that a 5% weight loss in a bell pepper is the maximum allowed. In this study, the application of HA per recommended rate of the product resulted in lowering weight loss by 4.76% compared to other treatments. In comparison, EM at recommended rate resulted in the highest weight loss at 6.53%. The respiration rate tends to increase, and the quality of bell pepper stored in ambient conditions was significantly reduced at about 5.54%. When stored longer for seven days, weight loss tends to increase at 11.61%, and at this stage, bell pepper shriveled and was unacceptable for consumption. Similar results were observed by Rahman et al. (2014), where weight loss of 10% occurred between 3 and 5 days after harvest (DAH), resulting in the fruit's poor appearance in pepper. Smith et al. (2006) reported that water loss is one of the principal physiological factors that negatively impact pepper fruit quality during shipment and storage and subsequent marketing. Robinson et al. (1975) added that the quality of most fruits and vegetables declines very fast with minimum weight loss (3% to 10%), which affects the visual quality and results in an unacceptable product due to shriveling.

Table 2 shows the interaction effect of fertigation frequency and organic amendments on firmness, shriveling (SI), and color index (CI) during postharvest of a bell pepper at ambient conditions. Significant differences among treatments on firmness using the hand penetrometer at harvest, with the highest 16 fertigation frequency in Treatment 7 of about 3.7 kgs/force and the lowest for Treatment 5 of only about 2.80 kgs/ force as observed. Flesh firmness is a critical quality attribute in the consumer acceptability of fresh fruits and vegetables (Rahman et al., 2014). Reduction in firmness can be observed in the study, and according to Gray et al. (1994), that firmness is reduced because of the ripening process that may alter the texture of the fruit and accompanied by structural changes or the cell wall component such as cellulose, hemicelluloses, and pectin. A study by Bayogan and Cantwell (2016) reported that considerable firmness loss in bell peppers occurs before significant shrivel or dehydration during storage. Interaction effect on shriveling can be observed on day four, but no significant differences in fertigation frequency and organic amendments were observed. Significant differences among treatments were observed on the shriveling index of bell pepper as affected by the different fertigation frequencies during the seventh day of storage, with the lowest rating in 16 fertigations (2.49) and the highest in 8 fertigations (3.03). Rating for shriveling is from 1 – 5 with 1 – no symptom of wilting or shriveling, 2 – with 1-10%, 3 – with 11-30%, 4 – 31-50%, and 5 – with extensive wilting/shriveling.

An interaction effect on the color index can also be observed after one week of storage in an ambient condition which showed significant changes at 16 fertigation frequencies, with the highest rating in Treatment 6 (2.67) and lowest or no color change in Treatment 2 and 7 (1.00) at eight fertigations daily. For color index scale follows a 1 – 6 rating with 1 – Green, 2 – Breaker, 3 – More green than orange/red, 4 – More orange/red than green, 5 – More orange/red with traces of green, 6 – Full orange/red. No significant differences were observed during the fourth day of storage in the color index and at eight fertigation frequencies, along with applying organic amendments. As observed in the color index of bell pepper, there were only slight changes in the color, from an index of 1 to 2.39 in Treatment 4, with the highest color change among other treatments, and did not change from green to red compared to sweet pepper or other variety of pepper were color changes can be observed, variety may be one of the reasons for this observation.

Table 2. Interaction effect fertigation frequency and organic amendments on firmness, shriveling (SI), and color index (CI) during postharvest of a bell pepper at ambient condition.

	Firmness (kgs/force)	SI	CI
Main Plot	Harvest	Day 4	Day 7

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Volume 19, Issue 03, March, 2023

Fertigation Frequency	A 8x/day	B 16x/day	A 8x/day	B 16x/day	A 8x/day	B 16x/day
Means	3.23b	3.16a	2.02	1.86	1.46	1.76
Sub-Plot						
Organic Amendments						
T1-Water	3.40abc	3.00bc	2.22	1.89	1.67bcd	1.56bcd
T2-EM 1L:400L	3.40abc	3.00bc	2.11	1.61	1.00d	1.33cd
T3-EM 1L:500L	2.90bc	3.47ab	2.22	2.22	1.67bcd	1.22cd
T4-EM 1L:600L	3.40abc	2.93bc	2.17	1.89	1.44cd	2.39ab
T5-HA 150g:100L	3.33abc	2.80c	1.67	1.89	2.11abc	1.89abcd
T6-HA 100g:100L	3.17abc	3.20abc	1.56	2.11	1.30cd	2.67a
T7-HA 50g:100L	3.00bc	3.70a	2.22	1.44	1.00d	1.28cd
CV (%) A	10.88	10.88	25.34	25.34	24.78	24.78
CV (%) B	10.02	10.02	17.74	17.74	30.73	30.73

Means within parameters with the same letter designation are not significantly different based on the 5% Least Significant Difference (LSD) Test.

In Table 3, VQR showed no significant differences among treatments. The values for VQR use the hedonic scale with 9-excellent, field fresh with no defect, 7-good, with minor defects, and 5- for fair, with moderate defects and basis for the limit of marketability/acceptability of bell pepper. The result showed that fertigation frequency with the application of different organic amendments did not prolong the visual quality of bell pepper longer than four days during storage at ambient conditions. Changes were observed from an acceptable visual quality from the first to the fourth day and degraded on the seventh day of storage. At the same time, shriveling was significant during the seventh day of the storage, where eight fertigations daily had the highest rating with 3.03 compared to 16 fertigation frequency with only 2.49. Significant differences were also observed among treatments, with the highest shriveling in Treatment 1 (3.28) and the lowest in Treatment 5 (2.28). No significant differences were observed on the color index on final firmness and day four.

Table 3. Firmness, VQR, SI, and CI of bell pepper as affected by fertigation frequency and organic amendments during postharvest.

Fertigation Frequency	Firmness (kgs/force) Day 7	VQR Day 4	VQR Day 7	SI Day 7	CI Day 4
A – 8 times daily	2.85	6.49	3.98	3.03a	1.29
B – 16 times daily	2.87	6.49	4.25	2.49b	1.34
Organic Amendment					
T1-Water	2.62	6.72	3.94	3.28a	1.56
T2-EM 1L:400L	2.60	6.50	3.67	2.67ab	1.06
T3-EM 1L:500L	2.73	6.22	4.17	3.03ab	1.22
T4-EM 1L:600L	3.09	6.83	4.33	2.69ab	1.25
T5-HA 150g:100L	3.57	6.33	4.17	2.28b	1.61
T6-HA 100g:100L	2.61	6.22	4.06	2.67ab	1.50
T7-HA 50g:100L	2.83	6.61	4.50	2.72ab	1.00
CV (%) A	2.74	10.89	10.22	6.71	28.84
CV (%) B	22.97	14.00	17.15	16.21	33.23

Means in a column with the same letter designation are not significantly different from each other based on the 5% level of Tukey's Honest Significant Difference (HSD) Test.

The external appearance of fruits, particularly their color, is of crucial importance when considering the different characteristics which define quality, and in the case of fruits destined for fresh consumption, a visual impression that does not coincide with the established standard quickly leads to refusal (Gomez-Ladron de Guevara et al., 1996). Therefore, the implication of this study with fertigation frequency and application of organic amendments is that soilless bell pepper shelf life can only be maintained for 4-5 days in ambient conditions and becomes unacceptable after a week of storage.

Table 4 shows the interaction effect of fertigation frequency and organic amendments on percent titratable acidity (% TA), total soluble solids (TSS), and pH of bell pepper during storage at ambient conditions. Results showed that EM at the recommended rate (T3 – 0.12%) at 16 fertigations was highest among treatments and lowest in Treatment 2 (0.05) at eight fertigations daily. Varying result for applying organic amendments was observed with varying fertigation frequency. Percent TA is referred to the citric acid content of bell pepper. An interaction effect was also observed on initial TSS between fertigation frequencies with significant differences among treatments at 16 fertigations daily. TSS was highest in Treatment 6 at 2.50 ºBrix compared to other treatments. Total soluble solid is a measurement of the sweetness of fruit or vegetables expressed in ºBrix. An interaction effect with significant differences among treatments was observed on initial pH, with the highest in Treatment 2 (6.49) at eight fertigation frequencies and the lowest in Treatment 6 (6.07) at 16 fertigations daily. Different effects on the pH of bell pepper fruit on varying fertigation, along with the application of different organic amendments, were observed. An interaction effect was observed on Vitamin C, with the highest on 16 fertigations daily (26.18) compared to 8 fertigations daily (20.44).

Moreover, Treatment 3 (29.11) was highest at 16 fertility rates and lowest in Treatment 7 (16.81) at eight fertility rates daily. Bell pepper contains ascorbic acid, a type of organic acid in fruit and vegetables, and a reference for taking the amount of Vitamin C through titration. Vitamin C is essential in building up the human body's resistance to several diseases. Its antioxidant property is associated with the reduction of cancer incidences. Bell pepper contains ascorbic acid, a type of organic acid in fruit and vegetables, and a reference for taking the amount of Vitamin C through titration. Vitamin C is essential in building up the human body's resistance to several diseases. Vitamin C effectively protects oxidative damage in tissues and suppresses the formation of carcinogens like nitrosamines (Gorton & Javis, 1999). As a result, the WHO estimated an increase of over 10 million new cancer cases. Lupulescu (1990) reported that Vitamin C has a role as an antioxidant and added that it reacts with compounds like histamines and peroxides to reduce inflammatory symptoms. Its antioxidant property is associated with the reduction of cancer incidences.

Table 4. Percent titratable acidity (% TA), total soluble solids (TSS), pH, and vitamin C of a bell pepper at harvest with interaction effect during storage at the ambient condition as affected by fertigation frequency and organic amendments

Main Plot	TA (%) Harvest		TSS (ºBrix) Harvest		pH Harvest		Vitamin C Harvest	
Fertigation Frequency	A 8x/day	B 16x/day	A 8x/day	B 16x/day	A 8x/day	B 16x/day	A 8x/day	B 16x/day
Means	0.08	0.09	1.85	1.93	6.32	6.26	20.44b	26.18a
Sub-Plot								
Organic Amendment								
T1-Water	0.08b	0.09ab	1.70ab	2.07ab	6.24b	6.22b	19.68ef	25.42abcd
T2-EM 1L: 400L	0.05b	0.08b	1.80ab	1.80ab	6.49a	6.30ab	20.50def	26.24abc
T3-EM 1L: 500L	0.07b	0.12a	2.07ab	1.70ab	6.34ab	6.27ab	19.27ef	29.11a
T4-EM 1L:600L	0.07b	0.08b	2.00ab	2.07ab	6.24b	6.22b	23.37bcde	26.65abc
T5-HA 150g:100L	0.09ab	0.07b	1.67b	1.80ab	6.43ab	6.32ab	22.96cde	22.14cde
T6-HA 100g:100L	0.10ab	0.10ab	1.87ab	2.50a	6.33ab	6.07b	20.50def	25.42abcd
T7-HA 50g:100L	0.08b	0.09ab	1.87ab	1.60ab	6.20b	6.44ab	16.81f	28.29ab

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CV (%) A	31.25	31.25	31.33	31.33	2.28	2.28	8.26	8.26
CV (%) B	28.84	28.84	12.43	12.43	1.67	1.67	12.69	12.69

Means within parameters with the same letter designation are not significantly different based on the 5% Least Significant Difference (LSD) Test

The final percent titratable acidity (% TA), total soluble solids (TSS), and pH of bell pepper with interaction effect on the seventh day of storage at ambient conditions as affected by fertigation frequency and organic amendments can be observed in Table 5. The result showed no significant differences in bell pepper's % TA, TSS, pH, and Vitamin C.

Table 5. Percent titratable acidity (TA%), total soluble solids (TSS), pH, and Vitamin C at day 7 of bell pepper storage at ambient conditions as affected by fertigation frequency and organic amendments.

Fertigation Frequency	TA (%) Day7	TSS (ºBrix) Day7	pH Day7	Vitamin C Day7
A – 8 times daily	0.16	2.50	6.59	18.16
B – 16 times daily	0.18	2.59	6.52	17.77
Organic Amendment				
T1-Water	0.17	2.73	6.53	17.55
T2-EM 1L: 400L	0.13	2.60	6.70	18.53
T3-EM 1L: 500L	0.18	2.63	6.51	22.43
T4-EM 1L:600L	0.16	2.43	6.66	16.77
T5-HA 150g:100L	0.18	2.60	6.32	15.80
T6-HA 100g:100L	0.20	2.27	6.54	17.75
T7-HA 50g:100L	0.17	2.57	6.63	16.97
CV (%) A	18.44	11.35	1.64	19.09
CV (%) B	31.09	12.96	3.67	25.75

Means in a column with the same letter designation is not significantly different from each other based on the 5% level of Tukey's Honest Significant Difference (HSD) Test.

Significant results among treatments were observed in Table 6 with an interaction effect on fertigation frequency and the application of organic amendments for chlorophyll a/b, total Chlorophyll, and total bell pepper carotenoids. Treatment 6 has the highest Chlorophyll at 14.62 and Treatment 5 at 14.55 at 8 and 16 fertigations daily, respectively. For Chlorophyll b, Treatment 5 has the highest, which is 30.70 at eight fertilizers, and Treatment 5 at 25.17 in 16 fertilizers daily. Treatment 6 (41.96) obtained the highest in total Chlorophyll at eight fertilizations daily and Treatment 5 at 39.72 in 16 fertilizations daily. Total carotenoids were highest in Treatment 2 (4.43) at eight fertilizers daily and 3.85 at 16 fertilizers daily. Different effects on bell pepper pigment were obtained at varying fertigation frequencies and by applying different concentrations of organic amendments. Chlorophyll a/b, total Chlorophyll, and total carotenoids at eight fertigation frequencies showed significant results applying organic amendments and in 16 fertigation frequencies. Results were more or less similar with chlorophyll a/b and total Chlorophyll affected by the humic acid application and total carotenoids by the application of effective microorganisms. Free radical scavenging activity (FRSA) of bell pepper obtained highest at 16 fertigations daily with the application of higher concentration of EM (T2-42.04). With this, the frequency of fertigation with the application of organic amendments dramatically influences the quality of bell pepper, specifically chlorophyll a/b, total Chlorophyll, total carotenoids, and FRSA. Consuming bell pepper and including it in our daily diet would significantly reduce the risk for chronic diseases and cancer due to its ample Vitamin C and antioxidant properties.

Kays and Paull (2004) reported that the stability of carotenoids is highly variable; in some fresh crops, degradation occurs in only a few days, while dried crops retained more than 50% of the carotenoids even after three years of storage. They added that several factors affect the rate of carotenoid loss, including the specific pigment, crop type, storage temperature, moisture content, and pre-storage treatments. The breakdown of carotene is of particular concern due to its role as a precursor of Vitamin A as a group. Xanthophylls, such as lutein, are more stable than the carotenes, where the former is esterified and enhances stability in contrast to the carotenes. According to Kader (2007), vegetable quality and quantity losses between harvest and consumption affect crop productivity. It is estimated that the magnitude of the postharvest losses of fresh horticultural crops is from 5 to 25% in developed countries and 20 to 50% in developing countries.

Free radical scavenging activity (FRSA) of bell pepper was significant among treatments with comparable results between irrigation frequency with the application of organic amendments resulting in the highest FRSA in Treatment 2 (27.91 and 42.04, respectively) and lowest in Treatment 1 (13.21 and 13.26, respectively). These results showed that organic amendments tend to enhance the FRSA content of bell pepper. FRSA, or the antioxidant property of particular fruit and vegetables, functions as an inhibitor for the oxidation of molecules by inhibiting the initiation or propagation of oxidizing chain reactions caused by the free radicals substances (Ismail et al., 2004). Antioxidants offer resistance against oxidative stress by scavenging the free radicals, inhibiting lipid peroxidation, and other mechanisms, thus preventing disease progression (Braugher et al., 1986). Reducing the risk of chronic diseases and preventing disease progression is possible by enhancing the body's natural antioxidant defenses or supplementing with dietary antioxidants (Stanner et al., 2000).

Table 6. Interaction effect of chlorophyll a/b, total Chlorophyll, and total carotenoids of a bell pepper at harvest in 8 and 16 fertigation daily as affected by organic amendments.

Main Plot	Chlorophyll a (%)		Chlorophyll b (%)		Total Chlorophyll (%)		Total Carotenoids (%)		Free Radicals (%)	
Fertigation Frequency	A 8x/day	B 16x/day	A 8x/day	B 16x/day	A 8x/day	B 16x/day	A 8x/day	B 16x/day	A 8x/day	B 16x/day
Means	11.42b	13.63a	24.89a	21.79b	36.30a	35.42b	2.41	2.60	21.88	24.23
Sub-Plot										
Organic Amendment										
T1-Water	9.71d	12.58bc	23.68cde	22.68def	33.39ef	35.26cd	2.64c	2.35c	13.21g	13.26g
T2-EM 1L:400L	11.36c	13.49ab	24.22cd	17.39h	35.57c	30.88g	4.43a	3.85b	27.91b	42.04a
T3-EM 1L:500L	11.33c	14.38a	24.62c	21.85fg	35.95c	36.24c	1.51d	2.41c	22.70cd	25.68bc
T4-EM 1L:600L	12.29bc	13.48ab	21.26fg	21.09g	33.55def	34.56cde	3.56b	2.57c	23.33cd	22.68de
T5-HA 150g:100L	11.00c	14.55a	30.70a	25.17c	41.70a	39.72b	0.33e	1.72d	22.19de	21.47de
T6-HA 100g:100L	14.62a	14.38a	27.33b	21.86fg	41.96a	36.24c	1.52d	2.80c	20.20ef	25.87bc
T7-HA 50g:100L	9.60d	12.54bc	22.41fg	22.49ef	32.01fg	35.03cde	2.86c	2.50c	23.60cd	18.59f
CV (%) A	10.44	10.44	4.65	4.65	1.23	1.23	12.66	12.66	8.14	8.14
CV (%) B	5.62	5.62	3.07	3.07	3.21	3.21	10.10	10.10	6.42	6.42

Means within parameters with the same letter designation are not significantly different based on the 5% Least Significant Difference (LSD) Test.

To date, EM has been adopted in over one hundred countries for experimentation, commercial production, and environmental management (Higa, 2012). According to Subadiyasa (1997), EM may interact with the soil-plant ecosystem to suppress plant pathogens and other disease agents, solubilized minerals, conserve energy, maintain the microbial and ecological balance of the soil, increase photosynthetic efficiency, and fix biological nitrogen. These results would be auspicious in the soilless production of different vegetables. Considerable interest then led the developers of EM to promote the technology more widely. Beneficial commercial cooperation between Kyusei Nature Farming and EM Technology soon resulted in positive effects on Japanese ecosystems (Higa, 2012).

HA is technically not a fertilizer, although, in some walks, people do consider it. Humic acids are an effective agent to use as a complement to synthetic or organic fertilizers. Regular humic acid use often reduces the need for fertilization due to the soil and plant's ability to make better use of it. In some instances, fertilization can be eliminated if sufficient organic material is present, and the soil can become self-sustaining through microbial processes and humus production. Applying EM and HA improves the quality of lettuce, especially Vitamin C, FRSA, Chlorophyll a/b, Total Chlorophyll, and Total carotenoids, and a promising result with the increase of application of the amount of nutrient solution.

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