ISSN: 18158129 E-ISSN: 18151027
Volume 18, Issue 06, June, 2022

Potential Impact of SRF-PB on Bell Pepper Growth and Yield (*Capsicum annuum* L.)

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ABSTRACT— Slow- and controlled-release fertilizers (S-CRF) were proposed as a compound to improve the nutrient use efficiency of plants and hence considered a response to address the problems due to the growth of the world's population and water shortage of bell pepper. Thus, this study adapted a physical barrier to help regulate a gradual release of fertilizer from the soil use of plastic bottle barriers. It aimed to evaluate the potential investigation of the effects of the slow-release fertilizers – plastic bottles of barriers (SRF-PB) and CRF on the growth and fruit yield. The experiment was laid out in RCBD with treatment (7) and replications (3). It was assigned as T_0 - control, T_1 - conventional application of fertilizer, T_2 - commercial CRF; and T_3 - 25%, T_4 - 50%, T_5 - 75%, and T_6 - 100% at the holed portion in SRF-PB. The results revealed that utilizing had significantly $(p < 0.05)$ increased the plant height on T_1, width of leaves and length of leaves on T_1; fresh dried on T_1 and oven-dried on T_2; early-to-flowering on T_2 and fruiting set between T_1 and T_2; and root characterizing were weight root, length root, and roots density with T_1 and T_2; T_2; and T_1 and T_6, respectively, the growth period of bell pepper. Furthermore, the specific higher root density of T_6 and T_2*'s* nutrient utilization efficiency has improved, resulting in a significant $(p < 0.05)$ due to the rise in T_2 and T_6 high yield of harvested fruits. In conclusion, SRF-PB of T_6 could be an alternative means for commercial T_2 in terms of achieving better productivity of bell pepper.

KEYWORDS: CRF, SRF-PB, Bell Pepper, Parameter Growth, Yield

1. INTRODUCTION

Green bell pepper is an annual plant that belongs to the Solanaceae family and is considered one of the most widely used condiments because of its increased palatability and taste of cooked vegetables [1] and higher nutrient content of minerals, vitamins, and potassium [2]. Economically, the green bell pepper plant was a high-value crop that provides higher net income to farmers. Because of this, it was highly recommended for cultivation in a large-scale system in the Philippines [3]. However, the total yield of bell pepper production continued to decline each year with an average decrease of 0.71% [4]. These decrements in yield are attributed to declining soil fertility [5]. This may therefore contribute to crop removal, soil erosion, and poor land management practices. To address such conditions, the use of inorganic fertilizers was initiated to supplement the available nutrients in the soil [6]. However, the conventional way of applying fertilizer to the soil had possessed a great concern about whether these are totally absorbed by crops or not. Taking up the nutrients required by crops may take some time or maybe be reduced due to evaporation, leaching, and soil erosion, especially in those areas that have heavy rainfall incidence. These excessive nutrient losses brought about by runoff of water inevitably pollute the river. The adverse effect of inorganic fertilizer spillage can be prevented when fertilizer nutrient release will be controlled with the use of a CRF. The CRF has been identified as the best cultural and management practice as it supplies localized nutrients to the surrounding substrates over some time [7].

CRF had proven to improve nutrient use efficiency and sustain high yields while reducing the environmental hazards associated with the nutrient loss [8]. Through this technology, farmers could have gained assurance that the fertilizer they applied was fully utilized during the crop's production period. Although in earlier sweet pepper studies it was found that a single basal application of CRF produced similar or better yields than the control fertilization methods [9- 12], in none of these experiments CRFs were compared to fertigation. Similarly, the Dept. of Horticultural Technology, Hungary was CRF of sweet peeper could be produced compared to the 2001 and 2002 with CRF 50% (15.4 N, 4.3 P_2O_5 and 15.4 K_2O) and CRF 90% (30.8 N, 8.6 P_2O_5 and 30.8 K_2O); and CRF 50% (15.0 N, 8.0 P_2O_5 and 16.0 K_2O) and CRF 90% (27.0 N, 14.0 P_2O_5 and 29.0 K_2O), respectively [12]. Regardless, Nitrogen compounds decomposed by microorganisms were commonly called slow-release fertilizers (SRFs). Slow-release fertilizers were the fertilizers characterized by the release of nutrients at a slower rate but the factors such as rate, pattern, and duration of release were not well controlled and may be strongly affected by handling conditions such as storage, transportation, distribution in the field and soil conditions such as moisture content and biological activity [13], [14]. Natural SRFs were plant manure, animal manure, and compost [15]. Consequently, water-soluble, SRFs and CRFs with Ammonium nitrate (dissolves all at once), non-coated (slowly decomposes to soluble N), and coated (nutrients "leak" through coating), respectively [16]. Henceforth, the use of synthetic slow- and controlled releases fertilizers (S-CRF) was very expensive in which low-earner farmers could hardly avail themselves. Thus, this study introduces an alternative way to control the release of fertilizer by utilizing plastic bottles (PB) as a physical barrier to slow releases having tiny holes to initiate a gradual release of fertilizer in crops' fragile soil environment. It specifically aimed to determine the effect of using CRF and SRF-PB as an alternative technology on the growth and yield of the green bell pepper.

2. Material and Methods

2.1 Experimental Design

The experiment was laid out in a Single Factorial following the Randomized Complete Block Design (RCBD) with six (6) treatments and replicated three (3) times with eight (8) samples. The six treatments were assigned as follows: T_0 – Control, T_1 - Conventional Fertilizers (water-soluble), T_2 - Commercial Fertilizer (CRF); and T_3 - 25%, T_4 - 50%, T_5 - 75%, and T_6 - 100% at the holed portion of SRF-PB.

2.2 Preparation of Plastic Bottle

A 200 ml plastic transparent barrier was utilized as a PB. These PB were thoroughly washed with clean tap water. After which, it was individually holed at an equal distance of 2 cm apart with approximately 0.5 mm diameters by using a tire wire.

2.3 Application of SRF and CRF

Before planting, a 10 *g*/hill Complete Fertilizer (14-14-14), 15 *g*/hill Urea (46-0-0), and 10 *g*/hill Muriate of Potash (0-0-60) were applied to satisfy the recommended rate of NPK fertilizers for green bell pepper. Fertilizer materials previously mentioned having the same rate of application were mixed in the soil and were placed individually inside the SRF-PB. Whereas, the commercial fertilizers of CRF *"osmocote"* were applied in the field for about 5 *cm* depth with a distance of 10 *cm* apart from the base of green bell pepper. Meanwhile, for conventional application of fertilizer, 10 *g*/hill of Complete Fertilizer (14-14-14) was applied during planting. Green bell pepper was a side dress with Urea (46-0-0) at the rate of 15 *g*/hill. At the flowering stage, 10 *g*/hill of Muriate of Potash (0-0-60) were applied.

2.3 Cultural Management Practices

2.3.1 Land Preparation

The total land area of 200 *sq*. meters was cultivated thoroughly employing plowing and harrowing using carabao-drawn implements to remove the weeds and to pulverize the soil before planting. This was then divided into blocks having a dimension of 1 *m* wide and 3 m long represented as one treatment with an alleyway of 0.25 *m*.

2.3.2 Seed Sowing and Seedling Preparation

The seeds of green bell pepper were sown in a seedbox and were placed in a modified shed house with plastic film roofing to protect the seedlings from direct rainfall. It was then being watered every morning. After 6-8 days of seed germination when the seedlings have reached the two-true leaf stage, pricking was done by transferring the individual seedlings in a seedling tray. Hardening was done after and lasted for one week by gradually exposing the seedlings to sunlight and/or outdoor conditions before transplanting.

2.3.3 Transplanting of the Seedlings

Vigorous seedlings of the green bell pepper plant from the seedling tray were considered as sample plants which were transplanted at about 15-20 *cm* depth with a space of 75 *cm* between rows and 25 cm between hills in double row planting.

2.3.4 Harvesting

A priming method of harvesting was employed, picking only those that were adequately mature or as the green bell pepper reached physiological maturity. Harvesting was done early in the morning. The harvested green bell pepper was classified or graded and weighed after harvest.

2.3.5 General Cares and Managements

Application of water was employed early in the morning about 6 am. Manual weeding was done as the weeds appeared by using a trowel or bolo. Hilling up was done to avoid the roots being exposed to sunlight from above ground. Monitoring of insect, pest, and disease infestation was done daily. Pest control measures were applied with the application of crushed garlic with hot chili pepper as an organic pesticide.

2.4 Data gathered

The data gathered from the start of the study until the study terminated were the following:

2.4.1 Horticultural Parameters

a. Plant height (cm). This parameter was gathered by measuring the height of 3 sample plants taken at random from each treatment plot from the base of the plant until the longest leaf of the plant using the meter stick.

b. Number of days from transplanting to flowering. This was recorded by counting the number of days from transplanting up to the time when 50% of the plants in each treatment had produced flowers.

c. Number of days from transplanting to fruiting set. This was taken by counting the number of days from transplanting up to the time when 50% of the plants in each treatment had produced fruits.

2.4.2 Root Characteristics

The researchers examined root weight ratio, length, and density root data from a variety of experimental investigations that recorded plant growth allocation changes in response to different treatments.

2.4.3 Yield and Yield Components

Three sample plants were randomly taken from the inner rows of each treatment plot and were used for the following parameters:

a. Number of fruits per plant. This was determined by counting the number of fruits that developed per sample plant per treatment before harvest.

b. Weight of marketable and non-marketable fruits harvested. This was obtained by weighing the marketable and non-marketable fruits harvested per plant per treatment using a weighing scale.

c. Fruit yield (t/ha). This was obtained by weighing the harvested fruit per treatment.

2.5 Data analyses

Data analyses were done using the Statistical Tool for Agricultural Research (STAR), Plant Breeding Genetics and Biotechnology Biometrics and Breeding Informatics, version 2.0.1 (2014). Treatment means were compared using Least Significance Difference (LSD) at a $p < 0.05$ level of significance.

3. Results and Discussion

3.1 Horticultural Growth Characteristics

3.1.1 Plant height (cm)

The plant height was significantly $(p < 0.05)$ affected by the different applications of control release fertilizer treatments of a green bell pepper at days after transplanting (DAT) (Table 1a). Its convention fertilizer T_1 (46.94 cm) of the tall plant height as compared to the control (T_0) as well as on other SRF-PB $(T_3$-$T_5)$ treatments of green bell pepper. The T_1 was a comparable effect with T_2 and T_6.

3.1.2 Width of leaves (cm)

The application of S-CRF had significantly $(p < 0.05)$ influenced the width of leaves of a bell pepper at DAT (Table 1b). The conventional way of fertilizer application (T_1) had significantly $(p < 0.05)$ influenced more width leaves as compared to CRF and SRF-PB $(T_2$ -$T_6)$ application and the control (T_0) for the rest of the growing period. The convention fertilizer T_1 (19.64 cm) of the width leaves of the treatments of green bell pepper.

3.1.3 Length of leaves (cm)

The length of leaves was significantly $(p < 0.05)$ affected by the application of green bell pepper at DAT (Table 1c). The conventional way of fertilizer application (T_1) had longer leaves from among the treatments. The convention fertilizer T_1 (120.93 cm) of the long leaves of the treatments of green bell pepper. The T_1 (water-soluble/conventional fertilizer) had a comparable effect to T_2 and T_6.

The plant height (taller), the width of leaves (more), and length of leaves (longer) of green bell pepper as conventional fertilizer (T_1) recorded [17] have much better leavers of slow and controlled release of fertilizer (S-CRF). However, treatment applied by CRF of N, K_2O, and P_2O_5 showed the highest weight of loose leaves [18]. Similarly, differences between the treatments in N, P_2O_5, and K_2O were bigger in 2002 than in 2001 [12]. Amazing leaves, especially the lower ones, were chlorotic (deficiency of iron or manganese) of Locascio [19], who observed that yield and dry weight (DW) of pepper plants were reduced when soluble N sources were used. Nevertheless, after treating green bell pepper produce, the waste remains (stem and leaves), effectuating the profitability of raw material to achieve phytochemical compounds [20]. Henceforth, stem diameter was related to the upper plant leaf dry weight, leaf area, and the capacity of plants to transport water from the soil to leaves [21]. In general, sun leaves have greater photosystem activity, acceleration of electron transport, quantum yield, carboxylation efficiency, and photosynthetic capacity compared with shade leaves difficulty the larger leaves, greater whole-plant leaf area, thinner leaves, and longer internodes (i.e., lower SLW (DW/leaf area) [22- 24], [21]. Consequently, the water use efficiency of shaded leaves was higher than for unshaded leaves [25]. Accordingly, to Larcher [21], plants adapted to shade have a later foliar surface; and specific leaf area and thinner leaves compared with plants accustomed to strong light [21]. Leaves adapted to low light have larger chloroplast size and greater chlorophyll content per chloroplast than leaves adapted to strong light.

Table 1a, 1b, and 1c. Plant height, width, and length of leaves of a green bell pepper were recorded at 70 days of transplanting (DAT) *(cm)*.

Treatments*	[d]Plant Height	[e]Width of Leaves	[f]Length of Leaves
T_0	29.44 c	14.17 c	69.90b
T_1	46.94 a^z	19.64 a^z	120.93 a^z
T_2	40.94 ab	17.48 ab	95.06 ab
T_3	34.00 bc	13.85 c	71.08 b
T_4	32.91 bc	15.53 bc	74.77 b
T_5	35.05 bc	15.84 bc	69.39 b
T_6	37.88 abc	15.29 bc	97.43 ab
CV (%)	*14.76*	*12.45*	*19.28*

**T*_0_ – control; T_1_ – convention fertilizes; T_2_ – commercial CRF; T_3_ - 25% holed portion of SRF-PB; T_4_ - 50% holed portion of SRF-PB; T_5_ - 75% holed portion of SRF-PB; T_6_ - 100% holed portion of SRF-PB.*

[d,e,f] – plant height, and width and leaves of leaves

[z]Mean separated within columns (by the main factor and by treatment) by the LSD test ($p < 0.05$).

3.1.4 Fresh dried and oven-dried weight roots of foliage (g/plant)

The fresh and oven-dried weight of roots was significantly ($p < 0.05$) influenced by the application of SRF-PB and CRF (Fig. 1). The T_1 and T_2 were 190 g of fresh dried and 53 g of oven-dried weight roots of foliage in the treatment, respectively. The conventional (T_1) had achieved the heavier foliage weight while T_2 had obtained the weighty oven-dried of roots as compared to the T_0. However, a comparable effect was observed from the rest of the SRF-PB treatments, except for T_3 (fresh weight) and T_5 (fresh weight and oven-dried weight) for the dominance of weight achieved by T_1 and T_2, respectively. It showed that conventional fertilizers, CRF and SRF promote better foliage production and accumulate a stable nutrient translocation towards the leaves for the build-up of leaf tissues [26].

3.1.5 Flowering and fruiting sets duration of green bell pepper

The application of T_2 had significantly ($p < 0.05$) influenced the duration of the flowering and fruiting set of green bell pepper (Fig. 2). Early flowering was experienced from T_1 and T_2 as compared to the T_0. The 31 days (T_1) and 32 (T_2) of flowering, and 48 days (T_2) of the fruiting set of green bell pepper in the treatment. This shows that T_2 provides better nutrients released that will be able to enhance the early fruiting set of green bell pepper. But it shows comparable fruiting set effect among all treatments, except for T_3 wherein only T_3 was made from SRF-PB which possibly triggered a constant release of nutrients resulting in a late fruiting set period of green bell pepper.

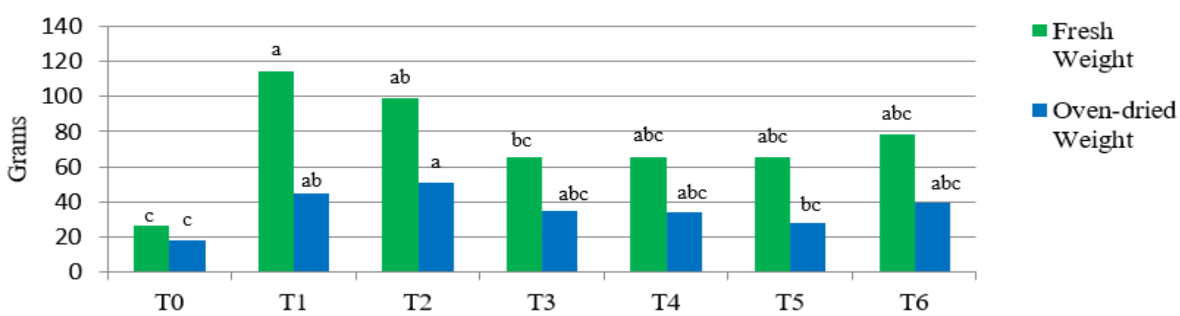

Figure 1. Fresh weight and oven-dried weight were recorded at 70 days of green bell pepper foliage.

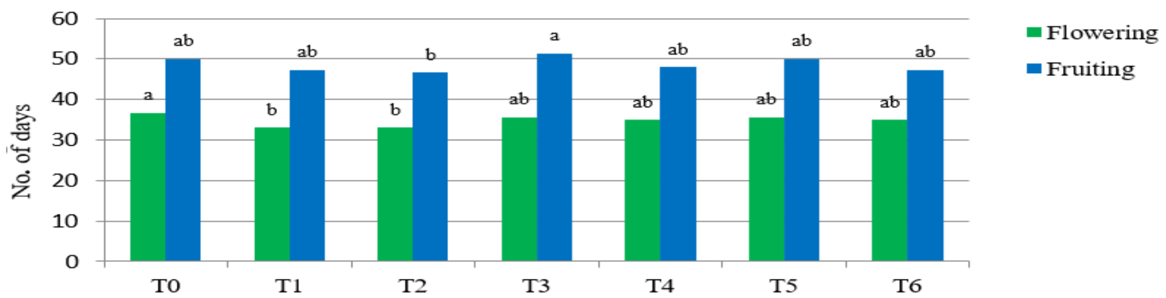

Figure 2. Flowering and fruiting set duration was recorded at 70 days of green bell pepper.

3.2 Root Characters of Green Bell Pepper

3.2.1 Weight, length, and density of roots

The application of SRF-PB to green bell peepers influenced the weight, length, and density of roots significantly *($p < 0.05$)* of root characters in the treatments. The T_1 and T_2 treatments of green bell pepper had significantly *($p < 0.05$)* heavier weight and length of root mass (Tables 2a and 2b), with 11.88 g and 31.16 cm, and 9.66 g and 26.55 cm, respectively. However, all SRF-PB treatments *(T_3-T_6)* had a similar effect on the weight of T_0 roots. In terms of length of roots, T_1 showed longer roots but exhibited a comparable effect with the rest of the treatments except for T_3.

Correspondingly, T_1 and T_6 have obtained a higher root density than the T_0 although showed comparable effects with the rest of the CRF and SRF-PB *(T_2-T_6)* applications (Tables 3c). The 0.32 ml of T_1 of roots density of green bell pepper. It signifies that T_6 as an innovative way for SRF application was a more effective means in root production of green bell pepper as it provides a similar effect to the conventional way of fertilizer application *(T_1)*.

This correlates to the study of Kohut [27] wherein controlled-release fertilizers can be expected to be adopted most rapidly in locations such as high rainfall areas or sandy soils. Numerically, from among the SRF treatments and CRF, T_1 and T_6 achieved the density of the roots of green bell pepper fruit. This could be attributed to better foliage achieved by T_1 and T_6 and higher root density produced. According to Wang's [28] findings, plants with a higher root density absorbed the most nutrients, resulting in more vigorous plant growth.

Table 2a, 2b, and 2c. Root characteristics were recorded at 70 days of green bell pepper.

Treatments*	[d]Weight of Roots *(g/plant)*	[e]Length of Roots *(cm)*	[f]Roots Density *(ml)*
T_0	2.61b	28.61 ab	0.13 b
T_1	11.88a	31.16 a	0.32 a^z
T_2	9.66 a^z	26.55 a^z	0.22 ab
T_3	6.11 ab	27.17 ab	0.22 ab
T_4	7.00 ab	23.89 b	0.26 ab
T_5	7.22 ab	26.27 ab	0.17 ab
T_6	7.22 ab	25.55 ab	0.30 a^z
CV (%)	*46.58*	*14.85*	*35.65*

**T_0 – control; T_1 – convention fertilizes; T_2 – commercial CRF; T_3 - 25% holed portion of SRF-PB; T_4 - 50% holed portion of SRF-PB; T_5 - 75% holed portion of SRF-PB; T_6 - 100% holed portion of SRF-PB.*

[d,e,f] - Weight and length of roots, and roots density

[z]Mean separated within columns (by the main factor and by treatment) by the LSD test ($p < 0.05$).

3.3 Yield and Yield Component

3.3.1 Fruit quality

ISSN: 18158129 E-ISSN: 18151027
Volume 18, Issue 06, June, 2022

The application of SRF-PB had significantly *($p < 0.05$)* affected the length and diameter of fruits, except however on the diameter of basal was non-significant (Table 3a and 3b). The application in the T_6 and T_2 was 100% holed SRF-PB of 13.59 cm and commercial CRF of 13.51 cm had significantly *($p < 0.05$)* longer fruit length of green bell pepper of harvest, respectively. The distal part diameter of 2.63 cm *(T_1)* and 12.36 - 13.09 *(T_1-T_6)* range of equatorial diameter significantly *($p < 0.05$)* influenced of achieved wider fruit in the harvest, respectively. The length of green bell pepper was within the range or even higher than the fruit length (7-10 cm of equatorial diameter) reported by Featherstone [29].

Table 3a and 3b. Length and diameter was recorded at 70 days of green bell pepper fruit *(cm)*.

Treatments*	^{d}Length Fruits	^{e}Diameter Fruit		
		^{e1}Distal	^{e2}Equatorial	^{e3}Basal
T_0	11.43 b	2.15b	10.96 b	8.09
T_1	11.70 ab	2.63 a^z	12.36 a^z	9.15
T_2	13.51 a^z	2.32 ab	12.18 a^z	8.49
T_3	12.43 ab	2.37 ab	12.41 a^z	8.75
T_4	12.03 ab	2.41 ab	12.35 a^z	8.21
T_5	12.74 ab	2.51 ab	12.51 a^z	8.92
T_6	13.59 a^z	2.46 ab	13.09 a^z	8.74
CV (%)	*9.08*	*9.03*	*4.36*	*8.38*

**T_0 – control; T_1 – convention fertilizes; T_2 – commercial CRF; T_3 - 25% holed portion of SRF-PB; T_4 - 50% holed portion of SRF-PB; T_5 - 75% holed portion of SRF-PB; T_6 - 100% holed portion of SRF-PB.*
$^{d,e(e1,e2,e3)}$ - Length of fruits and Diameter: distal, equatorial and basal
^{z}Mean separated within columns (by the main factor and by treatment) by the LSD test ($p < 0.05$).

3.3.2 Yield of marketable and non-marketable fruits

The marketable and non-marketable fruits were significantly *($p < 0.05$)* affected by the green bell pepper (Table 4a). The T_2 and T_6 were 1134 kg of complete CRF and 1192 kg of 100% holed portion of SRF-PB, respectively. It was significantly *($p < 0.05$)* affected had achieved a T_3-T_5 and T_0 in the treatment. The T_2 and T_6 had longer fruit on high-yields of green bell pepper of harvest. However, Haifa [26] and Ullah [30] reported that the application of CRF significantly *($p < 0.05$)* influent applicants of N, P, and K on the increased fresh yield of cabbage. In the upland field, cabbage yields were high when chemical fertilizer was applied by Naher [18] and Kamiyama [31]. The crop production system with high yield targets cannot be sustainable unless nutrient inputs to soil were at least balanced against nutrient removal by crops Naher [18] and Jahiruddin [32].

3.3.3 Yield of green bell pepper

The results of the actual and computed yield of the green bell pepper per hectare (Table 4b). It shows that among the treatments with SRF application of T_6 and T_2 were 12.42 and 11.82 t/ha giving a considerable high actual yield, respectively. Meanwhile, in terms of computed yield, results revealed that T_6 followed by T_2 shows a numerically higher value when compared to other treatments especially T_3, T_4, and T_5 (conventional and other SRF treatments), and the T_0 (control). The T_6's computed yield of 12.42 t/ha in soil chemical properties experiments [33], which was roughly one-quarter as high as the average state yield of green bell peppers, but was recorded output of 9.8 t/ha or 4 t/acre reported by Islam [34]. This indicates that the average yield of green bell pepper obtained by the application of 100% SRF-PB treatment could surpass the influence of conventional and commercial CRF. However, the yield of cabbage was very low in the Philippines compared to other developed countries due to unbalance application of fertilizer or no consideration for N, P, and K [35]. Henceforth, farmers could have been confident that the fertilizer-plastic bottle barriers they used were fully utilized throughout the growing season of their crop (Fig. 3).

Table 4a & 4b. Marketable and non-marketable; and foliage yield was recorded at 70 DAT of green bell pepper (*t/ha*).

Treat-ments*	dNon-marketable Number of transplanting per plant					eMarketable Number of transplanting per plant					fTotal Yield Computed
	56 DAT	*60 DAT*	*64 DAT*	*70 DAT*	*Total (g/fruit)*	*56 DAT*	*60 DAT*	*64 DAT*	*70 DAH*	Total *(g/fruit)*	
T_0	22 c	34 ab	38	1	96	112 b	120 ab	129 a	98	460	5.79 c
T_1	114 a	16 b	51	11	193	132 ab	56 b	249 a	191	629	7.76 b
T_2	109 ab	45 ab	63	8	226	246 a	95 ab	357 a	207	907	11.82 a^z
T_3	54abc	16 b	85	2	157	113 b	98 ab	201 a	165	577	8.85 b
T_4	31 bc	47 ab	47	16	143	112 b	91 ab	180 a	183	556	7.28 b
T_5	23 c	16 b	84	16	139	144 ab	84 ab	204 b	216	648	8.22 b
T_6	94 abc	68 a	46	8	216	166 ab	167 a	377 a	264	975	12.42 a^z
CV(%)	*29*	*38*	*36*	*12*	*38*	*48*	*5*	*66*	*49*	*49*	*27.32*

**T0* – control; T_1 – convention fertilizers; T_2 – commercial CRF; T_3 - 25% holed portion of SRF-PB; T_4 - 50% holed portion of SRF-PB; T_5 - 75% holed portion of SRF-PB; T_6 - 100% holed portion of SRF-PB.

d,e,f - Market and non-market, and total yield

zMean separated within columns (by the main factor and by treatment) by the LSD test ($p < 0.05$).

T_0 - Control | *T_1 - Convention fertilizer* | *T_2 - Commercial CRF* | *T_3 - 25% SRF-PB* | *T_4 - 50% SRF-PB* | *T_5-75% SRF-PB* | *T_6 -100% SRF-PB*

Figure 3. *SRF- plastic bottles, CRF, and conventions with fertilizers during the crop's production period.*

4. Conclusion

Based on the result of the study, the application of treatment T_1 (convention fertilizes) and T_2 (CRF) gave a significantly *($p < 0.05$)* influenced result in terms of plant height, the width of leaves, length of leaves, fresh and oven-dried, early-to-flowering, and fruiting, root characteristics of green bell pepper, and yield. As a result, the T_6 (100 % holed portion of SRF) and T_2 treatments achieve a considerably better impact on yield.

5. Recommendations

Since the study was conducted during the dry season with limited erosion occurring for the leaching effect of nutrients from the soil, follow-up studies on the application of innovative fertilizer during the rainy season should be conducted for the validation of the significance ($p < 0.05$) effect outcome of the study. Furthermore, other sizes of plastic bottles of barriers were suggested to be used for another study as treatments.

6. Acknowledgement

The authors are grateful to our researcher and, to a lesser extent, the Northwest Samar State University (NwSSU) research plan, as well as the reviewers of this paper for their helpful comments and improvements during the experiments.

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