BALANCED FERTILIZATION STRATEGY FOR SEMI-TEMPERATE VEGETABLES IN THE HIGHLANDS, PHILIPPINES

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ABSTRACT

On station and on farm experiments in the highlands were conducted to come up with a balanced fertilization strategy for selected semi-temperate vegetables. Cabbage, broccoli, carrots, bell pepper, and potato which are the major crops grown in the highlands were subjected to 24 fertilizer combinations. Ten best treatments were selected from initial experiments for verification and evaluation. Three trials for cabbage, broccoli, and potato while two trials for carrots and bell pepper were done.

On station results on cabbage showed that application rate of 250-100-100 kg $NP_2O_5K_2O$/ha + 7 tons/ha chicken manure significantly produced the heaviest with bigger and more compact cabbage heads. Similar results were noted from on farm trial. Marketable tuber yield of potato was highest with the application of 140-140-140 kg $NP_20_5K_20$/ha + 5 t/ha formulated organic fertilizer + Boron. For broccoli, fertilizer rate of 240-60-60 kg $NP_20_5K_20$/ha + 5 tons/ha formulated compost + Boron produced the heaviest yield and biggest curds. Reducing the recommended rate by 25% with chicken manure and Boron supplementation gave comparable yields. Bell pepper produced the heaviest at a fertilizer rate of 100-200-100 kg $NP_20_5K_20$/ha + Boron. Application of the recommended rate of 100-200-100 kg NP_20_5,K_20/ha+ 5 tons/ha formulated organic fertilizer + Boron gave comparable yield. On carrots, the heaviest yield was noted from application of 90-170-90 kg NPK/ha + Boron though it did not differ significantly from other treated plants. Higher return on investments was realized in most treatments with reduced fertilizer application.

The effects of the treatments on soil properties differ from each area planted with the test crop. An improvement in soil organic matter was noted in most treatments involving organic fertilizer application. While a general decrease in soil pH were noted from those treated with higher rate of inorganic fertilizers. Results indicated that combined application of organic-inorganic fertilizer proved to be more effective in terms of crop responses and on soil properties.

INTRODUCTION

Intensive land cultivation coupled with continuous and sometimes over application of inorganic fertilizers being practiced by highland farmers of Northern Philippines resulted to soil acidification and soil fertility depletion. These practices aggravated the occurrence of diseases like club root, scab and others. With these problems, balanced fertilization of the crops is encouraged.

Balanced fertilization strategy (BFS) involves the optimum use of organic and inorganic fertilizers with the proper grade and amounts to supply the correct ratio of plant nutrients to ensure that the soil will sustain high crop yields. It is primarily designed to supplement limiting nutrients (Govit and Kaore, 1997 as cited by Concepcion *et al*., 1998). Timely correction of nutrient deficiencies is vital to sustain high crop yields that can be solved by adopting the balanced fertilization strategy through integrated nutrient management, judicious and combined use of several nutrient sources. Presently, BFS technology is developed and adopted only for rice. No published reports were made on BFS technology specifically for semi-temperate vegetables while BFS for corn is on-going.

The research was conducted to formulate balanced fertilization strategy for the major semi-temperate crops such as broccoli (*Brassica oleraceae* Botrytis group), cabbage (*Brassica oleraceae* Capitata group), potato(*Solanum tuberosum*), carrot (*Daucus carota* L.), and bell pepper (*Capsicum annum*), to determine the effect of fertilization on some soil chemical properties, and the effect on the yield. It was conducted at the Benguet State University Experimental Station, Soil Science Department, College of Agriculture, La Trinidad, Benguet from March 2005 to April 2007; and at farmer's fields in Paoay, Atok, Benguet and Loo, Buguias, Benguet from January 2006 to June 2006.

MATERIALS AND METHODS

Rooted stem cuttings of potato (cv. Igorota/ BSUPo3) were used in the study for the first trial due to unavailability of potato tuber as planting materials. Two week-old stem cuttings were transplanted in the experimental area four days after application of organic fertilizers. First hilling-up was done two weeks after transplanting and the second hilling-up, three weeks after. Potato seed tubers (cv. Granola) were used during the succeeding trials.

The experimental area for cabbage was limed at a rate of 4 kg/plot (8 t/ha) using $CaCO_3$ three weeks before transplanting to adjust soil pH to 6.2. Cabbage seedlings (cv. Scorpio) were transplanted four days after application of organic fertilizers. For the second trial, no lime was applied because the soil pH was within the desirable pH for cabbage. Broccoli (cv. Nomad), carrot (cv. Kuroda), and bell pepper (cv. California wonder) were likewise planted four days after application of organic fertilizers.

There were 24 treatments laid out in 1 x 5 meter plot following the Randomized Complete Block Design (RCBD) with 3 replications for the two trials.

The number of treatments was reduced to ten in the third trial based on the best treatments observed from the two trials except for the control.

The organic fertilizers (chicken manure and formulated organic fertilizer) were applied once (during planting) and the inorganic fertilizer in split application where half of the fertilizer required was applied before planting and the other half was applied one month after planting . Five (5) ppm boron as micronutrient supplement was applied one month after planting as foliar spray and was applied once a week thereafter. Application was stopped three (3) weeks before harvesting.

The original fertilizer treatments of the studies where the best treatments were derived are as follows:

T1 - Control (no fertilizer application)
T2 – Farmers Practice
(140-140-140 kg/ha N, P_2O_5, K_20 + 7 t/ha chicken manure - POTATO)
(250-100-100 kg/ N, P_2O_5, K_20 + 7 t/ha chicken manure - CABBAGE)
(240-60-60 kg/ha N, P_2O_5, K_20 + 7 t/ha chicken manure - BROCCOLI)
(90-170-90 kg/ha N, P_2O_5, K_20 + 7 t/ha chicken manure - CARROT)
(100-200-100 kg/ha N, P_2O_5, K_20 + 7 t/ha chicken manure - BELL PEPPER)
T3 – Recommended Rate (RR) (140-140-140 kg/ha inorganic fertilizer) + 5 t/ha chicken manure (CM)
T4 – 75% RR + 25% CM
T5 – 50% RR + 50% CM
T6 – 25% RR + 75% CM
T7 – 100 % RR + 5 t/ha Formulated Organic Fertilizer (FOF)
T8 – 75% + 25% FOF
T9 – 50% + 50% FOF
T10 – 25% + 75% FOF
T11 – 100 %RR + 5 t/ha CM + 5 ppm Boron
T12 – 75% RR + 25% CM + 5 ppm Boron
T13 – 50% RR + 50% CM + 5 ppm Boron
T14 – 25% RR + 75% CM + 5 ppm Boron
T15 – 100 %RR + 5 tons/ha FOF + 5 ppm Boron
T16 – 75% RR + 25% FOF + 5 ppm Boron
T17 – 50% RR + 50% FOF + 5 ppm Boron
T18 – 25% RR + 75% FOF + 5 ppm Boron
T19 – 100 %RR
T20 – 5 t/ha FOF
T21 – 5 t/ha CM
T22 – 100 % RR + 5 ppm Boron
T23 – 5 t/ha FOF + 5 ppm Boron
T24 – 5 t/ha CM + 5 ppm Boron

The following selected treatments were evaluated for the succeeding trials:

Potato

T1- Control
T2- Farmer's practice

T3 – RR (140-140-140 kg/ha N, P_2O_5, K_20) + 5 t/ha chicken Manure (CM)
T4 – 75% RR + 25% CM
T5 – 100 %RR + 5 t/ha CM + 5 ppm Boron
T6 – 75% RR + 25% CM + 5 ppm Boron
T7 – 50% RR + 50% CM + 5 ppm Boron
T8 – 25% RR + 75% CM + 5 ppm Boron
T9– 100 %RR + 5 t/ha FOF + 5 ppm Boron
T10 – 50% RR + 50% FOF + 5 ppm Boron

Cabbage

T1- Control (no fertilizer application)
T2- Farmer's practice (250-100-100 kg/ha N, P_2O_5, K_2O + 7t/ha CM)
T3 – RR (250-100-100 kg/ha N, P_2O_5, K_2O + 5 t/ha CM
T4 – 75% RR + 25% CM
T5 – 25% RR + 75% CM
T6 – 100 %RR + 5 t/ha CM + 5 ppm B
T7 – 50% RR + 50% CM + 5 ppm B
T8 – 25% RR + 75% CM + 5 ppm B
T9 – 100 %RR + 5 t/ha FOF + 5 ppm B
T10 – 75% RR + 25% FOF + 5 ppm B

Broccoli

T1- Control
T2- Farmer's practice (240-60-60 kg/ha N, P_2O_5, K_2O + 7 t/ha CM)
T3 – RR (240-60-60 kg/ha N, P_2O_5, K_2O) + 5 t/ha CM
T4 – 75% RR + 25% CM
T5 – 100 %RR + 5 t/ha CM + 5 ppm B
T6 – 75% RR + 25% CM + 5 ppm B
T7 – 50% RR + 50% CM + 5 ppm B
T8 – 25% RR + 75% CM + 5 ppm B
T9– 100 %RR + 5 t/ha FOF + 5 ppm B
T10 – 50% RR + 50% FOF + 5 ppm B

Carrot

T1 - Control
T2 – Farmers Practice (90-170-90 kg/ha N, P_2O_5, K_2O + 7 t/ha CM
T3 – RR (90-170-90 kg/ha N, P_2O_5, K_2O) + 5 t/ha CM
T4 – 75% RR + 25% CM
T5 – 50% RR + 50% CM
T6 – 100 % RR + 5 t/ha FOF
T7 – 75% RR + 25% CM + 5 ppm B
T8 – 100 %RR + 5 t/ha FOF + 5 ppm B
T9 – 100 %RR
T10 – 100 % RR + 5 ppm B

Bell pepper

T1 - Control
T2 – Farmers Practice (100-200-100 kg/ha N, P_2O_5, K_2O + 7 t/ha CM)
T3 – 25% RR + 75% CM
T4 – 100 %RR (100-200-100 kg/ha $NP_2O_5K_2O$) + 5 t/ha CM + 5 ppm B
T5 – 50% RR + 50% CM + 5 ppm B
T6 – 100 %RR + 5 tons/ha FOF + 5 ppm B
T7– 100 %RR
T8 – 5 t/ha CM
T 9– 100 % RR + 5 ppm B
T10 – 5 t/ha CM + 5 ppm B

RESULTS AND DISCUSSION

Study 1. Balanced Fertilization Strategy on Potato

Agronomic Parameters

Weight of classified tubers. Weight of classified potato tubers as affected by the different fertilizer combinations are shown in Table 1. Plants applied with 75% RR + 25% CM produced the heaviest large sized tubers but produced a lower yield during the first trial. Heavier big sized tubers was gathered from plants treated with farmer's rate and 50% RR + 50% CM + boron (B) from the most recent trial. It was also observed that there was greater increase in weight of big sized tubers from these treatments. Application of 100% RR + 5 tons/ha formulated organic fertilizer (FOF) + B and 100% RR + 5 tons/ha CM registered heavier medium sized tubers.

The weight of small-sized tubers was highest from plants applied with 50% RR + 50% FOF + B but did not differ significantly from other treated plants except the control plants which produced the lowest tuber yield as a result of insufficient supply of nutrients from the soil.

Total tuber yield. Potato tuber yield as influenced by the different treatments is shown in Table 2. Plants fertilized with 100 % RR + 5 tons/ha FOF + B produced the highest yield of 13.39 t/ha but did not differ from other treated plants. Total marketable yield of potato was high from those applied with 100% RR + 5 tons/ha FOF + B in the two trials conducted. It differed significantly from the control plants. Likewise, plants applied with 100% RR + 5 tons/ha FOF + B produced the heaviest marketable tuber weight. The same trend was observed during the first trial. The control plants produced the lowest marketable tuber yield. On the other hand, non-marketable yield was lowest from plants fertilized with the farmer's practice.

Table 1. Weight of classified potato tubers as affected by the treatments from the two trials conducted

	TREATMENTS	CLASSIFICATION OF POTATO TUBERS (kg/plot)*									
		Large		Big		Medium		Small		Marble	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
1	Control	0.42d	0.35b	1.17b	0.57b	1.167b	0.47c	0.52b	0.63b	0.43a	0.75 a
2	Farmer's practice	1.08b	1.37a	1.42ab	2.68a	1.967ab	1.27b	1.10ab	0.95a	0.52a	0.25 e
3	100% RR + 5 tons/ha CM	1.90a	0.97a	2.0ab	2.12a	1.517ab	2.22a	0.65ab	1.07a	0.28a	0.33cde
4	75% RR + 25% CM	0.78c	1.60a	1.45ab	2.00a	1.717ab	1.80ab	1.00ab	1.45a	0.52a	0.42bcde
5	100 %RR + 5 tons/ha CM + B	1.73a	1.08a	2.17ab	1.87a	1.717ab	1.73ab	0.73ab	1.28a	0.42a	0.57bcde
6	75% RR + 25% CM + B	1.10b	0.92a	1.77ab	1.70a	1.717ab	1.35b	1.28ab	1.37a	0.40a	0.68bc
7	50% RR + 50% CM + B	0.40d	0.93a	1.8ab	2.55a	1.833ab	1.67ab	1.60a	1.47a	0.28a	0.67bcd
8	25% RR + 75% CM + B	1.27b	1.03a	2.45ab	2.10a	1.600ab	1.42b	1.12ab	1.22a	0.32a	0.50bcde
9	100% RR + 5 tons/ha FOF + B	0.63cd	1.23a	2.55a	2.07a	2.217a	2.23a	1.25ab	1.60a	0.35a	0.30de
10	50% RR + 50 FOF + B	0.47d	1.02a	1.87ab	1.78a	2.333a	1.97ab	1.02ab	1.72a	0.20a	0.62bcd

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

RR - recommended rate for potato (140-140-140 kg $NP_2O_5K_20$/ha)

CM-*chicken manure*

FOF-*formulated organic fertilizer*

Table 2. Tuber yield of potato as influenced by the different treatments from the two trials conducted

	TREATMENTS	YIELD (ha)*					
		Total Yield		Marketable Yield		Non-Marketable Yield	
		1st	2nd	1st	2nd	1st	2nd
1	Control	6.66 c	8.98 b	4.95 c	3.29 b	1.71 a	5.69 a
2	Farmer's practice	10.94 ab	11.74 a	8.05 ab	9.57 a	2.92 a	2.16 a
3	100% RR + 5 tons/ha CM	11.42 ab	12.06 a	9.76 ab	9.53 a	1.67 a	2.52 a
4	75% RR + 25% CM	9.85 b	13.09 a	7.11 bc	9.72 a	2.74 a	3.36 a
5	100 %RR + 5 tons/ha CM + B	12.19 ab	11.75 a	10.12 a	8.43 a	2.07 a	3.33 a
6	75% RR + 25% CM + B	11.29 ab	10.84 a	8.24 ab	7.14 a	3.02 a	3.69 a
7	50% RR + 50% CM + B	10.66 ab	13.10 a	7.25 abc	9.27 a	3.38 a	3.84 a
8	25% RR + 75% CM + B	12.15 ab	11.29 a	9.58 ab	8.19 a	2.57 a	3.09 a
9	100% RR + 5 tons/ha FOF + B	12.60 a	13.37 a	9.72 ab	9.72 a	2.84 a	3.42 a
10	50% RR + 50 FOF + B	10.58 ab	12.78 a	8.41 ab	8.58 a	2.20 a	4.20 a

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

Soil Chemical Properties

Analyses of some chemical properties of the soil are presented in Table 3. Slight decrease in pH was noted from all the treated plots except those applied with 25% RR + 75% CM + 5 ppm B. This could be

due to addition of N fertilizer to the soil. This nutrient is able to decrease the pH of the soil when mineralization takes place where H+ as one of the by-product leading to soil acidity. Increased total soil nitrogen content of 0.171% from the initial value of 0.099% was noted from application of 100% RR + 5 t/ha CM. However, the farmer's practice, 100% RR + 5 t/ha CM + B and 100% RR + 5 t/ha FOF + 5 ppm B lowered the nitrogen content of the soil. Varied results were also noted from the two trials but with improved nitrogen content of the soil.

Soil organic matter contents of the treated plots were generally increased particularly those applied with organic fertilizers. On the other hand, significant decrease in soil phosphorous was observed among the treatments.

Table 3. Some chemical properties of soil planted with potato as affected by balanced fertilization treatments

	TREATMENT	SOIL pH*		NITROGEN (%)*		ORGANIC MATER* (%)		PHOSPHO-ROUS* (ppm)	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
1	Control	5.10 a	4.85 f	0.19 cd	0.078 c	3.18 d	1.56 c	104.4 f	98.0 g
2	Farmer's practice	4.70 bc	5.30 bc	0.22 bc	0.090 bc	4.42 ab	1.79 bc	274.7 a	207.6 a
3	100% RR + 5 tons/ha CM	4.80 b	5.25 cd	0.19 cd	0.171 a	3.80 bc	3.40 a	140.2 cd	195.4 b
4	75% RR + 25% CM	4.60 c	5.30 bc	0.24 ab	0.138 abc	4.83 ab	2.74 abc	156.4 bc	149.4 e
5	100 %RR + 5 tons/ha CM + B	4.80 b	5.40 ab	0.18 cde	0.081 c	3.54 cd	1.61 c	129.7 de	180.6 c
6	75% RR + 25% CM + B	4.80 b	5.15 de	0.16 e	0.148 abc	3.13 d	2.96 abc	151.5 c	149.7 e
7	50% RR + 50% CM + B	4.70 bc	5.20 cd	0.20 bcd	0.113 abc	4.06 bc	2.25 abc	172.9 b	120.2 f
8	25% RR + 75% CM + B	5.05 a	5.50 a	0.20 bcd	0.162 ab	3.65 cd	3.23 ab	150.3 c	170.1 d
9	100% RR + 5 tons/ha FOF + B	4.70 bc	5.05 e	0.25 a	0.094 abc	4.90 a	1.86 abc	155.0 bc	144.4 e
10	50% RR + 50 FOF + B	5.05 a	5.25 cd	0.19 cd	0.121 abc	3.84 bc	2.42 abc	118.4 ef	146.4 e
	Initial Value	**5.70**	**5.50**	**0.12**	**0.099**	**2.40**	**1.98**	**240.0**	**223.2**

** Means within a column having the same letter are not significantly different at 5 % level DMRT.*

Study 2. Balanced Fertilization Strategy on Cabbage

Yield Parameters

The characteristics of cabbage heads as affected by the different fertilizer combinations are shown in Table 4. Plants applied with 100% RR + 5 tons/ha CM registered the biggest head. Apparently, the nutrient requirement for head formation was sufficiently supplied by this treatment. However, no significant differences existed among the treatments except the control which produced the smallest heads.

Head solidity was almost similar in all treated plants as compared with the control having loose puffy heads. This shows that combined ap

plication of organic and inorganic fertilizers will enhance cabbage head formation.

Table 4. The characteristics of cabbage heads as affected by fertilization treatments

		HEAD CIRCUMFERENCE (cm)*		HEAD SOLIDITY (g/cm)*	
		1st Trial	2nd Trial	1st Trial	2nd Trial
1	Control	34.31 b	36.00 b	1.23 b	2 b
2	Farmer's practice	49.03 a	45.33 a	3.33 a	4 a
3	100% RR + 5 tons/ha CM	49.70 a	45.67 a	3.67 a	4 a
4	75% RR + 25% CM	48.23 ab	42.00 a	3.13 a	4 a
5	25% RR + 75% CM	46.83 ab	43.11 a	3.23 a	4 a
6	100% RR + 5 tons/haCM + B	49.77 a	43.67 a	3.23 a	4 a
7	50% RR + 50% CM + B	49.63 a	43.00 a	3.23 a	4 a
8	25% RR + 75% CM + B	34.30 b	45.00 a	3.13 a	4 a
9	100% RR + 5 tons/ha FOF + B	49.77 a	44.00 a	3.07 a	4 a
10	50% RR + 50 FOF + B	49.25 a	42.11 a	3.00 a	4 a

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

RR - Recommended rate (250-100-100 kg $NP_2O_5K_20$/ha)
CM - chicken manure
FOF - Formulated organic fertilizer

Cabbage head yield was highest from plants applied with 50% RR + 50% CM + 5 ppm B (Table 5). While application of 25% RR + 75% CM + 5 ppm B gave lower yield per plot which did not differ from the control. This result confirmed the report of Kinoshita (1972) that cabbage does not form hard heads of good quality when N fertilizer is inadequate to meet its requirement.

Table 5. Head yield of cabbage as affected by fertilization treatments

	TREATMENTS	Yield (tons/ha)*			
		Total Yield		Marketable Yield	Non-Marketable Yield
		1st Trial	2nd Trial	1st Trial	1st Trial
1	Control	12.20 e	18.90 c	9.63 d	2.75 b
2	Farmer's practice	45.90 a	46.78 abc	44.50 a	1.40 b
3	100% RR + 5 tons/ha CM	42.61 ab	52.47 ab	37.21 ab	5.40 a
4	75% RR + 25% CM	34.51 cd	39.65 abc	28.85 bc	5.66 a
5	25% RR + 75% CM	32.98 cd	28.76 bc	32.26 bc	0.72 b
6	100% RR + 5 tons/haCM + B	38.70 bc	41.29 abc	36.99 ab	1.71 b
7	50% RR + 50% CM + B	32.18 cd	61.78 a	31.64 bc	0.54 b
8	25% RR + 75% CM + B	32.49 cd	22.57 c	30.46 bc	2.03 b
9	100% RR + 5 tons/ha FOF + B	35.37 cd	48.71 ab	33.88 bc	1.49 b
10	75% RR + 25% FOF + B	29.25 d	40.99 abc	28.22 c	1.03 b

** Means within a column having the same letter are not significantly different at 5 % level DMRT.*

Soil Chemical Properties

Slight improvement of the soil pH was attained after harvest of cabbage (Table 6). This could be attributed to the calcium and magnesium content of the manure released at the later part of production which could have counteracted the acidity causing elements.

Likewise, the nitrogen content of the soil after harvest was significantly increased by the fertilizer treatments. Application of 25% recommended rate + 75% chicken manure + boron gave the highest mean of nitrogen content of the soil. This result varied from the previous trial.

Improvement of soil organic matter content was noted. Plots treated with 25% recommended rate + 75% chicken manure + boron had the highest amount of organic matter retained to the soil and was significantly different from the different treatments except from treatments 2, 5 and 8.

Table 6. Chemical properties of soil planted with cabbage as affected by balanced fertilization treatments

	TREATMENT	Soil pH*		Nitrogen (%)*		Organic Matter* (%)		Phosphorous* (ppm)	
		1st Trial	2nd Trial	1st	2nd	1st	2nd	1st	2nd
1	Control	5.41 c	5.7 e	0.11 def	0.142 bc	2.27 bcd	2.84 bc	35.20 g	10.85 e
2	Farmer's practice	6.67 a	5.93 b	0.18 ab	0.153 b	3.65 ab	3.07 b	71.30 ab	109.6 c
3	100% RR + 5 tons/ha CM	6.38 ab	5.82 d	0.12 cdef	0.103 bc	2.32 cde	2.01 bc	54.30 ef	12.65 e
4	75% RR + 25% CM	6.40 ab	5.90 bc	0.15 abcd	0.130 bc	3.00 bc	2.57 bc	65.60 bc	184.6 a
5	25% RR + 75% CM	6.16 b	6.03 a	0.16 abcd	0.140 bc	3.12 abc	2.75 bc	67.85 abc	8.35 e
6	100% RR + 5 tons/haCM + B	6.32 ab	5.93 b	0.09 ef	0.120 bc	1.79 ef	2.37 bc	64.45 bcd	144.4 b
7	50% RR + 50% CM + B	6.18 b	5.91 bc	0.14 bcde	0.150 b	2.84 bcd	2.92 bc	65.20 bc	9.20 e
8	25% RR + 75% CM + B	6.23 b	5.83 d	0.16 abc	0.230 a	3.18 abc	4.55 a	75.80 a	11.30 e
9	100% RR + 5 tons/ha FOF + B	6.56 ab	5.86 cd	0.21 a	0.123 bc	4.11 a	2.49 bc	65.10 bc	8.80 e
10	75% RR + 25% FOF + B	6.43 ab	5.90 bc	0.15 abcd	0.130 bc	2.94 bcd	2.56 bc	49.50 f	7.50 e
	Initial Value	**6.2**	**5.8**	**0.11**	**0.095**	**2.10**	**1.89**	**286.00**	**286**

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

Improvement of soil organic matter content was noted. Plots treated with 25% recommended rate + 75% chicken manure + boron had the highest amount of organic matter retained to the soil and was significantly different from the different treatments except from treatment 2, 5 and 8.

The phosphorous content of the soil was also affected by the different treatments. There was a general decrease in the final P content of the soil. Apparently, the original phosphorous content was utilized by the

plants even with added fertilization. Soil treated with 75% recommended rate + 25% chicken manure had the highest soil P content which differed significantly with all the other treatments.

Study 3. Balanced Fertilization Strategy on Broccoli

Agronomic Data

Table 7 shows the agronomic data for broccoli as influenced by the different fertilizer combinations. Results revealed a decline in the number of formed curds from the previous trials however, the diameter of the curd increased. Plants applied with farmer's rate produced more curds but did not differ significantly from other treatments aside from the control. On the other hand, plants applied with 100% RR + 5 tons/ha CM + B registered the widest curds while smaller curds were noted from the control.

Table 7. Agronomic parameters of broccoli as affected by fertilization treatments

		NO. OF CURD/ PLOT*			CURD DIAMETER (cm)*			TOTAL YIELD (tons/ha)*		
		1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
1	Control	8e	18b	7.15c	5.50g	7.15c	6.33c	6.44f	3.19c	4.81g
2	Farmer's practice	24a	22a	10.36a	11.90c	10.36a	12.28ab	23.63ab	19.40ab	36.22a
3	100% RR + 5 tons/ha CM	23ab	22a	10.15a	15.00a	10.15a	12.15ab	22.01bc	23.10ab	32.98bc
4	75% RR + 25% CM	19c	22a	10.20a	11.07cde	10.20a	11.85ab	20.16c	21.37ab	32.89bc
5	100 %RR + 5 tons/ha CM + B	23ab	21a	10.0ab	13.10 b	10.05ab	12.97a	26.10a	18.75ab	33.93b
6	75% RR + 25% CM + B	22b	21a	9.95ab	11.40cd	9.95ab	11.70ab	14.63e	17.61ab	31.81c
7	50% RR + 50% CM + B	20c	22a	10.0ab	10.10 e	10.04ab	12.00ab	14.20e	15.33b	30.20d
8	25% RR + 75% CM + B	22b	22a	9.48b	11.90 c	9.48b	11.65ab	17.69d	19.80ab	25.92f
9	100% RR + 5 tons/ha FOF + B	23ab	22a	9.95ab	10.70de	9.95ab	11.55b	12.29e	25.34a	30.38d
10	50% RR + 50 FOF + B	12d	21a	9.93ab	7.87f	9.93ab	11.30 b	6.83f	20.43ab	27.45e

** Means within a column having the same letter are not significantly different at 5 % level DMRT.*

RR- recommended fertilizer rate (240-60-60 kg/N, P_2O_5, K_2O/ha)

Plants applied with farmer's rate registered the highest total yield which differed significantly from other treatments and the control plants, which revealed the lowest yield.

Soil Chemical Properties

Changes in soil chemical properties are shown in Table 8. Generally, the soil became strongly to moderately acidic (5.2 - 5.7) (FAO, 1973). Treatment 8 had the highest soil pH value after harvest but was not significantly different from treatment 7 and 10. The lowest pH value was obtained from control plots followed by treatments 3, 5, 2, and 9. There was also variation of the results from the previous trials.

Balanced fertilization treatments improved the soil nitrogen content after harvest . The farmers fertilizer rate of 260-60-60 kg/ha NP2O5K20 + 7 t/ha CM and those fertilized with a rate of 100% RR + 5 t/ha CM + 5 ppm B revealed the highest soil nitrogen content after harvest. The soil nitrogen values in these rates were significantly different from application of 25% RR + 75% CM + B and the control with values of 0.1% and 0.09%, respectively. Increased OM was also noted in most treatments applied with organic fertilizer.

Table 8. Some chemical properties of soil planted with broccoli as affected by fertilization treatments

		SOIL pH*			NITROGEN (%)			ORGANIC MATTER (%)			PHOSPHOROUS (ppm)		
		1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
1	Control	6.55a	4.60a	5.20ef	0.240bc	0.15a	0.090b	4.85bc	2.99a	1.80a	59.22e	22.50d	40.86g
2	Farmer's practice	5.80b	4.10de	5.35de	0.233c	0.12b	0.184a	4.69c	2.35b	3.68a	96.80d	45.65a	80.04d
3	100%RR + 5 tons/ha CM	6.30ab	4.05e	5.25e	0.237c	0.13b	0.175ab	4.73c	2.51b	3.49a	194.6a	41.25a	90.04bc
4	75% RR + 25% CM	6.25ab	4.15de	5.45bcd	0.230c	0.15a	0.176ab	4.63c	3.09a	3.50a	141.9b	38.35ab	84.54cd
5	100 %RR + 5 tons/ha CM + B	6.10ab	4.20d	5.30de	0.230c	0.16a	0.181a	4.57c	3.11a	3.60a	110.4cd	41.45a	95.21b
6	75% RR + 25% CM + B	6.40a	4.10de	5.45bcd	0.273ab	0.16a	0.131ab	5.44ab	3.16a	2.62a	139.9b	27.40cd	93.71b
7	50% RR + 50% CM + B	6.25ab	4.40bc	5.60ab	0.243bc	0.16a	0.156ab	4.85bc	3.10a	3.11a	120.7bc	31.80bc	106.20a
8	25% RR + 75% CM + B	6.20ab	4.50ab	5.70a	0.230c	0.16a	0.100b	4.65c	3.14a	2.00a	108.4cd	29.50cd	73.23e
9	100% RR + 5 tons/ha FOF + B	5.90ab	4.20d	5.40cde	0.300a	0.16a	0.164ab	5.98a	3.19a	3.28a	180.8a	31.15bc	86.38c
10	50% RR + 50 FOF + B	5.95ab	4.35c	5.55abc	0.303a	0.16a	0.121ab	6.07a	3.17a	2.40a	60.55e	23.20d	62.39f
Initial Value		**5.70**	**5.90**	**5.80**	**0.10**	**0.10**	**0.10**	**1.85**	**1.95**	**2.0**	**225.00**	**265.00**	**245.00**

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

Significant decrease of the phosphorous content was observed as a result of plant utilization. Application of 50% RR + 50% CM + B had the highest amount of phosphorous retained which differe from the other treatments. The control showed the lowest phosphorous content after harvest.

Study 4. Balanced Fertilization Strategy on Carrot

Agronomic Data

Classified root yield of carrots as affected by the different fertilizer combinations is presented in Table 9. Heavier big sized carrots were harvested from plants applied with 100% recommended rate + boron but did not differ significantly from those applied with the farmer's rate, 75% recommended rate + 25% chicken manure + boron, and 100% recommended rate alone. The lowest weight of big sized carrots was obtained from the control plants.

Table 9. The classification and characteristics of carrot roots as affected by fertilization treatments.

	TREATMENTS	CLASSIFICATION OF CARROT ROOT (kg/plot)*					
		Big		Medium		Small	
		1st	2nd	1st	2nd	1st	2nd
1	Control	1.57c	6.80c	3.80d	6.78a	2.63ab	5.00a
2	Farmer's practice	9.07a	13.50ab	5.65bc	6.63a	1.80abc	3.60a
3	100% RR + 5 tons/ha CM	6.97ab	9.95b	6.73abc	9.25a	1.37bc	3.90a
4	75% RR + 25% CM	7.37ab	10.75ab	5.07c	6.98a	2.90a	4.50a
5	50% RR + 50% CM	5.08b	8.43b	8.03a	4.55a	2.12abc	4.13a
6	100% RR + 5 tons/ha FOF	9.57a	9.70b	7.43ab	6.50a	1.50bc	4.75a
7	75% RR + 25% CM + B	5.3 2b	11.13ab	7.53ab	7.10a	1.65bc	4.05a
8	100% RR + 5 tons/ha FOF + B	5.47b	8.55b	7.53ab	7.48a	2.43ab	4.63a
9	100% RR	7.93ab	11.8ab	7.15abc	7.05a	1.27c	4.38a
10	100% RR + B	7.08ab	17.25a	8.88a	6.55a	1.35bc	3.13a

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

RR-recomended fertilizer rate (90-170-90 kg/ha N, P_2O_5, K_2O)

In the second trial, there was no significant effect of the treatments was observed on the medium sized carrots from the result of the recent trial. Moreover, plants applied with 100% recommended rate + 5 tons/ha chicken manure produced the highest weight of medium carrots. In contrast, application of 50% recommended rate + 50% chicken manure registered the lowest medium sized carrots.

Consistently, the control plants produced smaller roots as a result of insufficient amount of nutrients to the plants. While, plants treated with 100% recommended rate + boron produced lower weight of small sized carrots. Statistical analysis revealed no significant effect of the treatments on the weight of small carrots from the recent trial.

Total yield of carrots as affected by the balanced fertilization treatments is shown in Table 10. No significant effect was observed in

the total yield of carrots. However, application of 100% recommended rate + boron gave the highest total yield compared to farmer's rate and the control. In terms of marketable yield, plants grown in soils applied with 100% RR + B registered the highest which differed significantly with those applied with 50% RR + 50% CM.

Higher non-marketable yield was obtained from control plants followed by treatment 8 and 5. Plants applied with 75% recommended rate + 25% chicken manure + boron produced the lowest non-marketable yield.

Table 10. Root yield of carrot as affected by fertilization treatments.

	TREATMENTS	ROOT YIELD OF CARROT (tons/ha)*					
		Total Yield		Marketable Yield		Non-marketable Yield	
		1st	2nd	1st	2nd	1st	2nd
1	Control	18.18c	44.78a	14.40c	36.14ab	3.78a	8.64a
2	Farmer's practice	32.26ab	54.05a	29.74ab	46.17ab	2.52ab	7.88a
3	100% RR + 5 tons/ha CM	31.23ab	51.03a	27.13ab	44.73ab	4.10a	6.30a
4	75% RR + 25% CM	29.47ab	50.77a	27.59ab	43.25ab	1.88b	7.52a
5	50% RR + 50% CM	30.56ab	42.33a	27.41ab	34.16b	3.15ab	8.37a
6	100% RR + 5 tons/ha FOF	35.14a	44.73a	33.30a	37.71ab	1.84b	7.02a
7	75% RR + 25% CM + B	28.62b	48.70a	26.10b	43.07ab	2.52ab	5.63a
8	100% RR + 5 tons/ha FOF + B	31.01ab	50.49a	27.77ab	42.03ab	3.24ab	8.46a
9	100% RR	30.96ab	51.45a	29.43ab	45.01ab	1.53b	6.44a
10	100% RR + B	32.80ab	57.65a	31.18ab	51.53a	1.62b	6.12a

** Means within a column having the same letter are not significantly different at 5 % level DMRT*

Soil Chemical Properties

Table 11 shows the effect of the different treatments on the chemical properties of the soil. Generally, the result of the recent trial improved the soil from being strongly acidic to slightly acidic which is the ideal pH requirement for most of the vegetable crops. Results further revealed that application of 50% RR + 50% CM and 100% RR had increased soil pH from 5.40 to 6.40 which were significantly different from other treatments. On the other hand, decrease on the soil pH value was noted from the previous trial.

Application of 100 % RR + 5 tons/ha FOF + B, farmer's rate, 100% RR + 5 tons/ha CM and 100% RR + 5 tons/ha FOF retained higher amount of nitrogen and organic matter in the soil. The control plot had the lowest soil N and organic matter content.

Significant decrease of the soil phosphorous content was observed among the different treatments aside from treatments 2 and 3. This de-

crease indicates the utilization of phosphorous as enhanced by favorable soil pH value. Phosphorous requires neutral soil pH to become available to plants. On the other hand, high amount of phosphorous was retained in the soil from treatment 2.

More fruits were gathered from said treatments that gave impact on the total yield of the treated plants. Results significantly differed from plants applied with 100% RR + 5 tons/ha CM + B, farmer's rate. Control plants had lower and few fruits produced.

Table 11. Some chemical properties of soil planted with carrot as affected by fertilization treatments

	TREATMENT	SOIL pH*		NITROGEN* (%)		ORGANIC MATTER* (%)		PHOSPHO-ROUS* (ppm)	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
1	Control	4.45a	5.30d	0.190bc	0.055c	3.85bc	1.09e	118.0e	91.4g
2	Farmer's practice	4.20bc	5.95c	0.187bcd	0.132a	3.70cd	2.64a	157.0d	388.5a
3	100%RR + 5 tons/ha CM	4.25abc	5.95c	0.210abc	0.126a	4.15abc	2.52a	274.9a	285.5b
4	75% RR + 25% CM	4.30abc	6.15b	0.217abc	0.086b	4.33abc	1.72d	159.8d	173.1e
5	50% RR + 50% CM	4.35abc	6.40a	0.257a	0.094b	5.15a	1.88bcd	119.9e	147.1f
6	100% RR + 5 tons/ha FOF	4.30abc	5.95c	0.173cd	0.125a	3.48cd	2.49ab	170.0c	181.8d
7	75% RR + 25% CM + B	4.15c	5.95c	0.160cd	0.098b	3.17cd	1.96bcd	151.8d	148.7f
8	100% RR + 5 tons/ha FOF + B	4.35abc	6.15b	0.217abc	0.134a	4.10abc	2.68a	158.0d	194.7c
9	100% RR	4.40ab	5.35d	0.247ab	0.091b	4.93ab	1.81bcb	158.9d	146.7f
10	100% RR + B	4.30abc	5.30d	0.130d	0.092b	2.65d	1.83bcd	205.4b	175.8de
Initial Value		**5.90**	**5.40**	**0.11**	**0.11**	**2.15**	**2.2**	**265.0**	**225.00**

** Means within a column having the same letter are not significantly different at 5 % level DMRT.*

Study 5. Balanced Fertilization Strategy on Bell Pepper

Agronomic Parameters

Plants applied with 100% RR (100-200-100 kg $NP_2O_5K_20$/ha) + 5 ppm B and 100% RR produced the highest total yield during the 1st and 2nd trials, respectively (Table 12). More fruitd were gathered from said treatments which gave impact on the total yield of the treated plants. Results significantly differe from plants applied with 100% RR + t/ha CM + 5 ppm B and farmer's rate. The control plants had lower and few fruits produced.

Soil Chemical Properties

Table 13 shows some chemical properties of soil planted with bell pepper as affected by the different treatments. Generally, those applied

with organic matter improve the soil pH as compared to those treated with inorganic fertilizer alone that decreased the soil pH. Soil applied with 5 tons/ha CM + B, 5 tons/ha CM and farmer's rate significantly increased soil pH value.

Table 12. Agronomic parameters for bell pepper as influenced by fertilization treatments

	TREATMENT	TOTAL YIELD (tons/ha)*		NUMBER OF FRUIT*	
		1st	2nd	1st	2nd
1	Control	4.297c	3.17d	26c	20d
2	Farmer's practice	6.426bc	4.87c	38bc	29c
3	25% RR + 75% CM	6.429bc	6.07bc	38bc	42abc
4	100% RR + 5 tons/ha CM + B	11.785a	6.82abc	71a	37bc
5	50% RR + 50% CM + B	6.511bc	7.44abc	39bc	44abc
6	100% RR + 5 tons/ha FOF + B	6.341bc	9.85ab	37bc	65ab
7	100% RR	7.151b	11.07a	43b	69a
8	5 tons/ha CM	8.244b	8.69abc	49b	50abc
9	100% RR + B	7.195b	11.18a	42b	69a
10	5 tons/ha CM + B	7.254b	6.61abc	44b	42abc

** Means within a column having the same letter are not significantly different at 5 % level DMRT.*

RR- recommended fertilizer rate (100-200-100 kg/ha $NP_2O_5K_2O$)

Table 13. Some chemical properties of soil planted with bell pepper as affected by fertilization treatments

	TREATMENT	SOIL pH*		NITROGEN * (%)		ORGANIC MATTER * (%)		PHOSPHO-ROUS * (ppm)	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
1	Control	5.65 a	5.45 e	0.18c	0.058c	3.65cd	1.15d	45d	44.4 g
2	Farmer's practice	5.10 cd	6.30 ab	0.18c	0.115a	3.53d	2.29a	98a	164.3 a
3	25% RR + 75% CM	4.80 d	5.90d	0.22bc	0.093abc	4.38bc	1.85ab	75.9c	107.1cd
4	100% RR + 5 tons/ha CM + B	5.30 bc	6.10c	0.21bc	0.082bc	4.26bcd	1.63bc	56.2d	109.1c
5	50% RR + 50% CM + B	5.15 bc	6.20bc	0.23b	0.066c	4.57b	1.32c	90.95ab	90.88e
6	100% RR + 5 tons/ha FOF + B	5.45 ab	5.85d	0.22bc	0.089abc	4.45bc	1.78bc	76.45c	86.54e
7	100% RR	5.15 bc	5.50e	0.19bc	0.095ab	3.80bcd	1.89ab	39.85f	113.1c
8	5 tons/ha CM	5.40 abc	6.35ab	0.20bc	0.098ab	4.04bcd	1.94ab	55.45d	62.69f
9	100% RR + B	4.80 d	5.4e	0.27a	0.088abc	4.77a	1.76bc	84.75b	101.9 d
10	5 tons/ha CM + B	5.35 abc	6.40a	0.20bc	0.098ab	3.94bcd	1.94ab	41.05df	130.2 b
Initial Value		**5.35**	**5.6**	**0.12**	**0.10**	**2.35**	**2.0**	**215.0**	**235**

** Means within a cloumn having the same letter are not significantly different at 5 % level DMRT.*

Likewise the results of the recent trial showed that application of 5 tons/ha CM + B, 5 tons/ha CM and farmer's rate increased the nitrogen content of the soil after harvest while the other treatments had lower nitrogen content.

High consumption of phosphorous by the plants was observed from bell pepper production. Generally, there was significant decrease of the soil phosphorous content that could be attributed by the uptake of plants. Application of farmer's rate registered the highest phosphorous retained from the soil.

ECONOMIC ANALYSIS

BFS on Potato

Return on investments for potato production as affected by the different treatments is shown in Table 14. The highest return on investment of 48.6% was obtained from application of 75% RR + 25% CM. This is due to lower fertilizer inputs and relatively high yield. It was followed by the application of 50% recommended rate + 50% chicken manure + boron and 100% recommended rate + 5 tons/ha chicken manure. Negative ROI was obtained from the control.

Table 14. Return on cash expense (ROCE) in potato production per hectare as affected by different fertilizer treatments

	TREATMENT	TOTAL SALES (PhP)	TOTAL EXPENSES (PhP)	NET INCOME (PhP)	ROCE (%)
1	Control	55,930	85,000	-29,070	-34.2
2	Farmer's practice	162,690	118,750	43,940	37
3	100% RR + 5 tons/ha CM	162,010	114,250	47,760	41.80
4	75% RR + 25% CM	165,240	101,312.5	63,927.5	63.1
5	100 %RR + 5 tons/ha CM + 5 ppm B	143,310	114,450	28,860	25.22
6	75% RR + 25% CM + 5 ppm B	121,380	101,512.5	19,867.5	19.57
7	50% RR + 50% CM + 5 ppm B	157,590	99,825	57,765	57.87
8	25% RR + 75% CM + 5 ppm B	139,230	98,137.5	41,092.5	41.87
9	100% RR + 5 tons/ha FOF + 5 ppm B	165,240	128,200	37,040	28.89
10	50% RR + 50 FOF + 5 ppm B	145,860	106,700	39,160	36.70

BFS on Cabbage

Application of 50% recommended rate + 50% chicken manure + boron registered the highest ROI at 90.4%. Though it has higher fertilizer inputs, cabbage head formation was enhanced, gaining higher yield. Moreover, there is a relative difference among the ROI of the different treatments. The control plants had the lowest ROI as expected.

BFS on Broccoli

The different ROI for broccoli production as affected by the different fertilizer rates and combination is shown in Table 16. Higher return on investment was obtained from treatment 2 (application of farmer's rate) and was followed by application of 75% RR + 25% CM and 100% RR + 5 tons/ha CM + B. Lost of some of the investment was encountered from the control, having negative 73.5% ROI.

Table 15. Return on cash expense in cabbage production per hectare as affected by the different fertilizer treatments

	TREATMENT	TOTAL SALES (PhP)	TOTAL EXPENSES (PhP)	NET INCOME (PhP)	ROCE (%)
1	Control	567,000	78,000	-2130	-27.31
2	Farmer's practice	140,340	122,131	18209	14.91
3	100% RR + 5 tons/ha CM	157,410	117,631	39779	33.82
4	75% RR + 25% CM	118,950	102,098.25	16851.75	16.51
5	100 %RR + 5 tons/ha CM + 5 ppm B	86,280	93,532.75	-7252.75	-7.75
6	75% RR + 25% CM + 5 ppm B	123,870	117,831	6039	5.13
7	50% RR + 50% CM + 5 ppm B	185,340	98,015.5	87324.5	89.09
8	25% RR + 75% CM + 5 ppm B	67,710	93,732.75	-26022.75	-27.76
9	100% RR + 5 tons/ha FOF + 5 ppm B	146,130	131,581	14549	11.06
10	50% RR + 50 FOF + 5 ppm B	122,970	105,535.75	17434.25	11.52

Table 16. Return on cash expense in broccoli production per hectare as affected by the different fertilizer treatments

	TREATMENT	TOTAL SALES (PhP)	TOTAL EXPENSES (PhP)	NET INCOME (PhP)	ROCE (%)
1	Control	28860	80000	-51140	-63.93
2	Farmer's practice	217320	111293	106027	95.27
3	100% RR + 5 tons/ha CM	197880	106793	91087	85.29
4	75% RR + 25% CM	197340	94469.75	102870.25	108.89
5	100 %RR + 5 tons/ha CM + 5 ppm B	203580	106993	96587	90.27
6	75% RR + 25% CM + 5 ppm B	190860	94669.75	96190.25	101.61
7	50% RR + 50% CM + 5 ppm B	181200	95846.5	85353.5	89.05
8	25% RR + 75% CM + 5 ppm B	155520	92523.25	62996.75	68.09
9	100% RR + 5 tons/ha FOF + 5 ppm B	182340	120743	61597	51.01
10	50% RR + 50 FOF + 5 ppm B	164700	100471.5	64228.5	63.93

BFS on Carrot

Table 17 also shows the profitability of carrot production as affected by the different rates of inorganic and organic fertilizer combination. Results show favorable returns on investments and net income from all the treatments for the cropping period. Based on the prevailing prices of carrots of PhP 5/kg, plants applied with 100% RR + Boron had the highest return on investment at 95.5%. The application of 100% recommended rate + 5 tons/ha formulated organic fertilizer had the lowest ROI due to high cost of formulated organic fertilizer.

BFS on Bell Pepper

The effect of different rates of combined organic and inorganic fertilizers on the ROI of bell pepper is also shown in Table 18. The highest ROI was obtained from the application of 100% recommended rate + boron followed by the application of 100% recommended rate, 5 tons/ha chicken manure alone, and 100% recommended rate + 5 tons/ha formulated organic fertilizer. Negative ROI was obtained from control followed by farmer's practice, 25% RR +75% CM, 100% RR + 5 tons/ha CM + B.

Table 17. Return on cash expense in carrot production per hectare as affected by the different fertilizer treatments

	TREATMENT	TOTAL SALES (PhP)	TOTAL EXPENSES (PhP)	NET INCOME (PhP)	ROCE (%)
1	Control	104560	75000	29560	39.41
2	Farmer's practice	184680	109880.5	74799.5	68.07
3	100% RR + 5 tons/ha CM	178920	105380.5	73539.5	69.78
4	75% RR + 25% CM	173000	92160.38	80839.62	87.72
5	100 %RR + 5 tons/ha CM + 5 ppm B	136640	92440.75	44199.25	47.81
6	75% RR + 25% CM + 5 ppm B	150840	119130.5	31709.5	26.62
7	50% RR + 50% CM + 5 ppm B	172280	92360.38	79919.62	86.53
8	25% RR + 75% CM + 5 ppm B	168120	119330.5	48789.5	40.89
9	100% RR + 5 tons/ha FOF + 5 ppm B	180040	94130.5	85909.5	91.27
10	50% RR + 50 FOF + 5 ppm B	206120	94330.5	111789.5	118.51

Table 18. Return on cash expense in bell pepper production per hectare as affected by the different fertilizer treatments

	TREATMENT	TOTAL SALES (PhP)	TOTAL EXPENSES (PhP)	NET INCOME (PhP)	ROCE (%)
1	Control	63400	80000	-16600	-20.75
2	Farmer's practice	97400	118054.5	-20654.5	-17.5
3	100% RR + 5 tons/ha CM	121400	94013.63	27386.37	29.13
4	75% RR + 25% CM	136400	113754.5	22645.5	19.91
5	100 %RR + 5 tons/ha CM + 5 ppm B	148800	96977.25	51822.75	53.44
6	75% RR + 25% CM + 5 ppm B	197000	127504.5	69495.5	54.50
7	50% RR + 50% CM + 5 ppm B	221400	102304.5	119095.5	116.41
8	25% RR + 75% CM + 5 ppm B	173800	91250	82550	90.47
9	100% RR + 5 tons/ha FOF + 5 ppm B	223600	102504.5	121095.5	118.14
10	50% RR + 50 FOF + 5 ppm B	132200	91450	40750	44.56

CONCLUSIONS

Based on the results, the following conclusions are drawn:

BFS on Potato

1. Application of the different combinations of organic and inorganic fertilizers had varied effects on potato yield. Plants applied with 100% recommended rate + 5 tons formulated organic fertilizer + Boron produced the heaviest yield.

2. Reducing the inorganic fertilizer by 25% of the recommended rate with 75% chicken manure application + Boron gave comparable yields with those applied with full recommended rate and higher return on cash expense.

3. Improvement in soil chemical properties in terms of nitrogen, and organic matter were noted in most treatments applied with organic fertilizers while decreased soil pH and phosphorus was obtained.

BFS on Cabbage

1. For cabbage, farmer's fertilizer rate of 50% RR + 50% CM+ 5 ppm B outyielded the different fertilizer combinations and resulted to higher ROCE. However, comparable yields were obtained from the various fertilizer treatments.

2. Solid cabbage heads were obtained from all fertilized plants particularly from application of 100% RR + 5 tons/ha CM. While bigger head circumference were noted in most treatments.

3. There was varied effect of the treatments on soil chemical properties. A slight increase in soil pH, nitrogen and organic matter was noted in some fertilized plots especially those with organic fertilizers. Soil phosphorus decreased in all treatments.

BFS on Broccoli

1. Broccoli yield was high from application of farmer's practice that differed significantly from other treated plants. It also gave higher ROI.

2. The soil pH and phosphorous content decreased in all treatments but increase of nitrogen and organic matter was observed.

BFS on Carrot

1. Total yield of carrots was higher from application of 100 % RR + Boron, though it did not differ significantly from other treated plants.

2. The effects of treatments on classified carrots varied with each other. Heavier big carrot roots and higher ROI was noted from 100% RR + Boron while medium carrot roots were higher from those applied with 100% RR + 5 tons/ha chicken manure.

3. Slight differences in carrot diameter and length were obtained in most fertilized plants.

4. The soil nitrogen and organic matter content generally increased from those applied with 100% RR + 5 tons/ha organic materials. However, soil phosphorus decreased in some treatments which could be attributed to crop utilization of phosphorus.

BFS for Bell Pepper

Bell pepper yield was heavier from application of 100% RR + Boron. It appears that bell pepper was more responsive to inorganic fertilizer than those combined with organic fertilizers. Boron application had a slight effect on fruit yield.

RECOMMENDATIONS

The following fertilizer rates are recommended under La Trinidad condition or similar areas. These fertilizer rates are recommended because of the high ROI that can be realized.

1. BFS For Potato

For soil with medium organic matter content (2.2%) and for strongly acidic soil (pH 5.5).

a. 105-105-105 kg/ha N-P_2O_5-K_2O + 1.25 tons/ha CM + B
b. 70-70-70 kg/ha N-P_2O_5-K_2O + 2.5 tons/ha CM + B
c. 140-140-140 kg/ha N-P_2O_5-K_2O + 5 tons/ha CM

2. BFS for Cabbage

For soil with medium organic matter content (2%) and for moderately acidic soil (pH 6.0)

a.125-50-50 kg/ha N-P_2O_5-K_2O + 2.5 tons/ha CM + B
b. 250-100-100 kg/ha N-P_2O_5-K_2O + 5 tons/ha CM
c. 250-100-100 kg/ha N-P_2O_5-K_2O + 5 tons/ha FOF + B

3. BFS for Broccoli

For soil with medium organic matter content (2%) and for slightly acidic soil (pH 6.3)

a. 240-60-60 kg/ha N-P_2O_5-K_2O + 7 tons/ha CM
b. 180-45-45 kg/ha N-P_2O_5-K_2O + 1.25 tons/ha CM
c. 240-60-60 kg/ha N-P_2O_5-K_2O + 5 tons/ha CM + B

4. BFS for carrots

For soil with moderately high organic matter content (2.6%) and moderately acidic soil (5.6). Addition of 5 tons/ha CM is further recommended if the soil pH is below 5.4 and organic matter is below 2%.

a. 90-170-90 kg/ha N-P_2O_5-K_2O + Boron
b. 90-170-90 kg/ha N-P_2O_5-K_2O
c. 68-128-68 kg N-P_2O_5-K_2O + 1.25 tons/ha CM

5. BFS for bell pepper

For soil with moderately high organic matter content (3%) and slightly acidic soil (6.0). Addition of 5 tons/ha CM is further recommended if the soil pH is below 5.6 and organic matter content below 2%.

a. 100-200-100 kg N-P_2O_5-K_2O + Boron
b. 100-200-100 kg N-P_2O_5-K_2O
c. 5 tons/ha CM

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