Organic Vegetable Fertility Trials

Final Report
2013

Prepared For: PEI Certified Organic Producers Co-op
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Table of Contents

Introduction

The project *"Organic Vegetable Fertility Trials"* # PE0372, commenced April 2012. Partners included the PEI ADAPT Council, the PEI Certified Organic Producers Co-operative, the PEI Horticultural Association Inc., and Red Soil Organics.

The members of the PEI COPC during their strategic planning process identified the need for better profitability in vegetable production. To address this issue one potential area of work identified was fertility trials to evaluate the value of various soil and foliar amendments in carrot and broccoli production. Data collected/analyzed from the project will be used as an education/extension tool for producers looking at organic vegetable production on Prince Edward Island.

Objective

- To evaluate the performance of P.E.I. locally available fertility additives in an organic vegetable production system. The project will evaluate broccoli and carrots, with different additives to improve profitability of the crops.

Background

This project was established to evaluate crop response to various soil and foliar fertility amendments. The products trialed are currently being used by producers in some capacity with limited data on their effect to yield. The products identified having benefits to soil nutrition and micro organisms were: chicken manure pellets, compost, molasses, humic acid, calcium, liquid fish fertilizer, bio-stimulants and seaweed extracts. These products were evaluated in various combinations as pre-plant, transplant starter field solutions and post foliar treatments.

- Chicken manure in a pellet formulation is a basic amendment as a nitrogen source for plant growth. The product used in the trial was Actisol (4% Nitrogen).
- Compost amendment - humus and chitin (disease suppression). The compost used was a crab meal/cattle manure base (1% Nitrogen).
- Liquid Molasses - potash, sulfur and many trace minerals, along with its chelating properties and carbon source for beneficial soil microbes.

- Humic Acid - plant growth, nutrients uptake, soil texture and soil microbial growth. The product used was “Black Earth” Humic LP – Organo Liquid Hume 12%.
- Liquid fish emulsion - as a nitrogen and phosphorus source. Two products were used over the 2 years: Organic Gem (3-3-0.3) and Neptune’s Harvest (2-4-1).
- Natural Bio-stimulant - soil and plant health, boosting enzyme and microbial activity. The product used was “Agri-Gro”.
- Liquid Seaweed – micro nutrients and growth stimulator. The product used was a fish fertilizer/seaweed blend “Neptune’ Harvest (2-3-1).
- Calcium – calcium souce and cell strength. The product used was Calcium 25.

Materials and Methods

All plots were located on farm within commercial growers’ fields. The participating Farm was Red Soil Organics, Brookfield, Prince Edward Island.
A steering committee consisting of Joyce Kelly (PEICOPC), Susan MacKinnon (PEI Department of Agriculture), Matthew and Eddy Dykerman (Red Soil Organics), and Joanne Driscoll (PEIHA), were available for guidance and carry out an annual performance review.

The project staff was responsible for overall project operations: organize trials, seeding and planting schedules, assist with trial fertility applications, assist with transplanting of trials, plot harvest, crop assessment, data format and prepare reports. The participating farm was responsible for greenhouse production of seedlings, land preparation, spraying of fertility programs, crop management, transplanting and insect/disease/weed management.

Trial Design

Four (4) major vegetable crops were assessed under this project throughout the growing season: broccoli, cabbage, romaine lettuce, and carrot. Each plot was arranged after consultation with AAFC in terms of design, plot length and sampling techniques

All plots were established at the cooperating producers operation, Red Soil Organics. Transplant seedlings for these trials were established at the greenhouse of Red Soil Organics. The cooperating producer: seeded and performed the daily greenhouse operations, provided

equipment, supplies and manpower for each plots initial site management which included all aspects of land preparation (fertilization, cultivation, bed making, etc), direct seeded carrots (hill making, seeding), plots transplanting, plot weed/disease/insect maintenance. All grower inputs were recorded as to formulation, rate, date, etc.

Ken Lingley calibrated the field sprayer and the transplant solution applicator and arranged for proper nozzles for the application of the fertility products.

Crop trials were separated into romaine (2012 only), broccoli, cabbage and carrot pre-plant fertility evaluations and carrot post plant fertility evaluations. The transplant solution evaluations were included as sub-treatments within the main fertility trials. All trials were soil sampled prior to fertility applications and at harvest.

For the transplanted crops, plots were arranged in quadrants (4-8 rows x 30-50 metres long) per treatment. Within each quadrant, 3 sub sections were marked containing 4 replicates of 12 plants each with the center 10 plants harvested for yield and other data. Heads were harvested as individual plants reached maturity. At harvest, plant field data and marketable and unmarketable number and weight were recorded per treatment per sub section.

For the direct seeded carrot trials, plots were arranged in quadrants (14 rows wide) per treatment. In 2012, plot length was 100 metres for pre-plant treatments and 20 metres for post application treatments. In 2013, plot length was 100 metres. Sub sections within each treatment were marked for harvest, with 4 – 6 replicates for each treatment. Carrot plots were harvested in a once over harvest in the fall of the year. At harvest, plant field data and marketable and unmarketable number and weight were recorded per treatment per sub section.

Each plot included a standard which was used as a check. The standard is a system utilized most commonly by the participating farm. Crops were graded in accordance with the Canada Agricultural Products Standards Act.

Treatments

Pre-Plant Trials (Table 1): In 2013, compost was added to the trials and the Organic Gem Liquid Fish Fertilizer rate was increased. The pellet chicken manure was applied in 2 ways, depending on crop. For carrots the pellets were applied as a pre-plant broadcast to the field prior to hill making (Figure 1 and 2). For row crops the pellets were banded within the row using the mechanical bed shaper prior to transplanting.

Figure 1: Loading of bulk chicken manure pre-plant spreading.

Figure 2: Pre-plant broadcast application of chicken manure pellets.

Transplant Solution Trial (Table 2): Varied rates of transplant solution products were evaluated with Broccoli and Cabbage crops. The liquid treatments were premixed on a tank basis for each rate tested. The mechanical transplanter includes a solution applicator which applies the liquid within the row as the plant is dropped into the furrow. Immediately after harvest, the quadrants and sub sections were flagged with all plants in each treatment replicate counted (approximately 100 plants per treatment). Plot was monitored weekly for 4 weeks.

Post Foliar Fertility Trials (Table 3): Post foliar applications were evaluated on the carrot crop. Post applications were applied using a field sprayer with a 150 litres/acre sprayer output. The sprayer was calibrated to ensure correct product rates were applied.

Table 1: Pre Plant Fertility Treatments 2012 and 2013.

Treatment	Product(s) and Rate(s)	
	2012	**2013**
Pellets	Chicken Manure Pellets 1 t/ac	Chicken Manure Pellets 1 t/ac
Compost	n/a	Compost 7 t/acre
Liquid	Molasses 15 l/acre Black Earth Humic Acid 5 l/acre Agri Gro Bio-stimulant 400ml/acre Liquid Fish Hydrolysate (3-3-.3) 5 l/acre	Molasses 15 litres/acre Black Earth Humic Acid 5 l/acre Agri Gro Bio-stimulant 400ml/acre Liquid Fish Hydrolysate (3-3-.3) 20 l/acre
Pellets and Liquid	Both Pellets and Liquid Programs Combined	Both Pellets and Liquid Programs Combined
Pellets and Compost	n/a	Chicken Manure Pellets 0.5 t/acre (1/2 rate) Compost (Cattle base) 7 t/acre

Table 2: Transplant Solution Treatments 2013.

Treatment	Broccoli	Cabbage
	Product(s) and Rate(s)	
Zero	No Transplant Solution Used	No Transplant Solution Used
Rate 1	Liquid Fish Hydrolysate (3-3-.3) 20 l/acre Agri Gro Bio-Stimulant 300ml/acre	Liquid Fish Hydrolysate (3-3-.3) 20 l/acre Agri Gro Bio-Stimulant 600ml/acre
Rate 2	Liquid Fish Hydrolysate (3-3-.3) 20 l/acre Agri Gro Bio-Stimulant 600ml/acre	Liquid Fish Hydrolysate (3-3-.3) 20 l/acre Agri Gro Bio-Stimulant 1.2 l/acre

Table 3: Post Foliar Application Fertility Treatments.

Treatment	Product(s) and Rate(s)	
	2012	**2013**
Control	No post foliar applications (Pre-Plant Chicken Manure Pellets only)	No post foliar applications (Pre-Plant Chicken Manure Pellets only)
Grower	Gri Gro Bio-Stimulant 500 ml/acre Liquid Fish Hydrolysate (3-3-.3) 5 l/acre	Agri Gro Bio-Stimulant 500 ml/acre Liquid Fish Hydrolysate (3-3-.3) 5 l/acre
Test 1	Molasses 4 l/acre Agri Gro Bio-Stimulant 500 ml/acre Liquid Fish Hydrolysate (3-3-.3) 5 l/acre	Molasses 4 l/acre Agri Gro Bio-Stimulant 500 ml/acre Liquid Fish Hydrolysate (3-3-.3) 10 l/acre
Calcium	Calcium 25 - 0.4 pounds/acre	n/a
Grower + Calcium	Both Grower Program and Calcium 25	n/a
Test 1 + Calcium	Both test Program and Calcium 25	n/a
Test 2	n/a	Liquid Fish Hydrolysate (2-4-1) , 9 l/acre Liquid Fish Hydrolysate/Seaweed (2-3-1), 1.5 l/acre
Test 3	n/a	Molasses 4 l/acre Liquid Fish Hydrolysate (2-4-1) , 9 l/acre Liquid Fish Hydrolysate/Seaweed (2-3-1), 1.5 l/acre

Results and Discussion

Romaine lettuce and late season cabbage were added to the list of crops evaluated after grower consultation in the Spring of 2012.

The 2012 season was a challenging production year with the variable climatic conditions. Throughout the season, romaine crops were greatly affected resulting in tip burn and bolts. Transplant survival of the late season cabbage was effected by the dry conditions in July/August. The carrot and late season cabbage crops were delayed in maturity due to low and sporadic precipitation amounts.

2013 season was a better growing season for horticultural producers. The month of July experienced hot, dry periods however crops performed well once established.

The trials were evaluated separately for each crop and fertility treatment: romaine lettuce, broccoli, late season cabbage and carrots. In all trials, the pre-plant pellet treatment (Chicken Manure Pellets 4%N applied at 1 tonne/acre) is considered the standard (control) treatment.

Romaine

Two (2) plots were established for romaine lettuce in 2012. With the dry season, plants suffered and resulted in 95 – 100% unmarketable crop from bolting. No results are available. The romaine crop was dropped from evaluation in 2013.

Broccoli

Broccoli was evaluated in 2012 and 2013. The crop was evaluated for pre-plant application fertility programs (Table1). The cultivar Gypsy was used both years transplanted the month of July. Heads were harvested for single head production in 2012 and single head plus bunched heads in 2013 (Table 4). Florets were not harvested or calculated in result tables.

Table 4: Broccoli Field Schedule.

Year	Planting	Transplant Date	Harvest Interval
2012	First	July 6	August 3 - 17
2012	Second	July 26	September 3 - 17
2013	First	July 15	September 17-19

Figure 3: Broccoli Pre-Plant Fertility Trial 2013.

The pellets plus liquid program resulted in the highest yield in all 3 trials (Table 5). The pellets treatment outperformed the liquid treatment in 2012 with comparable yields in 2013. The liquid treatment produced a high percentage of buncher heads (18%) versus single head broccoli with lowest average head weights and delay in maturity. Head rot resulted in high losses for the second planting 2012 and first planting 2013 contributing to the low yields attained in both trials.

Table 5: Broccoli Pre-Plant Fertility Trial - Summary 2012 and 2013.

Treatment	Days To Harvest	Marketable Yield (t/ha)	% Crop Market Single Hd	% Crop Market Bunched	Yield (14 Box/ha)	Average Head Wt (g)	% Head Rot
First Planting 2012							
Pellets + Liquid	93	15.2	91	na	2090	520	0
Pellets	89	14.9	89	na	2042	523	0
Liquid	98	11.7	76	na	1736	473	0
Second Planting 2012							
Pellets + Liquid	105	7.1 a	48	na	1105	459	44
Pellets	101	3.7 ab	26	na	597	452	66
Liquid	115	1.9 b	14	na	319	431	42
First Planting 2013							
Pellets + Liquid	106	5.4 a	34	3	1124	315	45
Liquid	109	4.9 a	38	18	1188	288	38
Pellets	106	4.5 a	38	2	838	242	60

Cabbage

Late season cabbage was evaluated in 2012 and 2013. The crop was evaluated for pre-plant application fertility programs (Table1). The cultivar Lennox was used for the trial harvested in a once over harvest (Table 6).

Table 6: Late Cabbage Field Schedule.

Year	**Transplant Date**	**Harvest Date**
2012	July 12	October 17
2013	July 12	October 10

The pellet and pellet combinations outperformed the liquid program both years (Table 7). The liquid only program resulted in lowest marketable yield, % crop Marketable and head weight. The results show that as the rate of manure pellets is decreased, the yield and head weight also decrease. The pellet + compost treatment received ½ the rate of manure pellets and the liquid treatment received 0 rate of manure pellets. This suggests the liquid program provides insufficient fertility for cabbage crop production.

Table 7: Late Season Cabbage Pre-Plant Fertility Trial – Summary 2012 and 2013.

Treatment	Marketable Yield (t/ha)	% Crop Market	Average Head Wt (Kg)
2012 Planting			
Pellets	45.5 a	90	1.31
Pellets + Liquid	37.5 a	70	1.38
Liquid	15.9 b	58	0.73
2013 Planting			
Pellets + Liquid	42.3 a	92	1.36
Pellets	39.2 a	84	1.36
Pellets + Compost	36.5 a	92	1.27
Liquid	26.6 b	72	1.06

Transplant Solution

Utilizing a transplant solution has become a practice in vegetable production. This study was to evaluate the effectiveness of using fertilizer amendments in the transplant solution. In both crop trials, and across all pre-plant treatments, transplant survival increased when using Rate 2 solution (Table 10 and 11).

Table 10: Broccoli Plant Survival (% plant stand), 2013.

Treatment	Liquid	Pellets	Pellets and Liquid
Zero	95	70	60
Rate 1 (low)	86	86	85
Rate 2 (high)	100	87	92
Difference (Zero to high)	+5%	+17%	+32%

Table 11: Cabbage Plant Survival (% plant stand), 2013.

Treatment	Liquid	Pellets	Pellets and Liquid	Pellets + Compost
Zero	89	88	80	73
Rate 1 (low)	91	83	84	83
Rate 2 (high)	99	93	94	93
Difference (Zero to high)	+10%	+5%	+14%	+20%

Carrot

The carrot crop fertility trials were evaluated in 2 plots: pre-plant application (Table 1) and a post-foliar application (Table 3). Carrots were seeded July 4 and harvested October 17 in a once over harvest in both 2012 and 2013. After harvest, carrot roots were washed and graded into marketable and unmarketable categories. For all categories, roots were counted and weighed.

Pre-Plant Fertility Carrot Trial

All three (3) treatments resulted in comparable % crop marketable results, however in 2012 the pellet treatment (standard control) resulted in a 6 – 8 tonnes per ha lower yield when compared to the other treatments (Table 8). This is attributed to the low plant stand achieved in this plot block (39 seeds/metre) in 2012. Germination was higher in 2013 as the previous year was extremely dry.

The Pellet (0.5 rate) + Compost treatment achieved the highest plant stand, total yield and marketable yield.

Table 8: Carrot Pre-Plant Fertility Trial - Summary 2012 and 2013.

Treatment	Carrots per Metre	Total Yield (t/ha)	% Crop Marketable	Marketable Yield (t/ha)	Unmarketable Yield (t/ha)
2012					
Pellets + Liquid	50	51	82	42	9
Liquid	43	48	84	40	8
Pellets	39	42	80	34	8
2013					
Pellets + Compost	73	49	75	37 a	12
Control	55	45	76	34 ab	11
Pellets + Liquid	63	44	74	33 ab	11
Pellets	59	42	75	31 b	11
Liquid	57	35	74	26 c	9

Post Foliar Carrot Fertility Trial

Post foliar applications were made on the following dates: 2012, August 21 and September 28; 2013, August 13, September 2 and September 21.

The Grower, Test 1 and Test 3 treatments performed the best, over all treatment plots (Table 9). In 2012, these treatments increased total yield 2-5 tonnes/ha and marketable yield 2-9 tonnes/ha when compared to the control treatments. These results suggest the added foliar programs are beneficial for positive yield and marketability results.

Calcium 25 resulted in the lowest yields in 2012. Calcium 25 is also an expensive product and cannot be tanked mixed with other products, for these reason this treatment was dropped in 2013.

Table 9: Carrot Post Foliar Fertility Trial – Summary 2012 and 2013.

Treatment	Carrots per Metre	Total Yield (t/ha)	% Crop Marketable	Marketable Yield (t/ha)	Unmarketable Yield (t/ha)
2012					
Grower + Calcium	55	74	81	60 a	14
Grower	50	76	77	59 a	17
Test 1	49	72	78	56 a	16
Calcium + Test 1	54	70	76	53 ab	17
Pellets (control)	49	70	73	51 ab	19
Calcium	48	63	72	46 b	17
2013					
Grower + Pellets	62	50	82	41 a	9
Test 1 + Pellets	63	48	79	38 ab	10
Test 3 + Pellets	63	48	77	37 ab	11
Pellets (control)	55	45	76	34 b	11
Test 2 + Pellets	67	38	73	28 c	10

Note: All treatments in the post fertility trial received a pre-plant application of Chicken manure pellets at 1 tonne/acre. The Control treatment received no (0) post fertility applications.

Carrot Root Evaluation

Additional ratings were made on the carrot crop from each trial after harvest: root breakage, root shatter crack and Brix. Breakage and shatter were evaluated using a subsample of 10 carrot roots from 2 replicates per treatment. Roots were dropped onto a hard surface with the number of breaks and shatter recorded. Brix content was evaluated using a subsample from each treatment. The middle section of the roots were cut and juiced with brix levels taken from the liquid extract using a refractometer.

In both trials, the control treatments resulted in the highest breakage and shatter crack. The pellet + compost treatment gave the best results with 5% breakage and shatter. Brix levels were comparable over all treatments.

Table 10: Carrot Brix, Crack and Shatter Evaluation, 2013

Pre-Plant Application 2013	Brix %	Break %	Shatter %
Pellet + Compost	9	5	5
Control	8	25	10
Pellet + Liquid	9	10	0
Pellet	9	10	0
Liquid	9	20	0
Post Application 2013	Brix %	Break %	Shatter %
Grower	9	25	0
Test 1	9	15	0
Test 3	8	10	5
Control	8	25	10
Test 2	9	15	0

Brix- Level of brix content measured using a refratometer, expressed % concentration of sugar.
Break – Number of roots breaking horizontally, expressed as a percentage.
Shatter- Number of roots cracking longitudinally (lengthwise), expressed as a percentage.

Cost Estimates of Fertility Amendment Products

Amendment	Suggested Rate	Product Cost ($/acre)	Application Cost ($/acre)
Chicken Manure Pellets (Actisol)	1 t/acre	415.00	$38
Compost	7 t/acre	400.00	$60
Calcium 25	0.4 lb/acre	8.14	$38
Transplant Solution			
3-3-0.3 (Organic Gem)	20 l/acre	33.00	n/a
Bio-Stimulant (Agri Gro)	600 ml/acre	8.40	
		$41.40/acre	
Liquid Pre-plant Solution			
Molasses	15 l/acre	33.75	
Humic Acid (Black Earth)	5 l/acre	17.50	$38
3-3-0.3 Fish Hydrolysate (Organic Gem)	20 l/acre	33.00	
Bio-Stimulant (Agri Gro)	400 ml/acre	5.60	
		$89.85/acre	
Post Applications			
Molasses	4 l/acre	9.00	
3-3-0.3 Fish Hydrolysate (Organic Gem)	10 l/acre	16.50	$38 per
Bio-Stimulant (Agri Gro)	500 ml/acre	7.00	application
2-4-1 Fish Hydrolysate (Neptune's Harvest)	10 l/acre	21.90	
2-3-1 Fish/Seaweed (Neptune's Harvest)	1.5 l/acre	3.60	

Costs are estimates only.

Application cost is estimated for operator and machine per acre.

Figure 4: Carrot Fertility Trials, 2013.

Conclusion

This study shows the chicken manure pellet treatment in combination with liquid fertility amendments achieve the best results in horticultural production, maximizing yields and weight. For above ground crops (broccoli and cabbage), the liquid fertility treatment alone is not sufficient for maximizing crop potential. For root crops, the addition of post foliar applications increased total yields by 2 – 5 tonnes/ha.

Compost used in combination with the pellet treatment exceeded the other treatments when utilized in carrot production. This treatment produced the best results for plant stand, total yield, marketable yield, % break and % shatter.

For transplant production, the use of fertility amendments at planting increased survival in both crops resulting in plant stand increasing from 5-32%.

The PEI Horticultural Association Inc. would like to Thank the PEI Certified Organic Producers Co-op, Matt Dykerman, the staff of Red Soil Organics, Ken Lingley, AAFC (Dr. Aaron Mills, Kevin Sanderson and Sylvia Wyand) and the PEI ADAPT Council for their support and assistance on this project.

APPENDICES

Broccoli - Preplant Trials

2012 - First Planting

	Days to Harvest	Harvest Interval	Mkt Yield t/ha *	Crop Marketable Single Hd %	Crop Marketable Bunched %	Yield (Boxes/ha)	Avg. Hd Wt g	Head Size cm	Head Rot %
Pellets + Liquid	93	5	15.2 a	91	n/a	2090	520	15	0
Pellets	89	9	14.9 a	89	n/a	2042	523	15	0
Liquid	98	10+	11.7 ab	76	n/a	1736	473	14	0

2012 - Second Planting

	Days to Harvest	Harvest Interval	Mkt Yield t/ha *	Crop Marketable Single Hd %	Crop Marketable Bunched %	Yield (Boxes/ha)	Avg. Hd Wt g	Head Size cm	Head Rot %
Pellets + Liquid	105	10	7.1 a	48	n/a	1105	459	15	44
Pellets	105	13	3.7 a	26	n/a	597	452	15	66
Liquid	115	3+	1.9 a	14	n/a	319	431	14	42

2013- First Planting

	Days to Harvest	Harvest Interval	Mkt Yield t/ha *	Crop Marketable Single Hd %	Crop Marketable Bunched %	Yield (Boxes/ha)	Avg. Hd Wt g	Head Size cm	Head Rot %
Pellets + Liquid	106	2	5.4 a	34	3	1124	315	12	45
Liquid	109	2+	4.9 a	38	18	1188	288	12	38
Pellets	106	2	4.5 a	38	2	838	242	13	60

* Means followed by the same letter are not signigicantly different at the 5% level using Duncans multiple range test.

Broccoli: Explanation of table headings

Days to 10% Harvest- Number of days from seeding to the date by which 10% of the heads were harvested. An indication of maturity.
Harvest Interval -
Marketable Yield- Yield of marketable heads expressed as dozens of heads per hectare (doz/ha).
% Crop Marketable Single Head- The number of marketable heads as a percentage of the total number of heads cut.
% Crop Marketable Bunched- The number of marketable bunched heads as a percentage of the total number of heads cut.
Yield (Boxes/ha) – 14
Avg. Head Weight- The mean weight of marketable heads, expressed in grams (g).
Head size - The mean diameter of marketable heads, including wrapper leaves, expressed in centimeters (cm).
Head Rot - The number of marketable heads with rot as a percentage of the total number of heads cut.

Late Cabbage - Preplant Trials

2012 Trial					
	Mkt Heads %	Mkt Yield t/ha *	Avg Head Weight kg	Bag Count (22.62 kg)	Head sz cm
Pellet	90	45.5 a	1.31	16-18	18:14
Pellet + Liquid	70	37.5 a	1.38	16-18	19:15
Liquid	57.5	15.9 b	0.73	30-32	15:12
2013 Trial					
Pellet + Liquid	92	42.3 a	1.36	16-18	18:14
Pellet	84	39.2 a	1.36	16-18	19:14
Pellet + Compost	92	36.5 a	1.27	16-18	19:14
Liquid	72	26.6 a	1.06	20-22	17:13

* Means followed by the same letter are not signigicantly different at the 5% level using Duncans multiple range test.

Cabbage: Explanation of table headings

Marketable Heads- The number of marketable heads as a percentage of the total number of heads cut.

Marketable Yield- Yield of marketable heads expressed as tonnes per hectare (t/ha).

Avg. Head Weight- The mean weight of marketable heads, expressed in kilograms (kg).

Bag Count (22.62kg) -

Head Size - The mean polar diameter (measured from the base to the top of the head) of marketable heads expressed in centimetres (cm), and mean equatorial diameter (measured across the head) of marketable heads expressed in centimetres (cm).

Carrot - Preplant Trials

2012

	Carrots/ Meter	Total Yield t/ha	% Crop Mkt %	Mkt Yield t/ha *	Lrg %	Med %	Small %		Unmkt Yield t/ha	Small %	Short %	Prong %	Twist %	Growth Crack %	Aster Yellow %
Pellet + Liquid	50	51	82	42 a	3	57	40		9	12	20	20	39	6	3
Liquid	43	48	84	40 a	3	54	42		8	13	15	30	32	5	5
Pellet	39	42	80	34 b	1	62	37		8	13	21	20	40	4	2
2013															
Pellet + Compost	73	49	75	37 a	0	22	78		12	17	26	23	33	1	0
Control	55	45	76	34 ab	1	41	58		11	14	27	30	29	0	0
Pellet + Liquid	63	44	74	33 ab	0	33	67		11	15	30	27	26	2	0
Pellet	59	42	75	31 b	0	36	64		11	16	28	24	32	0	0
Liquid	57	35	74	26 c	0	38	62		9	22	45	13	18	1	1

* Means followed by the same letter are not significantly different at the 5% level using Duncans multiple range test.

Carrots : Explanation of table headings

Carrots/Metre- The number of carrots harvested per metre of row. This includes marketable and unmarketable totals. An indication of plant density as influenced by seeding rate, seed germination and plant establishment.

Total Yield - The total yield of carrots (marketable and unmarketable) expressed in tonnes per hectare (t/ha).
% Crop Marketable- The weight of marketable carrots as a percentage of the total crop weight.

Marketable Yield- The total marketable yield of carrots expressed in tonnes per hectare (t/ha).

Large (Over 45mm Diam) , Med (32 To 45mm Diam), Small (19 To 32mm Diam) – The weight of marketable carrots in each size category, as a percentage of the total marketable weight.

Unmarketable Yield- The yield of unmarketable carrots expressed in tonnes per hectare (t/ha).

Small- The percentage (by weight) of unmarketable carrots that were less than 19mm in diameter.

Short- The percentage (by weight) of unmarketable carrots that were less than 9 cm long.

Prong- The percentage (by weight) of unmarketable carrots that were pronged or forked, had more than one root.

Twist- The percentage (by weight) of unmarketable carrots that were twisted or curved severely enough to have significant effect on appearance and packaging.

Growth Cracks- The percentage (by weight) of unmarketable carrots with growth cracks, ie. splits running lengthwise of the carrot, either shallow or deep.

Aster Yellows- The percentage (by weight) of unmarketable carrots with aster yellows.