BIBLIOGRAPHY

GALBEY, ARLENE C. October 2008. Validation Trial of Effective Control Strategies Against Bacterial Wilt (*Ralstonia solanacearum*) (E.F.Smith) Yabuuchi *et al.* Benguet State University, La Trinidad, Benguet.

Adviser: Jocelyn C. Perez, MSc.

ABSTRACT

This study was conducted to evaluate the effective strategies for the control of bacterial wilt.

Results revealed that the application of formulated compost (12kgN/ha) lime (16 tons Ca O/ha) Urea (40kgN/ha), lime + urea (40kgN/ha +13.3-20 tons Ca O/ha) and lime + urea (20kg N/ha + 16-20 tons Ca O/ha) decreased the population of *R. solanacearum* in the soil. Marketable yield was observed to be high in plots treated with lime (16 tons Ca O/ha and urea (40kgN/ha) and the lowest was observed with the untreated plot(farmers practice). Non-marketable yield was observed to be high in plots treated with calcium hypochlorite (12kg/ha) and the lime + urea (20kg N/ha + 16-20 tons Ca O/ha) had no non-marketable yield also with urea(40kgN/ha).The highest ROI was obtained in treatment urea (40kgN/ha), calcium hypochlorite(12kgN/ha), formulated compost(12kgN/ha) and lime + urea (40kgN/ha +13.3-20 tons Ca O/ha) had the lowest percentage of ROI.

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INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important vegetable crops grown worldwide. It occupies a large area due to its adaptability combined with its outstanding nutritive value and yield. It is a good source of carbohydrates, starch and edible protein. Farmers grow potatoes preferably as a vegetable although it could serve as a substitute or supplement of rice.

One of the most serious diseases that attack potato is bacterial wilt. This disease is caused by *Ralstonia solanacearum* (Yabuuchi) formerly known as *Pseudomonas solanacearum* (E.F. Smith). Bacterial wilt is a soil borne disease of which control is difficult.

In 1996, Martin and French stated that bacterium thrives in warm temperature ranging from 35 to 37 degrees celsius on a relatively high soil moisture levels causing total destruction and loss of profit and capital especially during rainy season. The pathogen can also survive in the soil for at least 2-3 years and there is great variability in the virulence of the pathogen, which qualifies it as major constraint to potato production. It may occur in cooler climates such as relatively high elevation in the tropics on higher latitude.

Before intensive control measures can be employed, it is necessary to evaluate the wilt potentials of soils from the different growing areas in order to help local growers select fields suitable for seed potato production and minimizing the risks of loss from the disease.

This study was conducted to evaluate the effective strategies for the control of bacterial wilt.

The experiment was conducted in farmer's fields at Tulodan, Atok, Benguet and at the Department of Plant Pathology Laboratory from October 2007 to March 2008.

REVIEW OF LITERATURE

The Disease

Bacterial wilt is caused by *Ralstonia solanacearum* and is considered as one of the most important bacterial diseases in the world. This has been recognized by a previous Australian Centre for International Agricultural Research (ACIAR) project devoted to the control of this pathogen. Bacterial wilt has also been shown to be a major constraint in small – scale vegetable farming over much of South and Southern Asia (ACIAR, 2000).

Causal Organism

The phytopathogen *Ralstonia solancearum* has over 5000 genes, many of which probably facilitated the bacterial wilt disease development. It is gram negative plant pathogenic bacterium that causes wilt in variety of plants (Hayward, 1994). It is spore less, rod shaped, 1.5x 5 um and motile by polar flagellum usually lopotrichous. Colonies on agar are opalescent becoming darker with age. They are small, irregularly smooth, wet and shiny. The bacterium is aerobic and produces ammonia, hydrogen sulfide, and nitrates in specific media. Cultured bacterium losses its virulence rapidly, Colonies are deep pink in tetrazolim medium (TZC). The optimum temperature for growth of virulent *Ralstonia* ranges from 35^0 to 37^0C with the minimum 10^0C and maximum 41^0 C. The thermal death point lies at about 52^0C (Madilat, 2002).

The results of Villena (1998) showed that *R. solanacearum* grows best at room temperature (18^0-20^0C, 25^0C and 30^0C). At 70^0C - 80^0C, the number of colonies decrease after 10 to 40 minutes. The thermal death point established was at 90^0C and

the thermal death time is 0 minute at 90^0C. *R. solanacearum* thrives in slightly acidic to neutral and alkaline soils, but it grow best at ph 7 where it shows more growth in the visual assessment.

Symptomology

Below ground symptoms on the tubers are visible at harvest time especially when infection is severe. Bacterial ooze can be observed in the tuber's eyes or stolon end, causing soil to adhere. However, external symptoms are not always visible on infected tubers (French, 1996). Cut tubers often show brownish discoloration of the vascular ring and may change in color as the disease gets severe. Ooze comes out naturally from the infected vascular ring of the cut tuber (Bahar and Danish, 1990: Martin and French, 1996 as cited by Alkera, 2001).

Infected young plants die rapidly. Infection is characterized by the initial wilting of only part of the stem of a plant or even one side of a leaf or stem. If disease development is rapid, the entire plants wilt quickly without yellowing (Martin and French, 1996).

Dissemination

French (1996) added that the movement of tuber seed from the field in warm locations to cooler sites (at greater elevations in the tropics) has separately been reported to produce latent seed infection in healthy appearing fields. Such infected seeds have often resulted in serious outbreaks on even epidemics of bacterial wilt.

Management

In 1996, Martin and French stated that the agent variability of *R. solanacearum* and the strong influence of environmental conditions on resistance make bacterial wilt a disease difficult to manage. The first thing to consider when planting potato must be the variety. One must choose the variety that is adapted to the locality in order to achieve maximum production. Using the right variety ensures high yield and better quality. Series of varietal evaluation must be conducted to determine the performance of a new or previously untried variety (HARRDEC, 1996).

Organic fertilizer and Alnus compost significantly reduced bacterial wilt infection. The compost not only contains 2.4% nitrogen, phosphorus and 0.20% potassium but also bacteria and fungal antagonists like *Bacillus sp and Streptomyces sp., Trichoderma sp., Verticillium* sp. and *Aspergillus sp.* (Dida, 1998, as cited by Andres, 2000).

In addition, Oryan (1997) stated that application of 10 tons per hectare of formulated BSU compost could minimize bacterial growth and multiplication. It was also found that plants applied with 6 tons of chicken manure per hectare exhibit delayed symptom development, and weigh more in terms of marketable yields. Agronomic practices and bleaching powder application can reduce wilt and tuber rot by 50 – 100 % (Shekhawat *et al*., 1990). In 1998, Madilat added that the application of powdered bleach at the rates of 6.0 and 12.0 kg/ha and also effectively decreased the population and lowered the infection of *R. solanacearum.*

Baden (1995) as cited by Abance (1997) stated that the application of lime or urea effectively decreased the population of *R. solanacearum* with or without host. The

application of a combination of 0.3 g urea and 0.15 g urea plus 0.1, 0.12 and 0.15 g lime per pot reduced bacterial wilt population in soil with or without potato plant. Furthermore, a higher reduction in bacterial population was observed in the soil applied with these combinations with the presence of the host.

MATERIALS AND METHODS

Identification of Infested Area

A bacterial wilt infested farm in Atok was identified. Soil samples were taken and serial dilution was done. The quantification of the bacterial population was done using the selective medium. Initial counts were recorded.

Application of Treatments

Generation two certified seeds of the variety Igorota were used in this study. Before planting, the different treatments were applied in the soil.

The different treatments were as follows:

T_1 = Powdered bleach or Calcium hypochlorite (12 kg /ha)

T_2 = Formulated Compost (10 tons /ha)

T_3 = Lime (16 tons Ca O/ha)

T_4 = Urea (40 kg N/ha)

T_5 = Lime + Urea (40 kg N/ha + 13.3-20 tons Ca O/ha)

T_6 = Lime + Urea (20 kg N/ha + 16-20 tons Ca O/ha)

T_7 = Control (farmers practice)

Plots measuring 1 x 4 m were prepared. The treatments were laid out in a randomized complete block design (RCBD), replicated four times. Planting was done a week after the application of treatments. Prior to planting, irrigation was applied to initiate the release of the bactericidal ammonium in the treated plots.

The tubers were planted in double row at a distance of 30 cm between hills and between rows. All other cultural management practices was done to ensure yield.

Data Gathered

The data gathered were:

1. Population count- before application of treatments and one week after application of treatments. This was determined by counting the colony forming unit (CFU) per ten (10) grams of soil at 10^6 dilution in selective medium before and after the application of treatments.
2. Yield parameters (kg). Marketable tubers were weighed which include marble sized tubers. Non marketable tubers were also weighed which include tubers with physiological disorders.
3. Return of investment $= \frac{\text{Gross Income} - \text{Total Expenses}}{\text{Total Express}} \times 100\ \%$

Figure 1. Overview of the experiment

RESULTS AND DISCUSSION

Population Count of *R. solanacearum*

Assessment of population of *R. solanacearum* before and after application of treatments is presented in Table 1. Results reveal that the untreated plots (farmers practice) had the highest population of *R. solanacearum* after a week at 14.33 cfu and the lowest percentage population decrease at 9.47 %.This was followed by calcium hypochlorite (12 kg/ha) with 95.31 %.

Plots applied with other treatments showed 100 % reduction in bacterial wilt population.

Table 1. Population of *R. solanacearum* in the soil

TREATMENT	INITIAL COUNT	FINAL COUNT	% DECREASE
Calcium hypochlorite	42.67	2.00	95.31
Formulated Compost	35.47	0.00	100.00
Lime	22.67	0.00	100.00
Urea	29.50	0.00	100.00
Lime + Urea (1)	18.75	0.00	100.00
Lime + Urea (2)	18.50	0.00	100.00
Control	15.83	14.33	9.47

Yield as Affected by Different Treatments (kg/per plot)

Result showed that the plot treated with lime (16 tons Ca O /ha) gave the highest weight of marketable tubers with mean of 19.96 kg. This was followed by plot treated with urea (40 kg N/ha) with mean of 19.88 kg.Untreated plot (farmers practice) had the lowest weight of marketable tubers with mean of 17.40 kg. However, plot treated with lime + urea (20 kg N/ha + 16-20 tons Ca O/ha) had no non- marketable tubers. This was followed by urea (40 kg N/ha) with a mean of 0.75 kg. However, calcium hypochlorite (12 kg/ha) had the highest weight of non marketable yield tubers with a mean of 3.31 kg. Differences among treatment means however were not statistically significant.

Table 2. Mean weight of marketable and non-marketable tubers per plot (kg)

TREATMENT	YIELD	
	Marketable	Non - Marketable
Calcium hypochlorite (12kg/ha)	18.09	3.31
Formulated Compost (10tons/ha)	19.58	0.99
Lime (16tons/ha)	19.96	1.03
Urea (40kg/ha)	19.88	0.75
Lime + Urea (40kgN/ha+13.3-20tonsCa O/ha)	19.07	1.14
Lime + Urea (20kgN/ha+16-20tonsCa O/ha)	19.57	0.00
Control	17.40	3.17

Yield as Affected by Different Treatments (tons/ha)

Result showed that the plot treated with lime (16 tons Ca O /ha) gave the highest weight of marketable tubers with mean of 21.01 tons/ha. This was followed by plot treated with urea (40 kg N/ha) with mean of 20.72 tons/ha. Untreated plot (farmers practice) had the lowest weight of marketable tubers with mean of 2.94 tons/ha. However, plot treated with lime + urea (20 kg N/ha + 16-20 tons Ca O/ha) had no non-marketable tubers. This was followed by urea (40 kg N/ha) with mean of 1.18 tons/ha. However, control had the highest weight of non marketable yield tubers with mean of 15.74 tons/ha. Differences among treatment means however were not statistically significant.

Table 3. Computed yield of marketable and non-marketable tuber (tons/ha)

TREATMENT	YIELD	
	Marketable	Non-Marketable
Calcium hypochlorite (12kg/ha)	17.15	2.98
Formulated Compost (10tons/ha)	20.07	1.48
Lime (16tons/ha)	21.01	1.45
Urea (40kg/ha)	20.72	1.18
Lime + Urea (40kgN/ha+13.3-20tonsCa O/ha)	19.03	1.55
Lime + Urea (20kgN/ha+16-20tonsCa O/ha)	19.91	0.71
Control	2.94	15.74

Calcium hypochlorite

Formulated Compost

Lime

Urea

Lime + Urea (1)

Lime + Urea (2)

Control

Figure 2. Yield as affected by the different treatments

Return on Investment

The return on investment as affected by the different treatments is shown in Table 4. urea (40kg N/ha) had the highest ROI of 60.00%. This was followed by calcium hypochlorite (12kg/ha) with 32.87%, and formulated compost (10 tons/ha) with 24.86% respectively. Plots treated with lime + urea (40 kg N/ha + 13.3-20 tons Ca O/ha) had the lowest ROI of 6.01%.

Table 4. Return on investment

TREATMENT	YIELD (tons/ha)	GROSS RETURN (Php)	TOTAL PRODUCTION COST (Php)	NET RETURN (Php)	ROI %
Calcium hypochlorite	17.5	274,000.00	206,520.00	67,880	32.87
Formulated Compost	20.07	320,160.00	256,400.00	63,760	54.86
Lime	21.01	336,160.00	286,400.00	49,760	17.37
Urea	20.72	331,520.00	207,200.00	124,320	60.00
Lime + Urea (1)	19.03	304,480.00	287,200.00	17,280	6.01
Lime + Urea (2)	19.91	318,560.00	297,200.00	21,360	7.18
Control	15.74	251,840.00	206,400.00	45,240	21.92

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

The study was conducted at the farmer's field at Tulodan, Atok, Benguet and Department of Plant Pathology Laboratory to evaluate the effective strategies for the control of *R.solanacearum.*

Results showed that the application of the different treatments namely formulated compost (10 tons/ha), lime (16 tons Ca O/ha), urea (40kgN/ha), lime + urea 1 (40kgN/ha +13.3-20 tons Ca O/ha) and lime + urea 2(20kg N/ha + 16-20 tons CaO/ha) effectively reduced the bacterial wilt population. Based on marketable and non-marketable yield, the highest marketable yield was obtained in plots treated with lime (16 tons Ca O/ha) at 19.96 kg or a computed marketable yield of 21.01 tons /ha. This was followed by urea (40kg N/ha) with mean of 19.88 kg or a computed marketable yield 20.72 tons/ha. The lowest marketable yield was obtained in untreated plot with 17.40 kg or 15.74 tons/ha. On the other hand, the highest non-marketable yield was obtained in plots applied with calcium hypochlorite (12kg/ha) with mean of 3.31 kg or computed non-marketable yield of 2.98 tons/ha. The lowest weight of non-marketable yield was obtained in plots treated with lime + urea (20kg N/ha + 16-20 tons Ca O/ha) with no non-marketable tubers. The highest ROI was obtained in plots treated with urea (40kg N/ha) at 60.00%. This was followed by calcium hypochlorite (12kg/ha) with 32.87% and formulated compost (10 tons/ha) with 24.86%. Plots applied with lime + urea (40kgN/ha +13.3-20 tons Ca O/ha) and lime + urea (20kg N/ha + 16-20 tons Ca O/ha) had the lowest ROI of 6.01%.

Conclusion

The use of formulated compost (10 tons/ha), lime (16 tons Ca O/ha), urea (40kgN/ha), lime + urea (40kgN/ha +13.3-20 tons Ca O/ha) and lime + urea (20kg N/ha + 16-20 tons Ca O/ha) effectively reduced population of *R.solonacearum* in the soil by 100%. Application of lime (16 tons Ca O/ha) and urea (40kgN/ha) and formulated compost (10 tons/ha) gave the highest yield. Application of urea (40kgN/ha), calcium hypochlorite (12kg/ha) and formulated compost (10 tons/ha) had the highest percentage of ROI.

Recommendations

The following are hereby recommended:

1. Application of formulated compost (12kgN/ha), lime (16 tons Ca O/ha), urea (40kgN/ha), lime + urea (40kgN/ha +13.3-20 tons Ca O/ha) and lime + urea (20kg N/ha + 16-20 tons Ca O/ha) effectively reduced population of *R. solonacearum* in the soil.

2. The contribution of the use of certified planting materials and high quality seed tubers should also be noted.

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APPENDICES

Appendix Table 1. Population of *R. solanacearum* before application of treatments (actual data)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
Calcium hypochlorite	78.67	14.67	14.33	63.00	170.67	42.67
Formulated Compost	36.00	38.67	31.00	36.00	141.87	35.47
Lime	27.33	41.67	19.67	2.00	90.67	22.67
Urea	50.00	18.00	45.67	4.33	118.00	29.50
Lime + Urea (1)	24.67	17.33	21.33	11.67	75.00	18.75
Lime + Urea (2)	23.67	14.67	26.33	27.33	74.00	18.50
Control	19.33	6.00	15.00	23.00	63.33	15.83

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
BLOCK	3	1021.028	340.343	1.2433		
TREATMENT	16	2199.708	366.618	1.3393^{ns}	3.66	4.01
ERROR	18	4927.168	273.732			
TOTAL	27	8147.904				

^{ns} – not significant Coefficient of variation = 61.66%

Appendix Table 2. Population of *R. solanacearum* before application of treatments (transformed data)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
Calcium hypochlorite	9.36	4.33	4.28	8.44	26.41	6.60
Formulated Compost	6.50	6.72	6.06	6.50	25.78	6.40
Lime	5.73	6.95	4.94	1.91	19.53	4.90
Urea	7.57	4.74	7.26	2.58	22.15	5.53
Lime + Urea (1)	5.47	4.66	5.11	3.91	19.15	21.06
Lime + Urea (2)	5.37	4.33	5.63	5.73	21.06	5.26
Control	4.89	2.94	4.37	5.30	17.50	4.38

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
BLOCK	3	10.259	3.420	1.2934		
TREATMENT	16	17.070	2.845	1.0760^{ns}	3.66	4.01
ERROR	18	47.593	2.644			
TOTAL	27	74.922				

^{ns} – not significant Coefficient of variation = 30.04%

Appendix Table 3. Actual population of *R. solanacearum* after application of treatments (actual data)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
Calcium hypochlorite	0.00	0.00	0.00	8.00	8.00	2.00
Formulated Compost	0.00	0.00	0.00	0.00	0.00	0.00
Lime	0.00	0.00	0.00	0.00	0.00	0.00
Urea	0.00	0.00	0.00	0.00	0.00	0.00
Lime + Urea (1)	0.00	0.00	0.00	0.00	0.00	0.00
Lime + Urea (2)	0.00	0.00	0.00	0.00	0.00	0.00
Control	18.00	6.33	12.67	20.33	57.33	14.33

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
BLOCK	3	1.645	0.548	1.7149		
TREATMENT	16	40.967	6.828	21.3605**	3.66	4.01
ERROR	18	5.754	0.320			
TOTAL	27	48.635				

** – highly significant Coefficient of variation = 43.35%

Appendix Table 4. Actual population of *R. solanacearum* after application of treatments (transformed data)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
Calcium hypochlorite	0.71	0.71	0.71	3.33	5.46	1.36
Formulated Compost	0.71	0.71	0.71	0.71	0.00	0.71
Lime	0.71	0.71	0.71	0.71	0.00	0.71
Urea	0.71	0.71	0.71	0.71	0.00	0.71
Lime + Urea (1)	0.71	0.71	0.71	0.71	0.00	0.71
Lime + Urea (2)	0.71	0.71	0.71	0.71	0.00	0.71
Control	4.74	3.06	4.06	5.00	16.86	4.21

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
BLOCK	3	107.501	35.834	1.0000		
TREATMENT	16	276.327	46.055	1.2852^{ns}	3.66	4.01
ERROR	18	645.006	35.834			
TOTAL	27	1028.834				

^{ns} – not significant Coefficient of variation = 30.43%

Appendix Table 5. Marketable yield/plot (kg) (actual data)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
Calcium hypochlorite	15.40	6.52	18.90	18.51	72.35	18.09
Formulated Compost	19.43	18.12	20.79	19.99	78.33	19.58
Lime	18.49	18.69	19.62	23.05	79.85	19.96
Urea	21.49	18.66	20.60	19.27	79.52	19.88
Lime + Urea (1)	16.38	20.18	21.40	18.31	76.27	19.07
Lime + Urea (2)	18.90	20.57	19.60	19.00	78.07	19.57
Control	16.38	17.27	17.90	18.07	69.62	17.40

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
BLOCK	3	11.438	3.813	1.7848		
TREATMENT	16	22.612	3.769	1.7642^{ns}	3.66	4.01
ERROR	18	38.452	2.136			
TOTAL	27	72.503				

^{ns} – not significant Coefficient of variation = 7.66%

Appendix Table 6. Marketable yield/ha (tons/ha) (actual data)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
Calcium hypochlorite	12.22	19.93	18.63	17.84	68.62	17.15
Formulated Compost	19.70	17.07	22.64	20.90	80.31	20.07
Lime	17.79	18.19	20.10	27.97	84.05	21.01
Urea	24.23	18.15	21.14	19.37	82.29	20.72
Lime + Urea (1)	13.36	21.31	24.02	17.45	76.14	19.03
Lime + Urea (2)	18.60	22.15	20.06	18.84	79.65	19.91
Control	13.87	15.46	16.67	16.97	62.97	15.74

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
BLOCK	3	53.661	17.887	1.5125		
TREATMENT	16	85.893	14.315	1.2105^{ns}	3.66	4.01
ERROR	18	212.876	11.826			
TOTAL	27	3562.430				

^{ns} – not significant Coefficient of variation = 18.25%

Appendix Table 7. Non - Marketable yield/plot (kg) (actual data)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
Calcium hypochlorite	0.00	5.55	4.45	2.56	13.22	3.31
Formulated Compost	0.00	0.00	0.00	3.96	3.96	0.99
Lime	0.00	0.00	0.00	4.11	4.11	1.03
Urea	0.00	0.00	0.00	3.00	3.00	0.75
Lime + Urea (1)	0.00	0.00	0.00	4.54	4.54	1.14
Lime + Urea (2)	0.00	0.00	0.00	0.00	0.00	0.00
Control	6.09	0.00	0.00	5.16	12.67	3.17

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
BLOCK	3	22.703	7.568	2.8876		
TREATMENT	16	22.839	3.806	1.4524^{ns}	3.66	4.01
ERROR	18	47.173	2.621			
TOTAL	27	92.716				

^{ns} – not significant Coefficient of variation = 86.04%

Appendix Table 8. Return on investment (actual data)

TREATMENT	YIELD (Tons/ha)	GROSS RETURN (Php)	TOTAL PRODUCTION. COST (Php)	NET RETURN (Php)	ROI %
Calcium hypochlorite	17.50	274,000.00	206,520.00	67,880.00	32.87
Formulated Compost	20.07	320,160.00	256,400.00	63,760.00	54.86
Lime	21.01	336,160.00	286,400.00	49,760.00	17.37
Urea	20.72	331,520.00	207,200.00	124,320.00	60.00
Lime + Urea (1)	19.03	304,480.00	287,200.00	17,280.00	6.01
Lime + Urea (2)	19.91	318,560.00	297,200.00	21,360.00	7.18
Control	15.74	251,840.00	206,400.00	45,240.00	21.92

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
BLOCK	3	1745.89	581.96	1.49		
TREATMENT	16	8138.64	1356.44	3.49^{ns}	3.66	4.01
ERROR	18	694.04	388.00			
TOTAL	27	9007.57				

^{ns} – not significant Coefficient of variation = 80.89%