BIBLIOGRAPHY

PAQUITO JAEDARHLYN T. APRIL 2011. Comparison of Fermented and Fresh Wild Sunflower Extracts for Fertigation on Potato (*Solanum tuberusom*). Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The experiment was conducted at the Organic Demo Farm, Benguet State University, La Trinidad Benguet from November 2010 to February 2011 to compare the efficacy of wild sunflower extracts on the growth and yield of potato; to determine the best rate of fermented and fresh wild sunflower extracts for fertigating potato; to determine the more efficient kind and best rate of wild sunflower extract and, to assess the most economical kind and rate of wild sunflower extract.

Rates of fermented and fresh wild sunflower extracts significantly affected the total number, weight, and yield of classified potato tubers. Application of 2 tbsp/L water of formulated fermented and fresh wild sunflower extract had significant effects on the yield and total marketable weight of potato tubers.

On the other hand, the kind of wild sunflower extracts gave no significant differences on the physical and chemical properties of the soil as well as growth and yield parameters.

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INTRODUCTION

Potato is an important cash crop and livelihood of farmers in Benguet. It is believed to have originated somewhere between Mexico and Chile. It is one of the vegetables among cabbage, red beet, spinach, onions and Brussels sprouts that respond most to nitrogen. Potato is an outstanding source of Vitamin C, A, B1 (thiamin) and Riboflavin.

Its young sprouts develop best at soil temperatures of about 75 degrees Fahrenheit but later growth is best at a soil temperature of 68 degrees Fahrenheit and completely inhibited at 84 degrees Fahrenheit. Long days, high temperature and high amounts of nitrogen favor the heavy growth of potato (Martin and Leonard, 1970).

It has been a long time practice of most farmers in Benguet to use pesticide and chemical fertilizers in producing potatoes. Chemical fertilizers are used as a means of supplementing the food supplies in the soil. However effects of long time use of pesticide and chemical fertilizer application, causes depleted nutrients and unfavorable soil conditions. Destruction of living things including plants, animals, and human beings existed. One way of saving the land from unproductively and less fertile is by conversion to organic farming.

Organic farming depends on appropriate crop rotations, green manuring, recycling of farm manure and other ecological ways of building up soil fertility and productivity. It intentionally seeks sound conservation and quality enhancement of the soil, water, air and genetic resources through scientific method. The ecological integration of diversified farm components and farming system in the absence of synthetic chemical inputs exemplifies an organic farm (Tanacio, 2004).

Using plant resources around the farm is helpful in organic farming. One example of this is the utilization of wild sunflower for fertigating crops. It is rich in nitrogen which is most common nutrient applied by fertigation. Other nutrient elements applied more or less frequently include phosphorus, sulfur, potassium, zinc, and iron.

Fertigation (contraction of fertilization and irrigation) is the technique of supplying dissolved fertilizer to crops through an irrigation system. When combined with an efficient irrigation system both nutrients and water can be manipulated and managed to obtain the maximum possible yield of marketable production from a given quantity of these inputs (Pile, undated). With the fertigation system over feeding, waste and run-off, and stripes in the lawn from uneven applications will be eliminated.

Liquid fertilizers play an important role in plant growth. It gives a very important source of mineral elements and food for the plant. It has been extensively used in irrigated lands for direct application to crops. Donahue (1970) stressed that liquid fertilizers was known for many years where plants are able to absorbed essential elements through their leaves. The absorption takes place through the stomata of the leaves and through the epidermis. Movement of elements is usually faster through the stomata but the total absorption is as great through the epidermis.

This study has the following objectives:

a. To compare the efficacy of wild sunflower extracts on the growth and yield of potato.

b. To determine the best rate of fermented and fresh wild sunflower extracts for fertigating potato.

c. To determine the more efficient kind and best rate of wild sunflower extract.

d. To assess the most economical kind and rate of wild sunflower extract.

The study was conducted at Organic Demo Farm, Benguet State University, La Trinidad, Benguet from December 2010- February 2011.

REVIEW OF LITERATURE

Potato is an example of a crop in which irrigation can be used to manipulate development and yield in a number of ways. Thus where early production is the aim, irrigating before tuber initiation to hasten the vegetative growth is worthwhile (Spedding, 1981).

Moorby *et. al* (1975) as cited by Spedding (1981) stated that irrigating during the period of tuber expansion, to ensure that the stomata remain wide open and that there is no premature leaf senescence, will maintain high photosynthetic rates and enable good yields to be obtained.

Organic Production

Organic production is the conservation and maintenance of environment quality. Foods are safe to consume and contains significantly lower levels of pesticide residues than conventionally produced. Organic production relies heavily upon crop and soil management practices that aid water infiltration, resist soil erosion, improve soil tilt and productivity, recycle organic waste and reduce pollution of the soil and water (USDA, 2000).

Bawang (2009) cited salient advantages of organic farming namely: cutting the cost of farm inputs; making use of waste products; balance nutrient source; improvement of the soil properties; pest and disease control; consumer demand for organically produce crops, thus enhance better market price; enhance sustainable soil productivity; promote biodiversity, none use of genetically modified organism (GMO) and minimize food crops and environmental pollution.

Organic Fertilizer Materials

Organic materials, whether as farmyard manure, slurry, compost, grass turf, straw, or other crop residues, are beneficial in improving the physical, properties of the soil and it's moisture retention capacity, and also, by supplying a wide range of plant nutrients in unpredictable amounts (Hignett,1985).

Animal manures. Animal manures are high in nitrogen. Therefore, when it is mixed with a carbon material, such as chopped leaves or hay, they produced nitrogen-rich compost that can be used as a fertilizer. Dried manure is inclined to be richer in most major nutrients than fresh manure. Animal manures vary in nutrient rich. Chicken manure is among the most nutrient- rich (Pile, 1992). Manure contains many essential plant nutrients especially N, P, K as well as some trace elements, not generally found in the chemical fertilizers. Animal wastes help to build up and maintain soil fertility and tilth, and to cut down on erosion by Jones (1982).

Wild sunflower. Wild sunflower has been known to be a good source of organic N, besides being free; it is readily available on the farm. Sunflower as organic fertilizer insures vigorous growth of plants and influences nutrient absorption due to its role in granulation thereby improving the physical and chemical properties of the soil (Brady, 1974) as cited by Durante (1982).

Malucay (2008), noted the analysis of fresh wild sunflowers done in the laboratory by Pandosen (1986) showed that the N, P, K, Ca, and Mg components were 3.76%, 0.0077%, 4.44%, 1.90%, and 0.39% respectively. On the other hand, Palaleo, (1978) as cited by Durante (1982), chemical analysis of composted wild sunflower are as

follows: 70.2 me/ 100g compost (CEC), 0.38% N, 96.60ppm P, 6567.5 ppm K, 7.90% OM, 3206.0 ppm Ca, and a pH of 6.89.

Importance of Fertigation

Fertigation allows the landscape to absorb up to 90% of the applied nutrients, while granular or dry fertilizer applications typically result in absorption rates of 10% to 40% (Fertigation Systems, Undated). Plaster (1997), stated that a third way to fertilized a growing crop is injecting fertilizer into irrigation water called fertigation. It works best in sprinkler/ trickle irrigation but also be used with surface irrigation. Liquid application is the most commonly used of post plant surface applied-systems. Benefits include ease and uniformity of application, low labor requirements and ability to automate the system (Joiner, 1981).

The primary purpose of applying fertilizers in the form of spray is to overcome quickly some particular mineral deficiency that would impair the growth and yield of the plant. The most effective spray application must be repeated at a short interval while the plants are still growing (McVickar, 1970) cited by Guanzo (1982).However, Teuscher and Adler (1960) cited by Bagyan (1980) found out that fertilizer sprays are useful in helping weak plants to become established in maintaining vigorous growth of vegetables during dry seasons, but they can never actually take the place of root feeding and must be considered as supplemental.

Donahue (1970) stated that most of the 16 essential elements for plant growth can be absorbed by any plants when they are sprayed in the same part. N, P, K, Mg, Ca, S, Bo, Co, and Mo, has successfully used to supply the nutrients for plant growth by applying them as foliar sprays to the leaves (Zulueta, 1982).

Uses of Liquid Fertilizers

Edmond (1964), as cited by Gamboa (1977) reported that foliar sprays are used to correct a deficiency of some essential elements in a relatively short time to supply the raw materials which is if applied to soils, some reasons or other become unavailable to plants. Lockhart, *et al* (1975) stated that compared with solids, liquid fertilizers are easier, quicker and cheaper to handle and apply. A further increase in their use must be considered inevitable. Liquid fertilizers are simple, non-pressurized solutions of normal solid fertilizer raw materials.

Peligrina *et al* (1992) reported that Mr. Jose Barnachea, a farmer from Sibaan, Sta. Catalina applies 20 bags of fermented manure in two applications from transplanting of cabbage to harvesting. He used to add chemical fertilizer for his cabbage but he's no longer using any instead he use fermented manures. With this technique, according to him, he can save money for labor and chemical fertilizer but still have good harvest. Tswaran (1973) stated by Guanzo (1982), revealed that application of about 43 to80 kilogram of phosphoric acid/ha trough foliar application gives a greater profit than the soil application alone of the same quantity of fertilizers.

Tomin (2006) as cited by Boltican (2008) concluded that studying potato fertilized with liquefied chicken manure and complete fertilizer (14-14-14) at the rate of 6L fertilizer solution plus 16L water (1 to 4 sacks 14-14-14) can be the best rate of fertilizer for the growth and yield of potato.

Follet *et al* (1981) found out that anhydrous ammonia as liquid fertilizer is a feasible source of nitrogen but it also revealed that precipitation can occur when

ammonia is injected into water containing large quantities of dissolved calcium and magnesium salts due to increase in pH of the soil.

MATERIALS AND METHODS

Materials

The materials used in the experiment were potato tubers (cv "*raniag*"), fermented and fresh wild sunflower extracts, composted chicken dung, drums, watering cans, grub hoes, and 1.5L plastic containers, bolo or shredder and recording materials.

Methodology

An area of 165m^2 was thoroughly prepared and divided into 30 plots measuring 1m x 5m. Before land preparation, soil samples were collected for the initial and final soil physical and chemical properties of the experimental area. The samples for analysis were air dried at the Department of Soil Science Extension laboratory for analysis.

Cultural management. Composted chicken dung at a rate of 10 tons/ha was added to all plants and was incorporated in the soil before planting. Potato tubers with two sprouted eyes were planted at a distance of 30cm X 30cm between hills and rows at a depth of 2.54cm. Two weeks after plant emergence of tubers, hilling up was done. Zero chemical spraying was strictly implemented. All recommended cultural management practices like irrigation; weeding and pest and disease control were done to ensure plant growth and development of potato plants.

Watering was done twice a week after emergence. For the pest and diseases, organic farming practices were applied like manual picking of insects and removing the blight attacked leaves.

Preparation of fresh wild sunflower extract. Fresh wild sunflowers of vegetative stage with length of 30 inches were collected. These were chopped or shredded for faster

extraction. It was weighed and 68 kilograms of chopped wild sunflower was placed in a 200L- capacity drum. Then it was covered with plastic sheet. After two weeks, the liquid extract was collected and put into 1.5L containers (Figure 1).

Preparation of fermented wild sunflower extract. Eighty- seven kilograms of chopped wild sunflowers were collected and put into 200L capacity drum (Figure 2). It was added with 20L water, 1 L IMO (Indigenous Microorganism) and 1 L LAS (Lacto bacillus acid). After a week of extraction, the liquid extract was collected and then fermented. From the wild sunflower extract, 3L of it was added with 1 kg sugar and 2tsps FPJ seaweed (Tinoyan, 2010).

Fertigation with wild sunflower extracts. Application of fermented and fresh wild sunflower extracts was done once a week following the rates per treatment. The rates of fermented and fresh wild sunflower extracts were based on the recommended fertigation use that is 1tbsp/L water (Tinoyan, personal communication). From this recommended rate, lower and higher rates were formulated. The extract was measured and prepared in watering cans before fertigating it overhead on potato plants. Twenty- four liters of the diluted solution were applied per plot. Fertigation started two weeks after emergence and applied weekly thereafter. Fertigation was applied five times only because potato plants were harvested (68 DAP) before maturity due to severe late blight infection, an effect of climate change. Potato var. *raniag* has a maturity of 90 days.

The design used in the experiment was Randomized Complete Block Design in factorial arrangements with three replications. The factors studied were: kind of wild sunflower extract served as Factor A and the rates of wild sunflower extracts applied as Factor B.

Figure 1. Chopped wild sunflower applied with IMO for fermentation

Figure 2. Chopped wild sunflower extract applied with LAS for fermentation

Factor A. (Kind of Extract)

F_1= Fermented Wild Sunflower Extract

F_2= Fresh Wild Sunflower Extract

Factor B. (Rates of Extract)

T_1= Control

T_2= 0.5 tbsp / L water

T_3= 1 tbsp / L water

T_4=1.5 tbsp/ L water

T_5= 2 tbsp / L water

Figure 3. LAS and IMO

Figure 4. Chopped wild sunflower for fresh extract placed in a drum and covered

The data gathered were:

A. Chemical analysis of wild sunflower extracts

Samples of fermented and fresh wild sunflower were brought to the Natural Sciences and Research Unit in Saint Louis University for the analysis of nitrogen, phosphorus and potassium contents.

B. Soil Physical Analysis

1. Bulk density of the soil (g/cm^3). This was obtained using the core method.

2. Water holding capacity (%). It was determined through saturation method, wherein core was filled first with half submerged in water to be saturated through capillarity. The formula was:

$$\%WHC = \frac{\text{Weight of Saturated Soil} - \text{Weight of Oven Dry Soil}}{\text{Weight of oven dry soil}} \times 100$$

C. Soil Chemical Analysis

1. Initial and final soil pH. This was determined before and after harvesting using 1:2.5 $CaCl_2$ solution by electrometric method.

2. OM content of the soil (%). Organic matter of the soil was analyzed using Walkley -Black Method.

3. Total Nitrogen content of the soil (%). This was computed by multiplying the factor 0.05 to the % OM content of the soil.

D. Growth and Yield Parameters

1. Plant vigor. Plant vigor of the plant was rated using the following scale:

Scale	Description
1	very vigorous
2	vigorous
3	slightly vigorous
4	not vigorous

2. Pest infestation and disease infection. This was observed in 10 sample plants per plot using the following rating scale at 30 and 60 DAP (Cho, 1987) cited by Menes (2010).

Scale	Description	Remarks
1	No infection	High resistance
2	1-25% of the total plant	Mild resistance
3	26-50% of the total plant	Moderate resistance
4	51-75% of the total plant	Susceptible
5	76- 100% of the total plant	Very Susceptible

3. Number of classified tubers (B, M and S). Classified tubers as big, medium and small were counted and recorded per plot.

4. Weight of classified tubers (kg/m^2). Classified tubers as big, medium and small were weighed per plot and their corresponding weights were recorded.

5. Total yield (kg/m^2). Weight of the marketable and non-marketable tubers.

. 6. Dry matter yield. This was determined by oven drying sliced tubers (30g) of each different size per treatment for three days at 70 degrees Celsius. It was computed using the formula:

$$\% \text{ DMY} = \frac{\text{FW- ODW}}{\text{ODW}} \times 100$$

E. Return on Cash Expense (ROCE). Production cost, gross and net income were determined and computed using the formula:

$$\text{ROCE (\%)} = \frac{\text{Gross sales- Total Expenses}}{\text{Total Expense}} \times 100$$

RESULTS AND DISCUSSION

Chemical Analysis of Fermented and Fresh Wild Sunflower Extract

Chemical analysis of fermented wild sunflower extract with indigenous microorganisms is shown in Table 1. Result reveals that the nitrate-nitrogen, phosphorus and potassium content of fermented wild sunflower extract are 12.5ppm, 100ppm and 200ppm while the fresh wild sunflower extracts are 0.5ppm, 37.5ppm and 200ppm respectively. Fermented wild sunflower extracts has higher nitrogen and phosphorus than fresh wild sunflower extract but both have the same potassium content.

Soil Physical Analysis

Bulk Density of the Soil

Effect of the kind of wild sunflower extract. There are no significant differences on the bulk density of the soil as influenced by kind of wild sunflower extracts (Table 2). However, the bulk density was improved from the initial Db of 1.54 g/cm^3. The decrease in the Db of the soil could be attributed to blanket application of chicken manure that added organic matter in the soil and cultivation that enhances microbial activity.

Table 1. Chemical analysis of fermented wild sunflower extract

WILD SUNFLOWER EXTRACT	NO^{3-} (ppm)	P_2O_5 (ppm)	K_2O (ppm)
Fermented	12.5	100	200
Fresh	0.5	37.5	200

Table 2. Soil bulk density as affected by rates of wild sunflower extracts

TREATMENT	Db (g/cm^3)
Kind of Wild Sunflower Extract	
Fermented Wild Sunflower Extract	1.08
Fresh Wild Sunflower Extract	1.07
Rates of Wild Sunflower Extract	
Control	1.09
0.5 tbsp/ liter water	1.07
1 tbsp/ liter water	1.10
1.5 tbsp/ liter water	1.05
2 tbsp/ liter water	1.06
Factor A x Factor B	ns
Initial Db	1.54

*Means are not significantly different at 5% by DMRT.
ns = not significant

Wild sunflower extracts fertigated on potato plants served as food to microbes for faster decomposition and enhances porosity of the soil. Brady and Weil (2008) stated that solid particles of fine-textured soils tend to be organized in porous granules, especially if adequate organic matter is present. This ensures high total pore space but low bulk density.

Effect of different rates of wild sunflower extract. Bulk density of the soil was not significantly affected by the rates of application of the formulated wild sunflower extracts. However, an improvement of Db in all applied plants was computed. This

conforms with the report of Pandosen (1986) that a decrease in bulk density of the soil is realized when it is applied with fresh wild sunflower and sunflower- based compost. This indicates that the application of sunflower whether as compost or liquid fertilizer improves the bulk density of the soil.

Interaction effect. Result shows no significant interaction between the kind and rates of wild sunflower extracts on the bulk density of the soil at harvest.

Water Holding Capaciy of the Soil (WHC)

Effect of the kind of wild sunflower extract. The water holding capacity of the soil was not significantly affected by the fermented and fresh wild sunflower extracts. However, the soil fertigated with fermented wild sunflower extract had a higher total water holding capacity.

Effect of different rates of wild sunflower extracts. Table 3 shows no significant difference on the water holding capacity of the soil as affected by the application of formulated fermented and fresh wild sunflower extracts. The WHC value ranging from 63.3 to 65.8% was improved from the initial WHC of 53.7%. Sunflower as organic fertilizer insures vigorous plant due to its role in granulation thereby improving the physical and chemical properties of soil (Durante, 1982).

Interaction effect. Result shows no significant interaction between the formulated liquid fertilizer and the rates of application on the water holding capacity of the soil.

Table 3. Water holding capacity of the soil as affected by wild sunflower extracts

TREATMENT	WHC (%)
Kind of Wild Sunflower Extract	
Fermented Wild Sunflower Extract	67.3
Fresh Wild Sunflower Extract	65.8
Rates of Wild Sunflower Extract	
Control	66.7
0.5 tbsp/ liter water	66.7
1 tbsp/ liter water	63.3
1.5 tbsp/ liter water	68.5
2 tbsp/ liter water	67.6
Factor A x Factor B	ns
Initial	52.71

*Means are not significantly different at 5% by DMRT.
ns = not significant

Soil Chemical Properties

Soil pH

Effect of the kind of wild sunflower extract. No significant difference on the soil pH as affected by the kind of wild sunflower extracts was observed. Nevertheless, an increase from the initial of 5.12 was observed which could be due to the organic materials applied (chicken manure and wild sunflower extract).

Table 4. Soil pH as affected by wild sunflower extracts

TREATMENT	pH
Kind of Wild Sunflower Extract	
Fermented Wild Sunflower Extract	5.92
Fresh Wild Sunflower Extract	5.91
Rates of Wild Sunflower Extract	
Control	5.89
0.5 tbsp/ liter water	5.90
1 tbsp/ liter water	5.92
1.5 tbsp/ liter water	5.91
2 tbsp/ liter water	5.95
Factor A x Factor B	ns
Initial	5.12

*Means are not significantly different at 5% by DMRT.
ns = not significant

Effect of different rates of wild sunflower extracts. There were no significant differences on the soil pH as affected by the rates of fermented and fresh wild sunflower extracts. However it was observed that as the rate increased, the pH increased.

Interaction effect. No significant interaction was observed between the kind of wild sunflower extracts and rates of application on the pH of the soil. Soil pH from treatment combinations has almost the same values.

Organic Matter of the Soil

Effect of the kind of wild sunflower extract. Organic matter content of the soil was not affected by kind of wild sunflower extracts (Table 5). However, a higher mean OM value was registered by the plots fertigated with fermented compared to the fresh wild sunflower extract. In addition, the initial OM content of the soil (3.34%) was slightly increased.

Table 5. Organic matter content of the soil as affected by wild sunflower extracts

TREATMENT	OM (%)
Kind of Wild Sunflower Extract	
Fermented Wild Sunflower Extract	3.78
Fresh Wild Sunflower Extract	3.54
Rates of Wild Sunflower Extract	
Control	4.00
0.5 tbsp/ liter water	3.45
1 tbsp/ liter water	3.92
1.5 tbsp/ liter water	3.43
2 tbsp/ liter water	3.50
Factor A x Factor B	ns
Initial	3.34

*Means are not significantly different at 5% by DMRT.
ns = not significant

Effect of different rates of wild sunflower extract. The organic matter content of the soil was not significantly affected by the rates of application of fermented and fresh wild sunflower extracts. It was noted however, that the final organic matter content of the soil increased from the initial 3.34 to a range of 3.43- 4% due to the composted chicken manure and wild sunflower extract applied.

Interaction effect. Statistically, no significant interaction was obtained between formulated liquid fertilizer and rates of application on the organic matter content of the soil at harvest. However it was observed that 1.5 tbsp/liter water of fermented wild sunflower extract had higher organic matter content while the control ranked highest in fresh wild sunflower extracts.

Total Nitrogen Content of the Soil After Harvest

Effect of the kind of wild sunflower extract. Nitrogen content of the soil was not affected by the kind of wild sunflower extracts. As seen on the result, no significant differences were observed on the nitrogen content of soil between those treated with fermented and fresh wild sunflower extracts. Nitrogen content of the soil treated with fermented extract however slightly higher than those fertigated with fresh wild sunflower extract.

Effect of different rates of wild sunflower extracts. The rates of applied fermented and fresh wild sunflower extracts did not significantly affect the nitrogen content of the soil. The computed nitrogen content of the soil at harvest was equal and not far from the initial which is 0.18%.

Table 6. Total nitrogen content of the soil as affected by wild sunflower extracts

TREATMENT	N (%)
Kind of Wild Sunflower Extract	
Fermented Wild Sunflower Extract	0.19
Fresh Wild Sunflower Extract	0.18
Rates of Wild Sunflower Extract	
Control	0.20
0.5 tbsp/ liter water	0.17
1 tbsp/ liter water	0.20
1.5 tbsp/ liter water	0.17
2 tbsp/ liter water	0.18
Factor A x Factor B	ns
Initial	0.18

* Means are not significantly different at 5% level using DMRT.
ns = not significant

Interaction effect. Result show that there is no significant interaction between the kind and rates of wild sunflower extract on the organic matter content of the soil at harvest.

Growth and Yield Parameters

Plant Vigor

Effect of the kind of wild sunflower extract. Plant vigor as affected by the kind of wild sunflower extract is presented in Table 7. There are no significant differences on the utilization of fermented and fresh extracts as liquid fertilizer for potato. Plants however were very vigorous at 30 DAP. Figure 5 and 6 shows the plant stand of potatoes.

Table 7. Plant vigor as affected by wild sunflower extracts (30 DAP)

TREATMENT	PLANT VIGOR (%)
Kind of Wild Sunflower Extract	
Fermented Wild Sunflower Extract	1.20
Fresh Wild Sunflower Extract	1.27
Rates of Wild Sunflower Extract	
Control	1.5
0.5 tbsp/ liter water	1.17
1 tbsp/ liter water	1.30
1.5 tbsp/ liter water	1.00
2 tbsp/ liter water	1.17
Factor A x Factor B	ns

*Means are not significantly different at 5% level using DMRT.

ns = not significant
Plant vigor rating: 1- very vigorous 2- vigorous
3- Slightly vigorous 4- not vigorous

Effect of different rates of wild sunflower extracts. Plant vigor of potato was not significantly affected by the rates of applied wild sunflower extracts (Table 7). It was observed that the control plants was least vigorous than plants treated with wild sunflower extracts. The most vigorous plants were observed from those fertigated with 1.5tbsp/L water of wild sunflower extract.

Interaction effect. No significant interaction was noted between the kind and rates of wild sunflower extracts on plant vigor.

Figure 5. Overview of potato plants (23 DAP)

Figure 6. Overview of potato plants (26 DAP)

Late Blight (LB) Infection (30, 45 and 60 DAP)

Effect of the kind of wild sunflower extract. Late blight infection as affected by the kind of wild sunflower extracts is presented in Table 8. There is no significant effect of the kind of wild sunflower extract on the late blight infection rating. The result implies that the kind of extract fertigated has no bearing on late blight infection. It can be observed that the late blight infection progress from the rating of almost 2 at 30 DAP to 81-100 % (rating of 5 at 60 DAP).

Effect of different rates of wild sunflower extracts. Late blight infection of potato was not significantly affected by the rates of applied fermented and fresh wild sunflower extracts. Blight infection rating progressed from 30 DAP to 60 DAP. However, at 40 DAP late blight infection rating was slightly lower as the rate of wild sunflower extract

Table 8. Late blight infection as affected by wild sunflower extracts (%)

TREATMENT	30 DAP	40 DAP	60 DAP
Kind of Wild Sunflower Extract			
Fermented Wild Sunflower Extract	1.84	2.79	4.80
Fresh Wild Sunflower Extract	1.86	2.87	4.87
Rates of Wild Sunflower Extract			
Control	1.90	2.97	4.80
0.5 tbsp/ liter water	1.82	2.94	4.80
1 tbsp/ liter water	1.78	2.82	4.84
1.5 tbsp/ liter water	1.85	2.7	4.82
2 tbsp/ liter water	1.90	2.72	4.93
Factor A x Factor B	ns	ns	ns

*Means are not significantly different at 5% level using DMRT.
ns= not significant

Disease rating: Ten sample plants were rated as:
1= 1-20% infestation
2= 21-40% infestation
3= 41-60% infestation
4= 61-80% infestation
5= 81-100% infestation

was increased to 1.5tbsp/L water (2.7).

Interaction effect. Result show no significant interaction between the kind and rates of wild sunflower extracts on plant vigor. Based on different times of disease observation, late blight affected potato severely 60 days after planting. Figures 7 and 8 shows the infected potato plants.

Figure 7. Overview of potato plants attacked by late blight 30 DAP

Figure 8. Overview of potato plants attacked by late blight 45 DAP

Total Number of Classified Tubers (S, M, and B)

Effect of the kind of wild sunflower extract. Number of each tuber classification and the total number of classified potato tubers as affected by kind of wild sunflower extracts are shown in Table 9. Results show that there was no significant mean difference between the fermented and fresh wild sunflower extracts on the number of small, medium, big tuber sizes and the total number of potato.

Table 9. Total number of classified tubers- small, medium and big as affected by kind of wild sunflower extracts

TREATMENT	SMALL	MEDIUM	BIG	TOTAL
Kind of Wild Sunflower Extract				
Fermented Wild Sunflower Extract	51.40	36.33	16.67	104.40
Fresh Wild Sunflower Extract	48.87	35.20	18.47	102.53
Rates of Wild Sunflower Extract				
Control	34.17^{d}	26.00^{c}	7.83^{b}	68.00^{d}
0.5 tbsp/ liter water	37.33^{c}	26.67^{c}	11.33^{b}	75.00^{c}
1 tbsp/ liter water	49.50$_{b}$	37.33^{b}	15.83^{b}	102.67^{b}
1.5 tbsp/ liter water	64.67^{a}	45.67^{a}	28.17^{a}	138.5^{a}
2 tbsp/ liter water	65.00^{a}	43.17^{a}	24.67^{a}	132.83
Factor A x Factor B	ns	ns	ns	ns

*Means within a column are not significantly different at 5% level using DMRT.
ns= not significant

Effect of different rates of wild sunflower extracts. Rates of application of fermented and fresh wild sunflower extracts significantly affected the number of small, medium and big potato tubers and the total number of marketable tubers. Based on the results, it was noted that as the rate was increased, the number of tubers also increased. The highest rate of 2 tbsp/liter water had the highest total number of small tubers while the control and lowest rate of 0.5 tbsp/liter water produced the least. This trend was the same in the total number of classified tubers.

Interaction effect. There was no interaction effect between the kind of extract and rates of application on the total number of small, medium and big potato tubers.

Weight of Classified Tubers (S, M, and B)

Effect of the kind of wild sunflower extract. Weight per classified tubers (small, medium and big) as affected by the rates of application of fermented and fresh wild sunflower extract is presented in Table 10. There are no significant differences on the mean weight of classified tubers as can be noted in the similar values between kinds and rates of extracts.

Effect of different rates of wild sunflower extracts. Weight of small, medium and big potato tubers was highly affected by the different rates of application of fermented and fresh wild sunflower extracts applied (Table 10). Similar with the result on the number of classified potato tubers, weight of small and medium potato had increased as the rates are increased. Likewise, for big potato, tuber weight was increased as the rate increased to 1.5tbsp/L water then decreased at 2.0tbsp/L water.

Table 10. Weight of classified tubers- small, medium and big affected by wild sunflower extracts (kg/5m^2)

TREATMENT	SMALL	MEDIUM (kg/5m^2)	BIG
Kind of Wild Sunflower Extract			
Fermented Wild Sunflower Extract	0.43	0.81	0.39
Fresh Wild Sunflower Extract	0.43	0.73	0.38
Rates of Wild Sunflower Extract			
Control	0.28^d	0.49^c	0.27^d
0.5 tbsp/ liter water	0.31^d	0.58^c	0.32^c
1 tbsp/ liter water	0.40^c	0.77^b	0.35^c
1.5 tbsp/ liter water	0.55^b	1.03^a	0.54^b
2 tbsp/ liter water	0.60^a	1.08^a	0.45^a
Factor A x Factor B	ns	ns	ns

*Means within a column are not significantly different at 5% by DMRT.

ns= not significant

Interaction effect. No significant interaction was observed between the fermented and fresh wild sunflower extracts and the rates of application on the total weight of classified tubers.

Total Yield

Effect of the kind of wild sunflower extracts. No significant mean differences observed on the total yield of potato tubers between potato plants fertigated with wild sunflower extracts (Table 11). Although plants fertigated with fermented wild sunflower

Table 11. Total yield of potato tubers as affected by wild sunflower extracts (kg/5m^2)

TREATMENT	TOTAL MARKET-ABLE YIELD	NON MARKET-ABLE YIELD	TOTAL YIELD
Kind of Wild Sunflower Extract			
Fermented Wild Sunflower Extract	1.63	0.44	2.07
Fresh Wild Sunflower Extract	1.58	0.36	1.94
Rates of Wild Sunflower Extract			
Control	1.04^{d}	0.48	1.51^{c}
0.5 tbsp/ liter water	1.20^{c}	0.28	1.48^{c}
1 tbsp/ liter water	1.53^{b}	0.42	1.94^{b}
1.5 tbsp/ liter water	2.13^{a}	0.37	2.50^{a}
2 tbsp/ liter water	2.13^{a}	0.48	2.60^{a}
Factor A x Factor B	ns	ns	ns

* Means within a column are not significantly different at 5% by DMRT.
ns = not significant

extract produced slightly higher marketable tubers, the difference however, was not significant.

Effect of different rates of wild sunflower extracts. Figures 11 to 20 shows the potato tubers from the different treatments. Total weight of small, medium and big potato tubers was significantly affected by rates of application of fermented and fresh wild sunflower extracts. The higher the rates of wild sunflower extracts, the higher the tuber yield.

Figure 9. Tuber yield of potato cv *raniag* gathered from control

Figure 10. Tuber yield of potato gathered from plants fertigated with 0.5tbsp/L water of fermented wild sunflower extract

Figure 11. Tuber yield of potato fertigated with 1tbsp/L water of fermented wild sunflower extract

Figure 12. Tuber yield of potato tubers fertigated with 1.5tbsp/L water of fermented wild sunflower extract

Figure 13. Tuber yield of potato fertigated with 2tbsp/L water of fermented wild sunflower extract

Figure 14. Tuber yield of potato fertigated gathered from control

Figure 15. Tuber yield of potato fertigated with 0.5tbsp/L water of fresh wild sunflower extract

Figure 16. Tuber yield of potato fertigated with 1tbsp/L water of fresh wild sunflower extract

Figure 17. Tuber yield of potato fertigated with 1.5tbsp/L water of fresh wild sunflower extract

Figure 18. Tuber yield of potato fertigated with 2tbsp/L water of fresh wild sunflower extract

The trend in the marketable and total tuber yield revealed that fertigation of even the lowest rate of 0.5 tbsp/L water to potato plants significantly increased tuber yield as evidenced by the statistically significant difference of this treatment over the control or no fertigation. Even with the basal application of chicken manure at the rate of 10 tons/ha plus fertigation of wild sunflower extracts at a minimal rate of 0.5 tbsp/L water had a significant increase in tuber yield.

Interaction effect. No significant interaction effect between fermented and fresh wild sunflower extracts and rates of application on the total weight of classified tubers. The highest yielding treatment combinations was obtained from plants fertigated with fermented wild sunflower extracts at a rate of 1.5tbsp/L water (Figure 12) and fertigated with fresh wild sunflower extract at a rate of 2tbsp/L water (Figure 18).

Dry Matter Content of Potato Tubers

Effect of the kind of wild sunflower extracts. The dry matter yield of potato was not significantly affected by the kind of wild sunflower extracts as liquid fertilizer. The result implies that sunflower extracts applied is fermented or fresh, the dry matter yield of potato is not affected although numerically fermented slightly gave a higher DMY than those applied with fresh extract.

Effect of different rates of wild sunflower extracts. The dry matter yield of potato range from 20.05% to 21.50%. Although a general trend is observed wherein dry matter yield slightly increases as the rate increased up to 1.5tbsp/L water. However no significant effect was noted on rates of application of fermented and fresh wild sunflower extracts.

Table 12. Dry matter yield of potato tubers as affected by wild sunflower extracts

TREATMENT	DRY MATTER CONTENT (%)
Kind of Wild Sunflower Extract	
Fermented Wild Sunflower Extract	20.91
Fresh Wild Sunflower Extract	20.55
Rates of Wild Sunflower Extract	
Control	20.50
0.5 tbsp/ liter water	20.05
1 tbsp/ liter water	20.89
1.5 tbsp/ liter water	21.50
2 tbsp/ liter water	20.72
Factor A x Factor B	ns

*Means are not significantly different at 5% level using DMRT.
ns = not significant

Interaction effect. Results show no significant interaction effect between the kind and rates of wild sunflower extracts on the dry matter content of potato tubers.

Return on Cash Expense (ROCE)

Table 13 shows the return on cash expense of potato production as affected by fertigation rates of wild sunflower extracts. Computations show that those applied with 2tbsp/ liter water of fresh wild sunflower extracts resulted the highest return of investment of 33.81% due to lower variable cost compared to fermented wild sunflower extract. This was followed by F_1T_5, treatment combination, applied with 2tbsp/liter water

Table 13. Return on cash expense of potato tubers as affected by the application of wild sunflower extracts

TREATMENT	YIELD ($kg/5m^2$)	VARIABLE COST (PhP)	GROSS INCOME (PhP)	NET INCOME (PhP)	ROCE (%)
F1T1	1.42	108.66	85.20	-23.46	-21.59
F1T2	1.58	134.49	94.80	-39.69	-29.51
F1T3	2.05	134.49	123.00	-11.49	-8.54
F1T4	2.68	134.49	160.80	26.31	19.56
F1T5	2.62	134.49	157.20	22.71	16.88
F2T1	1.61	108.66	96.60	-12.06	-11.10
F2T2	1.38	116.99	82.80	-34.19	-29.22
F2T3	1.83	116.99	109.80	-7.19	-16.15
F2T4	2.31	116.99	138.60	21.61	18.47
F2T5	2.57	116.99	154.20	37.21	31.81

*Average selling price of potato tubers is PhP 60.00/ kg basing on the price at the organic market for the month of March, 2011.

and F_1T_4 having 24.33%, both applied with fermented wild sunflower extracts.

Results show negative net income in most of the treatments due to low tuber yield and early harvesting (before maturity). Plants were severely infected with late blight 60 DAP because of the occurrence of heavy rains and showers in the month of January, 2011 (Table 14) which enhanced late blight infection. At 68 DAP almost 100% of the potato leaves were severely attacked that affected photosynthesis and yield. Cloudy days and rains every afternoon triggered fast disease infection of potato plants. Thus, the experiment was terminated earlier without completing variety maturity of 90 days.

Table 14. Rainfall data for the month of January (BSU-PAG- ASA, April 1, 2011)

DAYS	INTENSITY (mm)
January 12	7.8
January 14	T
January 20	5.6
January 21	T
January 23	15.8
January 24	16.6

*T= trace/ drizzle

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

Chemical fertilizers are used by most farmers in Benguet as a means of supplementing the food supplies in the soil that leads to depletion in soil nutrients and resulted in unfavorable soil conditions. Thus, one way of saving the land from unproductively and less fertile is by conversion to organic farming. This study was conducted at Organic Demo Farm from December 2010 to February 2011 to compare the efficacy of wild sunflower extracts on the growth and yield of potato; to determine the best rate of fermented and fresh wild sunflower extracts for fertigating potato; to determine the more efficient kind and best rate of wild sunflower extract and, to assess the most economical kind and rate of wild sunflower extract.

Wild sunflower extracts have no significant effect on the bulk density, water holding capacity, pH, organic matter content and nitrogen content of the soil. However, the rates of fermented and fresh wild sunflower extracts have high significant effect on the total number of classified potato tubers, total weight of classified potato tubers, and total yield of potato tubers. Results revealed that the highest total number of potato tubers was observed from those applied with 1.5tbsp/L water. The highest total weight and total yield of potato tubers was obtained from those applied with 2tbsp/L water. Plant vigor and dry matter yield of potato was not affected significantly by wild sunflower extracts.

Conclusion

Based on the result, it is concluded that application of formulated wild sunflower extract either as fermented or fresh enhance better growth and yield of potato.

Formulated fermented and fresh wild sunflower extract has essential nutrient elements such as nitrogen, phosphorus, potassium and other micronutrients which are important on growth and yield of plants.

Recommendation

Either fresh or fermented wild sunflower extract can be used to enhance growth and yield of potato. It is recommended that 1.5 and 2 tbsp/L water of either fermented or fresh wild sunflower extracts are the best rate to use for fertigating potato. However taking into consideration, the added cost in fermenting wild sunflower extract and while the yield is almost the same as the fresh or unfermented wild sunflower extract, the later is more economical to use. It is also suggested that a follow- up study is necessary to determine the effects of adding the rates of fermented and fresh wild sunflower extracts for fertigation of potato.

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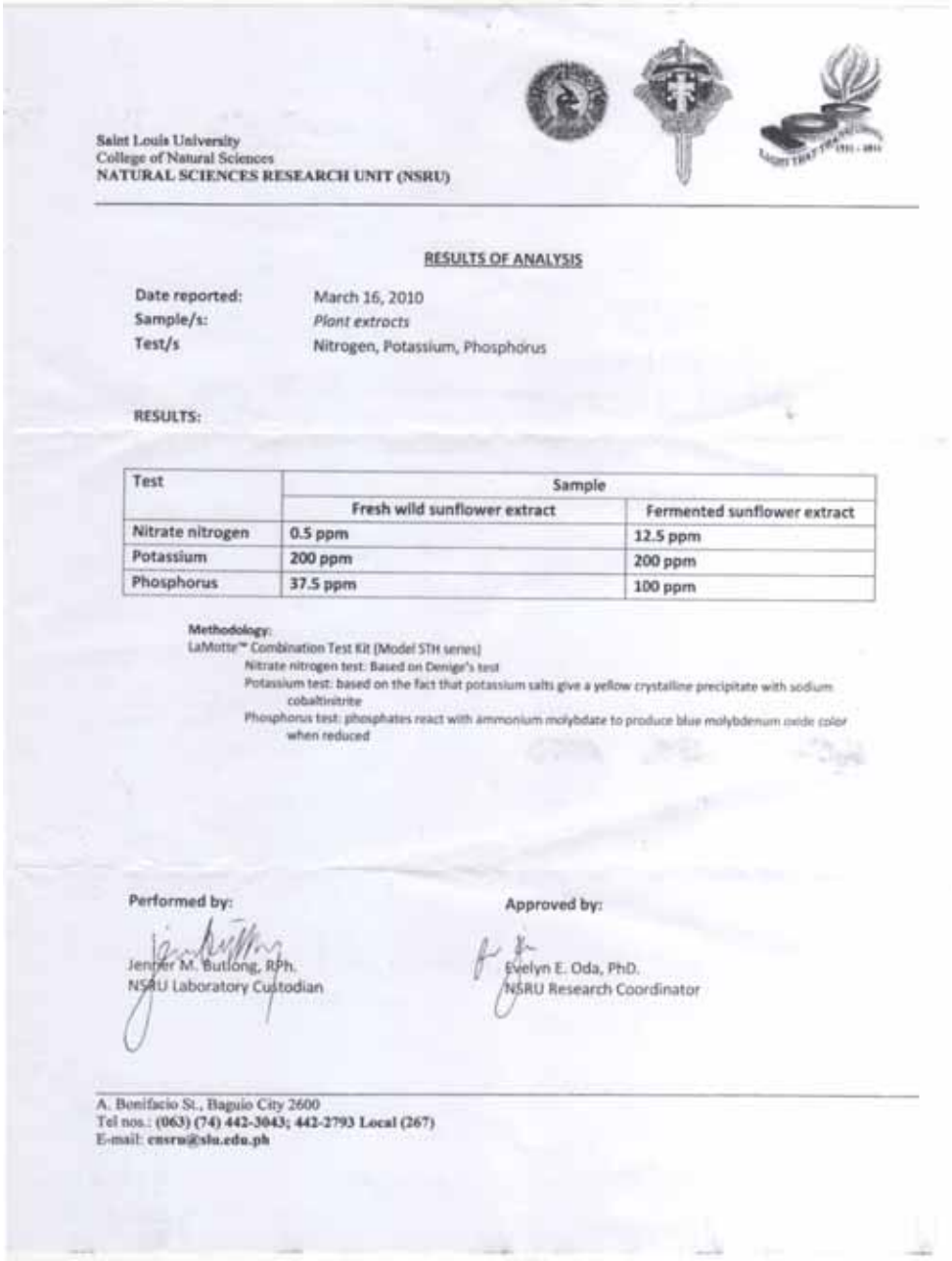
APPENDICES

APPENDIX A

Chemical Analysis of Wild Sunflower Extract



Saint Louis University
College of Natural Sciences
NATURAL SCIENCES RESEARCH UNIT (NSRU)

RESULTS OF ANALYSIS

Date reported: March 16, 2010
Sample/s: *Plant extracts*
Test/s Nitrogen, Potassium, Phosphorus

RESULTS:

Test	Sample	
	Fresh wild sunflower extract	Fermented sunflower extract
Nitrate nitrogen	0.5 ppm	12.5 ppm
Potassium	200 ppm	200 ppm
Phosphorus	37.5 ppm	100 ppm

Methodology:
LaMotte™ Combination Test Kit (Model STH series)
Nitrate nitrogen test: Based on Denige's test
Potassium test: based on the fact that potassium salts give a yellow crystalline precipitate with sodium cobaltinitrite
Phosphorus test: phosphates react with ammonium molybdate to produce blue molybdenum oxide color when reduced

Performed by:
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Appendix Table 2. Bulk density of the soil after harvest (g/ cm^3)

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	1.08	1.06	1.01	3.15	1.05
F_1T_2	1.09	1.04	1.09	3.22	1.07
F_1T_3	1.14	1.16	1.06	3.36	1.12
F_1T_4	1.01	1.11	1.07	3.19	1.06
F_1T_5	1.16	1.06	1.02	3.24	1.08
Subtotal	5.48	5.43	5.25	16.16	5.39
F_2T_1	1.12	1.21	1.07	3.4	1.13
F_2T_2	1.15	1.05	1.01	3.21	1.07
F_2T_3	1.04	1.14	1.07	3.25	1.08
F_2T_4	0.94	1.11	1.06	3.11	1.04
F_2T_5	1.05	1.13	0.92	3.1	1.03
Subtotal	5.3	5.64	5.13	16.07	5.36
TOTAL	10.78	11.07	10.38	32.23	21.49

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	1.05	1.07	1.12	1.06	1.08	5.38	1.08
F_2	1.13	1.07	1.08	1.04	1.03	5.35	1.07
TOTAL	2.18	2.14	2.20	2.10	2.11	10.73	
MEAN	1.09	1.07	1.10	1.05	1.06		1.07

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	0.0240	0.0120		3.55	6.01
F	1	0.0003	0.0003	0.08 ^{ns}	4.41	8.28
T	4	0.0118	0.0030	0.83 ^{ns}	2.93	4.58
F x T	4	0.0165	0.0041	1.14 ^{ns}	2.93	4.58
ERROR	18	0.0648	0.0036			
TOTAL	29	0.1173				

^{ns} = not significant CV (%) = 5.61

Appendix Table 3. Water holding capacity of the soil after harvest (%)

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	69.41	66.84	67.54	203.79	67.93
F_1T_2	64.47	65.63	65.87	195.97	65.32
F_1T_3	68.91	67.80	69.04	205.75	68.58
F_1T_4	68.48	59.98	69.41	197.87	65.96
F_1T_5	71.52	65.71	69.04	206.27	68.76
Subtotal	342.79	325.96	340.90	1009.65	336.55
F_2T_1	66.22	65.28	64.82	196.32	65.44
F_2T_2	67.38	71.01	65.96	204.35	68.12
F_2T_3	38.26	66.15	69.41	173.82	57.94
F_2T_4	72.11	64.84	76.25	213.2	71.07
F_2T_5	66.93	62.41	70.12	199.46	66.49
Subtotal	310.90	329.69	346.56	987.15	329.05
TOTAL	653.69	655.65	687.46	1996.80	665.60

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	67.93	65.32	68.58	65.96	68.76	336.55	67.31
F_2	65.44	68.12	57.94	71.07	66.49	329.05	65.81
TOTAL	133.37	133.44	126.52	137.03	135.25	665.60	
MEAN	66.69	66.72	63.26	68.52	67.63		66.56

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	71.87	35.94		3.55	6.01
F	1	16.87	16.87	0.08^{ns}	4.41	8.28
T	4	95.14	23.79	0.11^{ns}	2.93	4.58
F x T	4	113.83	28.46	0.13^{ns}	2.93	4.58
ERROR	18	3948.29	219.35			
TOTAL	29	4246.00				

^{ns} = not significant CV (%) = 22.25

Appendix Table 4. Soil pH after harvest

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	5.98	5.93	5.89	17.80	5.93
F_1T_2	5.88	5.97	5.80	17.65	5.88
F_1T_3	5.95	5.82	5.97	17.74	5.91
F_1T_4	5.83	5.97	5.89	17.69	5.909
F_1T_5	5.97	5.87	6.02	17.86	5.95
Subtotal	29.61	29.56	29.57	88.74	29.58
F_2T_1	5.69	5.87	5.97	17.53	5.84
F_2T_2	6.00	5.89	5.83	17.72	5.91
F_2T_3	5.96	5.87	5.94	17.77	5.92
F_2T_4	5.96	5.92	5.90	17.78	5.93
F_2T_5	5.93	5.92	6.00	17.85	5.95
Subtotal	29.54	29.47	29.64	88.65	29.55
TOTAL	59.15	59.03	59.21	177.39	59.13

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	5.93	5.88	5.91	5.90	5.95	29.57	5.91
F_2	5.84	5.91	5.92	5.93	5.95	29.55	5.91
TOTAL	11.77	11.79	11.93	11.83	11.83		
MEAN	5.89	5.90	5.92	5.92	5.92		5.91

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	0.0017	0.0009		3.55	6.01
F	1	0.0003	0.0003	0.04 ^{ns}	4.41	8.28
T	4	0.0147	0.0037	0.57 ^{ns}	2.93	4.58
F x T	4	0.0142	0.0036	0.55 ^{ns}	2.93	4.58
ERROR	18	0.1169	0.0065			
TOTAL	29	0.1478				

^{ns} = not significant CV (%) = 1.36

Appendix Table 5. Organic matter content of the soil after harvest (%)

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	4.87	4.47	3.04	12.38	4.13
F_1T_2	3.29	4.32	3.21	10.82	3.61
F_1T_3	4.92	4.5	3.55	12.97	4.32
F_1T_4	2.86	3.66	3.18	9.70	3.23
F_1T_5	3.24	4.12	3.41	10.77	3.59
Subtotal	19.18	21.07	16.39	56.64	18.88
F_2T_1	4.92	3.49	3.21	11.62	3.87
F_2T_2	2.86	3.87	3.15	9.88	3.29
F_2T_3	3.46	3.26	3.84	10.56	3.52
F_2T_4	3.72	3.98	3.15	10.85	3.62
F_2T_5	3.95	3.09	3.21	10.25	3.42
Subtotal	18.91	17.69	16.56	53.16	17.72
TOTAL	38.09	38.76	32.95	109.8	36.6

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	4.13	3.61	4.32	3.23	3.59	18.88	3.78
F_2	3.87	3.29	3.52	3.62	3.42	17.72	3.54
TOTAL	8.00	6.90	7.84	6.85	7.01		
MEAN	2	3.45	3.92	3.43	3.51		3.66

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	2.021	1.010		3.55	6.01
F	1	0.404	0.404	1.31^{ns}	4.41	8.28
T	4	1.848	0.462	1.5^{ns}	2.93	4.58
F x T	4	1.073	0.268	0.87^{ns}	2.93	4.58
ERROR	18	5.534	0.307			
TOTAL	29	10.879				

^{ns} = not significant CV (%) = 15.15

Appendix Table 6. Total nitrogen content of the soil after harvest (%)

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	0.24	0.22	0.15	0.61	0.20
F_1T_2	0.16	0.22	0.16	0.54	0.18
F_1T_3	0.25	0.23	0.18	0.66	0.22
F_1T_4	0.14	0.18	0.16	0.48	0.16
F_1T_5	0.16	0.21	0.17	0.54	0.18
Subtotal	0.95	1.06	0.82	2.83	0.94
F_2T_1	0.25	0.17	0.16	0.58	0.19
F_2T_2	0.14	0.19	0.16	0.49	0.16
F_2T_3	0.17	0.16	0.19	0.52	0.17
F_2T_4	0.19	0.20	0.16	0.55	0.18
F_2T_5	0.20	0.15	0.16	0.51	0.17
Subtotal	0.95	0.87	0.83	2.65	0.88
TOTAL	1.9	1.93	1.65	5.48	1.83

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	0.20	0.18	0.22	0.16	0.18	0.94	0.19
F_2	0.19	0.16	0.17	0.18	0.17	0.87	0.17
TOTAL	0.39	0.34	0.39	0.34	0.35		
MEAN	0.20	0.17	0.20	0.17	0.18		0.18

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	0.0047	0.0024		3.55	6.01
F	1	0.0011	0.0011	1.22^{ns}	4.41	8.28
T	4	0.0045	0.0011	1.22^{ns}	2.93	4.58
F x T	4	0.0037	0.0009	1.00^{ns}	2.93	4.58
ERROR	18	0.0158	0.0009			
TOTAL	29	0.0298				

^{ns} = not significant CV (%) = 16.67

Appendix Table 7. Dry matter content of potato tubers (%)

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	18.67	20.33	21.00	60.00	20.00
F_1T_2	21.67	21.33	18.33	61.33	20.44
F_1T_3	20.33	21.33	20.67	62.33	20.78
F_1T_4	20.33	22.33	21.33	63.99	21.33
F_1T_5	25.33	20.00	20.67	66.00	22.00
Subtotal	106.33	105.32	102.00	313.65	104.55
F_2T_1	22.67	20.67	19.67	63.01	21.00
F_2T_2	20.33	18.33	20.33	58.99	19.66
F_2T_3	20.33	22.33	20.33	62.99	20.10
F_2T_4	22.33	23.33	19.33	64.99	21.66
F_2T_5	18.67	19.67	20	58.34	19.45
Subtotal	104.33	104.33	99.66	308.32	102.77
TOTAL	210.66	209.65	201.66	621.97	207.32

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	20.00	20.44	20.78	21.33	22.00	104.00	20.91
F_2	21.00	19.66	21.00	21.66	19.45	102.77	20.55
TOTAL	41.00	40.10	41.78	42.99	41.45		
MEAN	20.50	20.05	20.89	21.50	20.73		20.73

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	4.86	2.43		3.55	6.01
F	1	0.95	0.95	0.39 ^{ns}	4.41	8.28
T	4	6.73	1.68	0.69 ^{ns}	2.93	4.58
F x T	4	11.49	2.87	1.18 ^{ns}	2.93	4.58
ERROR	18	43.78	2.43			
TOTAL	29	67.81				

^{ns} = not significant CV (%) = 7.52

Appendix Table 8. Plant vigor 30 DAP (%)

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	2	1	1	4	1.33
F_1T_2	1	2	1	4	1.33
F_1T_3	1	2	1	4	1.33
F_1T_4	1	1	1	3	1.00
F_1T_5	1	1	1	3	1.00
Subtotal	6	7	5	18	6.00
F_2T_1	2	2	1	5	1.67
F_2T_2	1	1	1	3	1.00
F_2T_3	1	2	1	4	1.33
F_2T_4	1	1	1	3	1.00
F_2T_5	2	1	1	4	1.33
Subtotal	7	7	5	19	6.33
TOTAL	13	14	10	37	12.33

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	1.33	1.33	1.30	1.00	1.00	5.96	1.19
F_2	1.67	1.00	1.30	1.00	1.33	6.30	1.26
TOTAL	3	2.33	2.60	2.00	2.33		
MEAN	1.5	1.17	1.3	1.00	1.17		1.23

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
BLOCK	2	0.87	0.44		3.55	6.01
F	1	0.04	0.04	0.17 ^{ns}	4.41	8.28
T	4	0.87	0.22	1.25 ^{ns}	2.93	4.58
F x T	4	0.46	0.12	0.66 ^{ns}	2.93	4.58
ERROR	18	3.13	0.17			
TOTAL	29	5.37				

^{ns} – not significant CV (%) = 0.34

Appendix Table 9. Late blight infection rating at 30 DAP

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	1.8	2.0	1.9	5.7	1.9
F_1T_2	1.7	1.7	1.9	5.3	1.8
F_1T_3	1.9	1.7	1.9	5.5	1.8
F_1T_4	2.0	1.7	1.8	5.5	1.8
F_1T_5	2.0	1.7	1.9	5.6	1.87
Subtotal	9.4	8.8	9.4	27.6	9.2
F_2T_1	1.8	2.0	1.9	5.7	1.9
F_2T_2	1.9	2.0	1.7	5.6	1.7
F_2T_3	1.4	2.0	1.8	5.2	1.7
F_2T_4	1.7	2.0	1.9	5.6	1.9
F_2T_5	2.0	2.0	1.8	5.8	1.9
Subtotal	8.8	10	9.1	27.9	9.3
TOTAL	18.2	18.8	18.5	55.5	18.5

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	1.91	1.77	1.83	1.83	1.87	9.20	1.84
F_2	1.90	1.87	1.73	1.87	1.93	9.30	1.86
TOTAL	3.80	3.64	3.56	3.70	3.80		
MEAN	1.90	1.82	1.78	1.85	1.90		1.85

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	0.0130	0.0070		3.55	6.01
F	1	0.0030	0.0030	0.113 ^{ns}	4.41	8.28
T	4	0.0600	0.0150	0.563 ^{ns}	2.93	4.58
F x T	4	0.0400	0.0100	0.375 ^{ns}	2.93	4.58
ERROR	18	0.4800	0.0270			
TOTAL	29	0.596				

^{ns} = not significant CV (%) = 8.88

Appendix Table 10. Late blight infection rating 45 DAP

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	3.00	3.00	3.00	9.00	3.00
F_1T_2	2.90	3.00	3.00	8.90	2.97
F_1T_3	2.90	2.80	2.70	8.40	2.80
F_1T_4	2.30	2.90	2.40	7.60	2.53
F_1T_5	2.80	2.40	2.70	7.90	2.63
Subtotal	13.90	14.10	13.80	41.80	13.93
F_2T_1	2.90	2.90	3.00	8.80	2.93
F_2T_2	3.10	2.70	2.90	8.70	2.90
F_2T_3	2.90	2.80	2.80	8.50	2.83
F_2T_4	2.70	3.00	2.90	8.60	2.87
F_2T_5	2.90	2.70	2.80	8.40	2.80
Subtotal	14.50	14.10	14.40	43.00	14.33
TOTAL	28.40	28.20	28.20	84.80	28.27

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	3.00	2.97	2.80	2.53	2.63	13.93	2.79
F_2	2.93	2.90	2.83	2.87	2.80	14.33	2.87
TOTAL	5.94	5.87	5.63	5.4	5.43		
MEAN	2.97	2.94	2.81	2.7	2.72		2.83

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	0.004	0.002		3.55	6.01
F	1	0.050	0.050	1.667 ^{ns}	4.41	8.28
T	4	0.360	0.090	3.000*	2.93	4.58
F x T	4	0.170	0.040	1.333 ^{ns}	2.93	4.58
ERROR	18	0.480	0.030			
TOTAL	29	1.064				

^{ns} = not significant CV (%) = 6.12

*= significant

Appendix Table 11. Late blight infection rating 60 DAP

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	4.30	5.00	4.9	14.2	4.73
F_1T_2	4.30	4.80	4.9	14	4.67
F_1T_3	4.60	5.00	5.00	14.6	4.87
F_1T_4	4.80	4.60	5.00	14.4	4.80
F_1T_5	4.80	5.00	5.00	14.8	4.93
Subtotal	22.80	24.40	24.80	72.00	24.00
F_2T_1					
F_2T_2	4.80	4.80	5.00	14.60	4.87
F_2T_3	4.90	5.00	4.90	14.80	4.93
F_2T_4	4.60	4.80	5.00	14.40	4.80
F_2T_5	4.70	4.80	5.00	14.50	4.83
Subtotal	4.90	4.90	5.00	14.80	4.93
TOTAL	23.90	24.30	24.90	73.10	24.37
	46.70	48.70	49.70	145.10	48.37

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	4.73	4.67	4.87	4.80	4.93	24.00	4.80
F_2	4.87	4.93	4.80	4.83	4.93	24.36	4.87
TOTAL	9.60	9.60	9.67	9.63	9.86		
MEAN	4.80	4.80	4.84	4.82	4.93		4.84

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	0.004	0.002		3.55	6.01
F	1	0.050	0.050	1.87 ^{ns}	4.41	8.28
T	4	0.360	0.090	3.38*	2.93	4.58
F x T	4	0.170	0.043	1.59 ^{ns}	2.93	4.58
ERROR	18	0.480	0.027			
TOTAL	29	1.064				

^{ns} = not significant
* = significant

CV (%) = 3.58

Appendix Table 12. Number of small potato tubers (kg/5m^2)

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	25	38	49	112	22.4
F_1T_2	51	28	43	122	24.4
F_1T_3	52	41	71	164	32.8
F_1T_4	52	61	77	190	38.0
F_1T_5	51	58	74	183	36.6
Subtotal	231	226	314	771	154.2
F_2T_1	34	19	40	93	18.6
F_2T_2	33	26	43	102	20.4
F_2T_3	40	48	45	133	26.6
F_2T_4	74	54	70	198	39.6
F_2T_5	82	52	73	207	41.4
Subtotal	263	199	271	733	146.6
TOTAL	494	425	585	1504	300.8

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	37.33	40.67	54.67	63.33	61.00	257.00	51.40
F_2	31.00	34.00	44.33	66.00	69.00	244.33	48.87
TOTAL	68.33	74.67	99.00	129.33	130.00		
MEAN	34.17	37.34	49.50	64.67	65.00		50.14

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	1288.067	644.040		3.55	6.01
F	1	48.133	48.140	0.6 ^{ns}	4.41	8.28
T	4	5108.467	1277.120	15.93**	2.93	4.58
F x T	4	345.530	86.380	1.08 ^{ns}	2.93	4.58
ERROR	18	1443.260	80.180			
TOTAL	29	8233.47				

^{ns} = not significant CV (%) = 17.86
** = highly significant

Appendix Table 13. Number of medium potato tubers (kg/5m^2)

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	22	29	35	86	28.67
F_1T_2	17	22	38	77	25.67
F_1T_3	34	34	39	107	35.67
F_1T_4	54	54	42	150	50.00
F_1T_5	43	42	40	125	41.67
Subtotal	170	181	194	545	181.67
F_2T_1	22	22	26	70	23.33
F_2T_2	29	19	35	83	27.67
F_2T_3	37	47	33	117	39.00
F_2T_4	36	46	42	124	41.33
F_2T_5	42	43	49	134	44.67
Subtotal	166	177	185	528	176
TOTAL	336	358	379	1073	357.67

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	28.67	25.57	35.67	50.00	41.67	181.68	36.37
F_2	23.33	27.67	39.00	41.33	44.67	176.00	35.20
TOTAL	52.00	53.34	74.67	91.33	86.37		
MEAN	26.00	26.67	37.34	45.67	43.17		35.77

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	92.47	46.24		3.55	6.01
F	1	9.64	9.64	0.26 ^{ns}	4.41	8.28
T	4	2000.54	500.14	13.34**	2.93	4.58
F x T	4	181.86	45.47	1.21 ^{ns}	2.93	4.58
ERROR	18	674.86	37.49			
TOTAL	29	2959.37				

^{ns} = not significant CV (%) = 17.12

** = highly significant

Appendix Table 14. Number of big potato tubers (kg/5m^2)

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	6	7	11	24	8.00
F_1T_2	12	6	13	31	10.33
F_1T_3	19	15	12	46	15.33
F_1T_4	29	24	28	81	27.00
F_1T_5	28	19	21	68	22.67
Subtotal	94	71	85	250	83.33
F_2T_1	4	8	11	23	7.67
F_2T_2	12	8	17	37	12.33
F_2T_3	17	16	16	49	16.33
F_2T_4	25	31	32	88	29.33
F_2T_5	23	26	31	80	26.67
Subtotal	81	89	107	277	92.33
TOTAL	175	160	192	527	175.67

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	8.00	10.33	15.33	27.00	26.67	83.33	16.17
F_2	7.67	12.33	16.33	29.33	26.67	92.33	18.47
TOTAL	15.67	22.66	31.66	56.33	49.34		
MEAN	7.84	11.33	15.83	28.17	24.67		17.57

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	51.27	25.64		3.55	6.01
F	1	24.30	24.30	2.16 ^{ns}	4.41	8.28
T	4	1796.20	449.05	39.99**	2.93	4.58
F x T	4	15.54	3.89	0.97 ^{ns}	2.93	4.58
ERROR	18	202.06	11.23			
TOTAL	29					

^{ns} – not significant CV (%) = 19.07

** = highly significant

Appendix Table 15. Weight of small potato tubers (kg/5m^2)

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	0.20	0.35	0.30	0.85	0.28
F_1T_2	0.40	0.25	0.35	1.00	0.33
F_1T_3	0.45	0.45	0.60	1.50	0.50
F_1T_4	0.45	0.45	0.70	1.60	0.53
F_1T_5	0.35	0.45	0.70	1.50	0.50
Subtotal	1.85	1.95	2.65	6.45	2.15
F_2T_1	0.25	0.20	0.38	0.83	0.28
F_2T_2	0.30	0.15	0.40	0.85	0.28
F_2T_3	0.20	0.30	0.45	0.95	0.32
F_2T_4	0.80	0.40	0.50	1.7	0.57
F_2T_5	0.75	0.55	0.75	2.05	0.68
Subtotal	2.3	1.6	2.48	6.38	2.13
TOTAL	4.15	3.55	5.13	12.83	4.28

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	0.28	0.33	0.50	0.53	0.50	2.14	0.43
F_2	0.28	0.28	0.32	0.57	0.68	2.13	0.43
TOTAL	0.56	0.61	0.82	1.10	1.18		
MEAN	0.28	0.31	0.41	0.55	0.59		0.43

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	0.12	0.06		3.55	6.01
F	1	0.00	0.00	0.00 ^{ns}	4.41	8.28
T	4	0.47	0.12	9.61**	2.93	4.58
F x T	4	0.10	0.03	2.05 ^{ns}	2.93	4.58
ERROR	18	0.22	0.01			
TOTAL	29	0.91				

^{ns} = not significant CV (%) = 23.25

** = highly significant

Appendix Table 16. Weight of medium potato tubers (kg/5m^2)

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	0.35	0.60	0.35	1.30	0.43
F_1T_2	0.20	0.75	0.65	1.60	0.53
F_1T_3	0.65	0.85	0.75	2.25	0.75
F_1T_4	1.30	0.85	1.25	3.40	1.13
F_1T_5	1.20	1.20	1.20	3.60	1.20
Subtotal	3.70	4.25	4.20	12.15	4.05
F_2T_1	0.35	0.60	0.70	1.65	0.55
F_2T_2	0.70	0.50	0.65	1.85	0.62
F_2T_3	0.75	0.75	0.85	2.35	0.78
F_2T_4	0.85	0.80	1.15	2.80	0.93
F_2T_5	1.25	0.75	0.90	2.90	0.97
Subtotal	3.90	3.40	4.25	11.55	3.85
TOTAL	7.60	7.65	8.45	23.70	7.90

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	0.43	0.53	0.75	1.13	1.20	4.04	0.81
F_2	0.55	0.62	0.78	0.93	0.97	3.85	0.77
TOTAL	0.98	1.15	1.53	2.06	2.17		
MEAN	0.49	0.58	0.77	1.03	0.97		0.77

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	0.05	0.02		3.55	6.01
F	1	0.02	0.02	0.59^{ns}	4.41	8.28
T	4	1.69	0.42	12.39**	2.93	4.58
F x T	4	0.15	0.04	1.18^{ns}	2.93	4.58
ERROR	18	0.61	0.03			
TOTAL	29	2.52				

^{ns} = not significant CV (%) = 22.49

** = highly significant

Appendix Table 17. Weight of big potato tubers (kg/5m^2)

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	0.25	0.25	0.35	0.85	0.28
F_1T_2	0.40	0.30	0.40	1.10	0.37
F_1T_3	0.35	0.20	0.35	0.90	0.30
F_1T_4	0.65	0.45	0.60	1.70	0.57
F_1T_5	0.50	0.35	0.40	1.25	0.42
Subtotal	2.15	1.55	2.1	5.8	1.93
F_2T_1	0.15	0.25	0.35	0.75	0.25
F_2T_2	0.20	0.15	0.45	0.80	0.27
F_2T_3	0.30	0.45	0.45	1.20	0.40
F_2T_4	0.45	0.55	0.55	1.55	0.52
F_2T_5	0.40	0.45	0.60	1.45	0.48
Subtotal	1.50	1.85	2.40	5.75	1.92
TOTAL	3.65	3.40	4.50	11.55	3.85

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	0.28	0.37	0.30	0.57	0.42	1.94	0.39
F_2	0.25	0.27	0.40	0.52	0.48	1.92	0.38
TOTAL	0.53	0.64	0.70	1.09	0.90		
MEAN	0.27	0.32	0.35	0.55	0.45		0.39

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	0.067	0.033		3.55	6.01
F	1	0.000	0.000	0.01 ^{ns}	4.41	8.28
T	4	0.292	0.073	11.93**	2.93	4.58
F x T	4	0.042	0.011	1.72 ^{ns}	2.93	4.58
ERROR	18	0.11	0.006			
TOTAL	29					

^{ns} = not significant CV (%) = 20.32

** = highly significant

Appendix Table 18. Total weight of marketable tubers (kg/5m^2)

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	0.85	1.30	0.85	3.00	1.00
F_1T_2	1.00	1.60	1.10	3.70	1.23
F_1T_3	1.50	2.25	0.90	4.65	1.55
F_1T_4	1.60	3.40	1.70	6.70	2.23
F_1T_5	1.50	3.60	1.25	6.35	2.12
Subtotal	6.45	12.15	5.80	24.40	8.13
F_2T_1	0.83	1.65	0.75	3.23	1.08
F_2T_2	0.85	1.85	0.80	3.50	1.17
F_2T_3	0.95	2.35	1.20	4.50	1.50
F_2T_4	1.70	2.80	1.55	6.05	2.02
F_2T_5	2.05	2.90	1.45	6.40	2.13
Subtotal	6.38	11.55	5.75	23.68	7.89
TOTAL	12.83	23.10	11.50	48.08	16.03

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	1.0	1.23	1.55	2.23	2.12	8.13	1.63
F_2	1.08	1.17	1.50	2.02	2.13	7.9	1.58
TOTAL	2.08	2.40	3.05	4.35	4.25		
MEAN	1.04	1.20	1.53	0.87	2.13		1.60

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	8.914	4.457	39.57	3.55	6.01
F	1	0.017	0.017	0.15 ^{ns}	4.41	8.28
T	4	6.194	1.548	13.75**	2.93	4.58
F x T	4	0.073	0.018	0.16 ^{ns}	2.93	4.58
ERROR	18	2.027	0.113			
TOTAL	29					

^{ns} = not significant CV (%) = 20.94

** = highly significant

Appendix Table 19. Total weight of non-marketable tubers (kg/5m^2)

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	0.45	0.50	0.30	1.25	0.42
F_1T_2	0.20	0.60	0.25	1.05	0.35
F_1T_3	0.30	0.65	0.55	1.50	0.50
F_1T_4	0.45	0.45	0.45	1.35	0.45
F_1T_5	0.45	0.80	0.25	1.50	0.50
Subtotal	1.85	3.00	1.80	6.65	2.22
F_2T_1	0.50	0.55	0.55	1.6	0.53
F_2T_2	0.20	0.25	0.20	0.65	0.22
F_2T_3	0.30	0.35	0.35	1.00	0.33
F_2T_4	0.43	0.20	0.25	0.88	0.29
F_2T_5	0.50	0.40	0.40	1.30	0.43
Subtotal	1.93	1.75	1.75	5.43	1.81
TOTAL	3.78	4.75	3.55	12.08	4.03

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	0.42	0.35	0.50	0.45	0.50	2.22	0.44
F_2	0.53	0.22	0.33	0.29	0.43	1.8	0.36
TOTAL	0.95	0.57	0.83	0.74	0.93		
MEAN	0.48	0.29	0.42	0.37	0.47		0.41

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	0.081	0.041	2.46	3.55	6.01
F	1	0.050	0.050	3.01^{ns}	4.41	8.28
T	4	0.148	0.037	2.25^{ns}	2.93	4.58
F x T	4	0.083	0.021	1.25^{ns}	2.93	4.58
ERROR	18	0.296	0.016			
TOTAL	29	0.658				

^{ns} = not significant CV (%) = 31.87

Appendix Table 20. Total tuber yield per plot (kg/5m^2)

TREATMENT	REPLICATION			TOTAL	MEAN
	BLOCK 1	BLOCK 2	BLOCK 3		
F_1T_1	1.30	1.80	1.15	4.25	1.42
F_1T_2	1.20	2.20	1.35	4.75	1.58
F_1T_3	1.80	2.90	1.45	6.15	2.05
F_1T_4	2.05	3.85	2.15	8.05	2.68
F_1T_5	1.95	4.40	1.50	7.85	2.62
Subtotal	8.3	15.15	7.60	31.05	10.35
F_2T_1	1.33	2.20	1.30	4.83	1.61
F_2T_2	1.05	2.10	1.00	4.15	1.38
F_2T_3	1.25	2.70	1.55	5.50	1.83
F_2T_4	2.13	3.00	1.80	6.93	2.31
F_2T_5	2.55	3.30	1.85	7.70	2.57
Subtotal	8.31	13.30	7.50	29.11	9.70
TOTAL	16.61	27.85	15.1	60.16	20.05

F x T TWO - WAY TABLE

TREATMENT	T_1	T_2	T_3	T_4	T_5	TOTAL	MEAN
F_1	1.42	1.58	2.05	2.68	2.62	10.35	2.07
F_2	1.61	1.38	1.83	2.31	2.57	9.70	1.94
TOTAL	3.03	2.96	3.88	4.99	5.19	20.05	
MEAN	1.51	1.48	1.94	2.50	2.60		2.01

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	2	9.16	4.58		3.55	6.01
F	1	0.13	0.13	0.58^{ns}	4.41	8.28
T	4	6.62	1.66	7.43**	2.93	4.58
F x T	4	0.27	0.07	0.30^{ns}	2.93	4.58
ERROR	18	4.01	0.22			
TOTAL	29	20.19				

^{ns} = not significant CV (%) = 23.34

**= highly significant