BIBLIOGRAPHY

PACIO, MARK STEFAN M. APRIL 2010. Effect of Time of Application and Different Rates of Wild Sunflower on the Yield of Romaine Lettuce *(Lactuca sativa L. var. Xanadu)* and Some Soil Properties. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The experiment was conducted at the Department of Soil Science Organic Demo Farm, Benguet State University, La Trinidad, Benguet from November to February 2009 to determine the effect of time of application of wild sunflower on the yield of lettuce and some soil properties; determine the effect of different rates of wild sunflower on the yield of lettuce and some soil properties; and, determine the interaction effect between time of application and different rates of wild sunflower on the yield of lettuce and some soil properties.

Time of fresh wild sunflower application and different rates of wild sunflower were the factors studied. Fresh wild sunflower application was done one week and two weeks before planting. The different rates of wild sunflower added were 2.5, 5, 7.5, 10, 12.5, and 15 tons/ha.

Increasing rates of fresh wild sunflower application significantly increases the yield and shelf-life of lettuce provided it is applied one week before planting. Further, 15 t/ha fresh wild sunflower is best for lettuce production. Likewise, wild sunflower improves the soil physical properties like Db, and WHC; chemical properties like pH, OM, N, P, and K content of the soil.

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INTRODUCTION

Lettuce (*Lactuca sativa Linn*) is a widely cultivated and universally grown vegetable crop. In the Philippines, lettuce is considered as one of the most important salad crop. Beside its palatable taste, lettuce is also popular due to its nutritive content.

Lettuce is usually grown in semi-temperate areas like Benguet. Production of lettuce is fast income generating. Income is dependent however, on the yield and quality of lettuce produced which are also affected by the agricultural practices employed.

Since lettuce is an important salad crop, good quality must be produced to satisfy consumer demand. This could be attained through proper nutrition especially with nitrogen that promotes vigorous vegetative growth. However, dependence on the use of the chemical fertilizers without realizing its deleterious effects on the soil and environment will eventually result to low quality production.

Organic fertilization in lettuce is an important way of improving the quality of the crop. Organic fertilizers are good sources of nutrients for plant growth and also improve soil structure. In sustainable agriculture, organic fertilizers are most required and recommended.

Organic fertilizers generally provide many advantages in terms of soil improvement and conservation, good yield, and high quality of produce. There is an assured reduction in production cost. Organic residues are easily obtained from decomposed weeds, rice straws, alnus compost, etc. The fibrous portion of the organic matter improves the physical properties. Its high humus content granulates sandy soils and improves their nutrient and water holding capacity.

Organic fertilizer application helps to improve soil properties and help maintain stable soil moisture content. Because they contain a wide variety of nutrient elements, they also help adjust and improve the nutrient balance in the soil. Improvement of soil tilth and texture, increase in soil fertility and reduced fertilizer cost are the most important benefits from organic fertilizers (Brady, 2000).

Wild sunflower has been known to be a good source of Nitrogen (N). Besides being free, it is abundant in farms. Sunflower, as an organic fertilizer ensures vigorous growth of plants and influences nutrient absorption due to its role in granulation thereby improving the physical and chemical properties of the soil (Pandosen, 1986).

It is therefore necessary to study the use of organic fertilizers like wild sunflower as an amendment and supplement to the soil as they improve the growth, yield, and performance of lettuce.

The study was conducted to:

1. Determine the effect of time of wild sunflower application on the yield of lettuce and some soil properties;

2. Determine the effect of different rates of wild sunflower on the yield of lettuce and some soil properties; and,

3. Determine the interaction effect between time of wild sunflower application and different rates of wild sunflower on the yield of lettuce and some soil properties of the soil.

The study was conducted at the Soil Science Experimental area, College of Agriculture, Benguet State University, La Trinidad, Benguet from November to February 2009.

REVIEW OF LITERATURE

Effect of Wild Sunflower

Umayat (1980) reported that extracts from wild sunflower can be used as alternative control of weed manifestation. Aside from that, it inhibits the germination of weed seeds when used as mulch in the field.

Bulwayan (1983) stated that as the rate of wild sunflower was raised from 3-6 tons per hectare, the weight of root nodule correspondingly increased. Further, as the rate of sunflower increases, the N content of the soil also increases.

Durante (1983) also claimed that application of 8 tons of fresh wild sunflower per hectare gave the highest mean yield in green pods of garden pea.

Pandosen (1986) claimed that the fresh chopped wild sunflower fertilized to snap beans gave better results in terms of growth and yield, physical and chemical properties in the soil and nutrient content of the plants than sunflower- based compost. Moreover, the experiments conducted proved that wild sunflower is a potential as an organic fertilizer for snap bean production.

According to Adchak (1993), application of 60 kg/ha urea in combination with 15 tons chopped fresh wild sunflower improved the growth and yield of cabbage plants. Likewise, improved physical and chemical properties of the soil were also observed.

De la Cruz (1998) found that incorporation of chopped fresh sunflower was effective in improving the growth and yield of cabbage rice when applied one week before planting time.

Effect of Organic Fertilizers on
Plant Growth

Organic fertilizer provides some of the elements essential for proper plant growth. It assures farmers of lower stable fertilizer cost and reliable local raw materials. Organic fertilizers are at least 50% to 60% cheaper than chemical fertilizers and is still effective in increasing the fertility of the soil (Anon, Bulletin Today, 1982)

Plants fertilized with chicken manure were claimed to mature earlier and were taller than the plants fertilized with sawdust, cow manure and pig manure (Toledo, 1982).

Effect of Organic Fertilizers on
Post Harvest Quality

Lungabas (1996) as cited by Lingaling (2006) claimed that compost appeared to enhance the post harvest quality of tomato. She indicated the good visual quality rating after storage, less loss of fruit quality and enhances sweetness of tomato. Furthermore, she stated that compost enhances the period from freshness to shriveling of tomato and she had recorded the longest shelf- life of tomato.

Koshino (1990) reported that nutrient elements from organic fertilizers are released slowly which is particularly important in avoiding salt injury, ensuring a continues supply of nutrients throughout the growing season and in producing better quality products.

Effect of Organic Fertilizers on Soil

One of the most efficient ways of growing crops with the aid of productive soils is the use of organic fertilizer which are obtained through decomposition of plants and animal's residue, which are now manufactured and available in the market. These organic

fertilizer do not only supply the necessary nutrient by the plants but application or through incorporation in the soil before planting can also improve the soil structures and conserve soil moisture, making it ideal for vegetables production because vegetables require soils rich in organic matter (Daoines, 1994).

Organic fertilizer increase organic matter content. As a result, soil alkalinity is increased. In addition, simple supply of organic matter helps to keep the soil loose and prevents packing, facilitates digging and cultivating, enable roots of crops to penetrate the soil, readily increases water holding capacity, and provides food for the growth in the form of essential nutrients needed by the plants (Cooke, 1992). In addition, organic matter binds particles into granular soil structure which is largely responsible for the loose, easily managed condition of a productive soil. It also increases the amount of water the soil can hold and proportion for plant growth (Brady and Weil, 2000).

Mabazza (1997) also claimed that organic fertilizers turn heavy soil lighter, more crumbly, friable and they hold light soil particles together to act as anchor against erosion and to increase the water holding capacity of the soil. They provide some of the large quantities of N needed by plants and release nutrients present in the soil by turning them into soluble compounds that can be absorbed by the roots of plants. Finally, they carry considerable quantities of elements often insufficient in the soil and provide readily available microelements, both activities promotes plant growth.

MATERIALS AND METHODS

Romaine lettuce seeds (var. xanadu) were sown in plastic seedling trays. An area of 210 square meters were thoroughly prepared for planting. This was subdivided into 42 plots measuring 1 x 5 meters each. The field layout followed the Randomized Complete Block Design (RCBD) involving factorial arrangement. The level of significance was tested using Duncan's Multiple Range Test (DMRT). There were 14 treatment combinations with 3 replications. The treatments were as follows:

FACTOR A – Time of Application

T_1 = One week before planting

T_2 = Two weeks before planting

FACTOR B – Rates of Wild Sunflower (t/ha)

R_1 = Control

R_2 = 2.5

R_3 = 5.0

R_4 = 7.5

R_5 = 10.0

R_6 = 12.5

R_7 = 15.0

Young shoots of fresh wild sunflower measuring one foot long from the tip to the base were gathered and chopped or shredded. These were incorporated to the soil at a depth of 15 cm. The treatments requiring wild sunflower application two weeks before planting (T_2) were prioritized followed by application one week before planting (T_1). At exactly a week after, the lettuce seedlings were transplanted to all experimental plots.

Strict implementation of other cultural management practices were done to ensure normal growth and development.

The data gathered were as follows:

A. Soil Physical Properties

1. Bulk density of the soil (g/cm^3). The bulk density was determined using the core method. Db was computed using the formula

$$Db = \frac{\text{Wt. of soil bulk (g)}}{\text{Vol. of soil } (cm^3)}$$

Vol. of soil = vol. of core sampler

Vol. of core sampler = $\pi r^2 h$

2. Water holding capacity (WHC) of the soil (%). The water holding capacity was determined through saturation method. The core samplers were packed with soil then the bottom of the cylinders were soaked in water to be saturated through capillarity.

$$\%WHC = \frac{\text{Wt. of saturated soil - oven dry wt of soil (g)}}{\text{Weight of saturated soil (g)}} \times 100$$

B. Soil Chemical Properties

1. Soil pH. The initial and final soil pH were obtained using the pH meter in a 1:2.5 $CaC1_2$ solutions.

2. OM content of the soil (%). OM content of the soil was analyzed using the Walkley and Black method.

3. Total Nitrogen nontent of the soil (%). The nitrogen content of the soil was derived from OM by multiplying percent OM with 0.05.

4. Available Phosphorus content of the soil (ppm). The available phosphorous content of the soil was analyzed using Bray No. 2 method.

5. Exchangeable Potassium content of the soil (ppm). Exchangeable Potassium content of the soil was determined using the Flame photometer method.

C. Horticultural Parameters:

a. Total yield (kg/5m^2). This is the total weight of marketable and non-marketable per plot.

b. Computed total yield (t/ha). This was obtained by converting the yield per plot into tons per hectare.

$$\text{Total yield in (t/ha)} = \frac{\text{Total weight (kg)}}{5\text{m}^2} \times 10{,}000\text{m}^2/\text{ha} \times 1 \text{ ton}/1000 \text{ kg}$$

D. Post Harvest Quality

1. Shelf-life. Representative samples per treatment were laid out on a table at room temperature. The number of days from storage up to the time it was unfit for consumption (e.g. discoloration, deformation of lettuce) were counted.

2. Weight loss. Weight loss was taken by subtracting the final weight of sample per treatment from the initial weight of the sample.

RESULTS AND DISCUSSIONS

Soil Physical Properties

Bulk Density (Db) of the Soil.

Bulk density is one of the soil parameters that favours yield. Lower bulk density means the soil has better permeability for air and water exchange such that root respiration and water absorption is facilitated. Mclaren (1990) stressed that higher bulk density as an effect of compaction can influence root growth by inhibiting its proliferation and density. This will result to poor essential nutrient absorption.

Organic matter can contribute to the improvement of bulk densities of soils. Humus from the decomposed organic matter can facilitate soil granulation and aggregation hereby creating pore spaces by its flocculating effect. This will give spaces for root enlargement and penetration to the lower horizon of the soil profile.

Effect of time of application . Table 1 shows no significant effect of time of wild sunflower application on the bulk density of the soil. Results imply that regardless of whether wild sunflower is applied one week or two weeks before planting, bulk density of the soil is affected.

Effect of rates of wild sunflower. Bulk density was not significantly affected by the rates of wild sunflower applied to the soil. However, it can be noted that the control shows the highest bulk density while those applied with an increasing amount of wild sunflower resulted to a decreasing bulk density.

It is observed that as the soil is applied with increasing rates from 2.5 to 12.5 t/ha wild sunflower, the bulk density is also decreasing although the differences between

means are not statistically significant due to the slight differences. The result could be attributed to the low rate increase.

Interaction effect between time of application and rates of wild sunflower. Bulk density of the soil was not significantly affected by the time and rates of application of wild sunflower as shown in Table 1. Application of 2.5 to 12.5 tons/ha showed slight differences irrespective of the time and rate of sunflower application.

Table 1. Bulk density (Db) of the soil as affected by time of application and rates of wild sunflower

TREATMENT	Db (g/cm^3)
Time of Application	
One week before planting	1.068 [a]
Two weeks before planting	1.073 [a]
Rates of Wild Sunflower (t/ha)	
Control	1.289 [a]
2.5	1.180 [a]
5.0	1.150 [a]
7.5	1.120 [a]
10.0	1.091 [a]
12.5	1. 001 [a]
R_7 – 15.0	0.866[a]

Means with common letters are not significantly different at 5% by DMRT

Water Holding Capacity (WHC) of the Soil

Effect of time of application. Table 2 presents the effect of time of application on the water holding capacity of the soil as affected by time of wild sunflower application. Statistical analysis showed no significance, though numerically, application of wild sunflower one week before planting revealed a higher WHC by 0.14% when compared to soils applied with wild sunflower two weeks after planting.

Table 2. WHC of the soil as affected by time of application and rates of wild sunflower

TREATMENT	WHC (%)
Time of Application	
One week before planting	73.48 [a]
Two weeks before planting	73.34 [a]
Rates of Wild Sunflower (t/ha)	
Control	70.71 [ab]
2.5	72.20 [ab]
5.0	72.36 [ab]
7.5	74.41 [a]
10.0	75.98 [a]
12.5	76.78 [a]
15.0	77.98[a]

Means with common letters are not significantly different at 5% by DMRT

Effect of rates of wild sunflower. Water holding capacity of the soil was greatly affected by the rates of wild sunflower application. It can be noted that increasing the rates of wild sunflower application showed a corresponding increasing water held by the soil. The increase in soil water-holding capacity could be attributed to the application of organic matter (Brady and Weil, 1996) in the form of sunflower that influenced the result.

Interaction effect between time of application and rates of wild sunflower. It was observed that the interaction between time of wild sunflower application and rates of wild sunflower applied to the soil showed no significant affect on the water holding capacity.

Soil Chemical Properties

Plants require essential nutrients for growth and development of cells and tissues. Without these essential nutrients from the soil, vegetative growth to maturity will not be possible to happen. Seeds may germinate and grow but if their food from the cotyledon will be exploited and the soil cannot provide nutrients for the plants, the plants will slowly wilt and certainly die and wither.

Essential elements are those that make up the cells and tissues of the plants. Nitrogen for example is the component of proteins in plants and calcium makes up the cell walls and also nutrients that are responsible in processes in plants like boron which is responsible for mitosis or the so-called cell division. Without these complementary functions of essential elements, plant activity to survive will not be possible (Pommel 1988).

Soil pH

Soil pH is one of the most important soil chemical properties that dictate crop performance Brady and Weil (2000). At extreme levels, above or below the neutral level, nutrient availability of the soil is being affected. In lower pH values (below 5.0 or lower) acidity is being eyed as a problem of the soil that leads to unavailability of basic cations essential for plant growth. Brady and Weil (2000) reported that at lower soil pH, the hydrogen ion is predominating and becomes toxic to the plant roots.

On the other hand, at higher soil pH (above pH 7.0 or alkaline), plant nutrients will be unavailable as a result of fixation. De La Cruz (1998) noted that plant perform best at optimum soil pH ranges. He also mentioned that organic matter improves the nutrient content of the soil and increase the soil pH after the decomposition process has taken place.

Effect of time of application . The soil pH as affected by the time of application of sunflower showed no significant difference however, it can be noted that soil applied with wild sunflower one week before planting has a pH of 5.80 while those that applied with the same organic fertilizer two weeks before planting had 5.28, having a mean difference of 0.58.

Effect of rates of wild sunflower . Varying rates of wild sunflower significantly affected the pH of the soil as shown in Table 3. This could be attributed to the amount of wild sunflower applied where organic matter is derived. Highest soil pH (5.59) was obtained from the highest rate of 15 tons/ha wild sunflower, while the control plots recorded the lowest soil pH (4.84). Furthermore, it can be observed that application of wild sunflower to the soil significantly increase the soil pH. Pandosen (1986) stressed

that organic matter contains considerable amounts of calcium and other basic cations that may check the soil pH.

Interaction effect between time of application and rates of wild sunflower. Table 3 presents the pH of the soil as affected by the time of application and varying rates of wild sunflower. There are no observed statistical differences between the interaction effect of time of wild sunflower application and rates of wild sunflower applied.

Table 3. Soil pH as affected by time of application and rates of wild sunflower

TREATMENT	SOIL pH
Time of Application	
One week before planting	5.18 [a]
Two weeks before planting	5.13 [a]
Rates of wild sunflower (tons/ha)	
Control	4.84 [c]
2.5	5.01 [bc]
5.0	5.13 [bc]
7.5	5.02 [bc]
10.0	5.15 [bc]
12.5	5.34 [ab]
15.0	5.60 [a]

Means with common letters are not significantly different at 5% by DMRT

Organic Matter (OM) Content of the Soil

Effect of time of application . Results of organic matter analysis reveal that the time of wild sunflower application did not significantly affect the final OM content of the soil. However, it can be served that soil applied with wild sunflower two weeks before planting has higher organic matter of 1.946% compared to soils applied with wild sunflower one week before planting with a mean of 1.870% having a difference of 0.076. The result implies that some OM were not utilized, the fact that lettuce plants are harvestable after two months.

Effect of rates of wild sunflower . The effect of the varying rates of wild sunflower on the organic matter content of the soil is shown in Table 4. Increasing the application of wild sunflower to the soil significantly increases the organic matter content of the soil. This could be due to the decomposed wild sunflower leaves as source of organic matter as claimed by Bulwayan (1983). Statistical analysis showed a significant difference among the treatments. Highest organic matter content can be observed in soils applied with 15 tons/ha wild sunflower while lowest was the control.

Interaction effect between time of application and rates of wild sunflower . Figure 1 shows the organic matter content of the soil as affected by timing of application and varying rates of wild sunflower. It can be observed that the organic matter of the soil increases with the increasing amount of wild sunflower regardless of the time of application. (Derek, 2004) reported that application of plant debris and other organic residues will increase the organic matter content of the soil.

Table 4. OM content of the soil as affected by time of application and rates of wild sunflower

TREATMENT	OM (%)
Time of Application	
One week before planting	1.870 [a]
Two weeks before planting	1.946 [a]
Rates of wild sunflower (t/ha)	
Control	0.6995 [d]
2.5	1.280 [c]
5.0	1.768 [b]
7.5	1.907 [b]
10.0	2.458 [a]
12.5	2.490 [a]
15.0	2.753 [a]

Means with common letters are not significantly different at 5% by DMRT

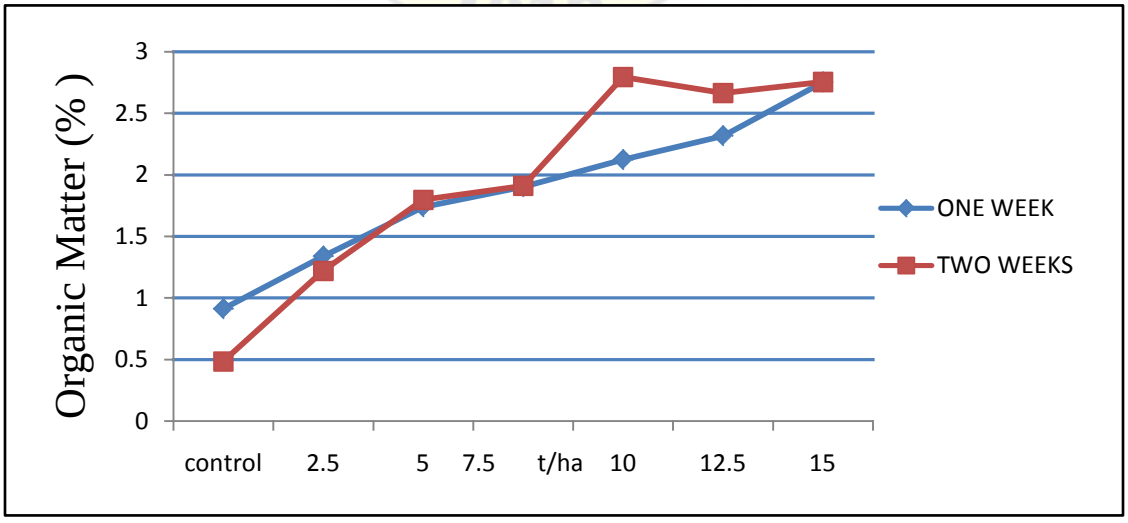

Figure 1. Interaction effect between time of application and rates of wild sunflower on the OM content of the soil

Total Nitrogen (N) Content of the Soil

Effect of time of application . The total nitrogen content of the soil as affected by the time of wild sunflower application is shown in Table 5. It can be noted that there is no significant differences on the treatment means as per statistical analysis, however an increase of .005 % nitrogen content was observed on two weeks wild sunflower application as compared to soils applied one week before planting.

Table 5. Total N content of the soil as affected by time of application and rates of wild sunflower

TREATMENT	TOTAL N (%)
Time of Application	
One week before planting	0.09336 [a]
Two weeks before planting	0.09867 [a]
Rates of Wild Sunflower (t/ha)	
Control	0.039500 [g]
2.5	0.063670 [e]
5.0	0.088170 [e]
7.5	0.094830 [d]
10.0	0.12260 [c]
12.5	0.12430 [b]
15.0	0.13900 [a]

Means with common letters are not significantly different at 5% by DMRT

Effect of rates of wild sunflower . Significant difference between treatment means on total soil nitrogen content were observed when applied with different rates of wild sunflower. Nitrogen content of the soil significantly increases with an increasing the rate of application of wild sunflower. This could be attributed to the Nitrogen release from wild sunflower. Wild sunflower is a good source of Nitrogen as was found by Pandosen (1986) that fresh wild sunflower has 3.76 % Nitrogen. Likewise, (Tisdale and Nelson, 1970) mentioned that the nitrogen content of the soil derived from the increasing amounts of organic matter added determine the influence of the quantity of the nitrogen in the soil

Interaction effect between time of application and rates of wild sunflower . The nitrogen content of the soil as affected by time of application and different rates of wild sunflower is presented in Figure 2. It can be observed that with the increasing level of wild sunflower application, the soil N increased regardless of whether wild sunflower is applied one week or two applied before planting. Highest nitrogen content of the soil was observed in soils applied with 15 tons/ha wild sunflower which corresponded to the highest amount of organic matter content (Mendiola, 1958).

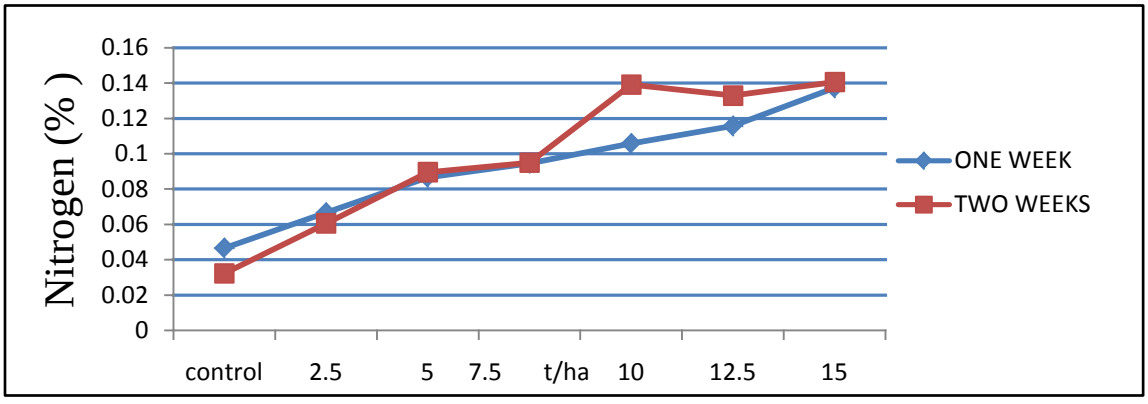

Figure 2. Interaction effect between time of application and rates of wild sunflower on the total N content of the soil

Available Phosphorus (P) Content of the Soil

Effect of time of application . The available phosphorus content of the soils as affected by the time of application of wild sunflower before planting is shown in Table 6. It can be observed that a highly significant difference between the treatment means is observed. They are comparable in terms of the amount of phosphorus as influenced by the application of wild sunflower. The lower mean value registered by one week wild sunflower application indicates that the plant absorbed the P. On the other hand, two weeks wild sunflower application indicates that more P were not absorbed because of late time of application. An organic material added to the soil has to undergo decay process in order to release nutrient elements for plant absorption.

Effect of rates of wild sunflower . Significant differences were noted on the available P content of the soil after harvest (Table 6). Application of increasing amounts of wild sunflower to the soil significantly increased the phosphorus content of the soil. The highest phosphorus content of the soil is observed in soils applied with 15 tons/ha wild sunflower followed by those soils applied with 12.5, 10.0, 7.5, 5.0, and 2.5 tons/ha with means 31.93, 31.18, 29.17, 27.91, and 26.82 ppm phosphorus, respectively. The increased level of phosphorus content of the soil maybe attributed to the amount of wild sunflower as source of organic matter content of the soil Palaleo (1978).

Interaction effect between time of application and rates of wild sunflower . The interaction time application and rates of wild sunflower is shown in Table 6. It can be observed that there is. This means that the soil responded well in the application of wild sunflower that may have contributed to the organic matter content of the soil where this phosphorus amounts were derived (Palaleo,1978).

Table 6. Available P content of the soil as affected by time of application and rates of wild sunflower

TREATMENT	AVAILABLE P (ppm)
Time of Application	
One week before planting	27.71 [a]
Two weeks before planting	30.71 [a]
Rates of Wild Sunflower (t/ha)	
Control	22.67 [d]
2.5	26.82 [c]
5.0	27.91 [bc]
7.5	29.17 [bc]
10.0	31.18 [abc]
12.5	31.93 [ab]
15.0	34.78 [a]

Means with common letters are not significantly different at 5% by DMRT

Exchangeable Potassium (K) Content of the Soil

Effect of time of application. Statistical analysis revealed highly significant differences on the treatment means as shown in Table 7. Higher potassium content of the soil after two weeks of wild sunflower application registered higher K (264.8 ppm) as compared to the one week application (251.6 ppm). The result implies that late application of fresh wild sunflower also delays the release of nutrient elements, thereby delaying plant absorption.

Table 7. Exchangeable K content of the soil as affected by time of application and rates of wild sunflower

TREATMENT	EXCHANGEABLE K (ppm)
Time of Application	
One week before planting	251.6 [a]
Two weeks before planting	264.8 [a]
Rates of Wild Sunflower (t/ha)	
Control	218.3 [d]
2.5	239.1 [cd]
5.0	256.7 [bc]
7.5	262.2 [ab]
10.0	272.3 [ab]
12.5	277.5 [ab]
15.0	281.2 [a]

Means with common letters are not significantly different at 5% by DMRT

Effect of rates of wild sunflower . Potassium content of the soil applied with the varying rates of wild sunflower revealed significant differences among treatment means. 15 tons/ha wild sunflower with 281.2 ppm K. On the other hand, the lowest was the control with only 218.3 ppm K. Results show that wild sunflower contribute potassium to the soil as proven by Pandosen (1986).

The increasing amount of wild sunflower application resulted to increasing amount of potassium in the soil. Pandosen (1986) found out through chemical analysis

that wild sunflower has 4.44% K. The increase of the potassium content of the soil may again be due to the application of sunflower to the soil as source of organic matter that had supplied the potassium content of the soil (Pataras, 1984).

Interaction effect between time of application and rates of wild sunflower . The interaction between the time of application and the different rates of wild sunflower on the exchangeable potassium content of the soil is not significant as shown in Table 7.

Horticultural Parameters

Total Yield per Plot

Effect of time of application . Table 8 shows the yield of plants per plot applied with wild sunflower one week and two weeks before planting. Statistical analysis reveals no significant difference between means obtained from the two times of application. Lesser mean was obtained from the plots applied with wild sunflower one week before planting as compared to two weeks after transplanting.

Effect of rates of wild sunflower. Statistical analysis showed significant differences among treatment means (Table 8). Plants in plots applied with 15 tons/ha wild sunflower obtained the highest significant yield. This could be due to the amount of wild sunflower that can be a source of organic matter and plant nutrients. Brady and Weil (2000), Brady (1996) Lagman (2003) noted that the increased application of organic matter increases the fertility of the soil that can be a source of essential elements for plant growth that may have affected the trend of the yield. It can be noted that the highest application of wild sunflower resulted to highest yield which maybe a result of more nutrients available in the soil.

Table 8. Total yield per plot as affected by time of application and rates of wild sunflower

TREATMENT	TOTAL YIELD ($kg/5m^2$)
Time of Application	
One week before planting	7.830[a]
Two weeks before planting	8.274[a]
Rates of Wild Sunflower (t/ha)	
Control	2.215[g]
2.5	4.605[f]
5.0	5.353[e]
7.5	8.197[d]
10.0	8.835[c]
12.5	10.840[b]
15.0	16.330[a]

Means with common letters are not significantly different at 5% by DMRT

On the other hand, control with no application of wild sunflower as a source of organic matter registered the lowest yield. This could be due to lesser nutrient reserves in the soil. Furthermore, it can be observed that from the yield, addition of wild sunflower at increasing amount resulted to increased yield. The more wild sunflower applied to the soil, the more yield was obtained.

Interaction effect between time of application and rates of wild sunflower. Yield per plot as affected by the interaction between time of application and rates of wild

sunflower is shown in Figure 3. It can be observed that both timing of application revealed similar trends in terms of the increasing yields control being the lowest and plots applied with 15 tons/ha wild sunflower significantly the highest. This confirms what Brady (2000) stated that increasing organic matter to the soil at maximum amounts can increase the yield.

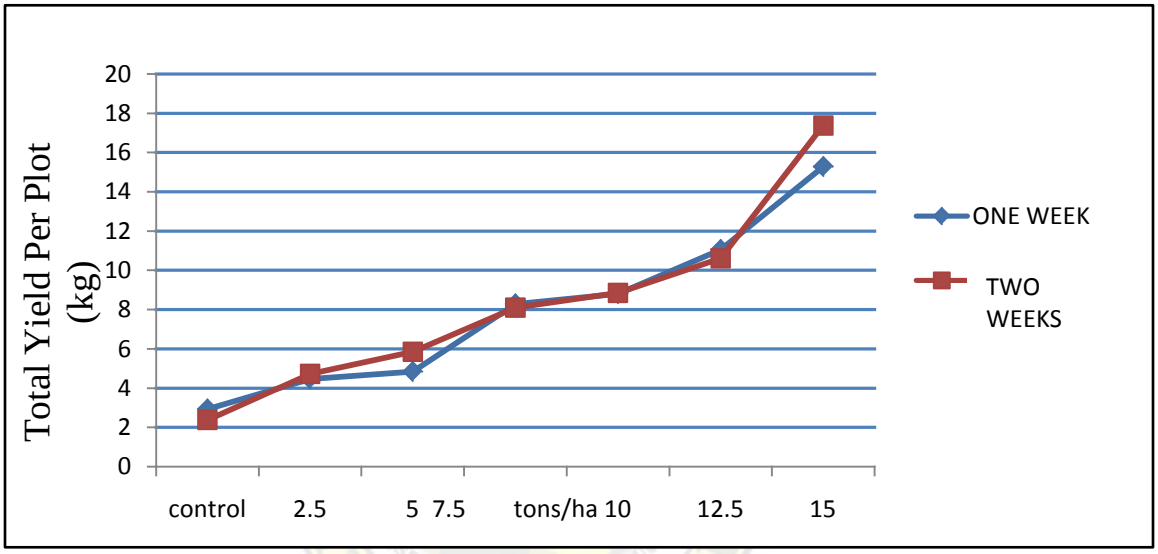

Figure 3. Interaction effect between time of application and rates of wild sunflower on total yield per plot

Computed Yield per Hectare

Effect of time of application. Computed yield per hectare is shown in Table 9. Statistical analysis showed no significant differences on the means. It can be observed however that yield from the plots applied with wild sunflower two weeks before planting is higher than those treatments applied with wild sunflower one week before planting. This could be due to the release of organic materials from the decomposing wild sunflower that are available for plant uptake.

Effect of rates of wild sunflower. Table 9 shows the yield of lettuce as affected by rates of wild sunflower. Results showed that plots applied with 15 tons/ha wild sunflower obtained the highest significant yield. This result could be due to the large amount of sunflower applied to the soil that could be the source of nutrients from the organic matter that were decomposed. It can be observed that increase in the amount of wild sunflower applied in the soil increase the yield which confirms the findings of Lagman (2003) It can also be noted that lowest yield was registered in the control.

Table 9. Computed total yield per hectare as affected by time of application and rates of wild sunflower

TREATMENT	COMPUTED TOTAL YIELD (t/ha)
Time of Application	
One week before planting	7,868[a]
Two weeks before planting	8,274[a]
Rates of Wild Sunflower (t/ha)	
Control	2,382[f]
2.5	4,553[e]
5.0	5,370[d]
7.5	81,97[c]
10.0	8,835[c]
12.5	10,840[b]
15.0	16,330[a]

Means with common letters are not significantly different at 5% by DMRT

Interaction effect between time of application and rates of wild sunflower. It can be observed that interaction between the two factors have similar trends. The yield increased as the rate of wild sunflower increased both applied one week, and two weeks before planting. Figure 4 shows that application of 15 tons/ha wild sunflower two weeks before planting obtained the highest yield. This could be due to the timely release of nutrients from the decomposed wild sunflower. For lettuce, nutrients may have been released from the decomposed organic matter from the wild sunflower (Daoines, 1994).

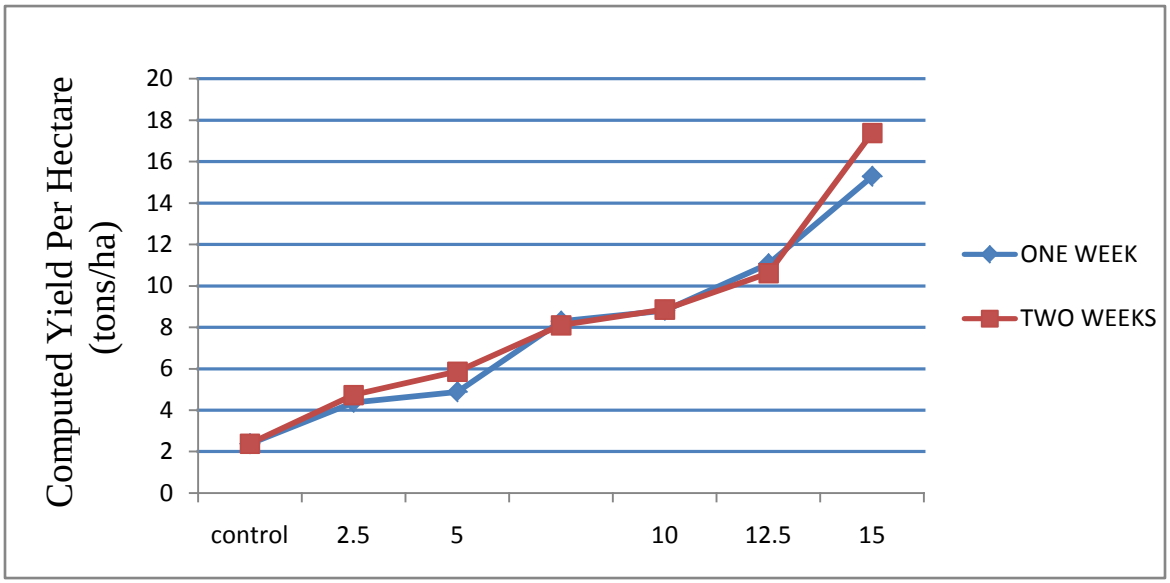

Figure 4. Interaction effect between time of application and rates of wild sunflower on the computed total yield per hectare

The result conforms with Makarat's (1984) statement that readily available nutrients in the soil contributed to faster growth and development of plants. Dagoon and Sangatanan (1985) stressed that nutrient release from organic matter takes time for the microorganisms to decompose the organic matter before the nutrients will be available for plant absorption.

Shelf-life

Effect of time of application. Table 10 shows the effect of time of application on the shelf – life of harvested plants. Statistical analysis revealed no significant differences on the treatment means.

Effect of rates of wild sunflower. Statistical analysis showed no significant differences on the treatment means. Numerically, highest number of days keeping the plants was observed in plants obtained from plots applied with 15 tons/ha of wild sunflower. Koshino (1990) reported that plants that absorb complete nutrients can play a significant role in lengthening the shelf-life of plants. Furthermore, he stressed that nutrients when synthesized in plants prolongs cell turgidity that can keep the plants in good shape for a longer period of time

Interaction effect between time of application and rates of wild sunflower. It can be observed that lowest number of days were observed in plants applied 2.5 tons/ha and 7.5 tons/ha at one week and two weeks before planting, respectively while highest number of days were observed in plants from plots applied with 7.5 tons/ha and 15 tons/ha at one week and two weeks before planting, respectively.

It can be observed further that the two timing of application resulted to varying fluctuation of the number of days of keeping. This confirmed to (Murakami, 1991) that plants depend on the availability and quantity of essential nutrients in the soil for development. This also conformed with the findings of Bautista and Mabesa (1977) that the timing of application of nutrients to the soil affected plant utilization and synthesis of nutrient in plant cells that may affect the fluctuation of the keeping quality of the plants.

Table 10. Shelf-life as affected by time of application and rates of wild sunflower

TREATMENT	SHELF-LIFE (DAYS)
Time of Application	
One week before planting	15.57 [a]
Two weeks before planting	15.29 [a]
Rates of Wild Sunflower (t/ha)	
Control	15.00 [a]
2.5	13.67 [a]
5.0	15.67 [a]
7.5	15.17 [a]
10.0	15.50 [a]
12.5	16.33 [a]
15.0	16.67[a]

Means with common letters are not significantly different at 5% by DMRT

Weight Loss

Effect of time of application. No significant effect on weight loss of plants as affected by time of application of wild sunflower is observed. However, application of wild sunflower one week before planting is higher by 0.49 grams when compared to the plants in plots applied with wild sunflower two weeks before planting. Koshino (1990) stressed that absorption of nutrients affect the plant make up and since the source is from

organic matter (wild sunflower), its availability is dependent on the nutrient release from the decomposing organic matter from the sunflower.

Effect of rates of wild sunflower. The effect of the varying rates of wild sunflower to weight loss of harvested lettuce is shown in Table 11. Significant differences can be observed on the treatment means. It can be noted that plants from plots applied with 15 tons/ha wild sunflower obtained the highest weight loss. The weight loss from this treatment could be attributed to the highest obtained yields that have resulted to the higher weight loss. On the other hand, lowest weight loss was observed in control.

Table 11. Weight loss as affected by time of application and rates of wild sunflower

TREATMENT	WEIGHT LOSS (G)
Time of Application	
One week before planting	83.50 [a]
Two weeks before planting	83.01 [a]
Rates of Wild Sunflower (t/ha)	
Control	61.92 [c]
2.5	78.15 [b]
5.0	81.37 [ab]
7.5	86.70 [ab]
10.0	88.27 [ab]
12.5	92.58 [a]
15.0	93.80 [a]

Means with common letters are not significantly different at 5% by DMRT

Interaction effect between time of application and rates of wild sunflower. The interaction effect between time of application and rates of wild sunflower on the weight loss of plants is not significant.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The experiment was conducted to determine the effect of time of wild sunflower application on the yield of lettuce and some soil properties; determine the effect of different rates of wild sunflower on the yield of lettuce and some soil properties; and, determine the interaction effect between time of application and different rates of wild sunflower on the yield of lettuce and some soil properties.

Fresh wild sunflower application one week and two weeks before planting showed no significant effect on yield of lettuce and Db, WHC, soil pH, and total N content of the soil. However, the available P and exchangeable K of the soil was greatly increased after the harvest of lettuce.

Application of wild sunflower significantly increased the yield of lettuce. Increasing the rate of wild sunflower application from 2.5 to 15 t/ha increased the yield and shelf life of lettuce. Physical and chemical properties of the soil such as water holding capacity, pH, OM, Nitrogen, Phosphorus and Potassium were significantly affected by the rates of wild sunflower applied.

On the other hand, interaction between time of application and rates of wild sunflower significantly increased the yield per plot and computed yield but not soil properties.

Conclusion

In line with the result of this research, it can be concluded that increasing rates of fresh wild sunflower application significantly increases the yield and shelf-life of lettuce

provided it is applied one week before planting. Further, fresh wild sunflower improves the soil properties.

Recommendations

It is recommended that application of 15 tons/ha wild sunflower leaves is best for lettuce production.

A follow-up study using other crops especially root crops and legumes should be done to investigate the impact of the wild sunflower leaves on tuber qualities and fruits of legumes.

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APPENDICES

Appendix Table 1. Bulk density of the soil (g/cm^3)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	II		
T_1R_1	1.13	1.10	1.20	3.43	1.14
T_1R_2	1.13	1.10	1.20	3.43	1.14
T_1R_3	1.06	1.05	1.07	3.18	1.06
T_1R_4	1.03	1.10	1.07	3.20	1.07
T_1R_5	1.05	1.01	1.05	3.11	1.04
T_1R_6	1.01	1.02	1.04	3.07	1.02
T_1R_7	1.07	1.03	1.05	3.15	1.05
Subtotal	7.48	7.41	7.68	22.57	1.07
T_2R_1	1.14	1.09	1.13	3.36	1.12
T_2R_2	1.05	1.08	1.08	3.21	1.07
T_2R_3	1.07	1.10	1.05	3.22	1.07
T_2R_4	1.02	1.01	1.04	3.07	1.02
T_2R_5	1.06	1.02	1.11	3.19	1.06
T_2R_6	1.09	1.02	1.05	3.16	1.05
T_2R_7	1.01	1.02	1.30	3.33	1.11
Subtotal	7.44	7.34	7.76	22.54	1.07
TOTAL	14.92	14.75	15.44	45.11	$\bar{x}$ = 1.07

T x R TWO WAY TABLE

TREATMENT	T_1	T_2	TOTAL	MEAN
R1	1.14	1.12	2.26	1.13
R2	1.14	1.07	2.21	1.11
R3	1.06	1.07	2.13	1.07
R4	1.07	1.02	2.09	1.05
R5	1.04	1.06	2.10	1.05
R6	1.02	1.05	2.08	1.04
R7	1.05	1.11	2.16	1.08
TOTAL	7.52	7.51	15.04	
MEAN	1.07	1.07		$\bar{x}$ = 1.07

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	0.023	0.011			
T	1	0.000	0.000	0.1300^{ns}	4.22	7.72
R	6	0.036	0.006	2.3040^{ns}	2.47	3.59
T x R	6	0.012	0.002	0.7704^{ns}	2.47	3.59
Error	26	0.069	0.003			
TOTAL	41					

ns -not significant

CV = 5.12 %

Appendix Table 2. Water holding capacity of the soil (%)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	II		
T_1R_1	67.70	71.30	73.15	212.15	70.72
T_1R_2	75.90	74.21	78.50	228.61	76.20
T_1R_3	76.11	71.43	69.35	216.89	72.30
T_1R_4	79.48	70.23	73.51	223.22	74.41
T_1R_5	74.61	75.03	78.30	227.94	75.98
T_1R_6	77.05	71.56	69.78	218.39	72.80
T_1R_7	70.91	73.07	71.97	215.95	71.98
Subtotal	521.76	506.83	514.56	1543.15	73.48
T_2R_1	68.91	67.55	70.33	206.79	68.93
T_2R_2	73.71	72.70	74.87	221.28	73.76
T_2R_3	75.91	75.96	74.70	226.57	75.52
T_2R_4	70.79	71.70	73.50	215.99	72.00
T_2R_5	78.90	78.15	75.05	232.10	77.37
T_2R_6	74.01	75.92	71.34	221.27	73.76
T_2R_7	70.93	71.71	73.81	216.45	72.15
Subtotal	513.16	513.69	513.60	1540.45	73.35
TOTAL	1034.92	1020.52	1028.16	3083.60	$\bar{x}$ = 73.415

T x R TWO WAY TABLE

TREATMENT	T_1	T_2	TOTAL	MEAN
R1	70.72	68.93	139.65	69.82
R2	76.20	73.76	149.96	74.98
R3	72.30	75.52	147.82	73.91
R4	74.41	72.00	146.40	73.20
R5	75.98	77.37	153.35	76.67
R6	72.80	73.76	146.55	73.28
R7	71.98	72.15	144.13	72.07
TOTAL	514.38	513.48	1027.87	
MEAN	73.48	73.35		$\bar{x}$ = 73.415

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	7.068	3.534			
T	1	0.207	0.207	0.0340^{ns}	4.22	7.72
R	6	168.325	28.054	4.5986^{**}	2.47	3.59
T x R	6	41.269	6.878	1.1275^{ns}	2.47	3.59
Error	26	158.615	6.101			
TOTAL	41					

** - highly significant
ns -not significant

CV = 3.36 %

Appendix Table 3. Soil pH

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	II		
T_1R_1	5.12	4.59	4.85	14.56	4.85
T_1R_2	5.23	5.13	5.01	15.37	5.12
T_1R_3	5.37	5.27	5.08	15.72	5.24
T_1R_4	5.29	4.15	5.03	14.47	4.82
T_1R_5	5.39	5.2	5.22	15.81	5.27
T_1R_6	5.8	5.24	5.15	16.19	5.40
T_1R_7	5.7	5.4	5.55	16.65	5.55
Subtotal	37.90	34.98	35.89	108.77	5.18
T_2R_1	5.21	4.5	4.79	14.50	4.83
T_2R_2	5.03	4.58	5.1	14.71	4.90
T_2R_3	5.25	4.98	4.8	15.03	5.01
T_2R_4	5.35	5.18	5.09	15.62	5.21
T_2R_5	5.27	4.83	4.98	15.08	5.03
T_2R_6	5.38	5.4	5.05	15.83	5.28
T_2R_7	5.7	6.01	5.21	16.92	5.64
Subtotal	37.19	35.48	35.02	107.69	5.13
TOTAL	75.09	70.46	70.91	216.46	$\bar{x}$ = 5.155

T x R TWO WAY TABLE

TREATMENT	T_1	T_2	TOTAL	MEAN
R1	4.85	4.83	9.69	4.84
R2	5.12	4.90	10.03	5.01
R3	5.24	5.01	10.25	5.13
R4	4.82	5.21	10.03	5.02
R5	5.27	5.03	10.30	5.15
R6	5.40	5.28	10.67	5.34
R7	5.55	5.64	11.19	5.60
TOTAL	36.26	35.90	72.15	
MEAN	5.18	5.13		$\bar{x}$ = 5.155

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	0.931	0.466	8.9017		
T	1	0.028	0.028	0.5309^{ns}	4.22	7.72
R	6	2.186	0.364	6.9655^{**}	2.47	3.59
T x R	6	0.468	0.078	1.4905^{ns}	2.47	3.59
Error	26	1.360	0.052			
TOTAL	41					

** - highly significant
ns -not significant

CV = 4.42 %

Appendix Table 4. OM content of the soil (%)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	II		
T_1R_1	0.86	0.91	0.93	2.70	0.90
T_1R_2	1.35	1.27	1.4	4.02	1.34
T_1R_3	1.78	1.59	1.85	5.22	1.74
T_1R_4	2.03	1.79	1.89	5.71	1.90
T_1R_5	1.97	2.25	2.15	6.37	2.12
T_1R_6	2.07	2.18	2.7	6.95	2.32
T_1R_7	2.78	2.61	2.87	8.26	2.75
Subtotal	12.84	12.60	13.79	39.23	1.87
T_2R_1	0.57	0.73	0.67	1.97	0.66
T_2R_2	0.93	1.03	1.7	3.66	1.22
T_2R_3	1.73	1.96	1.7	5.39	1.80
T_2R_4	2.17	1.87	1.69	5.73	1.91
T_2R_5	2.87	2.98	2.53	8.38	2.79
T_2R_6	2.35	2.94	2.7	7.99	2.66
T_2R_7	2.57	2.91	2.98	8.46	2.82
Subtotal	13.19	14.42	13.97	41.58	1.98
TOTAL	26.03	27.02	27.76	80.81	$\bar{x}$ = 1.93

T x R TWO WAY TABLE

TREATMENT	T_1	T_2	TOTAL	MEAN
R1	0.90	0.66	1.56	0.78
R2	1.34	1.22	2.56	1.28
R3	1.74	1.80	3.54	1.77
R4	1.90	1.91	3.81	1.91
R5	2.12	2.79	4.92	2.46
R6	2.32	2.66	4.98	2.49
R7	2.75	2.82	5.57	2.79
TOTAL	13.08	13.86	26.94	
MEAN	1.87	1.98		$\bar{x}$ = 1.93

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.226	0.113			
T	1	0.061	0.061	1.0896^{ns}	4.22	7.72
R	6	19.383	3.231	57.9697^{**}	2.47	3.59
T x R	6	1.094	0.182	3.2710^{*}	2.47	3.59
Error	26	1.449	0.056			
TOTAL	41	22.213				

** - highly significant
* - significant
ns -not significant

CV = 12.26 %

Appendix Table 5. Total N content of the soil (%)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	II		
T_1R_1	0.043	0.051	0.046	0.14	0.05
T_1R_2	0.067	0.063	0.07	0.20	0.07
T_1R_3	0.089	0.079	0.092	0.26	0.09
T_1R_4	0.101	0.089	0.094	0.28	0.09
T_1R_5	0.098	0.112	0.1075	0.32	0.11
T_1R_6	0.103	0.109	0.135	0.35	0.12
T_1R_7	0.139	0.13	0.143	0.41	0.14
Subtotal	0.64	0.63	0.69	1.96	0.09
T_2R_1	0.028	0.036	0.033	0.10	0.03
T_2R_2	0.046	0.051	0.085	0.18	0.06
T_2R_3	0.86	0.098	0.085	1.04	0.35
T_2R_4	0.108	0.093	0.084	0.29	0.10
T_2R_5	0.143	0.149	0.126	0.42	0.14
T_2R_6	0.117	0.147	0.135	0.40	0.13
T_2R_7	0.128	0.145	0.149	0.42	0.14
Subtotal	1.43	0.72	0.70	2.85	0.14
TOTAL	2.07	1.35	1.38	4.81	$\bar{x}$ = 0.115

T x R TWO WAY TABLE

TREATMENT	T_1	T_2	TOTAL	MEAN
R1	0.05	0.03	0.08	0.04
R2	0.07	0.06	0.13	0.06
R3	0.09	0.35	0.43	0.22
R4	0.09	0.10	0.19	0.09
R5	0.11	0.14	0.25	0.12
R6	0.12	0.13	0.25	0.12
R7	0.14	0.14	0.28	0.14
TOTAL	0.65	0.95	1.60	
MEAN	0.09	0.14		$\bar{x}$ = 0.115

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	0.000	0.000			
T	1	0.000	0.000	2.5423^{ns}	4.22	7.72
R	6	0.046	0.008	65.7804^{**}	2.47	3.59
T x R	6	0.002	0.000	3.1929^{*}	2.47	3.59
Error	26	0.003	0.000			
TOTAL	41					

** - highly significant
* - significant
ns -not significant

CV = 1 %

Appendix Table 6. Available P content of the soil (ppm)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	II		
T_1R_1	23.17	22.35	23.5	69.02	23.01
T_1R_2	27.03	25.9	27.85	80.78	26.93
T_1R_3	29.05	24.71	23.98	77.74	25.91
T_1R_4	30.75	24.85	26.96	82.56	27.52
T_1R_5	29.8	27.6	28.01	85.41	28.47
T_1R_6	31.3	31.5	27.6	90.40	30.13
T_1R_7	30.71	38.31	29.99	99.01	33.00
Subtotal	201.81	195.22	187.89	584.92	27.85
T_2R_1	22.71	20.59	23.7	67.00	22.33
T_2R_2	25.3	27.65	30.21	83.16	27.72
T_2R_3	31.05	29.78	28.9	89.73	29.91
T_2R_4	30.71	31.05	30.71	92.47	30.82
T_2R_5	37.9	34.35	29.41	101.66	33.89
T_2R_6	33.98	32.7	34.51	101.19	33.73
T_2R_7	34.7	36.8	38.15	109.65	36.55
Subtotal	216.35	212.92	215.59	644.86	30.71
TOTAL	418.16	408.14	403.48	1229.78	$\bar{x}$ = 29.28

T x R TWO WAY TABLE

TREATMENT	T_1	T_2	TOTAL	MEAN
R1	23.01	22.33	45.34	22.67
R2	26.93	27.72	54.65	27.32
R3	25.91	29.91	55.82	27.91
R4	27.52	30.82	58.34	29.17
R5	28.47	33.89	62.36	31.18
R6	30.13	33.73	63.86	31.93
R7	33.00	36.55	69.55	34.78
TOTAL	194.97	214.95	409.93	
MEAN	27.85	30.71		$\bar{x}$ = 29.28

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	9.233	4.616			
T	1	94.320	94.320	15.6206**	4.22	7.72
R	6	554.547	92.424	15.3067**	2.47	3.59
T x R	6	33.795	5.632	0.9328ns	2.47	3.59
Error	26	156.993	6.038			
TOTAL	41					

** - highly significant
* - significant
ns -not significant

CV = 8.39 %

Appendix Table 7. Exchangeable K content of the soil (ppm)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	II		
T_1R_1	210.21	217.9	215.31	643.42	214.47
T_1R_2	243.4	230.48	230.98	704.86	234.95
T_1R_3	253.75	260.38	251.05	765.18	255.06
T_1R_4	267.9	259.11	260.75	787.76	262.59
T_1R_5	248.21	258.21	270.31	776.73	258.91
T_1R_6	238.79	269.57	280.81	789.17	263.06
T_1R_7	257.24	271.03	287.9	816.17	272.06
Subtotal	1719.50	1766.68	1797.11	5283.29	251.59
T_2R_1	211.05	224.17	230.9	666.12	222.04
T_2R_2	250.15	248.79	230.71	729.65	243.22
T_2R_3	280.05	253.71	241.18	774.94	258.31
T_2R_4	267.4	247.98	269.8	785.18	261.73
T_2R_5	301.8	283.19	272.33	857.32	285.77
T_2R_6	298.05	297.29	280.79	876.13	292.04
T_2R_7	280.31	300.03	290.97	871.31	290.44
Subtotal	1888.81	1855.16	1816.68	5560.65	264.79
TOTAL	3608.31	3621.84	3613.79	10843.94	$\bar{x}$ = 258.19

T x R TWO WAY TABLE

TREATMENT	T_1	T_2	TOTAL	MEAN
R1	214.47	222.04	436.51	218.26
R2	234.95	243.22	478.17	239.09
R3	255.06	258.31	513.37	256.69
R4	262.59	261.73	524.31	262.16
R5	258.91	285.77	544.68	272.34
R6	263.06	292.04	555.10	277.55
R7	272.06	290.44	562.49	281.25
TOTAL	1761.10	1853.55	3614.65	
MEAN	251.59	264.79		$\bar{x}$ = 258.19

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	6.349	3.175			
T	1	1827.672	1827.672	11.2499**	4.22	7.72
R	6	18482.188	3080.365	18.9605**	2.47	3.59
T x R	6	1224.899	204.150	1.2566ns	2.47	3.59
Error	26	4224.008	162.462			
TOTAL	41					

** - highly significant
* - significant
ns -not significant

CV = 4.94 %

Appendix Table 8. Total yield (kg/5m^2)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	II		
T_1R_1	2.00	1.90	2.23	6.13	2.04
T_1R_2	4.35	4.10	4.67	13.20	4.37
T_1R_3	4.83	4.71	5.01	14.55	4.85
T_1R_4	8.61	8.05	8.22	24.88	8.29
T_1R_5	8.97	8.50	8.97	26.44	8.81
T_1R_6	11.45	10.72	11.00	33.17	11.06
T_1R_7	15.64	14.34	15.86	45.84	15.28
Subtotal	55.64	52.32	55.96	164.13	7.81
T_2R_1	2.21	2.54	2.41	7.16	2.38
T_2R_2	4.58	4.70	4.92	14.92	4.73
T_2R_3	5.67	6.00	5.90	17.57	5.85
T_2R_4	8.02	7.90	8.38	24.30	8.10
T_2R_5	8.84	9.00	9.14	26.57	8.85
T_2R_6	10.00	10.53	11.31	31.84	10.61
T_2R_7	18.00	17.21	16.90	52.11	17.37
Subtotal	57.32	57.88	58.96	174.47	8.27
TOTAL	112.96	110.20	114.92	338.60	$\bar{x}$ = 8.04

T x R TWO WAY TABLE

TREATMENT	T_1	T_2	TOTAL	MEAN
R1	2.04	2.38	4.42	2.21
R2	4.37	4.73	9.10	4.55
R3	4.85	5.85	10.70	5.35
R4	8.29	8.10	16.39	8.20
R5	8.81	8.85	17.66	8.83
R6	11.06	10.61	21.67	10.84
R7	15.28	17.37	32.65	16.33
TOTAL	54.70	57.89	112.59	
MEAN	7.81	8.27		$\bar{x}$ = 8.04

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.695	0.347			
T	1	2.064	2.064	15.3718**	4.22	7.72
R	6	780.341	130.057	968.7395**	2.47	3.59
T x R	6	6.638	1.106	8.2404**	2.47	3.59
Error	26	3.491	0.134			
TOTAL	41					

** - highly significant
* - significant
ns -not significant

CV = 4.55 %

Appendix Table 9. Computed total yield (t/ha)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	II		
T_1R_1	2.00	1.90	2.23	61.13	2.04
T_1R_2	4.35	4.10	4.67	13.12	4.37
T_1R_3	4.83	4.71	5.01	14.55	4.85
T_1R_4	8.61	8.05	8.22	24.88	8.29
T_1R_5	8.97	8.50	8.97	26.44	8.81
T_1R_6	11.45	10.72	11.00	33.17	11.06
T_1R_7	15.64	14.34	15.86	45.84	15.28
Subtotal	55.85	52.32	55.96	219.13	54.70
T_2R_1	2.21	2.54	2.41	7.16	2.38
T_2R_2	4.58	4.70	4.92	14.92	4.73
T_2R_3	5.67	6.00	5.90	17.57	5.85
T_2R_4	8.02	7.90	8.38	24.30	8.10
T_2R_5	8.43	9.00	9.14	26.57	8.85
T_2R_6	10.00	10.53	11.31	31.84	10.61
T_2R_7	18.00	17.21	16.90	52.11	17.37
Subtotal	56.91	57.88	58.96	174.47	57.89
TOTAL	112.76	110.20	114.92	393.60	$\bar{x}$ = 56.30

T x R TWO WAY TABLE

TREATMENT	T_1	T_2	TOTAL	MEAN
R1	2.04	2.38	4.42	2.21
R2	4.37	4.73	9.10	4.55
R3	4.85	5.85	10.70	5.35
R4	8.29	8.10	16.39	8.20
R5	8.81	8.85	17.66	8.83
R6	11.06	10.61	21.67	10.84
R7	15.28	17.37	32.65	16.33
TOTAL	54.70	57.89	112.59	
MEAN	7.81	8.27		$\bar{x}$ = 56.30

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	892704.762	446352.381			
T	1	1728342.857	1728342.857	11.1877**	4.22	7.72
R	6	770433561.905	128405593.651	831.1810 **	2.47	3.59
T x R	6	6793123.810	1132187.302	7.3288**	2.47	3.59
Error	26	4016628.571	154485.714			
TOTAL	41					

** - highly significant CV = 30.13 %

Appendix Table 10. Shelf-life (Days)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	II		
T_1R_1	13.00	15.00	17.00	45.00	15.00
T_1R_2	15.00	12.00	10.00	37.00	12.33
T_1R_3	17.00	14.00	16.00	47.00	15.67
T_1R_4	17.00	16.00	18.00	51.00	17.00
T_1R_5	15.00	16.00	17.00	48.00	16.00
T_1R_6	15.00	17.00	18.00	50.00	16.67
T_1R_7	18.00	14.00	17.00	49.00	16.33
Subtotal	110.00	104.00	113.00	327.00	15.57
T_2R_1	15.00	16.00	14.00	45.00	15.00
T_2R_2	16.00	14.00	15.00	45.00	15.00
T_2R_3	18.00	15.00	14.00	47.00	15.67
T_2R_4	11.00	16.00	13.00	40.00	13.33
T_2R_5	16.00	14.00	15.00	45.00	15.00
T_2R_6	15.00	15.00	18.00	48.00	16.00
T_2R_7	17.00	18.00	18.00	53.00	17.67
Subtotal	108.00	108.00	107.00	323.00	15.38
TOTAL	218.00	212.00	220.00	650.00	$\bar{x}$ = 30.95

T x R TWO WAY TABLE

TREATMENT	T_1	T_2	TOTAL	MEAN
R1	15.00	15.00	30.00	15.00
R2	12.33	15.00	27.33	13.67
R3	15.67	15.67	31.34	15.67
R4	17.00	13.33	30.33	15.17
R5	16.00	15.00	31.00	15.50
R6	16.67	16.00	32.67	16.34
R7	16.33	17.67	34.00	17.00
TOTAL	109.00	107.67	216.67	
MEAN	15.57	15.38		$\bar{x}$ = 30.95

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	3.000	1.500			
T	1	0.857	0.857	0.2971^{ns}	4.22	7.72
R	6	34.619	5.770	2.0002^{ns}	2.47	3.59
T x R	6	32.810	5.468	1.8957^{ns}	2.47	3.59
Error	26	75.000	2.885			
TOTAL	41	146.286				

ns -not significant CV = 5.49 %

Appendix Table 11. Weight loss (kg)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	II		
T_1R_1	61.00	58.60	63.50	183.10	61.03
T_1R_2	78.70	85.80	76.90	241.40	80.47
T_1R_3	80.00	87.50	77.10	244.60	81.53
T_1R_4	90.00	89.70	95.10	274.80	91.60
T_1R_5	75.30	85.60	96.70	257.60	85.87
T_1R_6	100.30	98.70	77.10	276.10	92.03
T_1R_7	103.40	90.30	81.60	275.30	91.77
Subtotal	588.70	596.20	568.00	1752.90	83.47
T_2R_1	53.50	65.20	69.20	187.90	62.63
T_2R_2	70.80	76.70	80.00	227.50	75.83
T_2R_3	85.40	80.30	77.90	243.60	81.20
T_2R_4	87.60	79.80	77.50	244.90	81.63
T_2R_5	81.00	93.50	97.50	272.00	90.67
T_2R_6	91.50	89.20	98.70	279.40	93.13
T_2R_7	100.50	99.40	87.60	287.50	95.83
Subtotal	570.30	584.10	588.40	1742.80	82.99
TOTAL	1159.00	1180.30	1156.40	3495.70	$\bar{x}$ = 83.23

T x R TWO WAY TABLE

TREATMENT	T_1	T_2	TOTAL	MEAN
R1	61.03	62.63	123.67	61.83
R2	80.47	75.83	156.30	78.15
R3	81.53	81.20	162.73	81.37
R4	91.60	81.63	173.23	86.62
R5	85.87	90.67	176.53	88.27
R6	92.03	93.13	185.17	92.58
R7	91.77	95.83	187.60	93.80
TOTAL	584.30	580.93	1165.23	
MEAN	83.47	82.99		$\bar{x}$ = 83.23

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	23.499	11.750			
T	1	2.429	2.429	0.0426^{ns}	4.22	7.72
R	6	4320.906	720.151	12.6395^{**}	2.47	3.59
T x R	6	249.829	41.638	0.7308^{ns}	2.47	3.59
Error	26	1481.381	56.976			
TOTAL	41	6078.044				

** - highly significant
ns -not significant

CV = 9.07%