BIBLIOGRAPHY

LIPAWEN, MELANIE Y. MAY 2009. Rates of Potassium and Organic Fertilization on the Yield and Quality of Carrots (*Daucus carrota)* cv. New Kuroda, Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted to determine the effects of rates of potassium and organic fertilization on the yield and quality of carrot. Specifically, to determine: 1) the effect of potassium and organic fertilization on the yield and quality of carrots, 2) the postharvest quality of carrots fertilized with potassium and organic fertilizer, and 3) some chemical properties of the soil planted with carrots fertilized with potassium and organic fertilizer.

Rates of potassium affected the yield and sugar content of carrots. Plants grown in plots applied with 90 kg K_2O / ha produced the highest yield.

Application of organic fertilizer affected the yield and shelf-life of carrots.. Application of 5 tons/ha chicken dung produced the highest yield. Organic materials improved organic matter and available nitrogen content of the soil.

No significant interaction effect between the rates of potassium and kinds of organic fertilizers on the yield and quality of carrots were obtained. However, application of 90 kg K_2O in combination with 5 tons/ha chicken dung gave higher yields.

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INTRODUCTION

Carrot (*Daucus carota*), an annual crop which belongs to umbilliferae or parsely family and now a popular crop, has gained more profitable and economic value to man. This is due to its palatability and high nutrient contents. There are two distinct groups such as Asiatic and European. Asiatic types are red colored due to anthocyanin pigment where as European types are orange due to carotene.

Carandang (1979) stated that carrot contains high amount of nutrients to appreciable quantities of thiamine, riboflavin and sugar. It is also a good source of calcium, potassium, and carotene. The nutrients help prevent blindness as well as enhance vigor. Carrots can be used also as a substitute for succulent feeds for daily ration of livestock animals and specially milk cows and hogs. It is also rich in dietary fiber, antioxidants and minerals.

Carrots thrive best at places with temperatures ranging from 15.6 to 21 ^{o}C. It is adaptable in sandy or silty soil with a pH ranging from 6.0 to 6.8.

Potassium (K) is essential to plant and animal life. It plays many important roles in plant nutrition. Plants absorb available K^+ from the soil and more readily from older to younger tissue that influences plant growth.

Potassium also provides sugar content of the plant. It helps increase the root length of the crop. It also enhances the physiological process in the plant including the opening and closing of stomata and tolerance to unfavorable condition.

This study was conducted to:

1. Determine the effect of different rates of potassium and organic fertilization on the yield and quality of carrots;

2. Determine the post harvest quality of carrots fertilized with different rates of potassium and organic fertilization; and,

3. Determine some chemical properties of soil planted with carrots fertilized with organic and rates of potassium (K).

The study was conducted at the Soil Science Experimental area, College of Agriculture, Benguet State University, La Trinidad Benguet from November 2008 to April 2009.

REVIEW OF LITERATURE

Role of Potassium

Potassium (K) has many functions in plants that include root growth, improves drought resistance, builds cellulose and reduces lodging, enhances many enzyme actions, reduces respirations that prevent energy losses, aids in photosynthesis and food formation, helps in the translocation of sugars and starch, increases protein content of plants, maintains turgidity that reduces water loss and wilting, helps retard crop diseases, and is involved in many other plant functions (Tisdale and Nelson, 1975 as cited by Raymundo, 2002).

Devlin (1997) claims that potassium is essential in photosynthesis. It is also absolutely essential in the development of chlorophyll. Photosynthesis decreases with insufficient supply of potassium and at the same time respiration may be increased. This condition seriously reduces the supply of carbohydrates and consequently the growth of the plant. The role of potassium in photosynthesis is complex but activation of enzyme and involvement in ATP production is probably more important in regulating photosynthesis than in the role of potassium in stomatal activity.

Effect of Potassium on Crop Quality

High level of available potassium improve physical quality, disease resistance and feeding value of grain and forage crops, as well as crop used for human food. Quality is becoming an increasingly important market factor so adequate Potassium will become more critical for the value of the crop produced (Tisdale and Nelson, 1975).

A research conducted in 1987 by the Potash Phosphate Industry (PPI) Research Institute, white and sweet potatoes, cabbage, cassava and other vegetable crops require Potassium for both yield and quality. When K is limited, tomatoes, potatoes and cabbage often shown dislocation of the internal tissue. For crop such as oranges, K improves fruit quality and specifically K influences the sizes of fruit, thickness rind, fruit color, acid/ sugar ratio, soluble solid and the vitamin content. Banana yield and quality are strongly influenced by K nutrition. It improves fruit weight, number and finger per bunch. In addition, K stimulated earlier fruit shooting and shorten the number of days to fruit maturity. The beneficial effect of K on banana fruit quality continues over and above levels of K require for top fruit yield (PPI, 1987).

Deficiency and Excess Symptoms of Potassium

Deficit of K is most likely observed on leached soils especially sandy soils. Compared to deficiencies of phosphorous and many other nutrients, deficiency of K is relatively easy to recognize in most plants. Potassium deficiency decreases root elongation and root thickness which affect the absorption of other nutrient elements. When K is deficient, some plants produce large concentrations of the basic amine putres cine (PPI Research Institute, 1987) as cited by Diong-an (2006). Because K is very mobile within the plants, it is translocated from older tissues to younger ones if the supply is inadequate. The symptoms of deficiency therefore usually occur earliest and most severely on the older leaves. In general when K is deficient, the tips and edges of the oldest leaves begin to yellow (chlorosis) and then die (necrosis) so that the leaves appear to have been burned on the edges. On some plants, the necrotic leaf edges may tear, giving the leaf a ragged appearance (Brady and Weil, 2002).

Excess K affects dry matter content, specific gravity in potato tubers. Since K stimulates water accumulation in tubers. K fertilizers application influences the usability of tubers for food (PPI, 1987) as cited by Diong-an (2006).

Effect of Organic Fertilizer on Plant Growth

Cid (2000) said that chicken dung contains 11 % nitrogen which is the highest among organic fertilizers, but lower in phosphorous and potassium. However, chicken dung propates better and faster vegetative growth.

According to Sullivan (2003) leguminous green manure can supply 30 to 50 percent of the nitrogen needs of high yielding rice varieties depending on quality and type of green manure crop, the time and method of application, soil fertilizer and cropping method. The sub covers provide enough nitrogen to produce high rice yields without additional nitrogen at one location. It was further found that organic rice is two to three times taller than the conventionally grown rice but costs more to produce.

In addition, de la Cruz (2004) claim that crops applied with animal manure performed better compared to those crops grown with commercial organic fertilizers. The slow release of nutrients from the animal manure minimizes the nutrient losses resulting to the efficient uptake of crops that lead to higher yield. Animal manure also serves as a valuable conditioner of the soil retaining humidity and improving structure and internal drainage.

Organic fertilizer generally provides some of the essential elements necessary for proper growth. It gives farmers lower stable fertilizer cost, reliable local fertilizer and increasing soil fertility (Pacsi, 2005).

Effect Organic Matter on Physical Properties of the Soil

The castings (vermicompost) form aggregates which are mineral clusters that combine is such a way that they can withstand water erosion and compaction and also increase water retention. Vermicompost have a very high water holding capacity.

According to Casio (1977) as cited by Capcapan (2003), organic matter or compost applied to a certain area about 3 to 5 tons/ha can enhance granulation, aeration and water holding capacity of the soil.

Brady and Weil (2002) also claimed that organic matter binds mineral particles into a granular soil structure that is largely responsible for the loose characteristics, easily manage condition of productive soil and also increases the amount of water as soil can hold more available water.

Tan (1975) as cited by Lingaling (2006) stated that compost improves the structure of the soil. This allows more air into the soil and improves soil fertility drainage and reduces erosion. Compost improves soil fertility by adding nutrients and by making it easier for plants to take up the nutrients in the soil.

Effect of Organic Fertilizer on Postharvest Quality of Crops

Nutrient elements from organic fertilizers are released slowly which are particularly important in avoiding salt injury, ensuring a continuous supply of nutrients throughout the growing season, and in producing products of better quality (Koshino, 1990). Moriconi (1989) as cited by Tomilas (1996) stated that the slow release of nitrogen in organic fertilizer results in a lower protein and higher sugar contents which gives a better taste of plants.

Effect of Organic Matter on the Chemical Properties of the Soil

In 1996, Brady and Weil as cited by Lacay (2008) reported that plant growth and development are affected by many factors; one crucial factor that may affect plant growth is the soil organic matter. Soils high in organic matter usually are productive. Plants can grow well so there is always a good harvest. So in order to maintain a good harvest the amount of organic matter in the soil must be maintained at a high level as cited by Lacay (2008). Sun and Hsieh (1992) reported that organic matter content of the soil is often used as an index of soil fertility. The alterations of the physical, chemical and biological properties of the soil are the three general effects of organic matter. Moreover, organic matter when properly decomposed will produce the humus vital in soil conditions affecting growth of plants.

Brady and Weil (2002) reported that organic matter is the primary source of the plant nutrients which includes nitrogen, phosphorus and sulfur. It also provides much of the cation exchange and water holding capacities of surface soil. Furthermore, organic matter supplies energy and body building constituents for most of the microorganism.

In 1996, Brady and Weil as cited by Lazo (2006) stated that both fulvic and humic acid in the soil solution even in small quantities enhances certain aspects of plant growth. Components of these substances probably act as regulator of specific plant functions such as cell elongation and lateral root initiation.

MATERIALS AND METHODS

Materials

The different materials used were carrot (cv. New Kuroda) seeds; different organic materials such as vermicompost, wild sunflower, chicken dung and hog manure, inorganic fertilizer such as muriate of potash (0-0-60), urea (46-0-0), and solophos (0-18-0), wooden planting guide and identifying tags and other farm implements like grub hoe, bolo, chemical reagents, laboratory equipments for the analysis.

Methodology

An area of 300 sq. meters were thoroughly prepared and divided into three blocks. Each block was subdivided into 20 plots with a dimension of 1 m wide x 5 m long. The experiment was laid out following the Randomized Complete Block Design (RCBD) following the factorial arrangement with the rates of potassium fertilizer as Factor A and kinds of organic fertilizer as Factor B.

The different treatments were as follows:

Factor A. Rates of Potassium Fertilizer (K) – kg K_2O/ha

K_1 – Control

K_2 – 80

K_3 – 90

K_4 – 100

Factor B. Kinds of Organic Fertilizers – O

O_1 - Control

O_2 – Vermicompost (20 tons/ha)

O_3 – Wild Sunflower (20 tons/ha)

O_4 – Chicken Dung, (5 tons/ha)

O_5 – Hog Manure, (10 tons/ha)

The different treatments were laid out following the RCBD factorial. For O_1 and K_1 (control) no application of organic fertilizers and potassium fertilizer. Organic fertilizers were applied and mixed thoroughly one (1) week before planting.

Seeds were sown with the use of wooden planting guide in order to have equal number of hills per plot. The pegs of the planting guide are spaced 8 cm x 15 cm between hills and rows. Five (5) to eight (8) seed were dropped in each hill and covered with thin layer of soil.

Application of the 46-0-0, 0-18-0 and different rates of 0-0-60 were applied two (2) weeks after emergence 50 % of the recommended rate 90 N – 170 P_2O_5 – 90 K_2O (BFS) of the crop. While the remaining 50% of the recommended rate was applied during hilling-up after four (4) weeks of the plants. The plants were hilled-up two times during the application of the inorganic fertilizer.

The plants were thinned four (4) weeks after emergence. Weak, abnormal, late emergence or small plants were uprooted leaving only one plant per hill.

The plants were maintained by employing agricultural management practices such as irrigation and weeding.

The data gathered were the following:

A. Agronomic Parameters

1. Marketable yield (kg). This was taken by weighing all carrot roots harvested per plot excluding the damaged roots.

2. Total yield (kg). This was the weight of all carrot roots harvested per plot which include the marketable and non-marketable.

3. Dry matter content (%). Two big, three medium and three small carrots including there stalk and leaves were used as representative samples on this dry matter content. These were determined by chopping the plant samples into small pieces, sun dried and oven-dried at a temperature maintained at 70^{o}C. The dried samples were cooled and weighed. This was computed following the formula:

$$\% MC = \frac{\text{Fresh weight} - \text{Oven dry weight}}{\text{Fresh weight}} \times 100$$

$$DMC = 100 - \% MC$$

4. Return of investment (ROI). The return of investment was computed per treatment using the formula:

$$ROI (\%) = \frac{\text{Gross Sale} - \text{Total Expenses}}{\text{Total Expenses}} \times 100$$

Classification of Roots

Classification of carrots were based on the Farmer's practice of Classification as adopted by Lingaling and Balaoing, (2006).

1. Big carrots (kg). These were the weight of big roots harvested per plot with roots measuring 15.0 cm long or more.

2. Medium carrots (kg). These were the roots measuring 13.0 to 14.0 cm.

3. Small carrots (kg). These were the weight of roots smaller than 13.0 cm long.

B. Postharvest Quality

1. Shelf life (days). Two big, three medium and three small were used as representative samples on this shelf-life of carrots. The shelf-life was done by counting the number of days from storing the samples to the onset of senescence (e.g. rotting of the carrots, discoloration and deformation of carrots).

2. Weight loss (%). This was done by weighing the fresh weight of the carrots to be stored and after the carrot was stored 15 days. The percent weight loss was computed using the formula below:

$$\% \text{ Wt. loss} = \frac{W_1 - W_2}{W_2} \times 100$$

Where: W1 - Initial weight

W2 – Final weight

3. Sugar Content (^{o}Brix). The sugar content of the carrot was done by extracting juice of the carrot using the juicer equipment. This was determined using Refractometer Method.

C. Soil Analysis

Chemical Properties of the Soil

Soil samples were collected at a depth of 0-30 cm from all the treatment plots for analysis of the chemical properties of the soil before and after the study.

1. Soil pH (Electrometric Method). Ten grams air dried soil samples were placed into a 10 ml beaker. Then 20-ml of 0.1M $CaCl_2$ was added and stirred thoroughly for a period of 15 to 30 minutes. The pH meter was calibrated with the use of standard buffer solution pH 7.0. The samples were stirred again and its pH was determined immediately to the nearest 0.1 pH unit. The glass electrode was washed with distilled water and wiped with tissue after each use.

2. Soil organic matter (%). This was analyzed using the Walkley-Black Method. One gram air dried soil (passed into also 5 mm mesh sieve) was placed in a 500 ml flask with 10-ml of 1N $K_2Cr_2O_7$ solution. Then 20-ml of sulfuric acid reagent was added rapidly. It was mixed thoroughly and allowed to react for 30 minutes. The reaction mixtures were diluted with 200-ml distilled water and 10-ml phosphoric acid solution was added. Then 1-ml of diphenylamine indicator was added. The solution was titrated with standard $FeSO_4$ solution to a brilliant green color. The percent organic matter content of the soil was computed using the following formula:

$$OM\ (\%) = 6.9\ \frac{(S-T)}{S}$$

Where:

6.9 – constant

S – ml for ferrous solution required for the blank

T – Volume of ferrous solution required for the sample.

3. Nitrogen content (%). The total nitrogen content of the soil was based from organic matter content of the soil. This was computed by using the formula below:

$$\%\ N = OM\ content \times 0.05$$

Where: 0.05 = conversion factor (constant)

4. Phosphorus content of the soil (ppm). The Bray No. 2 Method was used to determine this. A 2.85 gram crushed and sieved soil was weighed and placed into a 250-ml Erlenmeyer flask. 20-ml of the extraction solution (0.03 N NH_4F in 0.1 N HCl) from a pipette was added. The mixture was covered and shaken for one minute. The suspension was filtered immediately in Whatman No. 42 filter paper held in a filter tube. The filtrate should be clear. If not the solution should be quickly poured back through the same filter paper. A 5-ml aliquot of the clear filter was transferred into a 25-ml Volumetric Flask after the 1-ml had previously been discarded to rinse the pipette. 7.5-ml boric acid, 5-ml ammonium molybdate reagent were added and then mixed. Finally, add 2.5 ml of freshly diluted stannous chloride reagent was added with immediate mixing. The mixture was volumed with distilled water. After 5-6 minutes it was transferred into cuvete and immediately placed into the spectrophotometer for readings. The P-standards were made up in the range of 0.1 to 1 ppm P. Through the same steps as in the procedure including 5-ml of the extracting solution in each 25-ml final volume, a reagent blank was made with each series of determination and is employed for the 100 percent transmittance setting. The phosphorus content (ppm P) was computed using the formula:

$$\text{ppm P} = \text{ppm P of the soil solution} \times \frac{25}{5} \times \frac{20}{2.85}$$

5. Potassium (K) content of the soil (ppm). This was determined using Flame Photometer method. A four gram crushed and sieved soil was weighed and placed into 250-ml Erlenmeyer flask. 20-ml of the extraction solution (ammonium acetate) from a pipette was added. This was covered and shaken for 5-minutes. The suspension was filtered immediately in Whatman No. 40 filter paper held in a filter tube. The filtrate

should be clear. If not, the solution should be quickly poured back through the same filter paper. The K-standards were made. The potassium content were read using the Flame Photometer. The available potassium content (ppm K) was computed using the formula:

$$\text{ppm K} = \text{ppm K of the soil solution} \times \frac{20}{4}$$

The data gathered were statistically analyzed using the ANOVA. The significance between treatment means were analyzed using the Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Marketable Yield

Effect of rates of potassium. The marketable yields of carrots were significantly affected by the application of different rates of potassium (Table 1). Application of 90 kg/ha K_2O using 0-0-60 gave the heaviest marketable yield (16.6 kg/5m^2) compared to other potassium rates including the control (no fertilizer). It differed significantly from the rest of the treatments. The result implies that application of 90 kg K_2O / ha enhanced the highest yield of carrot plants. Baksh and Khattak, (1986) as cited by Balantan, (2002) found that applying KCl resulted to higher stem diameter and increased yield of potato plants than those applied with KNO_3.

Potassium plays an important role in obtaining high yield in potato because it is involved in carbohydrate metabolism and generally involved in metabolic processes like the translocation of sugars from one meristematic tissue to the other (Devlin, 1977 as cited by Diong-an, 2006).

Effect of kinds of organic fertilizer. Application of 5 tons/ha chicken dung produced the highest marketable yield of carrots (18.3 kg/5m^2) (Table 1). The result conforms with the study of Dangsian (2004) and Palasi (2008) that plots applied with chicken manure produced the highest plant yield. These effects on yield were attributed to the manure that contains essential plant nutrients as well as some trace elements not generally found in chemical fertilizers (Jones, 1982). With this application of 5 tons/ha chicken dung enhanced the higher yield of carrot plants.

Interaction effect. There were no interaction effect between the different rates of potassium and kinds of organic fertilizers on the marketable yield of carrots. However, it was noted that carrot plants grown in plots fertilized with 90 kg K_2O/ha in combination with 5 tons/ha chicken dung has the highest carrot yield with a mean of 19.3 kg/5m^2.

Table 1. Marketable yield of carrots as affected by different rates of potassium and organic fertilizers

TREATMENT		MEAN (kg/5m^2)
Rates of Potassium (K_2O)		
K_1	No Potassium Fertilizer (Control)	12.2^c
K_2	80 kg K_2O / ha	14.9^b
K_3	90 kg K_2O / ha	16.6^a
K_4	100 kg K_2O / ha	14.9^b
Kinds of Organic Fertilizer		
O_1	No Organic Fertilizer (Control)	9.9^c
O_2	20 tons / ha Vermicompost	14.8^b
O_3	20 tons / ha Wild Sunflower	15.5^b
O_4	5 tons / ha Chicken Dung	18.3^a
O_5	10 tons / ha Hog Manure	15.2^b

Means with the same letter are not significantly different at 5% level DMRT.

Total Yield

Effects of rates of potassium. The total yield was affected by different rates of potassium as shown in Table 2. Application of 90 kg K_2O / ha obtained the highest total yield with a mean of 17.25 kg/5m^2. It differed significantly from the other treatments. As the rate increase, the yield decrease.

Binawe, (1982) as cited by Diong-an, (2006) found that there is usually a point wherein additional fertilizer do not increase yield.

Effect of kinds of organic fertilizer. The different kinds of organic fertilizer affected the total yield of carrot (Table 2). Application of 5 tons/ha chicken dung had the highest yield (19.16 kg/5m^2) which differed with plants grown in plots applied with other organic fertilizer including the unfertilized plot (control). This could be attributed to the higher nutrient contents of chicken manure (5% N, 5% P_2O_5-K_2O) as compared to the other organic fertilizers. This also conforms with several findings on crops stating that increasing the level of organic fertilizer applied such as chicken manure enhanced the tuber formation and yield (Javar, 2003 and Brady and Buckman, 1974).

Interaction effect. Application of different rates of potassium in combination with organic fertilizer did not affect the total carrot yield. However, plants grown in soils applied with 80 kg K_2O / ha in combination with 5 tons/ha chicken dung gave the highest total yield with a mean of 21.0 kg/5m^2.

Table 2. Total yield of carrots as affected by different rates of potassium and organic fertilizers

TREATMENT		MEAN ($kg/5m^2$)
Rates of Potassium (K_2O)		
K_1	No Potassium Fertilizer (Control)	12.9^c
K_2	80 kg K_2O / ha	15.8^b
K_3	90 kg K_2O / ha	17.3^a
K_4	100 kg K_2O / ha	15.7^b
Kinds of Organic Fertilizer		
O_1	No Organic Fertilizer (Control)	10.5^c
O_2	20 tons / ha Vermicompost	15.4^b
O_3	20 tons / ha Wild Sunflower	16.1^b
O_4	5 tons / ha Chicken Dung	19.2^a
O_5	10 tons / ha Hog Manure	15.7^b

Means with the same letter are not significantly different at 5% level DMRT.

Dry Matter Content

Effect of rates of potassium. The different rates of potassium did not affect the dry matter content of the carrots (Table 3). Nevertheless, carrot plants grown in unfertilized plots (control) had the highest dry matter content with a mean of 11.33 % which did not significantly differed from the other rates of potassium. It could be noted that increasing the rates of potassium from 80 – 100 kg/ha decreases the dry matter contents of carrots.

Effects of kinds of organic fertilizer. Dry matter content of carrot was not significantly affected by the different kinds of organic fertilizer as shown in Table 3. Nevertheless, plants applied with 5 tons/ha chicken dung had the highest dry matter content with a mean of 11.37% which did not differ from the other organic fertilizer including the control. Among the organic fertilizer, application of 10 ton/ha hog manure gave the lowest dry matter content of carrots.

Interaction effect. There were no interaction effects of different rates of potassium and kinds of organic fertilizer on the dry matter content of carrot. However, it was observed that carrot grown in plots without potassium (control) and 10 tons/ha hog manure had the highest dry matter content of 11.79%.

Weights of Classified Carrot Roots

Big Carrots

Effects of rates of potassium. The weight of big carrots was affected by the application of different rates of potassium. Plants grown in plots applied with 90 kg K_2O/ha using 0-0-60 had the heaviest weight of 11.07 kg/5m^2. It differed significantly from the other rates of potassium and unfertilized plots (control) with the lowest mean of 7.94 kg/5m^2.

Size of tubers was reported to be enhanced by potassium by increasing the proportion of large tubers relative to small ones. Potassium promotes large size of potato by increasing water accumulation in tubers resulting to lower dry matter content and specific gravity (Baksh and Khattak, 1986 as cited by Diong-an, 2006).

Table 3. Dry matter content of carrots as affected by different rates of potassium and organic fertilizers

TREATMENT		MEAN (%)
Rates of Potassium (K_2O)		
K_1	No Potassium Fertilizer (Control)	11.3[a]
K_2	80 kg K_2O / ha	10.9[a]
K_3	90 kg K_2O / ha	10.5[a]
K_4	100 kg K_2O / ha	10.3[a]
Kinds of Organic Fertilizer		
O_1	No Organic Fertilizer (Control)	10.7[a]
O_2	20 tons / ha Vermicompost	10.6[a]
O_3	20 tons / ha Wild Sunflower	10.8[a]
O_4	5 tons / ha Chicken Dung	11.4[a]
O_5	10 tons / ha Hog Manure	10.4[a]

Means with the same letter are not significantly different at 5% level DMRT.

Effect of kinds of organic fertilizer. The weight of big carrots was affected by the application of different kinds organic fertilizer as shown in Table 4. The weight of big carrot was heavier from plots applied with 5 ton/ha chicken dung with a mean of 12.08 kg/5m^2 as compared to the other organic fertilizer treatments including the control. This result conforms with the report of findings of Toledo (1982) and Lingaling (2006) that plants grown in plots with chicken manure matured earlier that resulted in the production of heavier big carrots.

Interaction effect. Application of different rates of potassium and kinds of organic fertilizer did not affect the weight of big carrots. However, it was noted that plants grown in plots applied with 90 kg K_2O / ha and 5 tons/ha chicken dung produced the heaviest big carrots with a mean of 13.1 kg/5m^2.

Medium Carrots

Effect of rates of potassium. Application of different rates of potassium affected the weights of medium carrots as shown in Table 4. Heaviest weight of medium carrots was obtained in plants grown in plots applied with 90 kg K_2O / ha with a mean of 3.98 kg/5m^2. It differed significantly from the other rates including the control.

Effect of kinds of organic fertilizer. The weight of medium carrot was affected by different kinds of organic fertilizer application as shown in Table 4. Heaviest weight of medium carrot was obtained in plants grown in plots applied with 5 tons/ha chicken dung compared to other organic fertilizers including the control. It could be noted that application of vermicompost (20 tons/ha), wild sunflower (20 tons/ha) and hog manure (10 tons/ha) can also improve the weight of medium carrots

Interaction effect. There were no effects of different rates of potassium and kinds of organic fertilizer combinations on the weights of medium carrots. However, it was noted that plants applied with 90 kg K_2O / ha in combination with 5 tons/ha chicken dung produced the highest weight of medium carrots with a mean of 4.97 kg/5m^2.

Small carrots

Effect of rates of potassium. The weight of small carrots was not affected by the application of different rates of potassium as shown in Table 4. Nevertheless, that plants grown in plots applied with 80 kg K_2O/ha had the heaviest weight of small carrot with a mean of 1.9 kg/5m^2 as compared to the other rates including the control.

Effect of kinds of organic fertilizer. Application of different organic fertilizer did not affect the weights of small carrots as shown in Table 4. Plants grown in plots applied with 5 tons/ha chicken dung produced the heaviest small carrots with a mean of 1.8 kg/5m^2 compared to the other organic fertilizer treatments including the control.

Interaction effect. There were no interaction effects between rates of potassium and kinds of organic fertilizer on the weight of small carrots. However, it was observed that plants grown in plots applied with 80 kg K_2O / ha and 5 tons/ha chicken dung produced the heaviest small carrots with a mean of 2.3 kg/5m^2.

Table 4. Weight of big, medium and small carrots as affected by different rates of potassium and organic fertilizers

TREATMENT		MEAN ($kg/5m^2$) BIG	MEDIUM	SMALL
Rates of Potassium (K_2O)				
K_1	No Potassium Fertilizer (Control)	7.9[c]	2.9[c]	1.4[a]
K_2	80 kg K_2O / ha	9.5[b]	3.6[b]	1.9[a]
K_3	90 kg K_2O / ha	11.1[a]	4.0[a]	1.5[a]
K_4	100 kg K_2O / ha	9.8[b]	3.5[b]	1.6[a]
Kinds of Organic Fertilizer				
O_1	No Organic Fertilizer (Control)	6.6[c]	2.0[c]	1.3[a]
O_2	20 tons / ha Vermicompost	9.3[b]	3.8[b]	1.7[a]
O_3	20 tons / ha Wild Sunflower	10.1[b]	3.7[b]	1.6[a]
O_4	5 tons / ha Chicken Dung	12.1[a]	4.4[a]	1.8[a]
O_5	10 tons / ha Hog Manure	9.8[b]	3.7[b]	1.7[a]

Means with the same letter are not significantly different at 5% level DMRT.

Postharvest Quality of Carrots

Shelf-life

Effect of rates of potassium. The shelf-life of carrots under ambient room condition as affected by different rates of potassium is shown in Table 5. Application of different rates of potassium did not affect the shelf-life of carrots. Nevertheless, it was observed that plants grown in plots applied with 100 kg K_2O / ha had the longest shelf-life with a mean of 15 days. It could be noted that increasing the rates of potassium from 80 – 100 kg/ha will also increase the shelf-life of carrots.

Effect of kinds of organic fertilizer. Application of different kinds of organic fertilizer significantly affected the shelf-life of carrot under ambient room condition (Table 5). Plants grown in plots applied with 5 tons/ha chicken dung had the longest shelf-life with a mean of 15 days. It did not differ from the 20 tons/ha vermicompost and 20 tons/ha wild sunflower with means of 14.92 days, 14.92 days respectively. Plants grown in plots applied with 10 tons/ha hog manure and the unfertilized plots (control) with means of 14.33 days and 13.25 days had the lowest shelf-life. This result conforms with the study of Lingaling (2006) that organic matter helps prolong the storage life of carrots. Moreover, organic fertilizer prolongs the storage life of different crops such as cabbage, tomato and bush beans (Lubangas 1996).

Interaction effect. There were no interaction effects of different rates of potassium and kinds of organic fertilizer on the shelf-life of carrots. Plants grown in plots applied with 90 kg/ha K_2O and 20 tons/ha wild sunflower had the longest shelf-life with a mean of 16.33 days.

Table 5. Shelf-life of carrots as affected by different rates of potassium and kinds of organic fertilizers

TREATMENT		MEAN (days)
Rates of Potassium (K_2O)		
K_1	No Potassium Fertilizer (Control)	14.33[a]
K_2	80 kg K_2O / ha	14.33[a]
K_3	90 kg K_2O / ha	14.53[a]
K_4	100 kg K_2O / ha	14.73[a]
Kinds of Organic Fertilizer		
O_1	No Organic Fertilizer (Control)	13.25[c]
O_2	20 tons / ha Vermicompost	14.92[a]
O_3	20 tons / ha Wild Sunflower	14.92[a]
O_4	5 tons / ha Chicken Dung	15.00[a]
O_5	10 tons / ha Hog Manure	14.33[b]

Means with the same letter are not significantly different at 5% level DMRT.

Percent Weight Loss

Effect of rates of potassium. The percent weight loss of carrots was affected by the application of different rates of potassium (Table 6). Plants grown in plots applied with 80 kg/ha K_2O had the highest percent weight loss with a mean of 48.08%. However, the weight loss did not differ from the other treatments including the control.

Effect of kinds of organic fertilizer. Application of different kinds organic fertilizer affected the percent weight loss of carrots (Table 6). Among the organic fertilizers, the plants grown in plots applied with 20 tons/ha wild sunflower had the highest percent weight loss with a mean of 45.50 %. It was noted that the lowest weight losses of carrot roots stored under ambient conditions were obtained from plants grown in plots applied with 20 tons/ha vermicompost. While the carrots from unfertilized plots had the highest percent weight loss of 54.8 %. This implies that the shorter the shelf-life the higher the percent weight loss. These results also conform with the findings of Lingaling (2006) that the unfertilized carrots had the highest percentage weight loss.

Interaction effect. There were no interaction effects of different rates of potassium and kinds of organic fertilizer application on the weight loss of carrots. However, it was observed that plants grown in plots applied with 80 kg/ha K_2O and 20 tons/ha vermicompost had the lowest percent weight loss with a mean of 42.91% compared to the other treatment combinations including the control.

Sugar Content

Effect of rates of potassium. Table 7 shows the effect of rates of potassium on the sugar content of carrots. The rates of potassium affect the sugar content of carrots. Plants grown in plots applied with 100 kg K_2O/ha had the highest sugar content with a mean of 8.16^{o}Brix. The result conforms with the report of Tisdale and Nelson, (1975) as cited by Raymundo (2002) that potassium helps in the translocation of sugars and starch, increases protein content of the crop that maintains turgidity that reduces weight loss and wilting. This also implies that the higher the potassium uptake the higher sugar content released by the crop. Increasing the rates of potassium from 80 – 100 kg/ha resulted to increased the sugar contents from 6.22^{o}Brix to 8.16^{o}Brix.

Table 6. Percent weight loss of carrots as affected by different rates of potassium and organic fertilizers

TREATMENT		MEAN (%)
Rates of Potassium (K_2O)		
K_1	No Potassium Fertilizer (Control)	47.93[a]
K_2	80 kg K_2O / ha	48.08[a]
K_3	90 kg K_2O / ha	47.23[a]
K_4	100 kg K_2O / ha	45.07[a]
Kinds of Organic Fertilizer		
O_1	No Organic Fertilizer (Control)	54.58[a]
O_2	20 tons / ha Vermicompost	44.86[b]
O_3	20 tons / ha Wild Sunflower	45.50[b]
O_4	5 tons / ha Chicken Dung	45.03[b]
O_5	10 tons / ha Hog Manure	45.42[b]

Means with the same letter are not significantly different at 5% level DMRT.

Effect of kinds of organic fertilizer. Application of different kinds of organic fertilizers did not affect the sugar content of carrots. Nevertheless, plants grown in plots applied with 20 tons/ha vermicompost had the highest sugar content but did not differ from the other organic fertilizers applied. This conforms with the report of Moriconi, 1989 as cited by Tomilas (1996) that the slow release of nitrogen contained in organic fertilizers result in a lower protein and a higher sugar content which account for a better taste in plants.

Interaction effect. There were no interaction effects of different rates of potassium and kinds of organic fertilizer application on the sugar contents of carrots. However, it was observed that plants grown in plots applied with 100 kg/ha and 20 tons/ha vermicompost had the highest sugar content of carrots with a mean of 8.54^{o}Brix. The result implies that application of potassium and vermicompost increase the sugar content of carrots.

Table 7. Sugar content of carrots as affected by different rates of potassium and organic fertilizers

TREATMENT		MEAN (^{o}Brix)
Rates of Potassium (K_2O)		
K_1	No Potassium Fertilizer (Control)	5.19^{b}
K_2	80 kg K_2O / ha	6.22^{b}
K_3	90 kg K_2O / ha	6.80^{ab}
K_4	100 kg K_2O / ha	8.16^{a}
Kinds of Organic Fertilizer		
O_1	No Organic Fertilizer (Control)	6.41^{a}
O_2	20 tons / ha Vermicompost	6.85^{a}
O_3	20 tons / ha Wild Sunflower	6.81^{a}
O_4	5 tons / ha Chicken Dung	6.46^{a}
O_5	10 tons / ha Hog Manure	6.43^{a}

Means with the same letter are not significantly different at 5% level DMRT.

Chemical Properties of the Soil

Soil pH

Effects of rates of potassium. The soil pH after harvest as affected by different rates of potassium is shown in Table 8. Results show that application of different rates of potassium did not influence the soil pH. It could be noted that application of potassium at different rates lowered the pH from the initial value of 5.8 (Table 8). It was noted that soils applied with 100 kg K_2O per hectare had the lowest pH with a mean of 4.9 which did not differ from the other rates including the control.

Effect of kinds of organic fertilizer. The different kinds of organic fertilizer applied did not affect the pH of the soil after harvest (Table 8). The initial pH of the soil (5.8) markedly decreased when applied with different organic fertilizers. It was observed that soils applied with 20 tons per/ha vermicompost had the lowest pH of (4.8). Nelson and Tisdale (1976) claimed that continued use of nitrogenous (acid-forming) fertilizer materials will lead to soil acidity and reduces yield of crops.

Interaction effect. The application of different rates of potassium and kinds of organic fertilizer did not influence the pH of the soil after harvest. However, the lowest pH was registered from the soils applied with 100 kg K_2O / ha in combination with 20 tons/ha vermicompost (4.6).

Table 8. Soil pH as affected by different rates of potassium and different organic fertilizers

TREATMENT		MEAN
Rates of Potassium (K_2O)		
K_1	No Potassium Fertilizer (Control)	5.0[a]
K_2	80 kg K_2O / ha	5.1[a]
K_3	90 kg K_2O / ha	5.1[a]
K_4	100 kg K_2O / ha	4.9[a]
Kinds of Organic Fertilizer		
O_1	No Organic Fertilizer (Control)	4.9[b]
O_2	20 tons / ha Vermicompost	4.8[b]
O_3	20 tons / ha Wild Sunflower	5.1[ab]
O_4	5 tons / ha Chicken Dung	5.2[ab]
O_5	10 tons / ha Hog Manure	5.3[a]
INITIAL VALUE		5.8

Means with the same letter are not significantly different at 5% level DMRT.

Organic Matter Content of the Soil

Effect of rates of potassium. Table 9 shows the initial and final organic matter contents of the soil. The organic matter content of the soil after harvest was influenced by rates of potassium application. Soils applied with 80 kg/ha K_2O has the highest organic matter content of 2.66% but did not differ from those applied with 90 and 100 kg/ha K_2O with means of 2.58% and 2.65% respectively. It could be noted that application of potassium increased the organic matter content from 2.01% (initial) to a range of 2.58 to 2.66 %.

Effects of kinds of organic fertilizer. Application of different kind of organic fertilizers increased the organic matter contents of the soil as shown in Table 9. Application of 20 tons/ha vermicompost had the highest mean of 2.85%. It was noted that soils applied with different organic fertilizers increased the organic matter contents over the initial value (2.01%). This conforms with the study of Lacay (2008) and Lagman (2003) which state that vermicompost has high organic matter content. Also with the earlier findings of Lingaling (2006), Olangey (2000), Sheller (2000) and Tomilas (1996) on the effects of different organic materials added on the final organic matter content of the soil.

Interaction effect. Application of different rates of potassium and kinds of organic fertilizer in combination did not influence the organic matter content of the soil. However, soils applied with 80 kg K_2O / ha in combination with 20 tons/ha vermicompost registered the highest organic matter content of the soil after harvest with a mean of 2.93%.

Nitrogen Content of the Soil

Effect of rates of potassium. The nitrogen content of the soil after harvest was affected by rates of potassium application as shown in Table 10. Soils applied with 80 kg K_2O / ha had the highest nitrogen content of 0.135% which does not differ from 100 kg K_2O/ha with a mean of 0.133% but differ from the 90 kg K_2O / ha and the control with means of 0.128% and 0.117%, respectively.

Table 9. Organic matter content of the soil as affected by different rates of potassium and organic fertilizers

TREATMENT		MEAN (%)
Rates of Potassium (K_2O)		
K_1	No Potassium Fertilizer (Control)	2.34[b]
K_2	80 kg K_2O / ha	2.66[a]
K_3	90 kg K_2O / ha	2.58[ab]
K_4	100 kg K_2O / ha	2.65[a]
Kinds of Organic Fertilizer		
O_1	No Organic Fertilizer (Control)	2.06[c]
O_2	20 tons / ha Vermicompost	2.85[a]
O_3	20 tons / ha Wild Sunflower	2.66[ab]
O_4	5 tons / ha Chicken Dung	2.55[b]
O_5	10 tons / ha Hog Manure	2.68[ab]
INITIAL VALUE		2.01

Means with the same letter are not significantly different at 5% level DMRT.

Effect of kinds of organic fertilizer. Application of different kinds of organic fertilizers affected the nitrogen content of the soil after harvest. Application of organic fertilizer increased the nitrogen content of the soil over the initial value of 0.101% as shown in Table 10. Soils applied with 20 tons/ha vermicompost had the highest nitrogen content of 0.143%. This result implies that as the organic matter content of the soil increased the nitrogen also increased.

Interaction effect. There were no interaction effects of different rates of potassium and kinds of organic fertilizer on the nitrogen content of the soil. However, soils applied with 80 kg K_2O /ha and 20 tons/ha vermicompost had the highest nitrogen content of the soil after harvest with a mean of 0.150%.

Table 10. Nitrogen content of the soil as affected by different rates of potassium and organic fertilizers

TREATMENT		MEAN (%)
Rates of Potassium (K_2O)		
K_1	No Potassium Fertilizer (Control)	0.117^{b}
K_2	80 kg K_2O / ha	0.135^{a}
K_3	90 kg K_2O / ha	0.128^{ab}
K_4	100 kg K_2O / ha	0.133^{a}
Kinds of Organic Fertilizer		
O_1	No Organic Fertilizer (Control)	0.103^{c}
O_2	20 tons / ha Vermicompost	0.143^{a}
O_3	20 tons / ha Wild Sunflower	0.134^{ab}
O_4	5 tons / ha Chicken Dung	0.128^{b}
O_5	10 tons / ha Hog Manure	0.133^{ab}
INITIAL VALUE		0.101

Means with the same letter are not significantly different at 5% level DMRT.

Phosphorus Content of the Soil

Effect of rates of potassium. The phosphorus content of the soil after harvest was affected by rates of potassium fertilizer application (Table 11). Differences among the treatments were noted. There were varying percentage increases of 105.18, 122.78 and 130.25% on the phosphorus contents of the soil in plots applied with 80 to 100 kg/ha K_2O over the control. It was observed that plots applied with 100 kg K_2O per hectare had the highest phosphorus content of the soil with a mean of 396.3 ppm.

Effect of kinds of organic fertilizer. Phosphorus content of the soil was affected by different kinds of organic fertilizer applied (Table 11). Increased of phosphorus was obtained from plots applied with 10 tons/ha hog manure and 5 tons/ha chicken manure. The increase may be attributed to the effects of P-contents of the different organic fertilizer and to the initial P in the soil. This result also conforms to the study of Lingaling (2006) that animal manure such as hog manure and chicken manure increased the phosphorus content of the soil. While decreased phosphorus content of the soil was observed from the plots applied with 20 tons/ha vermicompost, 20 tons/ha wild sunflower and the control over the initial value (338.6 ppm). These results may be attributed to the plant uptake.

Interaction effect. Application of different rates of potassium and kinds of organic fertilizer affected the phosphorus contents of the soil at harvest. Application of 80 kg K_2O / ha in combination with 10 tons/ha hog manure had higher P-content with a mean of 787.58 ppm. The result implies that application of 80 kg K_2O per hectare in combination with 10 tons per hectare hog manure increase the phosphorus content of the soil from the initial (338.60ppm).

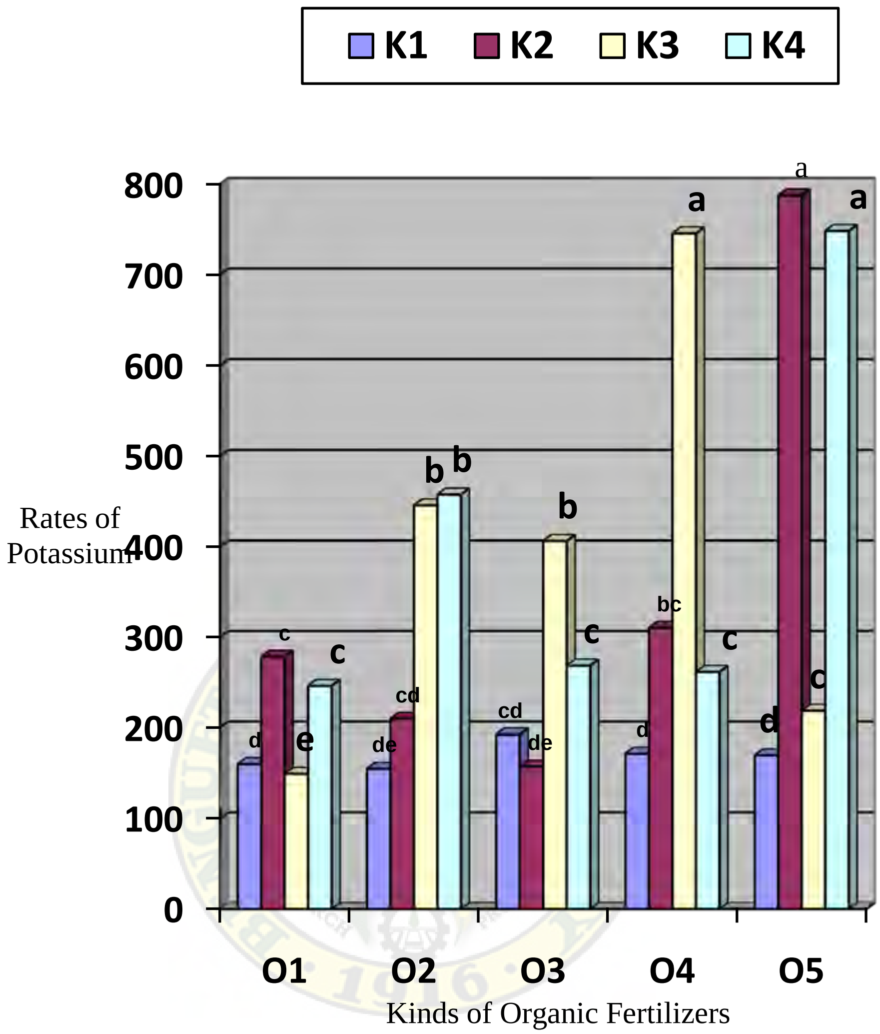

Figure 1. Available phosphorus content of the soil (ppm)

Table 11. Phosphorus content of then soil as affected by different rates of potassium and organic fertilizers

TREATMENT		MEAN (ppm)
Rates of Potassium (K_2O)		
K_1	No Potassium Fertilizer (Control)	169.9[c]
K_2	80 kg K_2O / ha	348.6[b]
K_3	90 kg K_2O / ha	378.5[ab]
K_4	100 kg K_2O / ha	396.3[a]
Kinds of Organic Fertilizer		
O_1	No Organic Fertilizer (Control)	208.5[c]
O_2	20 tons / ha Vermicompost	317.0[c]
O_3	20 tons / ha Wild Sunflower	256.1[d]
O_4	5 tons / ha Chicken Dung	372.3[b]
O_5	10 tons / ha Hog Manure	462.8[a]
INITIAL VALUE		338.60

Means with the same letter are not significantly different at 5% level DMRT.

Potassium Content of the Soil

Rates of potassium. The potassium contents of the soil after harvest were affected by application of different rates of potassium (Table 12). Soil applied with different rates of potassium from 80 to 100 kg/ha K_2O increased the potassium contents of 26.02, 29.47 and 39.94%, respectively over the control. The increases could be attributed to the potassium applied at different rates in the form of 0-0-60 (KCl) where the fertilizer reacts with soil.

Effect of kinds of organic fertilizer. Application of organic fertilizer did not affect the potassium contents of the soil. Nevertheless, soil applied with 5 tons/ha chicken dung had the highest potassium content of the soil. Decreased potassium contents of the soil was noted in some of the treatments over the initial value of 374.50 ppm. These result maybe attributed to the absorption of potassium by the plants for starch formation and translocation of sugars used in the development of storage root.

Interaction effect. There were no interaction effect of different rates of potassium and kinds organic fertilizer on the potassium contents of the soil. However, soils applied with 90 kg K_2O/ha in combination with 5 tons/ha chicken dung had the highest potassium content with a mean of 544.25 ppm.

Table 12. Potassium content of the soil as affected by different rates of potassium and organic fertilizers

TREATMENT		MEAN (ppm)
Rates of Potassium (K_2O)		
K_1	No Potassium Fertilizer (Control)	295.2[b]
K_2	80 kg / ha K2O	372.0[a]
K_3	90 kg / ha K2O	382.2[a]
K_4	100 kg / ha K2O	395.4[a]
Kinds of Organic Fertilizer		
O_1	No Organic Fertilizer (Control)	345.9[a]
O_2	20 tons / ha Vermicompost	357.8[a]
O_3	20 tons / ha Wild Sunflower	368.0[a]
O_4	5 tons / ha Chicken Dung	381.7[a]
O_5	10 tons / ha Hog Manure	352.5[a]
INITIAL VALUE		373.5

Means with the same letter are not significantly different at 5% level DMRT.

Return on Investment

The rates of potassium and organic fertilization on the ROI of carrots are presented in Table 13. Application of 90 kg K2O /ha in combination with 5 tons/ha chicken dung had the highest ROI of 87.69 %. While the lowest ROI was obtained from the unfertilized soil. This results means that for every peso investment there is 87.69 centavo return. This result implies that application of 90 kg K2O per hectare in combination with 5 tons per hectare chicken dung shown the best rates of potassium and organic fertilizer to use in the growing of carrot it has more return of investment. This high ROI is attributed to high yield of individual plots during the conduct of the study.

Table 13. Return of investment (ROI) as affected by rates of potassium and organic fertilizer application

TREATMENT	ROI (%)
K_1O_1	-26.58
K_1O_2	-16.36
K_1O_3	34.69
K_1O_4	53.30
K_1O_5	29.07
K_2O_1	6.51
K_2O_2	12.30
K_2O_3	43.25
K_2O_4	84.27
K_2O_5	45.95
K_3O_1	11.08
K_3O_2	23.77
K_3O_3	79.82
K_3O_4	87.69
K_3O_5	67.57
K_4O_1	3.02
K_4O_2	7.13
K_4O_3	20.80
K_4O_4	37.40
K_4O_5	57.57

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted to determine the effect of different rates of potassium and kinds of organic fertilizer on the yield and quality of carrots (*Daucus carota*) cv. New Kuroda. Specifically, to determine: (1) the effect of different rates of potassium and organic fertilizer on the yield and quality of carrots, (2) the postharvest quality of carrots fertilized with potassium and organic fertilizer, and (3) the effect of potassium and organic fertilizer on some chemical properties of the soil.

The study was conducted at the experimental area of Department of Soil Science, College of Agriculture, Benguet State University, La Trinidad Benguet from November 2008 to April 2009.

Effect of potassium. Application of different rates of potassium significantly affected the marketable yield and total yield of carrots, weights of big and medium carrots. In terms of postharvest quality of carrots it also significantly affected the sugar content only. It also significantly affected the organic matter, nitrogen, phosphorus and potassium content of the soil except soil pH.

Effect of organic fertilizer. Application of organic fertilizer also significantly affected the marketable and total yield of carrots except dry matter yield, weights of big, medium carrots. Postharvest quality in terms of percent weight loss and shelf-life of carrots was significantly affected. Organic matter, nitrogen and phosphorus content of the soil were also increased except potassium content and soil pH.

Interaction effect. Different rates of potassium and kinds of organic fertilizer significantly affected the phosphorus content of the soil but not on yield and quality of carrots

Conclusion

Based on the results, application of 90 kg K_2O and 5 tons/ha chicken dung produced high yield of carrots.

Recommendation

From the results, application of 90 kg K_2O/ha and 5 tons/ha chicken dung can be practiced to gain higher yield of carrots. A follow-up study should be done also to further investigate and verify the effect of potassium and organic fertilizer on carrots.

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APPENDICES

APPENDIX TABLE 1. Marketable yield ($kg/5m^2$)

TREATMENTS	BLOCK I	BLOCK II	BLOCK III	TOTAL	MEAN
K_1O_1	6.6	7.0	8.3	21.9	7.30
K_1O_2	13.9	10.5	10.2	34.6	11.53
K_1O_3	12.0	14.6	14.2	40.8	13.60
K_1O_4	18.0	13.9	15.6	47.5	15.83
K_1O_5	13.4	14.7	10.8	38.9	12.97
Subtotal	63.9	60.7	59.1	183.7	61.23
K_2O_1	10.7	11.5	9.8	32.0	10.67
K_2O_2	16.2	16.0	14.5	46.7	15.57
K_2O_3	16.5	14.0	13.2	43.7	14.57
K_2O_4	21.0	19.5	17.0	57.5	19.17
K_2O_5	14.4	15.6	14.3	44.3	14.77
Subtotal	79.8	77.6	69.1	224.2	74.74
K_3O_1	11.3	11.6	10.5	33.4	11.13
K_3O_2	19.9	14.9	16.7	51.5	17.17
K_3O_3	18.6	18.5	17.8	54.9	18.30
K_3O_4	19.9	18.6	20.1	58.6	19.53
K_3O_5	15.6	17.9	17.4	50.9	16.97
Subtotal	85.3	81.5	82.5	249.3	83.1
K_4O_1	7.8	12.2	11.0	31.0	10.33
K_4O_2	15.7	14.7	14.2	44.6	14.87
K_4O_3	16.6	17.8	11.8	46.2	15.40
K_4O_4	17.7	18.8	17.0	53.5	17.83
K_4O_5	17.7	16.3	13.9	47.9	15.97
Subtotal	75.5	79.8	67.9	223.2	74.40
BLOCK TOTAL	304.5	299.6	278.6		
GRAND TOTAL				880.4	
GRAND MEAN					14.7

K X O TWO WAY TABLE

TREATMENT	K_1	K_2	K_3	K_4	TOTAL	MEAN
O_1	21.9	32.0	33.4	31.0	118.3	9.9
O_2	34.6	46.7	51.5	44.6	177.4	14.8
O_3	40.8	43.7	59.8	46.2	185.6	15.5
O_4	47.5	57.5	58.6	53.5	217.1	18.1
O_5	38.9	44.3	50.9	47.9	182.0	15.2
TOTAL	183.7	224.2	249.3	223.2		
MEAN	12.2	14.9	16.6	14.9		14.7

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DF	SS	MS	F VALUE	Pr > F
BLOCK	2	18.930	9.465		
K	3	148.457	49.486	20.4672**	0.0000
O	4	445.126	111.281	46.0260**	0.0000
K X O	12	24.373	2.031	0.8400ns	
ERROR	38	91.876	2.418		
TOTAL	59	728.762			

** - highly significant

ns – not significant

CV = 10.57 %

APPENDIX TABLE 2. Total yield (kg/5m^2)

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
K_1O_1	6.9	7.6	8.6	23.1	7.70
K_1O_2	14.5	11.1	11.1	36.7	12.23
K_1O_3	12.3	15.5	15.4	43.2	14.40
K_1O_4	18.6	14.5	16.5	49.6	16.53
K_1O_5	14.3	15.6	11.4	41.3	13.77
Subtotal	66.6	64.3	63.0	193.9	64.63
K_2O_1	11.3	12.1	10.1	33.5	11.17
K_2O_2	16.5	16.3	15.1	47.9	15.97
K_2O_3	17.1	14.9	14.4	46.4	15.47
K_2O_4	22.3	21.1	19.6	63.0	21.00
K_2O_5	14.7	16.5	14.6	45.8	15.27
Subtotal	81.9	80.9	73.8	236.6	78.87
K_3O_1	11.9	12.2	11.1	35.2	11.73
K_3O_2	20.5	15.6	17.3	53.4	17.80
K_3O_3	19.2	18.8	18.4	56.4	18.80
K_3O_4	21.1	19.2	21.0	61.3	20.43
K_3O_5	15.9	18.5	18.0	52.4	17.47
Subtotal	88.6	84.3	85.8	258.7	86.23
K_4O_1	8.7	13.8	11.9	34.4	11.47
K_4O_2	16.9	15.3	15.1	47.3	15.77
K_4O_3	17.5	18.1	12.1	47.7	15.90
K_4O_4	18.9	19.2	17.9	56.0	18.67
K_4O_5	18.0	16.9	14.5	49.4	16.47
Subtotal	80.0	83.3	71.5	234.8	78.27
BLOCK TOTAL	317.1	312.8	294.1		
GRAND TOTAL				924	
GRAND MEAN					15.4

K X O TWO WAY TABLE

TREATMENTS	K_1	K_2	K_3	K_4	TOTAL	MEAN
O_1	23.1	33.5	35.2	34.4	126.2	10.5
O_2	36.7	47.9	53.4	47.3	185.3	15.4
O_3	43.2	46.4	56.4	47.7	193.7	16.1
O_4	49.6	63.0	61.3	56.0	229.9	19.2
O_5	41.3	45.8	52.4	49.4	188.9	15.7
TOTAL	193.9	236.6	258.7	234.8		
MEAN	12.9	15.8	17.3	15.7		15.4

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DF	SS	MS	F VALUE	Pr > F
BLOCK	2	14.953	7.477		
K	3	145.967	48.656	19.3441**	0.0000
O	4	463.687	115.922	46.0871**	0.0000
K X O	12	26.133	2.178	0.8658ns	
ERROR	38	95.580	2.515		
TOTAL	59	746.320			

** - highly significant
ns – not significant

CV = 10.30 %

APPENDIX TABLE 4. Dry matter content (%)

TREATMENTS	BLOCK			TOTAL	MEAN
	I	II	III		
K_1O_1	12.30	11.67	9.00	32.97	10.99
K_1O_2	11.03	11.48	12.27	34.78	11.59
K_1O_3	10.66	11.88	9.78	32.32	10.77
K_1O_4	12.62	11.81	10.09	34.52	11.51
K_1O_5	13.42	11.33	10.62	35.37	11.79
Subtotal	60.03	58.17	51.76	169.96	56.65
K_2O_1	10.09	11.89	10.28	32.26	10.75
K_2O_2	10.22	10.41	8.74	29.37	9.79
K_2O_3	12.77	11.45	10.25	34.47	11.49
K_2O_4	10.63	12.31	11.28	34.22	11.41
K_2O_5	12.93	11.85	9.71	34.49	11.50
Subtotal	56.64	57.91	50.26	164.81	54.94
K_3O_1	10.95	10.57	9.18	30.70	10.23
K_3O_2	11.63	11.62	8.92	32.17	10.72
K_3O_3	11.82	11.61	11.42	34.85	10.62
K_3O_4	11.22	10.40	11.18	32.80	10.93
K_3O_5	8.60	5.82	11.91	26.33	8.78
Subtotal	54.22	50.02	52.61	156.85	52.28
K_4O_1	14.06	9.79	8.19	32.04	10.68
K_4O_2	12.09	9.92	9.00	31.01	10.34
K_4O_3	8.64	10.98	8.45	28.07	9.37
K_4O_4	13.35	10.83	10.76	34.94	11.65
K_4O_5	11.54	8.71	8.23	28.48	9.49
Subtotal	59.68	50.23	44.63	154.54	51.51
BLOCK TOTAL	230.57	216.33	199.26		
GRAND MEAN				646.16	
GAND TOTAL					10.77

K X O TWO WAY TABLE

TREATMENT	K_1	K_2	K_3	K_4	TOTAL	MEAN
O_1	32.97	32.26	30.70	32.04	127.97	10.7
O_2	34.78	29.37	32.17	31.01	127.33	10.6
O_3	32.32	34.47	34.85	28.07	129.71	10.8
O_4	34.52	34.22	32.80	34.94	136.48	11.4
O_5	35.37	34.49	26.33	28.48	124.67	10.4
TOTAL	169.96	164.81	156.85	15.54		
MEAN	11.3	10.9	10.5	10.3		10.77

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DF	SS	MS	F VALUE	Pr > F
BLOCK	2	24.575	12.287		
K	3	10.172	3.391	1.85^{ns}	0.1546
O	4	6.565	1.641	0.90^{ns}	0.4762
K X O	12	26.224	2.185	1.19^{ns}	0.3233
ERROR	38	69.652	1.833		
TOTAL	59	137.189			

ns- not significant CV = 12.57 %

APPENDIX TABLE 5. Weight of big carrot (kg/5m^2)

TREATMENTS	BLOCK I	BLOCK II	BLOCK III	TOTAL	MEAN
K_1O_1	4.0	5.1	5.2	14.3	4.8
K_1O_2	9.9	6.0	6.0	21.9	7.3
K_1O_3	8.2	9.6	9.9	27.7	9.2
K_1O_4	11.7	8.4	10.5	30.6	10.2
K_1O_5	9.0	9.6	6.0	24.6	8.2
Subtotal	42.8	38.7	37.6	119.1	39.7
K_2O_1	7.7	7.5	7.0	22.2	7.4
K_2O_2	10.2	9.8	8.5	28.5	9.5
K_2O_3	8.4	8.0	8.7	25.1	8.4
K_2O_4	12.9	14.4	11.4	38.7	12.9
K_2O_5	9.3	9.6	9.5	28.4	9.5
Subtotal	48.5	49.3	45.1	142.9	47.6
K_3O_1	7.5	7.5	7.4	22.4	7.5
K_3O_2	12.3	10.2	11.3	38.8	11.3
K_3O_3	12.8	12.3	12.1	37.2	12.4
K_3O_4	13.0	12.9	13.3	39.2	13.1
K_3O_5	11.1	10.7	11.7	33.5	11.2
Subtotal	57.7	53.6	55.8	167.1	55.7
K_4O_1	5.4	7.5	7.2	20.1	6.7
K_4O_2	9.1	9.6	9.0	27.7	9.2
K_4O_3	12.6	12.3	6.6	31.5	10.5
K_4O_4	12.0	12.5	12.0	36.5	12.2
K_4O_5	10.8	11.4	8.7	30.9	10.3
Subtotal	49.9	53.3	43.5	146.7	48.9
BLOCK TOTAL	198.9	194.9	182.0		
GRAND TOTAL				575.8	
GRAND MEAN					48.9

K X O TWO WAY TABLE

TREATMENTS	K_1	K_2	K_3	K_4	TOTAL	MEAN
O_1	14.3	22.2	22.4	20.1	79.0	6.6
O_2	21.9	28.5	33.8	27.7	90.0	9.3
O_3	27.7	25.1	37.2	31.5	121.5	10.2
O_4	30.6	38.7	39.2	36.5	145.0	12.1
O_5	24.6	28.4	33.5	30.9	117.4	9.8
TOTAL	119.1	142.9	166.1	146.7		
MEAN	7.9	9.5	11.1	9.8		7.5

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DF	SS	MS	F VALUE	Pr > F
BLOCK	2	7.137	3.569		
K	3	74.437	24.812	16.2313**	0.0000
O	4	187.801	46.950	30.7130 **	0.0000
K X O	12	21.111	1.759	1.1508ns	0.3513
ERROR	38	58.090	1.529		
TOTAL	59	348.576			

** - highly significant CV= 12.91%
ns - not significant

APPENDIX TABLE 6. Weight of medium carrot (kg/5m^2)

TREATMENTS	BLOCK			TOTAL	MEAN
	I	II	III		
K_1O_1	1.4	1.0	1.9	4.3	1.43
K_1O_2	3.1	3.0	3.3	9.4	3.13
K_1O_3	3.2	3.2	3.1	9.5	3.13
K_1O_4	3.9	3.4	3.9	11.2	3.73
K_1O_5	3.2	2.7	3.6	9.5	3.17
Subtotal	14.8	13.3	15.8	43.9	14.59
K_2O_1	1.2	2.2	2.2	5.6	1.90
K_2O_2	4.1	4.4	4.8	13.3	4.43
K_2O_3	4.2	3.6	3.9	11.7	3.90
K_2O_4	4.9	4.6	4.7	14.2	4.73
K_2O_5	2.7	3.9	3.0	9.6	3.20
Subtotal	17.1	18.7	18.6	54.4	18.16
K_3O_1	2.3	2.6	2.5	7.4	2.47
K_3O_2	4.0	3.8	4.5	12.3	4.10
K_3O_3	4.9	3.5	3.9	12.3	4.10
K_3O_4	5.7	4.2	5.0	14.9	4.97
K_3O_5	3.6	4.2	5.1	12.9	4.30
Subtotal	20.5	18.3	21.0	59.8	19.93
K_4O_1	2.1	2.3	2.4	6.8	2.27
K_4O_2	3.9	3.0	3.4	10.3	3.10
K_4O_3	3.7	3.4	3.4	10.5	2.50
K_4O_4	3.6	4.8	4.4	12.8	3.60
K_4O_5	4.8	3.7	3.4	11.9	3.50
Subtotal	18.1	17.2	17.0	52.3	17.43
BLOCK TOTAL	70.5	67.5	72.4		
GRAND TOTAL				210.4	
BLOCK TOTAL					3.51

K X O TWO WAY TABLE

TREATMENTS	K1	K2	K3	K4	TOTAL	MEAN
O_1	4.3	5.6	7.4	6.8	24.1	2.0
O_2	9.4	13.3	12.3	10.3	45.5	3.8
O_3	9.5	11.7	12.3	10.5	44.0	3.7
O_4	11.2	14.2	14.9	12.8	53.1	4.4
O_5	9.5	9.6	12.9	11.9	43.9	3.7
TOTAL	43.9	54.4	59.8	52.3		
MEAN	2.9	3.6	4.0	3.5		3.50

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DF	SS	MS	F VALUE	Pr > F
BLOCK	2	0.610	0.305		
K	3	8.724	2.908	13.3089^{**}	0.0000
O	4	38.507	9.627	44.0587^{**}	0.0000
K X O	12	3.473	0.289	1.3244^{ns}	0.2455
ERROR	38	8.303	0.219		
TOTAL	59	59.617			

** - highly significant
ns- not significant

CV = 13.33 %

APPENDIX TABLE 7. Weight of small carrot (kg/5m^2)

TREATMENTS	BLOCK I	BLOCK II	BLOCK III	TOTAL	MEAN
K_1O_1	1.2	0.9	1.2	3.3	1.1
K_1O_2	0.9	1.5	0.9	3.3	1.1
K_1O_3	0.6	1.8	1.2	3.6	1.2
K_1O_4	2.4	2.1	1.2	5.7	1.9
K_1O_5	1.2	2.4	1.2	4.8	1.6
Subtotal	6.3	8.7	5.7	20.7	6.9
K_2O_1	1.8	1.8	0.6	4.2	1.4
K_2O_2	1.9	1.8	1.2	4.9	1.6
K_2O_3	3.3	2.4	0.6	6.3	2.1
K_2O_4	4.2	1.5	1.2	6.9	2.3
K_2O_5	2.4	2.1	1.8	6.3	2.1
Subtotal	13.6	9.6	5.4	28.6	9.5
K_3O_1	1.5	1.5	0.6	3.6	1.2
K_3O_2	3.6	0.9	0.9	5.4	1.8
K_3O_3	0.9	2.7	1.8	5.4	1.8
K_3O_4	1.2	1.5	1.8	4.5	1.5
K_3O_5	0.9	3.0	0.6	4.5	1.5
Subtotal	8.1	9.6	5.7	23.4	7.8
K_4O_1	0.3	2.4	1.4	4.1	1.4
K_4O_2	2.7	2.1	1.8	6.6	2.2
K_4O_3	0.3	2.1	1.8	4.2	1.4
K_4O_4	2.1	1.5	0.6	4.2	1.4
K_4O_5	2.1	1.2	1.8	5.1	1.7
Subtotal	7.5	9.3	7.4	24.2	8.1
BLOCK TOTAL	35.5	37.2	24.2		
GRAND TOTAL				96.9	
GRAND MEAN					1.6

K X O TWO WAY TABLE

TREATMENTS	K_1	K_2	K_3	K_4	TOTAL	MEAN
O_1	3.3	4.2	3.6	4.1	15.2	1.27
O_2	3.3	4.9	5.4	6.6	20.2	1.68
O_3	3.6	6.3	5.4	4.2	19.5	1.60
O_4	5.7	6.9	4.5	4.2	21.3	1.78
O_5	4.8	6.3	4.5	5.1	20.7	1.73
TOTAL	20.7	28.6	23.4	24.2	96.9	
MEAN	1.38	1.91	1.54	1.61		1.60

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DF	SS	MS	F VALUE	Pr > F
BLOCK	2	4.849	2.425		
K	3	2.187	0.729	1.12^{ns}	0.3535
O	4	1.966	0.491	0.75^{ns}	0.5616
K X O	12	3.388	0.282	0.43^{ns}	0.9396
ERROR	38	24.764	0.652		
TOTAL	59	37.154			

ns – not significant CV = 50.14 %

APPENDIX TABLE 8. Shelf-life (days)

TREATMENTS	BLOCK			TOTAL	MEAN
	I	II	III		
K_1O_1	13	13	13	39	13.00
K_1O_2	14	15	15	44	14.67
K_1O_3	15	14	13	42	14.00
K_1O_4	15	13	18	46	15.33
K_1O_5	14	14	16	44	14.67
Subtotal	71	69	75	215	71.67
K_2O_1	13	13	14	40	13.33
K_2O_2	15	13	18	46	15.33
K_2O_3	15	14	14	43	14.33
K_2O_4	14	15	14	43	14.33
K_2O_5	16	13	14	43	14.33
Subtotal	73	68	74	215	71.67
K_3O_1	13	13	14	40	13.33
K_3O_2	16	14	14	44	14.67
K_3O_3	15	16	18	49	16.33
K_3O_4	15	14	15	44	14.67
K_3O_5	13	14	14	41	13.67
Subtotal	72	71	75	218	72.67
K_4O_1	14	13	13	40	13.33
K_4O_2	14	14	17	45	15.00
K_4O_3	14	14	17	45	15.00
K_4O_4	16	14	17	47	15.67
K_4O_5	15	15	14	44	14.67
Subtotal	73	70	78	221	73.67
BLOCK TOTAL	289	278	302		
GRAND TOTAL				869	
GRAND MEAN					14.48

K X O TWO WAY TABLE

TREATMENTS	K_1	K_2	K_3	K_4	TOTAL	MEAN
O_1	39	40	40	40	159	13.25
O_2	44	46	44	45	179	14.92
O_3	42	43	49	45	179	14.92
O_4	46	43	44	47	180	15.00
O_5	44	43	41	44	172	14.33
TOTAL	215	215	218	221	869	
MEAN	14.33	14.33	14.53	14.73		14.48

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DF	SS	MS	F VALUE	Pr > F
BLOCK	2	14.433	7.217		
K	3	1.650	0.550	0.42^{ns}	0.7425
O	4	26.233	6.558	4.96^{**}	0.0026
K X O	12	14.433	1.213	0.91^{ns}	0.5462
ERROR	38	50.233	1.322		
TOTAL	59	106.983			

** - highly significant
ns – not significant

CV = 7.94 %

APPENDIX TABLE 9. Percent weight loss

TREATMENTS	BLOCK			TOTAL	MEAN
	I	II	III		
K_1O_1	57.75	59.90	50.40	168.05	56.02
K_1O_2	47.10	49.01	41.83	137.94	45.98
K_1O_3	46.03	45.81	39.73	131.57	43.86
K_1O_4	48.84	50.18	36.75	135.77	45.26
K_1O_5	44.22	57.99	43.33	145.54	48.51
Subtotal					
K_2O_1	55.95	55.74	50.51	162.2	54.07
K_2O_2	43.80	49.91	35.03	128.74	42.91
K_2O_3	49.87	52.90	44.79	147.56	49.19
K_2O_4	49.68	46.78	42.61	139.07	46.36
K_2O_5	45.64	49.81	48.23	143.68	47.89
Subtotal	244.94	255.14	221.17	721.25	240.42
K_3O_1	56.90	53.80	52.83	163.53	54.51
K_3O_2	46.43	54.08	38.31	138.82	46.27
K_3O_3	42.67	50.09	40.82	133.58	44.53
K_3O_4	42.52	47.23	41.75	131.50	43.83
K_3O_5	48.42	49.57	43.02	141.01	47.00
Subtotal	236.94	254.77	216.73	708.44	236.14
K_4O_1	58.10	57.93	45.13	161.16	53.72
K_4O_2	42.46	51.93	38.38	132.77	44.26
K_4O_3	43.82	47.98	41.48	133.28	44.43
K_4O_4	44.44	46.07	43.51	134.02	44.67
K_4O_5	46.05	53.97	44.79	144.81	48.27
Subtotal	234.87	257.88	213.29	706.04	235.35
BLOCK TOTAL	960.69	1030.68	863.23		
GRAND TOTAL				2854.6	
GRAND MEAN					47.58

K X O TWO WAY TABLE

TREATMENTS	K_1	K_2	K_3	K_4	TOTAL	MEAN
O_1	168.05	162.20	163.53	161.16	654.94	54.58
O_2	137.94	128.74	138.82	132.77	538.27	44.86
O_3	131.57	147.56	133.58	133.28	545.99	45.50
O_4	135.77	139.07	131.50	134.02	540.36	45.03
O_5	145.54	143.68	141.01	144.81	575.04	45.42
TOTAL	718.87	721.25	708.44	706.04	2854.60	
MEAN	47.93	48.08	47.23	45.07		47.57

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DF	SS	MS	F VALUE	Pr > F
BLOCK	2	709.806	354.903		
K	3	86.778	28.926	1.02^{ns}	0.3934
O	4	847.548	211.887	7.49^{**}	0.0001
K X O	12	217.887	18.157	0.64^{ns}	0.7931
ERROR	38	1074.925	28.287		
TOTAL	59	2936.944			

** - highly significant
ns – not significant

CV = 11.30 %

APPENDIX TABLE 10. Sugar content (^oBrix)

TREATMENTS	BLOCK I	BLOCK II	BLOCK III	TOTAL	MEAN
K_1O_1	5.10	5.22	5.10	15.42	5.14
K_1O_2	5.18	5.17	5.23	15.58	5.19
K_1O_3	5.21	5.20	5.22	15.63	5.21
K_1O_4	5.18	5.20	5.24	15.62	5.21
K_1O_5	5.20	5.20	5.20	15.60	5.20
Subtotal	25.87	25.99	25.99	77.85	25.95
K_2O_1	5.22	10.20	5.20	20.62	6.87
K_2O_2	5.21	10.30	5.21	20.72	6.91
K_2O_3	5.22	5.17	5.20	15.59	5.20
K_2O_4	10.00	5.20	5.50	20.70	6.90
K_2O_5	5.22	5.20	5.18	15.67	5.20
Subtotal	30.87	36.07	26.29	93.23	31.08
K_3O_1	5.20	5.10	10.20	20.50	6.83
K_3O_2	5.10	5.20	10.00	20.30	6.77
K_3O_3	5.20	10.00	10.00	25.20	8.40
K_3O_4	5.22	5.15	5.22	15.59	5.20
K_3O_5	5.22	5.20	10.00	20.42	6.81
Subtotal	25.94	30.65	45.42	102.02	34.01
K_4O_1	10.00	5.16	5.20	20.36	6.79
K_4O_2	5.23	10.30	10.10	25.63	8.54
K_4O_3	10.00	5.17	10.10	25.27	8.42
K_4O_4	5.20	10.40	10.00	25.55	8.52
K_4O_5	10.00	5.15	10.40	25.55	8.52
Subtotal	40.43	36.18	45.80	122.41	40.80
BLOCK TOTAL	123.11	128.89	143.50		
GRAND TOTAL				395.5	
GRAND MEAN					6.59

K X O TWO WAY TABLE

TREATMENTS	K_1	K_2	K_3	K_4	TOTAL	MEAN
O_1	15.42	20.62	20.50	20.36	76.90	6.41
O_2	15.58	20.72	20.30	25.63	82.23	6.85
O_3	15.63	15.59	25.20	25.27	81.69	6.81
O_4	15.62	20.70	15.59	25.55	77.46	6.46
O_5	15.60	15.67	20.42	25.55	77.24	6.43
TOTAL	77.85	93.30	102.01	122.36	395.52	
MEAN	5.19	6.22	6.80	8.16		6.59

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DF	SS	MS	F VALUE	Pr > F
BLOCK	2	11.044	5.522		
K	3	69.176	23.059	4.81^{**}	0.0062
O	4	2.300	0.575	0.12^{ns}	0.9746
K X O	12	30.560	2.547	0.53^{ns}	0.8810
ERROR	38	182.343	4.799		
TOTAL	59	295.423			

** - highly significant
ns – not significant

CV = 33.23 %

APPENDIX TABLE 11. Soil pH

TREATMENTS	BLOCK I	BLOCK II	BLOCK III	TOTAL	MEAN
K_1O_1	5.4	4.8	4.1	14.3	4.8
K_1O_2	5.1	4.7	4.7	14.5	4.8
K_1O_3	5.1	5.2	4.7	15.0	5.0
K_1O_4	4.9	5.2	4.6	14.7	4.9
K_1O_5	6.0	6.2	4.8	17.0	5.7
Subtotal	26.5	26.1	22.9	75.5	25.2
K_2O_1	6.5	4.4	4.8	15.7	5.2
K_2O_2	5.0	5.1	5.1	15.2	5.1
K_2O_3	5.9	4.9	4.5	15.3	5.1
K_2O_4	6.0	4.9	4.3	15.2	5.1
K_2O_5	5.3	5.3	4.5	15.1	5.0
Subtotal	28.7	24.6	23.2	76.5	25.5
K_3O_1	5.4	4.6	4.1	14.1	4.7
K_3O_2	5.1	5.0	4.4	14.5	4.8
K_3O_3	5.9	4.8	4.7	15.4	5.1
K_3O_4	5.8	5.2	5.1	16.1	5.4
K_3O_5	4.9	5.7	5.2	15.8	5.3
Subtotal	27.1	25.3	23.5	75.9	25.3
K_4O_1	5.2	4.7	4.4	14.3	4.8
K_4O_2	5.3	4.2	4.2	13.7	4.6
K_4O_3	6.0	5.0	4.3	15.3	5.1
K_4O_4	5.9	5.5	4.8	16.2	5.4
K_4O_5	4.9	5.3	4.8	15	5.0
Subtotal	27.3	24.7	22.5	74.5	24.8
BLOCK TOTAL	109.6	100.7	92.7		
GRAND TOTAL				302.4	
GRAND MEAN					5.1

K X O TWO WAY TABLE

TREATMENTS	K_1	K_2	K_3	K_4	TOTAL	MEAN
O_1	14.3	15.7	14.1	14.3	58.4	4.87
O_2	14.5	15.2	14.5	13.7	57.9	4.83
O_3	15.0	15.3	15.4	15.3	61.0	5.08
O_4	14.7	15.2	16.1	16.2	62.2	5.18
O_5	17.0	15.1	15.8	15.0	62.9	5.24
TOTAL	75.5	76.5	75.9	74.5	302.4	
MEAN	5.03	5.10	5.06	4.97		5.1

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DF	SS	MS	F VALUE	Pr > F
BLOCK	2	7.657	3.829		
K	3	0.141	0.047	0.29^{ns}	0.8336
O	4	1.672	0.418	2.56^{ns}	0.0542
K X O	12	2.184	0.182	1.11^{ns}	0.3779
ERROR	38	6210	0.163		
TOTAL	59	17.864			

ns – not significant CV = 8.02 %

APPENDIX TABLE 12. Organic matter content of the soil (%)

TREATMENTS	BLOCK I	BLOCK II	BLOCK III	TOTAL	MEAN
K_1O_1	1.13	2.08	2.17	5.38	1.79
K_1O_2	2.46	3.22	2.33	8.01	2.67
K_1O_3	2.50	2.43	2.35	7.28	2.43
K_1O_4	2.17	2.96	2.35	7.48	2.49
K_1O_5	2.08	2.60	2.27	6.95	2.32
Subtotal	10.34	13.29	11.47	35.1	11.7
K_2O_1	2.24	1.97	2.35	6.56	2.19
K_2O_2	3.77	2.51	2.51	8.79	2.93
K_2O_3	2.77	2.95	2.51	8.23	2.74
K_2O_4	2.6	2.50	2.44	7.54	2.51
K_2O_5	2.56	3.36	2.88	8.58	2.86
Subtotal	13.94	13.29	12.69	39.92	13.31
K_3O_1	2.29	1.91	1.88	6.08	2.03
K_3O_2	2.46	3.25	3.04	8.75	2.92
K_3O_3	2.68	2.86	2.76	8.30	2.77
K_3O_4	2.32	2.39	2.87	7.58	2.53
K_3O_5	2.51	2.98	2.44	7.93	2.64
Subtotal	12.26	13.39	12.99	38.64	12.88
K_4O_1	2.13	2.19	2.35	6.67	2.22
K_4O_2	3.11	2.77	2.78	8.66	2.89
K_4O_3	3.15	2.55	2.37	8.07	2.69
K_4O_4	2.41	2.68	2.85	7.94	2.65
K_4O_5	2.67	2.91	2.87	8.45	2.82
Subtotal	13.47	13.10	13.22		
BLOCK TOTAL	50.01	53.07	50.37		
GRAND TOTAL				153.45	
GRAND MEAN					2.56

K X O TWO WAY TABLE

TREATMENTS	K_1	K_2	K_3	K_4	TOTAL	MEAN
O_1	5.38	6.56	6.08	6.67	24.69	2.06
O_2	8.01	8.79	8.75	8.66	34.21	2.85
O_3	7.28	8.23	8.30	8.07	31.88	2.66
O_4	7.48	7.54	7.58	7.94	30.54	2.55
O_5	6.95	8.58	7.93	8.45	31.91	2.68
TOTAL	35.1	39.7	38.64	39.79		
MEAN	2.34	2.66	2.58	2.65		2.56

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DF	SS	MS	F VALUE	Pr > F
BLOCK	2	0.280	0.140		
K	3	1.012	0.337	2.99^{*}	0.0427
O	4	4.325	1.081	9.59^{**}	0.0001
K X O	12	0.379	0.032	0.028^{ns}	0.9892
ERROR	38	0.4282	0.113		
TOTAL	59	10.278			

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

CV = 13.13 %

APPENDIX TABLE 13. Nitrogen content of the soil (%)

TREATMENTS	BLOCK			TOTAL	MEAN
	I	II	III		
K_1O_1	0.06	0.10	0.11	0.27	0.090
K_1O_2	0.12	0.16	0.12	0.40	0.133
K_1O_3	0.13	0.12	0.12	0.37	0.123
K_1O_4	0.11	0.15	0.12	0.38	0.126
K_1O_5	0.10	0.13	0.11	0.34	0.113
Subtotal	0.52	0.66	0.58	1.76	0.585
K_2O_1	0.11	0.10	0.12	0.33	0.110
K_2O_2	0.19	0.13	0.13	0.45	0.150
K_2O_3	0.14	0.15	0.13	0.42	0.140
K_2O_4	0.13	0.13	0.12	0.38	0.126
K_2O_5	0.13	0.17	0.14	0.44	0.147
Subtotal	0.70	0.68	0.64	2.02	0.673
K_3O_1	0.11	0.10	0.09	0.30	0.100
K_3O_2	0.12	0.16	0.15	0.43	0.143
K_3O_3	0.13	0.14	0.14	0.41	0.136
K_3O_4	0.12	0.12	0.14	0.38	0.126
K_3O_5	0.13	0.15	0.12	0.40	0.133
Subtotal	0.61	0.67	0.64	1.92	0.638
K_4O_1	0.11	0.11	0.12	0.34	0.113
K_4O_2	0.16	0.14	0.14	0.44	0.147
K_4O_3	0.16	0.13	0.12	0.41	0.136
K_4O_4	0.12	0.13	0.14	0.39	0.130
K_4O_5	0.13	0.15	0.14	0.42	0.140
Subtotal	0.68	0.66	0.66	2.00	0.666
BLOCK TOTAL	2.51	2.67	2.52		
GRAND TOTAL				7.70	
GRAND MEAN					0.13

K X O TWO WAY TABLE

TREATMENTS	K_1	K_2	K_3	K_4	TOTAL	MEAN
O_1	0.27	0.33	0.30	0.34	1.24	0.10
O_2	0.40	0.45	0.43	0.44	1.72	0.14
O_3	0.37	0.42	0.41	0.41	1.61	0.13
O_4	0.38	0.38	0.38	0.39	1.53	0.13
O_5	0.34	0.44	0.40	0.42	1.60	0.13
TOTAL	1.76	2.02	1.92	2.00		
MEAN	0.12	0.13	0.13	0.13		0.13

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DF	SS	MS	F VALUE	Pr > F
BLOCK	2	0.0008	0.00040		
K	3	0.0028	0.00093	3.45*	0.0260
O	4	0.0109	0.00273	10.10**	0.0001
K X O	12	0.0011	0.00009	0.33ns	0.9796
ERROR	38	0.0103	0.00027		
TOTAL	59	0.0258			

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

CV = 12.81 %

APPENDIX TABLE 14. Phosphorus content of the soil (ppm)

TREATMENT	BLOCK				
	I	II	III	TOTAL	MEAN
K_1O_1	112.81	258.95	108.77	480.53	160.18
K_1O_2	151.58	152.28	161.40	465.26	155.09
K_1O_3	192.28	186.67	198.60	577.55	192.52
K_1O_4	166.32	190.88	157.89	515.09	171.70
K_1O_5	158.60	175.44	175.44	509.48	169.83
Subtotal	781.59	964.22	802.10	2547.91	849.3
K_2O_1	283.57	282.81	268.07	834.45	278.15
K_2O_2	110.88	289.47	228.58	628.93	209.64
K_2O_3	116.14	194.39	161.40	471.93	157.31
K_2O_4	206.32	359.65	364.91	930.88	310.29
K_2O_5	789.47	785.96	787.30	2362.73	787.58
Subtotal	1506.38	1912.28	1810.26	5228.92	1742.97
K_3O_1	124.21	117.19	207.02	448.42	149.47
K_3O_2	459.65	431.58	445.62	1336.85	445.62
K_3O_3	430.18	349.82	438.59	1218.59	406.20
K_3O_4	745.62	771.93	719.30	2236.85	745.62
K_3O_5	145.62	154.39	136.84	436.85	218.43
Subtotal	1905.28	1824.91	1947.37	5677.56	1892.52
K_4O_1	246.14	208.07	284.21	738.42	246.14
K_4O_2	470.18	607.72	294.74	1372.64	457.55
K_4O_3	261.38	277.19	266.67	805.24	268.41
K_4O_4	261.40	221.05	301.75	784.20	261.40
K_4O_5	766.67	729.82	748.25	2244.74	748.25
Subtotal	2055.77	2043.85	1895.62	5945.24	1981.75
BLOCK TOTAL	6,199.02	6,745.26	12,944.28		
GRAND TOTAL				19,399.3	
GRAND MEAN					323.32

K X O TWO WAY TABLE

TREATMENTS	K_1	K_2	K_3	K_4	TOTAL	MEAN
O_1	480.53	834.45	448.40	738.42	2501.82	208.49
O_2	465.26	628.93	1336.85	1372.64	3803.68	316.97
O_3	577.55	471.93	1218.59	805.24	3073.31	256.11
O_4	515.09	930.88	2236.85	784.20	4467.02	372.25
O_5	509.48	2362.73	436.85	2244.74	5553.80	462.82
TOTAL	2547.91	5228.92	5677.56	5945.24		
MEAN	169.9	348.6	378.5	396.3		323.32

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DF	SS	MS	F VALUE	Pr > F
BLOCK	2	7468.852	3734.426		
K	3	488506.973	162835.658	55.2722**	0.0000
O	4	475179.361	118794.840	40.3232**	0.0000
K X O	12	1586761.228	132230.102	44.8836**	0.0000
ERROR	38	111950.511	2946.066		
TOTAL	59	2669866.925			

** - highly significant CV = 16.79 %

APPENDIX TABLE 15. Potassium content of the soil (ppm)

TREATMENT	BLOCK I	II	III	TOTAL	MEAN
K_1O_1	265	234	264.5	763.5	254.50
K_1O_2	262.5	365	362.5	990	330.00
K_1O_3	334	227.5	334	895.5	298.50
K_1O_4	277.5	306	277.5	861	287.00
K_1O_5	306	334	277.5	917.5	305.83
Subtotal	1445	1466.5	1516	4427.5	1475.83
K_2O_1	393.5	378	317.5	1089	363.00
K_2O_2	362.5	334	362.5	1059	353.00
K_2O_3	378	422.5	408	1208.5	402.83
K_2O_4	500	317.5	317.5	1135	378.33
K_2O_5	362.5	348	378	1088.5	544.25
Subtotal	1996.5	1800	1783.5	5580	1860
K_3O_1	439	362.5	317.5	1119	373.00
K_3O_2	306	408	422.5	1136.5	378.83
K_3O_3	348	422.5	362.5	1133	377.67
K_3O_4	362.5	317.5	662.5	1342.5	447.50
K_3O_5	347.5	306	348	1001.5	333.83
Subtotal	1803	1816.5	2113	5732.5	1784.17
K_4O_1	348	539	292.5	1179.5	393.17
K_4O_2	317.5	457	334	1108.5	369.50
K_4O_3	378	393.5	393.5	1179.5	393.17
K_4O_4	348	393.5	500	1241.5	413.83
K_4O_5	410	404	408	1222	407.33
Subtotal	1801.5	2201.5	1928	5931	1977.00
BLOCK TOTAL	7046	7284.5	7340.5		
GRAND TOTAL				21,671	
GRAND MEAN					361.18

K X O TWO WAY TABLE

TREATMENTS	K_1	K_2	K_3	K_4	TOTAL	MEAN
O_1	763.5	1089	1119	1179.5	4151	276.73
O_2	990	1059	1136.5	1108.5	4294	286.27
O_3	895.5	1208.5	1133	1179	4416.5	294.43
O_4	861	1135	1342.5	1241.5	4580	294.43
O_5	917.5	1088.5	1001.5	1222	4229.5	281.97
TOTAL	4427.5	5580	5732.5	5931		
MEAN	295.2	372	382.2	395.4		361.18

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DF	SS	MS	F VALUE	Pr > F
BLOCK	2	2445.808	1222.904		
K	3	91294.217	30431.406	6.0826^{**}	0.0017
O	4	9444.275	2361.069	0.4719^{ns}	
K X O	12	27931.158	2327.597	0.4652^{ns}	
ERROR	38	190116.525	5003.066		
TOTAL	59	321231.983			

** - highly significant
ns – not significant

CV = 19.58 %