## BIBLIOGRAPHY

FELIPE, HERSON A. APRIL 2009. Yield Performance of Six Strawberry Cultivars Grown Inside Greenhouse from April to November 2008 at Balili, La Trinidad, Benguet.

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## ABSTRACT

Results of the study revealed that the growth of the six strawberry cultivars was greatly reduced when the dry season production period was extended to the rainy season for off – season production. Although there were berries produced from April to November, which ranged from 1.54 kg to 3.54 kg per 3 $m^2$ plot, this yield is far below 3.84 to 6.32 kg berries from the same plot during the dry season study of Langpaoen (2008). However, strawberry 'Whitney' produced almost similar total yield during the rainy season (3.54 kg) compared to its yield during the dry season (3.84 kg) evaluation. Reject berries almost doubled the weight of marketable berries.

As to the return on investment, 'Whitney' obtained 8.48% or Php. 0.08 for every peso spent in the production of berries while the rest of the cultivars registered a negative return on investment.

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## INTRODUCTION

According to Reed (1976), the Spaniards and other European experimented with a variety of mid-latitudinal vegetables and berries by the 1870's and apparently continued until the Philippine Revolution. Since, its introduction, the yield and quality of strawberry fruits were carried on with very little improvement. According to Hermano (1982), only four varieties have been grown in the Benguet province. After a few years, new varieties did not last long. Two Japanese varieties that are slightly day-neutral replaced the oldest varieties except Aliso that consistently produced the yield, thus it has been extensively planted by strawberry growers in the late 1980s. In the early 1990's, modern varieties were accessioned, evaluated, and commercially planted (Hermano, 1982).

In the early 1980s, the demand for this strawberry is increasing that made the fruit highly priced in the market. The Baguio-Benguet area where the climate is unique seems the only place in the country where strawberry is grown to supply the requirement. The strawberry fruits are available in the market during the months of December to April. This is because during this months, the temperature is low (14.7° to 23.3°C) and the day is less than 12 hours (11.16 to 11.82 hours) and the strawberry is a semi-temperate and photoperiodic crop (Darrow, 1960; Shepard, 1969 as cited by Hermano, 1982). But because of research and experimentation, some farmers went down to Mindanao trying to experiment strawberry production. But according to observation, the yield is lower than the yield in Baguio-Benguet because of the climate that affects the flowers during flower development. Once the rainy season starts, strawberry fruit rot due to fungal infect in the open field.

Studies on crop protection and cultural practices, varietal evaluation and crop

improvement were undertaken to improve the quality and production of strawberry, which is one of the main crops in the Cordillera region. However, strawberry growers observed that the yielding capacity of newly introduced cultivars decreased every year. It was suspected by Hermano (1982) that chilling effect from the origin might be fading, may be due to pest infections and other factors. Some farmers practice are planting runners while other growers commonly buy the mother plants for planting which may also affect yield performance.

Strawberry production is one of the main sources of livelihood of farmers as it has the highest return of investment (135-170%) compared to vegetables (seldom surpass 100%). At present, strawberry 'Sweet Charlie' still dominate at the production areas for more than ten years, but because the cultivar is classified as short day plant the 4.0 kg/m2 production cannot be attained during the rainy season inside greenhouse. There should be more cultivars for off-season production to provide berries the whole year round. Aside from the economic importance of strawberry, Hancock (1999) reported that the strawberry fruits contain protein, carbohydrates, minerals, vitamins and lipids including significant levels of ellagic acid, which is thought to be an anti-carcinogen. It is then worthwhile to identify those cultivars of strawberry with high yield and good quality berries that have the potential to produce the whole year round.

Result of the study will not only encourage strawberry growers to expand the area but also guide those who will import planting materials on the cultivars that are adapted to the local condition. Moreover, those who are producing tissue cultured planting materials and those researchers on crop improvement will be guided on the cultivars to propagate and improve.

The study was conducted at the Benguet State University Experiment Area at Balili, La Trinidad, Benguet from April 2008 to November 2008 to evaluate the yield performance of six cultivars which were imported from the United States of America (Hermano, 2006), determine the fruit quality and record fruit characteristics and determine the profitability of growing the cultivars during the rainy seasons.

## REVIEW OF LITERATURE

Description of Strawberry

Strawberry, a small plant of the rose family, is grown in its tasty heart-shaped fruits. Strawberry plants grow close to the ground and produce small, white flowers that have a pleasant odor. Strawberry fruit is greenish white at first and ripens to a bright red. Botanists do not classify the strawberry as a true berry because true berries have seeds within their fleshy tissue such as black currants and cranberries but for strawberry, the fleshy part is covered with dry, yellow "seeds", each of which is actually a separate fruit (Groman, 1997). Moreover, the author described strawberry plants to have short roots and short stem. Leaves grow from the stem in groups of three. The fruit seems to be strewn (scattered) among the leaves, and this maybe why the plants were first called strawberry. It later came to be called strawberry. The author explained also that the name "strawberry" may also be connected with straw that is put under the strawberry plants to protect the fruit from being soiled before it ripens.

Hancock (1999) wrote that the strawberry is a herbaceous perennial that has a central stem or crown from which leaves, roots, stolons and inflorescence emerge. The crown consists of a central core surrounded by a vascular ring. The core is composed primarily of pith, with a thin cambial layer surrounding it. At the top of each leaf along the crown is an auxiliary bud that produces runners, branch crowns or remain dormant, depending on environmental conditions. The roots begins to branch at 2-5 cm and it will continue branching into a fibrous mass with adequate and its water is available. Generally, there are 20-30 primary roots, hundreds of secondary

roots, tertiary and higher order roots. In the upper soil 10-15cm of the soil, the roots are concentrated u to 50-90%. Lateral roots live for 1 or 2 years whereas primary roots can live for 2-3 years depending on the species and environmental conditions. A vigorous plant *Fragaria ananassa* usually produces 10-15 stolons a year.

Strawberry parts were described by Halfacre and Barden (1979) as follows:

Root system. The root system of the strawberry is relatively shallow and moderately extensive. Mostly, the roots extend horizontally and vertically for a distance of about 12 inches (30 cm). A few roots were found between 1 and 2 foot levels. Since the range of root system is limited and shallow, strawberry plants are mulched in regions of comparatively high transpiration.

Stem and leaves. The stems are short and thick and are called crowns. They bear three hinds of buds; (1) those which develop into short, thick stems or crowns; (2) those which develop into long, slender stems called runners; and (3) those which develop into flowers. New plants are formed from runners. They have long internodes and form a new plant at the second node and every other node thereafter. The leaves arise in rosettes around the short crown like stem and are long petioled and trifoliate.

Flowers and fruits. The flower occurs in groups or clusters. Mature individual flowers are relatively large with five or more green sepals, five or more white petals and numerous stamens and numerous pistils distributed over a fleshy receptacle. The mature fruit is the fleshy receptacle to which is attached a large number of small seed-like fruits called achenes.

Climatic and Soil Requirement

Strawberries grow best in a cool, moist climate and thrive in many kinds of soil. But can also thrive to grow in a semi - temperate areas. These are usually planted in autumn or spring and grow only a little during the winter. The plants reproduce by sending out slender growths called runners. Roots extend from the runners into the soil and produce new plants that grow fruits. The harvesting season varies, depending on the climate and the type of the strawberry. Some types, produce fruits throughout the summer and autumn are called ever bearing. Most strawberry plants bear fruit for five to six years, but the best crops are produced during the first one or two years (Groman, 1997). Short day cultivars adapted to cooler climates can be grown in tropical and sub-tropical regions, they often require a chilling period for fully productivity. These cultivars developed for warm regions may not need one. The ability to grow well during the short days of October, November and December in North American greenhouses has classically been used in an indicator of a cultivar's regional adaptation. Those adapted to cooler regions generally grow poorly during this period and enter a rest period, whereas those adapted in warmer climates continue to grow. Day neutral types produce fruit approximately 3 months after planting regardless of the planting dates, although they perform poorly when temperature exceeds 26°C (Hancock, 1999).

There are also two types of strawberries now grown commercially, day-neutral and short day plants. Long day (ever bearing) plants are also available, but are rarely grown outside of home gardens. The short day types are actually facultative short day plants and initiate flower buds either under short day conditions (less than 14 hours of day length) or when temperatures are less than 15°C. Above 15°C, the critical photoperiod for floral induction is 8-12 hours, depending on the cultivar. Long day plants

typically initiated their flower buds when day lengths are greater than12 hours and temperatures are moderate (Hancock, 1999). Moreover the author discovered that a rest period is induced in strawberries by short days and low temperatures. The inductive short period is 4-6 weeks. A chilling requirement (-1 to 10°C) has to be met to break the seed dormancy period; temperatures around 0°C appear to be most effective.

Importance of Strawberry

The strawberry is the most widely adapted and most grown of the small fruits and is one of the most popular fruits in the world. Strawberries are grown from Florida to Alaska, from New England to California – in every state in the United States. They are grown throughout Europe, in Canada, in South America and many other countries. Important commercial producing centers include Europe (497,000 metric tons), the United States (220,300 metric tons), Lebanon (130,000 metric tons), Japan (128,000 metric tons), and Mexico (85,000 metric tons) (Edmund, et al., 1975).

Among the small fruits in the Unite States and the world, strawberries are second rank to grapes in total production. In Eastern United States, commercial strawberry plantings range from Maine to Florida and as far as west as Michigan and Louisiana. Heavy concentrations of strawberries are found in California, Oregon and Washington. Total strawberry production in the United States in 1975 was 246,000 metric tons (Halfacre and Barden, 1979).

The success story with strawberries in California is the result of many improvements including; more productive cultivars, utilization of temperature-photoperiod interactions, better control of pest through insect and disease resistance (especially virus diseases) and improve cultural techniques, such as soil fumigation and

the use of clear plastic mulches (Halfacre and Barden, 1979).

Locally, the strawberry has been in Benguet for the last 50 or more years with production yield that averages 12 tons per hectare. It is one of the main sources of income farmers and revenue for the province of Benguet and in the city of Baguio.

However, growers are disappointed over the scarcity of this fruit especially during the rainy months. This situation leads to a higher market price that goes as high as P100.00/kg. The demand for either fresh or processed strawberry has never been satisfied (Balaki, 1992). Aside from economic importance, strawberry fruit is also a good source of vitamin C and often eaten fresh with cream (Groman, 1997). Strawberry fruits are also processed in making jam, jelly and wine. It is also discovered that the strawberry fruits contains approximately 90% water and 10% total soluble solids, and numerous important dietary components. They are extremely high in vitamin C and standard serving of strawberries (ten fruits) supplies 95% of the recommended dietary requirements. Glucose and fructose are soluble sugars and 40% total dry weight. Citric acid comprising 885 total acids is the primary organic acid. It also contains significant levels of ellagic acid, which is also called an anticarcinogenic. Furthermore, many gardeners grow strawberry because the fruits grow so easily. Several studies had led to increased commercial strawberry production. Plant breeders have developed varieties suited to specific climates. Researchers also found various methods to control the major diseases and insect pests that attack strawberries. In addition, many commercial growers use mechanical equipment to plant and harvest strawberry efficiently. Some growers use large green houses to control the environment in which the fruit grows and improve production (Groman, 1997).

Varieties of Strawberry

The strawberry has developed from at least three species of the same genus, *Fragaria chiloensis, Fragaria virginiana,* and *Fragaria vesca*. *Fragaria chiloensis* and *Fragaria virginiana* are native to the new world, have 54 somatic chromosomes, and produce relatively large unit; whereas, *Fragaria vesca* is native to the world has 14 somatic chromosomes and produces small fruit. The authors mentioned that according to authorities, the three species and probably one or two others hybridized under natural conditions producing the parents of modern varieties. These varieties vary in adaptations to the climate and in length of physiologic dormant period (Edmond et al., 1975). Another study from Halfacre and Barden (1979), commercial strawberry originated as a cross between *Fragaria Chiloensis* and *Fragaria virginiana*. The hybrid nature of the garden strawberry, *Fragaria ananassa* were the hybrids of *Fragaria chiloensis* and *Fragaria virginiana* and was named *Fragaria ananassa* to denote the perfume of the fruit that smelled like a pineapple (Ananas). This was recognized by a French botanist Antoine Nicholas Duschesne (Hancock, 1999).

Recent studies, strawberries grow wild and are raised commercially in almost every country. Plant breeders have developed hundreds of varieties that are suited for different growing conditions. Wild strawberries were cultivated in ancient Rome. In the 1700s, a hybrid variety was developed in France by breeding wild strawberries brought from North America with others that came from Chile. Many varieties of this hybrid provide most commercially grown strawberries. The European haubois strawberry produces small fruit of a fine, aromatic flavor. Varieties of this strawberry are grown to make jam. The European wild strawberry grown in dry, sunny position.

The fruits are just over a centimeter in length, and very sweet (Groman, 1997). In addition to that, strawberry belongs to the genus *Fragaria* in the rose *Rosaceae*. The Wild strawberry is *Fragaria vesca*, the haubois strawberry is *Fragaria moschata* and the garden strawberry is a hybrid, *Fragaria ananassa*.

Local Studies on Strawberry

Guitelen et al. (1982) evaluated strawberry Gem, Fukuba, Fresno, Missionary, Seqouin, and Torey as to their keeping quality after harvest. As it was studied, Torey, Missionary and Fresno produced high yield, while Fresno was the earliest to initiate flowers. Gem has the highest percentage of sugar content and produced least yield. As to the quality, gem, Fresno and Torey were the less susceptible to weight loss and rotting and can be also kept for a longer period during storage than the other varieties under the conditions of the study. An experiment conducted on strawberry was the effect of the planting season on four varieties namely: Fukuba, Fresno, Sequoin, and Gem from June 1974 to May 1975 by Tipayno and Hermano (1977). Runner production of strawberry was highest during the month of January and long day length in June. Fukuba had the highest number of runners produced whereas Fresno had the least prolific. Early planting of strawberry in June produced the highest yield followed by July, August, September, October, November, December, January, February, March, April, and May. Among the varieties studied, Fresno produced the highest yield followed by Sequoin, Gem and Fukuba with computed yield per hectare of 10.57, 10.40, 9.05, and 6.28 tons, respectively. In the months of March, April and May plantings produced small fruits. Sequoin had the larger and heavier fruits while the smallest fruits were obtained from gem. Fruits harvested in the month of January,

February, March and April had high sugar content while those fruits harvested in May and June had very low sugar content (Tipayno and Hermano, 1997).

In 1982, Hermano reported that out of 17 collected or introduced varieties of strawberry were used for the tree planting studies, but for Shata, Ostira, Reveda and Rabunda were not included in the yield test because of their failure to produced runners. Similarly, the very few runners produced by cultivators Fresno, Solana, Lasses, Tioga, Salinas and Aliso limited the planting areas. According to the researcher, the strawberries used were generally photo – Periodic and Semi – temperate. Most of them flowered to months after the shortest day length (11.06hours) in la Trinidad, Benguet and produced runners in the month of July, about a month after the longest day length (June with 13.06 hours). The collected varieties in the locality like Penicillin, giant, missionary, and Royal Gem with the exception of Sequoin and exotic varietal introduction were less in sensitive to the climatic environments. The rest of the varieties like Fresno, Aliso, Tioga, Lasses and Salinas tended to flower throughout the year, but runner production was very light. Moreover, Hermano (1982) observed that the newly introduced varieties abroad had the better yielding potential and berry quality like size and texture than those collected locally. The promising horticultural characteristics of these varieties of the rest of the varieties namely: Penicillin, giant, Missionary and Royal Gem were reduced in the succeeding planting, especially in the third planting. The reduction of the growth and yielding potential of these varieties were assumed to be due to relatively high temperature than the country of origin and the possible virus infection. The report also mentioned that the varieties collected locally exhibited some superior horticultural characters compared to those newly introduced in terms of prolificacy

to produced runners and better tolerance to lead disease like spots, scorch and blight.

In another study, three Japanese varieties of strawberry namely: Toyonoka, Haroyoi and Harunoka were compared using mothers and runners as planting materials. Regardless of the varieties, runners as planting material significantly out yielded the mother plants. Among the varieties tested, Toyonoka significantly out yielded Haroyoi from diseases, which may have caused the higher yield. In the case of cultivar Harunoka, mother plants yielded as good as the runners (Balaki, 1992). As explained by Hermano (1999), there were two main groups of strawberry in relation to day length response: the short day and day neutral. The short day group flowers when the day length is less than 12 hours. The day neutral strawberries produce flower earlier are called early maturing like the Seascape. Likewise, those varieties like Aliso, which take longer days to flower, are called late maturing. The Japanese varieties introduced in the 1970's are slightly day neutral, like Harunoka and Toyonoka. Genetically, day neutral varieties are less hybrid. As they grow, they produce runners and fruits. These varieties produce year round berries in the region provided that the growing area is protected from heavy rains during rainy season, the author said.

## MATERIALS AND METHODS

Materials

Runners of the six strawberry cultivars planted in August 2007 by Langpaoen, which he evaluated up to March 2008 was continued in this study up to November 2008. Additional rice straw mulching materials, organic and inorganic fertilizers, pesticides were used as well as garden tools and equipment, weighing scale, identifying tags and pegs, tape measure, and record notes.

Methods

The experiment followed the randomized complete block design (RCBD) with three replications. The treatments were represented as follows:

| Code | Cultivar |
|---|---|
| $C_1$ | Sweet Charlie (check) |
| $C_2$ | Camarosa |
| $C_3$ | Festival |
| $C_4$ | Erlibrite |
| $C_5$ | Whitney |
| $C_6$ | Toyonoka |

Crop maintenance. The study was a continuation of a dry season evaluation so the established plants were taken cared of during the evaluation period. Crop protection was implemented; irrigation, fertilizer application, leaf pruning and other cultural practices were done equally to all the treatments throughout the duration of the study.

Harvesting berries. Berries were harvested when about 75% of the surface turns reddish and were done every three days. The harvested berries were directly placed in plastic boxes to prevent many touches that bruises the berries.

Data gathered. The data gathered, tabulated, computed and means were subjected to separation test using Duncan's multiple range test (DMRT) were the following:

1. Days from flower bud formation to fruit harvest. This was the number of days from the time flower buds appears to the day the fruit attain 75% ripe.

2. Yield per plant (g). This was computed by dividing the total yield per plot by the number of plants that produced fruits.

3. Total yield per plot (g). These was the total weight of marketable and non-marketable berries produced per plot from April 2008 to November 2008

4. Weight of marketable berries per plot (g). This was the total weight of marketable berries harvested from the first harvest in April 2008 to the termination of the study in November 2008.

5. Weight of rejects or culls per plot (g). This was the weight of insect-damaged/fungus –infested, too small (weighing less than 9g) and deformed fruits that were not sold to the market.

6. Average fruit weight (g). The weight of marketable fruits per plot was divided by the number of marketable fruits per plot to get the average weight of individual fruit.

7. Number of fruits produced per plant. Fruit counts was recorded every harvest and the total per month were divided by the number of plants per plot to get the number of fruits per plant per month.

8. Plant height (cm). Five plant samples were measured from the ground level to the tip of the longest leaf every end of the month from April 2008.

9. Sugar content (°B). The sugar content of the fruits at red ripe stage was determined using a hand refractometer every end of the month.

10. Fruit characteristics. The fruit characteristics of each cultivar in term of shape and color were recorded in photographs.

11. Fruit firmness. The firmness of fruits was evaluated by touch where the ratings were as follows:

Firm – fruit is hard when pressed between fingers.

Slightly firm – fruit is hard but crushed when pressure is applied.

Soft – fruit easily crushed by slight pressure in between fingers.

12. Number of runners produced per plot. The number of runners produced during the duration of the study were counted or recorded.

13. Cost and return analysis. All expenses that were incurred for each cultivar in the study were recorded and the return on investment (ROI) was computed using the formula:

ROI (%) Gross sales-Total expenses ÷ Total expenses × 100

14. Documentation through pictures. Observations that were not quantified were recorded in photographs throughout the duration of the study.

## RESULTS AND DISCUSSION

Days from Flower Bud Formation to Fruit Harvest

Strawberry 'Erlibrite' and 'Toyonoka' had significantly shorter period to attain red ripe stage from flower bud to fruit harvest (Table 1). This was followed by 'Sweet Charlie' was not different from 'Toyonoka' and the 'Camarosa'. 'Festival' and 'Whitney' had the most number of days from flower bud to fruit harvest which significantly differed from the rest of the cultivars studied. This study obtained 20 to 21 days from flower bud to fruit harvest while Langpaoen (2008) recorded 28 t0 31 days. The difference between the earlier study and this study might be the difference in season where the first study was for dry season while this study is for rainy season. Another reason might be that the observation and recording in this study was late where the flower buds were already protruded from the bract of the crown at the base of the leaf petioles. Kudan (2006) recorded 30 to 31 days in 'Sweet Charlie' while Langpaoen recorded 28 days, but this study had 22 days from flower bud to fruit harvest.

Yield per Plant

As shown in Table 1, the yield per plant ranged from 89.67 to 182.59g which did not show significant differences among the cultivars, but way below the 192.03 to 333.59 grams recorded by Langpaoen (2008) during the dry season. This result clearly shows that the yield per plant of strawberry during the dry season is higher than the rainy season when allowed to continue bearing fruits. This might be due to the reduced growth (Table 2) of plants and longer day length during the study (April to November 2008).

Average Fruit Weight

In fruit weight, there were no significant differences observed from the different cultivars studied as shown in Table 1. The weight of individual berries in the study ranged from 9.96 to 10.46 grams which is obviously lower than the average of 10.86 to 14.36 grams during the dry season study of Langpaoen (2008)(see also Figure 1).

Weight of Marketable Berries

As presented in Table 2, strawberry 'Whitney' and 'Erlibrite' had significantly higher marketable berries compared to 'Sweet Charlie' and 'Toyonoka' but slightly differed from 'Festival' and 'Camarosa'. Further comparisons show 'Erlibrite', 'Festival' and 'Camarosa' having similar marketable yields.

Table 1. Days from flower bud to fruit harvest, yield per plant and average weight per fruit

| CULTIVARS | MEAN (Days) | Weight (g) per plant | Weight (g) per fruit |
|---|---|---|---|
| Sweet Charlie | 22.00[bc] | 107.43[ab] | 9.96[a] |
| Camarosa | 22.33[b] | 102.96[ab] | 10.00[a] |
| Festival | 23.67[a] | 89.67[b] | 10.46[a] |
| Erlibrite | 20.33[d] | 141.91[ab] | 10.22[a] |
| Whitney | 24.67[a] | 182.59[a] | 10.37[a] |
| Toyonoka | 21.00[cd] | 127.22[ab] | 9.96[a] |

Means in a column with the same letter are not significantly different at 5% level by DMRT

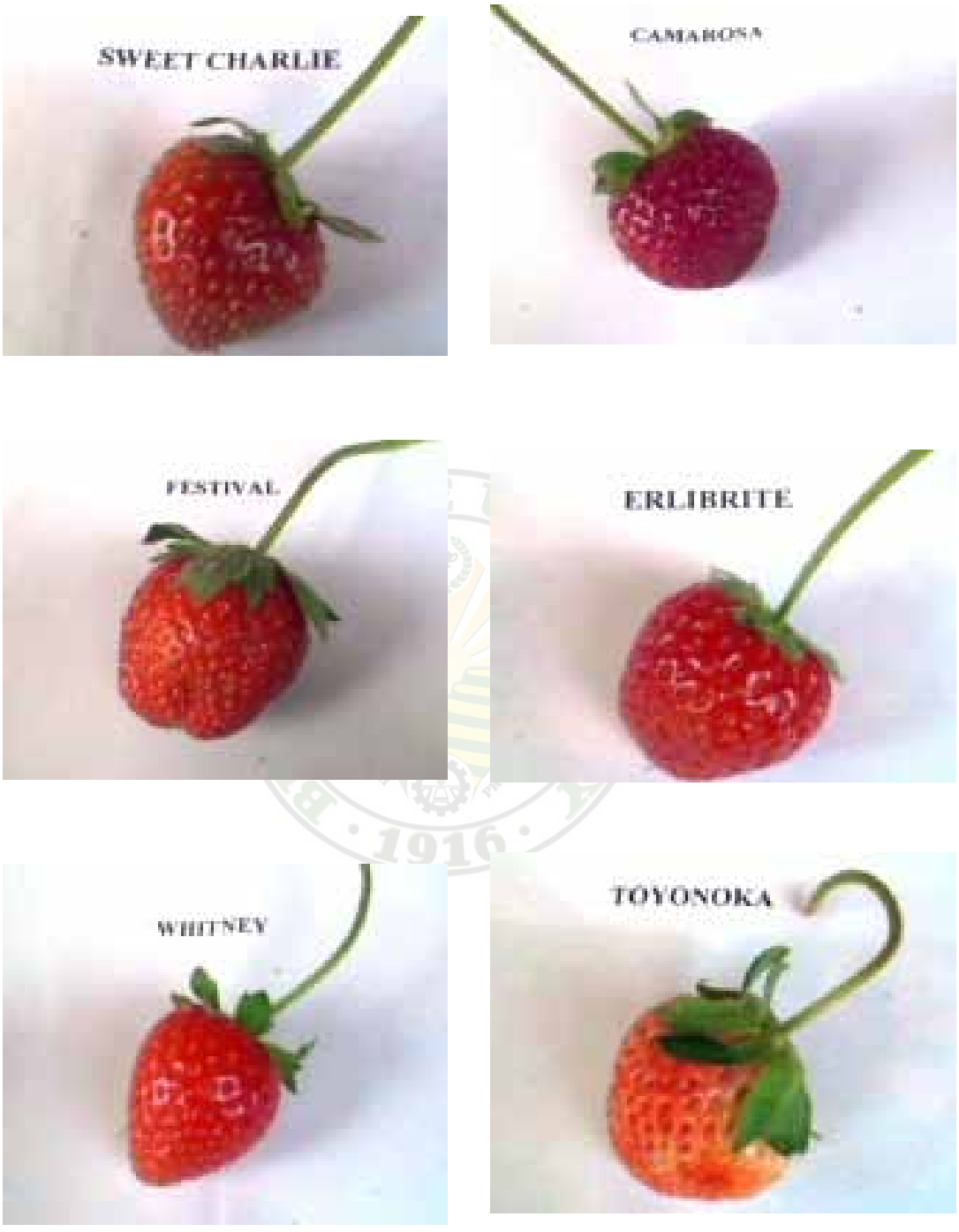


Figure 1. Photographs showing the berry characteristics of each cultivar in terms of shape and color. There were more fruit abnormalities in strawberry when the mother plants bear berries during the rainy season.

Weight of Rejects/Culls

Strawberry 'Whitney', 'Toyonoka', and 'Erlibrite' produced similar weights of berries classified as culls which slightly differed from 'Camarosa' and 'Sweet Charlie'. Strawberry 'Festival' produced lightest reject berries but not different to 'Sweet Charlie', 'Camarosa', and 'Erlibrite' (Table 2).

In the study of Langpaoen (2008), 'Toyonoka' and 'Camarosa' produced the heaviest reject berries during the dry season due to disease infection. Similarly, reject berries were recorded more in this study.

Table 2.Weight of marketable, reject fruits, and total yield per plot

| CULTIVARS | WEIGHT (g/plot) | | |
|---|---|---|---|
| | Marketable | Reject/cull | Total |
| Sweet Charlie | 260.3$^{c}$ | 1280.7$^{bc}$ | 1541.0$^{c}$ |
| Camarosa | 594.7$^{bc}$ | 1325.7$^{bc}$ | 1920.3$^{bc}$ |
| Festival | 657.3$^{bc}$ | 1121.7$^{c}$ | 1779.0$^{bc}$ |
| Erlibrite | 1101.7$^{ab}$ | 1657.7$^{abc}$ | 2759.3$^{ab}$ |
| Whitney | 1438.3$^{a}$ | 2099.0$^{a}$ | 3537.33$^{a}$ |
| Toyonoka | 461.3$^{c}$ | 1875.7$^{ab}$ | 2337.0$^{bc}$ |

Means in a column with the same letter are not significantly different at 5% level by DMRT

Total Yield

'Whitney' and 'Erlibrite' produced the heaviest yield per plot which significantly outyielded the 'Sweet Charlie', but slightly different from 'Toyonoka', 'Camarosa' and

'Festival' as presented in Table 2. The study of Langpaoen (2008) showed that 'Erlibrite' produced 6.13 kg per plot while 'Whitney' had the lowest total yield of 3.84 kg during the dry season but 'Whitney' had the heaviest during the rainy season. The very low yield might not only be due to the daylengths, but also deterioration of the plants where the plants become small and many died too as shown in Figure 2.

Number of Fruits Produced per Plant

Table 3 shows that the different cultivars evaluated had produced berries throughout the rainy season. In July and August, although 'Whitney' had similar berry counts with 'Toyonoka', 'Erlibrite', and 'Camarosa' significantly outnumbered the berries produced from 'Festival' and 'Sweet Charlie'. Except this months (July and August), the different strawberry cultivars have slight differences in berry counts. This result may indicate that 'Whitney' and 'Erlibrite' have potentials in producing more berries during the rainy season under greenhouse production.

Table 3. Number of fruits produced per plant

| CULTIVARS | MONTHS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | April | May | June | July | August | September | October | November |
| Sweet Charlie | 7.55$^{a}$ | 7.13$^{b}$ | 2.69$^{a}$ | 0.76$^{c}$ | 0.87$^{bc}$ | 0.58$^{b}$ | 1.89$^{ab}$ | 1.67$^{a}$ |
| Camarosa | 4.41$^{ab}$ | 10.33$^{ab}$ | 1.45$^{a}$ | 4.27$^{ab}$ | 1.50$^{abc}$ | 1.51$^{b}$ | 2.76$^{ab}$ | 1.02$^{a}$ |
| Festival | 3.02$^{b}$ | 9.06$^{ab}$ | 0.98$^{a}$ | 1.70$^{c}$ | 0.41$^{c}$ | 0.54$^{b}$ | 1.70$^{b}$ | 2.00$^{a}$ |
| Erlibrite | 1.33$^{b}$ | 10.19$^{ab}$ | 2.51$^{a}$ | 4.82$^{ab}$ | 1.52$^{abc}$ | 1.89$^{b}$ | 3.48$^{ab}$ | 3.21$^{a}$ |
| Whitney | 3.63$^{b}$ | 9.93$^{ab}$ | 1.68$^{a}$ | 5.38$^{a}$ | 2.36$^{a}$ | 5.17$^{a}$ | 3.97$^{a}$ | 3.03$^{a}$ |
| Toyonoka | 2.20$^{b}$ | 11.87$^{a}$ | 2.38$^{a}$ | 3.19$^{abc}$ | 1.88$^{ab}$ | 0.75$^{b}$ | 2.28$^{ab}$ | 3.37$^{a}$ |

Means in a column with the same letter are not significantly different at 5% level by DMRT

Figure 2. Overview of the different strawberry cultivars studied 16 months from planting (August 2007) to the termination of the study in November 2008. The plants reduced in size and several plants missing in some plots.

Table 4.Sugar content (°Brix) of the different cultivars on three sampling months

| CULTIVARS | MONTH | | |
|---|---|---|---|
| | JUNE | OCTOBER | NOVEMBER |
| Sweet Charlie | 4.87[c] | 4.73[c] | 5.67[b] |
| Camarosa | 6.67[b] | 5.20[bc] | 6.20[ab] |
| Festival | 5.87[bc] | 5.80[b] | 5.93[b] |
| Erlibrite | 5.87[bc] | 5.80[b] | 5.93[b] |
| Whitney | 5.67[bc] | 5.00[bc] | 5.80[b] |
| Toyonoka | 8.33[a] | 7.00[a] | 7.20[a] |

Means in a column with the same letter are not significantly different at 5% level by DMRT

Sugar Content

As shown in Table 4, 'Toyonoka' had characteristically higher sugar content compared to the other cultivars during the dry season (Langpaoen, 2008) and in the rainy season recorded in this study. Generally, the sugar content during the dry season is higher (7.06 to 10.00 °Brix) then slowly reduced during the rainy season (as shown in this study).

This result is consistent with the findings of Tipayno and Hermano (1977) where the sugar content of berries in January to April is higher than in May and June. The same observation by Kudan (2006) was not different where the sugar content measured in the month of October (7.79 °Brix) increased in November (8.70 °Brix). Kudan (2006) explained that the longer bright sunshine in November (5.38 hours) promoted higher sugar content compared to the shorter bright sunshine in October (4.97 hours).

Table 5. Plant height

| CULTIVARS | PLANT HEIGHT (cm) |
|---|---|
| Sweet Charlie | 15.90[b] |
| Camarosa | 18.17[ab] |
| Festival | 18.84[ab] |
| Erlibrite | 16.87[ab] |
| Whitney | 19.30[ab] |
| Toyonoka | 20.41[a] |

Means in a column with the same letter are not significantly different at 5% level by DMRT

Plant Height

There were no significant differences among the cultivars in terms of plant height as shown in Table 5. Apparently, there was reduction in plant height already when the plants continued from dry season to the rainy season. Plant height measured by Langpaoen (2008) ranged from 20.68 cm to 27.39 cm while this study recorded 16.87 cm to 20.41 cm. Mother plants will reduce in growth as they stay longer in the field as shown in Figure 2.

Fruit Firmness

The firmness of fruits was evaluated by touch method. Strawberry 'Sweet Charlie' 'Camarosa', 'Whitney' and 'Erlibrite' is slightly firm when pressed between fingers. 'Toyonoka' berries rated to be soft while the fruits of 'Festival are firm.

Table 6. Fruit firmness

| CULTIVARS | FIRM | SLIGHTLY FIRM | SOFT |
|---|---|---|---|
| Sweet Charlie | | ✓ | |
| Camarosa | | ✓ | |
| Festival | ✓ | | |
| Erlibrite | | ✓ | |
| Whitney | | ✓ | |
| Toyonoka | | | ✓ |

Number of Runners Produced per Plant

As shown in Table 7, 'Toyonoka', 'Whitney' and 'Festival' produced runners in April while the 'Erlibrite', 'Sweet Charlie', and 'Camarosa' did not have any runners. In May to August, 'Toyonoka' had significantly more runners compared to the other cultivars. On the other hand, 'Festival' showed that runners were produced from July to November while 'Whitney' produced runners in August and September, and the rest of the cultivars din not produced runners from April to November.

In the earlier study of Langpaoen (2008), 'Toyonoka' was recorded to be day neutral cultivar as it continued to produce runners. This is a clear indication that 'Toyonoka' is really a day neutral plant. It is expected that there are more runners to be produced during May to August due to longer days, but did not happen. The aging mother plants may not be productive when extended to the next cropping season.

Table 7. Number of runners produced per plant

| CULTIVARS | NUMBER OF RUNNERS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | April | May | June | July | August | September | October | November |
| Sweet Charlie | 0.00[b] | 0.00[b] | 0.00[b] | 0.67[b] | 1.00[b] | 0.00[b] | 0.33[b] | 0.00[a] |
| Camarosa | 0.00[b] | 0.00[b] | 0.67[b] | 0.00[b] | 0.00[b] | 0.00[b] | 0.67[ab] | 1.00[a] |
| Festival | 1.33[ab] | 0.00[b] | 0.00[b] | 1.33[b] | 9.00[b] | 6.00[ab] | 3.33[ab] | 1.00[a] |
| Erlibrite | 0.00[b] | 0.00[b] | 0.67[b] | 1.33[b] | 0.33[b] | 2.33[ab] | 0.33[b] | 0.00[a] |
| Whitney | 1.33[ab] | 0.00[b] | 0.00[b] | 0.00[b] | 5.67[b] | 1.67[ab] | 0.33[b] | 0.67[a] |
| Toyonoka | 5.33[a] | 8.67[a] | 17.00[a] | 17.00[a] | 30.00[a] | 15.67[a] | 4.67[a] | 0.00[a] |

Means in a column with the same letter are not significantly different at 5% level by DMRT

Cost and Return Analysis

Strawberry 'Whitney' obtained a positive return on investment of 8.48% or Php 0.08 for every peso spent in the production (Table 8). The rest of the cultivars incurred a negative ROI which means that the expenses were higher than the sales of berries. Obviously, the very low yield during the rainy season cannot generate net profit. The deterioration and death of plants, longer daylengths and higher pest damage are some of the factors that attributed to the negative return on investment in the berry production.

Table 8. Cost and return analysis per cultivar per $15m^2$

| PARTICULARS | CULTIVARS | | | | | |
|---|---|---|---|---|---|---|
| | Sweet Charlie | Camarosa | Festival | Erlibrite | Whitney | Toyonoka |
| YIELD (g) | 1920.3 | 3737.33 | 1799.0 | 1541.0 | 2337.0 | 2759.3 |
| SALES (Php) | 153.60 | 284.80 | 144.00 | 123.20 | 187.20 | 224.00 |
| Farm Input (Php) | | | | | | |
| 46 – 0 – 0 | 1.89 | 1.89 | 1.89 | 1.89 | 1.89 | 1.89 |
| 0 – 18 – 0 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 |
| 60 – 0 – 0 | 1.89 | 1.89 | 1.89 | 1.89 | 1.89 | 1.89 |
| X – tekh | 1.58 | 1.58 | 1.58 | 1.58 | 1.58 | 1.58 |
| Labor | 62.66 | 88.11 | 91.78 | 85.17 | 100.84 | 93.74 |
| Depreciation | 155.06 | 155.06 | 155.06 | 155.06 | 155.06 | 155.06 |
| Total Expenses | 224.35 | 249.8 | 253.47 | 246.86 | 262.53 | 255.43 |
| Net Profit/Loss (Php) | -101.15 | -92.6 | -109.47 | -22.86 | 22.27 | -68.23 |
| ROI (%) | -45.08 | -38.51 | -43.19 | -9.26 | 8.48 | -26.71 |

Note: Selling price during harvest was Php 60.00 to 150.00/kg

## SUMMARY, CONCLUSION AND RECOMMENDATION


Summary

The study was conducted at the Benguet State University Experimental Area at Balili, La Trinidad, Benguet to continue the study of Langpaoen from August 2007 to March 2008 to evaluate the yield performance of six cultivars which were imported from the United States of America, determine the fruit quality and record fruit characteristics and determine the profitability of growing the cultivars during the rainy season.

Results showed that among the six strawberry cultivars, 'Toyonoka' and 'Erlibrite' had significantly shorter period to attain red ripe stage from flower bud to fruit harvest compared to the different cultivars studied. The yield per plant and average fruit weight did not differ among the six cultivars but observed to be much lower than the dry season data. In terms of marketable berries, 'Whitney' and 'Erlibrite' had significantly outyielded 'Toyonoka' and 'Sweet Charlie' which did not differ from 'Camarosa' and 'Festival'. The weight of reject berries was higher during the rainy season than the dry season. Plant height was observed to deteriorate during the rainy season (15.90 to 20.41 cm) compared to the first season (20.68 to 27.39 cm) study of Langpaoen (2008). In runner production, 'Toyonoka' continued from dry season to rainy season to produce runners while the other cultivars could hardly produce runners except 'Festival' that had few runners from July to October. Except 'Whitney' registering a return on investment of 8.48% or Php 0.08 for every peso spent in the production, the rest of the cultivars studied incurred a loss in the berry production.

## Conclusion

Based on the results presented and discussed, it appears that extending the berry production from dry season to the rainy season under the condition of the study with the use of 'Sweet Charlie', 'Toyonoka', 'Camarosa', 'Festival' and 'Erlibrite' has no economic benefit. Strawberry 'Whitney' was observed to have the potential for whole year round production of berries.

## Recommendation

It is therefore recommended that 'Whitney' be continued to produce berries during the rainy season or off – season for whole year berry production inside greenhouse in La Trinidad, Benguet. It also recommended that this result be verified using the same condition of this study.

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**APPENDICES**

Appendix Table 1.Days from flower bud formation to fruit harvest

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 22 | 23 | 22 | 67 | 22.33 |
| $C_2$ | 24 | 25 | 25 | 74 | 24.67 |
| $C_3$ | 24 | 24 | 23 | 71 | 24.67 |
| $C_4$ | 21 | 22 | 23 | 66 | 22.00 |
| $C_5$ | 20 | 21 | 22 | 63 | 21.00 |
| $C_6$ | 20 | 21 | 20 | 67 | 22.33 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 2.333 | 1.167 | | | |
| Treatment | 5 | 39.333 | 7.867 | 18.15** | 3.33 | 5.64 |
| Error | 10 | 4.333 | 0.433 | | | |
| TOTAL | 17 | 46.000 | | | | |

** - Highly significant

Coefficient of Variation = 2.95%

Appendix Table 2. Yield per plant (g)

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 803.20 | 943.10 | 852.36 | 2598.97 | 866.32 |
| $C_2$ | 1678.92 | 1576.79 | 1186.23 | 4441.94 | 1480.65 |
| $C_3$ | 508.52 | 842.87 | 891.54 | 2242.93 | 747.64 |
| $C_4$ | 483.79 | 1240.30 | 841.52 | 2565.61 | 855.20 |
| $C_5$ | 9156.6 | 1086.00 | 761.09 | 2762.69 | 920.90 |
| $C_6$ | 1554.14 | 1109.72 | 941.99 | 3605.85 | 1201.95 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 150288.418 | 184199.107 | | | |
| Treatment | 5 | 1139105.333 | 227821.067 | 3.67* | 3.33 | 5.64 |
| Error | 10 | 621408.079 | 62140.808 | | | |
| TOTAL | 17 | 1910801.831 | | | | |

* - Significant

Coefficient of Variation = 24.63%

Appendix Table 3. Total yield

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 1954 | 1944 | 1863 | 5761 | 1920.33 |
| $C_2$ | 4090 | 3719 | 2803 | 10612 | 3537.33 |
| $C_3$ | 1263 | 1961 | 2113 | 5337 | 1779.00 |
| $C_4$ | 944 | 2054 | 1625 | 4623 | 1541.00 |
| $C_5$ | 2289 | 2715 | 2007 | 7011 | 2337.00 |
| $C_6$ | 3783 | 2669 | 1826 | 8278 | 2759.33 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 715452.333 | 357726.167 | | | |
| Treatment | 5 | 8202317.999 | 1640463.600 | 4.84* | 3.33 | 5.64 |
| Error | 10 | 3386039.667 | 338603.967 | | | |
| TOTAL | 17 | 12303810.000 | | | | |

* - Significant

Coefficient of Variation = 25.16%

Appendix Table 4. Weight of marketable berries

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 511 | 571 | 702 | 1784 | 594.67 |
| $C_2$ | 1686 | 1477 | 1152 | 4315 | 1438.33 |
| $C_3$ | 436 | 729 | 807 | 1972 | 657.33 |
| $C_4$ | 138 | 272 | 371 | 781 | 260.33 |
| $C_5$ | 533 | 609 | 242 | 1384 | 461.33 |
| $C_6$ | 1730 | 839 | 736 | 3305 | 1101.67 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 87450.778 | 43725.389 | | | |
| Treatment | 5 | 2859775.611 | 571955.122 | 6.71** | 3.33 | 5.64 |
| Error | 10 | 852881.222 | 85288.122 | | | |
| TOTAL | 17 | 3800107.611 | | | | |

** - Highly significant

Coefficient of Variation = 38.82%

Appendix Table 5. Weight of rejects or culls (g)

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 1443 | 1373 | 1161 | 3977 | 1325.67 |
| $C_2$ | 2404 | 2242 | 1651 | 6297 | 2099.00 |
| $C_3$ | 827 | 1232 | 1306 | 3365 | 1121.67 |
| $C_4$ | 806 | 1782 | 1254 | 3842 | 1280.67 |
| $C_5$ | 1756 | 2106 | 1765 | 5627 | 1875.67 |
| $C_6$ | 2053 | 1830 | 1090 | 4973 | 1657.67 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 456792.444 | 228396.222 | | | |
| Treatment | 5 | 2174341.611 | 434868.322 | 3.96* | 3.33 | 5.64 |
| Error | 10 | 1098696.889 | 109869.689 | | | |
| TOTAL | 17 | 3729830.944 | | | | |

* - Significant

Coefficient of Variation = 21.25%

Appendix Table 6. Average fruit weight

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 9.83 | 9.52 | 10.64 | 29.98 | 9.99 |
| $C_2$ | 10.22 | 10.70 | 10.19 | 31.12 | 10.37 |
| $C_3$ | 10.63 | 9.99 | 10.76 | 31.38 | 10.46 |
| $C_4$ | 9.86 | 9.71 | 10.31 | 29.88 | 9.96 |
| $C_5$ | 9.87 | 10.32 | 9.68 | 29.87 | 9.96 |
| $C_6$ | 10.48 | 10.11 | 10.08 | 30.68 | 10.23 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.144 | 0.072 | | | |
| Treatment | 5 | 0.738 | 0.148 | $0.96^{ns}$ | 3.33 | 5.64 |
| Error | 10 | 1.538 | 0.154 | | | |
| TOTAL | 17 | 2.421 | | | | |

$^{ns}$ – Not significant

Coefficient of Variation = 3.86%

Appendix Table 8. Plant height (cm)

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 20.43 | 15.63 | 18.46 | 54.52 | 18.17 |
| $C_2$ | 20.66 | 18.64 | 18.60 | 57.9 | 19.30 |
| $C_3$ | 18.68 | 19.21 | 16.64 | 54.53 | 18.18 |
| $C_4$ | 15.24 | 13.67 | 18.80 | 47.71 | 15.90 |
| $C_5$ | 18.76 | 22.80 | 19.66 | 61.22 | 20.41 |
| $C_6$ | 18.11 | 16.18 | 16.31 | 50.6 | 16.87 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 2.994 | 1.497 | | | |
| Treatment | 5 | 40.596 | 8.119 | $2.21^{ns}$ | 3.33 | 5.64 |
| Error | 10 | 36.770 | 3.677 | | | |
| TOTAL | 17 | 80.360 | | | | |

$^{ns}$ - Not significant

Coefficient of Variation = 10.51%

Appendix Table 9. Sugar content (°B) June

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 7.0 | 6.0 | 7.0 | 20 | 6.67 |
| $C_2$ | 5.2 | 6.6 | 5.2 | 17 | 5.67 |
| $C_3$ | 6.4 | 5.8 | 5.4 | 17.6 | 5.87 |
| $C_4$ | 4.0 | 5.6 | 5.0 | 14.6 | 4.87 |
| $C_5$ | 8.0 | 8.6 | 8.4 | 25 | 8.33 |
| $C_6$ | 6.2 | 5.4 | 6.0 | 17.6 | 5.87 |

ANALYSI OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.138 | 0.069 | | | |
| Treatment | 5 | 21.158 | 4.232 | 10.12** | 3.33 | 5.64 |
| Error | 10 | 4.182 | 0.418 | | | |
| TOTAL | 17 | 25.478 | | | | |

** - Highly significant

Coefficient of Variation = 10.41%

Appendix Table 10. Sugar content (°B) October

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 4.6 | 5.0 | 6.0 | 15.6 | 5.2 |
| $C_2$ | 5.0 | 4.8 | 5.2 | 15 | 5.0 |
| $C_3$ | 6.0 | 5.4 | 6.0 | 17.4 | 5.8 |
| $C_4$ | 5.0 | 4.8 | 4.4 | 14.2 | 4.73 |
| $C_5$ | 6.2 | 7.0 | 7.8 | 21 | 7.0 |
| $C_6$ | 5.6 | 6.0 | 5.8 | 17.4 | 5.8 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.724 | 0.362 | | | |
| Treatment | 5 | 9.931 | 1.986 | 9.10** | 3.33 | 5.64 |
| Error | 10 | 2.182 | 0.218 | | | |
| TOTAL | 17 | 12.838 | | | | |

** - Highly significant

Coefficient of Variation = 8.36%

Appendix Table 11. Sugar content (°B) November

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 5.6 | 5.2 | 7.8 | 18.6 | 6.2 |
| $C_2$ | 5.0 | 5.0 | 7.4 | 17.4 | 5.8 |
| $C_3$ | 6.0 | 5.6 | 6.2 | 17.8 | 5.93 |
| $C_4$ | 5.2 | 5.4 | 6.4 | 17 | 5.67 |
| $C_5$ | 6.6 | 7.0 | 8.0 | 21.6 | 7.2 |
| $C_6$ | 5.8 | 6.0 | 6.0 | 17.8 | 5.93 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 6.418 | 3.209 | | | |
| Treatment | 5 | 4.651 | 0.930 | $2.72^{ns}$ | 3.33 | 5.64 |
| Error | 10 | 3.422 | 0.342 | | | |
| TOTAL | 17 | 14.491 | | | | |

$^{ns}$ – Not significant Coefficient of Variation = 9.56%

Appendix Table 12. Number of fruits produced per plant in April 2008

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 1.61 | 5.63 | 6.00 | 13.24 | 4.41 |
| $C_2$ | 0.95 | 6.63 | 3.3 | 10.88 | 3.63 |
| $C_3$ | 0.9 | 3.5 | 4.67 | 9.07 | 3.02 |
| $C_4$ | 3.2 | 11.75 | 7.71 | 22.66 | 7.55 |
| $C_5$ | 2.15 | 2.2 | 2.25 | 6.6 | 2.2 |
| $C_6$ | 1.16 | 1.68 | 1.16 | 4 | 1.33 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 40.396 | 20.198 | | | |
| Treatment | 5 | 71.013 | 14.203 | 4.44* | 3.33 | 5.64 |
| Error | 10 | 31.973 | 3.197 | | | |
| TOTAL | 17 | 143.381 | | | | |

* – Significant

Coefficient of Variation = 48.44%

Appendix Table 13. Number of fruits produced per plant in May 2008

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 11 | 12.06 | 7.94 | 31 | 10.33 |
| $C_2$ | 12.88 | 10.11 | 6.8 | 29.79 | 9.93 |
| $C_3$ | 6.63 | 10.83 | 9.72 | 27.18 | 9.06 |
| $C_4$ | 7.0 | 6.33 | 8.07 | 21.4 | 7.13 |
| $C_5$ | 12.1 | 11.4 | 12.1 | 35.6 | 11.87 |
| $C_6$ | 11.63 | 9.68 | 9.25 | 30.56 | 10.19 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 5.417 | 2.708 | | | |
| Treatment | 5 | 37.100 | 7.420 | $2.01^{ns}$ | 3.33 | 5.64 |
| Error | 10 | 36.827 | 3.683 | | | |
| TOTAL | 17 | 79.343 | | | | |

$^{ns}$ – Not significant

Coefficient of Variation = 19.68%

Appendix Table 14. Number of fruits produced per plant in June 2008

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 0.95 | 2.06 | 1.35 | 4.36 | 1.45 |
| $C_2$ | 1.1 | 1.68 | 2.25 | 5.03 | 1.68 |
| $C_3$ | 0.35 | 0.77 | 1.83 | 2.95 | 0.98 |
| $C_4$ | 1.27 | 3.5 | 3.3 | 8.07 | 2.69 |
| $C_5$ | 2.45 | 1.9 | 2.79 | 7.14 | 2.38 |
| $C_6$ | 3.78 | 0.4 | 3.36 | 7.54 | 2.51 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 2.547 | 1.274 | | | |
| Treatment | 5 | 6.917 | 1.383 | $1.36^{ns}$ | 3.33 | 5.64 |
| Error | 10 | 10.145 | 1.014 | | | |
| TOTAL | 17 | 19.609 | | | | |

$^{ns}$ – Not significant

Coefficient of Variation = 51.67%

Appendix Table 15. Number of fruits produced per plant in July 2008

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 3.75 | 7.44 | 1.61 | 12.8 | 4.27 |
| $C_2$ | 6.15 | 5.94 | 4.05 | 16.14 | 5.38 |
| $C_3$ | 1.6 | 1.79 | 1.7 | 5.09 | 1.70 |
| $C_4$ | 1.13 | 0.33 | 0.81 | 2.27 | 0.76 |
| $C_5$ | 1.9 | 5.4 | 2.26 | 9.56 | 3.19 |
| $C_6$ | 7.95 | 3.5 | 3.0 | 14.45 | 4.82 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 11.441 | 5.720 | | | |
| Treatment | 5 | 49.794 | 9.959 | 3.19* | 3.33 | 5.64 |
| Error | 10 | 31.237 | 3.124 | | | |
| TOTAL | 17 | 92.471 | | | | |

* - Significant

Coefficient of Variation = 52.75%

Appendix Table 16. Number of fruits produced per plant in August 2008

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 3.35 | 0.47 | 0.67 | 4.49 | 1.50 |
| $C_2$ | 3.35 | 1.53 | 2.2 | 7.08 | 2.36 |
| $C_3$ | 0.35 | 0.63 | 0.25 | 1.23 | 0.41 |
| $C_4$ | 1.63 | 0.53 | 0.44 | 2.6 | 0.87 |
| $C_5$ | 3.2 | 1.5 | 0.95 | 5.65 | 1.88 |
| $C_6$ | 2.55 | 0.95 | 1.06 | 4.56 | 1.52 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 8.683 | 4.341 | | | |
| Treatment | 5 | 7.321 | 1.464 | 4.20* | 3.33 | 5.64 |
| Error | 10 | 3.489 | 0.349 | | | |
| TOTAL | 17 | 19.493 | | | | |

* - Significant

Coefficient of Variation = 41.51%

Appendix Table 17. Number of fruits produced per plant in September 2008

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 4.0 | 0.41 | 0.11 | 4.52 | 1.51 |
| $C_2$ | 6.7 | 3.21 | 5.61 | 15.52 | 5.17 |
| $C_3$ | 0.5 | 0.68 | 0.45 | 1.63 | 0.54 |
| $C_4$ | 0.31 | 0.8 | 0.63 | 1.74 | 0.58 |
| $C_5$ | 0.95 | 1.2 | 0.11 | 2.26 | 0.75 |
| $C_6$ | 3.6 | 0.84 | 1.22 | 5.66 | 1.89 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 7.968 | 3.984 | | | |
| Treatment | 5 | 46.845 | 9.369 | 7.17** | 3.33 | 5.64 |
| Error | 10 | 13.058 | 1.306 | | | |
| TOTAL | 17 | 67.871 | | | | |

** - Highly significant

Coefficient of Variation = 65.65%

Appendix Table 18. Number of fruits produced per plant in October 2008

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 4.95 | 1.12 | 2.22 | 8.29 | 2.76 |
| $C_2$ | 5.0 | 3.16 | 3.76 | 11.92 | 3.97 |
| $C_3$ | 1.8 | 2.05 | 1.26 | 5.11 | 1.70 |
| $C_4$ | 1.75 | 1.62 | 2.31 | 5.68 | 1.89 |
| $C_5$ | 1.45 | 3.05 | 2.35 | 6.85 | 2.28 |
| $C_6$ | 2.85 | 3.32 | 4.28 | 10.45 | 3.48 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 1.011 | 0.505 | | | |
| Treatment | 5 | 12.185 | 2.437 | $2.12^{ns}$ | 3.33 | 5.64 |
| Error | 10 | 11.481 | 1.148 | | | |
| TOTAL | 17 | 24.676 | | | | |

$^{ns}$ – Not significant

Coefficient of Variation = 39.94%

Appendix Table 19. Number of fruits produced per plant in November 2008

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 1.3 | 0.12 | 1.65 | 3.07 | 1.02 |
| $C_2$ | 5.74 | 1.95 | 1.41 | 9.1 | 3.03 |
| $C_3$ | 2.1 | 2.84 | 1.05 | 5.99 | 2.00 |
| $C_4$ | 2.25 | 1.31 | 1.44 | 5 | 1.67 |
| $C_5$ | 2.35 | 5.5 | 2.25 | 10.1 | 3.37 |
| $C_6$ | 3.0 | 3.42 | 3.22 | 9.64 | 3.21 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 2.903 | 1.451 | | | |
| Treatment | 5 | 13.773 | 2.755 | $1.48^{ns}$ | 3.33 | 5.64 |
| Error | 10 | 11.481 | 1.857 | | | |
| TOTAL | 17 | 35.250 | | | | |

$^{ns}$ – Not significant Coefficient of Variation = 57.18%

Appendix Table 20. Number of runners produced in April 2008

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_2$ | 4.00 | 0.00 | 0.00 | 4.00 | 1.33 |
| $C_3$ | 2.00 | 2.00 | 0.00 | 4.00 | 1.33 |
| $C_4$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_5$ | 9.00 | 7.00 | 0.00 | 16.00 | 5.33 |
| $C_6$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 1.849 | 0.924 | | | |
| Treatment | 5 | 4.975 | 0.995 | $3.03^{ns}$ | 3.33 | 5.64 |
| Error | 10 | 3.289 | 0.329 | | | |
| TOTAL | 17 | 10.113 | | | | |

$^{ns}$ – Not significant

Coefficient of Variation = 50.86%

Appendix Table 21. Number of runners produced in May 2008

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_2$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_3$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_4$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_5$ | 20.00 | 6.00 | 0.00 | 26.00 | 8.67 |
| $C_6$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 1.217 | 0.608 | | | |
| Treatment | 5 | 8.908 | 1.782 | 2.93$^{ns}$ | 3.33 | 5.64 |
| Error | 10 | 6.085 | 1.782 | | | |
| TOTAL | 17 | 6.210 | | | | |

$^{ns}$ – Not significant

Coefficient of Variation = 76.35%

Appendix Table 22. Number of runners produced in June 2008

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 2.00 | 0.00 | 0.00 | 2.00 | 0.67 |
| $C_2$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_3$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_4$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_5$ | 19.00 | 29.00 | 3.00 | 51.00 | 17.00 |
| $C_6$ | 0.00 | 2.00 | 0.00 | 2.00 | 0.67 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 1.799 | 0.900 | | | |
| Treatment | 5 | 24.058 | 4.812 | 8.09** | 3.33 | 5.64 |
| Error | 10 | 5.948 | 0.595 | | | |
| TOTAL | 17 | 31.806 | | | | |

** - Highly significant

Coefficient of Variation = 57.67%

Appendix Table 23. Number of runners produced in July 2008

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_2$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_3$ | 2.00 | 0.00 | 2.00 | 4.00 | 1.33 |
| $C_4$ | 0.00 | 0.00 | 1.00 | 1.00 | 0.67 |
| $C_5$ | 25.00 | 24.00 | 2.00 | 51.00 | 17.00 |
| $C_6$ | 2.00 | 2.00 | 0.00 | 4.00 | 1.33 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 1.317 | 0.659 | | | |
| Treatment | 5 | 21.868 | 4.374 | 5.70** | 3.33 | 5.64 |
| Error | 10 | 7.676 | 0.768 | | | |
| TOTAL | 17 | 30.862 | | | | |

** - Highly significant

Coefficient of Variation = 60.19%

Appendix Table 24. Number of runners produced in August 2008

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_2$ | 0.00 | 17.00 | 0.00 | 17.00 | 5.67 |
| $C_3$ | 4.00 | 2.00 | 21.00 | 27.00 | 9.00 |
| $C_4$ | 0.00 | 0.00 | 3.00 | 3.00 | 1.00 |
| $C_5$ | 31.00 | 22.00 | 37.00 | 90.00 | 30.00 |
| $C_6$ | 0.00 | 1.00 | 0.00 | 1.00 | 0.33 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 1.490 | 0.745 | | | |
| Treatment | 5 | 49.386 | 9.877 | 7.09** | 3.33 | 5.64 |
| Error | 10 | 13.940 | 1.394 | | | |
| TOTAL | 17 | 64.816 | | | | |

** - Highly significant

Coefficient of Variation = 55.26%

Appendix Table 25. Number of runners produced in September 2008

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_2$ | 4.00 | 1.00 | 0.00 | 5.00 | 1.67 |
| $C_3$ | 5.00 | 11.00 | 2.00 | 18.00 | 6.00 |
| $C_4$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_5$ | 5.00 | 41.00 | 1.00 | 47.00 | 15.67 |
| $C_6$ | 3.00 | 1.00 | 3.00 | 7.00 | 2.33 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 3.969 | 1.984 | | | |
| Treatment | 5 | 15.968 | 3.194 | $2.27^{ns}$ | 3.33 | 5.64 |
| Error | 10 | 14.071 | 1.407 | | | |
| TOTAL | 17 | 34.008 | | | | |

$^{ns}$ – Not significant

Coefficient of Variation = 69.80%

Appendix Table 26. Number of runners produced in October 2008

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 2.00 | 0.00 | 0.00 | 2.00 | 0.67 |
| $C_2$ | 1.00 | 0.00 | 0.00 | 1.00 | 0.33 |
| $C_3$ | 3.00 | 4.00 | 3.00 | 10.00 | 3.33 |
| $C_4$ | 0.00 | 0.00 | 1.00 | 1.00 | 0.33 |
| $C_5$ | 6.00 | 8.00 | 0.00 | 14.00 | 4.67 |
| $C_6$ | 0.00 | 1.00 | 0.00 | 1.00 | 0.33 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.750 | 0.374 | | | |
| Treatment | 5 | 4.857 | 0.971 | $3.09^{ns}$ | 3.33 | 5.64 |
| Error | 10 | 3.139 | 0.314 | | | |
| TOTAL | 17 | 8.746 | | | | |

$^{ns}$ – Not significant

Coefficient of Variation = 43.95%

Appendix Table 27. Number of runners produced in November 2008

| TREATMENT | REPLICATIONS I | II | III | TOTAL | MEAN |
|---|---|---|---|---|---|
| $C_1$ | 0.00 | 3.00 | 0.00 | 3.00 | 1.00 |
| $C_2$ | 0.00 | 2.00 | 0.00 | 2.00 | 0.67 |
| $C_3$ | 2.00 | 1.00 | 0.00 | 3.00 | 1.00 |
| $C_4$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_5$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $C_6$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARE | COMPUTED F | TABULAR F 0.05 | 0.01 |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.562 | 0.281 | | | |
| Treatment | 5 | 0.698 | 0.140 | $1.13^{ns}$ | 3.33 | 5.64 |
| Error | 10 | 1.236 | 0.124 | | | |
| TOTAL | 17 | 2.497 | | | | |

$^{ns}$ – Not significant

Coefficient of Variation = 39.17%