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# THE EFFECT OF POTASSIUM ON GROWTH AND YIELD OF STRAWBERRY (*FRAGARIA ANANASSA* (DUCHESNE EX WESTON) DUCHESNE EX ROZIER)

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**Abstract**

*Fragaria ananassa* (Duchesne ex Weston) Duchesne ex Rozier (Strawberry) variety chandler of Agriculture Research Station (ARS) Baffa, Mansehra was evaluated for different growth and yield parameters under five treatments. In this experiment Potassium was used in 5 different treatments of 3 replications (T0 = Control, T1 = 200 g/6.75m², T2 = 400 g/6.75m², T3 = 600 g/6.75m², T4 = 800 g/6.75m²). The results showed maximum value under T3 (405g/6.75m²) for characteristics like survival percentage (83.54%), plant height (32.05cm), canopy size (13.62cm), crown diameter (2.73cm), number of branches (35.83), number of leaves (67.00), leaf length (5.87cm), root length (3.51cm), total number of fruits (43.93), days to 50% fruiting (233.67), fruit diameter (3.96cm), fruit weight (411.40g). Moreover, transplanting date (20th Sep, 2013) is suitable to get maximum yield of strawberry variety "Chandler". The findings of this experiment showed that great variations in morphological, physical and agronomic traits of strawberry variety and can be utilized to develop high yield and better quality of strawberry.

**Key words:** Potassium, Strawberry, Plant canopy, Leaves, Crown diameter, Agronomic traits.

## Introduction

*Fragaria ananassa* (Duchesne ex Weston) Duchesne ex Rozier(Strawberry) is a nutritious fruit plant of family Rosaceae and are themodern cultivated varieties of *Fragaria virgoan* and *Fragaria chiloensis* grown world widely (Sharma & Shyan, 2009). More than 3822 thousand tones are produced annually in the world and USA, Japan, Spain, Poland, Korea and India are the major producer of Strawberry. The Strawberries has unique desirable taste, pleasant aroma and a major source vitamins, potassium, fibre, phenolics, flavonoids and the immense source of sugars (Sharma & Sharma, 2004). Higher proportion of phenolic compounds, flavonoids and vitamin C are found in strawberries than other berries (Häkkinen & Törrönen, 2000). Natural antioxidants such as flavonoids, vitamins, and glutathione are abundantly found in strawberry (Wang, *et al.,* 1996; Anwar *et al.,* 2015). In Pakistan strawberry is a major cash crop and cultivated in Karachi, Gujarat, Lahore, Charsadda, Islamabad, Swat, Mardan, Haripur, Mansehra and other parts of the country were pH of soil is 4.6 to 6.5 (Khalid *et al*., 2013). Khan *et al*., (2015) and Mehmood *et al.,* (2015) reported that soil texture and electric conductivity (ECe) are also the important factors controlling the growth of plants. Singh *et al*., 2008 determine the effect of vermin-compost on growth, physiological disorders, fruit yield and quality of 'Chandler' strawberry and found significant increase in fruit yield and flowering with vermin-compost based fertilizer. Khalid *et al*. (2013) carried out experiemental work on the effect of organic amendments on vegetative growth, fruit and yield quality of strawberry and reported that organic amendments enhanced vegetative growth and also improved quality of strawberry fruits. Hundreds of strawberry cultivars cultivated globally for commercial production and new improved varieties are constantly introduction. Usually the strawberries (fruits) have a very short shelf life (1~2 days) as they are highly perishable and susceptible to all kinds of mechanical damage, physiological disorders, loss of water and deterioration (Caner, Aday, and Demir, 2008). June varieties of strawberry are quantitative or optional short-day (SD) plants and produce flowers under SD conditions of temperatures ranging from 15 to 25°C (Guttridge, 1985; Taylor, 2000). Strawberry has also a strong interaction with photoperiod and temperature and floral initiation also takes place in many of the cultivars in long days (LD) if the temperature is below 15°C (Heide, 1977). Macro and micro elements such as N, P, K, Fe, and Mn are of great importance in the growth and production of strawberries (Daugaard, 2001; May & Pritts, 1990); Kessel, 2003; Ersoy & Demirsoy, 2006; Rahman *et al.*, 2015; Shah *et al.*, 2015). On basis strong evidence in the literature that increase in the stress with high levels of free radicals, with consequent negative effects on human health including cancer (Heinonen *et al*., 1998) and therefore, strawberries are an effective source of reducing the risk of cancer and to prevent several human diseases caused by oxidative stress (Block *et al*., 1992). In Potohar region of the country Chandler cultivar is usually cultivated, while Bird, Douglas and Commander are cultivated in Islamabad mostly for research purposes. In 1986 in NARC, Islamabad for the first time started the research work on the strawberry Pakistan. In Pakistan during the year 2008 to 2009 strawberry was cultivated on 78 hectares of land and about 274 tons were produced from it (Gop, 2009). Strawberry Performance are closely related to the parameters of vegetative growth such as leaf area, petiole length, diameter, corona, crown diameter, dry weight of the leaves and crown dry weight. Therefore each time more parameters must be studied in conventional as well as organic, farming practices of strawberry.

## Materials and Methods

The present research work was conducted on strawberry variety (Chandler) at Agricultural Research Station (ARS) Baffa. The studies were conducted at the nursery area of Horticulture Department, Agriculture Research Station Baffa, Mansehra during the winter season of 2013 – 2014 to examine the effects of Potassium on the Chandler variety of strawberry (*Fragaria ananassa* (Duchesne ex Weston) Duchesne ex Rozier). Here we tested the impact of various doses of Potassium on strawberries plants. Before conducting the experiment the field was prepared with the help of ploughing for experimental plots thoroughly and divided into main plots and then to subplots. Before Potassium application soil samples up to 25 cm depth were taken randomly from five different parts of the field and analyzed for Physico-chemical properties of the soil (Table 1.). The soil analyses were done in the Soil Science Laboratory of Agriculture Research Station Baffa, Mansehra Pakistan for determination of chemical properties.

Randomized Complete Block Design (RCBD) was employed for five treatments with three replications each having 30 plants. Uniform application of water and eradication of weed was ensured for the better growth and development of runners. The observations were taken and results were compiled for various treatment comparisons. In experiment: Potassium (K)

T0 Control
T1 200g (ONC)
T2 400g (ONC)
T3 600g (ONC)
T4 800g (ONC).

**Metrological detail of the Location:** ARS Baffa can be located at an elevation of 1019 m from sea level at 34°28'0 N & at 73°16'60 E longitude.

## Results

**Effects of potassium (K):** Various treatments of potassium (K) were used to optimize best amount for various growth and agronomic characteristics of strawberry grown in ARS Baffa. The results of the study are presented in the following order and the complete details are given in Table 2.

### Reproductive and vegetative characters

**Survival percentage:** The mean values of data regarding the potassium effect on survival percentage also show a significant effect (Fig. 1). In case of potassium the highest survival percentage (83.54%) was recorded in T3 (405g/6.75m²), while the lower survival percentage (56.64%) recorded in T0 (Control).

**Number of leaves:** In second experiment the potassium has an important effect on number of leaves (Fig. 2). The potassium the mean value for number of leaves in selected plants revealed that the highest number (67.00) was recorded in T3 (405g/6.75m²), while the lowest number of leaves (55.60) were recorded in T2 (270g/6.75m²).

### Leaf size

**a. Leaf length:** Potassium has a great impact on leaf length (Fig. 3). The maximum leaf length (5.87cm) was recorded in T3 (405g/6.75m²) and the lowest leaf length (5.46cm) was observed in T4 (540g/6.75m²).

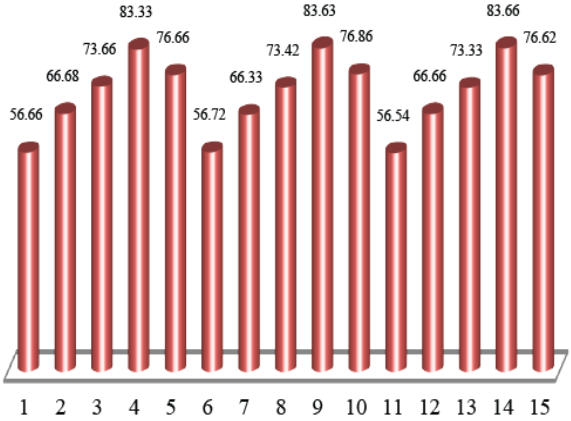


Fig. 1. Survival Percentage of Strawberry plants in three replicates.

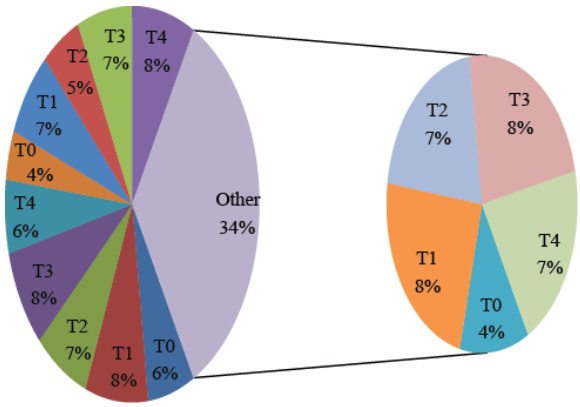


Fig. 2. Number of leaves recorded in three replicates.

**Table 1. Soil analyses of strawberry field at ARS Baffa (Mansehra).**

| pH | ECe(dS/m) | O.M% | Texture | Sand | Silt | Clay | P(ppm) | K(ppm) | N% |
|---|---|---|---|---|---|---|---|---|---|
| 7.4 | 0.281 | 0.91 | Silty loam | 29 | 60 | 10 | 6 | 112 | 0.0045 |

E.C = Electrical conductivity, O.M = Organic matter, K = Potassium, N = Nitrogen

Table 2. Data regarding the survival various morphological and agronomic traits under various treatments of ONC.

| Treatments | Survival percentage | Number of leaves | Leaves length (cm) | Leaves width (cm) | Numbers of branches | Plant height | Canopy size (cm) | Numbers of flowers | Days to 50% flowering | Number of fruits | Fruit weight (g) | Fruit length (cm) | Fruit diameter (cm) | Days to 50% fruiting | Root length (cm) | Crown diameter (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **T0** | 56.640 | 39.533 | 5.7800 | 5.2700 | 20.467 | 17.343 | 11.733 | 6.967 | 128.00 | 21.800 | 155.33 | 2.5667 | 2.0000 | 233.00 | 3.0700 | 1.7367 |
| **T1** | 66.557 | 63.000 | 5.6700 | 5.2400 | 23.467 | 19.550 | 11.627 | 11.867 | **131.67** | 30.733 | 386.67 | 3.6667 | 2.7333 | 229.67 | 2.6200 | 2.2933 |
| **T2** | 73.470 | 55.600 | 5.6167 | 5.2600 | 31.333 | 25.793 | 12.443 | 7.267 | 124.67 | 28.933 | 384.80 | 4.3333 | 3.0667 | 228.00 | 2.7300 | 2.2933 |
| **T3** | **83.540** | **67.000** | **5.8700** | **5.3800** | **35.833** | **32.050** | **13.623** | **14.800** | 120.67 | **43.933** | **411.40** | **6.0333** | **3.9667** | **233.67** | **3.5100** | **2.7367** |
| **T4** | 76.713 | 59.867 | 5.4600 | 5.2200 | 28.533 | 27.160 | 12.703 | 12.133 | 130.67 | 30.800 | 351.73 | 5.0667 | 3.2333 | 230.00 | 2.9200 | 1.8000 |
| CV Value | 0.25 | 14.37 | 1.41 | 0.21 | 4.03 | 1.55 | 1.74 | 13.13 | 1.35 | 13.13 | 1.02 | 5.36 | 4.13 | 0.88 | 0.35 | 9.97 |
| LSD Value | 0.3317 | 15.419 | 0.1511 | 0.0206 | 2.1198 | 0.7103 | 0.4061 | 2.6216 | 3.2430 | 7.7210 | 6.4698 | 0.4375 | 0.2331 | 3.8125 | 0.0193 | 0.4079 |

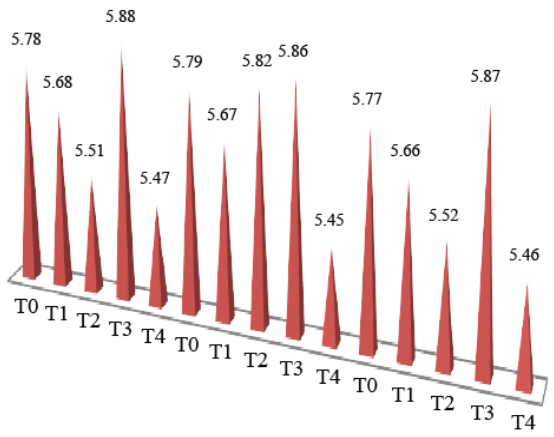


Fig. 3. Leaf lengths of Strawberry plants in three replicates.

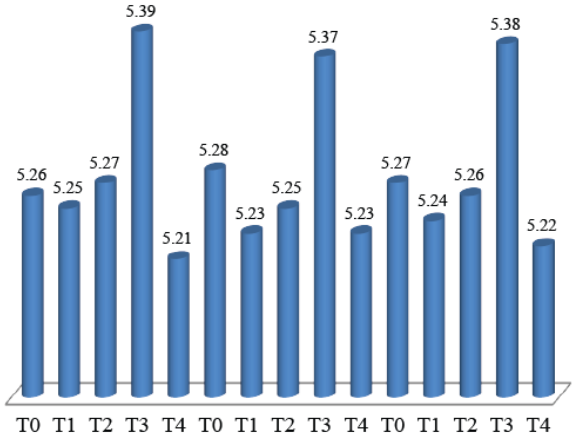


Fig. 4. Leaf widths of Strawberry plants in three replicates.

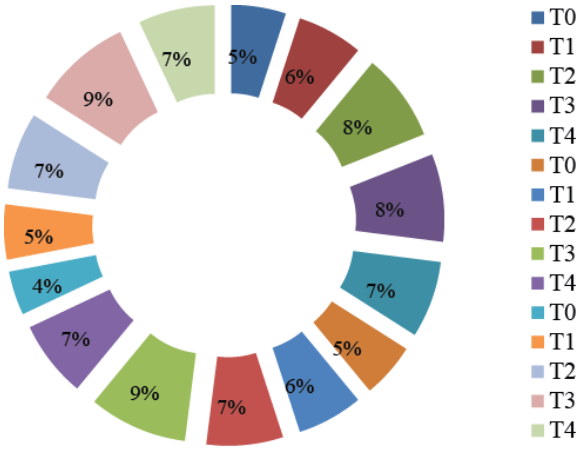


Fig. 5. Number of branches recorded in three replicates.

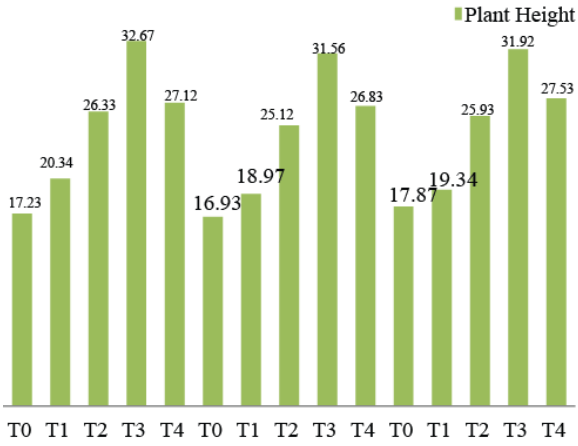


Fig. 6. Replicate data on plant height in experiment.

**b. Leaf width:** In the potassium treatments the mean value for leaf width showed that the highest leaf width (5.38cm) that was observed in T3 (405g/6.75m²), while the lowest leaf width (5.22cm) was recorded in T4 (540g/6.75m²) as shown in Fig. 4.

**c. Numbers of branches:** Potassium has a significant effect on number of branches of strawberry plants (Fig. 5). As for as the mean values of number of branches in selected plants are concerned, the highest number of branches (35.83) were recorded in T3 (405g/6.75m²), while the lowest number of branches (20.46) were recorded in T0 (control).

**Plant height:** The highest plant height (32.05cm) was recorded in T3 (405g/6.75m²), while the lowest plant height (17.34cm) was recorded in T0 (control) in potassium experiment (Fig. 6).

**Canopy size:** The mean values showed data that the potassium has a significant effect on canopy size (Fig. 7). The highest canopy size (13.62cm) was recorded in T3 (405g/6.75m²), while the lowest canopy size (11.62cm) was recorded in T1 (135g/6.75m²).

**Numbers of flowers:** The potassium has a significant effect on number of flowers selected plants (Fig. 8). The highest number of flowers (14.80) were recorded in T3 (405g/6.75m²), while the lowest number of flowers (6.96) were recorded in T0 (Control).

**Days to 50% flowering:** The potassium has an effect on days to 50% flowering (Fig. 9). The maximum days to 50%

Flowering (131.67) was recorded in T1 (135g/6.75m²), while the minimum days to 50% flowering (120.67) was recorded in T3 (405g/6.75m²), T1 (131.67) closely followed by T4 (130.67).

**Number of fruits:** Number of fruits in the selected plants showed that the highest number of fruits (43.93) was recorded in T3 (405g/6.75m²), while the lowest number of fruits (21.80) was recorded in T0 (Control) in the potassium experiment (Fig. 10).

**Fruit weight:** The average values regarding the fruit weight showed that the potassium has a significant effect on it (Fig. 11). The highest fruit weight (411.40g) was recorded in T3 (405g/6.75m²), while the lowest fruit weight (155.33g) was recorded in T0 (Control).

**Fruit size**

**a. Fruit length:** The highest fruit length (3.51cm) was recorded in T3 (405g/6.75m²), while the lowest fruit length (2.73cm) was recorded in T2 (270g/6.75m²) in the potassium experiment (Fig. 12).

**b. Fruit diameter:** The potassium has a significant effect on fruit diameter and the highest fruit diameter (3.96cm) was recorded in T3 (405g/6.75m²), while the lowest fruit diameter (2.00cm) was recorded in T0=Control (Fig. 13).

**Days to 50% fruiting:** The mean values of data showed that the potassium has a significant effect on days to 50% fruiting (Fig. 14). The highest number of days to 50% fruiting were 233.67 recorded in T3 (405g/6.75m²), while the lesser number of days to 50% fruiting were 228.00 recorded in T2 (270g/6.75m²).

**Root length:** The highest root length (3.51cm) was recorded in T3 (405g/6.75m²), while the lowest root length (2.73cm) was recorded in T2 (270g/6.75m²) in potassium experiment (Fig. 15).

**Crown diameter:** Data regarding the crown diameter, that the potassium has a significant effect on it. The highest crown diameter (2.73ccm) was recorded in T3 (405g/6.75m²), while the lowest crown diameter (1.73cm) was recorded in T0 control (Fig. 16).

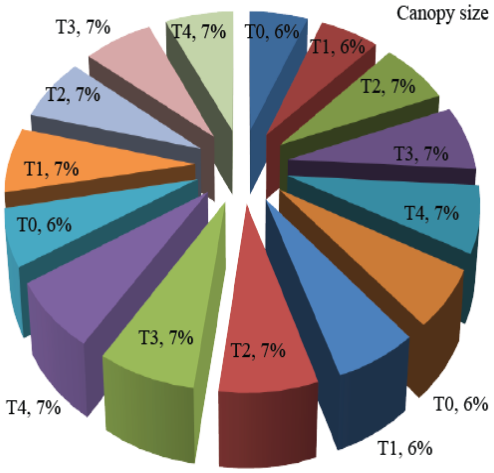


Fig. 7. Canopy size recorded in three replicates.

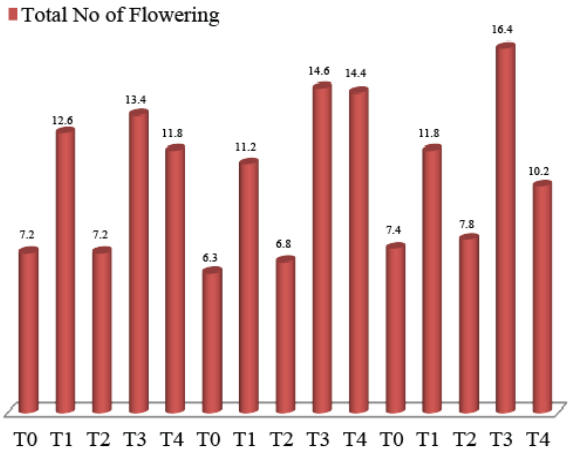


Fig. 8. Number of flowers of Strawberry plants in three replicates.

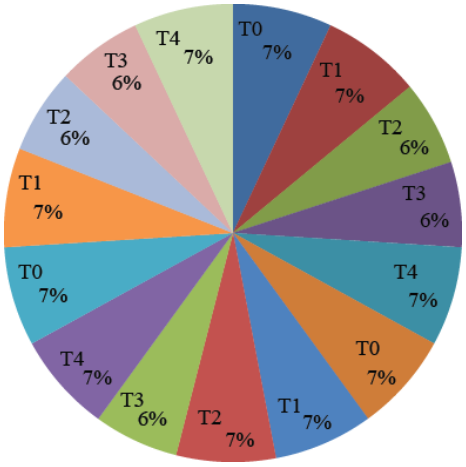


Fig. 9. Days to 50% flowering recorded in three replicates.

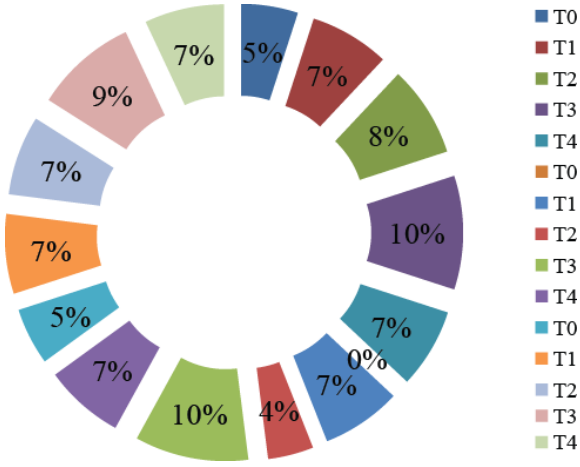


Fig. 10. Number of fruits of Strawberry plants in three replicates.

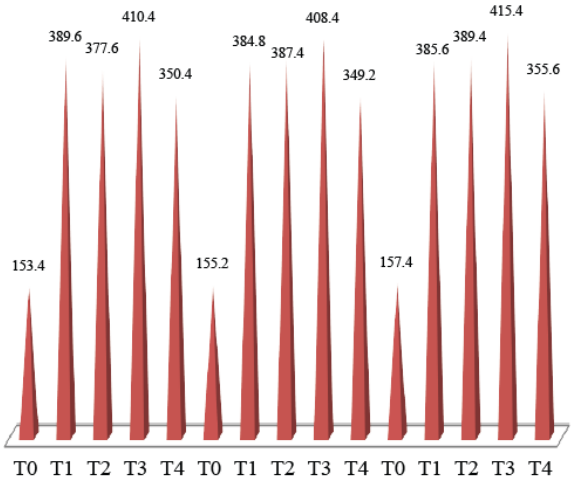


Fig. 11. Fruit weight recorded in three replicates.

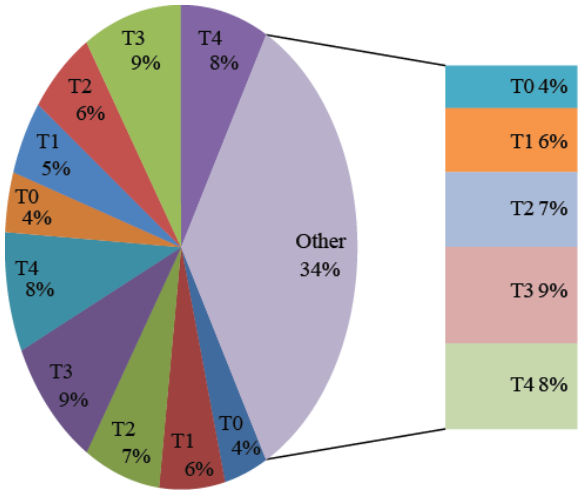


Fig. 12. Fruit length of Strawberry plants in three replicates.

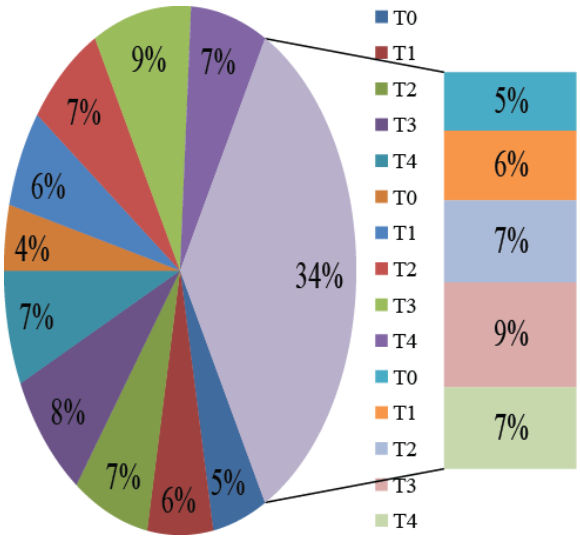


Fig. 13. Fruit diameter recorded in three replicates.

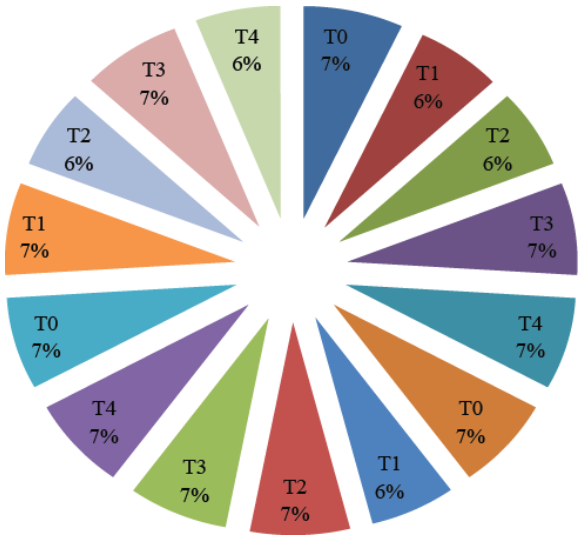


Fig. 14. Days to 50% fruiting of Strawberry plants in three replicates.

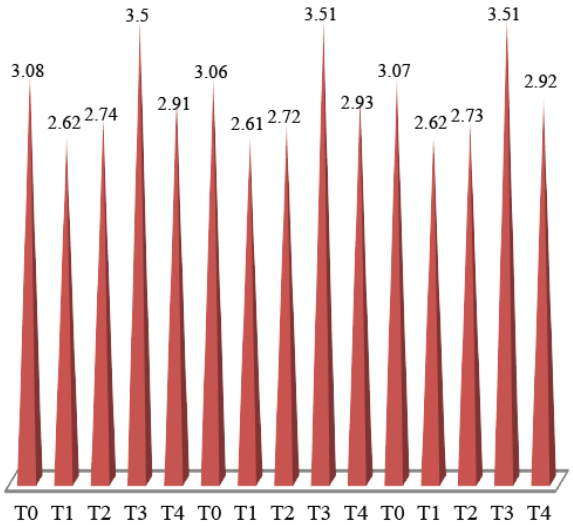


Fig. 15. Root lengths recorded in three replicates.

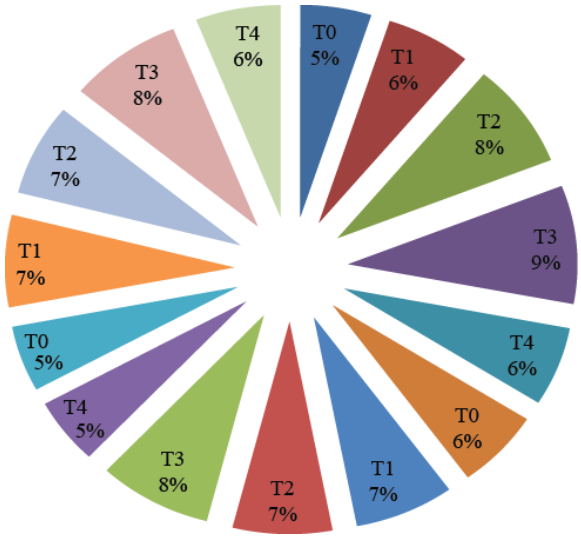


Fig. 16.Crown diameters of Strawberry plants in three replicates.

## Discussion

Our findings show that the highest survival percentage after transplantation was in T3 and minimum survival percentage was in T0. Apart from these levels of K, there might be effects of the climate, change in temperature, health of strawberry runners, physical damages during plantation and other cultural practice as well. Present findings are in line with the results of (Ambre & Comadug, 2010) who found that non-significant survival percentage were observed in egg plant grown under various doses of organic fertilizer conditions. The maximum numbers of leaves were found in T3 and minimum in T0, which is control. Similarly, the maximum leaf length was in T3 and minimum leaf length was in T4. Demirsoy *et al*., 2012 determined the effects of organic matter on growth contents and some growth parameters, 'Sweet Charlie' and 'Camarosa' cultivars of strawberry the maximum branches in the selected plants were under T3 and minimum branches in the selected plants were in T0 (control).The best plant heights were in T3 while lowest plant height was in T0. The higher adsorption of the nutrients resulted in increased plant height (Nehra *et al*., 2001). The findings of Dillep (2005) are in line with the present results that the maximum plant height of red chilli was recorded in plants grown under organic regime. Similar findings were stated by Premsekhar & Rajashree (2009) and Khan (2004) in okra. Moreover the maximum canopy size was recorded under T3 and minimum in T2 and T1 respectively. It might be due to the fact that plant canopy size is relevant to the plant vegetative growth, number of branches and plant height. Increases in any of these components ultimately enhance the plant canopy. The induction of early flower is suggested to be due to better nutritional status of plants, which increase the rate of photosynthesis needed for flower induction (Sharma, 1995). The maximum numbers of flowers were observed in T3 and minimum number was recorded in T1, and control respectively. The maximum numbers of fruits in the selected plants were in T3 and minimum number of fruits selected plants was in T2.The number of branches also increased the number of fruits per plant by providing more space for fruits (Nanthakumar & Veeraraghavathatham, 1999). Results showed that increasing the concentration of potassium to 300 ppm in nutrient solution increased number of fruits selected plants (Ebrahimi *et al*., 2012). The maximum fruit weight was in T3 and minimum fruit weight was in T2. Some results showed that increasing the concentration of potassium to 300 ppm in nutrient solution increased fruit weight Razieh Ebrahimi *et al*. (2012). The maximum fruit length was in T3 and minimum in T0. The better nutritional status of the soil improves the plant nutrient uptake, increased the efficiency of the process of photosynthesis, and hence higher amount of carbohydrates results an increase in fruit size (Jeevansab, 2000).The maximum root length was observed in T3 and minimum root length in T1. Results showed that increasing the concentration of potassium to 300 ppm in nutrient solution increased Root Length (Ebrahimi *et al*., 2012).Many of the growth parameters survival percentage (83.54%), plant height (32.05cm), canopy size (13.6cm), crown diameter (2.73cm), number of branches (35.83), number of leaves (67.00), leaf length (5.87cm), leaf width (5.38cm), root length (3.51cm), total number of flowers (14.80), total number of fruits (43.9), days to 50% fruit (233.67), fruit length (6.03cm), fruit diameter (3.96cm) and fruit weight (411.40g) were recorded in plants grown under T3 (405 g/6.75m$^2$) treatments showed best results. While the minimum values for most of the characteristics were either in T0 (control) or T1 (135g/6.75m$^2$) treatments. The results of the study showed that the potassium significantly affect all the parameters except few, for example leaf length & leaf width.

From the experimental results it was concluded that the potassium showed significant effect on different reproductive, vegetative and qualitative characters of strawberry plant, for example, earliest flowering, maximum plant height, more number of fruits per plant and more number of branches per plant etc.

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