GROWTH AND DEVELOPMENT OF SCION IN RESPONSE TO DEPTH OF CUT IN THE CLEFT METHOD OF AVOCADO (Persea americana MILL) PROPAGATION

P.Y. Adjei and J.K. Titriku
Department of Horticulture,
Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

ABSTRACT
Avocado development has become important in view of the fact that the fruit is one of the richest in terms of nutrients, from the tropical and sub-tropical regions of the world. Earlier work carried out at the Department of Horticulture, Kwame Nkrumah University of Science and Technology, Kumasi, showed that the ‘cleft’ method of avocado propagation showed more systematic plant development in terms of shoot height, leaf number, canopy spread, leaf sizes and stem girth than the side-graft and whip-and-tongue. However, the depth of ‘cut’ in the stock was not studied. Seedling stocks potted after two months were cleft-grafted using 1cm, 2cm, 3cm depth of cut and the control which is not predetermined but ranges between 2cm and 3cm. These were arranged in a randomised complete block design with three replications. The number of graft ‘take’ was observed. Other parameters studied included number of leaves, bud lengths, bud width, leaf sizes (width and lengths), the stock activity or growth, the plant height and the canopy spread. Results showed that plant height increases with depth of cut and the number of ‘take’ also increased with depth. Stock activity was greatest with 1cm cut, indicating that dwarfsness could result. There were more leaves with cut between 2-3cm and the growth of the other parameters was more systematic in the 2cm cut. The ‘cut’ in the cleft method must therefore be made specifically at 2cm depth or between 2-3cm for more uniform growth and development of the union.

INTRODUCTION
The Avocado (Persea americana) belongs to the family Lauraceae, a family of mainly sub-tropical trees and shrubs. Three ecological races (sub-species or botanical varieties) are recognised: the Mexican, Guatemalan and West Indian. These may be regarded as subtropical, semitropical and tropical respectively (Samson, 1992). It is an evergreen tree which grows up to 20 m tall and can be equally wide. Leaves are simple, ovate and spirally arranged (Rice et al., 1993). It is one of the major tropical fruits or species which are of enormous economic importance. The fruit is generally pear-shaped with a
large, round to egg-shaped central seed. The flesh in buttery texture, contains a high percentage of oil and protein, and exceeds even the banana in calorific value (Rice et al., 1993).

The avocado is becoming an increasingly important crop in many tropical and subtropical areas of the world. In Ghana, for example, a fruit may sell at fifty pesewas or five (5) thousand cedis and more depending on the time of the year. However, majority of the trees in these areas are seedlings (Samson, 1992). Apart from the disadvantage of a long juvenile behaviour in using seedlings many important cultivar characteristics which exist in other cultivars such as vigour, resistance or immunity to pests and diseases cannot be combined.

Due to the out breeding nature of the sub-species and human selection with cultivation, there are many interrassial hybrids and some of the principal commercial cultivars, such as Fuerte, Hass, Hall, and Both 7 & 8 are of hybrid origin (Nakasone and Paul, 1999). For avocados consumed locally, certain considerations about the fruit may be neglected but if international trade is an important option then avocados produced from seeds may not be accepted because the seed may not be firmly attached to the pulp, with the result that the fruits are easily damaged during transport and have a low seed to pulp ratio (Gaillard and Godefroy, 1995). This means that grafting or budding is of utmost importance if commercial trade in Ghana should be promoted. According to Gaillard and Godefroy, (1995), there are three main grafting techniques used in propagating avocado today. These are side, cleft and whip-and-tongue grafting. Studies carried out at the Department of Horticulture, KNUST, to compare these three methods by Adjei et al (2005) showed that the cleft-grafts provided the most vigorous seedlings in all the parameters studied. However, the depth of cut in the cleft method was not evaluated. Gaillard and Godefroy, (1995) have suggested a vertical cut of 2 to 4cm, depending on the size of the scion.

The present work carried out at the Department of Horticulture (KNUST) was therefore to assess the effect of 1cm, 2cm, 3cm and a control with 2-3cm cut on graft-take and growth of budded avocado seedlings.

**MATERIALS AND METHODS**

A hundred and twenty healthy seeds of unidentified races or varieties were bought from vendors on the KNUST campus.

The leathery skin or coat were removed and about 0.5cm flesh of the narrow top were cut off to aid germination. The potting medium was a top garden soil which had been screened of all unnecessary debris and pasteurized. The soil was put in polyethylene bags of 10cm × 20 cm dimension with holes for aeration and drainage in their lower third. The seeds were inserted (with the cut surfaces up) in the soil and covered with a thin soil just to cover the seeds in Mid October, 2006. After about a month, germination was effected.

**Graftage**

The cultivar used as scion was an elongated fruit, yellow-fleshed and its seed was not tightly embedded in the fruit. The flesh thickness was 1.5cm. It was a Guatemalan and West Indian hybrid and generally weighs from 400g upwards. On 2nd and 3rd January, 2007 (about two-and-a-half months after sowing) cleft graft was administered on ninety-six seedlings.

There were four different treatments. These were 1cm, 2cm, 3cm and a control with about 2-3cm cut which the graft man normally uses. Each treatment had twenty-four (24) seedlings grafted.

Terminal bud woods with similar diameters (about 7mm) were fetched from the designated cultivar which was located in Kumasi in the evening of the previous day. The budwood was treated with Kocide (fungicide) by dipping them in a solution for about ten minutes.

They were then allowed to dry before the grafting operation. The seedling root stocks upon which the budwoods were grafted were first topped, as...
and development of scion...

...and when the operation began at about 18 cm from the base of the seedlings. They were vertically and centrally split to the different depths or treatments. The budwoods were prepared in a wedge form with length similar to the depth of cut. They were then inserted and tied with the strip of budding tape. The whole operation was covered with polythene material (those used by ice-water sellers) and tied at the base of the graft. The grafted material was arranged in a randomized complete block design (RCBD) with three replicates. Each replicate had eight grafted treatments. Since the period of grafting (dry season) was characterized with high day and night temperatures with humidity sometimes as low as 45% (observed), the whole arrangement was put under shed covered with palm fronds on top and every side. Watering was done not only on seedlings but on the floors and sides of the shed to boost humidity and to reduce the micro temperature around the plants.

Data collection
After twenty eight days of graft development, the budding tape and polyethylene covers were removed for signs of successful grafts. A weekly data was taken from 15th February, 2007 on the number of leaves (by counting), the bud length in centimeters (with the meter rule), the bud width or size of the growing bud (in cm), leaf width and length. The rest were the stock activity (or development of the stock); the plant height and plant canopy were both taken on 21st May, 2007.

Statistical analysis
ANOVA was used for the analysis of variance and the separation of means performed by using the LSD test.

RESULTS
Plant Height and Canopy spread
The height, measured after three months of growth and development showed that height increased with depth of cut and the unpredicted (control) recorded the highest with 45.1 cm and this was followed by the 2 cm cut (T2) with 44.0 cm. The 1 cm (T1) cut recorded the least with 41.8 cm. No significant differences emerged. The Canopy spread was also measured after three months of plant growth and development. The 3 cm cut (T3) recorded 32.6 cm and was the highest. This was followed by the unpredicted (control) with the value of 32.4 cm. The 2 cm (T2) cut followed next with 30.6 cm and lastly by the 1 cm (T1) cut with 26.5 cm. There were no significant differences.

Graft ‘take’
This was not significantly different amongst the treatments. It was the control that made 50% take. The 1 cm and 2 cm cut each made 41.6%, whereas the 3 cm cut made 45.8%.

Scion Length and Width
Scion lengths were very similar for the 2 cm, 3 cm and the unpredicted (about 2.5 cm) cuts (Fig 1) at the beginning of the data collection (15/03/07). By the 8th (12/04/07) week, the 2 cm cut and the control had slightly different values, this was repeated at the 9th and 10th weeks. No statistical differences emerged. After three months, the control had a greater value than either the 2 cm or 3 cm cut.

As far as the scion width was concerned, all the treatments had similar values at the beginning of the measurement (Fig. 2). At the 8th week (12/04/07), they were all similar again except the 1 cm cut which had a lower value. This was repeated at the 9th week (Fig 2). At the 10th week, however, the 1 cm cut had a slightly higher value than the rest of them. After three months of graft development, only the control had a slightly higher value than the others.

Leaf Length and Width
Leaf length was lowest for the 1 cm cut and highest for the 3 cm cut at the beginning (Fig. 3). It grew quite systematically and by the 8th week (12/04/07), the 1 cm cut was similar to the 2 cm cut. The 3 cm cut had the highest leaf length by
Fig. 1 Bud (Scion) length

Fig. 2 Bud (Scion) width
Fig. 3: Leaf length

Fig. 4: Leaf width
the 8th week. No statistical differences emerged. By the 9th week, leaf lengths were very similar. After three months, those with deeper cuts (3 cm and the control) had greater leaf length values than the 1 cm or 2 cm cut. Statistical differences emerged (Fig 3).

In the case of the Leaf width, all the values were larger than the 1 cm cut at the beginning (Fig 4). By the 8th week (12/04/07), however, all of them had similar values around five (5) centimeters. By the 9th week, the 1 cm cut was the lowest. After three months of graft growth and development, the 1 cm cut recorded the lowest value. The highest was attained by the 3 cm cut (Fig. 4).

**Number of Leaves**
The number of leaves grew from an average of 3.3 at the beginning (15/02/07) to an average of 21.0 after three months (21/05/07) for the 1 cm cut. It grew from 13.3 to 25.0 for the 2 cm cut over the same period; from 16.7 to 28.3 for the 3 cm cut and then from 10.0 to 28.7 for the control. There were differences statistically.

**Stock Activity (growth)**
Growth and development of the stock was not quite systematic. At the beginning of the measurement (15/02/07), most of the sizes were 0.8 cm, except the 3 cm cut that was 0.7 cm; there was not much differences at the 8th week. The 1 cm cut recorded 1.0 cm at this period. The 2 cm cut had 0.9 cm and 0.8 cm in the 3 cm cut with 1.0 cm in the control. After three months of growth and development, the stock in the 1 cm cut had attained 1 cm and 0.9 cm for the 3 cm cut, whereas the control was 1 cm. there was statistical differences from the 1st week to the 8th week of graft development.

**DISCUSSION**

**Plant Height and Canopy Spread**
It was generally observed that plant height and canopy spread increased with depth in cut. Since the vertical cut provides a direct contact with the primary areas (meristematic) of tissue growth, a deeper cut could mean more of such tissues available for regeneration and formation of secondary tissues (Gaillard and Godefroy, 1995) to augment graft union and subsequent growth and development. Since the seedlings were very young (juvenile), cell division could be very rapid to fill the empty spaces and then aid growth.

**Graft ‘take’**
The percent ‘take’ followed similar trend as those of plant height and canopy spread. Those with the deeper cuts recorded more percent ‘take’. The insignificant differences might be due to the fact that, it was the same operation administered. However the generally low percent ‘take’ might be due to the seasonal effect, (dry season) which could particularly affect cuts made from the parent trees.

**Scion Length and width**
The cleft method of avocado propagation was generally found to increase seedling growth, and development (Adjei et al, 2005) compared to the side-grafting and the whip-and-tongue. This was due to the fact that it (cleft) resulted in the most vigorous seedling growth in terms of shoot height, leaf numbers, canopy spread, leaf sizes and stem girth. This vigour is augmented by the death of cut in the present study. Since the scion length and width would determine when the seedling goes to the field, the exhibition of different scion growth characteristics would mean that the depth of cut is as equally important as which method amongst the main three is employed. This difference in scion development due to the depth of cut (not significant though) could emphasize that precision vertical incision must not be take for granted.

**Leaf Length and Width**
The depth of cut influenced the leaf length and width. Those with deeper cuts showed greater lengths and widths. If these cuts increased the meristematic regions and therefore differentiations, nutrients absorption could also be influenced. Since the faster expanding leaves could
Absorb radiation and increase photosynthesis, these would augment greater or higher leaf length and width.

Number of leaves
Satoo et al (1956) made early observation that an increase in the number of leaves was influenced by wood production. The greater the cut, the better it is for more cells to differentiate to wood and therefore leaves. Koslowksi (1971) also reported that increase in leaf production affect the girth of trees (with bigger girth sizes when number of leaves increase) this might mean that better plant girth could result.

Stock Activity (growth)
The stock activity could give an indication of the nature of 'take' and the ensuing union. If the union is quite comprehensive, the stock should normally not tend to overgrow the scion or vice versa. The significant differences exhibited could mean there could be greater stock development in the 1 cm cut, especially. This is perhaps clear in the other growth parameters where the 1cm cut was in most cases demonstrating lower values. The stock in the control showed similar stock activity.

It however had greater (in some cases the greatest) growth parameters than the 1 cm cut.

CONCLUSION
Growth parameters studied in the cleft method were influenced by the depth of cut. The greater the depth, the better the graft 'take' and other growth parameters like scion growth and less stock activity (growth). Cuts must therefore be made greater than 1 cm and probably less than 4 cm.

ACKNOWLEDGEMENT
The authors are grateful to the Department of Horticulture for material support and particularly to the Principal Technician of the fruits section (Mr. Asante-Asiedu).

REFERENCES


## APPENDIX

A table of significant of mean differences

### Leaf Length

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d,f</th>
<th>ss</th>
<th>ms</th>
<th>vr</th>
<th>F pr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reps stratum</td>
<td>2</td>
<td>3.188</td>
<td>1.594</td>
<td>0.44</td>
<td></td>
</tr>
<tr>
<td>Reps<em>units</em>stratum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRTS</td>
<td>3</td>
<td>49.082</td>
<td>16.361</td>
<td>4.55</td>
<td>0.055</td>
</tr>
<tr>
<td>Residual</td>
<td>6</td>
<td>21.557</td>
<td>3.593</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>73.826</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grand mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRTS</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>6.27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10.78</td>
<td>11.57</td>
<td>9.57</td>
<td></td>
</tr>
</tbody>
</table>

### Leaf Number

**Week 1**

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d,f</th>
<th>ss</th>
<th>ms</th>
<th>vr</th>
<th>F pr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reps stratum</td>
<td>2</td>
<td>15.17</td>
<td>7.58</td>
<td>0.500</td>
<td></td>
</tr>
<tr>
<td>Reps<em>units</em>stratum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRTS</td>
<td>3</td>
<td>291.67</td>
<td>97.22</td>
<td>6.42</td>
<td>0.027</td>
</tr>
<tr>
<td>Residual</td>
<td>6</td>
<td>90.83</td>
<td>15.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>397.67</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grand mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRTS</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13.3</td>
<td>16.7</td>
<td>10.0</td>
<td></td>
</tr>
</tbody>
</table>

**Week 4**

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d,f</th>
<th>ss</th>
<th>ms</th>
<th>vr</th>
<th>F pr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reps stratum</td>
<td>2</td>
<td>91.167</td>
<td>45.583</td>
<td>14.52</td>
<td></td>
</tr>
<tr>
<td>Reps<em>units</em>stratum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRTS</td>
<td>3</td>
<td>176.917</td>
<td>58.972</td>
<td>18.79</td>
<td>0.002</td>
</tr>
<tr>
<td>Residual</td>
<td>6</td>
<td>18.833</td>
<td>3.139</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>286.917</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grand mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRTS</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>14.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16.00</td>
<td>18.33</td>
<td>24.67</td>
<td></td>
</tr>
</tbody>
</table>
### Growth and Development of Scion...

<table>
<thead>
<tr>
<th>Week</th>
<th>Source of Variation</th>
<th>d,f</th>
<th>ss</th>
<th>ms</th>
<th>vr</th>
<th>F pr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reps stratum</td>
<td></td>
<td>128.167</td>
<td>64.083</td>
<td>39.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reps<em>units</em>stratum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TRTS</td>
<td>3</td>
<td>94.917</td>
<td>31.639</td>
<td>19.31</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>6</td>
<td>9.833</td>
<td>1.639</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>11</td>
<td>232.917</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grand mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TRTS</td>
<td>1</td>
<td>14.33</td>
<td>16.67</td>
<td>18.67</td>
<td>22.00</td>
</tr>
<tr>
<td></td>
<td>Week 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Source of variation</td>
<td>d,f</td>
<td>ss</td>
<td>ms</td>
<td>vr</td>
<td>F pr</td>
</tr>
<tr>
<td></td>
<td>Reps stratum</td>
<td></td>
<td>132.0</td>
<td>167</td>
<td>66.083</td>
<td>61.00</td>
</tr>
<tr>
<td></td>
<td>Reps<em>units</em>stratum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TRTS</td>
<td>3</td>
<td>58.000</td>
<td>19.333</td>
<td>17.85</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>6</td>
<td>6.500</td>
<td>1.083</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>11</td>
<td>196.667</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grand mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TRTS</td>
<td>1</td>
<td>15.00</td>
<td>16.67</td>
<td>18.00</td>
<td>21.00</td>
</tr>
<tr>
<td></td>
<td>Week 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Source of variation</td>
<td>d,f</td>
<td>ss</td>
<td>ms</td>
<td>vr</td>
<td>F pr</td>
</tr>
<tr>
<td></td>
<td>Reps stratum</td>
<td></td>
<td>24.667</td>
<td>12.333</td>
<td>4.44</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reps<em>units</em>stratum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TRTS</td>
<td>3</td>
<td>97.583</td>
<td>32.528</td>
<td>11.71</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>6</td>
<td>16.667</td>
<td>2.778</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>11</td>
<td>138.917</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grand mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TRTS</td>
<td>1</td>
<td>14.00</td>
<td>18.67</td>
<td>20.00</td>
<td>21.67</td>
</tr>
<tr>
<td></td>
<td>Week 8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Source of variation</td>
<td>d,f</td>
<td>ss</td>
<td>ms</td>
<td>vr</td>
<td>F pr</td>
</tr>
<tr>
<td></td>
<td>Reps stratum</td>
<td></td>
<td>61.167</td>
<td>30.583</td>
<td>14.30</td>
<td></td>
</tr>
<tr>
<td>Reps<em>units</em>stratum</td>
<td>df</td>
<td>ss</td>
<td>ms</td>
<td>vr</td>
<td>F pr</td>
<td></td>
</tr>
<tr>
<td>--------------------</td>
<td>-----</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>TRTS</td>
<td>3</td>
<td>104.917</td>
<td>34.972</td>
<td>16.35</td>
<td>0.003</td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td>6</td>
<td>12.833</td>
<td>2.139</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>178.917</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grand mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRTS</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15.00</td>
<td>19.67</td>
<td>19.67</td>
<td>23.83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source of variation</td>
<td>d,f</td>
<td>ss</td>
<td>ms</td>
<td>vr</td>
<td>F pr</td>
<td></td>
</tr>
<tr>
<td>Reps stratum</td>
<td></td>
<td>7.167</td>
<td>3.583</td>
<td>0.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reps<em>units</em>stratum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRTS</td>
<td>3</td>
<td>162.000</td>
<td>54.000</td>
<td>6.55</td>
<td>0.025</td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td>6</td>
<td>49.500</td>
<td></td>
<td>8.250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>218.667</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grand mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRTS</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13.00</td>
<td>21.00</td>
<td>18.00</td>
<td>22.67</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**STOCK ACTIVITY**

<table>
<thead>
<tr>
<th>Reps<em>units</em>stratum</th>
<th>df</th>
<th>ss</th>
<th>ms</th>
<th>vr</th>
<th>F pr</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRTS</td>
<td>3</td>
<td>0.052158</td>
<td>0.017386</td>
<td>5.86</td>
<td>0.032</td>
</tr>
<tr>
<td>Residual</td>
<td>6</td>
<td>0.017817</td>
<td>0.002969</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>0.074492</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grand mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRTS</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.840</td>
<td>0.757</td>
<td>0.720</td>
<td>0.887</td>
<td></td>
</tr>
<tr>
<td>Week 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source of variation</td>
<td>d,f</td>
<td>ss</td>
<td>ms</td>
<td>vr</td>
<td>F pr</td>
</tr>
<tr>
<td>Reps stratum</td>
<td></td>
<td>0.004117</td>
<td>0.002058</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>Reps<em>units</em>stratum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRTS</td>
<td>3</td>
<td>0.48200</td>
<td>0.016067</td>
<td>5.14</td>
<td>0.043</td>
</tr>
<tr>
<td>Residual</td>
<td>6</td>
<td>0.018750</td>
<td>0.003125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>0.071067</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

60 *Journal of Ghana Science Association, Vol. 10 no. 2, December 2008*
<table>
<thead>
<tr>
<th>Week</th>
<th>Source of variation</th>
<th>d, f</th>
<th>ss</th>
<th>ms</th>
<th>vr</th>
<th>F, pr</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grand mean</strong> TRTS</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>0.0897</td>
<td>0.773</td>
</tr>
<tr>
<td><strong>Week 6</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reps<em>units</em>stratum</td>
<td>2</td>
<td>0.001950</td>
<td>0.000975</td>
<td>0.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRTS</td>
<td>3</td>
<td>0.032667</td>
<td>0.010889</td>
<td>6.68</td>
<td>0.024</td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td>6</td>
<td>0.009783</td>
<td>0.001631</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>0.044400</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Grand mean</strong> TRTS</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>0.897</td>
<td>0.810</td>
</tr>
<tr>
<td><strong>Week 7</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reps<em>units</em>stratum</td>
<td>2</td>
<td>0.000150</td>
<td>0.000075</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRTS</td>
<td>3</td>
<td>0.031025</td>
<td>0.010343</td>
<td>6.86</td>
<td>0.023</td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td>6</td>
<td>0.009050</td>
<td>0.001508</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>0.040225</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Grand mean</strong> TRTS</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>0.950</td>
<td>0.903</td>
</tr>
<tr>
<td><strong>Week 8</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reps<em>units</em>stratum</td>
<td>2</td>
<td>0.001617</td>
<td>0.000808</td>
<td>0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRTS</td>
<td>3</td>
<td>0.034967</td>
<td>0.011656</td>
<td>4.61</td>
<td>0.053</td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td>6</td>
<td>0.015183</td>
<td>0.002531</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>0.051767</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Grand mean</strong> TRTS</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>0.967</td>
<td>0.890</td>
</tr>
</tbody>
</table>