BIBLIOGRAPHY

BAYENG, JUNE O. APRIL 2011. Rooting of Pineapple Crown (*Ananas Comosus L.* Merr) as Affected by Different ANAA Concentrations. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

This study was conducted at the Pomology project, Department of Horticulture, College of Agriculture, Benguet State University, La Trinidad, Benguet from November 2010 to January 2011 to evaluate the effects of the different ANAA concentrations on the rooting of sliced pineapple crown and to establish the best ANAA concentration that would enhance rooting of the sliced pineapple crown.

Results show that the sliced crown treated with 250 ppm ANAA concentrations were the earliest to form root, had the longest average root length, production of more roots and had the highest percentage of survival with a mean of 90.47%.

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INTRODUCTION

Pineapple (*Ananas comosus L. Merr.)* which belongs to *Bromelieaceae* family ais one of the commercialized fruit crops in the Philippines which is extensively cultivated in the country. According to PCARRD (1995), products of the large plantations in Mindanao is mainly for export while the fruits produced in Luzon and Visayas supply the domestic markets. In 1993, a total of 66,925 ha were planted to pineapple producing 1,254,375 tons valued at more than Php 5,230 million.

Pineapple is considered as one of the highly marketable fruit crops in the international market. Pineapple is grown not only for its fruit but also for the fiber processed from its leaves. It is a source of a lustrous transparent fabric called pina fibers, where the Philippine "barong tagalong" for men and blouses and dressed for women are made. A special kind of paper that is thin and pliable with a smooth surface is also made from it.

Other processed products derived from pineapple includes dried pineapple glazed or crystallized concentrate, canned slices, and chunks or mixed with other fruits and pickles, jams, marmalade, candy or *nata de pinya.* The juice is a a very good source of alcohol and vinegar. It is also used in the biological coagulation of rubber. The by-products can also be used as cattle feeds (Bautista 1994).

Inspite of the economic potential of pineapple in the Philippines, propagation techniques must be improved.

There are several rooting techniques or practices used by the pineapple growers in Benguet. However, up to the present, there has been no rooting media formulation established that would effectively hasten rooting of the sliced pineapple crown. In this

endeavor, if slicing pineapple crown can be proven as one potential technique in propagating the crop, it may perhaps solve the problem on the quality and rate of rooting by using appropriate growth regulators, different concentrations, formulations and application as cited by Alingcayon (2000). Thus, this study was conducted to offer some insights and information to the end-users, the farmer themselves and future researchers on rooting techniques.

The study aimed to evaluate the effects of the different ANAA concentrations on the rooting of sliced pineapple crowns; and to establish the best ANAA concentration that would enhance rooting of the sliced pineapple crown.

The study was conducted at the Pomology project, Department of Horticulture, College of Agriculture, Benguet State University from November 2010 to January 2011.

REVIEW OF LITERATURE

The Crop

Pineapple belongs to the family *Bromeliaeceae*. A perennial and monocotyledonous herb, growing up to 1 m in height. Leaves are narrow, thick, rosette shapes, with a pointed tip and spiny margin, and are about 60 to 80 in number. The inflorescence is compact and bears 100 to 200 flowers. Flowers are perfect, opening first at the basal portion and later moving upward to produce fruit parthenocarpically. Fruit is cylindrical and dark green, changing from yellow flesh (Coronel and Verheij, 1992).

Types of Planting Material

In pineapple, production of planting materials can be done by cutting the stems lengthwise and burying them horizontally with the cut portion facing down. After 2-3 weeks, sprouts will come out from these cut stems (Bautista, 1994).

Pineapple is propagated through asexual method and there are three types of planting materials; the suckers, slips and crowns.

Suckers. Suckers are shoots arising on plants from below ground. Suckers are dug out and cut from the parent plant. In some cases, part of the old root maybe retained, although most new roots arise from the base of the suckers. It is important to dig the sucker out rather than pull it, to avoid injury to its base. Suckers are treated essentially as a rooted layer or as a cutting, in case few or no roots have formed. They are usually dug during the dry season (Hartman and Kester, 1990).

Crown. Crown is the shoot produced on top of a fruit. In herbaceous perennials, the crown is the part of the plant from which new shoots arises annually, and crown are usually used for propagation taken earlier before or at the time of harvest.

Slips. Slips are the most popular type of planting materials for commercial use. Slips can be stored for relatively long time and still retain sufficient vigor in replanting.

According to Hartman and Kester (1990) all types of planting materials must be cured or dried for one to several weeks after they are cut from the mother plant. This purpose allows a callus layer to develop over the cut surface, reducing losses from decay organisms after they are planted.

Rooting Hormone

All aspect of plant and development are influenced by plant growth regulators, or plant hormones (Ingles, 2000) Riely and Shry (1999) reported that the development of rooting hormones made the possibility of rooting certain plant cuttings that were considered impossible to root before. These chemicals also shortened the length of time required to root cuttings.

Wilkens (1969) said that the most common growth regulators are gibberilic acid (GA3), naphthalene acetic acid (NAA), Indolebutyric acid (IBA), cytokinins and abscisic acid. Riely and Shry (1999) further stated that alpha-napthalene acetic acid (ANAA) was also enumerated as widely used. Ingles (2000) reported that auxins such as idole acetic acid (IAA) can be included.

Hormone Concentration

Bleasedale (1975) stated that hormones may be used to overcome the inherent difficulties encountered in rooting; however, it can also inhibit growth of cutting if used at wrong concentration. It is important to consider the specific concentrations ranging from each individual species and cultivars. Adriance and Brison (1955) reported that growth regulators are more effective if the concentration is just below toxic level. Halfacre and Barden (1979) stated that high concentration may injure or kill the cuttings and too low concentrations may be ineffective. Weaver (1972) added that high concentration of growth regulators do not produce abnormalities in root formation and necrosis on tissues.

Rooting in Relation to Variety

Nye and Tinker (1977) have accepted the presence of differences in rooting patterns of different plant species. Every species has its inherent make-up. Poincelot (1980) stated that the hereditary potentials play much in the biochemical processes of plants and to regulate the pattern of plant development. Ingles (2000) enumerated reasons that could inhibit rooting of different species such as (1) naturally occurring rooting inhibitors in the plant tissue, (2) the lack of one are more rooting co-factors, found by several researchers to work synergistically with auxin in root initiation, or (3) a continuous schlerenchyma ring between the phloem and the cortex creates a physical barrier to developing roots as they attempt to emerge from the center of the vascular core. The effect of variety and their inherent factors is likewise considered. Although, Last *et al,* (1983) paid little attention to the inherent factors in rooting of trees. However, several studies showed their great effect on the rooting of lower plants.

The Root: Its Functions and Importance

According to Conquist, (1982) roots are typically the organs that anchor the plant into the soil and absorb water and soil nutrients. Berg (1997) mentioned that roots perform three main functions: the anchorage, absorption conduction and storage. Roots store surplus carbohydrates produced by the leaves as starch or sugar. In addition, Mauseth (1998) stated that roots also produce several hormones wherein shoot growth and development depend on the hormones cytokinin and gibberellins imported from the roots.

Anon (2000) stated that most roots g row underground so they are not easily seen added by Riely and Shry (1999). Hutchison (1980) also noted the roots are considered to be “stick in-the-mud”.

Moore *et al* (1995) again stated that root are important to plant growth because they provide chlorenchyma cells for water and dissolved nutrients. Roots are like photosynthetic cells with soils moisture and nutrients, and the absorption and transportation minerals from the soil to the top of plant or other plant part such as the shoots.

Adventitious Roots Formation

Brown (1996) mentioned that formation of adventitious roots can be divided into two phases. First is initiation, which is characterized by cell division and the differentiation of certain cells into a root initial and second growth, in which root initial expands by a combination of cell division and elongation. Ingles (2000) stated that adventitious roots are initiated in herbaceous plants from points just outside or between the vascular bundles. Meyer and Anderson (1973) reported that the roots initially arise

from the apical cells. Ingles (1994) identified them as growing points of adventitious roots and maybe formed but dormant in the vegetative tissue before the cuttings are taken. Hartman and Kester (1975) explained that they continue to divide forming a group of many cell which later develops into root primodial, from which the formation of adventitious roots begins coupled by distribution of roots.

MATERIALS AND METHOD

Materials

The materials used were pineapple crown, rooting hormone (ANAA), polyethylene bags, knife, compost and garden soil (1:1), beaker and labeling materials.

Methods

Following the Randomized Complete Block Design (RCBD), the field were divided into three (3) rows with each row representing a replication. Each row was further subdivided into 5 units representing the five (5) treatments. There were at least eight sliced pineapple crown in every replication in all five treatments.

Treatments were the following:

T_1 = 0 (Control)

T_2 = 250

T_3 = 500

T_4 = 750

T_5 = 1,000

Preparation of the Crown

Selected crown intended for the study was properly cleaned and sliced from the base section and dipped for thirty (30) minutes in the different ANAA concentrations. After treatment, the sliced pineapple crown was planted in 4”x5”x7” polyethylene plastic bags with 1:1 part by volume of compost and garden soil as the potting media for rooting.

Care and maintenance were given to the entire crow planted throughout the duration of the study.

Data Gathered

The data gathered and subjected to variance analysis and mean separation test by Duncan's Multiple Range (DMRT) were as follows:

1. Number of days to visible root formation. This was gathered by counting the number of days from treatment until the roots were about 0.5 cm long observed on the destructive samples.

2. Average root length (cm). The length of the roots in every sliced crown were measured one month from planting and the average length was computed as follows:

$$\text{Average root length} = \frac{\text{Length of Roots}}{\text{Number of Roots Produced per Plant}}$$

3. Percentage of rooted slice crown. This was obtained one month after planting the crown in the rooting media using the formula:

$$\text{Percentage of rooted crown} = \frac{\text{Number of Rooted Crown}}{\text{Total Number of Sliced Crown Planted}} \times 100$$

4. Average number of roots produced per crown. All the formed roots of every crown were counted one month from planting in the rooting media and was computed as follows:

$$\text{Average number of roots} = \frac{\text{Total Number of Roots Produced}}{\text{Number of Crown Samples Planted}}$$

5. Percentage of survival. This was obtained by using the formula:

$$\% \text{ Survival} = \frac{\text{Number of Sliced Crown Survive}}{\text{Total Number of Sliced Crown}} \times 100$$

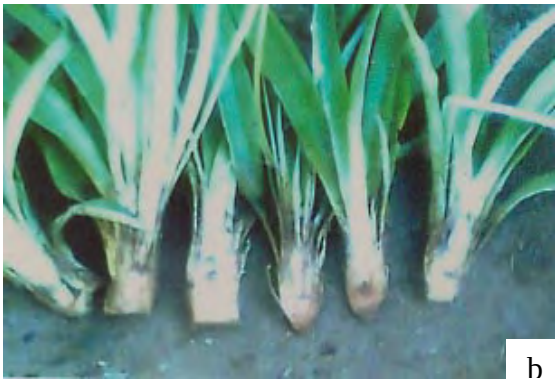
6. Number of days the crown are ready for transplanting. This was obtained when the roots from the samples of rooted crown have fully developed roots.

7. Number of days to emergence of new shoot. This was obtained by counting the days from planting to new shoots formation.

8. Documentation. This was taken through pictures.

- Preparation of the planting materials
- Dipping in ANAA solutions
- Planting in plastic bag
- Root length of treatments one month from rooting
- Overview of the experiment

a



b

c

Figure 1. Preparation and the overview of the experimental) Overview of the experimental area; b) sliced pineapple crowns before treatment; c) sliced pineapple crowns dipped in various ANAA concentrations before planting

RESULTS AND DISCUSSION

Number of Days to Visible Root Formation

Statistical analysis shows that there were significant differences among the treated and untreated pineapple crowns regarding days from planting to visible root formation as shown in Table 1.

Results showed that crowns treated with 250 ppm ANAA were the earliest to initiate visible roots with a mean of 19 days. It was followed by the crowns treated with 500 ppm ANAA with a mean of 21.33 days and the untreated crowns or the control with a mean of 21.66 days but is comparable to the crowns treated with 750 ppm ANAA with a mean of 22.33 days. The crowns treated with 1000 ppm ANAA had taken longer days to root formation having a mean of 24 days.

Results agree with the statement of Bleasedale (1973), that although hormones were known to promote earlier rooting of various kinds of cuttings, it is important to take into consideration individual plant species and different cultivar needs and specific concentrations to be used.

Reily and Shry (1999) also stated that some plants root easily from hard wood. In addition, they stated that cuttings require essentially the same conditions that seeds need to germinate; moisture oxygen and warmth {%^{0}F (% ^{0}C)} or above for the cuttings to root.

Table 1. Number of days to visible root formation

ANAA CONCENTRATION	MEAN (days)
0 ppm	21.66 ab
250 ppm	19.00 b
500 ppm	21.33 ab
750 ppm	22.33 ab
1,000 ppm	24.00 a

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

Table 2 shows that there were no significant statistical differences observed on the average root length of pineapple crowns as affected by the different concentrations of ANAA.

However, numerical results showed that the application of 250 ppm ANAA promoted the production of longer roots with a mean of 1.98 cm followed by the untreated crowns or the control (0 ppm) with a mean of 1.86 cm then followed further by the crowns treated with 500 ppm, 1000 ppm and 750 ppm ANAA all having a mean of 1.84 cm, 1.62 cm and 1.58 cm respectively.

These results correlate with the findings of Banwa (2010), that 250 ppm ANAA generally affected the rooting of tamarillo shoot tip cuttings. Cuttings treated at this concentration formed the longest roots. In addition, Akyapat (2009) reported that 250 ppm ANAA with 30 minutes soaking produced the longest and greater number of roots in passion fruit shoot tip cuttings.

Table 2. Average root length

ANAA CONCENTRATION	MEAN (cm)
0 ppm	1.86 a
250 ppm	1.98 a
500 ppm	1.84 a
750 ppm	1.58 a
1,000 ppm	1.62 a

*Means of the same letter are not significantly different at 5% level of DMRT

Delvin and Jackson (1961), stated that real stimulation of root elongation maybe achieved if enough concentrations are used.

The results in Table 3 shows no significant differences on the percentage of rooted sliced crown as affected by different ANAA concentrations observed within one month. Figure 2 shows the rooted pineapple crowns one month after treatment.

0 ppm

250 ppm

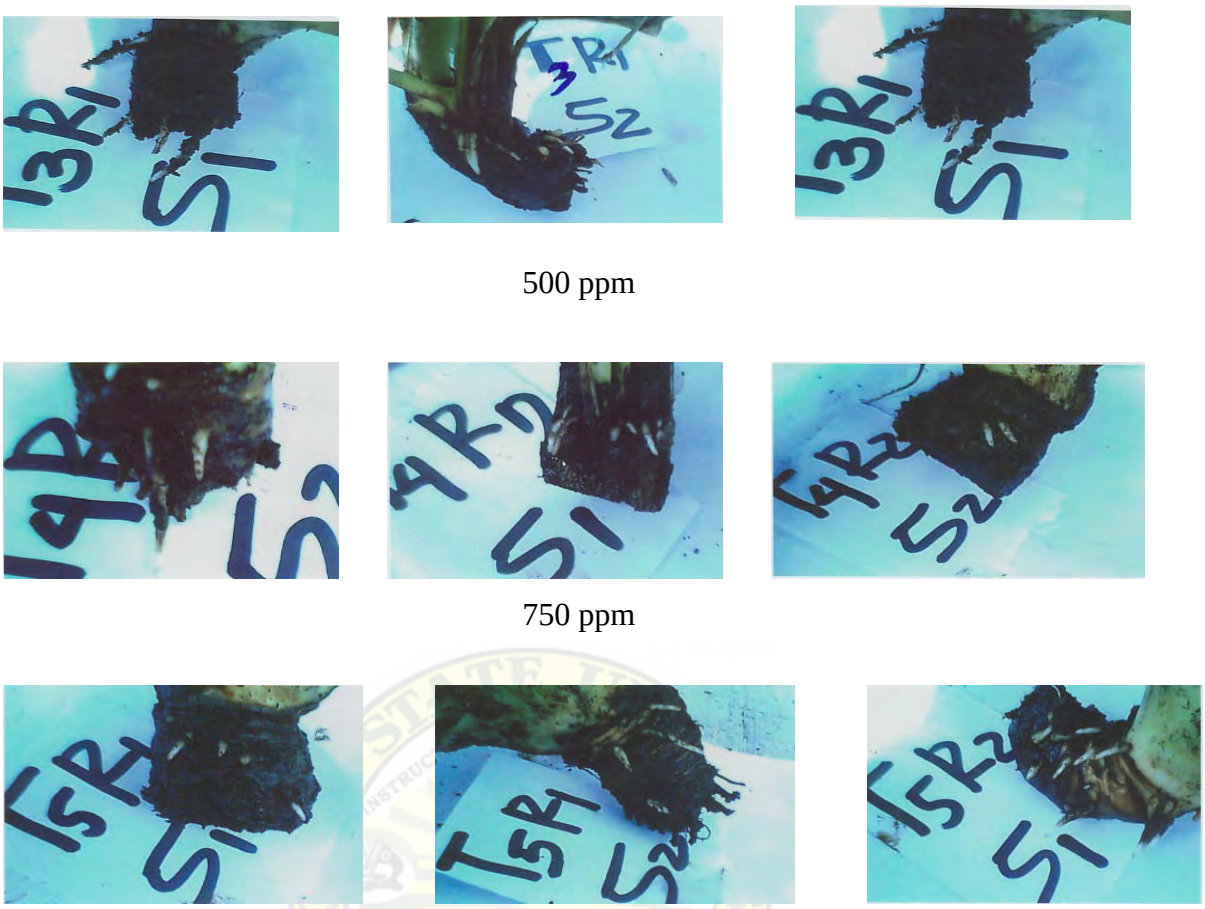


Figure 2. Rooted sliced pineapple crown after 1 month after treatment

But numerically, results revealed that 0 ppm (Control) and 250 ppm ANAA had obtained the highest percentage of rooted sliced crown with the mean of 80.95%, followed by the crowns treated with 500 ppm and 750 ppm ANAA with a mean of 76.19%. Sliced crown treated with 1000 ppm ANAA had the lowest rooting percentage with a mean of 66.67%

According to Halfacre and Barden (1979) as cited by Nuwatt (2007) that high concentrations of hormones might injure or kill the cuttings. On the other hand, too low concentrations do not have significant effects.

Table 3. Percentage of rooted sliced crown

ANAA CONCENTRATION	MEAN (%)
0 ppm	80.95 a
250 ppm	80.95 a
500 ppm	76.19 a
750 ppm	76.19 a
1,000 ppm	66.67 a

*Means of the same letter are not significantly different at 5% level of DMRT

Table 4 shows that there were significant differences on the average number of roots produced by the pineapple crown as affected by different concentrations of ANAA.

Crown treated with 250 ppm ANAA produced the highest number of roots with a mean of 9.28 roots per crown, followed by the crowns dipped in 500 ppm ANAA with 5.81 then followed further by the crowns dipped with 0 ppm ANAA (Control), 750 ppm and 1000 ppm ANAA all having a mean of 5.48, 4.14 and 4.00 respectively. However, all the former treatments are statistically comparable with each other.

In addition, Bleasedale (1973) stated that hormones maybe used to overcome the inherent difficulties encountered in rooting of cuttings that many also inhibit the grown of the cuttings if applied at the wrong concentration. These chemical not only speed up the healing of the wound and the productions of roots, but they also induce the development of a large number of roots and are now used widely for the propagation of several plants.

Likewise, Adriance and Brinson (1955) noted that the best stimulation of root formation is usually obtained from concentrations just below the toxic level.

Table 4. Average number of roots produced per crown

ANAA CONCENTRATION	MEAN
0 ppm	5.48 b
250 ppm	9.28 a
500 ppm	5.81 b
750 ppm	4.14 b
1,000 ppm	4.00 b

*Means of the same letter are not significantly different at 5% level of DMRT

Table 5 shows the effect of the different concentrations of ANAA used in the percentage of survival on rooted sliced pineapple crowns.

There were significant differences observed among the treatment means as shown in the results. Findings showed that sliced pineapple crowns dipped in 250 ppm of ANAA concentrations had the highest percentage of survival which indicates the effect of ANAA on the survival of pineapple crowns. Results also showed that the next higher survival percentage of sliced crowns were obtained from the untreated crowns or the control with a mean of 80.95% but is comparable with the crowns treated with 500 ppm ANAA with a mean of 76.19% then followed by the crown dipped in 1000 ppm and 750 ppm ANAA which has a mean of 66.66% and 61.90%.

Foster (1977), stated that propagators encourage root growth by using indole acetic acid (IAA). However, some growers prefer the synthetic auxins naphthalene acetic (^{0}C-NAA) because it is not affected by the inhibiting enzyme in the cuttings that destroy some of the natural auxins.

Table 5. Percentage of survival

ANAA CONCENTRATION	MEAN (%)
0 ppm	80.95 ab
250 ppm	90.47 a
500 ppm	76.19 ab
750 ppm	61.90 b
1,000 ppm	66.66 b

*Means of the same letter are not significantly different at 5% level of DMRT

Table 6 shows that there were significant differences on the number of days the sliced pineapple crowns produced new shoots as affected by the different concentrations of ANAA.

Crown treated with 550 ppm ANAA obtained earlier days to produce new shoots with a mean of 38.67 days, followed by the crowns showed in 0 ppm (Control) and 250 ppm with a comparable statistical analysis mean of 42.67 and 45.33 days respectively, then followed by the 1000 ppm and 750 ppm ANAA with a mean of 46.66 and 48.67 days.

Findings can corroborate with the earlier study of Almos (1998) that the application of ANAA at lower rates had no significant effects on the number of days to opening of lateral buds, final length of shoots leaf number, and percentage of rooted cuttings.

Table 6. Number of days to emergence of new shoots

ANAA CONCENTRATION	MEAN (days)
0 ppm	42.67 ab
250 ppm	45.33 ab
500 ppm	38.67 b
750 ppm	48.67 a
1,000 ppm	46.66 a

*Means of the same letter are not significantly different at 5% level of DMRT

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted at the Pomology project, Department of Horticulture, College of Agriculture, Benguet State University, La Trinidad, Benguet from November 2010 to January 2011 to evaluate the effects of the different ANAA concentrations on the rooting of sliced pineapple crowns and to establish the best ANAA concentration that would enhance rooting of the sliced pineapple crowns.

Results showed that crown treated with 250 ppm ANAA formed root faster with a mean of 19 days. It also attained the longest root length which has a mean of 1.98 cm and had the highest number of roots produced per crown with a mean of 9.28 likewise obtained the highest percentage of survival with a mean of 90.47% while the number of days to emergence of new shoots was obtained in 500 ppm ANAA with a mean of 38.67 days.

Conclusion

Based from the results, it is therefore concluded that the use of rooting hormone was effective especially in the rooting of pineapple crown. The use of 250 ppm ANAA enhances the earlier production of roots, highest average root length, highest percentage of survival and production of more roots. Treating pineapple crown with rooting hormones could be done to shorten the time to produce roots and to increase the percentage of survival.

Recommendation

From the proceeding results and discussion, it is recommended that 250 ppm concentration of ANAA for 30 minutes dipping can be used for sliced pineapple crowns to enhance faster rooting and higher survival percentage as well as induce the production of longer and higher number of roots.

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APPENDICES

Appendix Table 1. Number of days to visible root formation

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
0 ppm	21	23	21	65	21.66
250 ppm	18	18	21	57	19.00
500 ppm	18	23	23	64	21.33
750 ppm	18	23	26	67	22.33
1,000 ppm	23	23	26	72	24.00

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	36.9333	18.4667			
Treatment	4	39.3333	9.8333	2.91^{ns}	3.84	7.01
Error	8	27.0667	3.3833			
TOTAL	14	103.3333				

ns – not significant

Coefficient of variation = 8.49%

Appendix Table 2. Average root length (cm)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
0 ppm	2.88	1.05	1.64	5.57	1.86
250 ppm	1.69	1.86	2.38	5.93	1.98
500 ppm	2.43	1.18	1.91	5.52	1.84
750 ppm	2.01	1.27	1.45	4.73	1.58
1,000 ppm	1.50	2.11	1.26	4.87	1.62

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	0.9405	0.4702			
Treatment	4	0.3417	0.0854	0.27^{ns}	3.84	7.01
Error	8	2.5334	0.3167			
TOTAL	14	3.8156				

ns – not significant

Coefficient of variation = 31.71%

Appendix Table 3. Percentage of rooted sliced crown

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
0 ppm	85.71	71.43	85.71	242.85	80.95
250 ppm	71.43	71.43	100	242.85	80.95
500 ppm	85.71	71.43	71.43	228.57	76.19
750 ppm	71.43	57.14	100	228.57	76.19
1,000 ppm	57.14	71.43	71.43	200.00	66.67

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	761.8667	380.9333			
Treatment	4	408.1225	102.0306	0.71^{ns}	3.84	7.01
Error	8	1142.8000	142.8500			
TOTAL	14	2312.7892				

ns – not significant

Coefficient of variation = 15.69%

Appendix Table 4. Average number of roots produced per crown

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
0 ppm	5.29	5.43	5.71	16.43	5.48
250 ppm	7.71	13.00	7.16	27.84	9.28
500 ppm	5.86	6.71	4.86	17.43	5.81
750 ppm	3.00	3.00	6.43	12.43	4.14
1,000 ppm	3.43	3.57	5.00	12.00	4.00

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	4.1798	2.0899			
Treatment	4	54.7608	13.6902	3.94*	3.84	7.01
Error	8	27.7772	3.4722			
TOTAL	14	86.7178				

* – significant

Coefficient of variation = 32.44%

Appendix Table 5. Percentage survival

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
0 ppm	85.71	71.43	85.71	242.85	80.95
250 ppm	85.71	85.71	100.00	271.42	90.47
500 ppm	85.71	71.43	71.43	228.57	76.19
750 ppm	71.43	57.14	57.14	185.71	61.90
1,000 ppm	57.16	57.14	85.71	199.99	66.66

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	1550.9606	387.7401			
Treatment	4	353.6871	176.8435	4.22*	3.84	7.01
Error	8	734.6395	91.8299			
TOTAL	14	2639.2872				

* – significant

Coefficient of variation = 12.74%

Appendix Table 6. Number of days the crown produced new shoot

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
0 ppm	42	42	44	128	42.67
250 ppm	42	46	48	136	45.33
500 ppm	36	40	40	116	38.67
750 ppm	48	48	50	146	48.67
1,000 ppm	36	52	52	140	46.66

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	100.8000	50.4000			
Treatment	4	180.2667	45.0667	3.45*	3.84	7.01
Error	8	104.5333	13.0667			
TOTAL	14	385.6000				

* – significant

Coefficient of variation = 8.14%