BIBLIOGRAPHY

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ABSTRACT

The study was conducted at the laboratory area of the Department of Horticulture Benguet state University from February 10, 2008 to July 20, 2008 to assess the effect of cool storage in breaking dormancy of coffee Arabica seeds

Coffee arabica seeds were subjected to low temperature at 5^0C with various duration from 2-6 months, except the control (unstratified seeds).

Subjecting coffee arabica seeds to cool storage can enhance earlier germination of seeds; seedling from seeds subjected to 5^0C for one week had earliest days to complete emergence; more seeds resulted to higher percentage of seedling emergence; and more normal seedling developed. The appearance of leaves that were stratified for one week attained the shorter days for the true leaf to emerge. Similarly tallest seedlings developed and more vigorous seedlings were noted five months from sowing. It was further observed that the appropriate period of storing coffee arabica seeds in low temperature was one week cold storage.

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INTRODUCTION

Nature of the Study

Coffee is a source of happiness and with according to King Louis XIV who after experience it's excellent and distinctive Aroma began to recognize it's value. Coffee beverage is widely consumed around the world which is prepared from the roasted berries and is commonly called the beans of the plant. Coffee was first con sumed as early as the 9th century. When it appeared in the highlands of Ethiopia, it was soon introduced to Egypt and Yemen, and by the fifteenth century had reached Persia, turkey, and northern Africa, from the Muslim world. Coffee was introduced to Italy then to the west of Europe and to America. Coffee is one of the most popular beverages would wide and among the very important crop in the economy of many nation. In the Philippines, the coffee industry in 1740 during the Spanish regime. It is considered one of the high-value crops in the local and foreign market.

Coffee is one of the ten species of the flowing plants in the family Rubiace and is considered under Plantation crops the plant is an evergreen and considered shrub or small tree which may reach 5 meters (16 – 40 ft) in height when unpinned. The leaves are green and glossy, usually 10 – 15 centimeters or 3.9 – 5.9 inches in long and 6.0 centimeters in wide. It produces clusters of fragrant, while flowers that bloom simultaneously. The fruit is oval, about 1.5 centimeters long, and green when immature, but ripens to yellow, then crimson, becoming block on drying. Each berry usually contains two sends but from 5 to 10 percent of berries have only one these are called pea berries. Berries ripen in seven to nine months.

The study was conducted to assess and evaluate the germination and growth of seeds as affected by cold storage treatment if it will have significant effects on the germination and emergence characteristics of the seedlings.

The result of the study is important for it will serve as guide to people such as farmers, producers, and prospective growers who would like to plant coffee in their backyard or in their farms.

The study is also important to future researchers for it will surely provide appropriate information in the conduct of researches regarding coffee. If the result of the study will be conducive, it will ultimately be introduced to the coffee producers as well as in the community to encourage more production of the commodity.

The study was conducted to determine the effects of cold storage duration on the germination and seedlings characteristics' of coffee: to identify the appropriate cold storage duration that will promote germination and seedlings growth of coffee seeds.

The study was conducted at the horticulture service laboratory section, Department of Horticulture College of Agriculture, Benguet State University, La Trinidad Benguet from December 2007 to March 2008.

REVIEW OF LITERATURE

Ringor and Versola (1981) reported that the coffee industry in the Philippines is relatively small but a big portion of the produce is being absorbed not only by the local market but also in the foreign market.

The same authors also reported that Arabica coffee grows best in well drained loamy soil with ph ranging from 4.2 to 5.1 but Macanes (2002) reported that 4.5 to 6.5 pH is also tolerable. Another important requirement is that the soil must be much deeper than the coats system. On the other hand, PCAARD (1989) stated that the selective of coffee for the climate requirement depends on the species. In general, the coffee plant grows best in an environment which has a air movement of light breezes. Humidity of the site should be medium high 70 – 85% with temperature from 15 - 26° and rainfall of 190 – 200 cm distributed evenly through the year. Too much water tends to develop the wood of the tree at the expense of the flowers and fruit and Versola (1981)

Anenias (2001) reported that coffee rank second only to oil among the worlds' legally traded commodities, around the world. It is estimated that there are 25 million coffee growers, who are considered mostly small – scale growers. It is estimated that around 500,000 Filipinas depends on the coffee industry. According to Dimas (1996), there are four commercial coffee species cultivated in the Philippines namely: the Arabica (Coffee Arabia L.) also called "Benguet Coffee" or Fedilisan coffee, Robusta / Canephornia (Coffee Robusta L.) also called "Batangas Coffee; excels (Coffee Exelsa L)And Liberia (Coffee Liberia L.). Denenias (2001) reported that statistics from the international coffee Organization revealed that robusta accounts for 75% of the country's

total production and Arabica, 5 – 10%. The other, excelsa and liberica accounts for 15 – 20% of the country produced Dimas (1996).

Anenias (2001) further reported that the average that the average coffee production is at 485 Kilograms per hectares of green bears. This according to expertly is much lower than the ideal production of 1,500 kilograms per hectares. While most of the coffee farms are vitiated in Mindanao, the most area is found in Cavite, in terms of volume and quality. However from 1986 to 1997, the total hectares panted of coffee decrease from 149, 657 to 138, 830 hectares an average of 1% reduction per year.

According to Mojica (2001), world consumed of coffee continues to increase at 1.7 per year while domestic consumption also increased by 2.25 % per year. Exports predict that the level of consumption will follow population growth. This could be attributed to the proliferation of coffee shops, catering to a wider and younger chentele. Anenias (2001) stated that there is likewise clamor to produce move of the Arabica variety, most grown in Benguet province. (Mojica 2001).

It was stated by Joubest (1985) that the most important thing to bear on mind is that low temperature retard growth and below 12 + 0 + c the growth of the plant is inherited. Although coffee grown in many areas in north Africa where it is the place of origin and where such low temperature are experienced, where it is the place of origin and where such low temperature are experienced it is vitally important that the cold period must be short. (Joubert 1985).

Salorido (1967) reported that shade is necessary and equally beneficial during the early years. This is true particularly in plantations where the heart of the run has an effect on trees. Relatively speaking, the Fertilizer requirement of trees in the shade in lesser

than that of trees on the open. Shade help minimize soil erosion and help control weeds. A large volume of leaves to the ground serves as much and compost and where trees is sufficient water supply and soil nutrient is not deficient through out the years (Saborido 1967).

Williams (1975) found that the degree of shade and experience to sunlight strongly affect the response of coffee to fertilizers. In shaded mature coffee, favorable response been obtained from a combination of nitrogen and potash. Phosphorous is important in the early stage of growth but in the later stages of growth there are fewer report of marked responses to phosphorous fertilizer. The important of phosphorous seems to be related to obtaining favorable balance of nitrogen and potash, the former being present in the soil at relatively high levels in the shade. Organic matter in the soil is maintained under shaded condition. Balanced nutrition is achieved; however, the response of shaded coffee to chemical fertilizer is relatively low. (Williams 1975)

Williams (1975) represent that cool moist climate, coffee are generally vigorous in growth. There were on old words but not on young woods. On warm dry climate, coffee has generally moderate in growth, flowers on both old and young woods on not and dry climate coffee has poor growth defoliation of leaves on older wood and flower on young wood only. On not and with water available, coffee growth is very vigorous and coffee have abundant flowers I both older wood and young woods. The success of Arabica at high elevation in the tropics is also attributed to the generally favorable rainfall and atmospheric humidity of such regions. (Williams 1975).

The vigor of coffee was affected by the depth of soil, sunshine, humidity, temperature and rainfall. (Williams 1975).

Effect of Cold storage Temperature on
Seed Germination

Pre-treating seeds (cold stratification) is simple measure you can take which will break a seed's dormancy causing the seeds to be more ready to germinate. By subjecting the seeds to this pre treatment you are really only providing them with the effect that Mother Nature would have had on the seeds that they have been left to their natural course. However, by applying the pre-treatment yourself in a control and diminish factors detrimental to a seeds survival had it been left to make it on its own in the wild. By cold stratifying the seeds you are able to affect the time frame under which the seeds will germinate.

The pre-treatment or "stratification" of seeds is not fixed science and one shouldn't be overly concerned about the exact length of pre-treatment time. It is recommended that a particular species of seed will benefit from 2-3 months of cold stratification. This only mean that the past experience finds that this seeds "dormancy" is usually overcome by approximately this length of cold stratification and such the seeds are more susceptible to germination and will generally sprout at a more "even" rate.

Many tree seeds have what is called an "Embryonic dormancy" and generally speaking will not sprout until this embryo dormancy is broken or overcome.

In the wild "seed dormancy" an overcome by the seed spending time in the ground through a winter period and having its hard seed coat soften up a bit by being subjected to moisture and bacteria. By spending time in the ground the seed is undergoing a natural form of "cold stratification" or pre-treatment.

This cold moist period triggers the seeds embryo. Moisture is absorbed causing the seed and its embryo to swell and its growth and subsequent expansion eventually break through the soften seed coat in its search for warmth, sun and nutrients

Adriance and Brison (1955) stated that cold storage with moisture and temperature ranging 1° C to 5° C was found to be effective in breaking the dormancy period of seeds. He added that seed coat under cold storage has a tendency to softened thus allowing moisture entrance into the resulting in rapid germination. Dormancy is broken in nature by exposing to low temperature during winter (Daniel 1980). Similarly, Halfface and Barden (1979) mentioned that in seed stratification seeds must be placed in a moist medium at temperature from 4 to 7° C for 1 to 3 months. This requirement is true for deciduous ant and fruit tree beds. Furthermore, Delvin (1977) and Leopold et al. (1975) stressed that temperature near freezing enough to break dormancy.

As stated by Klingman and Ashton (1975), refrigeration or stratification is commonly used to shorten the period of Dormancy. Many seeds specially grass seeds, requires an alternation of the temperature from 20 - 20° C and exposing the seeds to a low temperature for five days prior to germination test make possible an accurate determination of variability. Moreover, Delvin (1977) as cited by Agnaya (2004) stated that the seed of plant that do not germinate immediately requires a period of after – ripening treatment either dry storage while others in moist and low temperature condition. Furthermore, Janick (1972), Hartman and Kester (1975), mentioned that subjecting the seeds to low temperature reduces the amount of germinating inhibitors that is present within the seed there by hasting germination.

Bleasdale (1978) explained tat the seeds retains its essential properties for many years as long as it is kept in dry temperature of -5 to 5 ^{o}C . Moreover, Dubermine (1974) discussed that the physiological explanation of these conditioning effect is unknown. However, in some seeds, low temperature may function to render the seeds coat more permeable to gasses in other substances.

Paing (1988), in her experiment on garden pea observed that cold stored for six weeks had the highlight total yield number of lateral shoots, longer pods, higher percentage of germination, shorten period of germination and the highest percentage of pod set.

Bucao (1983) reported that subjecting snap Beans *(Phaseolus Vulgaris L.)* observed that seed refrigerated for 42 days at 5° C had the highest percentage of germination, tallest plant, earliest to flower and with high percentage of pod set.

Bugtong (1984) reported that subject snap Beans to cold storage enhances earlier initiation of flower with higher percentage of pod set, heavier and longer pods and higher seeds developed resulting to higher yield.

MATERIALS AND METHODS

Materials

The materials used in the study was refrigerator, Polyethylene plastic bags, tissue paper, hand towel, grub hoe, watering can, nursery house and other materials as the need apprises.

Methods

The coffee seed was subjected to different duration of cold storage and was germinated in polyethylene plastic bags under green house with randy loam roil and was covered thinly with sand. To facilitate the germination, it will be irrigated every other day and these will be done to all treatments uniformly. The fallowing treatments were as follows:

Code	Cold storage period (Weeks)
T1	control no storage
T2	1 week storage
T3	2 weeks storage
T4	3 weeks storage
T5	4 weeks storage
T6	5 weeks storage

The experiment was laid in a randomized complete block design (RCBD) with three replication using 100 seeds per replication.

Data Gathered

1. Number of days fro sowing to 50% emergency. This was taken by counting the numbers of days from sowing to 50% germination.

2. Number of days to complete emergence. This was determined by counting the number of days from sowing up to complete germination.

3. Percentage germination. This was determined by using the Formula:

$$\text{Germination Percentage (\%)} = \frac{\text{number of seeds \& germination}}{\text{Total number of seeds sown}} \times 100$$

4. Percentage of normal seedlings. This was taken by using this Formula:

$$\text{Percentage of normal seedlings} = \frac{\text{no. of normal seedlings}}{\text{No. of seeds sown}} \times 100$$

5. Number of days to first appearance of leaves. This was taken by counting the number of days to first appearance of leaves.

6. Seedlings height (cm). This was done by measuring the base up to the shoot tip of the plant 3 months after sowing the seeds from 10 samples from each treatment.

7. Seedlings vigor. This was taken using the scale below

Rating	Description
4	most vigorous
3	vigorous
2	less vigorous
1	Poor

8. Documentation of the study through picture

RESULTS AND DISCUSSIONS

Number of Days to Emergence

The different cold stratification duration had significant effects on the number of days from sowing to 50% emergence (Table 1). Result shows that one week cold stratification enhanced earlier emergence of coffee arabica seeds with a mean of 98.667 days from sowing. It was followed by seeds stratified for 4 weeks, 2 weeks, and control (no cold storage) with a mean of 102.33 days, 107 days and 113.33 days respectively. Seeds that were stratified 3 weeks and 5 weeks had the longest period to attain 50% seedling emergence.

Table 1. Number of days from sowing to 50% emergence

TREATMENT	MEAN
Control (no cold storage)	113. 333bc
1 week cold storage	98.667e
2 weeks cold storage	107cd
3 weeks cold storage	118.667a
4 weeks cold storage	102.33de
5 weeks cold storage	115.33ab

Means the common letters are not significantly different at 5% level by DMRT

Based on the result, shorter duration of germination was observed on the seeds that were subjected to cold temperature.

The shorter germination can be explained by Weaver (1974) who mentioned that pre – treated seed stored in a medium of carefully controlled temperature are conditioned for rapid germination. However, Hartman (1972) mentioned that exact temperature probably varies with the different species and the time required for moist chilling among different seeds of the same kind that are grown in different areas. Adriance and Brison (1955) suggested that this pre – planting treatments preserves the viability and hastens germination. Delvin (1977) cited that the seeds of plants do not germinate immediately and requires a period of after – ripening treatment either by storage in moist or low temperature. Moreover, Daubenmire (1974) explained that the physiological explanation of this conditioning effect is still unknown. In some seeds, low temperature treatments may be done to render the seed coat more permeable to gasses and other substances.

Number of Days to Complete Emergence

Table 2 shows significant differences among the different cold stratification periods observed in the number of days from sowing to complete emergence. Result shows that seed stratified fore one week had the earliest duration to complete emergence with a mean of 139.67 days followed by the seeds stratified for four weeks, two weeks, and three weeks, with a mean of 150.33, 156.33, 166.33 respectively. Unstratified seeds had the longest period to complete emergence with 168 days. As previously mentioned, shorter germination duration was noted on the seeds that were subjected to cold treatments. Previous explanations further stated that subjecting seeds to low temperature of chilling condition has rendered the seed coats permeable to gaseous and water exchange enhancing earlier germination of the seeds.

Table 2. Number of days to complete emergence

TREATMENT	MEAN
Control (no cold storage)	168a
1 week cold storage	139.67d
2 weeks cold storage	156.53b
3 weeks cold storage	166.33a
4 weeks cold storage	150.33c
5 weeks cold storage	167.67a

Means the common letters are not significantly different at 5% level by DMRT

Percentage of Seedling Emergence

As presented in table 3, the percentage of germination was significantly different among the treatments as affected by the various cold treatment durations from sowing to emergence. It was observed that coffee seeds stratified for one week attained the highest mean of 88% followed by seeds stratified for four weeks, with a mean of 77.33% which were significantly higher as compared to the seeds that were unstratified having a mean of 68.33%.

Table 3. Percentage seedling emergence

TREATMENT	MEAN
Control (no cold storage)	68.33c
1 week cold storage	88a
2 weeks cold storage	75b
3 weeks cold storage	65cd
4 weeks cold storage	77.33b
5 weeks cold storage	63.67d

Means the common letters are not significantly different at 5% level by DMRT

It was observed however, that some seeds did not emerge for reason that cannot be explained although it may be due to death of a number of seeds during the long cold storage period. Hartman (1990) related this to high concentration of soil solutes in the upper layer of the germination media. However, Tipayno (2005) suggested that the failure of many seeds to germinate in some treatment can be attributed to injuries during the storage caused by inappropriate containers. He further mentioned that seeds stored in glass containers have high percentage germination while those in plastic containers had a very poor germination percentage.

Percentage of Normal Seedling

Table 4 shows the percentage of normal seedling under the different treatment. Based on the results, one week storage attained the highest percentage of normal seedling with a mean of 83.67%. This was followed by four weeks storage and two weeks, storage

which indicated higher percentage of normal seedlings. Three weeks storage significantly had lower percentage of normal seedlings as compared to the other treatment with 67.67% except for the control (no cold storage) and (5) five weeks storage which attained the lowest percentage of normal seedlings of 60.67% and 60%. This was affected by wilting of the plant, curly leaves and insect damage.

Table 4. Percentage of normal seedling

TREATMENT	MEAN
Control (no cold storage)	60.67 c
1 week cold storage	83.67 a
2 weeks cold storage	69.67 b
3 weeks cold storage	67.67 c
4 weeks cold storage	74.33 b
5 weeks cold storage	60 c

Means the common letters are not significantly different at 5% level by DMRT

Number of Days to First Appearance of Leaves

Table 5 shows that there are significant differences observed among the different cold stratification treatment on the number of days to first appearance of coffee leaves. Numerically, one-week cold storage attained the shortest days for the true leaf to emerge. It was followed by four weeks cold storage, two weeks cold storage and control (no cold storage). Five weeks cold storage significantly had shorter days to first appearance of

leaves as compared to three weeks cold storage which attained the longest days for the true leaf to emerge with a mean of 124.67 days.

Paing (1980) found out in his experiment that garden pea that refrigerated for a shorter period of cold storage appeared to be the best attaining the highest percentage of germination; complete emergence, percentage of normal seedling, tallest seedling and had the shortest days for the true leaf to emerge.

Table 5. Number of days to first appearance of leaves

TREATMENT	MEAN
Control (no cold storage)	117bc
1 week cold storage	105.67e
2 weeks cold storage	133cd
3 weeks cold storage	124.67a
4 weeks cold storage	109.67a
5 weeks cold storage	120. 30ab

Means the common letters are not significantly different at 5% level by DMRT

Seedling Height (cm)

Table 6 shows significant differences on the height of the seedling 5 months after emergence. This was obtained by measuring the seedling from the base up to the tip of secondary leaves. The results shows the tallest seedling were measured from seeds stratified for one week with a mean of 13.67 cm which are not statically different with the other treatment of seedling grown from stratified seeds at two weeks having a mean

height 12.23 cm and seedling from five weeks durations of stratification with a mean of 10.97 cm. further results shows that the height of the seedling may increase if seeds are subjected to cool stratification prior to sowing.

Table 6. Seedling height (cm)

TREATMENT	MEAN
Control (no cold storage)	10.67ab
1 week cold storage	13.67a
2 weeks cold storage	12.23a
3 weeks cold storage	9b
4 weeks cold storage	10.57ab
5 weeks cold storage	10.97ab

Means the common letters are not significantly different at 5% level by DMRT

The shortest seedling were obtained from plants that were stratified for three weeks cold storage having a mean of 9 cm followed by the unstratified seeds (control) having a mean of 10.67 cm. Results shows that cold stratification of coffee arabica seeds at 5^0C before planting stimulates faster growth and the greatest effect can be obtained by cold stratification for one week..

Seedling Vigor

The result in table 8 shows the seedling vigour as affected by the different cold treatment durations. This was obtained 5 months from sowing. It was noted that seeds

stratified for one week were the most vigorous among the treatment. This was followed by the seedling stratified for two weeks, four weeks, and five weeks, cold stratification. The least vigorous seedlings were observed on three weeks cold stage duration and the control (no cold storage).

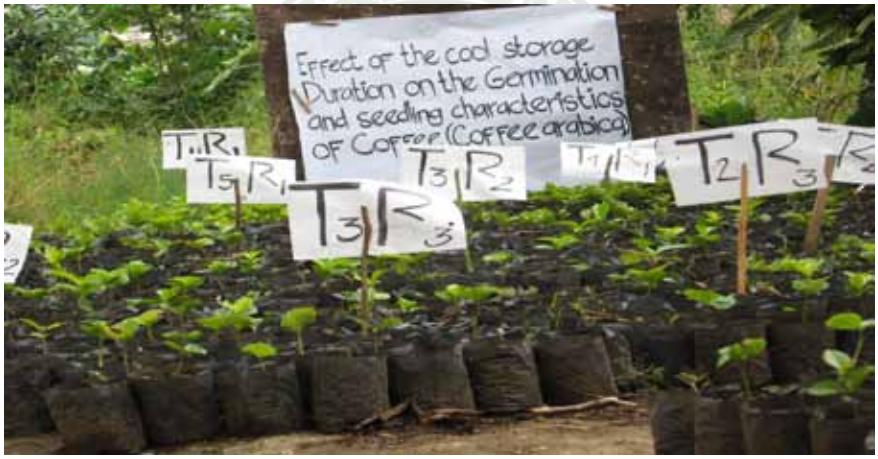
The result may imply that storing coffee seeds under cold temperature influences seedling vigor. As previously mentioned, cold stratification enhanced faster growth which may explained the performance of coffee seeds subjecting to cool treatments as having seedling that are more vigorous as compared to the unstratified seeds.

Table 7. Seedling vigor index

TREATMENT	MEAN
Control (no cold storage)	2 c
1 week cold storage	4 a
2 weeks cold storage	3 b
3 weeks cold storage	2 c
4 weeks cold storage	3 b
5 weeks cold storage	3 b

Rating: Most vigorous: 4: vigorous = 3: less vigorous = 2: poor = 1

Table 8. Documentation of the study



SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The influence of cold storage in the seeds of coffee arabica was studied at the laboratory area of the Department of Horticulture, Benguet State University, La Trinidad Benguet to determine its effects on the seeds of coffee if they were refrigerated at a temperature of 5^0C conducted from February 2008 to March 2008.

After the termination and analysis of data gathered the results was summarized as follows:

One week cold storage of coffee seeds showed the best performance among all treatments observed would enhance earlier germination. Seeds that were stratified for one week had the earliest duration to complete emergence as compared to the other treatments likewise it was observed that coffee seeds stratified for one week attained the highest percentage of seedling emergence. However, some seeds that subjected to longer cold storage duration were late to emerge for reason that cannot be precisely explained. The higher percentage of normal seedling under the different treatment was observed on the seeds having one week cold storage having the higher mean rate. One week cold storage was observed to enhance shorter days to first appearance of leaves. This was obtained by measuring the seedling from the base up to the tip of secondary leaves. The taller seedling was measured from the seeds stratified for one week having the higher mean rate. Shorter duration of cold stratification will enhance tallest seedling. The highest rate of seedling vigor as affected by the different cold treatment duration was

noted on the seeds stratified for one week having the most vigorous seedling among all treatments.

Generally, seeds kept in cold storage at various lengths of time performed better than control seeds (unstratified). Most of the differences were found to be either significant or highly significant.

Conclusion

Based on the results of study, it was found out that subjecting coffee arabica seeds to cold storage would enhance faster germination and the best period of seeds storage is one week cold storage prior to planting. It was also observed that seeds kept in cold storage for longer than 4 weeks did not perform well.

Recommendation

From the preceding results, it is recommended that cold storage of coffee Arabica seeds for a period of one week at 5^0C prior to sowing should be done in order to enhance faster germination and to promote faster and vigorous seedling growth. However, further study along this line is also recommended to verify these findings.

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APPENDICES

Appendix 1. Number of days for sowing to emergence

TREATMENTS	REPLICATIONS I	II	III	TOTAL	MEAN
T_1	110	107	113	340	113.33
T_2	99	95	102	396	98.67
T_3	107	110	104	321	107
T_4	119	122	115	356	118.67
T_5	102	165	100	306	102.33
T_6	115	111	120	346	115.33

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Squares	Mean of Square	Computed F	Tabular F 0.05	0.01
Block	2	1.333	0.666	0.05		
Treatment	5	867.333	73.466	12.63	0.00	05
Error	7	137.333	13.733			
Corrected total	17	1006.000				

*Highly significant Coefficient of variation: 3.410%

Appendix 2. Number of days for complete emergence

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	169	166	169	504	168
T_2	137	140	142	419	139.67
T_3	155	158	156	469	156.33
T_4	170	166	163	499	166.33
T_5	148	150	153	451	150.33
T_6	170	168	165	503	167.67

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Squares	Mean of Square	Computed F	Tabular F 0.05	0.01
Block	2		0.055	0.01		
Treatment	5	1981.611	396.322	54.13	0.00 05	
Error	10	73.222	7.32			
Corrected total	17	2054.00				

**Highly significant Coefficient of Variation: 1,712%

Appendix 3. Percentage of germination

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	67	68	68	203	68.33
T_2	87	88	89	264	33
T_3	73	75	77	255	75
T_4	63	65	69	195	65
T_5	78	76	78	232	77.33
T6	64	65	62	191	63.67

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Squares	Mean of Square	Computed F	Tabular F 0.05	Tabular F 0.01
Block	2	10.111	5.555	1.90		
Treatment	5	1251.111	250.222	94.23	0.00 05	
Error	10	26.555	7.32			
Corrected total	17	1287.777				

**Highly significant

Coefficient of Variation: 2,235 %

Appendix 4. Percentage of normal seedling

TREATMENTS	REPLICATIONS I	II	III	TOTAL	MEAN
T_1	60	59	63	182	60.67
T_2	84	84	83	251	83.67
T_3	69	70	70	209	69.67
T_4	55	59	65	203	67.67
T_5	75	73	75	223	74.33
T_6	60	63	57	180	60

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Squares	Mean of Square	Computed F	Tabular F 0.05	Tabular F 0.01
Block	2	8.3333	4.1666	0.57		
Treatment	5	1426.666	285.333	39.09	0.0001	
Error	10	73.000	7.30			
Corrected total	17	1508.000				

**Highly significant

Coefficient of Variation: 3.973 %

Appendix 5. Number of days to first appearance of leaves

TREATMENTS	REPLICATIONS I	II	III	TOTAL	MEAN
T_1	118	113	120	351	117
T_2	105	102	110	317	105.67
T_3	113	116	110	339	113
T_4	125	127	122	374	124.67
T_5	109	113	107	329	109.67
T_6	122	119	120	361	120.33

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Squares	Mean of Square	Computed F	Tabular F 0.05	Tabular F 0.01
Block	2	0.777	0.388	0.03		
Treatment	5	736.277	147.255	13.16	0.00 04	
Error	10	111.888	11.1888			
Corrected total	17	848.944				

**Highly significant Coefficient of Variation: 2,907%

Appendix 6. Seedling height

TREATMENTS	REPLICATIONS I	II	III	TOTAL	MEAN
T_1	12.3	9.4	10.9	32.9	10.87
T_2	13.8	12.8	14.4	41	13.67
T_3	13.8	10.8	12.1	36	12.23
T_4	11	6.7	9.3	27	9
T_5	11	12.5	8.2	31.7	10.57
T_6	10	11.9	11	32.9	10.97

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Squares	Mean of Square	Computed F	Tabular F 0.05	Tabular F 0.01
Block	2	5.560	2.780	1.10		
Treatment	5	37.676	7.534	2.99	0.0661	
Error	10	25.193	2.519			
Corrected total	17	68.425				

**Highly significant

Coefficient of Variation: 14.150 %

Appendix 7. Seedling vigor

TREATMENTS	REPLICATIONS I	II	III	TOTAL	MEAN
T_1	2	2	2	6	2c
T_2	4	4	4	12	4a
T_3	3	3	3	9	3b
T_4	2	2	2	6	2c
T_5	3	3	3	9	3b
T_6	2	2	2	6	3c

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Squares	Mean of Square	Computed F	Tabular F 0.05	0.01
Block	2	0.000	0.000			
Treatment	5	10.000	2.000	99999.0	0.00	01
Error	10	0.000	0.000			
Corrected total	17	10.000				

**Highly significant

Coefficient of Variation: 0%