BIBLIOGRAPHY

DAO-INES, GABBY K. APRIL 2010. Seed Germination and Seedling Growth of Blueberry (*Vacinium corymbossum)* as Affected by Different Cold Storage Duration. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted at the Pomology Nursery of Benguet State University, from November 2009 to March 2010 to find out the best durations of cold storage that will effectively break the dormancy of blueberry seeds; and to determine the effect of cold storage on seed germination and seedling growth of blueberry.

Results showed that the various durations of cold storage of blueberry seeds had significantly affected seed germination and seedling emergence. Seedlings resulted from the seeds subjected to one week cold storage had developed true leaf earlier; more seeds emerged resulted to higher percentage of seedling emergence; and more normal seedlings developed. Likewise, seeds subjected to one week cold storage resulted to seedlings having longer roots.

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INTRODUCTION

Blueberries are flowering plants belonging to the genus *Vaccinium ssp.* The species are native only to North America. The crop is considered as shrubs varying in size from 10cm to 4m tall. The smaller species are known as “low bush blueberries”, and the larger species are “high bush blueberries”. The leaves can be deciduous or evergreen, ovate to lanceolate, and from1-8cm long and 0.5-3.5cm broad. The flowers are bell-shaped, white, pale pink or red. Sometimes tinged greenish. The fruit is false berry 5-16mm diameter with a flared “crown” at the end. They are pale greenish at first, then reddish-purple and finally indigo on ripening. It has a sweet taste when mature, with variable acidity. Blueberry bushes typically bear fruit from May to June in the Western Hemisphere; “blueberry season’ peaks in July, which is National Blueberry Month in the United States and Germany.

Blueberries grow wild in many parts of the world. However, the United States and Canada supply about 95% of the blueberries used by the food industry. North American farmers harvest about 103 million pounds (47 million kilograms) of blueberries annually.

For centuries, blue berries were gathered from the forest and bogs by the Native Americans and these are usually consumed fresh and also it can be preserved. The Northeast Native American tribes revered blueberries and much folklore developed around them. The blossom ends of each berry, the calyx, forms a shaped of a perfect five-. pointed star. Parts of the blueberry plant were also used as medicine, for coughs and good for the circulation of the blood. Not only for medicine, the juice can also be made as an excellent dye for baskets and cloth. It can also used in other food preparation. Example, the dried berries were also crushed into a powder and into meat for flavor; it can be processed such as jellies,jams,pies,muffins and snack foods.

For early colonist, blueberries were probably one of the first familiar foods discovered on North American continent, since they were similar to other berry varieties found in Europe. Their abundance, natural sweetness and visibility made them on immediately welcome addition at a time when fresh food was in short supply, and sugar was scarce and expensive. Blueberry were canned and shipped to union troops during civil war soldiers in 1860's.

Blueberries have gained increasing recognition from health professionals for their very high antioxidant properties. Studies of the anthocyanin and pytochemicals found in the blueberries have shown that they provide a range of benefits, including reducing eyestrain, counteracting environmental carcinogens, promoting urinary tract health, fighting sun damage and protecting against cardiovascular disease. These are low in calories, low in fat and have no cholesterol, in addition to being a good source of dietary fiber and is packed with other vitamins (A,C,E) and minerals (potassium, manganese and magnesium).

`Blueberry can be potentially grown in forest or mountains. However, mass production could become a problem under high demand because it takes time to produce seedling from seeds. Therefore, it is imperative to conduct this study to be able to determine the best duration of cold storage of blueberry seeds that can provides the stimulus for earlier and uniform germination and reduce the longer duration and intervals of waiting time leading to higher percentage survival of the seedling. In addition, to be able to grow or to produce more blueberry in our community for economic, medicinal and food purposes.

The results of this study will provide baseline information's to researchers interested to work on blueberry in the future in order to help in the establishment of blueberry production industry and to encourage more farmers to produce more blueberry that is considered as a medicinal and has great potential to market when it is processed.

The study was conducted at the Nursery of the Pomology Project, Benguet State University, La Trinidad, Benguet second semester from November 15 to March 7, 2010 to find out the best duration of cold storage in breaking dormancy of blueberry seeds and to determine the effect of cold storage on seed germination and seedling growth of blueberry.

REVIEW OF LITERATURE

Description of the Plant

Wild blueberries are perennial shrubs found in the undergrowth of forests in northeastern United States and in the Atlantic provinces of Canada. Plants are propagated from seeds or cuttings. They produced underground stems of rhizomes, which periodically send up new shoots and developed roots. One original plant can thus cover an area ranging from 75 to 250 square feet depending on the age of the plant. Originally gathered by hand rakes although effective mechanical harvesters are being developed and improved. Various species abound including low bush and high bush varieties, which produced varying degrees of sweetness in the resulting fruit. For dried berries, the fruits are infused with a sugar solution to create a uniformly sweet and appealing product for used in baking and confectionery applications and granolos, as well as in shacks and trail mixes (Kuepper and Diver, 2004).

Seed Germination

Seed germination is defined as the activation of the metabolic machinery of the embryo leading to the emergence of new seedling plant (Hartman *et. al*., 1990). It is a sequence of step beginning with the uptake of water leading to rupture of the seed coat and germination usually determined visibly by observing the protrusion of the radicle or shoot (Devlin, 1977). Germination of seed will occur only when the embryo development is complete (Edmond *et al.*, 1964)

Seed Storage

Low temperature and low seed moisture are the most effective means of maintaining seed quality in storage (Doije, 2001). Roberts (1985) broadly classified seeds as orthodox and recalcitrant. Orthodox seeds can be dried to low moisture content and stored longer at low temperature whereas recalcitrant seeds survive for a few week or months in storage and are killed by desiccation below a certain high moisture content, example are mango mangos teen, rambutan, jackfruit,durian,and avocado. In addition, Hartman and Kester (1990) stated that seeds are usually in varying length of time after harvest. Storage condition that maintain seed viability are the low content of the seed, low storage temperature modification of the storage atmosphere, slow respiration and other metabolic process without injuring the embryo.

Methods of Breaking Dormancy

Several methods of breaking seeds dormancy are available but the following will just be mentioned:

Scarification. It is a treatment given to seeds having seed coat that is impermeable to water or gases (Devlin, 1977). This mentioned of breaking dormancy decreases the resistance of the seed coat to water absorption and embryo expansion by weakening the seed coat.

Scarification is any process of breaking, scratching, mechanically altering or softening the seed coverings to make them permeable to water and gases. Typical species with hard seed coats include members of legume, geranium, morning glory and linden families. The commonly used in scarification treatments were mechanical, chemical, and hot water treatments (Hartmann *et al.*, 1997).

Moist chilling seeds: seeds have the specific temperature requirements for germination and often contain inhibitors and promoters. Evidence to support their view dormancy is controlled by inhibitor-promoter balance that is altered by exposing the seeds to low temperature (scarification) while unimbibed are mentioned by Copeland and McDonald (1985). Any seed treatment that may increase germination percentage would improve the chances of escaping stress in the field (Antolin, 2001).

Stratification is an old method for germinating seeds of many species (Copeland and McDonald 1985). Adriance and Brinson (1955) as cited by Paing (1980) reported that stratification as a pre-plant treatment preserves viability and hastens the germination of seeds by reducing the amount of the germination inhibitor with in the seeds there by enhancing germination. In addition, stratification is a method of handling dormant seeds in which the imbibed seeds are subjected to a period of chilling to after-ripen the embryo. The common stratification temperature is 0 to 10°C for at higher temperatures; seeds often sprout prematurely and lower temperatures just above freezing delay sprouting. The time required for stratification defends on the kind of seed, and sometimes upon the individual lot of seed as well. For seeds of most species, one to four months is sufficient for low temperature stratification (Hartman *et al.*, 1997).

Furthermore, (Antolin, 2001) shows that stratification should be done only on fleshy extracted seeds. Outdoor stratification in other cold storage can be accomplished if the temperature remains below 40 degree Fahrenheit for six to twelve weeks. In this case, the seeds could be sown directly into the bed or growing medium.

Blueberries spoiled in NA with four weeks at 0-2°C and at preserves ranging from 10.7 to 26.7 kpa (80,200 mm hg) mold development limited their storage life to seven weeks in low pressure (Burg, 1976).

<u>Effect of Cold Storage Temperature on Seed Germination</u>

Adriance and Brinson (1955) stated that cold storage with moisture and temperature ranging from 1°C to 5°C is found to the effective in breaking the dormancy period of seeds. Thus added further that seed coat under cold storage has a tendency to soften, thus allowing moisture entrance into the seed resulting in rapid germination. Dormancy is broken in seeds by nature when exposed to lower temperature during winter (Daniel, 1980). Similarly, Halfacre (1979) mentioned that in seed stratification, seeds must be placed in a moist medium at temperature ranging from 4 to 7°C for 1 to 3 months. His requirement is true for deciduous nut and and fruit trees buds. Furthermore, Devlin (1977) and Leopold (1975) stressed that temperature near freezing point are usually the most effective, however, 10°C is often low enough to break dormancy.

A stated by Klingman and Ashton (1975), refrigerator or stratification is commonly used to shorten the period of dormancy. Many seeds especially grouse seeds, require alteration of the temperature 20-20°C and exposing the seeds to a low temperature for five days prior to germination test makes possible an accurate determination of variability. Likewise, (Devlin, 1977) as cited by Agnaya (2004) stated that the seeds of the 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 germination inhibitor that is present within the seed thereby hastening germination.

Paing (1980), in her experiment on garden pea observed that the cold stored seeds for six weeks had the highest total yield, higher number of lateral, shoots, longer pods, high percentage of germination, shorten period of germination and the highest percentage of pod set.

Bucao (1983) reported that subjecting snap beans (*Phaseolus vulgaris)* seed in the refrigerator for 42 days at 5°C had the highest percentage of germination, tallest plant, earliest to flower and had the highest percentage of pod set.

MATERIALS AND METHODS

The materials used in the study were blueberry seeds, refrigerator, tissue paper, styrofoam plates, seedling tray, and measuring materials.

The blueberry seeds were extracted from the fresh fruit through pressing the fresh fruit by using the hand. The seeds were placed in styrofoam plates with tissue paper and it was added water just enough to moisten to facilitate seed germination.

The blueberry seeds were stored at different durations of cold treatments in the refrigerator at 5°C. After subjecting to cold treatments, it was sown in the seedling tray and it was covered thinly with sand to facilitate seed germination.

The experiment was laid out in a Complete Randomized Design (CRD) using 50 seeds per treatment replicated three times.

The treatments used were the following:

Code	Cold Stratification Period
T1	Control (no. cold storage)
T2	1 week cold storage
T3	2 weeks cold storage
T4	3 weeks cold storage
T5	4 weeks cold storage
T6	5 weeks cold storage
T7	6 weeks cold storage

Data Gathered :

The data gathered were the following:

1. Number of days from sowing to seedling emergence. This was taken by counting the days from sowing of seeds to seedling emergence.

2. Number of days to first appearance of leaves. This was taken by counting the number of days from sowing to first appearance of leaves.

3. Percentage of seedling emergence. This was determined by using the formula:

$$\text{Percentage of emergence (\%)} = \frac{\text{Number of Seeds Germinant}}{\text{Total Number of Seeds Sown}} \times 100$$

4. Percentage of normal seedlings. Normal seedlings were those that have well developed roots with straight hypocotyls and leaves are dark green. This was taken using the formula:

$$\text{Normal Seedlings (\%)} = \frac{\text{Number of Normal Seedlings}}{\text{Total Number of Seeds Sown}} \times 100$$

5. Seedling height (mm). This was measured from the base up to the tip of the leaves with 2 sample plants for every treatment using the ruler after 113 days from sowing.

6. Number of leaves. The number of leaves per plant was taken and recorded. This was done 113 days after sowing the seeds.

7. Root length (mm). This was taken by measuring 2 representatives sample roots from the base to the tip.

8. Root number. This was taken by counting the roots 113 days after sowing the seeds.

9. Seedling vigor index. This was taken using the following scale below.

Rating	Description
1	most vigorous - excellent growth with dark green leaves
2	vigorous - good growth with green leaves
3	less vigorous – poor growth with yellow leaves

10. Documentation through pictures. Pictures were taken during planting stage and at seedling stage. Figure 1 shows an overview of the experimental area.

Figure. 1. Overview of the experimental area

RESULTS AND DISCUSSION

Number of Days from Sowing to Emergence

Seedling emergence as affected by the different cold storage duration was determined based on the number of days from sowing to the time the seedling had emerged on the soil surface (Table 1). Statistical results show that one week cold storage enhanced earlier emergence of blueberry with a mean of 14.67 days from sowing which is highly significant compared to other treatments. It was followed by the seeds subjected to three, five and four weeks cold storage with means of 17.67, 18.33 and 19.67 days respectively. The seeds that were not subjected to cold storage were the last to emerge with a mean of 22.33 days.

These findings corroborate with the earlier observations of Tocnang (2009), Agnaya (2004) and Comnang (2005) that seeds subjected to cold storage prior to planting had faster and uniform germination. Likewise, Paing (1980) found that cold storage shortened the period from sowing to germination of garden pea.

Weaver (1974) mentioned that pre-treated seeds in medium of carefully controlled temperature are conditioned for rapid germination. However, many seeds placed in an environment considered adequate for germination; still do not germinate because of some internal limitations and unfavorable environmental conditions (Devlin, 1977). Furthermore, Daubenmire (1974) explained that the physiological explanation of this conditioning effect is still unknown. In some seeds, low temperature may function to render the seed coat more permeable to gasses and other substances.

Table 1. Number of days from sowing to seedling emergence

TREATMENT	NUMBER OF DAYS
Control (no cold storage)	22.33[a]
One week cold storage	14.67[d]
Two weeks cold storage	22[ab]
Three weeks cold storage	17.67[cd]
Four weeks cold storage	19.67[abc]
Five weeks cold storage	18.33[bcd]
Six weeks cold storage	22[ab]

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

Number of Days from Sowing to First Appearance of Leaves

Table 2 shows significant statistical differences among the different cold storage duration affecting the number of days from sowing to first appearance of leaves. Results shows that seeds stored for one week attained the shortest days for leaf development and produced leaves within 20.33 days. This was followed by the seeds subjected to cold duration for three, four, and five weeks having the means of 24, 25.33 and 27 days respectively. Seeds subjected to two weeks cold storage and the control significantly had shorter days to first appearance of leaves which was statistically comparable to the seeds subjected to six weeks cold storage which were the last to develop leaves with a mean of 29 days.

Paing (1980) found in his experiment that garden pea refrigerated for a shorter period of cold storage appeared to be the best, attaining the highest percentage of

Table 2. Number of days from sowing to first appearance of leaves

TREATMENT	NUMBER OF DAYS
Control (no cold storage)	27.67[ab]
One week cold storage	20.33[c]
Two weeks cold storage	27.67[ab]
Three weeks cold storage	24b[c]
Four weeks cold storage	25.33[ab]
Five weeks cold storage	27[ab]
Six weeks cold storage	29 [a]

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

germination, complete emergence, percentage of normal seedlings, tallest seedlings and had the shortest days for the true leaf to emerge. Figure 2 shows an overview of blueberry seedlings during first appearance of leaves.

Percentage of Seedling Emergence

As shown in Table 3, there were significant statistical differences on the percentage of seedling emergence among the different treatments as affected by the various cold storage durations. It was observed that blueberry seeds subjected to one week cold storage attained the highest percentage of seedling emergence with a mean of 91.33 % which is not statistically different to the seeds that were not subjected to cold storage with mean of 87.67 %. On the other hand, the seeds subjected to six weeks cold

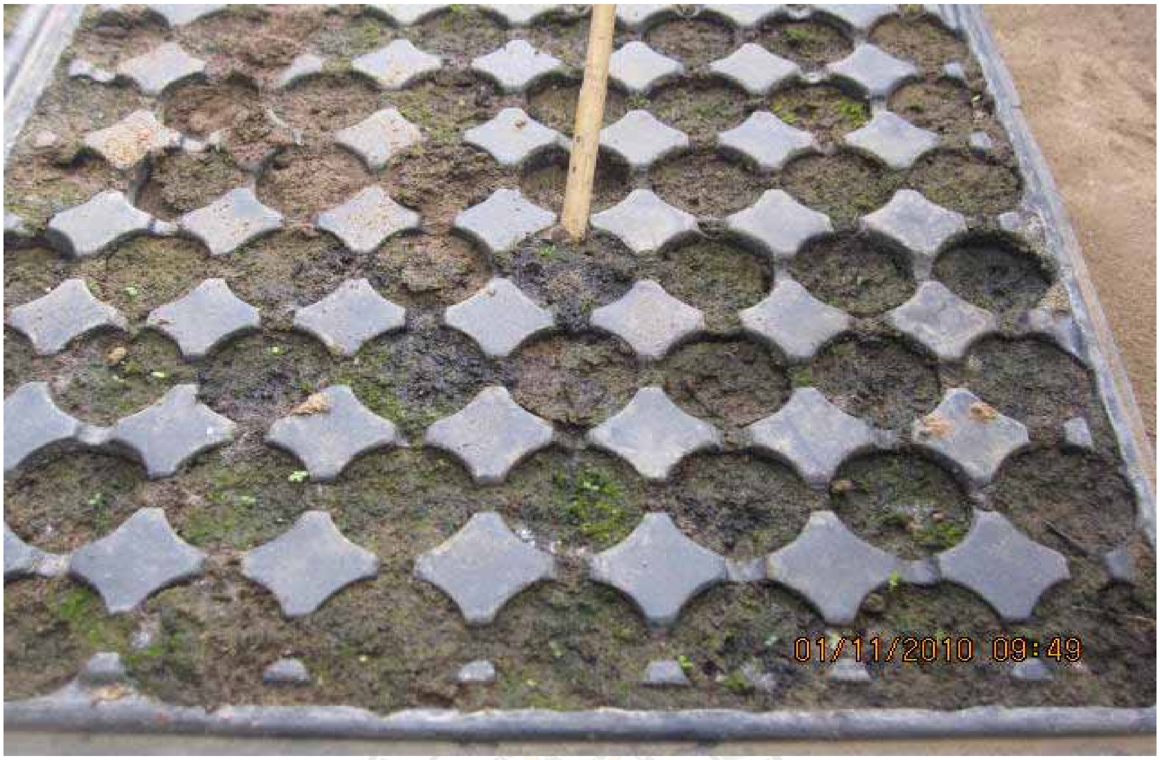

Figure 2. Overview of blueberry seedlings during first appearance of leaves

Table 3. Percentage of seedling emergence

TREATMENT	PERCENTAGE
Control (no cold storage)	87.67[a]
One week cold storage	91.33[a]
Two weeks cold storage	56.67[bc]
Three weeks cold storage	70.67[b]
Four weeks cold storage	67.33[b]
Five weeks cold storage	56.67[bc]
Six weeks cold storage	48.67[c]

Means with the same letters are not significantly different at level by DMRT

storage had the lowest percentage of seedling emergence with a mean of 48.67% which is significantly different with the rest of the treatments

It was observed however, that some seeds did not emerge for the reasons that can not be precisely explained although it may be due to chilling injury that caused the death of the embryo in the seeds during the long cold storage period and may also be due to the not fully decomposed coco coil dust added in the media that was used. Hartman and Kester (1990) stated that such results could be related this to high concentration of soil solutes in the upper layer of the germination media. Likewise, Handreck (1993) wrote that coir pith has a carbon-nitrogen ratio of 104:1 which means that it takes decades to decompose. The containing partly decomposed coco coir dust migth have released some toxic substance or gas that affected the emergence of seeds.

Percentage of Normal Seedlings

Table 4 shows that there were highly significant differences observed among the different cold storage duration in terms of percentage of normal seedlings. Based on the results, blueberry seeds subjected to one week cold storage had the highest percentage of normal seedlings with a mean of 84.67 %. It was followed by the seedlings resulting from seeds that were not subjected to cold storage with a mean of 78.67%. Seeds subjected to cold storage durations for three, four, two and five weeks obtained means of 62, 58, 50.67 and 49.33% of normal seedlings. Lastly, six weeks cold storage duration of blueberry seeds showed the lowest percentage of normal seedlings with a mean of 41.33%.

Table 4. Percentage of normal seedlings

TREATMENT	PERCENTAGE
Control (no cold storage)	78.67[a]
One week cold storage	84.67[a]
Two weeks cold storage	50.67[bcd]
Three weeks cold storage	62[b]
Four weeks cold storage	58[bc]
Five weeks cold storage	49.33[cd]
Six weeks cold storage	41.33[d]

Means with the same letters are not significantly different at level by DMRT

Salisbury and Ross (1992) explained that pre-chilling of seeds sometimes has a strong effect on growth in addition to its dormancy breaking action. If the embryos of peach seedlings are excised from their cotyledons, they will germinate without pre-chilling, but the seedlings are frequently stunted and abnormal. However, when excised embyos are treated with low temperature, they grow normal seedlings. Thus, it is pre-chilling and not the presence of the cotyledons that ensures their normality.

Seedling Height

The seedling (Table 5) of blueberry was obtained by measuring the seedling from the base up to the tip of its secondary leaves. Result shows that there were no significant statistical differences among the various cold storage durations. However, numerical results shows that seedlings from seeds subjected to one week cold storage had the tallest

Table 5. Seedling height

TREATMENT	HEIGHT (mm)
Control (no cold storage)	5[a]
One week cold storage	7.67[a]
Two weeks cold storage	5.17[a]
Three weeks cold storage	4.67[a]
Four weeks cold storage	5.50[a]
Five weeks cold storage	5.50[a]
Six weeks cold storage	5[a]

Means with the same letters are not significantly different at level by DMRT

seedlings with a mean of 7.67 mm. This was followed by the seedlings from the seeds subjected to four and five weeks cold storage durations with a means of 5.50 mm. However, seedlings from the seeds that were subjected to three weeks cold storage had the shortest height with a mean of 4.67 mm.

Results showed that one week cold storage duration of seeds prior to sowing enhanced growth of seedlings leading to taller seedlings. These findings corroborate with the observation of Tocnang (2009) who stated that cold storage of guapple seeds for a period of one week at 5 °C, will hasten seed germination, improve rate of seedling emergence and promote the development of taller seedlings. Likewise, Banagen (2008) reported that cold stratification of coffee Arabica seeds at 5 °C before planting stimulates faster growth and the greatest effect can be obtained from cold stratification for one week.

Number of Leaves per Plant

The result in Table 6 shows that there were no significant differences among the different cold storage duration with regards to the number of leaves per plant. However, numerical results revealed that seedlings from seeds subjected to one week cold storage had the highest number of leaves per plant with a mean of 3.83. Whereas, seedlings from seeds subjected to six weeks cold storage had the lowest number of leaves developed with a mean of 2.83.

Root Length

Regarding the root length of blueberry, it can be observed in Table 7 that there were significant statistical differences among the treatments as affected by the various durations of cold storage used. Results shows that seeds subjected to one week cold storage had the longest roots with a mean of 18.83 mm. Seedlings from the seeds

Table 6. Number of leaves per plant

TREATMENT	NUMBER OF LEAVES
Control (no cold storage)	3^{a}
One week cold storage	3.83^{a}
Two weeks cold storage	3^{a}
Three weeks cold storage	3.33^{a}
Four weeks cold storage	3.50^{a}
Five weeks cold storage	3.17^{a}
Six weeks cold storage	2.83^{a}

Means with the same letters are not significantly different at level by DMRT

Table 7. Root length

TREATMENT	ROOT LENGTH (mm)
Control (no cold storage)	14.50[b]
One week cold storage	18.83[a]
Two weeks cold storage	9[c]
Three weeks cold storage	9[c]
Four weeks cold storage	8.83[c]
Five weeks cold storage	10.17[c]
Six weeks cold storage	9[c]

Means with the same letters are not significantly different at level by DMRT

subjected to four weeks duration of cold storage had the shortest roots with a mean of 8.83 mm which is not statistically different with the root length of seedlings resulting from seeds subjected to two, three, five and six weeks cold storage.

Results showed that subjecting seeds to shorter duration of cold storage for a period of one week induce the production of roots. Meyer and Anderson (1952) explained that optimum temperature is usually about midway between two extremes of temperature at which germination will occur. It is not possible to designate any exact varies with the other prevailing environmental conditions and also with the exact criterion selected as an index of germination. The most favorable temperature for the elongation of the primary roots for example does not always correspond to the most suitable temperature for the development of the plumule.

Number of Roots

Table 8 shows that there were no significant differences on the number of roots as affected by different cold storage duration. Nevertheless, numerical figures suggest that seedlings coming from seeds subjected to one week cold storage had the highest number of roots with a mean of 4.17. Seedlings treated with four weeks duration of cold storage had an average number of roots of 3.83 while seedlings subjected to two, three and five weeks cold storage had the same means of 3.50. Seedlings subjected to six weeks duration of cold storage produced the least number of roots with a mean of 2.83.

Figure 3 shows uprooted seedlings during gathering of data regarding root length and root number 113 days from sowing.

Table 8. Number of roots

TREATMENT	NUMBER OF ROOTS
Control (no cold storage)	2.50[a]
One week cold storage	4.17[a]
Two weeks cold storage	3.50[a]
Three weeks cold storage	3.50[a]
Four weeks cold storage	3.83[a]
Five weeks cold storage	3.50[a]
Six weeks cold storage	2.83[a]

Means with the same letters are not significantly different at level by DMRT

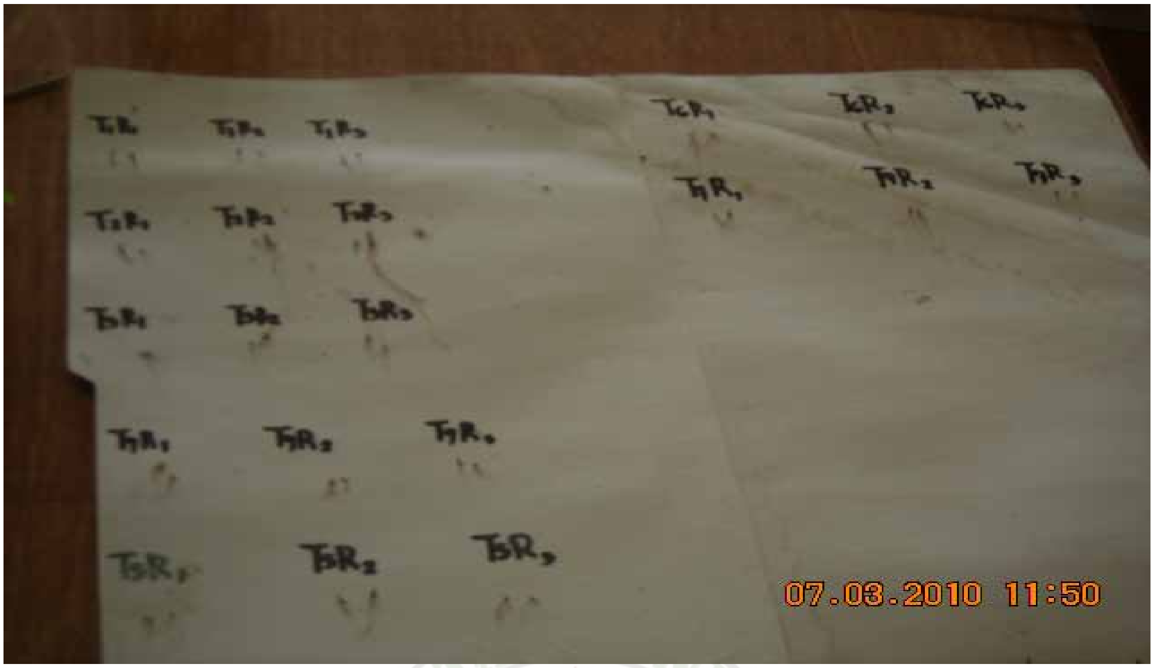

Figure 3. Uprooted seedlings of blueberry during gathering of data 113 days from sowing

Seedling Vigor Index

The results in Table 9 shows no significant statistical differences observed among the different treatments used in the study affecting the seedling vigor of blueberry seedlings. However, numerical results shows that seedlings coming from the seeds subjected to one week cold storage promoted the excellent growth of seedlings.

Tocnang (2009) observed that guapple seed subjected to one week and two weeks cold storage promoted excellent growth of seedlings. Likewise, Banagen (2008) noted that storing coffee seeds under cold temperature influences seedling vigor. Cold stratification enhanced faster growth which may explain the performance of coffee seeds subjected to cool treatments as having seedlings that are more vigorous as compared to the unstratified seeds. Figure 4 shows the overview of the experiment 113 days from sowing the seeds.

Table 9. Seedling vigor index

TREATMENT	SEEDLING VIGOR
Control (no cold storage)	2[a]
One week cold storage	1.67[a]
Two weeks cold storage	2.33[a]
Three weeks cold storage	2.33[a]
Four weeks cold storage	2.33[a]
Five weeks cold storage	2.33[a]
Six weeks cold storage	2.33[a]

Rating: 1= most vigorous; 2= vigorous; 3= less vigorous

Figure 4. Overview of the experiment 113 days from sowing seeds.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The germination and seedling growth of blueberry seeds as affected by different cold storage duration was studied at the Pomology Project Nursery, Benguet State University, La Trinidad, Benguet from November 15,2009 to March 7, 2010. the blueberry seeds were subjected to low temperature with an average of 5 °C at various periods from one to six weeks.

Result showed that there were significant statistical differences observed among the various cold storage duration used. One week cold storage of blueberry seeds showed the best performance among all treatments that enhanced earlier seedling emergence with a mean of 14.67 days and shorter days to develop true leaves with a mean of 20.33 days. Likewise, the same duration of cold storage attained the highest percentage of seedling emergence having a mean of 91.33 % and also with the percentage of normal seedlings with a mean of 84.67 %. The seedlings coming from the seeds subjected to one week cold storage had also produced longer root length with a mean of 18.83 mm which is highly significant to the other treatments.

With regards to the seedling height, number of leaves, number of roots and seedling vigor statistical results shows that there were no significant differences among the different cold storage duration used however numerical results shows that seedlings coming from the seeds stored for a period of one week had the tallest seedlings, more number of leaves and roots, and had more vigorous seedlings as compared to other treatments.

Conclusion

Based on the results of the study, subjecting blueberry seeds to cold storage for one week before sowing showed promising results. It was found out that it was the best among the various cold storage durations studied in enhancing faster germination and emergence of blueberry seeds.

Recommendation

From the preceding results, it is recommended that cold storage of blueberry seeds for a period of one week at 5 °C prior to sowing should be done in order to enhance faster seed germination and emergence as well as to promote longer root development and enhanced faster and vigorous seedling growth. However, further study along this line also recommended to verify these findings.

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APPENDICES

Appendix Table 1. Number of days from sowing to seedling emergence

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	22	24	21	67	22.33
T_2	16	14	14	44	14.67
T_3	23	19	24	66	22
T_4	14	20	19	53	17.67
T_5	19	19	21	59	19.67
T_6	18	16	21	55	18.33
T_7	21	22	23	66	22

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Between	6	145.905	24.317	5.738	2.85	4.46
Within	14	59.333	4.238			
Total	20	205.238				

**Highly significant   Coefficient of variation = 10.54%

Appendix Table 2. Number of days from sowing to first appearance of leaves

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	27	30	26	83	27.67
T_2	22	19	20	61	20.33
T_3	28	25	30	83	27.67
T_4	21	26	25	72	24
T_5	24	24	28	76	25.33
T_6	26	25	30	81	27
T_7	27	29	31	87	29

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Treatment	6	155.905	25.984	5.006	2.85	4.4
Error	14	72.667	5.190			
Total	20	228.571				

**Highly significant Coefficient of variation = 8.81%

Appendix Table 3. Percentage of seedling emergence

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	96	76	92	264	88
T_2	92	94	88	274	91.33
T_3	64	48	58	170	56.67
T_4	82	60	70	212	70.67
T_5	72	74	56	202	67.33
T_6	66	54	50	170	56,67
T_7	54	50	42	146	48.67

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Treatment	6	4704.476	784.079	10.468	2.85	4.46
Error	14	1048.667	74.905			
Total	20	228.571				

**Highly significant Coefficient of variation = 12.65%

Appendix Table 4. Percentage of normal seedlings

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	78	76	82	236	78.67
T_2	84	86	84	254	84.67
T_3	56	44	52	152	50.67
T_4	72	54	60	186	62
T_5	62	64	48	174	58
T_6	58	46	44	148	49.33
T_7	46	40	38	124	41.33

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Treatment	6	4533.333	755.556	18.711	2.85	4.46
Error	14	565.333	40.381			
Total	20	5098.667				

**Highly significant

Coefficient of variation = 10.47%

Appendix Table 5. Seedling height

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	4.5	4.5	6	15	5
T_2	6	8	9	23	7.67
T_3	5	5.5	5	15.5	5.17
T_4	5	4.5	4.5	14	4.67
T_5	4.5	7	5	16.5	5.5
T_6	5.5	7	4	16.5	5.5
T_7	5	6	4	15	5

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Treatment	6	2.143	0.357	2.55	2.85	4.46
Error	14	2.167	0.155			
Total	20	4.310				

Not significant Coefficient of variation = 12.15%

Appendix Table 6. Number of leaves per plant

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	3	3	3	9	3
T_2	4	4	3.5	11.5	3.83
T_3	3	3.5	2.5	9	3
T_4	3.5	3	3.5	10	3.33
T_5	4	3.5	3	10.5	3.5
T_6	3.5	3.5	2.5	9.5	3.17
T_7	5	3	2.5	8.5	2.83

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Treatment	6	18.000	3.000	2.55	2.85	4.46
Error	14	16.500	1.179			
Total	20	5098.667				

Not significant   Coefficient of variation = 19.74%

Appendix Table 7. Root length

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	18.5	11.5	13.5	43.5	14.5
T_2	15.5	18.5	22.5	56.5	18.83
T_3	9	10	8	27	9
T_4	10	8.5	8.5	27	9
T_5	10.5	8	8	26.5	8.83
T_6	9.5	11.5	9.5	30.5	10.17
T_7	8	8.5	10.5	27	9

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Treatment	6	270.667	45.111	9.792	2.85	4.46
Error	14	64.500	4.607			
Total	20	335.167				

** Highly significant   Coefficient of variation = 18.94%

Appendix Table 8 . Number of roots

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	2.5	2	3	7.5	2.5
T_2	4.5	4	4	12.5	4.17
T_3	4	3	3.5	10.5	3.5
T_4	4	3	3.5	10.5	3.5
T_5	2.5	4.5	4.5	11.5	3.83
T_6	4.5	4	2	10.5	3.5
T_7	3	3	2.5	8.5	2.83

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Treatment	6	5.810	0.968	1.69	2.85	4.46
Error	14	8.000	0.571			
Total	20	13.810				

Not significant Coefficient of variation = 22.20%

Appendix Table 9. Seedling vigor

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	2	2	2	6	2
T_2	2	2	1	5	1.67
T_3	3	2	2	7	2.33
T_4	2	2	3	7	2.33
T_5	3	2	2	7	2.33
T_6	2	2	3	7	2.33
T_7	2	2	3	7	2.33

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	0.01
Treatment	6	1.238	0.206	0.72	2.85	4.46
Error	14	4.000	0.286			
Total	20	5.238				

Not significant

Coefficient of variation = 24.40%