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RESEARCH PAPER

Germination and Early Growth of *Brachychiton populneus* (Schott & Endl.) in Response to Different Shade Percentages and Sowing Depths.

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A B S T R A C T:
A tree's ability to develop and its full potential depends on the environment in which it grows, especially during its early growth and germination stage. Due to the importance of planting depth and shadowing % as two important parameters for seed germination and early seedling growth under nursery conditions, this experiment was conducted to generate *Brachychiton populneus* seedlings at the optimal depth. In this study, three levels of shade conditions were tested with depths of 0, 1, 2, and 3 cm, respectively (0 percent shade, 50 percent shade, and 75 percent shade, respectively). The experimental design was factorial complete randomized design (CRD) with four replications for each treatment. At the end of the trial final germination percentages and vegetative growth parameters were measured. The results indicated that the different sowing depths and shade percentage treatments had a great significant influence on germination percentage, stem length, basal stem diameter, leaf number, and root length either in separately or in combination between both. Mean of germination percentage under zero shade percentage (full sunlight) significantly better than those under 50 and 75 shade percentage. Furthermore, the highest germination percentage was 80 % when the seeds were sown under full sunlight (zero shade percentage) and in 1 cm deep or under 50% shade percentage and 2 cm deep. Our results will help forest nurseries to produce healthy and a high quality of *B. populneus* seedlings for better chance of plantation programs.

KEY WORDS: Sowing depth, Shade percentage, Brachychiton populneus, Bottle tree germination, and seedling growth
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1.INTRODUCTION :

Brachychiton populneus (Schott & Endl.) R. Br. is a species of forest tree that belongs to Sterculiaceae family and it grows naturally in Eastern Australia (Eastern Victoria to Townsville). It is considered as a relatively slow growing species and its total height reaches 15-20 m at mature stage (Anderson, 2016). It is generally identified as Kurrajong or a Bottle tree since it can store water in its trunk; furthermore, it has a high deep root system, which supports the tree to resistant drought stress (Anderson, 2016; Karim *et al.*, 2020).

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The tree is planted in roadsides and gardens as decorative tree. Fibre materials were made from its stem bark, and shields were made from its soft spongy wood. The leaves can be used as an alternative fodder for drought-affected animal stock. The seeds can be used as a coffee supplement by roasting and crushing (Anderson, 2016).

At nursery, production of forest seedlings with a high quality, quantity and healthy depends on some factors. Among these factors, shade percentage (light intensity) and sowing depths are two the most important factors that affect the plant growth and physiology (Kozlowski and Pallardy, 1997; Uchida, 2000).

The light is essential factor influencing directly and indirectly on the plant growth. It contributes directly in seedling growth through governing its physiological characters such as photosynthesis, respiration, stomatal conductance, transpiration, hormone synthesis and chlorophyll creation (Pallardy, 2008). Light could also impact the plant growth indirectly through its influences on air temperature, humidity, soil temperature and soil moisture (Bhatla and Lal, 2018). The light intensity is more significant for growth performance since both high and low quantity of sunlight could cause plant stress and at this situation, the photosynthesis system works unsatisfactorily, thus plant growth will be reduced (Lambers *et al*., 2008).

The depth of seed sowing is another important factor affecting the germination and consequently the seedling growth (Lal, 2003, Adelani, 2015 and Kibru *et al*., 2015).

Subsequently, there is a world-wide interest in optimizing light regimes (Sherzad *et al.*, 2015; Fu *et al.*, 2017; Hamad *et al.*, 2020) and sowing depths (Kibru *et al.*, 2015 and Chima *et al.*, 2017; Hamad and Anwer, 2021) for diverse species in the nursery to attain healthy and high-quality seedlings. On the other hand, there is no previous study on the germination and growth performance of *B. populneus* in responses to shade percentages, sowing depths and their interactions under the nursery condition. Therefore, the present study was performed to determine the effect of different shade percentages, seed sowing depths and their interactions on the germination, growth, and biomass of *B. populneus* seedlings.

2.Materials and Methods

2.1 Seed collection

In Minera Park, of Erbil city, mature pods (fruit) of *Brachychiton populneus* trees were harvested. After the collection stage, seeds were manually removed from pods, washed of the outer coat, placed in paper bags, and maintained in a dry environment under 25 °C in the laboratory until the sowing date.

2.2 Place and Time of Seed Sowing

The study was carried out in Grdarasha research filed (Elevation: 415 meters above Sea level, Latitude: 36°06'47.0"N and Longitude: 44°00'44.8"E), that belongs to collage of Agriculture engineering sciences in Erbil Governorate. A mixture of soil media (2 sandy soil: 1 Peat moss) were prepared for all treatments. Plastic boxes (45 cm length * 30 cm width *15 cm high) were filled with the soil media equally. In the plastic box, four rows were made and the distance between rows were 6 cm. each row contains of 6 holes and the distance between holes were also 6 cm. So, 24 Seeds of *B. populneus,* which treated by soaking in boiling water until cool for 24h (Dardour *et al.*, 2014), were planted in each the plastic box by Dibbling sowing method in (1-9-2019) based on used treatments. After plantation completed boxes were watered regularly according to their needs.

2.3 Experimental design

The present experiment was laid out based on a factorial randomized complete design (CRD) with two factors. The first factor was three different shade conditions which were 0 % shade (full sunlight), 50 % shade, and 75% shade. The second factor was four different sowing depths which were 0 cm (surface sowing), 1 cm, 2 cm and 3 cm. Each treatment was replicated four times, where the number of experimental units were 48.

2.4 The studied parameters

Germination was monitored for a period of 6 weeks to calculate germination percentage. The germination percentage was measured based on the following equation:

$$\text{Germination Percentage} = \frac{\text{Number of germinated seeds}}{\text{Total number of seeds sown}} \text{ x } 100$$

Early growth parameters such as stem length, basal stem diameter, leaf number and root length, stem dry weight, leaf dry weight, root dry weight, total plant dry weight and root to shoot ratio and average leaf area of *B. populneus* seedlings were measured as an indicator of the seedling growth at the end of trial in May 2019. The stem length was measured from the soil surface to the highest living apical shoot using a ruler in centimetre units. Basal stem diameter was measured using a digital Vernier calliper in millimetre units (Digimatic calliper Mitutoyo-Japan). Leaf number for each seedling was calculated manually. After harvesting, the seedling roots were cleaned carefully from the soil by washing the soil. Then, root length was measured using a ruler in centimetre units. The harvested seedlings were then separated into their parts (stem, leaf and root) and oven dried at 80 C° until a constant dry weight was confirmed during 24 hours. The seedling parts were then weighted using a sensitive digital balance in gram units to get stem dry weight, leaf dry weight, root dry weight, total plant dry weight and root to shoot ratio. Leaf area was measured using gridline paper in square centimetre units. Specific leaf area ($cm^2.g^{-1}$) was a ratio between leaf area and leaf dry weight per seedling.

2.5 Data analyses

After all raw data collected for all treatments, the data were statistically analysed by a Two-Way Analysis of variance (ANOVA) using SPSS Software for showing significant differences in main factor or interaction effect. Duncan multiple range test was used to determine between treatments.

3.Results

Table 1, showed that shade percentage treatments had a high significant effect on germination percentage, stem length, basal stem diameter, leaf number and root length of *Brachychiton populneus*. The mean of germination percentage under zero shade percentage (full sunlight) were significantly better than those under 50 and 75 shade percentage, which are 48.75%, 43.75% and 16.88% respectively. In contrast, means of growth parameters (stem length, basal stem diameter, leaf number and root length) under zero shade percentage (full sunlight) significantly lower than those under 50 and 75 shade percentage. Moreover, stem length mean was significantly higher in 75 shade percentage (8.50cm) than those in 50 and zero shade percentage (5.94 cm and 3.13 cm respectively). However, means of basal stem diameter, leaf number and root length were recorded the best value of the seedlings grown under 50 shade percentage. So, based on the above results we can conclude that *B. populneus* seed requires full sunlight to improve its germination percentage while it needs 50 shade percentage to enhance most growth properties of its seedlings except stem length.

Table 1: Effect of shade percentages on means of germination percentage, stem length, basal stem diameter, leaf number and root length of *Brachychiton populneus*

Shade percentages	Germination percentage (%)	Stem length (cm)	Basal stem diameter (mm)	Leaf number	Root length (cm)
SP-0%	48.75 a	3.13 c	0.643 c	2.69 b	7.38 c
SP-50%	43.75 b	5.94 b	1.193 a	5.88 a	27.27a
SP-75%	16.88 c	8.50 a	0.939 b	5.75 a	19.41 b
P- value	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*

Means with the same letter in a column are not significantly different by Duncan at $p \leq 0.05$.

Based on P- value sowing depths had significant influence on germination percentage, stem length, basal stem diameter and leaf number of the studied species. However, they did not have significant impact on root length (Table 2). Furthermore, the seed sowing at 1 and 2 cm deep recorded higher germination percentage, which were 47.5 and 46.67 respectively, compared with those sowed in both 0 and 3 cm deep, which were 35 and 16.67 respectively. There were not differences among 0, 1, and 2 cm deep in terms of stem length, whereas stem length at 0 and 2 cm deep significantly better than those at 3 cm deep. Moreover, the greatest basal stem diameter (1.149 mm) and leaf number (5.83) were obtained from the seeds that were sown in 1 cm deep, while the lowest basal stem diameter (0.739 mm) and leaf number (3.67) were gotten from the seeds that were sown in 3 cm deep. Thus, all studied parameters were improved when the seeds were planted in 1 cm deep except lengths of stem and root.

Table 2: Effect of sowing depths on means of germination percentage, stem length, basal stem diameter, leaf number and root length of *Brachychiton populneus*

Sowing depths	Germination percentage (%)	Stem length (cm)	Basal stem diameter (mm)	Leaf number	Root length (cm)
SD-0 cm	35.00 b	6.67 a	0.919 b	4.42 bc	18.42 a
SD-1 cm	47.50 a	5.50 ab	1.149 a	5.83 a	18.57 a
SD-2 cm	46.67 a	6.67 a	0.892 b	5.17 ab	17.22 a
SD-3 cm	16.67 c	4.58 b	0.739 b	3.67 c	17.87 a
P- value	*0.000*	*0.002*	*0.001*	*0.005*	*0.593*

Means with the same letter in a column are not significantly different by Duncan at $p \leq 0.05$.

Interaction effect of different shade percentages and sowing depths illustrated that germination percentage, stem length, basal stem diameter, leaf number and root length of the seedlings were significantly affected by combination of both shade percentages and sowing depths (Table 3). The highest germination percentage was 80 when the seeds were sown under full sunlight (zero shade percentage) and in 1 cm deep or under 50% shade percentage and 2 cm deep, while the lowest germination percentage was zero when the seeds were sown under full sunlight and in 3 cm deep. Moreover, germination percentage under full sunlight and 1,0, and 2 cm deep was better than other treatment combinations except those planted under 50% shade percentage and 2 cm deep (SP-50%+SD-2cm).

Mean comparison among treatment combination showed that stem length of the seedlings was the highest for seeds grown under 75% shade percentage, in all sowing depths and under 50% shade percentage, in 0 and 2 cm deep. The greatest and smallest basal stem diameter and root length were recorded under 50% shade percentage, in 1 cm deep and under full sunlight, in 3 cm deep respectively. The maximum and minimum leaf number were noted under 75% shade percentage, in 1 cm deep and under full sunlight, in 3 cm deep respectively.

Table 3: Combination effect of shade percentages and sowing depths on means of germination percentage, stem length, basal stem diameter, leaf number and root length of *Brachychiton populneus*

Shade percentages	Sowing depths	Germination percentage (%)	Stem length (cm)	Basal stem diameter (mm)	Leaf number	Root length (cm)
SP-0%	SD-0 cm	65.00 b	4.00 c	0.915 abc	3.50 d	9.50 fg
SP-0%	SD-1 cm	80.00 a	4.25 c	0.958 abc	3.75 cd	8.00 g
SP-0%	SD-2 cm	50.00 c	4.25 c	0.700 c	3.50 d	12.00 ef
SP-0%	SD-3 cm	0.00 f	0.00 d	0.000 d	0.00 e	0.00 h
SP-50%	SD-0 cm	30.00 de	7.50 a	1.123 ab	5.75 abcd	28.23 ab
SP-50%	SD-1 cm	25.00 e	4.25 c	**1.290 a**	6.50 a	**32.00 a**

SP-50%	SD-2 cm	80.00 a	6.75 ab	1.190 a	6.25 ab	24.65 bc
SP-50%	SD-3 cm	40.00 d	5.25 bc	1.168 a	5.00 abcd	24.20 c
SP-75%	SD-0 cm	10.00 f	8.50 a	0.720 c	4.00 bcd	17.53 d
SP-75%	SD-1 cm	37.50 d	8.00 a	1.200 a	**7.25 a**	15.70 de
SP-75%	SD-2 cm	10.00 f	**9.00 a**	0.785 bc	5.75 abcd	15.00 de
SP-75%	SD-3 cm	10.00 f	8.50 a	1.050 abc	6.00 abc	29.40 a
P- value		*0.000*	*0.008*	*0.000*	*0.028*	*0.000*

Means with the same letter in a column are not significantly different by Duncan at p ≤ 0.05.

Table 4, investigated that different shade percentages had significant influence on plant biomass parameters and root to shoot ratio of the studied species. Stem dry weight and total plant dry weight of the seedlings grown under 50% shade percentage were significantly greater than those under 0 and 75 shade percentage. While the leaf dry weight, root dry weight and root to shoot ratio under 50% and 75% shade percentages were dramatically better than those under full sunlight (0 % shade percentage).

Table 4: Effect of shade percentages on means of stem dry weight, leaf dry weight, root dry weight, total plant dry weight and root to shoot ratio of *Brachychiton populneus*

Shade percentages	Stem dry weight (g)	Leaf dry weight (g)	Root dry weight (g)	Total plant dry weight (g)	Root-Shoot ratio
0%	0.031 c	0.043 b	0.020 b	0.093 c	0.208 b
50%	**0.064 a**	**0.165 a**	**0.065 a**	**0.294 a**	0.306 a
75%	0.039 b	0.146 a	0.058 a	0.242 b	**0.327 a**
P- value	*0.000*	*0.000*	*0.000*	*0.000*	*0.040*

Means with the same letter in a column are not significantly different by Duncan at p ≤ 0.05.

Comparison of means among different seed sowing depths showed that there were not significant differences between 1 and 2 cm depths in terms of stem dry weight, root dry weight, and root to shoot ratio. However, stem dry weight, leaf dry weight, root dry weight, total plant dry weight and root to shoot ratio of the seedlings that their seeds planted in 1 cm deep recorded the highest values compared with other sowing depths (Table 5).

Table 5: Effect of sowing depths on means of stem dry weight, leaf dry weight, root dry weight, total plant dry weight and root to shoot ratio of *Brachychiton populneus*

Sowing depths	Stem dry weight (g)	Leaf dry weight (g)	Root dry weight (g)	Total plant dry weight (g)	Root-Shoot ratio
0 cm	0.042 bc	0.076 c	0.029 c	0.147 d	0.245 ab
1 cm	**0.053 a**	**0.172 a**	**0.068 a**	**0.293 a**	**0.349 a**

2 cm	0.047 ab	0.119 b	0.054 ab	0.220 b	0.345 a
3 cm	0.036 c	0.105 bc	0.038 bc	0.179 c	0.181 b
P- value	*0.001*	*0.000*	*0.001*	*0.000*	*0.010*

Means with the same letter in a column are not significantly different by Duncan at p ≤ 0.05.

Table 6, revealed that there were not interaction effect of shade percentages and sowing depths on the root dry weight (P< 0.07) and root to shoot ratio (P< 0.157). On the other hand, other plant biomass parameters were statistically affected (P< 0.00) by combination effect of shade percentages and sowing depths. Furthermore, the seeds sown in different depths under 50% shade had significant higher stem dry weight than other treatment combinations except those sown in 1 cm depth under 75% shade. Leaf dry weight of the seedlings planted under 50% shade, in 1 and 2 cm deep and under 75% shade, in 1 and 3 cm deep were statistically had higher value compared with other treatment combinations. Moreover, the seedlings planted under 50% shade, in 1 cm deep had significantly greater total plant dry weight than other treatment combinations except those planted under 50% shade in 2 cm and 75% shade in 1 cm deep.

Table 6: Combination effect of shade percentages and sowing depths on means of stem dry weight, leaf dry weight, root dry weight, total plant dry weight and root to shoot ratio of *Brachychiton populneus*

Shade percentages	Sowing depths	Stem dry weight (g)	Leaf dry weight (g)	Root dry weight (g)	Total plant dry weight (g)	Root-Shoot ratio
0%	0 cm	0.042 b	0.040 cd	0.020 a	0.102 d	0.235 a
0%	1 cm	0.040 b	0.070 bcd	0.030 a	0.140 d	0.295 a
0%	2 cm	0.040 b	0.060 bcd	0.030 a	0.130 d	0.300 a
0%	3 cm	0.000 d	0.000 d	0.000 a	0.000 e	0.000 a
50%	0 cm	0.063 a	0.128 b	0.048 a	0.238 c	0.250 a
50%	1 cm	0.065 a	**0.230 a**	**0.095 a**	**0.390 a**	0.425 a
50%	2 cm	0.060 a	0.208 a	0.073 a	0.340 ab	0.275 a
50%	3 cm	**0.068 a**	0.095 bc	0.045 a	0.207 c	0.272 a
75%	0 cm	0.020 c	0.060 bcd	0.020 a	0.100 d	0.250 a
75%	1 cm	0.055 ab	0.215 a	0.080 a	0.350 ab	0.327 a
75%	2 cm	0.040 b	0.090 bc	0.060 a	0.190 c	0.460 a
75%	3 cm	0.040 b	0.220 a	0.070 a	0.330 b	0.270 a
P- value		*0.000*	*0.000*	*0.077*	*0.000*	*0.157*

Means with the same letter in a column are not significantly different by Duncan at p ≤ 0.05.

Table 7, illustrated that different shade percentages had significant influence on leaf area and specific leaf area of the studied species. Leaf area and specific leaf area of the seedlings were significantly improved by increased shade percentage, where the biggest and smallest value of both mentioned parameters recorded under 75% and 0% shade percentages respectively.

Table 7: Effect of shade percentages on means of leaf area and specific leaf area of *Brachychiton populneus*

Shade percentages	Leaf area (cm^2)	Specific leaf area ($cm^2.g^{-1}$)
0%	7.09 c	136.87 c
50%	29.93 b	189.97 b
75%	**36.02 a**	**280.12 a**
P- value	*0.000*	*0.000*

Means with the same letter in a column are not significantly different by Duncan at $p \leq 0.05$.

Results in Table 8, displayed that leaf area and specific leaf area were significantly differed by seed sowing depths. Both shallow seeding and deeper seeding caused to declining of leaf area. Additionally, the biggest leaf area (30.82 cm^2) was obtained from 1 cm sowing depths, while the lowest leaf area (18.64 cm^2) was found in surface sowing (0 cm). On the other hand, the maximum value of specific leaf area (269.12 $cm^2.g^{-1}$) was achieved in surface sowing (0 cm), whereas the minimum value of specific leaf area (140.69 $cm^2.g^{-1}$) was noted from 3 cm sowing depths. The reduction of leaf area with increasing sowing depths may be due to inconsistent growth in stem length and leaf number as seen in Tables 2, and subsequently reduced leaf expansion which may impact photosynthesis and growth of seedlings. Thus, declined leaf area might result to lesser photosynthetic capacity of the seedlings and finally limit growth (Ayobola *et al*., 2010 and Sikuku *et al*., 2018).

Table 8: Effect of sowing depths on means of leaf area and specific leaf area of *Brachychiton populneus*

Sowing depths	Leaf area (cm^2)	Specific leaf area ($cm^2.g^{-1}$)
0 cm	18.64 c	**269.12 a**
1 cm	**30.82 a**	183.22 b
2 cm	25.09 b	216.24 b
3 cm	22.83 bc	140.69 c
P- value	*0.001*	*0.000*

Means with the same letter in a column are not significantly different by Duncan at $p \leq 0.05$.

Results in Table 9, showed that interaction effect of shade percentages and sowing depths had high significant influence on the leaf area and specific leaf area. Furthermore, the widest leaf area (51 cm^2) was recorded under 75% shade and 3 cm sowing depth, while the narrowest leaf area was logged under zero shade percentage and 3 cm sowing depth. On the other hand, the highest specific leaf area (383.33 $cm^2.g^{-1}$) was verified under 75% shade and surface (0 cm) sowing depth, while the lowest specific leaf area was listed under zero shade percentage and 3 cm sowing depth.

Table 9: Combination effect of shade percentages and sowing depths on means leaf area and specific leaf area of *Brachychiton populneus*

Shade percentages	Sowing depths	Leaf area (cm^2)	Specific leaf area ($cm^2.g^{-1}$)
0%	0 cm	7.42 de	223.25 c
0%	1 cm	11.25 d	162.76 c
0%	2 cm	9.69 de	161.46 c
0%	3 cm	0.00 e	0.00 d
50%	0 cm	25.50 c	200.77 c
50%	1 cm	37.88 b	178.80 c
50%	2 cm	38.83 b	190.05 c
50%	3 cm	17.50 cd	190.25 c
75%	0 cm	23.00 c	**383.33 a**
75%	1 cm	43.33 ab	208.11 c
75%	2 cm	26.75 c	297.22 b
75%	3 cm	**51.00 a**	231.82 bc
P- value		*0.000*	*0.000*

Means with the same letter in a column are not significantly different by Duncan at $p \leq 0.05$.

4.Discussion

The relationship between depth and shade percentage has been studied for various plant species. In this present trial we found, that shade percentage treatments had a high significant effect on germination percentage and on many morphological characteristics of *Brachychiton populneus* seedlings. Germination percentage and morphological features such as stem length basal stem diameter, leaf number and root length, and total seedling leaf area of *B. populneus* were significantly affected by shade proportion and burial depth. Scientists have long studied the effects of shade and sowing depth on plant morphology, and the current research is no exception. The latest studies have demonstrated that plant morphology can be affected by shade. When sowing seeds, the depth at which they are planted has an impact on the plant morphology of the young seedlings (Khalid *et al*., 2019). To maximize seedling production, it is optimal to plant seeds at a depth that allows them to develop without being restricted by the substrate, but this is difficult to achieve. We have found that planting seeds deeper than the substrate limits the development of the primary root system, which in turn limits the amount of root growth and the yield of the plant. When plants are grown in a container instead of the field, this restriction on root development can be alleviated (Barnett, 1997).

Furthermore, different shade percentages and sowing depths showed that the combination of both shade percentages and sowing depths had a substantial impact on the seedlings' germination percentage, stem length, basal stem diameter, leaf number, and root length. This outcome is consistent with a number of earlier investigations, including those by

Singh *et al*. (1996) and Guo *et al*. (1999), which demonstrated that the maximum emergence occurred in 1.5–2 cm holes. It should be stressed that deeper seeding frequently delays the sprouting of seedlings but usually prevents some predation. Similar results from earlier studies suggested that unfavourable climate conditions may have contributed to some of the emergence failure over the time period (Guo *et al*., 1999). This reality is consistent with our investigation. Our study can be confirmed by this reality. In our investigation significant effect of shading was detected on ground line diameter, similar results was observed on seedlings height. Despite the complexity of the link between shade percentage and leaf area, our findings show that when shade percentage is high, the expansion of the leaf area widens, which influences how much light is intercepted and is a crucial factor in determining plant productivity (Gifford *et al*., 1984; Koester *et al*., 2014). Additionally, high-throughput phenotyping of plants frequently uses optical techniques in which estimations of photosynthesis produced from fluorescence signals are compared with growth in leaf area. Height growth was significantly impacted by shading, and as the amount of shade grows, so do the average leaf sizes (Wan *et al,* 2020). This relationship is significant because it provides us with information on how much energy to anticipate from a particular amount.

Over the past decade, there has been a significant amount of work done on the effects of shade and sowing depth on plant morphology. The depth in which seeds are planted is referred to as "sowing depth" and in this paper we provided the effect of the sowing depth on the root system of plants by looking at the influence of different sowing depths on the growth of the root system and in accessing resources in the soil. When they are planted at a depth that is deeper than the root base, the primary roots halt growth, while the lateral roots continue to grow. In this way, lateral roots are used both to grow the plant deeper into the soil, and to provide additional support to the primary roots. Root growth is inhibited when seeds are sown too deep (Tao *et al*., 2022).

5.Conclusion

We conclude from the results of this study and from earlier studies, that establishment and growth of *B. populneus* seedlings can be improved by increasing the amount of light reaching the under story. The results of the current study show that *B. populneus* sowing depth has the potential to develop into an efficient regeneration technique where the canopy opening is bigger and the seeds and seedlings are protected from rodents. Additionally, it should be noted that while deeper seeding may cause germination to take longer, it does guarantee the development of new growth to some level. Finally, it can be stated that the depth planted at 1 cm holes under 0% shade cover was the most effective condition in this study to boost germination percentage performance of *B. populneus*. After germination, the seedlings should be put in an open location after a few months under 50% shade.

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