

Effect of sowing depth on germination of important multipurpose trees

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Abstract: The experiment was conducted at the Agroforestry farm, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh during the period from March 2010 to August 2010 to investigate the effect of sowing depth on germination of 15 multipurpose trees (MPTs) viz. Bakphul (*Sesbania grandiflora*), Sadakoroi (*Albizia procera*), Ipil-ipil (*Leucaena leucocephala*), Eucalyptus (*Eucalyptus camaldulensis*), Akasmoni (*Acacia auriculiformis*), Sonalu (*Cassia fistula*), Babla (*Acacia nilotica*), Kalokoroi (*Albizia lebeck*), Raintree (*Albizia saman*), Jarul (*Lagerstroemia speciosa*), Mahogoni (*Swietenia mahogani*), Arjun (*Terminalia arjuna*), Polash (*Butea monosperma*), Minjiri (*Cassia siamea*) and Khoir (*Acacia catechu*). The seeds of these MPTs were sown at 10 different sowing depths which were 0.0cm, 0.5cm, 1.0cm, 1.5cm, 2.0cm, 2.5cm, 3.0cm, 3.5cm, 4.0cm and 4.5cm. Result revealed that germination was significantly influenced by sowing depth. Depending on the germination percent and germination period, optimum sowing depths of each MPTs were recorded. Optimum sowing depths were determined based on maximum germination percent and shortest germination period. Optimum sowing depths of 8 MPTs i.e. Bakphul, Sadakoroi, Ipil-ipil, Akashmoni, Sonalu, Babla, Kalokroi and Raintree are almost same (1.5-2.5cm). For other 7 MPTs i.e. Eucalyptus, Jarul, Mahogoni, Arjun, Polash, Minjiri and Khoir optimum sowing depths are 0.0, 0.0-0.5, 1.5-2.5, 1.0-3.0, 1.5-2.0, 0.5-1.0 and 0.5-1.0cm, respectively.

Key words: Sowing depth, multipurpose trees (MPTs), germination percent.

Introduction

Bangladesh is a densely populated country with 1,47,570 km² area having 162 million people (BBS, 2009). A vast majority of population who live in rural villages are directly dependent on the continued productivity of soil, water and forest for their food, timber, fodder and fruit. But these land and resources have been severely degraded and depleted due to over use by the fast increasing population pressure and encroached of habitat to other land use system. Increasing deforestation has resulted not only severe but also has threatened the ecological balance of the country. Under this alarming situation massive afforestation or reforestation program including first growing multipurpose trees can help in increasing the forest coverage of the country. For the above plantation purpose huge number of seedlings / saplings required. Seedlings / saplings can be raised in the nursery directly in seedbed or in container (Polybag, earthen pot, plastic pot etc.) Among the different containers polybags are the most suitable. In recent years, the use of polybag in the nursery practices has been increased considerably due to massive afforestation and reforestation programs. It has many advantages in raising stocks, easy transportation and irrigation, unbreakable characters, easy availability and white colors, easy to make holes for aeration and drainage. Above all each polybag contains equal volume of rooting media for each seedling which is very important growing tall, healthy and uniform seedlings in the nursery. It is reported that by planting more than one meter tall plant of eucalyptus hybrid the rotation period can be reduce by 25% (Schuchet and Pittenger, 1996). For vigorous and healthy seedling raising purpose important considerations are (i) Seed collection (ii) Nursery operations (iii) Plantation (iv) Maintenance and protection. (Dwivedi, 1992). Sowing depth is one of the most important nursery operations for seedling raising purpose. The moisture content of soil is also an important factor in germination. The moisture content of soil is directly proportional to the depth of soil (Miller *et al.* 1965).

Germination is a process which begins with water uptake and leads to the rupture of seed coat by the radical or the shoot. Cell division and enlargement of an embryo, and an overall increase in metabolic activity are also included in

this process. An actual germination being long before the rupture of the seed coat and is usually determined visibly by observing the protrusion of radical or shoots. Blockage of any of the steps leading to germination may, and very likely will cause a stage of dormancy in the seed (Bidwell, 1979). All of these processes are happened in the soil media and success of germination greatly depends on soil condition and depth. Therefore, the present study investigates the effect of sowing depth on germination of 15 multipurpose tree species (MPTs).

Materials and Methods

Effect of sowing depth on germination of 15 multipurpose trees was observed at the research field, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh during March 2010 to August 2010. The experimental site is geographically located at about 24°75' North latitude and 90°50' East longitudes (Khan, 1997). Fifteen MPTs were Bakphul (*Sesbania grandiflora*), Sadakoroi (*Albizia procera*), Ipil-ipil (*Leucaena leucocephala*), Eucalyptus (*Eucalyptus camaldulensis*), Akasmoni (*Acacia auriculiformis*), Sonalu (*Cassia fistula*), Babla (*Acacia nilotica*), Kalokoroi (*Albizia lebeck*), Raintree (*Albizia saman*), Jarul (*Lagerstroemia speciosa*), Mahogoni (*Swietenia mahogani*), Arjun (*Terminalia arjuna*), Polash (*Butea monosperma*), Minjiri (*Cassia siamea*) and Khoir (*Acacia catechu*). Seeds of these MPTs were used as planting materials for this study. The experiment was laid out in a Randomized Complete Block Design (RCBD) with 10 replications. Seeds were sown at 10 different soil depth these were 0.0cm, 0.5cm, 1.0cm, 1.5cm, 2.0 cm, 2.5cm, 3.0cm, 3.5cm, 4.0cm and 4.5cm. These different depths were the experimental treatments. Each MPTs was laid out in the same design side by side (Fig. 1). Seeds were sown in the 21 cm x 15 cm size polybag. Total 1500 polybag (15 MPTs x 10 different depth x 10 replication) were used in this study. Each polybag was filled with well prepared soil. Pretreated seeds were sown in the polybag. Two seeds were sown in each polybag. Germination of each MPTs was observed everyday upto 45 days and information of germination were recorded. Total number of germinated seeds per replication was also recorded. Data of germinated seeds

were collected from each treatment. The percentage of germination was calculated by using the formula: $PG = (NGS \div NSS) \times 100$, Where, PG= Percentage of germination, NGS = Number of germinated seeds, NSS= Number of seeds sown. Recorded data were analyzed statistically to find out variation resulting from experimental treatments using MSTAT-C package program (Russell, 1986). The mean of all treatments were calculated and analysis of variances under study was performed by F-variance test at 5% and 1% levels of significance. The means of parameter were separated by Duncan's Multiple Range Test (DMRT).

		Replication									
		R ₁	R ₂	R ₃	R ₄	R ₅	R ₆	R ₇	R ₈	R ₉	R ₁₀
Treatments (Depth cm.)	T ₁₀										
	4.5										
	T ₉										
	4.0										
	T ₈										
	3.5										
	T ₇										
	3.0										
	T ₆										
	2.5										
	T ₅										
2.0											
T ₄											
1.5											
T ₃											
1.0											
T ₂											
0.5											
T ₁											
0.0											

Fig. 1. Lay out for each MPTs

Results

1. Bakphul (*Sesbania grandiflora*): Sowing depth significantly influence the germination of Bakphul seeds (Table 1). Among the sowing depths, except 4.5 cm depth, seeds of Bakphul were germinated after different period where average germination period and germination period range were 8 and 5-11 days respectively (Table 2). From the results it was observed that, the shortest period (5 days) were need at 0.5 and 1.0 cm depth which were statistically similar with 1.5, 2.0 and 2.5cm depth, germination period range of which was 5-7 days (Table 1). Though seeds at 0.0, 3.0, 3.5 and 4.0cm depth were germinated but need more time (10-11 days) (Table 3). Statistically similar time required for germination at 0.5-2.5cm depth (5-7 days) but 100% seeds were germinated at 1.5-2.0cm depth followed by 1.0 & 2.5cm (90%) (Tables 1 & 4). This result indicates that optimum sowing depth of Bakphul seeds is 1.5-2.0 cm.

2. Sadakoroi (*Albizia procera*): The influence of different seed sowing depth of Sadakoroi was significant (Table 1). Sadakoroi seeds were sown at various depth i.e. 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0 & 4.5cm. Among these sowing depth, seeds of Sadakoroi were germinated after different period where average germination period and germination period range were 17 and 12-21 days respectively (Table 2). The results showed that the shortest period (12 days) was need at 1.5 cm depth which was statistically similar to 2.0 and 2.5cm depth with

germination period range of 12-14 days (Table 3). Seeds at 0.0, 0.5, 1.0, 3.0, 3.5, 4.0 and 4.5cm depth were germinated but need more time (17-21 days) (Table 3). Statistically similar time required for germination at 1.5-2.0 cm depth (12-14 days) but 100% seeds were germinated at 1.5-4.5cm depth (Tables 1 & 4). But 3.0-4.5cm sowing depth required more time (17-19 days) for germination. This result reveals that optimum sowing depth of Sadakoroi seeds is 1.5-2.5cm.

3. Ipil-ipil (*Leucaena leucocephala*): Different depth of sowing had significant effects on Ipil-ipil seed germination (Table 1). Among the different sowing depths, seeds of Ipil-ipil were germinated after different period where average germination period and germination period range were 17 and 13-22 days respectively (Table 2). From the results it was found that, the shortest period (13 days) were need at 2.5cm depth which were statistically similar with 2.0 3.0, 3.5, and 4.0 cm depth and germination period range of 13-15 days (Table 3). Though seeds at 0.0, 0.5, 1.0, 1.5, and 4.5cm depth were germinated but need more time (16-22 days) (Table 3). Statistically similar time required for germination at 2.0-4.0cm depth (13-15 days) but 100% seeds were germinated at 2.5-3.5cm depth (Tables 1 & 4). So, it may be concluded that optimum sowing depth of Ipil-ipil seeds is 2.5-3.5cm.

4. Eucalyptus (*Eucalyptus camaldulansis*): There was significant effect of sowing depth on Eucalyptus seed germination (Table 1). Among the sowing depth, except 1.5, 2.0, 2.5, 3.0, 3.5, 4.0 and 4.5cm depth, seeds were germinated after different period where average germination period and germination period range were 8 and 7-10 days respectively (Table 2). It was observed that, the shortest period (7 days) were need at 0.0cm depth which was statistically similar with 0.5cm were germination period range was 5-7 days (Table 3). Seeds germinated at 0.5 and 1.0 cm depth but need more time (8-10 days) (Table 3). 90% seeds are germinated at 0.0cm depth, 70% and 40% seeds were germinated at 0.5 and 1.0cm depth respectively, 0% seeds were germinated at 1.5-4.5cm depth (Tables 1 & 4). This result indicates that optimum sowing depth of Eucalyptus seeds is 0.0cm.

5. Akasmoni (*Acacia auriculiformis*): The effect of different sowing depth on Akasmoni seed germination was significant (Table 1). Seeds of Akasmoni were sown at various depths i.e. 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0 and 4.5cm. Among these sowing depth, except 0.0 and 4.5cm, seeds of Akasmoni were germinated after different period where average germination period and germination period range were 9 and 6-16 days respectively (Table 2). From the results it was observed that, the shortest period (6 days) were need at 1.0, 1.5 and 2.0cm depth followed by 0.5 and 2.5cm where germination period range was 5-7 days (Table 3). Germination of seeds at 3.0, 3.5 & 4.0cm depth need more time (9-16 days) (Table 3). Statistically similar time required for germination at 0.5-2.5cm depth (6-7 days) but 90% seeds were germinated at 1.0-2.0 cm depth (Tables 1 & 4). This result shows that optimum sowing depth of Akasmoni seeds is 1.0-2.0cm.

6. Sonalu (*Cassia fistula*): Influence of sowing depth on Sonalu seed germination was significant (Table 1). Sonalu seeds were sown at different depth i.e. 0.0, 0.5, 1.0, 1.5,

2.0, 2.5, 3.0, 3.5, 4.0 and 4.5cm. Among various sowing depths, except 0.0cm, seeds of Sonalu were germinated after different period where average germination period and germination period range were 31 and 22-44 days respectively (Table 2). The results showed that, the shortest period (22 days) were need at 0.5cm depth which was statistically similar with 1.0cm depth and germination period range was 22-23 days (Table 3). Though seeds at

1.5, 2.0, 2.5, 3.0, 3.5, 4.0 & 4.5cm depth were germinated but need more time (28-44 days) than seed germinated at 0.5cm depth (Table 3). Although more time required for germination at 1.5, 2.0, & 2.5cm depth (28-30 days) but highest per cent (80%) seeds were germinated at 1.0-2.5cm depth (Tables 1 & 4). So it may be concluded that optimum sowing depth of Sonalu seeds is 1.0-2.5cm.

Table 1. Germination percent of different MPTs sown at different depth

Sowing depth (cm)	Germination percentage														
	Bakphul	Sadakoroi	Ipil-ipil	Eucalyptus	Akashmoni	Solanu	Babla	Kalokoroi	Raintree	Jarul	Mahagoni	Arjun	Polash	Minjiri	Khoir
4.5	0.000g	100.00a	70.00c	0.00d	0.00g	30.00e	50.00f	40.00f	50.00e	0.00f	60.00d	30.00f	30.00f	0.00d	0.00f
4.0	40.00f	100.00a	80.00b	0.00d	30.00f	50.00d	60.00e	50.00e	70.00d	0.00f	80.00c	60.00c	50.00e	0.00d	0.00f
3.5	70.00d	100.00a	100.00a	0.00d	50.00e	60.00c	80.00c	60.00d	80.00c	0.00f	90.00b	80.00b	50.00e	0.00d	50.00e
3.0	70.00d	100.00a	100.00a	0.00d	60.00d	70.00b	90.00b	80.00b	90.00b	0.00f	90.00b	100.00a	70.00c	0.00d	60.00d
2.5	90.00b	100.00a	100.00a	0.00d	80.00b	80.00a	100.00a	90.00a	90.00b	50.00e	100.00a	100.00a	90.00b	0.00d	60.00d
2.0	100.00a	100.00a	80.00b	0.00d	90.00a	80.00a	100.00a	90.00a	90.00b	70.00d	100.00a	100.00a	100.00a	0.00d	80.00b
1.5	100.00a	100.00a	70.00c	0.00d	90.00a	80.00a	100.00a	80.00b	100.00a	80.00c	100.00a	100.00a	100.00a	50.00c	80.00b
1.0	90.00b	70.00b	70.00c	40.00c	90.00a	80.00a	90.00b	70.00c	100.00a	90.00b	90.00a	100.00a	70.00c	90.00a	100.00a
0.5	80.00c	50.00c	50.00d	70.00b	70.00c	60.00c	70.00d	60.00d	90.00b	100.00a	50.00e	50.00d	60.00d	90.00a	100.00a
0	60.00e	30.00d	30.00e	90.00a	0.00g	60.00c	40.00g	40.00f	70.00d	100.00a	30.00f	40.00e	30.00f	70.00b	70.00c
CV (%)	6.13	4.89	5.40	11.94	8.07	7.92	9.38	7.33	5.63	7.62	6.38	6.99	7.15	11.60	6.31
Sig. level	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**

In a column, the figure (s) having different letter are significantly different at 1% level of probability by DMRT

Table 2. Average germination period and ranges of germination of 15 MPTs

Species name	Average germination period (days)	Germination period range (days)
1. Bakphul (<i>Sesbania grandiflora</i>)	8	5-11
2. Sadakoroi (<i>Albizia procera</i>)	17	12-21
3. Ipil-ipil (<i>Leucaena leucocephala</i>)	17	13-22
4. Eucalyptus (<i>Eucalyptus camaldulansis</i>)	8	7-10
5. Akashmoni (<i>Acacia auriculiformis</i>)	9	6-16
6. Sonalu (<i>Cassia fistula</i>)	31	22-44
7. Babla (<i>Acacia nilotica</i>)	14	9-19
8. Kalokoroi (<i>Albizia lebbek</i>)	20	10-30
9. Raintree (<i>Samania saman</i>)	6	4-10
10. Jarul (<i>Lagerstroemia speciosa</i>)	25	23-27
11. Mahagoni (<i>Swietenia mahogani</i>)	26	21-30
12. Arjun (<i>Terminalia arjuna</i>)	28	22-32
13. Polash (<i>Butea monosperma</i>)	13	11-15
14. Minjiri (<i>Cassia siamea</i>)	9	8-10
15. Khoir (<i>Acacia catechu</i>)	11	4-17

7. Babla (*Acacia nilotica*): Seed germination was significantly affected by different sowing depth in case of babla (Table 1). Seeds of Babla were sown at various depths i.e. 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0 and 4.5cm of soil. Among these sowing depths, seeds of Babla were germinated after different period where average germination period and germination period range were 14 & 10-18 days respectively (Table 2). From the results it was found that, the shortest period (10 days) were need at 3.0 cm depth which were statistically similar with 2.5, 2.0, 1.5 and 1.0cm were germination period range was 10-12 days (Table 3). Though seeds at 0.0, 0.5, 3.5 and 4.0cm depth were germinated but need more time (14-19 days) (Table 3). Statistically similar time required for germination at 1.0-3.0cm depth (10-12 days) but 80% seeds were germinated at 1.5-2.0cm depth (Tables 1 & 4). This result reveals that optimum sowing depth of Babla seeds is 1.0-1.5 cm.

8. Kalokoroi (*Albizia lebbek*): Different depth of sowing had significant effects on Kalokoroi seed germination (Table 1). Among the sowing depth, seeds of Kalokoroi

were germinated after different period where average germination period and germination period range were 20 and 10-30 days respectively (Table 2). From the results it was observed that, the shortest period (10 days) were need at 2.0cm depth which were statistically similar with 2.5 and 1.5 cm were germination period range was 10-12 days (Table 3). Though seeds at 0.0, 0.5, 1.0, 3.0, 3.5, 4.0 and 4.5cm depth were germinated but need more time (15-30 days) (Table 3). Although similar time required for germination at 1.5-2.5cm depth (10-12 days) but maximum percentage (90%) seeds were germinated at 2.0-2.5cm depth (Tables 1 & 4). It may be concluded that optimum sowing depth of Kalokoroi seeds is 2.0-2.5cm.

9. Raintree (*Samania saman*): The effect of different sowing depth on Raintree seed germination was significant (Table 1). Seeds of Raintree were sown at various depths i.e. 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0 and 4.5cm. Among these sowing depth, seeds of Raintree were germinated after different period where average germination period and germination period range were 6 and 4-10 days respectively (Table 2). From the results it was observed that, the shortest period (4 days) were need at 0.0, 0.5 and 1.0cm depth which were statistically similar with 1.5, 2.0 and 2.5 cm were germination period range was 4-5 days (Table 3). Though seeds at 3.0, 3.5, 4.0 and 4.5cm depth were germinated but need more time (6-10 days) (Table 3). Statistically similar time required for germination at 0.0-2.5cm depth (4-5 days) but 100% seeds are germinated at 1.0-1.5cm depth (Tables 1 & 4). This result indicates that optimum sowing depth of Raintree seeds is 1.0-1.5cm.

10. Jarul (*Lagerstroemia speciosa*): Influence of sowing depth on Jarul seed germination was significant (Table 1). Among the sowing depth, except 3.0, 3.5, 4.0 and 4.5cm, seeds of Jarul were germinated after different period where average germination period and germination period range were 25 and 23-27 days respectively (Table 2). The

results showed that, the shortest period (23 days) were need at 0.0 cm depth which was statistically similar with 0.5, 1.0 and 1.5cm, germination period range was 23-24 days (Table 3). Statistically similar time required for

germination at 0.0-1.5cm depth (23-24 days) but 100% seeds were germinated at 0.0 and 0.5 cm (Tables 1 & 4). This result indicates that optimum sowing depth of Jarul seeds is 0.0-0.5cm.

Table 3. Length of germination period of 15 MPTs sown at different depth

Sowing depth (cm)	Germination period (days)														
	Bakphul	Sadakori	Ipil-ipil	Eucalyptus	Akashmoni	Solanu	Babla	Kalokori	Raintree	Jarul	Mahagoni	Arjun	Polash	Minjiri	Khoir
4.5	0.00c	19.00ab	16.00c	0.00c	0.00e	44.00a	19.00a	29.00a	10.00a	0.00d	30.00a	32.00a	14.00a	0.00c	0.00e
4.0	11.00a	18.00ab	15.00cd	0.00c	16.00a	39.00b	18.00a	30.00a	8.00ab	0.00d	30.00a	30.00b	14.00ab	0.00c	0.00e
3.5	10.00a	18.00ab	15.00cd	0.00c	12.00b	36.00c	15.00b	25.00b	7.00bc	0.00d	28.00ab	30.00b	14.00ab	0.00c	17.00a
3.0	10.00a	17.00bc	14.00cd	0.00c	9.00c	30.00d	14.00bc	26.00b	6.00bcd	0.00d	26.00bc	28.00c	13.00ab	0.00c	16.00a
2.5	7.00b	14.00cd	13.00d	0.00c	7.00cd	30.00d	12.00cd	11.00d	5.00cd	27.00a	25.00c	27.00cd	13.00ab	0.00c	16.00a
2.0	7.00b	14.00d	14.00scd	0.00c	6.00d	28.00d	10.00cd	10.00d	5.00cd	26.00ab	24.00cd	25.00d	12.00ab	0.00c	15.00a
1.5	6.00b	12.00d	19.00b	0.00c	6.00d	28.00d	9.00d	12.00d	5.00cd	24.00bc	22.00de	24.00de	12.00ab	10.00a	10.00b
1.0	5.00b	20.00ab	22.00a	10.00a	6.00d	23.00e	11.00cd	15.00c	4.00d	24.00bc	21.00e	22.00e	12.00ab	9.00ab	7.00c
0.5	5.00b	20.00ab	22.00a	8.00b	7.00cd	22.00e	14.00bc	24.00b	4.00d	24.00bc	24.00cd	25.00d	11.00b	9.00ab	5.00cd
0	10.00a	21.00a	22.00a	7.00b	0.00e	0.00f	19.00a	24.00b	4.00d	23.00c	25.00c	30.00b	13.00ab	8.00b	4.00d
Sig. Level	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**

In a column, the figure (s) having different letter are significantly different at 1% level of probability by DMRT

Table 4. Optimum sowing depth of 15 MPTs

Species name	Optimum sowing depth (cm)
1. Bakphul (<i>Sesbania grandiflora</i>)	1.5-2.0
2. Sadakori (<i>Albizia procera</i>)	1.5-2.5
3. Ipil-ipil (<i>Leucaena leucocephala</i>)	2.5-3.5
4. Eucalyptus (<i>Eucalyptus camaldulansis</i>)	0.0
5. Akasmoni (<i>Acacia auriculiformis</i>)	1.0-2.0
6. Sonalu (<i>Cassia fistula</i>)	1.0-2.5
7. Babla (<i>Acacia nilotica</i>)	1.0-1.5
8. Kalokori (<i>Albizia lebbbeck</i>)	2.0-2.5
9. Raintree (<i>Samania saman</i>)	1.0-1.5
10. Jarul (<i>Lagerstroemia speciosa</i>)	0.0-0.5
11. Mahagoni (<i>Swietenia mahogani</i>)	1.5-2.5
12. Arjun (<i>Terminalia arjuna</i>)	1.0-3.0
13. Polash (<i>Butea monosperma</i>)	1.5-2.0
14. Minjiri (<i>Cassia siamea</i>)	0.5-1.0
15. Khoir (<i>Acacia catechu</i>)	0.5-1.5

11. Mahagoni (*Swietenia mahogani*): Different sowing depths had significant effect on Mahagoni seed germination (Table 1). Among the sowing depth, seeds of Mahagoni were germinated after different period where average germination period and germination period range were, respectively 26 and 21-30 days (Table 2). From the results it was observed that, the shortest period (21 days) were need at 1.0cm depth which were statistically similar with 1.5 cm where germination period was 22 days (Table 3). Though seeds at 0.0, 0.5, 2.0, 2.5, 3.0, 3.5, 4.0 & 4.5cm depth were germinated but need more time (24-30 days) (Table 3). Germination of seeds at 1.5-2.5 cm depth (22-25 days), need more time than 1.0 cm depth, but 100% seeds are germinated at 1.5-2.5cm depth (Tables 1 & 4). This result indicates that optimum sowing depth of Mahagoni seeds is 1.5-2.5cm.

12. Arjun (*Terminalia arjuna*): Arjun seed germination was significantly affected by different sowing depth (Table 1). Seeds of Arjun were germinated after different period where average germination period and germination period range were 28 and 22-32 days, respectively (Table 2). From the results it was observed that, the shortest period (22 days) were need at 1.0cm depth followed by 1.5

cm depth (24 days) (Table 3). Though seeds at 0.0, 0.5, 2.0, 2.5, 3.0, 3.5, 4.0 and 4.5cm depth were germinated but need more time (26-32 days) (Table 3). Although time variation for germination at 1.0 - 3.0 cm depth (22-28 days) but 100% seeds were germinated at 1.0 - 3.0cm depth (Tables 1 & 4). It may be concluded that optimum sowing depth of Arjun seeds is 1.0 - 3.0cm.

13. Polash (*Butea monosperma*): Different sowing depth significantly influence the germination of Polash seed (Table 1). Seeds of Polash were germinated after different period where average germination period and germination period range were 13 and 11-15 days, respectively (Table 2). From the results it was observed that, the shortest period (11 days) were need at 0.5 cm depth followed by 1.0, 1.5 & 2.0cm where germination period was 12days (Table 3). Though seeds at 0.0, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0 and 4.5cm depth were germinated but need more time (12-14 days) (Table 3). Various time required for germination at 0.0-4.5cm depth (11-14 days) but 100% seeds were germinated at 1.5-2.0cm depth (Tables 1 & 4). This result indicates that optimum sowing depth of Polash seeds is 1.5-2.0cm.

14. Minjiri (*Cassia siamea*): Influence of different sowing depth on Minjiri seed germination was significant (Table 1). The average germination period and ranges of germination period were 9 and 8-10 days respectively (Table 2). From the results it was observed that, the shortest period (8 days) were need at 0.0cm depth followed by 0.5 & 1.0cm depth (9 days) (Table 3). Though seeds at 1.5 cm depth were germinated but need more time (10 days) (Table 3). Statistically similar time required for germination at 0.0-1.0 cm depth (8-9 days) and maximum per cent (90%) seeds were germinated at 0.5-1.0 cm depth (Tables 1 & 4). It may be concluded that optimum sowing depth of Minjiri seeds is 0.5-1.0cm.

15. Khoir (*Acacia catechu*): Sowing depth significantly influence the germination of Khoir seed (Table 1). Among the sowing depth, except 4.0 and 4.5cm, seeds of Khoir were germinated after different period where average germination period and germination period range

were 11 and 4-17 days respectively (Table 2). From the results it was observed that, the shortest period (4 days) were need at 0.0cm depth followed by 0.5 and 1.0cm depth (5-7 days) (Table 3). Although time variation for germination at 0.5-1.0cm depth (5-7 days) but 100% seeds were germinated at 0.5-1.0 cm depth (Tables 1 & 4). This result reveals that optimum sowing depth of Khoir seeds is 0.5-1.0cm.

Discussion

A seed is a miniature tree. Regeneration of trees largely depend on seed both naturally and artificially. Success of seedling raising as well as nursery management greatly depends on germination of seeds. Germination of seeds depends on some factors viz, (i) Seed-coat thickness (ii) Seed dormancy and (iii) Soil conditions i. e., sowing depth and moisture content. Seed germination is a process which begins with water uptake and leads to the rupture of seed coat. Seeds will not germinate promptly without proper condition, which are normally regarded as suitable for germination. Proper conditions are dormancy breakage by seed treatment, optimum moisture content in the soil and optimum sowing depth. Optimum sowing depth ensure the optimum germination period of any plants seed as well as germination percentage. Seeds will remain viable under soil in a certain period. So, if any plant seed will sow in deep soil it will lose its viability and ultimately can't germinate (Holmes *et al.* 1987).

In this study, all seeds of 15 MPTs were evenly treated by hot water treatment. The seeds of all MPTs were soaked in hot water (60°C) and then seeds were rinsed with cold water and kept in water overnight for breaking dormancy. It was observed from this study that maximum germination period required for Bakphul, Sadakoroi, Ipil-ipil, Akashmoni, Sonalu, Babla, Kalokroi and Raintree at the depths of less than 1.5cm and 2.5-4.5cm, were 11, 21, 22, 16, 44 and 30 days, respectively (Table 2) and germination percent ranged found 30-60% (Table 1). In these 8 MPTs (Bakphul, Sadakoroi, Ipil-ipil, Akashmoni, Sonalu, Babla, Kalokroi and Raintree) minimum germination period required at the depths of 1.5-2.5cm which were 5, 12, 13, 6, 22, 10 and 4 days, respectively (Table 2) and germination percent range was 80-100% (Table 1). Because of short germination period requirement and maximum germination percentage, 1.5-2.5cm is the optimum sowing depth of these 8 (eight) MPTs i. e., Bakphul, Sadakoroi, Ipil-ipil, Akashmoni, Sonalu, Babla, Kalokroi and Raintree. Similar results were also observed by Aref (2000) in *Acacia* species, Cox *et al.* (1993) in *Acacia constricta* and Gulcu *et al.* (2010) in *Cedar libani*. They reported that optimum sowing depth these species (*Acacia* species, *Cedar libani*) are at 1.0-3.0cm range due to maximum germination percentage and minimum time requirement. Seed size and Seed-coat thickness of *Acacia* species, *Cedar libani*, Bakphul, Sadakoroi, Ipil-ipil, Akashmoni, Sonalu, Kalokroi and Raintree are almost similar. For this reason, may be sowing depth of these species are almost same i. e., 1.5-2.5cm.

It was observed that, Mahogoni, Arjun and Polash seeds were germinated in short period (21, 22 and 11 days,

respectively) and maximum rate (100%) at 1.0-3.0cm depth (Tables 1 & 3). Due to short period requirement and maximum germination percentage this depth (1.0-3.0cm) will be the optimum sowing depth for Mahogoni, Arjun and Polash.

In case of Eucalyptus, Jarul, Minjiri and Khoir, maximum seeds (90-100%) were germinated at 0.0-1.0cm depth and minimum period were required i.e., 7, 23, 8 and 4 days, respectively (Table 3). Eucalyptus seeds are too small in size and seeds of Jarul, Minjiri and Khoir are very thin, because of this reason may be these (Eucalyptus, Jarul, Minjiri and Khoir) seeds were germinate from very lower depth i.e., 0.0-1.0cm than others (>1.0-4.5cm). If, small and thin seeds are sown at deep soil it will decomposed and can't germinate. So, surface layer of soil i.e., 0.0-1.0cm will be the optimum sowing depth these MPTs.

From the above discussion it is clear that optimum sowing depth of studied 15 MPTs i.e., Bakphul, Sadakoroi, Ipil-ipil, Eucalyptus, Akashmoni, Sonalu, Babla, Kalokroi, Raintree, Jarul, Mahogoni, Arjun, Polash, Minjiri and Khoir are 1.5-2.0, 1.5-2.5, 2.5-3.5, 0.0, 1.0-2.0, 1.0-2.5, 1.5-2.0, 2.0-2.5, 1.0-1.5, 0.0-0.5, 1.5-2.5, 1.0-3.0, 1.5-2.0, 0.5-1.0 and 0.5-1.0cm respectively.

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