STUDIES ON SOWING POSITION OF GARJAN SEEDS ON THEIR GERMINATION AND SEEDLING BEHAVIOUR

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A germination trial was carried out by sowing Garjan (*Dipterocarpus turbinatus* Gaertn. F.) seeds in different positions and soil depths to investigate their influence on germination and seedling behaviour. Early germination, better percentage and straight seedlings were found in cases where the seeds were sown half-buried in inverted and horizontal positions. But in half-buried vertical sowing position the germination percentage was poor.

Complete burial of seeds in horizontal, inverted and vertical positions appeared to effect germination period and percentage, as well as, seedling shape. In these conditions seedlings were mostly abnormal in shape— bent, spiral, forked, crooked, etc. When seeds were sown in fully-buried inverted position, germination started late and gave low percentage (43.3) in comparison with other fully-buried conditions.

Seeds which were sown horizontally and half-buried gave maximum germination percentage (82.2), early germination and straight seedlings.

INTRODUCTION

Chittagong and Chittagong Hill Tracts of Bangladesh are well known for natural Garjan (*Dipterocarpus turbinatus* Gaertn. F.). These are lofty trees having clean cylindrical boles and elevated crowns. The wood is the major raw material for railway sleepers, poles and boat-building. Due to its high demand and consequent over exploitation, Garjan is rapidly disappearing and needs large scale reforestation. Direct sowing of Garjan seeds is the usual practice in this country for reforestation work. Proper seed germination is one of the prerequisites for the success of plantation. Many research workers have demonstrated that there exists a specific planting depth which is optimal for seedling emergence and survival of a certain species. It is reasonable that the same could be true for wild plants in nature. Indeed the problem of optimal depth may even be more critical for the later (Koller 1972). The effect of seed sowing position and soil depth on the germination of Garjan seed and its seedling quality have been studied and reported in this paper.

MATERIALS AND METHODS

Ten kilograms of Garjan seeds were collected from Chainda in May, 1975. One lot of 100 seeds was used for noting the morphological characters, measurements and weight (Table 1).

Table 1. Average external measurements of Garjan fruits

Diameter (cm)	Length (cm)	Seed wt (gm)	Winged seed/kg (No)	Dewinged seed/kg (No)	Large lobes (cm)				Small lobes (cm)		
					1st		2nd		1st	2nd	3rd
					Length	Mid width	Length	Mid width	Length	Length	Length
1.86	2.89	3.94	251	287	9.92	2.17	9.86	2.20	0.54	0.61	0.58

Table 2. Variation in germination time and seedling shape in different sowing positions of Garjan seeds

Sowing positions	Germination (days)		Seedling shape
	Start	Final	
a Horizontal, half–buried	3	10	Straight
b Horizontal, full–buried	7	15	Bent at the joint of the cotyledonary petiole
c Half-buried, inverted	3	11	Straight
d Full-buried, inverted	15	35	Forked, spiral, bent, few straight
e Half-buried, vertical	2	7	Straight
f Full-buried, vertical	5	13	More or less same as *b*

Germination trials were conducted by sowing single seed in each polythene bag (15 cm wide and 25 cm long) filled in with normal hill soil. Seeds were sown in five different positions / treatments (Table 2). In each position 100 seeds were sown in randomised block design with 3 replications. Counting of seedlings was continued till no more germination was observed. Sketches were drawn for all the steps of the development of seedlings in each of the sowing positions. Number of days required for each phase of seedling development was also recorded.

RESULTS

Description of fruits and seeds : Garjan fruit is a samara seated in and enclosed by the calyx tube, broad at the base. Calyx tube is elliptical when young and sub-spherical on maturity, covering the entire fruit. Surface of calyx tube is striate ; striae extending into the calyx-lobes. Two of the calyx-lobes are enlarged into long wings and other three remain unenlarged. Wings are blunt at apex with one prominent nerve and two shorter parallel nerves so as to make the wing 3-nerved. Unenlarged calyx-lobes are orbicular and hardly 0.5 cm (0.2 in) long. Fruit is obconic and covered with small silvery white hairs. A thick dome-shaped spongy structure occurs towards the wing-end to which sometimes the remains of the style are attached. Each samara consists of one seed. It is difficult to separate the seed from the fruit without damaging it. The pericarp is tightly adnate to the seed and is thinner at the base, but thicker and fibrous toward the apex. Testa is thin, dark brown and adnate to the thick, fleshy, unequal cotyledons. The cotyledons are crumpled and it is difficult to locate the embryo. The radicle is directed towards the wing-end of the fruit (Fig. 1). The plumule is inconspicuous. The detail external measurement of the fruit is given in Table 1.

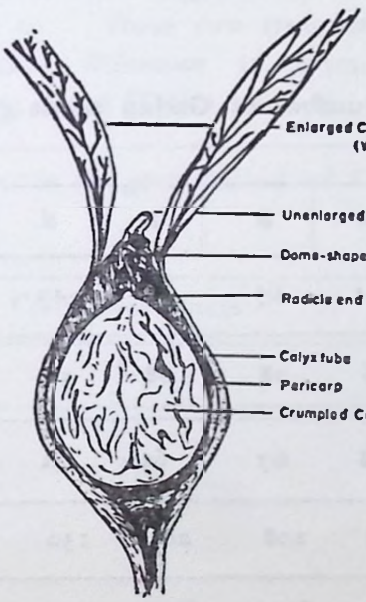


Figure 1. Longitudinal section of a Garjan fruit

The data show that fruits (seeds) of Garjan are large and heavy. The two large wings are nearly 4 times as long as the seed itself.

Seed germination and development of seedling : Germination of seed is hypogeous. The radicle emerges by breaking through the dome-shaped structure and curves rapidly downwards. The cotyledonary petiole elongates to a length of about 2.5 cm (1.0 in) enabling the plumule to emerge. The cotyledons remain within the fruit. Normally plumule starts growing with the elongation of cotyledonary petiole. But sometimes abnormal germination may take place when the development of cotyledonary petiole becomes either incomplete or late resulting in the elongation of plumule within the seed.

Early germination (three days from sowing) and straight seedling were noticed in the treatments *a*, *c* and *e* where seeds were sown half-buried (Table 2).

In treatments *a*, *c* and *e* times required for both starting and completion of germination were more or less the same. Germination percentages were also nearly equal in *a* and *c*. But in the treatment *e* the germination percentage was very low because the radicle died due to exposure to the sun (Tables 2 and 3).

Table 3. Number of Garjan seeds germinated in each treatment

Block	Treatments						Total	Mean
	a	*b*	*c*	*d*	*e*	*f*		
1	84	63	71	49	6	72	345	57.50
2	76	78	68	39	4	67	332	55.53
3	88	67	65	42	12	78	352	58.66
Total	248	208	204	130	22	217		
Mean	82.22	69.3	68.0	43.3	7.30	72.3		

Analysis of variance

Source	df	SS	MS	v-ratio	F
Treatment	5	11461.17	2292.23	70.1**	5.64
Block	2	34.30	17.15	0.5	
Residual	10	327.03	32.07		

***Significant at 1% level*

Complete burial of seed appeared to affect seedling shape, germination period and sometimes germination percentage. In treatments *b*, *d* and *f*, seedlings were mostly abnormal in shape — bent, spiral, forked and crooked (Fig. 2). As regards seed germination the positions *b* and *f* gave more or less the same result. But in case of *d* both starting and completion of germination were late and the percentage was also low compared to those of *b* and *f* (Table 3).

In case of half-buried seeds, the seedling shape was straight, whereas, it was mostly abnormal in the case of fully-buried seeds. It appears that both the depth and the sowing position have significant effect on germination and seedling shape. There was no significant difference in germination among treatments *a*, *b*, *c* and *f*; yet the appearance of seedling in all these cases were not the same. Seedlings were straight in *a* and *c*, whereas these were mostly abnormal in *b* and *f*. As regards germination all four conditions were significantly different from *d* and *e*. These two treatments had also significant difference in germination and seedling shape (Tables 3 and 4).

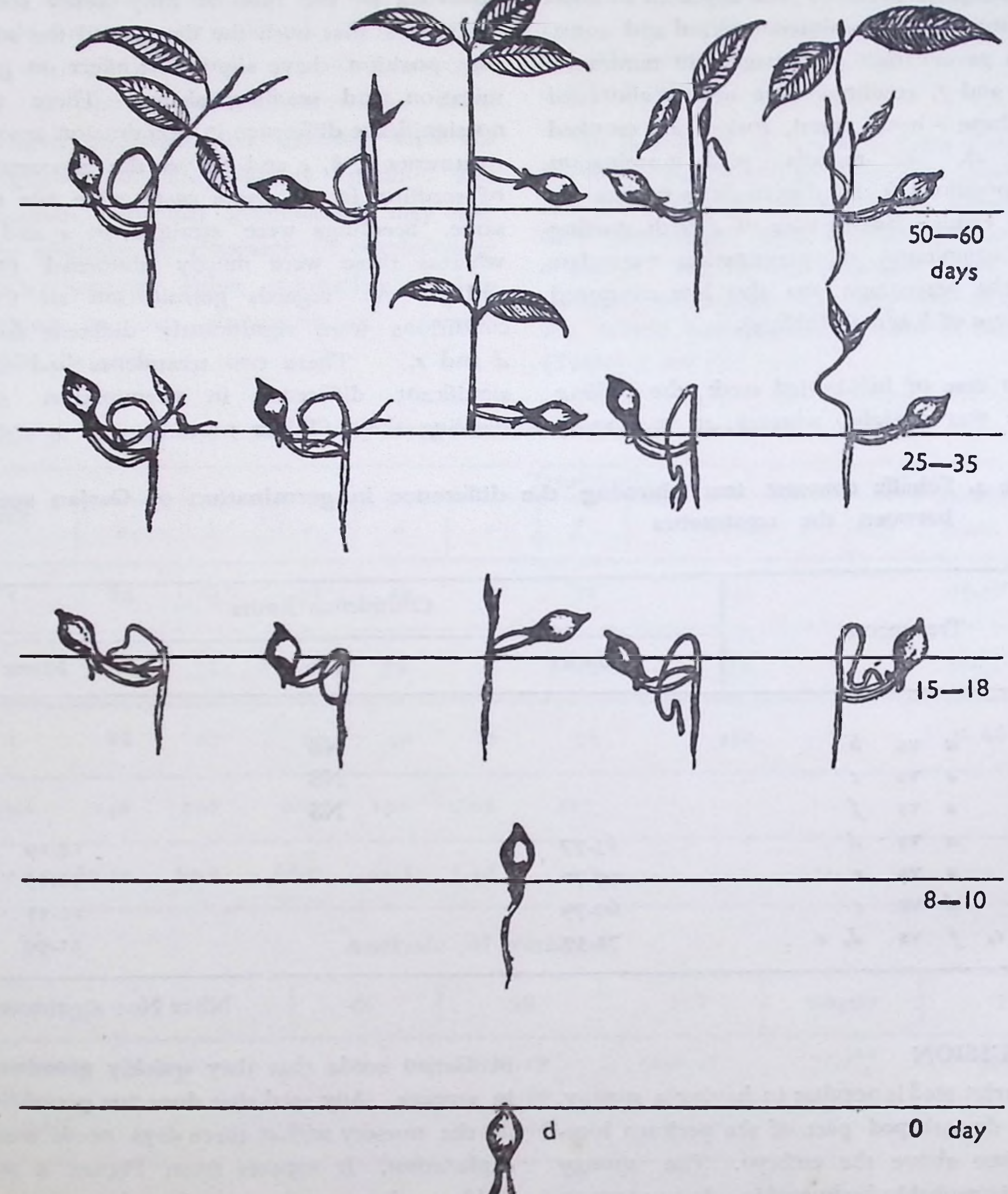
Table 4. Scheffe contrast test showing the difference in germination of Garjan seeds between the treatments

Treatments	Confidence limits	
	upper	lower
a vs *b*	NS	
a vs *c*	NS	
a vs *f*	NS	
a vs *d*	63.77	14.19
a vs *e*	99.71	50.13
d vs *e*	60.79	11.21
a, *b*, *c*, *f* vs *d*, *e*	71.57	21.99

NS= Not significant

DISCUSSION

Garjan seed is peculiar in having a spongy, thick, domeshaped part of the pericarp located just above the embryo. The spongy part is probably hygroscopic. It is common in Garjan seeds that they quickly germinate in storage. Any seed that does not germinate in the nursery within three days needs some explanation. It appears from Figure 2 and Table 2 that it took more than three days to



(Figure 2. contd.)

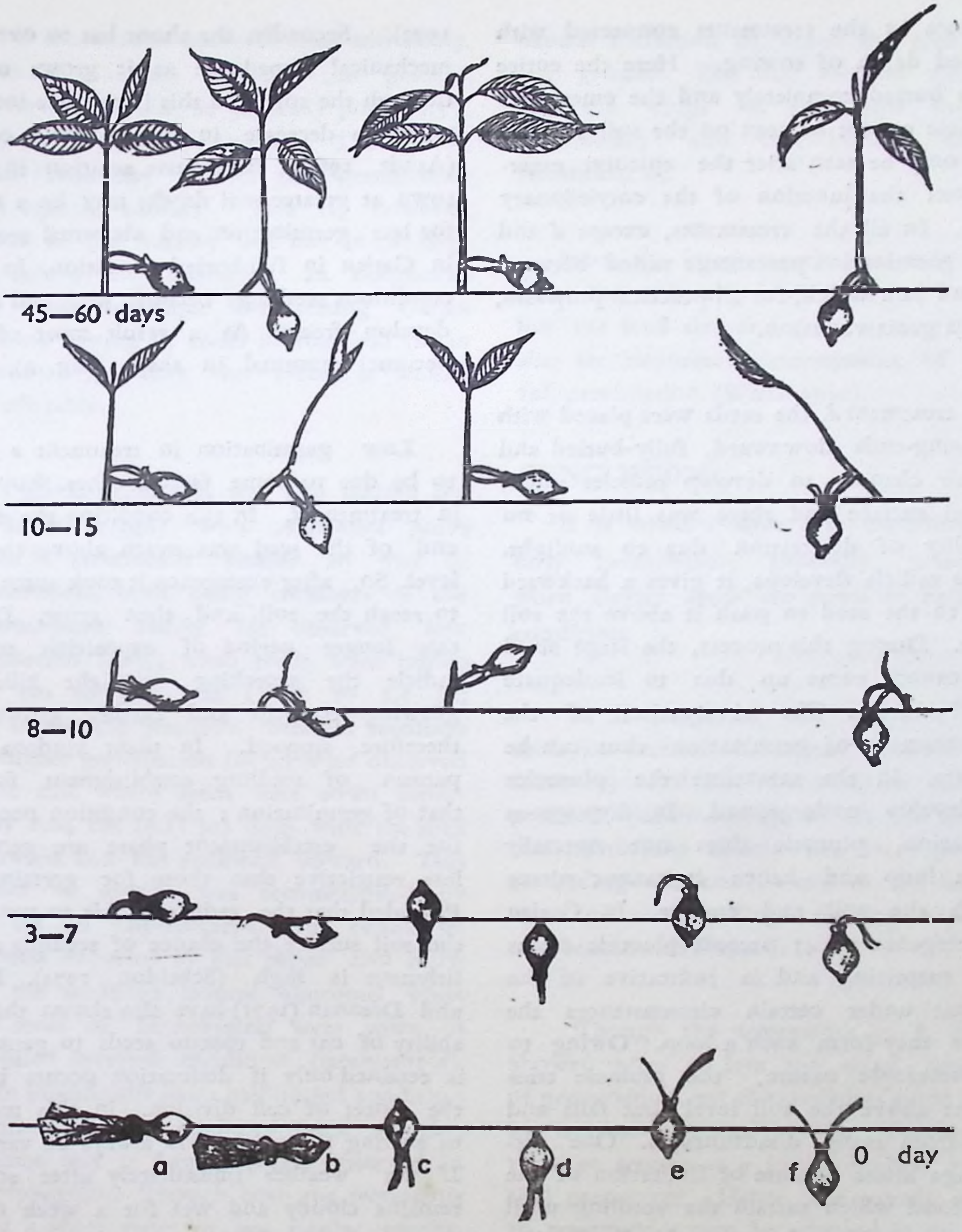


Figure 2. Sowing positions and seedling behaviour of Garjan seeds

germinate in the treatments connected with increased depth of sowing. Here the entire seed is buried completely and the emergence of radicle cannot be seen on the soil surface. It can only be seen after the epicotyl emerges from the junction of the cotyledonary petiole. In all the treatments, except *d* and *e*, the germination percentage varied between 68.0 and 82.2 which, for all practical purposes, is not a great variation.

In treatment *d*, the seeds were placed with the wing-ends downward, fully-buried and had fair chances to develop radicles under the soil surface and there was little or no possibility of desiccation due to sunlight. As the radicle develops, it gives a backward thrust to the seed to push it above the soil surface. During this process, the large sized seeds cannot come up due to inadequate upward thrust. The observation of the commencement of germination thus can be seen late. In the meantime the plumules also develop underground. In hypogeous germination, plumule does not normally form a loop and hence it cannot pierce through the soil and emerge. In Garjan the emergence of 43 percent plumule seems to be surprising and is indicative of the fact that under certain circumstances the plumule may form such a loop. Owing to its phototropic nature, the plumule tries to come above the soil level, but fails and suffers from many disadvantages. One disadvantage arises because of limitation of the stored food which sustain the seedling until it becomes established autotrophically (Koller 1972). Secondly, the shoot has to overcome mechanical impedence as it grows upward through the soil and this impedence increases with the decrease in soil moisture content (Arndt 1965). Inadequate aeration in seeds sown at greater soil depths may be a reason for late germination and abnormal seedlings in Garjan in full-buried condition. In these conditions seedlings become weak and cannot develop freely. As a result most of them become abnormal in shape (Fig. 2).

Low germination in treatment *e* seems to be due to some factors other than those in treatment *d*. In this condition the radicle end of the seed was much above the soil level. So, after emergence it took some time to reach the soil and then grow. During this longer period of exposition of the radicle the scorching sunlight kills the growing root-tip and further growth is, therefore, stopped. In plant kindom, the pattern of seedling establishment follows that of germination ; the condition necessary for the establishment phase are generally less restrictive than those for germination. Provided that the radicle is able to penetrate the soil surface, the chance of seedling establishment is high (Scheldon 1974). Berrie and Drennan (1971) have also shown that the ability of oat and tomato seeds to germinate is retained only if desiccation occurs before the onset of cell division. In this method of sowing the results will always be variable. If the weather immediately after sowing remains cloudy and wet for a week or so the result would be good. On the other hand if the weather becomes clear and sunny, before the radicle reaches the ground, the survival would be generally poor (7.3% obtained in this experiment). The use of partial shade may protect the germinating seeds against sunrays. This is, however, feasible in the nursery but not in the large scale field-sowing operation. In Bangladesh the usual technique for raising Garjan is direct sowing of seeds in the field (as in treatment *e*), where the result is mostly unpredictable.

A germination test was also carried out by Laurie (1940) with *Anisoptera glabra* which is structurally similar to that of *D. turbinatus,* both being members of the *Dipterocarpaceae* family. He observed low germination (40%) when seeds were buried 2.54 cm to 3.84 cm (1 in to 1.5 in) deep in slanting position. Straight seedlings and higher germination (66%) were observed in the case where seeds were sown superficially 0.64 cm (0.25 in) deep with the apex downward and the stalk-end upward. This method of sowing was recommended by him for all Dipterocarps. The results of the trials reported in this paper also show that the seedlings became abnormal when the seeds of *D. turbinatus* were sown in full-buried inverted condition (treatment *d*). But in superficially sown half-buried condition (treatment *c*), the seedlings were straight, the same way as Laurie (1940) observed in his experiment. Though both the treatments *a* and *c* show more or less similar results, yet it is desirable to follow treatment *a,* the natural condition in which the seed lies on the ground. The best method will be to clip the wings off and sow the seeds horizontally and half-buried condition (treatment *a*).

From the foregoing discussion it appears that not only the environmental condition but the seed size and their sowing position also are important determinants of successful germination (White 1968).

CONCLUSION

It is evident from the experiment that early germination, generally, takes place when Garjan seeds are sown in half-buried condition.

It is suggested not to sow Garjan seeds in vertical half-buried position (treatment *e*) and also in inverted full-buried position (treatment *d*), as in the first case the developing radicle has every possibility to undergo desiccation and in the later case most of the seedlings develop abnormally and become malformed.

Though the treatments *a*, *b*, *c* and *f* showed more or less the equal percentage of germination, yet the seedlings grow straight in treatments *a* and *c* only. Sowing position in treatment *a* gives highest germination percentage. Hence, the sowing position in treatment *a* may be adopted in the plantation practice.

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