NOTES

EFFECT OF SEED MATURITY AND DEVELOPMENT ON GERMINATION OF FIVE SPECIES FROM GARHWAL HIMALAYA, INDIA

A.K. Negi & N.P. Todaria

Post No. 59, Department of Forestry, HNB Garhwal University, Srinagar (Garhwal) - 246 174, (U.P.), India

The timing of seed collection is an important factor for the study of seed germination. The influence of maturity on seed germination has been studied by many workers. The general conclusion is that the more mature a seed is, the greater is its vigor and potential to become established as a seedling (Pollock & Roose 1972). However, with the increasing demand for large quantities of seed to meet annual reforestation and afforestation programmes it is advantageous to collect the maximum quantity of seed within the allowable ripening period (Wang 1991). In this investigation, some forest trees of Garhwal Himalaya were selected on the basis of social importance, to test the influence of ripening period on seed germination and seedling development.

Seeds of five forests tree species, viz. *Acer oblongum*, *Kydia calyciana*, *Terminalia chebula*, *T. tomentosa*, and *T. belerica* were collected from the Siwalik hills of Garhwal Himalaya at different periods of maturation. The physiological condition of maturity was determined usually in terms of changing fruit colour and number of mature seeds on the trees (Table 1). Seed collections were made at four time intervals, viz. 0, 10, 20, 30 and 40 days. Moisture content was measured immediately after each collection. Seeds were selected randomly from each species and soaked in tap water (8 -10 °C) for 24 h. Three replicates were conducted and each replicate contained 10 seeds per Petri dish (17 cm dia) containing Whatman No. 1 moist filter paper. Replicates were designed as randomized complete block design (RCBD) in a seed germinator at 30 °C in the dark as maximum germination was recorded at this temperature in earlier studies (Negi & Todaria 1993). Germination was recorded once the radicle and plumule had emerged with the test completed after 15 days.

Germinated seeds were transferred to polythene bags containing sand and alluvial soil (1:2) kept in the open for further development under natural conditions. Seedling development was measured after six months in terms of collar diameter and height. The temperature during this period was 10 - 35 °C (February to July). The plants were watered twice daily.

Table 1 shows that the percentage seed moisture content decreased with increasing maturity. However, the decrease in moisture content was not significant. No germination was recorded in the first two collections of *Kydia calyciana* but only in the first collection of *Terminalia tomentosa*. All species exhibited increased germination with time except *T. chebula*. *Terminalia chebula* showed better germination (26.67%) at the third collection (20 days) while the other species performed better in the last collection (40 days). *Acer oblongum* seeds started germinating in the first collection (0 day) and maximum germination (83.33%) was recorded in the last. There were significant differences in the germination of different collection groups. In *T. belerica* maximum germination (96.67%) was recorded at the fifth collection (40 days) which was significant at 5% level. Germination was maximum in *T. belerica* (96.67%) and minimum in *T. chebula* (26.67%).

Table 1. Effect of collection time on seed germination

Species	Collection time interval from seed shedding (days)	Change in fruit colour	Moisture (%)	Germination (%)
Acer oblongum	0	greenish grey	18.7 (±2.3)	6.67 (±0.58) a
	10	brownish grey	18.5 (±3.2)	13.33 (±0.58) ab
	20	reddish grey	18.0 (±2.8)	44.33 (±1.57) abc
	30	whitish grey	17.2 (±3.6)	50.00 (±2.08) bc
	40	light grey	16.9 (±1.6)	83.33 (±0.58) c
Kydia calyciana	0	green	25.2 (±4.2)	0.0 (±0)
	10	greenish brown	25.0 (±2.7)	0.0 (±0)
	20	light brown	24.7 (±3.2)	13.33 (±1.58) a
	30	brown	24.3 (±5.9)	20.0 (±0.58) a
	40	dark brown	23.3 (±3.2)	36.67 (±1.15) a
Terminalia tomentosa	0	yellowish green	24.3 (±2.3)	0.0 (±0)
	10	yellow	24.0 (±3.2)	3.3 (±0.58) a
	20	yellowish white	23.4 (±2.4)	20.0 (±0.58) a
	30	yellowish red	23.3 (±1.2)	30.0 (±1.25) a
	40	pinkish red	23.0 (±1.1)	36.67 (±2.08) a
T. chebula	0	light green	19.2 (±2.0)	3.3 (±0.58) a
	10	yellowish green	19.1 (±1.2)	3.3 (±0.58) a
	20	yellow	18.9 (±2.3)	26.67 (±2.65) a
	30	reddish yellow	18.4 (±1.1)	16.67 (±1.73) a
	40	yellow with black spots	18.1 (±1.0)	16.67 (±1.15) a
T. belerica	0	green	25.3 (±3.2)	6.67 (±0.58) a
	10	brownish green	25.0 (±2.8)	6.67 (±1.58) a
	20	brown	24.7 (±3.2)	36.67 (±2.08) ab
	30	greyish brown	24.3 (±3.4)	90.00 (±2.00) b
	40	bright brown	24.0 (±2.9)	96.67 (±3.21) b

Means followed by the same letter(s) are not significantly different at $p<0.05$ level.
Figures in parentheses represent the S.E.

The seedling development data are presented in Table 2. The death of *T. chebula* seeds from the first collection after transfer to polythene bags may be due to low vigor. Its maximum seedling development in terms of collar diameter and height was recorded after six months in the third collection. Maximum seedling development was observed in the last collection for all other species. The best seedling development was recorded in *Acer oblongum* (19.7 cm after six months) in terms of height. In terms of collar diameter, maximum growth was observed in *T. tomentosa* (17.2 mm after six months).

Table 2. Effect of collection time on seedling development

Species	Collection time interval (days)	Height (cm) 6 months	Collar diameter (mm) 6 months
Acer oblongum	0	18.7 (±2.0)	5.9 (±1.1)
	10	18.6 (±3.2)	5.8 (±1.2)
	20	18.5 (±2.8)	7.8 (±0.1)
	30	19.2 (±2.9)	8.0 (±1.1)
	40	19.7 (±2.3)	9.2 (±2.1)
Kydia calyciana	0	0	0
	10	0	0
	20	12.3 (±1.0)	5.1 (±1.1)
	30	14.7 (±0.3)	5.7 (±0.0)
	40	15.9 (±1.1)	6.2 (±1.1)
Terminalia tomentosa	0	0	0
	10	12.2 (±1.1)	15.2 (±2.3)
	20	12.0 (±0.9)	15.2 (±1.7)
	30	15.7 (±0.3)	17.2 (±1.3)
	40	15.8 (±1.1)	17.2 (±1.0)
T. chebula	0	0	0
	10	8.4 (±1.1)	9.0 (±1.1)
	20	9.3 (±2.0)	9.4 (±1.2)
	30	8.2 (±0.6)	9.1 (±1.2)
	40	8.9 (±1.2)	9.0 (±0.9)
T. belerica	0	10.2 (±1.1)	12.3 (±1.1)
	10	11.3 (±3.2)	12.4 (±1.3)
	20	10.9 (±1.3)	13.2 (±0.9)
	30	11.2 (±0.5)	13.0 (±0.9)
	40	12.1 (±2.1)	14.0 (±0.3)

The mean values are averages of 8-10 seedlings in each case, depending on survival of seedlings.
Figures in parentheses represent the S.E.

These results confirm earlier observations that seed germination and seedling development are higher in fully matured seeds. Milby (1986) noted that maximum germination in *Acer saccharum* was recorded in seeds which were collected after a period of maturity. The best time for seed collection was the first three weeks after natural shedding (Bardon *et al.* 1977). This hypothesis is verified by the present study that no drastic reduction in seed moisture content occurs within the first 3 - 4 weeks (Table 1). Poor germination was recorded in unripe or early collected seeds by Blommart (1972). The total seed germination in this study generally increases with increasing collection period (Table 1). Change in colour is the best index for field collection of seeds; thus for *A. oblongum* - light grey, *K. calyciana* - dark brown, *T. tomentosa* - pinkish red, *T. chebula* - yellow with black spots, and *T. belerica* - bright brown.

The maturity of seed not only influences seed germination but also seedling growth. This is due to the fact that mature seeds contain more food reserve which helps in germination and seedling development (Singh & Singh 1992). In addition, immature seeds are more susceptible to diseases and unfavourable environmental conditions.

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DIPTEROCARP FRUIT DISPERSAL AND SEEDLING DISTRIBUTION

S. Appanah & A.M. Mohd. Rasol

Forest Research Institute Malaysia, Kepong, 52109 Kuala Lumpur, Malaysia

Saving young regeneration (seedlings and saplings) of commercial timber species during logging operations would greatly further the sustainable management of forests. In context with management of the dipterocarp forests in Malaysia, such an effort may become the key to perpetuating the timber production of the forests, whether using Selective Fellings (e.g. Malaysian Selective Felling) or Regeneration Systems (e.g. Malayan Uniform System, and its modified version). The expense of enrichment planting in both cases may be reduced or eliminated if the seedlings of commercial species are not heavily destroyed during logging.

Conventional logging using tractors and skidders usually causes much damage to the young regeneration (Fox 1969). However, if we know more about their distribution, steps can be taken to protect them. With this in view, we carried out a study to observe the dispersal pattern of fruits, as well as the distribution of seedlings and saplings of dipterocarps.

Although the majority of the dipterocarps bear fruits with wings, they are merely gravity dispersed and fall close to the mother tree. Only on rare occasions are they blown far from the mother tree (Webber 1934). We therefore confined the study to the pattern of fruit dispersal and seedling distribution to a wide circle around the fruiting trees.