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Seed bank dynamics of *Buxus wallichiana* baillon. in a Himalayan moist temperate forest

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The Himalayan boxwood (*Buxus wallichiana* Baillon) is a dense leafy evergreen shrub or small tree found commonly in the western and central Himalayas at elevations ranging from 1200 m to 2900 masl, where it grows gregariously in patches in moist shady ravines. The tree is considered useful as the wood finds use in the manufacture of precision instruments, boxes, turnery works etc., while extracts of the leathery leaves and bark is used in local medicine (Govt. of India 1986). The seeds of boxwood are 4-5 mm long, 1-2 mm thick, shiny black and enclosed in three valved ovoid capsules, which are dispersed in an explosive mechanism on ripening of the fruits in August-September. There appears to be limited information on the germination requirements of boxwood seeds. Since, this tree has been identified as a potential species for reforestation in the denuded hill tops in higher elevations of upper and middle Himalayas, understanding the natural dispersal mechanisms, seed ecology and seed survival processes can help to develop strategies for natural and artificial regeneration programmes. The present study is an attempt to describe and quantify the size of seed banks of *Buxus wallichiana* in its natural habitat taking into account details like fecundity, annual seed rain, soil seed input as well as rate of loss of viability of seeds in soil.

The study was conducted during 1990-1994 in Mandal forest located approximately at 79°15’ E longitude and 30°25' N latitude having north to north east aspect and a slope ranging from 25° to 50°. It is part of Trishula Reserve Forest of Kedarnath Forest Division in western Himalayas. The natural altitudinal zonation of the vegetation is very well reflected in the Mandal forest from 1600 masl in Mandal village at the base, to 2700 masl. above Kanchula Kharak. The vegetation consists mainly of *Quercus leucotrichophora* (Banj) oak forests at lower elevations and *Quercus semicarpifolia* and *Q. floribunda* forests with a mixture of *Abies pindrow* at higher elevations. In Kanchula Kharak, where boxwood is predominant, nearly 87% of the mean annual rainfall (2600 mm) falls in the monsoon between June and September and about 10% falls as snow in winter between December and March. Average air temperature varied from 5.7°C to 23°C in Mandal and 0.5° to 14°C in Kanchula Kharak.

For estimating fecundity of boxwood, all reproductive trees found in a five ha plot near Kanchula Kharak were mapped, tagged and individuals spatially segregated and the number of fruiting branches per tree of different girth classes were counted. The annual fecundity per

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boxwood tree in Mandal forest ranged from 8.3 x 10^4 to 1.5 x 10^5 seeds. The average number of seeds per fruiting branch was estimated to be 696 (n = 9; SD = 135) and 1317 (n = 10; SD = 384) for trees smaller and greater than 20 cm gbh respectively.

To compare seed rain (total input of new seeds) among sites with different disturbance ages and at different distances from fruiting boxwood trees, the total and viable seed rain was estimated within 0-2 m, 3-6 m, 8-12 m and 15-25 m distance from nearest seed source by laying ten 0.25 m^2 quadrats after visually observing the seed dispersal phenomenon. The quadrats were laid out within the four distance ranges in two patch types corresponding to building patches (B) (2 - 35 years since disturbed and dominated by shade intolerant or pioneer species) and mature patches (M) (more than 35 years since disturbed and dominated by shade tolerant species) following Alvarez-Buylla Martinez-Ramos (1990). Observations on seed rain were taken in late October (after seed dispersal) and in March (after over wintering). To evaluate the effect of distance to seed source and patch type on the seed rain, log linear models were fitted.

The total and viable soil seeds per sample in October and March were a positive log-linear function of distance to the nearest fruiting boxwood trees and was also significantly affected by patch type. The best fit log linear models for seeds m^{-2} versus distance to nearest seed source that were significantly different according to 't' test, represents approximation of the dispersal curves of *Buxus wallichiana* as denoted by the equation, y = - 337.51 ln (x) + 1181.1 (R^2 = 0.618) for mature patch type (M), and y = -372.18 ln (x) + 1031.5 (R^2 = 0.841) for building patch type (B). These curves also suggest that in mature patches (M) seed fall decreases with distance faster than in building patches (B) and that at equal distances from nearest seed source seed fall is predicted to be higher in building than in mature patches. Distance to nearest seed source, patch type and interaction of the two explain a significant proportion of the variation in seed fall. The lower seed fall in mature patches may be explained by the association of this patch type with the presence of mature standing trees of other species like *Acer sterculiaceum.*

The soil seed content of boxwood was estimated by counting total seeds in soil samples and performing viability tests of seeds recovered. Two soil collections were made in October 1990 after seed dispersal and in March the following year. At each collection date, ten soil samples were taken from 30 x 30 cm^2 area up to 20 cm depth from random points in each of the four distance ranges. For building patch (B) distance of 0.5, 5, and 12 m and for mature patch (M) at distances of 3 and 16 m were available for estimating seed density. Seeds in the surface layer (0-5 cm), middle layer (5-10 cm) and in bottom layer (10-20 cm) were counted separately.

Nearly 75% of the total soil seeds were found to be in the top most five cm of soil. Only 18-22% was found in 5-10 cm and in that too viability was very low. The density of soil seeds differed significantly within the soil profile for each sampling distance. On an average 75, 20, and 5% of seeds were recovered from 0-5, 5-10 and 10-20 cm depths. Older seeds found in the deeper soil strata (10-20 cm) had lower viability than fresh ones found near the soil surface. Density of soil seeds was higher in October collection as compared to that in March collection (Fig. 1). Within a particular depth of soil, the soil seed density also varied significantly (p=0.05) depending on patch type and distance from seed source for both October and March. During both the collection periods maximum density of seeds was recorded at 5 m distance in building patch in 0-5 cm depth. The mean density of soil seeds across all soil depths ranged from 12 seeds m^{-2} (at 16 m distance in mature patch) to 1245 seeds m^{-2} (at 0.5 m distance in building patch) in March collection where as the densities recorded prior to the period immediately after the seed dispersal in October (1990) ranged from 21 to 2224 seeds m^{-2}. The mean soil seed bank density, regardless of patch type was 1328 m^{-2} in October and 562 m^{-2} in March (Table 1).

The general similarity between the spatial distribution of seed density in seed rain and in soil seed content, suggest that the soil seed stock could be attributed to a great extent, by the seed rain created by the standing adult

Table 1. Soil seed density (no.m^{-2}) of *Buxus wallichiana* at different depths at various distances from patch types to the nearest seed source of boxwood in Mandal forest. Observations taken in October after seed dispersal and in March after over wintering of seeds; [Figures in parenthesis represent number of viable seeds out of total number].

Distance*	Depth of soil layer (cm)							
	0-5		5-10		10-20		0-20 (Mean)	
	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar
0.5 (B)	1248	468	320	156	34	38	1602 (208)	680 (34)
5 (B)	1690	980	432	201	102	64	2224 (289)	1245 (74)
12 (B)	239	99	66	122	10	11	315 (25)	132 (10)
3 (M)	1935	521	422	156	149	67	2482 (323)	744 (42)
16 (M)	16	8	4	2	1	1	21 (3)	12 (2)
LSD (P = 0.05)	19.72	6.48	11.88	9.85	4.5	2.45	20.49	8.51

* Distance from Building patch (B) and Mature patch (M) to nearest seed source (m) each.

population of boxwood trees (Fig. 1). The average total seed rain content and soil seed content in October were significantly correlated ($r = 0.964$, $n = 5$, $p<0.05$). The correlation of seed rain and soil seed content in March was only marginally significant ($r = 0.881$, $n = 5$, $P<0.01$). The spatial distribution of newly dispersed seeds of boxwood was highly heterogeneous and most of the quadrats received only a low number of seeds. Comparison of viable seed rain and soil seed density suggests that boxwood seeds accumulate in soil for less than one year. Total seed recovered from soil collection made soon after the seed dispersal in October and after over wintering in March shows that the peak of seed production is high in building patches. However, the viability of soil seeds was much lower than that of seed rain. The distribution pattern of total and viable seeds in the soil profile also suggests that pathogens and predators are important depleting factors of the soil seed bank.

To estimate rate of loss in seed viability among buried boxwood seeds, a seed survivorship experiment was also set up. Mature seeds were collected in the fall (September) and 100 seeds were mixed with 250 g of sieved soil from the burial site and placed in 30 × 20 cm nylon mesh bags were buried at 2-5 cm depth, at randomly chosen sites in the study area following Guarigate & Azocar (1988). The bags were retrieved at regular sampling dates at monthly or bimonthly intervals. The seeds were then removed from the bags and tested for germinability and viability. Recovered seeds were designated as either germinated, viable or dead. The remaining seeds were incubated in TTZ (Triamine tetrazolium test) and stained embryos designated viable. If the sum of the seeds in the three categories did not total 100 for each recovered bag, the difference was designated as unrecovered.

Viability estimates for seeds taken from boxwood trees, soil samples and seed traps suggest that seeds retain maximum viability for a few months (3 - 4 months) after which loss of viability is fairly rapid. Freshly collected seeds had viability percentages greater than 90% and it dropped to 58% within 4 to 5 months and further dipped below 20% by the end of seventh month (Fig. 2). Germination was observed within 2 months of the start of the trial in November and reached a peak by March - April. The percentage of viable seeds decreased exponentiallwith time as described by the equation ln (% of dormant viable seeds) = 118.66 - 11.97 T, where, T = months since start of the experiment. ($r^2 = 0.83$, slope ' t' value = - 10.48, df = 4, $P< 0.01$, 95% CI for slope = -9.61, - 14.34).

Boxwood seeds appear to have a short life span in the soil primarily due to seed predation and pathogen attack. Predation appeared to be

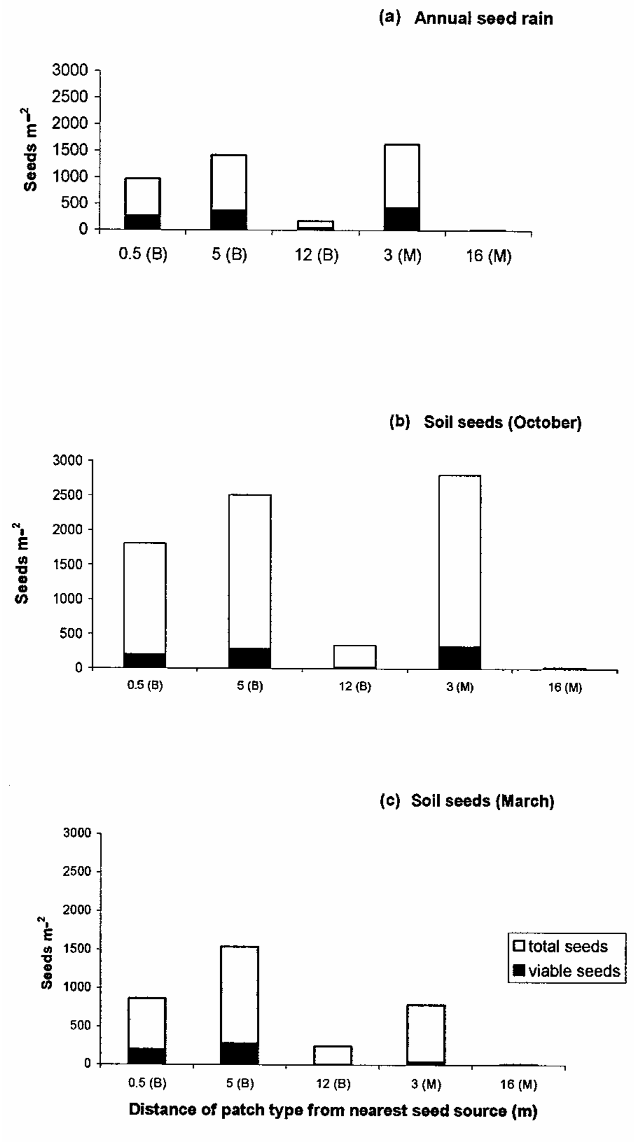

Fig. 1. a-c. Seed rain abundance and soil seed content in building (B) and mature (M) forest patches in Mandal forest. (a) annual seed rain (b) soil seed October collection and (c) soil seeds March collection. The mean soil seed density m^{-2} (n=10) are reported for each patch type. The distance from midpoint of patch to edge of crown of nearest fruiting tree of boxwood is also reported along with patch type.

the main cause for increased percent of unrecovered seeds in the latter part of the seed burial experiment. The higher viability of seeds in seed rain as compared to soil seed bank content measured in October and March is

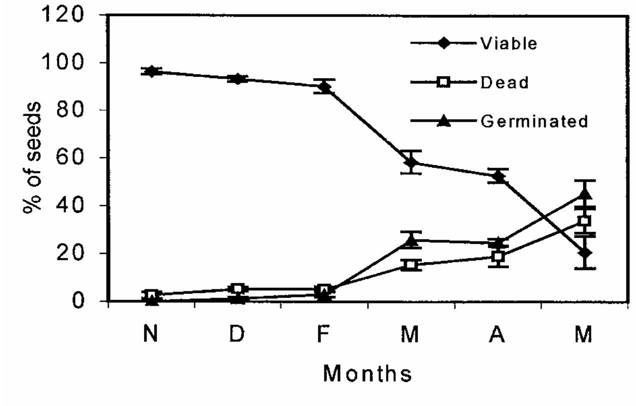

Fig. 2. Percentage of viable, germinated and dead seeds of *Buxus wallichiana* at each sampling date in seed survivorship experiment. Each value represents mean (± SD) of four replications of 100 seeds each.

probably a direct out come of this. This appears to be the trend even in tropical pioneer species such as *Cecropia obtusiflia* (Alvarez-Buylla & Martinez-Ramos 1990; Holthuijzen & Boerboom 1982)

In the current study on *Buxus wallichiana*, the proportion of seed rain to soil seeds was 44% in October and <10% in March, indicating that most of the seed input had entered the soil seed bank. However, the seed survivorship experiment with *Buxus wallichiana* showed that a high fraction of the seeds do not remain viable for more than four to five months. In summary, *Buxus wallichiana* seed bank dynamics appears to follow a transient strategy rather than a persistent seed bank strategy possibly as an adaptive response to a recruitment rate limited by unfavourable environmental conditions like prolonged snowfall retention.

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References

Alvarez-Buylla, E.R. & M. Martinez-Ramos.1990. Seed bank versus seed rain in the regeneration of a tropical pioneer tree. *Oecologia* **84**: 314-326.

Gaurigate, M.R. & A. Azocar. 1988. Seed bank dynamics and germination ecology in *Espeletia timotensis* (Compositae) an Andean Rosette. *Biotropica* **20**: 54-59.

Govt. of India. 1986. *The Useful Plants of India*. CSIR Publication, Delhi.

Holthuijzen, A.M.A. & J.H.A. Boerboom. 1982. The *Cecropia* seedbank in the Surinam lowland rain forest. *Biotropica* **14**: 62-68.