

Characteristics of Litchi Seed Germination

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Abstract. Seed germination of four *Litchi chinensis* Sonn. cultivars ('Deshi', 'Kasba', 'Purbi', and 'Early Bedana') was studied under various conditions, viz. in soil beds exposed to sunlight or in shade, in sand beds exposed to sunlight or in shade, and on moist filter paper. Among all, shaded, humid sand at $35 \pm 2\text{C}$ gave the highest germination. Delaying sowing seeds after removal from the fruit significantly reduced germination. Litchi seeds held in polyethylene bags up to 4 days at $37 \pm 2\text{C}$ at 90% relative humidity delayed loss of seed viability. Germination was improved by ethephon in 'Deshi' and 'Early Bedana', by IBA in 'Deshi' and 'Purbi', and by 100 mM GA₃ in all litchi cultivars. Cultivars responded differently to growth regulators, with 'Deshi' responding significantly better than 'Purbi', 'Kasba', or 'Early Bedana'. These studies point to the recalcitrant nature of litchi seeds. Chemical names used: gibberellic acid (GA₃); indole butyric acid (IBA); 2-chloroethylphosphonic acid (ethephon).

The heterogeneity of litchi propagated from seed may offer a method to develop new cultivars (Kadman and Slor, 1974; Kumar and Thakur, 1981). Litchi seed germination is sensitive to moisture (Fu et al., 1990; Ray and Sharma, 1985). However, the causes of rapid loss of seed viability by litchi and other recalcitrant seeds and the difficulties with long-term storage have not been investigated thoroughly (Chin, 1978; Chin et al., 1984; Fu et al., 1990; Kumari-Singh and Prasad, 1991). We investigated the germination of four cultivars of *L. chinensis* ('Deshi', 'Kasba', 'Purbi', and 'Early Bedana') under various conditions at $35 \pm 2\text{C}$ and $\approx 60\%$ RH. How germination capacity was affected by physical (holding seed in polyethylene bags or in open containers at 37C and $\approx 90\%$ RH) and chemical (effects of ethephon, IBA, or GA₃) treatments was also studied.

Materials and Methods

Fruit samples. Fully ripe fruits (≈ 2000) of 'Deshi', 'Kasba', 'Purbi', and 'Early Bedana' litchi were harvested from trees in the College of Agriculture, Sabour (Bhagalpur), India. Seed from the four cultivars was immediately sown in soil (loam) beds exposed to sunlight or

under shade, in sand beds exposed to sunlight or under shade, and on moist filter paper at ambient conditions ($35 \pm 2\text{C}$). Additional fresh seeds were used to test several treatments before sowing: 1) seeds were held in a 40- μm -thick polyethylene bag sealed with a rubber band, or were held in an open container, both at room temperature in a humidity-controlled chamber ($35 \pm 2\text{C}$ and $\approx 60\% \pm 4\%$ RH as determined with a psychrometer); 2) seeds were sown 2, 4, 6, or 8 h after removal (HAR) from the fruit, in sand beds under shade; 3) seeds were held at 37C and $\approx 90\% \pm 4\%$ RH, either in an open container or in a polyethylene bag for 1, 2, 3, or 4 days after removal (DAR) from the fruit and then sown in sand beds in shade.

Seeds were placed 2–3 cm deep in soil or sand. For each treatment there were four replications with 25 seeds per replication of each sowing condition and cultivar.

Seeds of each cultivar were soaked in 1, 10, or 100 mM of IBA, GA₃, or ethephon for 1 h and then sown in a sand bed under shade. The

control was soaked in distilled water for 1 h.

The beds were thoroughly irrigated in the morning and the evening. Germination was determined daily, with radicle emergence being the criterion of seed germination. Seeds that had not germinated after 8 days were subjected to amiability assay with 1% triphenyl tetrazolium chloride (TTC) solution. Data were subjected to three-factor randomized block design analysis of variance (ANOVA) with the help of Indostat Statistical Package according to Snedecor and Cochran (1961).

Results and Discussion

Germination conditions. Germination of litchi seed cultivars differed significantly and ranged from 92% in 'Deshi' to 60% in 'Early Bedana' sown in the sand bed under shade at 35C (Table 1). When the soil bed was exposed to sunlight, germination never exceeded 16%. While there was a marked improvement in germination of seeds on moist filter paper, seeds failed to germinate in the sand bed exposed to sunlight and shaded soil bed under any of these conditions. Optimum germination occurred in seeds sown immediately after removal from the fruit. There was already a substantial decline in the germination percentage of all cultivars 2 h after removal from the fruit (Fig. 1). Seed held in a polyethylene bag mostly had a slower loss of germination ability than those held in an open container. 'Deshi' litchi seed held in bags lost germinability minimally during storage, irrespective of storage method; in contrast, 'Early Bedana' had lost its capacity to germinate within 8 h after removal from the fruit.

Seeds of all litchi cultivars, whether held in a polyethylene bag or not at 37C and 90% RH, lost germinability to various degrees (Fig. 2). Loss in 'Early Bedana' was the fastest. There was a rapid decline in germination with the increase in days after removal, with the decline being mostly less for seeds held in polyethylene bags (Table 2). Ray and Sharma (1985) reported greater retention of viability in seeds stored in water rather than in air. Ray and Sharma (1987) also reported 42% viability up to 24 days when seeds had been left in the fruit that was held in polyethylene bags following treatment with 0.05% methyl 1,2-benzimidazole carbamate (benomyl) and 6%

Table 1. Percent germination of litchi seed under three conditions.*

Cultivars	Germination (%)		
	Sand bed under shade	Soil bed exposed to sunlight	On moist filter paper under ambient conditions
Deshi	92	0	23
Kasba	85	16	50
Purbi	84	16	40
Early Bedana	60	0	16
	<i>Analysis of variance</i>		
Source of variation	df	MS	F probability
Condition	2	16152.25	0.001
Cultivar	3	1055.52	0.0001
Condition \times cultivar	6	222.44	0.001
Error	24	0.88875	

*Seed germination was absent in the soil bed under shade and sand bed exposed to sunlight.

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wax emulsion. Cull and Paxton (1982) were able to retain viability for 1 or 2 weeks when stored in the fruit or in moist peatmoss in a freezer. Litchi seeds in intact fruit remain viable for 4 weeks (Menzel, 1985), losing viability within a day after separation from the fruit. However, adequate soil moisture and aeration were among principal requirements for optimum litchi seed germination (Xia et al., 1992a, 1992b). In our study, none of the seed of any cultivar germinated in a soil bed under shade (favoring retention of moisture,

but less aeration) or in a sand bed exposed to sunlight (favoring more aeration but rapid loss of moisture), reaffirming Xia et al. (1992a). Further, germination of litchi seeds was high in a sand bed under shade with regular morning and evening irrigation. This high rate may be due to the better bed aeration and the shading, which reduced water loss from the bed.

Growth regulators. Soaking litchi seeds for 1 h in ethephon improved germinability of 'Deshi' at 10 mM and for 'Early Bedana' at 1 and 100 mM (Table 3). Reduced germinability

with 10 mM may be due to chance. However, 1, 10, or 100 mM ethephon reduced germination in 'Kasba' and in 'Purbi'. The improving effect of IBA on 'Deshi' seed was similar to that of ethephon. In 'Purbi', 10 or 100 mM IBA improved germination. In 'Kasba' and 'Early Bedana', 1 and 10 mM IBA reduced germination. GA₃ at 1 mM reduced germination in 'Deshi', 'Kasba', 'Purbi', and 'Early Bedana'. GA₃ at 10 mM slightly improved germination in three cultivars, the exception being 'Kasba'. GA₃ at 100 mM increased the germination of all cultivars (Table 3), suggesting that GA₃ plays an important role in litchi germination. Sharma and Dhillon (1986) noted a decline in endogenous levels of gibberellin in litchi seeds at maturity. Such a decline may be a limiting factor in maintenance of seed viability and/or germination. Their results agree with those of Xia et al. (1992a) of a similar response to GA₃ by longan (*Euphoria longan* Steud.) seeds. The effect of the three growth regulators on litchi seeds differed among cultivars.

Thus, litchi seed germination can be best achieved on a humid sand bed under shade immediately after removal of the seed from the fruit. With an increase in time after removal, germination capacity is lost, reflecting the recalcitrant nature of litchi seed. Its germinability can be improved by ethephon, IBA, and GA₃ applications, among which GA₃ plays a greater role than the other two growth regulators.

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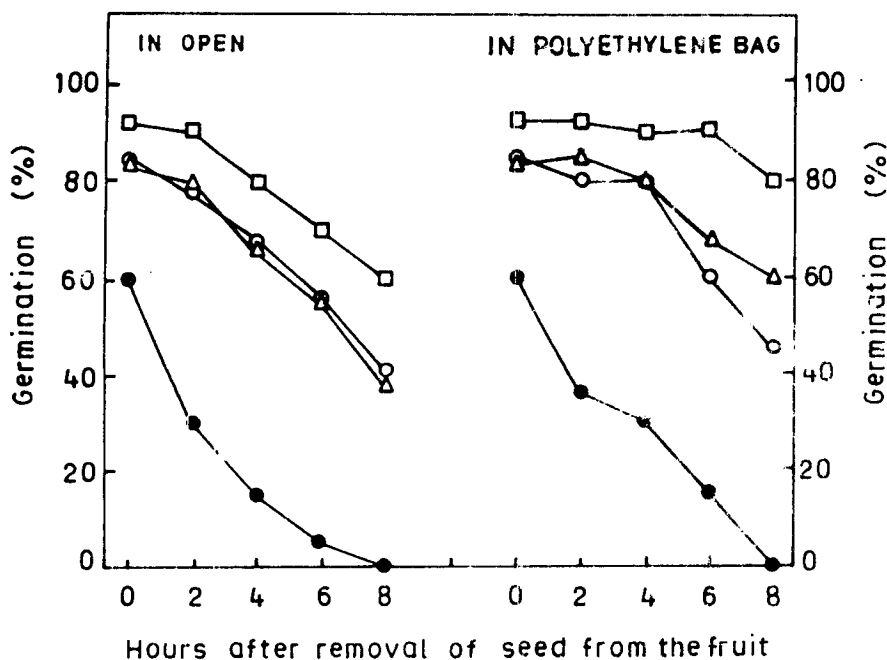


Fig. 1. Germination of litchi seeds held up to 8 h at 35°C, 60% RH (□ = 'Deshi'; ○ = 'Kasba'; △ = 'Purbi'; ● = 'Early Bedana').

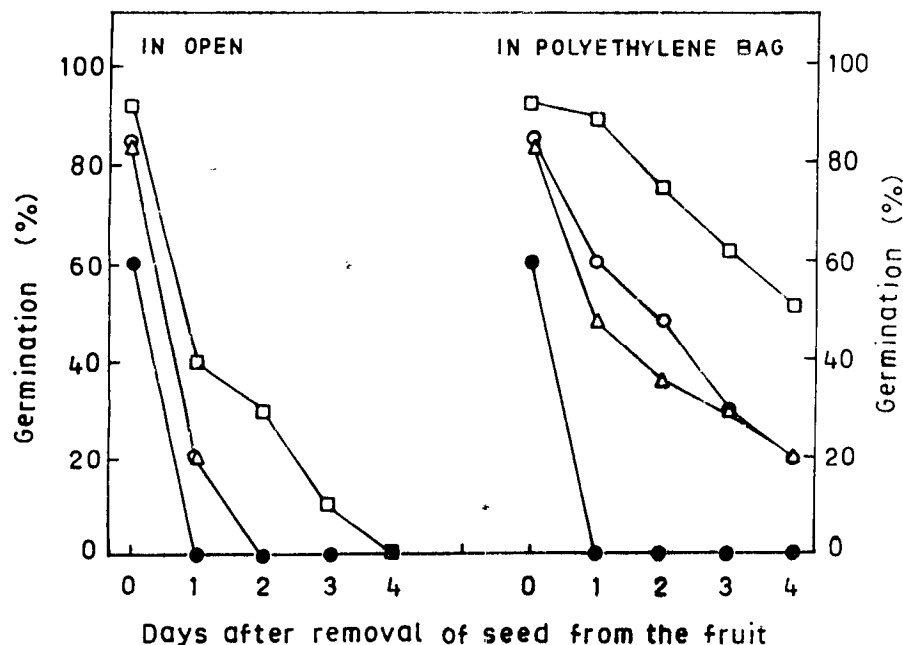


Fig. 2. Germination of litchi seeds held up to 4 days at 37°C, 90% RH (□ = 'Deshi'; ○ = 'Kasba'; △ = 'Purbi'; ● = 'Early Bedana').

Table 2. Statistical analysis of germination data (ANOVA) presented in Figs. 1 and 2. Seeds A) were held up to 8 h at room temperature (35C, 60% RH) and B) were held up to 4 days at 37C, 90% RH.

Source of variation	df	MS	F probability
<i>A) Hours after removal of seed from the fruit</i>			
Replication	1	0.62	0.599
Hours (H)	4	3932.30	0.000
Storage method (SM)	1	1280.00	0.002
Cultivars (C)	3	12826.80	0.000
H × SM	4	132.75	0.005
H × C	12	202.80	0.002
SM × C	3	47.33	0.002
H × SM × C	12	31.25	0.025
Error	39	2.22	
<i>B) Days after removal of seed from the fruit</i>			
Replication	1	1.51	0.269
Days (D)	4	12267.25	0.000
Storage method (SM)	1	10035.20	0.000
Cultivars (C)	3	5933.40	0.000
D × SM	4	674.45	0.001
D × C	12	223.48	0.025
SM × C	3	1363.06	0.001
D × SM × C	12	119.48	0.025
Error	39	1.20	

Table 3. Effect of soaking in ethephon, IBA, and GA₃ (in mM) for 1 h on percent germination of four litchi cultivars.

Cultivars	Germination (%)									
	Control	Growth regulators (mM)						1	10	100
		Ethephon			IBA					
	1	10	100	1	10	100	1	10	100	
Deshi	92	94	100	94	93	100	94	87	94	100
Kasba	85	73	47	47	54	67	80	73	73	94
Purbi	84	80	73	80	80	94	94	80	87	94
Early Bedanna	60	70	50	80	40	50	60	80	70	90
<i>Analysis of variance</i>										
Source of Variation	df	MS	F probability							
Replication	1	4.16	0.105							
Chemical (Chem)	2	661.16	0.002							
Concentration (Con)	3	413.81	0.002							
Cultivar (C)	3	4282.15	0.000							
Chem × Con	6	314.11	0.001							
Chem × C	6	400.44	0.001							
Con × C	9	261.22	0.005							
Chem × Con × C	18	111.90	0.005							
Error	47	1.52								

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