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Effects of Water Storage on Seed Germination and Seedling Growth of Rubber (*Hevea brasiliensis* Muell Arg.)

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Fresh rubber seeds stored under ambient conditions in water gave 45 per cent germination even after 20 days as compared to zero germination of seeds stored under open air conditions. The water storage treatment was better than the open air storage for seed moisture content, germination percentage and all growth attributes except for number of lateral roots.

Keywords: *Water storage, germination percentage, rubber seeds*

Rubber, an economically important perennial crop has the recalcitrant type of seeds of short viability (Marattukalam, Saraswathyamma & Premakumari, 1980; Rubber Research Institute of Malaysia, 1990). Hence, the seeds should be sown for germination as soon as they are collected. Viability can be prolonged by adopting different methods which check loss of moisture content and rate of respiration (Wycherley, 1971; Rubber Research Institute of Malaysia, 1974). Although moisture content is recognised as one of the prime factors that determine the seed viability, experimental data to ascertain the importance of moisture level in rubber seeds on germination and initial growth of seedlings are meagre. An experiment was conducted to observe the above aspects on storage of seeds for a short period.

MATERIALS AND METHODS

Fresh assorted rubber seeds of uniform size collected from Kanyakumari region of Tamil Nadu were used for the present study. Open air storage (26-30°C under shade) and water storage of seeds for five, 10, 15 and 20 days were studied. Seeds without storage were used as the control. The total number of treatments was nine, as shown below:

T1	Control	
T2	Seed storage in open air for	5 days
T3	Seed storage in open air for	10 days
T4	Seed storage in open air for	15 days
T5	Seed storage in open air for	20 days
T6	Seeds soaked in water for	5 days
T7	Seeds soaked in water for	10 days
T8	Seeds soaked in water for	15 days
T9	Seeds soaked in water for	20 days

Each treatment had three replications of 50 seeds. Thirty-five seeds were reserved for germination and the remaining seeds were used for an estimation of moisture content. For open air storage the seeds were kept in a tray under ambient conditions and for water storage the seeds were placed in water in a tray. The water was changed once at 10 days after storage. The seeds were planted for germination after five, 10, 15 and 20 days storage from both the lots. For moisture estimation, the fresh weight on collection,

weight after storage and oven dry weight were recorded. The proportion of moisture in fresh seeds and in stored seeds, as a percentage of fresh weight was estimated. Percentage germination was observed at seven, 14 and 21 days after sowing under laboratory conditions. On the 21st day all the sprouted seeds were uprooted, the root and shoot length were measured. The germinated seeds were then transplanted to the seedling nursery, at the campus of the Rubber Research Institute of India, Kottayam. The seedlings were planted in a completely randomised design with a spacing of 2 feet between rows and 1 foot between plants. Conventional cultural operations were carried out. Plant height and survival percentage were recorded one month after planting in the nursery. The germination relative index (GRI= Xn (h-n)), where Xn is percentage of seeds germinated on nth count; h is total number of counts; and n is count number as well as vigour index (VI = germination percentage x hypocotyle length) of the seeds were estimated following Kaur and Srivastava (1981) and Abdul Baki and Anderson (1973) respectively. The data was subjected to statistical analysis for differences of treatment means and correlations.

RESULTS AND DISCUSSION

Data on moisture content, germination percentage, GRI and VI are shown in *Table 1*. The differences between treatments were significant. Fresh seeds collected by the conventional method, recorded 39 per cent moisture which was gradually reduced to 9 per cent on 20 days storage at ambient conditions with temperature ranges from 26-30°C. Rubber seeds soaked in water for five to 20 days recorded 40-45 per cent moisture content which are significantly higher values than those of fresh seeds. As the storage time under ambient condition increased, the degree of desiccation also increased. The highest germination (91 per cent) was obtained for fresh seeds which was reduced to 64 per cent on five days storage with a steep fall to 20 and 17 per cent on 10 and 15 days storage, respectively. No germination took place after 20 days storage. For water stored seeds, 88 per cent germination was obtained after five days storage. As storage time prolonged to 10, 15 and 20 days, the germination percentage fell to 80, 60 and 45 per cent respectively. Here, the viability loss is gradual.

The results indicated that around 40 per cent moisture content is a requirement for better seed viability which can be attained by water storage. By this method, rubber seeds can be stored upto 10 days with 80 per cent, 15 days with 60 per cent and 20 days with 45 per cent germinability as against 64, 20, 17 and zero per cent viability for air storage under shade. The relationship between moisture content and germination percentage of seeds kept at ambient conditions is shown in *Figure 1*.

For one month storage of rubber seeds with 70 per cent viability Eikema (1941) recommended 40 per cent moisture retention plus powdered charcoal as the packing material. After dehiscence, moisture loss and depletion of reserve food due to respiration, are the major reasons for the short viability of rubber seeds. Chin, Aziz, Ang and Hamzah (1981) reported loss of viability in fresh seeds roughly parallel to loss of moisture down to a moisture content of 15-20 per cent below which seeds are not viable. Better GRI for the second observation (8-14 days) over the third observation (15-21 days) was obtained upto 10 days storage in water. After longer storage the index for the first observation

TABLE 1
EFFECTS OF STORAGE ON MOISTURE CONTENT, GERMINATION, GERMINATION RELATIVE INDEX AND VIGOUR INDEX

Treatment	*Moisture content*	*Duration of relative germination*			*GRI*	*Vigour index*	*Total germination(%)*
		Within 7 days after sowing	*Within 8-14 days after sowing*	*Within 15-21 days after sowing*			
T1	38.86	13.04	47.83	30.43	104.34	956.82	91.30
T2	34.39	18.18	22.72	22.72	81.80	340.42	63.63
T3	22.40	-	6.66	13.33	19.99	31.00	20.00
T4	12.59	-	-	16.67	16.67	25.00	16.67
T5	8.97	-	-	-	-	-	-
T6	40.32	18.75	37.50	31.25	106.25	839.12	87.50
T7	45.38	20.00	40.00	20.00	100.00	665.60	80.00
T8	40.51	30.00	30.00	-	90.00	372.00	60.00
T9	42.83	35.00	10.00	-	80.00	180.45	45.00
CV	2.18	13.42	5.37	7.25	15.76	5.39	2.04
CD	1.26	5.37	5.37	2.89	20.43	39.80	2.04
SE	0.42	1.74	1.77	0.94	6.81	22.99	1.77

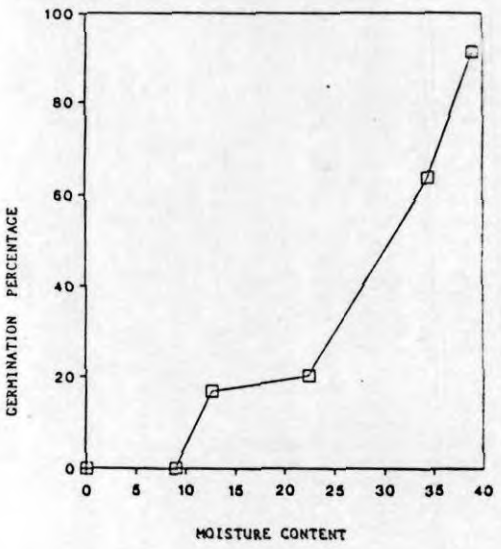

Figure 1. Relationship of moisture content and germination percentage

was better than the second observation and total germination was completed within 14 days. Early germination is a good indication of vigorous growth of the resultant seedlings (Senanayaka, Jayasekera & Samaranayake, 1975; Saraswathyamma & Bhaskaran Nair, 1976; Premakumari & Bhaskaran Nair, 1980). The VI of different treatments as shown in *Table 1* also support this view. Maximum vigour index was obtained for fresh seeds (956.82) with a drastic change to 25 per cent for 15 days storage at ambient conditions. Seeds after five days water storage recorded VI of 839.12 which gradually reduced to 180.45 as storage time prolonged to 20 days. The relatively high magnitude of GRI, VI and germination percentage for water stored seeds compared to open storage might be attributed to more water imbibition and thus greater efficiency in mobilisation and transport of reserve materials to small embryos (Bremner, Eckersall & Scott, 1963; Gupta, 1976).

Survival and some growth attributes such as tap root length, number of lateral roots and shoot length at the time of transplanting (21 days after sowing) as well as the plant height of the seedlings, one month after planting, are shown in *Table 2*. With respect to all characters, the performance of fresh seeds was the best and five days storage in water recorded as the second best. Treatment differences were significant. For all characters, except the number of lateral roots, a sudden fall was observed for storage in ambient conditions from fresh seeds to seeds stored longer whereas the deterioration was gradual for water stored seeds.

The correlation matrix of the characters under study is shown in *Table 3*. Positive significant associations among seed moisture content, germination percentage, survival percentage, and all the growth attributes under study, except the number of lateral roots, were evident from the *Table*. Positive associations of seed moisture content with germinability and seedling vigour have been reported in tea (Sebastiampillai & Anandappa, 1979; Barman, 1988). The increased germination percentage and seedling growth could be attributed to imbibition of water for the commencement of preemergence activity of germination.

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TABLE 2
EFFECTS OF STORAGE ON SEEDLING GROWTH AND SURVIVAL

Treatment	*Root growth 21 days after sowing (cm)*	*Shoot growth 21 days after sowing (cm)*	*Number of lateral roots 21 days after sowing (cm)*	*Plant height 1 month after field planting (cm)*	*Survival 1 month after field planting (%)*
T1	10.48	21.56	10.33	80.00	44.00
T2	5.35	12.27	8.76	50.00	42.50
T3	1.55	2.67	9.67	10.00	17.50
T4	1.50	1.58	9.24	nil	0.00
T5	0.00	0.00	0.00	nil	0.00
T6	9.59	19.44	10.75	75.00	42.00
T7	8.32	16.17	8.51	65.00	38.50
T8	6.20	9.11	7.37	55.00	21.00
T9	4.01	8.64	8.63	40.00	18.00
CV	8.55	5.00	4.15	4.55	5.71
CD	0.87	0.99	0.66	3.75	3.19
SE	0.29	0.33	0.22	1.24	1.05

TABLE 3
CORRELATIONS AMONG VARIOUS CHARACTERS

	Moisture content	*Percent germination*	*Root growth*	*Shoot growth*	*No of lateral roots*	*GRI*	*Vigour index*	*Plant height*
Survival	0.6976**	0.9806**	0.9790**	0.9093**	0.2347	0.8813**	0.9447**	0.7771**
Moisture content		0.6607**	0.6265**	0.6335**	0.2519	0.7826**	0.5205**	0.3082*
Percentage germination			0.9789**	0.9502**	0.2971	0.8675**	0.9580**	0.8521**
Root growth				0.9354**	0.3521	0.8341**	0.9773**	0.7950**
Shoot growth					0.3214	0.7684**	0.9326**	0.8732**
No of lateral roots						0.0659	0.4837*	0.4787*
GRI							0.7725**	0.6613**
Vigour index								0.8160**

* Significant at 5% P
** Significant at 1% P

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