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Germination Behaviour and Seedling Growth as Influence by Pretreatments of Seeds of *Cleistanthus Collinus* Benth under Storage

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Abstract: ***Cleistanthus collinus commonly known as Karra, Garari, belongs to family Euphorviaceae. In India, it occurs in many parts of Indian Peninsula. In Madhya Pradesh it is found as an associate of teak, sal and mixed forests. The wood is used for house posts. It's Fruits act as violent gastro-intestinal irritant. It's Leaves and bark used as fish poision. The tree flowers in April-May and fruits ripen in the following March-April. Natural regeneration of this species is very poor. The scarcity of natural reproduction may be attributed to the poor germination rate of the seeds. The present paper deals with the study of this species with respect to germination potential, seedling growth and biomass affected by different pretreatments with storage period. Different pretreatments were tried with fresh and stored seeds, seeds treated with hot water treatment (T2) proved to be the best treatment to stimulate seed germination as 52%, 56%, 54%, 46%, 41%, 34% and 27% in fresh and seed stored for 3, 6, 9, 12, 15 and 18 months respectively, while in control i.e. without any treatment, the germination was recorded as 20%, 24%, 18%, 14%, 10%, 4% and 0% in fresh and stored seeds for 3, 6, 9, 12, 15 and 18 months respectively. Similarly germination velocity index, seedling growth and biomass were also found to be most promising with treatment T2. The treatment T2 was found to be highly significant (P<0.05) over control and other treatments attempted.***

Keywords: Germination, viability, pretreatment, seedling growth, germination velocity index

1. Introduction

Cleistanthus collinus is a small tree that belongs to family Euphorviaceae and commonly known as Karra, Garari. It occurs in many parts of Indian peninsula. It is one of the commonest trees in some of the dry type of mixed forests. In Madhya Pradesh, it is found as an associate of teak, sal and mixed forests. The wood is used for house posts and roots, leaves and bark used as fish poision. Leaves, roots and especially the fruits act as violent gastro-intestinal irritant. The tree can grow on a variety of soils but deep sandy low supports better growth. In central India, it is frequently found on laterite soil. The tree is leaf-less in March-April. The small greenest flowers appear with the new leaves in April – May; sometimes also in September (Troup, 1921), and the fruits ripen in the following March – April. Natural regeneration of this species is very poor. The scarcity of natural reproduction may be attributed to the poor germination rate of the seeds. The role of pretreatment has been reported in many forestry species to enhance the germination of seeds. Promising results have been found from hot water and acid treatment on germination of seeds of *Cassia fistula* (Singh, 1987), Tectona grandis (Keiding & Kusden, 1974), *Santalum album* (Nagaveni and Srimathi, 1980), *Acacia melanoxylon* (Gupta and Thapliyal, 1974), *Leucaena leucocephala* (Babele and Kandya, 1985) and *Acacia nilotica* (Palani, et.al., 1995), Seed storage with particular reference to forestry species (Dent. 1948), Studies on pre-sowing seed treatment in three species of *Cassia* (Padma *et. al*,. 1996), pretreatment of seeds of *Albizia falcate*, *A. chinensis* and *A. richardiana* (Rai, S.N., 1978). Effect of different treatments to hasten tree seed germination (Seikh, M. I., 1980). The present paper deals with seed pretreatments for hastening the germination of *Cleistanthus collinus* during storage.

2. Materials and Methods

Seeds of *Cleistanthus collinus* (Garari) were collected from Seoni Division in the month of April from identified superior trees by hand plucking. After collection, fresh seeds were taken for germination studies. The 20 kg seeds were kept for storage for open condition to test the longevity and germination percentage. The germination test was undertaken at 3 months interval till the end of germination potential. 300 seeds, with three replicates of 100 seeds each, were taken separately for the entire test to be carried out for moisture content, viability, germination percentage, etc during this study.

Following pretreatments were tried to hasten the germination of fresh as well as stored seeds in open condition.

T0	Control
T1	Cold water for 24 hrs soaking
T2	Hot water for 24 hrs soaking
T3	5% H_2SO_4 for 10 minute soaking
T4	10% H_2SO_4 for 10 minute soaking
T5	20% H_2SO_4 for 10 minute soaking
T6	40% H_2SO_4 for 10 minute soaking
T7	60% H_2SO_4 for 10 minute soaking
T8	200 ppm GA_3 for 10 minute soaking
T9	500 ppm GA_3 for 10 minute soaking
T10	200 ppm IBA for 10 minute soaking
T11	500 ppm IBA for 10 minute soaking

T12 1% KNO_3 for 1 hour soaking
T13 5% lime water for 10 minutes
T14 10% lime water for 10 minutes
T15 20% lime water for 10 minutes

Note: In hot water treatment - Seeds were soaked in hot water, which has gradually cooled at normal temperature.

Before testing with various pretreatments, seeds were tested for viability percentage, germination percentage and germination velocity index. Following methods were used for various tests.

Viability Test
For this test, seeds were placed in water for 24 hours, thereafter seeds were de-coated longitudinally two halves with a penknife. Exposed seeds were immersed in 1% tetrazolium solution for 24 hours and were kept in darkness at 30˚C. After the period of treatment, tetrazolium was decanted off and the preparations were washed with water prior to evaluation. For examination the preparations were spread on a plate and kept wet throughout the determination.

Viability of seeds calculated by flowing formula:

$$\text{Viability \%} = \frac{\text{Viable seeds}}{\text{Total Seeds}} \times 100$$

Germination Test
Seeds (fully matured) were taken to study the germination behavior under the influence of different pretreatments. Experiments were conducted in field condition and in germination tray. New germinants were recorded daily starting from the day of germination till the 30 days after sowing to express germination percent of seeds.

Germination Velocity Index
GVI is computed by dividing the number of normal seedlings removed daily divided by the day on which they were removed after sowing. It can be expressed by the following-

$$\text{GVI} = \frac{\text{Number of seedlings removed daily}}{\text{Day after sowing}}$$

Growth of Seedlings
After one month of germination new germinants were shifted in polythene bags with Soil + Sand + FYM (1:1:1) potting mixture. Seedling length was measured after 3 months of seed sowing. Twenty seedlings were taken at random for measurement in each treatment.

3. Result & Discussions

Table 1 shows morphological and physical features of seeds of *Cleistanthus collinus.* Seeds were collected from Seoni Division in the month of April. The data reveals that seeds were found brown, blackish brown and dark black in color. The percentage occurance of healthy seeds was found to be 58%. The composition (%) of sound and unsound seeds was determined by placing the seeds in water. Empty seeds float, while many sound seeds sink in water. Performing the experiment, it was found that proportion in upper and lower layers was 42% to 58% respectively. The number of seeds per kg was found to vary between 17000 to 18000 and moisture percent was 5.42% to 5.70%. Viability of seeds was determined by Tetrazolium test method and 52% to 60% seeds were found viable as they showed more or less complete staining. Against this, 40 to 48% seeds were found to be non viable and showed very poor and less staining.

Table 1: General morphological and physical features of seeds of *Cleistanthus collinus*

Features		Observations
No. of seed/capsule		3-4
Nos. of Seeds/KG		17000-18000
Moisture (%)		5.42 – 5.70
Viability (%)		52-60
Purity (%)		94
Color (%)	Brown	40
	Blackish Brown	30
	Dark Black	30
Health (%)	Sound	58
	Unsound	42

The effect of different pre-treatments on seeds of *Cleistanthus collinus* was studied for different period of storage (Table 2 to 8). Among various pre-treatments tried with fresh and stored seeds, seed treated with hot water (T2) proved to be the best treatment to stimulate seed germination as 52%, 56%, 54%, 46%, 41%, 34% and 27% in fresh and seeds of stored 3, 6, 9, 12, 15 and 18 months respectively, whereas in control, the germination was recorded as 20%, 24%, 18%, 14%, 10%, 4% and 0% in fresh seeds stored for 3, 6, 9, 12, 15 and 18 months respectively followed by 47%, 52%, 49%, 43%, 38%, 30% and 23% seed germination with seed soaking in 500 ppm GA_3 for 10 minute (T9) in fresh and stored seed of 3, 6, 9, 12, 15 and 18 months respectively as compaire to control and other treatments with respect to germination potential and growth of seedlings. Similarly, germination velocity index, seedling growth and biomass were also found to be the most promising with treatment T2 and T9. The results also indicate that during storage the highest germination was found after 3 months of storage and thereafter the germination was found to have declined. Statistical analysis shows that the superiority of treatment T2 was found to be highly significant at 0.05% probability level over control and other treatments attempted (Table-9).

Table 2: Germination percent, germination velocity index (GVI), length of seedlings, biomass of seedlings of *Cleistanthus collinus* as affected by different pretreatments in fresh seeds.

SN	Pretreatment	% of G	GVI	Seedling length (cm)	Vigor	Biomass (mg)
T0	Control	20	1.70	3.60	72.00	33.40
T1	Cold water	40	3.10	4.10	164.00	39.50
T2	Hot water	52	4.70	5.90	306.80	42.10
T3	5% H_2SO_4 for 10 minute soaking	25	2.05	3.83	95.75	34.10
T4	10% H_2SO_4 for 10 minute soaking	30	2.45	3.97	119.10	36.50

T5	20% H_2SO_4 for 10 minute soaking	35	2.65	4.07	142.45	37.00
T6	40% H_2SO_4 for 10 minute soaking	42	2.95	5.38	225.96	40.10
T7	60% H_2SO_4 for 10 minute soaking	45	3.35	5.48	257.56	40.80
T8	200 ppm GA_3 for 10 minute soaking	46	3.37	5.59	251.55	40.90
T9	500 ppm GA_3 for 10 minute soaking	47	3.40	5.63	258.98	40.94
T10	200 ppm IBA for 10 minute soaking	39	3.00	5.22	203.58	40.25
T11	500 ppm IBA for 10 minute soaking	41	3.10	5.32	218.12	40.36
T12	1 % KNO_3 for 1 hour soaking	32	2.45	4.30	137.60	35.44
T13	5% lime water for 10 minutes	22	2.10	3.94	86.68	32.00
T14	10% lime water for 10 minutes	20	2.00	3.85	77.00	32.00
T15	20% lime water for 10 minutes	18	1.85	3.59	64.62	31.60

G: Germination, **GVI:** Germination Velocity Index, **TSL:** Total Seedling Length

Table 3: Germination percent, germination velocity index (GVI), length of seedlings, biomass of seedlings of *Cleistanthus collinus* as affected by different pretreatments in 03 month old seeds

SN	Pretreatment	% of G	GVI	Seedling length (cm)	Vigor	Biomass (mg)
T0	Control	24	1.90	3.66	87.84	33.70
T1	Cold water	44	3.40	4.22	185.68	39.75
T2	Hot water	56	4.84	5.98	334.88	42.50
T3	5% H_2SO_4 for 10 minute soaking	28	2.15	3.87	108.36	34.22
T4	10% H_2SO_4 for 10 minute soaking	34	2.53	4.03	137.02	36.60
T5	20% H_2SO_4 for 10 minute soaking	40	2.87	4.15	166.00	37.20
T6	40% H_2SO_4 for 10 minute soaking	46	3.35	5.44	250.24	40.25
T7	60% H_2SO_4 for 10 minute soaking	48	3.46	5.64	282.00	40.90
T8	200 ppm GA_3 for 10 minute soaking	50	3.90	5.72	286.00	41.15
T9	500 ppm GA_3 for 10 minute soaking	52	3.97	5.77	300.04	41.19
T10	200 ppm IBA for 10 minute soaking	44	3.20	5.35	235.40	40.40
T11	500 ppm IBA for 10 minute soaking	46	3.27	5.44	250.24	40.56
T12	1 % KNO_3 for 1 hour soaking	34	2.48	4.38	148.92	35.47
T13	5% lime water for 10 minutes	16	1.55	3.77	60.32	31.70
T14	10% lime water for 10 minutes	12	1.47	3.71	44.52	31.67
T15	20% lime water for 10 minutes	9	0.97	2.75	24.75	29.50

G: Germination, **GVI:** Germination Velocity Index, **TSL:** Total Seedling Length

Table 4: Germination percent, germination velocity index (GVI), length of seedlings, biomass of seedlings of *Cleistanthus collinus* as affected by different pretreatments in 06 month old seeds.

SN	Pretreatment	% of G	GVI	Seedling length (cm)	Vigor	Biomass (mg)
T0	Control	18	1.64	3.55	63.90	33.60
T1	Cold water	42	3.20	4.15	174.30	39.70
T2	Hot water	54	4.80	5.90	318.60	42.40
T3	5% H_2SO_4 for 10 minute soaking	24	2.14	3.82	91.68	34.18
T4	10% H_2SO_4 for 10 minute soaking	33	2.51	3.99	131.67	36.55
T5	20% H_2SO_4 for 10 minute soaking	37	2.70	4.10	151.70	37.00
T6	40% H_2SO_4 for 10 minute soaking	44	3.30	5.38	236.72	40.15
T7	60% H_2SO_4 for 10 minute soaking	46	3.39	5.59	262.73	40.84
T8	200 ppm GA_3 for 10 minute soaking	47	3.82	5.65	265.55	41.05
T9	500 ppm GA_3 for 10 minute soaking	49	3.87	5.71	279.79	41.07
T10	200 ppm IBA for 10 minute soaking	40	3.00	5.10	204.00	40.05
T11	500 ppm IBA for 10 minute soaking	42	3.17	5.20	218.40	40.15
T12	1 % KNO_3 for 1 hour soaking	22	2.02	4.12	90.64	33.17
T13	5% lime water for 10 minutes	12	1.47	3.65	43.80	29.80
T14	10% lime water for 10 minutes	9	0.97	2.94	26.46	29.70
T15	20% lime water for 10 minutes	5	0.51	2.70	13.50	29.25

G: Germination, **GVI:** Germination Velocity Index, **TSL:** Total Seedling Length

Table 5: Germination percent, germination velocity index (GVI), length of seedlings, biomass of seedlings of *Cleistanthus collinus* as affected by different pretreatments in 09 month old seeds.

SN	Pretreatment	% of G	GVI	Seedling length (cm)	Vigor	Biomass (mg)
T0	Control	14	1.38	3.47	48.58	33.50
T1	Cold water	36	2.67	5.08	182.88	39.49
T2	Hot water	46	3.39	5.70	262.20	42.10
T3	5% H_2SO_4 for 10 minute soaking	20	2.05	3.73	74.60	34.00
T4	10% H_2SO_4 for 10 minute soaking	28	2.42	3.90	109.20	36.19
T5	20% H_2SO_4 for 10 minute soaking	31	2.47	4.00	124.00	36.75
T6	40% H_2SO_4 for 10 minute soaking	38	2.94	5.22	198.36	40.00
T7	60% H_2SO_4 for 10 minute soaking	40	3.17	5.59	223.60	40.90

T8	200 ppm GA_3 for 10 minute soaking	42	3.24	5.48	230.16	40.34
T9	500 ppm GA_3 for 10 minute soaking	43	3.37	5.65	242.95	41.00
T10	200 ppm IBA for 10 minute soaking	36	2.85	4.77	171.72	39.80
T11	500 ppm IBA for 10 minute soaking	38	3.00	4.94	187.72	40.00
T12	1 % KNO_3 for 1 hour soaking	14	1.60	3.84	53.76	32.00
T13	5% lime water for 10 minutes	8	0.91	3.52	28.16	29.00
T14	10% lime water for 10 minutes	5	0.51	2.77	13.85	28.80
T15	20% lime water for 10 minutes	3	0.27	2.65	7.95	29.00

G: Germination, **GVI:** Germination Velocity Index, **TSL:** Total Seedling Length

Table 6: Germination percent, germination velocity index (GVI), length of seedlings, biomass of seedlings of *Cleistanthus collinus* as affected by different pretreatments in 12 month old seeds

SN	Pretreatment	% of G	GVI	Seedling length (cm)	Vigor	Biomass (mg)
T0	Control	10	0.98	3.39	33.90	33.10
T1	Cold water	28	2.37	4.82	134.96	39.19
T2	Hot water	41	3.30	5.50	225.50	41.85
T3	5% H_2SO_4 for 10 minute soaking	18	1.85	3.60	64.80	33.72
T4	10% H_2SO_4 for 10 minute soaking	20	2.10	3.74	74.80	36.10
T5	20% H_2SO_4 for 10 minute soaking	25	2.37	3.75	93.75	36.25
T6	40% H_2SO_4 for 10 minute soaking	30	2.47	5.09	152.70	39.80
T7	60% H_2SO_4 for 10 minute soaking	34	3.07	5.41	183.94	40.72
T8	200 ppm GA_3 for 10 minute soaking	36	3.15	5.39	194.04	40.12
T9	500 ppm GA_3 for 10 minute soaking	38	3.27	5.56	211.28	40.70
T10	200 ppm IBA for 10 minute soaking	30	2.70	4.59	137.70	39.70
T11	500 ppm IBA for 10 minute soaking	34	2.84	4.70	159.80	39.85
T12	1 % KNO_3 for 1 hour soaking	8	0.91	3.74	29.92	31.00
T13	5% lime water for 10 minutes	4	0.47	3.40	13.60	28.70
T14	10% lime water for 10 minutes	2	0.21	2.64	5.28	28.50
T15	20% lime water for 10 minutes	0	0	0	0.00	0

G: Germination, **GVI:** Germination Velocity Index, **TSL:** Total Seedling Length

Table 7: Germination percent, germination velocity index (GVI), length of seedlings, biomass of seedlings of *Cleistanthus collinus* as affected by different pretreatments in 15 month old seeds.

SN	Pretreatment	% of G	GVI	Seedling length (cm)	Vigor	Biomass (mg)
T0	Control	4	0.45	3.23	12.92	32.50
T1	Cold water	20	2.14	4.68	93.60	39.00
T2	Hot water	34	3.10	5.29	179.86	41.15
T3	5% H_2SO_4 for 10 minute soaking	11	1.10	3.53	38.83	33.12
T4	10% H_2SO_4 for 10 minute soaking	14	1.37	3.31	46.34	35.75
T5	20% H_2SO_4 for 10 minute soaking	19	1.87	3.37	64.03	35.90
T6	40% H_2SO_4 for 10 minute soaking	23	2.30	4.92	113.16	39.42
T7	60% H_2SO_4 for 10 minute soaking	26	2.43	5.31	138.06	39.90
T8	200 ppm GA_3 for 10 minute soaking	28	2.85	5.04	141.12	40.50
T9	500 ppm GA_3 for 10 minute soaking	30	2.64	5.46	163.80	40.55
T10	200 ppm IBA for 10 minute soaking	22	2.35	4.40	96.80	39.40
T11	500 ppm IBA for 10 minute soaking	26	2.40	4.55	118.30	39.55
T12	1 % KNO_3 for 1 hour soaking	4	0.47	3.51	14.04	30.82
T13	5% lime water for 10 minutes	2	0.21	2.87	5.74	28.25
T14	10% lime water for 10 minutes	0	0	0	0.00	0
T15	20% lime water for 10 minutes	0	0	0	0.00	0

G: Germination, **GVI:** Germination Velocity Index, **TSL:** Total Seedling Length

Table 8: Germination percent, germination velocity index (GVI), length of seedlings, biomass of seedlings of *Cleistanthus collinus* as affected by different pretreatments in 18 month old seeds.

SN	Pretreatment	% of G	GVI	Seedling length (cm)	Vigor	Biomass (mg)
T0	Control	0	0	0	0.00	0
T1	Cold water	14	1.37	4.25	59.50	38.00
T2	Hot water	27	2.84	5.10	137.70	41.00
T3	5% H_2SO_4 for 10 minute soaking	7	0.87	3.10	21.70	32.70
T4	10% H_2SO_4 for 10 minute soaking	9	1.05	3.21	28.89	34.50
T5	20% H_2SO_4 for 10 minute soaking	12	1.14	3.31	39.72	35.25
T6	40% H_2SO_4 for 10 minute soaking	18	1.85	4.75	85.50	37.75
T7	60% H_2SO_4 for 10 minute soaking	21	2.27	4.95	103.95	38.80
T8	200 ppm GA_3 for 10 minute soaking	22	2.25	4.30	94.60	39.40
T9	500 ppm GA_3 for 10 minute soaking	23	2.33	5.37	123.51	40.10
T10	200 ppm IBA for 10 minute soaking	20	2.17	4.15	83.00	39.25

T11	500 ppm IBA for 10 minute soaking	20	2.14	5.19	103.80	40.00
T12	1 % KNO_3 for 1 hour soaking	0	0	0	0.00	0
T13	5% lime water for 10 minutes	0	0	0	0.00	0
T14	10% lime water for 10 minutes	0	0	0	0.00	0
T15	20% lime water for 10 minutes	0	0	0	0.00	0

G: Germination, **GVI:** Germination Velocity Index, **TSL:** Total Seedling Length

Table 9: One way ANOVA for germination potential and seedling biomass of *Cleistanthus collinus* as affected by various pretreatments at every 3 months intervals under storage

Germination potential / Months			Sum of Squares	df	Mean Square	F	Sig.
GP/F	Germination	Between Groups	5459.250	15	363.950	19.857	.000
		Within Groups	586.500	32	18.328		
		Total	6045.750	47			
	TSL	Between Groups	31.931	15	2.129	23.467	.000
		Within Groups	2.903	32	.091		
		Total	34.834	47			
	Vigour	Between Groups	282089.604	15	18805.974	20.904	.000
		Within Groups	28788.169	32	899.630		
		Total	310877.773	47			
	Biomass	Between Groups	631.659	15	42.111	2.753	.008
		Within Groups	489.532	32	15.298		
		Total	1121.191	47			
GP/3	Germination	Between Groups	9773.813	15	651.588	54.018	.000
		Within Groups	386.000	32	12.063		
		Total	10159.813	47			
	TSL	Between Groups	43.855	15	2.924	18.937	.000
		Within Groups	4.940	32	.154		
		Total	48.795	47			
	Vigour	Between Groups	434448.354	15	28963.224	33.188	.000
		Within Groups	27926.849	32	872.714		
		Total	462375.203	47			
	Biomass	Between Groups	765.268	15	51.018	32.854	.000
		Within Groups	49.692	32	1.553		
		Total	814.960	47			
GP/6	Germination	Between Groups	10911.000	15	727.400	68.461	.000
		Within Groups	340.000	32	10.625		
		Total	11251.000	47			
	TSL	Between Groups	47.983	15	3.199	39.618	.000
		Within Groups	2.584	32	.081		
		Total	50.567	47			
	Vigour	Between Groups	434522.850	15	28968.190	38.302	.000
		Within Groups	24202.031	32	756.313		
		Total	458724.880	47			
	Biomass	Between Groups	936.569	15	62.438	235.654	.000
		Within Groups	8.479	32	.265		
		Total	945.047	47			
GP/9	Germination	Between Groups	9701.250	15	646.750	71.366	.000
		Within Groups	290.000	32	9.063		
		Total	9991.250	47			
	TSL	Between Groups	52.869	15	3.525	11.351	.000
		Within Groups	9.937	32	.311		
		Total	62.805	47			
	Vigour	Between Groups	363881.485	15	24258.766	21.024	.000
		Within Groups	36923.192	32	1153.850		
		Total	400804.677	47			
	Biomass	Between Groups	1026.265	15	68.418	51.618	.000
		Within Groups	42.415	32	1.325		
		Total	1068.680	47			
GP/12	Germination	Between Groups	8519.250	15	567.950	75.101	.000
		Within Groups	242.000	32	7.563		
		Total	8761.250	47			
	TSL	Between Groups	90.387	15	6.026	80.811	.000
		Within Groups	2.386	32	.075		
		Total	92.773	47			
	Vigour	Between Groups	271429.228	15	18095.282	38.834	.000
		Within Groups	14910.726	32	465.960		

		Total	286339.954	47			
	Biomass	Between Groups	4645.078	15	309.672	825.874	.000
		Within Groups	11.999	32	.375		
		Total	4657.076	47			
GP/15	Germination	Between Groups	5977.250	15	398.483	69.807	.000
		Within Groups	182.667	32	5.708		
		Total	6159.917	47			
	TSL	Between Groups	126.842	15	8.456	15.586	.000
		Within Groups	17.361	32	.543		
		Total	144.204	47			
	Vigour	Between Groups	170415.549	15	11361.037	52.985	.000
		Within Groups	6861.486	32	214.421		
		Total	177277.035	47			
	Biomass	Between Groups	7801.885	15	520.126	10.360	.000
		Within Groups	1606.579	32	50.206		
		Total	9408.465	47			
GP/18	Germination	Between Groups	4346.813	15	289.788	78.586	.000
		Within Groups	118.000	32	3.688		
		Total	4464.813	47			
	TSL	Between Groups	214.220	15	14.281	321.607	.000
		Within Groups	1.421	32	.044		
		Total	215.641	47			
	Vigour	Between Groups	111176.632	15	7411.775	43.492	.000
		Within Groups	5453.298	32	170.416		
		Total	116629.930	47			
	Biomass	Between Groups	15010.507	15	1000.700	1123.791	.000
		Within Groups	28.495	32	.890		
		Total	15039.002	47			

Conclusion

These results indicate that seeds of *Cliestanthus collinus* are simply associated with hard seed coat dormancy. This dormancy can easily be removed by hot water treatment. Hot water treatment was found to be the best pretreatment for enhancing germination potential in fresh and stored seed of *Cliestanthus collinus*.

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