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Seed Dormancy Breaking of Different Tea *Camellia sinensis & C. ammasica* Varieties and Clones

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Authors' contributions

This work was carried out in collaboration between all authors. Author AW designed and practically conducted the study. Author MS helped in data collection. Author FSH helped in designing and supervised the complete study. Author GH helped in literature searches. Author AN performed the statistical analysis. Author A. Sohail prepared the first draft of the manuscript. Authors KN, A. Seemab and BM practically involved in data collection and data setting. All authors read and approved the final manuscript.

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ABSTRACT

Different treatments influenced variably the rate of seed dormancy of tea verities. Among all treatments the T6 and T7 showed the best performance in breaking of seed dormancy which ultimately improves germination. Treatments can be utilized seed dormancy while Turkish variety showed best response against all the treatments for desire traits seed cracking sprouting.

Aims: Present research work on two varieties (*Qi men* and *Juking*), three clones (clone-105, clone-117 and clone-219) of *Camellia sinensis* and three varieties (Srilanka, Turkish and Indonasia) of *Camellia assamica* were evaluated for seed dormancy breaking through different treatments.

Treatments: Eight treatments (control, cold warm stratification, hot water treatment, sun drying, FYM paste and seed soaking.

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National Tea & High Value Crops Research Institute (NTHRI) Shinkiari Mansehra during 2016-17.
Experimental Design: Laid out in randomize complete block design (RCBD) with each having treatments.
Parameters: Observed different traits, pre-soaking seed weight, post soaking weight, number of seed cracked, mortality percentage, sprouted seeds, fresh weight of seed radical.
Results: Significant variations were observed in all the studied treatments and varieties. Seeds gained highest weight after soaking in cold stratification and sun drying treatment. Maximum seed cracking, seed sprouting were recorded in FYM paste treatment. However highest survival rate was found in opened water soaking treatment. Similarly highest fresh weight of radical was recorded during cold stratification treatment. While warm stratification caused death of all the embryos hence no traits were observed. Similarly under control conditions 0% cent seed cracking, seed sprouting were recorded in all the varieties. Among all the varieties Turkish variety showed best response while Qi men showed poorest response against all the treatments for desire traits seed cracking, seed sprouting.
Conclusion: Among the T6 and T7 showed breaking of seed dormancy significantly & ultimately improves germination. Results It can be applied to solve the problem of seed dormancy, seed cracking, sprouting and lower the mortality % age.

Keywords: Tea; C. sinensis; seed; dormancy; soaking; stratification; emergence.

1. INTRODUCTION

Tea *Camellia sinensis* L. isone of the oldest and widely-consumed beverage in the world originated in China's southwest region [1]. It belongs to genus *Camellia*, *Camelliaceae* family. It prefers tropical conditions having acidic soil (4.5- 6.5 pH) with > 50 inches rainfall/annum and average temperature of 12℃ - 38℃ [2]. Top six tea producing countries are China, India, Sri Lanka, Kenya, Indonesia and Turkey. The world tea production share of black and green tea is 97% and 3% [3]. Pakistan is the 3rd largest importer of tea in the world with an average per capita consumption is > 01 kg and increased @ 3.1% /year [3,4]. During 2016-17 Pakistan imports US$ 491 million of black tea with 63% share from Kenya and 30% from china for Green Tea [4].

It can be propagated either by sexual or asexual method, the 4-5 years mature tea plants produced viable seed [5]. Due to scarcity of clonal material, seedlings are stillourneed to achieve the goal [5]. Although, seed has the disadvantages e.g., heterogenous, different growth habit yield potential and losing its viability very quickly [6,7]. To get 100% germination it should be in the soil when become mature. However in local condition seeds mature during November and can be planted till January. [5]. But thisis not always be possible.

Failing of seeds to germinate under environ-mental conditions optimal for germination is called dormancy and true dormancy or innate dormancy is therefore caused by conditions within the seed that prevent germination [8]. Thus dormancy is a state of seed, not of the environment that reduces seed germination and breaking of dormancy could be one of the most important factors for early germination [9]. Keeping this in view present study an attempt has been made to break dormancy with objectives of break seed dormancy for early germination, increase survival rate during the nursery stage and shorten the nursery period for rapid germination.

2. MATERIALS AND METHODS

2.1 Location and Plant Material

Research study was conducted at National Tea & High Value Crops Research Institute (NTHRI), Shinkiari, Mansehra, during 2016-17. Seeds of 25 year's old tea species viz., *Camellia assamica* (Srilanka, Turkish, Indonasia) and *Camellia sinensis* (Qi men, Juekeng, Clone 105, Clone 117, Clone 219) were used. The collected material preserved in gene bank of NTHRI under control condition.

2.2 Experimental Plan

The experiment was laid out in randomize complete block design (RCBD) with replicates each having eight treatments.

2.3 Treatments

2.3.1 Factor-A: Treatments

T0: Control: Treatment in which nothing has been applied. Just seeds were picked and sown in the bags.
T1: Cold stratification: Tea seeds along-with moistened sand incubated at 2-6℃ for 8 h.
T2: Warm stratification: Seeds treated at 35℃ in incubator for 04 weeks.
T3: Hot water treatment: Seeds were soaked in warm water having temperature 50℃ for 30 m before sowing.
T4: Sun drying: Seed were placed on a dark black cloth open to sky for full sun dry for 12 hours/day.
T5: Water soaking (high shade tunnel) 752 tea Seeds (1.52 g /seed) soaked in 1400 ml water for 72 h.
T6: FYM Paste: Prepared FYM paste (3:1 liter H_2O + C_2H_6O) and kept seed moist compost paste for 36 h.
T7: Without shade soaking in water. Seeds put in water for direct sun light under plastic sheets for 48 hours.

2.3.2 Factor-B

Seeds of two tea species *Camellia sinensis* (Qi men, Juekeng, Clone-105, Clone-117, Clone-219) and *Camellia assamica* (Turkish, Srilanka, Indonasia) were used.

2.4 Filling of Polythene Tubes and Soil Sampling

Polythene tubes filled with soil (pH 5.5) and treated seeds sown at 2.5 cm depth during the month of November. Each treatment consisted of 100 bags placed in 3 time replicates.

2.5 Statistical Analysis

The collected data analyzed by using statistical software MSTATC. The mean values of the treatment combinations of each parameter were further compared by using least significant difference test (LSD) at 5% level of probability [10].

3. RESULTS AND DISCUSSION

3.1 Seed Dormancy

Can defined as a seed failing to germinate under environmental conditions optimal for germination, normally when the environment is at a suitable temperature with proper soil moisture. This true dormancy or innate dormancy is therefore caused by conditions within the seed that prevent germination. Thus dormancy is a state of seed, not of the environment. Induced dormancy, enforced dormancy or seed quiescence occurs when a seed fails to germinate because the external environmental conditions are inappropriate for germination, mostly in response to conditions being too dark or light, too cold or hot, or too dry [6]. The data recorded for different traits viz., pre and soaking weight of seed, seed cracked, survival rate, seed sprouted, leaves, fresh & dry weight of radical. Waheed et al. [8] tested the seed viability by Tetrazolium test for wild species and four cultivated varieties of rice before dormancy breaking treatments. They further spoked that seed kept in germination Chamber at 32℃ constant temperature with RH of 99% for 12 h in light. Till 14 days moistened practice for germination were continued, and emergence of radical was scored. Seed germination ≤ 25% noted as strongly dormant among the species while germination ≥ 50% as weakly dormant.

3.2 Pre Soaking Seed Weight

Data pertaining the weight of seed before soaking is given in Table 1. Maximum weight (19.66 g) of seed before soaking was recorded when seeds were treated with T4, followed by the seeds treated with T3 (19.573 g). While minimum weight of seed before soaking was observed in T1 (7.99 g). Different treatments of stratification, varieties and their interaction had significant effect on weight of seed before soaking. The difference in weight of seed before soaking for different varieties was also significant. Maximum weight of seed before soaking (18.57 g) was recorded in seeds of Srilankanvar:, followed by the seeds of Qi-men (15.70 g) while minimum weight of seed before soaking (13.03 g) was recorded in seeds of Indonesia var;. The interaction between treatments and varieties showed the maximum weight of seed before soaking (22.25 g) in case of Srilankan in T7 water soaking in high shade, while minimum weight (4.13 g) of seed before soaking was observed in Jue-king in T1 control. These results are not in agreement with [4,5,6,7], who reported that germination test temperatures above 27℃ are deleterious. Such type of study was also conducted by Hamid et al. 2017 on Coffee seed but it is not in agreement with the findings of the authors to [11].

Table 1. Weights of seed before soaking

Variety	T0	T1	T2	T3	T4	T5	T6	T7	Mean
Qi men	14.76M-O	10.227TU	21.167B-E	17.450IJK	18.333HI	14.500NOP	13.267PQR	15.900LMN	15.701B
Srilanka	20.35-F	12.200RS	21.400B-D	18.417HI	18.333GHI	20.350C-F	15.300MNO	22.250B	18.575A
Turkish	19.83E-H	5.700Z	9.350UV	21.383BCD	20.783B-E	7.367XY	7.633WXY	18.400GHI	13.806D
Indonasia	8.30 V-X	7.413XY	13.783OPQ	19.417FGH	24.200A	8.333VWX	9.400UV	13.403PQR	13.031E
Jueking	9.500UV	4.133 I	15.233MNO	16.333J-M	16.400JKL	7.633WXY	9.123UVW	20.107D-G	12.308F
Clone-105	12.467RS	6.600YZ	16.683JKL	19.367FGH	20.167DEF	13.400PQR	12.667QRS	17.767IJ	14.890C
Clone-117	11.667RS	7.530XY	20.350C-F	22.373B	20.450DEF	12.073RS	12.350RS	11.383ST	14.772C
Clone-219	7.600XY	10.180TU	20.217DEF	21.833BC	18.633HI	10.450TU	11.600ST	16.283K-N	14.600C
Mean	13.060C	7.998F	17.273B	19.572A	19.663A	11.763D	11.418E	16.937B	

Means not followed by the same letters differ significantly at 5% probability

Table 2. Increase in weight after soaking (g)

Variety	T0	T1	T2	T3	T4	T5	T6	T7	Mean
Qi men	12.544 H-Q	15.405 E-M	8.800 -U	5.597R-T	10.023 L-T	5.939 R-T	14.350 G-O	11.606 I-R	10.533DE
Srilanka	7.581 P-U	12.489 H-Q	11.136J-T	9.238N-U	11.634I-R	4.990TU	8.840 M-U	3.886U	8.724E
Turkish	6.311 Q-U	11.967 I-R	21.107B-F	6.172Q-U	12.021 I-R	20.872 B-F	18.349 C-H	5.691 R-U	12.811CD
Indonsia	26.881AB	22.260BCD	10.776K-T	10.392 L-T	8.696 O-U	19.149 C-G	17.642 D-I	11.805 I-R	15.950AB
Jueking	21.772BCD	30.021A	15.274 F-N	12.337H-Q	16.136 D-L	16.837D-K	21.554B-E	9.707 L L-U	17.955A
Clone-105	17.408 D-I	24.469ABC	10.821J-T	9.747 L-U	11.295 J-T	8.519O-U	16.984 D-K	10.677 K-T	13.740BC
Clone-117	14.354 F-O	21.894BCD	9.177N-U	5.062S-U	14.174 G-O	13.711 G-P	18.445C-H	17.406 D-J	14.278BC
Clone-219	25.844AB	14.658 F-O	11.153I-S	10.518 L-T	10.626 K-T	13.223 G-P	9.920L-U	7.446	12.924C
Mean	16.587AB	19.145A	12.281CD	8.633D	11.826CD	12.905BCD	15.761ABC	9.778D	

Means not followed by the same letters differ significantly at 5% probability

Table 3. Number of cracked seed

Variety	T0	T1	T2	T3	T4	T5	T6	T7	Mean
Qi men	0.000R	3.667 P-R	14.33 K-Q	0.0000 R	2.333QR	15.67J-P	30.00 E-I	21.33 H-L	10.92E
Srilanka	0.000R	4.667 P-R	36.67CDEF	0.0000 R	2.667QR	36.67CF	33.33 D-H	33.33D-H	18.42AB
Turkish	0.000R	18.33 I-O	23.67 G-K	0.0000 R	4.667 P-R	36.33CG	53.33 B	27.67E-J	20.50 A
Indonasia	0.000R	5.667O-R	7.333 M-R	0.0000 R	1.333 R	23.00 HK	30.67 D-I	36.33C-G	13.04CDE

Variety	T0	T1	T2	T3	T4	T5	T6	T7	Mean
Jueking	0.000R	19.67 I-M	14.67 K-Q	0.0000 R	3.000PQR	29.33 EI	14.67 K-Q	46.67 BC	16.00ABCD
Clone105	0.000R	0.667	9.000 L-R	0.0000 R	2.333QR	19.00I-N	76.67 A	27.00F-K	17.58 ABC
Clone117	0.000R	7.667MR	8.333 M-R	0.0000 R	2.000 QR	15.67J-P	37.67CDEF	43.33BCD	14.33BCDE
Clone219	0.00R	4.333 P-R	4.667 P-R	0.0000 R	2.000 QR	5.000 PR	40.33CDE	36.00C-G	11.54DE
Mean	0.000d	8.833c	14.83c	0.0000d	2.542d	22.58 B	39.58A	33.96A	

Means not followed by the same letters differ significantly at 5% probability

Table 4. Mortality percentage

Variety	T0	T1	T2	T3	T4	T5	T6	T7	Mean
Qi men	6.33 GH	6.667 FGH	6.667 FH	0.0000 I	8.333 AF	7.667 CH	6.333 GH	9.000 AD	6.375 B
Srilanka	8.000B-G	8.000 B-G	6.000 H	0.0000 I	8.000 BG	8.000 BG	7.333 DH	8.000 BG	6.667 AB
Turkish	7.000E-H	8.000 B-G	8.000 BG	0.0000 I	7.333 DH	6.667 FH	6.667 FH	8.000 BG	6.458 B
Indonasia	8.333 AF	9.000 A-D	8.000 BG	0.0000 I	8.333 AF	7.667 CH	8.667 AE	7.667 CH	7.208 A
Jueking	7.333DH	7.667 C-H	6.667 FH	0.0000 I	8.000 BG	8.333 AF	7.667 CH	8.333 AF	6.750 AB
Clone105	7.333DH	8.000 B-G	7.333 DH	0.0000 I	10.00 A	9.333 AC	7.333 DH	8.667 AE	7.250 A
Clone117	7.667CH	8.000 B-G	8.333 AF	0.0000 I	7.667 CH	8.000 BG	7.333 DH	8.333 AF	6.917 AB
Clone219	8.000 BG	7.333 DH	8.667 AE	0.0000 I	8.000 BG	9.667 AB	8.000 BG	8.333 AF	7.250 A
Mean	**7.500BC**	**7.833 A-C**	**7.458 BC**	**0.0000 D**	**8.208 AB**	**8.167 AC**	**7.417 C**	**8.292 A**	

Means not followed by the same letters differ significantly at 5% probability

Table 5. Fresh weights of seed radical

Variety	T0	T1	T2	T3	T4	T5	T6	T7	Mean
Qi men	0.000N	2.400A	2.000B	0.000N	1.467D-K	1.233I-M	1.200J-M	1.233I-M	1.192A
Srilanka	0.000N	1.533C-I	1.600CF	0.000N	1.167K-M	1.233I-M	1.100LM	1.300G-M	0.992CD
Turkish	0.000N	1.433E-K	1.367KM	0.000N	1.067LM	1.833BC	1.467D-K	1.100LM	1.033CD
Indonasia	0.000N	1.567C-H	1.067M	0.000N	1.167K-M	1.600C-G	1.433E-K	1.467D-K	1.038CD
Jueking	0.000N	1.267HM	1.600BC	0.000N	1.433E-K	1.600C-G	1.567C-H	1.500D-IJ	1.121AB
Clone105	0.000N	1.733B-E	1.467I-M	0.000N	1.767B-D	1.167KLM	1.333G-L	1.300G-M	1.096BC
Clone117	0.000N	1.433E-K	1.233LM	0.000N	1.100LM	1.333G-L	1.267H-M	1.367F-L	0.967D
Clone219	0.000N	1.567C-H	1.800B	0.000N	1.367F-L	1.433E-K	1.200J-M	1.167K-M	1.067ABC
Mean	0.000D	1.617A	1.517AB	0.000D	1.317C	1.429BC	1.321C	1.304C	

Means not followed by the same letters differ significantly at 5% probability

3.3 Post Soaking Seed Weight (g)

Table 2 revealed that maximum increase in weight (19.145 g) was recorded when seeds were treated with T1, followed by T6 (15.761 g). Minimum increase in weight was observed in T7 (9.77 g). Different treatments of stratification, varieties and their interaction had significant effect on increase in weight. Increasing trend among varieties were also significant this may be due to absorbents of water by tea seed Maximum increase in weight (17.95 g) was recorded in seeds of Juekeng, followed by the seeds of Indonasia (15.95 g). Minimum increase in weight (8.724 g) was recorded in seeds of Srilankan. The interaction between treatments and varieties showed that maximum weight (26.88) in case of Indonasia in T0 while minimum increase in weight (5.063) observed in Clone-117 ~~in~~ under T3. The results are more or less similar to [11], they reported that coffee seed gain its weight after post soaking during longitudinal axis cut.

3.4 Number of Seed Cracked

Data presented in Table 3 for Seed cracked. Different treatments of stratification, varieties and their interaction had significant effect on number of seed crackd. Maximum seed cracking (39.58) was recorded when treated with T6, followed by T7 (33.96) where control resultant nil. The difference of seed cracked for different varieties was also significant. Maximum seed cracked (20.50) by Turkish var; followed by Srilankan (18.52). Minimum Number of seeds cracked (10.92) of Qi men. The interaction between treatments and varieties showed the maximum number of Seed cracked (76.67) in case of clone 105 in T6, while all varieties produced its minimum cracking inT0 and T3 respectively. This is a clear evidence that treatment of seed before sowing for dormancy and viability check is necessary. However, tea seed coat is strong and very difficult to rupture if not treated well in time. Because normally it take a time of 6-7 months for germination [12].

3.5 Mortality Percentage of Seed

Different treatments of stratification, varieties and their interaction had significant effect on survival rate (Table 4). Maximum survival rate (8.29%) observed in T7, followed by T4 (8.20%) and 0% in T3. Maximum survival rate (7.250%) of Clone-105 and Clone-219, followed by Clone-117 (6.98%). Minimum survival rate (6.37%) was recorded in seeds of Qi-men. The interaction between treatments and varieties showed the maximum survival rate (10.00%) in case of clone 105 while treated with (T4), like previous results the minimum mortality rate (0.000%) was observed in all varieties in T3. Results are at Par with the results of [6]. Varieties Sri lanka and JueKing at par with each other statically in all the treatment whereas. Indonesia and Turkish are different among each other statically.

3.6 Fresh Weights of Seed Radical

Table 5 shows that different treatments of stratification, varieties and their interaction had significant effect on fresh weight of radical. Maximum fresh weight of radical (1.617) was recorded when seeds were treated with T1, followed by the seeds treated with T2 (1.517). Minimum fresh weight of radical was observed in T_0 and T3 (0.000) respectively. The difference in fresh weight of radical for different varieties has also been significant statically. Maximum fresh weight of radical (1.19) was noted in Qi men, followed by Juekeng (1.12). Minimum fresh weight (gm) (0.967) was recorded in Clone-117. The interaction between treatments and varieties showed the maximum fresh weight (gm) of radical (2.40) in case of Qi men T1, while minimum fresh weight (g) of radical observed in all varieties inT0 and T3 as usual. These results are contrary with the results of [12].

4. CONCLUSION

Different treatments influenced variably the rate of seed dormancy of tea verities. Out of them T6 Paste of “FYM with 3:1 liter H_2O + C_2H_6O” and “soaked in direct sun light” T7 showed the best performance in breaking of seed dormancy which not only enhance germination % age but also reduced the mortality during early nursery stage. These kinds of treatments can be utilized to solve the problem of seed dormancy. The Turkish variety showed best performance against all treatments and traits.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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