Uganda Journal of Agricultural Sciences
ISSN: 1026-0919 (Print); 2410-6909 (Online)
Volume 23 Number 1 (2025) pp. 1 - 9
DOI: http://dx.doi.org/10.4314/ujas.v23i1.1

Effect of dormancy breaking treatments on *Corchorus olitorius* L. accessions

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Abstract. *Corchorus olitorius* is an indigenous leafy vegetable, which is rich in nutrients and is used for food preparations in low-income households in Africa. However, its cultivation is deterred by delayed seed germination, due to its hard seed coat. The objective of this study was to assess the effect of different dormancy breaking methods on enhancing seed germination of *Corchorus olitorius* accessions. The experiment was conducted at the CSIR-Plant Genetic Resources Research Institute, Bunso in the Eastern region, Ghana. Seeds of six *Corchorus olitorius* accessions were subjected to four dormancy breaking treatments, which include no soaking, soaking in pure water for 24 hours; and soaking in hot water for 30, or 60 seconds at 90 ^{O}C. Parameters measured include seed vigour, germination percentage, plant height (cm), number of branches per plant, pod length (cm) and number of seeds per pod. Significant differences ($p<0.001$) were observed in seed vigour and germination percentage among the six *Corchorus olitorius* accessions subjected to all dormancy breaking treatments. The highest seed vigour was observed in accession GH10126 soaked in hot water for 30 seconds. The no soaking treatment of accessions GH10070, GH10126 and GH10441 had the lowest vigour. The highest germination percentage was observed in accession GH10308 soaked in hot water for 60 seconds. *Corchorus olitorious* seeds treated with hot water at 90 ^{O}C for 30 or 60 seconds, performed normally with regards to growth and yield when established under field conditions.

Key words: *Corchorus olitorius*, Germination, Seed vigour

Introduction

Corchorus olitorius L. is an annual erect herb in the Malvaceae family, sometimes referred to as bush okra or jute mallow (Youssef *et al.,* 2019). Although it originated in tropical Africa and Asia, it is now found all over the world. According to Odofin *et al.* (2011), it is a popular tropical green vegetable crop throughout Latin America, Africa, Asia, and some parts of the Middle East.

Its leaves and tender stems are rich in vitamins A and C, beta carotene, folic acid, iron, calcium, and several phenolic antioxidative compounds (Youssef *et al.,* 2019). Additionally, it is used for the production of fibres in textiles and their by-products are included in paints, cosmetics, medicine and other uses (FAO, 2021). Despite its numerous uses, it has been reported that poor and delayed seed germination due to dormancy, is one of the major challenges in its propagation (Kitis *et al.,* 2018).

Seed dormancy is the incapacity of a viable seed to germinate under favourable conditions (Finch-Savage and Leubner–Metzger, 2006). Seed dormancy in *C. olitorius* has been reported to be caused mainly by its hard seed coat (Schippers, 2000). Incubation at constant dry heat temperatures (40 ^{O}C, 50 ^{O}C, 60 ^{O}C, 70 ^{O}C, 80 ^{O}C, 90 ^{O}C) (Wahab, 2011,) seed scarification (Emongor *et al.,* 2004), and the use of selected chemicals substances such as dilute sulfuric acid (Palada and Chang, 2003) helps to break dormancy in *C. olitorius*.

Although efforts have been made to address the dormancy issues in Corchorus, farmers still face seed germination as a challenge to its cultivation. The objective of this study was to assess the effect of different dormancy breaking methods on enhancing seed germination of *Corchorus olitorius* accessions.

Materials and Methods

Study site

The study was conducted at the research field and Seed laboratory of the CSIR-Plant Genetic Resources Research Institute, Bunso in the Eastern region, Ghana. The site is located at latitude N 06^{o} 17.839, longitude W 000^{o} 27.595 and altitude 198.3 m above sea level. The soils of the site are classified as red clay loams of elevated ground to heavier alluvial soil (Bennett-Lartey and Ofori, 1999); while the annual mean rainfall is 1455 mm and temperatures range from 21.4 - 31.3 ^{o}C (Aboagye, 2005). *Corchorus olitorius* is common in the northern regions of Ghana.

Plant material

Seeds of six *C. olitorius* accessions with passport information (Table 1), were obtained from the same CSIR-Plant Genetic Resources Research Institute and cultivated to obtain seeds of good quality during the 2022 growing season. The six *Corchorus* accessions are landraces collected from Ghana and their characteristics are shown in Table 2.

Table 1. Passport data on *Corchorus olitorius* accessions

Accession number	Family	Scientific name	Common name	Country of origin	Locality	Latitude	Longitude
GH10070	Malvaceae	*Corchorus olitorius*	Ayoyo	Ghana	Bawku	11.0541^{o} N	0.2385^{o} W
GH10312	Malvaceae	*Corchorus olitorius*	Ayoyo	Ghana	Zangu	10.3788^{o} N	0.8624^{o} W
GH10080	Malvaceae	*Corchorus olitorius*	Ayoyo	Ghana	Bawku	11.0541^{o} N	0.2385^{o} W
GH10441	Malvaceae	*Corchorus olitorius*	Ayoyo	Ghana	Garu	10.7548^{o} N	0.1870^{o} W
GH10126	Malvaceae	*Corchorus olitorius*	Ayoyo	Ghana	Garu	10.7548^{o} N	0.1870^{o} W
GH10308	Malvaceae	*Corchorus olitorius*	Ayoyo	Ghana	Binduri	10.9721^{o} N	0.3066^{o} W

Table 2. Description of *Corchorus olitorius* accessions

Accession number	Pod length (cm)	Pod colour at maturity	Number of seed/pod	100-seed weight (g)	Leafiness	Seed colour
GH10070	6.21	Dark	173.9	0.157	Intermediate	Black
GH10312	4.27	Dark	155.0	0.081	Low	Black
GH10080	5.44	Dark	145.8	0.102	High	Black
GH10441	6.14	Dark	179.5	0.124	Intermediate	Black
GH10126	5.91	Dark	180.3	0.171	Intermediate	Black
GH10308	5.24	Dark	230.5	0.081	Low	Black

Treatments and design

This study was carried out in two parts, namely (a) seed vigour and germination; and (b) agronomic performance of the seed vigour tested seeds. In the laboratory, seeds of *C. olitorius* accessions were subjected to four dormancy breaking treatments, which included (i) no soaking, (ii) soaking in pure water for 24 hours, (iii) soaking in hot water (90 ^{O}C) for 30 seconds, and (iv) 60 seconds. The temperature of distilled water was 25 ^{O}C; while that of the hot water treatment was 90 ^{O}C. This was a 6 x 4 factorial experiment, arranged in a completely randomised design, with three replications.

The field part

Harvesting and processing of Corchorus seeds. Twenty dry pods for each of the six *Corchorus* accessions were harvested at physiological maturity and further processed. Seeds were dried to a moisture content of 7% before sampling. Seeds were cleaned by removing bad and infested seeds as well as inert materials to obtain high quality seeds. Seeds were sampled from the cleaned seed lot for viability test.

Seed vigour and germination test. Seed vigour and germination tests were conducted using seed boxes filled with sterilised topsoil. Fifty seeds per treatment for each accession, in three replicates were arranged in a completely randomised design. Germination count was taken at two days intervals from the first day of emergence until the final germination count at 14 days after sowing. The germination percentage was computed on the final count of germinated seeds using the formula (ISTA, 2007):

$$\text{Germination (\%)} = \frac{\text{Number of germinated seeds}}{\text{Total number of seeds sown}} \times 100$$

Seed vigour was expressed as the number of seeds germinated at first count. The number of normal seedlings germinated on the first count day, as specified in the germination test for each species, were counted. The number of normal seedlings gives an idea of the level of seed vigour in the sample (AOSA, 1983).

Seedling growth. Seedlings from the hot water treatments were transplanted at 3 weeks after germination on the field to assess the effect of the hot water treatment on the growth of the six *Corchorus* accessions in a randomised complete block design, in three replicates. Watering, insect pest control and weeding were administered following routine practices. Data collected during the growth and yield period included number of branches per plant, plant height, pod length and number of seeds per pod.

Data analyses

Data were analysed using the Statistical Package for Social Scientists (SPSS) Statistics 21 (IBM, Chicago, IL, USA). A Two-way ANOVA was used, and when the treatment means were significant, Tukey's HSD test was conducted to identify differences among treatment means.

Results

Seed vigour

Table 3 shows the effect of dormancy breaking on seed vigour of six Corchorus accessions. A significant interaction was observed between accession and dormancy treatments. The highest seed vigour was observed in accession GH10126, soaked in hot water for 30 seconds. The no soaking treatment of accessions (GH10070, GH10126 and GH10441) had the least vigour.

Table 3. Effect of different dormancy breaking treatment on seed vigour of six *Corchorus olitorius* accessions

Accession	Treatment	Seed vigour
GH10070	No soaking	0.0 (0.0)g
	Soaking in pure water (25ºC) for 24Hrs	1.3 (0.6)g
	Soaking in Hot water (90°C) for 30s	18.3 (0.6)cd
	Soaking in Hot water (90°C) for 60s	17.7 (2.5)cd
GH10312	No soaking	4.7 (0.6)g
	Soaking in pure water (25ºC) for 24Hrs	4.0 (1.7)g
	Soaking in Hot water (90°C) for 30s	18.0 (1.0)cd
	Soaking in Hot water (90°C) for 60s	21.7 (1.5)bc
GH10080	No soaking	10.3 (0.6)f
	Soaking in pure water (25ºC) for 24Hrs	11.3 (1.2)ef
	Soaking in Hot water (90°C) for 30s	15.0 (2.6)de
	Soaking in Hot water (90°C) for 60s	13.3 (3.1)ef
GH10441	No soaking	0.0 (0.0)g
	Soaking in pure water (25ºC) for 24Hrs	2.3 (0.6)g
	Soaking in Hot water (90°C) for 30s	23.0 (2.6)ab
	Soaking in Hot water (90°C) for 60s	23.7 (0.6)ab
GH10126	No soaking	0.0 (0.0)g
	Soaking in pure water (25ºC) for 24Hrs	1.0 (0.0)g
	Soaking in Hot water (90°C) for 30s	26.3 (1.5)a
	Soaking in Hot water (90°C) for 60s	25.0 (2.0)ab
GH10308	No soaking	1.0 (0.0)g
	Soaking in pure water (25ºC) for 24Hrs	1.0 (0.0)g
	Soaking in Hot water (90°C) for 30s	25.3 (4.2)ab
	Soaking in Hot water (90°C) for 60s	24.7 (0.6)ab
ANOVA	Accession	n.s.
	Treatment	***
	A x T	***

Seed germination

Data for the effect of the dormancy breaking treatment on seed germination of six Corchorus accessions are presented in Table 4. Significant interaction was observed with the highest germination percentage observed in accession GH10308 soaked in hot water for 60 seconds. The no soaking treatment of accessions (GH10070, GH10126 and GH10441) had no germination while accessions GH10308, GH10312, and GH10080 had little to moderate germination.

Table 4. Effect of different dormancy breaking treatment on germination percentage of six *Corchorus olitorius* accessions

Accession	Treatment	Germination (%)
GH10070	No soaking	0.00 (0.00)f
	Soaking in pure water (25ºC) for 24Hrs	4.67 (1.15)ef
	Soaking in Hot water (90°C) for 30s	46.67 (3.06)c
	Soaking in Hot water (90°C) for 60s	52.67 (3.06)abc
GH10312	No soaking	9.33 (1.15)ef
	Soaking in pure water (25ºC) for 24Hrs	12.67 (3.06)e
	Soaking in Hot water (90°C) for 30s	46.67 (6.43)c
	Soaking in Hot water (90°C) for 60s	47.33 (2.31)c
GH10080	No soaking	21.33 (2.31)d
	Soaking in pure water (25ºC) for 24Hrs	23.33 (3.06)d
	Soaking in Hot water (90°C) for 30s	30.00 (5.29)d
	Soaking in Hot water (90°C) for 60s	26.67 (6.11)d
GH10441	No soaking	0.00 (0.00)f
	Soaking in pure water (25ºC) for 24Hrs	6.67 (1.15)ef
	Soaking in Hot water (90°C) for 30s	49.33 (6.11)bc
	Soaking in Hot water (90°C) for 60s	54.00 (3.46)abc
GH10126	No soaking	0.00 (0.00)f
	Soaking in pure water (25ºC) for 24Hrs	2.00 (0.00)f
	Soaking in Hot water (90°C) for 30s	58.00 (2.00)ab
	Soaking in Hot water (90°C) for 60s	53.33 (4.16)abc
GH10308	No soaking	2.67 (1.15)f
	Soaking in pure water (25ºC) for 24Hrs	4.00 (0.00)ef
	Soaking in Hot water (90°C) for 30s	58.00 (7.21)ab
	Soaking in Hot water (90°C) for 60s	60.00 (2.00)a
ANOVA	Accession	**
	Treatment	***
	A x T	***

Table 5. Effect of hot water seed treatment on growth and yield parameters of six *Corchorus olitorius* accessions

Accession	Treatment	Number of branches/plant	Plant height (cm)	Pod length (cm)	Number of seeds per pod
GH 10070	30sec	17.5 (1.0)	85.06 (8.77)	5.30 (0.78)	148.6 (0.8)
	60sec	18.9 (2.0)	92.66 (8.00)	5.20 (0.39)	154.5 (7.7)
GH10126	30sec	17.2 (1.4)	97.68 (8.15)	5.59 (1.05)	161.1 (14.1)
	60sec	16.1 (0.8)	90.91 (2.21)	5.35 (0.14)	151.5 (2.5)
GH10312	30sec	16.3 (2.4)	89.12 (2.13)	4.82 (0.08)	136.3 (9.4)
	60sec	17.6 (3.0)	87.69 (6.90)	4.76 (0.40)	136.1 (6.6)
GH10080	30sec	17.7 (0.9)	59.27 (7.61)	5.19 (0.26)	162.5 (11.2)
	60sec	17.6 (0.4)	56.64 (5.70)	5.11 (0.30)	155.9 (10.9)
GH10441	30sec	16.5 (0.9)	86.84 (3.25)	5.79 (0.59)	146.9 (6.1)
	60sec	17.4 (0.7)	93.07 (5.78)	5.83 (0.11)	148.5 (16.0)
GH10308	30sec	17.0 (0.7)	86.76 (3.79)	4.97 (0.30)	141.0 (4.3)
	60sec	18.0 (1.4)	89.13 (4.48)	4.45 (0.31)	133.1 (4.9)
ANOVA	Accession (A)	n.s.	***	**	**
	Treatment (T)	n.s.	n.s.	n.s.	n.s.
	A x T	n.s.	n.s.	n.s.	n.s.

Each value is the mean of three replicates and the standard deviation is shown in parentheses. Two-way ANOVA: n.s.= not significant, **p<0.01, *** p<0.001. When significant interaction between Accession (A) and Treatment (T) was detected, Tukey's HSD test was performed to identify significant differences among the 2 treatments. Values with different letters are significantly different at p<0.05

Growth and yield

Table 5 depicts the effect of hot water treatment on growth and yield parameters of six *Corchorus olitorius* accessions. There was no significant interaction between accession and treatment. Among the six *Corchorus olitorius* accessions treated with hot water for 30 or 60 seconds, no significant differences were observed in in the number of branches per plant, plant height, pod length, or number of seeds per pod. On the other hand, plant height, pod length, and quantity of seeds per pod varied significantly among accessions.

Discussion

Seed vigour

Seeds treated with hot water at 90 °C for 30 or 60 seconds were more vigorous comparable with and without soaking in water treatments (Table 3). However, the soaking and no soaking in pure water treatments had no or few vigorous seedlings. This may be attributed to the hard seed coat of the accessions, which affected the imbibition of water. The vigour of a seed is a very important activity, which is used to assess plant population establishment (Finch-Savage *et al*., 2016).

Seed vigour is the combined characteristics of a seed lot that influence its activity and performance during germination and seedling emergence, especially under diverse environmental conditions (ISTA, 2015). Seeds which are less vigorous are less likely to survive in stressed environment. According to Abukutsa-Onyango *et al.* (2005), seed dormancy in jute mallow is usually as a result of hard seed coat, which prevents water from entering the seed.

Seed germination

Seeds of most of the accessions, which were not treated had no germination (Table 4). This could be as result of the hard seed coat. Although the seeds were adequately watered during the experiment, no germination was observed in the no soaking treatment of most of the accessions used in the study. This indicates that for Corchorus seeds to be vigorous, those accessions which have hard seed coats must be treated with hot water for either 30 or 60 seconds. Similarly, Larnyo and Atitsogbui (2020) also found a significantly higher germination rate when *C. olitorius* seeds treated with hot water at 70^{O} C; compared to the other treatments. Weimer *et al.* (2022) also found that steeping of *C. olitorius* seeds in hot water and concentrated sulphuric acid (98%) for 10 seconds and 5 or 10 minutes, respectively; significantly ($p<0.05$) improved germinability by 50% compared to 3% in the control. Masarirambi *et al.* (2016) reported that soaking of Corchorus seeds in boiling water for 10 s was the most effective for enhancing the germination of Corchorus seeds. Palada and Chang (2003) observed higher seed germination and seedling emergence when jute mallow seeds were steeped in boiled water.

Growth and yield

Regardless of the treatment, hot water (90 ^{O}C) treated seedlings established more in the field than in the no soaking and pure water treatments which had poor germination (Table 5). However, the accessions used in the study differed significantly in plant height, pod length, and number of seeds per pod in response to the different treatments administered. This indicates that treating *C. olitorius* seeds with hot water is necessary for optimum seedling growth. Similarly, McDonnell *et al.* (2012) stated that dipping seeds in hot water at different temperatures, affected seed germination as hot water seed treatment at 70-80 ^{O}C showed better growth compared to hot water seed treatment with >80 ^{O}C. Missanjo *et al.* (2014) also found hot water treatment to be one of the best pre-treatment seed methods for the increased growth of *Acacia polyacantha* seedlings. Tania *et al.* (2019), in their studies observed that bitter gourd soaked in hot water at 45 ^{O}C for 5 minutes expedited seedling growth and eventually increase the yield of fruit. Therefore, it appears imperative that treatment of *C. olitorius* seeds with hot water is necessary to obtain optimum seedling growth. This observation, however still requires field verification on a more wider scale, particularly under farmer conditions.

Conclusion

Soaking *Corchorus olitorius* seeds with hot water at 90 ^{O}C for 30 seconds and 60 seconds, considerably broke dormancy and thus promoted seed germination under field conditions. Seed vigour also responded alike. The treated seeds also had improved growth and yield parameters.

Acknowledgement

The CSIR-PGRRI (Plant Genetic Resources Research Institute), Eastern region-Ghana, provided facilities and plant material for this study. Many thanks to Mr. Benjamin Kwakye Adu and seed genebank staff of the CSIR-PGRRI for their assistance during the research.

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