JOURNAL OF ENGINEERING AND EARTH SCIENCES

JEES ISSN: 1897-8680
JEES 2023
VOLUME 16 ISSUE NO 1
PAGE 74 - 84

EVALUATION OF DIFFERENT PRIMING TREATMENTS ON MEAN GERMINATION TIME (MGT), CROP AND POD GROWTH RATE AND PERFORMANCE OF 'ONIYAYA' AND 'AMUGBADU' VARIETIES OF JUTE MALLOW

*,[1]Oyewusi, I. K., [2]Kayode, A. P., & [3]Ezeke, F. C.
[1,2]Department of Agricultural Technology, Federal Polytechnic, Ado Ekiti
[3]Department of Horticultural Technology, Federal Polytechnic, Ado Ekiti
Corresponding author: kayoyewusi@gmail.com

ABSTRACT

The successful cultivation of jute mallow is often hindered by low germination rate, poor seedling establishment, and slow growth. The experiment was conducted at the Teaching and Research Farm of the Department of Agricultural Technology of the Federal Polytechnic, Ado-Ekiti in June 2022. Thirty (30) Plastic buckets of 7-litre capacity were perforated at the bottom and filled with topsoil. The experiment was a 2 × 5 factorial combination of two cultivars of Jute mallow namely 'Oniyaya' and 'Amugbadu' and five priming treatment applications. All treatments were arranged in a Randomized complete block design (RCBD) with three replications. The germination percentage and mean germination time were also measured while the Crop Growth Rate (CGR) and Pod Growth Rate (PGR) were calculated throughout the entire crop duration to estimate the Partitioning coefficient (P_R). The result of the study revealed that a significantly higher number of seeds germinated under hydro priming over other treatments. Percentage germination was (85 %) and (79 %) for Oniyaya and Amugbadu varieties of jute mallow respectively while the mean germination time was (5 days at 120 MGT) under hydro priming. Hydro priming gave the highest value for fresh shoot biomass for Oniyaya (29.9 cm) over Amugbadu (26.56 cm). Similarly, days to first flowering were significantly shorter under hydro priming for Oniyaya (26 days) over Amugbadu (29 days). Under the hydro priming method, fresh leaf weight was significantly better when compared with all the treatments imposed while Oniyaya gave the highest yield (4.03 kg/ha) over Amugbadu (3.62 kg/ha). Hydro priming was found to be the most effective priming treatment, whereas the control showed little or no effect. The findings suggest that hydro priming is an effective seed enhancement technique that can improve the germination rate and overall performance of jute mallow crops. Farmers and seed producers should adopt these techniques to optimize cultivation and improve the overall yield and quality of jute mallow crops.

KEYWORDS: Mean Germination Time; Priming Treatments; Crop and Pod Growth Rate; Jute mallow varieties

INTRODUCTION

Jute mallow also known as Jew or jute mallow or bush okra is an annual crop popularly known in Southern Nigeria as "Ewedu" and Northern Nigeria as "Ayoyo". It plays a significant role in household nutrition and, therefore, is affordable. It is used to prepare sauce and soup delicacies and when cooked, facilitates swallowing of solid foods. Seed priming is a process of controlling the hydration level within the seeds so that the metabolic activities necessary for germination can occur while radical emergence is prevented. Different physiological activities within the seed occur at different moisture levels (Adelani, 2015; Binang et al., 2012). Seed priming is one of the techniques used to obtain higher yield that might improve seed performance under stress conditions which may prevent seed from germination (Adelani, et al., (2018a).

Seed treatments can enhance germination and establishment in many field crops such as maize, rice, and jute mallow seeds. The process increases the speed and uniformity of germination due to the ability of seeds to imbibe water for growth and development (Adelani, 2015; Binang et al., 2012). Priming has been commercially used to eliminate seed-borne fungi and bacteria, induce synchronized germination, and increase the vigour and growth of seedlings under stressed conditions for increased germination and emergence rate (Adelani et al., 2018b). The method is simple and inexpensive and it does not have special technical complexity (Adebisi et al., 2012; Pandey et al., 2019). The process helps to increase or alleviate phytochrome, induces dormancy in plants; enhances plants' water usage, decreases the time necessary for germination and emergence of seed to occur, and improves stand uniformity aiding in production management. (Binang et al., 2012). The hard seed resists water inhibition, uniform growth, and development of the embryo and as a result interferes with seed germination and water absorption (Kolodzielek et al., 2017).

Dormancy causes serious problems to successful seed germination and seedling establishment in jute mallow and different priming methods have been employed to ameliorate the trend in addition to dry heat treatment to alleviate the problem (Denton et al., 2013). However, the hard seed coat of jute mallow seeds causes physical dormancy hence, its delay in seed germination (Tareq et al., 2015). Attempts at breaking seed dormancy in jute mallow include the use of heat under constant temperatures (Denton, 2013), seed scarification (Emongor et al., 2004), and the use of chemicals such as sulphuric acid. Pandey et al., (2019) reported that when jute mallow seeds are primed in boiled water, seed germination and seedling emergence are enhanced. These studies produced germination percentages between 40 % - 80 %. Mechanical scarification usually makes the surface of seeds permeable to water but reduces seedling vigor. it reduces seedling vigor while the size of the seed makes it difficult to carry out mechanical scarification on jute mallow seeds (Pandey et al., 2019). Some of these treatments involve chemicals that do not only overburden small-scale farmers with high production costs but these chemicals are not easily accessible. It is important to exploit feasible and effective methods that can be used by small-scale farmers as well as commercial farmers to enhance germination and seedling vigor.

Several priming treatments will be examined in this study which may be easier than earlier attempts that are more difficult to apply especially by small-scale farmers. Wrong priming treatments of jute mallow seeds may cause unnecessary delays in anthesis. In addition, it may affect crop and pod growth rate, and dry matter yield which is directly linked to physiological processes such as photosynthesis, translocation, and partitioning (Agele et al., 2017; Oyewusi et al., 2020; Sarfraz et al., 2019). Poor priming treatments may also block certain physiological processes which may shut down photosynthesis, carbon assimilation, and normal plant metabolism (Kulac et al., 2012).

MATERIALS AND METHOD

Site Description

The experiment was conducted in the Teaching and Research Farm of the Department of Agricultural Technology of the Federal Polytechnic, Ado-Ekiti in June 2022. The experiment was carried out to examine the effect of Different Priming Treatments on Mean

Germination Time (MGT), Crop and Pod Growth Rate, and Performance of two varieties of Jute mallow. The study area experiences rainfall and sunshine with an annual rainfall of about 2000 mm-3000 mm and a temperature of between 25 to 30 degrees centigrade. This encourages fast growth of crops and other vegetables which cannot tolerate frost conditions.

Experimental location

The project was carried out in two phases; the first location was at the crop production laboratory while the second location was carried out at the Teaching and Research Farm of the Agricultural Technology of the Federal Polytechnic Ado-Ekiti.

Experimental design and treatments

Thirty (30) Plastic buckets of 7-litre capacity were perforated at the bottom and filled with topsoil. The experiment was a 2 x 5 factorial combination of two cultivars of Jute mallow namely 'Oniyaya' and 'Amugbadu' and five priming treatment applications which were;

i. Thermo-priming (40g of Jute mallow seeds were steeped in hot water treatment at 80^0c for 5 seconds and immediately spread out on absorbent paper to cool down in dry ambient conditions.
ii. Halo priming (40g of Jute mallow seeds were steeped in 10g Nacl; 20g and mixed in 30Cl of water for 12 hours)
iii. Chemo-priming (40g of Jute mallow seeds were steeped in 30Cl of 20g liquid urea for 12 hours)
iv. Hydro-priming (40g of Jute mallow seeds were steeped in 30Cl of fresh water for 12 hours)
v. Unprimed seeds or No priming (NP). (This served as the control).

All treatments were arranged in a Randomized complete block design (RCBD) with three replications making a total of 30 treatments.

Estimation of MGT and percentage germination

Germination counts at the laboratory were taken every three days and the final cumulative figure was expressed as a percentage of the total seed germinated. Germination of seeds (protrusion of radicle by 2 mm) was calculated to determine the MGT for each treatment as described by Oboho and Igharo (2017). The mean germination time was determined

The result obtained from the laboratory was used on the field for 40 days to determine the crop and pod growth effect and assess the performance of the two varieties of jute mallow in the study area. The germination percentage (GP) was calculated using Eq. 2.

$$\text{GP} = \frac{\text{No of seeds germinated}}{\text{No of the seeds tested}} \times 100 \qquad (1)$$

The numbers of seedling emergence were recorded daily, starting from the third day after sowing until 14 days after sowing. The seedling was scored as emerged when the cotyledons broke through the surface and the percentage of seedling emergence was calculated by dividing the total number of seedlings that emerged by the number of seeds sown and multiplied by a hundred.

Determination of soil physical and chemical properties

Soil samples were randomly taken at 0 - 30cm depth using a soil auger before land preparation and analyzed for physical and chemical properties in the laboratory in the Agronomy Department of the Federal University of Technology, Akure, Ondo State using Standard procedure as described by Black (1965).

Determination of crop growth rate

Crop Growth Rate (*CGR*), was calculated throughout the entire crop duration. The CGR was calculated as CGR =T/DH

Where T is the Total Biomass

DH is the number of days to maturity. The pod growth rate (PGR) was estimated as PGR=Y/RD

Where Y is the pod or fruit yield

RD is reproductive duration. The Partitioning coefficient (PR) was estimated as the ratio of pod growth rate to crop growth rate (Agele et al., 2017; Oyewusi et al., 2020).

Determination of percentage soil moisture content

The percentage moisture content of each soil sample was determined as follows:

Each pot was weighed and the weight differences (kg) were converted to volume (ml). The values obtained for each pot represented the volume of water applied to that particular pot at that period. The average volume of water used rate was determined for each jute mallow variety.

Determination of leaf area

Measurement of leaf length and width for five (5) leaves selected from the five plants of the two tested varieties were averaged to one value. Leaf area was calculated according to O'Neal et al., (2002).

$$LA = 0.919 + 0.682LW \quad (4)$$

Where

LA = leaf area,

L = leaf length, and

W = leaf width.

The values for each of the five plants selected from the two jute mallow varieties were averaged to get a single value for each plot. Then the average value for each plot in each replication for both varieties was calculated.

Data collection and analysis

Parameters taken included Measurement of plant height (cm), Number of leaves and branches, Stem girth (g), Fresh root weight (g) Leaf Area (cm^2), Days to first flowering, Number of seeds per plant, Shoot biomass (g) and fresh leaf weight (kg/ha). The germination percentage and mean germination time were also measured while the Crop Growth Rate (CGR) and Pod Growth Rate (PGR) were calculated throughout the entire crop duration to estimate the Partitioning coefficient (P_R). The data obtained were subjected to analysis of variance and the differences between the treatments were estimated by the use of the Duncan Multiple Range Test with the aid of Gestate Discovery Software (L.A.T., 2015). Mean, standard deviation, and standard error were also employed to determine the level of accuracy and deviation from the mean.

RESULTS AND DISCUSSION

Table 1 shows the result of soil chemical properties before the experiment. The pH of the soil was 4.16 which is acidic. The organic matter contents analyzed was 1.35%. Nitrogen content was low 0.10 g/kg. The available P content in the soil was low 4.16 mg/kg, K was also low (0.14 cmol/kg), Na (0.22 cmol/kg), Ca (1.80 cmol/kg), and Mg (0.70 cmol/kg). The result showed that the soil was sandy loam in texture with a high proportion of sand (56.80%). This implies that basic cations such as Ca, K, Na, and Mg would be leached more easily as texture determines the degree of retention or ease of leaching of basic cations (Wapa & Oyetayo, 2014).

Effect of different priming methods on mean germination time (GMT) and germination percentage (GP) of two varieties of Jute mallow

The result in Table 2 shows that a significantly higher number of seeds germinated under hydro priming over other treatments. Percentage germination was (85%) and (79%) for Oniyaya and Amugbadu varieties of jute respectively while the mean germination time was (5 days at 120 MGT). This shows that it took shorter days for both varieties under hydro priming to germinate when compared with other treatments. This is closely followed by thermo priming with hot water treatment for both varieties. The result recorded a germination percentage of (6 days or 144 MGT) for jute mallow seeds to germinate under hot water treatment for both varieties. This was closely followed by chemo priming (7 days at 168 MGT) while halo priming (priming in sodium chloride) took longer days to germinate (9 days at 216 hours). There was no germination for the control in the laboratory experiment under study.

Effect of different priming methods on growth and growth characters of two varieties of Jute mallow at harvest

The result of the effect of different priming methods on the growth development of two varieties of jute mallow at harvest is presented in Table 3. The result shows that hydro priming is significantly better among all the treatments imposed. Significantly higher values were recorded for hydro priming jute mallow varieties for plant height, number of leaves and branches, and leaf area over other treatments. There was however no significant difference in the stem girth for all the treatments. Plant height was highest under hydro priming for Oniyaya (101.6cm) over Amugbadu (97.0cm), number of leaves (149.6), (140.5), number of branches (20.5) (17.9), and leaf area (55.91cm^2) and (52.13cm^2) respectively. This was closely followed by chemo priming (liquid urea treatment). The result shows that Oniyaya performed significantly better than Amugbadu. The lowest value was however recorded for the control or no priming (NP).

Effect of different priming methods on yield and yield characters of two varieties of Jute mallow at harvest

The result in Table 4 shows that Oniyaya responded better to different priming methods over Amugbadu while hydro priming was significantly better than all other treatments imposed for yield and yield characters of jute mallow. Hydro priming gave the highest value for fresh shoot biomass for Oniyaya (29.9cm) over Amugbadu (26.56cm). Similarly, days to first flowering were significantly shorter under hydro priming for Oniyaya (26 days) over Amugbadu which took longer days to attain first flowering (29 days). Similarly, the number of seeds per plant was significantly higher for Oniyaya over Amugbadu (18.00) and (16.98) respectively. Under the hydro-priming method, fresh leaf weight was significantly better when compared with all the treatments imposed while Oniyaya gave the highest yield (4.03kg/ha) over Amugbadu (3.62kg/ha). This was closely followed by treatment with liquid urea fertilizer or chemo priming (CP). The lowest value was however recorded for control.

Effect of different priming methods on Crop Growth Rate (CGR) of two varieties of Jute mallow at harvest

The result in Table 5 shows that it took longer days for Oniyaya to attain maturity under the control or no priming treatment (55 days) while the shortest days to maturity were obtained under hydro priming for Oniyaya (42 days). There was no significant difference in the CGR and the PGR among all the tested jute mallow varieties based on the various treatments imposed. However, the partitioning coefficient was significantly higher for Oniyaya (1.50) under hydro priming over other treatments.

The seed quality tests revealed that hydro-priming is effective in inducing early germination and this enhanced the crop and pod growth rate of the tested jute mallow varieties thereby improving the leaf yield of jute mallow. A good priming technique will promote plant vigor which is characterized as the total properties that determine the activity and acceptable germination performance of the seed (Nyadanu et al., 2017). Germination rate is a necessary parameter in crop establishment on the field. The effect of treatments on the seed varied significantly, seeds primed into cold water in this study, were the only treatment that started germination from the fourth day of germination count. This is consistent with other findings that hydro-priming treatments enhanced early germination (Binang et al., 2012). Seed dormancy in jute mallow is physical dormancy and is usually a result of hard seed covering which prevents water from entering the seed **(**Emongor et al., 2004; Pandey et al., 2019). The cold water treatment in this study thus scarified the seed coat and caused water imbibition hence facilitating germination and emergence. Water in this study also provided a good medium for enzymes to catalyze the breakdown of seed coat and this allowed imbibition and gaseous exchange thereby enhancing germination and emergence. The effectiveness of hydro priming treatment to overcome seed dormancy as recorded here, agrees with that reported by Rahimi (2013) for *C syminum* under temperatures and water stress. According to Nkomo and Kambizi (2009) and Pandey et al., (2019**)**, pre-chilling treatment may stimulate the germination of *C. cunninghamiiin* seed. The poorer longevity of 'Amugbadu' seeds that were subjected to gradual cooling in ambient conditions following hot water-priming compared with those that were primed in cold water immediately, indicated that hot water priming at 80°C must have resulted in embryo damage. Similar results may have occurred with treatment with sodium chloride and chemotreatment. The poor germination of ''Amugbadu' seeds primed in hot water at 80°C compared with the values obtained for the untreated seeds damaged the seed embryo even when the treatment did not result in considerable dormancy alleviation. In this study, there was no significant difference in the CGR and the PGR among all the tested jute mallow varieties based on the various treatments imposed. However, the Partitioning coefficient was significantly higher for Oniyaya under hydro priming over other treatments. This agrees with the works of Ghiyasi et al., (2008) and Pandey et al., (2019) who opined that poor methods of seed priming reduce leaf production, alter seed setting efficiency, and promote senescence and abscission resulting in decreased total leaf area per plant and seed reduction (Agele et al., 2017; Oyewusi et al., 2020). Reduction in leaf relative water content reduces crop growth and thus biomass production **(**Aguyoh et al., 2013). Seed production which is positively correlated with leaf area may also be reduced by leaf area reductions induced by poor priming techniques (Agele & Olabomi, 2010) Dry matter partitioned into harvestable organs contributed to the yield of crops. In addition, efficient priming techniques enhanced dry matter partitioning in crops.

CONCLUSIONS AND RECOMMENDATIONS

The seed quality tests revealed that hydro priming is effective inducing early germination and this enhanced crop and pod growth rate of the tested jute mallow varieties thereby improving leaf yield of jute mallow. Hydro priming technique promoted seedling germination, emergence, and vigor which is characterized as the total properties that determine the activity and acceptable germination performance of seed. In addition, the Partitioning coefficient was significantly higher for Oniyaya under hydro priming with the highest germination percentage and mean germination time over other treatments. Farmers and seed producers should adopt these techniques to optimize cultivation and improve the overall yield and quality of jute mallow crops.

The study was limited to the Ado-Ekiti environment in the early rainy season. In addition, the study only focused on the two commonly grown jute mallow varieties in Ado-Ekiti. In addition, the study was conducted under controlled conditions, which may not accurately reflect the field conditions. The seed samples used in the study were obtained from a single source, which may not be representative of the entire population of jute mallow seeds available in the market. Further study is, therefore, necessary to examine the effect of priming at higher or lower concentrations while planting may be subjected to field conditions in the late rainy season to compare the seasonal effect on jute mallow under different treatments.

ACKNOWLEDGEMENTS

We appreciate the immense effort and contribution of the following individuals towards the success of this research; Dr. M.O. Akinola, Deputy Rector Administration, The Federal Polytechnic, Ado-Ekiti, and former Dean of School of Agriculture and Agricultural Technology (SAAT). Mr. Olowo, O.V, Director, Agric. In Schools, (AIS), Ministry of Agriculture, Ado-Ekiti for going through the manuscript. We appreciate the International Institute of Tropical Agriculture (IITA) for making the planting material available to us at the time it was needed. We acknowledge Dr. Ibitoye. A.O, of The Federal University of Technology, (FUTA), Akure, Ondo State, Nigeria for painstakingly carrying out the nutrient analysis. We also appreciate the contributions of Professor Agele, S.O, and Dr. Dele Famuwagun of FUTA, for their advice and guidance to make this work worthy of publication. We appreciate the editor of the Journal of Engineering and Earth Science for their timeliness and good quality work on paper review and publication. We appreciate the Dean of, the School of Agriculture and Agricultural Technology (SAAT), Dr. T. O. Daramola for her encouragement and words of advice to ensure success and progress in the staff performance. We appreciate our Rector, Dr. T. J. Alake for providing an enabling environment for study.

REFERENCES

Aboutalebian, M. A, Mohagheghi A, Niaz, S. A., Rouhi, H. R. (2012). Influence of hydro priming on seed germination behavior of canola cultivars as affected by saline and drought stresses. *Annals of Biological Research,3*(11),5216 - 5222.

Adelani, D. O. (2015). Effect of hydro-priming and potassium nitrate priming on the germination of *Balanites aegyptiaca* L. *Applied Tropical Agriculture,* 20(2), 17 - 23.

Adebisi, M. A., Abdul-Rafiu, A. M., Abdul, R. S., Daniel, I. O., Tairu, F. M. (2012). Seed longevity and vigour of watermelon (*Citrillus lanatus* Thumb Mansf.) seeds stored under ambient humid tropical conditions. *Nigerian Journal of Horticultural Science,17,* 169 - 176.

Adelani, D. O., Aduradola, M. A., Akande, M. T., & Bamikole, J.A. (2018a). Germination of *Chrysophyllum albidum* seeds in response to seed weights and temperatures. *Horticulture for improved livelihoods*. In: Aiyelaagbe, I.O.O., Adeoye, I.B and Akintoye, H.A (Eds). *Proceedings of III All Africa Horticultural Congress*. PP 275-279.

Adelani, D. O., Amos, S. O., & Ojo, O. S. (2018b). Effect of some pre-germination treatments and Seed weights on the germination of *Zizyphus mauritiana* Lam seeds. *Journal of Sustainable Environmental Management,10*, 218 - 234.

Agele, S. O., & Olabomi, A. (2010). Growth, fruit set efficiency and blossom end rot in Capsicum spp, in humid southwest Nigeria. *Applied Tropical Agriculture,15*, 112 - 124.

Agele, S. O., Oyewusi, I. K., Aiyelari, O. P., & Famuwagun, I. B. (2017). Dry matter production, biomass partitioning and seed setting efficiencies in early and late rainy season cowpea in the rain forest agroecology of South West Nigeria. *International Journal of Botany, 13* (3-4), 115 - 125.

Aguyor, J. N., Wachira, P., Migati., Gochene, C. K. K., Ombewa, C. B., & Mairuw, F. S. (2013). Effect of irrigation regimes of water use efficiency of soybean (*Glycine Max L Merrill*) under field conditions. *Journal of Agricultural Science and Technology,* 231 - 244.

Binang, W. B., Shiyam, J. Q., Ntia, J. D. (2012). Effect of seed priming method on agronomic performances and cost effectiveness of rain fed dry-seeded NERICA rice. *Research Journal of Seed Science, 5,* 136 – 143.

Denton, O. A., Oyekale, K. O., Adeyeye, J. A., Nwangburuka, C.C., & Wahab, O. D. (2013). Effect of dry heat treatment on the germination and seedling emergence of *Chochorus olitorius* seed. *Agricultural Science Research Journals, 3*(1), 18-22.

Emongor, V., Mathowa, T., & Kabelo, S. (2004). Acid and ethephon on the germination of Corchorus (Corchorus Widens) seed. *Journal of Agronomy, 3*(3), 196-200.

Emongor, V. E., Mathowa, T., Kabelo, S. (2004). The effect of hot water, sulphuric acid, Gibberellic acid and Ethephon on germination of Corchorus (Corchorus tridens) seed. *Journal of Agronomy, 3*(3), 196 - 200.

Ghiyasi M., Seyahjam, A. A., Tajbakhs, M., Amrma, R., Salehzade, H. (2008). Effect of osmo priming with polyethylene glycol (8000) on germination and seedling growth of wheat (*Triticum aestivum L.*) seeds under salt stress. *Research Journal of Biological Sciences*, *3*(10), 1249 - 1251.

Kolodziejek, J. (2017). Effect of seed position and soil nutrients on seed mass germination and Seedling growth in *Pencedanum oreoselinum* (Apiaceae). *Scientific Reports, 7,* 1959 - 1969.

Kulac, S., Nzokou, P., Guney, D., Cregg, B. M., & Turna, I. (2012). Growth and physiological response of Fraser Fir (Abies fraseri (Pursh) Poir.) seedlings to water stress: Seasonal and diurnal variations in photosynthetic pigments and carbohydrate concentration. *Horticultural Science,47*(10), 1512 -1519.

Mavengahama, S., & Lewu, F. B. (2012). Comparative evaluation of germination capability of three morphologically different wild genotypes of *Corchorus olitorius* L. from Northern KwaZulu-Natal, South Africa *African Journal of Biotechnology*, *11*(22), 6050 – 6054.

Nyadanu, D., Amoah, R. A., Kwarteng, A., Akromah, R., Aboagye, L., Adu-Dapaah, H, & Tsama, A. (2017). Domestication of jute mallow (*Chochorus olitorius L*.): ethno botany, production constraints and phenomics of local cultivars in Ghana. *Genetic resources and crop evolution, 64*(6), 1313-1329.

Nkomo, M., & Kambizi, L. (2009). Effect of pre-chilling and temperature on seed germination of *Chochorus olitorius* L. (Tiliaceae) (Jews mallow), a wild leafy vegetable. *African Journal of Biotechnology, 8*(6), 1078 - 1081.

Oboho, E. G., & Igharo, B. (2017). Effect of pre germination treatments on germination and Watering regimes on the early growth of *Pycnanthus angolensis* (Welw) Warb. *Journal of Agriculture and Veterinary Science, 10*(3), 62 - 68.

O'Neal, M., Douglas, A. L., & Rufus, I. (2002). An inexpensive, Accurate Method for Measuring Leaf Area and Defoliation through Digital Image Analysis. *Journal of Entomology*, 95(6), 1190 - 1194

Oyewusi, I. K., Akanbi, O. S. O., Agbona, A. I., Nduka, B. A., Kayode, A. P., & Achenege, P. (2020). Seed setting efficiency, leaf relative water content and yield traits of some cowpea (*Vigna unguiculata* L. Walp) varieties under water stressed conditions. *International Journal of Plant Breeding and Crop Science*, *7*(2), 696-704.

Pandey, S., Kumar, A., Pandey, S., & Singh, P. K. (2019). Seed priming: A tool for enhancing crop productivity. *Journal of Tropic Agriculture, 57*(1), 1-13.

Rahimi, A. (2013). Seed priming improves the germination performance of Cumin (*Cuminum syminum* L.) under temperatures and water stress. *Journal of Industrial Crops Product, 42*, 454 - 460.

Sarfraz, R. A., Hussain, A., Sabir, I. B., Fekih, A., Ditta, S., Xing, (2019). Role of biochar and plant growth-promoting rhizobacteria to enhance soil carbon sequestration– a review. *Environmental Monitoring and Assessment*, *191*, 251 https://doi.org/10.1007/s10661-019-7400-9

Tareq, M., Khan, M., Mollah, M., Hasan, M., & Alam, M. (2015). Effect of storage environment on jute seed qualities. *Bangladesh Journal of Environmental Science, 29*, 45 – 48,

Wapa, J. M., & Oyetola, S. O. (2014). Combining effects of nitrogen and different organic manures on major chemical properties of Typic Ustipsament in North East Nigeria. *American International Journal of Biology,2*(2),27-45.

Table 1: Physical and chemical properties of the soil at experimental site

Properties	Value
Ph (water) %	4.16
Total N (%)	0.10
Available P (mg/kg)	12.76
Ca^{2+} (Cmol/kg)	1.80
Mg^{2+} (Cmol/kg)	0.70
K^{+} (mg/kg)	0.14
Na^{2+} (Cmol/kg)	0.22
Organic carbon (%)	0.78
Organic matter (%)	1.35
Particle size distribution	-
Sand	56.80
Silt	20.00
Clay	23.20
Total porosity (g/g)	35.30
Water holding capacity (g/g)	0.061
Texture	Sandy loam
Bulk density)g/cm^3)	1.32

Table 2: Effect of different priming methods on mean germination time (GMT) and germination percentage (GP) of two varieties of Jute mallow

Treatment	Variety	Number of seeds planted	Number of seeds germinated	Percentage germination (%)	MGT in Hours	MGT in days
TP (HWT)	Oniyaya	100	65	65	144	6
	Amugbadu	100	60	60	144	6
HP (SCT)	Oniyaya	100	40	40	216	9
	Amugbadu	100	37	37	216	9
CP (LUT)	Oniyaya	100	50	50	168	7
	Amugbadu	100	45	45	168	7
HYP (FWT)	Oniyaya	100	85	85	120	5
	Amugbadu	100	79	79	120	5
NP (CLT)	Oniyaya	100	0	0	-	-
	Amugbadu	100	0	0	-	-

(TP: Thermo priming) - Hot water treatment,(HP:Halo priming) - Sodium chloride treatment.(CP:Chemo-priming) - Liquid urea treatment.(HYP: Hydro-priming) - Fresh water treatment.(NP:No priming) - Control.(MGT)-Mean germination time

Table 3: Effect of different priming methods on growth and growth characters of two varieties of Jute mallow at harvest

Treatment	Variety	Plant height (cm)	Number of Leaves	Number of branches	Stem girth (cm)	Leaf Area (cm^2)	Mean
TP (HWT)	Oniyaya	84.9[c]	99.0[d]	13.9[d]	0.70[a]	34.90[c]	46.68
	Amugbadu	82.7[c]	90.5[d]	11.0[d]	0.60[a]	31.00[c]	43.16
HP (SCT)	Oniyaya	85.5[c]	110.0[c]	15.0[c]	0.67[a]	39.04[c]	50.04
	Amugbadu	81.7[c]	103.5[c]	12.5[d]	0.59[a]	37.90[c]	47.29
CP (LUT)	Oniyaya	89.0[c]	134.0[b]	18.6[b]	0.69[a]	41.33[b]	56.72
	Amugbadu	87.9c	127.8[b]	16.9[c]	0.64[a]	39.90[b]	55.49
HYP (FWT)	Oniyaya	101.6[a]	149.6[a]	20.5[a]	0.79[a]	55.91[a]	65.68
	Amugbadu	97.0[b]	140.5[a]	17.9[b]	0.73[a]	52.13[a]	54.45
NP (CLT)	Oniyaya	65.9[d]	88.9[e]	14.0[d]	0.56[a]	30.99[c]	40.07
	Amugbadu	60.0[d]	80.0[e]	12.5[e]	0.52[a]	27.82[d]	36.18
SD		9.14	10.60	3.91	0.81	6.28	
SE±		2.89	3.35	1.28	0.26	1.99	

Mean followed by the same superscript significantly different at 0.05% probability on the same row using Duncan's Multiple Test(DMRT). (TP: Thermo priming) - Hot water treatment. (HP: Halo priming) - Sodium chloride treatment. (CP: Chemo-priming) - Liquid urea treatment. (HYP: Hydro-priming) - Fresh water treatment. (NP: No priming) - Control.

Table 4: Effect of different priming methods on yield and yield characters of two varieties of Jute mallow at harvest

Treatment	Variety	Fresh Shoot biomass (g)	Days to first flowering	Fresh root weight (g)	Number of seed/plant	Fresh leaf weight (kg/ha)	Mean
TP (HWT)	Oniyaya	21.00[c]	30.33[b]	1.89[a]	12.90[c]	1.36[d]	13.89
	Amugbadu	19.03[d]	38.90[a]	1.67[a]	10.11[c]	2.25[c]	14.79
HP (SCT)	Oniyaya	22.90[c]	34.34[b]	2.19[a]	12.95[c]	2.43[c]	15.36
	Amugbadu	20.00[d]	31.20[b]	2.00[a]	11.86[c]	2.90[c]	13.99
CP (LUT)	Oniyaya	26.18[b]	37.00[a]	1.90[a]	15.56[b]	3.26[b]	16.88
	Amugbadu	23.88[c]	33.18[b]	1.78[a]	13.67[c]	3.12[b]	15.71
HYP (FWT)	Oniyaya	29.00[a]	26.25c	2.70[a]	18.00[a]	3.83[b]	16.24
	Amugbadu	26.56[b]	29.00[c]	2.41[a]	16.98[b]	3.62[b]	15.93
NP (CLT)	Oniyaya	23.00[c]	39.00[a]	0.58[a]	12.99[c]	1.39[d]	15.79
	Amugbadu	22.35[c]	37.89[a]	0.26[a]	10.00[c]	1.20[d]	14.70
SD		4.82	5.81	1.32	3.68	1.58	
SE±		1.53	1.84	0.42	1.16	0.49	

Mean followed by the same superscript significantly different at 0.05% probability on the same row using Duncan's Multiple Test(DMRT). (TP: Thermo priming) - Hot water treatment. (HP: Halo priming) - Sodium chloride treatment. (CP: Chemo-priming) - Liquid urea treatment. (HYP: Hydro-priming) - Fresh water treatment. (NP: No priming) – Control

Table 5: Effect of different priming methods on Crop Growth Rate (CGR) of two varieties of Jute mallow at harvest

Treatment	Variety	Total Biomass (g) (T)	Number of days to maturity (DH)	CGR (g/mg/day)	PGR (g/mg/day)	Partitioning Coefficient (PR)
TP (HWT)	Oniyaya	21.00[c]	45[c]	0.56[a]	0.03[a]	0.53[b]
	Amugbadu	19.03[d]	50[b]	0.36[a]	0.04[a]	0.11[b]
HP (SCT)	Oniyaya	22.90[c]	48[b]	0.48[a]	0.05[a]	0.10[b]
	Amugbadu	20.00[d]	48[b]	0.42[a]	0.06[a]	0.14[b]
CP (LUT)	Oniyaya	26.18[b]	50[b]	0.52[a]	0.06[a]	0.11[b]
	Amugbadu	23.88[c]	48[b]	0.50[a]	0.07[a]	0.14[b]
HYP (FWT)	Oniyaya	29.00[a]	42[c]	0.60[a]	0.09[a]	1.50[a]
	Amugbadu	26.56[b]	48[b]	0.55[a]	0.08[a]	0.15[b]
NP (CLT)	Oniyaya	23.00[c]	55[a]	0.42[a]	0.03[a]	0.10[b]
	Amugbadu	22.35[c]	50[b]	0.45[a]	0.00[a]	0.00[c]
SD		4.82	4.88	NS	NS	2.49
SE±		1.53	1.54	NS	NS	0.78

(TP: Thermo priming) - Hot water treatment. (HP: Halo priming) - Sodium chloride treatment (CP: Chemo-priming) - Liquid urea treatment. (HYP: Hydro-priming) - Fresh water treatment. (NP: No priming) - Control. PGR: Pod Growth Rate.