

EFFECTS OF *GMELINA ARBOREA* BARK AND *AZADIRACHTA INDICA* LEAF POWDERS ON GERMINATION AND SEEDLING VIGOUR OF *CORCHORUS OLITORIUS* (JUTE MALLOW)

Habiba Maikudi MUHAMMED^{1*}, Ibrahim Abubakar Sadiq GUDUGI²,
Amina Rabe MUSA³, Aisha HUSSAINI¹, Zainab Jummai KASSIM⁴

¹ Department of Biological Sciences, Ibrahim Badamasi Babangida University, Lapai,
Niger State – Nigeria

² Department of Crop Production, Ibrahim Badamasi Babangida University, Lapai,
Niger State – Nigeria

³ Department of Biological Sciences Usmanu Danfodiyo University Sokoto – Nigeria

⁴ Department of Microbiology, Ibrahim Badamasi Babangida University, Lapai, Niger State – Nigeria

* Corresponding author. Email: habibamaliyu@gmail.com

Abstract: Effects of plants extract powders is the application of these extracts is to improved and increase the germination, emergence of the seedlings. Efficacy of *Gmelina arborea* bark and *Azadirachta indica* leaf powders on the germination and seedling vigour of *Corchorus olitorius* (jute mallow) was evaluated. Top loam soil was collected from Agriculture Research farmland of Ibrahim Badamasi Babangida University Lapai, Niger State, Nigeria and sterilized at 50 °C for an hour. *Gmelina arborea* bark and *Azadirachta indica* leaf were obtained from *Gmelina arborea* and *Azadirachta indica* leaves were also collected from the farmland and pulverized into powder form. Two kilograms (2 kg) of sterile soil samples in twenty one (21) polythene bags were amended with *Gmelina arborea* bark powder and *Azadirachta indica* leaf powders at different concentrations (100 g, 150 g, and 200 g) each in triplicates. Soil samples contained in three of the polyethylene bags were left un-amended to serve as control. *Corchorus olitorius* seeds was procured from the harvested farmland and were planted and raised in each polythene bag for a period of twelve (12) weeks. *Azadirachta indica* leaf powder had a significant impact on the growth of *Corchorus olitorius* (shoot length = 26.52 cm; root collar diameter = 0.33 cm, number of leaves = 21) at $p < 0.05$ compared to the control group (20.60 cm, 0.24 cm and 16 respectively) and its effects improved with increase in concentration. *Gmelina arborea* bark powder also had a less significant impact on the plant growth parameters (6.45 cm, 0.14 cm and 9 respectively) compared to the control. Its effect decreased with increase in concentration. *Azadirachta indica* leaf powder is a much better and more effective organic amendment than *Gmelina arborea* bark powder and could be employed by *Corchorus olitorius* farmers to improve soil fertility and crop yield.

Keywords: *Azadirachta indica*, *Corchorus olitorius*, germination, *Gmelina arborea*, seedling vigour.

Introduction

Jute mallow (*Corchorus olitorius* L.) is a popular vegetable in West Africa. *Corchorus olitorius* is commonly known as Long-fruited jute, Tossa jute, Jute mallow, Jew's mallow, Bush okra and West African sorrel [SEMRA & al. 2007], wild okra [NDLOVU & AFOLAYAN, 2008], Egyptian Spinach and Molokhiya [YOUSSEF & al. 2014]. The Yoruba of Nigeria call it “Ewedu”, the Hausa people and their Fulbe neighbours call it “Rama”. It is called “Ayoyo” in Nupe. It is dicotyledonous fiber-yielding plant of the genus *Corchorus* [ISLAM, 2013]. It is an annual herb with sparsely branching stems, often growing as tall as 4 m.

EFFECTS OF GMELINA ARBOREA BARK AND AZADIRACHTA INDICA LEAF POWDERS ...

Corchorus olitorius is rich nutritionally and serves as a source of nutrients for individuals that include it in their diet. It was observed in different literatures that this green, leafy vegetable is rich in beta-carotene for good eyesight, iron for healthy red blood cells, calcium for strong bones and teeth, and vitamin C for smooth, clear skin, strong immune cells, and fast wound-healing [ISLAM, 2013]. *Corchorus olitorius* possesses properties that can boost our immune system to help prevent diseases such as cancer, premature aging, osteoporosis, fatigue, high blood pressure and anemia.

Gmelina arborea Roxb. is a fast growing tree which grows on different localities and prefers moist fertile valleys with 750-4500 mm rainfall. Neem is a medium sized to large evergreen tree with straight trunk and dark brown to grey bark. It can grow up to 30 m in height and 70 cm in diameter. This tree is grown all over the northern states of Nigeria to provide shade along the major high- ways and the fruit is fed to livestock. *Gmelina arborea* fruits possess antibacterial activity. It has been found to be effective against some pathogenic bacteria involved in wounds and burns [AKYALA & al. 2013].

SHANKAR & al. (2014) analyzed allelochemicals effect of *Gmelina arborea* on *Vigna mungo* and *Vigna radiata*. The presence of allelopathic compounds such as polyphenols and terpenoids was analyzed. The extract inhibited the proteolytic enzyme important for seed germination. The extract inhibited the germination, seedling growth, and total protein content of both test crops. SHANKAR & al. (2014) analyzed the effect of allelochemicals from leaf leachates of *Gmelina arborea* on Inhibition of some essential seed germination enzymes in *Vigna mungo* (Green gram), *Vigna radiata* (Black gram), *Cajanus cajan* (Red gram), and *Cicer arietinum* (Chickpea).

Azadirachta indica A. Juss. is widely planted and naturalized in semiarid areas throughout Asia and Africa. It belongs to the family Meliaceae and is related with Chinaberry – *Melia azedarach* [NTALLI & al. 2010]. The leaves are glabrous and divided into leaflets with a sharp bitter taste. The bark is fairly thick, furrowed longitudinally or obliquely and is reddish brown inside and dark grey outside. The tree produces flowers throughout the year but fruits during the cold harmattan.

Adding neem leaves as organic matter increases the activity and number of soil organisms. Over time, a well-amended soil will supply more of the nutrients the plants require, which will reduce fertilizer requirements [KHAN & al. 2012]. The mode of action of organic amendments leading to plant disease control and stimulation of microorganisms is complex and dependent on the nature of the amendments [DIACONO & MONTEMURRO, 2011]. Azadirachtin, a phytochemical found in Neem repels more than 200 insect species, including such pests as locusts, gypsy moths, and cockroaches.

Poor crop plants germination and growth due to diseases, poor environmental conditions and poor soil conditions are of concern to every farmer. Jute (*Corchorus olitorius*) is a very important crop cultivated and consumed in Nigeria known for the sliminess of its leaves and tends to lose its value due to poor seed germination and seedling vigour. The research was carried out to determine the effects of *Gmelina arborea* bark and *Azadirachta indica* leaf amended soil on the germination and seedling vigour of jute mallow (*Corchorus olitorius*).

Materials and methods

Study area

The experiment was conducted at Department of Biological Science, Faculty of Natural Science, Ibrahim Badamasi Babangida University Lapai Niger State situated in the

middle belt (North Central) Zone of Nigeria and lies along latitude 80⁰ and 110⁰, 30⁰ East [AKINTAYO & al. 2011]. The experimental area is under subtropical climate, characterized by dry/harmattan and rainy season; the rainy season begins from March/April and ends October, the dry/harmattan season occurs between November and March.

Samples collection

Seeds of jute mallow, Fresh *Gmelina arborea* bark and *Azadirachta indica* leave samples were collected from *G. arborea* and *A. indica* trees of the Agriculture Research Farm of Ibrahim Badamasi Babangida University Lapai, Niger State, Nigeria.

Preparation of powdered samples of *G. arborea* bark and *A. indica* leaves

Each fresh sample was rinsed separately with clean tap water to make it dust and debris free. Then the samples were separately spread evenly and dried in a shady condition for four-seven days until they became dry while still retaining their colour [NAHAK & SAHU, 2010]. Powders were prepared by pulverizing the dried bark and leaf samples with the help of a mortar and pestle. Then the powders were passed through a sieve to obtain finer and more uniform particles. The powders were preserved in airtight condition in plastic buckets tightly covered till their use in soil amendment [MAMUN & SHAHJAHAN, 2011].

Soil sterilization

Soil sample was freed from debris and sterilized in a dry oven at 50 °C for an hour in the laboratory. Sterilized soil sample was allowed to cool for some minutes.

Amendment of soil

Two kilograms of sterilized soil was measured into each of the 21 polythene bags containing bored holes at the bottom to allow for drainage during the course of the experiment. The polythene bags were randomly divided into seven groups each containing three polythene bags. The seven groups are described below:

- I. The soil samples in the first group (*G. arborea* 100 g I, II and III) were mixed with 100 g *G. arborea* powder weighed with a weighing machine.
- II. The second group (*G. arborea* 150 g I, II and III) were mixed with 150 g *G. arborea* powder.
- III. The third group (*G. arborea* 200 g I, II and III) were mixed with 200 g *G. arborea* powder.
- IV. The fourth group (*A. indica* 100g I, II and III) were mixed with 100 g *A. indica* powder.
- V. The fifth group (*A. indica* 150 g I, II and III) were mixed with 150 g *A. indica* powder.
- VI. The sixth group (*A. indica* 200g I, II and III) were mixed with 200 g *A. indica* powder.
- VII. The seventh group (Control I, II and III) were left unmixed with any of the powdered samples.

The soil in all the three groups were supplied with water daily and allowed to stand for seven days [OLOGUNDUDU & al. 2013].

Raising of *Corchorus olitorius* seeds

Corchorus olitorius seeds were broadcast on soil samples contained in all twenty-one polythene bags on the eight day after amendment. Each polythene bag was supplied with water on a three day basis when rainfall became less frequent until the plants reached their fruiting stage. Seedlings were thinned to four (4) per bag ten days after planting.

Growth parameters**Seedling emergence test**

Eight seeds of *Corchorus olitorius* were broadcast on each of the amended soil replicates as well as the control. All soil samples were watered regularly and number of seedlings that emerged each day from all polythene bags was recorded for a period of ten days. The percentage seedling emergence per amended soil was calculated using the formula of OKUNOMO (2010) below:

$$\% \text{ Seedling emergence per soil sample} = \frac{\text{Number of emerged seedlings}}{\text{Total number of seeds planted}} \times \frac{100}{1}$$

Seedling morphology

The morphological characteristics of the seedlings were observed and recorded weekly for a period of twelve (12) weeks. The shoot length of seedlings was measured with a centimeter ruler and a tape. The root collar diameter was measured with the aid of a Vanier caliper and recorded in centimeters. Dickson quality index was calculated using one quality indices (slenderness index = shoot length/root collar diameter) given by DICKSON & al. (2000). The leaves, flowers and fruits were physically counted weekly.

Results**Seedling emergence**

The result of the seedling emergence test carried out for ten (10) days showed that soil amended with 200 g *G. arborea* bark powder had the highest percentage of emerged seedlings (100%), soil amended with 200 g *A. indica* leaf powder had the second highest percentage of emerged seedlings (87.5%), soils amended with 100 g *G. arborea* bark, 150 g *G. arborea* bark, 100 g *A. indica* leaf, as well as the control had 75% emerged seedlings while 150 g *A. indica* had the least percentage seedling emergence (62.5%).

Table 1. Percentage Seedling Emergence

Soil sample	Percentage Seedling Emergence (%)
Control	75
100 g <i>G. arborea</i>	75
150 g <i>G. arborea</i>	75
200 g <i>G. arborea</i>	100
100 g <i>A. indica</i>	75
150 g <i>A. indica</i>	62.5
200 g <i>A. indica</i>	87.5

Effects of the organic amendments on shoot length, root collar diameter and Dickson quality index of *Corchorus olitorius*

The results showed that soil amended with 100 g *Gmelina arborea* bark powder produced plants with the highest shoot length (17.11 cm) compared to 150 g *G. arborea* which had the second highest shoot length (15.9 cm) and 200 g *G. arborea* which had the least shoot length (6.45 cm). When compared with the control, *G. arborea* bark amended soil at all concentrations yielded plants with lower plant shoot length than the control (20.60 cm).

However there was no significant difference at $p < 0.05$ between the different concentrations of *Gmelina arborea* bark as shown in Table 2.

The results indicated that soil amended with 100 g *Gmelina arborea* bark powder produced plants with the highest root collar diameter (0.23 cm) compared to 150 g *G. arborea* which had the second highest root collar diameter (0.21 cm) and 200 g *G. arborea* which had the least root collar diameter (0.14 cm). When compared with the control however, *G. arborea* bark amended soil at all concentrations yielded plants with lower plant root collar diameter than the control (0.24). There was no significant difference at $p < 0.05$ between the different concentrations of *Gmelina arborea* bark as shown in Table 2.

Also, the results showed that that soil amended with 100 g *Gmelina arborea* bark powder produced plants with the highest Dickson quality index (64.04 cm) compared to 150 g *G. arborea* which had the second highest Dickson quality index (59.88 cm) and 200 g *G. arborea* which had the least root collar diameter (39.85 cm). When compared with the control, *G. arborea* bark amended soil at all concentrations yielded plants with lower Dickson quality index than the control (72.45 cm). There was a significant difference at $p < 0.05$ between the different concentrations of *Gmelina arborea* as shown in Table 2.

The results showed that soil amended with 200 g *Azadirachta indica* leaf powder produced plants with the highest shoot length (26.52 cm) compared to 150 g *A. indica* which had the second highest shoot length (25.95 cm) and 100 g *A. indica* which had the least shoot length (23.18 cm). When compared with the control however, *Azadirachta indica* leaf amended soil at all concentrations yielded plants with higher plant shoot length than the control (20.60 cm). There was however no significant difference at $p < 0.05$ between the different concentrations of *Azadirachta indica*.

The results indicated that that soil amended with 200 g *Azadirachta indica* leaf powder produced plants with the highest root collar diameter (0.33 cm) compared to 150 g *A. indica* which had the second highest root collar diameter (0.31 cm) and 100 g *A. indica* which had the least root collar diameter (0.29 cm). When compared with the control however, *Azadirachta indica* leaf amended soil at all concentrations yielded plants with higher plant root collar diameter than the control (0.24). There was however no significant difference at $p < 0.05$ between the different concentrations of *Azadirachta indica*.

Also, the results showed that that soil amended with 150 g *Azadirachta indica* leaf powder produced plants with the highest Dickson quality index (73.40 cm) compared to 200 g *A. indica* which had the second highest Dickson quality index (72.48 cm) the next higher Dickson quality index recorded was in control (72.45 cm) while the least was in soil amended with 100 g *A. indica* (69.85 cm). There was however no significant difference at $p < 0.05$ between the different concentrations of *Azadirachta indica*. This is demonstrated in Table 2 below:

EFFECTS OF *Gmelina arborea* BARK AND *Azadirachta indica* LEAF POWDERS ...**Table 2.** Effects of different concentrations of *Gmelina arborea* bark and *Azadirachta indica* leaf powders on shoot length, root collar diameter and Dickson quality index of *Corchorus olitorius*

TREATMENT	SHOOT LENGTH	ROOT COLLAR DIAMETER	DICKSON QUALITY INDEX
CONTROL	20.60 ± 4.90 ^a	0.24 ± 0.03 ^a	72.45 ± 7.21 ^a
100 g <i>G. arborea</i>	17.11 ± 4.31 ^a	0.23 ± 0.03 ^a	64.04 ± 7.45 ^a
150 g <i>G. arborea</i>	15.9 ± 3.89 ^a	0.21 ± 0.02 ^a	59.88 ± 7.16 ^a
200 g <i>G. arborea</i>	6.45 ± 1.13 ^a	0.14 ± 0.01 ^a	39.85 ± 4.14 ^b
100 g <i>A. indica</i>	23.18 ± 4.37 ^a	0.29 ± 0.04 ^a	69.85 ± 5.72 ^a
150 g <i>A. indica</i>	25.95 ± 5.16 ^a	0.31 ± 0.04 ^a	73.40 ± 6.19 ^a
200 g <i>A. indica</i>	26.52 ± 5.32 ^a	0.33 ± 0.05 ^a	72.48 ± 5.74 ^a

Values are MEAN ± SEM. Values with same superscript down the column are not statistically significant at (p < 0.05).

Effect of *Gmelina arborea* bark powder on number of leaves, flowers and fruits produced

The results showed that soil amended with 100 g *G. arborea* bark powder and control yielded the highest number of leaves (16), this was followed by 150 g *G. arborea* (14), least number of leaves was recorded in soil amended with 200 g *G. arborea* (9).

The control produced the highest number of flowers (2), soil amended with 100 g and 150 g *G. arborea* bark yielded equal number of flower (1), while 200 g *G. arborea* bark amended soil produced no flowers (0).

Highest number of pods produced was recorded in 100 g *G. arborea* bark amended soil and control (4), higher number of pods was recorded in 150 g *G. arborea* amended soil (3) and the least number of pod occurred in 200 g *G. arborea* amended soil (0). This is demonstrated in Table 3.

Effect of *Azadirachta indica* leaf powder on number of leaves, flowers and fruits produced

The results showed that soil amended with 200 g *Azadirachta indica* leaf powder yielded the highest number of leaves (21), this was followed by 150 g *A. indica* (20), and soil amended with 100 g *A. indica* (17). The least number of leaves was recorded in control (16).

The control produced the highest number of flowers (2), soils amended with 100 g 150 g and 200 g *A. indica* leaf powder yielded equal number of flower (1). Highest number of pods produced was recorded in 150 g *A. indica* leaf powder amended soil and control (4), higher number of pods was recorded in 200 g *A. indica* amended soil (3) and the least number of pods occurred in 100 g *A. indica* amended soil (2) as shown in Table 3.

Generally, results showed that *Corchorus olitorius* plants in soil samples amended with 200 g *Azadirachta indica* leaf powder had the highest number of leaves (21) with 200 g *G. arborea* bark powder amended soil having the lowest number of leaves (9). It was also observed that the control produced the highest number of flowers (2) as compared to soil samples amended with varied concentrations of *Gmelina arborea* bark and *Azadirachta indica* leaf powders. The lowest number of flower production was observed in soil amended with 200 g *Gmelina arborea* (0). Highest number of pods was produced by control, 100 g *Gmelina arborea*, and 150 g *Azadirachta indica* (4), while the lowest pod production was

observed in 200 g *Gmelina arborea* bark amended soil (0). Number of leaves, flowers and pod per plant in all soil samples is demonstrated in Table 4 below.

Table 3. Number of leaves, flowers and fruits produced after twelve weeks of planting

SOIL SAMPLE	NO. OF LEAVES	NO. OF FLOWERS	NO. OF PODS
100 g <i>G. arborea</i>	16	1	4
150 g <i>G. arborea</i>	14	1	3
200 g <i>G. arborea</i>	9	0	0
100 g <i>A. indica</i>	17	1	2
150 g <i>A. indica</i>	20	1	4
200 g <i>A. indica</i>	21	1	3
Control	16	2	4

Discussion

The seedling emergence test revealed that soil amended with 200 g *Gmelina arborea* bark had the highest germination percentage (100%). This finding disagrees with the finding of SHANKAR & al. (2014) that allelochemicals of *Gmelina arborea* are of inhibitory type to germination of *Vigna mungo* (Green gram), *Vigna radiata* (Black gram), *Cajanus cajan* (Red gram) and *Cicer arietinum* (Chickpea).

Azadirachta indica (200 g) amended soil produced plants with longest shoots (26.52 cm); this was followed by 150 g *A. indica* amended soil (25.95 cm) and lastly 100 g *A. indica* amended soil yielded plants with shortest shoot lengths (23.18 cm) when compared with the other two. This finding agrees with the finding of CHANNAL & al. (2000), study of allelopathic effect of leaf extracts from *Azadirachta indica*, *Acacia arabica*, *Eucalyptus tereticornis*, *Tamarindus indica*, *Tectona grandis*, *Samanea saman* and *Syzygium cumini*, all applied at 5 and 10% concentration, on seed germination, vigour index, seedling length, and seedling dry matter of sorghum and rice. Irrespective of concentration, all tree leaf extracts promoted germination in sorghum to (15-32% over the control), while only *Azadirachta indica* and *Acacia arabica* increased the germination in rice (3.50-3.81% over the control).

In contrast to this, 100 g *Gmelina arborea* amended soil yielded plants with highest shoot length (17.11 cm) followed by 150 g *G. arborea* amended soil (15.9 cm) and lastly, 200 g *G. arborea* amended soil yielded plants with the shortest length of shoot (6.45 cm). This agrees with the finding of SHANKAR & al. (2014) that *G. arborea* extracts inhibited seedling growth of *Vigna mungo* and *Vigna radiata*. It could be the result of the presence of allelochemicals in the amendment that were able to inhibit the synthesis of growth hormones which in turn prevented cell division and differentiation to increase the length of the shoot [ABUGRE & al. 2011]. Allelochemicals are not only species specific but organ specific [MARHAJAN & al. 2007].

Different allelochemicals have different sites of action in a plant. Thus, the sensitivity to allelochemicals and the extent of inhibition varies with species and organs. *Corchorus olitorius* plants in all replicates of soil amended with different concentrations of *Azadirachta indica* had longer shoots than the control and *G. arborea* amended soils. Plants from the control were generally longer than those in all *G. arborea* amended soils.

EFFECTS OF GMELINA ARBOREA BARK AND AZADIRACHTA INDICA LEAF POWDERS ...

Also, the results indicated that 200 g *Azadirachta indica* amended soil produced plants with the highest number of leaves (21); this was followed by 150 g *A. indica* amended soil and lastly (20), 100 g *A. indica* amended soil yielded the lowest number of leaves compared to the other two (17). The results of *Gmelina arborea* on the other hand showed that soil amended with 100 g *G. arborea* yielded plants with the highest leaf number (16); followed by 150 g *G. arborea* amended soil (14) and 100 g *G. arborea* amended soil yielded plants with the least number of leaves (9).

The control produced the highest number of flowers (2); 100 g and 150 g *G. arborea* bark as well as 100 g, 150 g and 200 g *Azadirachta indica* leaf amended soils yielded equal number of flower (1) while 200 g *G. arborea* produced no flowers.

Highest number of pods produced was recorded in 100 g *G. arborea* amended soil, 150 g *A. indica* amended soil and control (4); higher number of pods was recorded in 150 g *G. arborea* amended soil and 150 g *A. indica* amended soil (3); this was followed by 100 g *A. indica* amended soil (2) and the least number of pod occurred in 200 g *G. arborea* amended soil (0).

Conclusions

Azadirachta indica leaf powder at all concentration has a significant effect on the germination and seedling vigour of *Corchorus olitorius* than control and *Gmelina arborea* bark powder. However *G. arborea* bark powder at lower concentrations (less than 100 g to 2 kg of soil) would yield more significant effect on germination and seedling vigour of *C. olitorius* than higher concentrations. Higher concentrations of *Azadirachta indica* leaf powder yields more significant effect on germination and seedling vigour of *Corchorus olitorius* when compared with lower concentrations, control and *Gmelina arborea* bark.

Notes on contributors

Dr. Habiba Maikudi MUHAMMED is a plant biologist with special interest in plant pathology and plant physiology. Her focuses in the plant diseases and management methods of vegetable crops.

Dr. Ibrahim Abubakar Sadiq GUDUGI is a crop scientist with special interest in crop agronomy.

Amina Rabe MUSA is a plant biologist with special interest in ecology and physiology processes in plants.

Aisha HUSAAINI and Zainab Jummai KASSIM are research scientists with the department of biological and microbiological sciences of Ibrahim Badamasi Babangida University Lapai, Niger State, Nigeria.

Acknowledgements

We are grateful to the entire staffs of the Laboratory of Biological Sciences Department and the Agricultural research farm of Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria for providing technical assistance. We also acknowledge the financial assistance receive from the management of Ibrahim Badamasi Babangida University for sponsoring this research.

References

- ABUGRE S., APETORGBOR A. K., ANTWIWAA A. & APETORGBOR M. M. 2011. Allelopathic effects of ten tree species on germination and growth of four traditional food crops in Ghana. *Journal of Agricultural Technology*. **7**(3): 825-834.
- AKINTAYO O. I., RAHJI M. A. Y., AWOYEMI T. T. & ADEOTI A. I. 2011. Determinants of yield gap in lowland rice production in North-Central Nigeria. *Agrosearch*. **11**(1): 1-10. <http://dx.doi.org/10.4314/agrosh.v11i1.1>
- AKYALA I. A., DAVID I. & SIMON A. 2013. Phytochemical screening and antibacterial activity of *Gmelina arborea* fruit extracts. *International Journal of Microbiology and Immunology Research*. **1**(2): 26-31.
- CHANNAL H. T., KURDIKERI M. B. & SARANGAMATH P. A. 2000. Allelopathic effect of tree leaf extracts on germination of sorghum and rice. *Karnataka Journal of Agricultural Sciences*. **13**(2): 338-342.
- DIACONO M. & MONTEMURRO F. 2011. Long-term effects of organic amendments on soil fertility. In: *Sustainable Agriculture*. Volume 2: pp. 761-786. Springer, Dordrecht.
- DICKSON A., LEAF A. L. & HOSNER J. F. 2000. Quality appraisal of white spruce and white pine seedling stock in nurseries. *The Forestry Chronicle*. **36**: 10-13.
- ISLAM M. M. 2013. Biochemistry, medicinal and food values of jute (*Corchorus capsularis* L. and *C. olitorius* L.) leaf: A review. *International Journal of Enhanced Research in Science Technology & Engineering*. **2**(11): 135-44.
- KHAN Z., TIYAGI S. A., MAHMOOD I. & RIZVI R. 2012. Effects of N fertilisation, organic matter, and biofertilisers on the growth and yield of chilli in relation to management of plant-parasitic nematodes. *Turkish Journal of Botany*. **36**(1): 73-81.
- MAMUN M. S. A. & SHAHJAHAN M. 2011. Effect of some indigenous plant extracts on the germination of wheat seeds. *Bangladesh Journal of Agricultural Research*. **36**(4): 733-739.
- MARHAJAN S., SHRESTHA B. & JHA P. K. 2007. Allelopathic effects of aqueous extracts of leaves of *Parthenium hysterophorus* L. on seed germination and seedling growth of some cultivated and wild herbaceous species. *Scientific World*. **5**: 33-39.
- NAHAK G. & SAHU R. K. 2010. In vitro antioxidative activity of *Azadirachta indica* and *Melia azedarach* leaves by DPPH scavenging assay. *Natural Science*. **8**(4): 22-28.
- NDLOVU J. & AFOLAYAN A. J. 2008. Nutritional analysis of the South African wild vegetable *Corchorus olitorius* L. *Asian Journal of Plant Sciences*. **7**(6): 615-618.
- NTALLI N. G., VARGIU S., MENKISSOGLU-SPIROUDI U. & CABONI P. 2010. Nematicidal carboxylic acids and aldehydes from *Melia azedarach* fruits. *Journal of agricultural and food chemistry*. **58**(21): 11390-11394.
- OKUNOMO K. 2010. Germination and seedling growth of *Parkia bicolor* (A. Chev) as influenced by various nursery techniques. *African Journal of General Agriculture*. **6**(4): 190-193.
- OLOGUNDUDU A. F., ADELUSI A. A. & ADEKOYA K. P. 2013. Effect of light stress on germination and growth parameters of *Corchorus olitorius*, *Celosia argentea*, *Amaranthus cruentus*, *Abelmoschus esculentus* and *Delonix regia*. *Notulae Scientia Biologicae*. **5**(4): 468-475.
- SEMRA I., FILIZ S. & FERDAG C. 2007. Antibacterial and antifungal activity of *Corchorus olitorius* L. (Molokhia) extracts. *International Journal of Natural and Engineering Sciences*. **1**(3): 59-61.
- SHANKAR R. M., SHANMUGHAM V., ABDULRAZACK S. & RAMASAMY R. 2014. Effect of allelochemicals from leaf leachates of *Gmelina arborea* on inhibition of some essential seed germination enzymes in Green Gram, Red Gram, Black Gram, and Chickpea. *International Scholarly Research Notices*. 1-7.
- YOUSSEF K. M., MOKHTAR S. M. & MORSY N. E. 2014. Effect of hot air drying variables on phytochemicals and antioxidant capacity of Jew's mallow (*Corchorus olitorius* L.) leaves. *Journal of Food Sciences Suez Canal University*. **2**: 11-18.

How to cite this article:

MUHAMMED H. M., GUDUGI I. A. S., MUSA A. R., HUSSAINI A. & KASSIM Z. J. 2019. Effects of *Gmelina arborea* bark and *Azadirachta indica* leaf powders on germination and seedling vigour of *Corchorus olitorius* (jute mallow). **26**: 35-43. <https://doi.org/10.33628/jpd.2019.26.1.35>