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# Comparative studies on germination and seedling growth of on-season and off-season produced jute seeds

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ABSTRACT

To overcome the problems of crop loss and prolonged period of land engaged for jute seed production in on-season, the off-season production of jute seeds is being practiced but the seed quality of both these systems has not been thoroughly compared to get better seeds for higher yield in jute. Considering the above facts, the present research was carried out to perform a comparative study among different parameters, such as, germination and seedling growth of on-season and off-season produced seeds of *Corchorus capsularis* (Variety CVL-1) and *Corchorus olitorius* (Variety O-9897). In this study, significant influence of production period of seeds on germination percentage, seedling vigor index, germination co-efficient, shoot length, root length, shoot and root dry weight, ratio of root dry weight and shoot dry weight was observed. The highest seed germination percentage, seed germination co-efficient, seedling vigor index, shoot and root length, shoot and root dry weight, ratio of root dry weight and shoot dry weight were found in off-season Deshi jute seeds followed by on-season Deshi and off-season Tossa jute seeds. The lowest value of each of these properties was found in case of on-season Tossa jute seeds and seedlings. Based on the findings of this study, it may be concluded that off-season produced jute seeds showed better performance than those of on-season jute seeds in both the species in terms of seed germination and other relevant characters.

**Keywords:** Jute seeds, *Corchorus*, germination, seedling growth

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## 1 Introduction

Jute is a kind of natural fibre which is obtained from the bark of jute plants. It is the world's front bast (bark) fibre and the second most important textile fibre after cotton (Bari et al., 2015). It is a long, soft, shiny vegetable fibre that can be turned into coarse, strong threads. A large part of the world's total jute production is produced in Bangladesh. The land and climatic conditions of Bangladesh are favourable for high quality jute production. Among the jute growing countries of the world, Bangladesh ranks second in respect of production. Jute plays an important role in agro-ecology and socio-economic conditions of the farmers of Bangladesh (Uddin et al., 2014). It is an important cash crop as the country earns a lot of foreign exchange by exporting raw jute and its goods to the other countries of the world and for this reason

it is called the golden fibre of Bangladesh. Moreover, the leaves and soft stems of jute plats are also used as vegetables and they are a good source of energy, minerals, vitamins and many more (Antia et al., 2006).

Generally farmers obtain fibre from two species of jute, *Corchorus capsularis* L. and *Corchorus olitorius* L. These two species are locally called 'Deshi' and 'Tossa' jute, respectively. Quality seed is a basic need for the improvement of yield of any crop. Quality seeds ensure a successful crop production and increase in yield up to 15-20% (Ambika et al., 2014). Jute seed is one of the most important factors for successful jute production; while very little concern has been given on to assess the quality of its seed. Use of quality jute seeds of improved variety itself can provide 20% additional yield (Hossain et al., 1994). But lack of quality seeds is one of the major constraints of jute. Bangladesh requires about 4000-4500 metric tons of seeds annually whereas Bangladesh Agricultural Development Corporation (BADC) can supply only 800-1000 metric tons. Farmers produce 400-600 metric tons and rest of the demand is met up by importing from the other countries mostly from India (Pulok et al., 2014).

The growers normally collect jute seeds from the same plant cultivated for fibre purpose. But the plants which are used for seed production yield low quality fibre. Moreover, the land remains engaged and becomes ineffective for the cultivation of aman rice when jute is grown both for fibre and seed purpose (Hossain et al., 1990). Jute crop requires few months more for producing seeds and for this reason farmers keep some plants at the corner of the field while harvesting rest of the crop for fibre (Masum et al., 2010). After harvesting fibre crop, the crop for seed remains almost uncared for a long period. These seed crops due to long stay in the field are affected by hailstorm, diseases and insect pests. To surmount this problem, the farmers can easily obtain jute seeds from off-season grown plant (Hossain et al., 1988) without losing the normal economic fibre and subsequent crop. Hossain et al. (1988) for the first time recommended the method of off-season seed production in jute and described the detailed method (Hossain et al., 1990) of sowing jute seed in the off-season starting from August 1987 for the purpose of only seed production. They concluded that fertile and healthy seeds may be produced from the off-season grown plants on the basis of seed yield and 1000-seed weight. Therefore, more studies are needed to assess other properties such as germination percentage, speed of germination etc. The properties of seedlings grown from off-season produced seeds should also be studied in comparison with on-season produced jute seeds. Ali et al. (2004) conducted an experiment to reveal the effect of production season of jute seed on plant growth but their study was only confined with off-season produced Tossa jute seeds. Later, Hossain et al. (2013) conducted an experiment with on-season and off-season produced Deshi and Tossa jute seeds but they only assessed electrical conductivity of seeds, germination percentage and their relationship. But detailed comparative studies between off-season and on-season grown seeds on the basis of seed germination and seedling growth has not been done.

Based on the foregoing discussion, it can be inferred that a detailed study is required in order to lay down a profound understanding of different properties of on-season and off-season produced Deshi and Tossa jute seeds and seedlings. The present piece of research work was therefore undertaken to compare the quality of off-season and on-season produced seeds in terms of germination and their seedling growth and to recommend the better performing jute seeds between on-season and off-season grown jute plants.

## 2 Materials and Methods

### 2.1 Experimental site and design

The experiment was conducted in the laboratory of Department of Seed Science and Technology, Bangladesh Agricultural University, Mymensingh during June, 2017. The seeds of Deshi jute (*Corchorus capsularis* L.), variety CVL-1 and Tossa jute (*Corchorus olitorius* L.), variety O-9897 were used as plant materials in the experiment. Four treatments were included in the experiment namely, On-season Deshi jute seeds (T1), Off-season Deshi jute seeds (T2), On-season Tossa jute seeds (T3) and Off-season Tossa jute seeds (T4). The treatments were arranged with Petri dishes (9 cm diameter) in Completely Randomized Design (CRD) with four replications having four treatments. Thus, the total number of Petri dishes were 16 ($4 \times 4$).

### 2.2 Germination

One hundred pure seeds of each treatment were placed in Petri dish containing filter paper soaked with distilled water. For each test, four Petri dishes were used. The Petri dishes were placed in room temperature ($30 \pm 2$ °C) for 5 d for germination. Seedlings were counted every day up to the completion of germination on fifth day. A seed was considered to be germinated as seed coat ruptured and plumule and radicle came out up to 2 mm in length. Germination percentage was calculated using the following formula (Krishnasamy and Seshu, 1990; Sagar et al., 2019).

$$\%GE = \frac{S_G}{S_T} \times 100 \quad (1)$$

weher, $\%GE$ = germination percentage, $S_G$ = total number of seeds germinated, and $S_T$ = total number of seeds taken for germination.

## 2.3 Germination and vigor indices

The speed of germination of seed sample was monitored by counting the germinated seedling at an interval of 24 h and continued for five days. Days to 50% germination ($T_{50}$) was calculated using the following formula modified from Farooq et al. (2005).

$$T_{50} = d_i + \frac{(\frac{N}{2} - n_i)(d_j - d_i)}{n_j - n_i} \quad (2)$$

where, $N$ is the final number of germinated seeds and $n_i$, $n_j$ are cumulative numbers of seeds germinated by adjacent counts at days $d_i$ and $d_j$ (d), respectively; when $n_i < N/2 < n_j$. It is expressed in days.

Mean germination times (MGT) was calculated using the following formula (Ellis and Roberts, 1981).

$$MGT = \frac{\sum N_d}{\sum N} \quad (3)$$

Where, $N_d$ is the number of seeds germinated on day $d$, and $d$ is the number of days counted from beginning of germination.

Co-efficient of germination (CoG) and seedling vigor index (SVI) were calculated using the following formula modified from Copeland (1976).

$$CoG = \frac{100 \times (N_i + N_j + \ldots + N_n)}{N_i d_i + N_j d_j + \ldots + N_n d_n} \quad (4)$$

where,$CoG$ = co-efficient of germination, $N_i$, $N_j$ and $N_n$ are the numbers of seeds germinated on $d_i$, $d_j$ and $d_n$ days, respectively, and $d_n$ is the number of days to final count.

$$SVI = \sum \frac{G_{c_1}}{d_{c_1}} + \frac{G_{c_2} - G_{c_1}}{d_{c_2}} + \ldots + \frac{G_{c_n} - G_{c_{(n-1)}}}{d_{c_n}} \quad (5)$$

where, $SVI$ = seedling vigor index, $G_{c_1}$, $G_{c_2}$ and $G_{c_n}$ designate the cumulative seed germination 1st, 2nd and $n$th counts, respectively, and $d_{c_1}$, $d_{c_2}$ and $d_{c_n}$ designate days to 1st, 2nd and $n$th counts, respectively from the date to seed set for germination.

## 2.4 Seedling growth attributes

Seedlings obtained from standard germination test were used for seedling evaluation. Seedling shoot and root length were measured on day 5 of the germination test. Ten plant samples from each Petri dish were harvested and shoot and root length of individual plant were recorded. The shoot and root were also dried at 70 °C for 72 h for dry matter calculation.

## 2.5 Statistical analysis

The collected data on different parameters were statistically analyzed to obtain the level of significance using MSTAT-C package program. The mean differences were compared by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

# 3 Results

## 3.1 Percent germination

The germination percentage of seeds for different treatments varied from 82.67% to 87.50% (Figs. 1 and 3a). Among all treatments, the highest germination (87.50%) was observed in case of off-season Deshi jute (T2). On the other hand, on-season Tossa jute (T3) gave the lowest germination percentage (82.67%). The observed germination percentage of both varieties was well above the minimum standard germination percentage of 80% prescribed for jute (Anonymous, 2003) (Figs. 1 and 2).

## 3.2 Germination vigor indices

In this study mean germination time (MGT), days to 50% germination ($T_{50}$), germination co-efficient and seedling vigor index (SVI) were calculated for different treatments in order to understand speed of germination.

The MGT and $T_{50}$ results are presented in Table 1. The results showed that the differences between different values of MGT for different treatments are insignificant. Similar results were found in case of $T_{50}$. It was noticed that jute seeds started to germinate within one day and most of the seeds germinated by the second day but the MGT for off-season Deshi jute seeds (T2) was slightly lower (2.06 d) compared to the other treatments which indicated slightly higher germination rate in off-season Deshi jute seeds.

On the other hand, significant differences among the treatments were found for both the co-efficient of germination and seedling vigor index (Table 1). The highest vigor index (43.04) and co-efficient of germination (48.60) were observed in off-season Deshi jute seeds. On the contrary, the lowest vigor index (40.53) and co-efficient of germination (48.06) were found in on-season Tossa jute seeds (T3).

## 3.3 Seedling quality

Seedling characteristics such as shoot length, root length, shoot dry weight, root dry weight and ratio of root dry weight and shoot dry weight were measured in different treatments and shown in Fig. 3b∼Fig. 3f, respectively. For all the aforementioned parameters seedlings grown from off-season Deshi jute seeds (T2) exhibited better results compared to the seedlings grown in other treatments. In case of shoot length, it was observed that the results obtained in on-season Deshi jute seeds (T1), on-season Tossa jute seeds (T3) and off-season Tossa jute seeds (T4) were 3.04 cm,

Table 1. Effect of growing season on mean germination time (MGT), days to 50% germination, co-efficient of germination and seedling vigour index (SVI) of Deshi and Tossa jutes

| Treatments | MGT (d) | $T_{50}$ (d) | CoG | SVI |
|---|---|---|---|---|
| On-season Deshi jute seeds (T1) | 2.07 | 1.52 | 48.47 a | 42.85 a |
| Off-season Deshi jute seeds (T2) | 2.06 | 1.52 | 48.60 a | 43.04 a |
| On-season Tossa jute seeds (T3) | 2.07 | 1.53 | 48.06 b | 40.53 b |
| Off-season Tossa jute seeds (T4) | 2.07 | 1.53 | 48.38 ab | 42.06 a |
| SE (±) | 0.0095 | 0.0085 | 0.107 | 0.489 |
| Level of significance† | NS | NS | * | ** |
| CV (%) | 0.92 | 0.44 | 2.33 | 1.11 |

MGT = mean germination time, $T_{50}$ = days to 50% germination, CoV = co-efficient of germination, and SVI = seedling vigor index; † ** and * indicate that the the values in the same column are significantly different at 1% and 5%levels of probability, and NS indicates that the difference is not significant as per Duncan's Multiple Range Test (DMRT).

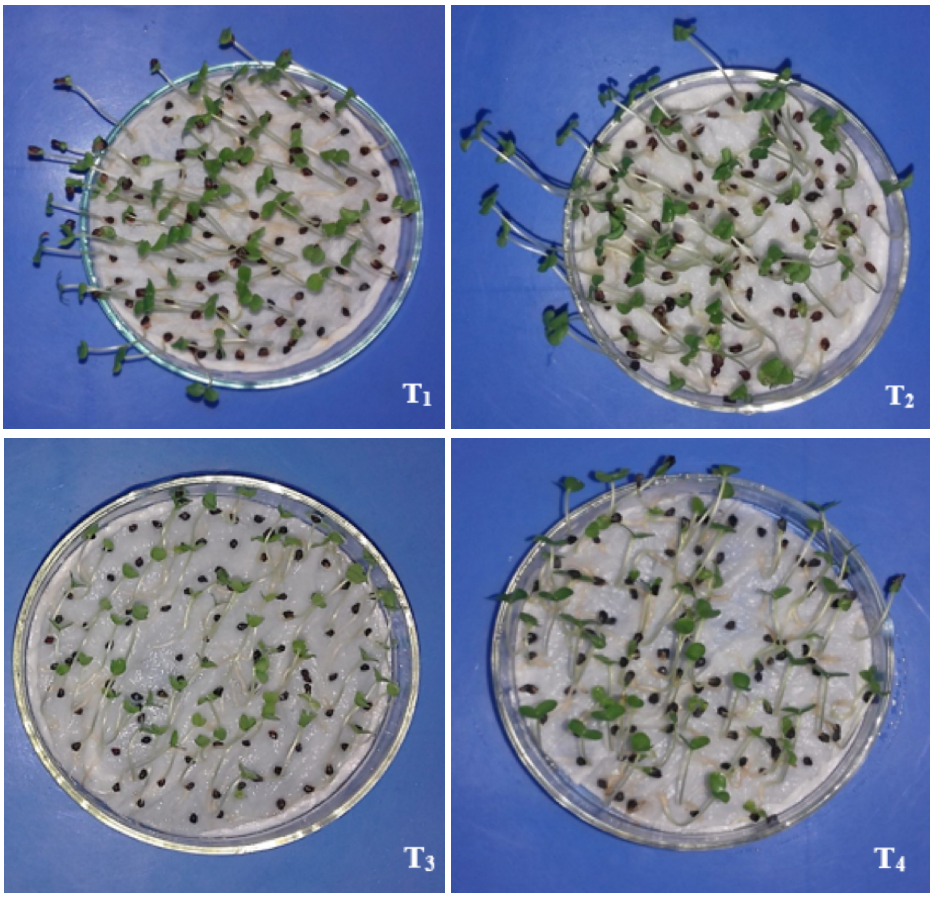


Figure 1. Effect of growing season on germination and seedling growth parameters of Deshi and Tossa jutes. RDW and SDW indicate root dry weight and shoot dry weight, respectively. T1 = On-season Deshi jute seeds, T2 = off-season Deshi jute seeds, T3 = On-season Tossa jute seeds, and T4 = Off-season Tossa jute seeds.

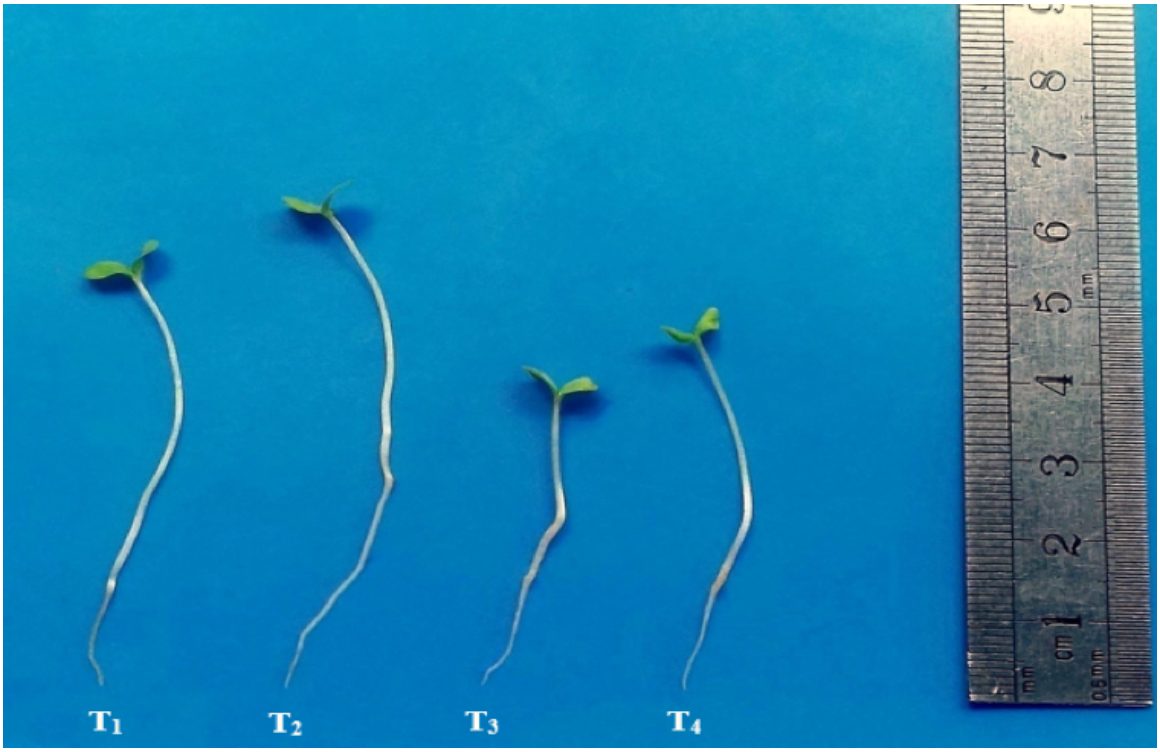


Figure 2. Effect of growing season on seedling growth at day 5 after germination (T1 = On-season Deshi jute seeds, T2 = Off-season Deshi jute seeds, T3 = On-season Tossa jute seeds, and T4 = Off-season Tossa jute seeds)

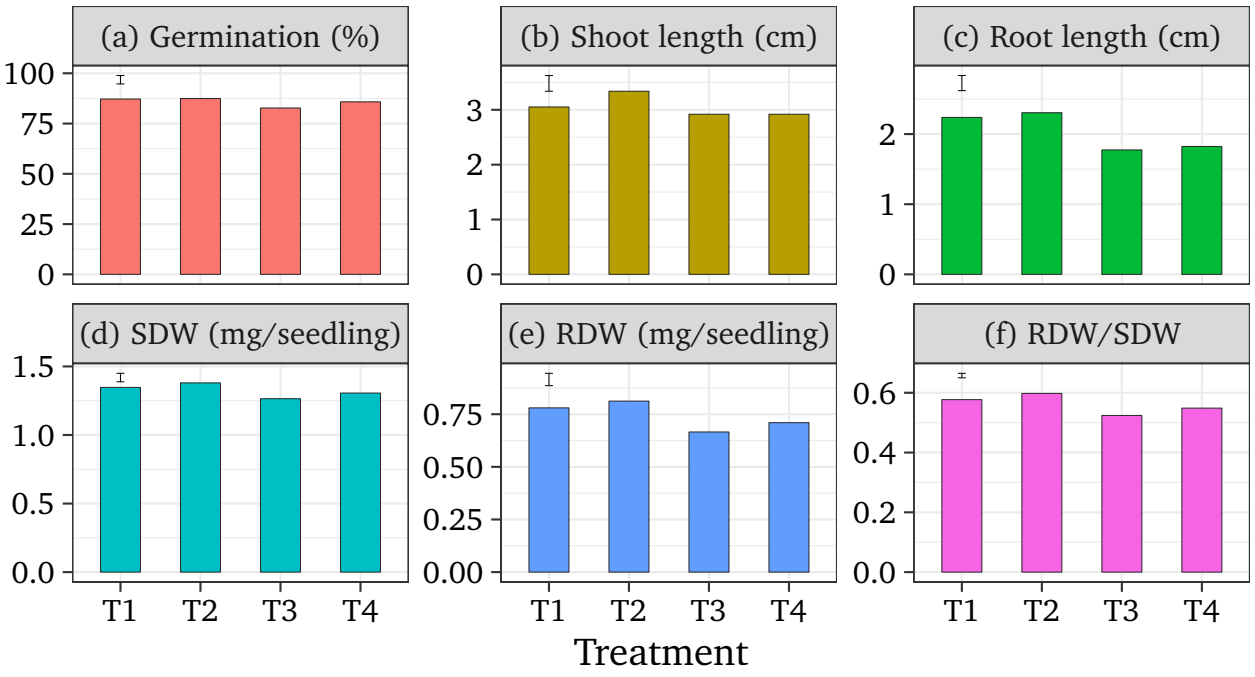


Figure 3. Effect of growing season on germination and seedling growth parameters of Deshi and Tossa jutes. RDW and SDW indicate root dry weight and shoot dry weight, respectively. T1 = On-season Deshi jute seeds, T2 = off-season Deshi jute seeds, T3 = On-season Tossa jute seeds, and T4 = Off-season Tossa jute seeds. The vertical line in a plot indicates least significant mean difference as per Duncan's Multiple Range Test (DMRT).

2.9 cm and 2.91 cm, respectively which were lower than that obtained for off-season Deshi jute seeds (T2) (3.33 cm). In case of root length it was found that the values obtained for on-season Deshi jute seeds (T1), on-season Tossa jute seeds (T3) and off-season Tossa jute seeds (T4) were 2.24 cm, 1.78 cm and 1.83 cm, respectively which were lower than the value obtained for off-season Deshi jute seeds (T2) (2.3 cm). Comparing the results of shoot dry weight it was found that the values obtained for on-season Deshi jute seeds (T1), on-season Tossa jute seeds (T3) and off-season Tossa jute seeds (T4) were 1.35 mg, 1.27 mg and 1.31 mg, respectively which were also lower than that obtained in off-season Deshi jute seeds (T2) (1.38 mg).

In case of root dry weight it was found that the results obtained for on-season Deshi jute seeds (T1), on-season Tossa jute seeds (T3) and off-season Tossa jute seeds (T4) were 0.78 mg, 0.66 mg and 0.71 mg, respectively which were again lower than that obtained in off-season Deshi jute seeds (T2) (0.81 mg). And finally, comparing the values of the ratio of root dry weight to shoot dry weight for different treatments, it was found that the values obtained for on-season Deshi jute seeds (T1), on-season Tossa jute seeds (T3) and off-season Tossa jute seeds (T4) were 0.58, 0.52 and 0.54, respectively which were lower than the values obtained in off-season Deshi jute seeds (T2) (0.598).

## 4 Discussion

Quality seed plays an important role in maximizing the production and productivity of field crops. It ensures higher seed germination, vigorous seedling growth, better quality of produce and higher crop yield (Verma, 2007; Singh, 2011).

Germination of seed is an essential prerequisite for growth and different physiological processes including production or yield of crops. According to Ashraf and Mehmood (1990), seed germination is first crucial and the most sensitive step in the life cycle of plants. In this study, the highest germination percentage was found in off-season produced Deshi jute seeds. The off-season produced Tossa jute seeds also gave higher germination percentage than on-season produced Tossa jute seeds. The results revealed that Deshi jute seeds gave better germination percentage than Tossa jute seeds. Results also showed that off-season seeding jute seeds exhibited higher germination percentage than on-season seeding. Hossain et al. (2013) also found that for both of the varieties CVL-1 and O-9897, off-season produced seeds gave higher germination percentage than on-season produced seeds.

According to Orchard (1977), Mean germination time (MGT) represents the mean time of a seed lot that requires initiate and end germination. The lower will be the value of MGT and days to 50% germination ($T_{50}$) the higher will be the rate of germination. Again, Copeland (1976) took both co-efficient of germination and vigor index into consideration as a measure of speed of gemination. Higher values of co-efficient of germination or vigor index are indicative to higher speed of germination. In this study, insignificant variation was found in case of MGT and $T_{50}$ among the treatments. But in the cases of co-efficient of germination and seedling vigor index, the highest values were found in case of off-season Deshi jute seeds. Based on the results it can be stated that the speed of germination is higher in Deshi jute seeds than that of Tossa jute seeds. It can also be said that the off-season seeding of jute provides higher germination speed than on-season seeding. Ali et al. (2004) also found a significant effect of production season of jute seeds on co-efficient of germination and vigor index while they conducted an experiment with two varieties of Tossa jute seeds.

Early seedling growth is an important stage in the life cycle of plants. In general, shoot length is an important trait for fibre crop because plants with higher shoot length will produce more fibre. In current study, highest shoot length was found in the seedlings grown from off-season Deshi jute seeds. Roots are crucial for water and nutrient acquisition. Deeper roots can extract more water from depth thus avoiding water deficits at critical growth stages which result in higher harvest indices and minimize loss of water by deep drainage (Ludlow and Muchow, 1990). In this experiment, seedlings grown from off-season produced jute seeds gave the highest root length. As stated by Richards et al. (2001), increased early vigor leads to faster and deeper growth of root. Again, higher dry root and shoot weight is a desirable trait. In present experiment in the cases of root dry weight, shoot dry weight and ratio of root and shoot dry weight the seedlings grown from off-season Deshi jute seeds gave the highest values. In case of Tossa jute seeds, for all the aforementioned parameters the off-season produced seeds also gave better results than on-season produced seeds.

## 5 Conclusions

Findings of the present study show that period of seed production of two jute species has significant effect on quality of seed and seedling apart from mean germination time and $T_{50}$. An early germination (2.06 days) with maximum germination percentage (87.50%), minimum time to germinate 50% seeds (1.52 days) and maximum germination co-efficient (48.60) were recorded for off-season Deshi jute seeds. The best seedling performance in respect of shoot length (3.33 cm), root length (2.30 cm), shoot dry weight (1.38 mg), root dry weight (0.813 mg), ratio of root dry weight to shoot dry weight (0.598) and vigor index (43.04) was observed in the seedlings of off-season

Deshi jute seeds. The off-season Tossa jute seeds also performed better in case most of the parameters than the on-season Tossa jute seeds. Based on the results of the present study, it is better to practice off-season production of jute seeds.

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## Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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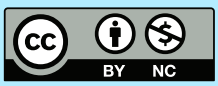




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