



## Effect of seeding date on the tray raised seedling quality for rice transplanter in Boro season

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### ABSTRACT

*Mechanical rice transplanter needs a special type of seedling raised in-tray. Low temperature affected the quality of rice seedlings in Boro season. The purpose of this study was to find out the effect of seeding date on the properties of tray-type seedlings of three rice varieties, namely BRRI dhan86, BRRI dhan89 and BRRI dhan92. This study was conducted in three locations namely Tangail, Rangpur and Gazipur, in the Boro season of 2019-20. Four sowing date and three locations were considered and two factorial randomized completely block design (RCBD) with three replications was followed in the study. This study revealed characteristics of tray-raised rice seedlings suitable for mechanical transplanting in Boro season. Seedling height and leaf number satisfied the requirement of transplanting. Seedling emergence was completed within 10 days after sowing (DAS). Seedling mortality of the tested three varieties started after 25 DAS in all locations. The seedling survival rate of BRRI dhan92, BRRI dhan89 and BRRI dhan86 exhibited the highest differences in different locations. The highest stem thickness of seedlings was observed in all the tested varieties if seeds were sown on the second and third week of December in Gazipur and Rangpur locations and third and fourth week of December in Rangpur location. All the tested varieties showed a stem thickness of more than 1.5 mm. The highest stem strength was obtained if seeds were sown in the tray on the third week of December. Variety showed inconsistent results on stem strength. The second and third week of December is an appropriate seeding time for optimum seedling height, stem strength and stem thickness in three locations. Seeding time affected the seedling emergence, mortality and height in the Boro season due to temperature variations and cold waves.*

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## I. Introduction

Mechanical intervention in various agricultural operations is urgently needed to boost crop production in Bangladesh and fill up the labor gap (Islam et al., 2016). The mechanical transplanter is the option to ensure a faster transplanting operation and minimize the burden of labor shortages in rice cultivation. In conventional manual transplanting practice, 8-12 laborers are required to transplant one acre. However, if a self-propelled rice transplanter is utilized, three individuals can transplant up to four acres in a day (CSISA, 2015). Under cold stress, rice is more sensitive than other cereal crops such as wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.) (Zhang et al., 2014). By and large, in Bangladesh, the Boro rice nursery remains in the field from mid-November to January. Low-temperature stress affects the Boro rice nursery during the seedling stage in the winter season. Rice showed sensitivity to extreme temperature during particular developmental stages (Dingkuhn et al., 1995). Plants that are cold tolerant at the seedling stage can produce more than susceptible genotypes as a higher survival percentage of genotypes at the seedling stage ensures an optimum plant population in the field. Yoshida et al. (1981) reported that for rice seed germination, the critical temperature is 10°C and for normal germination and early seedling growth in rice varieties is between optimum temperature 20-35°C. Pathak et al. (1999) detailed that at the rice seedling stage, low-temperature stress leads to poor germination, stunted seedling growth, poor seedling vigor, chlorosis of seedling, and seedling mortality. According to Ye et al. (2009), in cold temperatures, the growth of rice plants is reduced at any developmental stage from germination to grain filling. The low-temperature results in poor seedling establishment, stunting, yellowing, and high seedling mortality and shows various symptoms of cold injury such as chlorosis, necrosis or growth retardation. Cruz and Milach (2004) stated that cold tolerance at the seedling stage is an important characteristic for stable rice production, especially in direct seeding rice fields. The reduction in the coleoptile length under the low temperature of 18°C helped distinguish the tolerant genotypes and sensitive ones (Farzin et al., 2013).

To overcome the problem of damage caused by low temperature, rice breeders are making efforts to develop more cold-tolerant cultivars at the seedling stage (Smita et al., 2014). The critical temperature for root development is 12 to 16°C, for shoot development is 7 to 16°C and for the shoot and root development is 10°C (Basuchaudhuri, 2014). Low temperature affects the seedling establishment and mortality. Therefore, cold stress at the seedling stage is a significant constraint in Boro rice production (Priyanka and Jaiswal, 2017). Seedling height and root formation are also retarded due to low-temperature conditions. Cold stress can directly impact rice plants during germination, vegetative growth, and reproductive stages (Javeed et al., 2018). Optimum seedling height, number of leaves, stem thickness, shoot dry weight, root-shoot ratio, and seedling strength indicated the seedling quality. In tray-type seedlings, the suitable root formation is a prerequisite for making good mats for mechanical transplanter. The success of a rice transplanter depends on the quality of the seedlings and the density of seedlings in the tray has a significant effect on the quality of seedlings (Runsick and Wilson, 2009). Temperature variation was observed at the seedling stage in the Boro season. The sowing date is an essential factor in growing healthy seedlings in a tray. In view of the above information, the experiment was conducted to explore the effect of sowing date on trays on the characteristics of seedlings in the Boro season of three BRRI rice varieties.

## II. Materials and Methods

The experiment was conducted in Gazipur, Tangail, and Rangpur locations. Seeds from three Boro rice varieties BRRI dhan86 (V1), BRRI dhan89 (V2), and BRRI dhan92 (V3) were used for this experiment. Shaikh et al. (2021) observed that the seeding rate of 150 - 160 g tray<sup>-1</sup> was found better for raising mat-type seedlings suitable for mechanical transplanting. Therefore, the seeds rate was maintained as 150g in each tray. Sprouted seeds from each variety were sown on 08 December 2019 (DS1), 13 December 2019 (DS2), 18 December 2019 (DS3), 23 December 2019 (DS4) in Gazipur; 10 December 2019 (DS1), 15 December 2019 (DS2), 20 December 2019 (DS3), 25 December 2019 (DS4) in Rangpur district and 06 December 2019 (DS1), 11 December 2019 (DS2), 16 December 2019 (DS3), 21 December 2019 (DS4) in Tangail. The investigation followed two factorial randomised complete block designs (RCBD) with three replications.

Good quality seeds were collected from Biotechnology Division of BRRI, Gazipur. Seeds were sun-dried for one day and cleaned to remove impurities. Dry seeds were immersed in water to remove the impurities and unfilled grain. Seeds were treated with Autostin (e. i. Carbendazim) powder mixed with water to protect the seed from seed-borne diseases. Seed germination percentage was checked (>95%). Vigorous seeds were chosen by the specific gravity method. They were soaked in water for 24 hrs and placed in gunny bags to create a warm environment for sprouting. Seeds started to germinate within 48 hrs and those were sown after 72 hrs. The soil was taken from a weed-free field and sieving was done to remove any kind of stones, gravels, and roots from the soil. A wooden piece was used to break the clods. Plastic trays (580×280×25 mm) were used to frame for formation of the seedling mat. One layer of soil was spread on the tray and level using a leveller. [Anoop et al. \(2007\)](#) stated that the thickness of the mat is about 20 mm for best results in raising seedlings. Therefore, the mat-type seedlings were raised with 20 mm thick sieved soil. Sprouted seeds were broadcasted uniformly on the soil of each tray.

After sowing the seeds, a thin layer of fine and loose soil is spread on the seeds to a depth of 5 mm and the trays are kept in the shade. After two days, the tray is left in the field, irrigated by sprinkler method and the excess water is allowed to drain. Water was sprayed twice a day until seed emergence was complete. They were covered with polythene to protect the trays from cold harm and fowl. To keep poultry and livestock out, fences with nets were erected.

The trays were covered with polythene to protect them from cold sores and poultry. Seedlings were covered by polythene sheet at night time. Temperatures were recorded outside and inside the polythene cover at 6 hours intervals. Temperatures were recorded at every two days interval in three different locations stated before and daytime, night, inside and outside the polythene in-tray. The cold wave was recorded whenever it happened and managed by covering trays with plastic sheets at night. Seed germination, number of seeds, and seedling emergence per unit area were counted every five days of seedling raising. A 400 mm<sup>2</sup> metal sheet box was placed in three places in each tray to determine the seedling emergence, seedling mortality, and seedling density. Seedling height was measured every five days (from 5 to 30 days). The scale was used to measure the seedling height. The total number of fully opened green leaves was counted every five days (from 5 to 30 days) and mean per plant was computed. Vernier caliper was used for measuring stem thickness of 30 days seedling. Seedling strength was measured by dry weight of shoots in mg to the length of shoots per 10 mm and expressed as mg 10 mm<sup>-1</sup>. Randomly ten plants from each tray were collected and dried in the oven for seedling strength measurement. According to [Gomez and Gomez \(1984\)](#), data were analyzed as a two factorial design (variety × seeding date) using Crop Stat 7.2 software ([IRRI, 2007](#)). Least significant difference (LSD) test was done to compare the means.

### III. Results and Discussion

#### Temperature profile

The temperature during the experimental period in the three study locations were shown in figures 01 to 6. Low temperature, cold waves and foggy weather existed during the experimental period. Temperature fluctuation was observed day and night in all the study locations ([Figure 01](#), [Figure 02](#), [Figure 03](#) and [Figure 04](#)). The lowest night temperature (12°C) was observed on 18-20 December and 13°C on 24 December and 9 January in Gazipur. The minimum day temperature of 10°C was recorded from 25 to 30 December in Rangpur. The lowest 11°C temperature existed most of the days in Tangail location. Temperature variation (at least 2°C) was observed inside and outside the polythene cover ([Figure 05](#) and [Figure 06](#)).

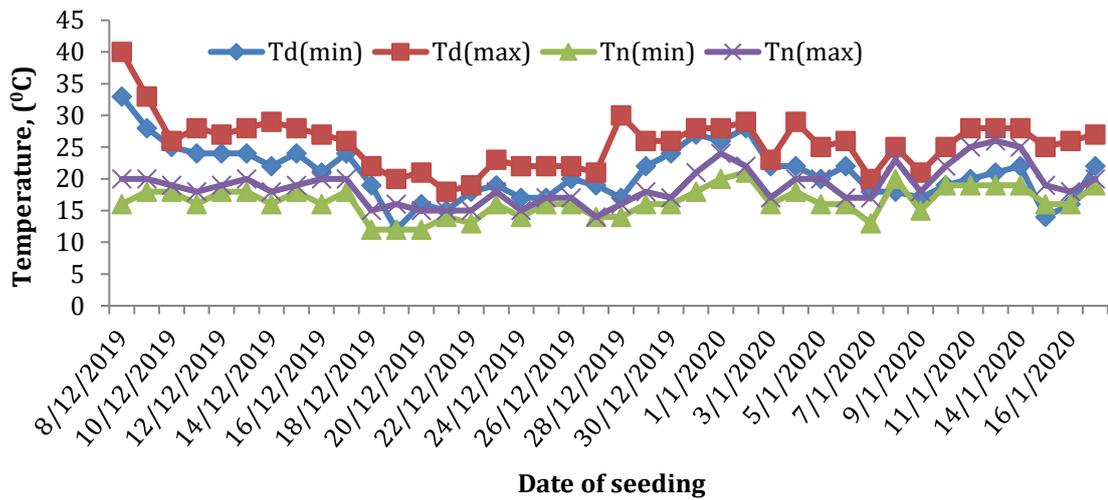


Figure 01. Day and night temperature during the experimental period in Gazipur location

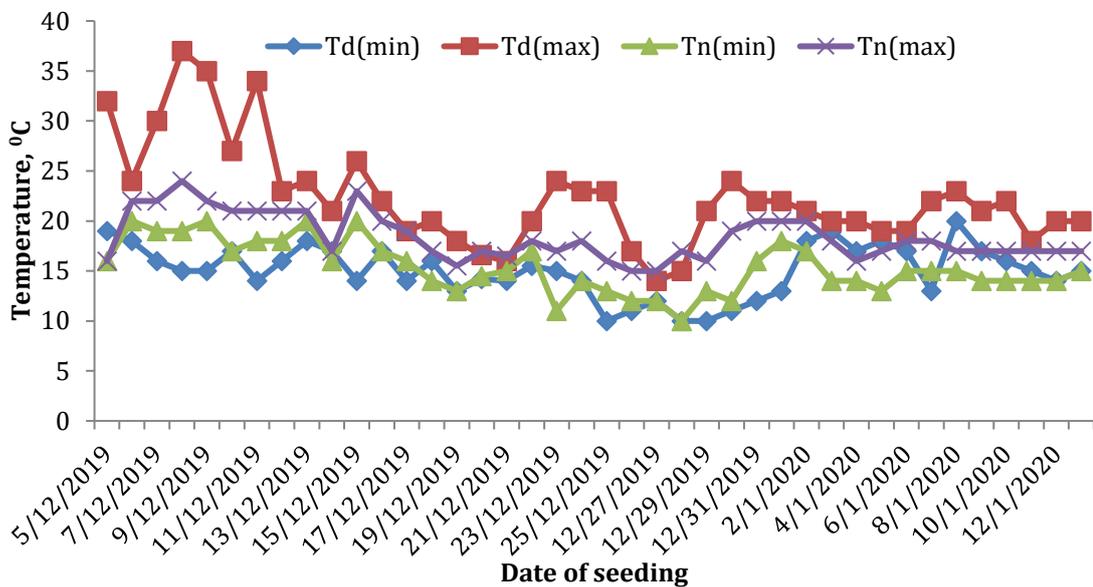


Figure 02. Day and night temperature during the experimental period in Rangpur location

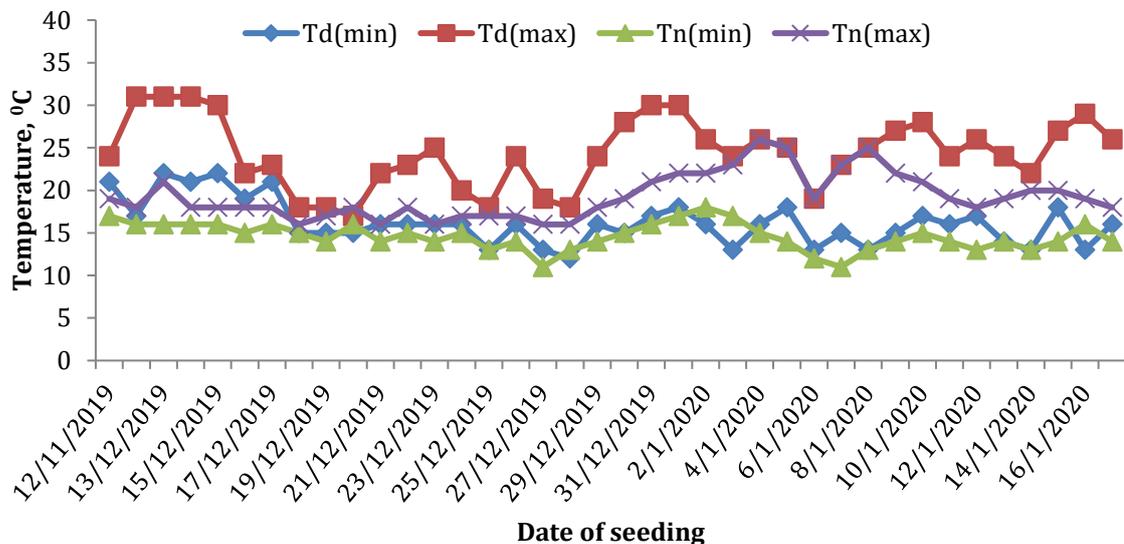
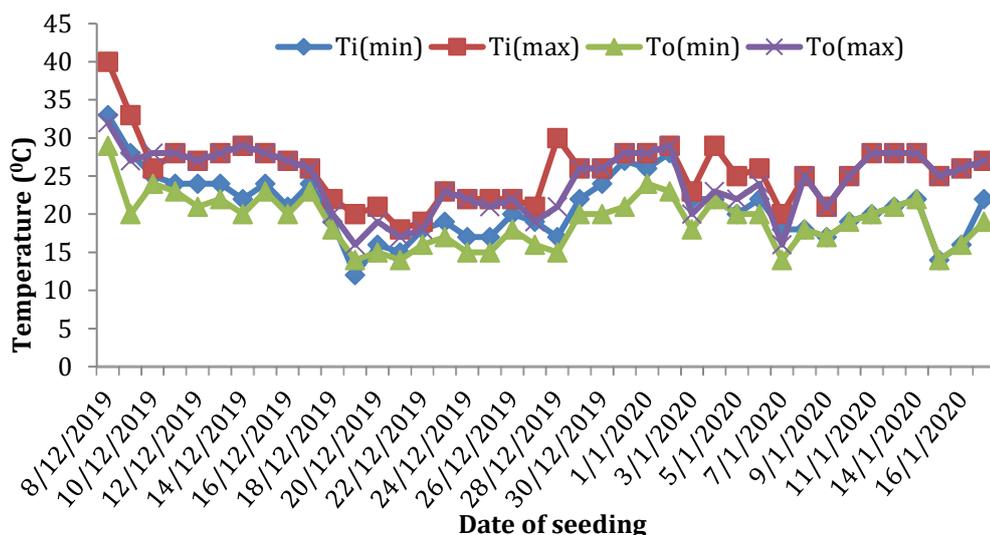
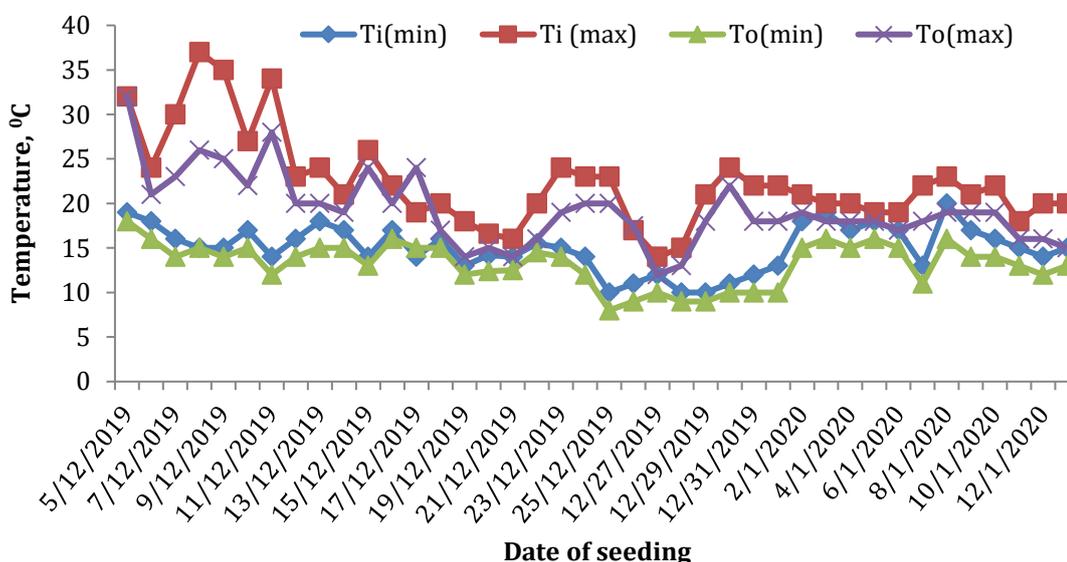


Figure 03. Day and night temperature during the experimental period in Tangail location

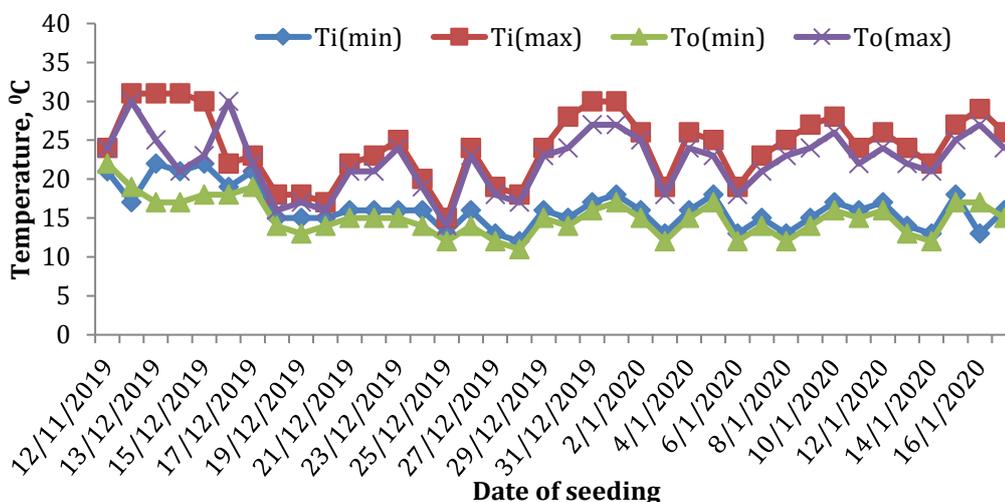
Note: Td(min): Minimum day temperature; Td(max): Maximum day temperature; Tn(min): Minimum night temperature; Tn(max): Maximum night temperature



**Figure 04. Inside and outside temperature of the seedbed cover during the experimental period in Gazipur location**



**Figure 05. Inside and outside temperature of the seedbed cover during the experimental period in Rangpur location.**



**Figure 06. Inside and outside temperature of the seedbed cover during the experimental period in Tangail location**

Note: Ti(min): Minimum inside temperature of day; Ti(max): Maximum inside temperature of day; To(min): Minimum outside temperature of day; To(max): Maximum outside temperature of day

### Seedling emergence

The effect of seeding date on seedling emergence in three study locations was shown in [Figure 07](#). Seedlings of all varieties emerged within 5 days of seeding at Gazipur and Rangpur locations. However, in Tangail location, seedlings started to emerge after 10 days of seeding if seeds were sown on 20-25th December. It might be due to severe cold. [Kamruzzaman et al. \(2014\)](#) mentioned that pre-germinated seeds cannot emerge quickly until passing a period of optimum temperature and humidity. Low temperature affects the physiological damage of plants, including low germination rate and stunted growth ([Zhang et al., 2014](#)). Seedling emergence completed within 10 DAS except at Tangail location. Seedling mortality of the tested three varieties started after 25 DAS in all locations. The seedling survival rate of BRRi dhan92, BRRi dhan89 and BRRi dhan86 exhibited the highest if seeds were sown on 13<sup>th</sup> December at Gazipur and 15<sup>th</sup> December in Rangpur location. The survival rate of BRRi dhan86, BRRi dhan89, and BRRi dhan92 showed the highest if seeds were sown on 21<sup>st</sup> December at Tangail location, although seedlings emerged lately, i.e. at 10 DAS.

### Seedling height

The effect of seeding date on seedling height in three study locations was shown in [Figure 08](#). In Gazipur location, the highest seedling height (96–103 mm) was observed at 25-30 DAS if seeds were sown on 13 and 18 December. The highest seedling height was observed (80 - 96 mm) at 25-30 DAS if seeds were sown on 15 and 20 December at Rangpur location. In Tangail location, the highest seedling height (76-85 mm) was obtained at 25-30 DAS if seeds were sown on 15 December. However, seedling height < 80 mm was obtained if seeds were sown on 10, 20, and 25 December at Tangail location. Stunted growth was observed at Tangail location. It might be due to low temperature. [Zhang et al. \(2014\)](#) stated that low temperature affected the seedling height. The highest seedling height at 25 - 30DAS were matched the requirement of mechanical transplanter. Optimum seedling height is the prerequisite of the mechanical transplanter ([Islam, 2018](#)). The author also mentioned that the optimum height of seedling should be 100-120 mm during Aman season. However, seedling height should not be less than 80 mm in Boro season. Seedling height having less than 80 mm increased the buried hill during mechanical transplanting.

### Leaf number

[Table 01](#) showed the effect of seeding time on leaf number for the tested rice variety in three locations. Time of seeding showed a non-significant effect on leaf number. In all locations, 3 leaves were found for all the time of seeding at 20 DAS. In all locations, 4-5 leaves were found for all dates of seeding at 25-30 days, suitable for mechanical rice transplanter.

### Stem thickness

The stem thickness decreased in late seeding at Tangail location ([Table 02](#)). It might be due to low temperature. The highest stem thickness (1.49mm) was found for DS3 (18 December) at Gazipur. The highest stem thickness (2.39mm) was found for DS1 (10 December) at Rangpur location. In Tangail, the highest stem thickness (1.44mm) was found for DS3 (20 December). For different DS, the highest stem thickness was found at Rangpur (2.00–2.39mm) followed by Gazipur (1.37–1.49mm). The thickness of the stem was less than in the other two places at Tangail. BRRi dhan86 showed the highest stem thickness (1.47 mm) at Gazipur location, followed by BRRi dhan92 (1.44 mm). BRRi dhan89 and BRRi dhan92 showed the highest stem thickness (2.21 mm) at Rangpur followed by BRRi dhan86 (2.08 mm). BRRi dhan92 exhibited the highest stem thickness (1.43 mm) at Tangail location, followed by BRRi dhan86 (1.37 mm). Every variety exhibited the highest stem thickness of 2.08–2.21 mm at Rangpur location, followed by 1.40-1.47 mm at Gazipur location. Every variety showed the lowest stem thickness at Tangail location (1.33-1.43mm). It might be due to the low temperature prevailing in the experimental location. The force exerted by the picker may damage the stem of seedlings. The highest stem thickness of seedling was found in all varieties for DS3 (18 December) at Gazipur, DS1 (10 December) at Rangpur, and DS3 (16 December) at Tangail location. The highest stem thickness was observed for BRRi dhan86 in DS3 (18 December) at Gazipur, BRRi dhan92 in DS1 (10 December) at Rangpur and BRRi dhan86 and BRRi dhan92 in DS3 (16 December) at Tangail location. The highest stem thickness of seedling (2.21 mm) was observed in BRRi dhan92 and BRRi dhan89 at Rangpur location.

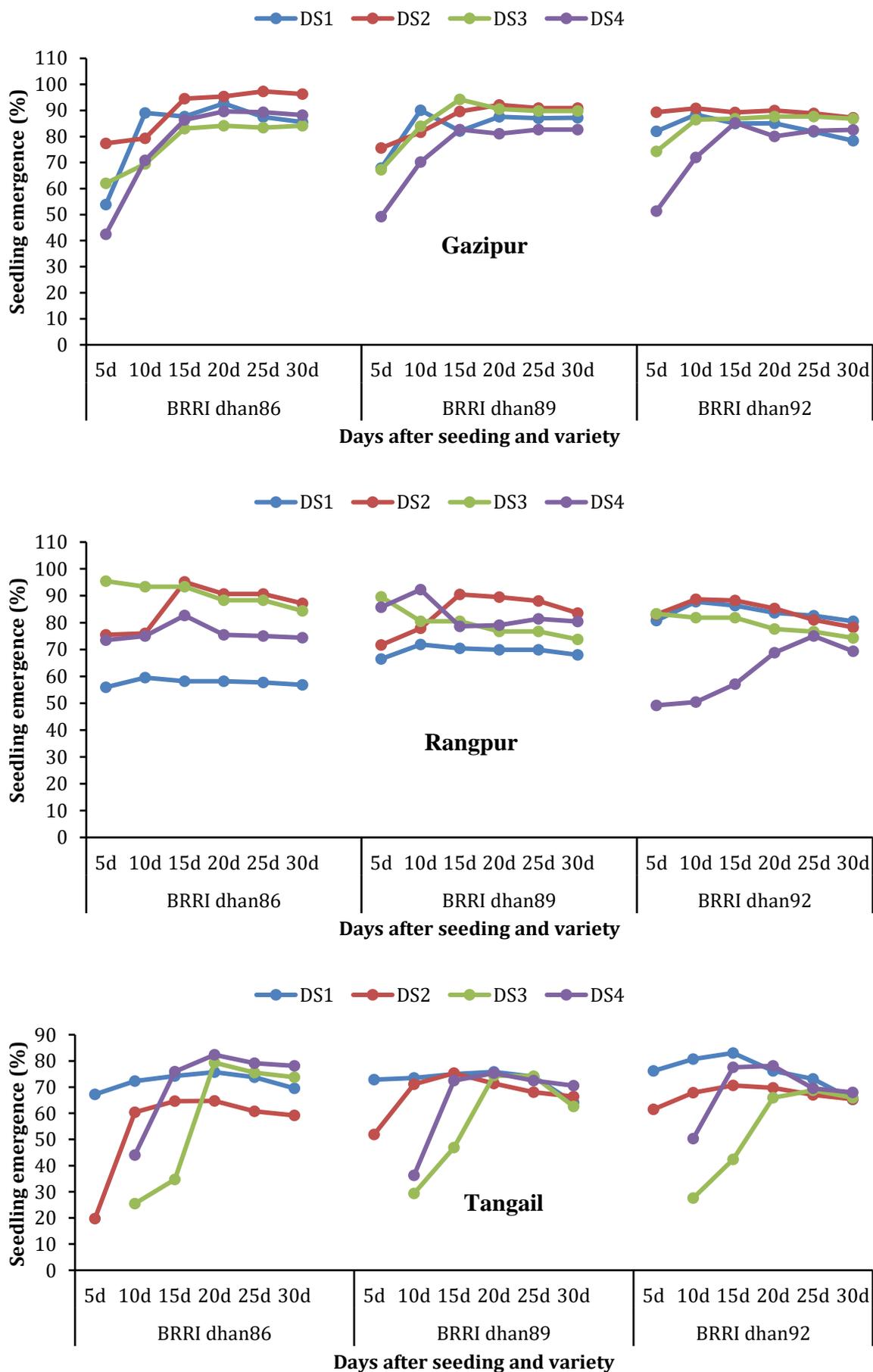


Figure 07. Effect of seeding date on seedling emergence

Effect of seeding date on the tray raised seedling

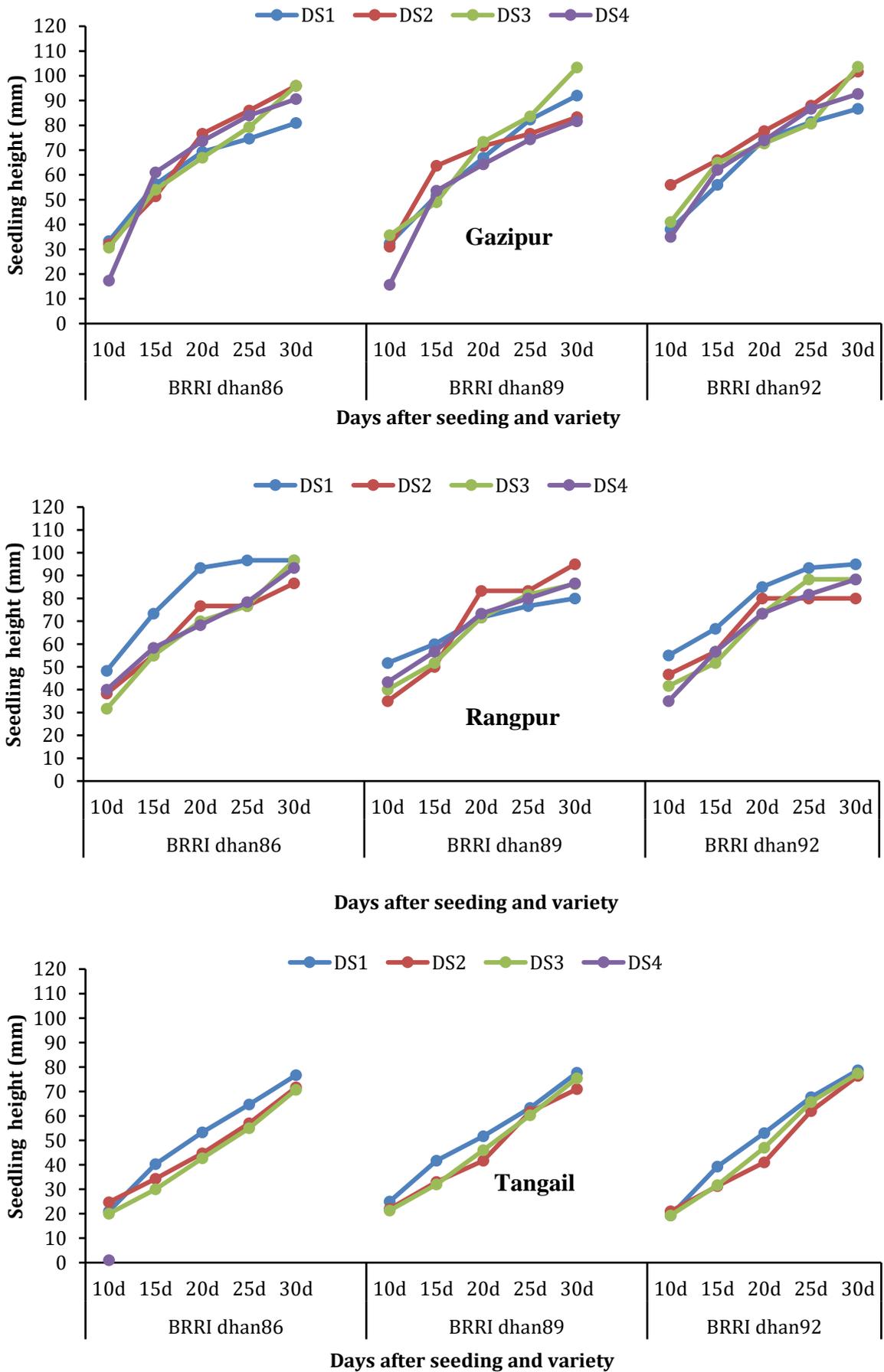


Figure 08. Effect of seeding date on seedling height

**Table 01. Effect of seeding date on seedling emergence**

Location	Treatment	Leaf count, no.				
		10DAS	15DAS	20DAS	25DAS	30DAS
Gazipur	<b>Date of seeding</b>					
	08 December	1.33	1.96	2.87	4.00	5.00
	13 December	1.21	2.00	3.00	4.00	5.00
	18 December	1.03	2.16	3.00	4.00	5.00
	23 December	1.00	2.00	3.00	4.00	5.00
	LSD (P=0.05)	0.11	0.12	0.08	0.00	0.00
	<b>Variety</b>					
	BRRi dhan86	1.17	2.12	3.00	4.00	5.00
	BRRi dhan89	1.13	1.97	2.92	4.00	5.00
	BRRi dhan92	1.14	2.00	2.98	4.00	5.00
	LSD (P=0.05)	0.10	0.10	0.07	0.00	0.00
Interactions LSD (P=0.05)	0.20	0.20	0.15	0.00	0.00	
Rangpur	<b>Date of seeding</b>					
	10 December	1.67	2.67	2.67	4.00	5.00
	15 December	1.56	2.11	3.00	4.00	5.00
	20 December	1.33	2.11	3.00	4.00	5.00
	25 December	1.56	2.00	3.00	4.00	5.00
	LSD (P=0.05)	0.58	0.31	0.23	0.00	0.00
	<b>Variety</b>					
	BRRi dhan86	1.58	2.17	2.92	4.00	5.00
	BRRi dhan89	1.42	2.08	2.83	4.00	5.00
	BRRi dhan92	1.58	2.42	3.00	4.00	5.00
	LSD (P=0.05)	0.50	0.27	0.19	0.00	0.00
Interactions LSD (P=0.05)	1.00	0.54	0.39	0.00	0.00	
Tangail	<b>Date of seeding</b>					
	06 December	1.00	2.00	3.00	4.00	5.00
	11 December	1.00	2.00	3.00	4.00	5.00
	16 December	1.00	2.00	3.00	4.00	5.00
	21 December	1.00	2.00	3.00	4.00	5.00
	LSD (P=0.05)	0.00	0.00	0.00	0.00	0.00
	<b>Variety</b>					
	BRRi dhan86	1.00	2.00	3.00	4.00	5.00
	BRRi dhan89	1.00	2.00	3.00	4.00	5.00
	BRRi dhan92	1.00	2.00	3.00	4.00	5.00
	LSD (P=0.05)	-	-	0.00	0.00	0.00
Interactions LSD (P=0.05)	0.00	0.00	0.00	0.00	0.00	

**Table 02. Effect of variety and seeding date on stem thickness, mm**

Variety	Gazipur location					Rangpur location					Tangail location				
	DS1	DS2	DS3	DS4	Avg.	DS1	DS2	DS3	DS4	Avg.	DS1	DS2	DS3	DS4	Avg.
BRRi dhan86	1.43	1.47	1.57	1.40	1.47	2.17	2.00	2.17	2.00	2.08	1.20	1.37	1.50	1.40	1.37
BRRi dhan89	1.50	1.40	1.40	1.30	1.40	2.33	2.00	2.17	2.33	2.21	1.30	1.37	1.33	1.30	1.33
BRRi dhan92	1.47	1.40	1.50	1.40	1.44	2.67	2.00	2.00	2.17	2.21	1.33	1.40	1.50	1.50	1.43
Average	1.47	1.42	1.49	1.37	1.44	2.39	2.00	2.11	2.17	2.17	1.28	1.38	1.44	1.40	1.38
LSD at 5%	0.06					0.46					0.20				

### Stem strength

Stem strength showed a significant effect on the date of seeding (Table 03). Delayed seeding increased the stem thickness in Tangail and Rangpur locations. DS3 (18 December) showed the highest stem strength (1.04 mm cm<sup>-1</sup>) at Gazipur location. In Rangpur, the highest stem strength (1.28 mm cm<sup>-1</sup>) was found for DS3 (20 December). In Tangail, highest stem strength (1.79 mm cm<sup>-1</sup>) was found for DS4 (21 December). For all the different DS, the highest stem strength was found at Tangail (1.21 mm cm<sup>-1</sup>) followed by Rangpur (1.09 mm cm<sup>-1</sup>) and Gazipur (0.95 mm cm<sup>-1</sup>) location. Variety showed a significant

effect on stem strength at Tangail and Rangpur locations. BRRI dhan86 exhibited significantly the highest stem strength (1.27 mm cm<sup>-1</sup>) and the lowest in BRRI dhan92 (1.16 mm cm<sup>-1</sup>) at Tangail location. BRRI dhan92 and BRRI dhan86 showed the highest stem strength (1.19 and 1.15 mm cm<sup>-1</sup>) in Rangpur location and the lowest in BRRI dhan89 (0.94 mm cm<sup>-1</sup>). Among the locations, each variety under this study showed the highest stem strength (1.16–1.27 mm cm<sup>-1</sup>) at Tangail location. Stem strength of every variety exhibited the lowest stem strength that Gazipur location than the other two locations. Varieties with high stem strength can protect against seedling damage when picking the seedlings in mechanical transplanting.

**Table 03. Effect of variety and seeding date on stem strength, mm cm<sup>-1</sup>**

Variety	Gazipur location					Rangpur location					Tangail location				
	DS1	DS2	DS3	DS4	Avg.	DS1	DS2	DS3	DS4	Avg.	DS1	DS2	DS3	DS4	Avg.
BRRI dhan86	1.00	0.92	0.88	0.96	0.94	1.31	0.85	1.27	1.16	1.15	1.05	1.18	1.06	1.81	1.27
BRRI dhan89	0.92	0.75	1.13	1.06	0.97	0.60	0.74	1.19	1.25	0.94	0.76	0.86	1.11	2.00	1.18
BRRI dhan92	0.97	0.82	1.10	0.95	0.96	1.08	1.02	1.39	1.28	1.19	0.90	1.12	1.06	1.56	1.16
Average	0.96	0.83	1.04	0.99	0.95	1.00	0.87	1.28	1.23	1.09	0.90	1.05	1.08	1.79	1.21
LSD at 5%	0.22					0.26					0.68				

#### IV. Conclusion

Temperature is the main driving force for the development of rice seedlings. For higher seed survival, seeds should be sown in the tray on 21<sup>st</sup> December at Tangail location, within 13<sup>th</sup> December at Gazipur location and on 15<sup>th</sup> December at Rangpur location. Stunted seedling growth was observed in Tangail location due to low temperature. The second and third week of December is an appropriate seeding time for optimum seedling height. Every rice variety exhibited 4-5 leaves at 25-30 days after seeding and satisfied the transplanting requirement. Stem thickness and stem strength depended on the seeding time. Stem thickness increased in early seeding. The highest stem thickness of seedling (2.21 mm) was observed in BRRI dhan92. The highest stem strength of seedling was found in all varieties for days after seeding on 20 December (DS3) at Rangpur and 20 December (DS3) at Gazipur and 25 December (DS4) in Tangail location. Variety showed inconsistent results on stem strength. Lower temperature and cold waves affected the seedling emergence, seedling survival, seedling height, stem thickness, and stem strength in the Boro season. As similar low temperature does not prevail every year, this study should be repeated in the same places for more years to confirm the results.

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