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Effect of Polythene Covering on Seedling Quality and Its Carryover Effect on Field Duration and Grain Yield of Rice

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ABSTRACT

Boro rice cultivation is often limit due to lack of a farmer's friendly technique for raising quality seedling in irrigated ecosystem. Experiment was conducted in Boro 2019-20 at BRRI RS, Rangpur to compare different polythene covering treatment on raising quality seedling of BRRI dhan88 and BRRI dhan89 and to measure its carryover effect on growth duration and grain yield of rice. The treatments were as T_1: Day polythene cover (from10:00 am to Sunset), T_2: Night polythene cover (Sunset to Sunrise), T_3: Day-night polythene cover but round shape opening (30 cm diameter) at both sides and T_4: No polythene cover (control). Seedbed was covered by transparent polythene from seeding to 30 days after seeding (DAS). Seedling strength was higher on 01 December seeding than 15 December in both the tested varieties. Day cover always had the lowest seedling strength in both the varieties. Day-night polythene cover treatment (T_3) produced significantly tallest seedling than the other polythene covering treatments for both the planting dates. Seedling mortality was higher in 30 January planting than 15 January planting for both the tested varieties due to prevailing low temperature (below 10°C for eight days). In 15 January planting, BRRI dhan88 and BRRI dhan89 produced higher number of tillers with day cover and night cover treatment, respectively. In 30 January planting, BRRI dhan88 produced higher tiller with day-night and control treatment but day cover had the lowest. Tiller production rate was sharply increased from 35–45 DAT and then decreased. Up to 45 DAT, it was statistically similar in both the varietiers with all treatments. Although, tiller number was higher in T_1, T_2 and T_4 than T_3 but productive tiller (%) was satistically similar among the treatments for both the varieties and planting dates. There was no significant difference in grain yield among the treatments for planting dates and varieties. Day-night polythene cover treatment (T_3) reduces growth duration by 2-3 days over other treatments. This treatment (T_3) is farmer's friendly for raising quality seedling in cold prone areas of Bangladesh.

INTRODUCTION

Temperature is one of the major factors for seedling growth especially in northern part of Bangladesh during Boro season. Northern part is relatively cooler and farmers' normally transplanted Boro rice from last week of January to February with aged seedling. Those who seeding at 1st week of December, seedlings are not affected by cold but who seeding from 2nd week of December, seedlings are affected by cold and became unable to transplant Boro rice timely. Low temperature in vegetative stage can cause slow growth and reduce seedling vigour (Ali *et al.*, 2006), lower number of seedlings (i.e. poor establishment), reduce tillering (Shimono *et al.*, 2002) increase plant mortality (Farrell *et al.*, 2006, Baruah *et al.*, 2009, Fujino *et al.*, 2004), increase the growth period (Alvarado and Hernaiz 2007). The optimum temperature for rice growth and development is 25-30°C. When temperature below as 10-12°C, often cause injury to vegetative organs, creating leaf chlorosis or

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damping-off in rice plants (Tajma, 1995). Quality seedling influences not only the speed of initial growth but also rooting especially under low temperature in transplanting time (Nishiyama, 1995). During cold spell, drain out the water at morning and again irrigate the seedbed, to remove dew on upper part of seedling and seedbed cover with transparent polythene from 10:00 am to sunset may reduce the cold injury in seedlings. But all are not farmers' friendly and there is also some controversy in seedbed covering by transparent polythene sheet at day or night time. So, it needs to develop a farmers' friendly seedling protecting technique during Boro season of Bangladesh.

MATERIALS AND METHODS

A field experiment was conducted at Bangladesh Rice Research Institute, Regional Station, Rangpur experimental farm during winter and irrigated ecosystem in 2019-20. Sprouted seed (80g m^{-2}) were seeded in the puddled seedbed on 1 and 15 December 2019. Seedbed size was 1.0 m × 3.0 m. Seedling age of normal seedbed (control) was also 45 days. No fertilizer was use in seedbed. Experiment was laid out in a factorial randomized complete block design (RCBD) with three replications using plot size of 3.0 m × 3.0 m. The treatments were as T_1: Day polythene cover (from 10:00 am to Sunset), T_2: Night polythene cover (Sunset to Sunrise), T_3: Day-night polythene cover but round shape opening (30 cm diameter) at both sides and T_4: No polythene cover (control). Seedbed was covered by transparent polythene from seeding to 30 DAS (days after seeding). Seedlings were hardened from 30 DAS to 45 DAS. Forty-five-day-old seedlings were transplanted at a spacing of 20 cm × 20 cm with single seedling per hill at 15 and 30 January 2020. At the time of transplanting, fertilizer was used as 120 kg N, 18 kg P and 75 kg K, 25 kg S and 3.6 kg Zn per hectare. Fertilizer N was splitted apply at 20, 35 Days After Transplanting (DAT) and before panicle initiation, respectively. Fertilizer P, K, S and Zn was applied at basal. Weeds, insects and diseases were controlled as when required to avoid yield loss.

Measurements and methods

Seedling strength Ten seedlings were randomly uprooted from each seedbed at 45 DAT in both the planting dates. Then the seedling height (cm) was measured from the base to tip of the seedling. Root of the seedlings were cut and removed from the base and oven dried at 70°C for 72 hrs and dry matter (mg) was weighted. Seedling strength was calculated from the following formula:

Seedling strength (mg/cm) = Dry weight of seedling (mg)/height (cm) of seedling

Seedling mortality (%): (Number of dead seedling in a plot/total number of seedling in a plot)*100. It was taken at 25 DAT in both the plantings.

Tillering pattern: It was started from 25 DAT and continues up to 55-65 DAT with 10 days interval. It was counted 2 × 2 hills from three spot in each plot and expressed as tiller number m^{-2}.

Productive tiller rate (PTR) was calculated as: (Number of panicles m^{-2} /number of maximum tillers m^{-2}) × 100.

Growing degree days (GDD) was calculated following Rajput (1980).

GDD = Σ [(Tmax + Tmin)/2-Tb]. Here, (Tb = Base temperature = 10°C). Where, Tmax = Maximum temperature, Tmin = Minimum temperature.

Plant height: It was measured from the base of the plant to tip of the panicle at harvest.

The crop reached maturity when 90% of the spikelets turned from green to yellow.

Data analysis

Statistical analyses were performed using Statistix 8, Analytical software, Tallahassee, FL, USA. Means of cultivation methods were compared according to the least significant difference test (LSD) at the 0.05 probability level. Figures were performed using MS Excel 2003.

RESULTS AND DISCUSSIONS

Ambient and inner air temperature of different polythene cover treatment

Cold didn't affect the seedling of 1 December seeding. So, outer and inner temperature was recorded from 15 December seeded plot.

Day vs day-night cover

Inner air temperature of day cover (T_1) was always higher than day-night cover (T_3) at 11:00am. It was 3.4°C and 2.1°C higher than ambient air temperature and day-night cover, respectively. Day-night cover had 1.3°C higher than ambient air temperature. Similarly, inner air temperaturewas 1.2°C and 0.6°Chigher than ambient air temperatureand day-night cover, respectively, at 5:00 pm. Day-night cover had 0.6°C higher than ambient air temperature (Table 1).

Table 1. Difference of ambient air and inner temperature of seedbed by polythene cover, Rangpur, Boro 2019-20.

Day	Temperature (°C)					
	11:00 am			5:00 pm		
	Outside polythene cover	Inside polythene cover		Outside polythene cover	Inside polythene cover	
		Day cover	Day-night cover		Day cover	Day-night cover
15 Dec 2019	24.0	26.0	26.0	22.0	23.0	23.0
16 Dec 2019	20.0	22.0	20.0	18.0	20.0	18.0
17 Dec 2019	21.0	24.0	21.0	18.0	18.0	18.0
18 Dec 2019	15.5	16.5	16.3	16.5	17.0	16.8
19 Dec 2019	14.8	15.5	15.0	15.0	16.0	15.8
20 Dec 2019	14.5	15.0	14.5	14.5	15.0	14.8
21 Dec 2019	14.0	14.5	14.2	14.5	15.0	14.7
22 Dec 2019	16.0	16.5	16.2	16.0	17.0	16.8
23 Dec 2019	19.0	20.0	19.8	18.8	20.0	19.5
24 Dec 2019	16.4	19.5	19.0	19.5	21.0	20.0
25 Dec 2019	21.3	26.0	22.0	18.4	19.4	18.8
26 Dec 2019	14.5	17.0	17.0	14.0	16.0	14.3
27 Dec 2019	19.0	23.0	21.5	17.0	17.8	17.5
28 Dec 2019	14.5	17.5	17.0	18.3	18.8	18.5
29 Dec 2019	22.0	27.0	23.0	18.0	19.5	18.3
30 Dec 2019	24.0	25.0	24.5	22.0	23.0	21.2
31 Dec 2019	25.0	30.0	26.0	20.5	23.0	22.5
01 Jan 2020	22.0	26.0	22.5	20.0	22.0	21.0
02 Jan 2020	21.5	27.0	23.0	18.5	19.5	19.0
03 Jan 2020	17.0	19.90	19.6	15.0	16.0	16.0
04 Jan 2020	21.0	27.0	22.0	21.0	22.0	21.5
05 Jan 2020	19.0	23.0	21.0	18.4	20.5	19.8
06 Jan 2020	15.5	20.0	17.8	13.5	15.5	15.0
07 Jan 2020	19.0	24.0	20.5	19.6	20.5	19.8
08 Jan 2020	21.8	20.0	22.2	20.4	20.8	20.6
09 Jan 2020	24.0	29.0	24.0	22.0	23.0	22.5
10 Jan 2020	18.0	21.5	20.5	17.0	18.0	17.5
11 Jan 2020	16.0	22.0	18.5	20.0	22.0	21.0
12 Jan 2020	16.0	20.0	20.0	17.0	19.0	20.0
13 Jan 2020	23.2	29.0	23.5	19.0	20.5	19.5
14 Jan 2020	24.5	31.0	25.0	20.0	22.0	21.0
15 Jan 2020	28.0	31.5	29.5	20.0	21.0	20.8
16 Jan 2020	25.5	32.0	26.2	21.3	22.0	21.5
17 Jan 2020	24.5	31.0	27.0	22.5	24.0	23.0
18 Jan 2020	24.0	31.0	26.5	22.5	24.5	23.5
19 Jan 2020	18.0	20.2	19.5	19.5	20.5	19.8
20 Jan 2020	17.9	20.0	19.4	19.0	20.1	19.5
Average	**19.8**	**23.2**	**21.1**	**18.6**	**19.8**	**19.2**

Night vs day-night cover

Inner air temperature of night cover (T_2) was always higher than day-night cover (T_3) at 7:00 pm. It was 0.9°C and 0.6°C higher than ambient air temperature and day-night cover, respectively. Day-night cover had 0.3°C higher than ambient air temperature. Similarly, inner air temperaturewas 1.2°C and 0.6°C higher than ambient air temperatureand day-night cover, respectively, at 7:00 am. Day-night cover had 0.6°C higher than ambient air temperature (Table 2).

Table 2. Difference of ambient air and inner temperature of seedbed by polythene cover, Rangpur, Boro 2019-20.

Day	Temperature (°C)					
	7:00 pm			7:00 am		
	Outside polythene cover	Inside polythene cover		Outside polythene cover	Inside polythene cover	
		Night cover	Day-night cover		Night cover	Day-night cover
15 Dec 2019	21.0	23.0	21.3	13.0	14.0	13.0
16 Dec 2019	17.5	18.0	17.5	16.0	17.0	17.0
17 Dec 2019	17.4	18.0	17.0	15.0	17.0	16.0
18 Dec 2019	14.0	14.5	14.3	14.0	15.0	15.0
19 Dec 2019	12.5	13.5	13.4	11.5	12.0	11.7
20 Dec 2019	13.7	14.5	13.9	13.0	13.8	13.5
21 Dec 2019	14.3	14.7	14.5	12.0	13.0	12.7
22 Dec 2019	15.5	15.8	15.6	14.5	15.0	14.8
23 Dec 2019	14.5	15.3	15.0	13.5	14.0	13.8
24 Dec 2019	15.0	15.8	15.4	11.5	13.0	12.7
25 Dec 2019	13.5	15.0	14.8	8.5	9.4	9.0
26 Dec 2019	14.0	16.0	13.0	9.0	11.0	10.5
27 Dec 2019	15.0	15.5	15.2	10.0	12.0	10.4
28 Dec 2019	14.0	14.3	14.1	8.5	10.2	10.0
29 Dec 2019	14.8	15.2	15.0	8.8	10.0	9.0
30 Dec 2019	15.5	16.5	16.0	9.8	10.5	10.0
31 Dec 2019	15.5	17.0	16.0	13.0	14.0	13.5
01 Jan 2020	19.5	20.7	20.2	15.5	17.0	16.0
02 Jan 2020	14.0	15.0	14.6	16.0	16.0	15.5
03 Jan 2020	20.0	22.0	20.0	16.0	20.0	16.3
04 Jan 2020	16.8	17.1	17.0	15.5	16.0	15.8
05 Jan 2020	14.5	14.8	14.6	15.0	15.4	15.0
06 Jan 2020	12.4	13.0	12.6	12.0	13.0	12.8
07 Jan 2020	14.0	15.0	14.5	11.0	12.0	11.5
08 Jan 2020	16.6	17.0	16.8	10.0	11.0	10.6
09 Jan 2020	16.0	17.0	16.5	14.6	15.0	14.8
10 Jan 2020	14.0	15.0	14.5	11.5	12.0	11.8
11 Jan 2020	13.0	14.0	13.6	12.0	12.5	12.3
12 Jan 2020	18.0	20.0	19.0	14.7	15.0	14.8
13 Jan 2020	16.0	16.4	16.2	10.0	11.5	11.5
14 Jan 2020	16.0	17.0	16.5	10.0	11.0	10.8
15 Jan 2020	16.5	17.5	17.0	10.5	16.5	11.0
16 Jan 2020	18.0	19.0	18.5	11.8	12.6	12.0
17 Jan 2020	18.0	19.0	18.5	13.0	13.6	13.4
18 Jan 2020	17.0	18.0	17.5	14.5	15.0	14.8
19 Jan 2020	17.0	18.0	17.7	14.0	15.0	14.7
20 Jan 2020	11.5	12.7	11.1	11.3	12.2	12.0
Average	**15.6**	**16.5**	**15.9**	**12.4**	**13.6**	**13.0**

Seedling strength

Seedling strength was much higher of 1 December seeding than 15 December seeding in both the tested varieties. Normal seedbed (T_4) had higher seedling strength in BRRI dhan88 followed by day-night polythene cover (T_3) at 1 December seeding. It was statistically higher in T_3 followed by T_4 and T_2. Day cover (T_1) had lowest seedling strength in both the varieties. At 15 December seeding, both night cover and day-night cover had higher seedling strength in both the varieties. In the other hand, day cover had also the lowest seedling strength in both the varieties. Seedling strength was lower at 15 December seeding than 1 December seeding might be due to lower Growing degree days (GDD) and prevailing low temperature (below 10°C) for more number of days after seeding up to transplanting (Table 3 and Fig. 1). BRRI dhan89 had higher seedling strength.

Table 3. Effect of polythene cover of seedbed on seedling strength, Boro 2019-20, Rangpur.

Treatment	Seedling strength (mg/cm) D/S: 1 Dec 2019		Seedling strength (mg/cm) D/S: 15 Decr 2019	
	BRRI dhan88	BRRI dhan89	BRRI dhan88	BRRI dhan89
Day cover **(T_1)**	4.40	4.76	1.95	2.01
Night cover **(T_2)**	5.56	6.12	2.51	3.01
Day-night cover (partial opening at both sides) **(T_3)**	5.83	8.56	2.50	4.04
Normal seedbed (control) **(T_4)**	6.14	6.15	0.96	2.88
GDD	749° days		710° days	

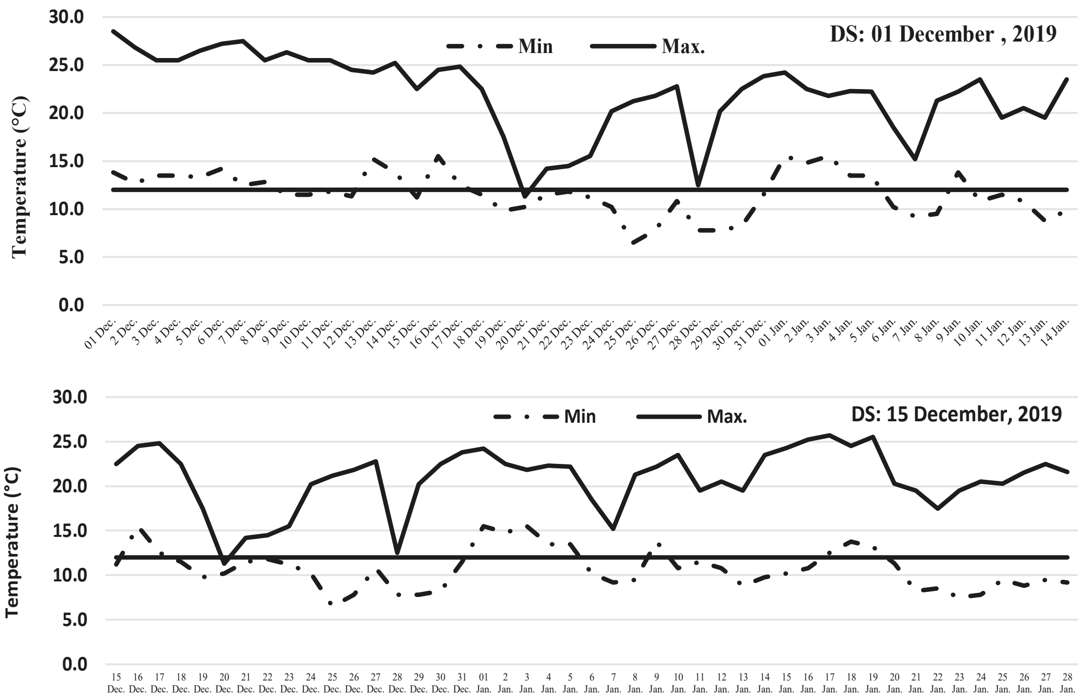


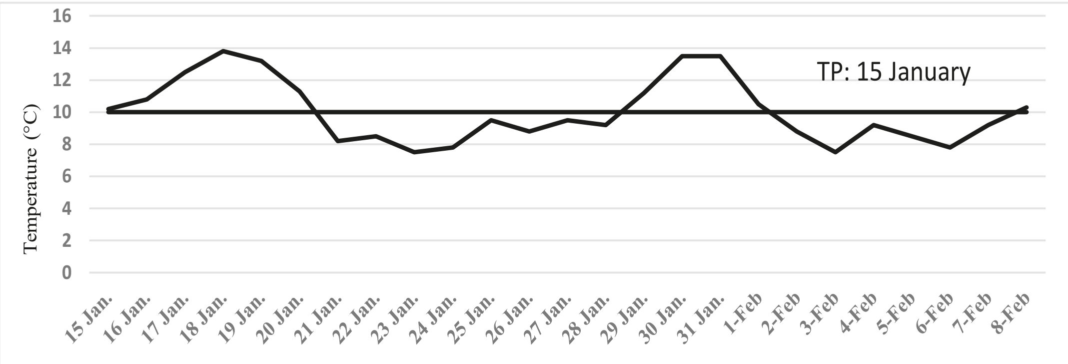
Fig. 1. Minimum and maximum temperature from seeding to seedling uprooting, Boro 2019-20, BRRI RS, Rangpur.

Seedling mortality

Seedling mortality was much higher at 30 January planting than 15 January planting in both the tested varieties. However at 15 January planting,it was higher in control seedbed in both the varieties. Day cover and night cover had similar seedling mortality and day-night (T_3) had the lowest mortality in both the varieties. At 30 January planting, it was also higher in control seedbed in both the varieties followed by day cover and night cover. BRRI dhan89 showed the lowest seedling mortality with day-night cover (T_3). Seedling mortality was higher at 30 January planting than 15 January planting might be due to prevailing low temperature (below 10° C) for more number of days after transplanting (Table 4 and Fig. 2).

Table 4. Effect of polythene cover of seedbed on seedling mortality, Boro 2019-20, Rangpur.

Treatment	Seedling mortality (%) at 25 DAT TP: 15 Jan 2020		Seedling mortality (%) at 25 DAT TP: 30 Jan 2020	
	BRRI dhan88	BRRI dhan89	BRRI dhan88	BRRI dhan89
Day cover **(T_1)**	5.2	3.0	20.2	29.9
Night cover **(T_2)**	5.2	3.0	18.7	20.2
Day-night cover (partial opening at both sides) **(T_3)**	4.5	1.5	17.9	9.0
Normal seedbed (control) **(T_4)**	7.5	7.5	23.9	23.1



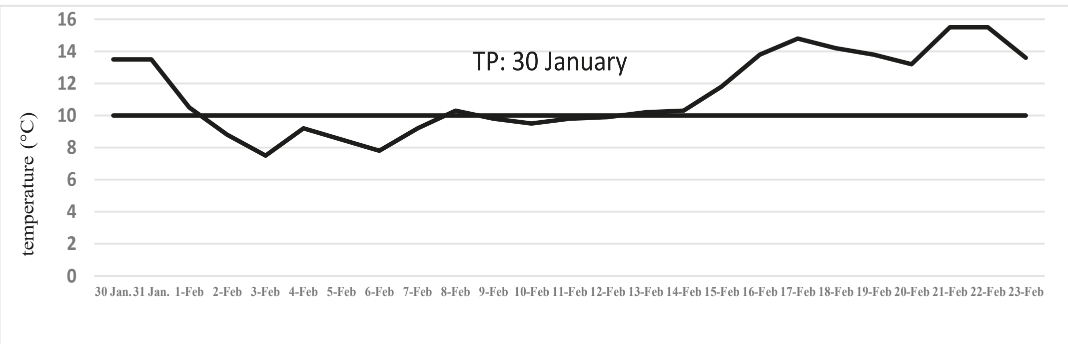


Fig. 2. Minimum temperature from transplanting to 25DAT, Boro 2019-20, BRRI RS, Rangpur.

Seedling height vs plant height

Taller seedling was obtained at 15 January planting but plant height was higher at 30 January planting in both the varieties. In both the plantings, day-night polythene cover treatment (T_3) produced significantly tallest seedling followed by day polythene cover treatment (T_3) in case of both the varieties but it didn’t reflect on plant height. Normal seedling (T_4) had the lowest seedling height (Fig. 3). There was no significant difference in plant height at both the plantings in case of both the varieties.

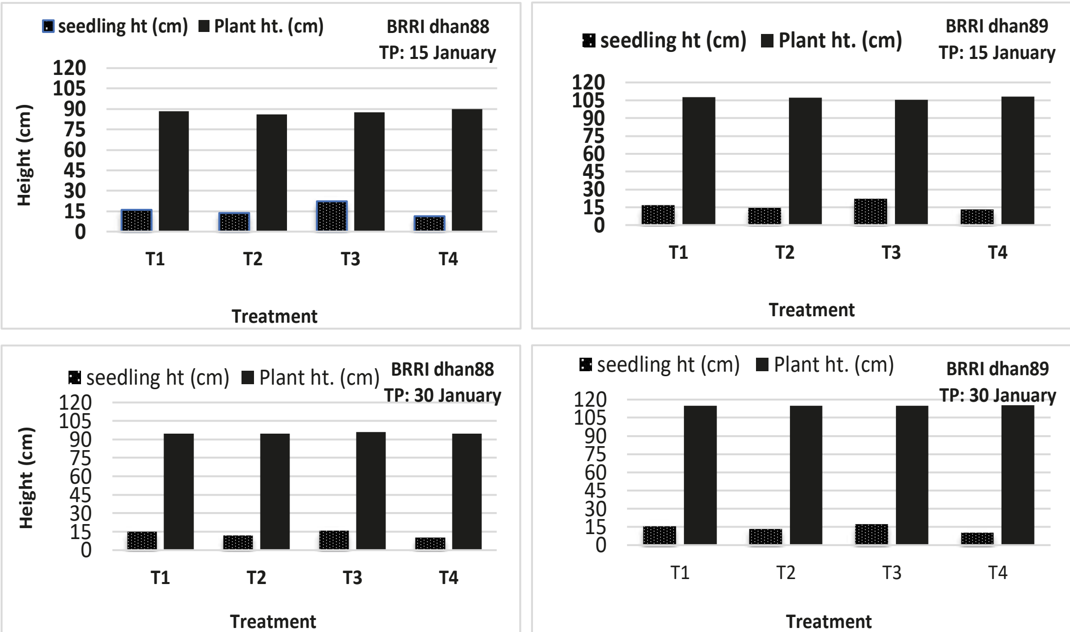


Fig. 3. Effect of polythene cover on seedling height and plant height, Boro 2019-20, BRRI Rangpur.

Tillering pattern

Up to 25 DAT,tiller number was increased very slowly for both the varieties. After 25 DAT, it wasincresed rapidly and reached peak at 65 DATat 15 January planting but it reached peak at 55 DAT of 30 January planting. BRRI dhan88 produced more tiller than BRRI dhan89 at both the plantings. At 15 January planting, BRRI dhan88 produced more tiller with day cover treatment followed by control treatment while day-night cover had the lowest. BRRI dhan89 produced more tiller with night cover treatment followed by no cover treatment but day-night cover had the lowest. At 30 January planting, BRRI dhan88 produced more tiller with day-night and no cover treatment,whereas day cover had the lowest. BRRI dhan89 produced more tiller with day cover treatment followed by night cover treatment,while day-night cover had the lowest (Fig. 4).

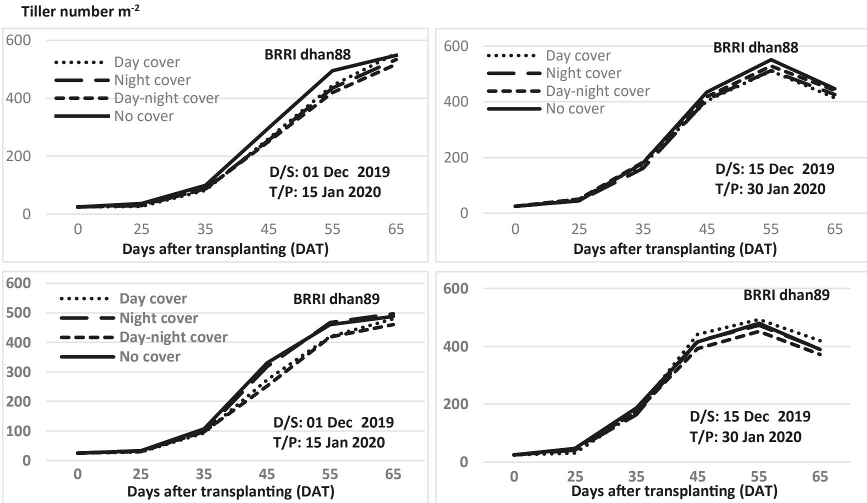


Fig.4. Tillering pattern of BRRI dhan88 and BRRI dhan89 under different polythene cover in seedbed during Boro 2019-20, BRRI RS, Rangpur.

Tiller production rate (no./day)

Tiller production rate was higher at 30 January planting than 15 January up to 45 DAT in both the varieties. At 15 January planting, it increased from 25DAT and sharply increased from 35 – 45 DAT for BRRI dhan88 due to might be increased temperature. It remains steady up to 55 DAT due to reached at maximum tillering stage and then decreased due to tiller mortality. Incase of BRRI dhan89, it wassharply increased from 35 – 45 DAT and then decreased due to tiller mortality. At 30 January planting, tiller production rate gradually increased and reached peak at 45 DAT for both the varieties (Fig. 5). Up to 45 DAT, it was statistically similar in both the varietiers with all treatments.

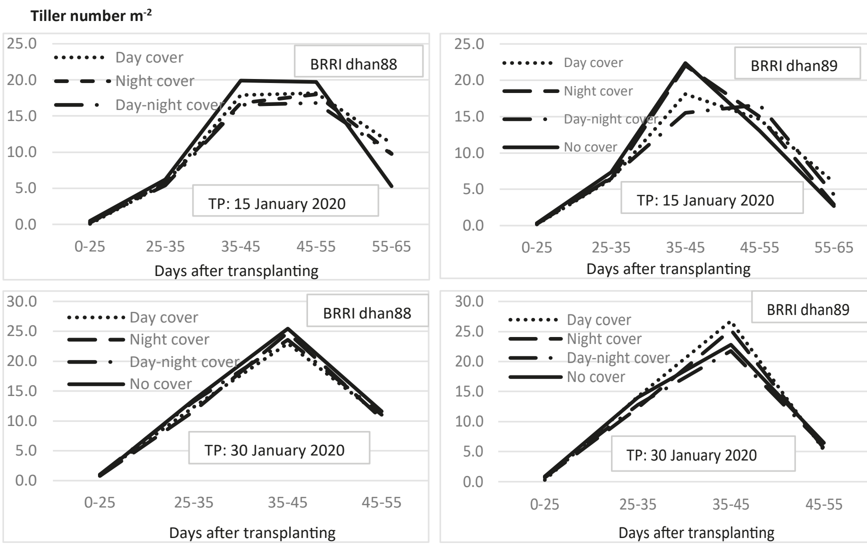


Fig. 5. Tiller production rate of BRRI dhan88 and BRRI dhan89 under different polythene cover in seedbed during Boro 2019-20, BRRI RS, Rangpur.

Productive tiller (%)

Polythene covering treatments of rice seedling didn't vary significantly in both the plantings but BRRI dhan88 had higher productive tiller rate at 30 January planting(Table 5). Although, tiller number was higher in T_1, T_2 and T_4 than T_3 but productive tiller rate was satistically similar in both the varieties, plantings due to might be production of early tiller caused by higher seedling strength.

Table 5. Effect of polythene cover of on productive tiller, Boro 2019-20, Rangpur.

Treatment	Productive tiller (%) TP: 15 Jan 2020		Productive tiller (%) TP: 30 Jan 2020	
	BRRI dhan88	BRRI dhan89	BRRI dhan88	BRRI dhan89
Day cover **(T_1)**	53.5	55.5	69.3	59.1
Night cover **(T_2)**	53.6	55.9	67.8	58.4
Day-night cover (partial opening at both sides) **(T_3)**	53.5	55.4	66.8	55.5
Normal seedbed (control) **(T_4)**	54.2	56.6	63.9	55.0
$Lsd_{0.05}$	ns	ns	ns	ns

Panicle number vs grain yield

Both the varieties produced higher number of panicles at 30 January planting and BRRI dhan88 produced more number of panicle with all the treatments (Table 6). There was no significant difference in grain yield at both the planting in both the varieties. BRRI dhan89 produced higher grain yield due to more number of grains per panicle and it was higher at 30 January planting (Table 6 and 7). Day-night polythene cover treatment (T_3) reduces growth duration by 2-3 days over other treatments might be due to higher seedling strength caused by no contact with fog and cold wave.

Table 6. Effect of polythene cover treatment in seedbed on yield and ancillary characters at 15 January planting, Boro 2019-20, BRRI RS, Rangpur .

Treatment	Panicle m^{-2}	TGD (days)	Yield (t ha^{-1})	Panicle m^{-2}	TGD (days)	Yield (t ha^{-1})
	BRRI dhan88			BRRI dhan89		
Day cover **(T_1)**	297	154	6.67	266	166	7.35
Night cover **(T_2)**	286	153	6.62	278	166	7.52
Day-night cover (partial opening at both sides) **(T_3)**	277	152	6.50	255	163	7.63
Normal seedbed (control) **(T_4)**	297	153	6.78	276	166	7.68
$Lsd_{0.05}$	18.7	ns	ns	16.79	ns	ns

Table 7. **Effect of polythene cover treatment in seedbed on yield and ancillary characters at 30 January planting, Boro 2019-20, BRRI RS, Rangpur.**

Treat	Panicle m^{-2}	TGD (days)	Yield (t ha^{-1})	Panicle m^{-2}	TGD (days)	Yield (t ha^{-1})
	BRRI dhan88			BRRI dhan89		
Day cover **(T_1)**	354	151	6.99	307	164	7.99
Night cover **(T_2)**	347	150	7.18	299	164	8.08
Day-night cover (partial opening at both sides) **(T_3)**	353	149	7.42	293	161	8.29
Normal seedbed (control) **(T_4)**	352	150	7.24	303	163	7.96
$Lsd_{0.05}$	ns	ns	ns	ns	ns	ns

CONCLUSION

Day-night polythene cover treatment (T_3) produces less tiller than day or night polythene cover and no polythene cover treatment but productive tiller (%) was satistically similar among the treatments for both the varieties and planting dates. Moreover, day-night polythene cover treatment (T_3) reduces growth duration by 2-3 days than the other treatments. Although, there was no significant difference in grain yield among the treatments in both the planting dates but day-night polythene cover (partial opening at both sides) produces taller and stronger seedling that helps farmers to easy uprooting and transplanting in time. Also, treatment T_3 is farmers friendly over T_1 and T_2 because it is hassle free, a few labour consuming (cost effective) and risk free that has the potentiality to produce higher seedling strength.

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