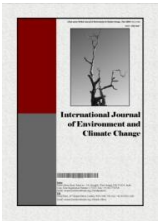

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Yield and Yield Attributing Parameters of Toria (*Brassica campestries)* under Real Time Rainfall Situation in an *Inceptisols* of Assam, India

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Authors' contributions

This work was carried out in collaboration among all authors. Authors RB and PKS designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors NB, RB and AS managed the analyses of the study. Authors PB, RK, BB and PN managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during *rabi* season of 2018-19 and 2019-20 in Dryland experimental field belong to soil order *Inceptisols*, Biswanath college of Agriculture, Assam Agricultural University, Biswanath chariali, Assam to study the ''Yield and yield attributing parameters of toria (*Brassica campestries)* under real time rainfall situation in an *Inceptisols* of Assam, India'' under AICRPDA, NICRA. The treatments consisting of 4 different dates of sowing

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i.e. S_1-41th SMW, S_2-44th SMW, S_3-46th SMW, and S_4- 48th SMW, & three variety *i.e.* V_1-JT-90-1(Jeuti), V_2-Yellow sarson (Benoy) and V_3- TS-38. Growth, yield and yield attributing characters of toria varieties were influenced by different dates of sowing. S_1 registered higher plant height (43.2 cm, 92.9 cm and 106.6 cm & 40.2 cm, 89.8 cm and 101.5 cm) and number of branch (3.8, 5.3 and 7.2 & 3.4, 5.1 and 6.9) at 30 DAS, 45 DAS and 60 DAS, respectively, during 2018-19 and 2019-20. Yield attributing characters like number of siliqua, number of seed per siliqua, 1000 seed weight (g) were gradually decreased with advancement of sowing dates. Among the three varieties V_1 (Jeuti) recorded highest seed yield (8.9 q ha^{-1} and 8.1 q ha^{-1}) and stover yield (23.4 q ha^{-1} and 22.2 q ha^{-1}) in 2018-19 and 2019-20, respectively. Highest HI (28.5% and 25.8%) was recorded in S_1 and lowest was recorded in S_4 (20.7% and 14.6%).

Keywords: Sowing dates; variety; seed yield; stover yield; harvest index (HI); inceptisols; standard meteorological week.

1. INTRODUCTION

Assam belongs to high rainfall zone of India with mean average annual rainfall 2295.80 mm and rice is the predominant crop covering 24.85 lakh ha [1]. During kharif season rice is cultivated in 18.88 lakh ha and rice monocroping system is practiced by majority of the farmers. Toria is cultivated in 2.81 lakh ha during rabi season and is the dominat rabi crop of Assam [2]. Average production of oilseed crop in Assam 2.15 lakh tone [1]. There is wide variability in winter rice cultivars which results in variable harvesting time and majority of the cultivars attains maturity during late November and December. This results in delayed sowing of toria after harvest of winter rice beyond the recommended sowing window (15th October to 15th November). The present investigation was therefore conducted to identify suitable toria varieties under delayed sown condition so that farmers can obtain economic yield. Oilseeds, the raw material for vegetable oils, occupy a significant position in India's national economy, next to food grains, accounting for about 10% of the cultivated area and value of all agricultural produce. Among oilseeds, rapeseed-mustard occupies a prestigious position and ranks second after groundnut in area and production, contributing 23 per cent of the total oilseed production. The requirements for vegetable oil seed have been projected to be around 34 million tons (MT) by 2020 AD. Out of which 14 million tons (MT) is to be contributed only by Rapeseed-Mustard to meet the annual domestic demand based on present level of consumption of fats and oils (8.5 kg Capita^{-1}year^{-1}) and the subsequent growth. Rapeseed-Mustard is the 3rd important oilseed crop in the world after soybean (*Glycine max*) and palm oil (*Elaeis guineensis jacq*.) which contributes 28.6% in the production of oilseeds. The global production of Rapeseed-Mustard and its oil is around 38-42 MT and 12-14 MT, respectively & India contributes 8.3% and 19.8% of world acreage and production, respectively. The seeds are highly nutritive containing 38-57% erucic acid, 5-13% linoleic acid and 27% oleic acid [3]. Rapeseed-mustard is considerably sensitive to weather as evidenced from the variable response to different date of sowing [4].

1.1 Objectives of the Study

1. To study the effect of different sowing dates on morphological characters of toria
2. To study the effect of different sowing dates on yield and yield attributing parameters of toria

2. MATERIALS AND METHODS

A field experiment was conducted during *rabi* season (October- February) of 2018-19 and 2019-20 at Dryland Technology Park, Biswanath college of Agriculture, Assam Agricultural University, Assam to study the 'yield and yield attributing parameters of toria (*Brassica campestries)* under real time rainfall situation in an *Inceptisols* of Assam, India' under All India Co-ordinate Research Project for Dryland Agriculture (AICRPDA), National Innovation on Climate Resilience Agriculture (NICRA). Recommended dose of urea, SSP and MOP @ 87, 220 and 25 kg ha^{-1} was applied one day ahead of sowing. Borax was applied @ 10 kg ha^{-1} along with other fertilizer. Climate of the study site is sub-tropical humid with hot summer and cold winter. The experimental site is situated at 26°84′20" N latitude and 93°13′15" E longitude having an altitude of 104 m above mean sea level. Soil of the experimental site was sandy loam in texture, pH 4.98, organic carbon

(0.45percent), available N (330.10 kgha^{-1}), available P_2O_5 (23.20 kgha^{-1}) and available K_2O (178.35 kgha^{-1}). The mean annual air and soil temperature of the area is 23.6°C and 24.6°C, respectively. The mean summer and winter soil temperature are 25.16°C and 19.74°C. The amount of rainfall received during the crop growing period were 139 mm (2018-2019) and 136.2 mm (2019-20). The treatments consisting of 4 different dates of sowing at 15 days interval *i.e.* S_1-1st sowing (41th SMW), S_2-2nd sowing (44th SMW), S_3-3rd sowing (46th SMW), and S_4- 4th sowing (48th SMW) & three variety *i.e*. V_1-JT-90-1(Jeuti), V_2-Yellow sarson (Benoy) and V_3-TS-38. Twelve treatment combination (S_1V_1-1st sowing with variety Jeuti,S_1V_2 -1st sowing with variety Benoy, S_1V_3 -1st sowing with variety TS-38; S_2V_1 -2nd sowing with variety Jeuti,S_2V_2 -2nd sowing with variety Benoy,S_2V_3-2nd sowing with variety TS-38; S_3V_1-3rd sowing with variety Jeuti,S_3V_2-3rd sowing with variety Benoy,S_3V_3 -3rd sowing with variety TS-38 S_4V_1-4th sowing with variety Jeuti,S_4V_2-4th sowing with variety Benoy and S_4V_3-4th sowing with variety TS-38) were laid out in factorial RBD (240 m^2) with three replications. Among three varieties JT-90-1(Jeuti) is suitable for delayed sowing, moderately susceptible to *alternaria* blight, aphids and sawfly & contains 43% oil and recommended for all zones except hill zone and Barak valley zone of Assam. The growth parameters like plant height and number of branch were recorded at 30 days after sowing (DAS), 45 DAS and 60 DAS from each plot at 5 randomly selected plant and yield attributing parameters like number of siliqua per plant, number of seeds per siliqua also recorded from 5 randomly selected plants. For test weight 1000 grains were randomly counted from each treatment, dried to 12% moisture and then their weight (g) was recorded. Seed yield and stover yield was recorded from 1 m^2 area and then calculated on per hectare basis and expressed in tonnes ha^{-1}, harvest index (%) and RWUE (kg ha^{-1} mm^{-1}) was recorded by using following formula-

$$\text{HI (\%)} = \frac{\text{Economic yield (Seed)}}{\text{Biological yield (Seed+stover)}} \times 100 \quad (1)$$

$$\text{RWUE (kg ha}^{-1}\text{ mm}^{-1}\text{)} = \frac{\text{Seed yield (kgha}-1\text{)}}{\text{Rainfall during crop growing period (mm)}} \quad (2)$$

Where, Harvest Index (HI) is the efficient utilization or assimilation of CO_2 in the forms of photosynthesis and Rain water Used Efficiency (RWUE) means the ratio of yield obtained of any crop to the amount of precipitation (rainfall) received during the crop periods.

3. RESULTS AND DISCUSSION

3.1 Growth Parameter

The growth attributing characters, *viz*. plant height, number of branches per plant showed a significant difference among the sowing dates which ultimately reflected in seed and stover yield. Delay in sowing caused a significant reduction in growth characters *viz*; plant height, number of branch. In Assam condition average maximum and minimum temperature during *rabi* season third week of October is in between 25-27°C and 16.2-17.7°C which is ideal for seed germination and development of toria seedling. Moreover, the sharp fall of both the mean and minimum temperatures from the third week of November onwards shorten the period of inflorescence initiation in Mustard and Rapeseed [5]. All the growth, yield and yield attributing characteristics were significantly higher on 1st date of sowing during 2018-19 and 2019-20. Thought sowing was done at recommended time in both years but in 2019-20 due to heavy rainfall, temperature affected germination of seed which ultimately affect growth and yield on first sowing date (Table 5). Plant height was found to be significant at different dates of sowing. But no significant difference was observed among three varieties and interaction. Highest plant height was recorded in 1st date of sowing (43.2 cm, 92.9 cm, &107.8 cm at 30 DAS, 45DAS and 60 DAS, respectively during 2018-19) which is at par with 2nd and 3rd sowing at 30 DAS and 60 DAS (Table 1). Similarly in 2019-20, 1st date of sowing highest plant height of 40.2 cm, 89.8 cm & 101.5 cm was observed at 30 DAS, 45DAS and 60 DAS respectively (Table 1). These may be due to prolonged vegetative growth period because of congenial environmental condition, especially atmospheric temperature, availability of adequate soil moisture through rainfall (Table 4) and more sunshine hours during its growth period which formed a basis for rapid cell division in meristematic tissues of the crop which led to better growth attributes. Gogoi *et al*. [6] also found that plant height decreased with delay in sowing date.4th sowing recorded lower plant height at three stages of growth because of lower temperature and moisture content during this period which retarded the growth of the plant. The late sown crop was subjected to relatively less time span available for plant growth and development.

The data revealed that the number of branches per plant increased progressively with enhancement in crop duration. Effect of sowing dates was found to be significant at 30 DAS, 45DAS and 60 DAS. Highest number of branches were observed in S_1 (3.78 and 3.49) which was at par with S_2 (3.67 and 3.46), S_3 (3.49 and 3.38) and S_4 (3.38 and 3.27) at 30 DAS in both the year. In 45 DAS and 60DAS S_1 (5.34 and 7.21 & 5.11 and 6.91, respectively during 2018-19 & 2019-20) recorded highest branch (Table 1). Lowest plant height and number of branch was recorded in 4th date of sowing during 2018-2019 and 2019-20. It was observed that significant reduction in number of branches per plant with delay in sowing dates due to high temperature. Jiotode et al. [7] reported that 43rd meteorological week recorded higher number of branch as compared to 46th meteorological week. Among three varieties and their interaction were also found to be non significant in both years.

3.2 Yield and Yield Attributing Parameters

Sowing dates significantly influenced yield and yield attributing characters. Number of siliqua per plant, number of seeds per siliqua and 1000 seed weight were successively decreased with delay in sowing from October to December. Highest number of siliqua per plant (140.6 and 134.7) was recorded in 1st sowing which was gradually decreased in 4th sowing (101.6 and 99.5) (Table 2). Late sowing restricted the growth duration and induced early flowering, delayed pod initiation and seed setting. Alam *et al*. [8] reported that early sowing gives better number of siliqua per plant, number of seeds per siliqua than late sowing. Chandrakar and Urkurkar [9] observed reduction in number of siliqua per plant and 1000-seed weight of Indian mustard due to delay in sowing beyond 23rd November. Number of seed per siliqua was found to be significant among three sowing dates (Table 2) in both the years. Highest number of seed was recorded 18.8 and 18.1 in first sowing which is at par with 2nd sowing dates (17.4 and 16.6) and lowest was observed in 4thsowing (10.0 and 9.5). Choudhary and Thakuria [10] and Sharma [11] reported that delay in sowing of rapeseed beyond 15 November restricted in shortening of the crop growth period and significantly less number of branches, siliquae per plant and number of seeds per siliqua. 1000 seed weight (g) was found to be significant at different dates of sowing and among three varieties. Highest 1000 seed weight was recorded in S_1 (3.21 g and 3.10 g) which was at par with S_2 (3.09 g and 2.95 g) and lowest recorded in S_4 (2.76 g and 2.67 g). Among three varieties V_2 (Yellow Sarson) recorded highest weight (3.26 g and 3.12 g) due to its bolder seeds & JT-90-1(Jeuti) recorded 2.88 g and 2.83 & TS-38 recorded 2.85 g and 2.74 g during 2018-19 and 2019-2020. Number of siliqua per plant, number of seed per siliqua and 1000 seed weight was found to be nonsignificant in different sowing dates and among three varieties.

The data revealed that date of sowing and varieties had significantly influenced the seed yield as well as stover yield of toria. Yield was found to be significantly different with dates of sowing, varieties and their interaction. With delay in the sowing of the three varieties of toria starting from 41th SMW to 48th SMW it was observed that the yield gradually decreased with delay in date of sowing (Table 2). 1st date of sowing (S_1) recorded a grain yield of 9.4 q ha^{-1} during 2018-19 which was at par with 2nd date of sowing (8.4 qha^{-1}). In 2019-20, 1st date of sowing (S_1) also recorded a yield of 8.0 q ha^{-1} while 4th sowing recorded lowest yield (5.8 qha^{-1}and 5.0 qha^{-1}in 2018-19 and 2019-20, respectively). The pooled mean of two years in respect of seed yield (8.7qha^{-1}) were also found to be higher in 1st date of sowing (S_1). Among three varieties JT-90-1(Jeuti) recorded highest yield in both the years (8.9 q ha^{-1}and 8.1q ha^{-1}) and yellow sarson recorded lowest yield (5.9 q ha^{-1}and 5.4 q ha^{-1}in both the year). The yield significantly varied due to the interaction effect between the sowing dates and varieties. Among the treatment combinations highest pooled mean (10.0qha^{-1}) was observed in S_1V_1 and the lowest pooled mean (4.1qha^{-1}) in S_4V_2 which differed significantly from the values of other treatments. This finding is conformity with Uikey et al. [12]. Similarly Kumar and Shashtry [13] and Gupta et al. [14] reported higher seed yield from *Pusa* bold due to longer seed filling period and longer reproductive phase resulting in higher yield. Significant reduction in yield due to delay in sowing of the crop (October to December) in different parts of the country was observed by Afroz et al. [15], Bala et al. [16], Alam et al. [8], Akhter et al. [17], Dinda et al. [18].

Table 1. Growth parameters of toria at different stages during 2018-19 and 2019-20

Treatment	Plant height (cm)						Number of branch plant^{-1}					
	30DAS		45DAS		60DAS		30DAS		45DAS		60DAS	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019- 20	2018-19	2019-20	2018-19	2019-20
S_1	43.2	40.2	92.9	89.8	107.8	101.5	3.78	3.49	5.34	5.11	7.21	6.91
S_2	42.1	39.5	91.0	87.8	103.3	101.3	3.67	3.46	4.17	4.88	7.07	6.77
S_3	37.9	38.3	88.1	85.7	101.6	98.3	3.49	3.38	4.43	4.41	6.67	6.29
S_4	27.7	29.1	86.2	83.6	92.9	94.4	3.38	3.27	4.95	4.23	6.57	6.23
CD (5%)	8.10	5.20	2.81	3.5	9.71	9.0	0.49	0.25	0.87	0.62	0.46	0.92
V_1	38.4	37.1	89.1	86.5	100.7	97.8	3.49	3.39	4.81	4.83	6.87	6.53
V_2	36.8	36.8	90.2	87.5	102.6	99.9	3.62	3.33	4.63	4.50	6.82	6.48
V_3	38.0	36.3	89.3	86.1	100.9	99.0	3.63	3.41	4.44	4.62	6.94	6.64
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Yield and yield attributing characters of toria during 2018-19 and 2019-20

Treatment	Siliqua plant^{-1}		Seeds siliqua-^{1}		1000 seed weight (g)		Seed yield (q ha^{-1})			Stover yield (q ha^{-1})		
							2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20						
Sowing date (S)												
S_1	140.6	134.7	18.8	18.1	3.21	3.10	9.4	8.0	8.7	23.4	22.9	23.2
S_2	136.4	127.8	17.4	16.6	3.09	2.95	8.4	7.6	8.0	22.5	21.6	22.0
S_3	127.1	121.4	11.8	11.2	2.93	2.81	6.7	6.0	6.3	21.6	21.2	21.4
S_4	101.6	99.5	10.0	9.5	2.76	2.67	5.8	5.0	5.3	20.8	19.6	20.2
CD (5%)	3.2	1.3	3.8	3.5	0.24	0.22	0.42	0.18	0.28	3.0	3.6	0.30
Variety (V)												
V_1	126.0	119.8	15.1	14.2	2.88	2.84	8.9	8.1	8.5	23.4	22.6	23.0
V_2	126.7	122.6	13.7	12.9	3.26	3.12	5.9	5.4	5.7	19.9	19.5	19.7
V_3	126.6	124.2	14.7	14.3	2.85	2.74	7.9	6.5	7.1	22.9	21.9	22.4
CD (5%)	NS	NS	NS	NS	0.30	0.28	0.42	0.17	0.24	6.9	5.7	0.26

Treatment	Siliqua plant^{-1}		Seeds siliqua-^{1}		1000 seed weight (g)		Seed yield (q ha^{-1})			Stover yield (q ha^{-1})		
							2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20						
Interaction (S x V)												
S_1V_1							11.0	9.1	10.0			24.4
S_1V_2							7.7	6.8	7.2			21.6
S_1V_3							9.6	8.1	8.8			23.5
S_2V_1							8.6	8.5	8.6			23.4
S_2V_2							7.1	6.4	6.7			20.0
S_2V_3							9.5	7.9	8.7			22.7
S_3V_1							8.0	7.5	7.7			22.6
S_3V_2							4.6	4.6	4.6			19.4
S_3V_3							7.4	6.0	6.6			22.2
S_4V_1							8.0	7.1	7.6			21.6
S_4V_2							4.3	3.9	4.1			18.0
S_4V_3							5.2	4.0	4.2			21.2
CD (5%)							0.85	0.32	0.49			0.52

In the present investigation different dates of sowing and three varieties exhibited significant influence on the stover yield. Crop sown on 42th SMW recorded significantly higher stover yield (23.4qha^{-1} in 2018-19 and 22.9 qha^{-1} in 2019-20) and lowest was recorded in 4th sowing (20.84qha^{-1} and 19.6 q/ha during 2018-19 and 2019-20, respectively) of toria which was at par with other dates of sowing (Table 2). Pooled mean of two years data revealed that first date of sowing (S_1) recorded 23.2qha^{-1}. Delay in sowing significantly reduced the stover yield due to environmental conditions (Temperature, rainfall, sunshine). Among the varieties JT-90-1(Jeuti) recorded significantly higher stover yield (23.4qha^{-1} and 22.6qha^{-1}) which was at par with yellow sarson (19.9 qha^{-1} and 19.5qha^{-1}) and TS-38 (22.9 qha^{-1}and 21.9 qha^{-1}) in both the years. This might be due to the cumulative effect of all the growth characters. All the growth and yield attributes which determined the seed and stover yield of mustard were adversely influenced when the sowing were done on early and late, which might have resulted in poor growth and translocation of photosynthates from source to sink and ultimately lower yield. The pooled mean of two years data showed significant differences among sowing dates and three varieties. Highest stover yield 24.4 qha^{-1} recorded in S_1V_1 which is at par with S_1V_3 (23.5 qha^{-1}) and lowest 18.0 q/ha in S_4V_2. Significant reduction in seed and stover yield of mustard in early and late sown have also been reported by Panwar et al. [19]; Singh et al. [20] and Panda et al. [21].

The Harvest index (HI) also exhibited significant difference among sowing dates, variety and their interaction. Highest HI (28.5% and 25.8% during 2018-19 and 2019-20, respectively) recorded in first sowing and lowest (20.7% and 20.0% during 2018-19 and 2019-20, respectively) recorded in last sowing. Among three varieties JT-90-1(Jeuti) recorded 27.4% and 26.3% and Yellow sarson recorded 22.4% and 21.5% HI (Table 3) in both years. Rain water use efficiency (RWUE) also

Table 3. Harvest index (%), RWUE (kg ha^{-1} mm^{-1}) and Benefit cost ratio during 2018-19 and 2019-20

Treatment	Harvest index (%)		RWUE (kg ha^{-1} mm^{-1})		B:C	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Sowing date (S)						
S_1	28.5	25.8	12.1	14.6		
S_2	27.0	26.0	17.1	31.7		
S_3	23.1	21.9	11.0	22.1		
S_4	20.7	20.0	9.7	20.7		
CD (5%)	1.3	1.14	8.8	24.9		
Variety (V)						
V_1	27.4	26.3	14.1	29.2		
V_2	22.4	21.5	10.4	17.0		
V_3	24.6	22.6	12.8	20.6		
CD (5%)	1.12	1.10	6.8	15.4		
Interaction (S x V)						
S_1V_1	30.7		14.1	10.7	2.57	2.20
S_1V_2	26.2		9.9	8.1	2.19	1.40
S_1V_3	28.5		12.2	9.6	2.13	1.80
S_2V_1	26.6		16.5	35.6	1.82	2.00
S_2V_2	25.6		14.8	26.7	1.94	1.20
S_2V_3	28.9		19.9	32.9	2.09	1.70
S_3V_1	25.9		13.3	25.9	1.42	1.60
S_3V_2	19.0		7.6	17.1	0.96	0.60
S_3V_3	24.3		12.0	23.4	1.63	1.10
S_4V_1	26.2		12.6	29.5	0.54	1.50
S_4V_2	19.0		9.3	16.1	0.82	0.40
S_4V_3	16.7		7.0	16.5	1.63	0.40
CD (5%)	3.4		2.7	4.0		

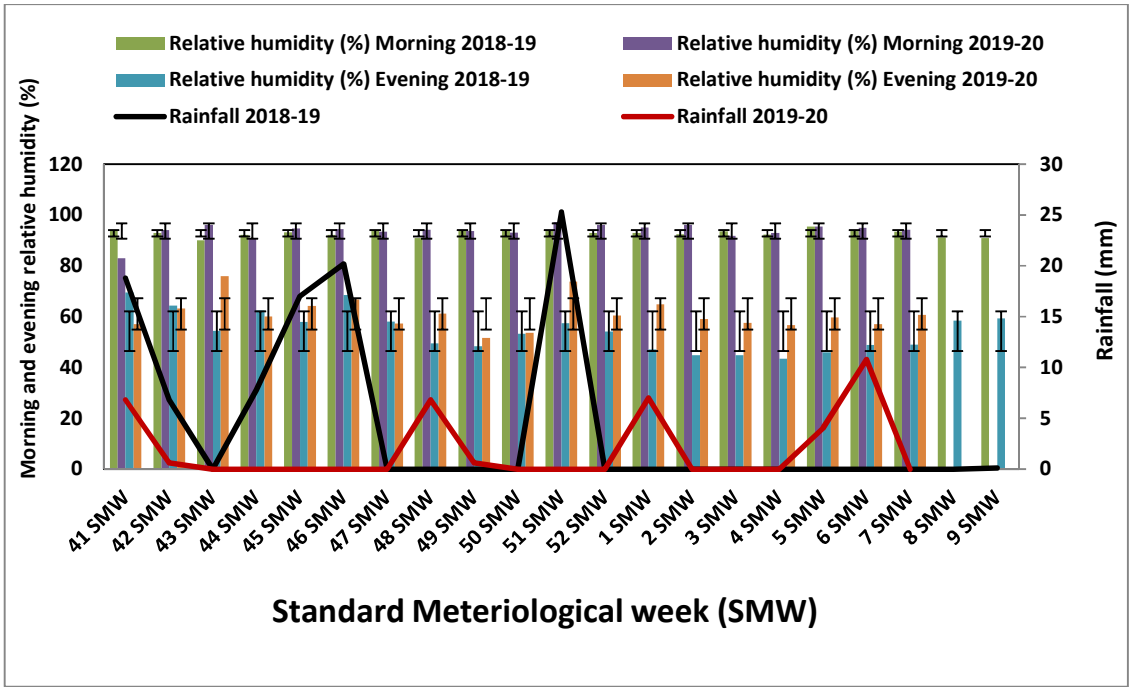

Fig. 1. Morning and evening relative humidity (%) & rainfall (mm) during 2018-19 and 2019-20

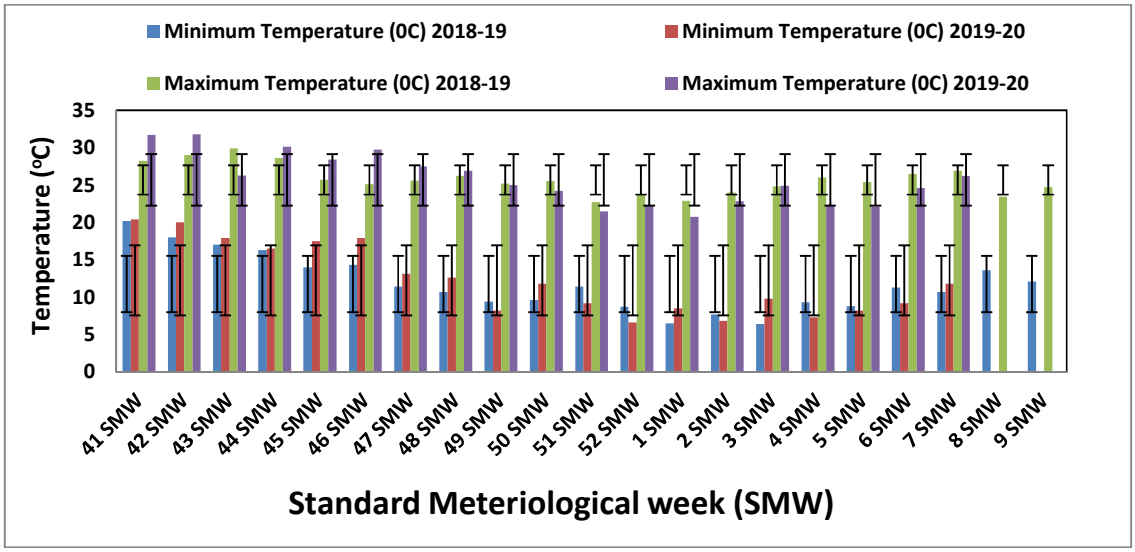

Fig. 2. Maximum and minimum temperature during 2018-19 and 2019-20

varied among sowing dates, variety and their interaction. S_1 and S_4 recorded highest and lowest RWUE (12.1kg $ha^{-1}mm^{-1}$ and 14.6 kg $ha^{-1}mm^{-1}$ & 9.7 $kgha^{-1}mm^{-1}$and 20.7 $kgha^{-1}mm^{-1}$ during 2018-19 and 2019-20, respectively). Among three varieties JT-90-1 recorded 14.1 kg $ha^{-1}mm^{-1}$and 29.2 $kgha^{-1}mm^{-1}$ which is at par with yellow sarson and TS-38 in both the years (Table 3). The average benefit cost ratio of 1st sowing was higher and decreased gradually up to 4th sowing. This corroborates the finding of Dinda et al. [18] and Gogoi et al. [6].

Table 4. Moisture Content (%) at 15 days interval during crop growing periods

Treatment	0 DAS		15 DAS		30 DAS		45DAS		60 DAS		75 DAS		90 DAS	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
S_1V_1	11.5	10.9	22.5	18.7	12.6	21.5	8.3	9.9	13.6	14.5	13.3	11.3	9.9	9.4
S_1V_2	11.8	10.7	22.3	18.3	11.8	20.4	8.4	9.7	12.9	15.1	12.8	12.1	9.7	8.8
S_1V_3	11.4	9.8	21.8	18.1	12.2	19.7	8.3	9.0	13.2	14.6	11.5	11.0	9.0	8.5
S_2V_1	22.7	17.9	12.9	20.6	8.8	11.4	9.6	15.5	11.3	12.1	10.0	9.1	9.5	10.7
S_2V_2	22.0	18.2	11.7	19.6	9.5	10.4	9.8	14.2	11.5	11.5	9.7	10.3	8.8	10.2
S_2V_3	22.3	18.1	11.7	19.6	10.9	10.7	10.2	14.5	10.5	12.0	10.1	10.8	8.6	11.0
S_3V_1	11.4	21.6	8.2	10.0	11.8	14.6	11.3	11.6	9.4	9.4	15.9	10.3	14.2	7.8
S_3V_2	11.0	21.1	8.5	9.0	12.1	13.5	11.4	12.0	9.1	8.8	15.3	10.8	14.2	7.9
S_3V_3	11.5	21.2	8.4	9.1	12.3	13.1	10.1	12.5	9.2	9.1	15.0	11.3	14.5	8.4
S_4V_1	8.5	9.6	13.0	12.1	12.5	8.9	9.8	11.2	8.1	8.0	13.2	12.2	10.2	19.9
S_4V_2	8.4	10.0	14.1	11.3	11.4	7.7	10.1	11.7	8.3	7.9	14.8	11.8	9.7	20.6
S_4V_3	8.5	9.9	14.4	11.1	12.3	7.9	10.0	11.9	8.0	7.5	14.2	12.4	9.9	21.3
CD (5%)	S=1.2	S=2.2	S=1.2	S=2.03	S=1.6	S=2.3	S=1.5	S=1.4	S=0.9	S=1.3	S=1.1	S=2.07	S=0.6	S=2.1
	V=NS	V=NS	V=NS	V=NS	V=NS	V=NS	V=NS	V=NS	V=NS	V=NS	V=NS	V=NS	V=NS	V=NS
	S X V=NS	S X V=NS	S X V=NS	S X V=NS	S X V=NS	S X V=NS	S X V=NS	S X V=NS	S X V=NS	S X V=NS	S X V=NS	S X V=NS	S X V=NS	S X V=NS

Table 5. Different weather parameters during crop growing periods

SMW	Rainfall		Relative humidity (%)				Minimum temperature (°C)		Maximum temperature (°C)	
			Morning		Evening					
	2018-19	2019-20*	2018-19	2019-20*	2018-19	2019-20*	2018-19	2019-20*	2018-19	2019-20*
41 SMW	18.8	6.8	93.8	83	69.5	57	20.2	20.4	28.2	31.7
42 SMW	6.8	0.6	93	94	64.4	63.2	18	20	29	31.8
43 SMW	0	0	90	96	54.4	76	17	17.9	29.9	26.3
44 SMW	7.8	0	92.2	91	62.5	60.1	16.3	16.5	28.6	30.1
45 SMW	17	0	93.2	94.7	58.0	64.2	14.0	17.5	25.7	28.4
46 SMW	20.2	0	92.1	94.5	68.5	66.8	14.3	17.9	25.1	29.7
47 SMW	0	0	93.7	93.4	58.1	57.2	11.4	13.1	25.6	27.5
48 SMW	0	6.8	91	94.2	49.4	61.2	10.7	12.6	26.2	26.9
49 SMW	0	0.6	94	93.7	48.4	51.7	9.4	8.2	25.2	25
50 SMW	0	0	93.7	93.1	53.2	53.7	9.6	11.8	25.5	24.2
51 SMW	25.3	0	93.7	97.2	57.4	73.8	11.4	9.2	22.7	21.5
52 SMW	0	0	93	96	54.2	60.5	8.7	6.6	23.7	22.2
1 SMW	0	7	93	95.1	47.1	64.8	6.5	8.5	22.9	20.7
2 SMW	0	0	92.5	96.0	44.8	59.0	7.7	6.8	24	22.8
3 SMW	0	0	93.5	91.8	44.8	57.5	6.4	9.8	24.8	24.9
4 SMW	0	0	92.4	93.0	43.4	56.7	9.3	7.3	26	22.2
5 SMW	0	4	95.5	95.5	46	59.7	8.8	8.2	25.4	22.1
6 SMW	0	10.8	93.7	95.0	48.8	57.0	11.3	9.2	26.5	24.6
7 SMW	0	0	93.4	94.2	49	60.7	10.7	11.8	26.9	26.2
8 SMW	0	-	91.2	-	58.4	-	13.6	-	23.4	-
9 SMW	0.1	-	91	-	59.3	-	12.1	-	24.7	-

**Harvested at 7th SMW*

4. CONCLUSION

From the findings of the present investigation it may be concluded that crop sown on 41th standard meteorological week (SMW) recorded higher growth rate, yield and yield attributes in all the 3 varieties in North Bank Plain Zone of Assam. Considering the B:C ratio obtained and the average productivity of the state it could be concluded JT-90-1 (*Jeuti*) could be delayed up to 48th standard meteorological week (26 Nov-2Dec) in *Inceptisols* in NBPZ of Assam which will facilitate cultivation of toria after harvest of long duration rice cultivars and help in better economic return to the farmers form rice-toria cropping system.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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