**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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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 monocropping system is practiced by majority of the farmers. Toria is cultivated in 2.81 lakh ha during rabi season and is the dominant 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 campestris) 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

Keywords: Sowing dates; variety; seed yield; stover yield; harvest index (HI); inceptisols; standard meteorological week.
(0.45 percent), available N (330.10 kg ha\(^{-1}\)), available P\(_2\)O\(_5\) (23.20 kg ha\(^{-1}\)) and available K\(_2\)O (178.35 kg ha\(^{-1}\)). 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\(_1\)-1\(^{st}\) sowing (41\(^{st}\) SMW), S\(_2\)-2\(^{nd}\) sowing (44\(^{th}\) SMW), S\(_3\)-3\(^{rd}\) sowing (46\(^{th}\) SMW), and S\(_4\)- 4\(^{th}\) sowing (48\(^{th}\) 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\(_1\) V\(_1\)-1\(^{st}\) sowing with variety Jeuti, S\(_1\) V\(_2\)-1\(^{st}\) sowing with variety Benoy, S\(_1\) V\(_3\)-1\(^{st}\) sowing with variety TS-38; S\(_2\) V\(_1\)-2\(^{nd}\) sowing with variety Jeuti, S\(_2\) V\(_2\)-2\(^{nd}\) sowing with variety Benoy, S\(_2\) V\(_3\)-2\(^{nd}\) sowing with variety TS-38; S\(_3\) V\(_1\)-3\(^{rd}\) sowing with variety Jeuti, S\(_3\) V\(_2\)-3\(^{rd}\) sowing with variety Benoy, S\(_3\) V\(_3\)-3\(^{rd}\) sowing with variety TS-38; S\(_4\) V\(_1\)-4\(^{th}\) sowing with variety Jeuti, S\(_4\) V\(_2\)-4\(^{th}\) sowing with variety Benoy and S\(_4\) V\(_3\)-4\(^{th}\) 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-

\[
HI (\%) = \frac{\text{Economic yield (Seed)}}{\text{Biological yield (Seed+stover)}} \times 100 \tag{1}
\]

\[
\text{RWUE (kg ha}^{\text{-1}} \text{mm}^{\text{-1}}) = \frac{\text{Seed yield (kg ha}^{\text{-1}})}{\text{Rainfall during crop growing period (mm)}} \tag{2}
\]

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 1\(^{st}\) 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 1\(^{st}\) 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 2\(^{nd}\) and 3\(^{rd}\) sowing at 30 DAS and 60 DAS (Table 1). Similarly in 2019-20, 1\(^{st}\) 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.4\(^{th}\) 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 S₁ (3.78 and 3.49) which was at par with S₂ (3.67 and 3.46), S₃ (3.49 and 3.38) and S₄ (3.38 and 3.27) at 30 DAS in both the year. In 45 DAS and 60DAS S₁ (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 4th sowing (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 S₁ (3.21 g and 3.10 g) which was at par with S₂ (3.09 g and 2.95 g) and lowest recorded in S₁ (2.76 g and 2.67 g). Among three varieties V₂ (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 41st SMW to 48th SMW it was observed that the yield gradually decreased with delay in date of sowing (Table 2). 1st date of sowing (S₁) 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 (S₁) also recorded a yield of 8.0 q ha⁻¹ while 4th sowing recorded lowest yield (5.8 qha⁻¹and 5.0 qha⁻¹in 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 (S₁). 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⁻¹in 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 S₁V₁ and the lowest pooled mean (4.1qha⁻¹) in S₄V₂ 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<sup>1</sup> |
|-----------|-------------------|-------------------------------------|
|           | 30DAS  | 45DAS  | 60DAS  | 30DAS  | 45DAS  | 60DAS  | 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<sub>1</sub> | 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<sub>2</sub> | 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<sub>3</sub> | 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<sub>4</sub> | 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    |

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

| Treatment | Siliqua plant<sup>1</sup> | Seeds siliqua<sup>-1</sup> | 1000 seed weight (g) | Seed yield (q ha<sup>-1</sup>) | Stover yield (q ha<sup>-1</sup>) |
|-----------|-----------------------------|---------------------------|------------------------|-------------------------------|-------------------------------|
|           | 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<sub>1</sub> | 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<sub>2</sub> | 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<sub>3</sub> | 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<sub>4</sub> | 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    |

Sowing date (S)

| Variety (V) | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 |
|-------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| V<sub>1</sub> | 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<sub>2</sub> | 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<sub>3</sub> | 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 Interaction (S x V) | Siliqua plant $^1$ | Seeds siliqua $^1$ | 1000 seed weight (g) | Seed yield (g ha$^{-1}$) | Stover yield (g ha$^{-1}$) |
|------------------------------|---------------------|-------------------|---------------------|--------------------------|--------------------------|
|                              | 2018-19  | 2019-20  | 2018-19  | 2019-20  | 2018-19  | 2019-20  | 2018-19  | 2019-20  | 2018-19  | 2019-20  |
| S$_1$V$_1$                   | 11.0     | 9.1      | 10.0     | 24.4      |
| S$_1$V$_2$                   | 7.7      | 6.8      | 7.2      | 21.6      |
| S$_1$V$_3$                   | 9.6      | 8.1      | 8.8      | 23.5      |
| S$_2$V$_1$                   | 8.6      | 8.5      | 8.6      | 23.4      |
| S$_2$V$_2$                   | 7.1      | 6.4      | 6.7      | 20.0      |
| S$_2$V$_3$                   | 9.5      | 7.9      | 8.7      | 22.7      |
| S$_3$V$_1$                   | 8.0      | 7.5      | 7.7      | 22.6      |
| S$_3$V$_2$                   | 4.6      | 4.6      | 4.6      | 19.4      |
| S$_3$V$_3$                   | 7.4      | 6.0      | 6.6      | 22.2      |
| S$_4$V$_1$                   | 8.0      | 7.1      | 7.6      | 21.6      |
| S$_4$V$_2$                   | 4.3      | 3.9      | 4.1      | 18.0      |
| S$_4$V$_3$                   | 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 q/ha 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\(_1\)V\(_1\) which is at par with S\(_1\)V\(_3\) (23.5 qha\(^{-1}\)) and lowest 18.0 q/ha in S\(_4\)V\(_2\). 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

| Treatment | Harvest index (%) | RWUE (kg ha\(^{-1}\) mm\(^{-1}\)) | B:C |
|-----------|------------------|-----------------------------|-----|
| 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 | 22.8 | 12.8 | 20.6 |  |
| CD (5%) | 1.12 | 1.10 | 6.8 | 15.4 |  |
| Interaction (S x V) |  |  |  |  |  |
| S\(_1\)V\(_1\) | 30.7 | 14.1 | 10.7 | 2.57 | 2.20 |  |
| S\(_1\)V\(_2\) | 26.2 | 9.9 | 8.1 | 2.19 | 1.40 |  |
| S\(_1\)V\(_3\) | 28.5 | 12.2 | 9.6 | 2.13 | 1.80 |  |
| S\(_2\)V\(_1\) | 26.6 | 16.5 | 35.6 | 1.82 | 2.00 |  |
| S\(_2\)V\(_2\) | 25.6 | 14.8 | 26.7 | 1.94 | 1.20 |  |
| S\(_2\)V\(_3\) | 28.9 | 19.9 | 32.9 | 2.09 | 1.70 |  |
| S\(_3\)V\(_1\) | 25.9 | 13.3 | 25.9 | 1.42 | 1.60 |  |
| S\(_3\)V\(_2\) | 19.0 | 7.6 | 17.1 | 0.96 | 0.60 |  |
| S\(_3\)V\(_3\) | 24.3 | 12.0 | 23.4 | 1.63 | 1.10 |  |
| S\(_4\)V\(_1\) | 26.2 | 12.6 | 29.5 | 0.54 | 1.50 |  |
| S\(_4\)V\(_2\) | 19.0 | 9.3 | 16.1 | 0.82 | 0.40 |  |
| S\(_4\)V\(_3\) | 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 (12.1 kg ha$^{-1}$ mm$^{-1}$ and 14.6 kg ha$^{-1}$ mm$^{-1}$ & 9.7 kg ha$^{-1}$ mm$^{-1}$ and 20.7 kg ha$^{-1}$ mm$^{-1}$ during 2018-19 and 2019-20, respectively). Among three varieties JT-90-1 recorded 14.1 kg ha$^{-1}$ and 29.2 kg ha$^{-1}$ 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].
| Treatment | 0 DAS   | 15 DAS    | 30 DAS    | 45DAS    | 60 DAS    | 75 DAS    | 90 DAS    |
|-----------|---------|-----------|-----------|----------|-----------|-----------|-----------|
|           | 2018-   | 2019-     | 2018-     | 2019-    | 2018-     | 2019-     | 2018-     | 2019-     | 2018-     | 2019-     | 2018-     |
| S1 V1     | 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       |
| S1 V2     | 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       |
| S1 V3     | 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       |
| S2 V1     | 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      |
| S2 V2     | 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      |
| S2 V3     | 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      |
| S3 V1     | 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       |
| S3 V2     | 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       |
| S3 V3     | 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       |
| S4 V1     | 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      |
| S4 V2     | 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      |
| S4 V3     | 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      | V=NS      |
| S X       | S X     | S X       | S X       | S X      | S X       | S X       | S X       | S X       | S X       | S X       | S X       | S X       | S X       | S X       |
| 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      | V=NS      |
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 (Jeulti) 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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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 |
| 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 | 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 | 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*
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