



## Research Article

# DETERMINATION OF SOWING TIME OF PARENTAL LINES OF HYBRID RICE SEED PRODUCTION IN MICRO-CLIMATIC CONDITION IN TARGET REGIONS OF WEST BENGAL

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**Abstract-** In view of the anticipated adverse impact of microclimatic conditions on 'A', 'B' and 'R' line of hybrid rice in West Bengal, a field experiment was conducted at the Teaching Farm, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India during *kharif* season 2012, *boro* season 2012-13, *kharif* season 2013 and *boro* season 2013-14 and quantify the impact of microclimatic conditions. The outcomes of the study have been found of utmost importance which would help in proper management of rice cultivation in West Bengal so as to minimize the adverse impact of microclimatic variation on synchronization of flowering and yield. Based on the mean GDD requirement for different phenophases of the parental lines, it was observed that GDD requirement for germination to panicle initiation was higher during *kharif* season than that of *boro* season. The lowest variation of GDD was revealed for germination to 100% flowering in both restorer and CMS line with co-efficient of variation 3.9 % and 7.6 % for restorer line and CMS line respectively. Similarly, HTU essentiality was higher in *kharif* season than that of *boro* season and co-efficient of variation was 28.4 % and 13.7 % in restorer and CMS line respectively. Whereas, germination to 50 % flowering higher co-efficient of variation was observed (47.8 % and 16.3 % in restorer and CMS line respectively). Similarly, there was difference between the *kharif* season and *boro* season in respect of PTU requirement for germination to 50 % flowering in both restorer and CMS line. Comparing the GDD, HTU and PTU trend it was noticed that GDD had minimum co-efficient of variation and thus, GDD was consistent parameter for predicting in flowering initiation of parental lines. The sowing dates should be chosen judiciously so that flowering may occur at the same time in both restorer and CMS line. It was recorded that GDD requirement of restorer line was 210-degree day higher than CMS line. Accordingly, the restorer line may be seeded at earlier date than CMS line.

**Keywords-** Hybrid rice, Micro climate, GDD, HTU and PTU

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## Introduction

The largest rice producing state in the country is West Bengal. At present, the cultivated area of rice is about 57 lakh hectares in West Bengal [1]. The demand for food is increasing gradually. We know due to rapid civilization and other infrastructure development, cultivated land of rice is gradually decreasing day by day [2]. Extensive cultivation of semi dwarf high yielding varieties coupled with the adoption of intensive input based management practices for several decades in the country converted an impressive growth in rice production in the post-independence era [3]. Four times rice production was increased, productivity three times but the area increase was only one and half times during this period. In order to keep pace with the growing population, the forecasted rice requirement by 2025 is about 130 m.t. plateauing trend in the yield of HYV's, declining and degrading natural resources like land and water and acute shortage of labor make the task of increasing rice production quite challenging. The current situation necessitates looking for some innovative technologies to boost rice production [4]. A key role in increasing the rice production is Hybrid rice technology [5]. A considerable increase in yield through hybrid rice technology will have a major impact on household food and nutritional security, income generation, besides an economic impact in the region. The main objective of this study is to determine of macro-climatic requirements for hybrid rice seed production in target regions of the State. With the above consideration, the present observation has been undertaken to evaluate fine tuning of hybrid specific and location specific seed production technology, microclimatic factors and potential selection of chemicals for higher seed set percentage in A line during *kharif* season 2012, *boro* season 2012-13,

*kharif* season 2013 and *boro* season 2013-14 at the Teaching Farm, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India.

## Materials and Methods

The main field was prepared following standard agronomic practices and intercultural operations. During field preparation fertilizer was added 100:50:50 N: P: K kg ha<sup>-1</sup>. While another dose of 50 kg N ha<sup>-1</sup> was applied as top dressing at 45 DAT. The main land was leveled properly and accordingly the requirement for the study it was made in to small sized plots (4.5 m × 2.05 m). A spacing of R to R: 30cm, A to A: 15cm, R to A: 20 cm were maintained and planting row ratio (Patil, 2008) was maintained in the ratio of 2:8 i.e. Restorer line (KMR-3R): CMS line (IR-58025 A). Intercultural operations and irrigations were carefully done for proper growth and development of plants. For hybrid rice seed production synchronization of flowering between restorer line and CMS line is very important [6]. Here in this experiment restorer line was seeded in three days interval which was name as Restorer line (R1), Restorer line (R2), Restorer line (R3). Simultaneously five CMS lines (A1, A2, A3, A4 and A5) were seeded in differential gap with restorer line (R2). A1, A2, A3, A4 and A5 were sown at 5, 7, 9, 11 and 13 days after R2 soaking the seeds [7]. Experiment was laid out in RBD (Randomize Block Design) with two replications. Macro climatic indices viz.; maximum and minimum temperatures, bright sunshine hour was taken from Department of Meteorology and Physics of Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal. Maximum possible day length was taken on daily basis from daily newspaper according to sunrise time and sunset time.

The parameters such as growth degree days (GDD), photo thermal unit (PTU) and helio thermal unit (HTU) were recorded in the field. The formula of GDD, PTU and HTU are

$$GDD = \sum_{i=1}^n \frac{[(T_{max.} + T_{min.}) - Base]}{2}$$

$$PTU = \sum_{i=1}^n \frac{[(T_{max.} + T_{min.}) - T_{Base}]}{2} \times MDL$$

$$HTU = \sum_{i=1}^n (GDD \times BSS)$$

Where,  $T_{max.}$  = Daily maximum temperature ( $^{\circ}\text{C}$ ),  $T_{min.}$  = Daily minimum temperature ( $^{\circ}\text{C}$ ), MDL = Maximum possible day length, BSS = Bright sunshine hour and  $T_b$  = Base temperature ( $^{\circ}\text{C}$ ) [during *kharif* season base temperature was taken  $10^{\circ}\text{C}$  and during *boro* season  $8^{\circ}\text{C}$ ]

## Results and Discussion

Development of an efficient and economically viable hybrid rice seed production package is important to harvest the benefit of a heterotic combination but the major limiting factors is non-synchronization of flowering between CMS and restorer lines, and low panicle exertion at the time of anthesis which causes low out crossing and ultimately low seed setting on the CMS line. Synchronization of flowering is most important factor, as the amount of seed setting depends on the pollen load during flowering. The phenological behavior of the parental lines varies from location to location and season to season. Thus, it is important to standardize to exact seeding difference between the parental lines for synchronization of flowering. The CMS line used in the KRH 2 hybrid combinations i.e. IR-58025A suffer from poor panicle exertion. Since the line contains the wild abortive (WA) cytoplasm it shows improper panicle exertion and at least 25-35 % spikelets remain enclosed within the flag leaf and thus reduce the number of spikelets available for out crossing [8].

Synchronization of flowering and out crossing in hybrid rice depends on various climatic factors like temperature, sunlight and relative humidity. Thus, the present study on "Refinement of Technology for Hybrid Seed Production in Rice" was carried out to develop a situation specific package for this region in the leading hybrid KRH 2 during *kharif* season 2012, *boro* season 2012-13, *kharif* season 2013 and *boro* season 2013-14.

### Determination of sowing window with reference to climatic factors;

Hybrid rice is a crop that has been bred from two very different parents i.e., restorer line (R) and CMS line (A). The efficiency of seed setting in CMS line depends upon supply of pollen from R line to A line, period of anthesis and prevailing weather conditions. (Krishnaswamy and Ramaswamy, 1979). To produce hybrid rice seed, flowering synchronization between restorer line (R) and CMS line (A) must be ensured. For successful pollination and higher seed production flowering synchronization is a prerequisite. Various climatic factors play a vital role in altering the flowering biology of rice plant [9]. The duration of each phenophase is assumed to depend on prevailing climatic factor in most of the plant's species.

The accumulated weather indices like Growing Degree Day (GDD), Photo thermal Unit (PHU), Helio Thermal Unit (HTU) are being considered as critical deciding factors for phenophasic development of most of the field crops which are not strictly photoperiod or thermo period sensitive. Rice being successfully cultivated during different seasons and different temperature and light environment in West Bengal condition, the GDD, HTU, PTU concept may be applied for analyzing phenological development.

Under the present investigation an attempt was made at the Teaching farm, Mandouri of Bidhan Chandra Krishi Viswavidyalaya in both *kharif* and *boro* seasons to elucidate the information on effect of different agro climatic indices such as Growing Degree Day (GDD), Photo Thermal Unit (PHU) and Helio Thermal Unit (HTU) for both restorer and CMS line so that synchronization of flowering can be made possible. For the experimental purpose the restorer line was seeded at three days interval (R1, R2 and R3 in *kharif* season; R4, R5 and R6 in *boro* season) and the CMS line was seeded at interval from R2 viz., {5 days

(S1), 7 days (S2), 9 days (S3), 11days (S4), 13 days (S5) in *kharif* season and 5 days (S6), 7 days (S7), 9 days (S8), 11days (S9), 13 days (S10) in *boro* season}. Observations were recorded on germination to panicle initiation (P1), germination to 50 % flowering (P2), germination to 100 % flowering (P3), panicle initiation to 50 % flowering (P4), panicle initiation to 100 % flowering (P5) in both parental lines.

Table-1 Mean GDD requirement at different phenophases

	P1	P2	P3	P4	P5
R1	1275.6	1904.4	1972.1	628.8	139.6
R2	1300.1	1921.1	1984.9	621.0	131.4
R3	1253.4	1868.0	1928.0	614.6	124.5
R4	1024.9	1749.3	1820.4	724.4	189.8
R5	1031.1	1766.9	1834.1	735.8	188.0
R6	1038.3	1775.8	1841.5	737.6	182.5
Mean	1153.9	1830.9	1896.8	677.0	159.3
Sd	135.0	75.8	73.8	61.2	30.6
CV (%)	11.7	4.1	3.9	9.0	19.2
S1	1049.7	1683.2	1754.0	633.5	144.3
S2	1076.9	1705.6	1773.3	628.8	139.6
S3	1092.6	1716.1	1780.9	623.5	133.0
S4	1075.2	1686.3	1751.8	611.2	133.4
S5	1056.9	1677.1	1740.5	620.2	130.7
S6	880.5	1570.9	1640.9	690.4	179.0
S7	890.4	1585.4	1670.1	695.0	185.6
S8	899.5	1295.5	1344.2	396.1	129.4
S9	898.3	1613.0	1695.6	714.7	200.2
S10	915.5	1653.8	1720.3	738.4	186.1
Mean	983.5	1618.7	1687.1	635.2	156.1
Sd	92.5	124.0	128.6	95.3	28.0
CV (%)	9.4	7.7	7.6	15.0	17.9
Mean GDD diff		212.2	209.7	41.9	3.2

Restorer line (R) seeding 3 days interval i.e.; *kharif* season (1) R1 (2) R2 (3) R3 and *boro* season (1) R4 (2) R5 (3) R6

CMS line (A) seeding firstly 5 days interval from R2 then from first CMS seeding 2 days interval: *kharif* season (1) S1 (2) S2 (3) S3 (4) S4 (5) S5 and *boro* season (1) S6 (2) S7 (3) S8 (4) S9 (5) S10

P1: Germination to panicle initiation; P2: Germination to 50% flowering; P3: Germination to 100% flowering; P4: Panicle initiation to 50% flowering; P5: Panicle initiation to 100% flowering

### Mean GDD requirement at different phenophases

#### Germination to panicle initiation (P1)

Among the three restorer lines (R1, R2 and R3 in *kharif* season and R4, R5 and R6 *boro* season), maximum mean GDD value (1300.1) was recorded in R2 and R6 (1138.3) in *kharif* season and *boro* season respectively similarly in case of CMS lines maximum (1092.6) value was noticed in S3 and S10 (915.5) in *kharif* season and *boro* season respectively. It was noticed that the mean value of GDD in both seasons were recorded as 1153.9 and 983.5 for restorer as well as CMS line respectively.

#### Germination to 50% flowering (P2)

Among the three restorer lines (R1, R2 and R3 in *kharif* season and R4, R5 and R6 *boro* season), maximum mean GDD value was recorded in R2 (1921.1) and R6 (1775.8) in *kharif* season and *boro* season respectively. Similarly, in case of CMS lines maximum value was noticed in S3 (1716.1) and S10 (1653.8) in *kharif* season and *boro* season respectively. Mean value of GDD in both *kharif* season as well as *boro* seasons were recorded as 1830.9 and 1618.7 for restorer as well as CMS line respectively.

#### Germination to 100% flowering (P3)

In case of germination to 100 % flowering, maximum mean Growing Degree Day (GDD) for restorer line was recorded in R2 (1984.9) and R6 (1841.5) in *kharif* season and *boro* season respectively, whereas, for CMS lines, maximum value was observed in S3 (1780.9) and S10 (1720.3) in *kharif* season and *boro* season respectively. In case of germination to 100 % flowering, it was observed that the mean values of GDD in both seasons were recorded as 1896.8 and 1687.1 for restorer as well as CMS line respectively.

**Panicle initiation to 50% flowering (P4)**

Regarding panicle initiation to 50 % flowering, highest value was recorded in R1 (628.8) and R6 (737.6) for restorer line and S1 (633.5) and S10 (738.4) for CMS line both in *kharif* season as well as *boro* season respectively. Mean value of GDD in both *kharif* season as well as *boro* seasons were recorded as 677.0 and 635.2 for restorer as well as CMS line respectively for panicle initiation to 50 % flowering.

**Panicle initiation to 100% flowering (P5)**

In this parameter, R1 (139.6) and R4 (189.8) as well as S1 (633.5) and S9 (200.2) showed maximum value both in restorer and CMS line in *kharif* season and *boro* season respectively. For the parameter, panicle initiation to 100 % flowering, mean value of GDD in both *kharif* seasons as well as *boro* seasons were recorded as 159.3 and 156.1 for restorer as well as CMS line respectively

Table-2 Mean HTU requirement at different phenophases

	P1	P2	P3	P4	P5
R1	6776.6	10725.5	11230.8	3948.9	997.6
R2	13002.0	31180.0	37217.5	18178.0	17146.3
R3	6478.2	10990.5	11558.0	4512.4	1150.3
R4	7821.7	14069.5	14673.3	6247.8	1711.7
R5	7931.8	14298.1	14932.9	6366.3	1697.9
R6	8142.6	14568.9	15126.2	6426.3	1605.6
Mean	8358.8	15972.1	17456.4	7613.3	4051.5
Sd	2371.4	7642.2	9834.6	5281.8	6422.1
CV (%)	28.4	47.8	56.3	69.4	158.5
S1	5317.7	9325.0	9751.1	4007.3	962.6
S2	5658.9	9607.8	10113.2	3948.9	997.6
S3	4925.0	9057.1	9553.0	4132.1	988.4
S4	5779.5	9933.9	10451.6	4154.5	1056.4
S5	5535.7	9851.6	10397.6	4315.9	1056.9
S6	6723.0	12687.5	13324.2	5964.6	1688.5
S7	6869.4	12870.5	13649.8	6001.2	1795.1
S8	6999.8	10505.1	10961.3	3505.4	1272.4
S9	7060.9	13203.6	13941.8	6142.7	1814.4
S10	7267.5	13624.6	14258.3	6357.1	1655.6
Mean	6213.7	11066.7	11640.2	4852.9	1328.8
Sd	853.4	1803.2	1906.1	1111.8	365.2
CV (%)	13.7	16.3	16.4	22.9	27.5
Mean HTU Dff.		4905.4	5816.3	2760.3	2722.8

Restorer line (R) seeding 3 days interval i.e.; *kharif* season (1) R1 (2) R2 (3) R3 and *boro* season (1) R4 (2) R5 (3) R6

CMS line (A) seeding firstly 5 days interval from R2 then from first CMS seeding 2 days interval: *kharif* season (1) S1 (2) S2 (3) S3 (4) S4 (5) S5 and *boro* season (1) S6 (2) S7 (3) S8 (4) S9 (5) S10

P1: Germination to panicle initiation; P2: Germination to 50% flowering; P3: Germination to 100% flowering; P4: Panicle initiation to 50% flowering; P5: Panicle initiation to 100% flowering

**Mean HTU requirement at different phenophases****Germination to panicle initiation (P1)**

Among the three restorer lines (R1, R2 and R3 in *kharif* season and R4, R5 and R6 *boro* season), maximum mean Helio Thermal Unit (HTU) value was recorded in R2 (13002.0) and R6 (8142.6) in *kharif* season and *boro* season respectively similarly in case of CMS lines maximum value was noticed in S4 (5779.5) and S10 (7267.5) in *kharif* season and *boro* season respectively. Mean value of HTU in both seasons i.e. *kharif* season and *boro* season were recorded as 8358.8 and 6213.7 for restorer as well as CMS line respectively.

**Germination to 50% flowering (P2)**

Among the three restorer lines (R1, R2 and R3 in *kharif* season and R4, R5 and R6 *boro* season), maximum mean HTU value was recorded in R2 (31180.0) and R6 (14568.9) in *kharif* season and *boro* season respectively similarly in case of CMS lines maximum value was noticed in S4 (9933.9) and S10 (13624.6) in *kharif* season and *boro* season respectively. For germination to 50% flowering (P2), it was noticed that the mean value of Helio Thermal Unit (HTU) in both seasons were recorded as 15972.1 and 11066.7 for restorer as well as CMS line respectively.

**Germination to 100% flowering (P3)**

In case of germination to 100 % flowering, maximum mean Helio Thermal Unit (HTU) for restorer line was recorded in R2 (37217.5) and R6 (15126.2) in *kharif* season and *boro* season respectively, whereas, for CMS lines, maximum value was observed in S4 (10451.6) and S10 (14258.3) in *kharif* season and *boro* season respectively. For the parameter, panicle initiation to 100 % flowering, mean value of HTU in both *kharif* season as well as *boro* seasons were recorded as 17456.4 and 11640.2 for restorer as well as CMS line respectively.

**Panicle initiation to 50% flowering (P4)**

Regarding panicle initiation to 50 % flowering, highest mean value of HTU was recorded in R2 (18178.0) and R6 (6426.3) for restorer line and S5 (4315.9) and S10 (6357.1) for CMS line both in *kharif* season as well as *boro* season respectively. Mean value of HTU in both *kharif* season as well as *boro* seasons were recorded as 7613.3 and 4852.9 for restorer as well as CMS line respectively for panicle initiation to 50 % flowering.

**Panicle initiation to 100% flowering (P5)**

In this parameter, R1 (139.6) and R4 (189.8) as well as S1 (144.3) and S9 (200.2) showed maximum value of Helio Thermal Unit (HTU) both in restorer and CMS line in *kharif* season and *boro* season respectively. In case of panicle initiation to 100 % flowering (P5) mean value of GDD in both *kharif* season as well as *boro* seasons were recorded as 4051.5 and 1328.8 for restorer as well as CMS line respectively.

Table-3 Mean PTU requirement at different phenophases

	P1	P2	P3	P4	P5
R1	16497.1	23984.3	24761.0	7487.2	1607.6
R2	16731.0	24066.1	24791.8	7335.1	1501.5
R3	16699.6	23912.7	24590.8	7213.1	1412.5
R4	17338.2	26169.4	27066.6	8831.3	2384.3
R5	11448.2	20451.1	21301.9	9002.9	2368.4
R6	11572.3	20685.0	21519.0	9112.7	2308.1
Mean	15047.7	23211.4	24005.2	8163.7	1930.4
Sd	2754.8	2216.8	2208.8	905.3	468.4
CV (%)	18.3	9.6	9.2	11.1	24.3
S1	13565.1	21158.8	21976.3	7593.7	1673.8
S2	13846.7	21333.9	22110.6	7487.2	1607.6
S3	13997.5	21380.8	22120.6	7383.3	1523.1
S4	13746.9	20974.5	21721.1	7227.6	1525.9
S5	13486.3	20804.4	21524.9	7318.1	1491.6
S6	9726.0	18071.2	18948.8	8345.2	2229.7
S7	9865.2	18294.9	19356.7	8429.7	2321.8
S8	9993.2	18115.2	19016.0	8122.0	1883.2
S9	10009.9	18723.3	19767.2	8713.4	2516.6
S10	10235.6	19278.1	20119.7	9042.5	2346.5
Mean	11847.2	19813.5	20666.2	7966.3	1911.9
Sd	1991.8	1437.9	1344.2	647.5	401.4
CV (%)	16.8	7.3	6.5	8.1	21.0
Mean PTU Dff.		3397.9	3339	197.44	18.447

Restorer line (R) seeding 3 days interval i.e.; *kharif* season (1) R1 (2) R2 (3) R3 and *boro* season (1) R4 (2) R5 (3) R6. CMS line (A) seeding firstly 5 days interval from R2 then from first CMS seeding 2 days interval: *kharif* season (1) S1 (2) S2 (3) S3 (4) S4 (5) S5 and *boro* season (1) S6 (2) S7 (3) S8 (4) S9 (5) S10

P1: Germination to panicle initiation; P2: Germination to 50% flowering; P3: Germination to 100% flowering; P4: Panicle initiation to 50% flowering; P5: Panicle initiation to 100% flowering

**Mean PTU requirement at different phenophases****Germination to panicle initiation (P1)**

Among the three restorer lines (R1, R2 and R3 in *kharif* season and R4, R5 and R6 *boro* season), maximum mean Photo Thermal Unit (PTU) value was recorded in R2 (16731.9) and R6 (17338.2) in *kharif* season and *boro* season respectively similarly in case of CMS lines maximum value was noticed in S3 (13997.5) and S10 (10235.6) in *kharif* season and *boro* season respectively. Mean value of PTU in both seasons i.e. *kharif* season and *boro* season were recorded as 15047.7 and 11847.2 for restorer as well as CMS line respectively.



**Germination to 50% flowering (P2)**

Among the three restorer lines (R1, R2 and R3 in *kharif* season and R4, R5 and R6 *boro* season), maximum mean of PTU value was recorded in R2 (24066.1) and R4 (26169.4) in *kharif* season and *boro* season respectively similarly in case of CMS lines maximum value was noticed in S3 (21380.8) and S10 (19278.1) in *kharif* season and *boro* season respectively. For the parameter germination to 50% flowering (P2), mean value of PTU in both seasons *i.e.* *kharif* season and *boro* season were recorded as 23211.4 and 19813.5 for restorer as well as CMS line respectively.

**Germination to 100% flowering (P3)**

In case of germination to 100 % flowering, maximum mean Photo Thermal Unit (PTU) for restorer line was recorded in R2 (24791.8) and R4 (27066.6) in *kharif* season and *boro* season respectively, whereas, for CMS lines, maximum value was observed in S3 (22120.6) and S10 (20666.2 ) in *kharif* season and *boro* season respectively. For the parameter, panicle initiation to 100 % flowering, mean value of PTU in both *kharif* season as well as *boro* seasons were recorded as 24005.2 and 20666.2 for restorer as well as CMS line respectively.

**Panicle initiation to 50% flowering (P4)**

Regarding panicle initiation to 50 % flowering, highest mean value of PTU was recorded in R1 (7487.2) and R6 (9112.7) for restorer line and S1 (7593.7) and S10 (9042.5) for CMS line both in *kharif* season as well as *boro* season respectively. For the parameter, panicle initiation to 100 % flowering, mean value of PTU in both *kharif* season as well as *boro* seasons were recorded as 905.3 and 7966.3 for restorer as well as CMS line respectively.

**Panicle initiation to 100% flowering (P5)**

In this parameter, R1 (1607.6) and R5 (2368.4) as well as S1 (1673.8) and S9 (2516.6) showed maximum value of Photo Thermal Unit (PTU) both in restorer and CMS line in *kharif* season and *boro* season respectively. For the parameter, panicle initiation to 100 % flowering, mean value of PTU in both *kharif* season as well as *boro* seasons were recorded as 1930.4 and 1911.9 for restorer as well as CMS line respectively.

Table-4 Comparative study

	Mean GDD		Mean HTU		Mean PTU	
	P2	P3	P2	P3	P2	P3
R LINE	1830.8	1896.8	15972.1	17456.4	23211.4	24005.2
A LINE	1653.8	1720.3	11066.7	11640.2	19813.5	20666.2
Deviation	212.2	209.7	4905.4	5816.3	3397.9	3339

**Comparative study of mean GDD, HTU and PTU****GDD required for *kharif* season**

Average temperature during *kharif* season: 27 °C

Base temperature during *kharif* season: 10 °C

So, Difference = (27 °C-10 °C) =17°C

As a result, days difference = (210/17) =12.4 days

From the above calculation it may be concluded that 12.4 days required for during *kharif* season to get better flowering synchronization. Thus, during *kharif* season, for getting better flowering synchronization as well as better seed yield 11 days to 13 days interval may be recommended between restorer line to CMS line in the Gangetic New Alluvial Zone of West Bengal.

**GDD required for *kharif* season**

Average temperature during *boro* season: 20°C

Base temperature during *boro* season: 8 °C

So, Difference = (20°C-8°C) =12°C

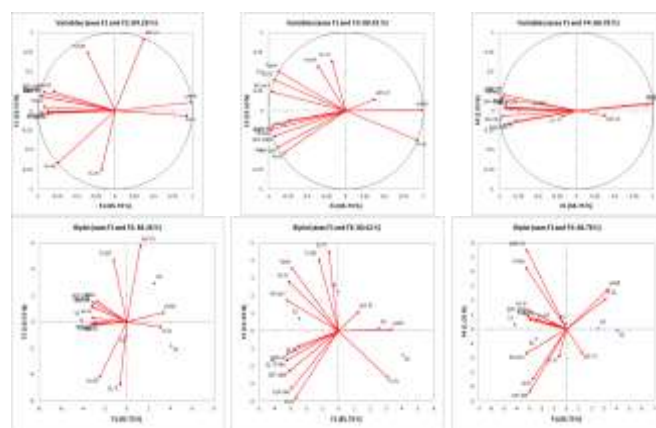
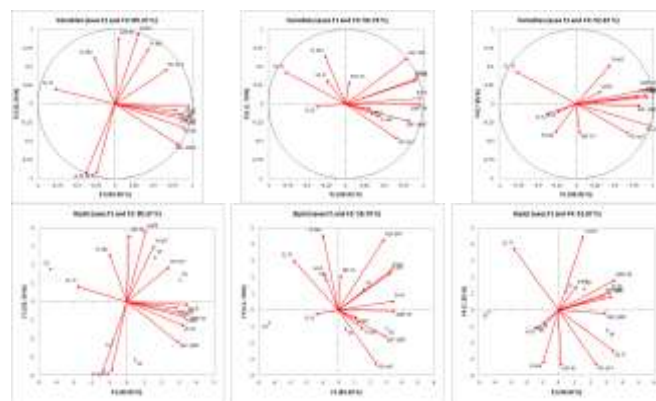
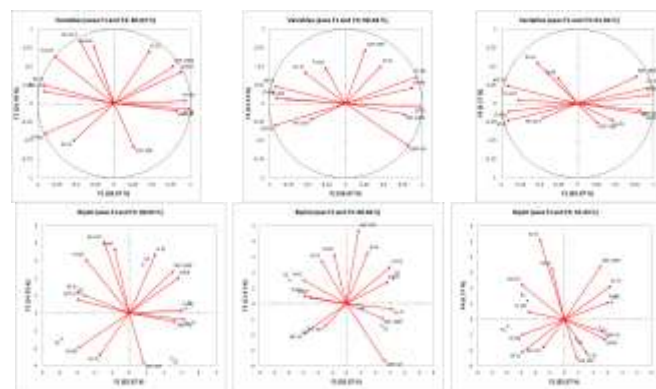
As a result, days difference = (210/12) =17.4 days

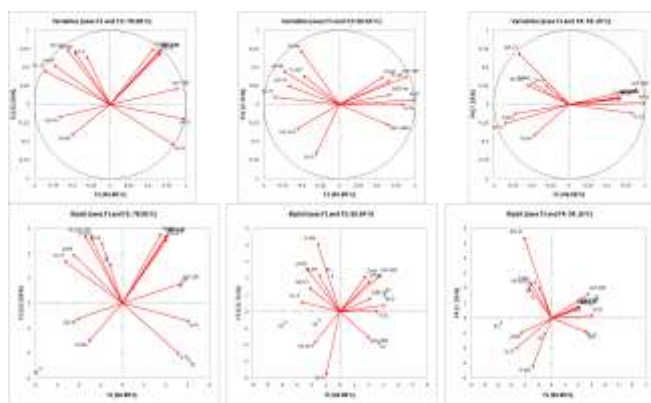
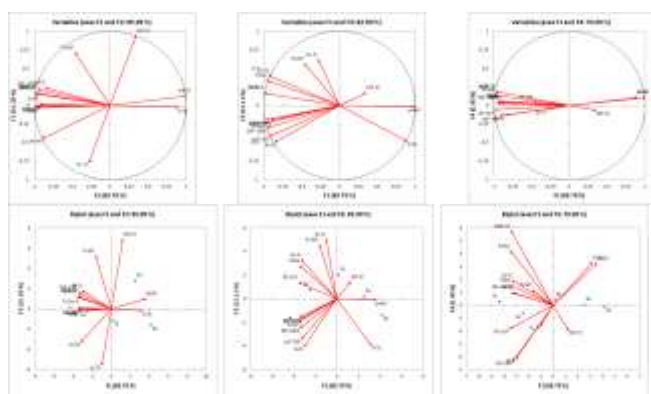
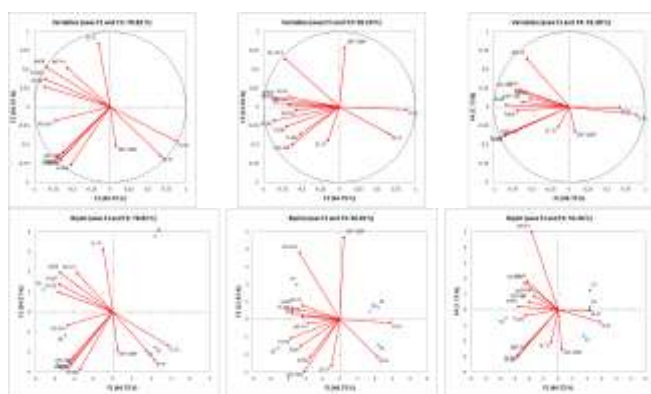
From the above calculation it may be concluded that 17.4 days required for during *boro* season to get better flowering synchronization between restorer line and CMS line. Thus, during *boro* season, for getting better flowering synchronization as well as better seed yield 16 days to 17 days interval may be recommended

between restorer line to CMS line in the Gangetic New Alluvial Zone of West Bengal.



Fig-1 Restorer line (KMR-3R) and CMS line (IR-58025 A)

Fig-2 Mean GDD requirement at different phenophases in *kharif* seasonFig-3 Mean GDD at different phenophases during *rabi* seasonFig-4 Mean HTU at different phenophases in *kharif* season

Fig-5 Mean HTU at different phenophases in *rabi* seasonFig-6 Mean PTU at different phenophases in *kharif* seasonFig-7 Mean PTU at different phenophases in *rabi* season

## Conclusion

Based on the mean Growing Degree Day (GDD) requirement for different phenophases of the parental lines, it was revealed that GDD requirement for germination to panicle initiation was higher during *kharif* season than that of *boro* season. The minimum variation of GDD was observed for germination to 100% flowering in both restorer and CMS line with co-efficient of variation 3.9 % and 7.6 % for restorer line and CMS line respectively. Similarly, Helio Thermal Unit (HTU) requirement was higher in *kharif* season than that of *boro* season and co-efficient of variation was 28.4 % and 13.7 % in restorer and CMS line respectively. Whereas, germination to 50 % flowering higher co-efficient of variation was observed (47.8 % and 16.3 % in restorer and CMS line respectively). Similarly, there was difference between the *kharif* season and *boro* season in respect of Photo Thermal Unit (PTU) requirement for germination to 50 % flowering in both restorer and CMS line. Comparing the GDD, HTU and PTU trend it was noticed that GDD had minimum co-efficient of variation and thus, GDD was consistent parameter for predicting in flowering initiation of parental lines. The sowing dates should be chosen judiciously so that flowering may occur at the same time in both restorer and CMS line. It was observed that GDD requirement of restorer line was 210-degree day higher than CMS line. Accordingly, the restorer line may be

seeded at earlier date than CMS line. Considering the average temperature of 27°C and 20°C during the two cropping seasons and base temperature of 10°C and 8°C of the *kharif* and *boro* season respectively in this region a seeding interval of 12.4 days during *kharif* season and 17.4 days during *boro* season was predicted. Among the macro climatic indices GDD was consistent parameter for predicting flowering initiation in parental lines. GDD requirement of restorer line was 210-degree day higher than CMS line. Considering the average temperature during the crop period and base temperature of this region during the *kharif* and *boro* season 12.4 days seeding interval during *kharif* season and 17.4 days interval during *boro* season was predicted.

**Application of research:** The sowing dates should be chosen judiciously so that flowering may occur at the same time in both restorer and CMS line. Sowing date should be adjusted on the basis of micro climate.

**Research Category:** Seed Science and Technology

**Abbreviations:** GDD: Growth Degree Days

PTU: Photo Thermal Unit, HTU: Helio Thermal Unit

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**\*\*Research Guide or Chairperson of research:** Prof Pranab Chattopadhyay

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Research project name or number: PhD Thesis

**Author Contributions:** All authors equally contributed

**Author statement:** All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

**Study area / Sample Collection:** Hybrid rice seed, Teaching Farm, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, 741 252, India

**Cultivar / Variety / Breed name:** Restorer line (KMR-3R), CMS line (IR-58025 A)

**Conflict of Interest:** None declared

**Ethical approval:** This article does not contain any studies with human participants or animals performed by any of the authors.

Ethical Committee Approval Number: Nil

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