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# Studies of morphological and physiological parameters of various rice (*Oryza sativa*) genotypes under *kharif* and different sowing windows during *Rabi* season in Konkan

**MH Keluskar, AV Mane, AK Shinde, RL Kunkerkar, SV Sawardekar, SD Dodake, SG Bhave, PM Haldankar, BD Wagmode, SB Bhagat and TJ Bedase**

## Abstract
The experiment was conducted at Regional Agriculture Research Station, Karjat during *kharif* -2020, *kharif*-2021, *rabi*-20-21 and *rabi*-21-22 for the studies of morphological and physiological parameters rice genotypes under kha*rif* and different sowing windows during *rabi* season in Konkan. The experiment was laid out with 40 early duration rice germplasms in Split Plot Design with three replications. The experiment consisted of two factors: Main plot - four date of sowing i.e. $S_1$-24$^{th}$MW,$S_2$-48$^{th}$ MW, $S_3$-50$^{th}$ MW, $S_4$ - 52$^{th}$ MW and sub plot 40 rice genotypes (V1 to V40). From the data, it is revealed that Hira and OR-1516-1-5-A showed the shortest days to maturity, while Ratnagiri-6 and Ratnagiri-1 required the longest time. Sowing in the 50$^{th}$ meteorological week with Ratnagiri-5 resulted in a longer maturity period, whereas *kharif* sowing with Hira resulted in a shorter duration. Ratnagiri-5 and Ratnagiri-1 required the most extended time to mature.

Karjat-3 had a higher average growth rate.Sahyadri-2 displayed a higher relative growth rate and Phondaghat$^{-1}$ demonstrated a higher net assimilation rate. Sowing in the 48$^{th}$ meteorological week with Hira resulted in a higher average growth rate, sowing in the 52$^{th}$ meteorological week with Ratnagiri-7 led to a higher relative growth rate, and sowing in the 50$^{th}$ meteorological week with Karjat-1 yielded a higher net assimilation rate.

Sahyadri-4 recorded significantly maximum grain yield per plant (24.62 g) which was at par with genotypeKarjat-3 (23.93g) over other genotypes. *Kharif* season (24$^{th}$ MW) with Sahyadri-4 recorded significantly higher grain yield per plant (22.86 g) which was superior over other treatment combinations during pooled mean.

**Keywords:** Rice genotypes, morphological and physiological parameters, kharif and different sowing window in Rabi season

## Introduction
Rice belongs to genus *Oryza*, of the family Poceace and is widely cultivated crop (FAO, 2000; Syed and Khaliq, 2008). Genus *Oryza* contains approximately 24 species, of which 21 are wild type and two; *O. sativa* and O. *glaberrima* are cultivated world-wide (Vaughan, 2003) [53]. It is the most important food crop worldwide, representing the staple food and more than half of world population depends on its consumption and income generation (Bucheyeki *et al*, 2011) [8]. Rice (*Oryza sativa* L., 2n=24) is important cereal crop in India and staple food of more than 60% of Indian population. Total production of rice estimated at record 130.84 million tonnes (Anonymous, 2023). Rice is the second important crop of Maharashtra and is grown over an area of 14.65 lakh hectares with an annual rice production of about 32.76 lakh tonnes. Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli has released and notified 34 rice varieties including 5 hybrids and has developed improved package of practices for cultivation of rice crop since 1972. The rice production has increased from 10.06 lakh tonnes (1970) to 15.69 lakh tonnes (2016) and productivity from 2.3tha$^{-1}$to 4.35tha$^{-1}$ wwwcal.researchgate.net Technological interventions boon for rice production in konkan region, 2020).

The major rice districts in Maharashtra are Thane, Raigad, Ratnagiri, Sindhudurg and Palghar along with west coast and Bhandara, Gondiia, Gadchiroli and Chandrapur in the eastern part of State, Konkan region occupies an area of about 3.69 lakh hectare under rice with production of about 12.94 lakh tonnes and productivity around 2.93 tonnes ha$^{-1}$ (Annonymous, 2023).

Rice is the main cereal crop in Konkan and it is cultivated in *kharif* as well as *rabi* season. During *kharif* season, the sowing of rice in the month of June and should be harvested in the month November, therefore the pre cultivation operations should belatein *rabi* season means the sowing of rice will be in the month of December. Most of area of Raigad and Ratnagiri, Sindhudurg water of canal will be provided in the month of December and harvest the crop in the end of May. That time lot of loss of crop due to pre monsoon rainfalls. Therefore, it is very important that harvesting be at end of April or the first week of May Dr. BSKKV, Dapoli released of high yielding varieties for the *kharif* and *Rabi* season. The sowing time of the rice crop is important for three major reasons. Firstly, it ensures that vegetative growth occurs during a period of satisfactory temperatures and total sunshine hours. Secondly, the optimum sowing time for each cultivar ensures the cold sensitive stage occurs when the minimum night temperatures are historically the warmest. Thirdly, sowing on time guarantees that grain filling occurs when milder autumn temperatures are more likely, hence good grain quality is achieved. Results from different studies revealed that the maximum yield potential of a rice crop is usually achieved when the crop is exposed to the most appropriate temperature range, which can be controlled by sowing at the proper time.

In the present study for the summer rice, the sowing of rice variety is in the 48$^{th}$ metrological week (1$^{st}$ December), 50$^{th}$ metrological week (15$^{th}$ Dec) and 52$^{th}$ metrological week (30$^{th}$,Dec) and keeping view to study growth parameters of various rice (*Oryza sativa*) genotypes under *kharif* and different sowing windows during *rabi* season in Konkan.

## Materials and Methods

The experiment was conducted at Regional Agriculture Research Station, Karjat during *kharif*-2020, *kharif*-2021, *rabi*-20-21 and *rabi*-21-22 for the evaluation of rice genotypes under *kharif* and different sowing windows during *rabi* season in Konkan. It is situated at 18°91'67" North latitude and 73°33' East longitude with an altitude of 194 meters (636 ft) above the mean sea level with warm and humid conditions throughout the year. The mean annual precipitation is 3500 mm, which is generally received during the month from June to November at the location. The experiment was laid out with 40 early duration rice germplasms in Split Plot Design with three replications during *kharif-2020* and *kharif-2021* as well as *Rabi 2020-21* and *rabi 2021-22* with different sowing windows.

The experiment comprised of forty genotypes of rice, laid out in Spilt Plot Design with three replications. The seeds were sown on 2$^{nd}$ week of June 2020 and 2021during *kharif* season and 1$^{st}$, 2$^{nd}$ and 3$^{rd}$ sowing on 1$^{st}$December, 15$^{th}$ December and 30$^{th}$ December during *Rabi* season on raised beds. After 25 days, seedlings were transplanted with spacing of 15 cm between row and 15 cm between plants in rows with plot size 2.10 m x 0.75 m. for each variety in the plot. The field experiment was conducted at normal fertility level on lateritic soil. Fertilizers applications were done @ 100 kg N, 50 kg $P_20_5$ and 50 kg $K_20$ per hectare.

## Results

Data on morphological and physiological parameters of various rice *(Oryza sativa)* genotypes under *kharif* and different sowing windows during *Rabi* season in Konkan are presented in Table-1 to Table-3.

### 1. Plant height (cm)

Plant height is an important morphological character. Taller plant with better canopy produces higher dry matter and characterized by high photosynthetic efficiency than short stature plant (Nimje, 2010) [39]. However, taller plants lodge at maturity because of top heaviness due to panicle weight and weaker lower stem, which ultimately reduces the yield. Therefore, non-lodging and medium tall plants would be preferable.

In present investigation, plant height increased up to harvest in all the rice genotypes. The rapid increase in height was observed during the period of tillering and flowering and thereafter rate of increase was slow up to harvest. The rice genotype $V_{39}$ (Sorati) recorded significantly higher plant height at tillering, flowering and harvesting stages followed by genotype China, Mhadi and rest of all other genotypes. Significantly lower plant height was recorded $V_{36}$.i.e.Hira (76.60cm) which was at par with $V_3$ i.e. Karjat -4 (78.74 cm) over other genotype.

Such trend in plant height was also reported by Yadava *et al.* (1988) showed that canopy height increased with crop age in rice. Singh and Jain (2000) found that the plant height increased gradually from tillering to flowering and remained almost constant thereafter till maturity. Chandrashekhar *et al.* (2017) [12] studied physiological analysis of growth and productivity in hybrid rice. The growth in terms of plant height increased rapidly at 60 DAT and later the increase was not much in all the cultivars.

Crop sown during *kharif* season i.e.$S_1$ (24$^{th}$ MW) produced significantly taller plant (115.81 cm) as compared to other sowing dates of *rabi* season i.e.$S_2$ (48$^{th}$ MW), $S_3$ (50$^{th}$ MW),$S_4$ (52$^{th}$ MW) for all growth stages of rice i.e. tillering, flowering and harvesting stages. Padmaja (2001) [50] conducted an experiment with ten genotypes during *kharif*, 1998 and 1999. The plant height measured at maximum tillering stage ranged from 45 cm (Swara) to 85 cm (SLO-13).The rice crop sown during *rabi* season, the $S_3$ i.e. 50$^{th}$ MW date of sowing recorded significantly higher plant height as compared to crop sown during $S_2$ i.e. 48$^{th}$ MW and $S_4$ i.e.52$^{th}$ MW for all growth stages. The rice genotype $V_{39}$ (Sorati) recorded significantly higher plant height at tillering, flowering and harvesting stages during both season i.e. *kharif* and *Rabi*. Interaction $S_3V_{39}$ i.e. 50$^{th}$ MW sowing with genotype Sorati recorded significantly higher height over other genotypes. Significantly lower plant height was recorded $V_{36}$.i.e.Hira (76.60 cm) which was at par with $V_3$ i.e. Karjat-4 (78.74 cm) over other genotypes. Interaction $S_4V_3$i.e.52$^{th}$ MW sowing with genotype Karjat-4 recorded significantly lower height.

Significant variation in plant height among the genotypes was earlier reported by many scientists (Padmaja (2001) [50]; Lohidas (2003) [33]; Akram *et al.*, 2007 [4]; Sabouri *et al*. 2008 [43], Courtney *et al.*, 2011 [10], Muhammad *et al.* (2012) [2]; Dutta *et al.* (2013) [14] evaluated sixty eight genotypes of rice and in their experiment they recorded 132.70 cm as mean height of genotypes.

### 2. Days to first flowering

The reproductive phases start with flowering and ends with maturity. In present investigation, crop sown during $S_1$–*kharif* season (24$^{th}$ MW) produced significantly maximum days to first flowering (80.50 days) as compared to other sowing dates of *rabi* season (48$^{th}$ MW, 50$^{th}$ MW, 52$^{th}$ MW).The rice crop sown during *rabi* season, $S_2$ (48$^{th}$MW) date of sowing recorded significantly maximum days to first flowering which was at par with $S_3$ (50th MW) and $S_4$ (52thMW). The rice genotype OR-1516-1-5-A.recorded significantly minimum (Early) days to first flowering followed by genotype Hira. Rice genotype $V_{10}$ recorded significantly maximum days to first flowering which was at par with $V_{11}$over others. Interaction $S_1V_{11}$ i.e. *kharif* season with genotype Ratnagiri-6 recorded significantly maximum days to first flowering followed by $V_9$ i.e. genotype Ratnagiri-1, $V_{10}$ i.e. geno type Ratnagiri-5over others. In case of *rabi* season $S_2V_{10}$ i.e. sowing 48th MW genotype Ratnagiri-5 recorded significantly higher days to first flowering followed by $S_2V_{11}$ i.e. 48th MW genotype Ratnagiri-6.

**3. Days to 50% flowering**

Crop sown during $S_2$-*rabi* season (48th MW) produced significantly maximum days to 50% flowering (88.48 days) as compared to other sowing dates of *rabi* season as well as$S_1$–*kharif* season (24th MW).Significantly maximum days of 50% flowering was recorded in $S_2$ (88.48 days) which was at par with $S_4$ (88.17 days).The rice genotype Hira and OR-1516-1-5-A.Recorded significantly minimum (Early) 69.83 days to 50% flowering. Rice genotype$V_{11}$ i.e. Ratnagiri-6 (93.63 days) recorded significantly maximum (late) days to 50% flowering which was at par with $V_{10}$ i.e. Ratnagiri-5 (93.54days).Interaction $S_1V_{10}$ (*kharif* with Ratnagiri-5) and $S_2V_{10}$ (*Rabi* i.e.48th MW sowing) with genotype Ratnagiri-5 (95.33 days) showed maximum days to 50% flowering. Similarly $S_3V_{36}$ (50th MW with Hira) recorded minimum days to 50% flowering over others. Similar work was done and reported by many scientists (Sadeghi 2011, Shet *et al.* (2012), Augustina *et al.* (2013) [40, 46, 6] and Sharma *et al.* 2014) [45] and Dhakal (2014) [13]. These scientist reported that days to 50% flowering is an important phenological observation which influences the crop growth performance

**4. Days to physiological maturity**

Crop sown during $S_1$–*kharif* season (24th MW) produced significantly minimum days to physiological maturity (113.81 days) as compared to other sowing dates of *rabi* season. The rice crop sown during *rabi* season, $S_3$ (the 50th MW) date of sowing recorded significantly maximum days to physiological maturity (117.27 days) as compared to crop sown during $S_2$ (48th MW) and $S_4$ (52thMW). Significantly higher days to maturity was recorded in $V_{10}$ (Ratnagiri-5) followed by $V_{11}$ (Ratnagiri-6), $V_{31}$ and $V_{32}$.Significantly minimum days to maturity was recorded in $V_{36}$ (Hira). Interaction $S_1V_{10}$ (*kharif* with genotype Ratnagiri-5) and $S_3V_{10}$ (*Rabi* sowing 50th MW) with genotype Ratnagiri-5 showed significantly higher days to maturity. Similarly $S_1V_{36}$ (*Kharif* with genotype Hira recorded less days to maturity.

Similar results also reported by Dhakal (2014) [13], conducted a study with fifty rice genotypes during *kharif* 2013. Maturity duration ranged from 108 to 142 days with an average of 124 days. Muhammad *et al.* (2012) [36] evaluated ten rice genotypes during their experiment. Days to maturity showed same trend as observed in case of days to heading. The early heading lines matured early and late heading lines matured late. The maturity period ranged from 137 to 148 days. Zia-Ul, *et al.* (2005) [58], Ashrafuzzaman *et al.* (2009) [48] and Shahidullah *et al.* (2009) [48].

**5. Total chlorophyll content (mg/g)**

Chlorophyll content plays vital role in the process of photosynthesis thus direct influence on grain production. Miah *et al* (1996) [34] reported that a chlorophyll pigment plays an important role in the photosynthesis process as well as biomass production. The total chlorophyll content (mg/g) as influenced periodically by the different treatments at various crop growth stages. It was observed that the chlorophyll content increased with advancing age of the crop up to 80 DAT, after that it decreased. Similar trend were reported by Abdul Baset Mia *et al.* (2012) [2] and Hussain *et al.* (2014) [26].

In the present investigation, at flowering stage, the date of sowing during *kharif* season recorded higher total chlorophyll content (4.09 mg/g) than rest of the date of sowing in *rabi* season. The sowing dates $S_3$ recorded maximum total chlorophyll content (3.99 mg/g) over $S_2$and $S_4$.At harvesting stage,$S_1$date of sowing during *kharif* season recorded significantly higher total chlorophyll content (1.01mg/g) than rest of the date of sowing in *rabi* season. The sowing dates $S_3$ recorded significantly maximum total chlorophyll content (0.99 mg/g) over $S_2$.At flowering stage, maximum chlorophyll content was recorded in $V_{13}$ i.e.Ratnagiri-24 (4.21mg/g) which was followed by $V_8$i.e. Phondaghat-1 (4.15 mg/g). Interaction $S_1V_8$ (kharif sowing) with genotype Phondaghat-1 and rabiseason $S_2V_{13}$ (sowing 50th MW with genotype Ratnagiri-24 recorded significantly higher chlorophyll content over others. Such variation in photosynthesis pigment was reported by Munshi (2005) [37], Hossain *et al* (2008) [25] and Kiran *et al* (2013) [29]. Abdul Baset Mia *et al.* (2012) [2] reported that total chlorophyll content decreased gradually from tillering to flowering stages.

**6. Chlorophyll stability index**

Chlorophyll stability is a function of temperature and it is found to correlate with drought tolerance. Chlorophyll stability index is a measure of intensity of membrane or heat stability of the pigments under stress condition.

In the present investigation, the Chlorophyll stability index was influenced periodically by the different treatments at various crop growth stages. It was observed that the chlorophyll stability index increased with advancing age of the crop up to flowering after that it decreased.

At tillering stage, $S_1$ sowing during *kharif* season recorded maximum chlorophyll stability index than rest of the date of sowing in *rabi* season. Among the *rabi* season, $S_3$ recorded maximum chlorophyll stability index over $S_2$ and $S_4$.At flowering stage, sowing during *kharif* season recorded maximum chlorophyll stability index than rest of the date of sowing in *rabi* season.$S_4$ recorded maximum chlorophyll stability index over $S_2$ and $S_3$at harvesting stage. At tillering stage, maximum chlorophyll stability index was recorded in V11i.eRatnagiri-6 (0.679mg/g) which was followed by IR2289-6-22-5 (0.672 mg/g), OR-1516-1-5-A (0.672 mg/g) and IRRI-36 (0.672 mg/g). At harvesting stage, maximum chlorophyll stability index was recorded in$V_4$i.e Karjat-7 (0.462mg/g) which was followed by IR2289-6-22-5 (0.653mg/g), Phondaghat-1 (0.653 mg/g), Phondaghat-1 (0.653 mg/g). Interaction S1V1 kharif sowing with genotype Karjat-1, $S_1V_2$, $S_1V_2$, $S_1V_{15}$, $S_1V_{34}$ and $S_1V_{15}$recorded significantly higher CSIover others. Patel *et al.* (2006) studied performance of *kharif* rice under raised and sunken beds system. Chlorophyll stability index was found significantly higher in RCPL-29 followed by Vivek Dhan 82 as compared to other varieties both at vegetative and heading stages. Kardile *et al.* (2018) [28] reported that at 60 DAT,RTN-13-4-3-1 (2.0662 mg/g) recorded highest total chlorophyll content followed by KJTRH-21.At 90 DAS,RTNRH-10 (1.572 mg/g) recorded maximum total chlorophyll content followed by RTN-84-2-1-2.

**7. Leaf water potential**

Leaf water potential is highly variable depending on several soil, plant and environmental factors, soil water content, wind speed, vapour pressure deficit, solar radiation, temperature and relative humidity may contribute to changes in plant water potential. These factors acting alone or jointly with soil water deficit could intensity plant water stress causing stomatal closure and thus influencing the potential values. Gaosegelwe and Kirkham (1990) [22] have suggested that LWP might be used as an easy and fast way to screening genotypes for drought avoidance. It is the key input factor for photosynthesis. It is well established that there will be 50 percent reduction in the rate of photosynthesis if water content in the leaf tissue drops down even by 10 percent below the optimum relative water content.

At tillering stage $S_1$ (*kharif* sowing) recorded maximum leaf water potential and $S_4$recorded minimum leaf potential. Among genotype $V_{13}$recorded maximum leaf water potential and $V_{37}$ recorded minimum leaf water potential. Interaction $S_1V_{13}$ (*kharif* with genotype Ratnagiri-24) maximum and $S_4V_{33}$ (*rabi* sowing) MW 52$^{th}$ and genotypes Narmada recorded minimum leaf water potential.

This decreasing trend in leaf water potential at later stage of growth at all three locations and soil types could be attributed to decreasing soil moisture content with advancement of growth stages in mango also reported by Hailmichael *et al* (2016) [24].

**8. Absolute growth rate (AGR) g/day**

Data on absolute growth rate, relative growth rate, net assimilation rate and leaf area index of rice genotypes are presented in Table 2. Amongst various growth parameters an absolute growth rate (AGR) is a plain and simple measure of rate of increase in weight. The mean AGR was maximum, irrespective of their groups to complete life cycle. This could be due to the rapid rate of increase in total dry matter during this period as the AGR mainly depends on the accumulation of dry matter (Nimje, 2010) [39]. After reaching the maximum AGR it decrease till maturity due to aging of leaf shedding (Nicknejad *et al*., 2009) [38].

In the present investigation, at flowering and harvesting stage, date of sowing during *kharif* season recorded minimum absolute growth rate (AGR) g/day than rest of the date of sowing in *rabi* season. The sowing dates in *rabi* season, $S_2$ recorded maximum absolute growth rate (AGR) g/day over $S_3$ and $S_4$ at tilleringstage.$S_4$ recorded maximum absolute growth rate (AGR) g/day over $S_2$ and $S_3$ at flowering stage and at harvesting stage. At harvesting stage, the rice variety $V_2$ i.e. Karjat-3 recorded maximum absolute growth rate (AGR) 1.2373 g/day which was at par with $V_4$ i.e. $V_8$-Karjat-184, $V_{23}$- Ratnagiri-73, $V_{36}$-Hira. Interaction $S_1V_4$ (*kharif* with genotypeKarjat-7) and among *Rabi* season $S_2V_{36}$ (sowing 48$^{th}$ MW with genotype Hira) recorded significantly maximum absolute growth rate (AGR) than other combinations. Similar finding were also reported by Erfani and Nasiri (2000) [15] reported that CGR, NAR and leaf area index (LAI) were higher throughout growth stages in improved genotypes than traditional genotypes.

**9. Relative growth rate (RGR)**

The concept of growth of the plant in terms of compound interest law was given by Blackman (1919). The RGR is the rate of increase in dry weight per unit dry weight per unit time. The fall in RGR at the time maturity of crop might be because of respiratory activity of plants, thus higher amount of photosynthesis might have been used for maintenance of developing organs. Relative growth rate (RGR) decreased with the age of crop (Golam, 2001) [20].

In the present investigation, date of sowing (24$^{th}$MW) in *kharif* season recorded maximum relative growth rate (RGR) 0.0138 g/g/day and 0.0184 g/g/day than rest of the date of sowing in *rabi* seasonal flowering and harvesting stage.$S_3$ recorded maximum relative growth rate (RGR) 0.400 g/g/day over $S_2$ and $S_4$ at tilleringstage.$S_4$ recorded maximum relative growth rate (RGR) 0.0136 g/g/day and 0.0182 g/g/day over $S_2$ and $S_4$ at flowering and harvesting stage.

At harvesting stage, the rice variety $V_6$ i.e.Sahyadri-2 recorded maximum relative growth rate (RGR) 0.0237 g/g/day which was at par with $V_1$-Karjat-1, $V_2$-Karjat-3, $V_3$-Karjat-4, $V_5$-Karjat-184, $V_6$-Sahyadri-2, $V_7$-Sahyadri-4, $V_9$-Ratnagiri-1, $V_{10}$-Ratnagiri-5, $V_{11}$-Ratnagiri-6, $V_{12}$-Ratnagiri-7, $V_{14}$-Ratnagiri-73, $V_{15}$-Ratnagiri-711, $V_{17}$ - IRRI-15, $V_{18}$-IRRI-20, $V_{19}$-IRRI-21, $V_{21}$-IRRI-27, $V_{22}$-IRRI-28, $V_{23}$-IRRI-34, $V_{24}$-IRRI-36, $V_{25}$ -IRRI-47, $V_{26}$-IRRI-52, $V_{29}$-IRRI-62, $V_{30}$-IR-35, $V_{32}$-IR-2289-6-22-5, $V_{34}$-Ananda, $V_{35}$-Ambpandhari, $V_{36}$-Hira, $V_{37}$-OR $V_{38}$-China, $V_{39}$-Sorati, $V_{40}$-Mhadi. Interaction $S_1V_{25}$ (*kharif* sowing) genotype IRRI-47 recorded significantly higher relative growth rate (RGR) at harvesting stage at par with $S_1V_2$, and $S_1V_{22}$, over others. Similarly $S_4V_{12}$ (sowing 52 MW) with genotype Ratnagiri-7 recorded significantly higher relative growth rate (RGR) than other combination. Similar decrease of RGR with the age of crop was reported by Chandrasekhar *et al.* (2001) [11] reported that CGR, LAI, LAD and SLW had direct effect on dry matter production and yield whereas RGR had negative and significant correlation with grain yield (Kulmi, 1992) [30].

**10. Net assimilation rate (NAR)**

NAR is the rate of increase in dry weight per unit leaf area. NAR measures, the efficiency of leaf area and hence, it can be used as a measure of source activity (Nimje, 2010) [39]. The increase in the NAR can be attributed to the high chlorophyll values during this period. Shahidullah *et al.* (2009) [48] were also reported by such significant variation in NAR among the developed rice genotypes.

In the present investigation, date of sowing during *kharif* season - $S_1$ recorded minimum net assimilation rate. (NAR) g/dm2/day than rest of the date of sowing in *rabi* season at flowering and harvesting stage (Table 2). $S_3$ recorded maximum net assimilation rate. (NAR) g/dm2/day over $S_2$ and $S_4$ at flowering stage and harvesting stage. The rice variety $V_8$ i.e. Phondaghat-1 recorded maximum net assimilation rate. (NAR) 0.0790g/dm2/day which was at par with $V_{14}$ i.e. Ratnagiri -73at harvesting stage. The rice crop sown $S_1$i.e. *kharif* season with $V_8$ i.e. Phondaghat-1 recorded significantly higher net assimilation rate. (NAR) 0.1104g/dm2/day which were followed by $S_1V_{14}$at harvesting stage. Interaction $S_1V_8$, (*kharif* sowing) with genotype Phondaghat-1 and *rabi* season $S_3V_1$, (sowing 50thMW) with genotype Karjat-1 recorded significantly higher net assimilation rate. (NAR) over others.Similar increasing trend of NAR with the age of crop was also reported by Chandrasekhar *et al.* (2001) [11] reported that CGR, LAI, LAD and SLW had direct effect on dry matter production and yield whereas RGR had negative and significant correlation with grain yield (Kulmi, 1992) [30]. Chandrika *et al.* (2015) [9] studied physiological attributes and yield of developed rice varieties. Results showed that maximum LAI, CGR, RGR, NAR, LAD and LAR were recorded in the variety RNR-15038.

**11. Leaf area index (LAI)**

The LAI is one of the most important growth parameters having influenced on plant growth. Watson (1947) defined the LAI as the total area of leaves present per unit area of land. It gives an idea about the size of the photosynthetic system. The sowing dates $S_1$ recorded maximum LAI over rest of the date of sowing in *rabi* season. However the sowing dates in *rabi* season, $S_4$ recorded maximum LAI at tillering stage.$S_3$ recorded maximum LAI at flowering and harvesting stage. At harvesting stage, maximum LAI was recorded in $V_{21}$i.e.IRRI-27 (4.619) which was at par with $V_9$ i.e. $V_9$ i.e. Ratnagiri-1, $V_5$ i.e. Ratnagiri -5,$V_9$ i.e. Ratnagiri-73, $V_{17}$ i.e. IRRI-15, $V_{18}$ i.e. IRRI-20, $V_{19}$ i.e. IRRI-21,$V_{20}$ i.e. IRRI-22,$V_{21}$ i.e. IRRI-27,$V_{22}$ i.e. IRRI-28,$V_{25}$ i.e. IRRI-47,$V_{26}$ i.e. IRRI-52,$V_{32}$ i.e.IR2289-6-22-5, $V_{36}$ i.e. Hira,$V_{37}$ i.e.OR-1516-1-5-A).Interaction $S_1V_{21}$ (*kharif* sowing) with genotypes IRRI-27) recorded significantly higher leaf area index. (LAI) and among *rabi*-$S_3V_{30}$ recorded maximum leaf area index. (LAI) than other combinations. Similar results were also reported by Park *et al.* (2004) [51], Kumar *et al.* (2006) [31] and Chandrika *et al.* (2015) [9].

**12. Number of tillers per plant**

Crop sown during $S_1$–*kharif* season (24th MW) produced significantly minimum number of tillers per plant (8.04) as compared to other sowing dates of *rabi* season (48th MW, 50th MW, 52th MW). The rice crop sown during *rabi* season, $S_2$ (the 48th MW) date of sowing recorded significantly maximum number of tillers per plant (10.37) as compared to crop sown during $S_3$ (50th MW) and $S_4$ (52th MW). Significantly maximum number of tillers per plant was recorded in $S_2$ (10.37) which was at par with the other sowing date $S_3$ (50th MW) and $S_4$ (52th MW).

The rice genotype$V_7$ i.e.Sahyadri-4 recorded significantly maximum number of tillers per plant (11) which was at par with $V_{19}$ i.e.IRRI-21 (11.5) and $V_{40}$i.e.Mhadi (10.42) Rice genotype $V_{36}$ i.e. Hirarecorded significantly minimum number of tillers per plant (8.63) which was at par with $V_8$ i.e. Phondaghat-1 (9) and $V_{32}$ i.e. IR2289-6-2-5 (8.29). $S_2V_6$ i.e. crop sown in $S_2$ date of sowing (48th MW) and $S_3V_6$ i.e. crop sown in $S_3$ date of sowing (50th MW) with Sahyadri-2was recorded significantly higher number of tillers per plant (12) which was at par with $S_2V_{40}$ i.e. crop sown in $S_2$ date of sowing (48th MW) (11.7) and $S_3V_{40}$ (11.7) i.e. crop sown in $S_3$ date of sowing (50th MW). Yoshida *et al.* (1972) [57] studied the physiological aspect of high yields in rice and reported that number of panicles per unit area is the most important component of rice yield. It accounts for 89% of the variation in grain yield. Similar results by Gallagher and Biscoe (1978) [23] found that tiller number directly affects the number of panicle and as a consequence affects the total yield. Miller *et al.* (1991) [35] found that tiller number directly affects the number of panicle and as a consequence affects the total yield. Chandrasekhar *et al.* (2001) [11] studied physiological analysis of growth and productivity in hybrid rice. The taller number increased up to 60 DAT and remained almost constant during later growth stages. Maximum tillers (12.7/plant) were produced by APHR-2 than other cultivars. Lavanya *et al.* (2018) [32] studied various rice genotypes for grain yield by physiological approaches. They found that maximum productive tiller number was observed in the genotypes DRRH2 and RPHR1005 (15.7) followed by KRH2 (15.3) and minimum productive tiller number was observed in PUSA5A X BR827-35 (8.7).

**13. Panicle length (cm)**

Crop sown during $S_1$–*kharif* season (24th MW) produced significantly maximum panicle length (21.62cm) as compared to other sowing dates of *rabi* season (48th MW, 50th MW, 52th MW).The rice crop sown during *rabi* season,$S_3$ (the 50th MW) date of sowing recorded significantly maximum panicle length (21.55 cm) as compared to crop sown during $S_2$ (48th MW) and $S_4$ (52th MW).The rice variety laldodki recorded significantly maximum panicle length (24.15) which was at par with $V_6$ i.e. Sahyadri-2, $V_7$ i.e. Sahyadri-4, $V_{20}$ i.e. IRRI-22, $V_{29}$ i.e. IRRI-62, $V_{30}$ i.e. IR-35 and $V_{34}$i.e. Ananda. In case of *rabi* season $S_3V_{20}$ i.e. IRRI-22crop sown in $S_3$ date of sowing (50th MW) with was recorded significantly higher panicle length (25.58cm) which was at par with $S_1V_7$, $S_1V_7$, $S_1V_{17}$, $S_1V_{24}$, $S_1V_{25}$, $S_1V_{26}$, $S_1V_{27}$, $S_2V_{31}$ and $S_1V_{37}$ i.e. crop sown in $S_1$ date of sowing (24th MW), $S_2V_7$, $S_2V_{26}$ and $S_2V_{34}$ i.e. crop sown in $S_2$ date of sowing (48th MW), $S_3V_7$, $S_3V_{19}$, $S_3V_{26}$, $S_3V_{31}$ i.e. crop sown in $S_3$ date of sowing (50th MW) and$S_4V_6$, $S_4V_7$, $S_4V_{30}$, $S_4V_{31}$ i.e. crop sown in $S_4$ date of sowing (52th MW). Similar results reported by Fageria and Baligar (2001) [18] reported that panicle length and spikelet number had the highest correlation with grain yield. Panicle length had the high positive and significant correlation to number of grains per panicle and significant and negative correlation to grain yield. Sharma (2002) [44] reported that there had been significant variation in panicle length in aromatic rice varieties. Ashrafuzzaman *et al.* (2009) [48] working on yield and yield contributing characters in aromatic rice reported that BR34 possessed the longest panicle (19.73 cm) and Kataribhog had the shortest panicle (16.20 cm). Faruq Golam*et al.* (2011) [19] observed that significant variation was observed in length of panicle among the genotypes at 5% levels. The data for panicle length ranged from 19.30 to 26.77. Abdul Baset Mia *et al.* (2012) [2] reported that Binasail recorded the longest and BRRIdhan32 showed the shortest panicle length. Arooj *et al.* (2015) [3] evaluated agronomic traits for yield and yield components in advance breeding lines of rice. Chandrika *et al.* (2015) [9] observed that maximum panicle length of 28.4 cm was recorded in genotype RNR 15038 and minimum panicle length of 22.4 cm of was recorded in genotype.

**14. Grain yield per plant (g)**

Grain yield is the economic part of the total dry matter. This is the end product of the plants life cycle and it is of much interest to mankind. Yield is a compound character and is a sum total of the contribution made by a number of physiological characters. It is an ultimate product of the action and interaction of a number of component plant characters. To the plant physiologist, it is net economic gain from the source and sinks capacity (Nimje, 2010) [39].

In the present investigation, crop sown during $S_1$–*kharif* season (24th MW) produced significantly minimum grain yield (14.76 g) as compared to other sowing dates of *rabi* season (48th MW, 50th MW, 52th MW).The rice crop sown during *rabi* season, $S_3$ (the 50th MW) date of sowing recorded significantly maximum grain yield per plant (17.91g) which was at par with $S_2$ and $S_4$ over others. Significantly maximum grain yield per plant (g) was recorded in $S_3$ (17.91g) which was superior over the other date of sowing. The rice variety $V_7$ i.e. Sahyadri-4 recorded significantly maximum grain yield per plant (24.62 g) which was at par with variety $V_2$ i.e. Karjat-3 (23.93 g). The rice crop sown $S_1$i.e. *kharif* season (24th MW) with variety $V_7$ i.e. Sahyadri-4 recorded significantly higher grain yield per plant (22.86 g).In case of *rabi* season $S_4V_7$ i.e. crop sown in $S_4$ date of sowing (52th MW) with Sahyadri-4 was recorded significantly higher grain yield per plant (25.32 g) which was at par with $S_2V_7$ (25.14 g) i.e. crop sown in $S_2$ date of sowing (48th MW) and $S_3V_7$ (25.17 g) i.e. crop sown in $S_3$ date of sowing (50th MW). However, $S_4V_3$ with rice genotype Karjat-4 recorded significantly minimum grain yield per plant (11.02 g).

Similar results were reported by Muhammad *et al.* (2012) [36] evaluated ten rice genotypes during the experiment. All genotypes produced variable grain yield ranging from 1.64 to 3.43 tons per hectare. Higher paddy yield was harvested from cultivar KS-133. It was noted that the lowest paddy yields were produced by well adopted cultivars IR 6. Chandrika *et al.* (2015) [9] observed that rice genotypes exhibited significant differences in grain yield. Among the genotypes RNR 15038 recorded highest grain yield of 6142 kg. $ha^{-1}$ followed by RNR 15048 with (5788 kg. $ha^{-1}$). The lowest grain yield was recorded in Rajendra (3597 kg $ha^{-1}$) followed by HR-12 (3733 kg.$ha^{-1}$). Chandrashekhar *et al.* (2017) [12] reported that significantly higher grain yield of 5.76 tons $ha^{-1}$in SRI as compared to NTP (5.09 tons $ha^{-1}$). The SRI obtained 11% higher grain yield than NTP. Among the nutrient management practices, $T_3$ recorded higher grain yield (6.01 tons $ha^{-1}$) followed by $T_4$ (5.87 tons $ha^{-1}$). Lower grain yield was recorded by $T_2$ (4.14 tons $ha^{-1}$) over other treatments. Kardile *et al.* (2018) [28] conducted field experiment with 6 pre-release cultures, 5 pre-release rice hybrids and 2 checks genotypes to study the yield variation during *kharif*. They found that the RTNRH-10 (31.76g/plant) recorded highest grain yield per plant followed by RTNRH-17 (30.40g /plant) as compared to other genotypes.Sidhu*et.al*. (1992), Fageria and Baligar (2001), Patel *et al.* (2010) [18],

### 15. Straw yield per plant (g)

Production of straw yield is total biomass production efficiency of any crop (Nimje, 2010) [39]. In the present investigation, crop sown during $S_1$–*kharif* season (24th MW) produced significantly minimum grain yield per plant (22.39 g) as compared to other sowing dates of *rabi* season (48th MW, 50th MW,52th MW).The rice crop sown during *rabi* season, $S_4$ (The 52th MW) date of sowing recorded significantly maximum straw yield per plant (25.38g $plant^{-1}$) as compared to crop sown during $S_2$ (48th MW) and $S_3$ (50th MW).Significantly maximum straw yield per plant (g) was recorded in $S_2$ (25.38g $plant^{-1}$) which was at par with date of sowing $S_3$–*kharif* season (48th MW).

The rice genotype Sahyadri-4 recorded significantly maximum straw yield per plant (32.87 g $plant^{-1}$) followed by genotype $V_2$ i.e. Karjat-3 (31.81 g $plant^{-1}$). Rice genotype $V_3$ i.e. Karjat-4 recorded significantly minimum straw yield per plant (19.00 g $plant^{-1}$) which was followed by $V_{35}$-Ambpandhari (20.78 g $plant^{-1}$).The rice crop sown $S_1$ i.e. *kharif* season (24th MW) with genotype $V_7$ i.e. Sahyadri-4 recorded significantly higher straw yield per plant (32.19 g $plant^{-1}$) which was at par with $V_2$ i.e. Karjat-3. In case of *rabi* season $S_4V_2$ i.e. crop sown in $S_4$ date of sowing (52th MW) with Karjat-3 was recorded significantly higher straw yield per plant (33.43 g $plant^{-1}$) which was at par with $S_2V_2$ i.e. crop sown in $S_2$ date of sowing (48th MW) and $S_3V_2$ i.e. Crop sown in $S_3$ date of sowing (50th MW).Variation in straw yield in rice genotypes has also been reported by Nimje *et al.* (2010) [39] reported production of straw yield is total biomass production efficiency of any crop. Gimhavanekar *et al.* (2020) [21] reported variation in straw yield in different rice genotype. Significantly maximum straw yield was recorded in kalakrishna (29.92 g per plant) which was at par with Pusasugandha (29.79 g per plant) Ghansal regional (29.65 g per plant). Basmati-107 (29.53 g per plant), Kala Jeera (28.73 g per plant) Shrabanmasi (28.72 g per plant) and Parag (28.71 g per plant).

**Table 1:** Effect of different treatments on morphological and phenological parameters

| Sr. No | Genotypes | Plant height (cm) | | | Days to first flowering | Days to 50% flowering | Days to physiological maturity |
|---|---|---|---|---|---|---|---|
| A] Main plot (Date of sowing) | | Tillering | Flowering | Harvesting | | | |
| 1 | $S_1$: 24th MW | 64.11 | 113.06 | 115.81 | 80.50 | 84.89 | 113.81 |
| 2 | $S_2$: 48th MW | 56.91 | 83.71 | 86.30 | 84.02 | 88.48 | 116.96 |
| 3 | $S_3$: 50th MW | 61.20 | 87.60 | 90.27 | 83.51 | 87.94 | 117.27 |
| 4 | $S_4$:52th MW | 51.90 | 78.33 | 80.99 | 83.73 | 88.17 | 117.13 |
| | SE ± | 0.43 | 0.52 | 0.49 | 0.100 | 0.093 | 0.103 |
| | C.D. at 5% | 1.30 | 1.80 | 1.71 | 0.345 | 0.322 | 0.357 |
| B) Sub plot (Varieties) | | | | | | | |
| 1 | V1:Karjat-1 | 59.07 | 83.65 | 86.08 | 81.17 | 85.54 | 112.79 |
| 2 | V2:Karjat-3 | 60.80 | 90.22 | 92.99 | 82.04 | 86.58 | 115.42 |
| 3 | V3:Karjat-4, | 55.60 | 75.89 | 78.74 | 84.25 | 88.71 | 117.83 |
| 4 | V4:Karjat-7 | 53.86 | 80.61 | 82.98 | 85.13 | 89.50 | 118.46 |
| 5 | V5:Karjat-184 | 58.22 | 83.97 | 86.58 | 75.33 | 79.83 | 108.33 |
| 6 | V6:Sahyadri-2 | 61.59 | 91.75 | 94.43 | 83.96 | 88.42 | 117.00 |
| 7 | V7:Sahyadri-4 | 59.63 | 89.55 | 92.07 | 85.42 | 89.63 | 119.13 |
| 8 | V8:Phondaghat -1 | 62.40 | 97.15 | 99.79 | 86.38 | 90.88 | 119.71 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9 | V9:Ratnagiri-1 | 59.58 | 90.04 | 92.82 | 87.13 | 91.63 | 120.71 |
| 10 | V10:Ratnagiri-5 | 57.80 | 85.71 | 88.41 | 89.13 | 93.54 | 122.71 |
| 11 | V11:Ratnagiri- 6 | 62.55 | 93.63 | 96.33 | 89.04 | 93.63 | 122.17 |
| 12 | V12:Ratnagiri- 7 | 64.73 | 93.48 | 95.78 | 85.42 | 89.79 | 118.08 |
| 13 | V13:Ratnagiri -24 | 54.24 | 83.57 | 86.15 | 69.08 | 73.23 | 99.31 |
| 14 | V14:Ratnagiri-73 | 56.75 | 79.75 | 82.47 | 67.42 | 71.88 | 99.13 |
| 15 | V15:Ratnagiri-711 | 56.43 | 84.97 | 87.28 | 85.33 | 89.58 | 117.75 |
| 16 | V16:IRRI-14 | 57.07 | 93.78 | 96.78 | 85.96 | 90.21 | 119.63 |
| 17 | V17:IRRI-15 | 58.34 | 97.33 | 99.94 | 84.83 | 89.04 | 118.17 |
| 18 | V18:IRRI-20 | 56.55 | 94.17 | 96.85 | 83.75 | 88.33 | 117.29 |
| 19 | V19:IRRI-21 | 59.18 | 94.47 | 97.08 | 84.71 | 89.13 | 118.29 |
| 20 | V20:IRRI-22 | 55.10 | 96.89 | 99.79 | 83.46 | 88.08 | 117.50 |
| 21 | V21:IRRI-27 | 48.96 | 82.84 | 85.82 | 82.71 | 87.17 | 116.54 |
| 22 | V22:IRRI-28 | 61.13 | 88.68 | 91.18 | 83.92 | 88.42 | 117.38 |
| 23 | V23:IRRI-34 | 58.43 | 94.06 | 96.71 | 88.13 | 92.58 | 121.75 |
| 24 | V24:IRRI-36 | 52.51 | 89.22 | 91.82 | 86.50 | 90.96 | 120.38 |
| 25 | V25:IRRI-47 | 56.44 | 91.40 | 94.26 | 84.88 | 89.21 | 118.00 |
| 26 | V26:IRRI-52 | 55.91 | 92.58 | 95.03 | 84.83 | 89.08 | 118.42 |
| 27 | V27:IRRI-53 | 50.70 | 83.57 | 86.23 | 85.21 | 89.75 | 118.96 |
| 28 | V28:IRRI-55 | 58.58 | 95.83 | 98.60 | 85.50 | 89.92 | 119.17 |
| 29 | V29:IRRI-62 | 56.95 | 91.74 | 94.46 | 85.33 | 89.75 | 119.00 |
| 30 | V30:IR-35 | 60.08 | 96.67 | 99.59 | 85.67 | 90.08 | 119.21 |
| 31 | V31:Laldodaki | 61.04 | 93.37 | 96.00 | 88.54 | 92.88 | 122.13 |
| 32 | V32:IR2289-6-22-5 | 55.37 | 84.08 | 86.55 | 88.17 | 92.75 | 122.29 |
| 33 | V33:Narmada | 54.16 | 82.99 | 85.97 | 85.33 | 89.79 | 118.79 |
| 34 | V34:Ananda | 61.35 | 92.85 | 95.62 | 82.42 | 86.79 | 115.83 |
| 35 | V35:Ambpandhari | 53.27 | 88.81 | 91.35 | 85.17 | 89.75 | 118.21 |
| 36 | V36:Hira | 51.52 | 73.89 | 76.60 | 65.63 | 69.83 | 98.75 |
| 37 | V37:OR-1516-1-5-A | 64.81 | 97.52 | 100.49 | 65.42 | 69.83 | 99.17 |
| 38 | V38:China | 70.38 | 104.38 | 106.81 | 76.63 | 81.08 | 110.50 |
| 39 | V39:Sorati | 75.36 | 115.94 | 118.51 | 77.00 | 81.33 | 110.33 |
| 40 | V40:Mhadi | 64.76 | 98.93 | 101.61 | 86.00 | 90.50 | 119.33 |
| | SE± | 1.27 | 0.96 | 0.94 | 0.305 | 0.296 | 0.223 |
| | C.D. at 5% | 3.54 | 2.67 | 2.63 | 0.850 | 0.823 | 0.621 |
| Interaction Effect (S x M) | | | | | | | |
| | SE ± | 2.55 | 1.92 | 1.89 | 0.611 | 0.592 | 0.446 |
| | C.D. at 5% | 7.07 | 5.35 | 5.25 | 1.700 | 1.646 | 1.241 |
| | General Mean | 58.53 | 90.67 | 93.34 | 82.941 | 87.368 | 116.295 |

S1: 24th MW (11th-17th June), S2: 48th MW (26th November-2nd December), S3: 50th MW (10th-16th December), S4: 52th MW (24th-31st December

**Table 2:** Effect of different treatment on physiological parameters of rice genotypes

| Sr. No | Genotypes | Total chlorophyll content (mg/g) | | | Chlorophyll stability index | | | Leaf water potential (bar) | Absolute growth rate AGR) (g/day) | | | Relative growth rate (RGR) (g/g/day) | Net assimilation rate (NAR) (g/dm 2/day) | Leaf area index (LAI) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A] Main plot (Date of sowing) | | | | | | | | | | | | | | |
| | | Tillering | Flowering | Harvesting | Tillering | Flowering | Harvesting | Flowering | Tillering | Flowering | Harvesting | | | |
| 1 | $S_1$: 24th MW | 1.97 | 4.09 | 1.01 | 0.654 | 1.091 | 0.440 | 5.31 | 0.1281 | 0.3925 | 1.0354 | 0.0184 | 0.0377 | 3.568 |
| 2 | $S_2$: 48th MW | 1.87 | 3.74 | 0.94 | 0.640 | 1.084 | 0.432 | 5.88 | 0.1311 | 0.3904 | 1.0332 | 0.0179 | 0.0390 | 4.145 |
| 3 | $S_3$: 50th MW | 1.99 | 3.99 | 0.99 | 0.648 | 1.093 | 0.438 | 6.10 | 0.1304 | 0.3883 | 1.0275 | 0.0180 | 0.0923 | 4.281 |
| 4 | $S_4$:52th MW | 1.84 | 3.72 | 0.92 | 0.645 | 1.014 | 1.444 | 5.93 | 0.1304 | 0.3934 | 1.0397 | 0.0182 | 0.0368 | 4.194 |
| | SE ± | 0.023 | 0.03 | 0.01 | 0.008 | 0.033 | 0.006 | 0.19 | 0.0011 | 0.0020 | 0.0053 | 0.0009 | 0.0073 | 0.077 |
| | C.D. at 5% | 0.070 | NS | 0.038 | NS | NS | NS | 0.64 | NS | NS | NS | NS | 0.0251 | 0.232 |
| B) Sub plot (Varieties) | | | | | | | | | | | | | | |
| 1 | V1:Karjat-1 | 1.79 | 3.66 | 0.92 | 0.626 | 1.075 | 0.434 | 5.60 | 0.1302 | 0.3878 | 1.0246 | 0.0165 | 0.0663 | 3.829 |
| 2 | V2:Karjat-3 | 1.80 | 3.73 | 0.92 | 0.645 | 1.061 | 0.448 | 6.03 | 0.1465 | 0.4585 | 1.2373 | 0.0201 | 0.0596 | 4.024 |
| 3 | V3:Karjat-4, | 1.84 | 4.01 | 0.96 | 0.633 | 1.061 | 0.441 | 6.02 | 0.1250 | 0.3752 | 0.9675 | 0.0168 | 0.0613 | 4.000 |
| 4 | V4:Karjat-7 | 1.77 | 3.95 | 0.93 | 0.634 | 1.063 | 0.462 | 5.83 | 0.1383 | 0.4112 | 1.0618 | 0.0155 | 0.0573 | 3.602 |
| 5 | V5:Karjat-184 | 1.94 | 3.87 | 0.97 | 0.638 | 1.055 | 0.439 | 5.93 | 0.1288 | 0.3806 | 1.0104 | 0.0165 | 0.0565 | 3.956 |
| 6 | V6:Sahyadri-2 | 1.92 | 3.92 | 0.98 | 0.628 | 1.068 | 0.452 | 5.81 | 0.1249 | 0.3755 | 1.0068 | 0.0237 | 0.0615 | 4.058 |
| 7 | V7:Sahyadri-4 | 1.90 | 3.72 | 0.92 | 0.618 | 1.043 | 0.451 | 4.73 | 0.1305 | 0.3981 | 1.0192 | 0.0173 | 0.0588 | 4.008 |
| 8 | V8:Phondaghat -1 | 2.01 | 4.15 | 1.04 | 0.652 | 1.095 | 0.453 | 5.60 | 0.1452 | 0.4168 | 1.1292 | 0.0161 | 0.0790 | 4.043 |
| 9 | V9:Ratnagiri-1 | 1.79 | 3.57 | 0.89 | 0.644 | 1.082 | 0.435 | 6.66 | 0.1272 | 0.3839 | 1.0261 | 0.0206 | 0.0541 | 4.156 |
| 10 | V10:Ratnagiri-5 | 1.94 | 3.90 | 0.98 | 0.660 | 1.078 | 0.433 | 6.09 | 0.1362 | 0.3883 | 1.0024 | 0.0175 | 0.0635 | 4.307 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | V11:Ratnagiri- 6 | 2.00 | 4.02 | 1.00 | 0.679 | 1.088 | 0.445 | 6.17 | 0.1264 | 0.3776 | 0.9902 | 0.0168 | 0.0542 | 3.625 |
| 12 | V12:Ratnagiri- 7 | 1.97 | 3.88 | 0.97 | 0.640 | 1.055 | 0.448 | 5.73 | 0.1285 | 0.3847 | 1.0558 | 0.0216 | 0.0596 | 4.050 |
| 13 | V13:Ratnagiri -24 | 2.12 | 4.21 | 1.06 | 0.641 | 0.983 | 0.415 | 5.70 | 0.1166 | 0.3488 | 0.9464 | 0.0156 | 0.0588 | 3.995 |
| 14 | V14:Ratnagiri-73 | 1.99 | 4.01 | 0.99 | 0.646 | 1.063 | 0.418 | 6.20 | 0.1348 | 0.4103 | 1.0902 | 0.0167 | 0.0686 | 4.134 |
| 15 | V15:Ratnagiri-711 | 1.93 | 3.92 | 0.98 | 0.638 | 1.041 | 0.436 | 5.94 | 0.1277 | 0.3724 | 0.9915 | 0.0202 | 0.0621 | 3.858 |
| 16 | V16:IRRI-14 | 1.93 | 3.89 | 0.97 | 0.633 | 1.066 | 0.405 | 5.50 | 0.1335 | 0.4089 | 1.0589 | 0.0158 | 0.0560 | 4.282 |
| 17 | V17:IRRI-15 | 1.95 | 3.90 | 0.98 | 0.660 | 1.087 | 0.432 | 5.09 | 0.1285 | 0.3893 | 1.0179 | 0.0171 | 0.0600 | 4.503 |
| 18 | V18:IRRI-20 | 2.01 | 4.05 | 1.00 | 0.634 | 1.054 | 0.436 | 5.38 | 0.1292 | 0.4000 | 1.0648 | 0.0212 | 0.0613 | 4.021 |
| 19 | V19:IRRI-21 | 1.93 | 3.80 | 0.95 | 0.639 | 1.080 | 0.422 | 5.67 | 0.1188 | 0.3678 | 0.9820 | 0.0164 | 0.0432 | 4.395 |
| 20 | V20:IRRI-22 | 1.92 | 3.75 | 0.93 | 0.642 | 1.055 | 0.405 | 5.48 | 0.1311 | 0.4007 | 1.0630 | 0.0154 | 0.0503 | 4.263 |
| 21 | V21:IRRI-27 | 1.97 | 3.95 | 0.99 | 0.647 | 1.092 | 0.430 | 5.75 | 0.1363 | 0.4012 | 1.0817 | 0.0214 | 0.0380 | 4.619 |
| 22 | V22:IRRI-28 | 1.84 | 3.63 | 0.91 | 0.646 | 1.060 | 0.435 | 6.37 | 0.1370 | 0.4185 | 1.1305 | 0.0206 | 0.0354 | 4.263 |
| 23 | V23:IRRI-34 | 1.87 | 3.74 | 0.94 | 0.655 | 1.086 | 0.418 | 5.87 | 0.1391 | 0.4265 | 1.1407 | 0.0208 | 0.0371 | 3.947 |
| 24 | V24:IRRI-36 | 1.88 | 3.75 | 0.93 | 0.672 | 1.083 | 0.443 | 5.75 | 0.1276 | 0.3904 | 1.0349 | 0.0168 | 0.0373 | 3.975 |
| 25 | V25:IRRI-47 | 1.99 | 3.98 | 0.99 | 0.645 | 1.085 | 0.440 | 6.22 | 0.1201 | 0.3607 | 0.9538 | 0.0239 | 0.0370 | 4.119 |
| 26 | V26:IRRI-52 | 1.91 | 3.92 | 0.98 | 0.647 | 1.089 | 0.437 | 6.07 | 0.1272 | 0.3663 | 0.9596 | 0.0177 | 0.0539 | 4.165 |
| 27 | V27:IRRI-53 | 1.95 | 3.89 | 0.97 | 0.647 | 1.045 | 0.447 | 6.02 | 0.1290 | 0.3776 | 0.9989 | 0.0170 | 0.0324 | 3.860 |
| 28 | V28:IRRI-55 | 1.93 | 3.93 | 0.99 | 0.640 | 1.093 | 0.432 | 5.95 | 0.1175 | 0.3422 | 0.8945 | 0.0158 | 0.0406 | 3.940 |
| 29 | V29:IRRI-62 | 2.00 | 3.98 | 0.97 | 0.670 | 1.102 | 0.442 | 6.14 | 0.1298 | 0.3916 | 1.0258 | 0.0163 | 0.0380 | 3.665 |
| 30 | V30:IR-35 | 1.91 | 4.02 | 1.01 | 0.638 | 1.065 | 0.451 | 5.79 | 0.1224 | 0.3905 | 1.0130 | 0.0201 | 0.0344 | 4.000 |
| 31 | V31:Laldodaki | 1.87 | 3.82 | 0.96 | 0.655 | 1.054 | 0.448 | 6.15 | 0.1343 | 0.4033 | 1.0300 | 0.0158 | 0.0373 | 3.888 |
| 32 | V32:IR2289-6-22-5 | 1.86 | 3.84 | 0.95 | 0.672 | 1.093 | 0.453 | 6.20 | 0.1286 | 0.3647 | 0.9896 | 0.0163 | 0.0589 | 4.353 |
| 33 | V33:Narmada | 1.95 | 3.90 | 0.98 | 0.668 | 1.085 | 0.441 | 5.73 | 0.1221 | 0.3633 | 0.9391 | 0.0157 | 0.0624 | 4.058 |
| 34 | V34:Ananda | 2.02 | 4.03 | 1.01 | 0.625 | 1.042 | 0.435 | 5.85 | 0.1315 | 0.4087 | 1.0682 | 0.0172 | 0.0389 | 3.647 |
| 35 | V35:Ambpandhari | 1.88 | 3.93 | 0.98 | 0.640 | 1.055 | 0.440 | 5.47 | 0.1334 | 0.3910 | 1.0301 | 0.0201 | 0.0358 | 4.034 |
| 36 | V36:Hira | 1.90 | 3.81 | 0.95 | 0.650 | 1.073 | 0.443 | 5.54 | 0.1354 | 0.4527 | 1.1927 | 0.0195 | 0.0342 | 4.148 |
| 37 | V37:OR-1516-1-5-A | 1.81 | 3.70 | 0.93 | 0.672 | 1.083 | 0.443 | 5.21 | 0.1241 | 0.3741 | 0.9796 | 0.0194 | 0.0614 | 4.363 |
| 38 | V38:China | 1.91 | 3.82 | 0.96 | 0.660 | 1.084 | 0.453 | 5.39 | 0.1255 | 0.3774 | 1.0215 | 0.0163 | 0.0582 | 3.988 |
| 39 | V39:Sorati | 1.88 | 3.78 | 0.95 | 0.638 | 1.035 | 0.433 | 5.62 | 0.1370 | 0.4088 | 1.0805 | 0.0175 | 0.0691 | 4.014 |
| 40 | V40:Mhadi | 1.98 | 4.13 | 0.95 | 0.650 | 1.079 | 0.434 | 5.45 | 0.1235 | 0.3709 | 0.9689 | 0.0170 | 0.0214 | 3.731 |
| | SE± | 0.052 | 0.05 | 0.03 | 0.014 | 0.018 | 0.011 | 0.29 | 0.0049 | 0.0184 | 0.0512 | 0.0026 | 0.0045 | 0.168 |
| | C.D. at 5% | 0.15 | 0.14 | 0.07 | NS | NS | NS | 0.80 | 0.0136 | 0.0513 | 0.1426 | 0.0074 | 0.0125 | 0.467 |
| Interaction Effect (SxM) | | | | | | | | | | | | | | |
| | SE ± | 0.104 | 0.07 | 0.05 | 0.027 | 0.035 | 0.022 | 0.58 | 0.0098 | 0.0369 | 0.1025 | 0.0053 | 0.0090 | 0.336 |
| | C.D. at 5% | 0.29 | NS | 0.14 | 0.076 | NS | NS | 1.60 | 0.0272 | 0.1025 | 0.2851 | 0.0147 | 0.0251 | 0.933 |
| | General mean | 1.92 | 3.89 | 0.96 | 0.647 | 1.070 | 0.438 | 5.80 | 0.1300 | 0.3911 | 1.0340 | 0.0181 | 0.0515 | 4.047 |

S1: 24th MW (11th-17th June), S2: 48th MW (26th November-2nd December), S3: 50th MW (10th-16th December), S4: 52th MW (24th-31st December

**Table 3:** Effect of different treatment on yield and yield attributes characters of rice genotypes

| Sr. No | Genotypes | Number of tillers per plant | Panicle length (cm) | Grain yield per plant (g) | Straw yield per plant (g) |
|---|---|---|---|---|---|
| **A) Main plot (Date of sowing)** | | | | | |
| 1 | $S_1$: 24th MW | 8.04 | 21.62 | 14.76 | 22.39 |
| 2 | $S_2$: 48th MW | 10.37 | 21.30 | 17.31 | 24.86 |
| 3 | $S_3$: 50th MW | 10.36 | 21.55 | 17.91 | 25.30 |
| 4 | $S_4$:52th MW | 10.18 | 21.48 | 17.78 | 25.38 |
| | SE ± | 0.07 | 0.15 | 0.022 | 0.073 |
| | C.D. at 5% | 0.24 | NS | 0.076 | 0.254 |
| **B) Sub plot (Varieties)** | | | | | |
| 1 | V1:Karjat-1 | 9.79 | 19.35 | 13.64 | 20.93 |
| 2 | V2:Karjat-3 | 9.79 | 21.22 | 23.93 | 31.81 |
| 3 | V3:Karjat-4, | 9.75 | 17.29 | 11.00 | 19.00 |
| 4 | V4:Karjat-7 | 10.29 | 20.06 | 20.20 | 27.87 |
| 5 | V5:Karjat-184 | 10.21 | 20.89 | 15.92 | 23.46 |
| 6 | V6:Sahyadri-2 | 10.75 | 23.03 | 23.05 | 30.22 |
| 7 | V7:Sahyadri-4 | 11.00 | 23.37 | 24.62 | 32.87 |
| 8 | V8:Phondaghat -1 | 9.00 | 21.81 | 15.40 | 22.49 |
| 9 | V9:Ratnagiri-1 | 9.54 | 19.93 | 18.08 | 25.83 |
| 10 | V10:Ratnagiri-5 | 9.50 | 19.09 | 14.29 | 22.25 |
| 11 | V11:Ratnagiri- 6 | 9.58 | 21.46 | 14.23 | 21.81 |
| 12 | V12:Ratnagiri- 7 | 9.33 | 20.47 | 18.98 | 25.98 |
| 13 | V13:Ratnagiri -24 | 9.65 | 20.13 | 18.20 | 25.31 |
| 14 | V14:Ratnagiri-73 | 10.29 | 20.57 | 21.12 | 28.74 |
| 15 | V15:Ratnagiri-711 | 9.54 | 20.99 | 18.71 | 26.42 |
| 16 | V16:IRRI-14 | 9.92 | 21.16 | 15.80 | 23.13 |
| 17 | V17:IRRI-15 | 9.42 | 22.17 | 15.05 | 22.30 |
| 18 | V18:IRRI-20 | 9.42 | 21.61 | 17.03 | 24.15 |

| | | | | | |
|---|---|---|---|---|---|
| 19 | V19:IRRI-21 | 10.42 | 22.65 | 15.80 | 23.25 |
| 20 | V20:IRRI-22 | 10.29 | 23.31 | 15.33 | 22.95 |
| 21 | V21:IRRI-27 | 9.25 | 22.90 | 16.39 | 24.27 |
| 22 | V22:IRRI-28 | 9.25 | 22.05 | 16.48 | 24.52 |
| 23 | V23:IRRI-34 | 9.63 | 24.15 | 16.30 | 23.80 |
| 24 | V24:IRRI-36 | 9.58 | 21.25 | 15.80 | 22.88 |
| 25 | V25:IRRI-47 | 9.75 | 22.31 | 16.91 | 24.28 |
| 26 | V26:IRRI-52 | 10.08 | 22.95 | 17.69 | 25.27 |
| 27 | V27:IRRI-53 | 9.96 | 22.66 | 17.37 | 25.29 |
| 28 | V28:IRRI-55 | 10.04 | 21.84 | 15.73 | 23.06 |
| 29 | V29:IRRI-62 | 10.00 | 23.04 | 15.64 | 23.22 |
| 30 | V30:IR-35 | 8.29 | 23.03 | 15.53 | 23.49 |
| 31 | V31:Laldodaki | 9.33 | 23.25 | 14.00 | 21.88 |
| 32 | V32:IR2289-6-22-5 | 9.29 | 21.36 | 14.12 | 21.37 |
| 33 | V33:Narmada | 9.88 | 22.23 | 15.12 | 22.66 |
| 34 | V34:Ananda | 10.13 | 23.10 | 14.92 | 22.17 |
| 35 | V35:Ambpandhari | 8.75 | 21.98 | 13.28 | 20.78 |
| 36 | V36:Hira | 8.63 | 19.78 | 14.67 | 22.09 |
| 37 | V37:OR-1516-1-5-A | 9.46 | 18.89 | 16.12 | 23.74 |
| 38 | V38:China | 9.83 | 20.17 | 19.84 | 26.84 |
| 39 | V39:Sorati | 9.63 | 20.67 | 19.83 | 27.12 |
| 40 | V40:Mhadi | 10.42 | 19.52 | 19.95 | 27.70 |
| | SE± | 0.24 | 0.44 | 0.13 | 0.297 |
| | CD at 5% | 0.66 | 1.22 | 0.36 | 0.826 |
| **Interaction Effect (S x M)** | | | | | |
| | SE± | 0.47 | 0.87 | 0.256 | 0.594 |
| | CD at 5% | 1.32 | 2.43 | 0.713 | 1.652 |
| | General mean | 9.74 | 21.48 | 16.939 | *24.483* |

$S_1$: 24th MW (11th-17th June), $S_2$: 48th MW 26th November-2nd December), $S_3$: 50th MW (10th-16th December), $S_4$: 52th MW (24th-31st December)

## Conclusion

The results revealed that Hira and OR-1516-1-5-A showed the shortest days to maturity, while Ratnagiri-6 and Ratnagiri-1 required the longest time. Karjat-3 had a higher average growth rate, Sahyadri-2 displayed a higher relative growth rate, and Phondaghat-1 demonstrated a higher net assimilation rate. Interaction $S_1V_{21}$ (*kharif* sowing) with genotypes IRRI-27) recorded significantly higher leaf area index. (LAI) and among *rabi*-$S_3V_{30}$ recorded maximum leaf area index. (LAI) than other combinations. Sahyadri-4 had the highest number of tillers, followed by Sahyadri-2, IRRI-21, and Mhadi. IRRI-34 exhibited the longest panicle length, followed by Sahyadri-2 and Sahyadri-4. Sahyadri-4 had the highest yield per plant, followed by Karjat-3. Sowing in the 52th meteorological week with Sahyadri-4 resulted in the highest yield, followed by sowing in the 48th and 50th meteorological weeks.Sahyadri-4 recorded significantly maximum grain yield per plant (24.62 g) which was at par with genotype Karjat-3 (23.93g) over other genotypes. *Kharif* season (24th MW) with Sahyadri-4 recorded significantly higher grain yield per plant (22.86 g) which was superior over other treatment combinations during pooled mean.

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