Effect of dates of sowing on grain yield of ~~*rabi*~~*Rabi* rice (*Oryza sativa* L.).

ABSTRACT:

Aim: To determine the optimum date of sowing to realize higher grain yield in *rabi* rice.
Study Design: Split plot design.
Place and Duration of study: Krishi Vigyan Kendra, Rudrur, Nizamabad during *rabi,* 2022.
Methodology: The experiment consisted of totally fifteen treatments which was laid out in split plot design with three replications. Treatments included were five dates of sowing in main plot M_1-20th November, M_2-1st December, M_3-10th December, M_4-20th December and M_5-30th December and three treatments of varieties in sub plots S_1-JGL 24423 (long slender variety), S_2-Ganga Kaveri (medium slender variety) and S_3-RNR 15048 (short slender variety) randomly placed in subplots of the main plot.
Results: Maximum plant height (100.3 cm), number of tillers m^{-2} (432), dry matter accumulation (15869 kg ha^{-1}), grain yield (7219 kg ha^{-1}), straw yield (8387 kg ha^{-1}) and HI (46.1) was noticed in crop Sown on 30th December. Significantly maximum number of tillers m^{-2}, dry matter accumulation (14263 kg ha^{-1}), grain yield (6127 kg ha^{-1}), straw yield (8650 kg ha^{-1}) was observed in S_2-Ganga Kaveri while significantly higher plant height (100.6 cm) and HI (45.0) was found in S_3-RNR 15048. Lowest height was recorded in S_2-Ganga Kaveri (92.6 cm), and above parameters were recorded lowest in crop sown on 20th November, while lowest number of tillers m^{-2} and straw yield (8122 kg ha^{-1}) was observed in crop sown on 1st December. Significantly less number of tillers m^{-2} (326), dry matter accumulation (13981 kg ha^{-1}), grain yield (6166 kg ha^{-1}), ~~straw~~and straw yield (7526 kg ha^{-1}) was recorded in S_3-RNR 15048, while lowest HI (43.9) was recorded in S_1-JGL 24423.
Conclusion: Crop sown on 30th December revealed better performance in terms of grain yield under the present study during *rabi* conditions. Among varieties, Ganga Kaveri (S_2) performed better in terms of grain yield.

Key words: Sowing dates, varieties, yield, Rice.

1.INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important food crops in the world, forms the staple diet of billions of people and provides 70 % direct employment to the rural India. In Asia, its cultivation is crucial to maintain the food security as more than 90 % of rice production is consumed in this continent. Rice contributes 32-59 % of the dietary energy and 25-44% of the dietary protein in 39 countries. Globally, rice is grown in an area of 165.3 million hectares with an annual production of 502.98 million metric tons and 4.63 million tons ha^{-1} of productivity (FAO, 2022). The projected demand for rice by 2050 is estimated to be 197.40 million tons for a population of 1.65 billion almost 80% higher than the current demand (Joshi, 2021). India is the second largest producer of rice after China and it is the staple food for more than two-thirds of the Indian population contributing to 40% of the total foodgrain production. Rice plays a pivotal role in the food and livelihood security of the Asian people as the continent wise data shows, more than 90% of rice production and consumption takes place in Asia and more than two billion people are getting 60-70 % of their energy requirement from rice and its derived products (Outlook, 2022).

In India, rice crop is grown in an area of 45.8 million hectares occupies prime position in the world with a production of 124.4 million metric tons and productivity of 2717 kg ha^{-1} (Indiastat, 2021). In Telangana, rice is the major crop extensively cultivated in all the districts in an area of 97.98 lakh acres with the production of 202.18 lakh tons during 2021– 22 (Socio - economic outlook of Telangana, 2023).

The time of sowing in rice is very crucial to ensure adequate vegetative growth which influence the grain yield during a period of optimum temperature with high solar radiation. Selecting the appropriate sowing date for each cultivar guarantees that the vulnerable cold sensitive phase coincides with historically warmer minimum night temperatures, thus ensuring that grain filling takes place during milder temperature conditions. sowing too early or too late diminishes yields in a manner that cannot be offset by any other input or agricultural practice (Kapoor *et al*., 2017). Most of the world rice is grown in the tropics and the critical determinant for the growth to be temperature. Rice is being a tropical and sub-tropical plant that requires a fairly high temperature ranging from 20º to 40ºC. Crop is adversely affected by high temperature in the lower elevation of the tropics and by lower temperature in the temperate regions. The critical temperature differs with variety, duration of critical temperature, diurnal changes and physiological changes of plant. Higher maximum and minimum temperature during ear initiation depress the yield. In general, high temperature accelerates the floral initiation. Rice is most sensitive to high temperatures at heading and next most sensitive at about 9 days before heading. One or two hours of high temperature at anthesis has a decisive effect on the incidence of sterility. High temperatures before or after anthesis have much less effect on sterility. Optimum temperature for ripening is 20-25 ºC. Too high and too low temperature may cause adverse effect on flowering and prevent pollen shedding leading to high infertility and production of chaffy grains resulting in yield loss. In order to ensure a determined yield level, avoid damage due to too high and low temperature. It is necessary to optimize time of sowing to attain maximum yield.

There is large diurnal variation in *rabi* season in Telangana region with colder nights and bright sunny days and temperature gradually increases from march onwards with very low relative humidity which is very favourable for higher yields. The crop is very much subjected to wide environmental conditions. Some research on long slender rice grain varieties was carried out in *rabi* season. The research on evaluation of fine grain varieties in *rabi* season is meagre. Keeping the above factors in mind, the present study is proposed during *rabi* 2022.

2. METHODS AND MATERIALS

Field experiment was conducted at Krishi Vigyan Kendra, Rudrur, Nizamabad during *rabi* (2022). The experimental site is geographically located in Northern Telangana agro climatic zone of Telangana. The soil of experimental site is silty clay in texture with nearly neutral pH in reaction (8.1), E.C (1.94 ds m^{-1}), low in organic carbon (0.42 %), medium in available N (231.1 kg ha^{-1}) & Phosphorous (29.8 kg ha^{-1}) and high in available potassium (350.5 kg ha^{-1}).

The experiment consisted of totally fifteen treatments which was laid out in split plot design with three replications. Treatments included were five dates of sowing in main plot M_1-20th November, M_2-1st December, M_3-10th December, M_4-20th December and M_5-30th December and three treatments of varieties in sub plots S_1-JGL 24423 (long slender variety), S_2-Ganga Kaveri (medium slender variety) and S_3-RNR 15048 (short slender variety) randomly placed in subplots of the main plot. JGL 24423 is a long slender, non-lodging, less shattering and resistant to brown plant hopper with medium duration of 135-140 days with a yield potential of 7500 to 8000 kg ha^{-1}. Ganga Kaveri is a medium slender grain type with medium duration of 135 days duration. It is highly resistant to blast, brown plant hopper with a yield potential of 8750 to 9500 kg ha^{-1}. RNR 15048 is a short slender grain type with medium duration (135 days) and highly photosensitive in nature. It is highly resistant to blast and gives higher yields (6500 to 7500 kg ha^{-1}).

The treatments are sown with a spacing of 15×15 cm. Recommended dose of fertilizers 120-60-40 NPK ha^{-1}, urea, single super phosphate, murate of potash are the fertilisers used in this experiment. ~~Adequate plant~~Adequate plant protection measures were taken as per requirement. Randomly five plants were selected and tagged from each plot for recording various growth and yield parameters periodically and at harvest through destructive and non-destructive sampling. The rainfall of 22 mm was received during 2 rainy days during the entire period of crop growth. The mean maximum temperature and minimum temperature recorded was 33.4^{o}C and 19.3^{o}C respectively. The mean weekly bright sunshine hours varied from 4.2 to 9.1 hr day^{-1} with an average of 7.3 hr day^{-1}. All the data recorded in the study were conducted statistical analysis of variance technique for split plot design.

3.RESULTS AND DISCUSSIONS

3.1 Growth Parameters

3.1.1 plant height

Varied sowing dates showed significant influence on plant height at different growth stages of rice.

Rice crop sown on 30th December recorded significantly higher plant height (38.7 cm) at Maximum tillering stage over crop sown on 20th November (34.6 cm) and 1st December (34.2 cm). However, plant height of crop sown on 30th December was comparable with plant height of the crop sown on 20th December (37.3 cm) and 10th December (37.0 cm).

At panicle initiation stage, significantly higher plant height was observed in crop sown on 30th December (75.2 cm) and which was comparable with the plant height of the 20th December (70.2 cm) sown crop. Significantly lower plant height was recorded in crop sown on 1st December (59.1 cm), which was on par with that of plant height recorded with 20th November sowing (59.8 cm). Crop sown on 10th December recorded plant height of 64.7 cm, which was comparable with the plant height recorded in crops sown on 20th November, 1st December and 20th December.

At 50 % flowering stage, crop sown on 30th December recorded significantly higher plant height (91.4 cm) and which was on par with 20th December (90.6 cm) and 10th December (87.9 cm) sown crop plant height. Significantly lower plant height was observed in crop sown on 20th November (78.9 cm) over the rest of the treatments.

At physiological maturity stage, significantly higher plant height was observed in crop sown on 30th December (100.3 cm) and which was on par with that of plant height recorded with 20th December (98.9 cm) and 10th December (94.6 cm) sown crop. Significantly lower plant height was recorded in M_1-Sowing on 20th November (92.4 cm) which was on par with crop sown on 1st December (92.6 cm). Significantly higher plant height at all stages of the crop growth were observed with delayed sowing i.e., on 30th December. This might be due to optimum weather conditions favoured in rapid cell division and elongation of plants. The vegetative growth period had a positive effect on the plant growth. Similar findings were reported by Bindu and Bhanumurthy (2007). These results align with the research conducted by Anil and Siddi (2020) and Bindu (2004), who reported that plant height is influenced by genotypes, various management factors and the environment. The increased plant height observed in delayed sowings in the season could be attributed to greater exposure to solar radiation and heightened photosynthetic activity. These findings are consistent with those reported by Roy (1999), who reported that the initial stunted growth of the *boro* crop may be attributed to an extended period of cold weather during the vegetative growth stage. However, as the air temperature increased, the plant height gradually improved.

Different varieties of rice crop shown significant influence on plant height at different growth stages in different sowing times. Plant height gradually increases as the crop growth stages advance until it reaches the maturity stage. Plant height was increasing gradually from tillering, thereafter increased linearly up to 50 % flowering and then it continued to increase till maturity but at a diminishing rate.

At maximum tillering stage, significantly higher plant height (37.2 cm) was observed with RNR 15048 and which was statistically on par with Ganga Kaveri (36.4 cm). Significantly lower plant height (35.5 cm) was noticed with JGL 24423 and which was comparable with Ganga Kaveri. At panicle initiation stage, significantly higher plant height (66.4 cm) was recorded with RNR 15048 which was comparable with that of plant height of Ganga Kaveri (66.2 cm) and JGL 24423 (64.9 cm).

At 50 % flowering stage, significantly higher plant height (91.1 cm) was recorded with RNR 15048 over other varieties. Significantly lower plant height (84.2 cm) was noticed with Ganga Kaveri which was on par with JGL 24423 (84.6 cm). At physiological maturity, significantly higher plant height (100.6 cm) was recorded with RNR 15048 over other varieties and JGL 24423 (94.1 cm) and Ganga Kaveri (92.6 cm) were comparable with each other. Higher plant height was observed with RNR 15048 compared to other varieties during the different crop growth stages. It might be due to the genetic character of the variety and higher photosynthetic efficiency. These results are similar to those obtained by Anil and Siddi (2020), Nizamani *et al*. (2014) and Suleiman *et al*. (2014) who observed that plant height differed significantly among the varieties.

Treatments	Maximum tillering	Panicle initiation	50% Flowering	Physiological maturity
Main plot: Sowings dates				
M_1- 20th November	34.6	59.8	78.9	92.4

M_2- 1st December	34.2	59.1	84.2	92.6
M_3- 10th December	37.0	64.7	87.9	94.6
M_4 - 20th December	37.3	70.2	90.6	98.9
M_5- 30th December	38.7	75.2	91.4	100.3
SEm(±)	0.67	2.00	1.24	2.60
CD (p=0.05)	2.23	6.60	4.11	6.50
Sub plot: Varieties				
S_1- JGL 24423	35.5	64.9	84.6	94.1
S_2- Ganga Kaveri	36.4	66.2	84.2	92.6
S_3- RNR 15048	37.2	66.4	91.1	100.6
SEm(±)	0.41	0.77	1.30	1.67
CD (p=0.05)	1.22	2.40	3.85	4.95
Interaction				
M×S				
SEm(±)	1.17	3.46	2.25	6.20
CD (p=0.05)	NS	NS	NS	NS
S×M				
SEm(±)	1.01	2.45	2.77	4.70
CD (p=0.05)	NS	NS	NS	NS

Table 1 Plant height (cm) at different growth stages of rice as influenced by sowings dates and varieties

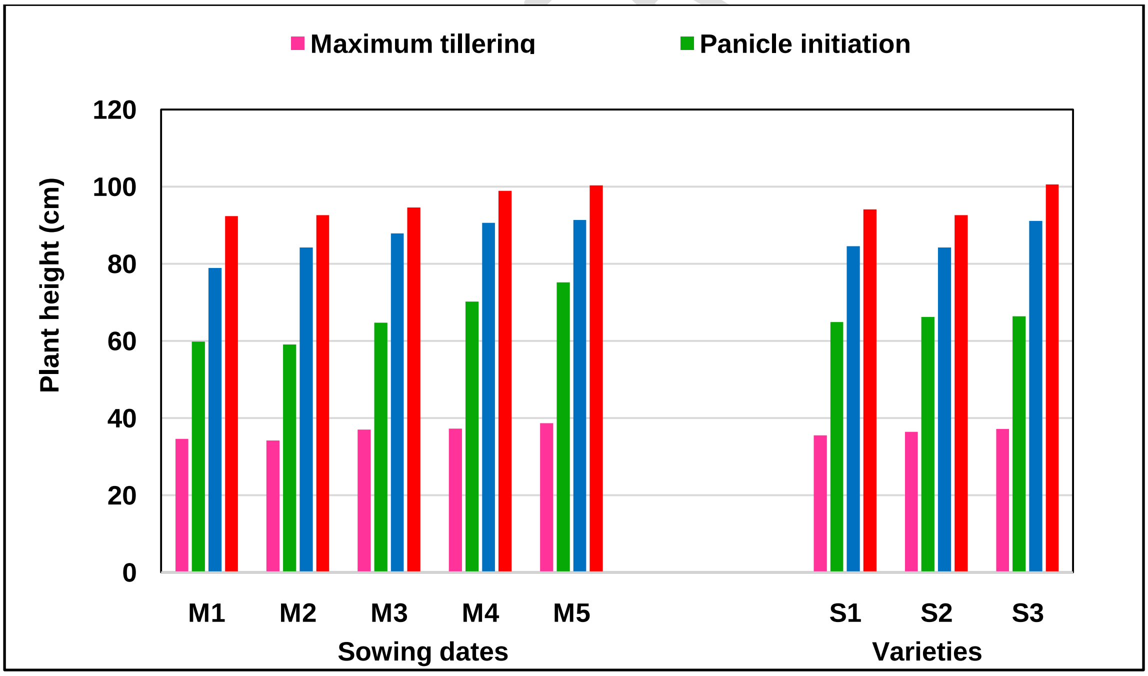

Fig. 1. **Plant height (cm) at different growth stages of rice as influenced by sowings dates and varieties**

3.1.2 Number of tillers m^{-2}

Varied sowing dates showed significant influence on number of tillers m^{-2} in rice at different growth stages.

At maximum tillering stage, crop sown on 30^{th} December recorded significantly higher number of tillers m^{-2} (459) over the advanced sowings and followed by crop sown on 20^{th} December (430) which was on par with the other treatments. Significantly lower number of tillers m^{-2} (403) was observed in crop sown on 1^{st} December which was comparable with that of tillers (411) in crop sown on 20^{th} November and 10^{th} December. At panicle initiation stage, significantly higher number of tillers m^{-2} (453) was observed in crop sown on 30^{th} December over other sowing times and followed by crop sown on 20^{th} December (417) which was on par with the rest of the treatments and crop sown on 20^{th} November produced lowest number of tillers m^{-2} (396).

At 50 % flowering stage, crop sown on 30^{th} December recorded significantly higher number of tillers m^{-2} (445) over the rest of the treatments and followed by crop sown on 20^{th} December recorded 398 number of tillers which was on par with other dates of sowings. At physiological maturity stage, crop sown on 30^{th} December recorded significantly higher number of tillers m^{-2} (432) over the other treatments and followed by 20^{th} December sown crop (399) which was on par with 10^{th} December (383) and 20^{th} November (375) sowings. Significantly lower number of tillers m^{-2} (371) was observed with crop sown on 1^{st} December. This might be due to availability of favourable weather conditions during crop growth cycle. The tillering ability of the crop sown on 20^{th} November was affected severely as minimum temperatures dropped to below 10°C (9.6°C during the standard week 49). The rice crop exhibits optimal tillering rates within a temperature range of 25-31°C, while it performs poorly at critical low temperatures ranging from 9-16°C. The variation in the number of total and effective tillers per hill can be attributed to differences in cultivar genetics, temperature and sunlight levels among the various cultivars and transplanting dates as reported by Yoshida. (1981), Sarwar *et al*. (2017) and Roy *et al*. (2019).

Different varieties of rice shown significant influence on number of tillers m^{-2} at different growth stages of rice crop. Number of tillers m^{-2} were increasing from transplanting and reached maximum at maximum tillering and thereafter it decreased as the stage progress.

At maximum tillering stage, medium slender variety Ganga Kaveri recorded significantly higher number of tillers m^{-2} (538) over other varieties followed by long bold variety JGL 24423 (367), which was on par with short slender variety RNR 24423 (365). At Panicle initiation, 50% flowering and physiological maturity stage, significantly higher number of tillers m^{-2} (540, 531 and 512) were observed in Ganga Kaveri over other varieties followed by JGL 24423 (355, 346 and 338), which was on par with RNR 24423 (346, 330 and 326). The number of tillers m^{-2} varied among the cultivars (Gomosta *et al*., 2001). It might be due to differences in genetic makeup of these rice varieties. These results are similar to those obtained by Anil and Siddi (2020), Mali and Choudhary (2013) and sarwar *et al*. (2017).

3.1.3 Dry matter accumulation

Varied sowing dates showed significant influence on dry matter accumulation in rice at different growth stages.

At maximum tillering stage, crop sown on 30^{th} December recorded significantly higher dry matter accumulation (4877 kg ha^{-1}) over the other treatments and followed by 20^{th} December (4607 kg ha^{-1}) which was on par crop sown on 10^{th} December (4461 kg ha^{-1}) and 1^{st} December (4368 kg ha^{-1}). Significantly lower dry matter accumulation was recorded in crop sown on 20^{th} November (4130 kg ha^{-1}) over the rest of the treatments. At panicle initiation stage, significantly higher dry matter accumulation (9877 kg ha^{-1}) was recorded with crop sown on 20^{th} December and which was on par with 30^{th} December (9874 kg ha^{-1}) and 10^{th} December (9691 kg ha^{-1}) sowings. Significantly lower dry matter accumulation (9137 kg ha^{-1}) was recorded with crop sown on 1^{st} December and which was comparable with 20^{th} November sown crop dry matter accumulation (9186 kg ha^{-1}).

At 50 % flowering stage, crop sown on 30^{th} December recorded significantly higher dry matter accumulation (14474 kg ha^{-1}) and which was on par with crop sown on 20^{th} December (14022 kg ha^{-1}) and 10^{th} December (13948 kg ha^{-1}). Significantly lower dry matter accumulation (13219 kg ha^{-1}) was recorded with crop sown on 20^{th} November and which was comparable with that of crop sown on 1^{st} December (13387 kg ha^{-1}). Similarly, at physiological maturity stage, crop sown on 30^{th} December recorded significantly higher dry matter accumulation (15869 kg ha^{-1}) and which was on par with crop sown on 20^{th} December (15242 kg ha^{-1}) and 10^{th} December (15283 kg ha^{-1}). Significantly lower dry matter accumulation (14448 kg ha^{-1}) was recorded with crop sown on 20^{th} November and which was comparable with that of crop sown on 1^{st} December (14675 kg ha^{-1}).

Dry matter production of early-planted crop was lower and it increased with the advancement of sowing dates due to the favourable weather conditions. The results are in line with the findings of Mannan *et al*. (2012). Taller plants, higher LAI and increased tiller production might have led to higher dry matter accumulation with crop sown on 30th December. The results are in line with the findings of Bindu and Bhanumurthy (2007).

Among the varieties, significantly higher dry matter accumulation was found in Ganga Kaveri from the maximum tillering to physiological maturity stage. At maximum tillering, panicle initiation, 50 % flowering and at physiological maturity, significantly higher dry matter accumulation was observed in Ganga Kaveri (4564, 9924, 14445 and 15800 kg ha^{-1}, respectively) and which was on par with JGL 24423 (4549, 9751, 14199 and 15529 kg ha^{-1}, respectively). Significantly lower dry matter accumulation (4353, 8985, 12786 and 13981 kg ha^{-1}, respectively) was observed with RNR 15048. Variations in dry matter accumulation among the different varieties could be attributed to their genetic potential as well as differences in height and growth rates. The results are in line with the findings of Anil and Siddi (2020) and Dileep *et al*. (2018).

Treatments	**Maximum tillering**	**Panicle initiation**	**50% flowering**	**Physiological maturity**
Main plot: Sowings dates				
M_1- 20th November	411	396	387	375
M_2- 1st December	403	397	384	371
M_3- 10th December	411	404	397	383
M_4 - 20th December	430	417	398	399
M_5- 30th December	459	453	445	432
SEm(±)	7.30	7.54	10.39	7.28
CD (p=0.05)	24.17	24.97	34.40	24.10
Sub plot: Varieties				
S_1- JGL 24423	367	355	346	338
S_2- Ganga Kaveri	538	540	531	512
S_3- RNR 15048	365	346	330	326
SEm(±)	6.01	6.21	7.77	6.00
CD (p=0.05)	17.85	18.45	23.10	17.84
Interaction				
M×S				
SEm(±)	12.64	13.10	17.99	12.60
CD (p=0.05)	NS	NS	NS	NS
S×M				
SEm(±)	13.18	13.61	17.58	13.16
CD (p=0.05)	NS	NS	NS	NS

Table 2. Number of tillers m^{-2} at different growth stages of rice as influenced by sowings dates and varieties

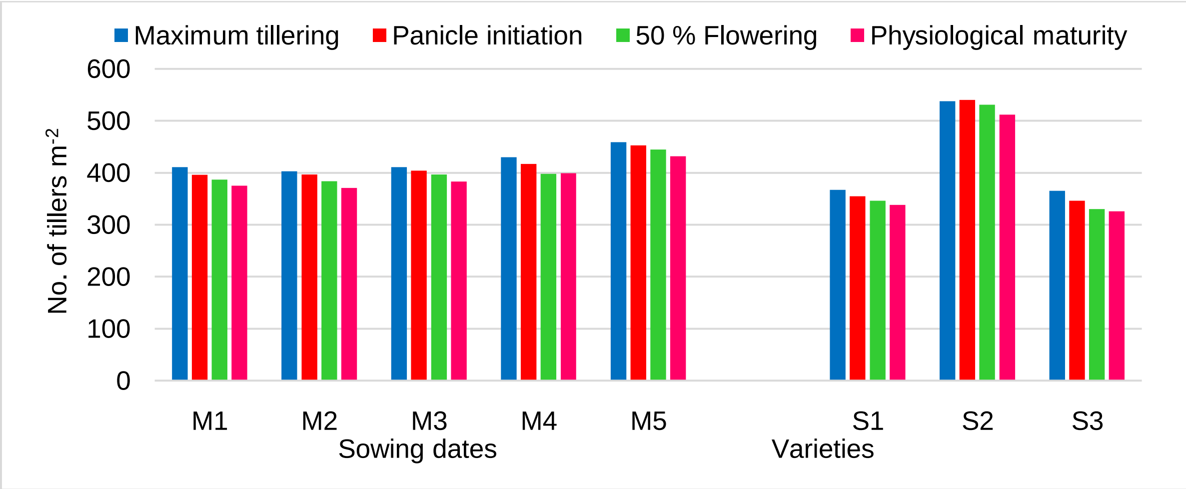

Fig. 2. Number of tillers m^{-2} at different growth stages of rice as influenced by sowings dates and varieties

Treatments	Maximum tillering	Panicle initiation	50% Flowering	Physiological maturity
Main plot: Sowings dates				
M_1- 20th November	4130	9186	13219	14448
M_2- 1st December	4368	9137	13387	14675
M_3- 10th December	4461	9691	13948	15283
M_4 - 20th December	4607	9877	14022	15242
M_5- 30th December	4877	9874	14474	15869
SEm(±)	67.67	148.42	217.50	238.13
CD (p=0.05)	224.10	491.54	720.31	788.62
Sub plot: Varieties				
S_1- JGL 24423	4549	9751	14199	15529
S_2- Ganga Kaveri	4564	9924	14445	15800
S_3- RNR 15048	4353	8985	12786	13981
SEm(±)	50.45	107.15	154.91	169.22
CD (p=0.05)	149.86	318.33	460.22	502.73
Interaction				
M×S				
SEm(±)	117.20	257.08	376.72	412.45
CD (p=0.05)	NS	NS	NS	NS
S×M				
SEm(±)	114.29	245.57	356.80	390.10
CD (p=0.05)	NS	NS	NS	NS

Table 3. Dry matter accumulation (kg ha^{-1}) at different growth stages of rice as influenced by sowings dates and varieties

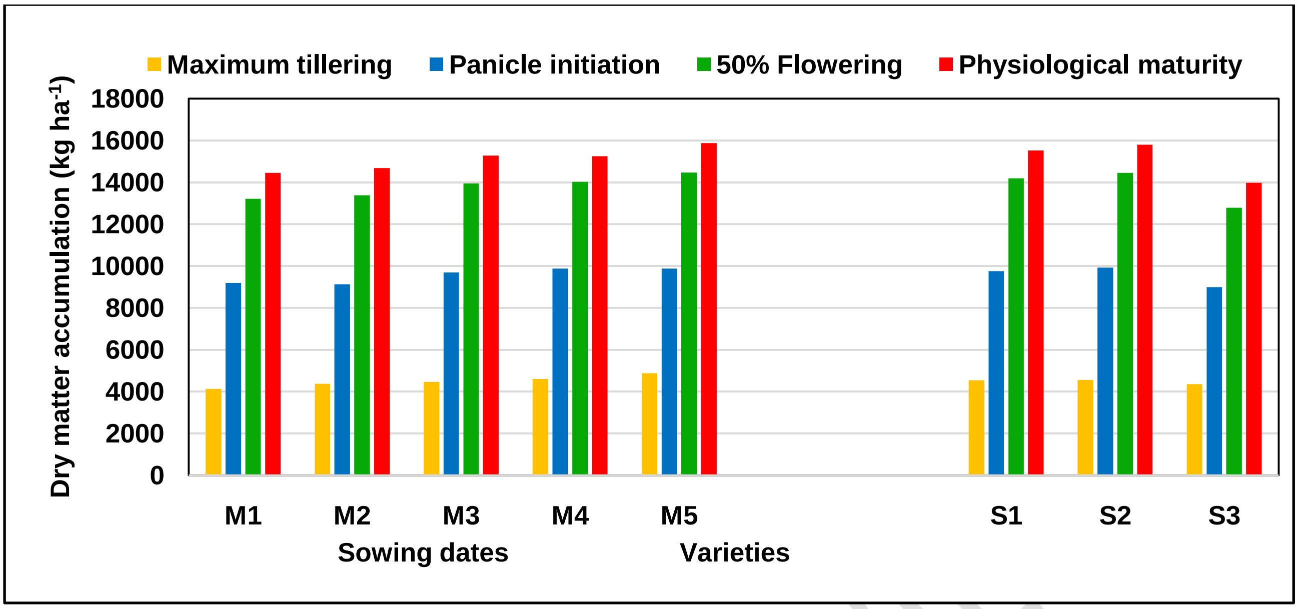

Fig.3. Dry matter accumulation (kg ha^{-1}) at different growth stages of rice as influenced by sowings dates and varieties

3.2 Yield parameters

3.2.1 Grain yield

The effect of sowing dates was found significant for grain yield in rice crop. Crop sown on 30th December recorded significantly higher grain yield (7219 kg ha^{-1}) over other dates of sowing followed by 20th December (6758 kg ha^{-1}) which was on par with 10th December (6648 kg ha^{-1}). Significantly lower grain yield (6067 kg ha^{-1}) was recorded with crop sown on 20th November which was on par with 1st December (6289 kg ha^{-1}). The increase in grain yield during delayed sowing dates can be attributed to the optimization of growth parameters and yield attributing factors like higher number of panicles m^{-2}, an increased number of filled grains panicle^{-1}, and test weight, all of which positively contribute to the overall grain yield. These results corroborate with the findings of Bindu (2004). The enhanced yield could be attributed to the optimal growth and development parameters, as well as the yield-contributing factors associated with favourable weather conditions. These conditions led to increased growth and development, resulting in a higher accumulation of photosynthates in the grains. These results are in line with the findings of Chendge *et al*. (2017) and Walia *et al*. (2014). It was observed that the grain yield increased by 16.8 % with delayed sowing from 20th November to 30th December. The yield potentiality of the crop depends on the type of genotype and the environmental condition especially the air temperature and solar radiation of a particular area (Singh *et al*., 1997). Cultivars sown on December 30th benefited from consistently favourable temperature conditions throughout their growth cycle, experiencing minimal stress during both the seedling and reproductive growth stages. Similar findings on sowing dates were also reported by Singh and Singh (2007).

The effect of varieties was found significant for grain yield in rice crop. Among different varieties tested, medium slender variety Ganga Kaveri recorded significantly higher grain yield (6879 kg ha^{-1}) which was on par with the long bold variety JGL 24423 (6744 kg ha^{-1}). Short slender variety RNR 15048 recorded significantly lower grain yield (6166 kg ha^{-1}). The superiority of Ganga Kaveri and JGL 24423 might be due to its better growth, dry matter accumulation and yield attributes *i.e*., a greater number of filled grains panicle^{-1} and test weight. These results are in line with the findings of Bindu (2004). Significantly lower grain yield was found in short slender variety RNR 15048 (6166 kg ha^{-1}) which was 10.9 % and 8.6 % lesser than Ganga Kaveri and JGL 24423, respectively might be due to poor yield attributing characters like lower test weight and higher number of unfilled grains panicle^{-1} resulting in higher sterility %. The combined impact of growth and yield characteristics ultimately manifested in the form of grain production. Similar findings were reported by Hussain *et al*. (2009) and Anil and siddi (2020). The superiority of variety Ganga Kaveri might be due to its superior growth characteristics like its ability to accumulate higher dry matter. These results are in accordance with Bindu (2004).

3.2.2 Straw yield

Varied sowing dates showed significant influence on straw yield of rice. Crop sown on 30th December recorded significantly higher straw yield (8387 kg ha^{-1}) and which was on par with 10th December (8365 kg ha^{-1}) and 20th December (8226 kg ha^{-1}). Crop sown on 1st December recorded significantly lower straw yield (8122 kg ha^{-1}) which was on par with crop sown on 20th November (8123 kg ha^{-1}). The later three delayed sowings resulted in an increased straw yield primarily due to the higher dry matter accumulation. This can be attributed to the extended vegetative phase and favourable climatic conditions, which positively influenced dry matter production and subsequently augmented the straw yield. These observations align with the findings of previous research conducted by Assaduzzaman (2006) and Bindu (2004).

Different varieties of rice showed significant influence on straw yield. Among different varieties tested, S_2-Ganga Kaveri recorded significantly higher straw yield (8650 kg ha^{-1}) and was on par with S_1-JGL 24423 (8558 kg ha^{-1}). Significantly lower straw yield was found in S_3-RNR 15048 (7526 kg ha^{-1}). These findings are consistent with those reported by (Roy *et al*., 2019). The cultivation of various rice varieties at different times significantly influences their potential.

3.2.3 Harvest index

The effect of sowing dates was found nonsignificant for harvest index in rice crop, while numerically higher harvest index (46.1 %) was recorded in crop sown on 30th December and lowest harvest index (42.7 %) was recorded in crop sown on 20th November. The significant increase in the harvest index can be primarily attributed to the higher grain yield achieved through improved performance in various yield related traits. These findings are consistent with those reported by Anil and siddi (2020). The effect of varieties was found nonsignificant for harvest index in rice crop, while numerically higher harvest index was recorded in the cultivar RNR 15048 (45.0 %) and lowest harvest index was recorded in the variety JGL 24423(43.9 %) and Ganga Kaveri (44.2 %). Similar findings were observed by Salahuddin *et al*. (2009).

Table 4. Yield of rice as influenced by sowing dates and varieties.

Treatments	**Grain yield (kg ha^{-1})**	**Straw yield (kg ha^{-1})**	**Harvest index**
Main plot: Sowings dates			
M_1- 20th November	6067	8123	42.7
M_2- 1st December	6289	8122	43.6
M_3- 10th December	6648	8365	44.3
M_4- 20th December	6758	8226	45.1
M_5- 30th December	7219	8387	46.1
SEm(±)	104.5	70.4	0.90
CD (p=0.05)	340.7	229.4	NS
Sub plot: Varieties			
S_1- JGL 24423	6744	8558	43.9
S_2- Ganga Kaveri	6879	8650	44.2
S_3- RNR 15048	6166	7526	45.0
SEm(±)	81.1	84.2	0.70
CD (p=0.05)	240.0	248.2	NS
Interaction			
M×S			
SEm(±)	198.0	120.0	1.50
CD (p=0.05)	NS	NS	NS
S×M			

SEm(±)	185.5	175.0	1.50
CD (p=0.05)	NS	NS	NS

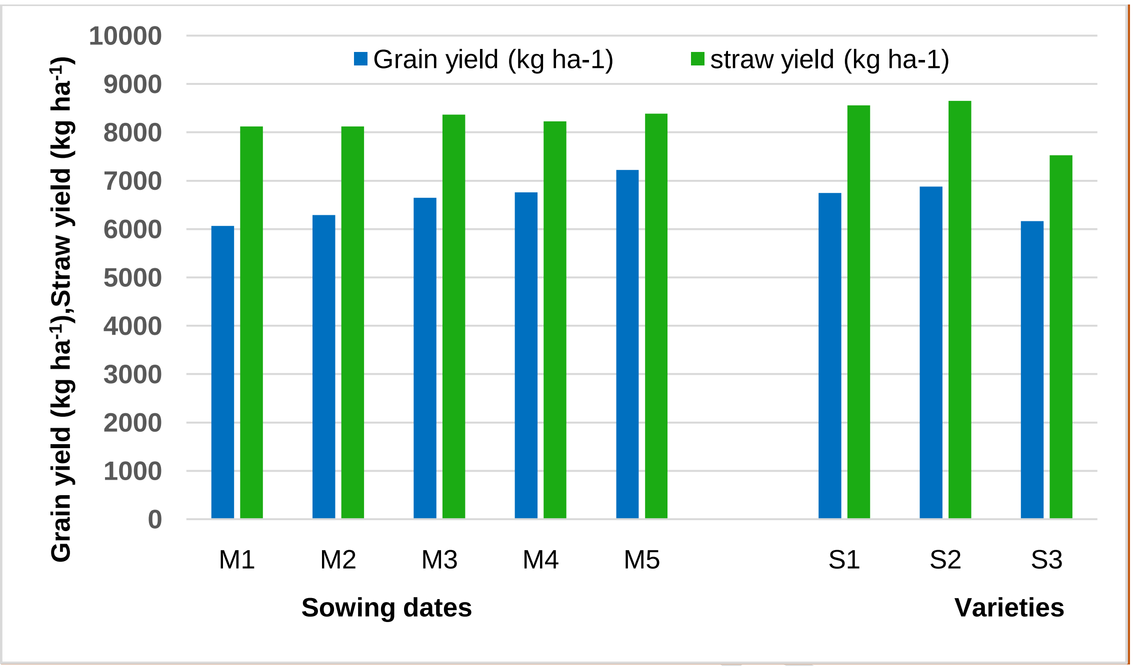

Fig.4. Yield of rice as influenced by sowing dates and varieties.

4. CONCLUSION

Based on the research work, it can be concluded that among different sowing dates, crop sown on 30th December (M_5) performed better in terms of dry matter accumulation and grain yield and among the varieties, Ganga Kaveri (S_2) performed better in dry matter accumulation resulting in higher grain yield under *rabi* conditions.

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