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Effect of Sowing Time on the Growth and Yield of Different Rice Varieties Under Climatic Condition of Konkan

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ABSTRACT: *A field experiment was conducted during rainy season of 2013 and 2014 at Agronomy Department Farm, College of Agriculture, Dr. B.S.K.K.V., Dapoli to assess the effect of sowing time on the growth and yield of different rice varieties under climatic conditions of Konkan. The experiment revealed that the sowing during 23th meteorological week (4th to 10th June) produced significantly higher growth attributes viz., plant height, number of leaves, number of tillers, dry matter production, leaf area and leaf area index and grain and straw yield. Among the different varieties, promising hybrid Sahyadri-4 and bold seeded Jaya recorded significantly higher grain and straw yield as compared to rest of varieties under study.*

Keywords**:** *Sowing time, rice varieties, yield.*

INTRODUCTION

Rice (*Oryza sativa L.*) is one of the most important staple food grain crop of the world, which constitute the principle food for 60 per cent of the world's population and 2/3rd of Indian population. Rice based agriculture is the largest source of livelihood of majority of rural mass in *Konkan*, which lies along the Arabian seacoast at the extreme western part of the Indian peninsula.

Time of sowing is the most important factor in influencing the crop yield. Performance of a genotype entirely depends upon the time of sowing. Delay in sowing generally results in yield reduction which cannot be compensated by any other means. Studies investigating the effect of seeding date on rice grain yields have been sporadically conducted since very past. Despite numerous studies on rice seeding dates conducted in India, the rate of yield loss from delayed seeding has never been quantified. Specific information on the rate of yield decline of modern rice cultivars to seeding date in rice producing areas of Konkan region is needed to assist rice producers in making crop management decisions. Yield potential, as influenced by seeding date, is valuable to farmers because they often make decisions on which crop species or cultivar to seed while considering commodity prices, production costs and environmental conditions. Technological progress in mechanization, pest control, fertilization and cultivar development has changed rice production practices and increased grain yields. Since most of the previous studies on rice were published, but today, rice yields are closer to reaching their genetic yield potential due to improved management and pest control. Thus, environmental conditions, as influenced by seeding date, may have a greater relative effect on rice grain yields. In context to this genetic advance, optimum sowing time is even more relevant and non-monetary input, since varieties are comparatively more sowing time responsive. Sowing of rice during the optimum period of time resulted in high grain yield.

Over the years, rice yields have increased due to advances in breeding and crop management.

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About 432 notified rice varieties have become available for production, and many of these cultivars have exceptional yield potential Diwakar and Kumar [1]. In Maharashtra state, considerable efforts are being made to evolve high yielding and superior varieties of rice. As a result, many high yielding varieties have been developed and released for general cultivation in the state. In Konkan many promising, high yielding and widely cultivated varieties have been evolved by Dr. B.S.K.K.V., Dapoli through Agriculture Research Stations, Karjat, Ratnagiri and Palghar. It is therefore, highly essential to study the response of popular varieties among the farmers to different climatic situations with respect to sowing times. Besides these varieties, the variety Swarna released by Acharya N.G. Ranga Agricultural University, Hyderabad in 1979 and Jaya released during Indian Intensive Rice Breeding Programme in 1966 are the most accepted and widely grown in India. Therefore, it is also necessary, to find out the climatic response of such varieties in comparison with varieties developed under the jurisdiction of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. The reasons of low productivity of rice in rainfed lowland ecosystem are many and varied. Lack of suitable varieties with stress tolerance at various stages of growth is one of the limiting factor. Under rainfed lowland conditions, crop has to experience varying depth of water of various stages of growth affecting adversely its performance.

MATERIAL AND METHODS

The experiments were conducted during Kharif 2013 and 2014 at Agronomy farm, College of Agriculture, Dr. B.S.K.K.V., Dapoli, Dist-Ratnagiri, Maharashtra, India. The experiment was conducted in lateritic soil of Konkan, which was medium in available nitrogen (306.21 kg ha^{-1}) and phosphorus (11.8 kg ka^{-1}), high in available potassium (271.89 kg ha^{-1}), very high in organic carbon (1.2%) and slightly acidic in reaction (pH 6.1). The experiment was laid out in split plot design with three replication. There were three main plot treatments consisting sowing times *viz.*, 23rd meteorological week (4th June to 10th June), 24th meteo rological week (11th June to 17th June) and 25th meteo rological week (18th June to 24th June) and sub plot treatments consistingnine different durationvarieties. *viz.*, Karjat-5 (125-130 days), Karjat-7 (115-120 days), Ratnagiri-24 (105-110), Karjat-2 (135-140 days), Palghar-1 (125-130 days), Karjat-3 (110-115 days), Swarna (140-145 days), Sahyadri-4 (115-120 days) and Jaya (125-130 days). The gross and net plot sizes were 7.2 m × 2.1 m and 6.8 m × 1.8 m, respectively. The rice varieties were sown according to sowing times and transplanted at 21 DAS at spacing of 20 cm × 15 cm.

RESULT AND DISCUSSION

Effect of Sowing Times

Data in Table 1 indicated that days taken to complete life cycle (maturity) was reduced with each successive delay in planting in both the years, however first year crops taken more time than second year and early maturity (approximately 3-4 days) was recorded. It might be due to the environmental condition that was not same for both years. Similar results were reported by Singh *et al.* 2012 [2]. All the growth and developmental parameters studies were also influenced by varying environments. Each and every parameter were tuned sluggish with delay in seeding. Early sowing availed more time to complete lifecycle *i.e.* maturity in both the year. The maximum dry matter at harvest was produced when crop was planted earlier in both the years 38.83 g and 36.99 g during 2013 and 2014, respectively, but maximum plant height was observed (77.15 cm) in the first year at early dates of planting. More leaf area index (LAI) was recorded in the first year in all three environments (Table 2). Number of tillers $hill^{-1}$ were also recorded maximum 13.35 during first year and at early planting dates. Over all first year and early seeding dates prove more congenial to growth and

Table 1
Duration of different varieties with respect to sowing times of the crop during the year of 2013 and 2014.

	Duration (Days) during year 2013			*Duration (Days) during year 2014*		
Physiological stages	*23rd Met. week*	*24th Met. week*	*25th Met. week*	*23rd Met. week*	*24th Met. week*	*25th Met. week*
	Total duration					
V1-Karjat-5	126	123	119	124	121	117
V2-Karjat-7	118	116	113	117	115	111
V3-Ratnagiri-24	110	107	103	108	106	102
V4-Karjat-2	140	136	133	136	133	131
V5-Palghar-1	128	125	121	125	122	118
V6-Karjat-3	114	112	109	114	112	108
V7-Swarna	144	140	136	140	137	135
V8-Sahyadri-4	120	118	115	119	117	114
V9-Jaya	132	129	125	127	124	121

Table 2
Growth attributing characters of rice at harvest as influenced by the different treatments

Sym.	Treatments	Plant height			Number of leaves hill^{-1}			Number of tillers hill^{-1}			Dry matter production hill^{-1}			Mean leaf area (cm^2)			Leaf area index		
		2013	2014	Pooled mean	2013	2014	Pooled mean	2013	2014	Pooled mean	2013	2014	Pooed mean	2013	2014	Pooled mean	2013	2014	Pooled mean
Sowing time																			
S_1	23rd Met. week (4th to 10th June)	77.15	75.80	76.48	15.90	15.44	15.67	10.52	8.81	9.78	38.83	36.99	37.91	174.75	165.44	170.09	1.16	1.10	1.13
S_2	24th Met. week (11th to 17th June)	73.94	71.84	72.89	14.57	13.98	14.27	9.22	7.99	8.72	37.31	35.29	36.30	161.28	153.44	157.36	1.08	1.02	1.05
S_3	25th Met. week (18th to 24th June)	65.93	64.40	65.17	12.60	9.32	10.96	8.32	7.00	7.77	34.54	32.85	33.70	141.42	126.14	133.78	0.94	0.84	0.89
	S.E.±	1.03	1.03	0.73	0.39	0.39	0.27	0.13	0.16	0.10	0.52	0.51	0.37	3.82	3.20	2.49	–	–	–
	C.D. at 5%	4.04	4.05	2.38	1.52	1.52	0.89	0.51	0.62	0.33	2.05	2.01	1.19	15.02	12.57	8.13	–	–	–
Varieties																			
V_1	Karjat – 5	83.80	81.22	82.51	15.27	14.44	14.86	8.97	8.81	8.89	40.60	38.79	39.70	144.76	153.37	149.07	0.97	1.02	1.00
V_2	Karjat – 7	72.56	69.83	71.19	13.88	12.94	13.41	9.37	7.67	8.52	36.27	34.55	35.41	127.66	123.53	125.59	0.85	0.82	0.84
V_3	Ratnagiri – 24	76.46	72.84	74.65	13.81	12.21	13.01	9.17	7.37	8.27	34.87	31.79	33.33	180.33	168.96	174.65	1.20	1.13	1.17
V_4	Karjat – 2	67.33	66.45	66.89	16.56	14.86	15.71	10.59	9.38	9.73	36.61	35.05	35.83	199.91	193.29	196.60	1.33	1.29	1.31
V_5	Palghar – 1	63.59	62.64	63.12	11.89	8.90	10.39	9.70	6.77	8.23	35.55	33.28	34.41	86.65	75.45	81.05	0.58	0.50	0.54
V_6	Karjat – 3	69.59	67.54	68.56	12.13	11.54	11.84	10.50	8.88	9.69	35.09	32.83	33.96	115.00	86.84	100.92	0.77	0.58	0.68
V_7	Swarna	66.11	64.89	65.50	17.73	15.13	16.43	7.63	9.27	8.45	38.26	36.83	37.55	221.26	197.47	209.37	1.48	1.32	1.40
V_8	Sahyadri -4	77.23	73.20	75.21	16.80	14.92	15.86	9.97	8.49	9.64	37.40	36.02	36.71	185.50	177.81	181.65	1.24	1.19	1.22
V_9	Jaya	80.41	77.51	78.96	11.12	11.27	11.19	8.01	6.80	7.41	37.62	36.29	36.96	171.29	158.34	164.82	1.14	1.06	1.10
	S.E.±	1.47	1.50	1.04	0.54	0.69	0.43	0.22	0.26	0.17	1.13	1.14	0.80	4.31	4.13	2.95	-	-	-
	C.D. at 5%	4.18	4.27	2.92	1.54	1.96	1.22	0.62	0.73	0.47	3.21	3.25	2.23	12.25	11.75	8.29	-	-	-
Interaction Effect																			
	S.E.±	2.55	2.60	2.55	0.94	1.20	1.06	0.38	0.45	0.41	1.96	1.98	1.95	7.46	7.15	7.23	-	-	-
	C.D. at 5%	N.S	N.S.	N.S.	N.S	N.S	N.S	N.S.	N.S.	N.S.	N.S.	N.S.	5.47	N.S.	N.S.	N.S.	-	-	-
General Mean		72.34	70.68	71.51	14.35	12.91	13.63	9.35	7.94	8.76	36.89	35.05	35.97	159.15	148.34	153.75	-	-	-

development in comparison to other tested environments. Similar results were reported by Singh *et al* 2012 [2].

The maximum height of plant was recorded with 23rd meteorological week sowing which was significantly followed by 24th meteorological week but found significantly superior with late sowing of 25th meteorological week at harvest during both the years of experimentation. Whereas in the pooled mean, sowing during 23rd meteorological week were significantly superior significance over 24th and 25th meteorological week sowing in ascending order. Similarly, the number of functional leaves hill^{-1} in the treatment of 23rd meteorological week sowing was maximum and remained at par with sowing during 24th meteorological week and both these former sowings were significantly superior over 25th meteorological week sowing. This superior ability of the crop under 23rd meteorological week ultimately reflected in the maximum leaf area and leaf area index as compared to 25th meteorological week sowing and followed by 24th meteorological week sowing and which was within the level of significance during both the years of study. The increased leaf area and leaf area index in the 23rd meteorological week is due to better crop growing environment.

The dry matter accumulation hill^{-1} seems to be reliable index of crop growth and in the present investigation it was more influenced by 23rd meteorological week sowing, which was followed significantly by sowing during 24th meteorological week and both of these sowing times found significantly superior to 25th meteorological week sowing during both the years of experimentation. Whereas in the pooled mean, sowing during 23rd meteorological week proved its significant superiority over rest of sowing times. This was due to increased leaf area and leaf area index in 23rd meteorological week due to favourable weather condition. The other reason of high dry matter accumulation in 23rd meteorological week may be due to the significant increase in morphological parameters which responsible for the photosynthetic capacity of the plant thereby increasing the straw yield. Kathiresan *et al.* 1997 [3] observed that seeding of rice, a week before onset of monsoon, showed the maximum dry matter production and was on par with seeding along with the onset of monsoon. The maximum number of tillers hill^{-1} was associated with the sowing during 23rd meteorological week at harvest during both the years of study and in the pooled mean. The higher tiller production in the 23rd meteorological week sowing might be due to crop experienced favourable weather condition.

All the yield deciding components were reduced drastically with each delay in seeding (variable environment). The entire yield components which were studied performed better during the second year as compared to first year (Table 3). The similar results were also reported by Singh *et al.* 2012 [2], which indicates that second year environments were more conducive during reproductive phase while first year was good for vegetative growth *i.e.* dry matter production.

The sowing during 23rd meteorological week was significantly superior in terms of some yield contributing characters viz., number of panicle hill^{-1}, number of filled grains panicle^{-1} and number of unfilled grains panicle^{-1} and it was decreased significantly in the 24th and 25th meteorological week in descending order during both the years of experimentation and in the pooled mean. Whereas the yield contributing characters *viz.*, length of panicle, test weight and weight of filled grains panicle^{-1} attained the significant level among the sowing during 23rd and 24th meteorological week and both found significantly superior to sowing during 25th meteorological week during both the years of study and in the pooled mean.

Thus, sowing during 23rd meteorological week recorded significantly higher grain yield ha^{-1} as compared to 25th meteorological week and found statistically at par with sowing during 24th meteorological week sowing. The mean increase in grain yield due to sowing during 23rd meteorological week over sowing during 24th and 25th meteorological week was to the tune of 7.65 and 21.98 per cent respectively. The increased yield contributes might be due to result of optimum growth and development parameters associated with 23rd meteorological week sowing followed by the 24th meteorological week sowing, which associated with favourable weather condition responsible for more growth and development of crop. The results are in the conformity with the work done by Padhi 1995 [4].

However, higher straw yield was recorded by the sowing during 23rd meteorological week and was at par with the 24th meteorological week sowing but

Table 3
Mean yield contributing characters of rice as influenced by the different treatments.

Sym.	Treatments	Number of Panicles hill^{-1}			Length of Panicle (cm)			Test weight (g)			Weight of filled panicle^{-1} grains (g)			Number of filled grains panicle^{-1}			Number of unfilled grains panicle^{-1}		
		2013	2014	Pooled mean	2013	2014	Pooled mean	2013	2014	Pooled mean	2013	2014	Pooed mean	2013	2014	Pooled mean	2013	2014	Pooled mean
Sowing time																			
S_1	23rd Met. week (4th to 10th June)	9.89	8.40	9.14	21.43	21.98	21.71	23.23	24.16	23.69	2.06	2.20	2.13	91.40	98.74	95.07	14.66	10.21	12.44
S_2	24th Met. week (11th to 17th June)	8.38	7.53	7.96	20.73	21.61	21.17	22.67	23.90	23.28	1.95	2.06	2.01	82.03	84.96	83.50	18.11	13.51	15.81
S_3	25th Met. week (18th to 24th June)	7.29	6.64	6.97	19.76	20.51	20.13	21.56	22.59	22.07	1.75	1.86	1.81	70.40	79.74	75.07	23.32	18.75	21.09
	S.E. ±	0.05	0.05	0.03	0.19	0.10	0.11	0.30	0.09	0.16	0.03	0.04	0.02	0.72	0.67	0.49	0.12	0.09	0.08
	C.D. at 5%	0.20	0.19	0.11	0.76	0.40	0.36	1.17	0.36	0.51	0.11	0.15	0.08	2.83	2.62	1.60	0.46	0.37	0.25
Varieties																			
V_1	Karjat–5	8.93	8.47	8.70	21.30	20.49	20.89	27.21	28.51	27.86	1.97	1.96	1.97	58.29	63.47	60.88	27.77	23.86	25.81
V_2	Karjat–7	8.67	7.53	8.10	20.60	22.15	21.38	24.34	26.32	25.33	1.92	1.93	1.92	76.20	79.38	77.79	13.77	12.29	13.03
V_3	Ratnagiri–24	8.87	7.27	8.07	21.20	21.13	21.16	17.33	16.47	16.90	1.96	1.70	1.83	86.98	92.37	89.68	31.04	29.03	30.04
V_4	Karjat–2	10.07	8.42	9.24	18.37	21.44	19.91	21.82	22.80	22.31	1.81	1.84	1.83	77.21	83.59	80.40	15.79	13.74	14.76
V_5	Palghar–1	9.40	6.53	7.97	20.75	20.88	20.82	18.66	18.76	18.71	1.83	1.96	1.89	90.98	98.46	94.72	15.88	14.38	15.13
V_6	Karjat–3	9.40	8.07	8.73	20.54	20.54	20.54	23.71	24.33	24.02	1.80	2.09	1.94	68.34	74.63	71.48	11.19	7.24	9.21
V_7	Swarna	7.13	8.60	7.87	18.61	20.02	19.31	18.90	21.14	20.02	1.81	1.95	1.88	60.85	78.22	69.53	33.05	12.75	22.90
V_8	Sahyadri–4	7.33	6.31	6.82	23.80	24.71	24.25	24.21	26.16	25.19	2.12	2.48	2.30	107.50	111.98	109.74	8.09	5.00	6.54
V_9	Jaya	6.87	6.53	6.70	20.60	20.93	20.76	26.18	27.43	26.80	2.07	2.44	2.25	105.15	108.24	106.69	11.71	9.50	10.61
	S.E.±	0.13	0.14	0.09	0.29	0.18	0.17	0.20	0.21	0.14	0.04	0.03	0.02	1.35	1.34	0.94	0.28	0.25	0.18
	C.D. at 5%	0.36	0.38	0.26	0.83	0.50	0.47	0.57	0.60	0.41	0.11	0.09	0.07	3.83	3.82	2.64	0.78	0.70	0.51
Interaction Effect																			
S.E.±	0.22	0.23	0.22	0.50	0.30	0.41	0.35	0.37	0.35	0.07	0.05	0.06	2.33	2.33	2.31	0.48	0.43	0.45	
C.D. at 5%		N.S.	N.S.	0.63	N.S.	N.S.	N.S.	N.S.	N.S.	N.S	N.S.	N.S.	0.17	N.S.	N.S.	6.47	N.S.	N.S.	1.26
General Mean		*8.52*	*7.53*	*8.02*	*20.64*	*21.36*	*21.00*	*22.49*	*23.55*	*23.02*	*1.92*	*2.04*	*1.98*	*81.28*	*87.82*	*84.55*	*18.70*	*14.20*	*16.45*

Table 4
Interaction effect of the sowing times and varieties on number of panicle hill^{-1} of rice in the pooled mean.

Sowing time	*Varieties*								
	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9
S_1	10.20	10.20	9.20	9.70	8.30	11.20	8.60	7.50	7.40
S_2	8.50	7.70	8.60	9.33	8.00	8.50	7.80	6.67	6.50
S_3	7.40	6.40	6.40	8.70	7.60	6.50	7.20	6.30	6.20
MEAN	8.70	8.10	8.07	9.24	7.97	8.73	7.87	6.82	6.70
S.E.±	0.22								
C.D. at 5%	0.63								

Table 5
Interaction effect of the sowing times and varieties on weight of grains panicle^{-1} of rice in the pooled mean.

Sowing time	*Varieties*								
	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9
S_1	2.05	2.05	2.11	1.91	2.06	2.09	2.03	2.43	2.42
S_2	2.01	1.95	1.79	1.86	1.90	2.07	1.92	2.30	2.26
S_3	1.84	1.77	1.59	1.71	1.73	1.67	1.70	2.16	2.09
Mean	1.97	1.92	1.83	1.83	1.89	1.94	1.88	2.30	2.25
S.E.±	0.06								
C.D. at 5%	0.17								

found to be significantly superior over the 25th meteorological week sowing during both the years of study. Whereas in the pooled data, the sowing during 23rd meteorological week proved its significant superiority over remaining sowing times in terms of straw yield ha^{-1}.Magnitude of increase in mean straw yield under the 23rd meteorological week sowing over 24th and 25th meteorological week sowing was to the tune of 5.67 and 16.72 per cent, respectively. This might be due to increased morphological characters viz., plant height, number of leaves hill^{-1}, number of tillers hill^{-1} and dry matter production hill^{-1} observed in the 23rd meteorological week sowing. The foregone discussion suggests that second year environmental condition was much better for grain production than first year which was good for vegetative growth. Delay in sowing significantly reduced the grain yield and straw yield but it was more pronounced in second year. The production of above ground biomass a straw yield was more in first year and grain yield in second year. Maximum straw yield (57.86 q ha^{-1}) was obtained during first year where as highest grain yield (52.22 q ha^{-1}) was recorded in second year at early date of seeding. Similar results were reported by Singh *et al.* 2012 [2].

Effect of Varieties

Genotype behaviors in response to its environment and it is clearly established in this study. Early maturing varieties take less time to attained maturity (103-118 days) in comparison to other tested varieties

Table 6
Mean yield of grain (q ha^{-1}) and straw (q ha^{-1}) of rice as influenced by the different treatments.

Sym.	*Treatments*	*Grain yield (q ha^{-1})*			*Straw yield (q ha^{-1})*		
		2013	*2014*	*Pooled mean*	*2013*	*2014*	*Pooled mean*
Sowing time							
S_1	23rd Met. week(4th to 10th June)	50.22	52.22	51.22	57.86	56.90	57.38
S_2	24th Met. week(11th to 17th June)	45.92	49.24	47.58	55.15	53.44	54.30
S_3	25th Met. week(18th to 24th June)	40.19	43.79	41.99	49.71	48.62	49.16
	S.E.±	1.35	1.33	0.95	0.93	0.97	0.67
	C.D. at 5%	5.28	5.22	3.08	3.67	3.82	2.20
Varieties							
V_1	Karjat – 5	41.43	42.55	41.99	66.07	63.26	64.67
V_2	Karjat – 7	47.66	49.99	48.82	49.56	50.71	50.14
V_3	Ratnagiri – 24	39.19	37.16	38.17	47.66	45.03	46.34
V_4	Karjat – 2	46.55	48.84	47.70	55.37	52.76	54.06
V_5	Palghar – 1	43.45	44.73	44.11	51.83	47.01	49.42
V_6	Karjat – 3	44.45	46.87	45.66	50.29	49.10	49.69
V_7	Swarna	43.17	53.28	48.22	54.73	57.54	56.14
V_8	Sahyadri -4	52.55	56.72	54.64	57.26	57.11	57.18
V_9	Jaya	50.48	55.63	53.05	55.39	54.37	54.88
	S.E.±	0.73	0.78	0.53	1.23	0.95	0.77
	C.D. at 5%	2.07	2.22	1.48	3.49	2.71	2.16
Interaction Effect							
	S.E.±	1.26	1.35	1.30	2.124	1.65	1.88
	C.D. at 5%	N.S.	N.S.	3.64	N.S.	N.S.	5.29
General Mean		45.44	48.42	46.93	54.24	52.99	53.61

Table 7
Interaction effect of the sowing times and varieties on grain yield (q ha^{-1}) of rice in the pooled mean.

Sowing time	*Varieties*								
	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9
S_1	47.04	52.65	41.84	49.37	49.36	49.63	54.39	59.28	57.43
S_2	42.18	51.28	39.68	47.85	43.70	45.06	46.42	57.52	54.54
S_3	36.75	42.54	33.00	45.87	39.26	42.30	43.86	47.12	47.20
Mean	41.99	48.82	38.17	47.70	44.11	45.66	48.22	54.64	53.05
S.E.±	1.30								
C.D. at 5%	3.64								

viz. medium duration (118-127 days) and long duration (132-142 days). Data in Table 1 indicated that during second year the crop took less time and completed its life cycle in quick succession as compared to first year. This is due congenial environment especially more sunlight availed during second year as compared to the previous year. As the vegetative parameters *viz*., plant height, number of leaves hill^{-1}, number of tillers hill^{-1}, dry matter production hill^{-1} and leaf area index are governed by the genotypic characters of the varieties. Hence, the higher plant height was associated with the tall variety Karjat-5(83.80 and 81.22 cm) followed by short duration Ratnagiri-24 and Sahyadri-4. The long duration variety Swarna was typically known for the production of large number of leaves, this variety produced maximum number of leaves at harvest. The long duration Karjat-2 (10.59 and 9.38) recorded maximum tillers at harvest and closely followed by Swarna during 2014. In case of leaf area (221.26 and 197.47 cm^2) and leaf area index (1.48 and 1.32), at harvest the highest value was associated with long duration and more leaf producing variety Swarna. In case of dry matter production hill^{-1}(40.60 g and 38.79 g hill^{-1}) the maximum value was recorded by medium duration variety Karjat-5 which was closely followed by another medium duration Jaya at harvest. The genetic make-up of the cultivars was responsible for the variation in vegetative parameters. Moreover, the current study is in agreement with the investigation made by Ravishankar *et al.* 2007 [5] who observed that the growth attributes were influenced significantly due to variety.

Though, the growth and development parameters of the different varieties were higher in the first year, but yield contributing characters and ultimately yield were at higher side during the second year. This is because of more congenial environment during flowering and grain filling stage during the second year. A high intensity rainfall in the first year during flowering and grain filling stage of most of the varieties was responsible for decreased value of yield contributing characters and yield. Therefore, the data in Table 2 indicated that although, number of panicle hill^{-1} were more in all the varieties during the first year. However, panicle length and weight of filled grain panicle^{-1} were comparatively less than the same varieties grown during the second year. This is because of less filled grains and more unfilled grains produced by many varieties during the first year. Similar results were reported by Singh *et al.*2012 [2].

Perusal of the data presented in Table 2 revealed that hybrid Sahyadri-4 produced significantly thehighest length of panicle, weight of filled grains panicle^{-1}, number of filled grains panicle^{-1} and least value of number unfilled grains panicle^{-1} during both

Table 8
Interaction effect of the sowing times and varieties on straw yield (q ha^{-1}) of rice in the pooled mean.

Sowing time	*Varieties*								
	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9
S_1	69.87	57.46	48.12	55.87	52.96	53.34	63.53	59.41	55.87
S_2	67.09	49.28	47.80	54.16	51.01	50.49	54.90	57.41	55.52
S_3	57.04	43.67	43.10	52.16	44.30	45.25	49.98	54.72	53.25
Mean	64.67	50.14	46.34	54.06	49.42	49.69	56.14	57.18	54.88
S.E.±	1.88								
C.D. at 5%	5.29								

the years and in the pooled data, though the quantum was more pronounced in the second year for all the yield characters (Tables 2). The medium duration variety Jaya was at par with Sahyadri-4 in some of the yield contributing characters *viz.*, weight of filled grains panicle^{-1} and number of filled grains panicle^{-1}. The medium duration and bold seeded genotype Karjat-5 produced significantly higher test weight than rest of the varieties and was followed by another medium duration bold seeded variety Jaya during both year and in the pooled data. In case of number of panicle hill^{-1}, long duration varieties Karjat-2 during 2013 as well as in the pooled data and Swarna during 2014 recorded the highest values. Most of the parameters recorded higher value under Sahyadri-4 as compared to rest of the straight varieties. The similar results were also reported by Mehta *et al.*2004 [5]. This result clearly indicates that the hybrid was more remunerative than the conventional varieties.

The grain yield is the combined result of increased yield contributing characters and straw yield is as that of growth attributing characters. Hence, the higher grain yield was recorded in most of varieties grown during the second year as compared to the previous one. Whereas, the higher straw yield was associated with the first year. Medium duration variety Karjat-5 produced significantly higher straw yield during both the years and in the pooled data to the tune of 66.07, 63.26 and 64.67 q ha^{-1} respectively, in comparison to the other tested varieties. The increase in the mean straw yield under medium duration variety Karjat-5 over the short duration Sahyadri-4, late duration Swarna, medium duration Jaya, late duration Karjat-2, early duration Karjat-7 and Karjat-3, medium duration Palghar-1 and early duration Ratnagiri-24 was to the tune of 13.10, 15.19, 17.84, 19.63, 28.98, 30.15, 30.86 and 39.55 per cent, respectively. This was due to the increased morphological characters viz., plant height and dry matter production hill^{-1} observed in the Karjat-5. Reddy *et al.* 2012 [7] reported that the medium duration varieties produced more straw yield as compared to the short and long duration varieties.Short duration hybrid Sahyari-4 was remunerative and produced significantly the highest grain yield than rest of the varieties and followed by medium duration Jaya within level of significance. The hybrid Sahydari-4 significantly outyielded all the varieties during both the years and in the pooled mean and produced the grain yield of 52.55, 56.72 and 54.64 q ha^{-1} respectively, which was higher than the other tested varieties. The mean increase in the grain yield of the short duration hybrid Sahyadri-4 over medium duration Jaya, short duration Karjat-7, long duration Swarna and Karjat-2, short duration Karjat-3, medium duration Palghar-1 and Karjat-5 and short duration Ratnagiri-24 was to the tune of 3.00, 11.92, 13.31, 14.55, 19.67, 23.87, 30.13 and 43.15 per cent, respectively. Hybrid Sahyadri-4 and conventional variety Jaya performed better due to more conversion of photosynthates into economic produce, which resulted in higher yield contributing characters in the respective varieties. Similar results were reported by Mehta *et al.* 2004 [6]. They reported that the hybrid produced more yield than the conventional varieties. Perusal of data revealed that the response of all the varieties improved in the second year. It might be due to favorable environmental conditions during reproductive stages. Similar results were reported by Singh *et al.*2012 [2].

Interaction Effect

As regards to the yield contributes, significant interactions were found between the sowing times and varieties in respect to pooled mean of number of panicle hill^{-1} and weight of filled grains panicle^{-1}. Early duration variety Karjat-3 when sown during 23rd meteorological week recorded significantly higher number of panicles hill^{-1} in the pooled mean as compared to rest of the treatment combinations. Whereas, the short duration hybrid Sahyadri-4 and medium duration Jaya sown during 23rd meteor ological week recorded similar weight of filled grains panicle^{-1} in the pooled mean as compared to rest of the treatment combinations except the same varieties sown during 24th meteo rological week which were at par with both of the former treatment combinations. Higher yield contributing characters in the respective varieties are the reasons of genotypic characters of those varieties and their better performance under the favourable environ ment. These findings corroborate the reports of Padhi 1995 [4].

The higher grain and straw yield were the cumulative enhanced effect of yield contributes and growth attributes. That's why, the treatment combination recorded higher values of most of the yield contributes recorded increased grain yield in

such treatment combinations. Whereas, in case of straw yield it was proportional to the higher growth attributing combinations. The interaction effects among the different sowing times and varieties for both grain and straw yield were found to be significant in the pooled mean of the data. The short duration hybrid Sahyadri-4 sown during 23rd meteorological week recorded significantly higher grain yield as compared to rest of the treatment combinations except the same variety sown during 24th meteorological week and medium duration Jaya sown during 23rd meteorological week, which were at par with the former treatment combination. On the other hand, in case of straw yield, significantly higher values was recorded under the combination of medium duration variety Karjat-5 and 23rd meteorological week sowing and it remained at part with the same variety when sown during 24th meteorological week. Further, rest of the treatment combinations were significantly inferior as compared to the highest treatment combination *i.e.* variety Karjat-5 sown during 23rd meteorological week. Similarly Padhi 1995 [4] reported that the higher yield was produced due to the early sowing in the month of June by most of the varieties.

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