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Effect of Sowing Time on the Performance of Different Rice Genotypes in Konkan Climate

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A field experiment was conducted to assess the influence of sowing time on the performance of different rice genotypes in lateritic soil with low to medium soil fertility during *Kharif* 2013 and 2014. The experiment was laid out in split plot design with sowing time in 3 main plots and rice genotypes in 9 sub-plots resulting in 27 treatment combinations that were replicated thrice. The pooled mean of the data revealed that significantly highest grain yield was obtained in short duration hybrid Sahyadri-4 sown during 23rd meteorological week (MW) followed by the same hybrid sown during 24th MW and medium duration variety Jaya sown during 23rd MW. However, in case of straw yield, significantly highest value was recorded by the medium duration variety Karjat-5 sown during 23rd MW followed by the same cultivar sown during 24th MW. The highest nitrogen, phosphorus and potassium content and nutrient uptake were recorded in rice sown during 23rd MW compared to other sowing times. The short duration hybrid Sahyadri-4 recorded the highest nitrogen (N), phosphorus (P), potassium (K) and total nutrient uptake in grains among the 9 genotypes, except medium duration cv. Karjat-5 having the highest total K uptake. Whereas, in straw cv. Karjat-5 recorded significantly the highest uptake of N, P and K followed by the short duration hybrid Sahyadri-4.

(***Key words***: *Sowing times, Rice, Genotypes, Economics and Yield*)

Rice (Oryza sativa L.) is one of the most important staple food-grain crops of the world, which serves as the principal food for 60% and 66% of the global and the Indian population, respectively. Rice is intensively grown in 88 countries across the world in an area of about 160 million hectares with annual production of 465.48 million tonnes (Anonymous, 2012). More than 90 % of the world's rice is produced and consumed in Asia where it is an integral part of culture and tradition. Although it is not a tropical plant, it is believed to be associated with wet and humid climate.

Rice based farming is the largest source of livelihood for majority of the rural mass in *Konkan,* along the Arabian seacoast in the extreme western part of the Indian peninsula. Among the wet season crops in *Konkan*, rice alone occupies an area about 3.83 lakh hectares with production of 10.59 lakh tonnes and productivity of 2.76 t ha^{-1} (Anonymous, 2013). In *Konkan* region of Maharashtra, about 80 % of rice crop is grown in lowland conditions, spreading over an area of 40-60 kms in width and 700 km in length all along the west-coast. But, the yields are highly variable due to aberrations in weather like late onset of monsoon, heavy continuous rains, intermittent dry-spells and heavy rains at the time of harvesting.

Time of sowing is the most important factor influencing the crop yields. Performance of a genotype entirely depends upon the time of planting. Delay in planting 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 in the 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.

Varieties play a unique role in maximizing yield by improving the input use efficiency as the genetic potential of a variety limits the expression of its yield and affects plant growth in response to environment conditions. The reasons of low productivity of rice in rainfed lowland ecosystems are many and varied. Lack of suitable varieties with stress tolerance at various

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stages of growth is one of the limiting factors. Under rainfed lowland conditions, the rice crop experiences varying depths of water logging at different stages of growth affecting adversely its performance. Of late, many promising genotypes have been evolved for midland and lowland ecosystems, making it essential to investigate differential response of some promising genotypes under rainfed lowland conditions.

MATERIALS AND METHODS

The experiment was conducted during *Kharif* 2013 and 2014 at Agronomy farm, College of Agriculture, Dr. B.S.K.K.V., Dapoli, Dist- Ratnagiri, Maharashtra. The experiment was laid out in a split plot design with 3 replications. There were 3 main plot treatments consisting of sowing times *viz*., 23rd meteorological week (MW) (4th June to 10th June), 24th MW (11th June to 17th June) and 25th MW (18th June to 24th June) and sub-plot treatments consisting 9 different genotypes of varying growth durations *viz*., Karjat-5 (125-130 days), Karjat-7 (115-120 days), Ratnagiri-24 (105-110 days), 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 soil was lateritic, clay loam in texture, medium in available nitrogen (306.21 kg ha^{-1}), phosphorus (11.8 kg ka^{-1}) and potassium (271.89 kg ha^{-1}), high in organic carbon (1.2 %) and slightly acidic in reaction (6.1). The rice genotypes were sown as per the treatments and 21 days old seedlings were transplanted at a spacing of 20 cm x 15 cm, subsequently. Urea as a source of nitrogen, single super phosphate (SSP) for phosphorus and muriate of potash (MOP) for potassium were applied as per standard recommendations. All these treatments were imposed as per the schedule and data on growth, yield and nutrient uptake obtained during the course of investigation were statistically analyzed by analysis of variance as per the procedure described by Gomez and Gomez (1983) and Panse and Sukhatme (1985).

Table 1. *Mean yield of grain and straw of rice as influenced by 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.Em.±	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.Em.±	0.73	0.78	0.53	1.23	0.95	0.77
	CD at 5%	2.07	2.22	1.48	3.49	2.71	2.16
Interaction Effect							
	S.Em.±	1.26	1.35	1.30	2.124	1.65	1.88
	CD 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

RESULTS AND DISCUSSIONS

Effect of sowing time

Rice sown during 23rd MW recorded significantly recorded higher grain yield than rice sown during 24th and 25th MW (Table 1). The mean increase in grain yield due to sowing during 23rd MW over sowing during 24th and 25th MW were to the tune of 7.65 and 21.98%, respectively. The increased yield in 23rd MW sown rice might be due to the result of optimum growth and developmental parameters, and yield attributes associated with favourable weather conditions. These results are in the conformity with the work done by Gill *et al*. (2006) and Brahmanand *et al.* (2001).

The straw yield of rice also followed a similar trend as grain yield (Table 1) and decreased significantly with subsequent delay in sowing beyond 23rd MW. Magnitude of increase in mean straw yield under the 23rd MW sowing over 24th and 25th MW sowing was to the extent of 5.67 % and 16.72 %, 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} associated with the 23rd MW sowing. Similar findings were also reported by Brahmanand *et al.* (2001).

The results (Table 1) suggest that the 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 or straw yield was more in first year where as grain yield was higher during the second year. The maximum straw yield (57.86 q ha^{-1}) was obtained during first year where as the 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).

The sowing during 23rd and 24th MW recorded almost identical and higher N, P and K content in grain and straw of rice than that of 25th MW sowing during both the years of experimentation (Tables 2, 3 & 4). While perusal of the pooled mean revealed that the sowing during 23rd MW recorded significantly more N, P and K content in both grain and straw over remaining sowing times. This might be due to the fact that the early sowing of rice was more effective for dry matter production and subsequent N, P and K concentration as reported by Kabat and Satapathy (2011) and Pandey *et al.* (2008).

The uptake of N, P and K was maximum in the crop sown during 23rd MW followed by 24th and 25th MW sowing during both the years of study as well as for the pooled data. Since, uptake is a function of grain and straw yield and their nutrient content, significant improvement in the content of these nutrients coupled with increased grain and straw yield increased the uptake of nutrients substantially. These results corroborated with the findings of Pandey *et al.* (2007) and Ramana *et al.* (2007).

Effect of genotypes

A perusal of the yield data for both the years as well the pooled data (Table 1) revealed that the short duration hybrid Sahyadri-4 significantly out yielded all the other genotypes. 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%, respectively. Hybrid Sahyadri-4 and conventional variety Jaya performed better due to more conversion of photosynthates into the reproductive parts which resulted in higher yield contributing characters in these genotypes. Similar results of higher grain yield in hybrids were reported by Mehta *et al*. (2004), Rao and Moorthy (2002) and Kumar *et al.* (2001) . Perusal of data revealed that the response of all the genotypes 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).

Medium duration variety Karjat-5 produced significantly higher mean straw yield (64.67 q ha^{-1} and also during both the years in comparison to the other tested genotypes of rice (Table 1). The increase in the mean straw yield in medium duration variety Karjat-5 over the short duration Sahyadri-4, long duration Swarna, medium duration Jaya, long 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 %, respectively. This was due to the increased morphological characters *viz*., plant height and dry matter production hill^{-1} observed in the Karjat-5. Manjunath *et al*. (2012), Reddy *et al*. (2012) and Ghose *et al*. (2001), reported that the medium duration varieties produced more straw yield as compared to the short and long duration varieties.

Table 2. *Nitrogen content and nitrogen uptake in grain, straw and total uptake of rice as influenced by the different treatments*

Sym.	Sowing Date	Nitrogen content (%)						Nitrogen uptake (kg ha^{1})								
		Grain			Straw			Grain			Straw			Total		
		2013	2014	mean	2013	2014	mean	2013	2014	mean	2013	2014	mean	2013	2014	mean
Sowing time																
S1	23rd Met. week (4th to 10th Junc)	1.145	1.153	1.149	0.525	0.521	0.523	57.61	60.48	59.05	30.45	29.73	30.09	88.06	90.21	89.14
S2	24th Met. week (11th to 17th June)	1.123	1.133	1.130	0.506	0.504	0.505	51.80	54.88	53.34	28.03	27.12	27.57	79.82	81.99	80.91
S3	25th Met. week (18th to 24th June)	1.093	1.073	1.083	0.461	0.459	0.460	44.06	48.35	46.21	23.09	22.38	22.74	67.15	70.74	68.94
	SEm±	0.005	0.008	0.005	0.006	0.009	0.005	1.71	1.84	1.26	0.76	1.08	0.66	2.43	0.87	1.77
	CD at 5%	0.021	0.032	0.016	0.023	0.034	0.017	6.70	7.23	4.10	2.97	4.22	2.14	9.53	10.10	5.77
Varieties																
V1	Karjat – 5	1.098	1.096	1.097	0.535	0.529	0.532	45.54	46.85	46.19	35.39	33.58	34.49	80.93	80.43	80.68
V2	Karjat – 7	1.088	1.088	1.088	0.474	0.480	0.477	52.00	54.51	53.26	23.59	24.52	24.06	75.59	79.03	77.31
V3	Ratnagiri – 24	1.068	1.052	1.060	0.458	0.449	0.454	41.97	39.18	40.58	21.93	20.22	21.07	63.90	59.40	61.65
V4	Karjat – 2	1.148	1.149	1.149	0.495	0.485	0.490	53.50	56.13	54.81	27.46	25.63	26.54	80.95	81.76	81.35
V5	Palghar – 1	1.078	1.074	1.076	0.492	0.481	0.486	47.02	48.13	47.58	25.67	22.62	24.15	72.70	70.76	71.73
V6	Karjat – 3	1.108	1.109	1.109	0.482	0.478	0.480	49.35	52.03	50.69	24.35	23.59	23.97	73.70	75.62	74.66
V7	Swarna	1.181	1.186	1.183	0.504	0.511	0.508	51.07	63.39	57.23	27.69	29.47	28.58	78.76	92.86	85.81
V8	Sahyadri -4	1.168	1.170	1.169	0.522	0.521	0.521	61.48	66.46	63.97	29.97	29.77	29.87	91.45	96.23	93.84
V9	Jaya	1.155	1.157	1.156	0.515	0.520	0.518	58.46	64.45	61.46	28.65	28.29	28.47	87.11	92.74	89.92
	SEm±	0.005	0.006	0.004	0.006	0.006	0.004	0.88	1.00	0.66	0.76	0.66	0.50	1.40	1.05	0.97
	CD at 5%	0.015	0.016	0.011	0.017	0.017	0.012	2.51	2.84	1.85	2.15	1.87	1.39	3.98	3.93	2.73
Interaction Effect																
	SEm±	0.009	0.010	0.009	0.010	0.011	0.010	1.53	1.73	1.61	1.31	1.14	1.21	2.43	2.40	2.39
	CD at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
General Mean		1.122	1.120	1.121	0.497	0.495	0.496	51.15	54.57	52.86	27.19	26.41	26.80	78.34	80.98	79.66

Table 3. *Phosphorus content (%) and phosphorus uptake (kg ha^{-1}) in grain, straw and total uptake of rice as influenced by the different treatments*

Sym.	Sowing Date	Phosphorus content (%)						Phosphorus uptake (kg ha^{-1})								
		Grain			Straw			Grain			Straw			Total		
		2013	2014	mean	2013	2014	mean	2013	2014	mean	2013	2014	mean	2013	2014	mean
Sowing time																
S1	23rd Met. week (4th to 10th June)	0.358	0.362	0.360	0.160	0.155	0.157	18.11	19.18	18.64	9.34	8.95	9.14	27.45	28.13	27.79
S2	24th Met. week (11th to 17th June)	0.345	0.350	0.347	0.150	0.145	0.147	15.95	17.11	16.53	8.44	7.94	8.19	24.39	25.05	24.72
S3	25th Met. week (18th to 24th June)	0.309	0.314	0.312	0.117	0.112	0.115	12.49	14.21	13.35	5.96	5.57	5.77	18.46	19.78	19.12
SEm±	0.005	0.003	0.003	0.003	0.003	0.002	0.65	0.59	0.44	0.31	0.32	0.16	0.88	0.93	0.60	
CD at 5%	0.018	0.013	0.009	0.014	0.014	0.008	2.57	2.32	1.44	1.20	1.25	0.52	3.44	3.66	1.95	
Varieties																
V1	Karjat – 5	0.326	0.331	0.329	0.180	0.176	0.178	13.56	14.13	13.84	12.27	10.96	11.61	25.83	25.08	25.46
V2	Karjat – 7	0.319	0.326	0.322	0.110	0.115	0.113	15.20	16.29	15.74	5.51	5.94	5.72	20.71	22.22	21.47
V3	Ratnagiri – 24	0.279	0.270	0.275	0.106	0.096	0.101	11.00	10.10	10.55	5.12	4.34	4.73	16.12	14.43	15.27
V4	Karjat – 2	0.348	0.354	0.351	0.137	0.122	0.130	16.24	17.30	16.77	7.65	6.52	7.08	23.89	23.82	23.85
V5	Palghar – 1	0.302	0.306	0.304	0.127	0.107	0.117	13.19	13.72	13.45	6.65	5.02	5.83	19.84	18.74	19.29
V6	Karjat – 3	0.336	0.344	0.340	0.122	0.117	0.119	15.03	16.15	15.59	6.19	5.84	6.01	21.22	21.98	21.60
V7	Swarna	0.384	0.388	0.386	0.149	0.164	0.156	16.67	20.82	18.75	8.30	9.50	8.90	24.96	30.32	27.64
V8	Sahyadri -4	0.376	0.384	0.380	0.177	0.175	0.176	20.00	21.96	20.98	10.22	10.05	10.14	30.23	32.01	31.12
V9	Jaya	0.366	0.376	0.371	0.167	0.169	0.168	18.77	21.02	19.90	9.31	9.22	9.27	28.08	30.25	29.16
	SEm±	0.007	0.007	0.005	0.006	0.006	0.004	0.45	0.48	0.32	0.37	0.38	0.26	0.71	0.73	0.50
	CD at 5%	0.021	0.019	0.014	0.016	0.016	0.011	1.27	1.36	0.91	1.04	1.08	0.73	2.03	2.07	1.42
Interaction Effect																
	SEm±	0.013	0.011	0.012	0.010	0.010	0.010	0.77	0.83	0.79	0.64	0.66	0.64	1.24	1.26	1.24
	CD at 5%	N.S.	N.S.	N.S	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
General Mean		0.337	0.342	0.340	0.142	0.137	0.140	15.52	16.83	16.17	7.91	7.49	7.70	23.43	24.32	23.87

Table 4. *Potassium content (%) and potassium uptake (kg ha^{-1}) in grain, straw and total uptake of rice as influenced by the different Treatments*

Sym.	Sowing Date	Potassium content (%)						Potassium uptake (kg ha^{-1})								
		Grain			Straw			Grain			Straw			Total		
		2013	2014	mean	2013	2014	mean	2013	2014	mean	2013	2014	mean	2013	2014	mean
Sowing time																
S1	23rd Met. week (4th to 10th June)	0.463	0.470	0.467	1.233	1.229	1.231	23.38	24.81	24.10	71.77	70.45	71.11	95.16	95.27	95.21
S2	24th Met. week (11th to 17th June)	0.446	0.455	0.451	1.191	1.187	1.189	20.58	22.12	21.35	66.20	64.20	65.20	86.78	86.33	86.55
S3	25th Met. week (18th to 24th June)	0.402	0.411	0.406	1.065	1.061	1.063	16.24	18.61	17.43	53.64	52.16	52.90	69.89	70.77	70.33
	SEm±	0.005	0.007	0.004	0.011	0.012	0.008	0.61	0.83	0.52	1.06	1.42	0.89	1.64	1.55	1.13
	CD at 5%	0.019	0.027	0.014	0.044	0.046	0.026	2.39	2.27	1.68	4.18	5.59	2.90	6.46	6.08	3.68
Varieties																
V1	Karjat – 5	0.424	0.428	0.426	1.343	1.331	1.337	17.61	18.33	17.97	88.85	84.51	86.68	106.45	102.86	104.65
V2	Karjat – 7	0.412	0.422	0.417	1.036	1.040	1.038	19.71	21.10	20.40	51.69	53.56	52.62	71.40	74.66	73.03
V3	Ratnagiri – 24	0.375	0.377	0.376	1.002	0.994	0.998	14.78	14.08	14.43	47.93	44.83	46.38	62.71	58.92	60.81
V4	Karjat – 2	0.444	0.452	0.448	1.138	1.126	1.132	20.74	22.09	21.41	63.13	59.55	61.34	83.87	81.65	82.76
V5	Palghar – 1	0.393	0.397	0.395	1.110	1.097	1.103	17.29	17.90	17.60	57.84	51.67	54.75	75.13	69.57	72.35
V6	Karjat – 3	0.437	0.445	0.441	1.066	1.062	1.064	19.48	20.92	20.20	54.05	52.78	53.41	73.52	73.69	73.61
V7	Swarna	0.492	0.504	0.498	1.208	1.220	1.214	21.26	26.92	24.09	66.67	70.52	68.60	87.93	97.44	92.68
V8	Sahyadri -4	0.484	0.494	0.489	1.302	1.300	1.301	25.60	28.17	26.89	74.67	74.38	74.53	100.28	102.55	101.41
V9	Jaya	0.475	0.487	0.481	1.264	1.262	1.263	24.16	27.14	25.65	70.02	68.62	69.32	94.18	95.76	94.97
	SEm±	0.010	0.010	0.007	0.031	0.032	0.022	0.63	0.63	0.44	2.42	2.21	1.62	2.81	2.45	1.84
	CD at 5%	0.029	0.029	0.020	0.089	0.090	0.062	1.79	1.80	1.24	6.87	6.30	4.55	8.00	6.96	5.18
Interaction Effect																
	SEm±	0.017	0.018	0.017	0.054	0.055	0.054	1.09	1.09	1.08	4.19	3.84	3.97	4.87	4.24	4.52
	CD at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
General Mean		0.437	0.445	0.441	1.163	1.159	1.161	20.07	21.85	20.96	63.87	62.27	63.07	83.94	84.12	84.03

Table 5a *Interaction effect of the sowing times and varieties on grain yield (q ha^{-1}) of rice (pooled mean of two seasons)*

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
SEm±	1.30								
CD at 5%	3.64								

Table 5b. *Interaction effect of the sowing times and varieties on straw yield (q ha^{-1}) of rice (pooled mean of two seasons)*

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
SEm±	1.88								
CD at 5%	5.29								

The data presented in Tables 2, 3 & 4 revealed that duration variety Swarna and short duration hybrid Sahyadri-4 had statistically at par N, P and K concentrations in their grains and both recorded significantly higher N, P and K concentrations in grain than other tested genotypes during both the years of the field study. However, P and K content in grain in the medium duration variety Jaya was also at par with both of these former varieties during both the years of experimentation. The pooled data however revealed that long duration variety Swarna had significantly the highest N, P and K concentration in its grain, than rest of the genotypes, except for P and K content where short duration hybrid Sahyadri-4 was at par. In addition medium duration variety Jaya was also at par with both of the above varieties with respect to K content in grain. During both the years under consideration, the highest N, P and K concentration in straw was obtained in the medium duration variety Karjat-5 which was at par with the short duration hybrid Sahyadri-4. The N content during 2014 and P and K content (both the years and pooled) in straw Jaya was also at par with Karjat-5 and Sahyadri-4. In case of N, P and K uptake in grain and total uptake, the short duration hybrid Sahyadri-4 was superior over the rest except in total K uptake, where medium duration Karjat-5 recorded significantly higher value. In terms of N, P and K uptake in the straw, the medium duration Karjat-5 recorded significantly higher value than rest of the genotypes except the short duration Sahyadri-4, which was at par with respect to P uptake in the straw during the year 2014. In fact, the significant variations in N, P and K concentrations in grain and straw and the grain and straw yields have caused significant differences in N, P and K uptake by the different varieties. Varietal differences in nutrient uptake has been reported by Chaudhary *et al.* (2008), Ramana *et al.* (2007) and Sudhakar *et al.* (2003)

Interaction effect

The interaction effect among the different sowing times and genotypes for both grain and straw yield were found to be significant as revealed by pooled mean of the data (Table 5a and 5b). The short duration hybrid Sahyadri-4 sown during 23rd MW recorded significantly higher grain yield as compared to rest of the treatment combinations except the same genotype sown during 24th MW and medium duration Jaya sown during 23rd MW, which were at par with the former treatment combination. On the other hand, significantly highest straw yield was recorded in medium duration variety Karjat-5 sown during 23rd MW but it remained at par with the same variety when sown during 24th MW. Ramana *et al.* (2007), Padhi (1995) and Singh and Paliwal (1980) reported higher rice straw yield in most of the genotypes when sown early sowing in the month of June.

In *Konkan* region of India, rice crop should be sown during 23rd MW to obtain higher grain, straw yield and better utilization of nutrients. Rice hybrid Sahyadri-4 and cv. Jaya performed better in terms of grain and straw yields, and uptake of major nutrients. Thus, it can be concluded that hybrid Sahyadri-4 or conventional variety Jaya should be sown during 23rd meteorological week (4th - 10th June) for obtaining higher yields in *Konkan* region of India.

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