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Effect of sowing times on yield and economics of different rice genotypes under climatic condition of Konkan

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Abstract
A field experiment was conducted to assess the effect of sowing time on yield and economics of different rice varieties under climatic condition of Konkan on lateritic soil having low to moderate soil fertility status during *Kharif*, 2013 and 2014. The experiment was laid out in split plot design with three main plot viz., sowing times and nine sub plot treatments viz., varieties. Thus, there were 27 treatment combinations, replicated three times. The pooled mean of data showed that the significantly higher grain yield was recorded by short duration hybrid Sahyadri-4 sown during 23rd meteorological week followed by same hybrid sown during 24th meteorological week and medium duration variety Jaya sown during 23rd meteorological week. However, in case of straw yield in the pooled data, the significantly higher value was recorded by medium duration variety Karjat-5 sown during 23rd meteorological week followed by same variety sown during 24th meteorological week. In respect of economics of treatment combinations, the highest net returns and B:C ratio were obtained when rice crop was sown during 23rd meteorological week with short duration hybrid Sahyadri-4 which was closely followed by the medium duration variety Jaya sown during 23rd meteorological week.

Keywords: climatic condition, economics, rice genotypes, 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 is intensively grown in 88 countries across the world on an area about 160.01 million hectares with annual production of 465.48 million tonnes [1]. More than 90 per cent of the world's rice is produced and consumed in Asia where it is an integral part of culture and tradition. Rice, it is believed, is associated with wet, humid climate, though it is not a tropical plant. It is probably a descendent of wild grass that was most likely cultivated in the foothills of the far Eastern Himalayas.

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. 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 per hectare yield of 2.76 tonnes [1]. In *Konkan* region of Maharashtra about 80 per cent of rice crop is a low land, spreading over a 40-60 km in width and stretching to a length of 700 km all along the west-coast. But the yields are highly variable due to aberration in weather like late onset of monsoon, heavy continuous rains, intermittent dry spell and heavy rains at the time of harvesting, etc.

Time of sowing is the most important factor in influencing the crop yield. 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 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.

Varieties play a unique role in maximizing yield by improving the input- use efficiency as the genetic potential of variety limits the expression of its yield and affects plant growth in response to environment condition. 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.

Of late, many promising varieties have been evolved for midland and lowland ecosystems, making it essential to investigate effect of sowing times on yield and economics of different rice genotypes under climatic condition of Konkan.

Materials and Methods

The experiment was conducted during *Kharif* 2013 and 2014 at Agronomy farm, College of Agriculture, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Distt. - Ratnagiri, Maharashtra. 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 meteorological week (11th June to 17th June) and 25th meteorological week (18th June to 24th June) and sub plot treatments consisting nine different duration varieties. *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 soil was lateritic, clay loam in texture, 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 rice varieties were sown according to sowing times and transplanted at 21 DAS at spacing of 20 cm x 15 cm. In nutrient management, urea was applied as source of nitrogen, Single Super Phosphate (SSP) for phosphorus, while Murate of Postash (MOP) for potassium. All these treatments were imposed as per the schedule and statistical data of these variables obtained during the course of investigation were analyzed by analysis of variance method as per the procedure (Split plot design) described by [3& 4].

Results and Discussion

Effect of Sowing times

Data insulate in Table 1 indicated that, 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 during both the years and pooled. 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 (Pooled data). The increased yield might be due to result of optimum growth and development parameters and yield contributes associated with 23rd meteorological week of sowing followed by 24th meteorological week treatment, which associated with favourable weather condition responsible for more growth and development of crop. These results are in the conformity with the work done by [5 & 6].

Table 1: Mean yield of grain (q ha^{-1}) and straw (q ha^{-1}) 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.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 1.1: 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								

Table 1.2: 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								

However, higher straw yield was recorded by the sowing during 23rd meteorological week and was at par with the 24th meteorological week of sowing but both found to be significantly superior over the 25th meteorological week of 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 (Pooled data). 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 in the 23rd meteorological week sowing. Similar findings were also reported by [5]. 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 [7].

Sowing of rice during 23rd meteorological week gave the highest gross returns (Rs. 79,370 ha^{-1}, Rs. 81,882 ha^{-1} and Rs. 80,626 ha^{-1}), net returns (Rs. 13,780 ha^{-1}, Rs. 14,886 ha^{-1} and Rs. 14,333 ha^{-1}) and benefit to cost ratio (1.21, 1.22 and 1.22) followed by 24th and 25th meteorological week sowing during year 2013, 2014 and in pooled mean, respectively (Table 4). Among all these sowing times 23rd meteorological week sowing was found to be economically most profitable as its mean B:C ratio was 1.22. The B:C ratios recorded under 24th and 25th meteorological week were 1.13 and 1.04, respectively. The increased gross returns, net returns and benefit to cost ratio due to sowing during 23rd meteorological week were mainly due to increased grain and straw yield under 23rd meteorological week over rest of the sowing times. Similar findings were also reported by [8 & 9].

Effect of Varieties

Data indicated in Table 1 showed that 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 [10, 11 & 12]. 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 [7].

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 (Table 1). 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. [13, 14 & 15] reported that the medium duration varieties produced more straw yield as compared to the short and long duration varieties.

Among varieties tested, the short duration hybrid Sahyadri-4 accrued maximum gross returns (Rs. 82398 ha^{-1}, Rs. 87998 ha^{-1} and Rs. 85198 ha^{-1}), net returns (Rs. 15237 ha^{-1}, Rs.19067 ha^{-1} and Rs. 17152 ha^{-1}) and benefit: cost ratio (1.23, 1.28 and 1.26) followed by the medium duration variety Jaya with gross income of Rs. 79229 ha^{-1}, Rs. 85971 ha^{-1} and Rs. 85198ha^{-1}, net income of Rs. 13832 ha^{-1}, Rs. 18642 ha^{-1} and Rs. 16237 ha^{-1} and benefit: cost ratio of 1.21, 1.28 and 1.25 during the year 2013, 2014 and in the mean (Table 2). These increased economic values were due to the significant improvement in the grain and straw yield in their varieties. These results are in conformity with that of [16], they reported that higher gross and net returns and more benefit: cost ratio were recorded through the cultivation of hybrid rice Pro-Agro 6201 followed by the high yielding variety Saket-4. Similarly, [17] reported that the hybrids proved more remunerative than high yielding varieties with respect to economics.

Table 2: Economics of the rice cultivation as affected by different treatments

Sym.	Sowing Dates	Gross Returns (Rs. ha^{-1})			Cost of cultivation (Rs. ha^{-1}) (input cost)			Net Returns (Rs. ha^{-1})			B: C Ratio		
		2013	2014	mean	2013	2014	mean	2013	2014	mean	2013	2014	mean
Sowing time													
S_1	23rd Met. week (4th to 10th June)	79370	81882	80626	65590	66995	66293	13780	14886	14333	1.21	1.22	1.22
S_2	24th Met. week (11th to 17th June)	73019	75816	74418	65185	66671	65928	7834	9144	8489	1.12	1.14	1.13
S_3	25th Met. week (18th to 24th June)	64196	70190	67193	63565	65375	64470	631	4815	2723	1.01	1.07	1.04
Varieties													
V_1	Karjat – 5	69140	70101	69621	63939	65061	64500	5201	5040	5121	1.08	1.08	1.08
V_2	Karjat – 7	74254	77622	75938	65015	66461	65738	9239	11161	10200	1.14	1.17	1.16
V_3	Ratnagiri – 24	62436	59168	60802	63719	64475	64097	-1283	-5308	-3296	0.98	0.92	0.95
V_4	Karjat – 2	73919	76491	75205	64853	66299	65576	9066	10192	9629	1.14	1.15	1.15
V_5	Palghar – 1	69083	69786	69435	64367	65651	65009	4716	4135	4426	1.07	1.06	1.07
V_6	Karjat – 3	70070	73094	71582	64425	65871	65148	5645	7223	6434	1.09	1.11	1.10
V_7	Swarna	69227	83431	76329	64143	67047	65595	5084	16384	10734	1.08	1.24	1.16
V_8	Sahyadri -4	82398	87998	85198	67161	68931	68046	15237	19067	17152	1.23	1.28	1.26
V_9	Jaya	79229	85971	82600	65397	67329	66363	13832	18642	16237	1.21	1.28	1.25

Table 3: Economics of the rice cultivation as affected by different treatment combinations.

Treatments	Gross Returns (Rs. ha^{-1})			Cost of cultivation (Rs. ha^{-1})			Net Returns (Rs. ha^{-1})			B: C Ratio		
	2013	2014	mean	2013	2014	mean	2013	2014	mean	2013	2014	mean
S_1V_1	72372	82589	77481	64749	65709	65229	7623	16880	12252	1.12	1.26	1.19
S_1V_2	80142	85002	82572	65825	67109	66467	14317	17893	16105	1.22	1.27	1.25
S_1V_3	69211	63016	66114	64529	65123	64826	4682	-2108	1287	1.07	0.97	1.02
S_1V_4	78156	77495	77826	65663	66947	66305	12493	10548	11521	1.19	1.16	1.18
S_1V_5	79947	74518	77233	65177	66299	65738	14770	8219	11495	1.23	1.12	1.18
S_1V_6	78373	76953	77663	65235	66519	65877	13138	10434	11786	1.20	1.16	1.18
S_1V_7	77831	94437	86134	64953	67695	66324	12878	26742	19810	1.20	1.40	1.30
S_1V_8	90447	93366	91907	67971	69579	68775	22476	23787	23132	1.33	1.34	1.34
S_1V_9	87854	89558	88706	66207	67977	67092	21647	21581	21614	1.33	1.32	1.33
S_2V_1	70265	69118	69692	64344	65385	64865	5921	3733	4827	1.09	1.06	1.08
S_2V_2	79342	77466	78404	65420	66785	66103	13922	10681	12302	1.21	1.16	1.19
S_2V_3	64141	60762	62452	64124	64799	64462	17	-4038	-2011	1.00	0.94	0.97
S_2V_4	72699	77209	74954	65258	66623	65941	7441	10586	9014	1.11	1.16	1.14
S_2V_5	67338	69715	68527	64772	65975	65374	2566	3740	3153	1.04	1.06	1.05
S_2V_6	67584	72913	70249	64830	66195	65513	2754	6718	4736	1.04	1.10	1.07
S_2V_7	65722	80213	72968	64548	67371	65960	1174	12842	7008	1.02	1.19	1.11
S_2V_8	86617	90299	88458	67566	69255	68411	19051	21044	20048	1.28	1.30	1.29
S_2V_9	83465	84646	84056	65802	67653	66728	17663	16993	17328	1.27	1.25	1.26
S_3V_1	64784	58596	61690	62724	64089	63407	2060	-5493	-1717	1.03	0.91	0.97
S_3V_2	63277	70399	66838	63800	65489	64645	-523	4910	2194	0.99	1.07	1.03
S_3V_3	53957	53726	53842	62504	63503	63004	-8547	-9777	-9162	0.86	0.85	0.86
S_3V_4	70904	74769	72837	63638	65327	64483	7266	9442	8354	1.11	1.14	1.13
S_3V_5	59963	65124	62544	63152	64679	63916	-3189	445	-1372	0.95	1.01	0.98
S_3V_6	64251	69417	66834	63210	64899	64055	1041	4518	2780	1.02	1.07	1.05
S_3V_7	64128	75644	69886	62928	66075	64502	1200	9569	5385	1.02	1.14	1.08
S_3V_8	70131	80330	75231	65946	67959	66953	4185	12371	8278	1.06	1.18	1.12
S_3V_9	66368	83708	75038	64182	66357	65270	2186	17351	9769	1.03	1.26	1.15

Interaction Effects

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 (Table 1.1 and 1.2). 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 par 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 [18, 19 & 20] reported that the higher yield was produced due to the early sowing in the month of June by most of the varieties.

Economic analysis of Rice production

On the basis of economic analysis (Table 3), it is seen that the highest net returns and B:C ratio were obtained when the rice crop was sown during 23rd meteorological week with short duration hybrid Sahyadri-4 which was closely followed by the medium duration variety Jaya sown during 23rd meteorological week. Thus, these results clearly showed that

with respect to economics sowing during 23rd meteorological week with either short duration hybrid Sahyadri-4 or medium duration conventional variety Jaya were profitable by means of net returns and B:C ratio.

Conclusion

From the present results of study, it can be concluded that in *Konkan* region, rice crop be sown during 23rd meteorological week to obtain higher grain and straw yield, net returns and B: C ratio. Similarly, rice hybrid Sahyadri-4 and variety Jaya be grown for obtaining higher grain and straw yield, net returns and benefit: cost ratio. Thus, it can be concluded that *Kharif* rice in *Konkan* be sown during 23rd meteorological week with hybrid Sahyadri-4 or conventional variety Jaya, so as to obtained higher yield and economic returns.

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