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Assessment of Sodicity Tolerance in Rice (*Oryza sativa* L.) Germplasm

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Abstract

The experiment on 113 genotypes (aromatic and non-aromatic rice) including three checks *viz.,* Sarjoo 52, FL 478, and CSR 10 of rice (*Oryza sativa* L.) was conducted to work out the identification of elite genotypes based on grain yield and their various yield attributing traits. The grain yield per plant ranged from 8.898g for NDRK 50047 to 24.658g in the case of IR 13 T 141 with a general mean of 16.464g. Out of 113 genotypes, thirty-six genotypes produced significantly higher grain yield per plant than the general mean. The best ten genotypes for higher grain yield per plant were IR 13 T 141, IR 11 T 230, IR 13 T 145, IR 12 T 147, IR 11 T 171, IR 11 T 132, IR 11 T 205, IR 12 T 193, AT 401, and CSR 43. Similarly, the genotypes showed that very high mean performance in the desired direction for various characters; may also be used as donors for improving the characters for which they had high mean performance in yield and yield contributing traits. The availability of large genetic variability, as well as the nature of heritability and gene actions, are all important factors in the success of selection in improving plant traits. The basic material for a plant breeding programme is genetic diversity, which is used to generate superior genotypes through selection.

Keywords: Rice, *Oryza sativa,* Elite genotypes, Grain yield, Yield components Salt tolerance

Introduction

Rice (*Oryza sativa* L.) has chromosome number 2n = 24 (n=12) and basic chromosome number x=5 and is a member of the Gramineae (Poaceae) family. Rice belongs to the genus *Oryza*, and there are approximately 24 kinds found in tropical, sub-tropical, and warm temperate regions around the world. The *Oryza sativa* and *Oryza glaberrima* are the two most often cultivated species. The *Oryza sativa* plant is classified into three subspecies: *Indica, Japonica,* and *Javanica*.

Rice (*Oryza sativa* L.) is the most important staple food crop in the world. Asia is the leader in rice production accounting for about 90% of the world's production. India has the world's largest rice-growing area (43.78 million hectares), accounting for 28.26% of all rice-growing land, and ranks second in overall production (118.40 million tonnes) after China, with an average yield of 2705 kg/hectare (Anonymous, 2019-20). Asia covers around 140.036 million hectares and produces 5.32 tonnes per hectare (Anonymous, 2017-18). More than 80% of our population eats rice as their major meal and staple diet, either entirely or partially. Uttar Pradesh is a major rice-growing state in India. Rice is grown on 6.45 million hectares and produces 18.251 million tonnes in Uttar Pradesh (UP), with an yield of 4.95 tonnes per hectare (Uttar Pradesh Directorate of Agricultural Ministry, 2017-18). Agriculture is the most important occupation in UP because around 80% of the population lives in rural areas and 75% of the total workforce is engaged in cultivation/farming, which accounts for 27% of the state's GDP. Families in the state rely on agriculture as their primary source of income.

Although India's average rice productivity is substantially lower than the global average, the development of high yielding, broadly adapted pure-line rice varieties, combined with advances in production technology, has enabled to meet the demand for rice to a satisfactory level over the last

four decades. However, fast-rising demand, owing to India's ever-growing population, has compelled us to look for another quantum leap in rice yield. To solve this challenge, the creation of improved high-yielding pure line and hybrid rice varieties appropriate for harsh conditions (salt-affected soil) will be a key strategy. Inland salinity areas in UP are primarily found in the districts of Raibareilly, Azamgarh, Sultanpur, Faizabad, Lucknow, Unnao, and Pratapgarh.

Aromatic rice is a small but unique sub-group of rice that is prized for its superior quality. Aromatic rice has been grown for generations in the traditional territories of the Indian subcontinent's northwestern regions. Aromatic rice emits a specific aroma in the field at the time of flowering, harvesting, in storage, milling, cooking, and eating (Efferson, 1985). Aroma development is influenced by both genetic factors and environmental factors. Mostly, a single recessive gene has been reported to control aroma, but there are also reports of a dominant gene, and multiple factors/polygenes, controlling aroma (Singh *et al*., 2000). Aroma is due to certain chemicals present in the endosperm and such chemicals are also found in the vegetative parts, which emit aroma in the standing crop in some cases even at early stages of growth. The biochemical basis of aroma was identified as the compound 2-acetyl-1-pyroline. The compound is known to be present in raw grain as well as in plants. There are 100 more volatile molecules associated with the fragrance development in rice, including hydrocarbons, acids, alcohols, aldehydes, ketones, esters, phenols, and other substances, in addition to 2-acetyl-1-pyroline. (Singh *et al*., 2005).

Germplasm is the most useful natural resource for creating successful variations since it possesses all the necessary characteristics. (Hawkes, 1981). Breeders can recombine favourable phenotypes of diverse qualities to generate superior genotypes capable of providing high and steady yields due to the availability of acceptable variability in germplasm collections. With the use of genetic parameters like coefficients of variation, heritability, and genetic progress, the existing variability in a population can be partitioned into heritable and non-heritable components to serve as a basis for selecting some outstanding genotypes over existing ones.

Although yield is a complicated character that appears through multiplicative interactions of other characters known as yield components, identifying factors responsible for high yields has proven difficult (Grafius, 1959).

The soil sodicity is a major factor that adversely affects the growth and yield of crop plant. Approximately one-third of the land area on which rice is grown is affected by salinity. Approximately 10% of the world's total land area (950 million ha), 20% of the world's arable land (300 million ha) and 50% of the total irrigated land (230 million ha) are affected by soil salinization. Further, it is expected to influence 50% of total cultivated land in 2050 at a dis-quieting rate. Every year almost 12 billion US$ are globally lost due to salt stress that significantly affects the agricultural production (Shrivastav *et al*., 2022).

The number of salt-affected areas is growing every day because of excessive irrigation water use combined with poor drainage and irrigation water of poor quality. The only way to boost productivity is to develop cultivars for sodic soil. As a result, adapting high-yielding rice varieties to a variety of stress environments, such as sodic and salt-affected soil, would be a significant technique for addressing this problem.

The rice breeding scenario has progressed in recent years. Few important achievements have been addressed in this area. Changes in climatic circumstances, in addition to biotic and abiotic challenges, pose a serious danger to rice production sustainability, making it challenging for rice molecular breeders to improve production and productivity under these stress conditions.

Materials and Methods

The study's goal was to determine the status of elite genotypes based on grain yield and various yield attributing traits among 113 genotypes (aromatic and non-aromatic rice) in a field experiment at the A.N.D. University of Agriculture and Technology's Main Experimental Station in Narendra Nagar (Kumarganj), Ayodhya, India, during the *Kharif* of 2018 under natural sodic soil with the pH, EC and ESP were 9.5, 3.2 dSm-1 and 45%, respectively. Geographically, experimental site is located between

24° 47¢ and 26° 56¢N latitude, 82° 12¢ and 83° 98¢E longitude and at an altitude of 113 m above mean sea level. This area falls in sub-tropical climatic zone. The study's experimental materials are 113 genotypes that included three check varieties: Sarjoo 52, FL 478, and CSR 10. The experiment was designed with an augmented design. Days to 50% flowering, chlorophyll content, leaf nitrogen, leaf temperature, flag leaf area (cm), plant height (cm), panicle bearing tillers per plant, panicle length (cm), spikelets per panicle, grains per panicle, spikelet fertility (percent), biological yield per plant (g), harvest-index (percent), 1000-grain weight (g), and grain yield per plant were among the sixteen grain yield traits observed. Federer's (1956) analysis of variance for Augmented Design.

Results and Discussion

The results of an analysis of variance for augmented design for sixteen characters to see if there were any significant changes between the various treatments (checks) are provided. With the exception of chlorophyll content and panicle bearing tiller per plant, mean squares due to checks were extremely significant for all fourteen characters, whereas mean sum of squares due to blocks were highly significant for all fifteen characters except panicle bearing tiller per plant. Only for panicle bearing tillers per plant did the mean squares due to blocks exhibit significance as presented in **Table 1**.

Table 1. Analysis of variance of augmented design for 16 characters in rice genotypes

S. No.	Characters	Sources of variation		
		Blocks	Checks	Error
	Degree of freedom	10	2	20
1	Days to 50% lowering	87.60012**	717.07638**	0.31352
2	Chlorophyll content	7.70623**	0.02150	0.10558
3	Leaf nitrogen	0.03307**	0.03496**	0.00065
4	Leaf temperature	7.79106**	3.28954**	0.39504
5	Flag leaf area (cm^2)	177.50943**	1198.80388**	3.84368
6	. Plant height (cm)	227.34473**	374.80927**	49.17389
7	Panicle bearing tillers/plant	3.03571*	3.08501	0.95376
8	Panicle length (cm)	30.52569**	41.93319**	0.10494
9	Spikelets/panicle	6793.52427**	6131.31184**	3.14637
10	Grains/panicle	5226.46163**	8570.66888**	3.77866
11	Spikelet fertility (%)	27.26834**	321.56878**	0.80395
12	Biological yield/plant (g)	375.23544**	532.99278**	0.54627
13	Harvest index (%)	27.42357**	75.34074**	0.66473
14	L/B ratio	0.29320**	2.15928**	0.03811
15	1000- grain weight (g)	2.95271**	44.24653**	0.02777
16	Grain yield/plant (g)	46.88795**	38.77322**	0.14937

*, ** Significant at 5% and 1% probability levels, respectively.

The mean performance of 113 diverse rice genotypes including 3 checks (Sarjoo 52, FL 478, and CSR 10) for 16 characters is presented in **Table 2** and the most desirable lines for different characters are listed in **Table 3**. A very wide range of variation in the mean performance of genotypes was observed for all the sixteen characters under study. The comparison of the mean performance of 113 genotypes for sixteen traits using the least significant differences revealed the existence of a very high level of variability in the germplasm collections evaluated in the present study.

Table 2. Mean, range, coefficient of variation (CV) and least significant differences (LSD) for 16 characters in rice

S. No	Genotypes	Days to 50% flowering	Chlorophyll content	Leaf Nitrogen	Leaf temperature	Flag leaf area (cm^2)	Plant height (cm)	Panicle bearing tillers/ plant	Panicle length (cm)	Spikelets/ panicle	Grains/ panicle	Spikelet fertility (%)	Biological yield/ plant (g)	Harvest index (%)	L/B ratio	1000 grain weight (g)	Grain yield/ plant (g)
1	Jallahri	117.219	7.022	0.444	37.944	39.095	92.600	8.993	24.372	139.018	104.069	75.064	32.445	37.021	2.447	23.178	12.092
2	Kalanamak	116.219	7.772	0.494	33.754	37.165	99.030	8.263	25.732	157.118	115.609	73.696	41.065	34.240	2.587	21.978	14.352
3	CSR-27	96.219	11.192	0.414	34.944	30.855	83.400	7.393	24.932	103.248	88.599	86.184	47.085	37.405	2.787	19.878	18.092
4	Improved PB-1	111.219	7.692	0.444	38.214	31.145	93.990	7.023	25.722	116.938	93.669	80.413	45.655	29.298	2.497	14.678	13.752
5	NUD-2008	102.219	8.472	0.464	34.384	30.965	93.230	7.563	22.762	105.928	100.069	94.716	41.875	33.398	2.227	21.778	14.292
6	NUD-2009	95.219	10.202	0.564	37.754	29.845	85.060	7.963	24.802	133.228	85.499	64.514	52.045	33.792	2.597	23.278	18.172
7	CSR-23	98.219	7.782	0.474	36.404	40.815	87.190	9.263	22.362	142.528	118.379	83.169	38.655	38.524	2.997	19.778	15.152
8	CSR-30	108.219	10.172	0.584	38.074	43.965	80.440	7.373	24.012	156.048	119.069	76.401	46.605	36.208	2.817	24.078	17.332
9	CSR-36	105.219	10.182	0.564	34.104	29.045	97.200	8.063	24.972	168.898	123.589	73.237	39.675	39.239	3.057	26.878	15.862
10	Jaya	101.219	12.472	0.514	37.454	28.785	88.200	10.183	23.112	160.518	129.339	80.621	53.075	35.228	2.997	15.278	19.322
11	NDRK 5062	104.349	13.262	0.654	36.914	30.368	103.597	10.409	26.615	197.951	159.875	80.801	44.138	40.866	3.037	22.328	17.955
12	NDRK 5099	99.349	12.912	0.704	34.354	33.538	104.047	9.819	26.365	194.711	169.655	87.215	46.248	42.642	3.217	25.148	19.605
13	NDR 2064	95.349	13.412	0.794	35.574	33.908	103.567	9.509	27.045	191.161	173.545	90.896	44.238	40.026	3.157	22.758	17.635
14	NDRK 5038	94.349	12.762	0.784	36.284	33.668	102.567	9.169	25.725	180.181	166.755	92.678	45.548	37.387	3.077	30.358	16.985
15	NDRK 5047	104.349	12.202	0.714	34.744	35.758	104.594	9.919	26.725	209.711	190.925	91.150	44.488	41.303	2.657	28.938	18.285
16	NDRK 5042	105.349	13.652	0.604	35.024	35.398	102.687	10.269	25.645	242.401	197.025	81.323	39.658	41.723	2.557	24.808	16.475
17	CSR 28	109.349	12.812	0.594	38.244	46.698	104.047	10.439	28.665	191.901	161.655	84.300	50.048	40.792	2.777	23.928	20.305
18	Pusa Basmati 1	99.349	13.552	0.644	36.544	32.668	109.377	8.089	29.275	198.881	161.725	81.358	41.728	36.197	3.257	17.278	15.095
19	NDRK 5026	98.349	15.252	0.724	37.774	32.768	119.707	7.829	28.385	172.411	129.465	75.077	44.158	35.433	3.137	25.598	15.635
20	FL 449	92.349	13.792	0.744	34.044	33.798	105.557	5.909	22.215	170.611	149.525	87.733	49.598	30.027	3.537	24.738	14.925
21	SambhaMahsuri	109.755	13.049	0.568	36.537	30.745	71.520	5.409	21.878	182.318	151.099	82.707	47.152	41.781	3.257	21.341	19.738
22	PNR 381	92.755	12.529	0.518	36.077	22.315	103.170	5.489	22.308	181.258	148.769	81.923	44.132	40.952	2.697	24.881	18.068
23	IR11T265	83.755	13.459	0.578	32.427	24.485	96.590	7.579	23.218	179.438	145.729	81.082	40.492	40.183	2.477	23.871	16.218
24	IR11T159	90.755	12.829	0.628	34.727	25.235	102.610	8.129	24.838	169.518	141.539	83.364	42.932	42.840	2.357	25.321	18.408
25	IR11T255	86.755	12.649	0.718	28.827	23.335	95.570	6.909	24.108	170.568	145.729	85.268	42.602	41.632	2.787	23.671	17.728
26	CSR 28	92.755	13.729	0.708	36.397	32.355	104.760	7.429	24.228	152.848	138.829	90.630	45.972	33.066	2.717	26.801	15.078
27	NDRK 50031	91.755	11.429	0.588	32.427	22.595	100.900	6.519	24.078	170.218	136.799	80.287	45.172	38.829	2.197	24.321	17.508
28	NarendraUsar 3	96.755	12.799	0.638	32.427	22.495	104.080	7.369	23.938	166.258	135.439	81.382	45.862	38.525	2.397	23.351	17.638
29	NDR 510	85.755	12.099	0.568	35.777	23.595	117.900	8.619	23.068	105.338	87.719	83.567	40.262	38.383	3.287	20.871	15.368
30	USAR 1	92.755	13.299	0.528	34.427	20.185	125.760	8.249	22.518	130.188	109.679	84.307	35.642	40.356	3.197	21.781	14.288
31	NDRK 50005	96.275	13.502	0.624	35.610	30.781	98.010	7.939	21.755	151.391	136.629	90.081	58.682	34.923	2.803	25.681	20.488

S. No	Genotypes	Days to 50% flowering	Chlorophyll content	Leaf Nitrogen	Leaf temperature	Flag leaf area (cm^2)	Plant height (cm)	Panicle bearing tillers/ plant	Panicle length (cm)	Spikelets/ panicle	Grains/ panicle	Spikelet fertility (%)	Biological yield/ plant (g)	Harvest index (%)	L/B ratio	1000 grain weight (g)	Grain yield/ plant (g)
32	IR 45427-2B-2-2B-1-1	93.275	15.152	0.564	33.050	18.341	63.830	6.199	18.835	125.821	100.609	79.864	43.022	36.985	2.523	19.991	15.818
33	NDRK 50039	102.275	12.202	0.664	34.980	21.001	87.110	7.499	19.465	110.351	88.639	80.198	38.032	38.063	3.193	24.051	14.358
34	NDRK 50052	98.275	13.122	0.604	33.440	22.171	90.400	8.529	24.015	141.431	111.499	78.768	33.162	40.194	2.733	21.661	13.198
35	NDRK 50045	96.275	12.332	0.574	33.720	19.881	87.300	7.609	20.235	119.741	84.799	70.822	37.512	39.418	3.723	21.011	14.678
36	Narendra User 2	94.275	14.202	0.524	33.980	23.451	106.110	8.919	26.045	155.431	139.509	89.599	58.682	29.255	3.523	22.921	17.108
37	IR 12 T 193	100.275	13.642	0.594	34.030	20.481	107.370	7.399	24.805	164.821	136.229	82.570	57.492	39.463	3.543	19.201	22.718
38	IR 13 T 141	102.275	14.362	0.574	36.940	21.241	96.500	10.639	25.985	163.811	135.529	82.651	60.822	40.439	3.503	18.541	24.658
39	NDR 359	101.275	13.192	0.674	35.300	21.471	101.670	10.699	27.245	184.251	145.999	79.200	61.732	34.227	3.133	26.271	21.138
40	IR 74095 AC 5	96.275	13.062	0.704	35.410	34.241	80.910	8.359	29.565	144.001	119.899	83.152	54.592	36.627	2.763	25.261	19.978
41	Deepak	106.319	16.262	0.648	37.750	20.928	89.210	10.899	27.528	137.278	113.585	82.687	56.978	37.270	2.880	24.484	21.058
42	Narendra 6093	101.319	14.052	0.728	37.090	33.198	100.000	10.389	29.638	150.288	116.185	77.242	63.948	31.568	2.830	24.844	20.028
43	IR 12 T 195	100.319	14.512	0.678	36.160	45.728	99.310	12.699	29.658	150.848	124.275	82.392	57.488	33.389	2.890	23.754	19.108
44	PusaSugandha 4	105.319	15.722	0.678	36.610	25.918	90.310	9.359	28.918	146.518	126.175	86.158	46.918	38.541	3.160	22.374	18.058
45	Pusa 1121	100.319	13.482	0.698	35.880	24.458	95.280	10.569	29.148	155.918	132.155	84.822	55.738	38.153	2.780	21.554	21.088
46	Sugandha 3	103.319	13.292	0.668	37.710	23.478	89.740	8.659	26.338	149.078	130.185	87.397	39.078	44.123	2.840	22.904	17.218
47	Moti Gold	105.319	14.352	0.708	36.510	22.858	88.200	12.689	26.388	210.638	186.675	88.887	58.718	35.299	2.700	21.184	20.568
48	NDRK 5070	89.319	14.852	0.358	37.410	25.058	100.230	10.169	23.758	180.818	154.435	85.565	41.058	44.859	3.370	22.554	18.338
49	NDRK 5049	87.319	14.922	0.468	37.300	17.558	119.990	8.869	24.048	123.468	106.705	86.350	40.248	40.684	2.900	22.834	16.418
50	NDRK 5027	97.319	14.782	0.408	37.520	27.058	114.300	10.839	23.648	158.118	124.375	78.649	38.078	50.162	3.220	23.544	18.938
51	NDRK 50035	90.292	12.852	0.404	32.144	15.781	89.430	5.646	21.125	79.181	65.222	81.711	21.352	42.167	2.797	19.448	8.998
52	NDRK 5092	95.292	10.942	0.484	31.994	17.181	111.540	10.806	21.365	88.471	74.752	83.817	20.822	51.858	3.167	22.288	11.108
53	NDRK 50032	91.292	11.652	0.444	33.374	30.881	95.510	9.276	21.345	135.131	131.532	96.509	49.022	35.045	3.067	23.368	17.148
54	KashturiChandauli	102.292	13.212	0.544	34.474	20.131	85.610	7.316	22.225	148.741	136.912	91.571	52.852	39.941	2.497	23.748	21.268
55	NDRK 50047	96.292	12.282	0.534	30.744	16.571	105.510	6.706	20.215	59.321	47.092	78.624	22.062	40.571	3.307	22.978	8.898
56	NDRK 50036	100.292	11.182	0.504	33.304	19.101	86.520	6.576	20.795	130.511	110.232	84.195	55.572	31.911	3.247	23.698	17.648
57	NDRK 5036	95.292	12.482	0.494	32.144	10.981	94.960	5.846	19.185	80.841	67.312	82.564	25.642	38.431	3.077	20.718	9.758
58	NDRK 50053	100.292	12.362	0.464	35.004	21.121	98.110	7.876	22.395	132.131	119.522	89.920	50.572	41.180	3.307	22.238	21.008
59	IR 12 T 147	98.292	15.632	0.434	34.284	31.881	86.690	8.176	21.585	137.341	103.632	75.640	55.452	42.940	3.407	23.748	24.088
60	NDRK 50028	91.292	11.972	0.464	35.404	13.801	112.210	7.206	19.715	86.751	69.222	79.421	24.052	44.365	3.167	22.428	10.758
61	NDRK 5083	91.359	11.679	0.494	34.577	25.258	95.437	10.756	20.098	68.285	57.332	84.211	27.132	48.277	3.660	23.404	13.128
62	NDRK 5007	89.359	11.939	0.504	33.817	23.148	95.767	7.336	21.598	91.625	66.792	73.492	31.312	43.109	3.240	24.654	13.478
63	NDRK 5014	94.359	12.879	0.564	34.937	14.728	105.447	7.346	19.238	90.885	70.362	77.805	31.322	41.962	2.240	19.234	13.108
64	NDRK 5067	104.359	14.179	0.594	34.917	17.528	99.537	9.166	20.668	66.755	61.982	92.545	24.622	45.551	2.570	22.044	11.198

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65	NDRK 5019	89.359	12.309	0.524	34.927	19.728	119.577	7.926	20.058	96.835	79.872	82.588	37.122	43.056	3.130	23.304	15.988
66	NDRK 50033	92.359	10.889	0.504	33.357	21.038	106.447	7.206	17.138	103.065	82.942	80.631	28.032	43.546	3.160	22.674	12.178
67	NDRK 5017	102.359	13.309	0.544	33.617	33.428	108.737	12.086	22.968	142.285	119.392	83.783	42.142	35.616	2.860	21.724	14.938
68	NDRK 5089	80.359	13.639	0.674	33.667	27.128	110.467	10.166	23.608	93.395	77.052	82.627	37.632	39.252	3.360	22.234	14.728
69	NDRK 50056	86.359	12.909	0.694	33.847	23.728	108.717	9.186	19.628	120.625	99.552	82.519	44.492	40.010	2.660	24.504	17.798
70	NDRK 5011	97.359	13.479	0.664	34.087	17.628	95.447	9.176	19.398	90.775	76.082	83.894	26.442	42.211	2.460	22.944	11.108
71	NDRK 50019	99.172	14.692	0.568	38.907	20.535	106.693	10.316	22.662	99.818	86.775	86.993	29.575	44.531	3.440	23.218	13.125
72	NDRK 5087	86.172	12.062	0.758	37.267	14.135	120.713	7.266	20.262	75.678	65.475	86.463	27.725	42.395	3.580	21.958	11.755
73	CST 7-1	97.172	12.062	0.408	37.377	24.435	119.003	9.856	25.352	80.288	59.995	74.021	29.235	43.190	3.760	22.708	12.605
74	Pokkali (Acc 108921)	105.172	14.102	0.518	37.247	27.735	165.593	6.516	25.272	110.538	93.845	84.902	41.425	37.254	3.080	21.948	15.425
75	IR 86731-1-1-1-3-3-2-1	94.172	13.932	0.458	37.047	19.235	109.473	13.986	20.192	78.008	66.185	84.702	23.555	43.034	3.870	22.718	10.155
76	IR 87856-1AJAY1-B	113.172	13.892	0.468	36.587	22.735	107.593	9.696	20.962	135.558	106.165	78.164	35.905	37.459	3.670	22.058	13.475
77	IR 64527-2B-2-1-1	98.172	12.852	0.548	35.657	20.235	109.803	14.056	21.002	171.198	151.885	88.938	40.125	38.255	3.450	22.638	15.335
78	IR 85920-11-2-1AJAY1-2-B	114.172	13.702	0.508	36.107	16.435	98.683	7.986	20.192	83.558	65.165	77.504	30.725	47.947	3.500	21.928	14.625
79	IR 85921-9-2-1AJAY1-1-B	94.172	13.092	0.608	35.377	20.235	92.973	6.076	19.062	75.968	63.905	83.923	26.295	47.076	3.480	22.568	12.315
80	Kalanamak 3	110.172	15.262	0.598	37.207	32.735	109.713	9.656	26.642	96.178	68.535	70.569	29.945	45.193	3.640	21.518	13.475
81	Sundari	96.205	15.889	0.624	36.884	21.461	94.510	12.953	23.015	95.628	71.102	72.458	28.705	35.684	2.377	23.644	10.665
82	IR 45427-2B-2-2B-1-1	80.205	15.759	0.584	36.844	37.591	109.820	10.433	24.575	86.088	73.932	84.869	35.995	40.373	3.077	22.494	14.695
83	IR 71866-3 R -1-2-1-B	94.205	14.179	0.574	37.744	21.141	103.410	9.793	25.625	128.278	100.682	77.821	39.605	37.862	3.117	21.624	15.145
84	IR 65427-2B-2-2	83.205	15.859	0.544	37.634	20.441	98.740	12.193	23.315	116.048	95.902	82.065	29.705	45.469	2.937	22.714	13.675
85	NDRK 50050	109.205	16.389	0.594	37.854	17.341	97.580	7.753	21.085	116.628	97.082	82.726	29.165	42.910	2.807	22.054	12.755
86	NDRK 50055	105.205	15.049	0.514	36.944	21.141	99.810	8.543	20.835	128.308	95.312	73.311	44.715	41.260	2.817	23.594	18.415
87	NDRK 50057	90.205	14.639	0.544	36.794	23.841	90.710	10.603	23.395	114.258	100.722	88.000	43.265	40.084	2.817	24.234	17.365
88	NDRK 5003	106.205	15.989	0.634	35.544	28.841	117.540	6.783	22.805	183.608	167.052	91.625	40.535	43.253	3.917	22.124	17.535
89	NDRK 5034	96.205	15.549	0.664	39.054	22.841	90.630	9.563	20.535	104.348	91.412	87.229	26.155	41.819	3.187	21.774	11.265
90	IR 86341-B-AJAY1-B	97.205	15.799	0.594	38.104	31.181	104.010	10.533	22.975	97.888	77.712	78.074	36.225	43.067	2.607	24.754	15.695

S. No	Genotypes	Days to 50% flowering	Chlorophyll content	Leaf Nitrogen	Leaf temperature	Flag leaf area (cm^2)	Plant height (cm)	Panicle bearing tillers/ plant	Panicle length (cm)	Spikelets/ panicle	Grains/ panicle	Spikelet fertility (%)	Biological yield/ plant (g)	Harvest index (%)	L/B ratio	1000 grain weight (g)	Grain yield/ plant (g)
91	NDRK 50029	88.892	12.862	0.544	35.237	27.885	138.633	7.643	23.715	93.551	82.232	88.361	39.962	41.896	2.277	23.708	16.678
92	AT 401	98.892	13.312	0.744	38.097	40.195	94.653	7.243	22.985	145.621	120.522	82.850	64.472	33.952	2.977	25.958	21.818
93	NDRK 50044	102.892	14.102	0.684	38.387	28.755	86.323	8.783	24.855	124.341	101.442	81.783	49.622	43.651	2.767	22.778	21.588
94	IR 11 T 183	97.892	14.812	0.634	37.377	28.645	88.193	10.893	23.815	214.911	186.822	86.804	61.692	33.630	3.467	20.098	20.678
95	IR 11 T 171	97.892	14.012	0.764	38.497	29.425	83.933	6.813	19.645	99.661	72.372	73.002	53.382	44.348	3.437	19.208	23.598
96	IR 11 T 230	96.892	14.302	0.714	36.037	37.665	106.753	6.933	24.605	168.541	144.742	85.877	59.652	41.129	2.367	24.958	24.458
97	NDRK 50046	93.892	14.312	0.714	35.277	35.665	101.193	7.373	24.145	154.371	122.632	79.487	40.632	47.399	2.737	24.118	19.188
98	NDRK 50030	95.892	14.312	0.734	36.397	24.995	102.633	7.483	21.065	111.951	92.582	82.984	51.952	33.667	2.797	27.108	17.428
99	NDRK 5095	106.892	15.772	0.704	36.377	21.565	90.213	9.483	18.775	181.711	163.372	89.865	41.762	38.335	3.167	24.488	15.948
100	NDRK 5093	87.892	16.252	0.554	36.387	24.405	122.473	9.173	22.945	112.071	93.362	83.591	28.562	44.247	3.267	22.268	12.578
101	IR 86376-47-3-1-B	93.162	12.586	0.728	34.867	13.575	95.990	10.476	19.795	121.651	100.749	83.040	29.892	42.854	3.237	24.198	12.835
102	IR 55179-3B-11-3	89.162	11.426	0.378	34.137	21.655	101.490	10.366	19.055	76.691	60.219	79.274	25.732	43.964	3.097	23.418	11.355
103	IR 11 T 205	99.162	11.976	0.488	35.967	32.315	95.290	10.416	22.415	161.811	138.329	85.485	63.002	36.840	2.797	22.778	23.095
104	IR 11T 208	94.162	13.296	0.428	34.807	15.945	94.750	9.256	19.725	111.761	91.439	82.119	28.652	41.578	3.037	21.468	11.945
105	IR 11 T 213	91.162	13.896	0.438	34.767	19.455	101.340	10.126	21.045	106.261	88.179	83.339	36.622	32.270	3.527	23.838	11.825
106	IR 12 T 210	88.162	12.376	0.518	35.667	19.525	93.300	9.606	22.865	141.771	106.159	74.966	40.442	34.314	3.127	22.518	13.865
107	IR 13 T 144	92.162	11.346	0.478	35.557	20.825	86.990	10.116	20.885	99.461	80.749	81.611	35.122	39.518	2.797	21.758	13.885
108	IR 13 T 145	96.162	14.406	0.578	35.777	20.725	85.410	10.946	20.655	110.801	97.539	88.348	52.762	46.122	2.627	22.958	24.255
109	IR 11 T 132	99.162	13.976	0.568	34.867	20.725	85.410	10.676	20.505	111.951	98.419	88.220	49.802	47.112	2.597	21.868	23.395
110	CSR 43	97.162	13.826	0.528	37.197	45.465	89.750	10.606	24.045	192.561	164.699	85.418	54.432	39.950	2.427	23.048	21.665
1	Sarjoo 52©	103.524	13.506	0.662	35.929	43.655	92.103	9.215	24.701	177.463	155.197	87.440	48.493	35.975	2.662	25.291	17.465
2	FL 478 ©	88.690	13.537	0.556	35.954	33.935	88.665	9.633	21.867	142.865	111.901	78.328	53.808	30.799	3.161	22.356	16.584
3	CSR 10©	101.633	13.594	0.575	36.888	22.793	80.722	8.581	20.957	132.335	103.028	77.841	62.294	32.714	2.277	21.455	20.185
Mean		97.468	13.202	0.581	35.630	26.121	99.589	8.905	23.184	135.224	112.264	82.695	42.205	39.614	3.026	22.856	16.464
Std. Dev.		7.365	1.811	0.100	1.839	7.708	13.094	1.798	2.811	38.558	34.316	5.514	11.033	4.534	0.486	2.239	3.714
Std. Error		0.693	0.170	0.009	0.173	0.725	1.232	0.169	0.264	3.627	3.228	0.519	1.038	0.427	0.046	0.211	0.349
C. V. %		7.556	13.718	17.268	5.161	29.509	13.148	20.194	12.125	28.514	30.567	6.668	26.142	11.447	16.049	9.797	22.556
Range	Lowest	80.205	7.022	0.358	28.827	10.981	63.830	5.409	17.138	59.321	47.092	64.514	20.822	29.255	2.197	14.678	8.898
	Highest	117.219	16.389	0.794	39.054	46.698	165.593	14.056	29.658	242.401	197.025	96.509	64.472	51.858	5.133	30.358	24.658
LSD_1		0.4980	0.2890	0.0226	0.5590	1.7438	6.2372	0.8686	0.2881	1.5777	1.7290	0.7975	0.6574	0.7252	0.1736	0.1482	0.3438
LSD_2		1.6518	0.9586	0.0751	1.8541	5.7835	20.6865	2.8810	0.9557	5.2327	5.7344	2.6451	2.1803	2.4052	0.5759	0.4916	1.1401
LSD_3		1.9073	1.1068	0.0867	2.1410	6.6782	23.8867	3.3267	1.1035	6.0422	6.6215	3.0542	2.5176	2.7772	0.6650	0.5677	1.3165
LSD_4		1.4086	0.8175	0.0640	1.5812	4.9322	17.6415	2.4569	0.8150	4.4624	4.8903	2.2557	1.8594	2.0511	0.4911	0.4192	0.9723

Table 3. The most desirable genotypes identified for high mean performance for 16 characters under sodic soil

S.No.	Characters	Genotypes
1	Days to 50% flowering	IR 45427-2B-2-2B-1-1 (80.205), NDRK5089 (80.359 days), IR65427-2B-2-2 (83.205 days), IR11T265 (83.775 days), NDRK 510 (85.775 days), NDRK 5087 (86.172 days), NDRK 50056 (86.359 days), IR11T255 (86.775 days), NDRK 5049 (87.319 days) and NDRK 5093 (87.892 days)
2	Chlorophyll content	NDRK 50050 (16.389), Deepak (16.262), NDRK 5093 (16.252), NDRK 5003 (15.989), Sundari (15.889), IR 65427-2B-2-2 (15.859), IR 86341-B-AJAY1-B (15.799), NDRK 5095 (15.772), IR 45427-2B-2-2B-1-1 (15.759) and Pusa Sugandha 4 (15.722).
3	Leaf nitrogen	NDR 2064 (0.794), NDRK 5038 (0.784), IR 11 T 171 (0.764), NDRK 5087 (0.758), AT 401 (0.744), FL 449 (0.744), NDRK 50030 (0.734), IR 86376-47-3-1-B (0.728), Narendra 6093 (0.728) and NDRK 5026 (0.724)
4	Leaf temperature	NDRK 5034 (39.054), NDRK 50019 (38.907), IR 11 T 171 (38.497), NDRK 50044 (38.387), CSR 28 (38.244), Improved PB-1 (38.214), IR 86341-B-AJAY1-B (38.104), AT 401 (38.097), CSR-30 (38.074) and Jallahri (37.944)
5	Flag leaf area (cm^2)	CSR 28 (46.698 cm^2), IR 12 T 195 (45.728 cm^2), CSR 43 (45.465 cm^2), CSR-30 (43.965 cm^2), CSR-23 (40.815 cm^2), AT 401 (40.195 cm^2), Jallahri (39.095 cm^2), IR 11 T 230 (37.665 cm^2), IR 45427-2B-2-2B-1-1 (37.591 cm^2) and Kalanamak (37.165 cm^2)
6	Plant height (cm)	IR 45427-2B-2-2B-1-1 (63.830 cm), Sambha Mahsuri (71.52 cm), CSR-30 (80.44 cm), IR 74095 AC 5 (80.91 cm), CSR-27 (83.4 cm), IR 11 T 171 (83.933 cm), NUD-2009 (85.06 cm), IR 13 T 145 (85.41 cm), IR 11 T 132 (85.41 cm) and KashturiChandauli (85.61 cm)
7	Panicle bearing tillers/ plant	IR64527-2B-2-1-1 (14.056), IR86731-1-1-1-3-3-2-1 (13.986), Sundari (12.953), IR12T195 (12.699), Motigold (12.689), IR65427-2B-2-2 (12.193), NDRK 5017 (12.086), IR13T145 (10.946) and Deepak (10.899), IR11T183 (10.893)
8	Panicle length (cm)	IR 12T195 (29.658 cm), Narendra 6093 (29.638 cm), IR74095AC5 (29.565 cm), Pusa Basmati (29.275 cm), Pusa 1121 (29.148 cm), Pusa Sugandha 4 (28.918 cm), CSR 28 (28.665 cm), NDRK 5026 (28.385 cm), Deepak (27.528 cm) and NDRK 359 (27.245 cm)
9	Spikelets/panicle	NDRK 5042 (242.401), IR11T183 (210.629), Motigold (210.638), NDRK 5047 (209.711), Pusa basmati 1 (198.881), NDRK 5062 (197.951), NDRK 5099 (194.711), CSR 43 (192.561), CSR 28 (191.901) and NDRK 2064 (191.161)
10	Grains/panicle	NDRK 5042 (197.025), NDRK 5047 (190.925), Motigold (186.675), NDR 2064 (173.545), NDRK 5099 (169.655), NDRK5003 (167.052), NDRK 5038 (166.755), CSR 43 (164.699), NDRK 5095 (163.372) and CSR 28 (161.655)
11	Spikelet fertility (%)	NDRK 50032 (96.509%), NUD 2008 (94.716%), NDRK 5038 (92.678%), NDRK 5067(92.545%), NDRK 5003 (91.625%), Kashtir-ichandauli (91.571%), NDRK 5047 (91.15%), NDR 2064(90.896%), CSR 28 (90.630%) and NDRK 50005 (90.810%)
12	Biological yield/plant (g)	AT 401 (64.472g), Narendra 6093 (63.948g), IR 11T 205 (63.002g), NDR 359 (61.732g), IR 11T 183 (61.692g), IR 13T141 (60.822g), IR 11T230 (59.652g), Motigold (58.718g) NDRK 50005 (58.682g), and Narendra Usar 2 (58.682g)
13	Harvest index (%)	NDRK 5092 (51.858%), NDRK 5027 (50.162%), NDRK 5083 (48.277%), IR 85920-11-2-1AJAY1-2-B (47.947%), NDRK 50046 (47.399%), IR 11 T 132 (47.112%), IR 85921-9-2-1AJAY1-1-B (47.076%), IR 13 T 145 (46.122%), NDRK 5067 (45.551%) and IR 65427-2B-2-2 (45.469%)
14	L/B ratio	NDR 359 (5.133), NDRK 5038 (5.077), NDRK 5003 (3.917), IR 86731-1-1-1-3-3-2-1 (3.870), CST 7-1 (3.760), NDRK 50045 (3.723), IR 87856-1AJAY1-B (3.670), NDRK 5083 (3.660), Kalanamak 3 (3.640) and NDRK 5087 (3.580)
15	1000-grain weight (g)	NDRK 5038 (30.358g), NDRK 5047 (28.938g), NDRK 50030 (27.108g), CSR-36 (26.878g), CSR 28 (26.801g), NDR 359 (26.271g), AT 401 (25.958g), NDRK 50005 (25.681g), NDRK 5026 (25.598g) and IR11T159 (25.321g)
16	Grain yield/plant (g)	IR 13 T 141 (24.658g), IR 11 T 230 (24.458g), IR 13 T 145 (24.255g), IR 12 T 147 (24.088), IR 11 T 171 (23.598g), IR 11 T 132(23.395g), IR 11 T 205 (23.095g), IR 12 T 193(22.718g), AT 401(21.818g) and CSR 43 (21.665g)

The mean performance of sixteen characters is described character-wise in the following. Days to 50% flowering varied from 80.205 (IR 45427-2B-2-2B-1-1) to 117.219 days (Jallahari) with a general mean of 97.468 days. Out of 110 genotypes, nineteen entries were significantly earlier for days to 50% flowering over the general mean. The best ten genotypes for early flowering were IR 45427-2B-2-2B-1-1 (80.205), NDRK5089 (80.359), IR65427-2B-2-2 (83.205), IR11T265 (83.775), NDRK 510 (85.775), NDRK 5087 (86.172), NDRK 50056 (86.359), IR11T255 (86.775), NDRK 5049 (87.319) and NDRK 5093 (87.892). NDRK5089 was statistically *at par* with the earliest flowering genotype IR 45427-2B-2-2B-1-1. The lowest and highest means for chlorophyll content were recorded for Jallahri (7.022) and NDRK 50050 (16.389), respectively. The general mean for chlorophyll content was 13.202. Thirty-six genotypes showed significantly high chlorophyll content over the general mean and the best ten genotypes among them were NDRK 50050 (16.389), Deepak (16.262), NDRK 5093 (16.252), NDRK 5003 (15.989), Sundari (15.889), IR 65427-2B-2-2 (15.859), IR 86341-B-AJAY1-B (15.799), NDRK 5095 (15.772), IR 45427-2B-2-2B-1-1 (15.759) and Pusa Sugandha 4 (15.722). The lowest and highest means for leaf nitrogen were recorded for NDRK 5070 (0.358) and NDR 2064 (0.794), respectively. The general mean for leaf nitrogen was 0.581. Forty-two genotypes showed significantly higher leaf nitrogen over the general mean and best ten genotypes among them were NDR 2064 (0.794), NDRK 5038 (0.784), IR 11 T 171 (0.764), NDRK 5087 (0.758), AT 401 (0.744), FL 449 (0.744), NDRK 50030 (0.734), IR 86376-47-3-1-B (0.728), Narendra 6093 (0.728) and NDRK 5026 (0.724).

The lowest and highest means for leaf temperature were recorded for IR11T255 (28.827) and NDRK 5034 (39.054), respectively. The general mean for leaf temperature was 35.630. Twenty-nine genotypes showed a significant leaf temperature over the general mean and best ten genotypes among them were NDRK 5034 (39.054), NDRK 50019 (38.907), IR 11 T 171 (38.497), NDRK 50044 (38.387), CSR 28 (38.244), Improved PB-1 (38.214), IR 86341-B-AJAY1-B (38.104), AT 401 (38.097), CSR-30 (38.074) and Jallahri (37.944). The general mean for the flag leaf area was 26.121 cm^2. The lowest and highest mean for flag leaf area were recorded in the case of NDRK 5036 (10.981cm^2) and CSR 28 (46.698 cm^2), respectively. Twenty-eight genotypes possessed significantly greater flag leaf area over the general mean. The best ten genotypes for higher flag leaf area were CSR 28 (46.698 cm^2), IR 12 T 195 (45.728 cm^2), CSR 43 (45.465 cm^2), CSR-30 (43.965 cm^2), CSR-23 (40.815 cm^2), AT 401 (40.195 cm^2), Jallahri (39.095 cm^2), IR 11 T 230 (37.665 cm^2), IR 45427-2B-2-2B-1-1 (37.591 cm^2) and Kalanamak (37.165 cm^2). Plant height ranged from 63.830 cm (IR 45427-2B-2-2B-1-1) to 165.593 cm (Pokkali (Acc 108921)) with a general mean of 99.589 cm. Twenty-nine, out of 110 genotypes had significantly shorter plant stature than the general mean. The best ten genotypes for shorter plant height were IR 45427-2B-2-2B-1-1 (63.830 cm), Samba Mahsuri (71.52 cm), CSR-30 (80.44 cm), IR 74095 AC 5 (80.91 cm), CSR-27 (83.4 cm), IR 11 T 171 (83.933 cm), NUD-2009 (85.06 cm), IR 13 T 145 (85.41 cm), IR 11 T 132 (85.41 cm) and Kashturi Chandauli (85.61 cm). None of these was found statistically *at par* with the shortest genotype, IR 45427-2B-2-2B-1-1 (63.830 cm). The general mean for panicle bearing tillers per plant was 8.905. Panicle-bearing tillers ranged from 5.409 (Samha Mahsuri) to 14.056 (IR64527-2B-2-1-1). Out of 110 entries, thirty-four entries exhibited significantly higher panicle bearing tillers per plant than the general mean. The best ten genotypes for higher mean performance for this character were IR64527-2B-2-1-1 (14.056), IR86731-1-1-1-3-3-2-1 (13.986), Sundari (12.953), IR12T195 (12.699), Motigold (12.689), IR65427-2B-2-2 (12.193), NDRK 5017 (12.086), IR13T145 (10.946) Deepak (10.899) and IR11T183 (10.893). IR64527-2B-2-1-1 constituted the top non-significant group for this trait alone because none of the remaining entries were statistically *at par* with it.

The lowest and highest means for panicle length were recorded for NDRK 50033 (17.138 cm) and IR 12T195 (29.658 cm), respectively. The general mean for panicle length was 23.184 cm. Forty-three genotypes showed significantly longer panicle length

over the general mean and best ten genotypes among them were IR 12T195 (29.658 cm), Narendra 6093 (29.638 cm), IR74095AC5 (29.565 cm), Pusa Basmati (29.275 cm), Pusa 1121 (29.148 cm), Pusa Sugandha 4 (28.918 cm), CSR 28 (28.665 cm), NDRK 5026 (28.385 cm), Deepak 27.528 cm) and NDRK 359 (27.245 cm). Only IR 12T195, constituted the top non-significant group for panicle length. The general mean for spikelets per panicle was 135.224 with the range of 59.321 (NDRK50047) to 242.401 (NDRK 5042). Out of 110 entries, fourty one genotypes exhibited significantly greater number of spikelets per panicle than the general mean. NDRK 5042 (242.401), IR11T183 (210.629), Motigold (210.638), NDRK 5047 (209.711), Pusa Basmati 1 (198.881), NDRK 5062 (197.951), NDRK 5099 (194.711), CSR 43 (192.561), CSR 28 (191.901) and NDRK 2064(191.161) emerged as the best genotypes for higher mean performance for spikelets per panicle. The general mean for spikelets per panicle was 112.264 with the range of 47.92 (NDRK 50047) to 197.025 (NDRK 5042). Out of 110 entries, twenty-three genotypes exhibited significantly greater number of spikelets per panicle than the general mean. NDRK 5042 (197.025), NDRK 5047 (190.925), Motigold (186.675), NDR 2064 (173.545), NDRK 5099 (169.655), NDRK5003 (167.052), NDRK 5038 (166.755), CSR 43 (164.699), NDRK 5095 (163.372) and CSR 28 (161.655) emerged as the best genotypes for higher mean performance for spikelets per panicle. The spikelet fertility (%) varied from 64.514 % (NUD 2009) to 96.509 % (NDRK 50032) with a general mean of 82.695 %. Thirty-four out of 110 genotypes exhibited higher spikelet fertility than the general mean. The best ten genotypes for higher fertility percentage were NDRK 50032 (96.509%), NUD 2008 (94.716%), NDRK 5038 (92.678%), NDRK 5067(92.545%), NDRK 5003 (91.625%), Kashtirichandauli (91.571%), NDRK 5047 (91.15%), NDR 2064(90.896%), CSR 28 (90.630%) and NDRK 50005 (90.810%). NUD 2008, NDRK 5038, NDRK 5067, constituted the top non-significant group for this trait along with NDRK 50032.The general mean for biological yield per plant was 42.205g. The entry NDRK 5092 recorded lowest mean (20.822g) for biological yield whereas, highest mean (64.472g) was observed in case of AT 401.

Out of 110 entries, twenty-six produced significantly higher biomass than the general mean. The best ten genotypes for higher biomass production were AT 401 (64.472g), Narendra 6093 (63.948g), IR 11T 205 (63.002g), NDR 359 (61.732g), IR 11T 183 (61.692g), IR 13T141 (60.822g), IR 11T230 (59.652g), Motigold (58.718g), NDRK 50005 (58.682g), and Narendra Usar 2 (58.682g). The top non-significant group for higher biological yield per plant comprised of four genotypes *viz*., AT 401, Narendra 6093, IR 11T 205 and NDR 359.The lowest and highest means for harvest–index were observed for Narendra Usar 2 (29.255%) and NDRK 5092 (51.858%), respectively. The general mean for harvest–index was 39.614%. Out of 110 genotypes, forty five genotypes exhibited significantly better partitioning of photosynthates than the general mean. The best ten genotypes which also possessed harvest-index statistically *at par* were NDRK 5092 (51.858%), NDRK 5027 (50.162%), NDRK 5083 (48.277%), IR 85920-11-2-1AJAY1-2-B (47.947%), NDRK 50046 (47.399%), IR 11 T 132 (47.112%), IR 85921-9-2-1AJAY1-1-B (47.076%), IR 13 T 145 (46.122%), NDRK 5067 (45.551%) and IR 65427-2B-2-2 (45.469%).The L:B ratio varied from 2.197 (NDRK 50031) to 5.133 (NDR 359) with general mean of 3.026mm. Out of 110 entries, fifty six genotypes exhibited significantly higher L:B ratio than the general mean. The best ten lines were NDR 359 (5.133), NDRK 5038 (5.077), NDRK 5003 (3.917), IR 86731-1-1-1-3-3-2-1 (3.870), CST 7-1 (3.760), NDRK 50045 (3.723), IR 87856-1AJAY1-B (3.670), NDRK 5083 (3.660), Kalanamak 3 (3.640) and NDRK 5087 (3.580). The one genotypes, NDRK 5038 constituted top non- significant group of higher L:B ratio along with NDR 359.The 1000- grain weight ranged from 14.678g in case of Improved PB-1 to 30.358g for NDRK 5038 with a general mean of 22.856g. Out of 110 entries, twenty-eight genotypes had significantly higher 1000–grain weight than the general mean and the best ten genotypes among them were NDRK 5038 (30.358g), NDRK 5047 (28.938g), NDRK 50030 (27.108g), CSR-36 (26.878g), CSR 28 (26.801g), NDR 359 (26.271g), AT 401 (25.958g),

NDRK 50005 (25.681g), NDRK 5026 (25.598g) and IR11T159 (25.321g). The grain yield per plant ranged from 8.898g for NDRK 50047 to 24.658g in case of IR 13 T 141with a general mean of 16.464g. Out of 113 genotypes, thirty-- six genotypes produced significantly higher grain yield per plant than the general mean. The best ten genotypes for higher grain yield per plant were IR 13 T 141 (24.658g), IR 11 T 230 (24.458g), IR 13 T 145 (24.255g), IR 12 T 147 (24.088), IR 11 T 171 (23.598g), IR 11 T 132(23.395g), IR 11 T 205 (23.095g), IR 12 T 193(22.718g), AT 401(21.818g) and CSR 43 (21.665g).

Similarly, the genotypes showing very high mean performance in desirable direction for various characters listed in **Table 4**, which may also be used as donors for improving the characters for which they had high mean performance.

Table 4. The mean performance of high yielding genotypes in aromatic and non-aromatic group in sodic soil for other characters

S. No.	Genotypes	High mean performance of grain yield per plant (g)	High mean performance for other characters
1	IR 13 T 141	24.658	BY/P
2	IR 11 T 230	24.458	FLA, BY/P
3	IR 13 T 145	24.255	PH, PBT/P, HI
4	IR 12 T 147	24.088	-
5	IR 11 T 171	23.598	LN, LT, PH
6	IR 11 T 132	23.395	PH, HI
7	IR 11 T 205	23.095	BY/P
8	IR 12 T 193	22.718	-
9	AT 401	21.818	LN, LT, FLA, BY/P, 1000-GW
10	CSR 43	21.665	FLA, S/P, G/P

DF=Days to 50% flowering, CC=Chlorophyll content (SPAD value), LN= Leaf nitrogen (SPAD value), LT= Leaf temperature (SPAD value), FLA=Flag leaf area (cm^2), PH=Plant height (cm), PBT/P=Panicle bearing tillers / plant, PL=Panicle length (cm), S/P=Spikelets / panicle, G/P= Grains per panicle, SF=Spikelet fertility (%), BY/P= Biological yield / plant (g), HI=Harvest index (%), L/B=L/B ratio, 1000-GW=1000- grain weight (g) and GY/P=Grain yield / plant(g)

The availability of large genetic variability, as well as the nature of heritability and gene action, are all important factors in the success of selection in improving plant traits. The basic material for a plant breeding programme is genetic diversity, which is used to generate superior genotypes through selection. The phenotypic, genotypic, and environmental coefficients of variation can be used to assess and compare the nature and magnitude of variability present in breeding materials for various traits. In a general sense, heritability refers to the proportion of heritable genetic variance in total phenotypic variance, whereas in a more specific meaning, it refers to the ratio of fixable additive genetic variance to total phenotypic variance. Estimates of heredity aid in predicting expected selection progress. By taking into consideration the character's genetic variability and heritability, the genetic advance in percent of mean provides an indicator of expected selection response.

The estimates of direct selection parameters, coefficients of variation, heritability and genetic advance in per cent of mean were computed for sixteen characters of 113 germplasm lines including 3 checks (**Table 5**). The high estimates (>20%) of phenotypic (PCV) and genotypic (GCV) coefficients of variation were recorded in case of grains per panicle, spikelets per panicle, flag leaf area, biological yield per plant and grain yield per plant. These similar results have also been reported by earlier scientists (Khedikar *et al.,* 2003; Saxena *et al.,* 2005; Singh and Singh, 2005; Dhanwani *et al.,* 2013; Gyawali *et al.,* 2018 and Parimala and Devi, 2019).

Table 5. Estimates of coefficient of variation, $h^2_{(bs)}$ (broad sense) and genetic advance in per cent of mean for 16 characters in rice

S. No.	Characters	Range	Mean	Coefficient of variation		Herita-bility in broad sense (%)	Genetic advance in per cent of mean
				PCV	GCV		
1	Days to 50% flowering	80.205-117.219	97.468	6.672	6.647	99.26	13.6421
2	Chlorophyll content	7.022-16.389	13.202	10.106	9.801	94.06	19.5807
3	Leaf nitrogen	0.358-0.794	0.581	15.403	14.766	91.90	29.1598
4	Leaf temperature	28.827-39.054	35.630	3.756	3.315	77.92	6.0288
5	Flag leaf area (cm^2)	10.981-46.698	26.121	26.199	25.084	91.67	49.4721
6	Plant height (cm)	63.830-165.593	99.589	11.564	9.191	63.17	15.0485
7	Panicle bearing tillers/plant	5.409-14.056	8.905	17.037	13.031	58.50	20.5318
8	Panicle length (cm)	17.138-29.658	23.184	10.470	10.377	98.22	21.1853
9	Spikelets/panicle	59.321-242.401	135.224	26.220	26.187	99.75	53.8776
10	Grains/panicle	47.092-197.025	112.264	28.201	28.147	99.62	57.8734
11	Spikelet fertility (%)	64.514-96.509	82.695	6.115	6.018	96.86	12.2015
12	Biological yield/plant (g)	20.822-64.472	42.205	23.935	23.870	99.46	49.0373
13	Harvest index (%)	29.255-51.858	39.614	9.882	9.667	95.70	19.4808
14	L/B ratio	2.197-5.133	3.026	14.141	12.593	79.31	23.1016
15	1000- grain weight (g)	14.678-30.358	22.856	8.679	8.649	99.29	17.7534
16	Grain yield/plant (g)	8.898-24.658	16.464	21.375	21.245	98.79	43.4988

High estimates of broad sense heritability (> 75%) were recorded for spikelets/panicle, grains/panicle, biological yield/plant, 1000-grain weight, days to 50% flowering, grain yield/plant, panicle length, spikelet fertility, harvest index, chlorophyll content, leaf nitrogen, flag leaf area, L/B ratio and leaf temperature.

The high estimates of genetic advance in per cent of mean (>20%) were recorded for grains/panicle, spikelet's/panicle, flag leaf area, biological yield/plant, grain yield/plant, leaf nitrogen, L/B ratio, panicle length, panicle bearing tillers/plant. The high to very high estimates of direct selection parameters for above mentioned nine characters indicated that these would be ideal traits for improvement through selection in context of materials evaluated owing to existence of high genetic variability represented by high coefficients of variation and high transmissibility denoted by high heritability for them. The high estimates of direct selection parameters observed for the above characters are broadly in agreement with earlier reports in rice (Thakur *et al.,* 1999; Kumar *et al.,* 2001; Roy *et al., 2001;* Mohammad and Deva, 2002; Nayak *et al.,* 2002; Yadav *et al.,* 2002; Chaudhary *et al.*, 2004; Shukla *et al.*, 2004; Mall *et al.,* 2005; Suman *et al.,* 2005; Singh *et al.*, 2006; Panwar *et al.*, 2007; Babar *et al.,* 2009; Anjaneyulu *et al.,* 2010; Dhanwani *et al.,* 2013; Lingaiah *et al.,* 2014; Gyawali *et al.,* 2018; Parimala and Devi, 2019). Panicle length with moderate PCV and GCV values and high heritability resulted in strong genetic advance, implying that due to high transmissibility, even if variability is moderate, a reasonable response to selection may be attained for this trait. Despite high heritability in the broad sense, days to 50% flowering resulted in low genetic progress due to low variability, as measured by low PCV and GCV values, indicating that improving trait through selection in the context of current material would be difficult due to a lack

of genetic variability. The availability of large genetic variability, as well as the nature of heritability and gene action, are all important factors in the success of selection in improving plant traits. The basic material for a plant breeding programme is genetic diversity, which is used to generate superior genotypes through selection.

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