DoI: https://doi.org/10.58537/jorangrau.2026.54.1.01

J. Res. ANGRAU 54 (1) 1-10, 2026

ASSOCIATION STUDIES IN ELITE SALT TOLERANT LINES UNDER DIRECT SEEDED CONDITIONS IN RICE (*Oryza sativa* L.)

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Date of Receipt : 17-12-2025 Date of Acceptance : 20-02-2026

ABSTRACT

In the present study 24 elite salt tolerant lines including two checks developed at ARS Machilipatnam were evaluated during *kharif*, 2023 at Agricultural College Farm, Bapatla, Andhra Pradeshunder direct seeded conditions to test their suitability for direct seeding with EC 2.1 dSm^{-1}, pH 7.2 in a randomized complete block design (RCBD) for association studies. The correlation studies revealed that early vigour traits like root length at 15 and 30 DAS, shoot length at 15 and 30 DAS, field emergence at 15 DAS, days to 50 per cent flowering, plant height, lodging related traits like culm thickness (mm), culm diameter (mm) and yield contributing traits like panicle length (cm), number of filled grains per panicle, biological yield and harvest index (%) were positively correlated with grain yield at both phenotypic and genotypic levels suggesting the simultaneous improvement of all these traits and direct selection of the above traits can contribute for improvement of grain yield. The path coefficient analysis revealed that at both phenotypic and genotypic levels, important yield contributing traits like days to 50 per cent flowering, number of filled grains per panicle, biological yield and harvest index showed not only positive direct effect but also positive correlation with grain yield suggesting the importance of direct selection for above traits.

Keywords: Correlation, Direct seeded, Path analysis and Salt tolerance.

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the world's most important cereal crops, meeting the nutritional needs of nearly half of the global population. As a staple, rice fulfils a significant portion of the carbohydrate requirements worldwide. In India, rice farming is undergoing substantial changes driven by climate challenges, economic pressures and advancements in agricultural technology. One major shift is the adoption of direct seeding to address rising labour costs and facilitate more intensive double and triple cropping systems. The availability of high-yield, short-duration rice varieties and effective chemical weed control has made this approach more economically viable. Additionally, direct seeding enhances water use efficiency (Gupta *et al.,* 2006). When implemented with minimal or no tillage, direct-seeded rice serves as a promising resource-conserving technology (RCT). Early growth vigour is a critical trait for

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*Corresponding Author Email: t.haritha@angrau.ac.in success in direct-seeded rice systems (Cairns *et al.,* 2009).

Paddy is categorized as salinity susceptible cereal. In India alone, 6.73 million hectares of land are degraded by salt on irrigated land which accounts to greater than 10 percent of the agricultural crop land presenting a serious threat to global food security.Hence, Salt-tolerant lines of paddy are crucial for ensuring rice production in saline-prone areas, such as coastal regions and salt-affected soils. Such varieties can withstand high salt concentrations, allowing better water and nutrient absorption while maintaining growth and yield. They help sustain food security, especially in regions where soil salinity limits traditional rice cultivation. Salt stress raises the concentration of Na^+ in cells, disrupting the normal function of K^+ and affecting cellular metabolism. It induces excessive ROS production, leading to oxidative stress and lipid peroxidation, damaging cell membranes, proteins and DNA. To cope with this osmotic stress, rice accumulates significant amounts of proline, betaine and soluble sugars, helping cells maintain osmotic balance. Simultaneously, salt stress significantly elevates abscisic acid (ABA) levels, regulating stomatal closure to reduce water transpiration and promoting root growth (Qingyang Li *et al.,* 2024).Additionally, rice increases the levels of antioxidant enzymes (such as superoxide dismutase, peroxidase, and catalase) and non-enzymatic antioxidants (such as ascorbic acid and glutathione) to remove excess ROS and mitigate oxidative damage. In general salt-tolerant paddy reduces the need for soil amendments and excessive irrigation, making farming more sustainable. Developing and adopting such varieties is essential for addressing climate change challenges and expanding rice cultivation in marginal lands.

Correlation studies are essential for understanding the relationships between various factors that influence crop growth, yield and sustainability. They help researchers and farmers identify key traits linked to high productivity, such as plant height, grain size, or drought resistance, aiding in crop improvement programs. By analyzing the correlation between soil nutrients, climate conditions and plant performance, farmers can optimize resource use, improve soil fertility, and enhance yield prediction. Additionally, these studies support pest and disease management by identifying plant characteristics associated with resistance. Overall, correlation studies play a crucial role in advancing sustainable and efficient agricultural practices.Thus, the present study was conducted to test the suitability of salt-tolerant lines of paddy under direct seeded conditions.

MATERIAL AND METHODS

The present investigation was carried out using 24 elite salt tolerant lines including two checks(FL478 - resistant salt tolerant check and BPT5204 - yield check) and evaluated in randomized complete block design (RCBD) for yield and component traits under direct seeded condition at Agricultural College Farm, Bapatla, Andhra Pradesh during *kharif*, 2023(Table 1). FL 478 is widely used in research and breeding programmes as a donar for salinity tolerance especially at seedling stage. Each genotype was grown in five rows of 3.0 m length with a spacing of 20 cm between rows and 15 cm between plants, within the row. The data was recorded from five competitive plants taken from each replication on root length at 15 DAS & 30 DAS (cm), shoot length at 15 DAS & 30 DAS (cm), field emergence(%), root volume at 15 DAS & 30 DAS (cm^3), days to 50 per cent flowering, plant height (cm), number of productive tillers per plant, panicle length (cm),number of filled grains per panicle,

Table 1. Details of the rice genotypes studied in the present investigation

DS1	MCM 142	DS13	MCM 109
DS2	MCM 208-14-1-1	DS14	IR17F1107
DS3	MCM 147-1-1-2-1	DS15	MCM 253-5-3-1
DS4	MCM 258-8-2-7	DS16	MCM 143
DS5	MCM 148-2-1-1-1	DS17	MCM 141
DS6	MCM 149-3-1-1-1-1	DS18	BPT 5204
DS7	MCM 151-3-21-1	DS19	FL 478
DS8	MCM 153-1-1-1	DS20	MCM 153-2-1-2-1
DS9	MCM 253-6-2-2	DS21	MCM 253-8-2-2
DS10	MCM 100	DS22	MCM 106-2-10-2-2
DS11	MCM 103	DS23	MCM 305-32-2-1
DS12	MCM 125	DS24	MCM 305-14-1-1-1

spikelet fertility (%), culm strength, percent lodging (%), basal internodal length (cm), culm diameter (mm), culm thickness (mm), biological yield (kg/ha), grain yield (kg/ha) andharvest index (%).The phenotypic and genotypic correlation coefficients were worked out to determine the degree of association of a character with yield and also among the yield components (Falconer, 1964).Path coefficient analysis was carried out by using the correlation coefficients to know the direct and indirect effects of the component characters on yield as suggested by Wright (1921) and illustrated by Dewey and Lu (1959).

RESULTS AND DISCUSSION

From the above correlation studies, it can be concluded that early vigour traits like root length at 15 and 30 DAS, shoot length at 15 and 30 DAS, field emergence at 15 DAS, days to 50 per cent flowering, plant height, lodging related traits like culm thickness,culm diameter and yield contributing traits like panicle length, number of filled grains per panicle, biological yield and harvest index were positively correlated with grain yield at both phenotypic and genotypic levels suggesting the simultaneous improvement of all these traits and direct selection of the above traits can contribute for improvement of grain yield under direct seeded conditions (Tables 2 &3). Direct selection of early vigour traits along with strong and thick culm, considering intermediate plant height, long panicles and a greater number of filled grains will be rewarding for rice varietal development under direct seeded conditions with good yield. But simultaneously, careful selection of genotypes with good productive tillers, spikelet fertility, culm strength with a score of one, minimum percent of lodging and basal internodal length are highly essential for generating high yielding genotypes under direct seeded conditions to minimize lodging risk**.** Similar results were earlier reported by Patel *et al*. (2014), Srivastava *et al*. (2017), Katiyar *et al*. (2019), Akshitha *et al*. (2020) and Heera *et al*. (2023).

The path coefficient analysis revealed that, at both phenotypic and genotypic levels, the traits *viz.,*days to 50 per cent flowering, number of filled grains per panicle, biological yield and harvest index showed not only positive direct effect but also positive correlation with grain yield suggesting the

Table 2. Correlation coefficients (genotypic) for 21 grain yield and yield contributing characters in 24 genotypes of rice (*Oryza sativa* L.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
RL 15 DAS	**1.000**	0.071	-0.047	0.355*	0.125	0.173	-0.088	-0.187	-0.124	0.173		0.076	0.239	-0.352*	-0.407*	-0.223	0.065	0.389*	0.409*	-0.111	**0.298***
RL 30 DAS		**1.000**	-0.148	-0.149	-0.001	0.238	-0.576**	0.387*	-0.052	0.139	0.054	0.246	-0.132	-0.353*	-0.118	-0.409*	0.330*	0.333*	0.122	0.520**	**0.431***
SL 15 DAS			**1.000**	0.398*	0.090	-0.138	0.088	0.264	0.649**	0.556**	-0.295*	0.325*	-0.127	0.001	-0.196	-0.148	0.243	0.382*	0.459*	0.123	**0.458***
SL 30 DAS				**1.000**	0.103	0.131	0.122	0.007	0.416*	0.577**	-0.313*	0.339*	0.232	0.064	-0.103	-0.109	0.030	0.227	0.463**	-0.328*	**0.172**
FE 15DAS					**1.000**	0.185	-0.044	0.231	-0.202	-0.011	-0.336*	-0.102	-0.001	0.117	0.164	0.007	-0.449*	-0.363*	0.505**	-0.047	**0.368***
RV 15 DAS						**1.000**	0.743**	-0.181	0.294*	0.246	-0.208	0.087	-0.438*	0.314*	0.136	0.231	0.311*	0.377*	-0.149	0.553**	**0.251**
RV 30DAS							**1.000**	0.033	0.263	0.071	0.242	-0.239	-0.234	0.256	0.040	0.408*	0.236	0.017	-0.117	0.355*	**0.091**
DFF								**1.000**	0.439*	0.175	0.190	0.207	-0.059	0.190	0.159	-0.300*	0.171	0.173	0.497**	0.434*	**0.660****
PH (cm)									**1.000**	0.769**	-0.390*	0.689**	0.001	0.317*	0.089	-0.040	0.166	0.400*	0.317*	0.348*	**0.490****
PL (cm)										**1.000**	-0.571**	0.753**	-0.024	-0.081	-0.266	-0.079	0.516**	0.456*	0.330*	0.477**	**0.565****
NPTPP											**1.000**	-0.329*	-0.142	-0.174	-0.146	-0.169	0.119	0.197	0.069	-0.094	**0.001**
NFGPP												**1.000**	0.115	-0.021	-0.062	-0.355*	-0.006	0.254	0.426*	0.155	**0.443***
SF (%)													**1.000**	0.497**	0.513**	0.273	-0.492**	-0.277	0.097	-0.449*	**-0.172**
CS														**1.000**	0.888**	0.478**	-0.306*	-0.289*	-0.163	-0.031	**-0.136**
L (%)															**1.000**	0.421*	-0.461**	-0.496**	-0.246	0.060	**-0.155**
BIL (cm)																**1.000**	0.013	-0.222	-0.481**	-0.135	**-0.470****
CD (mm)																	**1.000**	0.746**	-0.012	0.481**	**0.313***
CT (mm)																		**1.000**	0.207	0.254	**0.353***
BY (Kg/ha)																			**1.000**	-0.045	**0.765****
HI (%)																				**1.000**	**0.623****
GY (Kg/ha)																					**1.000**

* **Significant at 5% level** ** **Significant at 1% level**

RL-Root length (cm), **SL**-Shoot length (cm), **FE**-Field emergence (%), **RV-** Root volume (cm^3), **DFF** -Days to 50 per cent flowering, **PH** -Plant height (cm), **NPTPP** -Number of productive tillers per plant, **PL**-Panicle length (cm), **NFGPP**-Number of filled grains per panicle, **SF**-Spikelet fertility (%), **CS** -Culm strength, **L(%)-** Per cent Lodging, **BIL**-Basal internodal length (cm), **CD**-Culm diameter (mm), **CT**-Culm thickness (mm), **BY**-Biological yield (kg/ha), **GY**-Grain yield (kg/ha), **HI**-Harvest index (%)

Table 3. Correlation coefficients (phenotypic) for 21 grain yield and yield contributing characters in 24 genotypes of rice (*Oryza sativa* L.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
RL 15 DAS	1.000	0.0734	-0.026	0.343*	0.144	0.110	-0.108	-0.125	-0.080	0.072	0.003	0.078	0.211	-0.341*	-0.399*	-0.192	0.085	0.370*	0.393*	-0.081	0.297*
RL 30 DAS		1.000	-0.128	-0.118	0.032	0.126	-0.387*	0.326*	-0.121	0.047	0.077	0.200	-0.096	-0.285*	-0.097	-0.317*	0.281	0.266	0.097	0.465**	0.380*
SL 15 DAS			1.000	0.355*	0.047	-0.050	0.032	0.213	0.552**	0.331*	-0.241	0.310*	-0.018	0.011	-0.183	-0.139	0.250	0.388*	0.380*	0.100	0.361*
SL 30 DAS				1.000	0.082	0.073	0.032	-0.040	0.358*	0.358*	-0.232	0.367*	0.159	0.069	-0.094	-0.066	0.077	0.234	0.397*	-0.242	0.147
FE 15DAS					1.000	0.090	-0.043	0.217	-0.182	-0.084	-0.334*	-0.111	0.002	0.097	0.157	0.054	-0.375*	-0.346*	0.516**	-0.058	0.402*
RV 15 DAS						1.000	0.182	-0.146	0.099	0.205	-0.251	0.082	-0.115	0.177	0.085	0.173	0.132	0.205	-0.111	0.389*	0.152
RV 30DAS							1.000	-0.016	0.212	0.157	0.207	-0.265	-0.254	0.213	0.045	0.285*	0.136	0.005	-0.076	0.231	0.085
DFF								1.000	0.352*	0.068	0.165	0.140	-0.051	0.143	0.135	-0.229	0.135	0.105	0.423*	0.289*	0.540**
PH (cm)									1.000	0.488**	-0.258	0.534**	0.009	0.227	0.055	-0.082	0.236	0.366*	0.182	0.303*	0.321*
PL (cm)										1.000	-0.388*	0.528**	-0.135	-0.054	-0.199	-0.048	0.356*	0.312*	0.169	0.331*	0.323*
NPTPP											1.000	-0.253	-0.090	-0.138	-0.133	-0.144	0.137	0.188	0.016	-0.083	-0.055
NFGPP												1.000	0.1853	-0.021	-0.060	-0.329*	0.019	0.238	0.354*	0.123	0.351*
SF (%)													1.000	0.361*	0.369*	0.129	-0.297*	-0.231	0.042	-0.272	-0.127
CS														1.000	0.880**	0.456*	-0.275	-0.241	-0.154	-0.014	-0.123
L (%)															1.000	0.401*	-0.428*	-0.452*	-0.227	0.059	-0.137
BIL (cm)																1.000	0.027	-0.196	-0.400*	-0.076	-0.369*
CD (mm)																	1.000	0.676**	-0.062	0.425*	0.223
CT (mm)																		1.000	0.170	0.217	0.282
BY (Kg/ha)																			1.000	-0.104	0.776**
HI (%)																				1.000	0.528**
GY (Kg/ha)																					1.000

*** Significant at 5% level ** Significant at 1% level**

RL-Root length (cm), **SL**-Shoot length (cm), **FE**-Field emergence (%), **RV-** Root volume (cm^3), **DFF** -Days to 50 per cent flowering, **PH** -Plant height (cm), **NPTPP** -Number of productive tillers per plant,

PL-Panicle length (cm), **NFGPP**-Number of filled grains per panicle, **SF**-Spikelet fertility (%), **CS** -Culm strength, **L(%)-** Per cent Lodging, **BIL**-Basal internodal length (cm), **CD**-Culm diameter (mm),

CT-Culm thickness (mm), **BY**-Biological yield (kg/ha), **GY**-Grain yield (kg/ha), **HI**-Harvest index (%)

Table4.Direct and indirect effects of different traits on grain yield at genotypic level in 24 genotypes of rice (*Oryza sativa* L.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	**-0.0059**	-0.0004	0.0003	-0.0021	-0.0007	-0.0010	0.0005	0.0011	0.0007	-0.0010	-0.0001	-0.0004	-0.0014	0.0021	0.0024	0.0013	-0.0004	-0.0023	-0.0024	0.0007	**0.2980***
2	-0.0004	**-0.0050**	0.0007	0.0007	0.0000	-0.0012	0.0029	-0.0019	0.0003	-0.0007	-0.0003	-0.0012	0.0007	0.0018	0.0006	0.0021	-0.0017	-0.0017	-0.0006	-0.0026	**0.4310***
3	-0.0034	-0.0109	**0.0737**	0.0294	0.0066	-0.0102	0.0064	0.0195	0.0478	0.0410	-0.0217	0.0240	-0.0094	0.0000	-0.0145	-0.0109	0.0179	0.0282	0.0339	0.0091	**0.4580***
4	-0.0479	0.0201	-0.0538	**-0.1350**	-0.0139	-0.0177	-0.0165	-0.0009	-0.0561	-0.0779	0.0422	-0.0458	-0.0313	-0.0086	0.0140	0.0147	-0.0040	-0.0307	-0.0626	0.0442	0.1719
5	-0.0042	0.0000	-0.0030	-0.0035	**-0.0335**	-0.0062	0.0015	-0.0078	0.0068	0.0004	0.0113	0.0034	0.0000	-0.0039	-0.0055	-0.0002	0.0150	0.0122	-0.0169	0.0016	**0.3680***
6	0.0075	0.0103	-0.0060	0.0057	0.0080	**0.0432**	0.0321	-0.0078	0.0127	0.0106	-0.0090	0.0038	-0.0189	0.0136	0.0059	0.0100	0.0134	0.0163	-0.0065	0.0239	0.2506
7	-0.0230	-0.1511	0.0229	0.0321	-0.0116	0.1950	**0.2624**	0.0089	0.0691	0.0188	0.0636	-0.0629	-0.0614	0.0674	0.0106	0.1072	0.0619	0.0043	-0.0307	0.0930	0.0913
8	-0.0203	0.0420	0.0287	0.0007	0.0251	-0.0196	0.0037	**0.1085**	0.0476	0.0190	0.0207	0.0225	-0.0065	0.0207	0.0172	-0.0326	0.0186	0.0188	0.0539	0.0471	**0.660****
9	0.0196	0.0082	-0.1025	-0.0657	0.0319	-0.0464	-0.0416	-0.0694	**-0.1580**	-0.1215	0.0617	-0.1088	-0.0002	-0.0501	-0.0140	0.0063	-0.0263	-0.0632	-0.0500	-0.0550	**0.490****
10	-0.0271	-0.0218	-0.0870	-0.0902	0.0018	-0.0385	-0.0112	-0.0274	-0.1203	**-0.1564**	0.0894	-0.1178	0.0037	0.0128	0.0416	0.0123	-0.0807	-0.0713	-0.0516	-0.0745	**0.565****
11	-0.0030	-0.015	0.0825	0.0875	0.0941	0.0582	-0.0679	-0.0533	0.1093	0.1599	**-0.2799**	0.0922	0.0397	0.0488	0.0408	0.0472	-0.0334	-0.0550	-0.0193	0.0264	0.0006
12	0.0100	0.0323	0.0427	0.0445	-0.0134	0.0114	-0.0315	0.0272	0.0904	0.0988	-0.0432	**0.1313**	0.0151	-0.0028	-0.0081	-0.0466	-0.0007	0.0333	0.0559	0.0204	**0.4430***
13	0.0388	-0.0215	-0.0207	0.0376	-0.0002	-0.0709	-0.0379	-0.0096	0.0002	-0.0039	-0.0230	0.0187	**0.1620**	0.0806	0.0831	0.0443	-0.0798	-0.0449	0.0157	-0.0727	-0.1724
14	0.0922	0.0924	-0.0001	-0.0167	-0.0307	-0.0821	-0.0672	-0.0499	-0.0830	0.0214	0.0457	0.0055	-0.1302	**-0.2618**	-0.2325	-0.1253	0.0800	0.0757	0.0427	0.0082	-0.1362
15	-0.1098	-0.0317	-0.0528	-0.0279	0.0443	0.0368	0.0109	0.0427	0.0239	-0.0717	-0.0393	-0.0166	0.1382	0.2393	**0.2695**	0.1134	-0.1243	-0.1335	-0.0664	0.0163	-0.1554
16	0.0307	0.0564	0.0203	0.0150	-0.0010	-0.0319	-0.0563	0.0414	0.0055	0.0108	0.0233	0.0489	-0.0377	-0.0660	-0.0580	**-0.1379**	-0.0018	0.0306	0.0664	0.0186	-0.4700**
17	0.0088	0.0446	0.0329	0.0041	-0.0608	0.0421	0.0319	0.0232	0.0225	0.0699	0.0161	-0.0008	-0.0667	-0.0414	-0.0625	0.0017	**0.1354**	0.1010	-0.0016	0.0652	**0.3130***
18	0.0611	0.0523	0.0601	0.0357	-0.0571	0.0592	0.0026	0.0272	0.0629	0.0716	0.0309	0.0399	-0.0435	-0.0454	-0.0778	-0.0349	0.1172	**0.1571**	0.0325	0.0399	**0.3530***
19	0.3242	0.0965	0.3640	0.3673	0.4002	-0.1183	-0.0929	0.3937	0.2511	0.2617	0.0546	0.3376	0.0768	-0.1291	-0.1952	-0.3815	-0.0094	0.1640	**0.7927**	-0.0355	**0.765****
20	-0.0498	0.2337	0.0552	-0.1472	-0.0212	0.2486	0.1593	0.1949	0.1563	0.2140	-0.0423	0.0698	-0.2015	-0.0141	0.0271	-0.0607	0.2161	0.1140	-0.0201	**0.4492**	**0.623****
21	**0.2980***	**0.4310***	**0.4580***	0.1719	**0.3680***	0.2506	0.0913	**0.660****	**0.490****	**0.565****	0.0006	**0.4430***	-0.1724	-0.1362	-0.1554	-0.470**	**0.3130***	**0.3530***	**0.765****	**0.623****	

* Significant at 5% level ** Significant at 1% level Diagonal bold letters indicate direct effect Residual effect = 0.285

1. Root length at 15 DAS (cm), 2. Root length at 30 DAS (cm), 3. Shoot length at 15 DAS (cm), 4. Shoot length at 30 DAS (cm), 5. Field emergence at 15 DAS (%), 6. Root volume at 15 DAS (cm^3), 7. Root volume at 30 DAS (cm^3), 8. Days to 50 per cent flowering, 9. Plant height (cm), 10. Panicle length (cm), 11. Number of productive tillers per plant, 12. Number of filled grains per panicle, 13. Spikelet fertility (%), 14. Culm strength, 15. Per cent lodging (%), 16. Basal internodal length (cm), 17. Culm diameter (mm), 18. Culm thickness (mm), 19. Biological yield (kg/ha), 20. Harvest index (%), 21. Grain yield (kg/ha)

Table5.Direct and indirect effects of different traits on grain yield at phenotypic level in 24 genotypes of rice (*Oryza sativa* L.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	**0.0647**	0.0048	-0.0017	0.0222	0.0093	0.0071	-0.0070	-0.0081	-0.0052	0.0047	0.0002	0.005	0.0137	-0.0221	-0.0258	-0.0124	0.0055	0.0239	0.0254	-0.0053	**0.2970***
2	0.0031	**0.0425**	-0.0055	-0.0050	0.0013	0.0054	-0.0165	0.0139	-0.0051	0.0020	0.0033	0.0085	-0.0041	-0.0121	-0.0041	-0.0135	0.0120	0.0113	0.0041	0.0198	**0.3800***
3	0.0001	0.0005	**-0.0036**	-0.0013	-0.0002	0.0002	-0.0001	-0.0008	-0.0020	-0.0012	0.0009	-0.0011	0.0001	0.0000	0.0007	0.0005	-0.0009	-0.0014	-0.0014	-0.0004	**0.3610***
4	-0.0343	0.0118	-0.0355	**-0.0998**	-0.0081	-0.0073	-0.0032	0.0040	-0.0358	-0.0357	0.0231	-0.0366	-0.0158	-0.0069	0.0093	0.0066	-0.0076	-0.0234	-0.0396	0.0242	0.1466
5	-0.0110	-0.0024	-0.0036	-0.0062	**-0.0763**	-0.0068	0.0032	-0.0166	0.0139	0.0064	0.0254	0.0085	-0.0001	-0.0074	-0.0119	-0.0041	0.0286	0.0264	-0.0394	0.0044	**0.4020***
6	0.0003	0.0003	-0.0001	0.0002	0.0002	**0.0026**	0.0005	-0.0004	0.0003	0.0005	-0.0007	0.0002	-0.0003	0.0005	0.0002	0.0004	0.0003	0.0005	-0.0003	0.0010	0.1524
7	-0.0098	-0.0351	0.0029	0.0029	-0.0039	0.0165	**0.0907**	-0.0014	0.0193	0.0142	0.0188	-0.0240	-0.0230	0.0194	0.0041	0.0259	0.0124	0.0004	-0.0069	0.0210	0.0846
8	-0.0030	0.0078	0.0051	-0.0009	0.0052	-0.0035	-0.0004	**0.0239**	0.0084	0.0016	0.0039	0.0034	-0.0012	0.0034	0.0032	-0.0055	0.0032	0.0025	0.0101	0.0069	**0.5400****
9	0.0030	0.0046	-0.0209	-0.0135	0.0069	-0.0037	-0.0080	-0.0133	**-0.0378**	-0.0184	0.0097	-0.0202	-0.0003	-0.0086	-0.0021	0.0031	-0.0089	-0.0138	-0.0069	-0.0115	**0.3210***
10	-0.0036	-0.0023	-0.0166	-0.0180	0.0042	-0.0103	-0.0079	-0.0034	-0.0245	**-0.0502**	0.0195	-0.0265	0.0068	0.0027	0.0100	0.0024	-0.0179	-0.0157	-0.0085	-0.0166	**0.3230***
11	-0.0004	-0.0100	0.0314	0.0302	0.0436	0.0328	-0.0270	-0.0215	0.0337	0.0507	**-0.1306**	0.0331	0.0117	0.0180	0.0174	0.0188	-0.0179	-0.0246	-0.0021	0.0108	-0.0547
12	0.0013	0.0033	0.0052	0.0061	-0.0019	0.0014	-0.0044	0.0023	0.0089	0.0088	-0.0042	**0.0167**	0.0031	-0.0003	-0.0010	-0.0055	0.0003	0.0040	0.0059	0.0020	**0.3510***
13	-0.0041	0.0019	0.0004	-0.0031	0.0000	0.0023	0.0050	0.0010	-0.0002	0.0026	0.0018	-0.0036	**-0.0195**	-0.0071	-0.0072	-0.0025	0.0058	0.0045	-0.0008	0.0053	-0.1269
14	0.0050	0.0042	-0.0002	-0.0010	-0.0014	-0.0026	-0.0031	-0.0021	-0.0033	0.0008	0.0020	0.0003	-0.0053	**-0.0146**	-0.0128	-0.0066	0.0040	0.0035	0.0022	0.0002	-0.1233
15	-0.0404	-0.0098	-0.0185	-0.0095	0.0158	0.0086	0.0045	0.0137	0.0056	-0.0201	-0.0134	-0.0061	0.0374	0.0890	**0.1012**	0.0405	-0.0433	-0.0457	-0.0229	0.0059	-0.1367
16	0.0028	0.0046	0.0020	0.0010	-0.0008	-0.0025	-0.0041	0.0033	0.0012	0.0007	0.0021	0.0048	-0.0019	-0.0066	-0.0058	**-0.0145**	-0.0004	0.0028	0.0058	0.0011	-0.3690*
17	0.0067	0.0222	0.0198	0.0061	-0.0297	0.0104	0.0108	0.0107	0.0187	0.0282	0.0108	0.0015	-0.0235	-0.0217	-0.0338	0.0022	**0.0791**	0.0535	-0.0049	0.0337	0.2229
18	0.0021	0.0015	0.0023	0.0014	-0.0020	0.0012	0.0000	0.0006	0.0021	0.0018	0.0011	0.0014	-0.0013	-0.0014	-0.0026	-0.0011	0.0039	**0.0058**	0.0010	0.0013	0.2819
19	0.3570	0.0880	0.3457	0.3607	0.4692	-0.1013	-0.0687	0.3842	0.1655	0.1540	0.0147	0.3220	0.0380	-0.1399	-0.2060	-0.3640	-0.0563	0.1546	**0.9093**	-0.0949	**0.7760****
20	-0.0422	0.2413	0.0518	-0.1258	-0.0298	0.2019	0.1202	0.1500	0.1574	0.1720	-0.0431	0.0636	-0.1412	-0.0074	0.0305	-0.0394	0.2208	0.1126	-0.0542	**0.5191**	**0.5280****
21	**0.2970***	**0.3800***	**0.3610***	0.1466	**0.4020***	0.1524	0.0846	**0.5400****	**0.3210***	**0.3230***	-0.0547	**0.3510***	-0.1269	-0.1233	-0.1367	-0.3690*	0.2229	0.2819	**0.7760****	**0.5280****	

* Significant at 5% level ** Significant at 1% level Diagonal bold letters indicate direct effect Residual effect = 0.285

1. Root length at 15 DAS (cm), 2. Root length at 30 DAS (cm), 3. Shoot length at 15 DAS (cm), 4. Shoot length at 30 DAS (cm), 5. Field emergence at 15 DAS (%), 6. Root volume at 15 DAS (cm^3), 7. Root volume at 30 DAS (cm^3), 8. Days to 50 per cent flowering, 9. Plant height (cm), 10. Panicle length (cm), 11. Number of productive tillers per plant, 12. Number of filled grains per panicle, 13. Spikelet fertility (%), 14. Culm strength, 15. Per cent lodging (%), 16. Basal internodal length (cm), 17. Culm diameter (mm), 18. Culm thickness (mm), 19. Biological yield (kg/ha), 20. Harvest index (%), 21. Grain yield (kg/ha)

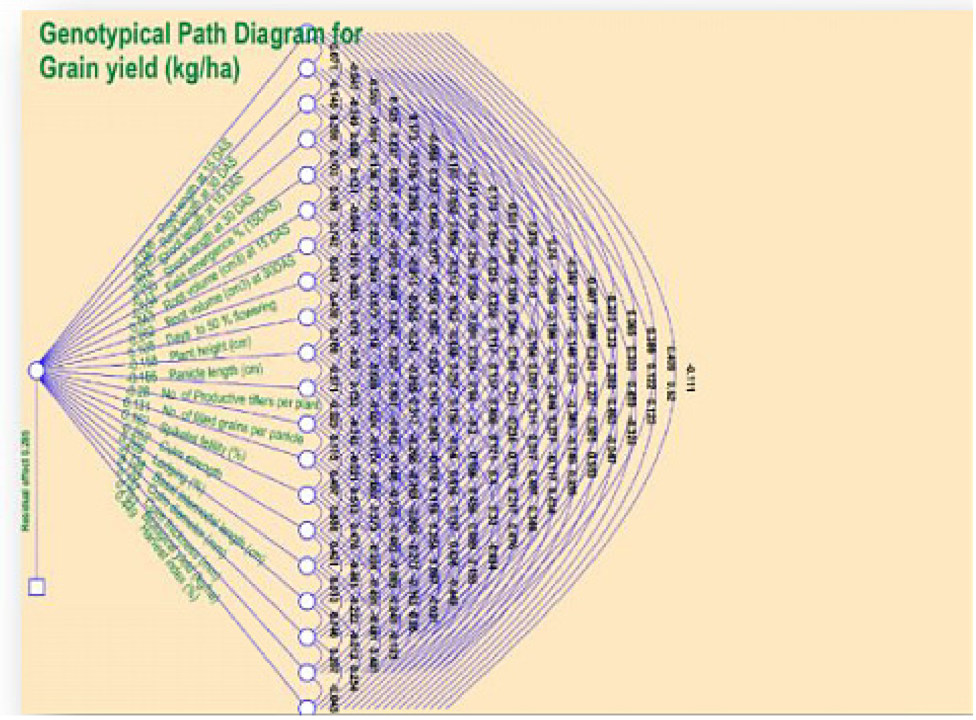

Fig. 1.Genotypic path diagram showing direct and indirect effects of yield,yield components and lodging traits on grain yield in 24 genotypes of rice(*Oryza sativa* L.)

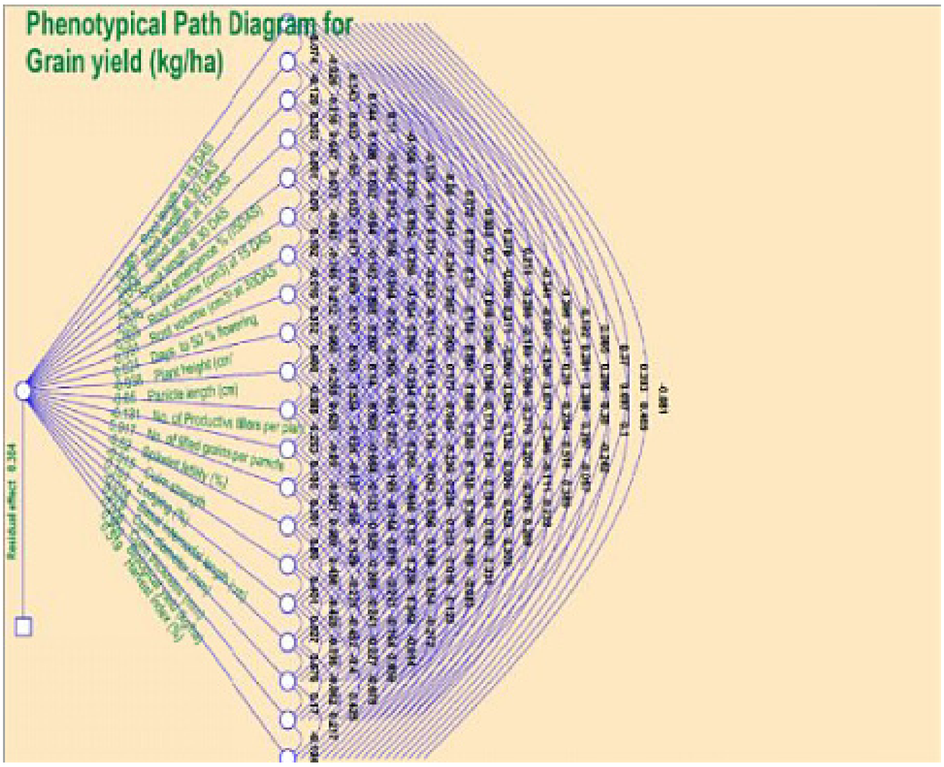

Fig.2.Phenotypic path diagram showing direct and indirect effects of yield,yield components and lodging traits on grain yield in 24 genotypes of rice(*Oryza sativa* L.)

importance of direct selection for above traits. The residual effect in the present study was 0.304 and 0.285 at phenotypic and genotypic levels respectively, indicating that the characters included in the present study clearly explained the direct and indirect effects on the dependent variable to some extent (Tables 4 & 5 and Fig 1 & 2). The residual effect permits precise explanation about the pattern of interaction of other possible components with yield.Similar results were earlier reported by Katiyar *et al*. (2019), Saha *et al*. (2019) and Heera *et al*. (2023). In general, direct selection of genotypes with good early vigour traits and field emergence; short stature (100-110 cm); desirable flowering duration based on objective; lodging resistance by selection of wider culm; longer panicles are very useful for developing high yielding genotypes under direct seeded conditions.

CONCLUSION

From the present study, it can be concluded that seven elite salt tolerant lines like MCM 208-14-1-1, MCM 147-1-1-2-1, MCM 149-3-1-1-1-1, MCM 151-3-21-1, MCM 253-5-3-1, MCM 141 and MCM 305-32-2-1 under direct seeded conditions (EC=2.3 dSm^{-1}, pH= 7.2) recorded performance not only for yield contributing traits like number of productive tillers per plant, panicle length, spikelet fertility (%) and number of filled grains per panicle but also for early vigour traits like root length, shoot length, field emergence, root volume, days to 50 per cent flowering and lodging related traits like per cent lodging, basal internodal length, culm diameter and culm thickness which are very important under direct seeding conditions to combat weeds and withstand lodging. This is because most of the rice production in coastal areas is being affected by salinity, it is imperative to grow salt tolerant cultivars with high yield potential and also amenable for direct seeded conditions to cut down labour cost and to improve water use efficiency. Phenotypic screening alone is not sufficient because salinity tolerance is a quantitative trait controlled by multiple genes. Hence these lines should be subjected to molecular analysis using *Saltol* linked markers to confirm the presence of salinity tolerance. These genotypes also should be tested in saline soils under dry direct seeded conditions as DSR is not generally advised in saline soils due to salt injury. They can also be used as parents for future crossing programme for developing salt tolerant varieties suitable for DSR conditions.

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