Genotypic and phenotypic correlation and Path analysis of Yield and Seedling Vigour Related Traits in wild introgression lines

Abstract

Early establishment of crop plants are highly influenced by resource availability in its environment. Seedling early vigour refers to the ability of seeds to germinate quickly and uniformly, resulting in the robust crop establishment especially under stress environments. Modern cultivars which are bred for transplanting under irrigated conditions with semi-dwarf architecture lacks early seedling vigour, required under stress situations. Vigorous seedlings have additional advantage of better nutrient uptake by smothering weed plants and inhibit their growth. Improving rice plant architecture with high seedling vigour is a major breeding objective in the context of climate change effect. Backcross Introgression Lines derived from interspecific crosses were screened for seedling vigour traits and yield related traits and correlation analysis was employed to assess the trait association. Among all the 31 traits studied for correlation concluded that positively significant correlation was observed for panicle length, panicle weight, filled grains, total number of grains. Genotypic and phenotypic correlation revealed that the traits panicle length, panicle weight, filled grains, total number of grains, days to 50% flowering have shown significant correlation with single plant yield. Path analysis concluded that days to 50% flowering, number of tillers, fresh weight, dry weight, germination percentage and total number of grains had shown a positive direct effect with single plant yield. Days to 50% flowering, panicle weight, total numbers of grains had a positive significant and direct contribution towards yield improvement. Therefore, these traits are given more weightage while selecting the genotypes, for further utilization in crop improvement programmes.

Keywords: Rice, Seedling Vigour, Correlation, BILs, Wild species

Introduction

Rice is a vital food crop that feeds nearly half of the world's population. The rice crop is subjected to various unfavourable stress environments including drought, salt, extreme temperatures, and various biotic stresses. To overcome these negative impacts, high-quality seed should be used (Mia *et al*. 2009). Seedling vigour is a crucial factor in seed quality, which influences germination, seedling growth, longevity, and resistance to adverse environmental conditions (Falconer et al. 1996, Jan et al. 2019, Sunday et al. 2007, Panse et

Comment [1]: The introduction lacks a clear statement of the research problem, objectives, and questions. These need to be explicitly stated early on to guide the reader.

Comment [2]: Don't italic

al. 1954). Vigorous seeds improves germination speed, uniformity and percentage leading to successful field establishment, crop performance, and better yield (Foolad et al. 2007). Farmers prefer cultivars with robust seedling vigour for optimal crop establishment (Savage et al. 2016). Keeping in this view, the present study on correlation and path analysis of 31 agronomic related traits was carried out to detect the major contributing traits to improve seedling vigour.

Materials & methods

Comment [3]: -Samples and sampling techniques require further proof. Details of the phenotypic and genotypic correlations between yield and seedling viability traits. What is the sampling framework? What are the inclusion / exclusion criteria?

The present study was carried out using 164 backcross introgression lines derived from a cross between MTU1010 and *Oryza rufipogon* which were developed at ICAR- IIRR (Rao et al., 2022) and phenotypic and genotypic correlation between yield and seedling vigour traits were estimated. The materials were raised during Kharif-2023 at ICAR-IIRR field in Augmented block design to estimate yield related traits. The same set of lines were examined for seedling vigour and related traits in paper roll towel method in laboratory. The data was collected on characters viz germination percentage, shoot length, root length, fresh weight, dry weight, seedling vigour index-I, seedling vigour index-II at 7th and 14th day of germination.

Phenotyping of yield-related traits

Trait evaluation was conducted with three randomly selected plants per genotype in each replication. The average results were statistically evaluated. Phenotyping was done for the following traits: plant height (cm), tiller number (TN), productive tiller number (PTN), panicle length (PL cm), panicle weight (PW g), total number of grains per panicle (TG), filled grains per panicle (FG), unfilled grains per panicle (UFG), test weight (TW g), and Single plant yield (SPY g).

Phenotyping of Seedling vigour-related traits

Germination test

The germination test was conducted using the petriplate method. 100 well-dried seeds were put on a sterilized petriplate lined with Whatman filter paper, with enough moisture for seedling emergence at room temperature. The germination percentage was obtained by counting the number of seeds germinated on the third and seventh day.

Seedling growth test

To determine seedling vigour, a paper roll test was used. Ten seeds were evenly distributed on a brown germination sheet with water-absorbing capacity. The sheet was carefully rolled with two distal edges tied using rubber bands and placed vertically in a tray filled with water. The tray was then incubated at room temperature. On the 7th and 14th day of incubation, 10 seedlings from each genotype were measured for shoot and root length. Seedlings were oven-dried and their dry matter weight was assessed. Seedling vigour is assessed in a controlled lab environment using several factors.

Seedling vigour index

At random, five seedlings were chosen from each replication, and on the seventh and fourteenth day following planting, observations concerning the duration of seedling were made. The seedlings were oven dried and measured for dry shoot and root weight. The seedling vigour indicators were determined using the Kharb et al. (1994) method.

Seedling vigour index-I was estimated using germination percentage and seedling length on the 7th and 14th day.

Seedling vigour index- I: $$\frac{\text{Seedling germination percent x Seedling length (cm)}}{100}$$

Seedling vigour index- II was estimated using germination percentage and seedling dry weight on the 7th and 14th day.

Seedling vigour index- II: $$\frac{\text{Seedling germination percent x Seedling dry weight (g)}}{100}$$

Results and Discussion

Correlation of mean phenotypic data

A positively significant correlation was observed for panicle length, panicle weight, filled grains, total grains with single plant yield. Positively non- significant correlation was observed between the traits dry weight on the 7th day, unfilled grains, grain width, grain area, seedling vigour index-I on the 14th day, root length on the 14th day, spikelet fertility and total length on the 14th day.

Negative correlation as observed for germination on the 7th day, seedling vigour index-I on the 7th day, seedling vigour index-II on the 7th day, germination on the 14th day, shoot length on the 14th day, fresh weight on the 14th day, dry weight on the 14th day, seedling vigour index-II on the 14th day, thousand grain weight, grain length, shoot length on the 7^{th} day, root length on the 7^{th} day, total length on the 7^{th} day, fresh weight on the 7^{th} day with single plant yield (Table 1).

Genotypic correlation using replicated data

A positively significant genotypic correlation was observed for characters panicle length, panicle weight, grain area, total number of grains, filled grains, days to 50% flowering with single plant yield and similar results were reported by Deepthi *et al.* (2022), Vanisree *et al.* (2013) and Rachana *et al.* (2018). The traits, germination on the7^{th} day, number of productive tillers, shoot length on the7^{th} day, root length on the 7^{th} day, total length on the 7^{th} day, seedling vigour index - I on the 7^{th} day, dry weight 7^{th} on the day, root length on the14^{th} day, total length on the14^{th} day, seedling vigour index - I on the 14^{th} day, fresh weight on the14^{th} day, seedling vigour index - II on the14^{th} day, plant height, number of tillers, unfilled grains, spikelet fertility, 1000 grain weight and grain width showed a positive correlation with single plant yield this results are in accordance with the reports of Lakshmi *et al.*(2020), Madakemohekar *et al.* (2015). Fresh weight on the 7^{th} day, germination on the14^{th} day, shoot length on the14^{th} day, seedling vigour index - II at 7^{th} day, dry weight on the14th day and grain length exhibited a negatively non-significant genotypic correlation with single plant yield and are presented in (Table 2, Fig.1a).

Phenotypic correlation using replicated data

A positively significant association was observed for traits panicle length, panicle weight and filled grains, total number of grains, days to 50% flowering with single plant yield and similar results were reported by Deepthi *et al.* (2022) for panicle length and total number of filled grains, Vanisree *et al.* (2013) and Rachana *et al.* (2018) for total number of grains, Parimala *et al.* (2020), Elizabeth *et al.* (2011) for panicle length and panicle weight.

The traits germination on the 7^{th} day, root length on the 7^{th} day, total length on the 7^{th} day, dry weight 7^{th} on the day, shoot length on the 14^{th} day, root length on the 14^{th} day, total length on the 14^{th} day, seedling vigour index - I on the 14^{th} day, fresh weight on the 14^{th} day, seedling vigour index - II on the 14^{th} day, plant height, number of tillers, number of productive tillers, unfilled grains, spikelet fertility, and 1000 grain weight, grain width, grain area had shown a positive and nonsignificant correlation with single plant yield and this results was in accordance with the results of Lakshmi *et al.*(2020), Madakemohekar *et al.*(2015). While seedling vigour index - I on the 7^{th} day, fresh weight on 7^{th} day, seedling vigour index - II on the 7^{th} day), germination on the 14^{th} day, dry weight on the 14^{th} day, grain length have shown a negatively non-significant phenotypic correlation with single plant yield (Table 3, Fig.1b).

Path coefficient analysis

Path coefficient analysis distinguishes between direct and indirect impacts of yield components on grain yield. Path analysis gives a comprehensive image of character relationships, enabling effective selection strategies. Path coefficient analysis distinguishes itself from basic correlation by identifying the causes and their relative importance and cause. The impact of various plant characteristics on seed output at both phenotypic and genotypic levels. The direct and indirect effects of different characters on gain yield per plant are presented Fig.2.

In the present investigation conducted on yield and its related traits the highest positive direct effect on single plant yield was exhibited by days to 50% flowering, plant height, number of tillers, number of productive tillers, panicle length, panicle weight, number of filled grains, number of unfilled grains, spikelet fertility, grain length, grain width and grain area (Fig 1), similar results were also reported by Madhavilatha et al. (2013), Naseer et al. (2013), Babu et al. (2015), Kishore et al. (2018), Kumar et al. (2018), Manohora et al. (2015), Edukondalu et al. (2017), Kumari and Parmar et al. (2020) and Archana et al. (2018).

Among seedling vigour and its related traits the highest positive direct effect on single plant yield was exhibited by total length on the 7th day, seedling vigour index-I on the 7th day, seedling vigour index-II on the 7th day, germination on the 14th day, total length on the 14th day, fresh weight on the 14th day, dry weight on the14th day (Fig 2), as reported by Madhavilatha et al. (2013), Naseer et al. (2013) , Babu et al. (2015), Kishore et al. (2018) , Kumar et al. (2018) , Manohora et al. (2015), Kumari and Parmar et al. (2020). Negative direct effects on single plant yield was exhibited by germination on the 7th day, shoot length on the 7th day, root length on the 7th day, fresh weight on the 7th day, dry weight on the 7th day, shoot length on the 14th day, root length on the 14th day, seedling vigour index on the 14th day. The residual effect for yield and seedling vigour related traits were 0.942 and 0.308 respectively. High residual effects for yield related traits indicates the consideration of additional parameters that are strongly effecting the grain yield apart from the traits studied. Prioritizing the traits showing highest positive direct effects on single plant yield during breeding programmes will increase the single plant yield as these traits are significant contributors to crop improvement.

Conclusion

Comment [4]: -The resulting presentation is quite intensive and laborious to complete. Use more textual descriptions to guide the reader through the key findings.
-Many of the tables currently provided do not adequately explain the implications of the results in this study. Clearly interpret and synthesize these findings.
-Summarize the parts of the findings and summarize how they handle specific parts of the entire study survey. This helps the reader to understand "what to do then" without getting lost.

Among all the 31 traits studied for correlation and path analysis with single plant yield, the positive significant correlation was observed for the traits panicle length, panicle weight, filled grains, total number of grains. Genotypic and phenotypic correlation reveals that the traits panicle length, panicle weight, filled grains, total number of grains, days to 50% flowering showed significant correlation with single plant yield. Results of path analysis concluded that, days to 50% flowering, number of tillers, fresh weight, dry weight, germination percentage and total number of grains had shown a positive direct effect with single plant yield. The, traits days to 50% flowering, filled grains, total numbers of grains have proved a positive significant and direct contribution towards yield improvement. Therefore, these traits are given more importance while selecting the genotypes and promoting for generation advancement as well as in breeding programmes for crop improvement for yield and seedling vigour.

Acknowledgement

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	DFF	PH	NT	NPT	SPY	G7	SL7	RL7	TL7	FW7	DW7	SVI 7	SVII 7	G14	SL14	RL14	TL14
DFF	1	0.2282	0.1189	0.1305	0.1062	0.024	0.0193	0.0976	0.0761	0.0704	0.0028	0.0539	0.0468	-0.0489	0.056	-0.0008	0.0271
PH		1	0.3253*	0.3353*	0.2874	0.1369	0.2634	0.1835	0.2148	0.1279	0.2232	0.2455	0.1841	0.1242	0.2584	0.0623	0.1652
NT			1	0.9938**	0.0888	0.1806	0.1346	0.1497	0.1499	-0.0148	-0.074	0.1491	-0.0176	0.1815	0.079	0.0283	0.056
NPT				1	0.0914	0.1967	0.1393	0.1653	0.1626	-0.0157	-0.0721	0.1611	-0.0196	0.1839	0.0872	0.0314	0.0619
SPY					1	-0.0001	-0.0191	-0.0053	-0.0097	-0.1084	0.0023	-0.0279	-0.0613	-0.0111	-0.0141	0.0321	0.0124
G7						1	0.458**	0.6125**	0.5849**	0.0577	0.0914	0.6842**	0.1547	0.6528**	0.4528*	0.551**	0.5557**
SL7							1	0.8478**	0.9243**	0.5015**	0.285	0.9054**	0.5825**	0.3942*	0.5671**	0.3157*	0.4703**
RL7								1	0.986**	0.4537*	0.2012	0.9543**	0.5233**	0.4961**	0.5414**	0.4825**	0.5581**
TL7									1	0.484**	0.2345	0.9713**	0.5596**	0.481**	0.5678**	0.4464*	0.5494**
FW7										1	0.334*	0.4442*	0.8996**	0.0113	0.2271	0.1035	0.1745
DW7											1	0.2349	0.4382*	0.1237	0.2501	0.0735	0.1678
SVI 7												1	0.535**	0.5162**	0.5774**	0.4692**	0.5678**
SVII 7													1	0.1047	0.2837	0.1079	0.2051
G.14														1	0.5646**	0.6864**	0.6925**
SL14															1	0.6607**	0.8918**
RL14																1	0.9288**
TL14																	1
FW14																	
DW14																	
SVI 14																	
SVII 14																	
PL																	
PW																	
FG																	
UFG																	
TG																	
SF																	
TGW																	
GL																	
GW																	
GA																	

Table1. Correlation of mean yield and seedling vigour related traits of MTU1010/ *Oryza rufipogon*BILs during Kharif 2023

Contd..

**Significance at o.5%, *Significance at 1%, Note:G7=Germination on the 7th day, SL7= Shoot length on 7th day, RL7= Root length 7th day,TL7=Total length on the 7th day, FW7=Fresh weight on the 7th day,DW7= Dry weight on 7th day, , G14=Germination on the 14th day, SL14= Shoot length on 14th day, RL14= Root length on 14th day, TL14=Total length on the 14th day, DW14= Dry weight on 14th day, FW14=Fresh weight on the 14th day , SVI-1-7= Seedling vigour index 1 on 7th day, SVI-1-14= Seedling vigour index 1 on 14th day, , SVI-2-7= Seedling vigour index 2 on 7th day, SVI-2-14= Seedling vigour index 2 on 14th day, DFF= Days to 50% flowering, PH=Plant height,NT= Number of tillers, NPT= Number of productive tillers, PL= Panicle length, PW= Panicle weight, TG= Total number of grains per panicle, FG= Total number of filled grains per panicle, UFG= Total number of unfilled grains per panicle, SF=Spikelet fertility, SPY= Single plant yield, TGW= Thousand grain weight, GL=Grain length, GW=Grain width, GA=Grain area.

	FW14	DW14	SVI 14	SVII 14	PL	PW	FG	UFG	TG	SF	TGW	GL	GW	GA
DFF	0.0642	0.1294	0.0131	0.0459	0.011	0.1499	0.2506	0.3775*	0.3455*	-0.2978	-0.3335*	-0.243	-0.0419	-0.1795
PH	0.0273	-0.0463	0.1843	0.0837	0.4736**	0.1637	0.2023	0.111	0.2069	-0.0621	-0.1321	-0.0107	-0.1115	-0.0783
NT	-0.1577	-0.1644	0.0858	-0.1259	0.2008	-0.0467	-0.033	0.0679	-0.0017	-0.0607	-0.1175	0.0066	-0.1622	-0.147
NPT	-0.1445	-0.1602	0.0908	-0.1094	0.2111	-0.0314	-0.0158	0.0731	0.0143	-0.0609	-0.128	0.0021	-0.1518	-0.1428
SPY	-0.0191	-0.0932	0.0014	-0.0147	0.3474*	0.3479*	0.3471*	0.0993	0.321*	0.0231	-0.0271	-0.032	0.0719	0.0441
G7	0.1228	-0.0567	0.5904**	0.2367	0.1386	0.1672	0.1309	0.0989	0.1439	-0.0557	0.0178	0.0214	0.053	0.0302
SL7	0.233	0.0521	0.4857**	0.2976	0.0962	0.0724	0.0804	0.0629	0.0892	-0.0442	-0.0626	-0.0623	-0.056	-0.0721
RL7	0.1954	0.0625	0.5678**	0.2918	0.0769	0.1566	0.1445	0.1042	0.157	-0.0771	-0.0656	-0.1569	0.0972	-0.0185
TL7	0.2138	0.0614	0.5613**	0.3036*	0.0856	0.1354	0.1291	0.0946	0.1409	-0.0693	-0.0668	-0.1323	0.0522	-0.036
FW7	0.2062	0.1033	0.1475	0.1937	-0.0167	-0.014	-0.0042	0.018	0.0033	-0.0401	-0.0092	-0.1388	0.0223	-0.0728
DW7	0.1259	-0.0049	0.1742	0.121	0.0273	0.0481	0.059	0.1855	0.1173	-0.1263	-0.0774	0.0245	-0.1416	-0.1184
SVI 7	0.2393	0.0502	0.5901**	0.329*	0.0984	0.1466	0.1355	0.0849	0.1425	-0.0491	-0.0329	-0.1006	0.054	-0.0167
SVII 7	0.2202	0.0171	0.1929	0.1898	0.0203	0.0238	0.0431	0.0434	0.0514	-0.0372	-0.0173	-0.1417	0.052	-0.0819
G14	0.0693	-0.2402	0.8148**	0.2223	0.1176	0.117	0.0533	0.0733	0.0709	-0.0888	0.0909	0.0192	0.0834	0.0792
SL14	0.3637*	0.0178	0.8701**	0.4678**	0.115	0.1304	0.1077	0.1019	0.1261	-0.0851	0.0035	-0.0718	0.0967	0.0304
RL14	0.2444	0.0406	0.897	0.3914*	0.0943	0.1691	0.1098	0.0011	0.0903	-0.0153	0.037	-0.0917	0.2149	0.1225
TL14	0.3267*	0.0332	0.9701**	0.4667**	0.1137	0.1664	0.1194	0.051	0.1167	-0.0512	0.0239	-0.0906	0.1772	0.0888
FW14	1	0.3894*	0.2721	0.877**	-0.1216	0.0599	0.0781	-0.0044	0.0623	0.0592	-0.0177	-0.1654	0.143	-0.0078
DW14		1	-0.0608	0.5498**	-0.0798	0.0096	-0.0377	-0.0003	-0.031	0.0094	-0.0334	0.0011	0.0024	0.0594
SVI 14			1	0.4227*	0.1047	0.1584	0.1006	0.055	0.1028	-0.0595	0.0587	-0.0496	0.1563	0.1005
SVII 14				1	-0.0575	0.1253	0.1111	0.0295	0.1019	0.031	0.0068	-0.0917	0.1021	0.0307
PL					1	0.5437**	0.4908**	0.2013	0.4766**	-0.0463	0.0494	0.056	-0.0583	0.0254
PW						1	0.9117**	0.2248	0.8299**	0.0707	-0.0746	-0.1074	0.063	0.0048
FG							1	0.3148*	0.9356**	0.0548	-0.3374	-0.203	-0.0699	-0.1614
UFG								1	0.6295**	-0.849	-0.3633	-0.0645	-0.1367	-0.1325
TG									1	-0.2708	-0.4113	-0.1902	-0.108	-0.1814
SF										1	0.2106	0.0115	0.0669	0.0349
TGW											1	0.3392*	0.3639*	0.5106**
GL												1	-0.0875	0.578**
GW													1	0.6536**
GA														1

	G7	SL7	RL7	TL7	SVI.I7	FW7	DW7	SVI.II7	G14	SL14	RL14	TL14	SVI.I14	FW14	DW14	SVI.II14	DFF
G7		0.5151**	0.6799**	0.649**	0.7171**	0.0741	0.1241	0.1928	0.8167**	0.5515**	0.6711**	0.6686**	0.7162**	0.1002	-0.0223	0.2792	0.2912
SL7			0.8613**	0.9312**	0.9249**	0.6047**	0.5542**	0.6881**	0.4476*	0.598**	0.3618*	0.51**	0.5222**	0.2522	0.0754	0.3435*	0.999**
RL7				0.9873**	0.9676**	0.5263**	0.3621*	0.5968**	0.5829**	0.5829**	0.5696**	0.6247**	0.6344**	0.2075	0.091	0.3351*	0.999**
TL7					0.9839**	0.5671**	0.4333*	0.6437**	0.5584**	0.6054**	0.5222**	0.6079**	0.6187**	0.2276	0.0887	0.3478*	0.999**
SVI.I7						0.533**	0.4421*	0.6236**	0.6084**	0.6335**	0.555**	0.6411**	0.6622**	0.2534	0.089	0.3854*	0.999**
FW7							0.4992**	0.9739**	-0.0063	0.2496	0.0762	0.1688	0.1345	0.2866	0.0454	0.1958	0.6092**
DW7								0.6671**	0.1772	0.3457*	0.0614	0.2067	0.2227	0.2645	-0.064	0.2215	0.999**
SVI.II7									0.1167	0.3453*	0.1423	0.2551	0.2347	0.3173*	0.0299	0.2499	0.492**
G14										0.6017**	0.7637**	0.7481**	0.8344**	0.1632	-0.1688	0.336*	0.2084
SL14											0.6972**	0.9067**	0.887**	0.4835**	0.0753	0.5581**	0.999**
RL14												0.9344**	0.9257**	0.3397*	0.1251	0.5075**	0.999**
TL14													0.985**	0.4399*	0.1111	0.5757**	0.7996**
SVI.I14														0.3846*	0.0214	0.533**	0.6707**
FW14															0.4304*	0.9307**	0.6056**
DW14																0.6072**	0.9316**
SVI.II14																	0.4319*
DFF																	
PH																	
NT																	
NPT																	
PL																	
PW																	
FG																	
UFG																	
TG																	
SF																	
TGW																	
GL																	
GW																	
GA																	
SPY																	

Table 2 Genotypic Correlation of yield and seedling vigour-related traits of MTU1010/ *Oryza rufipogon*BILs during Kharif 2023

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	PH	NT	NPT	PL	PW	FG	UFG	TG	SF	TGW	GL	GW	GA	SPY
G7	0.1559	0.2208	0.2358	0.1752	0.1954	0.1317	0.1318	0.1504	-0.0938	0.1051	0.0543	0.0363	-0.8422	0.0054
SL7	0.2913	0.1517	0.1544	0.1209	0.0713	0.074	0.1034	0.0978	-0.0982	0.999**	-0.0889	-0.097	0.0364	0.0126
RL7	0.2	0.1691	0.1824	0.1085	0.1812	0.161	0.1404	0.1763	-0.1231	0.5018**	-0.2126	0.1225	0.1069	0.0243
TL7	0.2347	0.1688	0.1792	0.1157	0.1523	0.1402	0.133	0.1572	-0.119	0.3232*	-0.1806	0.0575	0.0889	0.0212
SVI.I7	0.2698	0.1721	0.1827	0.1308	0.1675	0.1457	0.1184	0.1565	-0.092	0.3765*	-0.1408	0.0573	0.0069	0.0008
FW7	0.1466	-0.043	-0.0477	0.0168	-0.0254	-0.0168	0.0129	-0.0082	-0.0434	0.2098	-0.2395	0.1252	-0.5893**	-0.0975
DW7	0.2605	-0.078	-0.0909	-0.0172	0.0357	0.143	0.1682	0.1719	-0.0801	0.4957**	-0.1047	-0.1327	-0.5241**	0.1027
SVI.II7	0.191	-0.0312	-0.0346	0.0242	0.0018	0.0219	0.0618	0.0393	-0.0704	0.1546	-0.218	0.0819	-0.5788**	-0.0698
G14	0.1487	0.2116	0.221	0.1341	0.1321	0.0443	0.0839	0.0642	-0.129	0.2949	0.0202	0.1004	-0.3431*	-0.014
SL14	0.3022*	0.0797	0.0911	0.1435	0.117	0.0986	0.1279	0.1225	-0.1346	0.5938**	-0.128	0.1222	0.3096*	-0.0013
RL14	0.0742	0.0371	0.0468	0.1307	0.2114	0.1389	-0.0328	0.0977	0.0051	0.5644**	-0.1645	0.2921	-0.0104	0.028
TL14	0.1936	0.0617	0.073	0.1476	0.1809	0.1306	0.0442	0.118	-0.0637	0.3339*	-0.1624	0.2317	0.1474	0.0158
SVI.I14	0.2158	0.0942	0.1046	0.1273	0.1668	0.0994	0.0567	0.098	-0.086	0.3592*	-0.0939	0.2	-0.0151	0.0122
FW14	0.1028	-0.1784	-0.1656	-0.13	0.0635	0.1036	0.0074	0.0846	0.0808	0.1697	-0.3181*	0.2042	-0.1038	0.0315
DW14	-0.0467	-0.2285	-0.2247	-0.0946	0.0479	0.0281	0.0409	0.0366	0.0078	0.1032	-0.0968	0.0077	0.4094*	-0.0712
SVI.II14	0.1069	-0.152	-0.1379	-0.0829	0.1116	0.1069	0.0393	0.0983	0.0328	0.1536	-0.231	0.1735	-0.0053	0.0024
DFF	0.6456**	0.999**	0.999**	0.999**	0.999**	0.6159**	0.9861**	0.7493**	-0.0581	-0.3434*	0.999**	0.999**	-0.3534*	0.8349**
PH		0.3379*	0.3479*	0.5497**	0.2005	0.2425	0.1143	0.2315	-0.0606	-0.1383	-0.0258	-0.1571	0.3977*	0.2934
NT			0.999**	0.255	-0.0338	-0.0183	0.0843	0.0153	-0.0886	0.3587*	0.0134	-0.1924	-0.6885**	0.0669
NPT				0.2661	-0.0222	0.0004	0.0933	0.0332	-0.0889	0.3398*	0.0122	-0.1847	-0.6299**	0.0717
PL					0.5142**	0.496**	0.2581	0.4813**	-0.1059	0.9631**	0.0532	-0.0902	-0.3511*	0.3961*
PW						0.9524**	0.3529*	0.8744**	-0.0411	0.999**	-0.1466	0.0511	-0.8652**	0.4219*
FG							0.4611*	0.9504**	-0.0962	-0.6518**	-0.2774	-0.1124	-0.9546**	0.4397*
UFG								0.7147**	-0.8834**	-0.656**	-0.1026	-0.2073	0.1399	0.1165
TG									-0.3853*	-0.7769**	-0.2572	-0.1618	-0.7034**	0.3881*
SF										0.6847**	0.0499	0.1202	-0.8906**	0.0502
TGW											0.999**	0.999**	0.0134	0.1403
GL												-0.14	-1	-0.1511
GW													0.601**	0.0536
GA														0.528**
SPY														

**Significance at o.5%, *Significance at 1%, Note:G7=Germination on the 7th day, SL7= Shoot length on 7th day, RL7= Root length 7th day,TL7=Total length on the 7th day, FW7=Fresh weight on the 7th day,DW7= Dry weight on 7th day, , G14=Germination on the 14th day, SL14= Shoot length on 14th day, RL14= Root length on 14th day, TL14=Total length on the 14th day, DW14= Dry weight on 14th day, FW14=Fresh weight on the 14th day , SVI-1-7= Seedling vigour index 1 on 7th day, SVI-1-14= Seedling vigour index 1 on 14th day, , SVI-2-7= Seedling vigour index 2 on 7th day, SVI-2-14= Seedling vigour index 2 on 14th day, DFF= Days to 50% flowering, PH=Plant height,NT= Number of tillers, NPT= Number of productive tillers, PL= Panicle length, PW= Panicle weight, TG= Total number of grains per panicle, FG= Total number of filled grains per panicle, UFG= Total number of unfilled grains per panicle, SF=Spikelet fertility, SPY= Single plant yield, TGW= Thousand grain weight, GL=Grain length, GW=Grain width, GA=Grain area.

Table 3 Phenotypic Correlation of yield and seedling vigour-related traits of MTU1010/ *Oryza rufipogon*BILs during Kharif 2023

	G7	SL7	RL7	TL7	SVI.I7	FW7	DW7	SVI.II7	G14	SL14	RL14	TL14	SVI.I14	FW14	DW14	SVI.II14
G7	1	0.4579**	0.614**	0.5856**	0.6843**	0.0743	0.1116	0.1822	0.6535**	0.455*	0.5516**	0.5573**	0.5919**	0.0897	-0.0051	0.2353
SL7			0.8486**	0.9246**	0.9054**	0.5356**	0.4568**	0.6137**	0.3911*	0.5663**	0.3148*	0.4689**	0.4828**	0.2146	0.0694	0.3033*
RL7				0.9861**	0.9547**	0.4755**	0.3196*	0.5432**	0.4971**	0.5448**	0.4856**	0.5616**	0.5707**	0.1791	0.0876	0.2955
TL7					0.9713**	0.5104**	0.3733*	0.5836**	0.4805**	0.5697**	0.4483*	0.5513**	0.5622**	0.1961	0.0847	0.3077*
SVI.I7						0.469**	0.3733*	0.5595**	0.5156**	0.5788**	0.4708**	0.5694**	0.5907**	0.2099	0.0812	0.334*
FW7							0.511**	0.9743**	0.0286	0.2261	0.084	0.162	0.1391	0.2425	0.0634	0.1858
DW7								0.6639**	0.1291	0.2739	0.0616	0.1719	0.1779	0.2657	0.0286	0.2353
SVI.II7									0.1213	0.3051*	0.1382	0.2336	0.2209	0.2655	0.0526	0.2285
G14										0.5615**	0.6849**	0.6903**	0.8137**	0.0363	-0.2362	0.219
SL14											0.6599**	0.8908**	0.8685**	0.3727*	0.0535	0.4753**
RL14												0.9292**	0.8976**	0.2341	0.0571	0.4023*
TL14													0.97**	0.3248*	0.0609	0.477**
SVI.I14														0.2595	-0.0395	0.4278*
FW14															0.4868**	0.9333**
DW14																0.6251**
SVI.II14																
DFF																
PH																
NT																
NPT																
PL																
PW																
FG																
UFG																
TG																
SF																
TGW																
GL																
GW																
GA																
SPY																

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	DFF	PH	NT	NPT	PL	PW	FG	UFG	TG	SF	TGW	GL	GW	GA	SPY
G7	0.2659	0.1417	0.1864	0.2015	0.1298	0.158	0.126	0.1047	0.1416	-0.0629	0.096	0.0237	0.0322	-0.1599	0.0081
SL7	0.999**	0.2775	0.1387	0.1434	0.0964	0.0642	0.0732	0.0759	0.0878	-0.0607	0.999**	-0.0555	-0.0604	0.0055	0
RL7	0.999**	0.1913	0.1505	0.166	0.0795	0.1561	0.1429	0.1126	0.1582	-0.0877	0.4749**	-0.1541	0.1032	0.0078	0.0145
TL7	0.999**	0.2247	0.1518	0.1645	0.0875	0.1325	0.126	0.1048	0.1415	-0.082	0.3069*	-0.1283	0.0553	0.0074	0.0104
SVI.I7	0.999**	0.2565	0.1523	0.1639	0.0976	0.1409	0.1307	0.096	0.1421	-0.0628	0.3563*	-0.0959	0.0508	0.0063	-0.0122
FW7	0.5272**	0.1261	-0.0387	-0.0378	-0.008	-0.0249	-0.0139	0.0122	-0.0067	-0.0295	0.1815	-0.1554	0.0769	-0.0655	-0.0668
DW7	0.999**	0.2124	-0.066	-0.0685	-0.0268	0.0096	0.0712	0.1225	0.1034	-0.0655	0.4063*	-0.0312	-0.0703	-0.0447	0.0937
SVI.II7	0.4319*	0.1666	-0.0295	-0.0273	-0.0008	-0.0046	0.0129	0.0504	0.0293	-0.0514	0.1357	-0.1366	0.0544	-0.0618	-0.048
G14	0.1837	0.1314	0.1888	0.1907	0.1135	0.1068	0.0449	0.0802	0.0663	-0.0983	0.26	0.0267	0.0773	-0.0089	-0.0028
SL14	0.999**	0.2722	0.0901	0.0979	0.1133	0.1152	0.0947	0.1129	0.119	-0.0992	0.5419**	-0.0579	0.0894	0.055	0.0089
RL14	0.999**	0.0657	0.0352	0.0378	0.0882	0.1596	0.1027	0.0037	0.0851	-0.0191	0.4973**	-0.0868	0.2107	0.0129	0.022
TL14	0.7235**	0.1736	0.0657	0.0711	0.1091	0.1532	0.1086	0.0577	0.11	-0.0603	0.3021*	-0.081	0.1714	0.0349	0.0177
SVI.I14	0.6124**	0.1951	0.0959	0.1004	0.0997	0.1439	0.0886	0.0643	0.0961	-0.0719	0.328*	-0.0385	0.1499	0.0247	0.0118
FW14	0.493**	0.0803	-0.1442	-0.1289	-0.1063	0.0398	0.0623	0.0074	0.0535	0.0469	0.1381	-0.1624	0.1154	-0.0069	0.0218
DW14	0.7808**	-0.0431	-0.1779	-0.1706	-0.104	0.0199	-0.0028	0.0206	0.0052	0.0063	0.0865	-0.0413	-0.0045	0.0296	-0.0415
SVI.II14	0.3754*	0.0897	-0.1249	-0.11	-0.0736	0.0842	0.0734	0.0351	0.0728	0.0172	0.1335	-0.1156	0.1056	0.0054	0.0061
DFF		0.6428**	0.999**	0.999**	0.999**	0.999**	0.5436**	0.8539**	0.6843**	-0.0476	-0.3434*	0.999**	0.999**	-0.0484	0.7445**
PH			0.3264*	0.3361*	0.4794**	0.1741	0.212	0.0999	0.2099	-0.0471	-0.1377	-0.0197	-0.1228	0.047	0.2595
NT				0.9938**	0.212	-0.034	-0.0247	0.067	0.0046	-0.0592	0.3476*	0.0003	-0.1514	-0.0957	0.058
NPT					0.2207	-0.02	-0.008	0.072	0.0201	-0.0591	0.3293*	-0.0041	-0.1438	-0.0966	0.0636
PL						0.5389**	0.4912**	0.2038	0.4762**	-0.0466	0.8494**	0.0562	-0.1018	0.0027	0.3048*
PW							0.9127**	0.237	0.8322**	0.062	0.999**	-0.0981	0.0288	-0.0467	0.3374*
FG								0.3265*	0.9367**	0.0457	-0.5753**	-0.1952	-0.0895	-0.097	0.3428*
UFG									0.6366**	-0.8468**	-0.5681**	-0.0735	-0.1475	0.0573	0.0754
TG										-0.2762	-0.7096**	-0.1864	-0.1277	-0.0579	0.3076*
SF											0.5602**	0.0226	0.0744	-0.1317	0.0488
TGW												0.999**	0.999**	0.0018	0.1252
GL													-0.0892	-0.224	-0.0768
GW														0.044	0.077
GA															0.0253
SPY															

**Significance at o.5%, *Significance at 1%, Note:G7=Germination on the 7th day, SL7= Shoot length on 7th day, RL7= Root length 7th day,TL7=Total length on the 7th day, FW7=Fresh weight on the 7th day,DW7= Dry weight on 7th day, , G14=Germination on the 14th day, SL14= Shoot length on 14th day, RL14= Root length on 14th day, TL14=Total length on the 14th day, DW14= Dry weight on 14th day, FW14=Fresh weight on the 14th day , SVI-1-7= Seedling vigour index 1 on 7th day, SVI-1-14= Seedling vigour index 1 on 14th day, , SVI-2-7= Seedling vigour index 2 on 7th day, SVI-2-14= Seedling vigour index 2 on 14th day, DFF= Days to 50% flowering, PH=Plant height, NT= Number of tillers, NPT= Number of productive tillers, PL= Panicle length, PW= Panicle weight, TG= Total number of grains per panicle, FG= Total number of filled grains per panicle, UFG= Total number of unfilled grains per panicle, SF=Spikelet fertility, SPY= Single plant yield, TGW= Thousand grain weight, GL=Grain length, GW=Grain width, GA=Grain area

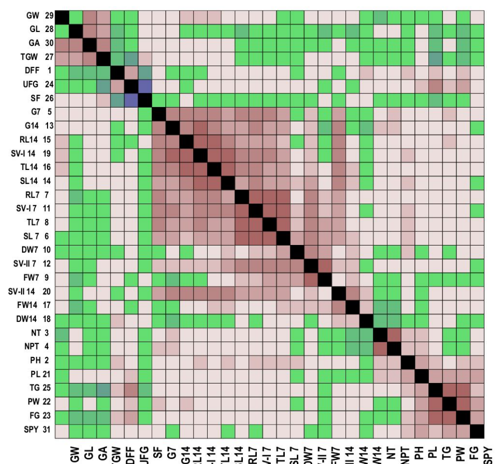


Fig 1(a): Genotypic Correlogram

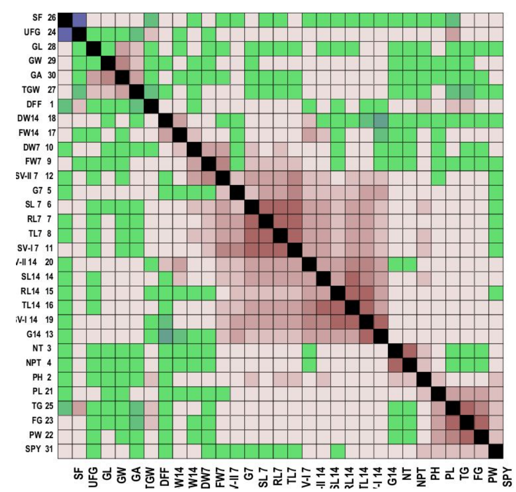
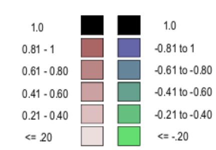


Fig 1(b): Phenotypic Correlogram



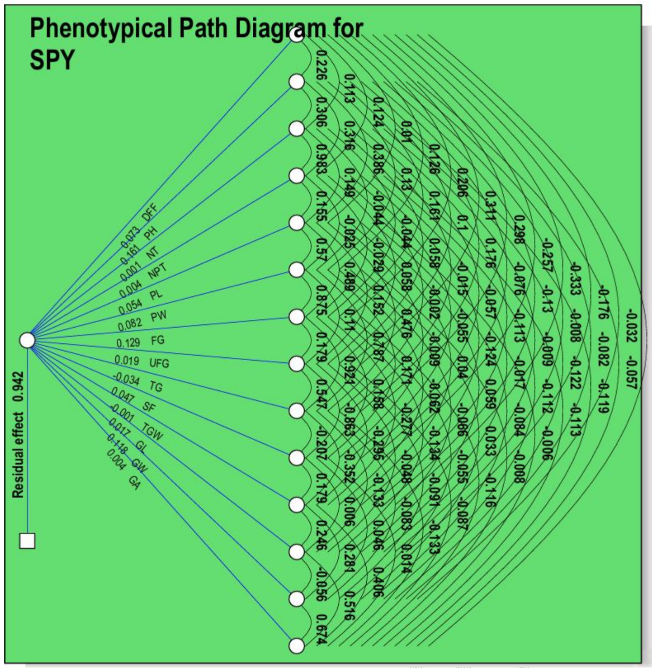


Fig 2 (a): Path diagram for yield related traits

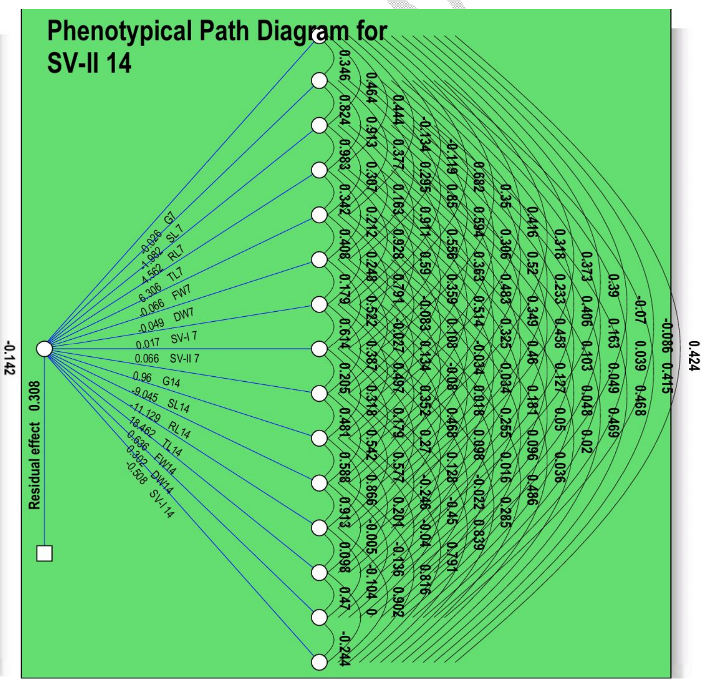


Fig 2 (b): Path diagram for Seedling vigour related traits