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Character association and Path analysis in rice (*Oryza sativa* L.) genotypes evaluated under organic management

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Abstract
The present investigation is carried out at College of Agriculture, Padannakkad, Kerala Agricultural University, to study the character association and path analysis in sixty-five genotypes of rice (*Oryza sativa* L.) under organic management. Among the correlation coefficients of thirteen growth characteristics with grain yield plant^{-1}, for the characteristics chlorophyll content of flag leaf, chlorophyll content of third leaf, number of tillers plant^{-1}at 30DAT, the genotypic correlation coefficients were higher than phenotypic correlation coefficients, indicating the less influence of environment on these characters. However, in the case of parameters namely, number of tillers plant^{-1}at 60DAT, number of tillers plant^{-1}at 90DAT and number of tillers plant^{-1}at harvest, the phenotypic correlation coefficients were higher than genotypic correlation coefficients, which indicates that the influence of environment on these characters is high. Among these characters, number of tillers at harvest and number of tillers at 60DAT possessed both positive association and direct effects. Hence, selection for these characters could bring improvement in organic rice yield improvement programmes.

Keywords: Correlation, organic management, path analysis, rice, yield, yield components

Introduction
Organic farming is gaining much importance in the world with more than 100 countries already practicing it with global area under organic production accounting more than 31 million hectare (Yadav, 2007) [11]. Among these Asian regions constitutes 4.1 million hectares which includes China, India and Russia. In India, organic production is practiced in 2775 hectare. The annual organic rice production in India is 3500 tonnes (Deshpande *et al*., 2010) [3]. Rice has immense potential under organic farming as it is a staple food for about 60% population of India.

But it is estimated that more than 95% of organic production is based on crop varieties that are bred for the conventional high-input sector. Recent studies have shown that such varieties lack important traits required under organic and low-input production conditions. This is primarily due to selection in conventional breeding programmes being carried out in the background of high inorganic fertilizer and crop protection inputs (Bueren *et al*., 2011) [2].

Currently, plant varieties that have been bred specifically for organic systems are meager. To increase organic farmers' success, we must increase the number of varieties bred for organic systems. Grain yield is a complex character dependent on many component characters and it responds poorly to direct selection. Hence, to improve grain yield under organic management, the knowledge on the association between grain yield and growth parameters will be helpful. The main aim of present study was to understand the association among grain yield and growth parameters.

Materials and Methods
The present study was conducted in the Department of Plant Breeding and Genetics, College of Agriculture, Padannakkad, Kerala Agricultural University. The materials comprised of 65 genotypes of rice conserved in the Department of Plant Breeding and Genetics, College of Agriculture, Padannakkad (Table 1), which include 15 traditional genotypes of Kerala, a collection of 39 improved varieties developed for conventional rice farming, out of which 32 varieties are of Kerala Agricultural University and 11 rice varieties/ cultures developed by Kerala Agricultural University adopting strategies of Organic Plant Breeding (OPB) (Table 1). Field trials were laidout during rabi season in the field of a progressive organic rice farming group (Arayidampadasekharam) in Mayyil Panchayath of Kannur district Kerala.

Seeds of 65 rice genotypes were sown during September 2013 in plastic trays which were filled with organic soil. Transplanting of seedlings according to their maturity duration was resorted keeping inter and intra row spacing of 15 cm and 10 cm respectively. Plots consisting of 7 rows of 10 plants each were laid out in a randomized block design with two replications.

All cultural operations were carried out as per the organic cultural management practices followed by the farming group for the last five years. Observations on root length, root weight, root spread, chlorophyll content of flag leaf and third leaf, plant height at all growth stages 30DAT, 60DAT, 90DAT and at harvest), number of tillers at all growth stages (30DAT, 60DAT, 90DAT and at harvest), total biomass and grain yield plant^{-1} (gm) were recorded on ten randomly selected plants in each replication for each treatment after leaving the border rows. Observations were taken as per the "Standard evaluation system for rice" (IRRI, 1996) [5].

Table 1: Rice genotypes used for the investigation

S. No	Genotype	Parentage / Pedigree	Evolved at
Traditional genotypes of Kerala			
1	Ayirankana	Traditional cultivar	Wayanad, Kerala
2	Chembav	Traditional variety	Wayanad, Kerala
3	Gandakasala	Traditional cultivar	Wayanad, Kerala
4	Kalladiyaran	Traditional cultivar	Wayanad, Kerala
5	Kandoorkutty	Traditional cultivar	Wayanad, Kerala
6	Kuthiru	Traditional cultivar	Wayanad, Kerala
7	Kuttoos	Traditional cultivar	Wayanad, Kerala
8	Njavara	Traditional variety	Wayanad, Kerala
9	Orkayama	Traditional cultivar	Wayanad, Kerala
10	Red Mahsuri	Traditional variety	Wayanad, Kerala
11	Valankunhivithu	Traditional variety	Wayanad, Kerala
12	Valicha	Traditional variety	Wayanad, Kerala
13	Valichoori	Traditional variety	Wayanad, Kerala
14	Velambalan	Traditional variety	Wayanad, Kerala
15	Vellathondi	Traditional variety	Wayanad, Kerala
Improved varieties developed for conventional rice farming			
16	Aathira	BR 51-46-1 X Culture 23332-2	RARS, Pattambi, KAU
17	Aishwarya	Jyothi x BR 51-46-1	RARS, Pattambi, KAU
18	Anashwara	Mutant of PTB 20	RARS, Pattambi, KAU
19	Annapurna	TN 1 x PTB 10	RARS, Pattambi, KAU
20	Aruna	Jaya x PTB 33	RRS, Moncompu, KAU
21	Asha	IR 11-1-66 x Kochuvithu	RRS, Moncompu, KAU
22	Badhra	IR 8 x PTB 20	RRS, Moncompu, KAU
23	Bhagya	Tadukkan x Jaya	RARS, Kayamkulam, KAU
24	CO-47	IR 50 x CO 43	TamilNaduAgril. University
25	Dhanu	PTB 20	RARS, Kayamkulam, KAU
26	FL-478	IR 29 x Pakkali B	IRRI, Philippines
27	Gouri	MO 4 x Cul. 25331	RRS, Moncompu, KAU
28	Haryana basmati	Sona x Basmati-370	Haryana
29	IR-28	IR 833-6-2-1--1 x IR 2040	IRRI, Philippines
30	Kanakam	IR 1561 x PTB 33	RRS, Moncompu, KAU
31	Kanchana	IR 36 X Pavizham	RARS, Pattambi, KAU
32	Karishma	MO 1 x MO 6	RRS, Moncompu, KAU
33	Karthika	Triveni x IR 1539	RARS, Pattambi, KAU
34	Karuna	CO-25 X H_4	RARS, Pattambi, KAU
35	Kasthuri	Basmati 370 x CRR88-17-1-5	Gujarath
36	Krishnanjana	MO 1 x MO 6	RRS, Moncompu, KAU
37	Mahsuri	Taichung 65 x MayanaEbos 6080/2	Andra Pradesh
38	Makom	ARC 6650 x Jaya	RRS, Moncompu, KAU
39	Neeraja	IR 20 X IR 5	RARS, Pattambi, KAU
40	Onam	Kochuvithu x TN 1 x Triveni	RARS, Kayamkulam, KAU
41	Prathyasha	IET 4786 x Aruna	RRS, Moncompu, KAU
42	Pusa Basmati	Pusa 1301 x Pusa1121	IARI, New delhi
43	Remanika	Mutant of MO 1	RRS, Moncompu, KAU
44	Remya	Jaya x PTB 33	RRS, Moncompu, KAU
45	Renjini	MO 5 x M 28-1-1	RRS, Moncompu, KAU
46	Revathy	Cul. 12814 x MO 6	RRS, Moncompu, KAU
47	Sagara	Mass selection from Oorumundakan local	RARS, Kayamkulam, KAU
48	Samyuktha	Pureline selection from Cul. C2	RARS, Pattambi, KAU
49	Swarnaprabha	Bhavani x Triveni	RARS, Pattambi, KAU
50	Swetha	IR 50 X C 14-8	RARS, Pattambi, KAU
51	Uma	MO 6 x Pokkali	RRS, Moncompu, KAU
52	Vaishakh	Pureline selection from Swarnaprabha	RARS, Pattambi, KAU
53	Vytilla-1	Pure line selection from Chettivirippu	RRS, Vyttilla, KAU
54	Vytilla-4	Chettivirippu x IR 4630-22-2-17	RRS, Vyttilla, KAU
Varieties/ cultures developed by KAU adopting strategies of OPB			
55	Culture JK-14	Jaya x Kuthiru	PRS, Panniyur, KAU,Kerala
56	Culture JK-15	Jaya x Kuthiru	PRS, Panniyur, KAU,Kerala
57	Culture JK-59	Jaya x Kuthiru	PRS, Panniyur, KAU,Kerala
58	Culture JK-71	Jaya x Kuthiru	PRS, Panniyur, KAU,Kerala
59	Culture JO-532-1	Jaya x Orkayma	PRS, Panniyur, KAU,Kerala
60	Culture JO-583	Jaya x Orkayma	PRS, Panniyur, KAU,Kerala

61	Culture MK-115	Mahsuri x Kuthiru	KAU, Kerala
62	Culture MK-157	Mahsuri x Kuthiru	KAU, Kerala
63	Ezhome-1	Jaya x Kuthiru	PRS, Panniyur, KAU,Kerala
64	Ezhome-2	Jaya x Orkayma	PRS, Panniyur, KAU,Kerala
65	Ezhome-3	Mahsuri x Kuthiru	KAU, Kerala

Results and Discussion

Studies on association of characters gain importance in plant breeding, because they aim the plant breeders to know the inter-character influence and help to strike economic and reliable balance between various characters. Moreover, genotypic correlations have their own importance because of their stability and reliability as these relationships arise through genetic reasons namely, linkage or pleiotropy (Vanaja *et al*., 1998) [9]. Since yield is a complex character, the practice of unilateral selection often results in retrograde or less optimum progress in isolating superior genotypes. Therefore, the knowledge of inter relationships of characters, play a vital role in developing appropriate selection criteria for the improvement of complex characters like grain yield. The results and discussion of correlation and path analysis studies between grain yield palnt^{-1} and different growth parameters are presented below (Table 2 and Table 3).

Correlation

The present investigation indicated that, the genotypic correlation coefficients were higher than the phenotypic correlation coefficients indicating that, the observed relationships among the various characteristics were due to genetic causes. Among the correlation coefficients of thirteen growth characteristics with grain yield plant^{-1}, for the characteristics chlorophyll content of flag leaf, chlorophyll content of third leaf, number of tillers plant^{-1}at 30DAT, the genotypic correlation coefficients were higher than phenotypic correlation coefficients, indicating the less influence of environment on these characters. Similar results were reported by (Vanaja *et al*., 1998) [9]. However, in the case of parameters namely, number of tillers plant^{-1}at 60DAT, number of tillers plant^{-1}at 90DAT and number of tillers plant^{-1}at harvest, the phenotypic correlation coefficients were higher than genotypic correlation coefficients, which indicates that the influence of environment on these characters is high.

The highest significant positive genotypic correlation of grain yield plant^{-1} with number of tillers at 30DAT followed by number of tillers plant^{-1} at 90DAT, number of tillers plant^{-1}at 60DAT, number of tillers plant^{-1}at harvest, and significant negative genotypic correlation of grain yield plant^{-1} with chlorophyll content of flag leaf and chlorophyll content of third leaf reveals that improvement in grain yield plant^{-1} could be achieved by exercising selection simultaneously for increased number of tillers plant^{-1}at 30DAT, number of tillers plant^{-1}at 90DAT, number of tillers plant^{-1}at 60DAT, number of tillers plant^{-1}at harvest and reduced chlorophyll content of flag leaf and third leaf. It was evident from genotypic and phenotypic correlation coefficients that number of tillers plant^{-1}at 60 DAT plays a higher role compared to number of tillers at 30 DAT, at 90 DAT and at harvest to increase the straw yield plant^{-1}.

Path Analysis

Though the correlation studies are helpful in measuring the association between yield and yield components; they do not provide the exact picture of the direct and indirect cause of such association which can be obtained through path analysis (Wright, 1923) [10]. Path analysis is very useful to pinpoint the important component which can be utilized for formulating selection parameters.

Low residual effect obtained in path analysis of current experiment indicates that the causative factor included in the analysis have been adequate to explain variability in yield. Path coefficient analysis revealed that the highest positive direct effect was exhibited by plant height at 90DAT. It may also due to organic farming, as it is an organic varietal trait. Positive direct effect of plant height on grain yield was earlier reported by Nagaraju *et al*. (2013) [7], Dhurai *et al*. (2014) [4]. Second highest positive direct effect on grain yield plant^{-1} was contributed by the characteristic chlorophyll content of third leaf. High positive direct effect excerted by chlorophyll content of third leaf on grain yield plant^{-1} and at the same time its negative significant correlation with grain yield plant^{-1} indicates that there should be optimum chlorophyll content of third leaf at flowering stage for maximizing grain yield plant^{-1}. Highest positive direct effect of chlorophyll content was earlier reported by Kumar and Nilanjaya, (2014) [6].

Other characteristics namely, root weight, root spread, plant height at 30DAT, plant height at 60DAT, number of tillers plant^{-1}at 60DAT, number of tillers plant^{-1}at harvest also exhibited positive direct influence on grain yield plant^{-1}indicating their importance in determining this complex character and therefore, should be kept in mind while practicing selection aimed at the improvement of grain yield plant^{-1}. These results are in accordance with the findings of Kumar and Nilanjaya, (2014) [6] for number of tillers.

The highest negative direct effect was exhibited by plant height at harvest. This indicates that tallness in rice reduces the paddy yield due to high accumulation of photosynthates in vegetative parts as compared to reproductive parts (i.e. seed formation and grain filling) and lodging susceptibility (Zahid *et al*., 2006) [12]. Hence while selecting the genotypes, emphasis should be given to those becoming tall for up to reproductive stage for the improvement of grain yield plant^{-1}. Negative direct effect of plant height was earlier reported by Ramakrishnan *et al*. (2006) [8] and Kumar and Nilanjaya, (2014) [6]. Negative direct effect was also exhibited by the characteristics namely, Chlorophyll content of flag leaf, root length, number of tillers plant^{-1}at 30DAT, number of tillers plant^{-1}at 90DAT, total biomass plant^{-1}. These results are in accordance with the findings of Akhtar *et al*. (2011) [1] for number of tillers; Kumar and Nilanjaya, (2014) [6] for root length.

Conclusion

Character association and path analysis studies conducted in the present investigation reveal that, in yield improvement programmes of organic rice, breeder should give emphasis for growth parameters like high plant height up to 90DAT, optimum plant height at harvest, high chlorophyll content of third leaf with optimum chlorophyll content of flag leaf, high number of tillers at all the growth stages with high number of productive tillers plant^{-1}, high root weight and root spread with optimum root length, total biomass plant^{-1}.

Table 1: Estimation of correlation coefficients between yield and growth parameters of 65 rice genotypes

		A	B	C	D	E	F	G	H	I	J	K	L	M	N
A	rg	1													
	rp	1													
B	rg	0.0319	1												
	rp	0.0423	1												
C	rg	0.3849**	-0.5172**	1											
	rp	0.5314**	-0.0755	1											
D	rg	0.2912**	0.1804*	-0.2087*	1										
	rp	0.1932*	0.1252	-0.0604	1										
E	rg	0.4017**	0.1804*	-0.1864*	0.9476**	1									
	rp	0.1138	0.0839	-0.0534	0.8186**	1									
F	rg	-0.2195*	-0.1763*	-0.2178*	-0.3379**	-0.5132**	1								
	rp	-0.1379	-0.0701	-0.1013	-0.2702**	-0.3680**	1								
G	rg	-0.0386	-0.1776*	-0.0051	-0.3105**	-0.4481**	0.9823**	1							
	rp	-0.0446	-0.1246	-0.0041	-0.2781**	-0.3429**	0.9159**	1							
H	rg	-0.0261	-0.2461**	0.141	-0.2179*	-0.3262**	0.8601**	0.9133**	1						
	rp	-0.0063	-0.1765*	0.1015	-0.2014*	-0.2623**	0.7702**	0.8554**	1						
I	rg	0.0062	-0.2382**	0.1584	-0.1907*	-0.3013**	0.8639**	0.9176**	0.9979**	1					
	rp	0.0028	-0.1708	0.0907	-0.1822*	-0.2664**	0.7702**	0.8548**	0.9904**	1					
J	rg	-0.0927	-0.04	0.1492	-0.787**	-0.8034**	0.2997**	0.3076**	0.2505**	0.2486**	1				
	rp	0.0096	-0.0469	0.1349	-0.5625**	-0.4697**	0.3263**	0.3214**	0.2057*	0.1957*	1				
K	rg	-0.139	-0.0573	0.0103	-0.6951**	-0.7148**	0.3128**	0.2853**	0.1832*	0.1815*	1.0077**	1			
	rp	0.0135	-0.0131	0.1516	-0.5106**	-0.4246**	0.2911**	0.2843**	0.1485	0.1405	0.8415**	1			
L	rg	-0.1114	0.018	-0.0274	-0.6743**	-0.6887**	0.318**	0.2937**	0.1678	0.1654	0.9074**	1.0206**	1		
	rp	0.0157	-0.0481	0.1338	-0.4631**	-0.3802**	0.2558**	0.2576**	0.1087	0.1126	0.7463**	0.8709**	1		
M	rg	-0.0414	0.0702	0.0144	-0.578**	-0.5397**	0.1396	0.1654	0.0294	0.0254	0.8545**	0.9614**	0.9794**	1	
	rp	0.0454	-0.0133	0.159	-0.4322**	-0.3455**	0.1552	0.1681	0.0087	0.0092	0.7108**	0.8275**	0.8796**	1	
N	rg	-0.1938*	-0.1601	0.1083	-0.3959**	-0.3831**	0.1702	0.1105	0.0311	0.0367	0.6139**	0.6601**	0.5043**	0.3899**	1
	rp	-0.0825	-0.1414	0.0595	-0.3494**	-0.2802**	0.1384	0.0971	0.0232	0.0316	0.4534**	0.4623**	0.3828**	0.3386**	1
O	rg	-0.1203	0.039	-0.0056	-0.4386**	-0.345**	0.0514	0.1056	0.0434	0.0165	0.3282**	0.2749**	0.2829**	0.2723**	-0.0312
	rp	-0.0316	0.0046	0.0676	-0.3989**	-0.2723**	0.065	0.114	0.0306	0.0082	0.3157**	0.3036**	0.3298**	0.3669**	-0.0063

(Significance levels 5% - '*', 1% - '**')

A - Root length,
B - Root weight,
C - Root spread,
D - Chlorophyll content of flag leaf,
E - Chlorophyll content of third leaf,
F - Plant height at 30DAT,
G - Plant height at 60DAT,
H - Plant height at 90DAT,
I - Plant height at harvest,
J - Number of tillers at 30DAT,
K - Number of tillers at 60DAT,
L - Number of tillers at 90DAT,
M - Number of tillers at harvest,
N - Total biomass plant^{-1},
O – Grain yield plant^{-1}

Table 2: Estimation of direct and indirect effect of growth parameters on yield of 65 rice genotypes

		A	B	C	D	E	F	G	H	I	J	K	L	M	N
A	G	-0.4514	-0.0144	-0.1738	-0.1314	-0.1813	0.0991	0.0174	0.0118	-0.0028	0.0418	0.0627	0.0503	0.0187	0.0875
	P	-0.0993	-0.0042	-0.0527	-0.0192	-0.0113	0.0137	0.0044	0.0006	-0.0003	-0.001	-0.0013	-0.0016	-0.0045	0.0082
B	G	0.0019	0.0582	-0.0301	0.0105	0.0105	-0.0103	-0.0103	-0.0143	-0.0139	-0.0023	-0.0033	0.001	0.0041	-0.0093
	P	-0.0015	-0.0346	0.0026	-0.0043	-0.0029	0.0024	0.0043	0.0061	0.0059	0.0016	0.0005	0.0017	0.0005	0.0049
C	G	0.0221	-0.0297	0.0574	-0.012	-0.0107	-0.0125	-0.0003	0.0081	0.0091	0.0086	0.0006	-0.0016	0.0008	0.0062
	P	-0.0148	0.0021	-0.0278	0.0017	0.0015	0.0028	0.0001	-0.0028	-0.0025	-0.0037	-0.0042	-0.0037	-0.0044	-0.0017
D	G	-0.3739	-0.2317	0.2679	-1.2839	-1.2166	0.4338	0.3986	0.2797	0.2448	1.0104	0.8925	0.8658	0.742	0.5083
	P	-0.0677	-0.0439	0.0212	-0.3505	-0.2869	0.0947	0.0975	0.0706	0.0639	0.1971	0.1789	0.1623	0.1515	0.1225
E	G	0.4042	0.1815	-0.1875	0.9534	1.0062	-0.5164	-0.4509	-0.3282	-0.3032	-0.8084	-0.7192	-0.693	-0.543	-0.3855
	P	0.0329	0.0243	-0.0155	0.2369	0.2894	-0.1065	-0.0992	-0.0759	-0.0771	-0.1359	-0.1229	-0.11	-0.1	-0.0811
F	G	-0.0172	-0.0138	-0.017	-0.0264	-0.0401	0.0782	0.0768	0.0673	0.0676	0.0234	0.0245	0.0249	0.0109	0.0133

	P	-0.0061	-0.0031	-0.0045	-0.012	-0.0163	0.0443	0.0406	0.0341	0.0341	0.0145	0.0129	0.0113	0.0069	0.0061
G	G	-0.036	-0.1654	-0.0048	-0.2893	-0.4176	0.9153	0.9318	0.851	0.855	0.2866	0.2659	0.2737	0.1541	0.103
	P	-0.0019	-0.0054	-0.0002	-0.0121	-0.015	0.04	0.0436	0.0373	0.0373	0.014	0.0124	0.0112	0.0073	0.0042
H	G	-0.0929	-0.8777	0.5028	-0.7772	-1.1634	3.0681	3.2579	1.0567	3.5593	0.8935	0.6535	0.5986	0.1048	0.111
	P	-0.0035	-0.0974	0.056	-0.1111	-0.1447	0.4249	0.4719	0.5517	0.5464	0.1135	0.082	0.06	0.0048	0.0128
I	G	-0.0259	0.991	-0.6592	0.7933	1.2536	-3.5942	-3.8176	-4.1515	-1.0605	-1.0344	-0.7549	-0.6881	-0.1059	-0.1525
	P	-0.0018	0.1108	-0.0589	0.1182	0.1729	-0.4999	-0.5548	-0.6428	-0.649	-0.127	-0.0912	-0.0731	-0.006	-0.0205
J	G	0.0395	0.017	-0.0635	0.3352	0.3422	0.1276	-0.131	-0.1067	-0.1059	-0.4259	-0.4292	-0.3864	-0.3639	-0.2614
	P	-0.0018	0.0086	-0.0248	0.1034	0.0863	-0.06	-0.0591	-0.0378	-0.036	-0.1838	-0.1547	-0.1372	-0.1306	-0.0833
K	G	-0.0148	-0.0061	0.0011	-0.0741	-0.0762	0.0333	0.0304	0.0195	0.0193	0.1074	0.1066	0.1088	0.1025	0.0704
	P	0.0018	-0.0018	0.0206	-0.0692	-0.0575	0.0395	0.0385	0.0201	0.019	0.1141	0.1355	0.118	0.1122	0.0627
L	G	0.1211	-0.0195	0.0298	0.7325	0.7481	-0.3454	-0.319	-0.1823	-0.1797	-0.9856	-1.1086	-1.0862	-1.0638	-0.5478
	P	-0.0019	0.0058	-0.0161	0.0557	0.0457	-0.0307	-0.031	-0.0131	-0.0135	-0.0897	-0.1047	-0.1202	-0.1057	-0.046
M	G	-0.0156	0.0265	0.0054	-0.2185	-0.204	0.0528	0.0625	0.0111	0.0096	0.323	0.3634	0.3702	0.378	0.1474
	P	0.0075	-0.0022	0.0264	-0.0718	-0.0574	0.0258	0.0279	0.0014	0.0015	0.1181	0.1375	0.1461	0.1661	0.0562
N	G	0.0149	0.0123	-0.0083	0.0305	0.0295	-0.0131	-0.0085	-0.0024	-0.0028	-0.0473	-0.0509	-0.0389	-0.0301	-0.0771
	P	0.0089	0.0152	-0.0064	0.0377	0.0302	-0.0149	-0.0105	-0.0025	-0.0034	-0.0489	-0.0498	-0.0413	-0.0365	-0.1078

(Residual effect (Genotypic) = 0.2572, Residual effect (Phenotypic) = 0.6097, Bold: Direct effects, Normal: Indirect effect)(**A** - Root length, **B** - Root weight, **C** - Root spread, **D** - Chlorophyll content of flag leaf, **E** - Chlorophyll content of third leaf, **F** - Plant height at 30DAT, **G** - Plant height at 60DAT, **H** - Plant height at 90DAT, **I** - Plant height at harvest, **J** - Number of tillers at 30DAT, **K** - Number of tillers at 60DAT, **L** - Number of tillers at 90DAT, **M** - Number of tillers at harvest, **N** - Total biomass plant^{-1})

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