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Effective Selection Criteria for Yield Improvement in Interspecific Derivatives of Mungbean [Vigna Radiata (L.) Wilczek]

KEYWORDS: mungbean, interspecific hybridization, correlation, path analysis

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ABSTRACT *Mungbean [Vigna radiata (L.) Wilczek] also known as green gram or moong, one of the most important pulse crop is extensively grown in South and South East Asian countries. The average productivity of mungbean is very low in comparison to cereals. Grain yield is a complex character hence selection based on yield is not effective. Hence selection based on traits other than yield can be more effective. Interspecific hybridization is important for genetic enhancement of crop plants. The present study is therefore conducted with the objective to identify the component traits for selection for yield improvement involving derivatives of interspecific crosses. A set of 58 interspecific derivatives of mungbean and 6 checks were grown in a simple lattice design in summer and kharif seasons to determine association among different traits and their contribution towards seed yield. It was found that in both summer and kharif seasons, plant height, 100 seed weight, days to 50% flowering, days to maturity and harvest index are most important parameters for selection for higher yield whereas number of pods per plant and biological yield are important only in the kharif season in interspecific derivatives of mungbean.*

INTRODUCTION

Mungbean [Vigna radiata (L.) Wilczek] also known as green gram or moong is one of the most important pulse crop extensively grown in South and South East Asian countries under varying climatic conditions. In India it is grown in kharif, spring/ summer (North India) and rabi season (South India). India alone with an area of 3.42 million hectare and production of 1.70 million tonnes accounts for about two-third of global production (Anonymous 2013). Mungbean is a highly nutritious crop and is regarded as a quality pulse due to its rich protein content and excellent digestibility. The average productivity of mungbean is very low in comparison to cereals. So far, only marginal increase in yield level has been realized through various tools of genetic improvement. Grain yield is a complex character, highly influenced by the environment. Hence, selection based on yield is not very effective. Selection based on traits other than yield that are less influenced by the environmental factors can be more effective.

Interpsecific hybridization is important for genetic enhancement of crop plants to transfer desirable characteristics from related species. The introgressed materials developed through wide crosses can also contribute as genetic reservoirs for novel genes apart from contributing to the yield and yield components (Pandiyan et al 2010).

Grain yield is a quantitative trait and has a multiplicative effect of number of component traits. Thus, a thorough understanding of yield contributing traits, inter-relationships among them and with yield is a pre-requisite for selection in breeding programmes. With more variables in correlation studies, indirect associations become more complex and important. In such circumstances, path analysis provides an effective means in finding out direct and indirect causes of association. Path analysis helps in determining the forces governing the correlations and thus, provides a tool for selection of better genotypes.

Therefore, the present investigation was conducted with the objective to identify the component traits for selection for yield improvement involving derivatives of crosses between cultivated mungbean with urdbean and ricebean.

MATERIAL AND METHODS:

A set of 58 interspecific derivatives of interspecific crosses of mungbean x urdbean and mungbean x ricebean, 2 checks of summer mungbean varieties (SML 668 and SML 832), 2 checks of summer urdbean varieties (Mash 218 and Mash 1008) and 2 checks of ricebean varieties (RBL6 and RBL 35) in the summer season and Same set of 58 interspecific derivatives of interspecific crosses of mungbean x urdbean and mungbean x ricebean and 2 checks of kharif mungbean varieties (PAU911 and ML818), 2 checks of kharif urdbean varieties (Mash 1-1 and Mash 114) and 2 checks of ricebean varieties (RBL6 and RBL 35) in the Kharif season. The experiments were conducted during summer 2013 and Kharif 2013 seasons in the Experimental Area of Pulses Section, Department of Plant Breeding and Genetics during summer 2013 and kharif 2013 seasons. These 64 genotypes were sown in paired rows of 3 m each in simple lattice design (8x8) with two replications. Row to row and plant to plant spacing was kept at 22.5 cm and 10-15 cm, respectively. Data for the morphological traits i.e. days to 50% flowering, days to maturity, Primary branches per plant, Secondary branches per plant, Plant height, Number of clusters per plant, number of pods per plant, number of seeds per pod, seed yield per plant, 100 seed weight, biological yield per plot and harvest index were recorded. Data for days to 50% flowering and days to maturity were recorded on plot basis whereas for rest of the characters data were recorded from five randomly selected plants in each replication. The correlation coefficients for all the character combinations were calculated as per method given by Al-Jibouri et al (1958). The correlation coefficient was partitioned with components of direct and indirect effects by path coefficient analysis as per method of Deway and Lu (1959).

RESULTS AND DISCUSSIONS:

From correlation matrix of both seasons i.e summer and kharif for different characters it was evident that genotypic correlation coefficients in general were higher in magni-

Volume : 4 | Issue : 11 | November 2014 | ISSN - 2249-555X

tude than the corresponding phenotypic correlation coefficients. This indicated that there was an inherent association among various characters under study.

Summer season:
Phenotypic and genotypic correlation coefficients for summer season for different yield parameters are given in Table 1 and path analysis in 1a. At phenotypic level seed yield was significantly and positively correlated with plant height (0.5708**), 100 seed weight (0.4810**), days to maturity (0.4696**), days to 50% flowering (0.3059**), and harvest index (0.2571**). A perusal of Table 1 further reveals that days to 50% flowering was significantly and positively correlated with days to maturity (0.8850**) , plant height (0.6673**) and 100 seed weight (0.3738**) but had a significant and negative correlation with biological yield (-0.4321**), number of seeds per pod (-0.4040**) and primary branches per plant (-0.2309**). Days to maturity was significantly and positively correlated with plant height (0.7899**) and 100 seed weight (0.4774**) but significantly and negatively correlated with biological yield (-0.4077**), number of seeds per pod (-0.3502**) and primary branches per plant (-0.1760*). Primary branches per plant also exhibited positive and significant correlation with number of clusters per plant (0.5796**), secondary branches per plant (0.5678**), number of pods per plant (0.2493**), harvest index (0.2315**) and 100 seed weight (0.1765**). Similarly secondary branches per plant exhibited positive and significant correlation with number of clusters per plant (0.8004**), number of pods per plant (0.5565**), 100 seed weight (0.4036**) and harvest index (0.3973**) and negative significant correlation with seeds per pod (-0.3062**). Plant height was found to be positively and significantly correlated with 100 seed weight (0.4805**) and negatively with biological yield (-0.4215**). Number of clusters per plant was significantly and positively correlated with number of pods per plant (0.7522**), harvest index (0.6206**) and 100 seed weight (0.4805**). Number of pods per plant was found to be significantly and positively correlated with harvest index (0.8266**), 100 seed weight (0.5235**) and biological yield (0.4048**). Number of seeds per pod was found to be positively and significantly correlated with harvest index (0.2735**) and biological yield (0.2298**). 100-seed weight was positively and significantly correlated with harvest index (0.6827**) and a negative correlation with with biological yield per plant (0.2988**). Biological yield also exhibited positive and significant correlation with harvest index (0.4435**).

Even though the correlation is quite helpful in determining the components of complex traits like yield, the exact picture of the relative importance of direct and indirect influence of each character is not provided by such studies. The genotypic as well as phenotypic correlations were partitioned into direct and indirect effects with the help of path analysis and are shown in table 1a. The path coefficient analysis among 12 studied characters revealed that 100 seed weight (1.5014), biological yield per plant (1.0532), days to maturity (0.1285) and number of clusters per plant (0.1134) exerted a positive direct effect on seed yield. Number of pods per plant (-1.4505) and number of seeds per pod (-0.6361) exerted negative direct effect on seed yield. At genotypic level also these parameters showed a direct effect on grain yield. Both days to 50% flowering and days to maturity contributed indirectly and positively to seed yield via number of seeds per pod and 100 seed weight. Primary branches and secondary branches contributed indirectly and positively to seed yield through 100 seed weight, but secondary branches contributed indirectly via seeds per pod also. Plant height contributed indirectly and positively to seed yield via 100 seed weight and number of pods per plant. Positive indirect effect of clusters per plant via 100 seed weight and biological yield to seed yield per plant was also revealed in the study. Similarly number of pods per plant contributed indirectly to seed yield through 100 seed weight and biological yield per plant. Number of seeds per pod contributed indirectly through number of pods per plant and biological yield. 100 seed weight exerted negative indirect effect on seed yield via pods per plant and biological yield per plant. Similarly biological yield per plant contributed negatively and indirectly to seed yield via number of pods per plant, number of seeds per pod and 100 seed weight. Harvest index contributed positively to seed yield via number of seeds per pod, 100 seed weight and biological yield per plant.

Kharif season:
Similarly for kharif season, phenotypic and genotypic correlation coefficients for different yield parameters are given in Table 2 and path analysis in 2a. At phenotypic level seed yield was significantly and positively correlated with harvest index (0.8021**), 100 seed weight (0.7145**), days to maturity (0.6271**) plant height (0.6028**), days to 50% flowering (0.5468**), number of pods per plant (0.5060**) and biological yield (0.2890**). The table 2 further reveals that days to 50% flowering was significantly and positively correlated with days to maturity (0.8625**), plant height (0.7037**), 100 seed weight (0.6516**), number of pods per plant (0.5478**), harvest index (0.5197**) and number of clusters per plant (0.3097**) but had a significant and negative correlation with number of seeds per pod (-0.3761**). Days to maturity was significantly and positively correlated with plant height (0.8272**), 100 seed weight (0.7957**), number of pods per plant (0.6418**), harvest index (0.6139**), number of clusters per plant (0.2911**) and secondary branches per plant (0.1831*) but had a significant and negative correlation with seeds per pod (-0.4026**). Primary branches per plant also exhibited positive and significant correlation with secondary branches (0.4348**) and number of clusters per plant (0.3669**) and a significant and negative correlation with plant height (-0.1980*). Secondary branches exhibits a significant positive correlation with number of clusters per plant (0.5404**), number of pods per plant (0.3810**) and 100 seed weight (0.2556**) and had a negative significant correlation with number of seeds per pod (-0.3669**). Plant height was found to be positively and significantly correlated with 100 seed weight (0.7682**), harvest index (0.5521**) and number of pods per plant (0.5212**) and significantly, negatively correlated with number of seeds per pod (-0.2882**) and biological yield (-0.2195). Number of clusters per plant had a significant and positive correlation with number of pods per plant (0.4874**), 100 seed weight (0.4040**) and harvest index (0.2528**) and significant negative correlation with number of seeds per pod (-0.3801**) and biological yield per plant (-0.2290**). Number of pods per plant was found to be significantly and positively correlated with harvest index (0.8379**) and 100 seed weight (0.7954**) and significantly and negatively correlated with seeds per pod (2991**). Number of seeds per pod was found to be positively and significantly correlated with biological yield (0.2077*) and had a negatively significant correlation with 100 seed weight (-0.1776*). 100-seed weight was found to be positively and significantly correlated with harvest index (0.8396) and significantly negatively correlated with biological yield (-0.1914*). Biological yield also exhibited positive and significant correlation with harvest index (0.3373**).

Path coefficients for yield parameters for kharif season given in Table 2a revealed that at phenotypic level, 100 seed

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weight (1.7612) and biological yield (0.8634) exerted the significant and positive direct effect on grain yield whereas number of pods per plant(-1.0943) and number of seeds per pod(-0.3596) exerted negative direct effect on seed yield. At genotypic level also these parameters showed a similar effect on seed yield. Days to 50% flowering and days to maturity contributed indirectly and positively to seed yield via number of seeds per pod and 100 seed weight and contributed negatively via number of pods per plant. Similarly, days to maturity contributed indirectly positive to seed yield via number of seeds per pod and 100 seed weight and contributed negatively via biological yield and number of pods per plant. Primary branches exhibited indirectly and positively to seed yield through 100 seed weight and indirectly and negatively via biological yield per plant. Secondary branches contributed indirectly and positively to seed yield via number of seeds per pod and 100 seed weight and contributed indirectly and negatively via number of pods per plant. Plant height contributed indirectly positive to seed yield via 100 seed weight and contributed indirectly and negatively via biological yield per plant and number of pods per plant. Positive indirect effect via 100 seed weight and negative indirect effect via number of pods per plant and biological yield per plant to seed yield per plant by number of clusters per plant was revealed. Similarly number of pods per plant contributed indirectly and positively to seed yield through 100 seed weight, number of seeds per pod and biological yield per plant. Number of seeds per pod contributed positively and indirectly through number of pods per plant and biological yield and negatively and indirectly via 100 seed weight to seed yield. Similarly, 100 seed weight exerted negative indirect effect on seed yield via number of pods per plant and biological yield per plant. Biological yield per plant contributed negative indirectly to seed yield via number of pods per plant and 100 seed weight. Harvest index contributed indirectly and positively to seed yield via 100 seed weight and biological yield per plant and had a negative indirect effect via number of pods per plant.

From the review of literature it was evident that the numbers of studies on interspecific hybridization in mungbean have been rather limited. As far as cultivated mungbean genotypes are concerned, a number of studies have been conducted to work out inter-relationships among various traits and with seed yield. Srivastava and Singh (2012) revealed that seed yield had positive and significant correlation with number of pods per plant, 100-seed weight, days to maturity and number of pods per cluster. They also observed that number of pods per plant, number of seeds per pod, number of cluster per plant had maximum direct effect on seed yield. Highly significant correlation of grain yield per plant with days to 50% pod formation and 100-seed weight were revealed by Begum et al (2013). Nand et al (2013) reported a positive and significant correlation with seed yield by traits like 50% flowering, number of branches per plant, number of pods per plant, days to maturity and 100 seed weight. The path analysis revealed that number of seeds per pod, pod length, 50 % flowering and 100 seed weight has a positive direct effect on seed yield. Primary branches per plant, number of clusters per plant, number of seeds per plant had a significant and positive correlation with seed yield. Harvest index, number of pods per plant, number of seeds per pod and days to maturity showed maximum positive direct effect towards seed yield as reported by Persanna et al (2013).

CONCLUSIONS:

It is evident that for summer season, plant height, 100 seed weight, days to maturity, days to 50% flowering and harvest index were important parameters for selection for higher seed yield in this set of interspecific derivatives of mungbean. Path analysis revealed that biological yield and numbers of clusters per plant were having a direct effect on seed yield. During kharif season harvest index, 100 seed weight, days to maturity, plant height, days to 50% flowering, number of pods per plant and biological yield were found to be important parameters for selection whereas for both summer and kharif seasons 100 seed weight, days to 50% flowering, days to maturity and harvest index were common parameters for effective selection for high seed yield in the interspecific derivatives of mungbean.

Table 1: Phenotypic (P) and Genotypic (G) correlation coefficients for yield parameters: Summer season

Yield parameters		Days to maturity	Primary branches	Secondary branches	Plant height	Clusters/ plant	Pods/ plant	Seeds/ pod	100 seed Weight	Biological yield	Harvest index	Seed yield/ plant
Days to 50% flowering	P	0.8850**	-0.2309**	0.0215	0.6673**	0.0713	0.0745	-0.4040**	0.3738**	-0.4321**	-0.0367	0.3059**
	G	0.8874	-0.2948	0.0299	0.7042	0.0903	0.0919	-0.4093	0.4424	-0.6299	-0.0704	0.3135
Days to maturity	P		-0.1760*	0.0416	0.7899**	0.0588	0.0795	-0.3502**	0.4774**	-0.4077**	0.0604	0.4696**
	G		-0.2203	0.0500	0.8281	0.0743	0.1121	-0.3523	0.5639	-0.5793	0.0760	0.4788
Primary branches/ plant	P			0.5678**	-0.1084	0.5796**	0.2493**	0.0323	0.1765*	0.0187	0.2315**	-0.0498
	G			0.6594	-0.1509	0.6961	0.3312	0.0463	0.0914	0.1335	0.2886	-0.0732
Secondary branches/ plant	P				-0.0597	0.8004**	0.5565**	-0.3062**	0.4036**	-0.0182	0.3973**	0.0446
	G				-0.0936	0.8230	0.4460	-0.3759	0.2878	-0.2260	0.1904	0.0783
Plant height	P					-0.1063	-0.1013	-0.1482	0.4805**	-0.4215**	0.0303	0.5708**
	G					-0.1549	-0.1813	-0.1543	0.5847	-0.6326	0.0375	0.5955
Clusters/ plant	P						0.7522**	-0.1292	0.4877**	0.1334	0.6206**	-0.0405
	G						0.6847	-0.1744	0.3734	-0.0598	0.4375	-0.0534
Pods/plant	P							-0.1472	0.5235**	0.4048**	0.8266**	-0.0686
	G							-0.2380	0.4623	0.1569	0.6451	-0.0933
Seeds/pod	P								0.0493	0.2298**	0.2735**	-0.1282
	G								0.0680	0.2958	0.3784	-0.1322
100 seed Weight	P									-0.2988**	0.6827**	0.4810**
	G									-0.4559	0.7118	0.5643
Biological yield	P										0.4435**	-0.1366
	G										0.2741	-0.1774
Harvest index	P											0.2571**
	G											0.3718

Critical value of 'r' at 5% =0.1720 and that at 1% = 0.2237

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Table 1(a): Path coefficients for yield parameters: Summer season

Yield parameters		Days to 50% flowering	Days to maturity	Primary branches/ plant	Secondary branches	Plant height	Clusters/ plant	Pods/ plant	Seeds/ pod	100 seed weight	Biological yield	Harvest index	Correlation with seed yield
Days to 50% flowering	P	-0.0800	0.1137	-0.0003	-0.0005	0.0098	0.0081	-0.1080	0.2570	0.5612	-0.4550	0.0000	0.3059**
	G	0.4319	0.8719	-0.4363	-0.0309	-2.0951	-0.0226	-0.2191	0.4994	3.1230	-2.0667	0.2540	0.3135
Days to maturity	P	-0.0708	0.1285	-0.0002	-0.0010	0.0116	0.0067	-0.1153	0.2227	0.7167	-0.4294	0.0001	0.4696**
	G	0.3833	0.9871	-0.3260	-0.0515	-2.4637	-0.0186	-0.2673	0.4298	3.9804	-1.9007	-0.0741	0.4788
Primary branches/ plant	P	0.0185	-0.0226	0.0013	-0.0139	-0.0016	0.0657	-0.3617	-0.0206	0.2650	0.0197	0.0003	-0.0498
	G	-0.1273	-0.2174	1.4797	-0.6796	0.4489	-0.1741	-0.7898	-0.0565	0.6455	0.4381	-1.0406	-0.0732
Secondary branches/ plant	P	-0.0017	0.0054	0.0007	-0.0244	-0.0009	0.0908	-0.8072	0.1948	0.6059	-0.0192	0.0005	0.0446
	G	0.0129	0.0494	0.9758	-1.0305	0.2785*	-0.2058	-1.0637	0.4587	2.0312	-0.7416	-0.6864	0.0783
Plant height	P	-0.0534	0.1015	-0.0001	0.0015	0.0174	-0.0120	0.1469	0.0943	0.7215	-0.4439	0.0000	0.5708**
	G	0.3042	0.8174	-0.2233	0.0965	-2.9751	0.0387	0.4325	0.1883	4.1270	-2.0754	-0.1352	0.5955
Clusters/ plant	P	-0.0057	0.0076	0.0008	-0.0196	-0.0016	0.1134	-1.0910	0.0822	0.7322	0.1405	0.0008	-0.0405
	G	0.0390	0.0733	1.0300	-0.8481	-0.4609	-0.2501	-1.6328	0.2128	2.6358	-0.1962	-1.5780	-0.0534
Pods/plant	P	-0.0060	0.0102	0.0003	-0.0136	-0.0015	0.0853	-1.4505	0.0937	0.7860	0.4264	0.0010	-0.0686
	G	0.0397	0.1106	0.4900	-0.4596	0.5395	-0.1712	-0.3848	0.2905	3.2635	0.5148	-2.3261	-0.0933
Seeds/pod	P	0.0323	-0.0450	0.0000	0.0075	-0.0022	-0.0147	0.2136	-0.6361	0.0740	0.2420	0.0003	-0.1282
	G	-0.1768	-0.3477	0.0685	0.3874	0.4592	0.0436	0.5675	-1.2201	0.4802	0.9705	-1.3646	-0.1322
100 Seed Weight	P	-0.0299	0.0613	0.0002	-0.0099	0.0071	0.0553	-0.7594	-0.0314	1.5014	-0.3147	0.0008	0.4810**
	G	0.1911	0.5566	0.1353	-0.2965	-1.7395	-0.0934	-1.1025	-0.0830	7.0587	-1.4959	-2.566	0.5643
Biological yield	P	0.0346	-0.0524	0.0000	0.0004	-0.0062	0.0151	-0.5872	-0.1462	-0.4486	1.0532	0.0005	-0.1366
	G	-0.2721	-0.5718	0.1976	0.2329	1.8820	0.0150	-0.3742	-0.3609	-3.2183	3.2809	-0.9883	-0.1774
Harvest index	P	0.0029	0.0078	0.0003	-0.0097	0.0004	0.0704	-1.1990	0.1740	1.0251	0.4671	0.0657	0.2571**
	G	-0.0304	0.0750	0.4270	-0.1962	-0.1116	-0.1094	-1.5384	-0.4617	5.0242	0.8992	-3.6059	0.3718

Table 2: Phenotypic (P) and Genotypic (G) correlation coefficients for yield parameters: Kharif season

Yield parameters		Days to maturity	Primary branches	Secondary branches	Plant height	Clusters/ plant	Pods/ plant	Seeds/ pod	100 seed Weight	Biological yield	Harvest index	Seed yield/ plant
Days to 50% flowering	P	0.8625**	-0.1425	0.1519	0.7037**	0.3097**	0.5478**	-0.3761**	0.6516**	-0.0561	0.5197**	0.5468**
	G	0.8983	-0.2268	0.1729	0.7600	0.3551	0.6535	-0.4078	0.6817	-0.0341	0.5701	0.5577
Days to maturity	P		-0.1477	0.1831*	0.8272**	0.2911**	0.6418**	-0.4026**	0.7957**	-0.1510	0.6139**	0.6271**
	G		-0.1803	0.2314	0.8953	0.3472	0.7670	-0.4223	0.8601	-0.2031	0.6834	0.6412
Primary branches/ Plant	P			0.4348**	-0.1980*	0.3669**	0.0863	0.0542	0.0867	-0.1258	0.0557	-0.0597
	G			0.3892	-0.2243	0.3311	-0.0138	0.0756	-0.0035	-0.1401	-0.0324	-0.0961
Secondary branches/ plant	P				0.0888	0.5404**	0.3810**	-0.3669**	0.2556**	-0.1424	0.1587	0.0552
	G				0.1118	0.5837	0.3828	-0.4402	0.2374	-0.1514	0.1308	0.0806
Plant height	P					0.1704	0.5212**	-0.2882**	0.7682**	-0.2195*	0.5521**	0.6028**
	G					0.2266	0.6573	-0.3188	0.8458	-0.2635	0.6410	0.6402
Clusters/plant	P						0.4874**	-0.3801**	0.4040**	-0.2290**	0.2528**	0.1060
	G						0.5351	-0.4480	0.3964	-0.2515	0.2548	0.1260
Pods/plant	P							-0.2991**	0.7954**	0.1617	0.8379**	0.5060**
	G							-0.3995	0.8603	0.0372	0.8227	0.6126
Seeds/pod	P								-0.1776*	0.2077*	0.0370	-0.1446
	G								-0.2172	0.2172	-0.0081	-0.1557
100 seed Weight	P									-0.1914*	0.8396**	0.7145**
	G									-0.1751	0.8718	0.7586
Biological yield	P										0.3373**	0.2890**
	G										0.3052	0.3643
Harvest index	P											0.8021**
	G											0.8802

Critical value of ‘r’ at 5% =0.1720 and that at 1% = 0.2237

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Table 2(a): Path coefficients for yield parameters: Kharif season

Yield parameters		Days to 50% flowering	Days to maturity	Primary branches/ plant	Secondary branches	Plant height	Clusters/ plant	Pods/ plant	Seeds/ pod	100 seed weight	Biological yield	Harvest index	Correlation with seed yield
Days to 50% flowering	P	-0.0595	0.0100	0.0041	0.0053	-0.0506	0.0024	-0.5995	0.1353	1.1475	-0.0484	0.0002	0.5468**
	G	-0.2493	0.1965	0.0049	-0.0017	-0.1034	0.0362	-0.7376	0.1391	1.6092	-0.0366	-0.2996	0.5577
Days to maturity	P	-0.0516	0.0115	0.0043	0.0063	0.0595	0.0023	-0.7023	0.1448	1.4014	-0.1304	0.0003	0.6271**
	G	-0.2239	0.2187	0.0039	-0.0023	-0.1218	0.0354	-0.8657	0.1441	2.0302	-0.2183	-0.3591	0.6412
Primary branches/ plant	P	0.0085	-0.0017	-0.0289	0.0151	0.0142	0.0029	-0.0944	-0.0195	0.1528	-0.1086	0.0000	-0.0597
	G	0.0565	-0.0394	-0.0215	-0.0039	0.0305	0.0338	0.0156	-0.0258	-0.0083	-0.1507	0.0170	-0.0961
Secondary branches/ plant	P	-0.0090	0.0021	-0.0126	0.0346	-0.0064	0.0043	-0.4169	0.1320	0.4501	-0.1230	0.0001	0.0552
	G	-0.0431	0.0506	-0.0084	-0.0099	-0.0152	0.0595	-0.4321	0.1501	0.5605	-0.1628	-0.0687	0.0806
Plant height	P	-0.0419	0.0095	0.0057	0.0031	-0.0719	0.0013	-0.5703	0.1036	1.3529	-0.1895	0.0003	0.6028**
	G	-0.1894	0.1958	0.0048	-0.0011	-0.1361	0.0231	-0.7419	0.1087	1.9964	-0.2834	-0.3368	0.6402
Clusters/ plant	P	-0.0184	0.0033	-0.0106	0.0187	-0.0122	0.0079	-0.5333	0.1367	0.7116	-0.1977	0.0001	0.1060
	G	-0.0885	0.0759	-0.0071	-0.0058	-0.0308	-0.1020	-0.6040	0.1528	0.9358	-0.2705	0.1339	0.1260
Pods/plant	P	-0.0326	0.0074	-0.0025	0.0132	-0.0375	0.0038	-1.0943	0.1076	1.4008	0.1396	0.0004	0.5060**
	G	-0.1629	0.1678	0.0003	-0.0038	-0.0894	0.0546	-1.1287	0.1363	2.0309	0.0400	-0.4323	0.6126
Seeds/pod	P	0.0224	-0.0046	-0.0016	-0.0172	0.0207	-0.0030	0.3273	-0.3596	-0.3128	0.1793	0.0000	-0.1446
	G	0.1016	-0.0924	-0.0016	0.0044	0.0434	-0.0457	0.4509	-0.3411	-0.5130	0.2336	0.0043	-0.1557
100 Seed Weight	P	-0.0388	0.0091	-0.0025	0.0088	-0.0552	0.0032	-0.8704	0.0639	1.7612	-0.1653	0.0004	0.7145**
	G	-0.1699	0.1881	0.0001	-0.0024	-0.1151	0.0404	-0.9711	0.0741	2.3605	-0.1882	-0.4581	0.7586
Biological yield	P	0.0033	-0.0017	0.0036	-0.0049	0.0158	-0.0018	-0.1770	-0.0747	-0.3371	0.8634	0.0002	0.2890**
	G	0.0085	-0.0444	0.0030	0.0015	0.0359	-0.0257	-0.0420	-0.0741	-0.4133	1.0752	-0.1603	0.3643
Harvest index	P	-0.0309	0.0071	-0.0016	0.0055	-0.0397	0.0020	-0.9169	-0.0133	1.4786	0.2912	0.0202	0.8021**
	G	-0.1421	0.1495	0.0007	-0.0013	-0.0872	0.0260	-0.9286	0.0082	2.0578	0.3281	-0.5254	0.8802

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