Path Coefficient Analysis for Husk and Contributing Traits in Isabgol (*Plantago ovata* Forsk.)

Vineet Kaswan*[1] and SR Maloo[2]

[1]*Department of Molecular Biology and Biotechnology, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology,Udaipur-313001, Rajasthan*

[2]*Dean, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur-313001, Rajasthan*

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The study was conducted at Udaipur, Rajasthan, India during rabi, 2009-11. The aim of study was to evaluate the inter-relationship of trait and husk recovery using path analysis with 24 isabgol genotypes collected from four major isabgol growing states namely Gujarat (4), Madhya Pradesh (1), Rajasthan (17) and Haryana (2) of India. The path coefficient analysis based on husk recovery, as a dependent variable implicated that seed yield/ plant had the highest positive direct effect on husk recovery. This trait was followed by spikes/plant, leaf width and swelling factor. Biological yield/plant and harvest index had negative direct effect on husk recovery. The overall results demonstrated that seed yield/plant and spikes/plant were the most contributing traits on isabgol husk recovery and direct selection based on these traits would be advantageous.

Key Words: Husk recovery, Isabgol, Path analysis, *Plantago ovata*

Introduction

Ever since the dawn of human civilization, plants have been used as a source of medicines, and are a major component of Ayurvedic and Unani medicines (Chudiwal *et al.,* 2010). Out of a large number of medicinal plants known in present scenario, *Plantago ovata* Forsk. (family Plantaginaceae) commonly known as isabgol and commercially as blond psyllium (Dalal and Sri Ram, 1995) is grown in India for its use in ayurvedic medicines (Bist *et al.,* 2001). Economic value of isabgol is mainly related to mucilage content of the seed which mainly present in seed husk. A good crop may yield about 800-1000 kg of seeds per hectare. Harvested seed is processed through a series of grinding mills to separate the husk, about 30 per cent husk by weight is thus recovered. The seed husk, is not only a highly effective laxative but is also used in lowering blood cholesterol levels, ice cream making and cosmetics (Dhar *et al.,* 2005).

Complex trait like husk recovery is highly influenced by many genetic factors and environmental fluctuations. Path coefficient is an excellent means of studying direct and indirect effects of interrelated components of a complex trait (Sodavadiya *et al.,* 2009). Path coefficient analysis, a statistical device developed by Wright (1921), which measures the direct influence of one variable upon the other. Each correlation coefficient between a predictor variable and the response variable is partitioned into its component parts: the direct effect or path coefficient (a standardized partial regression coefficient) for the predictor variable and indirect effects, which involves the product of a correlation coefficient between two predictor variables with the appropriate path coefficient in the path diagram (Dewey and Lu, 1959). By determining the inter-relationships among husk recovery components, a better understanding of both the direct and indirect effects of the specific components can be attained and applied in isabgol improvement programmes. Therefore, this experiment was conducted to study the relations of certain agro-morphological traits with husk yield in isabgol.

Materials and Methods

The experiments were conducted at the instructional farm of the Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan) during *rabi* 2009-10 and 2010-11. The material for present study consisted of 24 genotypes of isabgol from four major isabgol growing states. During both the years, trials were laid out in randomized block design with three replications with plot size of 60 m^2. Row to row and plant to plant distance was kept at 30 and 15 cm, respectively. Fertilizers were applied 25 kg N: 20 kg P_2O_5 and 25 kg K_2O/ha at the time of sowing

*Author for Correspondence: E-mail: vineetkaswan@gmail.com

while 25 kg N/ha was top-dressed one month after sowing. Immediately after sowing a light irrigation was given. Second irrigation was given after three weeks and third one at the time of formation of spikes. Seven irrigations were given during the entire crop period. The plots were weeded manually to keep weed pressure low. Other recommended agronomic management practices were adopted for optimum crop growth and development. The data was recorded on fifteen agro-morphological traits. Five competitive plants were randomly selected and tagged from each replication in a genotype for recording detailed observations for 11 traits *viz.*, plant height, leaf width, effective tillers/plant, spikes/plant, weight of spike, weight of seeds/spike, spike length, test weight, seed yield/plant, biological yield/plant and harvest index (%). Days to 50% flowering and days to maturity were monitored as the number of days from sowing to when 50% of the plants flowered and 100% of the plants attained physiological maturity within a plot, respectively. Husk recovery (%) and swelling factor were calculated according to Kalyansundaram *et al.* (1982) and Kokate (1994), respectively.

The methodology proposed by Dewey and Lu (1959) was used to perform the path analysis for husk recovery and its components keeping husk recovery as resultant variable and its components as causal variables. For this purpose computer software Windostat (version 7.0) developed by Indostat Services Ltd., Hyderabad (India) was used.

Result and Discussion

The phenotypic as well as genotypic correlation coefficients between husk recovery and different traits were subjected to path coefficient analysis separately for partitioning these values into direct and indirect effects. The results obtained for direct and indirect effects of different traits on husk recovery at phenotypic and genotypic level are summarized in Table 1. The results of path analysis at genotypic and phenotypic level revealed that seed yield/plant (6.104 and 0.988) has maximum positive and significant direct effect on husk recovery followed by spikes per plant (1.297 and 0.583), leaf width (0.477 and 0.549) and swelling factor (0.293 and 0.461). This means that a slight increase in one of these traits may directly contribute to husk recovery. On the other hand, negative and significant direct effect of biological yield/plant (-6.026 and -1.259) and harvest index (-1.567 and -0.121) was observed on husk recovery. Effective tillers/plant showed negative and significant direct effect (-0.505) on husk recovery at genotypic level whereas, at phenotypic level its direct effect (0.042) on husk recovery was positive and significant. At genotypic level weight of seeds/spike and spike length exhibited positive and significant direct effect (0.453 and 0.929) with husk recovery. Days to maturity at genotypic level showed positive direct effect (1.407) on husk recovery with negative significant correlation.

Maximum positive indirect effects at genotypic and phenotypic level of biological yield/plant (5.721 and 0.902), spikes/plant (5.602 and 0.86), effective tillers/plant (3.904 and 0.57), harvest index (3.203 and 0.519), weight of seeds/spike (3.146 and 0.44), weight of spike (3.073 and 0.406), spike length (1.39 and 0.2), plant height (1.069 and 0.142) and leaf width (1.062 and 0.167) via seed yield/plant and biological yield/plant (1.224 and 0.516) and seed yield/plant (1.19 and 0.508) via spikes/plant were observed on husk recovery. Days to 50% flowering showed positive indirect effect (1.431) via days to maturity on husk recovery at genotypic level. Most of the traits showed their positive indirect effect only through seed yield/plant. Hence it may be concluded that seed yield/plant is the main trait which is responsible for manipulation of husk recovery in isabgol. Maximum negative indirect effect at both level of spikes/plant (-5.691 and -1.115), seed yield/plant (-5.647 and -1.15), effective tillers/plant (-3.043 and -0.577), weight of spike (-2.195 and -0.324), plant height (-1.853 and -0.39), weight of seeds/spike (-1.757 and -0.324), spike length (-1.346 and -0.244), days to 50% flowering (-1.274 and -0.23), harvest index (-1.212 and -0.178) and days to maturity (-1.167 and -0.16) *via* biological yield/plant were noticed on husk recovery. At genotypic level negative indirect effect of days to maturity (-1.497) via days to 50% flowering, weight of seeds/spike (-1.022) via weight of spike and weight of seeds/spike (-1.127) via harvest index was recorded on husk recovery. Days to maturity showed negative significant correlation with husk recovery due to indirect negative effect of days to 50 % flowering and biological yield/plant while, its direct effect was positive. The high values (R_g= 0.198 and R_p= 0.257) of residual effect towards husk recovery in the present study might be due to many other traits which were not studied, environmental factors and sampling errors (Sengupta and Karatia, 1971).

The path coefficient analysis revealed a clear idea about the highest contributing trait to husk recovery and

Table 1. Phenotypic (P) and genotypic (G) path coefficient analysis showing direct and indirect effects of different traits on husk recovery in isabgol

Trait		Plant height	Days to 50% flowering	Leaf width	Effective tillers/ plant	Spikes/ plant	Weight of spike	Weight of seeds/ spike	Spike length	Test weight	Seed yield/ plant	Biological yield/ plant	Harvest index	Days to maturity	Swelling factor	Correlation with husk recovery
Plant height	G	<u>-0.110</u>	-0.264	-0.029	-0.117	0.317	-0.029	0.007	0.455	0.009	1.069	-1.853	0.387	0.272	-0.091	0.023
	P	<u>0.216</u>	0.035	-0.043	0.007	0.083	0.017	0.000	0.044	0.011	0.142	-0.391	0.038	-0.023	-0.128	0.007
Days to 50% flowering	G	-0.020	<u>-1.472</u>	-0.133	0.010	0.155	0.212	-0.060	0.024	0.103	0.301	-1.274	0.607	1.431	-0.068	-0.185
	P	0.022	<u>0.346</u>	-0.117	0.000	0.105	-0.005	-0.009	-0.004	0.078	0.074	-0.230	0.026	-0.326	-0.062	-0.103
Leaf width	G	0.007	0.410	<u>0.477</u>	-0.004	0.024	-0.402	0.192	0.139	-0.022	1.062	-0.533	-0.494	-0.351	-0.049	0.456**
	P	-0.017	-0.074	<u>0.549</u>	0.001	0.034	-0.073	0.032	0.018	-0.026	0.167	-0.103	-0.034	0.041	-0.064	0.453**
Effective tillers/ plant	G	-0.026	0.029	0.004	<u>-0.505</u>	0.820	-0.110	0.118	0.271	0.009	3.904	-3.043	-0.852	-0.158	0.025	0.486**
	P	0.036	-0.003	0.008	<u>0.042</u>	0.332	-0.027	0.014	0.033	0.007	0.570	-0.577	-0.053	0.020	0.036	0.439**
Spikes/plant	G	-0.027	-0.176	0.009	-0.320	<u>1.297</u>	-0.016	0.040	0.102	0.025	5.602	-5.691	-0.466	0.043	0.028	0.451**
	P	0.031	0.062	0.032	0.024	<u>0.583</u>	-0.032	0.007	0.011	0.016	0.860	-1.115	-0.035	-0.050	0.060	0.453**
Weight of spike	G	-0.003	0.325	0.200	-0.058	0.021	<u>-0.958</u>	0.483	0.636	-0.090	3.073	-2.195	-0.846	-0.414	-0.015	0.159
	P	-0.020	0.009	0.217	0.006	0.101	<u>-0.183</u>	0.063	0.064	-0.087	0.406	-0.324	-0.057	-0.045	0.033	0.185
Weight of seeds/ spike	G	-0.002	0.196	0.203	-0.132	0.115	-1.022	<u>0.453</u>	0.449	-0.093	3.146	-1.757	-1.127	-0.167	-0.003	0.258*
	P	0.001	-0.039	0.210	0.007	0.045	-0.137	<u>0.085</u>	0.058	-0.084	0.440	-0.324	-0.065	0.028	0.004	0.229
Spike length	G	-0.054	-0.038	0.071	-0.147	0.142	-0.656	0.219	<u>0.929</u>	-0.033	1.390	-1.346	-0.236	0.005	0.013	0.260*
	P	0.059	-0.008	0.062	0.009	0.039	-0.074	0.031	<u>0.159</u>	-0.026	0.200	-0.244	-0.017	0.023	0.002	0.216
Test weight	G	0.005	0.768	0.054	0.023	-0.165	-0.438	0.214	0.156	<u>-0.197</u>	0.606	0.327	-0.689	-0.792	0.038	-0.090
	P	-0.011	-0.133	0.069	-0.001	-0.047	-0.078	0.035	0.021	<u>-0.203</u>	0.109	0.072	-0.050	0.090	0.071	-0.056
Seed yield/plant	G	-0.019	-0.073	0.083	-0.323	1.190	-0.483	0.233	0.212	-0.020	<u>6.104</u>	-5.647	-0.822	-0.004	0.026	0.458**
	P	0.031	0.026	0.093	0.024	0.508	-0.075	0.038	0.032	-0.022	<u>0.988</u>	-1.150	-0.064	-0.017	0.043	0.454**
Biological yield/ plant	G	-0.034	-0.311	0.042	-0.255	1.224	-0.349	0.132	0.208	0.011	5.721	<u>-6.026</u>	-0.315	0.272	0.010	0.329**
	P	0.067	0.063	0.045	0.019	0.516	-0.047	0.022	0.031	0.012	0.902	<u>-1.259</u>	-0.017	-0.043	0.009	0.319*
Harvest index	G	0.027	0.570	0.150	-0.275	0.386	-0.517	0.326	0.140	-0.087	3.203	-1.212	<u>-1.567</u>	-0.694	0.039	0.488**
	P	-0.067	-0.073	0.155	0.018	0.170	-0.086	0.045	0.023	-0.084	0.519	-0.178	<u>-0.121</u>	0.055	0.072	0.446**
Days to maturity	G	-0.021	-1.497	-0.119	0.057	0.040	0.282	-0.054	0.004	0.111	-0.015	-1.167	0.773	<u>1.407</u>	-0.093	-0.293*
	P	0.014	0.332	-0.067	-0.002	0.086	-0.024	-0.007	-0.011	0.054	0.049	-0.160	0.019	<u>-0.340</u>	-0.051	-0.108
Swelling factor	G	0.034	0.342	-0.080	-0.043	0.126	0.048	-0.005	0.040	-0.025	0.536	-0.208	-0.208	-0.449	<u>0.293</u>	0.401**
	P	-0.060	-0.047	-0.076	0.003	0.076	-0.013	0.001	0.001	-0.031	0.092	-0.025	-0.019	0.038	<u>0.461</u>	0.402**

Residual effect R_g= 0.198 and R_p= 0.257 at genotypic level and phenotypic level, respectively; *,**: Significant at 5% and 1% level of significance, respectively relative importance of each trait. The results suggested that improvement of husk recovery is directly influenced by seed yield/plant, biological yield/plant, harvest index, spikes/plant, leaf width and swelling factor and selection of these traits might have good impact on husk recovery. Among all these traits seed yield/plant has maximum positive and significant direct effect on husk recovery. Earlier, Qingyu (1992) has also reported highly significant direct effect of seed yield/plant on husk content in sunflower. It is quite evident that the positive direct effect of seed yield/plant on husk recovery was mainly due to spikes/plant. Therefore, seed yield/plant and spikes/plant instead of many selection criteria should firstly be used in selection to increase the husk recovery in isabgol breeding programmes.

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