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Phenotypic correlation among yield and yield-related traits in resistant F_2 segregants of yard long bean (*Vigna unguiculata* subsp. *sesquipedalis*)

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Abstract
A study was conducted to assess the phenotypic correlation among yield and its component traits in the resistant F_2 segregants of yard long bean (*Vigna unguiculata* subsp. *sesquipedalis*). Thirteen resistant F_2 plants, identified under field and artificial inoculation, were evaluated for yield and related quantitative traits. The phenotypic correlation analysis revealed a positive association of yield per plant with pod length, pod weight, pods per plant, and hundred seed weight, indicating the importance of these characters in determining yield performance. Vine length showed a weak or negative correlation with yield, suggesting that excessive vegetative growth may not contribute directly to yield in resistant backgrounds. Days to first flowering also showed negative correlation with yield. The results provide preliminary insights into trait relationships within resistant segregants, which may aid in the selection of desirable combinations for further breeding.

Keywords: Yard long bean, F_2 population, phenotypic correlation, yield, pod traits

Introduction

Yard long bean (*Vigna unguiculata* subsp. *sesquipedalis*), com.monly known as asparagus bean or snake bean, is an important vegetable legume widely consumed in tropical and subtropical regions for its tender, nutritious pods rich in protein, vitamins, and minerals. The crop holds immense significance both as a dietary staple and as a source of income for smallholder farmers, particularly in Asian countries such as India, China, and Southeast Asia (Kongjaimun *et al.*, 2012) [6].

A major constraint facing yard long bean cultivation is its high susceptibility to anthracnose, a devastating fungal disease caused by *Colletotrichum gloeosporoides*, which can lead to severe pod, leaf, and stem infections, ultimately resulting in drastic yield reductions or even total crop failure, especially in humid and warm climates like those of Kerala. Management of anthracnose through chemical means is often unsustainable and costly, making the development of resistant genotypes a primary breeding objective (Dushimeyesu *et al.*, 2023) [3]. Furthermore, selecting for resistance becomes particularly challenging when it must be combined with desirable horticultural traits such as pod length, pod number, and overall yield (George *et al.*, 2022) [4].

In the context of plant breeding, understanding the genetic and phenotypic relationships among yield and its component traits is essential for devising efficient selection strategies. Several studies in yard long bean and related legumes have demonstrated that traits such as pod length, pod weight, number of pods per plant, and number of seeds per pod have significant correlations with overall yield and can be used as indirect selection criteria. Correlation and path coefficient analyses have revealed that improving these associated traits can result in yield gain, provided that resistance to major diseases like anthracnose is also incorporated. Additionally, studies in cowpea (the progenitor of yard long bean) confirm that yield components are highly heritable and amenable to improvement through conventional breeding and selection (Santos *et al.*, 2024) [8] (Sherly *et al.*, 2024) [9].

Given these considerations, research aimed at disentangling the phenotypic association among yield and its component traits, specifically within resistant F_2 populations, is fundamental. Such work not only aids in marker-assisted or conventional selection for high-yielding, disease-resistant genotypes but also provides a basis for understanding the quantitative inheritance patterns and genetic architecture of key agronomic traits (Akinmade *et al.*, 2025) [1].

Materials and Methods

Thirteen F_2 plants derived from a cross between resistant parent VU53 and susceptible parent KAU Deepika were used for the study. These plants were identified as resistant based on prior screening under field and artificial inoculation.

Observations were recorded for vine length, primary branches per plant, length of leaflet, breadth of leaflet, days to first flowering, pod length, pod girth, pod weight, pods per plant, seeds per pod, hundred seed weight, yield per plant, days to harvest and crop duration.

Phenotypic correlation alone were estimated (since the data was unreplicated) using the standard method of Al-Jibouri *et al.* (1958) [2] to study the associations among yield and its components. Path coefficient analysis was not performed as the data set comprised unreplicated observations from selected resistant F_2 plants, which may not allow reliable partitioning of direct and indirect effects.

Results

Phenotypic correlation coefficients among thirteen characters on yield per plant in F_2 population of yard long bean are depicted in Table 1. Yield per plant (YPP) exhibited highly significant positive correlations with pod length (PL, r = 0.89, p<0.001), pod weight (PW, r = 0.83, p<0.001), pods per plant (PPP, r = 0.61, p<0.05), seeds per pod (SPP, r = 0.56, p<0.05), hundred seed weight (HSW, r = 0.57, p<0.05), and days to harvest (DTH, r = 0.70, p<0.01). These results indicate that increases in the component traits is strongly and positively associated with yield gains in the F_2 yardlong bean population.

Pod length (PL) and pod weight (PW) not only highly correlated with yield, but also strongly associated with each other (r = 0.77, p<0.01), suggesting that selection for longer pods may also result in heavier pods, contributing further to enhanced yield.

Yield per plant was significantly and negatively associated with vine length (VL, r = −0.55, p<0.05) and days to first flowering (DFF, r = −0.66, p<0.05), indicating that plants with shorter vines and early flowering tended to have better yield outcomes.

Other significant positive correlations included pods per plant (PPP) with seeds per pod (SPP, r = 0.41, p<0.05) and pod length (r = 0.53), underscoring the compounded effect these traits have on determining overall yield.

Negative and significant association was found between crop duration (CD) and yield per plant (r = −0.61, p<0.05), as well as between CD and pod length and pods per plant, suggesting that genotypes with shorter crop duration are favorable for higher yield.

Several secondary traits such as leaf length, leaf breadth, primary branches, pod girth, and days to first flowering showed mixed or weak associations with yield, highlighting the need for prioritizing pod-related traits and harvest timing in selection schemes.

Table 1: Phenotypic correlation coefficients among thirteen characters on yield per plant in F2 population of yard long bean

	YPP	VL	BR	LoL	BoL	DFF	PL	PG	PW	PPP	SPP	HSW	DTH
YPP													
VL	-0.554*												
BR	-0.072	0.423											
LoL	0.351	-0.449	-0.086										
BoL	0.211	-0.044	0.172	0.81***									
DFF	-0.659*	0.286	0.279	-0.403	-0.458								
PL	0.89***	-0.76**	-0.37	0.317	0.077	-0.616*							
PG	-0.36	0.038	0.494	-0.283	-0.249	0.531	-0.35						
PW	0.83***	-0.487	-0.025	0.054	0.032	-0.416	0.77**	-0.264					
PPP	0.614*	-0.369	-0.132	0.575*	0.313	-0.585*	0.533	-0.236	0.087				
SPP	0.558*	-0.336	0.309	0.698**	0.588*	-0.445	0.399	-0.153	0.428	0.41			
HSW	0.569*	-0.162	0.365	0.336	0.474	-0.309	0.378	-0.241	0.488	0.317	0.4		
DTH	0.696**	-0.231	0.148	0.389	0.456	-0.463	0.516	-0.358	0.652*	0.272	0.466	0.468	
CD	-0.607*	0.73**	0.137	-0.72**	-0.474	0.408	-0.68**	0.012	-0.304	-0.69**	-0.525	-0.372	-0.392

* Significant at 5 percent level ** Significant at 1 percent level. *** Significant at 0.1 percent level YPP-Yield per plant; VL-Vine length (cm) ; BR-Primary branches per plant; LoL-Length of leaflet (cm); BoL-Breadth of leaflet (cm) DFF-Days to first flowering; PL-Pod length (cm); PW-Pod weight (g); PG-Pod girth (cm); PPP-Pods per plant; SPP-Seeds per pod; HSW-Hundred seed weight (g); DTH-Days to harvest; CD-Crop duration.

Discussion

The present study revealed several key phenotypic correlations among yield and yield-related traits in F_2 segregants of yardlong bean, offering valuable insights for breeding programmes targeting simultaneous improvement of yield and disease resistance.

1. Yield Associations with Pod Traits

Strong and significant positive correlations were observed between yield per plant (YPP) and pod length (PL), pod weight (PW), pods per plant (PPP), seeds per pod (SPP), and hundred seed weight (HSW). Similar results have been reported in multiple studies on yardlong bean and common bean, where these yield components consistently show strong effects on total yield, suggesting that direct selection based on these traits will be effective in improving yield. Sherly *et al.* (2024) [9] emphasize that individual pod weight and number of pods per plant are major contributors to yield, both at phenotypic and genotypic levels. Haque *et al.* (2021) [5] also found positive and significant associations among pod length, pods per plant, and yield, supporting their use in selection programs.

2. Pod Length and Pod Weight

Pod length was highly correlated with pod weight and yield, affirming that longer pods tend to be heavier and contribute more to overall productivity. This association has been corroborated by earlier path analysis studies indicating that pod length and pod weight exert both direct and indirect effects on yield (Sherly *et al.*, 2024) [9]. Improvement in pod length is therefore likely to positively influence both pod weight and total yield.

3. Crop Duration, Flowering, and Yield

Yield per plant was negatively and significantly correlated with vine length (VL), days to first flowering (DFF), and crop duration (CD). This observation implies that earlier flowering, shorter vines, and reduced crop duration are associated with higher yield, likely due to more efficient resource allocation and earlier reproductive development. Similar findings regarding the negative association between flowering time and yield have been described in leguminous crops, including yardlong bean and chickpea, highlighting the advantage of early-maturing genotypes for higher productivity and stress escape (Haque *et al.*, 2021, Wingler *et al.*, 2025) [5, 11].

4. Plant Architecture and Yield

Weak or non-significant correlations were observed between primary branches (BR), leaflet dimensions (LoL, BoL), and yield per plant. Such results suggest that vegetative growth parameters alone may not be reliable predictors of yield without concurrent improvements in reproductive traits. This aligns with the findings from multivariate analyses in legumes, where yield is more closely linked to reproductive and harvest index-related traits than to vegetative growth parameters (Talekar *et al.*, 2022, Ramkumar *et al.*, 2021) [10, 7].

The observed correlations indicate that selection emphasis should be placed on pod length, pod weight, pods per plant, and seeds per pod for yield improvement in anthracnose-resistant backgrounds. Negative associations with vine length and crop duration further suggest that compact and early-maturing genotypes should be prioritized. Multivariate and selection index approaches are recommended to simultaneously improve these complex, interrelated traits for maximum genetic gain.

Conclusion

The study revealed positive phenotypic associations of yield with pod length, pod weight, pods per plant, and hundred seed weight among resistant F_2 segregants of yard long bean. These traits can be considered as reliable selection indices for developing high-yielding anthracnose resistant genotypes in subsequent generations.

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