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Correlation coefficients among Yield Attributing Traits and Disease Assessment Parameters for Rust in French bean (*Phaseolus vulgaris* L.)

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ABSTRACT: The French bean is a popular leguminous vegetable grown for its green tender pods as well as dry beans. However, the successful cultivation of this crop is hampered by various biotic stresses. Rust induced by *Uromyces phaseoli* is one among them, and it causes yield losses ranging from 18 to 78% and disease is more severe during the Rabi season. Several fungicides are used to control rust fungus, but their continued use raises ecotoxicological concerns. The correlation measures the relationship between various plant traits and disease assessment parameters and determines the component characters on which selection can be based for improvement of varieties. Correlation studies in French bean aid in determining the relationship between yield enhancing characteristics and disease evaluation factors. In this study, all disease incidence parameters were positively correlated among themselves and inversely correlated with yield per plant.

Keywords: French bean, rust, rabi and correlation.

INTRODUCTION

The French bean, *Phaseolus vulgaris* L. (2n=22), is one of the most significant leguminous vegetables in the Fabaceae family. Rajmah, kidney bean, snap bean and string bean are some other names for it. Its popularity can be attributed to its high protein content and nutritional balance, as well as specific therapeutic characteristics that result in greater biological efficiency (Duke, 1981). Phytochemicals present in seeds, such as polyphenols, are helpful to human health. Its pods can be used to augment diuretics and drain toxins from the body, as well as in diabetic treatment (Prajapati, 2003). It is a native New World crop that originated predominantly in Central and South America (Kalpan, 1981). Legume vegetables are sensitive to a wide range of biotic and abiotic stresses. Rust (*Uromyces phaseoli* L.) is one of the biotic stress that has expanded rapidly throughout bean-growing regions. Rust can lower yield by 18 to 78%, with the greatest loss occurring during the *rabi* season (Grafton *et al.*, 1985; Mohan *et al.*, 1993).

The study of correlation aids in the determination of relationships between various characters and provides a thorough comprehension of each character's contribution to the genetic composition of the plant. It measures the relationship between various plant traits and disease assessment parameters and determines the component characters on which selection can be based for improvement of varieties. Correlation studies helps to find the association between yield attributing traits and disease assessment parameters. Hence, information regarding the nature and extent of association of characters gives an idea in the selection of cultivars for rust resistance in French bean.

MATERIAL AND METHODS

During 2019-2020 and 2020-2021, the experiment was conducted at the ICAR-Indian Institute of Horticultural Research in Bengaluru. Ten varieties/lines were tested in a randomised block design with three replications in a paired row system with a 30 × 10 cm spacing. The data from the previous two years was pooled and analysed using SPSS software.

Table 1: Correlation coefficients among yield attributing traits and disease assessment parameters for rust in french bean varieties/lines under natural epiphytotic conditions during 2019-2020 and 2020-2021.

Character	DFF	DFP	NOP	PT	PW	PL	PD	DFDI	PDIFL	PDIPF	PDIPM	PDISD	PDIES	AUDPC	NPES	rFLPF	rPFPD	rPDSD	rSDES	Yield
DFF	1.00																			
DFP	0.967**	1.00																		
NOP	0.648*	0.698	1.00																	
PT	-0.439	-0.393	-0.261	1.00																
PW	0.078	0.196	0.426	-0.188	1.00															
PL	0.507	0.539	0.401	-0.760*	0.265	1.00														
PD	-0.384	-0.275	0.338	0.081	0.435	-0.042	1.00													
DFDI	0.219	0.228	0.180	-0.534	0.148	0.887**	-0.108	1.00												
PDIFL	0.160	0.261	-0.277	-0.084	0.303	0.224	-0.250	0.073	1.00											
PDIPF	0.047	0.140	-0.407	-0.054	0.184	0.230	-0.264	0.143	0.971**	1.00										
PDIPM	0.015	0.092	-0.465	-0.068	0.103	0.249	-0.284	0.187	0.941**	0.993**	1.00									
PDISD	0.009	0.072	-0.500	-0.087	0.093	0.269	-0.338	0.236	0.922**	0.981**	0.994**	1.00								
PDIES	-0.033	0.001	-0.575	-0.144	0.040	0.314	-0.426	0.342	0.846**	0.922**	0.949**	0.973**	1.00							
AUDPC	0.017	0.082	-0.494	-0.100	0.110	0.274	-0.347	0.236	0.931**	0.983**	0.953**	0.999**	0.977**	1.00						
NPES	0.131	0.173	-0.440	-0.217	0.083	0.398	-0.411	0.346	0.892**	0.934**	0.888**	0.873**	0.798**	0.885**	1.00					
rFLPF	0.157	0.268	-0.266	-0.101	0.335	0.223	-0.259	0.068	0.995**	0.957**	0.920**	0.902**	0.829**	0.916**	0.969**	1.00				
rPFPD	-0.174	-0.181	-0.693*	-0.196	-0.250	0.316	-0.390	0.400	0.640**	0.766**	0.831**	0.861**	0.918**	0.856**	0.873**	0.611**	1.00			
rPDSD	-0.140	-0.246	-0.554	-0.269	-0.216	0.292	-0.560	0.533	0.079	0.182	0.253	0.352	0.543	0.356	0.466	0.078	0.629	1.00		
rSDES	-0.179	-0.305	-0.506	-0.301	-0.284	0.258	-0.505	0.512	-0.105	-0.015	0.060	0.157	0.364	0.164	0.285	-0.100	0.513	0.969**		
Yield	0.378	0.426	0.927**	-0.251	0.443	0.419	0.507	0.413	-0.457	-0.535	-0.574	-0.598	-0.634*	-0.597	-0.557	-0.445	-0.678*	-0.455	-0.374	1.0

** Significant at 5% level of significance; * Significant at 1% level of significance

DFF	Days to first flowering	**PDIPM**	Percent disease index during pod maturity
DFP	Days to first pod formation	**PDISD**	Percent disease index during seed development
NOP	Number of pods per plant	**PDIES**	Percent disease index during end of the season
PT	Pod thickness	**AUDPC**	Area under disease progress curve
PW	Pod weight	**NPES**	Number of pustules at the end of the season
PL	Pod length	**rFLPF**	Rate of infection during flowering to pod formation
PD	Pod diameter	**rPFPD**	Rate of infection during pod formation to pod development
DFDI	Days taken to appear first disease incidence	**rPDSD**	Rate of infection during pod development to seed development
PDIFL	Percent disease index during flowering	**rSDES**	Rate of infection during seed development to end of the season
PDIPF	Percent disease index during pod formation		

RESULTS AND DISCUSSION

Table 1 shows the relationship between yield attributing features and partial resistance components. Under open field conditions pod length correlated significantly with days to first disease incidence (0.882**), PDI during flowering stage was correlated significantly with PDI during pod formation (0.971**), PDI during pod maturity (0.941**), PDI during seed development (0.922**), PDI during end of the season (0.846**), with AUDPC (0.931**), number of pustules/5cm^2 during end of the season (0.892**), rate of infection during flowering to pod formation (0.995**), rate of infection during pod formation to pod development (0.640**). PDI during pod formation was correlated with PDI during pod maturity (0.993**), PDI during seed development (0.981**), PDI during end of the season (0.922**), AUDPC (0.983**), number of pustules at the end of the season (0.934**), rate of infection 'r' during flowering to pod formation (0.995**), rate of infection 'r' during pod formation to pod maturity (0.640**). PDI during pod maturity was correlated with PDI during seed development (0.994**), PDI during end of the season (0.949**), AUDPC (0.953**), number of pustules at the end of the season (0.888**), rate of infection 'r' during flowering to pod formation (0.920**), rate of infection 'r' during pod formation to pod development (0.831**).

PDI during seed development was significantly correlated with PDI during end of the season (0.973**), AUDPC (0.999**), number of pustules at the end of the season (0.873**), rate of infection during flowering to pod formation (0.902**), rate of infection during pod formation to pod development (0.861**). PDI at the end of the season was correlated with AUDPC (0.977**), number of pustules at the end of the season (0.798**), rate of infection during flowering to pod formation (0.829**), rate of infection during pod formation to pod development (0.918**). AUDPC was correlated significantly with number of pustules at the end of the season (0.885**), rate of infection during flowering to pod formation (0.916**), rate of infection during pod formation to pod development (0.856**).

Number of pustules at the end of the season was correlated with rate of infection during flowering to pod formation (0.969**), rate of infection during pod formation to pod development (0.873**). Rate of infection during flowering to pod formation was correlated with rate of infection during pod formation to pod development (0.611**). Rate of infection during pod development to seed development was correlated with rate of infection during seed development to end of the season (0.969**). Yield per plant was showed significant negative correlation with PDI at the end of the season (-0.634*) and rate of infection during pod formation to pod development (-0.678*).

In the present study high significant correlations (r^2) were observed among resistance parameters in open field conditions. Correlation matrix suggests that PDI, AUDPC were good and more reliable parameters for evaluation and selection for resistance to bean rust (Said and Taher 2020). Similar results were previously obtained when correlation statistics were performed between different disease parameters of wheat rusts and grain yield of the studied wheat genotypes (Xiaowen *et al*., 2008; Boulot, 2007). Yield and percent severity of rust, AUDPC were significant and negatively correlated (r=-0.77) and a positive association between disease progress rate and percent severity (r=0.53) were observed in French bean (Azmeraw and Hussien 2017). Singh *et al*. (2015) reported high positive correlation coefficients among AUDPC, LP and NPL ranging from 0.751 to 0.808 in pea against rust as an indication that these traits may be under the same genetic control. Significant association between days taken to appear first disease and number of aecial cups per pustule (Singh *et al*., 2023). Omara *et al*. (2022) reported that positive relation between final rust severity and number of pods per plant in French bean for rust.

CONCLUSIONS

The present study can be concluded that disease incidence parameters were correlated positively among themselves. Yield and yield attributing traits were negatively correlated with disease incidence parameters. However, there was a substantial negative association between yield per plant and the Percent Disease Index (PDI) at the end of the season and the rate of infection during pod formation to pod development. Furthermore, a vast number of French bean varieties/lines must be tested for rust.

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Conflict of Interest. None.

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