

Genotypes and environment interaction in response to *Bipolaris sorokiniana* causing leaf blight in barley

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Abstract

The present study was conducted on eight barley genotypes with varying resistance to leaf blight of barley caused by *Bipolaris sorokiniana* across five environments. GGE biplot analysis was carried to study the relationships among test environments, discriminating ability of test environments and representativeness of test environments. Based on analysis, it is revealed that the five environments fell into three apparent groups: Faizabad, Karnal and Hisar formed one group, Varanasi formed another group and Pantnagar formed the third environment. Among the five environments, Karnal & Faizabad are most representative whereas Varanasi and Pantnagar are least representative. Test environments that are both discriminating and representative (Karnal & Faizabad) are good test environments for selecting generally adapted genotypes. Discriminating but non-representative test environments (Pantnagar) are useful for selecting specifically adapted genotypes if the target environments can be divided into mega-environments. They are useful for culling unstable genotypes if the target environment is a single mega-environment. Non-discriminating test environment i.e. Varanasi (those with very short vectors) is less useful because it provides little discriminating information about the genotypes.

Keyword: Barley, GGE Biplot, GxE interaction, *Bipolaris sorokiniana*

Introduction

In India, barley varieties are released after rigorous screening for various diseases and insect pests at multilocations. Leaf spot incited by *Bipolaris sorokiniana* is one of the important diseases of barley causing severe yield and quality reduction in north eastern plain zones and also in north western plains zone. The AICW&BIP centres viz., Karnal, Faizabad, Pantnagar, Varanasi and Hisar have been the testing centres for leaf blight resistance. It was observed that the disease severity varies from one place to another place. In Pantnagar, the severity is always low compared to other centers and the Varanasi centre records the highest score every year. An attempt was made to analyse the existence of any genotype x environment interaction in leaf blight screening under artificial epiphytotic condition using GGE biplot.

Recently, the GGE biplot analysis was proposed to study multi-environment trials (MET) and genotype x environment interaction (GEI) (Yan, 2001; Zerihun, 2011). It is a graphical display of two important parts of variation, G and GEI, which are relevant in genotype evaluation. It

is constructed using the principal components PC1 and PC2 obtained after single-value partitioning (Yan, 2002).

Furthermore, the biplot can be useful in determining breeding objectives and selecting sites (Yan and Hunt, 2002), visualizing trait relations (Yan and Rajcan, 2002), studying genotype susceptibility and/or race/isolate virulence groups (Yan and Falk, 2002).

Material and methods

Screening of the germplasm accessions with the identified monosporidial culture: Eight selected barley genotypes with varying degree of resistance to leaf blight were evaluated for leaf blight in the field during crop seasons 2008-09, 2009-10 and 2010-11 at Karnal, Faizabad, Pantnagar, Varanasi and Hisar. The genotypes were grown as two rows of one meter length.

The inoculum of *B. sorokiniana* (monosporidial culture) was multiplied in Karnal using autoclaved sorghum seeds in the laboratory and supplied to all screening centres. The field inoculation was started with this multiplied inoculum after mid January and continued till first week of March. The blight recordings were taken in double digit system on flag and next below leaf of the plant and later converted to average per cent disease severity and the per cent green leaf area (100 per cent leaf blight area) was used for GGE biplot analysis.

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Table 1. Average per cent leaf blight severity of barley genotypes during three crop seasons (2008-11)

Variety	Pedigree	Mean of average per cent leaf blight severity				
		Pantnagar	Hisar	Faizabad	Varanasi	Karnal
DWRUB52	DWR 17/K 551	30	13	35	84	23
RD2035	RD 137/PL 107	27	39	39	99	27
RD2552	RD 2035/DL 472	16	37	46	99	30
Jyoti	K 12/CN 294	42	23	53	89	19
NDB1173	BYTLRA 3(94-95)/NDB 217	16	24	45	92	27
BH902	BH 945/RD 2552	42	20	45	92	26
K603	K 257/C 138	74	57	57	92	63
RD2503	RD 103/BH 153//RD 2046	89	68	89	96	74

Results and discussion

Relationships among test environment: Fig. 1 is the environment-vector view of the GGE biplot for the data in Table 1. It is based on an environment-centered (centering = 2) G by E table without any scaling (scaling = 0), and it is environment-metric preserving (SVP = 2) and its axes are drawn to scale. This biplot explained 95% of total variation of the environment-centered G by E table.

The lines that connect the test environments to the biplot origin are called environment vectors. The cosine

of the angle between the vectors of two environments approximates the correlation between them. For example, Karnal, Faizabad and Hisar were positively correlated (an acute angle), Varanasi and Pantnagar were slightly negatively correlated (an obtuse angle). The presence of wide obtuse angles (*i.e.*, strong negative correlations) among test environments is an indication of strong crossover GE. Here the largest angle is slightly larger than 90° (between Varanasi and Pantnagar), implying that the GE is moderately large.

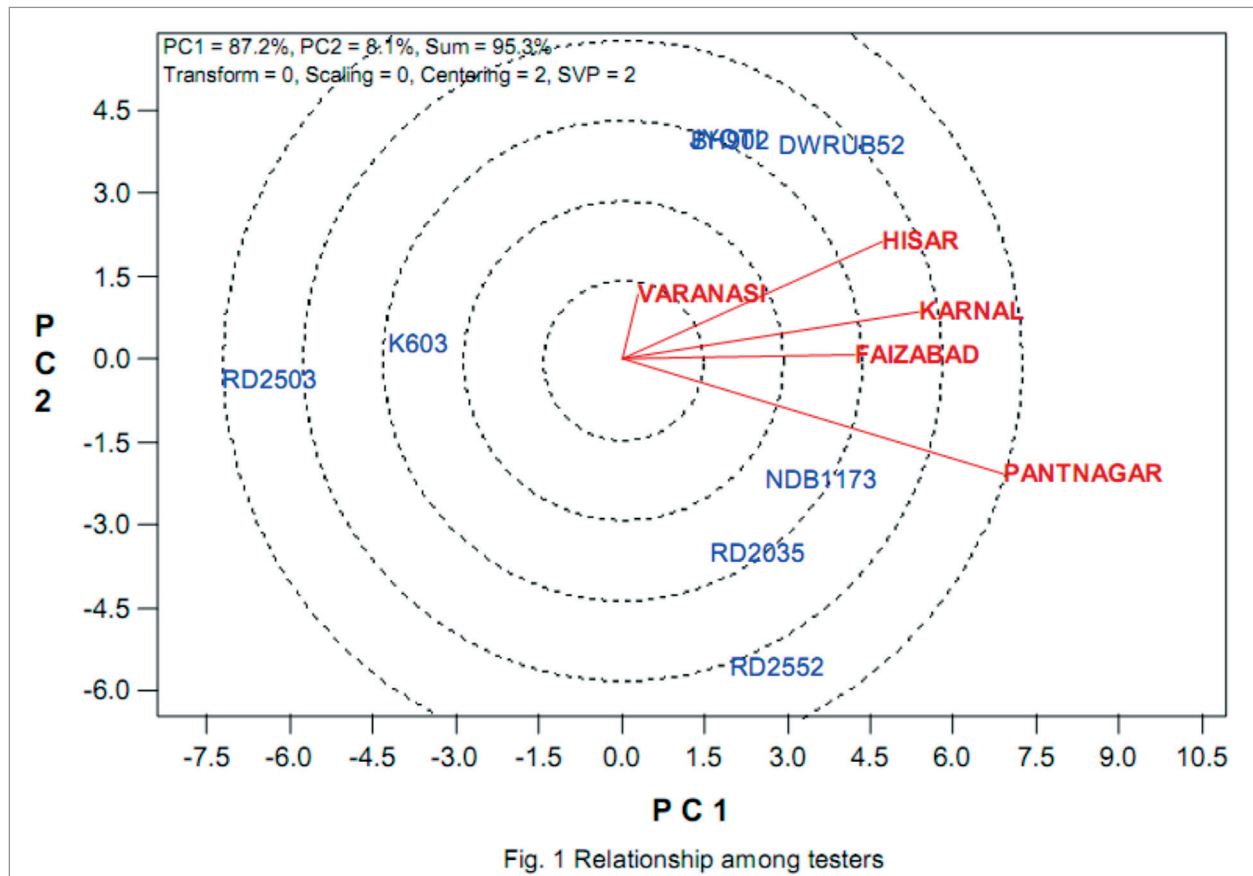


Fig. 1 Relationship among testers

The distance between two environments measures their dissimilarity in discriminating the genotypes. Thus, the five environments fell into three apparent groups: Faizabad, Karnal and Hisar formed one group, Varanasi formed another group and Pantnagar formed the third environment. The similarity (covariance) between two environments is determined by both the length of their vectors and the cosine of the angle between them.

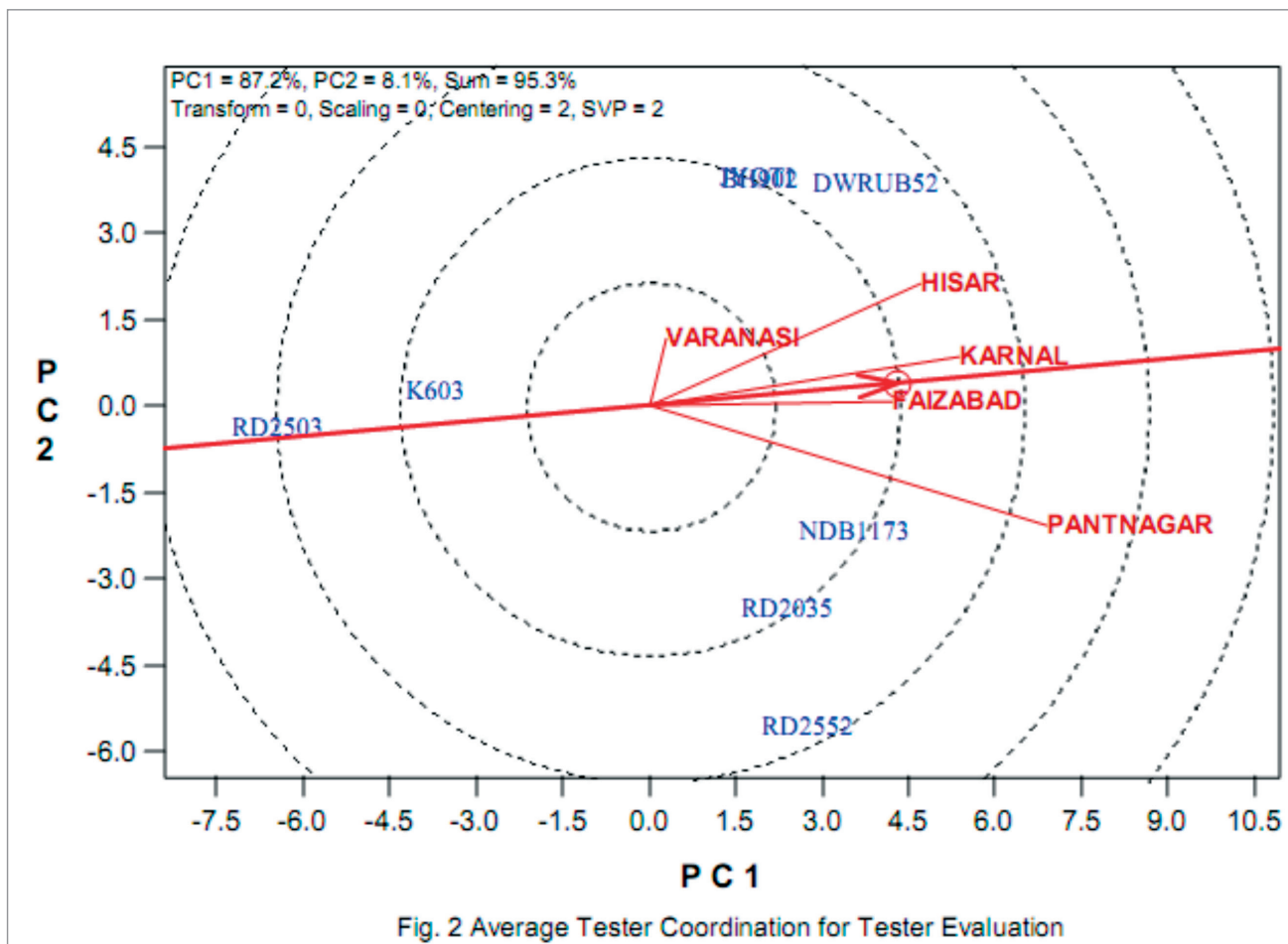
The presence of close associations among test environments suggests that the same information about the genotypes could be obtained from fewer test environments, and hence the potential to reduce testing cost. If two test environments are closely correlated consistently across years, one of them can be dropped without loss of much information about the genotypes.

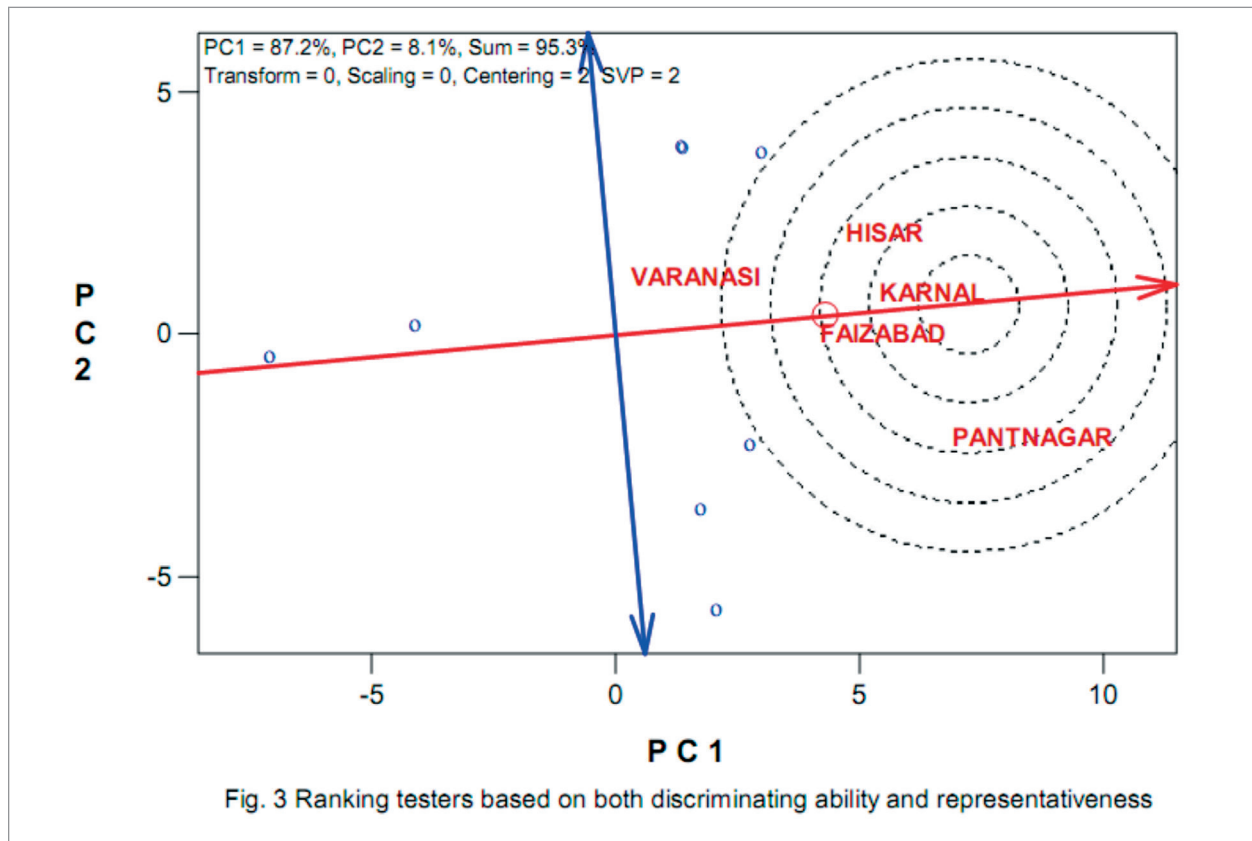
Discriminating ability of test environment: The concentric circles on the biplot help to visualize the length of the environment vectors, which is proportional to the standard deviation within the respective environments and is a measure of the discriminating ability of the environments. Therefore, among the five environments, Pantnagar was most informative and Varanasi least discriminating. According to Byth and Montgomery (1981)

test environments that are consistently non-discriminating (non-informative) provide little information on the genotypes and, therefore, should not be used as test environments.

Representativeness of test environments: Fig. 2 presents the same biplot as Fig. 1 except that an "Average-Environment Axis" [AEA, or average-tester-axis, has been added. The average environment (represented by the small circle at the end of the arrow) has the average coordinates of all test environments, and AEA is the line that passes through the average environment and the biplot origin. Fig. 2 can be interpreted as follows:

A test environment that has a smaller angle with the AEA is more representative of other test environments. Thus, Karnal & Faizabad are most representative whereas Varanasi and Pantnagar least representative. Test environments that are both discriminating and representative (Karnal & Faizabad) are good test environments for selecting generally adapted genotypes. Discriminating but non-representative test environments (Pantnagar) are useful for selecting specifically adapted genotypes if the target environments can be divided into mega-environments. They are useful for culling unstable





genotypes if the target environment is a single mega-environment. Non-discriminating test environment *i.e.* Varanasi (those with very short vectors) is less useful because it provides little discriminating information about the genotypes.

Ideal test environments for selecting generally adapted genotypes: Within a single mega-environment, the ideal test environment should be most discriminating (informative) and also most representative of the target environment. Figure 3 defines an "ideal test environment", which is the center of the concentric circles. It is a point on the AEA in the positive direction ("most representative") with a distance to the biplot origin equal to the longest vector of all environments ("most informative"). Faizabad is closest to this point and is, therefore, best, whereas Varanasi was poorest for selecting cultivars adapted to the whole region.

References

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