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Study on relationship among nonparametric stability statistics in safflower

Abdolvahab Abdulahi[1], Sayyed Saeid Pourdad[1] and Reza Mohammadi[1]

[1]Dryland Agricultural Research Institute, Kermanshah, P. O. Box 67145-1164, Iran
E-mail: sspourdad@yahoo.com

Abstract
The objective of present investigation was to study relationship among nonparametric stability statistics. Yield data of 16 safflower genotypes selected from Iran/ICARDA joint project grown in 18 rain-fed environments during 2003-05 in Iran was collected. Experiments were conducted in Randomized Completely Block Design (RCBD) with four replications in each environment. In this investigation, low values of sum of yield ranks and Shukla's stability variance, rank-sum (RS), were associated with high yield, but the other nonparametric stability methods were not significantly correlated with mean yield. The parameters, $S_i^{(3)}$, $NP_i^{(3)}$ and $NP_i^{(4)}$ were positively correlated with RS (P<0.05). Clustering of 10 nonparametric rank measures and mean yield rank grouped these measures in four groups: 1. $S_i^{(1)}, S_i^{(2)}, S_i^{(3)}$, $NP_i^{(1)}, NP_i^{(2)}, NP_i^{(3)}$ and $NP_i^{(4)}$ measures that show only stability, 2. $S_i^{(6)}$ parameter , 3. RS and Y(mean yield rank) and 4.TOP measure. These parameters are associated with the static concept of stability as they define stability in the sense of homeostasis.

Key words: safflower – stability - nonparametric – nonparametric relationship

Introduction

Nonparametric measures for stability based on ranks provide a viable alternative to existing parametric measures based on absolute data. They are easy to use and interpret, and as compared with parametric measures are less sensitive to errors of measurement. Furthermore, addition and deletion of one or a few observations is not as likely to cause great variation in the estimation as would be the case for parametric stability measures (Nassar and Huehn, 1987, Kaya *et al.*, 2003). Nassar and Huehn (1987) proposed four nonparametric measures of phenotypic stability (1) $S_i^{(1)}$ is the mean of the absolute rank differences of a genotype over the n environments, (2) $S_i^{(2)}$ is the variance among the ranks over the n environments, (3) $S_i^{(3)}$ and (4) $S_i^{(6)}$ are the sum of the absolute deviations and sum of squares of ranks for each genotype relative to the mean of ranks, respectively. Thennarasu (1995) proposed the nonparametric statistics $NP_i^{(1)}$, $NP_i^{(2)}$, $NP_i^{(3)}$ and $NP_i^{(4)}$ based on ranks of adjusted mean of the genotypes as those whose position in relation to the others remained unaltered in the set of environments assessed as stability measures.

The objective of this study was to (i) apply nonparametric tests to investigate the crossover and non-crossover interaction in multi environment trials (MET) and (ii) study the relationship among nonparametric stability statistics.

Materials and Methods

This study was carried out with 16 safflower genotypes (Table 1) in 18 environments (year-location combinations during 2003-2005) including six dryland agricultural research stations viz. Sararood (Kermanshah province), Ardebil (Ardebil province), Ghamlo (Kordestan province), Gonbad (Golestan province), Shirvan (North Khorasan province), during 2003-05. Experiments were conducted in Randomized Completely Block Design (RCBD) with four replications in each environment. Two non parametric statistical procedures namely Bredenkamp method (Bredenkamp, 1974, Huehn and Leon, 1995) and van der Laan-de Kroon method (de Kroon and van der Laan, 1981, Huehn and Leon, 1995) were applied.

The four nonparametric stability statistics ($S_i^{(1)}$, $S_i^{(2)}$, $S_i^{(3)}$,and $S_i^{(6)}$) that combine mean yield and stability have been described in detail by Nassar and Huehn (1987), Sabaghnia *et al.* (2006) and Mohammadi *et al.* (2007). Other nonparametric stability measures that proposed by Thennarasu ($NP_i^{(1)}$, $NP_i^{(2)}$, $NP_i^{(3)}$ and $NP_i^{(4)}$)described in detail by Thennarasu (1995) and Mohammadi *et al.* (2007). Kang's (1988) rank-sum(RS) and parameters of Fox *et al*. (1990) (TOP, MID and LOW) are other nonparametric stability methods that were calculated here.

Results

The Spearman's rank correlations between each pair of nonparametric stability measures were calculated (Table 2) and demonstrate a high positive significant rank correlation between $S_i^{(1)}, S_i^{(2)}, S_i^{(3)}$, $NP_i^{(1)}, NP_i^{(2)}, NP_i^{(3)}$ and $NP_i^{(4)}$. The measures $S_i^{(3)}$, $NP_i^{(2)}, NP_i^{(3)}$ and $NP_i^{(4)}$ had significantly negatively correlated with the percentage of environments in which it ranked in the top third of genotypes (TOP).The parameters, $S_i^{(3)}, NP_i^{(3)}$ and $NP_i^{(4)}$ were positively correlated with RS (P<0.05). Mean yield rank had positive correlation with RS (P<0.05). Clustering of 10 nonparametric rank measures and mean yield rank grouped these measures in four groups: 1. $S_i^{(1)}, S_i^{(2)}, S_i^{(3)}$, $NP_i^{(1)}, NP_i^{(2)}, NP_i^{(3)}$ and $NP_i^{(4)}$ measures that show only stability, 2. $S_i^{(6)}$ parameter , 3. RS and Y(mean yield rank) and 4.TOP measure.

Discussion

We found that the three nonparametric statistics of Huehn (Nassar and Huehn, 1987, Mohammadi *et.al.*, 2007) ($S_i^{(1)}$, $S_i^{(2)}$ and $S_i^{(3)}$) and the $NP_i^{(1)}$, $NP_i^{(2)}, NP_i^{(3)}$ and $NP_i^{(4)}$ parameters of Thennarasu (1995) clustered together as same-class statistics. These parameters classified genotypes as stable or unstable in a similar group. These parameters were positively and significantly correlated (P<0.01), indicating that these measures were similar under different environmental conditions (Fig 1 and Table 2). Mohammadi *et al*. (2007) also found significantly positive correlations among these parameters in durum wheat. These parameters are associated with the static concept of stability (Mohammadi *et al*., 2007 and Nassar and Huehn, 1987), as they define stability in the sense of homeostasis.

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Table1. Code, names and origin of safflower genotypes.

Code of genotypes	Genotype	Origin
G1	CH-5	America
G2	PI-250537	World Bank of Safflower
G3	Syrian	Syria
G4	CW-74	America
G5	Dincer	Turkey
G6	Zarghan279	Iran
G7	LRV-55-245	Iran
G8	PI-198290	World Bank of Safflower
G9	Hartman	America
G10	Gila	America
G11	Kino-76	ICARDA
G12	Yenice	Turkey
G13	PI-537636	World Bank of Safflower
G14	PI-537636-s	World Bank of Safflower
G15	LRV-51-51	Iran
G16	PI-537598	World Bank of Safflower

Table 2. Spearman's rank correlation coefficients between the different nonparametric stability parameters for grain yield of 16 genotypes

Parameter	$S_i^{(1)}$	$S_i^{(2)}$	$S_i^{(3)}$	$S_i^{(6)}$	$NP_i^{(1)}$	$NP_i^{(2)}$	$NP_i^{(3)}$	$NP_i^{(4)}$	TOP	RS
$S_i^{(2)}$	0.989**									
$S_i^{(3)}$	0.893**	0.888**								
$S_i^{(6)}$	0.054	0.069	0.131							
$NP_i^{(1)}$	0.987**	0.978**	0.889**	0.062						
$NP_i^{(2)}$	0.616*	0.596*	0.826**	0.108	0.624**					
$NP_i^{(3)}$	0.718**	0.683**	0.898**	0.240	0.695**	0.909**				
$NP_i^{(4)}$	0.699**	0.667**	0.879**	0.233	0.678**	0.919**	0.996**			
TOP	-0.314	-0.323	-0.560*	0.054	-0.327	-0.846**	-0.658**	-0.685**		
RS	0.438	0.462	0.517*	0.263	0.426	0.328	0.527*	0.516*	-0.264	
Y	-0.435	-0.418	-0.277	0.091	-0.442	-0.116	-0.044	-0.044	-0.106	0.550*

*, ** significant at the 0.05 and 0.01 levels, respectively

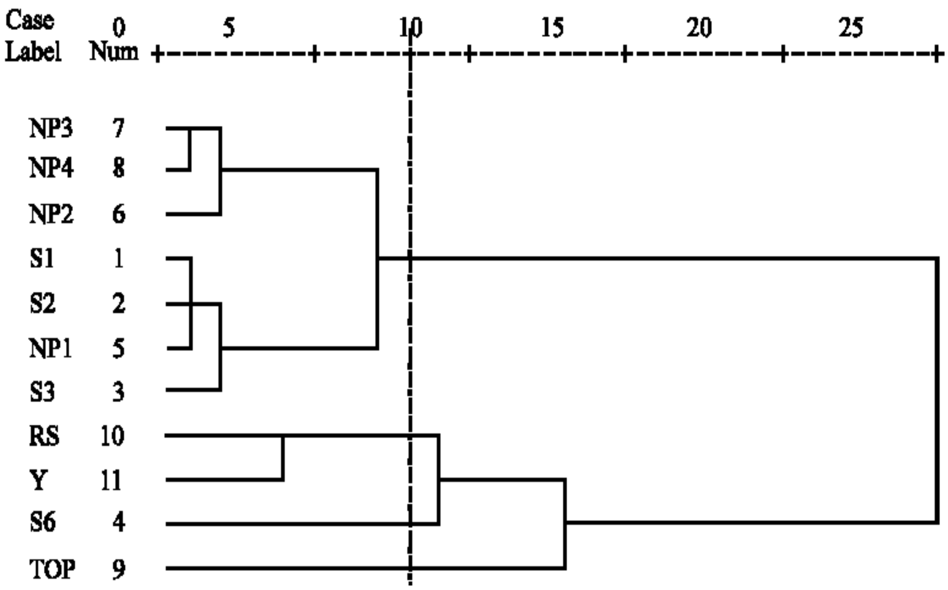

Figure 1. Dendrogram presenting hierarchical clustering of 10 nonparametric rank measures and mean yield rank.