## Graphical Method in Studies of Adaptability and Stability of Cultivars

José Airton R. Nunes[1], Magno A. P. Ramalho[2], Ângela de F. B. Abreu[3]
[1]Departamento de Biologia, Universidade Federal de Lavras (DBI/UFLA), [2]Prof. Titular DBI/UFLA, [3]Pesquisadora, EMBRAPA Arroz e Feijão , DBI/UFLA.

This study proposes a novel methodology that uses, principally, a graphical method to make the data visualization and interpretation of experiments conducted in various environments easier.

The graphic method is established based on the standardization of the means of the cultivars evaluated in experiments conducted in various environments by the expression $z_{ij} = (x_{ij} - \bar{x}_{.j})/s_{.j}$, where $z_{ij}$ is the value of the standardized variable corresponding to cultivar $i$ in environment $j$ where $i = 1,...,n$ and $j = 1,...,a$; $x_{ij}$ is the mean of cultivar $i$ in environment $j$; $\bar{x}$ is the mean of environment $j$; $s_{.}$ is the phenotypic standard deviation of the cultivar means in environment $j$.

As the standardized variable $z_{ij}$ assumes positive and negative values, the graphical visualization is facilitated by adding a constant so the $z_{ij}$ values are always positive. This way the mean of the $z_{ij}$ values for cultivar $i$ in $a$ environments ($\bar{Z}_{i.}$) is a measure for the adaptation of cultivar $i$ while the coefficient of variation of $z_{ij}$ for cultivar $i$ in the different environments ($CV_{Z_i}$) is a measure for the stability of cultivar $i$. The standardized values ($z_{ij}$) are used to construct a diagram for each cultivar. The dimensions of the axes (environments) are equivalent to the values of $z_{ij}$ of cultivar $i$ in environment $j$.

### Example of Application

For an exemplification we used data of an evaluation of 25 common bean lines in 11 environments in Brazil, in 2002 and 2003. Figure 1 presents the estimates of the means ($\bar{Z}_{i.}$) and of the coefficients of variation ($CV_{Z_i}$) obtained by the graphic method.

The constant three was added in the present case to make all $z_{ij}$ values positive. This way, values below this constant indicate a performance below the mean of the environment. The Scott Knott test at a significance level of 5% classified the lines in two groups, of which the more adapted one presented $\bar{Z}_{i.}$ values above 3.26 (Ouro Negro) (Figure 1).

According to the values of coefficients of variation the most unstable lines were CIV-453, CIV-76 and Carioca, and the most stable ones OP-S-64, Ouro Negro and CIV-151 (Figure 1). It is worth emphasizing that OP-S-64 associated a high adaptability with a high stability which evidently is what every breeder wishes. This fact can easily be visualized in Figure 2A *or* (Figure 2A). Note that this line presented a performance above the mean in most environments, only lower in environment 7, forming a nearly perfect circumscribed circle, "full ball". Cultivar Carioca on the other hand presented less absolute adaptation in nearly all evaluated environments and low stability, "slack ball", which is also quickly visualized in Figure 2B *or* (Figure 2B).

The graphic method therefore allows that the breeder's decisions *are* taken graphically or statistically based on the inference drawn on the mean $(\bar{Z}_{i.})$ and coefficient of variation $(CV_{Z_i})$ of the standardized values.

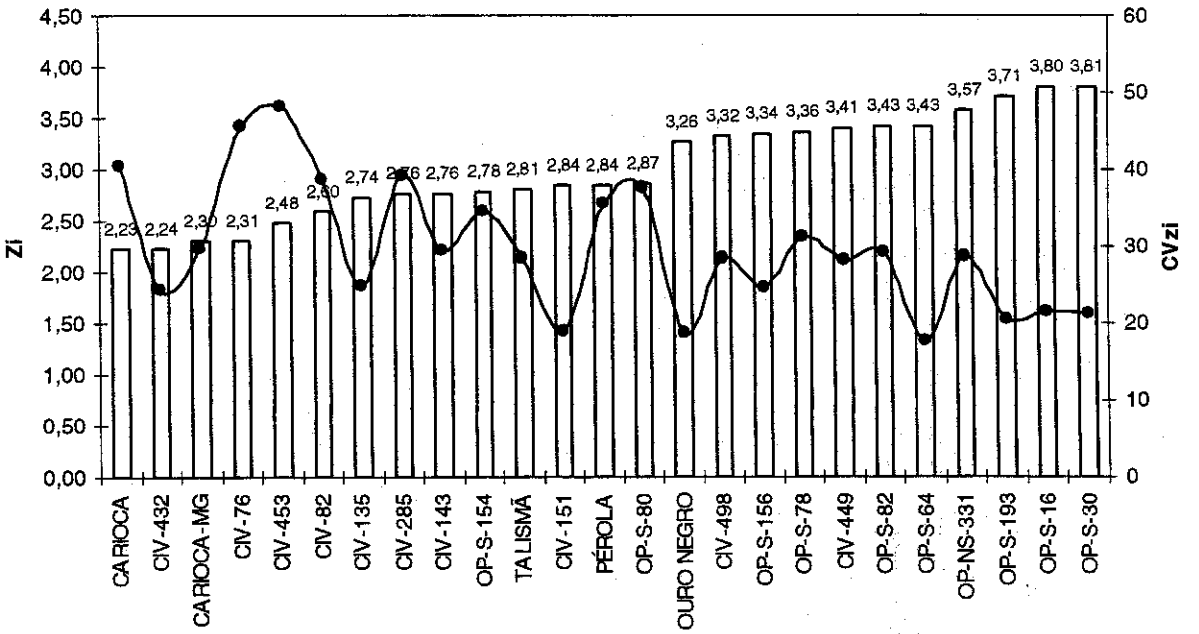


Figure 1. Estimates of the means ($\overline{Z}_{i.}$) and coefficients of variation ($CV_{Z_i}$) by the graphic method for 25 common bean lines evaluated in 11 environments in Brazil, in 2002 and 2003.

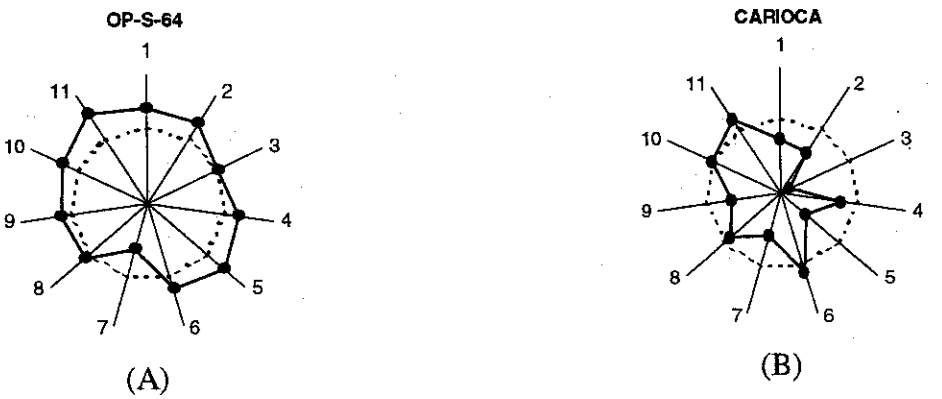


Figure 2: Representation of the performance of the common bean lines OP-S-64 (A) and Carioca (B) using the graphic method. The dotted line represents the mean of the environment, the value of the constant (three) associated to variable Z, and the axes of each one of the evaluated environments.

**References**

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