IMPROVED SCREENING METHOD FOR HIGH DI-NITROGEN FIXATION IN SOYBEAN

Raphael Lemes Hamawaki[1,2], Curtis Wolf[1], Stella K. Kantartzi[1]
[1]Southern Illinois University, Carbondale, IL, USA
[2]Ministry of Education of Brazil, CAPES Foundation, Brasilia, Brazil

Introduction

The rate of di-nitrogen (N_2) fixation varies throughout the growth cycle of soybean (Lawn and Brun, 1974; Thibodeau and Jaworski, 1975; Latimore et al., 1977; Imsande, 1989; Keyser and Li, 1992). Restrictions in nitrogen (N) supply in periods of high requirement suggest that N accumulation follows a different pattern from that of symbiosis in soybean (Phillips and DeJong, 1984; Keyser and Li, 1992). To date, a limited number of studies investigated the genetic control of N_2 fixation efficiency in soybean due to assessment difficulties (Nicolás et al., 2002; Santos et al., 2013). Therefore, the objective of this study was to assess the variation in N_2 fixation capacity at the early and late growth stages of soybean.

Table 1. Correlation coefficients between leaf (LAT) and pod (LAT) atom% ^{15}N excess and traits related to di-nitrogen fixation.

	SPD	SDW	-LAT%	-PAT%
SPD	1.00	-0.28**	0.43**	-0.10**
SDW		1.00	0.03^{ns}	0.47**
-LAT%			1.00	0.15**
-PAT%				1.00

+SPD, SPAD meter measurement; SDW, shoot dry weight. Significance at p<0.01**

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Material and Methods

A two-year experiment (2015 and 2016) was carried out under greenhouse conditions to evaluate 22 soybean lines against a supernodulating check ('SS2-2'). The lines were assigned to a randomized complete block with four blocks and four replications per block and inoculated with the *Bradyrhizobium japonicum* strain USDA 110 at the seed stage (2×10^5 rhizobia cells per seed). Leaf and pod wall samples were collected at 35 d after emergence and at the R7 growth stage, respectively, to measure the atom% ^{15}N excess. The percentage of N derived from the atmosphere (%Ndfa) by each genotype was calculated as follows (Unkovich et al., 2008):

$$\%Ndfa = \left(1 - \frac{\text{atom\% }^{15}\text{N excess N}_2\text{fixing soybean genotype}}{\text{atom\% }^{15}\text{N excess non} - \text{nodulating soybean line}}\right)$$

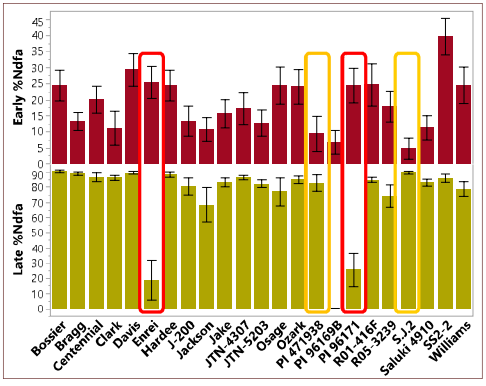

Figure 1. Mean %Ndfa measured at the early (35 d after emergence) and late (R7) growth stage of 22 soybean lines and the supernodulating line 'SS2-2' grown under greenhouse conditions.

Results

Atom% ^{15}N excess in the leaf (LAT) was significantly correlated with that in the pod wall (PAT). The strongest correlation was found between -LAT and SPAD meter readings as well as between -PAT and shoot dry weight (Table 1). The 23 soybean lines demonstrated different patterns of N2 fixation activity in the two growth stages (Figure 1). For instance, Enrei and PI 96171 showed high %Ndfa at the early growth stage, but low at the late growth state, whereas S.J.2, PI 471938, and Saluki 4910 showed the opposite trend.

Conclusions

- Soybean genotypes showed different N_2 fixation capacity according to the time of assessment in plant development.
- Measuring %Ndfa both at the early and late growth stage was necessary for identifying genotypes with different patterns of N_2 fixation.
- Auxiliary traits, such as SPAD meter readings at the early growth stage and shoot dry weight at the late growth stage, might be useful to select genotypes with improved N_2 fixation.

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