INTRODUCTION

Total plant N uptake, N harvest index (NHI) and N concentration in seeds (%N_{seed}) may explain seed yield generation in crops. In soybean, NHI and grain harvest index (HI) may also vary as a function of %N_{seed} and by the %N present in the stover fraction (%N_{stover}). This approach has been summarized algebraically in an equation proposed by Sinclair (1998):

$$\text{Eq. 1} \quad \text{NHI} = \frac{\%N_{seed} \times HI}{(\%N_{seed} - \%N_{stover}) + \%N_{stover}}$$

OBJECTIVES

1) Provide evidence about the effect of NHI and %N_{seed} on yield-to-N uptake relationship;
2) Implement Sinclair’s equation (Eq. 1) for NHI:HI relationship and extend it to P and K; and
3) Study the influence of seed:stover ratio on the relationship of N with P, and K uptake.

MATERIALS AND METHODS

- Biomass was sampled at R7 for Argentina (ARG) and Kansas (KS), and at R8 for Indiana (IN).
- Database included: 1) seed yield (dry basis), 2) %N, %P and %K in seeds and stover, and 3) seed, stover, and total biomass.
- A curve following Eq. 1 was fitted using the NLIN procedure of SAS software to estimate parameters of %Nutrient_{seed} and %Nutrient_{stover} for each nutrient.

**Table 1:** Sites, years, plant density, genotypes, and main characteristics for each data set.

<table>
<thead>
<tr>
<th>Data set</th>
<th>Site</th>
<th>Year</th>
<th>Water supply</th>
<th>Plant density</th>
<th>Genotype</th>
<th>Main characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kansas</td>
<td>US</td>
<td>2014</td>
<td>Rainfed</td>
<td>30 (16-49)</td>
<td>1</td>
<td>2008 IV Row spacing, inoculation, plant density, fertilization strategy</td>
</tr>
</tbody>
</table>

RESULTS (continuation)

**Objective 2**
- For the fitted curve %N_{seed} was 5.89 and 1.28 g 100 g^{-1} for %N_{stover} (Fig. 3A).
- Data from P showed a similar trend when PHI and HI (Fig. 3B), while KHI fitted a model (Fig. 3C) that tended to be more linear than NHI and PHI (close to the 1:1 ratio).

![Fig 2: Relationship between N harvest index (NHI) (A), P harvest index (PHI) (B) and K harvest index (KHI) (C) and harvest index (HI) for the metadata (n = 167). Solid line represents the fitted model of Eq. 1 and the dashed lines represent the 95% CI. Dotted line in Fig. 2C represents the 1:1 ratio when parameters of the Eq. 1 are equals.](image)

**Objective 3**
- Variation in plant N-to-P uptake residuals was primarily explained by changes in %P_{stover} (R^2 = 0.38; Fig. 3A).
- For %K_{stover} and %K_{seed} residuals were both statistically significant (p<0.001) but changes in %K_{stover} explained most of the variation of N:K relationship (R^2 = 0.57; Fig. 3B).

![Fig 3: Plant N uptake as a function of plant P (A) and K uptake (B). Bubble sizes represent different ranges of seed yield. Percentage of variance (R^2) provided by both linear regression between residuals of Fig. 3A as a function of seed and stover P and K concentration (insets in Fig. 3A and 3B).](image)

CONCLUSIONS

- NHI was the main variable explaining variation for yield-to-uptake for N.
- The NHI:HI relationship adequately modeled by Sinclair’s equation, followed by P and with a more linear fit for K.
- Plant N uptake was strongly related to P and K uptake, with stover concentration accounting for a large proportion of the variation on the nutrient ratios; implying that the vegetative plant fraction can act either as storage or supply.

REFERENCES