Assessing the relative efficiency of two experimental designs in soybean selection

Curtis Wolf, Raphael Lemes Hamawaki, and Stella K. Kantartzi

Dept. Plant, Soil, and Agricultural Systems, Southern Illinois University, Carbondale, IL

Introduction

Intra-cultivar variation in soybean is underexploited due to the general assumption that genotypes in advanced generations are fairly homogeneous (Fasoula and Boerma, 2007). Thus, one of the goals in plant breeding might be the determination and utilization of differences within cultivars as a source of genetic variation, which could be achieved through ultra-low density planting (Tokatlidis et al., 2010). However, information on field designs that could better reveal any intra-cultivar differences is limited. The aim of this study was to investigate the efficiency of completely randomized design (CRD) at ultra-low plant density (12,000 plants ha^{-1}) and randomized block design (RCBD) at relatively high plant density (340,000 plants ha^{-1}) in uncovering the presence of genetic variation related to seed yield.

Materials & Methods

We evaluated five soybean cultivars (Saluki 4910, Saluki 4411, Davis, Blackhawk, and Pharaoh) in two environments at Carbondale, IL using two experimental designs (CRD at ultra-low plant density and RCBD at relatively high plant density) and assessed the relative efficiency based on the coefficient of variation (CV), p-value, experimental power, and mean squared error.

Fig. 1 Soybean plants sown under ultra-low density.

Results

The analysis of variance revealed that CRD under ultra-low plant density ($p < 0.001$) was more effective in revealing significant variation for seed yield compared with RCBD ($p = 0.4879$). The CV of CRD was higher than that of RCBD (Fig. 2). Additionally, the power of CRD (1.000; $\sigma = 45.211$; $\delta = 38.679$) was markedly higher than that of RCBD (0.2874; $\sigma = 438.897$; $\delta = 169.065$).
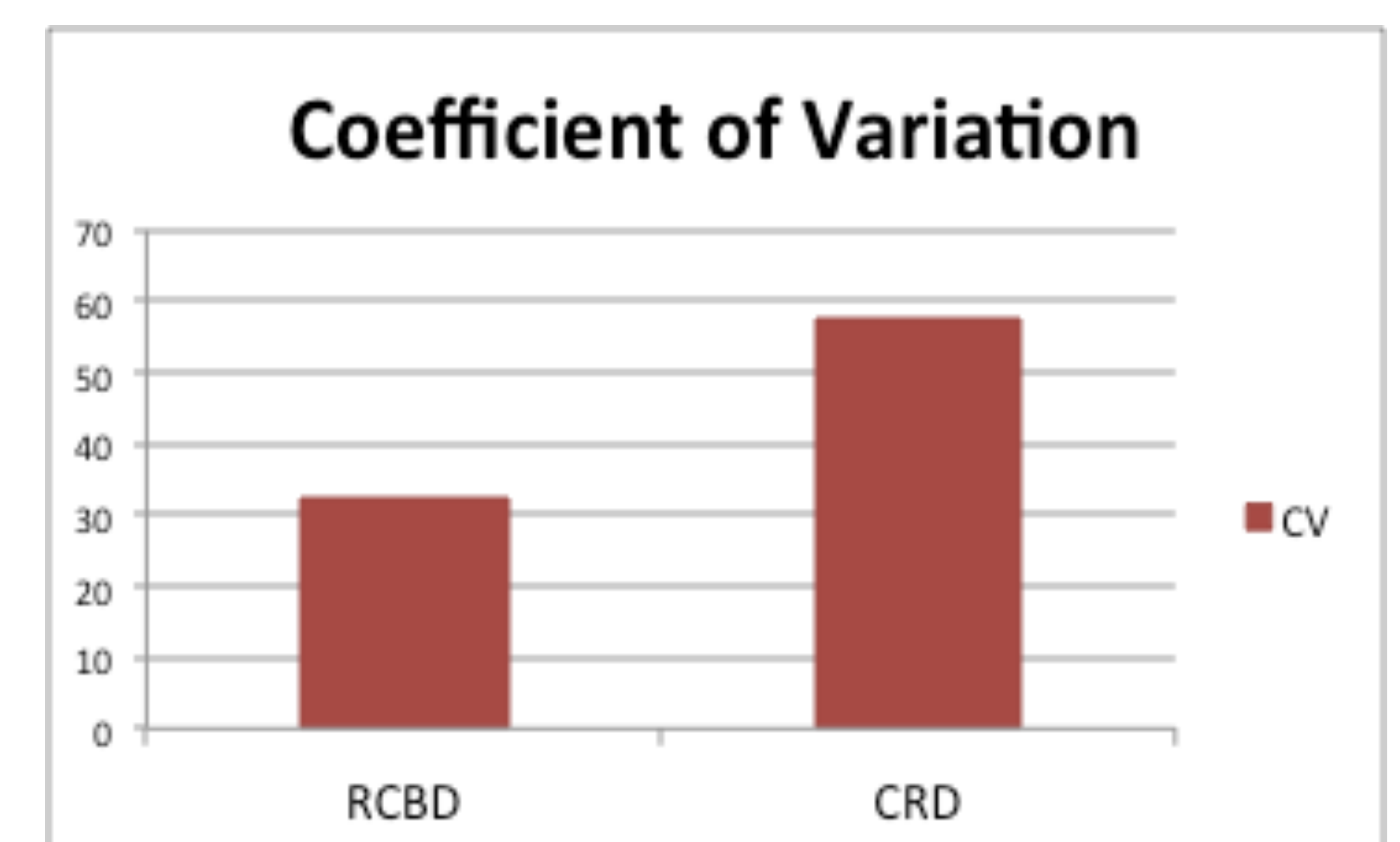

Fig. 2 Coefficient of variation for seed yield in completely randomized design (CRD) at ultra-low plant density (12,000 plants ha^{-1}) and randomized block design (RCBD) at relatively high plant density (340,000 plants ha^{-1}).

Conclusions

Our data suggested that CRD at ultra-low plant density might be more effective in identifying lines with advanced seed yield potential within elite soybean cultivars.

References

Tokatlidis I. S., Papadopoulos I. I., Baxevanos D., and Koutita O. (2010) Genotype x environment effects on single-plant selection at low density for yield and stability in climbing dry bean populations. Crop Science, v 50, p. .775-783.

Fasoula V. A., and Boerma H. R. (2007) Intra-cultivar variation for seed weight and other agronomic traits within three elite soybean cultivars.Crop Science, v. 47, p. 367-373.