Comparative effects of bmr-12 and D genes on straw quality of photoperiod sensitive sorghums.

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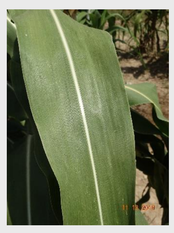
Rapidly increasing forage requirements of West African production systems prompted sorghum breeding programs to develop dual-purpose varieties that produce grain for food and fodder as a feed. Sorghum landraces produce large quantities of biomass but with poor forage quality, while improved varieties produce good quality forage but in smaller quantities. Improving dual-purpose varieties requires a balance between productivity and forage quality. Recessive alleles of two genes are known to improve sorghum forage value by reducing stem lignin content: the Dry gene (D) which controls stem juiciness (Xia et al., 2018) and the brown midrib gene (Oliver et al., 2005). This work evaluates the effects of introgression of these two alleles in Kalla Kéné (Diakité et al., 2018), a photoperiod-sensitive variety from Mali with dry stem and white midrib.

Material and method

Population development

Three near-isogenic lines (ISOJ, ISOB, and ISOJB) were developed from four successive backcrosses between the recurrent parent Kalla Kéné and Redlan (bmr-12) a bmr juicy sorghum as donor parent. Line ISOJ has juicy allele, ISOB the brown midrib and ISOJB both alleles (juicy stem and brown midrib).

ISOB line. The BMR trait produces a brown midrib color, especially on the underside of the leaf.



Kalla kene recurrent parent - white midrib.

ISOJ line - Green midrib identifies juicy stems.

ISOJB line. The presence of both characters (BMR and juicy stem) is identified by a stronger diffusion of the brown coloration on the top of the leaf.

Experimental design

Stem quality of the isogenic lines was studied in interaction with sowing dates (3 levels) using a split-plot design repeated over two years.

Measurements were focused on phenology, morphology and stem chemical composition. Stem juiciness was assessed both by the green color of the midrib and by direct measurement of the extractable water content. Stem chemical composition was evaluated by near infrared spectroscopy.

A press allows direct measurement of the stem water extractable.

A near infrared spectroscope.

Results and discussion

- Genotype and sowing date effects are highly significant. Genotype x sowing date interaction is not significant.
- Delay in sowing leads to a decrease in lignin content (Fig.1a), a later maturity (Fig.1b), followed by a sharp decrease in stem height and biomass production (Fig 1.c).
- Lines with bmr-12 gene have a more strongly reduced lignin content compared to the one with only juicy allele.
- Lignin content of ISOJB (BMR and juicy) line were not significantly different from those of BMR-only varieties. Thus, there is no cumulative effect of the two genes on lignin content.
- For all environments (2 years by 3 sowing dates), the decrease in lignin content does not lead to lodging.

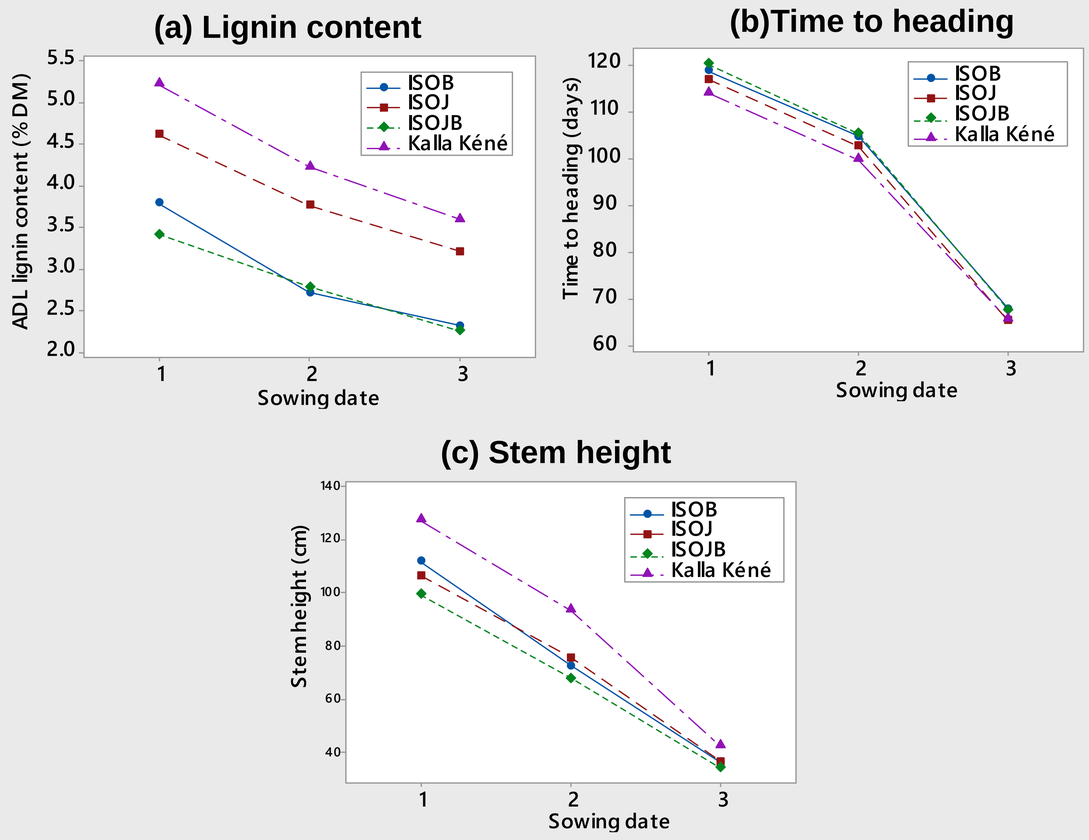


Fig 1. Sowing date effect on (a) stem lignin content, (b) time to heading and (c) stem height.

References

- Diakité, O.S., Mamadou, A., Sissoko, A., Sanogo, S., Kouressy, M., Vaksmann, M., Daniel K. Dzidzienyo, Danquah, E., Tongoona, P., Traoré, K., Témé, N., 2018. Brown midrib 6 and 12 Genes Introgression in Two Nigerien and One Malian Sorghum Varieties. J Basic Appl Sci Res 8, 1–10.
- Oliver, A.L., Pedersen, J.F., Grant, R.J., Klopfenstein, T.J., 2005. Comparative Effects of the Sorghum bmr-6 and bmr-12 Genes: I. Forage Sorghum Yield and Quality. Crop Sci. 45, 2234–2239.
- Xia, J., Zhao, Y., Burks, P., Pauly, M., Brown, P.J., 2018. A sorghum NAC gene is associated with variation in biomass properties and yield potential. Plant Direct 2, 1-11

Conclusion

The use of the BMR trait appears to be the best way to improve forage quality of photoperiod sensitive sorghums without lowering straw productivity.

Innovative dual-purpose varieties will help develop value chains around fodder production. This will have a positive impact on farmers' incomes, especially close to urban centers where fodder deficits are a constraint for intensive livestock production.

Conversion of malian elite sorghum varieties to bmr lines is underway.