Evaluation of performance of Sorghum varieties for sugar accumulating potential under local conditions in Tokyo
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[Introduction] Sorghum (Sorghum bicolor (L.) Moench) is a self-pollinating C4 grass belonging to the family Poaceae, classified into grain sorghum and sweet sorghum. As the 5th most important cereal crop, it serves as a staple food in many countries of Asia and Africa. High resilience to harsher climates, short cultivation time, high energy use efficiency and high sugar accumulating capacity make sweet sorghum competitive as a bioenergy crop. It is well adapted to the semi-arid regions, accumulating sugars in its stem at a level comparable to that of sugarcane during the rainy season. However, failing to accumulate sugars at the same level during the post-rainy season, indicates a strong dependence of its sugar accumulating potential on the environmental factors, mainly light and water availability, and temperature. Thus, selection of high sugar yielding varieties is mainly determined by its performance under the local environmental conditions where it is cultivated. The aim of this study was to assess the performance of grain and sweet sorghum varieties for sugar yield under the local environmental conditions in Tokyo.

[Materials and Methods] Nine varieties of sorghum assessed consisted of two grain sorghum and two sweet sorghum varieties commercially available in Japan, and five other popular sweet sorghum varieties cultivated around the world. Cultivation was carried out at the Institute of Sustainable Agri-ecosystem Services (ISAS), The University of Tokyo (Nishitokyo city, Tokyo).

[Results and Discussion] Brix values of stem juice from the lower-most internode at 30 days after anthesis (30 DAA), strongly correlated with the sucrose levels, but not the hexose levels; elucidating the use of brix to screen sorghum varietal populations for high sucrose content. Among the varieties screened, Roma and Cowley were found to have highest sucrose levels at this stage. The trend of sugar accumulation along the length of the stem for all varieties was found to show maximum brix values at internodes in the intermediate position, presenting reduced ability to accumulate sugars further down the stem. Various growth characteristics such as the plant height, number of leaves, number of tillers, stem girth, panicle length and days to flowering were scored for correlation with sucrose levels and total sugar levels. A strong negative correlation between stem girth and total sugars, indicated that varieties with thinner stalks had higher levels of total sugar in their lower stems; and a strong positive correlation between total sugars and days to flowering, indicated that a longer vegetative period could increase the sugar yielding capacity of sorghum. Transcript levels of two vacuolar invertase isoforms SbIvr1 and SbIvr2 in the lowermost internode were determined for all varieties. Compared to Mini sorghum, a grain sorghum variety, the high sucrose accumulating varieties, Roma and Cowley showed 35 and 70 fold lower SbIvr2 transcript levels respectively, while the SbIvr1 transcript levels weren't different between the varieties. Further determination of SbIvr2 transcript correlation with the sucrose content revealed a strong negative relationship suggesting a direct role of SbIvr2 in varietal differences with respect to sucrose accumulating potential of sorghum.

The overall performance of sweet sorghum under the local environmental conditions in Tokyo was better in terms of sugar yielding capacity in comparison to grain sorghum, with Roma and Cowley being the high sucrose yielding varieties.

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