

Morphological Traits in First Ratoon of different *Saccharum* Species within the Diversity Panel of the World Collection of Sugarcane and Related Grasses

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Introduction:

- The Genus *Saccharum* is an important source of sugar and biofuel.
- Breeding programs probably have not fully realized the genetic potential including yields or genetic resistance to biotic and abiotic stresses within available germplasm.
- The World Collection of Sugarcane and Related Grasses (WCSRG) located in Miami, FL is likely a source of such genes.
- To investigate this collection, and later associate yield and resistance genes with molecular markers in an association map, a diversity panel of WCSRG and related genera including 18 species was created at Canal Point, FL (Figures 1, 2 and 3).
- These phenotypic data should be useful for biofuel feedstock advancement.

Materials and Methods:

- From the Miami WCSRG, 300 accessions, including 18 species and 10 sugarcane checks, were planted at Canal Point, FL outside in containers in a randomized complete block design with three replications in March 2013.
- Leaf length and width, and stalk diameter measurements were taken in 2014.
- The plants were harvested in September of 2013 and August of 2014 and stalks were counted and stalk weights and Brix were measured.
- The data were subjected to mixed model analysis using SAS.
- The various traits were correlated including, stalk height (cm), Brix (%), leaf width (mm) and length cm, internode length (cm) and diameter (mm), fresh and dry biomass (kg) and stalk number.
- Principal component analysis was performed on the phenotypic data.

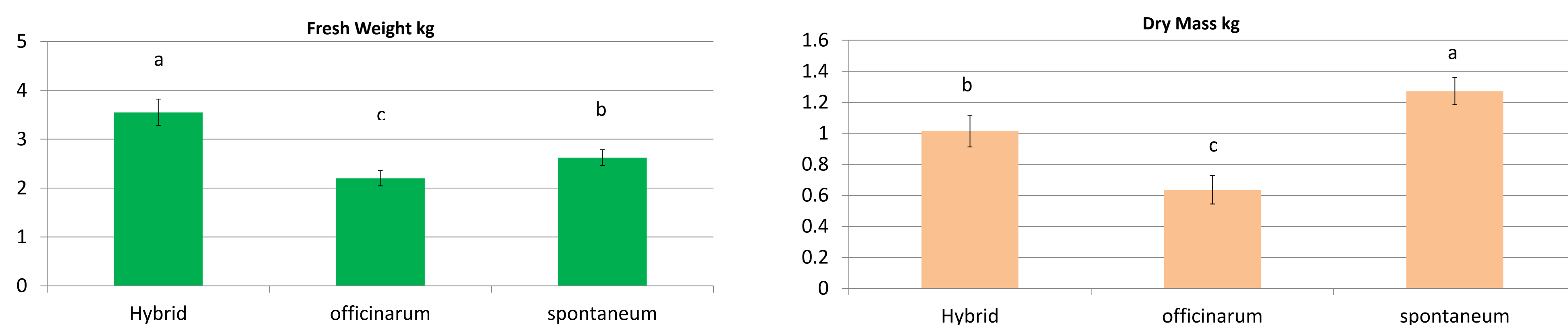


Fig. 4. Fresh and dry mass means (kg) with standard error bars from the three major species of the World Collection of Sugarcane and Related Species diversity Panel. Groups a, b, and c are significant at $P=0.05$ with 95% based on LSD.

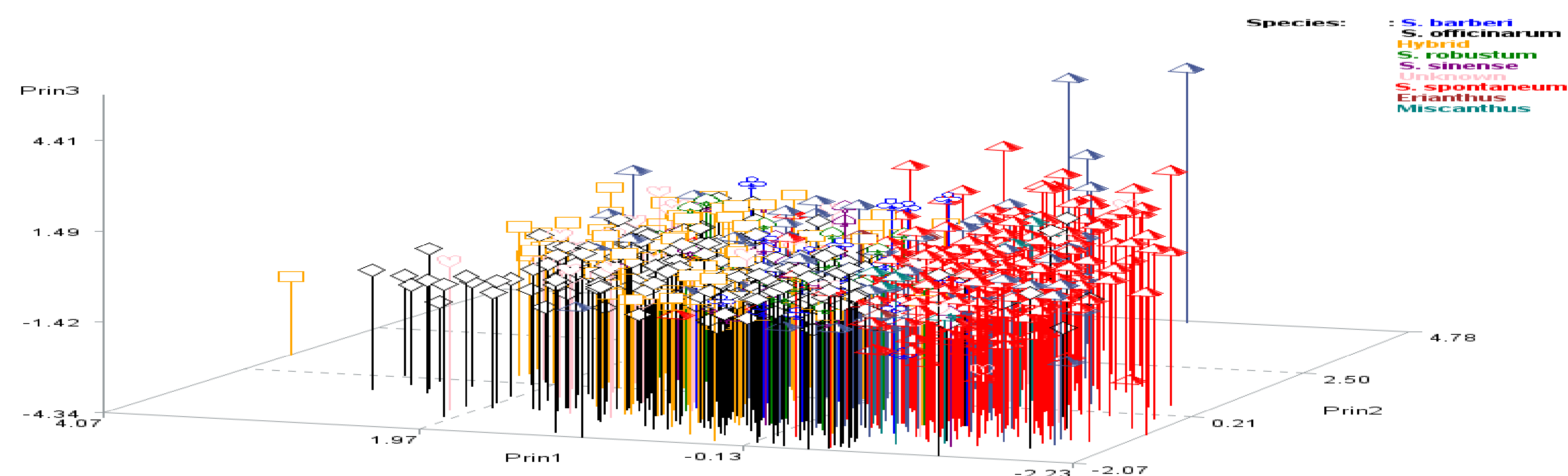


Fig. 6 Principle component analysis of the Phenotypic data from the diversity panel

Results:

- Hybrids had significantly the highest fresh biomass and *Saccharum spontaneum* had significantly the highest dry biomass (Figure 4).
- Correlations between traits changed depending on the sub population examined (Fig. 5).
- The correlations differed by species.
- For the hybrid subpopulation (n=40), biomass correlated with stalk height (fresh 0.29, dry 0.27), leaf length (fresh 0.33, dry 0.30), internode length (fresh 0.19, dry N.S.) Brix (fresh 0.34, dry 0.34), water (fresh 0.43, dry 0.35).
- For the *S. officinarum* (n=79) subpopulation, biomass correlated with stalk height (fresh 0.53, dry 0.48), leaf length (fresh 0.24, dry 0.18), leaf width (fresh 0.20, dry N.S.) stalk diameter (fresh 0.46, dry 0.37), internode length (fresh 0.34, dry 0.31), Stalk number (fresh 0.34, dry 0.44), Brix (fresh 0.27, dry 0.33), water content (fresh 0.67, dry 0.61), and volume (fresh 0.56, dry 0.46).
- For the *S. spontaneum* (n=107) subpopulation, biomass correlated with stalk height (fresh 0.39, dry 0.33), stalk diameter (fresh 0.32, dry 0.20), leaf width (0.12 fresh, dry N.S.), internode length (fresh 0.15, dry 0.12), stalk number (fresh 0.30, dry 0.38), Brix (fresh 0.17, dry 0.19), water (fresh 0.24, dry 0.12), and volume (fresh 0.40, dry 0.28).
- The principle component analysis showed some separation of species (Fig. 6).
- Most traits loaded onto the first PCA representing 4.21 proportion of the variance including stalk diameter (0.95), leaf width (0.80) and length (0.54), stalk number (-0.67), Brix (0.47), water (0.85), and volume (0.88). On the second PCA mostly biomass loaded (fresh 0.91, dry 0.91), and the third PCA internode (0.86) and stalk height (0.81) loaded.



Fig. 1. A diverse panel of 300 accessions selected from The World Collection of Sugarcane and Related Grasses planted at Canal Point, FL

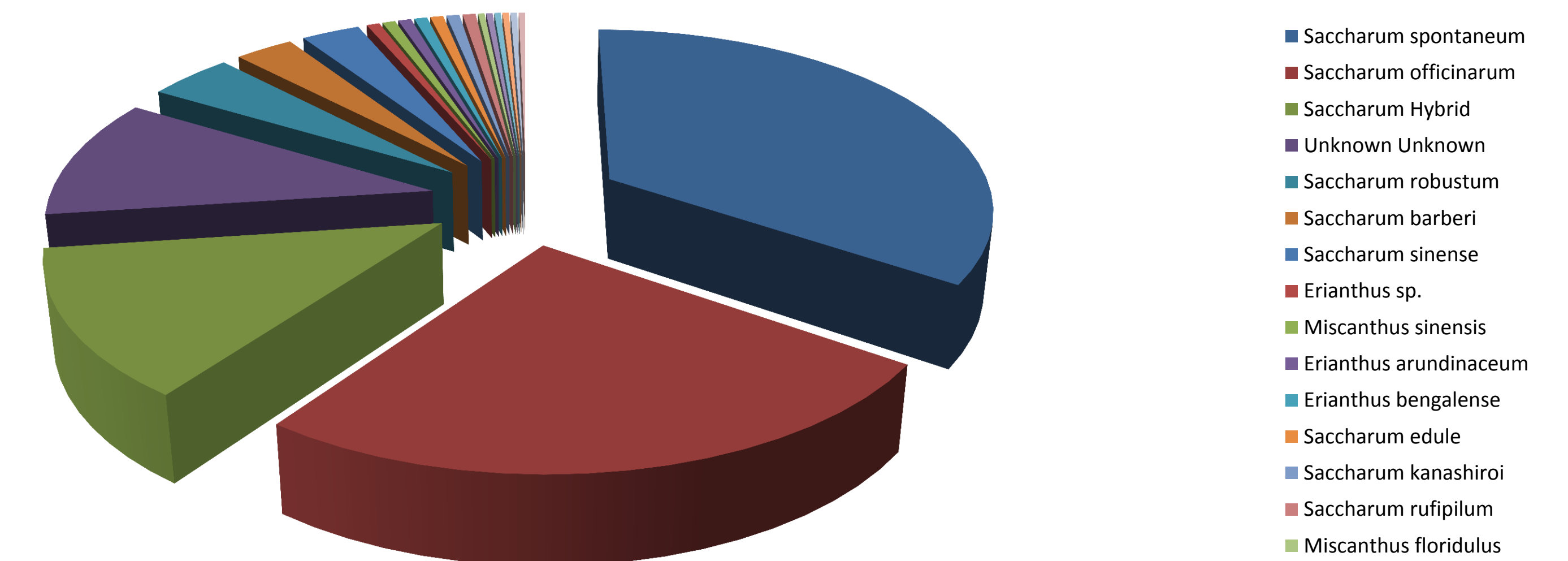


Fig. 2. Pie chart of the population of each species within the diversity panel

Discussion:

- The results indicated that several traits were correlated which could lead to QTLs that affect multiple traits.
- Correlations were mostly consistent with known species trait trends examples including *spontaneum* having more stalks and stalks with narrow diameter and lower Brix, and *officinarum* having fewer wider stalks with high Brix.
- There were differences in correlations between species populations and there could be differences within sub populations which could lead to population specific QTLs.
- Principal Component analysis identified some patterns; with differences being mostly between *spontaneum* and other species.
- Saccharum spontaneum* had more smaller diameter stalks with more dry biomass.
- There were some traits that correlated regardless of species, including height and weight which always correlated with each other and with Brix.



Fig. 3 Examples of the diversity within the World Collection of Sugarcane and Related Grasses diversity panel.

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A

B

C

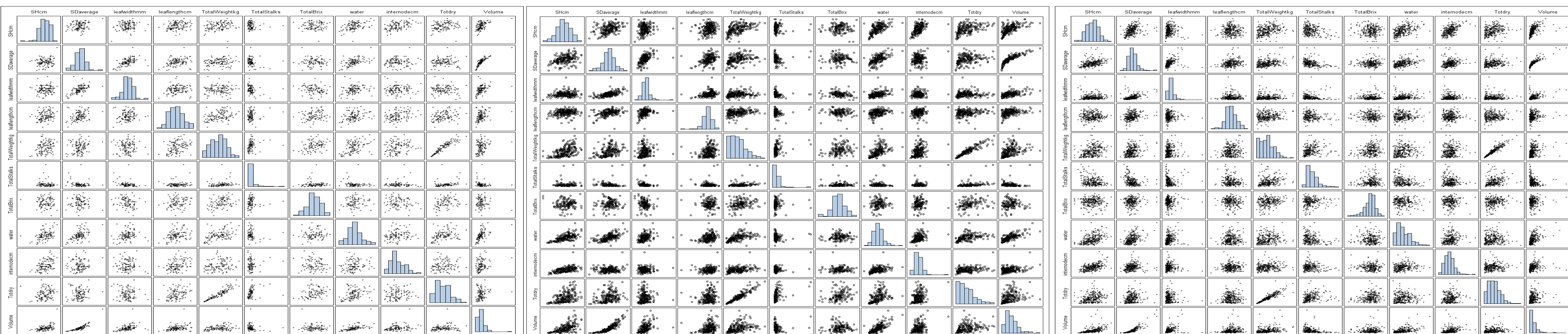


Fig. 5 Correlations between Stalk Height cm (SHcm), Stalk Diameter (SDaverage), internode length cm (Internodecm), leaf width mm (Leafwidthmm), leaf length cm (leaflengthcm), Fresh biomass kg (TotalWeightkg), Stalk number (Total Stalks) and Brix (Total Brix), Sample Water content g (Water), Dry mass kg (Totdry), Stalk Volume cm³ (Volume). For A: B: *Saccharum* hybrids, B: *Saccharum officinarum* and C: *S. spontaneum*