

## Precision of Sugarcane Biomass Estimates in Pot Studies Using Fresh and Dry Weights

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### ABSTRACT

Sugarcane (*Saccharum* spp.) field studies generally report fresh weight (FW) rather than dry weight (DW) due to logistical difficulties in drying large amounts of biomass. Pot studies often measure biomass of young plants with DW under the assumption that DW provides a more precise estimate of treatment effects than FW. The purpose of our research was to compare experimental precision of FW and DW measurements on sugarcane green and brown leaves, and on stalks in pot studies. Four pot studies harvested after 2-6-months growth were conducted at Canal Point, FL from 2005 to 2009 with each experiment being a combination of some of the following treatments: genotype, crop cycle (plant-cane or first ratoon), water-table depth, water availability, soil type, or N rate. For green leaves, brown leaves, and stalks, we measured FW and DW, and calculated DW:FW ratio. Analyses of variance, regression, and estimates of CV and repeatability were used to compare treatment responses and appraise experimental precision. For all parameters, treatment responses were generally similar for FW and DW. Similar CVs and highly significant regressions ( $r^2 = 0.74-0.99^{****}$ ) were consistently found between FW and DW. The relationship between FW and DW:FW was consistently poor ( $r^2 = 0.00-0.25$ ) with slopes of approximately 0 for the regression lines, indicating that changes in FW had little effect on DW:FW. Repeatability values were generally low for all traits, but similar between FW and DW. Results suggest that measuring biomass as FW rather than DW would save substantial resources in conducting pot studies.

### INTRODUCTION

Biomass accumulation and partitioning in field crops are critical traits used in genotype selection and agronomic research because they are directly or indirectly associated with crop yields. Sugarcane is an important crop for both sugar and biofuels worldwide because of high stalk sucrose content and high biomass production due to its C4 photosynthesis pathway. Many investigators have reported sugarcane dry matter accumulation (Thompson, 1978; Muchow et al., 1994; Robertson et al., 1996; Singels et al., 2000; Glaz, 2006) and partitioning (Beeharry, 2001; Singels et al., 2005) as affected by genotype and growth environment at different growth stages (Singels et al., 2000; Singels et al., 2005; Gilbert et al., 2007). Measurements of biomass of sugarcane components are generally calculated as FW for field experiments. For pot studies that harvest plants before they become too large, often DW rather than FW is measured. However, particularly for stalks, estimating DW can be difficult and time consuming. It is difficult to completely dry stalks and verify when they are totally dry. Moreover, many research facilities may not have adequate drier space for the large amounts of leaf and stalk biomass accumulated in pot studies that are harvested 2-6 months after planting or ratooning.

Several studies have reported both FW and DW of sugarcane entire shoots or other plant parts (Beeharry, 2001; Liu and Helyar, 2003; Wagih et al., 2003; Gilani et al., 2008). However, we are not aware of any study that has compared experimental precision of FW and DW. Little is known about the quantitative relationships between FW and DW for each plant component in sugarcane and repeatability for FW, DW, and ratio of DW to FW. The purpose of this research was to compare experimental precision of FW and DW measurements in sugarcane pot studies with up to 6 months of growth on sugarcane green leaves, brown leaves, and stalks.

## MATERIALS AND METHODS

In order to compare precision of FW and DW measurements, we used our unpublished data from four pot studies conducted from 2005 to 2009. These studies were originally designed to address other issues. The pertinent materials and methods from those studies are described in the following paragraphs.

All studies used pots that were 38 cm in both diameter and depth with four small holes (1.5 cm diameter) at the base. Treatments in the first study (Study 1) included four genotypes [‘CP 80-1743’ (Deren et al., 1991), ‘CP 89-2143’ (Glaz et al., 2000), ‘CP 89-2376’ (Glaz et al., 2005), and ‘CP 96-1252’ (Edmé et al., 2005)] and three water-table depths (5, 19, and 33 cm). Pots were filled with Pahokee muck soil (euic, hyperththermic Lithic Haplosaprist) and placed into individual containers that were used to adjust water levels to desired water-table depth treatments. Single-bud stalk sections were planted in flats on 7 Feb. 2005 and one shoot was transplanted to each pot on 21 Mar. 2005. Fertilization with P (39 kg ha<sup>-1</sup>), K (280 kg ha<sup>-1</sup>), and a standard grower’s mix of micro nutrients at rates of 0.9, 0.9, 0.9, 2.3, 0.9, and 0.9 kg ha<sup>-1</sup> of B, Cu, Fe, Mn, Mo, and Zn was performed on 28 Mar. 2005 based on sugarcane production recommendations for muck soils in Florida (Sanchez, 1990). The water-table treatments started on 5 Apr. 2005 until the plant-cane crop was harvested from 5 to 8 July 2005. Shoots were cut near the soil surface and immediately separated into green leaves, brown leaves, and stalks. Fresh weight of each plant component was recorded. Each plant fresh sample was dried in a forced-air oven at 58°C and weighed until its weight was stable for 2 d. The DW:FW ratio for each plant component was reported as a percentage and calculated as 100×DW/FW. The same procedures were followed for the ratoon harvest in mid-October 2005. The experiment was a randomized complete block (RCB) design with 10 replications.

Treatments in Study 2 included 14 genotypes (CP 02-1143, CP 02-1458, CP 02-1554, CP 02-1564, CP 02-2015, CP 02-2281, CP 89-2143, CPCL 99-1225, CPCL 99-1401, CPCL 99-1777, CPCL 99-2103, CPCL 99-2206, CPCL 99-2574, and CPCL 99-4455) and two water-table depths (5 and 25 cm). Two buds on separate stalk sections were planted in each pot filled with Pahokee muck soil on 9 Sept. 2006. Plants were thinned to one per pot after emergence. Using the same rates as in Study 1, P, K, and micro nutrients were applied when water-table treatments were initiated on 17 Oct. 2006. Water-table treatment duration was 95 d. Pots were then flooded from 20 Jan. to 19 Feb. 2007 when plants were cut and immediately separated into green leaves, brown leaves, and stalks. Procedures similar to Study 1 were then followed. The ratoon regrowth was harvested on 17 June 2007. Pots in Study 2 were arranged in a RCB design with four replications.

Study 3 was conducted in 2008-2009. Three genotypes were used in this study, namely CP 80-1743, CP 01-2390, and ‘TCP 87-3388’ (Irvine et al., 1997) to represent a genotype adapted to Florida organic (muck) soils, Florida sand soils, and Texas Vertisols, respectively. Single-bud stalk sections were planted in pots filled with Pahokee muck or Margate sand (siliceous, hyperthermic Mollic Psammaquent) soils on 8 Dec. 2008. The muck and sand soils were collected from sugarcane production fields south of South Bay, FL and near Clewiston, FL, respectively. Fertilization with P, K and micro nutrients was performed at planting based on test results on both soils and based on recommendations for sugarcane nutrient management in Florida (Gilbert and Rice, 2009). No N fertilizer was used for the muck soil because annually approximately 900 kg ha<sup>-1</sup> of N is made available by microbial oxidation (Glaz and Gilbert, 2006), but the sand soil received four levels of N (0, 75, 150, and 225 kg N ha<sup>-1</sup>). Nitrogen fertilizer for each N rate was equally split between applications at 43 and 121 days after planting (DAP). All pots were well watered during the experiment. At 184 DAP (9 June 2009), all plants were harvested and biomass components measured following procedures similar to Study 1. Pots were arranged as RCB with five replications.

Study 4 was conducted in a greenhouse to investigate effects of soil and water on FW, DW, and DW:FW ratio for green leaves, brown leaves, and stalks of ratoon regrowth. Treatments included two genotypes (CP 80-1743 and CP 01-2390), two soils (Pahokee muck and Margate sand), and two water regimes [well watered (WW) and water stress (WS)]. Single-bud stalk sections were planted in each pot on 27 Jan. 2009. Pots were well watered and fertilized before initiation of water treatments. Plants were harvested on 20 Apr. 2009. When average ratoon stalk length reached about 50 cm (May 26), water was withheld from the WS treatment pots, letting soil moisture gradually decline by evapotranspiration. When leaves of the WS plants clearly rolled up (June 18), plants in all pots were cut and FW, DW, and DW:FW ratio for green leaves, brown leaves, and stalks were recorded using the same methods as described above. This study was arranged as a split plot planted in a RCB design with seven replications. Soil type × water regime was the main plot and genotype was the subplot.

Significance of each fixed effect was analyzed using the MIXED procedure of SAS (SAS Institute, 2003). Block was considered as a random effect and all other treatments were considered as fixed effects. If the hypothesis of equal means for DW:FW ratio among treatments was rejected by the ANOVA test, trait means were compared with Fisher LSD values at  $P = 0.05$  that were calculated with the SE values generated by the Diff option in SAS. Variance components were determined using the PROC VARCOMP procedure of SAS (SAS Institute, 2003). Genetic repeatability ( $R$ ) of FW, DW, and DW:FW ratio for each plant component was calculated based on the following equation (Becker, 1992; Falconer and Mackay, 1996):

$$R = \frac{\sigma_G^2}{\sigma_G^2 + \sigma_E^2}$$

where  $\sigma_G^2$  is the between-genotype variance and  $\sigma_E^2$  is the residual variance. The MIXED procedure of SAS (SAS Institute, 2003) was used to test if the DW:FW ratio for each plant component was different among the four studies after the DW:FW ratio data in each study were

pooled across treatments. Fisher LSD values at  $P = 0.05$  among studies were calculated with the SE values generated by the Diff option in SAS.

## RESULTS

### Study 1

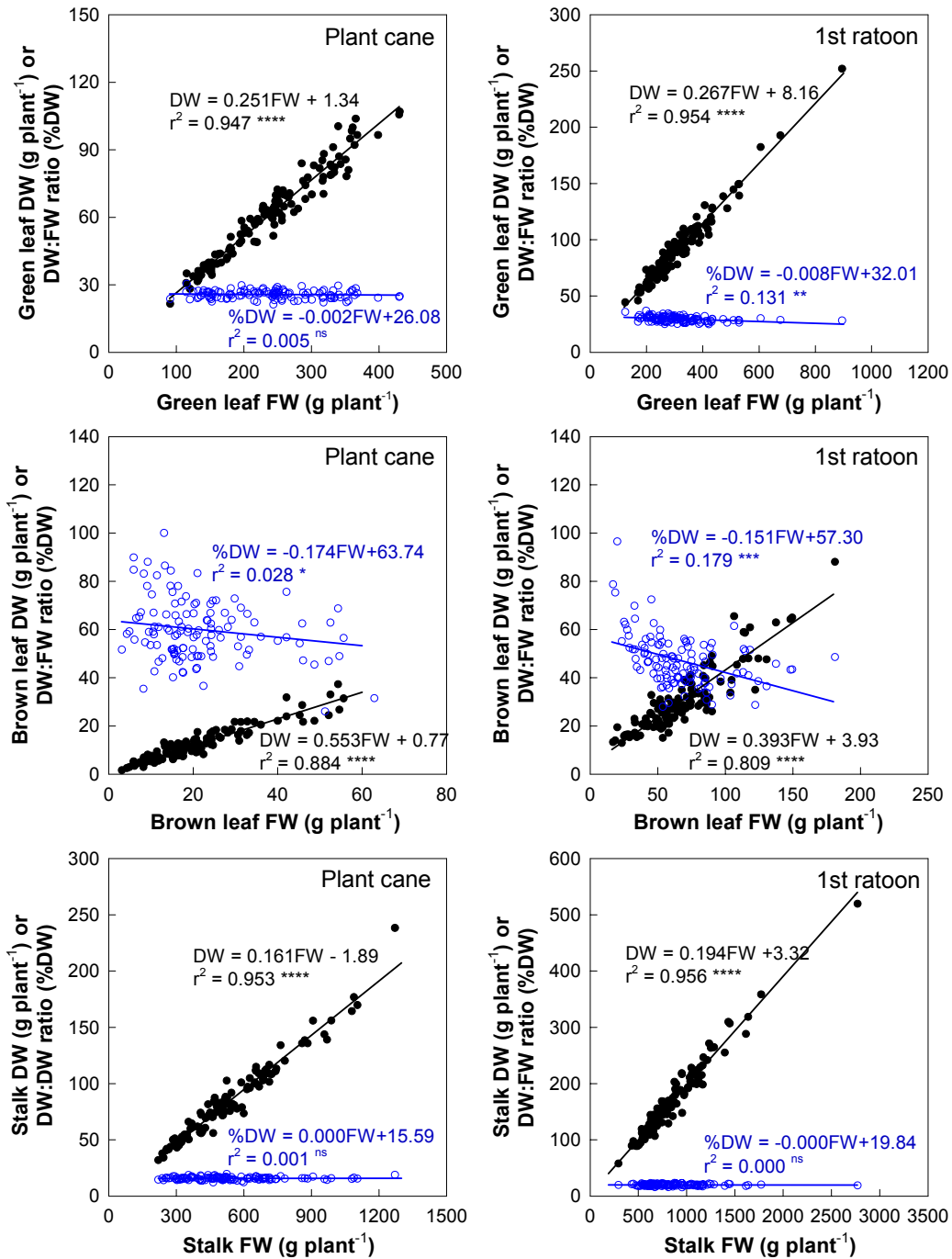
In Study 1, the crop  $\times$  water-table interaction for green leaves was significant based on DW data but not for FW (Table 1). The reverse was true for stalks; the crop  $\times$  water table interaction was significant based on FW data but not for DW. Otherwise, all main effects and their interactions that were significant based on FW were also significant based on DW. The CV and repeatability values between FW and DW for each plant component were similar in Study 1 (Table 1). The DW:FW ratio of green leaves was significantly affected by crop, genotype, and the crop  $\times$  water-table depth interaction. For brown leaves, only the crop and crop  $\times$  water interaction were significant for DW:FW ratio. However, all effects and interactions, except for the three-way interaction, were significant for the DW:FW ratio of stalks in Study 1. There were strong linear relationships between FW and DW for each plant component for both plant cane and ratoon ( $r^2 = 0.79^{****}$  to  $0.96^{****}$ ) (Fig. 1); due to interactions data are presented separately for crops. However, there were no strong linear relationships for the DW:FW ratio with FW for any of the plant components.

**Table 1. Significance ( $P$  value) of fixed effects, maximum, minimum, mean, coefficient of variation (CV), and repeatability for fresh weight (FW), dry weight (DW), and DW:FW ratio expressed as %DW for green leaves, brown leaves, and stalks for Study 1.**

Fixed effect†	df	Green leaf			Brown leaf			Stalk		
		FW	DW	%DW	FW	DW	%DW	FW	DW	%DW
Crop (C)	1	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Genotype (G)	3	0.0129	0.0009	0.0107	0.3066	0.2319	0.8875	<0.0001	<0.0001	<0.0001
C $\times$ G	3	0.7170	0.6853	0.1225	0.9060	0.6945	0.1814	0.2954	0.2004	0.0070
WaterT (WT)	2	<0.0001	<0.0001	0.0923	<0.0001	<0.0001	0.6133	<0.0001	<0.0001	<0.0001
C $\times$ WT	2	0.1422	0.0136	0.0053	0.0193	0.0020	0.0003	0.0469	0.0681	0.0003
G $\times$ WT	6	0.428	0.2916	0.8303	0.9270	0.6574	0.8384	0.0298	0.0294	0.0030
C $\times$ G $\times$ WT	6	0.9742	0.9300	0.9638	0.9841	0.8332	0.7182	0.9337	0.9265	0.6039
		---- (g plant <sup>-1</sup> ) ----			---- (g plant <sup>-1</sup> ) ----			---- (g plant <sup>-1</sup> ) ----		
Maximum‡		895.0	251.9	36.9	181.2	88.0	96.5	2770.4	519.5	23.3
Minimum		90.8	21.5	21.2	3.1	1.6	26.0	219.9	31.9	12.0
Mean		275.9	76.2	27.6	44.6	21.4	53.2	690.0	125.3	17.7
CV (%)		24.4	23.6	7.3	41.3	37.0	21.8	26.9	28.6	6.8
Repeatability		0.06	0.09	0.03	0.03	0.00	0.02	0.41	0.38	0.19

† “Crop” represents plant cane or ratoon regrowth and “WaterT” indicates water-table depth.

‡ Maximum, minimum, mean, and CV of each trait were determined across crops (plant cane and ratoon), genotypes, and water-table depths.



**Figure 1.** Relationships of fresh weight (FW) with dry weight (DW, closed circle) and DW:FW ratio expressed as %DW (open circle) for sugarcane green leaves, brown leaves, and stalks for Study 1. Data are pooled over all treatments; ns, \*\*, and \*\*\*\* represent not significant ( $P > 0.05$ ), and significant at  $P < 0.01$ , and  $P < 0.0001$ , respectively.

## Study 2

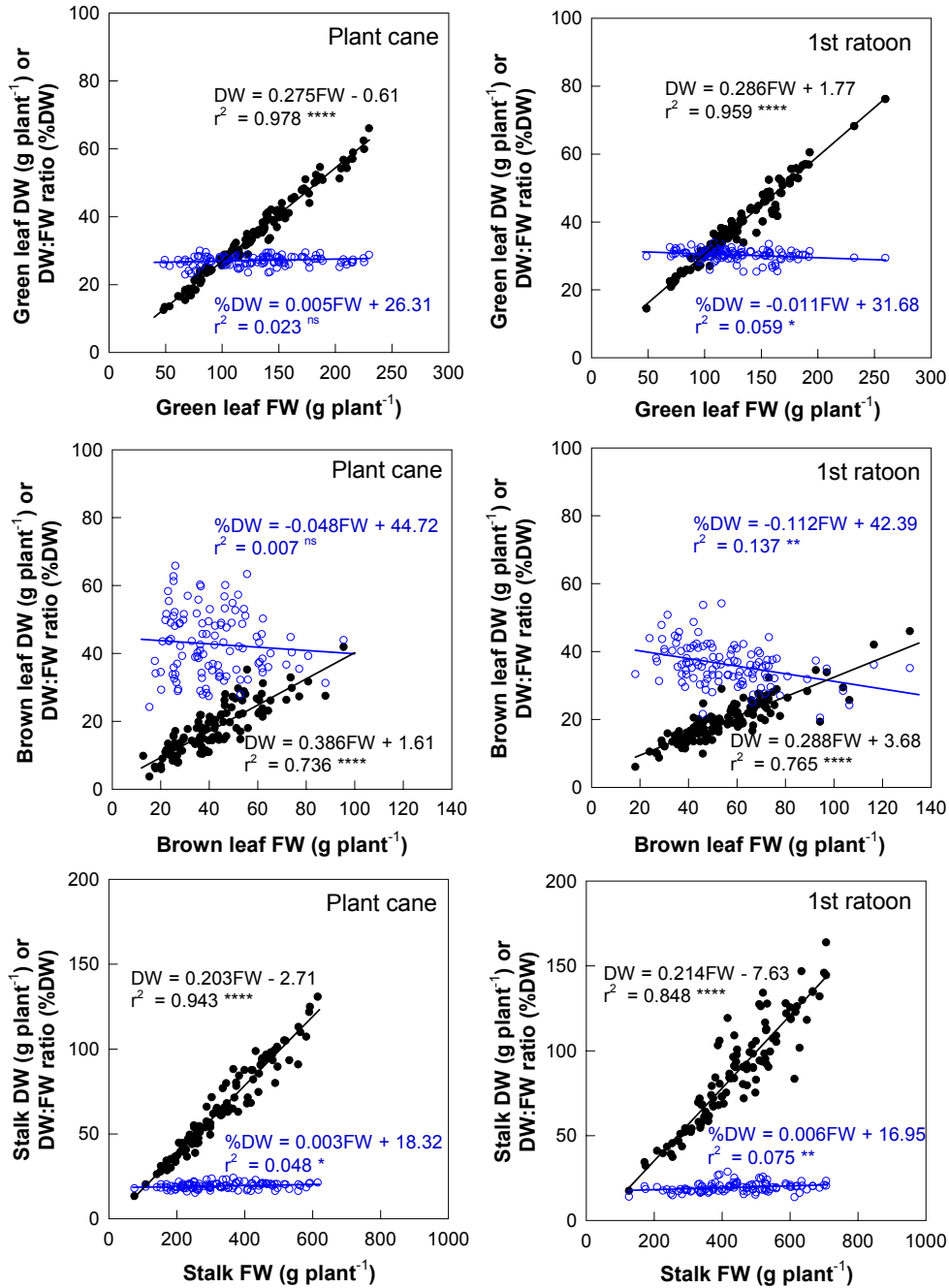
In Study 2, all main effects and their interactions that were significant based on FW were also significant based on their DW except that the main effect of crop was significant for green leaf DW but not for FW (Table 2). The CV and repeatability values between FW and DW for each plant component were similar in Study 2. The crop main effect on the DW:FW ratio was significant for green leaves and brown leaves, and the crop  $\times$  water-table depth interaction was significant for stalks. There were no significant interactions on the DW:FW ratio for any trait. Water-table depth did not affect DW:FW ratio for any other traits except for significant interaction of crop  $\times$  water table depth on stalk DW:FW ratio. Similar to Study 1, the DW was highly and linearly related to FW ( $r^2 = 0.74^{****}$  to  $0.98^{****}$ ); due to interactions data are presented separately for crops but is pooled across genotypes and water-table treatments. The relationships between DW and FW and between DW:FW ratio and FW for green leaves, brown leaves, and stalks in Study 2 (Fig. 2) were similar to those found in Study 1 (Fig. 1).

**Table 2. Significance (*P* value) of fixed effects, maximum, minimum, mean, coefficient of variation (CV), and repeatability for fresh weight (FW), dry weight (DW), and DW:FW ratio expressed as %DW for green leaves, brown leaves, and stalks for Study 2.**

Fixed effect†	df	Green leaf			Brown leaf			Stalk		
		FW	DW	%DW	FW	DW	%DW	FW	DW	%DW
Crop (C)	1	0.2593	0.0011	<0.0001	<0.0001	0.0008	<0.0001	<0.0001	<0.0001	0.5443
Genotype (G)	13	<0.0001	<0.0001	<0.0001	0.0302	0.0001	0.1616	<0.0001	<0.0001	<0.0001
C $\times$ G	13	0.1819	0.4064	0.2106	0.0160	<0.0001	0.8452	0.0311	0.0352	0.1408
WaterT (WT)	1	<0.0001	<0.0001	0.2360	<0.0001	<0.0001	0.2379	<0.0001	0.0194	0.0601
C $\times$ WT	1	0.0080	0.0028	0.1851	0.0341	0.0004	0.5625	0.0002	<0.0001	0.0091
G $\times$ WT	13	0.4089	0.4174	0.4580	0.4534	0.3615	0.6013	0.0741	0.2483	0.6732
C $\times$ G $\times$ WT	13	0.6673	0.6633	0.5553	0.2202	0.1669	0.7932	0.5595	0.4859	0.1972
		---- (g plant <sup>-1</sup> ) ----			---- (g plant <sup>-1</sup> ) ----			---- (g plant <sup>-1</sup> ) ----		
Maximum‡		259.5	76.2	33.8	131.2	46.0	65.8	706.2	163.8	28.6
Minimum		39.7	12.5	22.9	12.8	3.7	20.5	75.0	13.4	13.6
Mean		128.9	37.1	28.6	48.4	18.6	39.4	388.2	75.6	19.4
CV (%)		19.4	18.5	14.2	28.3	24.8	18.4	21.1	23.9	10.1
Repeatability		0.41	0.48	0.20	0.00	0.00	0.05	0.47	0.53	0.36

†“Crop” represents plant cane or ratoon regrowth and “WaterT” indicates water-table depth.

‡ Maximum, minimum, mean, and CV of each trait were determined across crops (plant cane and ratoon), genotypes, and water-table depths.



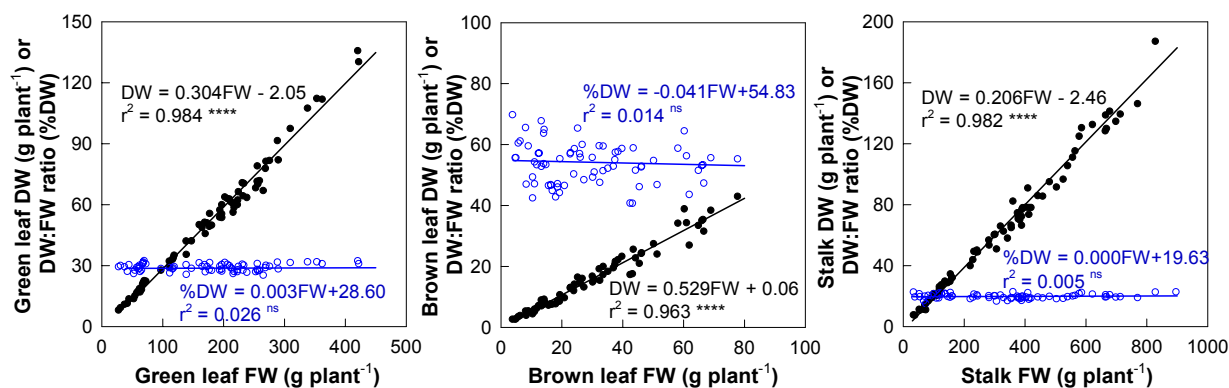
**Figure 2.** Relationships of fresh weight (FW) with dry weight (DW, closed circle) and DW:FW ratio expressed as %DW (open circle) for sugarcane green leaves, brown leaves, and stalks for Study 2. Data are pooled over all treatments; ns, \*, \*\*, and \*\*\*\* represent not significant ( $P > 0.05$ ), and significant at  $P < 0.05$ ,  $P < 0.01$ , and  $P < 0.0001$ , respectively.

### Study 3

All comparisons that were significant for FW in Study 3 were also significant for DW, except that the genotype effect was significant on DW but not for FW ( $P = 0.0571$ ) (Table 3). There were no interactions between genotype  $\times$  soil on any plant components for FW and DW. Compared with their FW, the DW of green leaves, brown leaves, and stalks had similar CV and repeatability values, indicating that DW did not improve the experimental precision. The mean DW:FW ratios averaged across treatments for green leaves, brown leaves, and stalks were 29.1, 53.6, and 19.8%, respectively. Similar to Studies 1 and 2, there were strong linear relationships between DW and FW for all three plant components ( $r^2 = 0.96^{****}$  to  $0.98^{****}$ ) in Study 3 (Fig. 3). The DW:FW ratio was not correlated with FW for green leaves, brown leaves or stalks. The variability of brown leaf DW:FW ratio was much greater when FW was low.

**Table 3. Significance ( $P$  value) of fixed effects, maximum, minimum, mean, coefficient of variation (CV), and repeatability for fresh weight (FW), dry weight (DW), and DW:FW ratio expressed as %DW for green and brown leaves, and stalks for Study 3.**

Fixed effect	df	Green leaf			Brown leaf			Stalk		
		FW	DW	%DW	FW	DW	%DW	FW	DW	%DW
Genotype (G)	2	0.1557	0.0777	<0.0001	0.1890	0.0942	0.0081	0.0571	0.0127	<0.0001
Soil (S)	4	<0.0001	<0.0001	0.2342	<0.0001	0.0002	0.3098	<0.0001	<0.0001	0.0120
G $\times$ S	8	0.8401	0.8554	0.8307	0.7440	0.6933	0.6030	0.8194	0.7662	0.6876
		---- (g plant <sup>-1</sup> ) ----			---- (g plant <sup>-1</sup> ) ----			---- (g plant <sup>-1</sup> ) ----		
Maximum		421.9	135.8	32.4	77.7	43.0	69.7	895.7	203.5	22.9
Minimum		27.4	8.1	25.2	3.8	2.6	40.7	33.6	7.4	15.0
Mean		176.8	51.8	29.1	29.6	15.7	53.6	342.9	68.2	19.8
CV (%)		43.0	46.1	3.6	54.7	56.4	10.3	50.7	53.6	6.3
Repeatability		0.08	0.11	0.74	0.04	0.07	0.16	0.11	0.16	0.41



**Figure 3.** Relationships of fresh weight (FW) with dry weight (DW, closed circle) and DW:FW ratio expressed as %DW (open circle) for green leaves, brown leaves, and stalks for Study 3. Data are pooled over all treatments and genotypes; ns and \*\*\*\* represent not significant ( $P > 0.05$ ) and significant at  $P < 0.0001$ , respectively.

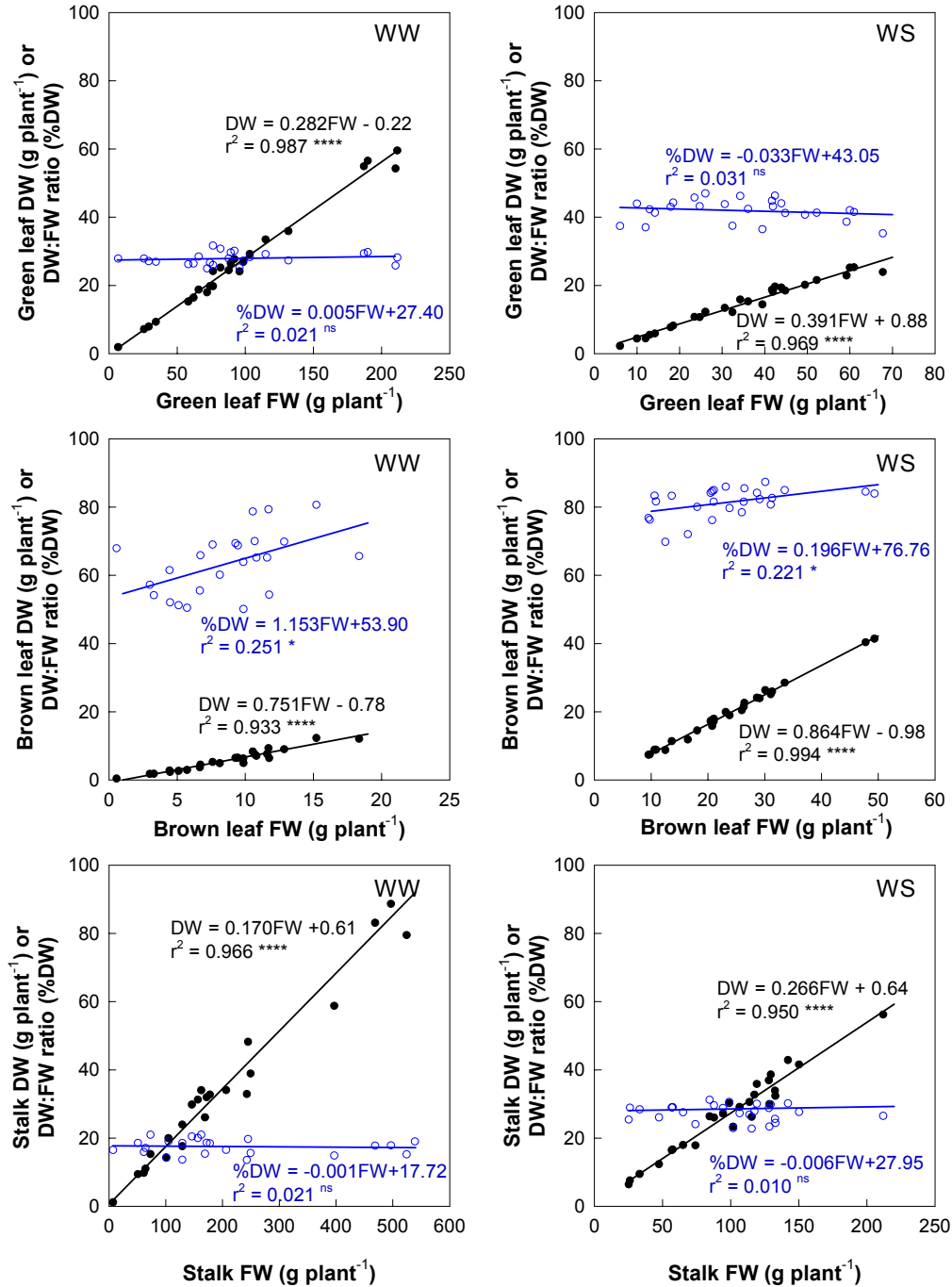
**Study 4**

Significances of the main effects and interactions of water, soil, and genotype on FW in Study 4 depended on plant components. Similar to the three studies described above, if the treatment effects on FW were significant, their effects on DW were also significant except for the three-way interaction for stalk FW and DW (Table 4). The CV and repeatability values of DW for each plant component were comparable to those of FW, suggesting that experimental precision was similar for DW and FW. Water deficit stress (WS) significantly affected DW:FW ratio for all three plant components ( $P < 0.001$ ). Soil type influenced only stalk DW:FW ratio ( $P < 0.05$ ), and genotype significantly influenced green leaf DW:FW ratio ( $P < 0.01$ ) only. Except for the significant ( $P < 0.05$ ) interactions of water  $\times$  genotype on stalk DW:FW ratio and soil  $\times$  water on brown leaf DW:FW ratio, there were no interactions among water, soil, and genotype for DW:FW ratio (Table 4). Water deficit stress significantly decreased plant tissue water content, resulting in increased DW:FW ratio. Similar to the other three studies, strong linear relationships existed between DW and FW for green leaves ( $r^2 = 0.97-0.99^{****}$ ), brown leaves ( $r^2 = 0.93-0.99^{****}$ ), and stalks ( $r^2 = 0.95-0.97^{****}$ ) under both the WW and WS conditions (Fig. 4), but water treatment greatly affected the slopes of regression lines. There were no relationships between DW:FW ratio and FW for green leaves and stalks within the water treatment, whereas brown leaf DW:FW ratio increased by 1.153% and 0.196% for every 1 g increase in FW under the well watered and water-stressed treatments, respectively (Fig. 4).

**Table 4. Significance ( $P$  value) of fixed effects, maximum, minimum, mean, coefficient of variation (CV), and repeatability for fresh weight (FW), dry weight (DW), and DW:FW ratio expressed as %DW for green leaves, brown leaves, and stalks for Study 4.**

Fixed effect†	df	Green leaf			Brown leaf			Stalk		
		FW	DW	%DW	FW	DW	%DW	FW	DW	%DW
Soil (S)	1	0.0017	0.0007	0.1531	0.5301	0.6469	0.7460	0.0015	0.0023	0.0150
WaterD (WD)	1	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0228	<0.0001
S $\times$ WD	1	0.5409	0.8737	0.6145	0.9226	0.6835	0.0269	0.0632	0.1925	0.7414
Genotype (G)	1	0.0003	<0.0001	0.0093	0.0005	0.0008	0.1791	0.0021	0.0001	0.0653
S $\times$ G	1	0.2617	0.3589	0.1272	0.0030	0.0026	0.1195	0.6398	0.9588	0.4918
WD $\times$ G	1	0.0374	0.0472	0.5680	0.1784	0.0952	0.4614	0.1505	0.1476	0.0346
S $\times$ WD $\times$ G	1	0.1751	0.1405	0.1503	0.0456	0.0382	0.6464	0.0932	0.0307	0.2325
		---- (g plant <sup>-1</sup> ) ----			---- (g plant <sup>-1</sup> ) ----			---- (g plant <sup>-1</sup> ) ----		
Maximum		211.5	59.5	46.9	49.3	41.4	87.4	539.0	102.4	31.2
Minimum		6.0	1.9	24.9	0.6	0.4	50.1	6.9	1.1	13.5
Mean		63.6	20.3	35.2	16.4	12.8	73.0	153.1	31.6	22.6
CV (%)		52.3	46.4	6.4	40.3	43.5	8.6	61.5	52.6	8.6
Repeatability		0.11	0.26	0.02	0.37	0.33	0.00	0.21	0.40	0.37

† “WaterD” represents water deficit.



**Figure 4.** Relationships of fresh weight (FW) with dry weight (DW, closed circle) and DW:FW ratio expressed as %DW (open circle) for green leaves, brown leaves, and stalks for the well-watered (WW) and water stress (WS) sugarcane plants in Study 4. Data are pooled over all treatments; ns, \*, and \*\*\*\* represent not significant ( $P > 0.05$ ), and significant at  $P < 0.05$  and  $P < 0.0001$ , respectively.

To compare the DW:FW ratio for each plant component among the four studies, the DW:FW ratio data were averaged across all treatments within each study except for the WS treatment in Study 4 (Table 5). Although some significant differences were detected between studies in tissue DW:FW ratio, green leaves had fairly consistent DW:FW ratios (27.6-29.1%) among the studies with the lowest CV (2.6%) and stalk DW:FW ratios ranged from 17.4 to 19.8% with a CV of 6.5%, while brown leaf DW:FW ratios had the greatest range (39.3-63.9%) and variation (CV = 19.2%) among the four studies.

**Table 5. Ratio of dry weight (DW) to fresh weight (FW) expressed as %DW for green leaves, brown leaves, and stalks. Data are means  $\pm$  SE of pooled data for all treatments within each study except for Study 4 which only used data from the well-watered treatment.**

Study	Green leaves	Brown leaves	Stalks
1	27.6 $\pm$ 0.2	53.4 $\pm$ 0.9	17.7 $\pm$ 0.2
2	28.8 $\pm$ 0.2	39.3 $\pm$ 0.6	19.4 $\pm$ 0.2
3	29.1 $\pm$ 0.2	53.6 $\pm$ 0.8	19.8 $\pm$ 0.2
4	27.8 $\pm$ 0.4	63.9 $\pm$ 1.9	17.4 $\pm$ 0.5
LSD <sub>0.05</sub>	1.3	4.5	1.0

## DISCUSSION

Although there were some significant differences among the test genotypes in FW, DW, and DW:FW ratio, the repeatability values of these three traits were low and varied among plant traits and among studies (Tables 1 to 4). Overall, measurements on stalks had the greatest repeatability and measurements on brown leaves had the least. Dry weight did not improve repeatabilities of green leaves, brown leaves, or stalks compared with FW. Of the four studies, Study 2 had the greatest repeatability values of FW, DW, and DW:FW ratio for green leaves and stalks. This was probably because Study 2 had more genotypes (14) than Studies 1, 3, or 4 which had 4, 3, and 2 genotypes, respectively. In addition, large within-genotype variation among replications suggested by the high CVs for most measurements in all studies may have contributed to the low repeatabilities (Tables 1 to 4).

Collection of both FW and DW sugarcane data from a complex potted study with many plants is usually time consuming and requires a dryer with large capacity for all samples. Even for young plants such as those used in these studies, it is difficult to dry sugarcane stalk samples and to determine when they are dry because of high water content and dense stalks. Results of our studies indicated that strong linear relationships existed between sugarcane tissue DW and FW (Figs. 1 to 4) and treatment effect on DW was the same as the effect on FW in most cases (Tables 1 to 4). Therefore, FW should be reliable for assessing treatment and genotype differences in leaf and stalk biomass for pot studies of sugarcane for the first 6 months of growth. The relationships between FW and DW:FW were consistently poor in all studies with slopes of approximately 0 for the regression lines and wide ranges of FW indicating that changes in FW had little effect on DW:FW.

## ACKNOWLEDGMENTS

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