**Tillering algorithm equations – Buster – GLH-31 March 2023**

***Leaf size distribution***

. The leaf size profile was estimated using a relationship between leaf number on an axis (numbered from the base) and the fully expanded leaf area of individual leaves using the equation (Dwyer and Stewart, 1986) –

Y = Yoexp[a(X-Xo)2 + b(X-Xo)3] [1]

where Y is the mature leaf area of an individual leaf, X is the leaf number, Yo is the mature leaf area of the largest leaf, Xo is the leaf number of the largest leaf, and a and b are empirical constants controlling the breadth and skewness.

being skewed towards later leaves.

The parameters Xo, Yo, a, and b have each been generalised via associations with TLN in sorghum (Carberry et al., 1993), maize (Keating and Wafula, 1992; Birch et al., 1998), and pearl millet (van Oosterom et al., 2001a). Although parameter values differed across these crops, in their comprehensive analysis van Oosterom et al. (2001a) observed that estimates for Xo, a, and b based on associations with TLN were similar, suggesting that species differences in leaf area profiles were predominantly associated with differences in Yo. Hence, the general associations of Xo, a, and b with TLN as reported by van Oosterom et al (2001a) were used here -

Xo = 3.58 + 0.60\* TLN [2]

a = 0.00955 + (0.0608/(1 – 0.1293\*TLN)) [3]

b = 0.00144 + (0.0025/(1 – 0.1100\*TLN)) [4]

Leaf size profile data for the elite sorghum hybrid ‘Buster’ that covered a range in TLN from 12 to 18 was collated from field and lysimetry experiments (Lafarge et al. 2002; van Oosterom et al., 2021). There was a linear association of Y0 with TLN over this range (Fig. 2), such that –

Yo = -137.4 + 42.1\* TLN [5]

Chart, scatter chart

Description automatically generated

Figure 2. Association between the area of the largest leaf on the main culm (Yo, cm2) and total leaf number (TLN) on that culm for the elite sorghum hybrid ‘Buster’.

Need to check fit using these equations for 16-leaf main culms for D1 and D2 treatments (Lafarge data) - use average leaf size by leaf and calc se and plot both with fitted value curve

Leaf size profiles for tillers in relation to main culm ???

Calculate position of largest leaf on T1 using its TLN (eg 15 for 16-leaf MC) and subtract 1 (tiller effect). Reduce position of largest leaf on each subsequent tiller by 1

Predict size of largest leaf from same equation as MC (but with TLN on tiller so it will be smaller)

Calculate average leaf sizes by leaf for tillers with standard number of leaves eg for 16-leaf MC, use T1 with 15, T2 with 14, T3 with 13 etc to avoid confounding with leaf number variation on tiller axes.

Plot averages, se and predicted values as for MC

Data in area - tanguy expt individual leaf data.xls

***Total Tiller Number***

There was a strong linear relationship between TTN and the slightly modified S/D index across genotypes and experiments (Fig. 4) as found in the original study (Alam et al., 2014a). By grouping genotypes it was possible to quantify relationships for high, medium, and low tillering types. Buster fitted high tillering group

Figure 4. Total number of tillers emerged for individual genotypes grouped by those showing consistently high (◊), medium (**□**), or low (Δ) tillering versus S/D index for data from experiments of Alam et al. (2014a). Data are Best Linear Unbiassed Estimates (BLUEs) from each of three experiments. The sorghum hybrid ‘Buster’ (●) aligned best with the high tillering group.

Linear regressions:

High group: y = 0.30x + 0.33 R2 = 0.85

Medium group: y = 0.25x – 0.27 R2 = 0.87

Low group: y = 0.21x – 0.82 R2 = 0.89

The total number of tillers that would emerge (TTN) was calculated at the time of full expansion of leaf five based on this propensity to tiller (PTT -intercept) and the plant assimilate supply/demand index (S/D). Slope could be associated with intercept

***Tiller Appearance***

Over a range of experiments (Lafarge and Hammer, 2002; Kim et al., 2010a) for the elite sorghum hybrid ‘Buster’, no tillers emerged prior to about the full expansion of leaf four. The first tillers (if they occurred) emerged at around full expansion of leaf five and originated from the axillary buds of leaf two (so denoted T2) and leaf one (T1). If both T1 and T2 appeared they were simultaneous (Lafarge et al., 2002). Emergence of any subsequent tillers was synchronised with leaf appearance, with one newly emerged tiller for each additional fully expanded leaf, so that, for example T3 emerged at full expansion of leaf six.

Tillers produced the same number of leaves as the main culm less the leaf number from which they emerged. Hence, if the main culm produced 16 leaves, T3, which emerged from the axillary bud of leaf three at full expansion of leaf six, would produce 13 leaves, and so on. Given that tillers emerged with their first fully expanded leaf, each tiller reached full expansion of its flag leaf two phyllochrons after the main culm.

Lafarge et al. (2002) reported a common hierarchy of tiller emergence of T3>T4>T2>T1>T5>T6 across diverse density treatments. Hence, if TTN=2 only T3 and T4 emerged, if TTN=4 then T2 and T1 also emerged, and if TTN=6 then T5 and T6 also emerged