

Day- Length "Leafy" in Maize

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Leaf quantity above the ear in maize is increased by the *Leafy* mutation (chromosome 3, H. Cai, personal communication) - but there is a second source, which is ostensibly the short-night reaction.

In short-night leafy, the increase in the quantity of leaves is similar to that of *Lfy* (20 leaves above the ear is common in tall tropical backgrounds in the author's work to date; cf. 17 *additional* leaves, Shaver, 38th Ann Corn & Sorghum Res Conf 161-180, 1983), though it happens with a natural, wild-type frequency, occurring in a transect of maize types from the subspecies (tropical, subtropical, and temperate), it does not appear to be a classical dominant, and there is a difference in segregation frequency between some strains (cf. Reeves and Stansel, Am J Botany 27:27-30, 1940; author's data, ¼ seemingly most common). Given that the context appears to be the night-length reaction and the manifestation is above the ear, perhaps the premiere hypothesis for the cause is that the ear has a lesser induction requirement (perhaps critical nightlength) than the tassel, so that the ear initiates before the tassel, in departure from the canon (canon: cf. Salamini and Brandolini, *Breeding Strategies for the Improvement of Maize Production in the Tropics*, FAO, Firenze, Italy, 1985, p. 98-99, 143-157). Logically, the event may trace to the length of night, degree of darkness, and (seasonal) change in nightlength (possibly not the quantity of night cycles of certain length). The phenomenon has been recognized by others (e.g., [indebted to] M. Goodman, personal communication); the maize literature is littered with reports that could possibly be this phenomenon (examples: Langham, Genetics 25:88-107, 1940; Galinat and Naylor, Am J Botany 38:38-47, 1951), but they are difficult to dissociate with *id*, etc., because of absent information.

An early case study, in the author's cultivations, involved 4 plants of an F1 of Jala (♀) x Mexican June grown in a tall greenhouse (Karl, MNL 82:18, 2008) in Franklinville, New York, USA, planted in April of 1999. Their heights were 15, 18, 20, and > 29 ft (Karl, *Tallest Corn*, Karl, Allegany, NY, 2009; leaf total $\times \sim .87 \approx$ estimate of plant height when tasseled and with fully extended internodes). The 29-ft plant was, logically, completing its growth through the fall months, specifically being in early anthesis at 29 ft in early October (6 months), whereas the other 3 plants completed their height by August. The 29-ft plant had 10 more leaves (41 total) than 2 neighboring 27-ft (fully grown) Jala plants (20-ft sib of the 29-ft plant had approximately 23 leaves), though the extension of nodes beyond leaf collars began at the same nodal range in the 3 plants (at about leaf 20, 11 ft), which, along with ear vents (channels on the sides of the internodes to accommodate ear shoots) on the 29-ft plant beginning 3 nodes below this, correlates to where earing begins and compellingly reveals that the leafiness of the 29-ft plant occurred above ear. It seems that the (natural, New York) onset of critical nightlength for the ear induced the ear primordia in this genotypical segregant, leaving the undifferentiated apical meristem under the modulation of a longer critical nightlength to manufacture the leafy phenotype for the upper plant in lieu of the traditional 5 leaves above the ear. This architecture can range into the peculiar appearance of the plant thrusting out a thicket of short, thin upper leaves and internodes from its inundated meristem, last minute, in an effort to clinch reproduction. It is the same as seen in some plants of *Leafy* silage fields in September. There was an epidemic of this architecture on many of the neighboring Jala plants that were planted too late; they were going "leafy" at 20+ ft, having 30-40 leaves (below the tassel). In 2002, nearby in Allegany, New York, a Jala plant whose early growth was in a similar but HID (light) and temperature-enhanced environment had the gross number of 49 leaves counted on its brachytic stalk with an 18-ft whorl.

A similar scenario, but of alternative etiology - and which originally alerted the author to the short-night leafy phenomenon - happened in a cross of Huehuetenango teosinte (♀) and Jala, in which the F1 (♂) was back-crossed to Jala, and the seed was planted near San Jose, Costa Rica, (Piedades) in February 2008. One plant was cultivated to maturity (21 ft) with a 1-hr middle-of-the-night exposure to an ~ 8 ft-candle (Francis, Crop Sci 10:465-468; Nelson, *Greenhouse Operation and Management*, Reston Pub Co, Reston, VA, 1985) irradiance of light. The plant had at least 10 leaves above its ear (image in: Karl, *Tallest Corn*, Karl, Allegany, NY, 2009). For an ostensibly unknown reason, the canon uses a 3-hr night break; though, the 1-hr exposure was

adequate to cause the leafy phenotype. Similarly, a Coscomatepec (Veracruz 406) plant with 18 leaves above its ear, developed in a light-polluted night at a second location (Alajuelita) near San Jose in 2007.

In a third example, in Olean, New York, in June of 2009, tropical and temperate cultivars were planted in a field and subjected to long-night treatments by being covered with black plastic sheeting. The treatment lasted 20 days and some of the covers were pervious to a degree of light transmission. A significant addition of leaves above ear (≥ 10) was observed on the *delayed flowering* stock, seed coming from the bank envelope, as well as >20 leaves on Jala and Montaña-race plants at an apparent frequency of $\frac{1}{4}$ again (this case further negates the involvement of heterosis in short-night leafy). Again, all of these cases implicate something along the lines of an oblique critical nightlength, where the chemical environment of the plant cannot resist ear induction but does resist tassel induction.

A very distinct anecdote occurred in a May 2010 field planting at Allegany, New York, in a cross of Galinat's teosinte-chromosome 9 strain with Don Shaver's Stiff Stalk *pi*, where 3 starkly distinct and uniform segregants of (possibly exact) 30 plants displayed a substantial number of leaves above ear, compared to the uniform several above ear on the normal majority.