

Nitrogen Release from Controlled-Release Fertilizers in Seepage-Irrigated Tomato Production in South Florida

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Introduction

Controlled-release fertilizers (CRFs) are soluble fertilizers encapsulated in resin, polymer, or sulfur coated urea covered with a polymer. Manufacturers measure CRF nutrient release duration as 75% nitrogen (N) release at a constant temperature between 20 to 25°C. An increase or decrease in temperature will increase or decrease CRF N release. Thus, release from CRFs may be accelerated in the fall when soil temperatures in polyethylene mulched tomato beds can reach 40 °C.

Objective

The purpose of this study was to evaluate N release duration of CRFs incubated in pouches under polyethylene-mulch covered raised beds and to determine the CRF duration suitable for incorporation into a fall tomato fertility program.

Materials and Methods

- On 15 Aug, 2011 raised-beds (76-cm wide and 20-cm high) were formed on Basinger fine sand in Immokalee, FL.
- Tomatoes were fertilized with a top and bottom mix containing 224 kg·ha⁻¹ N, 49 kg·ha⁻¹ P, and 400 kg·ha⁻¹ K.
- Beds were fumigated and covered with white on black polyethylene mulch.
- Fiberglass mesh pouches (12.7 × 14 cm) containing CRFs ESN [Environmentally Smart N (44N-0P-0K), 90 day release (DR)], D120U [Duration-urea (43N-0P-0K)], D120NPK [Duration-NPK (19N-2.6P-10.8K), 120 DR], and D180U [Duration-urea (43N-0P-0K), 180 DR] from Agrium Advanced Technologies Inc. equivalent to 3.5 g N were buried 10 cm below the bed surface.
- Tomato cultivar BHN 726 was planted on 3 Sept. 2011 and grown using seepage irrigation.
- A data logger collected soil temperature 10 cm below the bed surface.
- Pouches were collected at eight dates during the season and ground in 300 ml DI water.
- N content was measured by combustion (AOAC 993.13) using an Antek 9000 N analyzer (Pac. Co., Houston, TX.).
- A nonlinear regression model (Equation 1) was fit to the data to determine N release rate.

$$\text{Equation 1. Percent N Release} = a - (a-b) * e^{-ct}$$

- a= total N released (%)
- b=the intercept or N release when t=0
- c=release rate
- t=time (d)

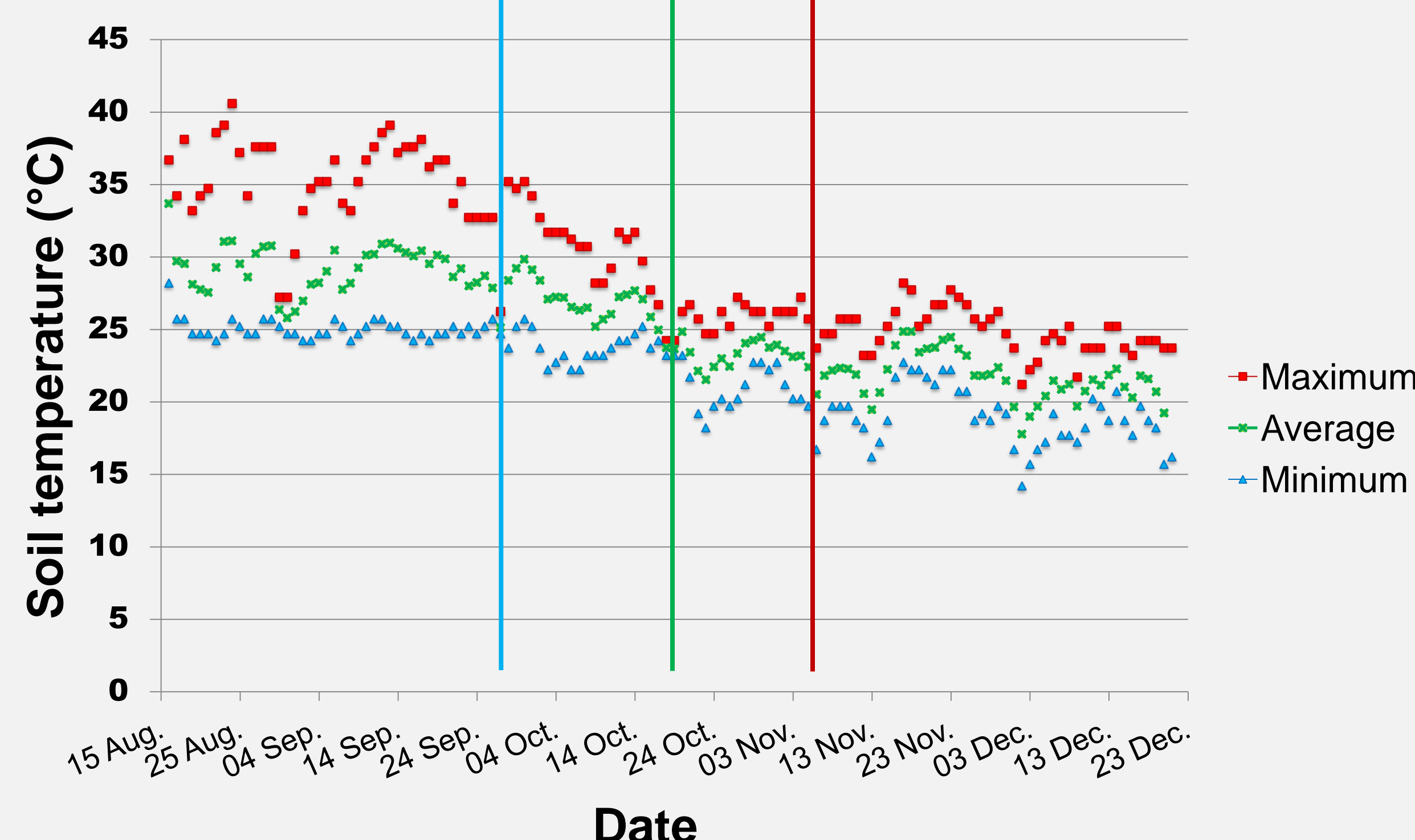


Fig. 1. Minimum, average, and maximum soil temperatures at 10 cm below the white on black polyethylene-mulch covered raise-bed surface during Fall 2011 tomato growing season in Immokalee, FL.

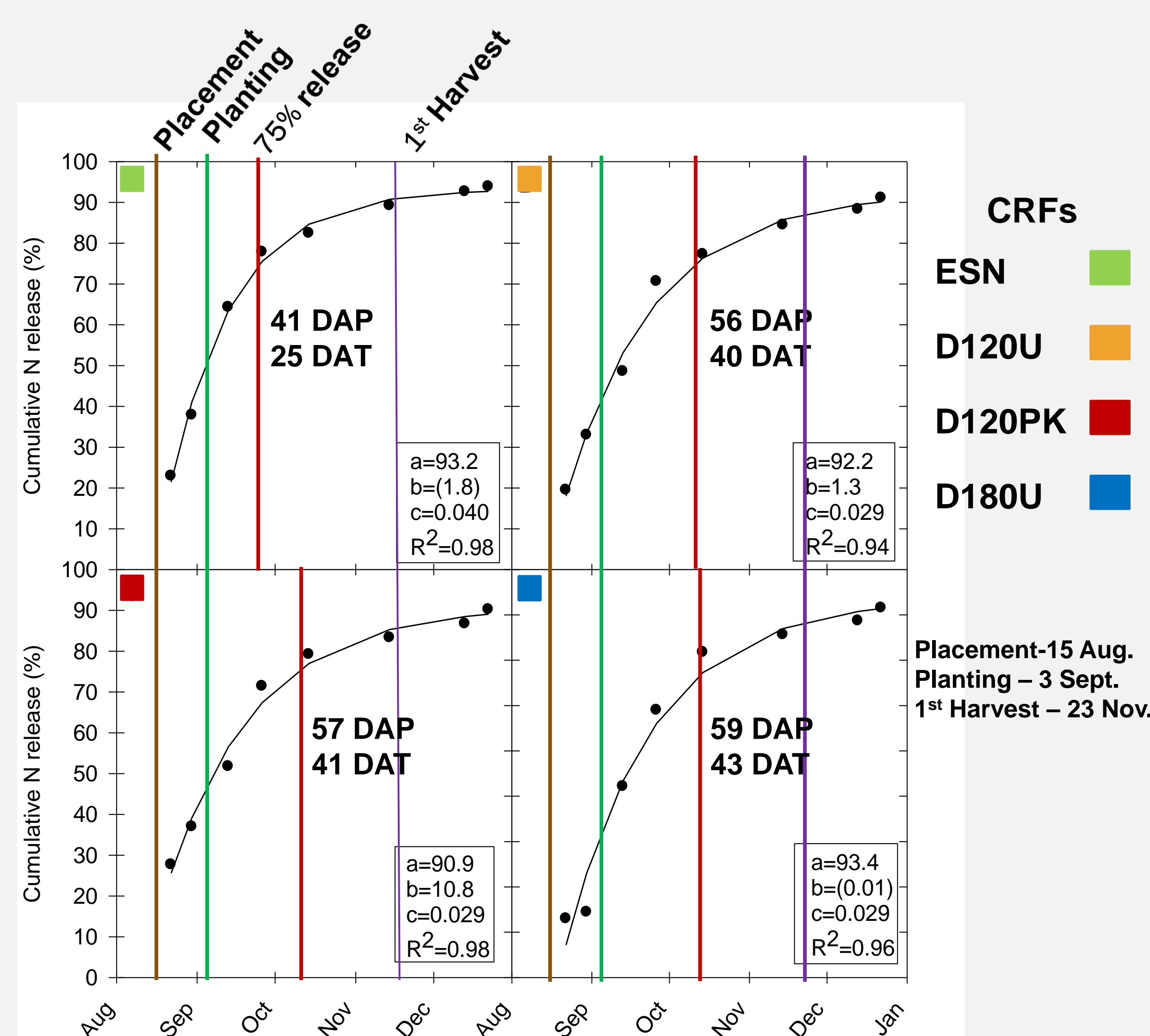


Fig. 2. Controlled-release fertilizer (CRF) nitrogen (N) release data (●) and nonlinear N release curve (line) that follows the equation (Percent N Release = $a - (a-b) * e^{-ct}$). CRFs were incubated in pouches 10 cm below the surface of white on black polyethylene-mulch covered vegetable beds for 129 days in Southwest FL. The nonlinear regression was significant for the four CRFs with $P < 0.0001$. The numbers preceding days after placement (DAP) and days after transplant (DAT) correspond to the number of days until 75% N release was reached.

Table 1. Nitrogen (N) release from controlled release fertilizers (CRFs) incubated in pouches during a 129 day tomato season during Fall 2011.

CRF ^z	Stated release	Days to 75% N release		Total N released (%)
		After bed placement ^y	After transplant	
ESN	90	42a	26	93.8a ^x
D120U	120	58b	42	91.1b
D120NPK	120	56b	40	90.2b
D180U	180	56b	40	91.5b
<i>P</i> -value		0.0001		0.0001

^zCRFs from Agrium AT (Loveland, CO),

^yPlacement was on 15 Aug. 2011, and transplant was on 3 Sept. 2011.

^xMeans followed by different letters are significantly different, within columns, according to Duncan's Multiple Range Test, 5% level.

Results

- Minimum, average, and maximum soil temperatures were 16.2, 26.1, and 40.1 °C during the season (Fig. 1).
- ESN had the greatest N release rate compared to D120U, D120NPK, and D180U, which were not different. Nonlinear regression fit N release from all CRFs ($R^2 \geq 0.94$). The 75% CRF N release for ESN, D120U, D120NPK, and D180U was 41, 56, 57, and 59 DAP, respectively (Fig. 2).
- Season total N release for ESN, D120U, D120NPK, and D180U was 93.8%, 91.1%, 90.2%, and 91.5%, respectively (Table 1).
- The total N release measured (Table 1) and fit in the model (a value) (Fig. 2) were similar.



Conclusion

Nitrogen release from CRFs was accelerated due to high fall bed temperatures. Therefore, based on a one year study a CRF of 180 DR should be recommended for early fall plantings.

References

Carson, L.C., M. Ozores-Hampton, and K.T. Morgan. 2013. Nitrogen release from controlled-release fertilizers in seepage-irrigated tomato production in south Florida. Proc. Florida State Hort. Soc. 126: In Press.