DSSAT User Guide to fertilizer characteristics

DSSAT Version 4.8.5
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DSSAT-CSM provides a flexible means of specifying fertilizer types. Properties of fertilizers are stored in an external file, FERCH048.SDA, found in the ..\DSSAT48\StandardData directory. This allows users the flexibility to create custom fertilizer blends and to modify the properties, chemical content, and other fertilizer characteristics such as slow and controlled release, urease inhibitors, and nitrification inhibitors. In addition, trace mineral content can be specified although these are not currently used by the model.

Table 1 Provides definitions for the fertilizer parameters found in the fertilizer characteristics file. Values of these parameters used in the lookup table were gathered from multiple sources for 140 fertilizer types.

Table 1. Variables defined in Fertilizer look-up table	
Variable	**Definition**
CDE	Fertilizer type code (combine with "FE" prefix)
Description	Common name of fertilizer
NO3%	Percentage of NO3-N in total N (%)
NH4%	Percentage of NH4-N in total N (%)
Urea%	Percentage of urea-N in total N (%)
UIEFF	Urease inhibitor effectiveness (%)
UIDUR	Duration of urease inhibitor (d) (acts as a step function, effectiveness goes to zero after this time)
NIEFF	Nitrification inhibitor effectiveness (%)
NIDUR	Duration of nitrification inhibitor (d) (acts as a step function, effectiveness goes to zero after this time)
NREL50	Controlled N release rate, expressed as time for 50% of N to be released (d)
NRFNC *	Controlled N release function type (see below for choices)
NSIGK	Sigmoid logistics curve K value (k=0.8 for step-like function; k=0.2 for linear-like function)
N% **	Content of elemental N in fertilizer by weight (%)
P% **	Content of elemental P in fertilizer by weight (%)
K% **	Content of elemental K in fertilizer by weight (%)
C% **	Content of elemental Ca in fertilizer by weight (%)
MG% **	Content of elemental Mg in fertilizer by weight (%)
S% **	Content of elemental S in fertilizer by weight (%)
Values of NRFNC *	
LIN	Linear. Constant rate of N release per day.
STP	Step function. No N release until day NREL50, when all N is released (e.g., sulfur coating).

SIG	Sigmoid function. Initially slow release, increasing to a maximum rate at NREL50, then decreasing to zero. (for step-like function k=0.8, for linear-like function k=0.2)
** These variables are not currently used by DSSAT-CSM and are for documentation only	

Adding new fertilizer types

New fertilizer types can be added to the FERTCH048.SDA file in order to describe and model the effects of custom blends and fertilizers that are not included in the list. Fertilizer ID FE900 has been included as a placeholder for users who wish to enter a new fertilizer type. If more than one new fertilizer is needed, copy a line of fertilizer characteristics, change the fertilizer ID (FE###) to a unique number, and enter the characteristics of that fertilizer.

Once a new fertilizer has been added, the fertilizer code becomes available to XBuild and the DSSAT-Cropping System Model. (You may have to refresh the XBuild database for the new fertilizer to show up.)

Slow-release and controlled-release fertilizers are modeled using a sigmoid function:

$$N_{released} = \frac{N_0}{1+exp[k*(N_{rel50}-t)]}$$

where

$N_{released}$ = Total N which has been released since application of fertilizer

N_o = Total N applied

N_{rel50} = Controlled N release rate, expressed as time for 50% of N to be released (d)

k = Sigmoid logistics curve "k" value

t = time in days

Every day, the amount of N released is computed as the difference between total N released yesterday and total N released today. The value of sigmoid k can be modified such that the function behaves more like a step function (k = 1.0) or closer to a linear release function (k ≈ 0.2).

Figure 1 shows the simulated effects on soil N dynamics of four slow-release fertilizers compared to a urea fertilizer with no coating. The four slow-release fertilizers have combinations of two sigmoid k values (controls the steepness of the release curve) and two Nrel50 values (controls the timing of the release). All five theoretical fertilizer treatments were applied on day 2 at 195 kg[urea-N]/ha. All four slow-release fertilizers resulted in higher soil inorganic N at the end of the season, but the two with the slower release (k=0.2) resulted in the highest ending soil N values.

Nitrification and urease inhibitors are modeled using two input parameters: the effectiveness of the inhibitor and the duration of that effect. Nitrification or urea hydrolysis rates simulated by DSSAT-CSM are simply reduced by the effectiveness amount for the duration specified. These have a demonstrated effect in the model, but the effect on soil inorganic N is not large. We still must test these effects against measured data to have confidence in the input coefficients used with these fertilizers, but because these coefficients are externalized in a lookup table, modifications to the rates can be made easily with no further changes to model code.

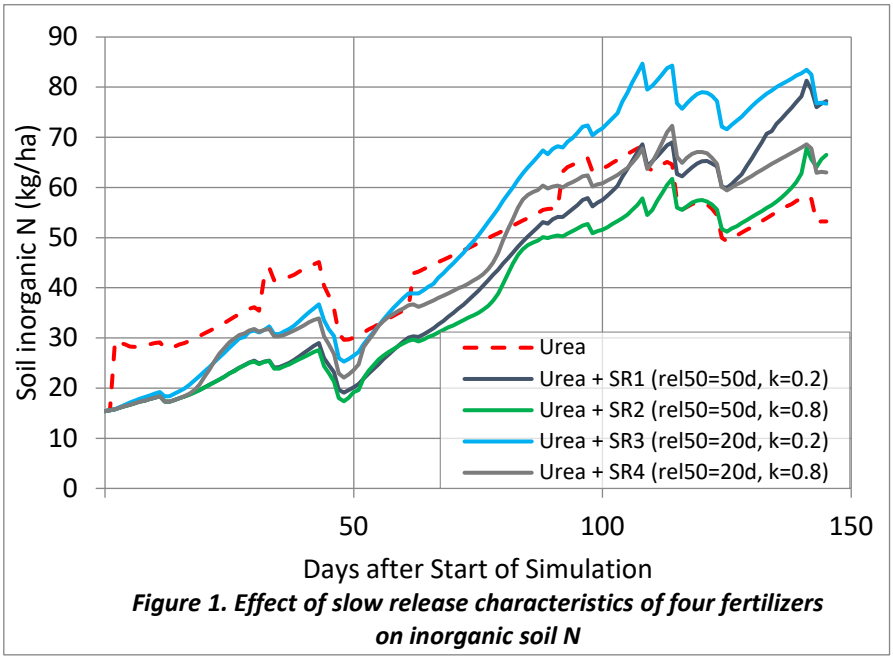

Figure 1. Effect of slow release characteristics of four fertilizers on inorganic soil N