Nitrogen Mineralization in a Potato Cropping System

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INTRODUCTION

- Most potatoes (Solanum tuberosum L.) in the Pacific Northwest are produced in low rainfall regions on sandy soils and rely on intensive irrigation and fertilization to produce high tuber yield and quality. Potatoes are often grown in three to four year rotations with either corn, wheat or alfalfa.

- The crop residue decomposition and subsequent release of nutrients in inorganic forms renders the nutrients in available forms. Nitrogen mineralization is related to many different factors.

- The mineralized N from the previous years crop residue during the subsequent crop growing season will contribute to N requirement of the crop in rotation. However, excess release of N in the fall, immediately following the crop harvest could contribute to N leaching.

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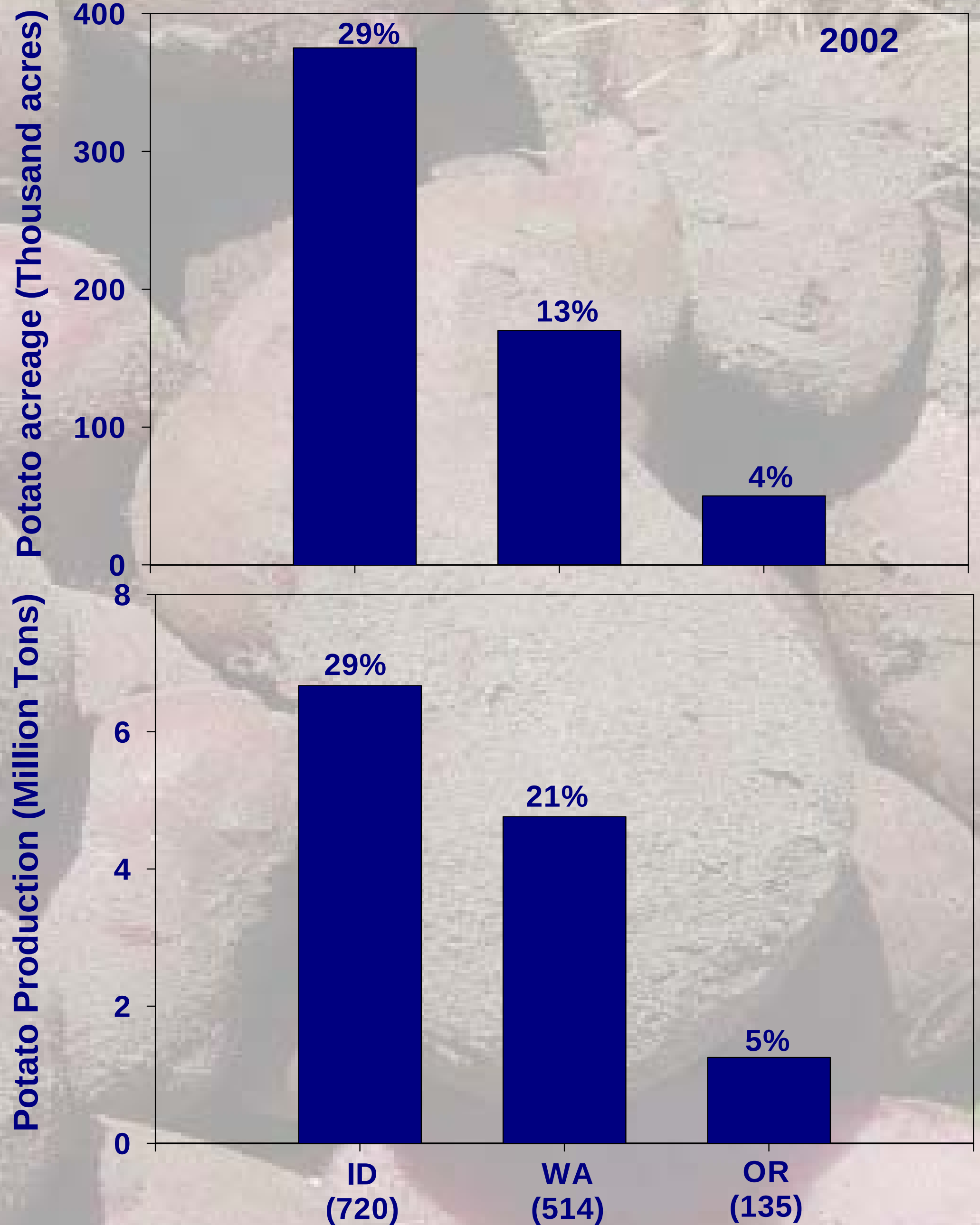


2002
Potato acreage (Thousand acres)
400
300
200
100
0
29%
13%
4%
Potato Production (Million Tons)
8
6
4
2
0
29%
21%
5%
ID
(720)
WA
(514)
OR
(135)

Preliminary estimates of Crop residues and total N input to the soil in the PNW

Main Crops	*Yields (Mg ha^{-1})*	*Crop Residue (Mg ha^{-1}) dry wt. basis*	*N in Crop residue (kg ha^{-1})*	*Yields*
Potato	75.4 Tubers	2.8	40 (1.4% N)	673 cwt
Sp. Wheat	6.0 (Grain)	11.9	90 (0.65% N)	89 bushels
Field corn	14.1 (Grain)	11.6	147 (1.28% N)	225 bushels
Sweet corn	19.8 (Fr. wt. cobbs)	9.7	84 (0.87% N)	
Cover Crops				
Mustard	N/A	5.1	128 (2.5% N)	
Sudan grass	N/A	2.7	46 (1.7% N)	
Wheat	N/A	1.7	30 (1.7% N)	
Oat / Vetch	N/A	0.51 + 0.38	7 + 15 (1.3% , 3.9% N)	

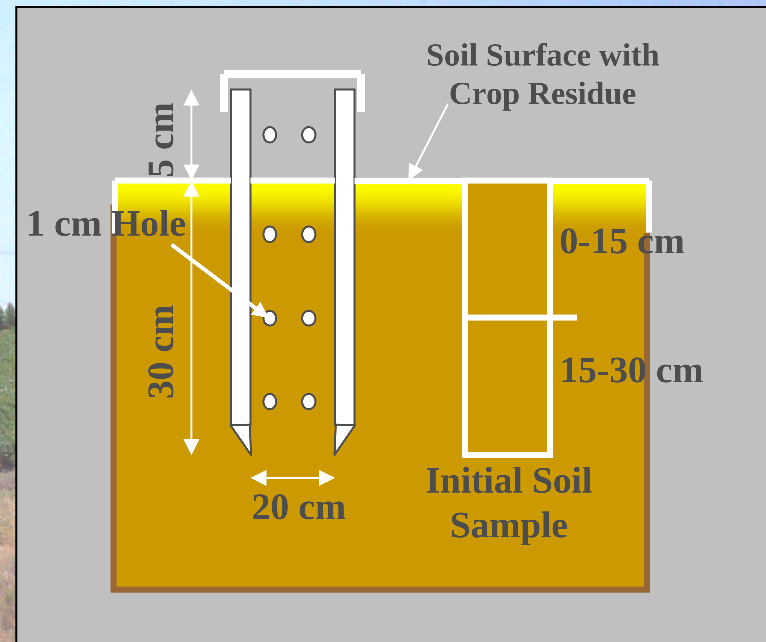
OBJECTIVES

- The purpose of this study was to increase the understanding of soil organic nitrogen release in potato rotations to improve our ability to predict in season nitrogen availability for potato, based on changes in soil temperature and crop residue.

MATERIALS and METHODS

- The experiment was conducted on a Quincy fine sand soil at the USDA-ARS research site in Paterson, WA.
- The technique adapted in this study was widely recognized and used in several in-situ mineralization studies (Cabrera, et al., 1994; Schepers and Meisinger, 1994; Cassman and Munns, 1980; Dou, et al., 1997).
- PVC columns (130 mm diameter x 355 mm height) were driven into soil to 300 mm depth.
- The columns were capped to prevent any precipitation or irrigation application on the soil inside the column which could leach the mineralized nutrients beyond the depth of sampling, thus, could underestimate the mineralization.

In-Situ N Mineralization



Method used for collection soil samples for Gravimetric Soil Moisture, Plant Residue, pH and KCl extraction for NO_3 and NH_4

MATERIALS and METHODS

- Soil samples were taken adjacent to the column at 0-150 and 150-300 mm depths. This initial soil sample was used to measure the initial content of nitrate (NO_3-N) and ammonium (NH_4-N) at the time of installation of the incubation columns.

- The soil extraction (using 2M KCl) was done in field moist condition, and gravimetric soil water content was determined.

- The soil columns were excavated at the end of the incubation period and concentrations of KCl extractable NH_4-N and NO_3-N in the 0-150 and 150-300 mm depth soil sample were analyzed.

- The difference in concentrations of NH_4-N and NO_3-N in the soil sample at the end of incubation period and those at the initial time represents the amount of N being mineralized.

Table 1. Nitrogen mineralized (NH_4_ N + NO_3_N) in top 30 cm depth Quincy fine sand in the Pacific Northwest (PNW) [mg kg^{-1}]

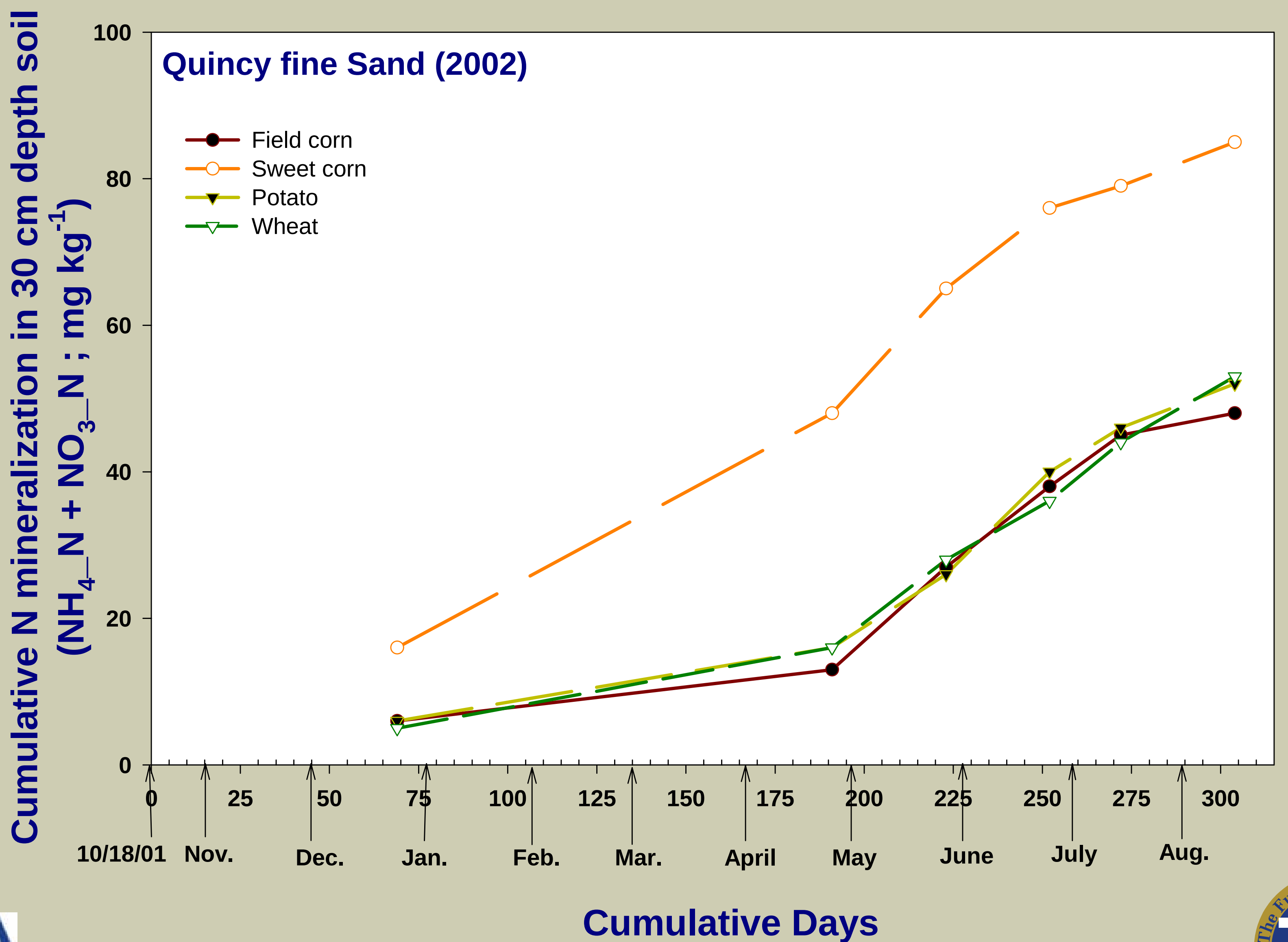
Duration	Year	Alfalfa	Corn (Field)	Corn (Sweet)	Potato	Wheat
October-March	2000[a/]	ND	33	ND	7	16
	2001	9	9	ND	6	10
	2002[b/]	ND	6	16	6	5
March-May	2000	ND	15	ND	12	16
	2001	16	10	ND	10	14
	2002	ND	7	32	10	11
May-August	2000	45	25	ND	12	25
	2001	51	39	ND	51 (?)	50 (?)
	2002	ND	35	37	36	37
August-September	2000	16	13	ND	5	8
	2001	28	34	ND	28 (?)	64
	2002 [c/]	ND	ND	ND	ND	ND
Total	2000	61	86	ND	36	65
	2001	104	92	ND	96	138 (?)
	2002	ND	48	85	52	53
Mean		83	75	85	44	59

ND = No Data

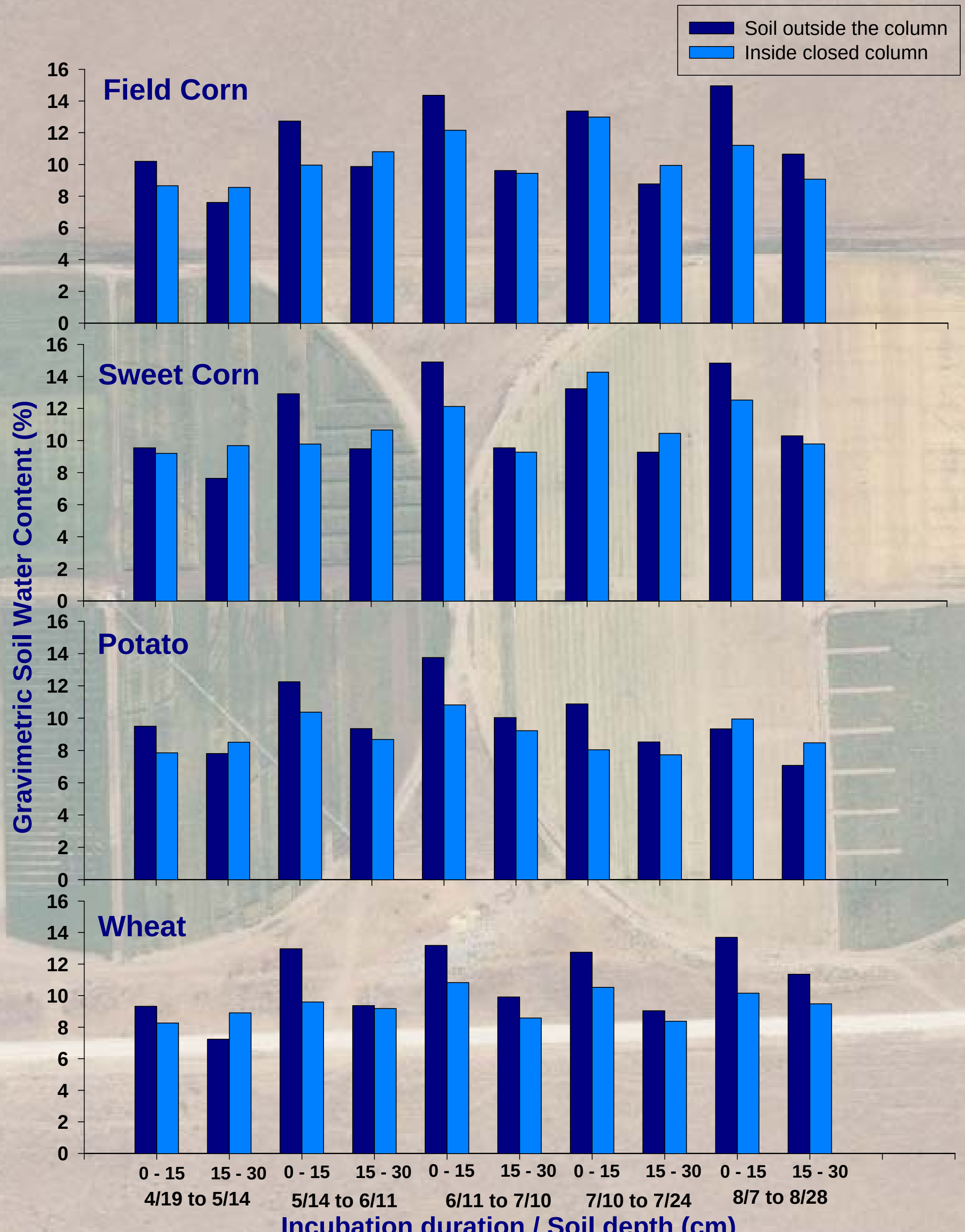
a/ = Incubation began in January 2000 (no data for October-December)

b/ = No alfalfa data in this year. Instead Sweet corn study began this year.

c/ = No measurements were made in 2002 during August – September period.



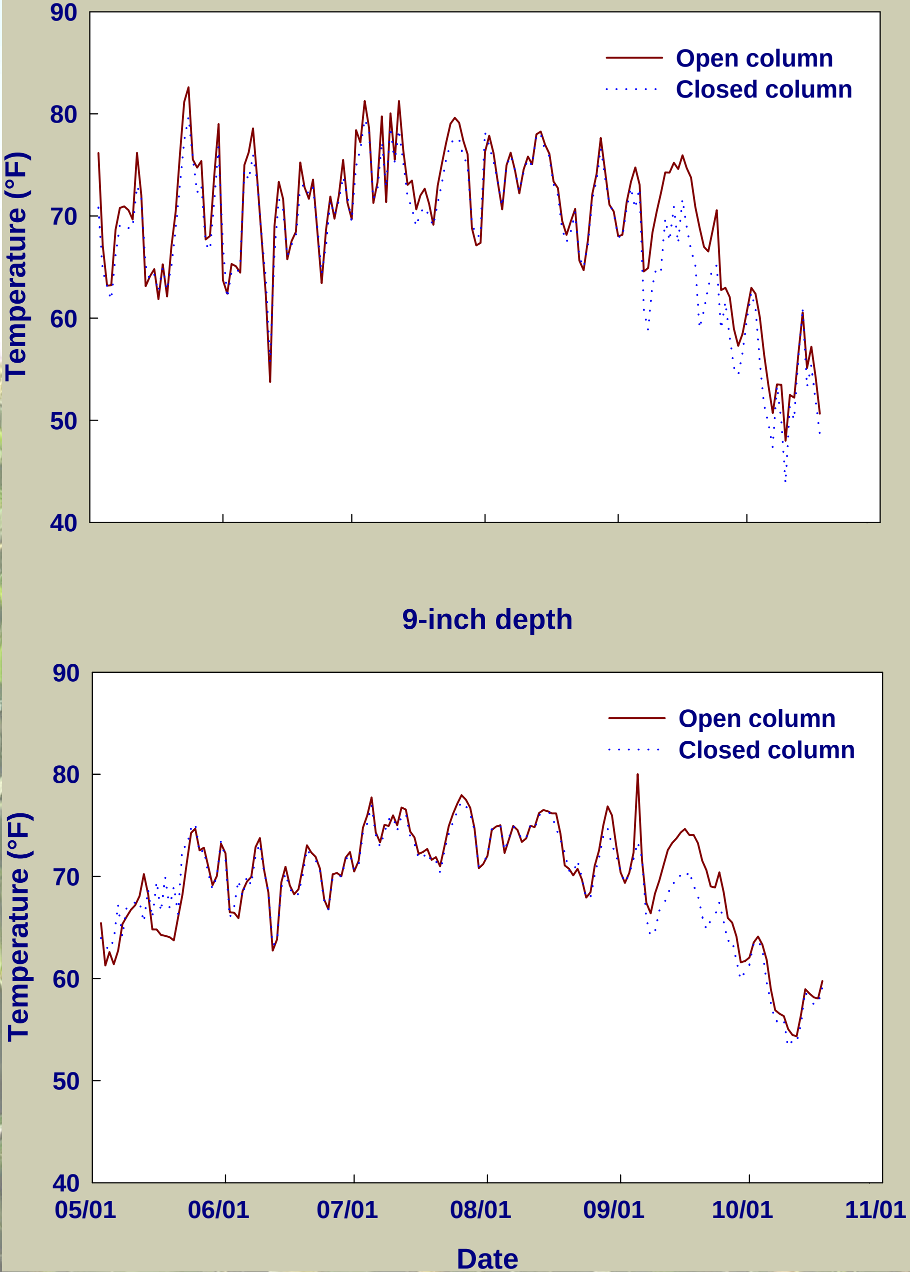
Quincy fine Sand (2002)
Field corn
Sweet corn
Potato
Wheat
Cumulative N mineralization in 30 cm depth soil
(NH_4_N + NO_3_N ; mg kg^{-1})
0
20
40
60
80
100
0
25
50
75
100
125
150
175
200
225
250
275
300
10/18/01
Nov.
Dec.
Jan.
Feb.
Mar.
April
May
June
July
Aug.
Cumulative Days

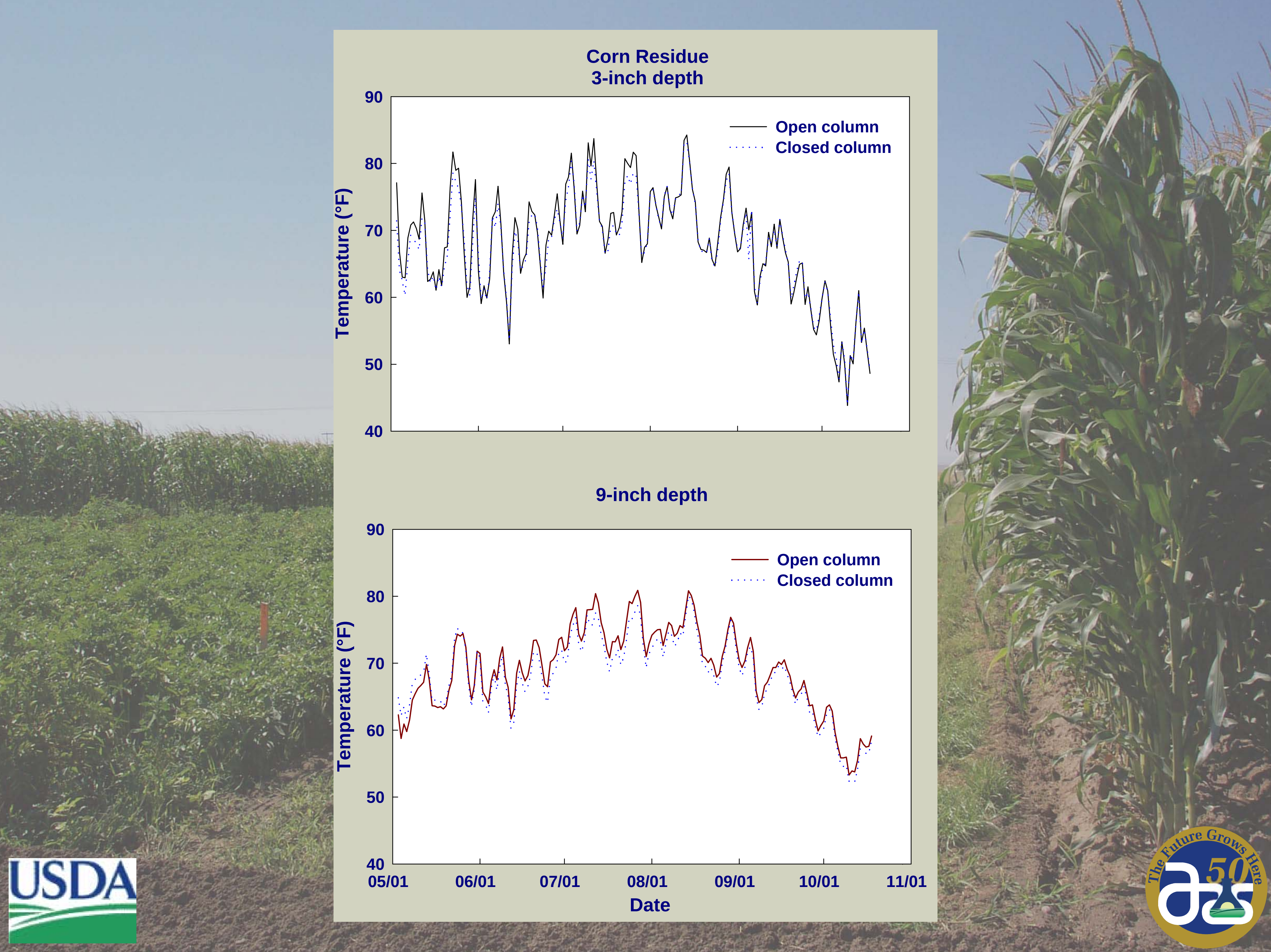


Soil outside the column
Inside closed column
Field Corn
Sweet Corn
Potato
Wheat
Gravimetric Soil Water Content (%)
0 - 15
15 - 30
4/19 to 5/14
5/14 to 6/11
6/11 to 7/10
7/10 to 7/24
8/7 to 8/28
Incubation duration / Soil depth (cm)

Potato Residue

3-inch depth




Corn Residue
3-inch depth
Temperature (°F)
90
80
70
60
50
40
Open column
Closed column
9-inch depth
Temperature (°F)
90
80
70
60
50
40
Open column
Closed column
05/01
06/01
07/01
08/01
09/01
10/01
11/01
Date
USDA
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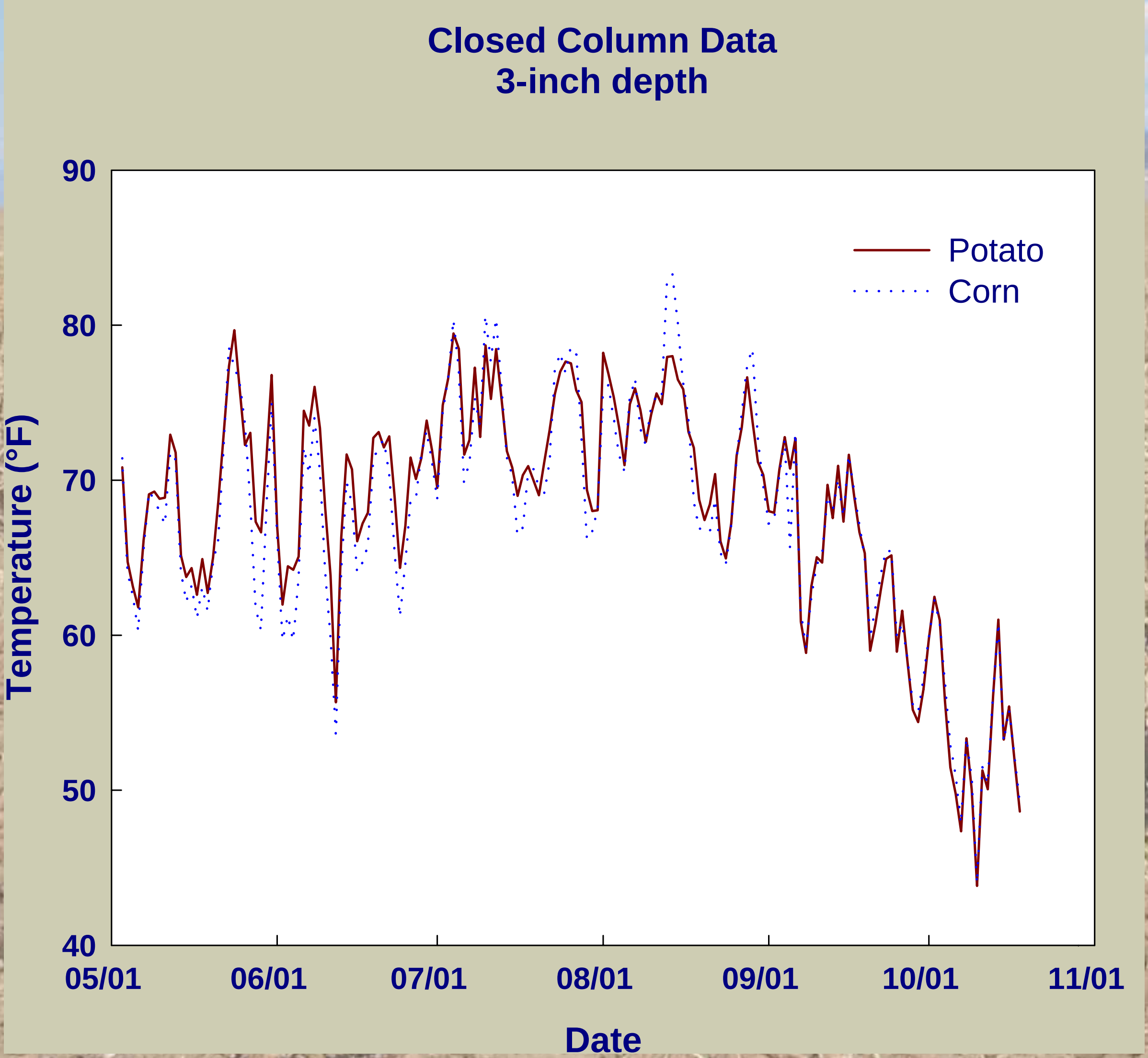
50

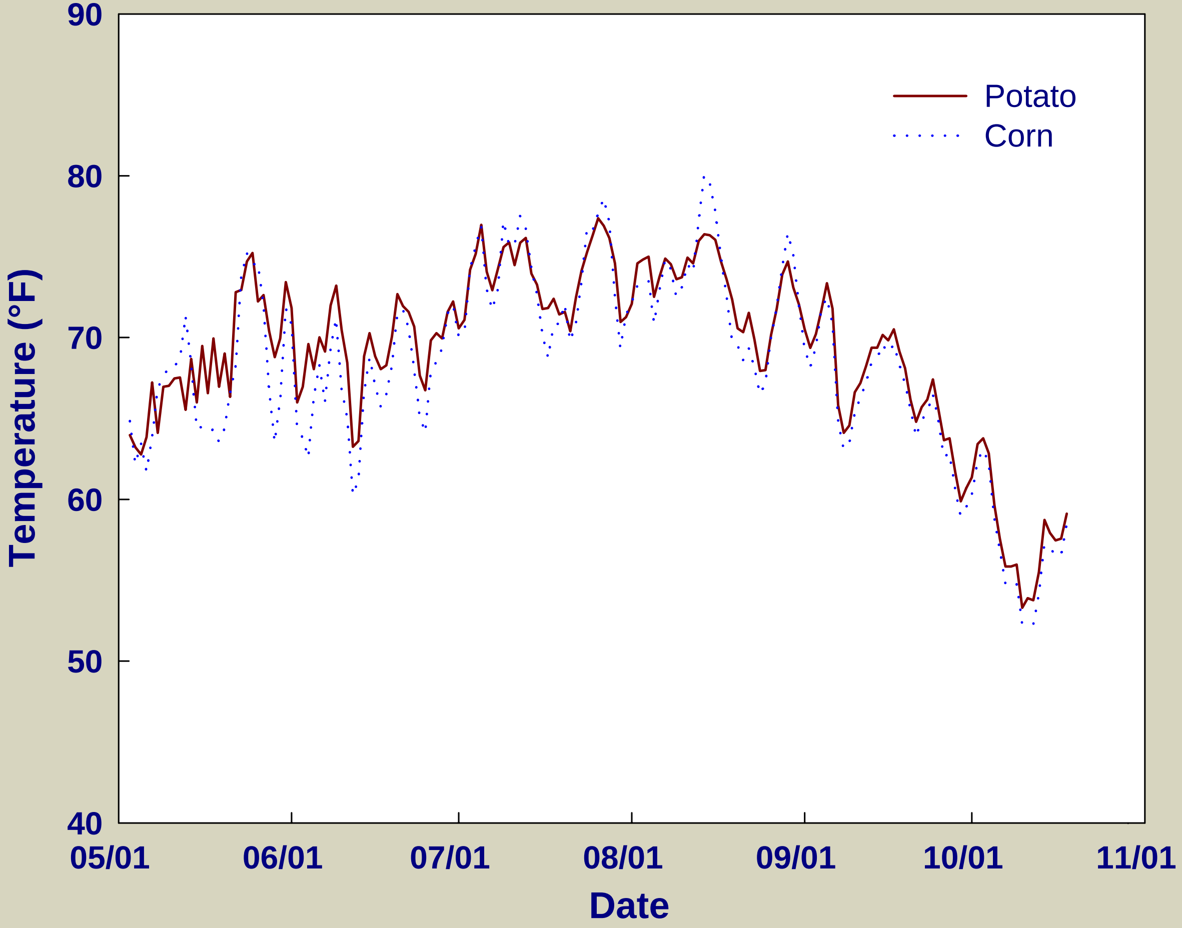
SUMMARY and CONCLUSIONS

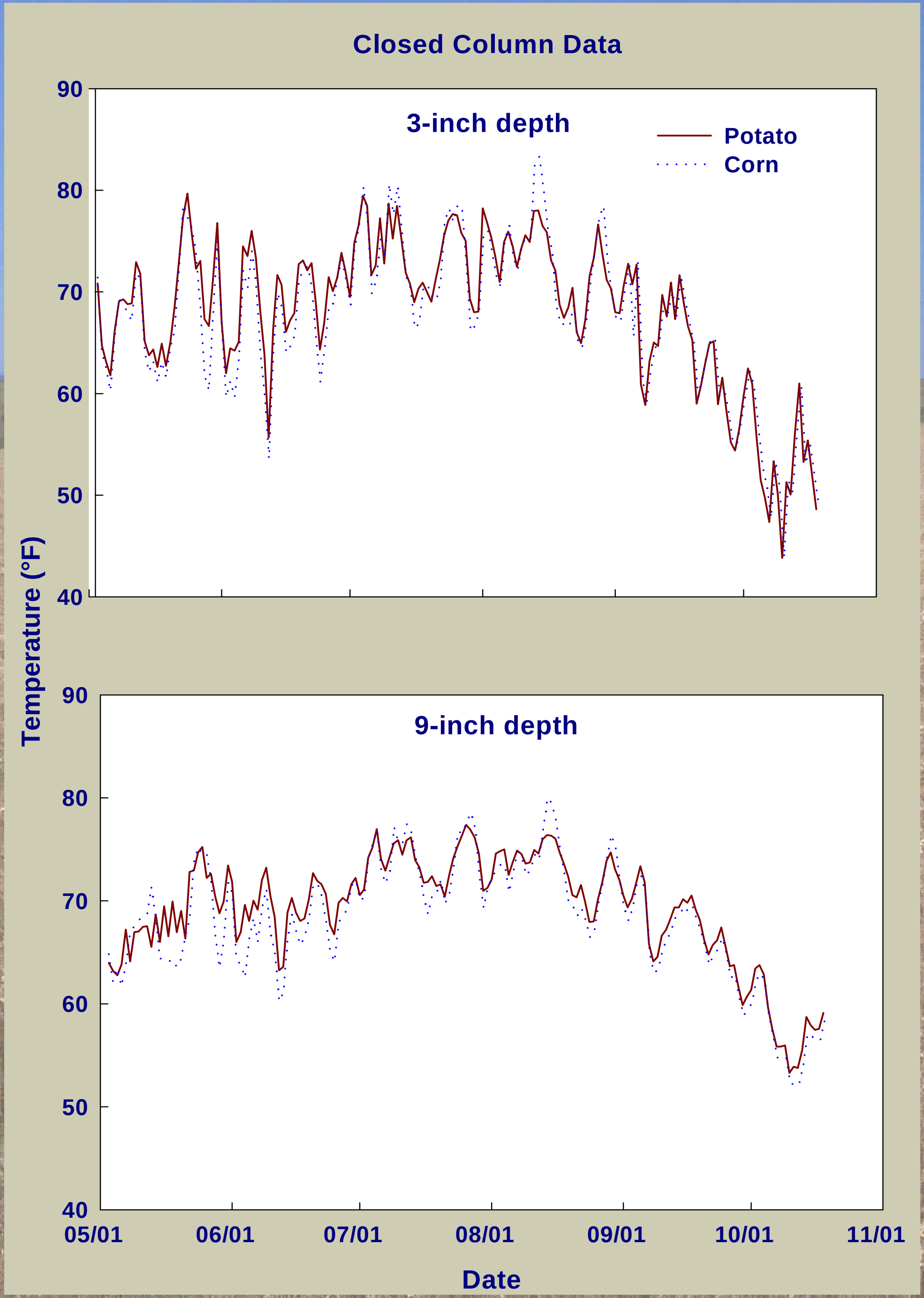
- Three years field study [except Sweet corn (1 yr.), Alfalfa (2 yrs.)] showed that the mean N mineralized (NO_3-N plus NH_4-N) in the top 30 cm depth soil contributed to 85, 83, 75, 59, and 44 mg kg^{-1} from Sweet corn, Alfalfa, Field corn, Wheat and Potato residues respectively.
- The peak period of N mineralization was May through August.
- The soil moisture and temperature conditions inside the incubation column were quite comparable to those in the bulk soil throughout the incubation period despite closing the soil column, during the entire incubation period.
- The information on the N mineralization from previous years crop residues is important to fine tune N fertilization for the crop in rotation.



Closed Column Data
3-inch depth
Potato
Corn
Temperature (°F)
90
80
70
60
50
40
05/01
06/01
07/01
08/01
09/01
10/01
11/01
Date

Closed Column Data
9-inch depth





Closed Column Data
3-inch depth
Potato
Corn
9-inch depth
Temperature (°F)
90
80
70
60
50
40
05/01
06/01
07/01
08/01
09/01
10/01
11/01
Date