Understanding Long-term Cropping Systems Effects on Water-stable Aggregates

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Introduction

- Water-stable aggregates (WSA) are an important indicator of soil quality that can be changed by soil and crop management practices. Understanding cropping systems that contribute most to increasing WSA can help identify strategies to promote WSA.

Objectives

- Investigate the effect of long-term cropping systems and different crops grown in these systems on WSA at different times of a growing season.

Hypotheses

- Perennial and diverse cropping systems will promote higher WSA than annual systems.
- Perennials and winter small grains in the cropping systems will promote higher WSA than summer annuals alone.
- Seasonal fluctuation in WSA will be greater under summer annuals than small grains and perennials.

Methods

- Studied soil from the 36-year old Hunter Rotation Experiment at Penn State Russell Larson Agricultural Research Center, Rock Springs, PA.

Fig.1 Aerial View of the Hunter Rotation Experiment

Experimental Design

Randomized Complete Block Design

- **Main Plot:** 10 crops nested in four cropping systems (Table 1), and grouped into 4 crop types.
- **Sub plot:** Four dates as repeated measures
  1. 25 May
  2. 13 July
  3. 22 August
  4. 1 November

Soil Analysis

- Collected soil cores of 7.5 cm diameter to 15 cm depth.
- Percent WSA measured using standard wet-sieving technique and slaking.

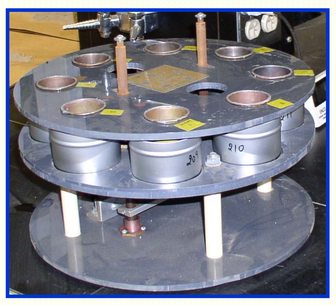


Fig.2 Standard Wet-sieving Machine

Statistical Analysis

ANOVA using PROC MIXED of SAS with Repeated Measures.

- **Fixed Effects:** Cropping systems, crops, dates.
- **Random Effects:** Blocks
- Means compared using Bonferroni's test ($p<0.05$).

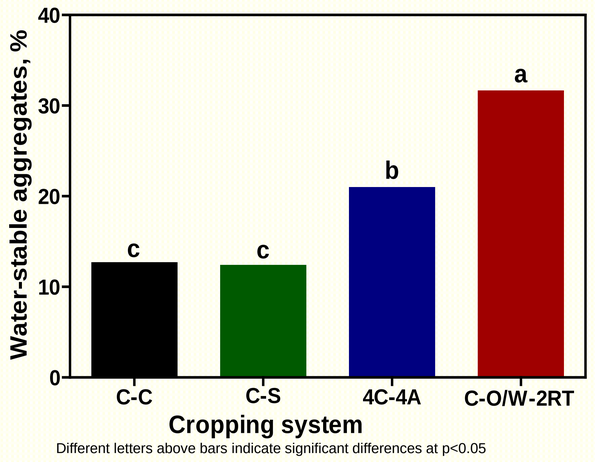
Table 1. 10 Crops Studied & Grouped into Four Crop Types in the Four Cropping Systems

C. System Type	Cropping System	Crops Sampled	Crop Type	Notation
Annual	i) Continuous corn (C-C)	Corn	Summer annual in annual systems	SAa
	ii) Corn-soybean (C-S)	Corn, soybean		
Annual-perennial	iii) 4 yr corn-4 yr alfalfa (4C-4A)	Yr 4 of corn	Summer annual in perennial system	SAp
		Yr 4 of alfalfa	Perennial	PR
Diverse	iv) Corn-oats-wheat-2 yr red clover + timothy hay (C-OW-2RT)	Corn	Summer annual in perennial system	SAp
		Oats, wheat	Winter small grain	SG
		Red clover+ timothy	Perennial	PR

Results

Fig. 3a-b. Percent WSA among Cropping Systems in May and Crop Types at Four Dates

a.



Different letters above bars indicate significant differences at p<0.05

b.

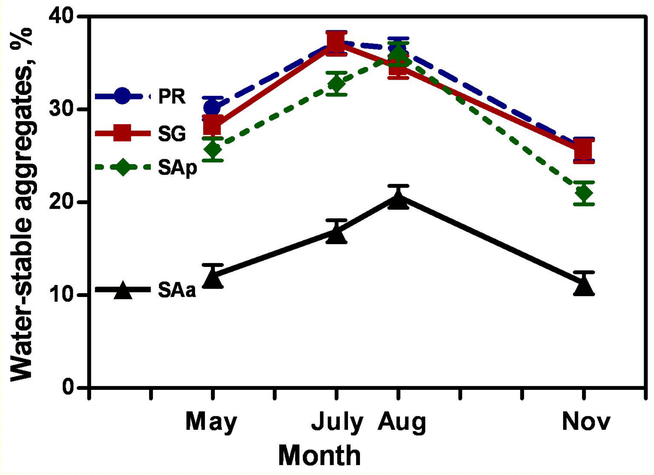


Table 2. Percent WSA and its Change Among Four Crop Types from May-Aug & Aug-Nov

Crop Type	Percent WSA				Change in % WSA	
	May	July	August	November	May-Aug	Aug-Nov
SAa	12.1c	16.9c	20.6b	11.3c	8.5a	-9.3b
SAp	25.7b	32.8b	36.0a	21.0b	10.3a	-15.0a
SG	28.1ab	37.1a	34.6a	25.5a	6.5a	-9.1b
PR	30.1a	37.2a	36.5a	25.7a	6.4a	-10.8b

Different letters within a column indicate significant differences at p<0.05

- Perennial and diverse cropping systems had 2-3 times higher WSA than annual systems (Fig. 3a).
- The interaction of crop types x month was significant (Fig. 3b).
- Soils under PR, SG as well as SAp had higher WSA than SAa at all four dates. PR and SG had higher or similar WSA compared to SAp (Table 2).
- WSA increased in all soils from May-Aug, and the increase did not differ among the crop types (Table 2). From Aug-Nov, however, WSA decreased under all the four crop types with a significantly greater decrease under SAp than the other three crop types.

Conclusions

- Perennial and diverse cropping systems promoted higher WSA than annual systems.
- PR, SG, and SAp promoted higher WSA than SAa on all four dates, PR had higher WSA than SAp on 3 of the 4 dates, and SG had higher WSA than SAp in July and November.
- Seasonal fluctuation in WSA from Aug.-Nov. was higher under SAp than PR and SG.

Acknowledgements

Funding from the Department of Crop & Soil Sciences, Pennsylvania State University is appreciated.