

Determining Lime Requirement Using Buffer Tests in Eastern Washington and Northern Idaho

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Introduction

- Accelerated soil acidification resulting from application of ammonia-based fertilizers has been an issue of increasing concern in the Palouse region of Eastern Washington and Northern Idaho^{5,2}
- Regional soil pH has continued to decline while KCl extractable Al has increased.
- Determining appropriate lime rates for the inland Pacific Northwest has been a pressing question.
- Buffer tests provide a quick and easy method of measuring a soil's buffering capacity and active and reserve acidity, and lime rates can be derived from the results.
- Regional calibration and screening of common buffer testing methods has been effective in other places.
- Early work in eastern WA and northern ID, recommended the use of Woodruff buffer adjusted to pH 6⁶

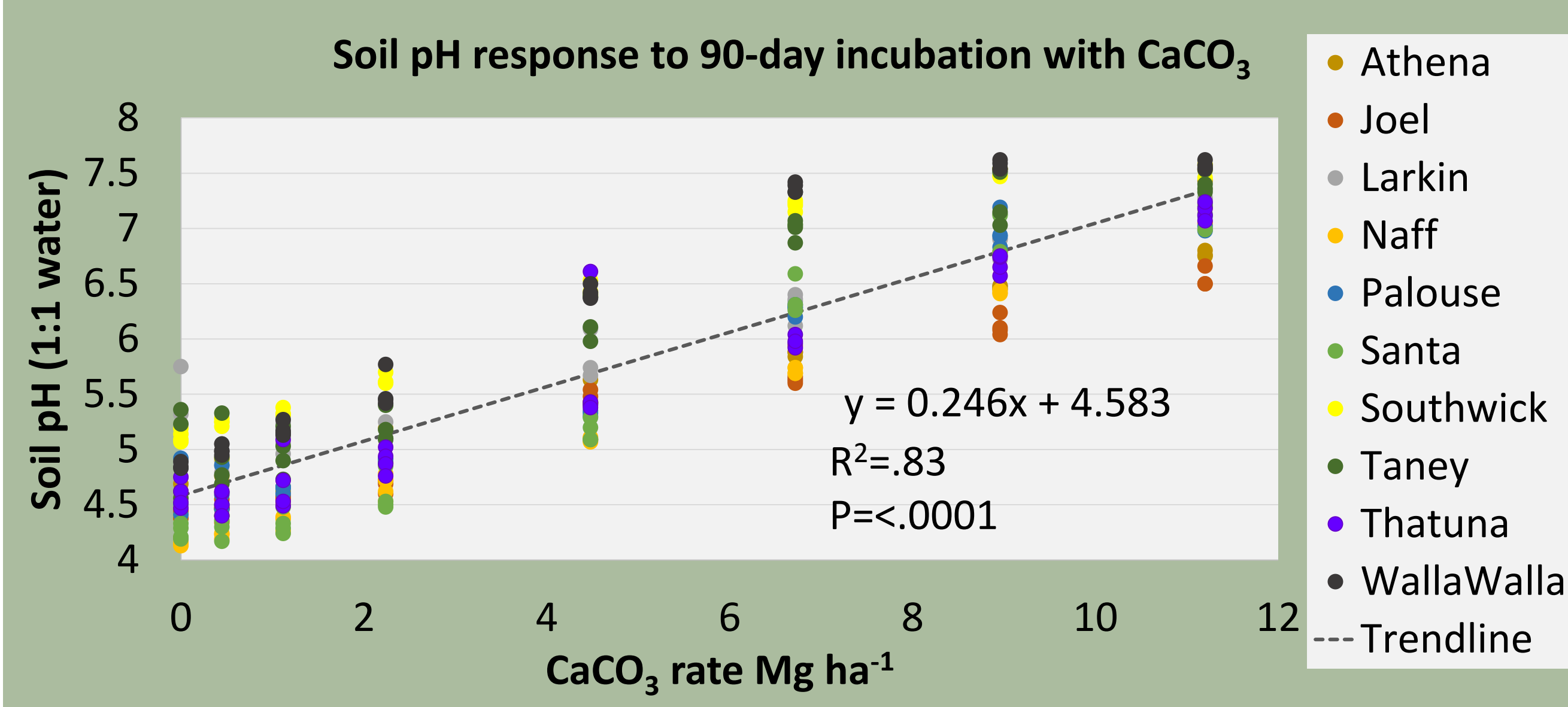
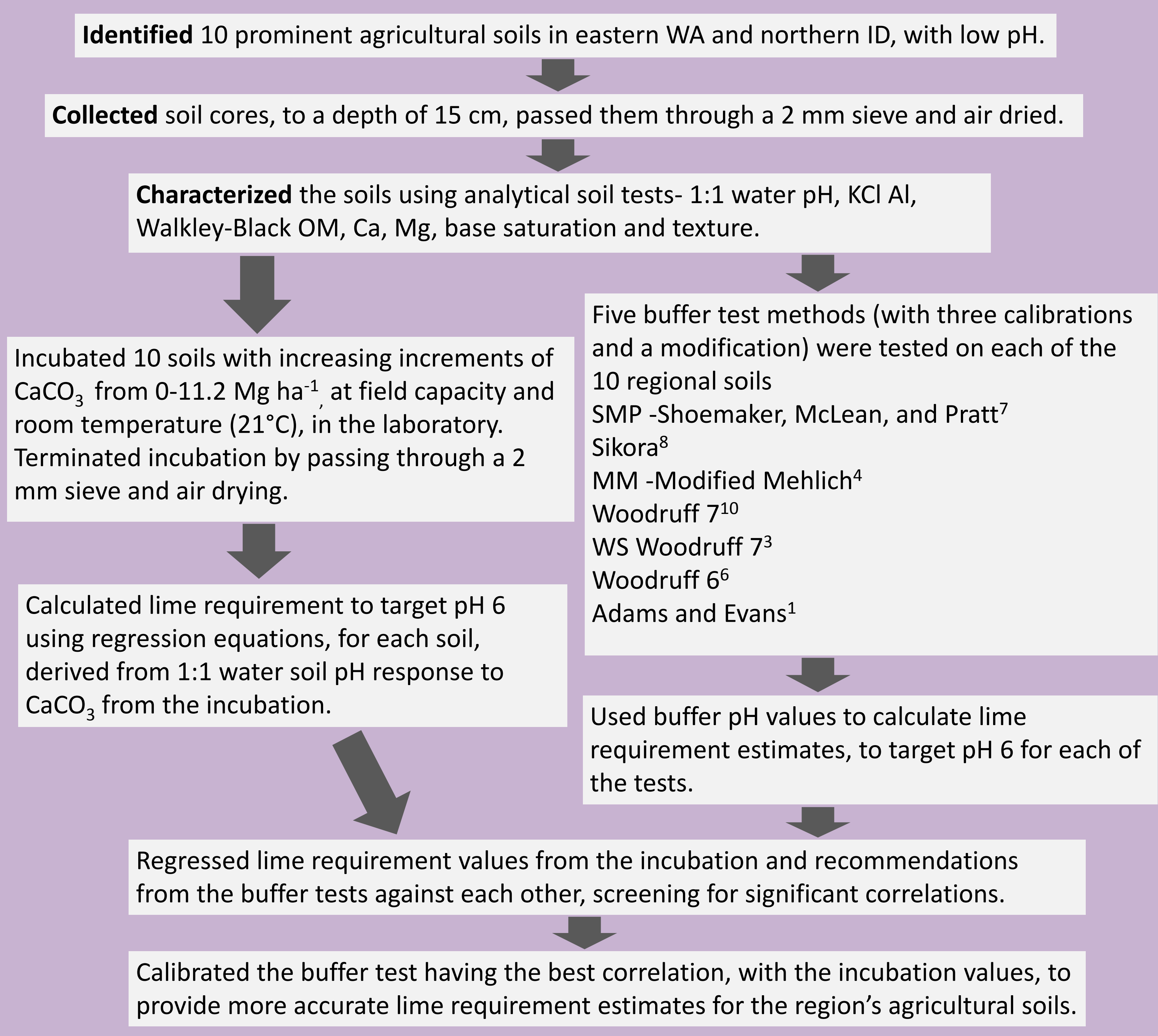
Objective: To screen commonly used buffer tests to determine which would provide the best lime requirement estimates for the agricultural soils of eastern Washington and northern Idaho

Summary and Conclusions

- The response of eastern Washington and northern Idaho's acidic agricultural soils to the Woodruff 7 buffer test, correlates well (0.78 R²) to the response by the same soils to CaCO₃ and corroborates earlier work by Mohebbi and Mahler⁶. In this region the relationship is maintained at buffer pH levels below 6, without adjustments to the original test protocol.
- The Woodruff 7 buffer test over-predicts lime requirement for the region's soils using the current calibration.
- Calibrating the Woodruff 7 buffer pH values, to the incubation recommendation, corrected for over prediction.
- Buffer tests currently used by soil test labs in eastern WA, (Adams and Evans, and SMP) had poor correlation with the incubation, with R² values of 0.07 and 0.1 respectively.
- Field validation supporting use of the Woodruff test, and the recommended calibration, will be an essential next step.
- Preliminary multivariate analysis suggests that measuring soil properties such as organic matter and KCl extractable aluminum could predict lime requirement comparably to the buffer tests, next steps will include exploring that relationship.



Methods



The soil pH response for 10 prominent agricultural soils of eastern WA and northern ID, soils to a 90 day laboratory incubation with increasing increments of CaCO₃, from 0-11.2 Mg ha⁻¹

Soil series	Starting Soil pH	Equation	R ²	Laboratory recommendation CaCO ₃ Mg ha ⁻¹		
				Target pH 5.5	Target pH 6	Target pH 6.5
Southwick	5.33	y=0.24x+5.18	0.95	1.3	3.4	5.4
WallaWalla	5.25	y=0.26x+5.1	0.87	1.6	3.5	5.4
Taney	4.68	y=0.26x+4.85	0.92	2.5	4.4	6.4
Palouse	5.02	y=0.24x+4.57	0.96	3.9	6	8
Santa	4.36	y=0.29x+4.12	0.94	4.7	6.4	8.1
Thatuna	4.53	y=0.24x+4.48	0.94	4.3	6.4	8.4
Athena	4.50	y=0.22x+4.42	0.97	4.8	7	9.2
Naff	4.47	y=0.26x+4.12	0.97	5.4	7.3	9.3
Joel	4.65	y=0.196x+4.36	0.98	5.8	8.4	10.9
Larkin	5.15	y=0.78x+4.39	0.94	6.2	9	11.7
Range	4.36-5.33		0.98-0.87	1.3- 6.2	3.4-9	5.4-11.7

A unique linear regression equation describes the soil pH response of each soil to CaCO₃ and was used to predict the quantity of CaCO₃ required to raise the soil to different target pH values

Acknowledgements

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References

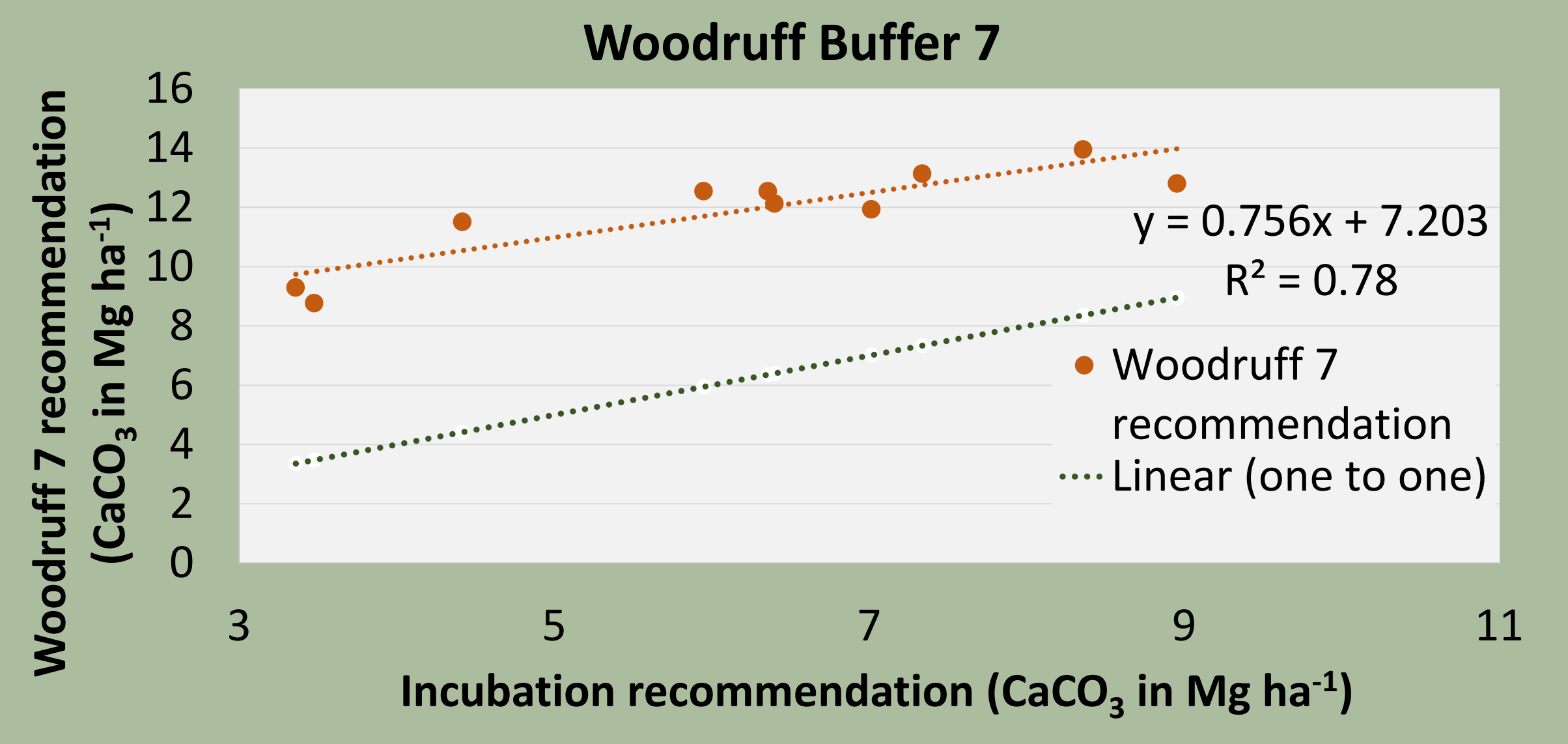
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Soil series	Taxonomic Classification	Extent hectares	pH 1:1 water	OM %	Ca meq 100g ⁻¹	Mg meq 100g ⁻¹	CEC meq 100g ⁻¹	Base Saturation		Al Saturation			
								%	mg kg ⁻¹	%	%	%	%
Athena	HAPLOXEROLLS	2,052,841	4.50	4	4	0.9	15.8	48	46	3.23	29.5	59.6	11
Joel	ARGIXEROLLS	107865	4.65	5	9.5	1.6	23.3	50.1	68	3.24	27.5	52.6	19.8
Larkin	ARGIXEROLLS	372271	5.15	5	8.9	1.4	20.6	54.6	8	0.43	26.7	54.9	18.4
Naff	ARGIXEROLLS	827676	4.47	3.7	5.8	2	15.5	55.5	104	7.46	26.7	55.9	17.4
Palouse	HAPLOXEROLLS	1871224	5.02	5.1	6	1.3	18.1	49.5	18	1.1	28.9	55.4	15.6
Santa	FRAGIXERALFS	381519	4.36	3.6	4.1	1.2	14.1	41.6	139	11	26.2	58.2	15.6
Southwick	ARGIXEROLLS	332230	5.33	3.3	7.4	1.7	17.3	56.4	5	0.32	25.1	56.1	18.9
Taney	ARGIXEROLLS	453693	4.68	3.6	5.8	1.2	16.8	46.1	51	3.37	24.5	56.5	19.1
Thatuna	ARGIXEROLLS	590963	4.53	4.2	4.6	0.9	15	45.2	64	4.74	27.2	56.7	16.1
Walla													
Walla	HAPLOXEROLLS	3263513	5.25	2.8	6.3	2.3	15.4	66.6	6	0.43	29.6	56.1	14.3

Initial characterization of soils used for the study showed a pH range of 4.36 to 5.33 and KCl extractable Al values ranging from 5-139 mg kg⁻¹

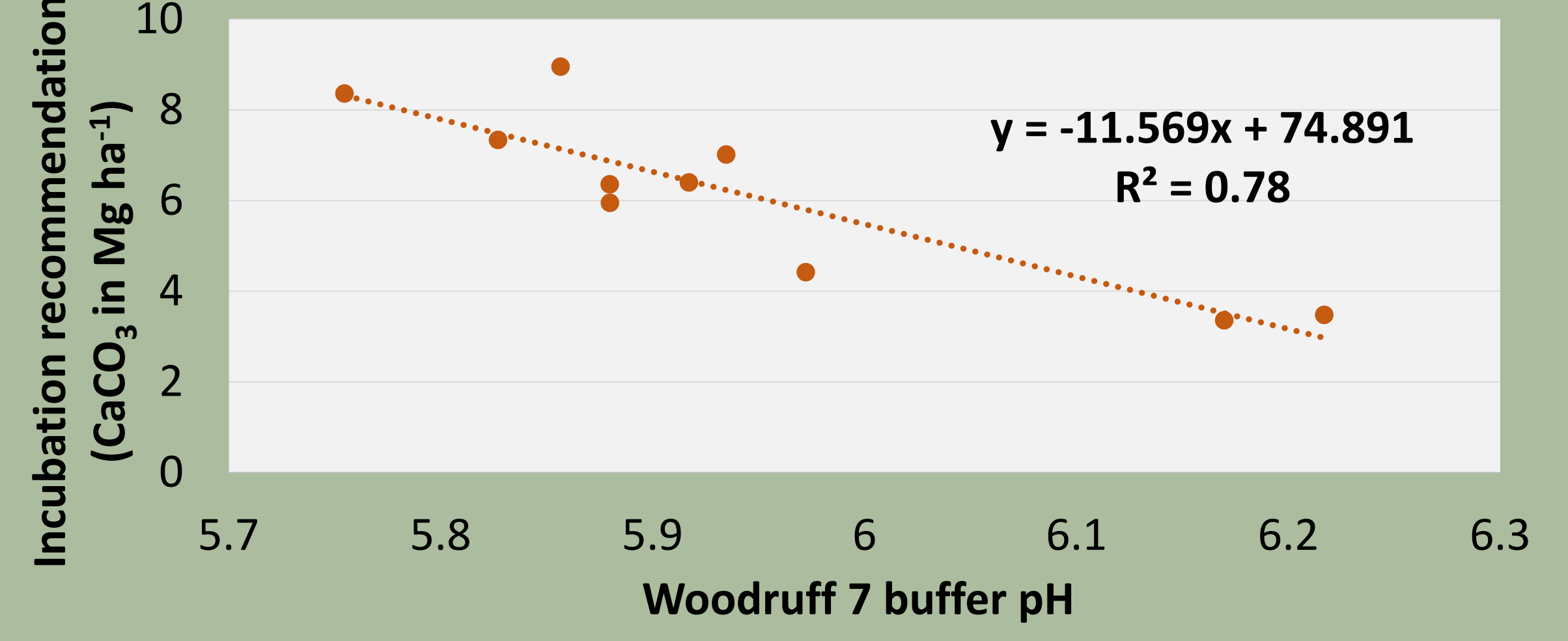
Buffer Test	Target pH	P-value	R ²
Woodruff 7 ¹⁰	6	0.0007	0.78
Woodruff 6	6	0.0012	0.75
Modified Mehlich	6	0.032	0.46
Sikora	6	0.0439	0.42
Adams and Evans	6	0.0672	0.36
SMP ³	6	0.0965	0.31
SMP ⁹ (McLean)	6	0.1256	0.27
WS Woodruff 7 ³	6	0.9497	0.0005
SMP ⁹ (van Lierop)	6	0.9882	0

Correlation values for all buffer tests and calibrations used, including the SMP and Adams and Evans tests commonly used by soil analysis labs in the region



A linear regression of the Woodruff buffer test recommendation³ had an R² of 0.78 with the CaCO₃ incubation recommendation to target pH 6 values. The best correlation from the group of 9 tests screened. Despite the strong correlation, the Woodruff 7 test over-recommends the quantity of CaCO₃ required to increase soil to pH 6.

Calibrating Woodruff 7 buffer test to incubation recommendation (target pH 6)



Correlating values from the CaCO₃ incubation, directly to the Woodruff buffer pH, corrects for over-prediction resulting from the buffer test's current calibration.

