Influence of Soil Sampling Grid Size on Application Accuracy and Economics of Site-Specific Nutrient Applications in Row Crops

UNIVERSITY OF GEORGIA EXTENSION

GEORGIA Precision Ag

Matt Tucker[1], Simerjeet Virk[1], Glen Harris[1] and Amanda Smith[2]

[1]Department of Crop and Soil Sciences, University of Georgia, Tifton, GA 31793

[2]Department of Agricultural and Applied Economics, University of Georgia, Tifton, GA 31793

Introduction

- Most agricultural production fields in the southeastern U.S. have large inherent soil and nutrient spatial variability which requires utilizing precision soil sampling methods such as grid or zone sampling to inform site-specific nutrient applications.
- While more efficient ways to develop and use zones for soil sampling are still explored, grid-based soil sampling remains the most commonly used strategies by consultants and growers due to ease of implementation.
- To reduce soil sampling costs, most growers are trending towards larger grid sizes. However, an increase in grid size also means increased potential for under- and over-application of nutrients (Wollenhaupt et. al., 1994).
- A thorough economical analysis considering the nutrient application accuracy associated with different grid sizes is important to determine which grid-based precision soil sampling strategies are truly cost-effective.

Hypothesis

An economic analysis on different grid-based soil sampling strategies will help determine a cost-effective grid-size(s) for precision soil sampling that also accurately depicts spatial nutrient variability.

Objective

To perform an economic analysis to determine the most cost-effective soil sampling strategy for site-specific application of nutrients and other soil amendments.

Methods

Precision Soil Sampling –

- 9 fields ranging in the size of 20 to 93 acres in the coastal plains of Georgia were used for this study.
- Grid soil sampling was conducted within each field using grid sizes of 1.0, 2.5, 5.0, 7.5, and 10.0 acres.
- Spatial nutrient and variable-rate prescription maps for fertilizing cotton (1200 lb/ac yield goal) were created using each strategy for lime, phosphorus (P), and potassium (K) using ArcGIS software.

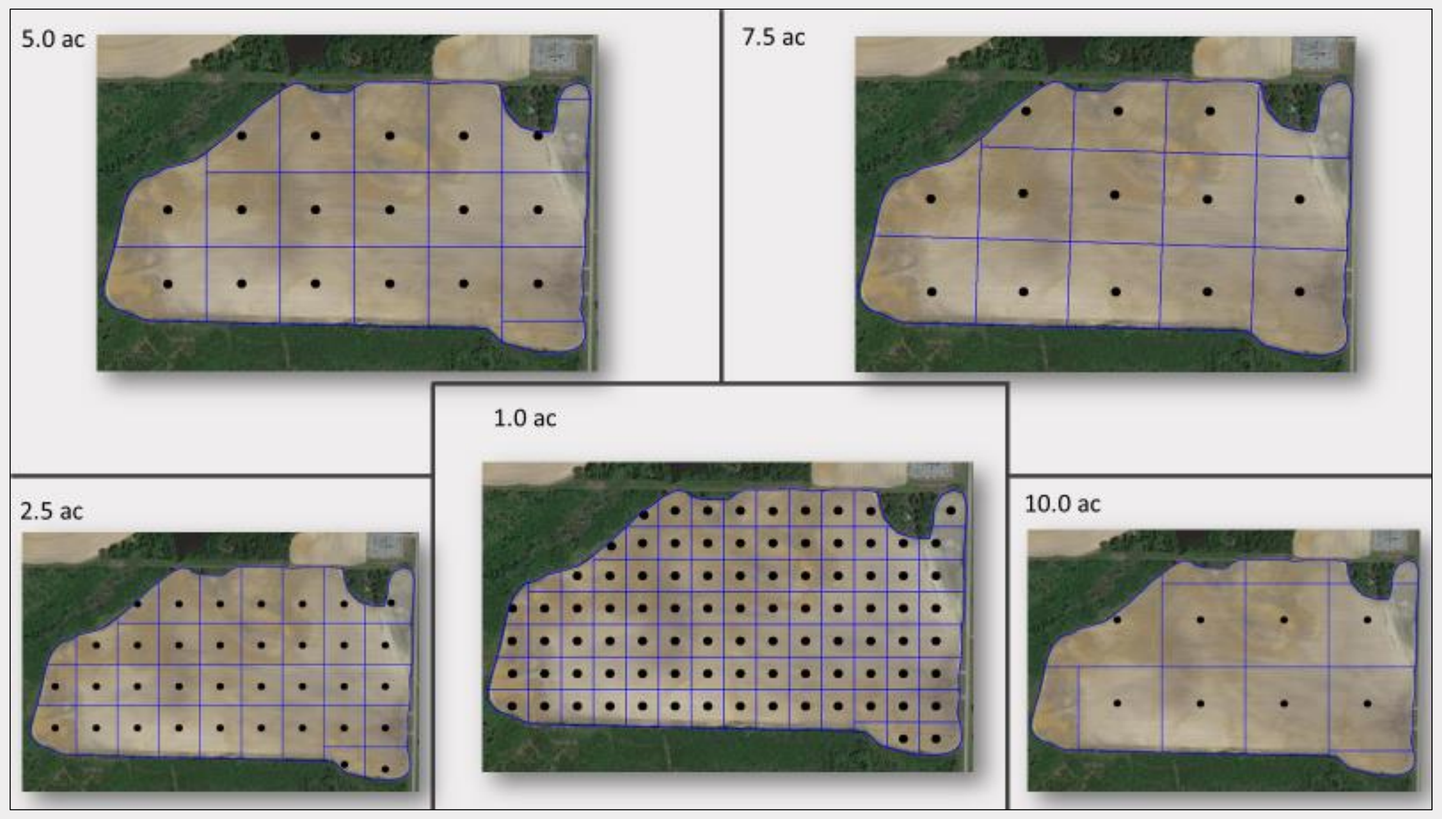

Figure 1. Soil sampling maps showing different grid sizes used in this study for one of the fields. The total number of sampling points vary between different grid sizes and among the fields. Data from all soil samplings were combined and assumed to represent actual spatial variability within each field.

Economic Analysis –

- Spatial correlation and accuracy analysis for different strategies were performed using JMP Pro 15.
- The total amount of fertilizer required for each grid strategy was computed using AgLeader SMS.
- The cost of soil sampling associated with each strategy along with the per pound costs of different nutrients (lime, P and K) were used to perform the economic analysis.

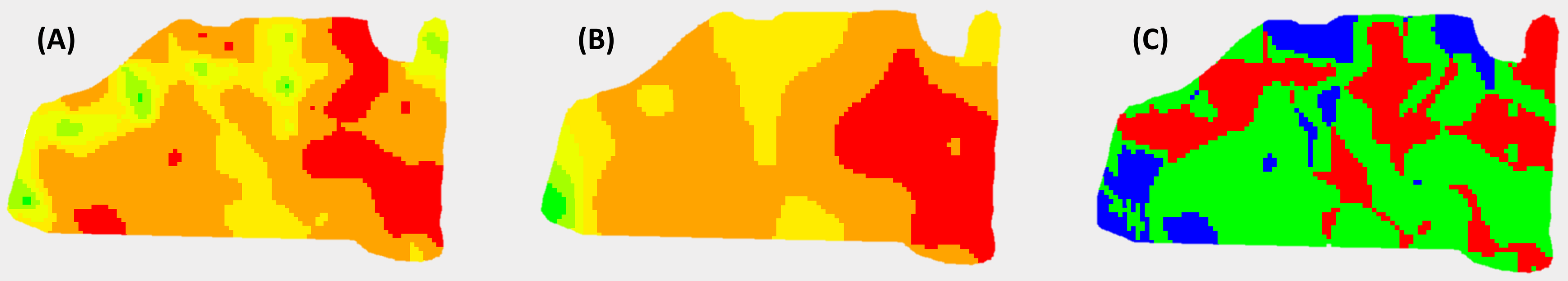

Figure 2. Prescription map for phosphorus (P) based on (A) all sampling points combined (assumed to represent actual spatial variability) and (B) using 2.5-ac grid sampling. (C) represents difference map showing areas of on-target (green), under- (red) and over-application (blue) of fertilizer.

Results

Table 1: Application accuracy (%) and costs ($/ac) for lime, phosphorus and potassium associated with different grid sizes for all nine fields. Application accuracy represents percent area in the field that received the target fertilizer rate. Application costs include the cost of soil sampling ($/ac) plus the fertilizer costs ($/ac) for soil sampling based on each grid size.

Grid Size	Application Accuracy (%)								
	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7	Field 8	Field 9
	---- Lime ----								
1.0	87	89	95	90	95	75	91	90	91
2.5	66	85	92	78	93	82	41	70	13
5.0	51	75	75	81	87	80	68	65	77
7.5	46	66	94	11	92	75	41	70	81
10.0	45	34	65	54	30	75	41	48	76
	---- Phosphorus ----								
1.0	84	92	82	75	88	81	91	92	91
2.5	58	82	40	36	82	57	60	82	68
5.0	49	70	19	53	51	46	65	81	63
7.5	42	74	32	32	64	55	60	82	67
10.0	42	77	42	20	37	55	64	72	57
	---- Potassium ----								
1.0	85	88	86	89	84	73	84	84	87
2.5	57	72	64	59	61	42	57	64	61
5.0	52	66	59	68	48	30	55	61	39
7.5	49	49	63	38	45	27	54	57	51
10.0	44	54	53	32	60	26	64	54	58

Grid Size	Application Costs ($/ac)								
	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7	Field 8	Field 9
	---- Lime ----								
1.0	43	20	34	33	34	43	40	38	56
2.5	35	14	28	27	30	41	31	33	64
5.0	31	15	23	26	32	41	35	36	55
7.5	33	20	30	5	30	42	30	31	51
10.0	41	17	22	18	39	42	30	22	55
	---- Phosphorus ----								
1.0	37	16	48	27	24	79	28	15	45
2.5	27	15	56	47	19	74	19	9	44
5.0	31	13	79	36	23	81	29	8	48
7.5	24	14	60	44	14	72	25	8	46
10.0	23	10	36	56	6	68	32	5	50
	---- Potassium ----								
1.0	56	89	48	17	71	65	33	22	86
2.5	54	85	46	20	68	58	31	23	85
5.0	48	82	22	14	70	55	30	24	84
7.5	41	86	39	22	68	44	29	20	82
10.0	55	86	43	27	73	48	22	16	79

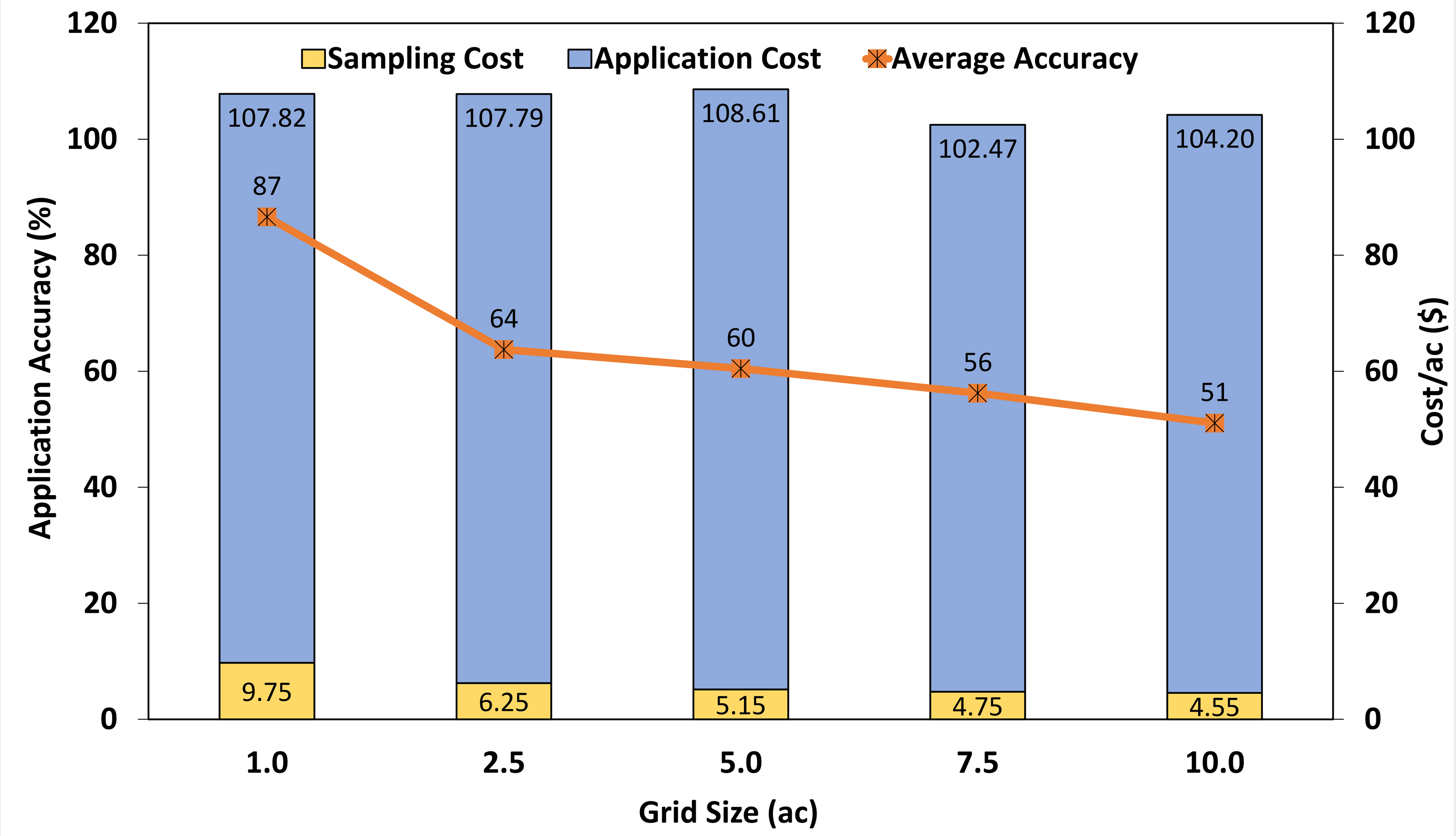

Figure 3. The total application cost ($/ac) along with the application accuracy (%) averaged across all three nutrients (lime, phosphorus and potassium) and all fields for different soil sampling grid sizes. The soil sampling cost ($/ac), which includes the cost of pulling soil samples ($4/ac) plus the analysis ($6/sample), is also presented (length of the yellow bars) for each grid-based soil sampling strategy. Current lime and fertilizer prices (P & K) were accessed from the 2020 UGA row-crop production budgets.

Conclusions

- While the soil sampling cost decreased considerably with an increase in grid size, the total application cost was still comparable ($104 - $108/ac) among the precision soil sampling using different grid sizes.
- Higher application inaccuracies and similar application costs associated with larger grid sizes suggests that precision soil sampling strategies on smaller grid sizes (1.0 – 2.5 ac) are cost-effective and optimal for accurate fertilizer placement.
- Future studies will be focused on comparing the application accuracy and economics of different grid versus zone-based precision soil sampling strategies for the coastal plain soils in the southeastern US.

Acknowledgements

Thanks to the Georgia Cotton Commission for funding this project, the collaborating growers, and the UGA farm managers for their cooperation and support, and the UGA Precision Ag team for data collection support.

References

Wollenhaupt et. al. (1994). Mapping Soil Test Phosphorus and Potassium for Variable-Rate Fertilizer Applications. J. of Prod. Agric., 7:441-448.