Title: Peony Nutrient Status in Alaska in 2015: Final Report for the Project "Assessing Alaska Peony Nutrient Requirement to Reduce Cost and Improve Competitiveness of the Cut Flower"

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Project Summary

Alaska peony cut flower industry has grown at a fast pace in recent years. As more growers join the industry, knowledge on soil and plant nutrient management is in a great demand. In the past, most soil fertility studies have focused on agronomic crops. Little is known about soil fertility conditions and nutrient requirement for peonies in Alaska. A field survey was initiated in 2012 and recommendation from that survey was to take soil and plant tissue samples from peony fields across the state both from well grown peonies and poorly grown peonies so that reference concentrations for nutrients in soil and plant tissue can be established. Upon such establishment, growers should be able to check their soil and tissue test results against those reference numbers so that their peony nutrient status can be ascertained. Also, there are needs for growers to understand the correct way of sampling soil and plant tissues so that they can gain more insight on their peony production.

The objectives of the project were: 1) collecting soil and tissue samples of well and poorly grown peonies; 2) analysis of the nutrient concentrations in the samples; 3) interpret the test results to individuals where samples are taken; 4) compile the results and establish the nutrient standards in Alaska; 5) present the results in the growers' conference and publish the results in APGA web site; and 6) create a YouTube video of the sampling procedure and standardize the sampling protocol for growers' use.

Project Approach

State wide soil and tissue samples were taken in the summer of 2015 in three regions: interior, south central, and Kenai Peninsula. In all, there are 90 soil samples, and 126 plant samples (Objective 1). Of those samples, 80 soil and tissue samples were sent to Brookside Lab for analysis for soil and plant nutrients. The remaining samples were the samples that are not in the project plan but requested by growers late in the season, and those samples were prepared and were sent for analysis in the Palmer Soil Laboratory of the School of Natural Resources and Extension, University of Alaska Fairbanks (Objective 2). The analytical items for soil included soil organic matter content, soil pH (both active pH and buffer pH), soil cation exchange capacity (CEC), mineral N, extractable P, exchangeable K, Melhich 3 Ca, Mg, Mn Cu, Zn and hot water extractable B. The analytical items for plant tissue included the nutrient concentration of N, P, K, Ca, Mg, B, Fe, Cu, Zn. The results were interpreted and sent to individuals through email from which his/her results were compared with the regional level for those analytical items. This whole process was finished by the end of May of 2016 (Objective 3). Regional average and ranges for well-and poorly- established peony were calculated and tabulated (Tables 1 to 5), and they can be used for the reference of growers' sample analysis (Objective 4). A YouTube video of how to take soil samples and meaning of the soil test items were made in cooperation with the publication office of School of Natural Resources and Extension (Objective 6).

Goals and Outcomes Achieved

The 2015 results that have been interpreted and sent to individuals through email for his/her results relative to the regional level for those analytical items were gone over and discussed with each individual grower over the winter of 2015 – 2016 prior to spring (Objective 3). All research results were presented in the annual peony conference in Homer in Jan 28 – 30 of 2016 (Objective 5).

All 2015 results were compiled and summarized in tables (Tables, 1, 2, 3, 4, and 5). There were apparent difference between "good" and "poor" for both Sarah Bernhardt and Duchess in soil organic matter content, active soil pH and total cation exchange capacity (Table 1), but those differences were very narrow, indicating that those parameters were not the ones that related to status of peony growth in the field at time of soil sampling. Comparing the mineral N, extractable P and Mehlich 3 P, a difference was found for mineral N in the interior for Sarah Bernhardt and in South Central for Duchess between "good" and "poor" (Table 2). For extractable P, the difference between "good" and "poor" was relatively large for both Sarah and Duchess for the interior, south central and Kenai Peninsula (Table2). For exchangeable K, a difference was also found between "good and "poor" for Duchess in the interior and Sarah Bernhardt in the Kenai Peninsula (Table 2). For micro nutrients, the only large difference was found in Zn for Duchess in the interior and south central between "good" and 'poor" (Table 3). Other micronutrients were similar between "good" and "poor" for all regions.

For nutrient concentration in peony tissues, a large difference was found for N concentration between "good" and "poor" in all three locations for both cultivars (Table 4), but those differences were narrow for P and K concentration. In some occasions, the "poor peony" had a higher P and K concentrations (Table 4). There were narrow differences between "good" and "poor" for all micronutrient concentrations (Table 5).

We have taken soil and tissue samples both "good" and "poor" peonies at each peony field. In soil samples, there were P and K cases where the concentrations in soil were different between "good" and "poor". But in plant tissue samples, only N showed a larger difference between "good" and "poor". Apparently, the tissue results do not corresponding with the soil test results, which means the soil test results at time of soil sampling didn't reflect plant tissue nutrient status. For perennial root crops such as peonies, the root has a tendency to store nutrients. In previous studies at UAF, Zhang et al. (2014) reported that Sarah Bernhardt roots contain 0.94% N, 0.17% P, 0.62% K, 0.46% Ca, 0.11% Mg, and trace

amount of micronutrients (3.3 mg Cu, 19 mg Zn, 4.4 mg B, 182 mg Fe, and 18 mg Mn per kg root stock) in the root samples taken in the fall. Those stored nutrients would be used to support shoot and root growth in the next spring. Since N is needed in large quantity, the stored N in roots may not satisfy the plant growth in the spring, therefore for soil without enough N supplement, plant would show stunted growth as compared with the "good" ones. Soil test mineral N is only an instant status of N in soil because soil N released from organic matter is totally controlled by microorganism activities in soil, which is in turn affected by environmental factors such as temperature, and water availability.

A YouTube video (**https://www.youtube.com/watch?v=Y_MM9AbfHqs**) of how to take soil samples and meaning of the soil test items was made in cooperation with the publication office of School of Natural Resources and Extension (Objective 6).

Beneficiaries

The beneficiaries of this research study are all of the present and future peony growers in the state of Alaska. In combination with previous soil and tissue sample results (e.g.2014), we are one step closer to develop an adequate nutrient management for peony growers. In addition, the YouTube video developed from this project will help growers to take soil and tissue sample correctly so that the results can be better used for diagnostics and for nutrient management in peony field.

Lessons Learned

We have accomplished every objective in the proposal. The research results provide guidelines for peony nutrient diagnostic concentrations for "good peony" and "poor peony" for nitrogen nutrients. For other nutrients, problem existed with the interpretation of the 2015 final results, especially when compared with the results from previous years' studies. Soil tests nevertheless provided ranges of sufficient and deficient nutrient concentrations. To develop a reliable peony nutrient management

guideline, a minimum of three year results are needed to cover a wide range of weather variations since weather (i.e. temperature and precipitation) affects plant's ability to take up nutrients. We have collected soil and tissue data in 2014, now 2015. We need to collect one additional year data in order to develop such guideline, and one additional year data to validate the to be developed guideline.

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Additional Information

Zhang, M., P. Holloway, R.V. Veldhuizen. 2014. Peony nutrient requirement. Annual Alaska peony conference. Jan. 30 – 31, 2014, Anchorage, Alaska, USA.

Zhang, M. R.V. Veldhuizen. 2015. Peony research report of 2014. Annual Alaska peony conference. Jan. 30 – 31, Fairbanks, Alaska, USA.

Zhang, M. and R.V. Veldhuizen. 2016. Peony research report 2015, presentation in annual conference of Alaska Peony Growers Association, January 28 to 30, 2016, Homer, Alaska.

Table 1. Average values of soil organic matter (SOM), pH, cation exchange capacity (CEC) from the interior, south central, and the Kenai Peninsula.

Analytical item	Sarah Bernhardt		Duchess	
	Good	Poor	Good	Poor
Interior				
SOM (%)	8.18 (2.69 – 13.3)	9.07 (3.03 – 16.5)	5.00 (2.27 – 8.40)	4.56 (2.60 – 6.5)
pH	5.8 (4.9 – 7.6)	5.8 (7.6 – 5.2)	6.0 (4.9 – 7.0)	6.2 (5.0 – 7.0)
CEC (meq/100g)	18.02 (10.81 – 22.70)	17.84 (7.53 – 23.90)	13.45 (8.34 – 21.30)	13.28 (7.09 – 17.80)
South Central				
SOM (%)	8.87 (3.41 – 14.50)	7.25 (2.14 – 10.77)	6.50 (1.32 -11.67)	5.94 (1.15 – 10.73)
pH	5.9 (5.5 – 6.8)	5.9 (5.3 – 6.9)	6.1 (5.5 – 6.7)	5.7 (5.7 – 5.7)
CEC (meq/100g)	9.97 (5.57 -15.00)	10.33 (6.65 – 14.73)	7.52 (6.40 – 8.64)	6.34 (4.30 – 8.38)
Kenai Peninsula				
SOM (%)	13.44 (11.68 – 15.38)	13.78 (12.32 – 14.69)	12.83 (8.89 – 16.63)	13.44 (7.95 – 17.45)
pH	5.7 (4.8 – 6.1)	5.4 (4.8 – 6.1)	5.6 (5.0 – 5.9)	5.6 (5.1 – 6.3)
CEC (meq/100g)	13.42 (9.37 – 16.84)	13.16 (10.45 – 14.91)	14.06 (10.11 – 25.19)	14.80 (10.45 – 21.08)

[1]Numbers in the parenthesis = range of the tested item in the samples.

Table 2. Average values (and ranges) of soil mineral N (NH_4-N + NO_3-N), Mehlich 3 phosphorus, and exchangeable potassium concentration from the interior, south central, and the Kenai Peninsula.

Analytical item	Sarah Bernhardt		Duchess	
	Good	Poor	Good	Poor
Interior				
Ammonium (ppm)	27.6 (1.0 – 95.4)	37.4 (0.7 – 328.6)	6.2 (0.8 – 20.9)	2.5 (0.8 – 4.2)
Nitrate (ppm)	15.1 (0.5 – 59.4)	18.1 (0.5 – 77.1)	17.3 (0.5 – 63.9)	21.0 (0.5 – 95.7)
Mineral N (ppm)	42.7 (1.5 – 98.7)	30.5 (1.4 – 79.0)	23.5 (1.3 – 84.8)	23.5 (1.3 – 99.9)
Mehlich 3 P (ppm)	310 (81 – 518)	282 (61 – 775)	182 (54 – 360)	106 (76 – 131)
Exchange K (ppm)	430 (155 – 710)	467 (183 – 1883)	188 (45 – 265)	145 (68 – 215)
South Central				
Ammonium	2.3 (0.5 – 3.6)	2.6 (1.6 – 3.8)	2.2 (1.3 – 3.0)	2.4 (1.4 – 3.3)
Nitrate	3.4 (0.6 – 7.5)	3.5 (0.5 – 9.6)	14.3 (28.1 – 0.5)	8.1 (15.6 – 0.5)
Mineral N (ppm)	5.6 (3.1 – 8.0)	6.1 (2.6 – 11.2)	16.5 (1.8 – 31.1)	10.4 (1.9- 18.9)
Mehlich 3 P (ppm)	68 (42 – 101)	47 (24 – 101)	42 (36 -47)	37 (31 – 42)
Exchange K (ppm)	213 (130 – 315)	206 (140 – 360)	162 (126 – 197)	196 (187 – 205)
Kenai Peninsula				
Ammonium	3.8 (3.0 – 5.0)	5.0 (3.5 – 8.3)	5.6 (3.6 – 9.4)	6.3 (3.3 – 12.4)
Nitrate	5.9 (0.5 – 16.1)	10.4 (1.8 – 29.3)	14.3 (0.5 – 4.6)	13.8 (0.7 – 37.6)
Mineral N (ppm)	9.7 (3.8 (19.7)	15.4 (6.8 – 32.8)	19.9 (4.3 – 52.4)	20.2 (4.6 – 41.0)
Mehlich 3 P (ppm)	48 (19 – 93)	45 (10 – 74)	58 (13 – 99)	80 (10 – 255)
Exchange K (ppm)	163 (74 – 302)	137 (70 – 220)	131 (52 – 387)	147 (49 – 402)

[1]Numbers in the parenthesis = range of the tested item in the samples.

Table 3. Average values (and ranges) of key soil micronutrient concentrations from the interior, south central and the Kenai Peninsula.

Analytical item	Sarah Bernhardt		Duchess	
	Good	Poor	Good	Poor
Interior				
Ca (ppm)	1872 (909 – 2414)	1891 (597 – 2547)	1599 (510 – 2537)	1686 (437 – 2352)
Mg (ppm)	328 (86 – 581)	330 (73 – 469)	257 (54 – 601)	266 (45 – 522)
B (ppm)	0.69 (0.44 – 1.1)	0.67 (0.46 – 0.90)	0.63 (0.5 – 0.8)	0.61 (0.5 – 0.8)
Mn (ppm)	26.0 (11.0 – 49.0)	25.0 (8.0 – 50.0)	25.7 (10.0 – 54.0)	20.8 (8.0 – 39.0)
Cu (ppm)	2.8 (1.3 – 8.2)	3.0 (1.3 – 9.0)	3.3 (1.2 – 5.0)	3.0 (1.0 – 4.0)
Zn (ppm)	13.2 (2.5 – 60.0)	11.0 (2.2 – 27.0)	7.1 (2.1 – 15.0)	4.7 (2.0 – 9.8)
South Central				
Ca (ppm)	1261 (605 2358)	1395 (637 – 2310)	1025 (987 – 1063)	751 (439 – 1063)
Mg (ppm)	101 (46 – 208)	94 (37 – 215)	50 (46 – 54)	52.0 (49.0 – 55.0)
B (ppm)	0.69 (0.5 – 0.8)	0.60 (0.5 – 0.8)	0.6 (0.5 – 0.7)	0.5 (0.5 – 0.6)
Mn (ppm)	18.0 (7.0 – 25.0)	16.5 (6.0 – 25.0)	37.0 (19.0 – 55.0)	20.0 (10.0 – 29.0)
Cu (ppm)	2.6 (1.3 – 5.8)	2.6 (1.0 – 5.8)	2.3 (1.2 – 3.4)	2.3 (1.3 – 3.3)
Zn (ppm)	5.0 (2.0 – 8.8)	3.9 (1.8 – 6.0)	8.0 (4.6 – 11.4)	4.1 (2.8 – 5.5)
Kenai Peninsula				
Ca (ppm)	1678 (543 – 2305)	1519 (974 – 2313)	1725 (1127 – 3277)	1818 (1129 – 3136)
Mg (ppm)	95.0 (34.0 – 152.0)	73.0 (25.0 – 98.0)	149 (75 – 411)	145 (60 – 324)
B (ppm)	0.6 (0.5 – 0.7)	0.6 (0.3 – 0.8)	0.5 (0.4 – 0.6)	0.6 (0.4 – 0.8)
Mn (ppm)	8.0 (6.0 – 13.0)	9.0 (4.0 – 12.0)	11.0 (6.0 – 19.0)	11.0 (5.0 – 19.0)
Cu (ppm)	1.3 (0.9 – 2.0)	1.1 (0.7 – 1.3)	1.4 (1.0 – 2.4)	1.8 (1.1 – 3.8)
Zn (ppm)	3.2 (1.8 – 4.7)	2.5 (1.9 – 3.5)	3.6 (1.9 – 5.3)	5.8 (1.7 – 20.2)

[1]Numbers in the parenthesis = range of the tested item in the samples.

Table 4. Average values (and ranges) of nitrogen, phosphorus, and potassium concentrations in peony tissue from the interior, south central and Kenai Peninsula.

Analytical item	Sarah Bernhardt		Duchess	
	Good	Poor	Good	Poor
Interior				
Nitrogen (%)	2.37 (1.96 – 2.95)	2.08 (1.55 – 2.99)	2.41 (2.13 – 3.06)	2.08 (1.65 – 2.89)
Phosphorus (%)	0.27 (0.19 – 0.36)	0.28 (0.16 – 0.35)	0.26 (0.19 – 0.34)	0.26 (0.20 – 0.33)
Potassium (%)	1.06 (0.79 – 1.33)	1.24 (0.86 – 1.85)	1.15 (0.97 – 1.32)	1.40 (1.09 – 1.77)
South Central				
Nitrogen (%)	2.01 (1.78 – 2.30)	1.67 (1.39 – 1.88)	2.07 (1.84 – 2.30)	1.70 (1.26 – 2.13)
Phosphorus (%)	0.24 (0.21 – 0.29)	0.24 (0.19 – 0.30)	0.22 (0.16- 0.28)	0.17 (0.16 – 0.18)
Potassium (%)	1.13 (0.97 – 1.29)	1.01 (0.87 – 1.19)	1.20 (1.13 – 1.27)	1.08 (1.01 – 1.15)
Kenai Peninsula				
Nitrogen (%)	2.00 (1.86 – 2.25)	1.59 (1.34 – 1.88)	2.03 (1.72 – 2.51)	1.93 (1.43 – 2.38)
Phosphorus (%)	0.22 (0.18 – 0.25)	0.19 (0.14 – 0.21)	0.20 (0.24 – 0.13)	0.19 (0.12 – 0.25)
Potassium (%)	1.05 (0.67 – 1.50)	0.99 (0.71 – 1.35)	0.92 (0.63 – 1.26)	0.99 (0.52 – 1.30)

[1]Numbers in the parenthesis = range of the tested item in the samples.

Table 5. Average values (and ranges) of key micronutrient concentrations in peony tissue from the interior, south central and Kenai Peninsula.

Analytical item	Sarah Bernhardt		Duchess	
	Good	Poor	Good	Poor
Interior				
Ca (%)	1.05 (0.64 – 1.42)	0.73 (0.42 -1.14)	1.23 (0.70 – 1.85)	0.90 (0.56 – 1.27)
Mg (%)	0.34 (0.19 – 0.47)	0.28 (0.14 – 0.35)	0.37 (0.29 – 0.48)	0.30 (0.25 – 0.35)
S (%)	0.21 (0.14 – 0.27)	0.19 (0.12 – 0.24)	0.20 (0.15 – 0.24)	0.18 (0.13 – 0.21)
B (ppm)	13.6 (2.3 – 51.6)	11.9 (2.7 – 25.0)	14.9 (2.1 – 21.7)	12.0 (1.3 – 24.2)
Fe (ppm)	77.6 (36.2 – 112.0)	64.4 (34.1 – 94.7)	56.5 (37.4 – 113.0)	58.4 (34.2 – 94.2)
Cu (ppm)	4.4 (1.5 – 5.7)	4.5 (2.0 – 6.3)	4.5 (3.9 – 5.3)	4.1 (2.7 – 5.3)
Zn (ppm)	28.2 (17.5 – 43.5)	28.0 (18.9 – 41.1)	35.6 (18.7 – 47.2)	30.5 (15.9 – 46.0)
South Central				
Ca (%)	0.91 (0.61 – 1.22)	0.90 (0.72 – 1.12)	1.12 (1.08 – 1.16)	0.96 (0.74 – 1.17)
Mg (%)	0.18 (0.11 – 0.22)	0.19 (0.13 – 0.23)	0.20 (0.13 – 0.26)	0.20 (0.14 – 0.25)
S (%)	0.18 (0.15 – 0.21)	0.17 (0.14 – 0.20)	0.21 (0.18 – 0.23)	0.15 (0.13 – 0.17)
B (ppm)	14.4 (5.6 – 25.6)	11.9 (7.3 – 17.0)	23.8 (17.2 – 30.3)	18.8 (10.5 – 27.1)
Fe (ppm)	57.7 (40.4 – 89.9)	45.3 (27.0 – 70.1)	38.5 (31.6 – 45.3)	38.5 (29.2 – 47.7)
Cu (ppm)	4.8 (3.2 – 7.0)	3.7 (3.2 – 4.1)	4.0 (3.6 – 4.3)	2.6 (2.2 – 2.9)
Zn (ppm)	37.4 (21.3 – 48.7)	37.6 (26.2 – 51.2)	56.1 (46.4 – 65.7)	45.7 (38.5 – 52.9)
Kenai Peninsula				
Ca (%)	1.05 (0.70 – 1.33)	0.92 (0.80 – 1.08)	1.27 (0.95 – 1.85)	1.20 (0.78 – 1.76)
Mg (%)	0.21 (0.10 – 0.33)	0.19 (0.11 – 0.25)	0.34 (0.21 – 0.45)	0.32 (0.20 – 0.43)
S (%)	0.18 (0.17 – 0.21)	0.15 (0.13 – 0.17)	0.19 (0.16 -0.23)	0.18 (0.15 – 0.24)
B (ppm)	17.0 (4.0 – 30.8)	15.3 (2.9 – 26.0)	16.7 (4.2 – 35.5)	16.7 (3.6 – 33.9)
Fe (ppm)	107.9 (33.2 – 360.0)	99.5 ((28.8 – 357.0)	78.6 (36.4 – 266.0)	79.0 (32.1 – 300)
Cu (ppm)	4.1 (2.7- 5.9)	3.2 (1.2 – 4.6)	4.2 (3.4 – 6.3)	3.6 (2.8 – 4.6)
Zn (ppm)	32.7 (20.8 – 45.9)	26.5 (18.5 – 31.6)	42.0 (17.2 – 56.2)	37.5 (14.7 – 52.4)

[1]Numbers in the parenthesis = range of the tested item in the samples.