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Title: Soil Amendments for Blueberry Plant Establishment and Variety Trial

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Proposed Project

4/1/2019 - 12/31/2019

Total Project Request: \$4,534

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Please reference PSU Ref. Number in all correspondence.

**Title: Soil Amendments for Blueberry Plant Establishment and Variety Trial
Progress report for the fourth year included**

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Duration: 2015-2019, continuing

Justification:

Soils that are best suited for blueberries are sandy with high organic matter with a high-water table, and pH 4.5 to 4.8. Since few Pennsylvania soils are ideal for blueberries, they are typically amended with sulfur to lower the pH and peat moss is incorporated in the planting hole to increase organic matter. Blueberries are usually mulched with sawdust to conserve soil moisture, lower soil pH, and provide nitrogen as the organic material decomposes. There are reports in the literature of substituting fresh or aged pine bark for peat moss in the planting hole, but there have been few comparisons of hardwood and softwood materials. Another potential soil amendment is sheep wool, which reportedly can reduce soil pH and provides some essential plant elements. Data from these trials will be used to revise current recommendations for highbush blueberry varieties and pre-plant soil amendments and post-plant mulching.

Objectives:

Objectives for this project include:

- 1.) To evaluate different organic materials as soil amendment.
- 2.) To evaluate various materials as mulch for blueberries on a limestone soil.
- 3.) To evaluate new highbush blueberry varieties.

Research completed 2015 - 2018

The site selected for the planting had an initial soil pH of 5.1. Phosphorus and magnesium were optimum, potassium was deficient, and calcium was excessive. The rye cover crop was plowed under in early May and the following fertilizers were broadcast and incorporated: di-ammonium phosphate (DAP, 18-46-0), ammonium sulfate (21-0-0) and potassium sulfate ((0-0-52) to provide 25 pounds nitrogen per acre, 50 pounds of P₂O₅ per acre and 110 pounds of K₂O per acre. Since the original soil pH was fairly low, we felt that the fertilizers would lower the pH adequately without adding sulfur.

One-year old blueberry plants were purchased from Nourse Farms in Massachusetts and from DeGrandchamp Farms in Michigan. On May 29, 2015, planting holes were dug with shovels and were about 12" deep and 18" wide. One of four soil amendments were mixed with soil in the planting hole: 1.5 gallons of sphagnum peat (control), 1.5 gallons of softwood sawdust, 1.5 gallons of hardwood sawdust, or

0.22 pounds of washed sheep wool. On July 13, 2015 the following mulching treatments were applied to a 2'-wide strip under the plants: 4" of hardwood or softwood sawdust or 1.76 pounds of washed sheep wool. Each year plants were fertilized with ammonium sulfate at a rate of 7 pounds of nitrogen per acre.

In mid-August of each year leaves were collected for leaf nutrient analysis. Before drying the leaves, the greenness of each leaf was measured with a SPAD meter as an indication of leaf chlorophyll concentration. After drying, the average dry weight of the leaves was recorded as a measure of leaf size. During the winter of each year, plant height and spread were measured, and soil samples were analyzed for pH and soil nutrients. For 2018, leaves have been collected but not yet analyzed.

In 2016 and 2017 the plants were too small to fruit. Therefore, during bloom all flowers from each plant were removed and counted. Plants were allowed to fruit in 2018, but due to constant rainy weather and heavy infestation by spotted wing drosophila, some fruit dropped from the plants before being harvested. While harvesting the fruit, berries were also collected from the ground under the plants and good (saleable) and bad (nonsaleable) berries were counted and weighed. Data were analyzed by analysis of variance and means were compared with Tukey's Honestly Significant Difference at the 5% level of significance.

Results for mulching experiment in 2018

Average leaf dry weight is an indicator of leaf size (Table 1). Plants with hardwood soil amendment and hardwood mulch (Hw/Hw) had the largest leaves and plants with wool soil amendment and wool mulch (w/w) had the smallest leaves. Leaf greenness, measured with the SPAD meter was similar for all treatments (Table 1). Plant height and spread were greatest when peat moss (ck) was used as a soil amendment and either hardwood or softwood sawdust was used as the mulch, whereas the w/w plants were the smallest. The treatments also affected the shape of the canopy, where the w/w plants were more narrow than the ck/hw plants.

The combination of poor weather and spotted wing drosophila resulted in relatively low yields (Table 2). The ck/sw plants produced the most berries, whereas the w/w plants had the fewest berries. Plants with hw/hw had the largest berries and plants with w/w, w/sw, and ck/sw had the smallest berries. The lowest percentage of fruit was harvested from the hw/hw plants and the highest percentage was harvested from the w/w plants.

After four years, plants with non-composted sawdust as soil amendments are nearly as large, and not statistically different than plants receiving peat moss as a soil amendment at planting. Wool does not appear to be a viable option as a soil amendment or mulch. Plants with wool as a soil amendment and then mulched with sw were about 12% smaller than plants receiving peat moss soil amendment and sw mulch. In addition, wool mulch did not control weeds as well as sawdust mulch. Though in early years of the study softwood sawdust appeared to be preferable to hardwood sawdust, differences have become less apparent between hardwood and softwood sawdust when used as a soil amendment or as a mulch.

Results for blueberry variety trial in 2018

For the variety trial, five plants of each of the following 10 varieties were planted in 2015: 'Bonus', 'Nelson', 'Legacy', 'Liberty', 'Chandler', 'Huron', 'Reka', 'Draper', 'Northland', and 'Superior'. Each year plant height and spread were measured, and the plants were cropped in 2018. 'Huron' and

‘Northland’ plant survival was poor, but the surviving ‘Huron’ plant was very productive (Table 3). Yield was highest for ‘Liberty’ and lowest for ‘Reka’. Yield for ‘Reka’ was at least partially due to bird feeding. ‘Chandler’ produced the largest berries and ‘Superior’ produced the smallest berries.

Japanese beetles were counted on plants three times during the season and the total number of beetles counted per plant are presented in Table 4. More beetles were counted on ‘Huron’ and ‘Superior’ plants than the other varieties (Table 4). Berries started to ripen before bird netting could be applied, so the percentage of berries damaged by birds was estimated by estimating the number of pedicels per plant without fruit. ‘Reka’ had more bird damage than the other varieties, probably because it is one of the earlier-ripening varieties in this trial. Plant height did not differ significantly for the 10 varieties, but ‘Northland’ plants were the widest and ‘Draper’ had the smallest width. The growth habit was quite different for the cultivars. ‘Northland’ had the smallest height/width ratio, whereas ‘Nelson’ and ‘Draper’ had the highest ratio (Table 4).

Plans for 2019 and 2020: For the soil amendment experiment, we plan to continue to record plant size and changes in soil pH and nutrient levels, as well as leaf nutrients and leaf color. Now that the bushes are large enough to produce a substantial crop we plan to harvest the bushes once or twice a week each year to record yield (pounds of fruit/plant). For each harvest, we will take a random sample of fruit to estimate average berry weight and this value will be used to estimate the number of berries harvested per plant.

For the variety trial, we also plan to harvest bushes and obtain yield, berry size and number of berries per plant as described for the soil amendment experiment. In addition to yield, a sample of fruit from each harvest will be evaluated for quality characteristics. Berry color will be measured with a colorimeter, soluble solids concentration will be measured with a refractometer, fruit firmness will be rated, and picking scar size will be estimated. Japanese beetle damage and other observations will also be recorded.

Table 1. The effect of soil amendments and mulches on leaf color and average leaf dry weight, and plant spread and height for ‘Patriot’ blueberry plants in 2018. Abbreviations for treatments: Ck=peat moss, HW=hardwood sawdust, SW=softwood sawdust, and w=wool.

Soil	mulch	SPAD	Leaf DW (mg/leaf)	Plant spread (inches)	Plant ht. (inches)	Ht/Spread Ratio
Ck	Hw	45.0 ^z	201ab ^y	29.9a	34.3a	1.16b
Ck	Sw	44.8	198ab	29.2ab	34.2a	1.19ab
Hw	Hw	48.0	210a	26.2ab	32.3ab	1.29ab
Sw	Sw	45.0	200ab	26.4ab	32.5b	1.25ab
W	Sw	43.0	195ab	25.8bc	30.7bc	1.20ab
w	w	42.0	192b	22.2c	28.8c	1.33a
P-value ^x		0.139	0.024	0.0001	0.0001	0.0484

^z SPAD values are nondestructive estimates of chlorophyll, where high values are darker green.

^y Values within columns followed by common letters do not differ at the 5% level of significance, by Tukey’s test.

^x P-values less than 0.05 indicate that there is a 5% chance that differences between treatment means are due to something other than the treatments.

Table 2. The effect of soil amendments and mulches on fruit characteristics of ‘Patriot’ blueberry plants in 2018.

Soil Amendment	Mulch	Wt picked (g)	FW picked (g)	Est. Pick no.	Bad wt. (g)	Drop wt (g)	Number dropped	Est. Drop FW (g)	Est. Total number	Est. Picked (%)	Good picked (%)
Ck	Hw	145	0.69b ^z	180	14	84	179	0.46	360ab	49ab	90
Ck	Sw	251	0.68b	322	29	106	215	0.48	540a	59ab	88
Hw	Hw	77	0.91a	76	12	64	109	0.55	185b	37b	81
Sw	Sw	129	0.76ab	153	15	69	132	0.50	285sb	52ab	88
W	Sw	202	0.63b	258	19	74	154	0.46	412ab	60ab	86
W	w	90	0.68b	116	11	31	62	0.51	178b	65a	86
P-value		0.194	0.009	0.075	0.202	0.124	0.068	0.782	0.044	0.047	0.217

^z Values within columns followed by common letters do not differ at the 55 level of significance, by Tukey’s test.

Table 3. Plant survival, yield and average berry weight (FW) for 10 blueberry cultivars in 2018.

Cultivar	Plant survival (%)	Total yield ((g/plant)	FW (g)	Good fruit (%)
Bonus	100a	287	1.37ab ^z	64.3ab
Chandler	100a	769	1.72a	53.7b
Draper	100a	352	1.45ab	64.6ab
Huron	20b	1189	0.96bc	80.4a
Legacy	80a	748	1.19ab	83.0a
Liberty	100a	1245	1.11ab	69.2ab
Nelson	100a	377	1.20ab	78.7ab
Northland	60ab	556	0.75bc	64.8ab
Reka	100a	168	0.86bc	73.2ab
Superior	100a	676	0.70c	54.4b
P-value	0.001	0.192	0.001	0.018

^z Means within columns followed by common letters do not differ at the 5% level of significance, by Tukey’s HSD.

Table 4. Japanese beetles per plant, percent of the crop lost to birds, and plant height and width in fall of 2018.0.001

Cultivar	Beetles/plant	Bird damage(%)	Height (in)	Width (in)	Ht./Width ratio
Bonus	3.2b	0.0a	^{28.0}	21.7ab	1.36ab
Chandler	02b	0.0a	35.4	32.0ab	1.15b
Draper	8.4b	2.0a	31.2	20.7b	1.54a
Huron	14.0ab	0.0a	30.2	23.9ab	1.26ab
Legacy	5.0b	0.0a	33.7	29.4ab	1.24b
Liberty	0.4b	0.0a	35.8	29.3ab	1.27ab
Nelson	1.6b	0.0a	37.8	22.4ab	1.71a

Northland	8.3b	0.0a	33.0	33.3a	0.97b
Reka	5.6b	28.4b	33.6	27.5ab	1.22b
Superior	38.8a	0.0a	29.0	24.3ab	1.23b
P-value	0.0001	0.0427	0.2918	0.0427	0.0010

^z means within columns followed by common letters do not differ at the 5% level of significance, by Tukey's HSD.

Budget for 2019: The original proposal submitted in 2015 for the project included budgets for 5 years, ending in 2019. We did not request funding for 2018 because we had adequate unexpended funds to harvest the plants in 2018, and would like to continue harvest for 2019 and 2020.

Salaries- \$145

Wages- \$2,523

Fringe- \$251

Fringe benefits are computed using the fixed rates of 38.97% applicable to Category I Salaries, 14.74% applicable to Category II Graduate Assistants, 7.81% applicable to Category III Salaries and Wages, 0.18% applicable to Category IV Student Wages, and 25.34% for Category V, Postdoctoral Scholars and Fellows, for fiscal year 2019 (July 1, 2018, through June 30, 2019). If this proposal is funded, the rates quoted above shall, at the time of funding, be subject to adjustment for any period subsequent to June 30, 2019, if superseding Government approved rates have been established. Fringe benefit rates are negotiated and approved by the Office of Naval Research, Penn State's cognizant federal agency.

Supplies- \$500

Miscellaneous- \$1,115

TOTAL- \$4,534

Other Support: N/A