A Comparison of Plant Growth of Bush Beans Using Various Commercially Available Soil Amendment Products.

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Abstract:

The purpose of this trial was to determine if commercially available products sold as enhancements to plant growth were in effect beneficial and did in fact enhance plant growth and production.

Green beans grown in soil amended with three commercially available products were compared with soil amended with acidified composted cotton burrs and unamended soil to determine their effectiveness on plant growth and yield. Each treatment was replicated six times in a randomized complete block design. There were no significant differences at the 10% level of probability in plant growth, number of flower buds or beans, or nitrogen-fixing bacterial nodules of green beans.

Methods and Materials:

This trial was conducted at the Pioneer Sand Co., Southwest Soil facility, 58521 Amber Road, Olathe Colorado.

Sandy loam soil provided by Southwest Soil was placed in three raised beds provided by Pioneer Sand. This soil was run through a screen to remove the clumps, rocks, and sticks. The test plots were irrigated with domestic water using RainBird Xeri-spray XS-180 and XS-090 nozzles based on the moisture content of the soil. The soil was analyzed for its chemical properties prior to the start of the project and for each treatment at the conclusion of the trial.

Each plot was one square foot in size with a six inch border on all four sides. Products were applied prior to planting according to label directions and worked into each plot with a hand trowel to ensure contamination of the border area and neighboring plots did not occur. The Composted Cotton Burr treatment consisted of the same weight of CCB

as used in the Soil Mender treatment. The control plots received no amendments. No additional treatments of these products were applied during the time of this trial.

The products evaluated and application rates based on company recommendations were as follows:

1. Soil Secrets (Soil Secrets, LLC) – TerraPro[ii] (1.2 cubic feet/1000 ft^2), Protein Crumbles[iii] (60 lbs/1000 ft^2), plus Endo 900 (An Endomycorrhiza product).
2. Soil Mender (Soil Mender Products, LP) – Acidified Composted Cotton Burrs (65 cubic feet/1000 ft^2), and YumYum[iv] (50 pounds/1000 ft^2). The Foliar Plus [v] component of this product, a liquid foliar plant food and soil drench was not applied in this trial. See comments under "testing of product components."
3. BioSol – Planter's Kit (20 pounds/1000 ft^2) plus Mycorrhizae (inoculum [vi])
4. Control – No amendments.
5. Acidified Composted Cotton Burr – 65 cubic feet/1000 ft^2.

Five Kentucky Wonder bush bean seeds (Northrup-King) were planted in each plot on two inch spacing. One seed was planted in the center of each plot and the other four seeds arranged in a square around the central bean seed. All seeds were planted at a depth of 1 inch. Beans were selected to take advantage of their quick germination and growth. Plants were not staked.

Planting was accomplished on July 26 and plots harvested on September 20, 2010. A screen was built to prevent predation by squirrels and other rodents.

Plants from each plot were dried and tops and roots weighed separately. Data for each plot was recorded for plant height, root and top weight, number of beans and buds, and number of nitrogen-fixing nodules.

Analysis:

Table 1 – Soils Analysis[vii]

Treatment	pH	Electric Conductivity (EC) dS/m 1:1 / EC_e [1]	% organic matter	Nitrate Nitrogen ppm	P_2O_5 ppm Olsen-P /ABDPTA [2]	Potassium ppm
Initial Soil	7.9	1.76 / 5.28	1.5	13.6	17/2.89	157
1. Soil Secrets	8.2	0.57 / 1.71	1.5	4	20/3.4	150
2. Soil	8.0	0.90 / 2.70	1.9	2.4	20/3.4	260

Mender						
3. BioSol	8.3	0.36 / 1.08	1.5	3.0	25/4.25	146
4. Control	8.1	0.41 / 1.23	1.3	1.2	16/2.72	161
5. Acidified Composted Cotton Burr	8.2	0.60 / 1.80	2.1	1.2	18/3.06	257

[1]To convert 1:1 EC to Saturated Paste (EC_e), the 1:1 number was multiplied by 3.
[2]To convert Olsen-P to AB-DPTA the number provided was multiplied by a factor of 0.17. AB-DPTA is the P-extraction technique used in Colorado to determine P-application rates.

Table 2 – Means for Treatments

Treatment	Plant Height in mm	Average Top Weight gms	Average Root Weight gms	Average Total Weight gms	Average Number of Beans/plant	Average Number of Buds/plant	Average Number of Bean & Buds/plant	Average Number of Nodules
1. Soil Secrets	21.88	1.20	0.31	1.51	2.49	1.44	3.93	20.77
2. Soil Mender	30.47	1.59	0.23	1.82	3.03	1.633	4.67	12.43
3. Biosol	26.12	1.63	0.34	1.97	3.89	1.03	4.93	28.14
4. Control	25.58	1.64	0.56	2.19	1.93	1.87	3.80	18.77
5. ACCB	23.15	1.37	0.31	1.68	2.91	1.81	4.72	20.87

Data was adjusted according to the number of bean plants in each plot and a 2-way analysis of variance was used to determine probability levels for each treatment. The statistical program MSTAT-C was used for this analysis.

Table 3 – ANOVA-2

Data Set	Probability for Treatment	Probability for Replication
Plant Height	0.1250	0.6011
Top Dry Weight	0.4027	0.2142
Root Dry Weight	0.2655	0.3170
Total Plant Dry Weight	0.2115	0.0911
# of beans	0.2002	0.0857
# of buds	0.5170	0.9066
Beans + Buds	0.7245	0.3568
Nitrogen-fixing nodules	0.1805	0.7661

Note: Probability levels above 0.10 were considered insignificant in this trial.

Discussion:

Soil Test results:

A composite soil sample was taken prior to the trial and composite samples from each treatment were collected at the end of the trial to determine changes in nutrient, organic

matter and EC. All samples were evaluated by Ward Laboratories, Inc., Kearney, Nebraska.

pH levels increased for each treatment during the trial from 7.9 to a high of 8.3. This increase was in part due to the high pH level (8.1) of the water used for irrigation. The addition of Acidified Composted Cotton Burrs of treatment 2 and 5 had no affect on reducing soil pH.

The electrical conductivity (EC) of the soil was initially 5.28, a level above which is acceptable for beans. Beans suffer a yield reduction of 10% at 1.0 dS/m, 25% at 2.3 dS/m and a 50% yield reduction when the salt level reaches 3.3 dS/m. Irrigation during the trial leached salts out of these soils. It should be noted the Soil Mender treatment had the highest EC level of the treatments by the end of the trial and would have had a negative impact on bean production. The other treatments had salt levels more in line with the salt tolerance level of beans.

Treatment 2 and 5 had elevated organic contents compared to the other treatments. This was most likely due to the addition of the Acidified Composted Compost Burr as an amendment in these treatments.

Nitrogen levels decreased during the trial from the initial level of 13.6 to a low of 1.2 ppm. This is due to leaching and plant use. Beans are nitrogen-fixing plants (legumes) and fix atmospheric nitrogen for a portion (30 to 40%) of their nitrogen needs. In general 10 to 20 ppm soil N is needed to maximize bean production. The initial soil N level of 13.6 ppm fit this requirement. Excess soil nitrogen levels can delay nitrogen-fixation and delay production. Other vegetables normally require a starting level of nitrogen of 40 ppm plus additional applications of nitrogen during the growing season. Soil tests were not conducted at the time the products were applied thus the starting N levels of these products are unknown.

The phosphorus level was low (2.89 ppm AB-DPTA) at the start of the trial and remained low regardless of the products applied. A phosphorus level of 7 ppm (AB-DPTA) is recommended for beans in Colorado. [viii]

A soil potassium level of 120 ppm is adequate for bean production. The unamended soil had a potassium level of 157 ppm. By the end of the trial the two treatments containing Composted Cotton Burrs had increased soil potassium levels.

In future trials soil samples need to be taken from each plot when amendments are applied and again at the end of the trial. This would determine the starting levels of each nutrient and allow for the statistical analysis of each treatment.

While an increase in nutrients may be considered an important feature of any treatment only certain levels of nutrients are needed for plant growth. Anything over those levels are not necessary and may have a negative effect on plant growth and yield.

Testing of product components:

In order to test the effectiveness of the components of a soil treatment each item should be tested separately. This would allow for statistical analysis of each of the components of a treatment and their interactions. Due to limited space, time, and funds this trial did not examine each component separately or the numerous combination of components possible. This trial examined the initial components recommended for these treatments. Amending soil with these products did not result in any significant differences ($P \leq 0.10$) for plant height, plant weight, yield, or nitrogen-fixing nodule formation of bush beans when compared with unamended soil.

Statistical Analysis:

There was no significant difference (≤10% level of Probability) for any of the treatments when comparing plant height, plant weight, number of beans or number of buds (Table 2 & 3). Thus no treatment was better than another even when compared with non-amended soil.

A significant difference for total plant dry weight and number of beans was shown for replication. This may have been due to the northern-most raised bed being more in the shade than the other two raised beds.

The addition of M-FF (Endo 900) in the Soil Secrets program was ineffective in increasing plant growth or yield. The percentage of mycorrhizal-forming fungi (M-FF) on the roots was not evaluated.

A second year needs to be conducted to eliminate any question as to the long term effectiveness or lack of effectiveness of the products examined in this trial. The use of these commercially available products with other vegetables needs to be examined. Non-legume vegetables need to be included in any future trials.

Support:

Southwest Soils, a Division of Pioneer Sand Co., Inc., provided raised beds, soil, and water and funded the soil tests. Gary Messano provided assistance in planting, maintaining and harvesting the plots.

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[i] C.E. Swift, CSU Extension Agent, Horticulture, G. Messano, CSU Master Gardener, C. Scroggs, General Manager, Southwest Soils.

[ii] Cultured humus, worm castings, rock dust, indigenous soil borne organisms, plus mycorrhizal spores. http://www.soilsecrets.com/terrapro.htm

[iii] Selected vegetable proteins with ideal amino acid profiles for soil microbes, fishmeal, crab meal, shrimp meal, and seaweed/kelp. http://www.soilsecrets.com/crumblies.htm

[iv] Yum Yum is a blend of organic and natural alfalfa meal, cottonseed meal, greensand, kelp meal, planters II, rock phosphate, humate and dry molasses. http://www.soilmender.com/products/yym.php

[v] Soil Mender Foliar Plus contains liquid fish, compost tea, humic acid, kelp, molasses, liquid seaweed, apple cider vinegar, chelated zinc & biostimulants.
http://www.soilmender.com/products/fertilizers/foliarplus.php

[vi] The inoculum specified was applied to the seed immediately prior to planting.

[vii] Note: Information on other nutrients examined is available from the senior author.

[viii] Guide to Fertilizer Recommendations in Colorado: Soil Analysis and Computer Process, CSU Publication.