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*Research Article*

# Soil Nutrient Availability, Plant Nutrient Uptake, and Wild Blueberry (*Vaccinium angustifolium* Ait.) Yield in Response to N-Viro Biosolids and Irrigation Applications

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We compared the impact of surface broadcasted N-Viro biosolids and inorganic fertilizer (16.5% Ammonium sulphate, 34.5% Diammonium phosphate, 4.5% Potash, and 44.5% s and/or clay filler) applications on soil properties and nutrients, leaf nutrient concentration, and the fruit yield of lowbush blueberry under irrigated and nonirrigated conditions during 2008-2009 at Debert, NS, Canada. Application rates of N-Viro biosolids were more than double of inorganic fertilizer applied at a recommended N rate of 32 kg $ha^{-1}$. The experimental treatments NI: N-Viro with irrigation, FI: inorganic fertilizer with irrigation, N: N-Viro without irrigation, and F: inorganic fertilizer without irrigation (control) were replicated four times under a randomized complete block design. The NI treatment had the highest OM (6.68%) followed by FI (6.32%), N (6.18%), and F (4.43%) treatments during the year 2008. Similar trends were observed during 2009 with the highest soil OM values (5.50%) for NI treatment. Supplemental irrigation resulted in a 21% increase in the ripe fruit yield. Nonsignificant effect of fertilizer treatments on most of the nutrient concentrations in soil and plant leaves, and on ripe fruits yield reflects that the performance of N-Viro was comparable with that of the inorganic fertilizer used in this study.

## 1. Introduction

Local authorities both overseas and in Canada are continually searching for environmentally acceptable and economically viable means of sewage sludge disposal. The Halifax Regional Municipality in Nova Scotia, Canada, has entered into a partnership with the N-Viro company to treat its biosolids for producing N-Viro biosolids that have been registered as a fertilizer under the Canada Fertilizer Act. The United States Environmental Protection Agency promotes the recycling of sludge material on some crop lands since it is an excellent source of several plant nutrients. The use of N-Viro biosolids as a fertilizer on agricultural lands provides essential plant nutrients while improving the physical and chemical soil properties and enhancing agricultural yield [1, 2].

Nutrients contained in the processed biosolids are slowly released, as those from organic manures, and are stored for a longer time in the soil, thereby ensuring a positive residual effect on plant root development and growth leading to higher crop yields [3, 4]. Literature reports that the release of nitrogen (N) from impregnated waste paper (biosolids) was found to be slow and steady [5]. The N-enriched cow dung used in maize production gave yield comparative inorganic fertilizer and increased the soil nutrient contents [6]. The application of commercially processed vermicomposts produced from food wastes, paper wastes, and cattle manure to soils increased their microbial biomass and dehydrogenase activity, in addition to increasing the yields of pepper growth and nutrient availability [7]. Application of biosolids to the dryland winter wheat is a feasible method of recycling plant nutrients [8].

Northeastern North America is the World's leading producer of wild blueberry with over 86,000 ha under management, producing 112 million kg of fruit valued at $470 million annually [9]. Blueberry fields are developed from native stands on deforested farmland by removing competing vegetation [10]. The crop is unique, as it is native to North America and has never been cultivated. Wild blueberries follow a two-year production cycle where one year produces vegetative growth, followed by a year in which bloom, pollination, and fruit growth and development occur. The majority of fields are situated in naturally acidic soils (pH range 4.5 to 5.5) that are low in nutrients and have high proportions of bare spots, weed patches, and gentle to severe topography [11]. Most of the soils in lowbush blueberry production in Canada are prone to wind, have very low nutrient and water storage capacities, and therefore, require constant application of nutrients and irrigation water.

Despite environmental management threats, in cases of less care, the application of nitrogenous manure with irrigation management can help minimize nutrient losses in vadose zone and improve crop production [12, 13]. The effect of N-Viro application on the soil properties, soil nutrient availability, plant nutrient uptake, and the fruit yield of the lowbush blueberry under irrigated and nonirrigated Nova Scotian conditions is unknown. This study was conducted to fill this knowledge gap in order to develop economically viable and environmentally accepted nutrient management strategies for the use of N-Viro biosolids in lowbush blueberry production in the Atlantic Canada.

## 2. Materials and Methods

*2.1. The Study Site.* This study was conducted at the field station of Nova Scotia Wild Blueberry Research Institute, Debert (45° 26′ N, 63° 28′ W), NS, Canada from the vegetative sprout year of 2008 (May 18) to the crop year of 2009 (August 15). The selected field had been under commercial management over the past decade and received biennial pruning by mowing for the past several years along with conventional fertilizer, weed, and disease management practices. The soil at the experimental site is classified as sandy loam (Orthic Humo-Ferric Podzols), which is a well-drained acidic soil. These strongly acidic soils, known as "Truro 52", are of the Hebert association and are mostly found in the Colchester County of Nova Scotia [14].

*2.2. Experimental Design and Treatments.* A lowbush blueberry field of 0.12 ha was divided into 16 plots of equal size (9 m × 3 m). There was a 3 m buffer strip around and between the 8 irrigated and the 8 nonirrigated plots. The irrigated plots were separated from the nonirrigated plots in order to minimize moisture movement from one treatment to the other. The following 4 experimental treatments were replicated 4 times under randomized complete block design (RCBD):

(i) NI; N-Viro with irrigation,

(ii) FI; inorganic fertilizer with irrigation,

(iii) N; N-Viro without irrigation, and

(iv) F; inorganic fertilizer without irrigation (control).

Table 1: Chemical composition of N-Viro biosolids on dry weight basis.

| Components | Value ($\times 10^3$), mg kg$^{-1}$ |
|---|---|
| Total nitrogen (N) | 8 |
| Water insoluble nitrogen (WIN) | 5 |
| Available phosphoric acid ($P_2O_5$) | 10 |
| Soluble potash ($K_2O$) | 5 |
| Calcium (Ca) | 100 |
| Organic matter | 200 |
| Neutralizing value ($CaCO_3$ equivalency) | 250 |
| Maximum moisture content | 38% |
| Fineness passing # 10 mesh Tyler screen | 65% |
| Fineness passing # 100 mesh Tyler screen | 40% |

*2.3. Application of N-Viro Biosolids and Inorganic Fertilizer.* The N-Viro biosolids used in this study were a product of sludge prepared through chemical and thermal treatments and contained 0.8% of available N and a range of macro- and micronutrients (Table 1). These biosolids were the residual solids left over after the treatment of municipal wastewater. They include organic matter and inorganic compounds from the sewage itself and those produced in the treatment process. The biosolids can be in either liquid or solid form, depending on the treatment process. In this case, the mixing, drying, and pasteurizing of municipal sewage sludge produced a solid granular material, that is, N-Viro biosolids for use as liming material nutrient sources in agricultural soils. Detailed procedure of N-Viro preparation is available at http://www.n-viro.ca/nviro/process-overview.

The N-Viro biosolids were applied to the plots by surface broadcast method at beginning of every year. Initial soil nutrient contents were determined from the soil samples collected prior to the fertilizer application. Representative N-Viro samples were sent for chemical analysis to the Quality Evaluation Division Laboratory, Nova Scotia Department of Agriculture, Truro, NS, which uses the combustion method [15], for total N and the Mehlich-3 soil extraction method [16], to extract the rest of the reported nutrients from soil solutions. Nutrient extraction from N-Viro samples is achieved by using the wet digestion procedure [17] and concentrated nitric acid ($HNO_3$). Nutrient concentrations of the samples were assessed by inductively coupled plasma emission spectroscopy (ICP OES) using the Atom Scan 16 (Thermo-Jarrell Ash, Franklin, Mass, USA) with appropriate standard curves.

The inorganic fertilizer comprised Ammonium sulphate (16.5%), Diammonium phosphate (34.5%), Potash (4.5%), and sand and/or clay filler (44.5%). The inorganic fertilizer was also surface broadcasted at the recommended N rate of 32 kg ha$^{-1}$ at beginning of every year. Application rate of N-Viro biosolids was more than double of inorganic fertilizer. The inorganic fertilizer and the N-Viro biosolids used in this study were supplied by the Truro Agromart Ltd. (547 Onslow Road, Truro NS B2N 5G7 Canada; http://www.truroagromart.ca/).

*2.4. Soil Sampling and Analysis.* Bulk and intact soil core samples were collected from the top 20 cm soil layer prior to the start of experiment and during both years of the study. The bulk soil samples were used to determine soil textural class using hydrometer method [18], for sand, silt, and clay content. These soil samples were also analyzed for macro- and micronutrients by the Quality Evaluation Division Laboratory, Nova Scotia Department of Agriculture, Truro, NS. The macronutrients included N, Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Sodium (Na), and Sulphur (S). The micronutrients included Boron (B), Iron (Fe), Manganese (Mn), Copper (Cu), and Zinc (Zn). The Laboratory follows protocols of the combustion method [15], for total N and the Mehlich-3 soil extraction method [16], to extract the above macro- and micronutrients from soil solutions using the wet digestion procedure [17], and concentrated nitric acid ($HNO_3$). Nutrient concentrations of the samples are assessed by ICP OES using the Atom Scan 16 (Thermo-Jarrell Ash, Franklin, Mass, USA) with appropriate standard curves.

The soil intact core samples collected with a soil sampler (Soilmoisture Equipment Corp., Santa Barbara, Calif) were used to determine soil bulk density ($\rho_b$) using the standard procedure [19], that involves oven-dry (at 110°C for 24–48 h) soil mass ($M$) and volume ($V$) of the intact cores as

$$\rho_b = \frac{M}{V}. \tag{1}$$

In the third week of July 2008 and 2009, the bulk soil samples were again collected and analyzed to determine the availability of soil macro- and micronutrients for plant uptake. These samples were different from those used for oven-drying.

*2.5. Plant Leaf Sampling and Analysis.* Concurrent with soil sampling, plant leaves were also randomly sampled [20], from each treatment plot in order to determine the plant leaf nutrient uptake. The plots were divided into sampling areas avoiding low spots, trouble spots, and areas with obvious differences in the plant health. The leaves were collected by hand from 20 random blueberry stems at four to six locations zigzagged within each grid. The dusty leaves or those having soil on them were rinsed with distilled water and dried. To complete the drying process the leaves were placed in the oven at 65°C for 8–10 h [11]. The leaf samples were analyzed by the Quality Evaluation Division Laboratory, Nova Scotia Department of Agriculture, Truro, NS, for macro- and micronutrients listed in the soil analysis section using standard methods [15–17].

*2.6. Supplemental Irrigation and Weather Information.* Initial baseline soil water characteristics were established prior to the supplemental irrigation application. The values of wilting point (WP) and field capacity (FC) were determined for the soil of the study site by constructing a soil water release curve. A line-source sprinkler irrigation system was used for supplemental irrigation to the plots in irrigation treatment as the soil moisture reached WP conditions. For first year, irrigation was applied on July 11 and August 1, 2008. For second year, irrigation was applied on June 5, June 18, July 20, and August 6, 2009. The soil water contents were monitored at 20 cm soil depth in each plot with a time domain reflectometry (TDR) probes. The plots were irrigated to FC conditions. Quantity of supplemental irrigation was precisely recorded with flow meters. The Environment Canada website, that is, http://www.weatheroffice.gc.ca/canada_e.html was accessed to download daily rainfall and temperature data for Debert, NS.

The crop year 2009 (1,147 mm year$^{-1}$) was drier than the sprout year 2008 (1,414 mm year$^{-1}$). The mean minimum and maximum temperatures in the year 2009 were −23.8 and 26.2°C on January 26, 2009 and August 08, 2009, respectively. Because of more precipitation received during the year 2008, comparatively less extreme temperatures were recorded during this year. The mean, minimum and maximum temperatures in the year 2008 were −19.3 and 22.8°C on January 21, 2008 and July 24, 2008, respectively.

Comparatively wetter conditions during sprout year (2008) did not require substantial supplemental irrigation. A total of 189 L of supplemental irrigation was provided to the irrigated plots on July 11, 2008 (115 L) and on August 01, 2008 (74 L), respectively, that amounted to 0.87 mm irrigation per plot during the whole sprout year. On the other hand, the overall lower precipitation and comparatively warmer summer during 2009 demanded frequent supplemental irrigations. Four supplemental irrigations were applied on June 05, June 18, July 20, and August 06 in 2009 that resulted in the application of 149 mm of the supplemental irrigation per plot during the whole fruit year (2009). The supplemental irrigation increased the soil water contents in the irrigated plots.

*2.7. Fruit Yield.* Fruit yield was harvested between August 10 and 25, 2009. The berries were collected from a randomly selected 1 m$^2$ area in each experimental plot using hand rakes. The berries were then separated and weighed into unripe and ripe fruit. It is not usual to report the yield of unripe berries. However, we calculated and have reported the yield for both ripe and unripe berries.

## 3. Statistical Analysis

Analysis of variance (ANOVA) for macro- and micronutrients in soil and plant leaves and fruit yield was performed using statistical software package [21]. Factorial RCBD was considered for constructing ANOVA. Irrigation and fertilizer were the two factors. The macro- and micronutrients in soil, plant leaves and the fruit yield were the dependent variables. When ANOVA indicated a significant effect of any factor or their interaction(s), the treatment means were separated using Tukey's mean separation test. Tukey's mean separation was shown by homogenous group letters, that is, the mean value with letter "a" is significantly different (and large) from

Table 2: Initial physical, hydrological, and chemical properties of the soil at the field station of Nova Scotia Wild Blueberry Research Institute, Debert, NS, Canada.

| Parameter | Value |
|---|---|
| Physical properties | |
| Sand | 72% |
| Silt | 22% |
| Clay | 6% |
| Bulk density | $1.27\ g\,cm^{-3}$ |
| Hydrological properties | |
| Field capacity | $0.22\ cm^3\,cm^{-3}$ |
| Wilting point | $0.09\ cm^3\,cm^{-3}$ |
| Chemical properties | |
| pH | 5.0 |
| Cation exchange capacity | $8.5\ meq\,(100\,g)^{-1}$ |
| N | $0.0\ mg\,kg^{-1}$ |
| $P_2O_5$ | $27\ mg\,kg^{-1}$ |
| $K_2O$ | $44\ mg\,kg^{-1}$ |
| Ca | $98 \times 10^3\ mg\,kg^{-1}$ |
| Mg | $22 \times 10^3\ mg\,kg^{-1}$ |
| Na | $7 \times 10^3\ mg\,kg^{-1}$ |
| S | $25\ mg\,kg^{-1}$ |
| B | $0.11\ mg\,kg^{-1}$ |
| Fe | $186\ mg\,kg^{-1}$ |
| Mn | $19.5\ mg\,kg^{-1}$ |
| Cu | $0.22\ mg\,kg^{-1}$ |
| Zn | $2.4\ mg\,kg^{-1}$ |

those represented by letters other than "a" and not different from those represented with same letter or its combination with any other letter(s), for example, "ab or ac".

## 4. Results and Discussion

*4.1. Soil Properties.* According to the soil analyses results, the soil of the experimental site is sandy loam comprising 70% sand and 6% clay. The soil is neutral with average CEC and low concentrations of macro- and micronutrients (Table 2).

Irrigation treatment effected CEC during 2008 period. The studied soil properties including organic matter (OM) and pH remained unaffected during 2008, and OM, CEC, and pH were unaffected during 2009. Mean values of the soil OM were 5.90 and 4.76% during 2008 and 2009, respectively. This, approximately 20%, decrease in soil OM over the period of two years resulted in the release of nutrients from N-Viro biosolids due to their slow breakdown. However, there was an increasing trend in the soil OM content with irrigation and N-Viro treatments. The NI treatment had the highest OM (6.68%) followed by FI (6.32%), N (6.18%), and F (4.43%) treatments during the year 2008. Similar trends were observed during the year 2009 with the highest soil OM values (5.50%) for the NI treatment (Table 3).

The irrigation treatment improved ($P < .05$) CEC of the soil. In general, the soil CEC values increased from 8.31 in 2008 to $9.51\ meq\,(100\,g)^{-1}$ in 2009. There was a trend for greater CEC to occur in plots treated with irrigation and N-Viro, compared to that in soils managed without irrigation and/or with inorganic fertilizer (Table 3). The NI treatment resulted in the highest CEC during the two years that is, $9.50\ meq\,(100\,g)^{-1}$ in 2008 and $10.7\ meq\,(100\,g)^{-1}$ in 2009, among all the treatments. Comparatively higher CEC values for the irrigated N-Viro plots indicate a considerable improvement in nutrient exchange capacity of the soils in presence of larger soil water contents and organic biosolids.

Table 3: Means separation for the values of soil organic matter (OM), cation exchange capacity (CEC), and pH.

| Nutrients | Year | NI[a] | FI[b] | N[c] | F[d] |
|---|---|---|---|---|---|
| OM (%) | | 6.68a | 6.32a | 6.18a | 4.43a |
| CEC (meq/100 g) | 2008 | 9.50a | 7.75a | 8.75a | 7.25a |
| pH | | 4.98a | 5.05a | 4.95a | 4.93a |
| OM (%) | | 5.50a | 4.30a | 4.40a | 4.83a |
| CEC (meq/100 g) | 2009 | 10.7a | 8.83a | 9.50a | 9.35a |
| pH | | 4.95a | 4.85a | 4.83a | 4.75a |

[a] N-Viro with irrigation; [b] Commercial fertilizer with irrigation; [c] N-Viro without irrigation; [d] Commercial fertilizer without irrigation. [d] Tukey's LSD letters mean differences in mean values within a row.

A decreased soil pH was recorded in 2009 from 2008 for all treatments and their interactions. The wild blueberries are distinct among fruit crops in their soil and fertility requirements as they require an acidic (low pH) soil. Iron chlorosis results if soil pH is appreciably higher than 5.5, whereas, when soil pH drops below 4.8, the possibility of Mn toxicity arises. In either case, plants do not perform well [22]. In case of iron chlorosis the plants cannot uptake enough iron through their roots. Overall, there was a decreasing trend in the soil pH from 2008 to 2009. These results are in agreement with the findings of Eaton et al. [20] who collected soil and leaf samples from 44 lowbush blueberry fields throughout Nova Scotia in 1989-90 and in 1997-98 and reported that the soil pH was decreased by repeated fertilizer applications between the two sample periods.

*4.2. Macro- and Micronutrients in Soil.* There was no effect of irrigation or fertilizer treatments on any of the macronutrients in the soil samples collected during 2008. In the same year, however, Cu was affected ($P < .05$) by irrigation. During 2009, Ca availability in soil was also ($P < .01$) affected by irrigation and fertilizer treatments and by their interaction. The interaction of irrigation and fertilizer was also significant ($P < .05$) on P and Mg presence in soil during 2009. The soil N did not differ significantly among the treatments.

The Tukey's mean separation test showed that the mean values of N, P, K, Ca, Na, and S during 2008, and all the macronutrients except Ca during 2009, for the all treatments were not different from one another. During 2009, irrigation ($393\ mg\,kg^{-1}$) and N-Viro ($390\ mg\,kg^{-1}$) resulted in greater presence of Ca in soil than in nonirrigated ($120\ mg\,kg^{-1}$) and inorganic fertilizer ($123\ mg\,kg^{-1}$) plots. Among the individual treatments the mean values of Ca in soil were the greatest in NI (648 mg $kg^{-1}$) followed by FI (138 mg $kg^{-1}$), N (132 mg $kg^{-1}$), and F (108 mg $kg^{-1}$) treatments.

*4.3. Leaf Nutrient Concentration.* Analysis of variance for leaf nutrient concentration of macronutrients, during 2008 season, showed that there was an effect ($P < .01$) of irrigation treatments on Mg concentration in plant leaves. Fertilizer treatment and the interaction between irrigation and fertilizer had a highly significant ($P < .01$) effect on P concentration in plant leaves, while during 2009 there was an effect of the irrigation treatment on N ($P < .01$) and Ca ($P < .05$) concentrations; however, there was no effect for fertilizer treatment and the interaction between the two factors. For concentration of micronutrients in plant leaves during 2008, there was an effect of irrigation on Mn and Zn ($P < .01$) and on Cu ($P < .05$) concentrations. Fertilizer treatment also affected Cu ($P < .01$) and B concentrations in plant leaves. During 2009, the fertilizer treatment affected ($P < .01$) Fe and Zn concentrations in plant leaves.

Results of Tukey's mean separation test for macronutrient show that, during 2008, the Mg concentration in plant leaves was higher under irrigation (0.180 mg $kg^{-1}$) compared to no irrigation treatment (0.146 mg $kg^{-1}$). Higher Mg concentration was possibly due to the plant method of nutrient uptake, that is, water uptake from soil [23]. Phosphorus concentration was higher under N-Viro treatments (0.131 mg $kg^{-1}$) than in inorganic fertilizer treatments (0.118 mg $kg^{-1}$). Phosphorus concentration under NI treatment appears to have had the highest mean value (0.138 mg $kg^{-1}$) compared to other interactions. Similarly, NI treatment had the highest mean values for Mg (193 mg $kg^{-1}$) concentration in plant leaves. During 2009, N and Ca concentrations in plant leaves were higher in irrigated plots compared to nonirrigated plots; mean values were 1655 and 1568 mg $kg^{-1}$ for N and 0.628 and 0.567 mg $kg^{-1}$ for Ca, respectively. Phosphorus was higher under N-Viro treatment compared to inorganic fertilizer treatment; mean values were 0.113 and 0.108 mg $kg^{-1}$, respectively.

For micronutrients, during 2008, the mean values of Mn, and Zn were higher with irrigation compared to without irrigation treatments; their mean values were 2598 and 1990 mg $kg^{-1}$, and 16.8 and 14.6 mg $kg^{-1}$, respectively. Boron under N-Viro treatment (26.3 mg $kg^{-1}$) was higher than fertilizer treatment (24.3 mg $kg^{-1}$). The NI gave the highest mean values for plant leaf Mn and it was statistically different from the other three treatments. The N-Viro with irrigation treatment gave highest mean for plant leaf Zn, and it was statistically different and larger from FI and F treatments and not different from N treatment. The mean values of Zn uptake were higher in irrigated plots (16.8 mg $kg^{-1}$) than in nonirrigated plots (14.6 mg $kg^{-1}$). The NI treatment resulted in higher and larger uptakes of Zn (17.4 mg $kg^{-1}$) than the rest of the treatments.

During 2009, the Fe uptake under irrigation treatment was higher (47.8 mg $kg^{-1}$) than that without irrigation (40.2 mg $kg^{-1}$). A similar trend was shown by Zn uptake as it was higher under irrigation treatments (14.7 mg $kg^{-1}$) compared to without irrigation treatments (13.2 mg $kg^{-1}$). That might be related to the fact that most plant nutrient uptake occurs with water uptake through the roots in soil [23]. Interactions between irrigation and fertilizer treatments on micronutrient concentration in plant leaves were significant for all the micronutrients except for Cu. The highest mean values were under NI, 17.4, 21.5, 1572, and 15.4 mg $kg^{-1}$ for B, Fe, Mn, and Zn, respectively. Our results agreed with the findings of previous studies [20, 24–27].

*4.4. Fruit Yield.* Supplemental irrigation resulted in a 21% increase in the ripe fruit yield from nonirrigated (2620 kg $ha^{-1}$) and irrigated (3320 kg $ha^{-1}$). Our results are in agreement with the findings of Seymour et al. [12] who studied the effect of irrigation on lowbush blueberry crop yield and quality near the coast of Maine; they reported that the irrigated plots averaged 43% higher yield than rain fed plots for the 2000-2001 production cycle. There was an effect ($P < .05$) of irrigation on the yield of unripe fruits also; however, the Tukey's mean separation test did not result in separation of mean values of either ripe or unripe berries' yield for different treatment. These results show that the application of N-Viro biosolids resulted in fruit yield comparable to that from inorganic fertilizer application.

Based on the quotation from the nutrient sources supplier for this experiment, Truro Agromart Ltd. (547 Onslow Road, Truro NS B2N 5G7 Canada; http://www.truroagromart.ca/), the N-Viro and the inorganic fertilizer cost \$116 and \$280 CAD, respectively, per hectare. This results in approximately 2.5 times economical availability of N-Viro than the commercial inorganic fertilizer. We concluded that the increasing prices of inorganic fertilizers would compel farmers to use economically available N-Viro that, coupled with supplemental irrigation, performed better than the inorganic fertilizer regarding improved soil properties, soil nutrient availability, plant nutrient uptake, and the lowbush blueberry yield during this study.

## 5. Summary and Conclusions

Since the processed biosolids (N-Viro) are rich in organic matter and plant nutrients, they should supply the required nutrient to plants as do the commercially available inorganic fertilizers. This study investigated the impact of N-Viro biosolids application on soil properties, soil nutrient availability, leaf nutrient concentration, and the fruit yield of lowbush blueberry (*Vaccinium angustifolium* Ait.) grown under irrigated and nonirrigated conditions during 2008 and 2009 at the Wild Blueberry Research Institute, Debert, NS, Canada. Four treatments, that is, N-Viro with irrigation (NI), inorganic fertilizer with irrigation (FI), N-Viro without irrigation (N), and inorganic fertilizer without irrigation (F) were replicated four times under randomized complete block design. Soil samples, collected from the top 20 cm soil layer, and the plant leaf samples were analyzed for concentration of macro- and micronutrients in soil and plant leaves, respectively.

We have discussed our findings on the impact of (1) N-Viro biosolids and (2) supplemental irrigation on the availability of (A) macro- and (B) micronutrients, plant nutrient concentration, and the fruit yield of lowbush blueberry.

Results showed that the soil pH decreased over time in all the treatments in the range of 4.93 (2008) and 4.79 (2009). Largest amount of soil organic matter was recorded for NI treatment (6.68%) followed by FI (6.32%), N (6.18%), and F (4.43%) treatments during the year 2008. During the subsequent year (2009), a similar trend was observed when soil organic matter was highest for NI treatments (5.50%).

Presence of soil moisture coupled with organic decomposition of N-Viro resulted in more availability of soil macronutrients for plant uptake. Higher plant leaf nutrient uptake was recorded in irrigated plots than in nonirrigated plots. Irrigation or fertilizer did not significantly ($P > .05$) affect the ripe fruit yield; however, irrigation had significant ($P < .05$) effect on the yield of unripe fruits. A 21% increase in the ripe fruit yield was recorded for irrigated treatments ($3320\,\mathrm{kg\,ha^{-1}}$) in comparison with yield from nonirrigated treatments ($2620\,\mathrm{kg\,ha^{-1}}$). Best nutrient management practices may include the use of economically viable organic N-Viro to substitute the expensive and potentially hazardous commercial fertilizers.

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