BC Agricultural Climate Adaptation Research Network

Summary of Research on Management Practices for Climate Change Mitigation

Berries

SCOPE

This document is a high-level overview of recent, primarily BC-based, published research and research in progress investigating management practices with potential to mitigate climate change. Many practices are in early stages of evaluation for their impacts to carbon (C) sequestration and/or greenhouse gas emissions (primarily N_2O), and/or have not been trialled in the BC context. Therefore, the objective of this research summary is to provide a brief overview of what research has been done, where it took place, and a short description of key methods and results. This review does not include an exhaustive inventory of relevant research outside of BC. It is intended to provide an introduction to past research and research in progress.

OVERVIEW

The amount of land under berry production in BC is over 11,600 ha. The vast majority of that area is under blueberry production (90%). Other berry crops include cranberries, raspberries, strawberries, and blackberries. Nearly all commercial berry production in BC is in the Fraser Valley, and all BC-based BMP research to-date has occurred in the South Coast region. Relevant management practices are listed in Table 1.

TABLE 1: MANAGEMENT PRACTICE DESCRIPTIONS and MITIGATION POTENTIAL

Management Practice Area	Description and Potential for Climate Change Mitigation
Organic amendments	Compost, mulch, etc., applied in the crop row, intended to increase soil C and reduce N_2O emissions.
Nitrogen management	Type, rate, timing, and placement of nitrogen in crop rows to decrease N_2O emissions; impacts to soil C are variable.
Cover cropping	Cover crops are typically grown in alleyways and, less frequently, as alternative mulch in crop rows. Can be native vegetation or sown, permanent or annual, and grown in production and/or non-production seasons. Intended to increase soil C, with variable impacts to soil N_2O emissions.
Biochar	Applied to crop rows and/or alleyways, and is intended to increase soil C and decrease N_2O emissions.
Pruning residues	Mulching pruning residues and returning them to the soil is intended to increase soil C and moderate soil temperature as well as preserve soil moisture.
Irrigation	Type (drip, sprinkler), frequency, and volume of irrigation can impact N_2O emissions and soil C.
Drainage	Installing drainage (and pumps) to reduce soil moisture content can reduce N_2O

improvements	emissions but with impacts to soil C.

RESEARCH SUMMARY: HIGHLIGHTS and GAPS

RESEARCH HIGHLIGHTS

Nitrogen management

- **N fertigation** reduced N_2O emissions compared to broadcast application when new sawdust was applied, but not when used with old sawdust; no differences in yield were found between the two treatments.
- **New sawdust mulch** increased cumulative CO_2 emissions (largely CO_2 and CH_4), but only in the first year after application; no differences in yield was found between the treatments.
- **N fertigation** increased NO_3^- in leachate compared to broadcast application, and increasing N application rates (1.5x and 2x recommended) reduced yields in mature raspberry plants.
- High **N application rates** (1.5x and 2x recommended) increased blueberry yields for three years during plant establishment, but reduced yields during plant maturity.

Drainage

- **Drains plus pumps** in blueberry fields reduced the number of days of ponding compared to fields without drains; the drains-only treatment had numerically, but not statistically significant, lower ponding days than no drains, and numerically, but not statistically significant, higher ponding days than drains plus pumps.

Organic amendments

- **New sawdust mulch** increased cumulative CO_2 emissions (largely CO_2 and CH_4), but only in the first year after application; no differences were found in yield between the treatments.

Cover Crop, Biochar, Irrigation, and Pruning Residues

- No research available

RESEARCH GAPS

- A relatively small amount of research has taken place in BC
- The research conducted to date has largely been limited to research stations, and many studies have been short (2 to 3 years duration)
- There has been no research for strawberry or blackberries, although the area under production for these crops is much smaller than blueberries in BC
- Specifics areas of research that merit further study include:
    - Drainage, which is likely to provide multiple benefits (i.e. climate change adaptation), and while there is some research forthcoming regarding impacts to N_2O emissions and soil C, further research will be beneficial in different soils and berry types
    - Cover crops, biochar, and pruning residue management are practices that would benefit from evaluation

RESEARCH RECOMMENDATIONS

Priorities for future studies include:

- Establishment of 1 or 2 long-term (5-10 years) field experiments with 1 to 3 important management practices (e.g., fertilization or drainage) using several measurement methods with the focus on changes in soil organic carbon (SOC) and non-CO2 GHG fluxes and crop yields.

- Using multiple measurement methods will improve confidence in estimates of the net GHG balance (NGHGB). Continuous autochamber measurements can help develop sound gap filling algorithms for measurements using manual chambers. At the field scale, eddy covariance measurements can provide NGHGB estimates at seasonal and annual scales.

- Replications of treatments and measurements at different sites, over multiple years, specifically for:
    - Mulch impacts on N_2O emissions and soil C
    - Nitrogen management (including nitrification inhibitors) on N_2O emissions

- Evaluation of biochar, irrigation and pruning residue managements in multiple sites after completing small trials for the initial evaluation of the most promising practices

TABLE 2: RESEARCH HIGHLIGHTS

Management Practice Area	Research Highlights [c]	Research Limitations

Nitrogen management
 	
[SC, 3, 1*] [a]
	• UBC Farm, blueberries (organic) – 2 yrs [B1]
	  ○ **N fertigation (bloodmeal)** only reduced N_2O emission (compared to broadcast application) when new sawdust was applied, but not when used with old sawdust
	  ○ No differences in yield between treatments
	• Agassiz research station, blueberry – 3 yrs [B3]
	  ○ Soil C and emissions were not measured, but **fertigated N** increased NO_3^- in leachate compared to broadcast application; increasing N application rates (1.5x and 2x recommended) reduced yields for mature plants
	• Agassiz research station, blueberry – 6yrs [B4]
	  ○ High N application rates (1.5x and 2x recommended) increased yields for three years during plant establishment, but reduced yields during plant maturity
	
	Research in Progress:
	• * Agassiz research station, raspberry – (2017 to ongoing)
	  ○ Five **alleyway cover crop** treatments (rye, red clover, rye + red clover, red clover + mustard, rye + red clover + radish), combined with five **N application rates** (zero to 2x recommended)
	  ○ Measuring: total C and N, aggregate stability, N leaching, microbial biomass C and N, available N, raspberry yields and quality
		• Limited published BC data
		
		• Lacking studies that measure yield, soil C, and N_2O emissions together
		
		• Nitrification inhibitors not evaluated

Cover cropping
 	
[SC, 1*] [a]
	Research in Progress:
	• * Agassiz research station, raspberry – (2017 to ongoing)
	  ○ Five **alleyway cover crop** treatments (rye, red clover, rye + red clover, red clover + mustard, rye + red clover + radish), combined with five **N application rates** (zero to 2x recommended)
	  ○ Measuring: total C and N, aggregate stability, N leaching, microbial biomass C and N, available N, raspberry yield and quality
		• Limited published BC data
		• Lacking studies that measure yield, soil C, and N2O emissions together

Drainage
 	
[SC, 2, 1*]
	• Delta, 11 commercial farm sites, blueberry, 2 yrs [B5]
	  ○ Soil C and emissions were not measured, but **drains plus pumps** reduced number of days of ponding compared to fields without drains; the drains-only treatment had numerically but not statistically lower ponding days than no drains, and numerically but not statistically higher ponding days than drains plus pumps
	• Delta, commercial farm, blueberry – 1 yr [B2]
	  ○ High fertility, **poorly drained** fields and moderately well-drained with sub-surface drainage @ 45cm depth
		• Research limited to blueberry fields in Delta

	○ Application of 5cm of sawdust added every 3 years and ammonium sulphate fertilizer @ 110 kg N/ha in four split applications ○ Measured: Net ecosystem production, Gross primary production, Ecosystem respiration, NO2 fluxes, CH4 fluxes, Climate (atmosphere and soil), Leaf Area Index (LAI). Data are available in the Biomet database. ● *Delta, 9 commercial farm sites, blueberry – 3yrs ○ Comparing **well drained** fields to poorly drained fields ○ Measuring: total C, emissions (N_2O, CH_4, and CO_2), and yield	
Organic amendments [1]	● UBC Farm, blueberries (organic) – 2 yrs [B1] ○ **New sawdust mulch** increased cumulative CO_2 emissions, but only in the first year after application ○ No differences in yield between treatments	● Limited data
Irrigation [0]	● No known, published BC data	● Lacking BC data
Pruning residues [0]	● No known, published BC data	● Lacking BC data

[a] [Agricultural region [b], number of studies in the region]
[b] BC Agricultural Regions: Vancouver Island/Coast (VC), South Coast (SC), Cariboo Chilcotin Coast (CC), Thompson Nicola (TN), Okanagan (OK), Kootenay (KT), Omenica Skeena (OS), and Peace (PC)
[c] References include both peer-reviewed publications and Master's theses and can be found in the published research and research in progress spreadsheets
* Research with an asterisk (*) is in progress or manuscripts in prep

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