BC FoodWeb

Peer-reviewed research

RESEARCH SUMMARY

Production Type
- Wine grape

Practice Benefit(s)
- Improved nutrient management
- Improved soil health

Research Location
- Summerland, B.C.

Cover crops for irrigated vineyards in B.C.: A look at nitrogen and carbon benefits

Researchers: M. Sharifi, K. Salimi, D. Rosa, and M. Hart.

KEY TAKEAWAYS

- Of the 23 cover crop species we tested for use in vineyards, **legumes were generally the best for adding carbon (C) and nitrogen (N) to the soil**. Specifically, Ladino white clover, Dutch white clover, and clover blend (mix of clover species) produced the most biomass and had the highest C and N content.
- Cover crop species that don't add as much C or N to the soil **can still be useful in situations with limited water or nutrients** (or in restoration projects) because they need less water and nutrients and are less likely to compete with grapevines.

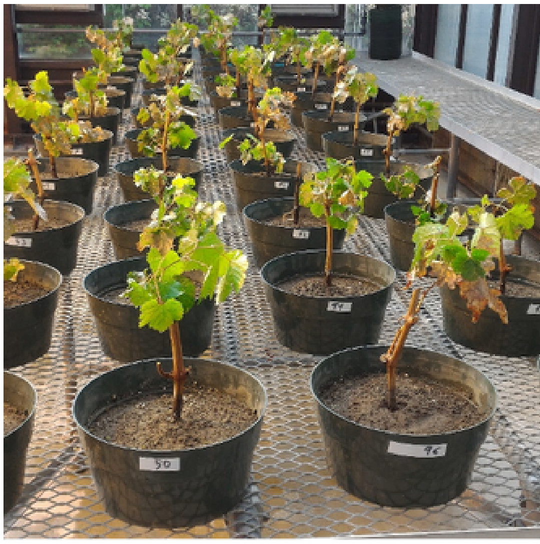

Figure 1. Merlot cuttings growing in soil mixed with milled cover crops. Photo by Daniel Rosa.

HOW CAN THIS RESEARCH BE USED?

- Wine grape growers can use these results to choose cover crops that **align with their specific goals**, such as increasing N for grapevines or increasing soil carbon, while also considering field-specific conditions, like soil fertility and water availability.
- **It is important to note that the right cover crop will vary depending on each grower's goals and environmental conditions.**

WHY WAS THIS RESEARCH DONE?

We studied the potential of 23 plant species to increase soil N and C as cover crops in semi-arid irrigated vineyards. This study is the first part of a larger, multi-phase project that is exploring how cover crop use can help improve vineyard productivity and sustainability over the long term.

A well-chosen cover crop can offer many benefits, such as controlling weeds, adding C and N to the soil, and improving soil structure and biodiversity. However, the choice of plant species is critical to a cover crop's usefulness. An inappropriate choice can lead to undesirable outcomes, such as competing with grapevines for water and nutrients, or attracting pests, which can reduce fruit quality and yield.

This study included two experiments. First, we grew cover crops and measured their biomass, N and C concentration, and calculated total N and C content in their biomass. Then we milled the cover crop biomass and mixed them back into the soil and grew grapevines to see how each cover crop affected initial grapevine growth and N and C uptake.

WHAT WAS THE OUTCOME?

Carbon and nitrogen contributions to the soil

To describe each cover crop's suitability for different uses in the field, we grouped them into four categories based on their biomass and total N content (Table 1). Because plant tissues contain a lot of C, cover crops with more biomass can add more C to the soil.

Table 1. 23 vineyard cover crop species grouped by relative biomass, total N content, and recommended use. Total N content is calculated by multiplying cover crop N concentration and biomass (dry weight).

	Group 1	**Group 2**	**Group 3**	**Group 4**
Biomass (includes roots)	High	High	Moderate	Low
Total nitrogen content	High	Moderate	Moderate	Low
Cover crop species	Ladino white clover, Dutch white clover, clover blend	Fall rye, winter peas, alsike clover, Winfred brassica	Birdsfoot trefoil, flame crimson clover, common vetch, buckwheat, Morton winter lentil, tall fescue, pubescent wheatgrass, perennial ryegrass	Fairway crested wheatgrass, red fescue, buffalo grass, white mustard, common yarrow, spring lentil
Recommended use	Under-vine and alleyways (recommend blending with grasses in alleyways)	Alleyways	Under-vine	Vineyard restoration or conservation projects

Generally, legumes produced more biomass and had higher N concentration and total N content in their above-ground biomass compared to grasses and forbs (a flowering plant that is not woody and not grass) (Table 2). Legumes perform biological N fixation, which means that they can convert N from the air into a form that plants can use, through beneficial bacteria that live in their roots. We found that most (83-90%) of the total N in the legume species came from biological N fixation, while the rest came from existing N in the soil.

The N concentration and carbon-to-nitrogen (C:N) ratio values have an inverse (opposite) relationship, meaning that cover crop species with high N concentration have a lower C:N ratio (Table 2).

Table 2. Approximate seeding rate, N concentration, and C:N ratio of the above-ground biomass of 23 vineyard cover crop species, ordered from highest N concentration to lowest. Seeding rates were calculated based on the weight of 1,000 seeds and an assumed 70% germination rate. The biomass of Indian ricegrass and sheep fescue were too low to analyze C and N content.

Plant species	Approximate seeding rate (kg/ha)	Shoot total N concentration (%)	Shoot C:N ratio
Clover blend	3.0	3.0	13
Alsike clover	1.7	2.9	14
Winter peas	70.8	2.8	15
Ladino white clover	7.1	2.7	14
Dutch white clover	2.5	2.6	15
Common vetch	25.8	2.5	17
Flame crimson clover	9.2	2.4	16
Birdsfoot trefoil	4.9	2.2	19
Spring lentil	21.2	2.0	20
Morton winter lentil	21.2	2.0	21
Common yarrow	1.3	1.9	19
Perennial ryegrass	17.3	1.9	18
Red fescue	7.3	1.8	20
Fairway C. wheatgrass	13.5	1.7	25
White mustard	6.7	1.5	27
Pubescent wheatgrass	12.7	1.4	28
Buffalo grass	7.8	1.4	29
Tall fescue	15.0	1.2	33
Fall rye	59.1	1.0	41
Buckwheat	27.8	0.9	45
Winfred brassica	6.4	0.9	47
Indian ricegrass	1.4	N/A	N/A
Sheep fescue	2.6	N/A	N/A

Legume

Forb

Grass

Group 1 species, consisting of Ladino white clover, Dutch white clover, and clover blend (mix of clover species), produced the most biomass (and therefore the highest total C content) and had the highest total N content (Table 1). This means that Group 1 cover crops can be an excellent source of N for grapevines and are ideal for both under-vine and in alleyways where they can enrich the soil with C and N as they decompose. In alleyways, we recommend mixing Group 1 species with grasses. The legumes will provide N to the grass and their combined biomass will be higher than either group alone.

Group 2 species have high biomass (and therefore high total C content) but less total N content than Group 1 (Group 2 species listed in Table 1). They can supply high amounts of C and moderate amounts of N to the soil, making them suitable for alleyways. They are less suitable for under-vines as they may compete with grapevines for N.

Group 3 species have moderate biomass and total N content. This group consists of a mix of grasses, legumes, and forbs (Group 3 species listed in Table 1). Group 3 species are ideal for resource-limited environments because they have low nutrient and water requirements and are less likely to compete with grapevines for resources.

Group 4 species have low biomass (and therefore low total C content) and low total N content. This group mainly consists of grasses, a few forbs, and one legume (Group 4 species listed in Table 1). Although they contribute less C and N to the soil compared to the other groups, they can still be beneficial in situations such as conservation and restoration projects, where the goal is to establish vegetation with limited resources (such as nutrients and water).

Impacts on grapevine growth

Overall, we found that high levels of N in the soil led to high levels of N in grapevines. Some of the cover crops, like flame crimson clover, clover blend, and tall fescue, absorbed a lot of N from the soil, which can lower the N available for grapevines. This means that when using cover crops, even N-fixing legumes, grape growers should think about both the grapevines' and the cover crops' N needs to avoid competition between them.

One way to reduce competition between cover crops and grapevines is by not using cover crops under the vines in the first two years of a new vineyard. This gives grapevines time to grow their roots. In their first year, perennial legumes like clover are still developing their ability to fix N and depend on the N in the soil, so they might compete with young grapevines for it. But once they are established, these legumes will add N to the soil, which can help the grapevines grow instead of competing with them.

WHAT'S NEXT?

This study is the first part of a multi-phase project and helps us understand the role that various cover crops can have depending on field-specific characteristics and goals of the vineyard manager. The next stages of the project, which will be reported on in future research briefs, include:

1. Testing the cover crops in vineyard conditions to ensure successful establishment and evaluating their impact on soil fertility, grape yield, and fruit quality.
2. Testing the drought tolerance of the cover crops and making sure the water needs of grapevines and cover crops are not conflicting.

HOW WAS THE RESEARCH DONE?

This research was conducted in a greenhouse at the Summerland Research and Development Centre (SuRDC) in 2018. The research had 2 experiments:

1. Cover crop screening

We chose 23 cover crop species by looking at research studies and talking with agricultural experts and wine grape growers. We first germinated the cover crop seeds in flat trays for 2 weeks (seeding rates in Table 2). The seedlings were then transplanted into pots filled with soil from the SuRDC's experimental farm and grown for 4 months in a greenhouse. The greenhouse temperature was maintained at 25°C during the day and 20°C at night. We kept the soil at optimum moisture by weighing the soil weekly and watering as needed. Pots were all fertilized the same, using triple super phosphate (for phosphorus) and potassium muriate (for potassium). At harvest, we separated the aboveground (shoots) and belowground (roots) plant parts and washed the roots. The shoots and roots were weighed, dried, weighed again for dry weight, and then ground. We measured the C and N concentrations of plant tissues and calculated C and N content by multiplying the concentrations by the (dry) biomass weight.

2. Grapevine growth in cover crop soil

The cover crops from experiment 1 (described above) were ground down to less than 1 mm in size and then mixed back into the same soil where they were grown. This soil was then added to larger pots for grapevine testing. We moved merlot cuttings into the pots and let them grow for 5 months. Greenhouse conditions were maintained as described for experiment 1. No fertilizer was added. We harvested the grapevines and measured and calculated C and N content in vine tissues using the same method used for the cover crops.

ABOUT THIS BRIEF

This brief is based on the following scientific journal article:
Sharifi, M., Salimi, K., Rosa, D., & Hart, M. (2024). Screening cover crops for utilization in irrigated vineyards: A greenhouse study on species' nitrogen uptake and carbon sequestration potential. *Plants, 13,* 1959. https://doi.org/10.3390/plants13141959

Want to learn more?
For any questions regarding this research, contact Mehdi Sharifi at mehdi.sharifi@AGR.GC.CA

Watch a recording of a cover crop field day in Oliver, BC with Mehdi Sharifi: https://farmfolkcityfolk.ca/2022/07/cover-cropping-field-day-covert-farms-family-estate/

Listen to a podcast interview with Dr. Mehdi Sharifi on the "Best Organic Practices for Enhancing Vineyard Soil Health": https://organicfederation.ca/podcast/best-organic-practices-for-enhancing-vineyard-soil-health/

For more research briefs like this one, visit bcfoodweb.ca/research-briefs

Funding for this research was provided in part by the Government of Canada under the previous funding framework (the Canadian Agricultural Partnership) as well as by the British Columbia Wine Grape Council, and was administered by the Canadian Grapevine Certification Network (CGCN-RCCV). This research was conducted by Agriculture and Agri-Food Canada (Summerland Research and Development Centre) and the University of British Columbia (Okanagan).

Funding for this research brief was provided in part by the governments of Canada and British Columbia under the Sustainable Canadian Agricultural Partnership, a federal-provincial-territorial initiative; additional funding provided by CleanBC.