# Healthy Soils Demonstration Project Results: Winter Cover Crops in Annual Rotations

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**Project Summary:** Replicated plots of purple vetch were planted at two rates in December 2018 (70 lb seed/A (T1) and 140 lb seed/A (T2)) and November 2019 (35 lb seed/A (T1) and 70 lb seed/A (T2)) alongside a fallow control. The field was coming out of wheat and then planted to tomato in 2019 and rice in 2020. Cover crop termination began on 4/12/19 and 3/20/20. Soil samples were collected annually and greenhouse gas samples were collected throughout project duration around field and irrigation events (see Veronica Suarez Romero handout).

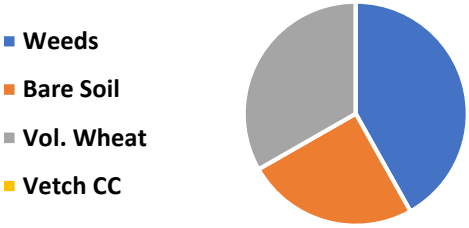
**Challenges:** The cover crop was planted at twice the intended rate in 2019, due to an error with the planter. The first-time equipment is used to plant a cover crop, consider calibrating and doing a test run to accommodate cover crop seed size. The ground was worked heavily in fall 2018 and needed moisture to protect the integrity of the beds so that beds would not collapse when the cover crop was drill seeded. However, once it began raining, the rain continued heavily for weeks. Thus, planting was delayed to the end of December 2018. Some growers plant cover crops before there is rain forecasted and let seeds to sit in the ground to germinate after first rainfall. Minimizing tillage, when possible, will maintain soil structure and may allow for more flexibility in fall cover crop planting. In addition, the very heavy winter and spring rains meant termination was delayed by 3 weeks (originally scheduled for mid-March 2019).

***For all results, values denoted by different letters indicate significant differences between treatments.***

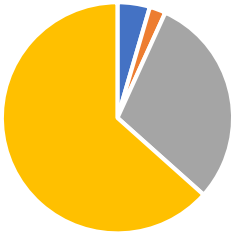
**Percent Cover 2019 (data collected March 18th)** : Five 1-$m^2$ areas of each plot were randomly evaluated for total weeds, bare soil, volunteer wheat (in 2019), and vetch. Both rates of the vetch cover crop had significantly lower weed cover and bare soil compared to the fallow control. There were no significant differences in wheat cover between treatments in 2019. Maintaining soil coverage throughout the year is an important practice for improving soil health.

| 2019 Average % Cover | | | |
|---|---|---|---|
| | Fallow Control | Low (T1) | High (T2) |
| Weeds | 42 a | 5 b | 3 b |
| Wheat | 33 a | 30 a | 22 a |
| Vetch | 0 b | 63 a | 73 a |
| Bare Soil | 25 a | 2 b | 2 b |

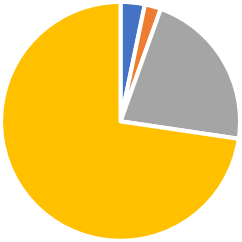
Control (volunteer wheat + weeds)




T1 (vetch low rate)



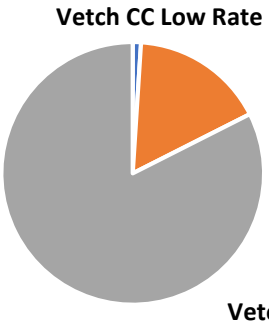
T2 (vetch high rate)



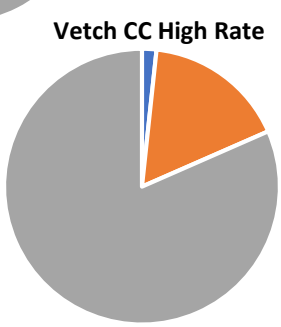
The 2017 Healthy Soils Demonstration Project is funded by Greenhouse Gas Reduction Funds and is part of California Climate Investments, a statewide program that puts billions of Cap-and-Trade dollars to work reducing GHG emissions, strengthening the economy, and improving public health and the environment.

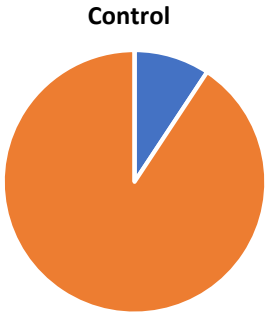
California Climate Investments — Cap and Trade Dollars at Work

## Percent Cover 2020 (data collected March 16th):




| 2020 Average % Cover | Fallow Control | Low (T1) | High (T2) |
|---|---|---|---|
| Weeds | 91 a | 16 b | 9 b |
| Vetch | 0 b | 81 a | 82 a |
| Bare Soil | 9 a | 1 b | 2 b |

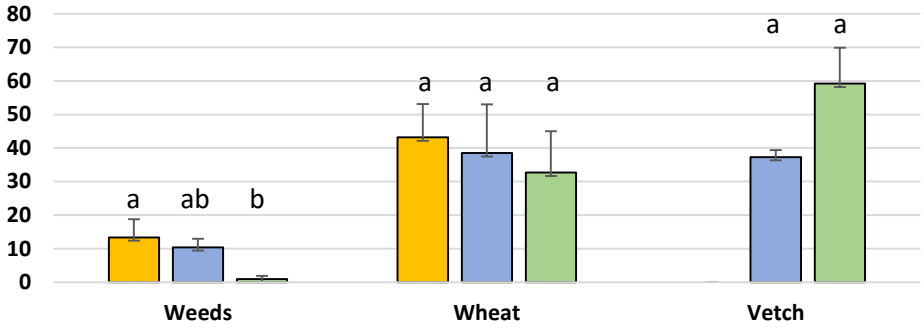


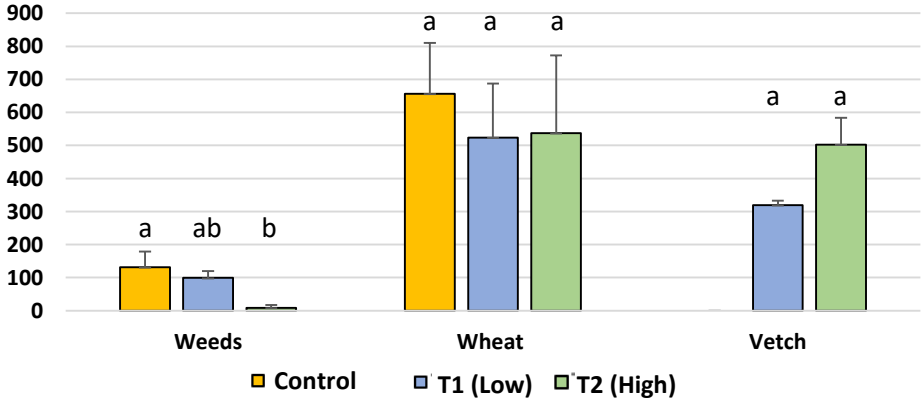


**Biomass Samples 2019**: Three 1 $m^2$ areas were randomly removed from each plot on 3/18/19, dried, and sent to the lab for analysis. One sample from each plot was separated into weeds, wheat, and vetch and those samples were run separately. Wet soil conditions delayed cover crop termination, and on 4/16/19 biomass samples were collected again from a portion of the field that remained. The field was planted in the T1 (low) rate. Vetch contributed more C and N at the higher planting rate.

### Total lbs/A of Nitrogen from Biomass samples separated by Weeds, Wheat and Vetch

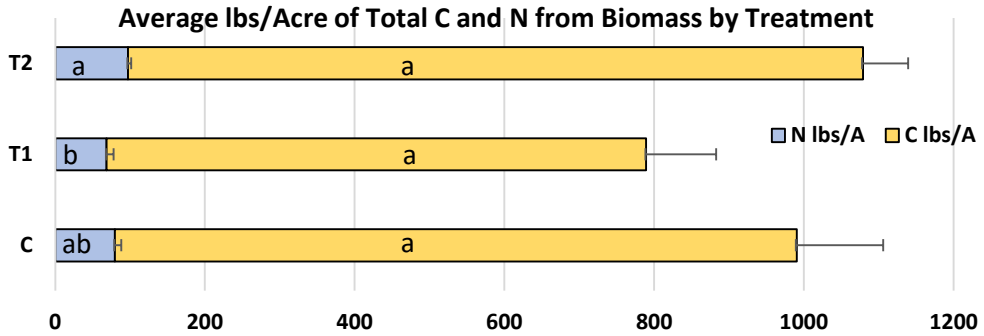



### Total lbs/A of Carbon from Biomass samples separated by Weeds, Wheat and Vetch

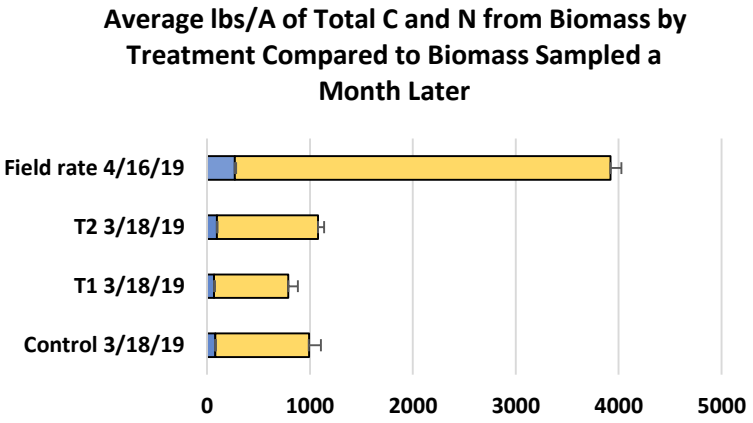


**<u>Biomass Samples 2019</u>**: *Where the N and C is coming from*: Although the volunteer wheat and weeds contribute N and C, vetch is higher in %N and contributes more N per lb biomass (the table below provides the breakdown from one plot of each rate as an example). Volunteer wheat was sampled when still green, so N hadn't been moved into the seed. While wheat may mine residual soil N from depth, it won't fix N.

| | Type | Dry Wt (lbs) | N (%) | N (lbs/ac) | C (%) | C (lbs/ac) |
|---|---|---|---|---|---|---|
| T1 (Low) | weeds | 0.16 | 2 | 15 | 21 | 133 |
| T1 (Low) | wheat | 0.40 | 4 | 58 | 44 | 706 |
| T1 (Low) | vetch | 0.20 | 5 | 41 | 42 | 336 |
| T2 (High) | weeds | 0.00 | 3 | 0 | 40 | 0 |
| T2 (High) | wheat | 0.56 | 2 | 56 | 44 | 993 |
| T2 (High) | vetch | 0.24 | 4 | 38 | 35 | 340 |

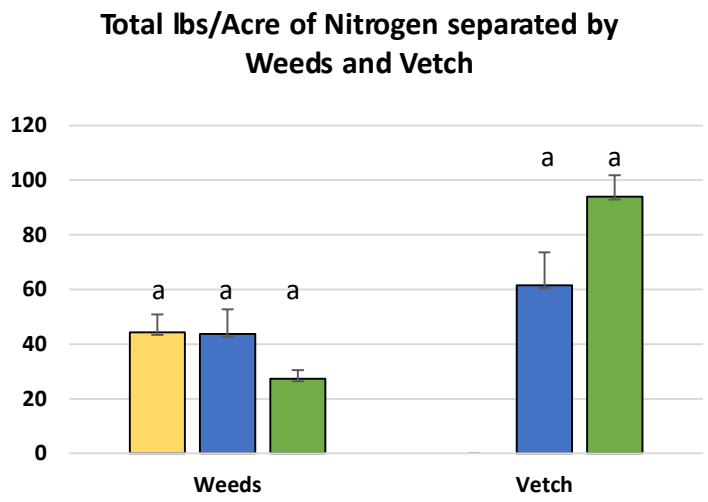


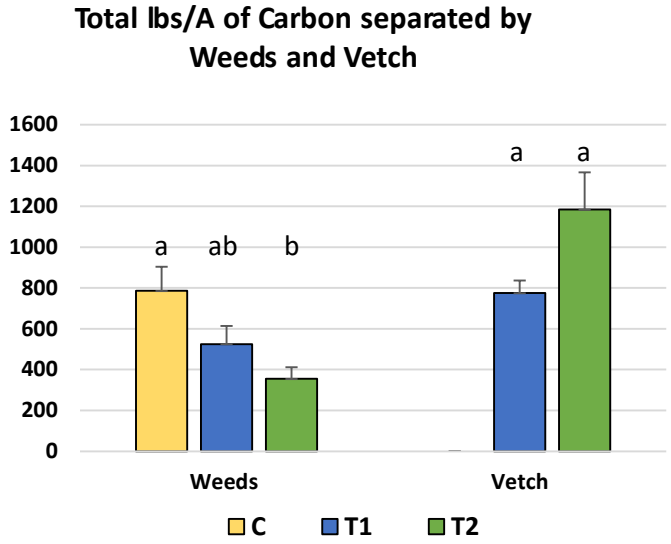

*The difference a (warm) month makes*: The comparison of the T1 samples collected on 3/18 to the field rate (same planting rate) samples collected on 4/16 indicate that the cover crop total N increased by almost a factor of 4 (69 lb N/A compared to 271 lb N/A) in the last month of growth (Figure to right). Similarly, total C increased by a factor of 5 (from 721 lb C/A to 3651 lb C/A). (photos below). For reference, on 3/18/19, control plots averaged 910 lb C/A and 80 lb N/A and T2 averaged 981 lb C/A and 97 lb N/A.




Difference between vetch cover crop on 3/18/19 (L) and 4/11/19 (R).

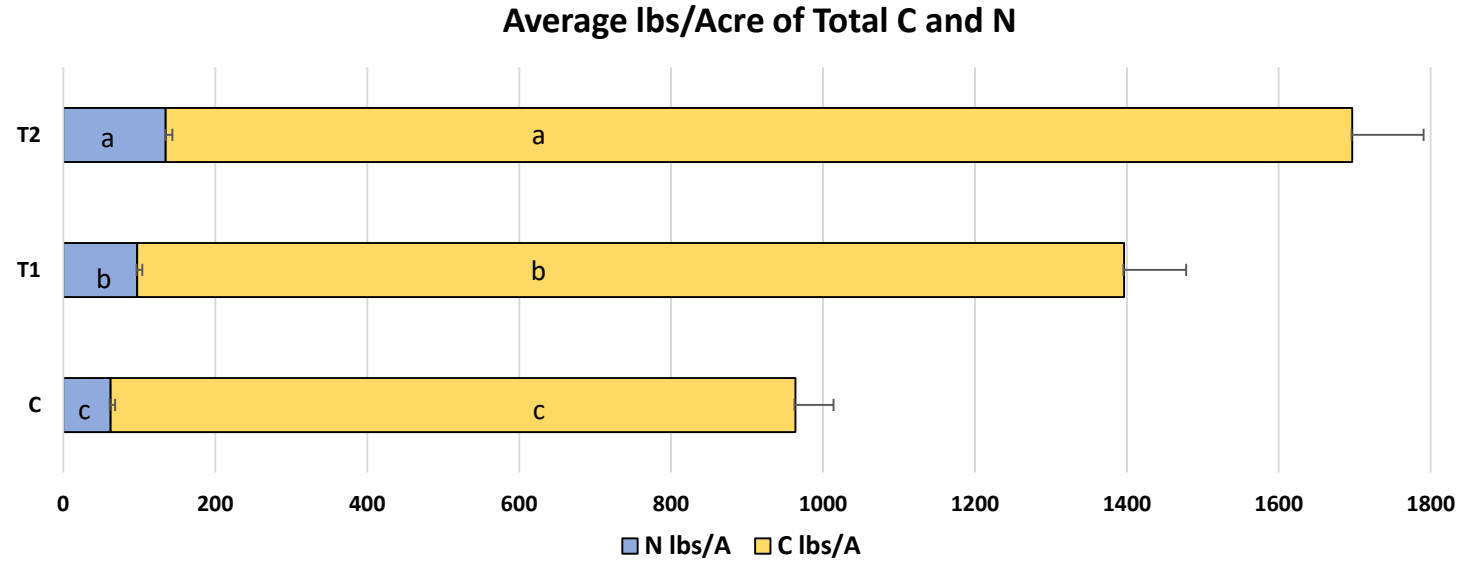
**Biomass Samples 2020**: Biomass samples were collected and analyzed using the same procedures as 2019, except that no wheat was collected from separated samples, only vetch and weeds. Samples were collected the same week as cover crop termination.



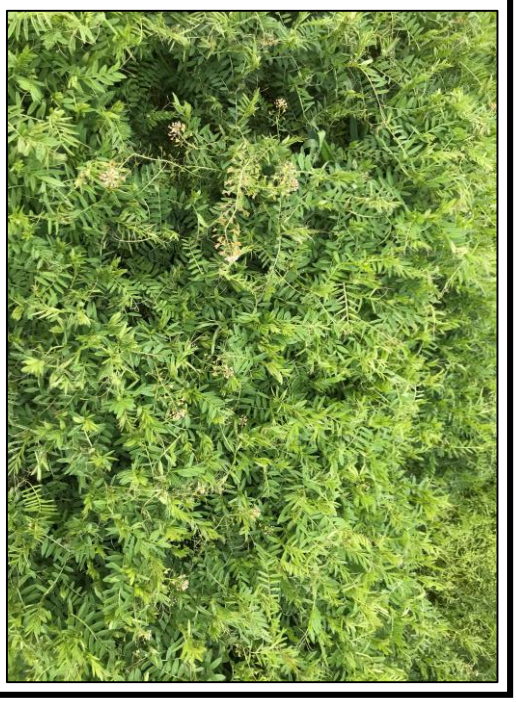




The higher rate of vetch contained more nitrogen in lbs/A (135) than the lower rate of vetch (97) and both treatments were significantly higher than the control plots (62), which only contained weeds. Both treatments also contained more carbon in lbs/A (T1: 1299, T2: 1562) than the control plots (902), though were not significantly different from each other. Again, vetch contributes more N per pound biomass because it is higher in %N (the table below provides the breakdown from one plot of each rate).

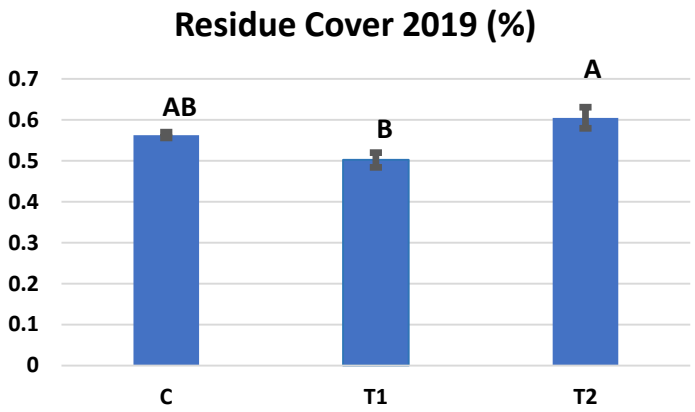
| Trmt. | Dry Weight (lbs) | N (%) | N (lbs/A) | C (%) | C (lbs/A) |
|---|---|---|---|---|---|
| Control Weeds | 0.64 | 2 | 54 | 36 | 927 |
| T1 (Low) Weeds | 0.25 | 4 | 29 | 38 | 374 |
| T1 (Low) Vetch | 0.54 | 3 | 86 | 41 | 899 |
| T2 (High) Weeds | 0.31 | 2 | 31 | 37 | 456 |
| T2 (High) Vetch | 0.85 | 3 | 92 | 37 | 1256 |

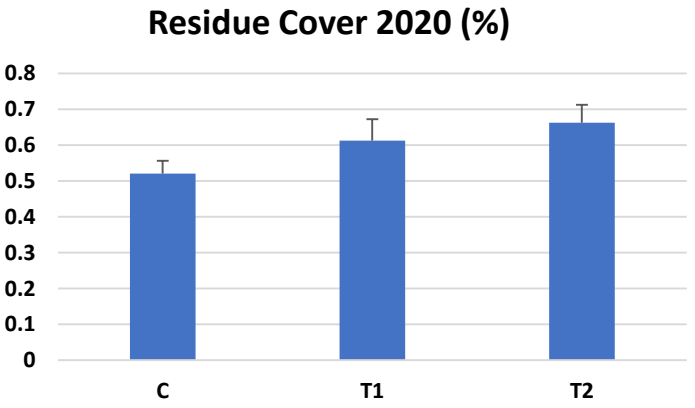


**2020 Photos (L-R):** Control, T1 (low rate) and T2 (high rate) on 3/16/20. Plot scale above and close-up.

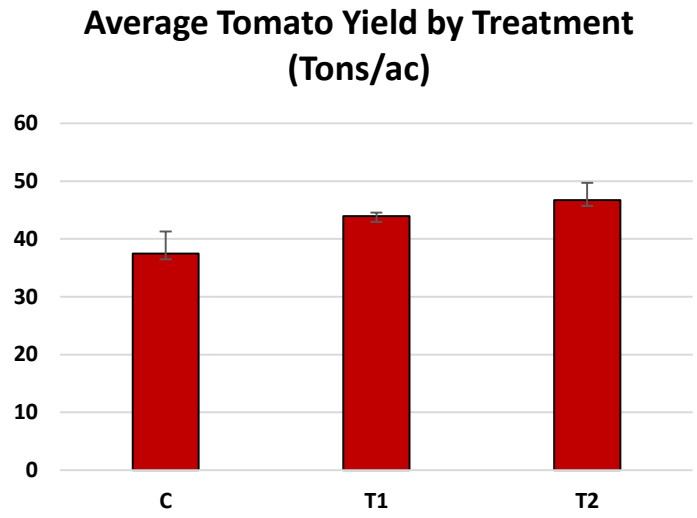


**Residue Cover**: Residue cover can improve water infiltration and reduce loss of topsoil to erosion, among other things. On 5/16/19 and 3/23/20, tape was placed in a transect of each plot and at 6-inch intervals the absence or presence of residue on the soil surface was counted. Total points with residue were converted to a percent. In 2019, T1 (low) had significantly less residue cover than T2 (high) or Control plots. In 2020, there were no significant differences between treatments.




**Yield data 2019**: On 8/9/19, 15-foot lengths of tomatoes from a middle bed of each plot were hand harvested, sorted for red, green, and culled fruit, and evaluated for quality (Brix, hue, and pH). There were no statistically significant differences in yield or quality. However, a variety trial was planted in two of the plots, which may have affected the results.




**Is a higher seeding rate worth it?**

While there was a difference in residue cover between the two seeding rates in year one, the main difference between the two seeding rates was with regard to total nitrogen. Total N with the higher seeding rate was significantly higher both years, while total carbon was only higher in year two. Both treatment rates provided the benefit of out-competing weeds and reducing bare soil. When selecting a seeing rate, growers can make decisions on cost per unit N in cover crop residue with regard to additional seed costs based on the ability to apply other N sources and total budget.

**Acknowledgements**:

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