FINAL REPORT
North Central Region
Sustainable Agriculture Research and Education (SARE) Program

Report Year: 2014

Project Title: Examining Water and Nutrient Dynamics of a Cover Crop in an Upper Great Plains Vineyard

Project Number: FNC14-947
Producer/Project Leader: Christopher Graham
Address: 9421 Deerview Rd.
City, State Zip Code: Piedmont, SD 57769
Phone: 917.344.9490
E-mail: cjg2131@gmail.com
Website:

WORK ACTIVITIES

Establishment
The goal of this project was to evaluate the effect of integrating cover crops within a newly planted vineyard, consisting of Frontenac and Marquette grapes in a semi-arid region of western South Dakota. Because of a wet and cool spring, the grapes were not planted until late May – early June and consequently, this is when the project was officially underway.

Grapes were planted into an alfalfa/wheatgrass mixture. For ease of establishment, this cover was considered the 'cover crop' for this experiment. Three treatments were established in both the Frontenac and Marquette grapes:
A) A complete clearing of all vegetation aside from the grapes both within the row and between the row ('All Clear')
B) A clearing of the vegetation within the grape row, but between rows had cover ('Row Clear') and
C) Grapes were planted into standing cover with the between rows left with cover ('No Clear').

Soil Moisture and Weather
Soil moisture probes (Decagon EM50) were inserted approximately 3 inches into the soil in each treatment. Soil moisture measurements were taken every 60 minutes for the duration of the growing season. Additionally, a weather station (Decagon Devices) was set up to measure air temperature, precipitation and evapotranspiration on a thirty minute time interval.

Fertilizer Application
Labelled ammonium sulfate fertilizer (Icon Isotopes) was used to track uptake by the plant. In brief, nitrogen exists in two isotopes ^{14}N and ^{15}N. The vast majority (>99%) of all N in the environment is in the ^{14}N form. By using fertilizer enriched in ^{15}N, one can track the enrichment in plant tissue and calculate the amount in the plant from the enriched source. Fertilizer was applied in solution at a rate of 40 lbs/ac. To estimate fertilizer recovery, isotopic enrichment was analyzed using a GC-MS at the University of Wyoming. Due to an early September frost, leaf fall happened early and thus, total biomass was not calculated. An estimated value was used for the purpose of fertilizer recovery calculations.

RESULTS

Soil Moisture

Figure 1 shows the temporal variation in soil moisture for each treatment. Since there were no significant differences between grape varieties, this figure represents an average for each treatment. Cumulative precipitation is represented (in purple) on the secondary axis. This growing season saw nearly 16 inches of rainfall, which matches the typical yearly total in just five months. Unfortunately, these wet conditions did not allow for an ideal comparison of treatments.

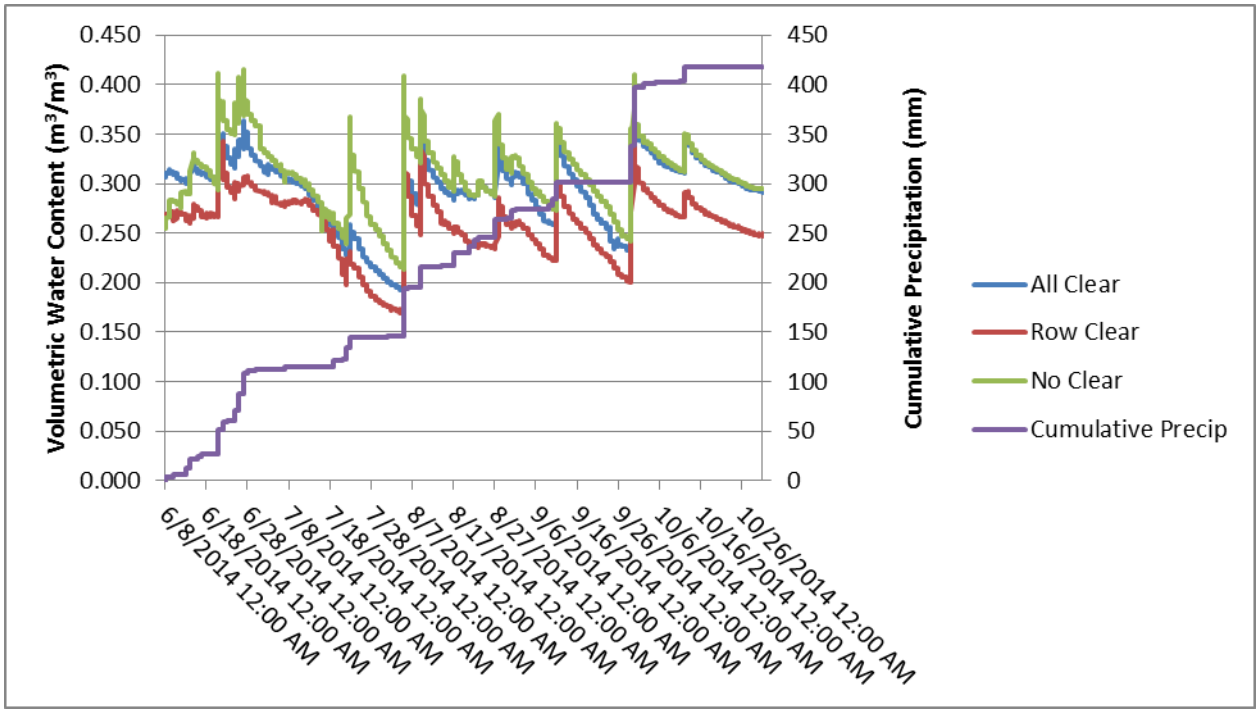

Figure 1. Soil moisture and cumulative precipitation for each vineyard treatment

Nonetheless, on average the No Clear treatment maintained higher soil moisture content and generally retained more water after rainfall events, particularly in late July. Based on the placement of the moisture sensors, comparison between the Row Clear and No Clear treatments is particularly useful. These sensors were placed in the vine row whereas the All Clear sensor was placed between rows assuming the in-row moisture would be the same as the Row Clear treatment. Between these two treatments, the Row Clear soil moisture averaged just 84% of the No Clear. Additionally, during the hottest portions of the summer, Row Clear soil moisture averaged between 68-78% of No Clear. Clearly, with respect to maintaining soil moisture for plant uptake, maintaining continuous cover is more beneficial.

Fertilizer Recovery

Overall, fertilizer N recovery/uptake by all treatments was very low with an average of approximately 11% of applied fertilizer taken up in the leaf tissue. For most crops, including grapes, typical N recovery ranges from 30-50%. The reasons for this low recovery are speculative but it is likely that the large amount of precipitation shortly after application of fertilizer (roughly 5 inches in the first month) moved much of the N out of the rootzone either through leaching or denitrification. Concurrently, the grapes were newly transplanted and just established a root system

with lower N uptake, which further allowed for N losses. Nonetheless, there were still interesting differences detected between grape varieties and treatments.

When comparing N uptake by variety, Frontenac grapes had a statistically ($p=0.10$) greater recovery over Marquette (11.9% vs. 9.6%). It is difficult to interpret what this means in a practical sense, but this greater uptake efficiency means that less N is potentially lost to the environment. It is important to note, however, that this is just an analysis of leaf tissue and there may be differences between varieties in how N is allocated to other vegetative and reproductive parts of the plant.

With respect to treatment differences by variety, there were no statistical differences in N uptake. In the Frontenac grapes, the treatments averaged 12.1%, 12.2% and 11.5% for All Clear, Row Clear and No Clear, respectively. In the Marquette grapes, average uptake was 9.7%, 11.4% and 7.6% for All Clear, Row Clear and No Clear, respectively. Despite a lack of statistical significance, a difference of nearly 4% N uptake in the Row Clear and No Clear treatments in the Marquette grapes could be a large difference in total N in the plant tissue. For example, assuming 2 tons of biomass/ac., the Row Clear treatment averaged 2.3% N content versus 1.6% N in the No Clear. In total N uptake, these differences equate to roughly 30% more total N taken up in the Row Clear treatment and over 50% more fertilizer N (may not be fair to assume equal biomass production?). For any given acre of vineyard, this difference is relatively small in total N but it may add up to a significant amount when quantified across a larger growing region.

Conclusion

In conclusion, this project found that maintaining full cover kept moisture in the soil better than the other two treatments, which is highly beneficial for growing grapevines in a semi-arid region. Based on mid-summer soil moisture levels, this effect may be amplified during hotter, drier growing seasons. Conversely, maintaining full cover did reduce the amount of N in plant tissue and that taken up by fertilizer. Although this difference was not statistically significant, it may have an economic impact when comparing yields. Further research is necessary to investigate drier growing seasons and also on more mature grapevines with respect to grape yield.

WORK PLAN FOR 2015

This is a one-year project. However, we will conduct an early-Spring workshop and will continue to monitor soil moisture during the growing season.

OUTREACH

This project includes a grower's workshop to be conducted with South Dakota State University Extension staff. The purpose of the project will be to discuss the results of this project as well as general vineyard water management in the context of our semi-arid climate. There is a good network of growers in the region and attendance is expected to very high. Moreover, we hope to use this workshop as an opportunity to strengthen our grower community and create future collaborations.