

Cover Crop Management Effects on Soil C and N pool and Fresh-Market Tomato Yield

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Abstract

Depending on management, cover crops may improve soil and environmental quality and tomato yield. We evaluated the effects of hairy vetch residue management and the biculture of hairy vetch (*Vicia Villosa R.*) and rye (*Secale Cereale L.*) on Soil Organic Carbon (SOC), Microbial Biomass Nitrogen (MBN), soil inorganic nitrogen, and tomato yield for two years in a plastic high tunnel in Sapporo, Japan. SOC in the surface 10 cm depth was 2.87% to 17.5% significantly greater in hairy vetch incorporation, hairy vetch mulch, and the biculture of hairy vetch and rye treatments, than in a no cover crop treatment (bare fallow). Residual soil nitrate-N, subject to leaching losses after winter, was increased by cover crops, more so by hairy vetch incorporation and mulch than the biculture. MBN and inorganic N ($\text{NO}_3^- \text{-N} + \text{NH}_4^+ \text{-N}$) were greater in hairy vetch incorporation than either hairy vetch mulch or bicultural. Tomato total yield was 11.1% to 43.8% significantly greater in hairy vetch incorporation and mulch than in the bare fallow.

However, the effects of the biculture on MBN, inorganic N, and tomato yield varied with C/N ratio of residues and best results were obtained with a C/N ratio of 17.6 than with 23.7.

Therefore, if adequate seeding hairy vetch to rye ratio (2:1) is used, the biculture is a better management practice to increase SOC at surface soil layer and tomato yield with least residual N.

Keywords: Cover crops, Green manure crops, Soil structure, Soil fertility, Weed control, Mulching

Introduction

A cover crop is a specific plant that is grown primarily for the benefit of the soil rather than the crop yield [1]. Cover crops are commonly grown to suppress weeds in the farm, manage soil erosion, help to build and improve soil fertility & quality, control diseases & pests and also promote biodiversity. Cover crops are mainly grasses or legume plants but may be comprised of other green plants also. Most often, a cover crop is grown in the same piece of land during the off-season before the field is needed for growing the cash crop/main crop. In essence, a cover crop provides the nutrients to the land for an incoming main crop. Benefits of cash crops includes improving the health of the soil, resulting in the significantly larger, healthier cash crop for the next growing season, Improves the biodiversity by increasing the variety of species in a given piece of land, Reduce the amount of water that drains off from the field, protecting waterways & downstream ecosystems from the erosion. Because each root of the cover crop creates pores in the soil, it helps in allowing water to filter deep into the ground. As a result, a cover crop can help in conserving water and prevents soil erosion. Helps in breaking disease cycles by reducing the amount of bacterial & fungal diseases in the soil. Provides nutrients to the soil like manure does. They are also known as "living mulches" because they can prevent soil erosion and evaporation losses. Mulch is a layer made of organic material, such as crop residue that is left on the surface of the soil to prevent water runoff & protect the soil from the damaging effects of heavy rainfall and water evaporation. These crops add fertility to the soil without addition of any fertilizers made of chemicals via biological

nitrogen fixation. A cover crop can offer a natural way to increase fertility of soil & to reduce soil compaction, conserve soil moisture by reducing evaporation, decrease overall energy use and also provide additional forage for livestock feed. Plants like Rye, Buck wheat, Clover, Hairy vetch and Sorghum etc.

One of the major uses of the cover crops is to increase soil fertility by adding nutrients to the soil. Generally these types of cover crops are referred to as "green manure" crops. They are used to maintain a certain range of macronutrients and micronutrients in soil of the various nutrients, the impact that these crops have on management of nitrogen has received the most attention from the researchers & farmers, because nitrogen is often the most limiting and essential nutrient in crop production.

Often, green manure crops are grown for a specific period and then plowed in the same land before reaching full maturity in order to improve the soil fertility and its quality. Also the stalks are left to block the soil from being eroded.

Green manure crops are generally leguminous, meaning they are the part of the pea family, Fabaceae. This family is unique by the quality of the species in its set pods, such as bean, lupins, lentil and alfalfa. Leguminous cover crops are generally high in nitrogen & can also provide the required quantity of nitrogen (N) amounts required for the crop production [2]. In conventional farming, this nitrogen is typically applied by adding chemical fertilizers that are containing nitrogen. This quality of cover crops is known as "fertilizer replacement value" [3-5].

Another unique quality of leguminous cover crops is that they can

form symbiotic relationships with the rhizobial bacteria that reside in the root nodules of legume plants [6,7]. Lupins is nodulated by the *Bradyrhizobium Sp.* (Lupinus) named soil microorganism. Bradyrhizobia are encountered as microsymbionts in other leguminous crops like *Argyrolobium*, *Ornithopus*, *Lotus*, *Acacia*, *Lupinus* of Mediterranean origin. These bacteria convert biologically unavailable atmospheric nitrogen gas $-N_2$ to biologically available form which is ammonium - NH^{+4} through the process known as biological nitrogen fixation.

Cover crops can also improve quality of the soil by increasing soil organic matter levels through the input of cover crop biomass over time in farms. Increased soil organic matter enhances the soil structure, as well as the water & nutrient holding, buffering capacity of the soil. It can also lead to increased carbon sequestration in soil, which has been promoted as a strategy to help offset the rise in the levels of atmospheric carbon dioxide. Cover crops can Also help in conserving water, in temperate regions particularly in years with below average precipitation .They can draw down or reduce the soil water supply in the spring season at regions where particularly if climatic growing conditions are good. In these cases, just before planting of main or cash crop, farmers often face a tradeoff between the benefits of increased cover crop growth & the drawbacks of reduced soil moisture for main crop production in that season as a result, C/N ratio is also balanced with this application [8].

Conclusions

Our research concludes that cover crop management is influenced differently by soil C and N pool & tomato yields. Regardless of management, hairy vetch & rye treatments improved SOC at a surface of 10 cm soil depth. However, the positive (+) effects of cover crops on STN varied with soil depths from years, and HV incorporation treatment tended to be more effective than other treatments in increasing by STN. Residual soil nitrate- N is subjected to leaching losses after winter season, increased with HV monoculture more especially when the hairy vetch residues were placed on soil surface than compared with the biculture of hairy vetch and rye.

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