ENZYME ACTIVITY AND PEANUT NODULATION WITH THE INCLUSION OF COVER CROPS IN ORGANIC AND CONVENTIONAL AGRICULTURE IN THE TEXAS HIGH PLAINS

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ABSTRACT

Organic farming has been increasingly adopted in the Texas High Plains (THP), but restrictions on synthetic fertilizer use may be problematic if a system cannot mineralize sufficient nutrients from organic matter breakdown to meet crop needs. Cover crops are a tool utilized by both organic and conventional producers for nutrient management, weed control and soil conservation. A one-year study was conducted in organic peanuts in Lubbock and Vernon, TX, to assess the ability of cover crops to increase indicators of organic matter breakdown and nutrient mineralization. Both cover crops and management system impacted activities of N-acetyl-β-D-glucosaminidase and β-glucosidase, as well as carbon mineralization, although results varied by location. Cover crop treatments improved both parameters over fallow, as did organic treatments. These findings suggest cover cropping and other organic farming practices can enhance nutrient mineralization of organic matter in the short-term.

INTRODUCTION

The Texas High Plains (THP) region has long been a major producer of US cotton (*Gossypium hirsutum)* and peanuts (*Arachis hypogea)* (National Agricultural Statistics Service, 2020) and has quickly become a leader in organic production of both crops (Zapata et al., 2022). Restrictions and requirements of organic production make cover cropping an important nutrient management strategy for producers. Past studies on cover crop use in the region have addressed nutrient management challenges associated with cover crops but have focused on their impact in conventional systems (Lewis et al., 2018). Organic production does not allow the use of synthetic fertilizer making organic matter input the main source of nutrients. Measuring activities of enzymes such as N-acetyl-β-D-glucosaminidase and β-glucosidase can indicate a system's ability to breakdown organic matter, and subsequently release nutrients. Mineralizable carbon (CMIN) is another indicator of a system's ability to utilize organic substrates and is an estimator of soil biological activity. The purpose of this study was to investigate the effects of both cover crop use and management strategy on the ability of a system to utilize organic substrates for nutrient acquisition by measuring enzyme activities and carbon mineralization.

MATERIALS AND METHODS

The study was conducted at two locations during the growing season (April-November) of 2020: in the THP at the AgriLife Research Center in Lubbock (33.693, 101.828) and in the Texas Rolling Plains at the Vernon AgriLife Research Center (34.091, 99.365). Peanut variety ACI 236 was planted in Lubbock and Vernon on May 7, 2020 and May 11, 2020, respectively; however, the Lubbock location was replanted on June 10. Conventional peanuts in Vernon were inoculated with Bradyrhizobia while organic peanuts were not. Plots were designed as separate randomized complete blocks for organic (ORG) and conventional no-till management (CONV) and included 4 cover crop treatments, with three replications each. Cover crop treatments were rye (*Secale cereale*) (rye), radish (*Raphanus sativus*) (rad), rye/vetch (*Vicia villosa*) mix (rv), and rye/radish/vetch (rvr) mixes. Fallow, reduced-tillage conventional plots were used as the control (f). Plots measured 35.1 x 13.5 ft with 3.3 ft rows. Termination method differed between ORG and CONV to comply with restrictions on the use of synthetic herbicides in organic systems. ORG cover crops were terminated via stalk cutter in Lubbock and sweep plow in Vernon, in late April 2020. CONV cover crops were terminated in Lubbock using 2,4-D on March 31 and two Roundup applications on April 27 and May 5. In Vernon, CONV cover crops were terminated with a single Enlist Duo application on April 17. CONV plots in Lubbock received urea ammonium nitrate (UAN) at 89 lb. UAN acre^{-1} while ORG received approximately 8,030 lb. compost acre^{-1} during the previous cotton rotation in 2019. In Vernon, CONV plots received fertilizer at 149 lb. ammonium polyphosphate acre^{-1} and ORG plots received 8,800 lb. compost acre^{-1} however, compost was applied just before peanut planting in April. Soil samples were collected at each location prior to peanut planting (pre), during mid-season (mid) and after peanut harvest (post). Cores were collected and divided by depth (0-4 in & 4-8 in), then composited. Samples were air-dried and sieved to 2 mm. Enzyme assays for β-glucosidase (BG) and N-acetyl-β-D-glucosaminidase (NAG) were conducted according to the NRCS colorimetric method (Scott, 2019). Mineralizable carbon (CMIN) was determined during 3-day CO_2 incubations (Franzluebbers, 2015). Results were analyzed in SAS using PROC GLIMMIX. Unless otherwise noted, alpha = 0.05.

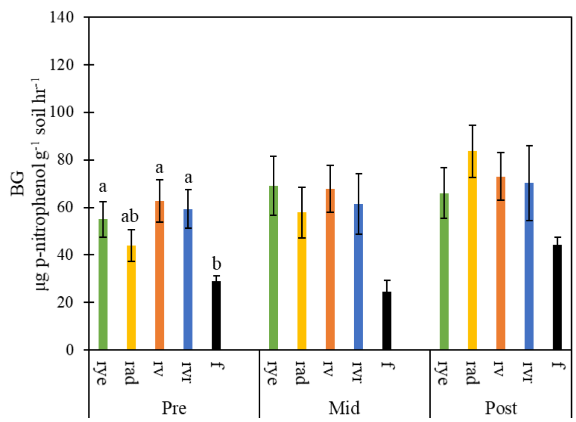
RESULTS AND DISCUSSION

Enzyme Activities

No depth interactions were identified for either enzyme at either location, so data for management and cover crop selection were pooled to include both depths. The radish cover crop failed in Lubbock, so it is not included. Results for BG were significant at Vernon only (Figure 1). The presence of cover crops, specifically with rye, rv and rvr, increased BG activity over fallow (Figure 1A). Management effects were observed as well, with BG activity being greater in ORG than CONV (Figure 1B). Significance at Vernon but not Lubbock was likely caused by application of compost just before planting, providing additional substrates for BG to degrade.

NAG activity was more variable and showed significance at both sites. At Lubbock NAG activity was greater in rv treatments compared to r and rvr in post-harvest samples (Fig 2A). The rv treatments showed greater activity in Vernon compared to rye and radish treatments at pre-plant (Fig 2B). Vernon results also indicated significant management effects at mid and post-harvest, with ORG greater at mid-season and CONV greater at post-harvest (Fig 2C).

A.



B.

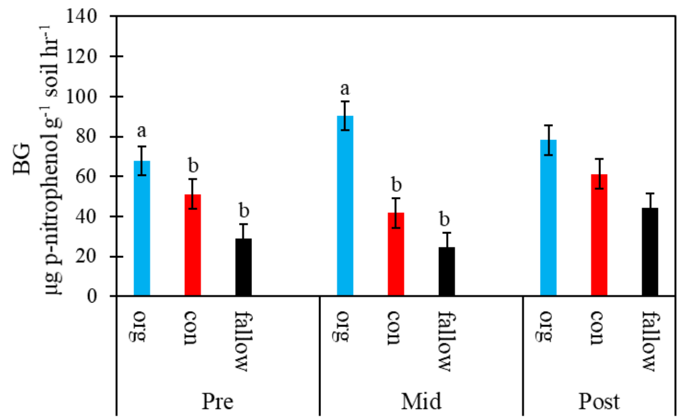
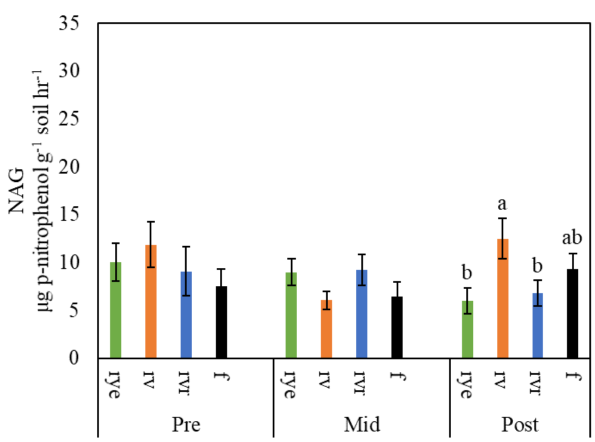


Figure 1. β-glucosidase enzyme activity at Vernon according to cover crop selection (A) and management (B). Bars within sample collection with the same letter are not different at $P < 0.05$

A.



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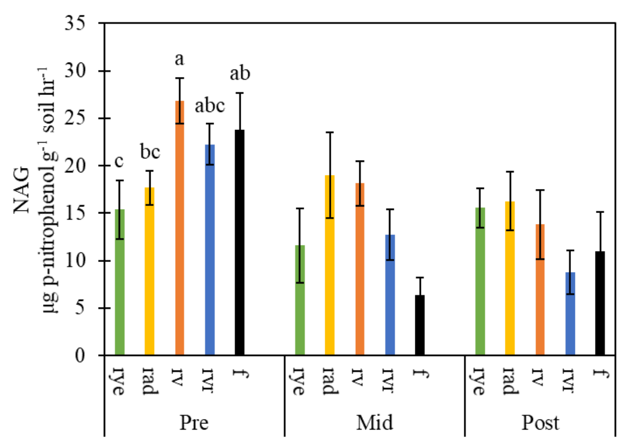


C.

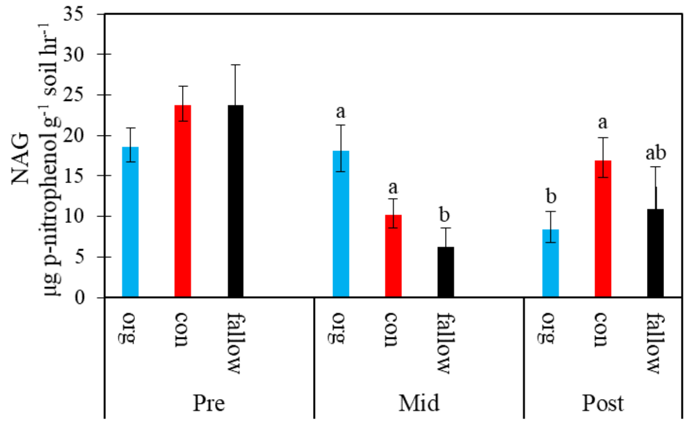
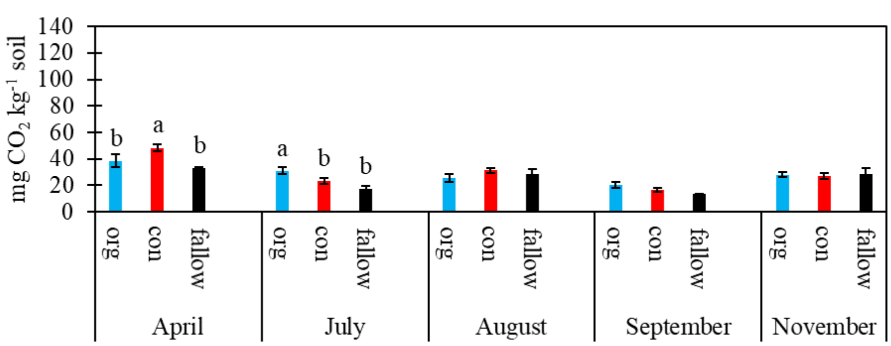


Figure 2. N-acetyl-β-D-glucosaminidase enzyme activity at Lubbock according to cover crop selection (A), at Vernon according to cover crop selection (B) and at Vernon according to management (C). Bars within sample collection with the same letter are not different at P < 0.05

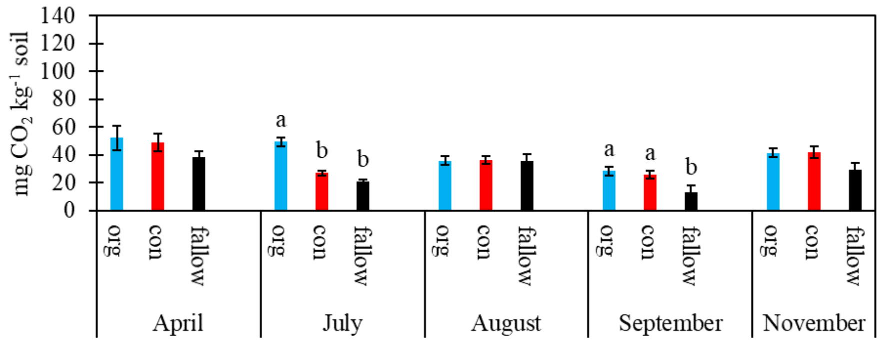
Mineralizable Carbon

Mineralizable carbon was not different at the 4 to 8 inch sampling depth with cover crop selection at either location, so only data from 0 to 4 inches is presented (Fig 3). Total CMIN was greater in Lubbock and no significant cover crop effects were detected in Vernon. In April, at the Lubbock site, rye was greater than fallow, while in September rv was greater than rye and fallow (Fig 3C). While no management effects were observed in Lubbock at lower depths, results indicated increased CMIN in CONV over fallow in April and ORG over fallow in September, at P=0.1 (Fig 3A). CMIN responded to management in three separate months in Vernon. In April, CONV was greater than ORG and fallow, while in July ORG was greater than CONV and fallow at both depth ranges (Fig 3B). In September, both ORG and CONV were greater than fallow but not different from each other.

A.



B.



C.

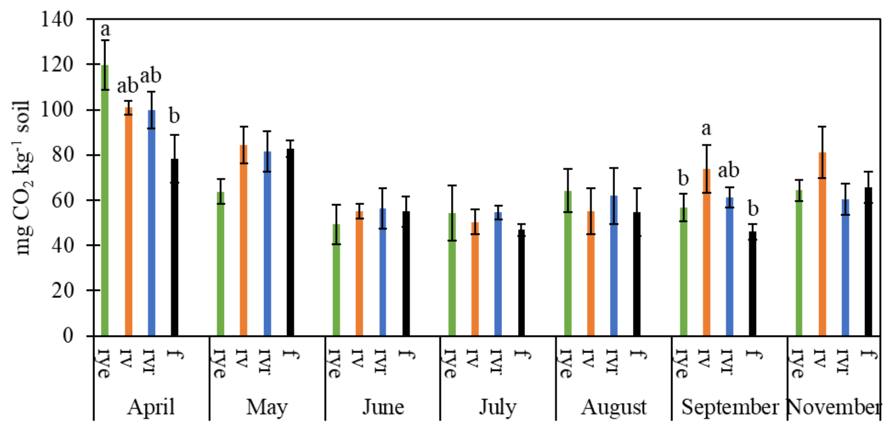


Figure 3. Mineralizable carbon at Lubbock according to cover crop at 0-4 inches (A), management from 0-4 inches (B), and at Vernon according to management at 0-4 inches (B). Bars within sample collection with the same letter are not different at $P < 0.1$

CONCLUSION

Cover crop presence and management strategy have potential to enhance soil enzyme activities and carbon mineralization, both of which are important for nutrient cycling in systems dependent on organic inputs as nutrient sources. Organic management generally increased both factors over conventional and fallow management, while cover crops, legumes and nonlegumes, also resulted in increased nutrient cycling parameters. Further research should examine the sustainability of organic systems in the THP and evaluate the viability of organic nutrient management strategies relying on factors such as enzyme activity and carbon mineralization to enhance crop nutrient availability.

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