Urban Conservation Agriculture

Don Immanuel A. Edralin[1], Gilbert C. Sigua[2] and Manuel R. Reyes[1]

[1]North Carolina Agricultural and Technical State University, Sockwell Hall, Greensboro, NC 27411

[2]Coastal Plains Soil, Water and Plant Research Center, ARS- USDA, Florence, SC 29501

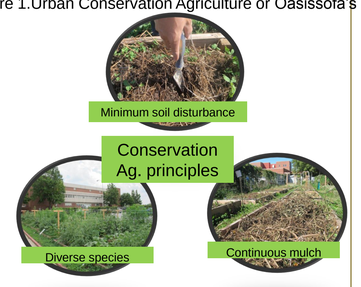
Introduction

Vegetables are important sources of vitamins and nutrients for human nutrition. USDA recommends filling half of the food plates with vegetables in every meal. While it is important in promoting good health, access to fresh vegetables is limited especially in urban desert communities. Conservation agriculture (CA) with vegetables (Figure 1) may be a solution to the food desert problem in the US as well as in other communities worldwide with limited access to fresh vegetables. This may be done by converting part of the lawns or impervious surfaces to vegetable production through CA. CA principles could prove attractive to homeowners by having fresh vegetables and also by reducing their inversion or tilling of soil to control weeds and improve soil moisture retention by the presence of continues mulch that also controls weeds (Figure 2). The diverse species rotation that potentially limits the insect, pests and diseases may also be beneficial. This poster exhibits the results of three-year vegetable yield after converting part of a lawn into conservation agriculture vegetable plots as well as soil bulk density, volumentric water content, temperature and CO_2 flux results.

Methodology

A lawn at Sockwell Hall, North Carolina A&T State University was converted into a vegetable production area comparing till, no-till, CA-Summer (Vegetables in all seasons except summer) and CA-Winter (Vegetables in all seasons except winter) (Figure 4 & 5). CA summer and winter treatments when not planted with vegetables are planted with sunhemp (*Crotolaria juncea*) and clover (*Trifolium* sp.) covercrops, respectively. Soil were imported to the site due to having a shallow soil depth as it was a parking lot before it was a turf lawn. Vegetable beds were designed to be like the size of house sofa's as such it is called oasissofa's. All plots were irrigated the same using with drip irrigation and were fertilized the same as well. Soil CO_2 flux were measured using Licor 8100a automated soil flux system during summer 2014 (Figure 3). Vegetable yields are reported on a per square meter basis.

Figure 1.Urban Conservation Agriculture or Oasissofa's



Taken from Edralin et al., 2012. Conservation Agriculture in Urban Deserts. Presented as poster in SSSA meaning, Cincinnati Ohio.

Figure 2. Principles of Conservation Agriculture

Figure 3. Automated soil flux system, Licor 8100a

Treatments

1. Tilled (Continuous turning over of soil no residue retention)
2. No-till (No-tilling of soil with residue retention)
3. CA-Winter (Vegetables in all seasons except winter)*
4. CA-Summer (Vegetables in all seasons except summer)*

_* Cover crops are planted during times not planted with vegetables

Experimental design and statistical analysis

Randomized complete block design with 4 replications, Analysis of variance were analyzed using SAS 9.2.

Turf lawn, Sockwell Hall, 2011 — Urban conservation agriculture, Fall 2011

Figure 4. Turf lawn converted to Urban Vegetable Conservation Agriculture

CA/ Oasissofa Study: summer 2012 (left) and summer 2013 (right)

Figure 5. Urban Vegetable Conservation agriculture summer 2012 and 2013

Results

Table 1. Fall 2011 Vegetable Yield+.

Vegetables	Yield (kg m^{-2})
Broccoli	2.72
Lettuce	1.55
Collard greens	1.67
Kale	1.02

+Means were not compared statistically due to recent field establishment.

Table 2. Winter – Spring 2012 Vegetable Yield+.

Vegetables	Yield (kg m^{-2})
Asian greens	1.11
Lettuce	0.94
Spinach	0.97
Snow pea	0.66

+Means were not compared statistically due to recent field establishment.

Table 3. Summer 2012 Vegetable Yield.

Vegetables	Treatment Yield (kg m^{-2})	
	With Cover crop	No Cover crop
Celebrity tomato	10.91	9.56
Cherry tomato	8.30	12.05
Eggplant	3.76	5.38
Okra *	1.70 ^{b}	4.46 ^{a}

*Means under each vegetable having the same letters are not significantly different at 5% level of significance as indicated by Fisher's protected LSD test.

Table 4. Fall 2012 Vegetable Yield.

Vegetables	Treatment Yield (kg m^{-2})		
	Conservation Agriculture Summer	No - till	Tilled
Lettuce	0.80	0.73	0.61
Collard greens *	0.87 ^{a}	0.68 ^{b}	0.55 ^{b}

*Means under each vegetable having the same letters are not significantly different at 5% level of significance as indicated by Fisher's protected LSD test.

Table 5. Summer 2013 Vegetable Yield.

Vegetables	Treatment Yield (kg m^{-2})		
	Conservation Agric Winter	No - till	Tilled
Tomato *	9.40 ^{a}	6.67 ^{b}	6.43 ^{b}
Pepper	7.41	6.47	5.85

+Means under each vegetable having the same letters are not significantly different at 5% level of significance as indicated by Fisher's protected LSD test.

Table 6. Summer 2014 Vegetable Yield.

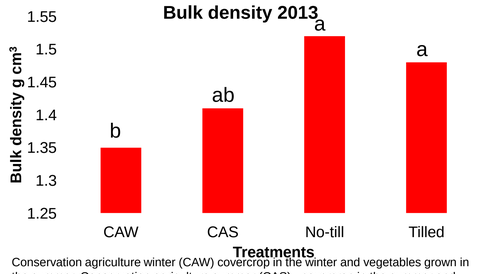
Vegetables	Treatment Yield (kg m^{-2})		
	Conservation Agric Winter	No - till	Tilled
Tomato *	6.74^{b}	8.87^{a}	9.14^{a}
Pepper	1.40	0.94	1.14

+Means under each vegetable having the same letters are not significantly different at 5% level of significance as indicated by Fisher's protected LSD test.

Soil Characteristics

Soil characteristic	Value
Soil type	Loamy sand
pH	8.5
EC	0.24 dS/m
Soil water content (NRCS Method)	0.24 g/g

Figure 6. Soil pH, EC and soil water content.



Conservation agriculture winter (CAW) covercrop in the winter and vegetables grown in the summer, Conservation agriculture summer (CAS) - covercrop in the summer and vegetables grown in the winter

*Means having same letters are not significantly different at 5% level of significance as indicated by Fisher's protected LSD test.

Figure 7. Soil bulk density as a result of treatments 2013

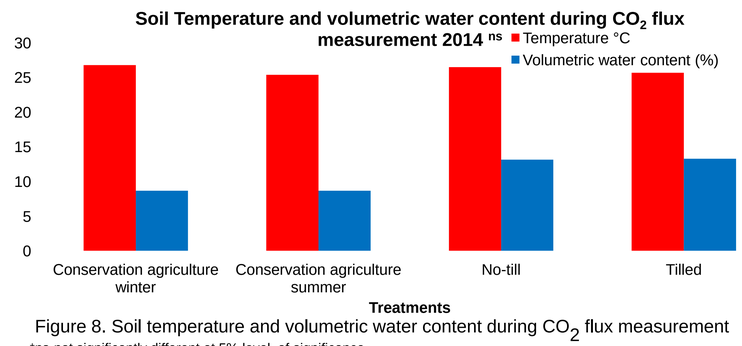
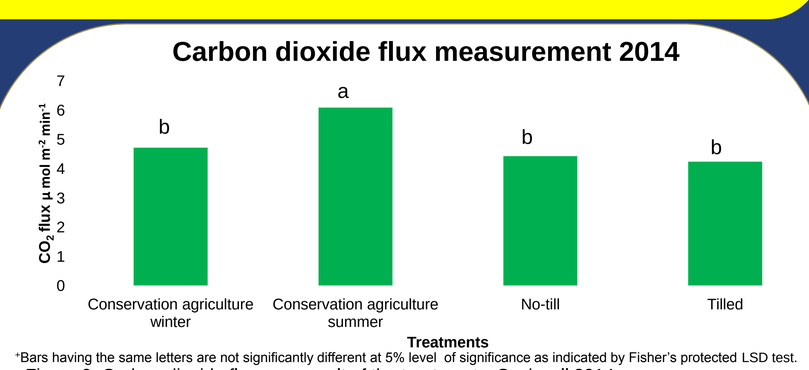


Figure 8. Soil temperature and volumetric water content during CO_2 flux measurement

+ns-not significantly different at 5% level of significance.



*Bars having the same letters are not significantly different at 5% level of significance as indicated by Fisher's protected LSD test.

Figure 9. Carbon dioxide flux as a result of the treatments. Sockwell 2014

Discussion

During summer 2012 fruit vegetables did not differ from with covercrops and without except okra. Okra provided less ground cover compared to others and the cover crops underneath re-grew and competed with the crop. Fall 2012, lettuce was harvested before winter with an average yield of 700 g per square meter (Table 4). However collard greens lasted until the winter 2012-2013 season and it withstood chilling conditions. Collard greens under CA were 260 g greater per square meter than tilled and no-till with both having 615 g average yield. Summer of 2013 gave an average of 6.6 kg per square meter for pepper while tomatoes under CA resulted in 2.8 kg more yield per square meter than no-till and tilled (6.6 kg). However a year after establishment there was already a seen difference in yield in favor of CA and can also be observed in year 3 (Table 5). With the other vegetables the non-significant effect of CA means that CA did not reduce the yield of vegetables compared to no-till and tilled plots. However in summer 2014 yield of CA tomato reduced by about 2 kg compared to T and NT. The reduction might be due to nutrient immobilization due to residues of sunhemp (*Crotolaria juncea)*. However, pepper yields were not affected by the treatments, although their yields are generally low. More research needs to be done but at this point it was observed that the effect of CA can be seen shortly after establishment. Given such success in shorter time is an advantage in promoting CA. Regardless of treatment, converting part of the lawn in urban lands could give about 1 kg per square meter of leafy vegetables and about 6 kg per square meter of fruit-vegetables (Tables 1 to 6).

The anthropogenic soil is loamy sand with a basic pH of 8.5 and EC of 0.24 dS/m (Figure 6). The soil compaction, as indicated by their bulk densities, of tilled and no-till was higher than CA-winter but not significantly different to CA-summer however the trend can be seen that it is lower than tilled and no-till (Figure 7). The degree of soil compaction is important especially for root penetration, water movement and biological action and so the lower compaction on CA indicates a better soil quality than tilled and no-till. During carbon dioxide flux measurement, the soil temperature and volumetric water content were not significantly different and on average are at 26 °C and 11%, respectively (Figure 8). The CO_2 flux showed to be higher in CA summer compared to CA winter, no-till and tilled (Figure 9). This measurement was conducted after the soils and plants were established to about 1.5 month and so the immediate effects of tillage may not be accounted. The higher CO_2 flux in CA summer may be due to the high residue cover crop sunhemp planted year after year and retained on the soil surface compared to other treatments including CA-winter with clovers. This may also indicate higher biological activity as CO_2 are released by soil organisms from respiration.

Conclusion

Conservation agriculture in urban areas may be a solution to the food desert problem in the US and in other countries as it brings fresh fruits and vegetables to the household. CA has potentials in improving yield of vegetables while improving the quality of anthropogenic soil for food production.

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Contact information:
Don Immanuel A. Edralin
Graduate Research Assistant
Energy and Environmental Systems
North Carolina Agricultural and Technical State University
Email: dedralin@aggies.ncat.edu
Phone: +1 336-303-1516

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