Summer Cover Crops for Organic Production System

Gurudev Mayalagu*[1], Srinivasa R. Mentreddy[1], Carol Garrett[2], and Joseph Kloepper[2]

[1]Department of Natural Resources & Environmental Sciences, Alabama A & M University Normal, AL 35762 US

[2]Auburn University, Auburn, AL 35849 US

ABSTRACT

Cover crops when integrated into cropping systems return economic and environmental benefits. Cover crops help suppress insects, diseases, and weeds, conserve soil and water, enable efficient nutrient cycling and improve soil and crop productivity. Summer cover crops are viable options for crop rotation in sustainable cropping systems. Despite growing interest in short-season summer annual cover crops, there is limited published research on these crops. In a study conducted at Alabama A&M University, five summer cover crops, sunflower (*Helianthus annuus* L.), buckwheat (*Fagopyrum esculentum* Moench), Sudan-sorghum (*Sorghum bicolor* (L.), velvet bean (*Mucuna pruriens* L.), and iron-clay peas *(Vigna unguiculata* L. Walp.) were evaluated against no-cover crop fallow treatment using randomized complete block design. The results showed that sunflower with a significantly higher leaf area index also intercepted a greater proportion (90%) of incoming photosynthetically active radiation (PAR). The biomass production by cover crops ranged from 2.2 Mg ha^{-1} for velvet bean to 6.3 Mg ha^{-1} for Sudan sorghum. The weed biomass was significantly lower in iron clay peas (0.4 Mg ha^{-1}) than Sudan-sorghum (1.3 Mg ha^{-1}), buckwheat (1.3 Mg ha^{-1}), or sunflower (1.4 Mg ha^{-1}) plots. This study showed the potential of summer cover crops for biomass production and suppression of weeds especially in no-till organic farming system.

INTRODUCTION

In organic farming, particularly in no-till agriculture, weed management practices are exigent. In a farming practice of crop rotation the following year after summer cash crops, the land is usually left fallow where the weeds resurge and become a problem to the farmer. A sustainable approach to handle such a situation is by using summer cover crops, which not only suppress weeds, but also help build soil organic matter, conserve soil moisture, boost microbial diversity and growth, reduce leaching losses of nutrients, minimize ground water pollution and importantly breaks disease and insect pest cycles. Wang et al., (2002) had reviewed research work on *Crotalaria* spp., a summer legume for its nematode and disease suppressive nature. Cover crops enhance sustainability of agricultural systems (Sainju et al., 2002), and reduce nitrate leaching (Di and Cameron, 2002). A positive relationship between cumulative absorption of radiation and dry matter was reported by McKenzie and Hill (1991). There is limited research on cover crop and weed biomass during the cover cropping period (Brennan and Smith, 2003). In this study, five summer cover crops were evaluated for light interception, biomass production and weed suppression.

OBJECTIVES AND HYPOTHESIS

Objectives:

- To evaluate five summer cover crops (sunflower, Sudan sorghum, buckwheat, velvet bean, Iron-clay peas) for their ability to compete for light with weeds against fallow control.
- To compare biomass of five summer cover crops and their effect on weed biomass compared to fallow.
- To estimate leaf area of five summer cover crops.
- To assess correlations among different parameters of five summer cover crops.

Hypothesis:

- ➢ Summer cover crops significantly compete for light and suppress weeds.
- ➢ Summer cover crop biomass affects weed biomass.
- ➢ There is no correlation between summer cover crops biomass, weed biomass, leaf area and light interception.

Table 1. Intercepted PAR (L*i*) and above ground biomass of summer cover crops

Cover Crop	Biomass (Mg ha^{-1})	L*i* (%)
F	0 ^{b}	74.0 ^{c}
VB	2.2 ^{ab}	51.0 ^{d}
BW	3.5 ^{ab}	86.5 ^{ab}
ICP	5.0 ^{a}	84.6 ^{abc}
SF	4.8 ^{a}	90.3 ^{a}
SS	6.3 ^{a}	75.6 ^{bc}

Table 2. Coefficient of correlation between different parameters of summer cover crops

Parameter	Coefficient of correlation (r)
Cover crop biomass *vs.* Li	+0.63 **
LA *vs.* Li	+0.33 ^{ns}
Li *vs.* weed biomass	-0.88 **
LA *vs.* weed biomass	-0.46 ns
Cover crop biomass *vs.* weed biomass	-0.72***

** and *** Significant at the ≤ 0.05 and 0.01 probability level, respectively; NS = Not significant; The mean values in each column followed by same alphabet are not significantly different; PAR = Photosynthetically active radiation;

MATERIALS AND METHODS

Location: Winfred Thomas Agricultural Research Station, Alabama A & M University, Hazelgreen Alabama.

Summer Cover Crops: 1. SF, Sunflower (*Helianthus annuus* L.); 2. BW, Buckwheat (*Fagopyrum esculentum* Moench); 3. Iron-clay peas (ICP), *(Vigna unguiculata* L., Walp). 4. VB, Velvet bean (*Mucuna pruriens* L.) and 5) SS, Sudan sorghum (*Sorghum bicolor* (L); CONTROL: F, Fallow.

Experimental Design: Randomized Complete Block with four replications of each treatment; **Net Plot Area**: 1m x 6m.

OBSERVATIONS AND MEASUREMENTS

Above ground biomass and leaf area (LA):

The above ground biomass of cover crops and weeds were collected separately from an area of 0.25 m^2 before flail mowing the cover crops. The leaf area was determined with leaf area meter (LI-COR 3100, LI-COR Inc., Lincoln, NE) Fresh and dry weights were recorded.

Photosynthetically Active Radiation (PAR):

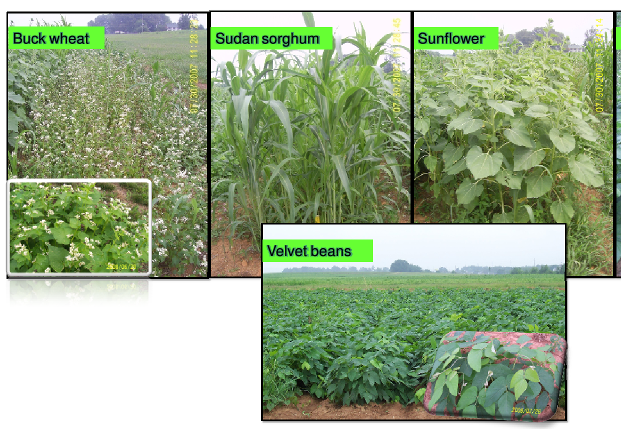
PAR was measured using AccuPAR LP80 (Decagon Devices, Pullman, WA, US). The incident and transmitted PAR was measured above and below the cover crop canopy, respectively. The transmitted radiation was calculated as the average of two measurements made perpendicular and parallel to crop row.

The percentage light intercepted by the crop canopy *(Li)* was calculated using the following equation:

$$Li = 1 - \left(\frac{PARt}{PARio}\right) * 100$$

Where L*i* = intercepted PAR; PARt = PAR transmitted to the bottom of the canopy; and PARio is total PAR incident upon the crop canopy.

Statistical Analysis: All data were analyzed using proc GLM procedures of SAS (2003). Means separation was done by the DMRT.



Summer cover crops used in this experiment

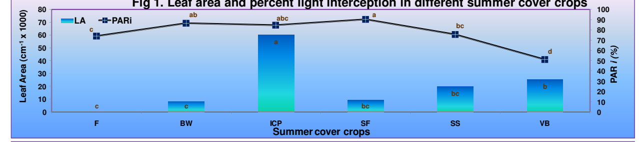


Fig 1. Leaf area and percent light interception in different summer cover crops

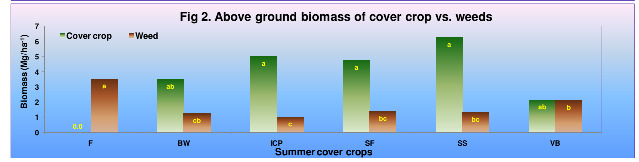


Fig 2. Above ground biomass of cover crop vs. weeds

The bars with same alphabets are not significantly different.

RESULTS

Leaf area index (LAI): There were significant differences for leaf area index among cover crops (Fig. 1). The LAI ranged from 0.82 for Buckwheat to 6.0 for Iron-clay-peas. Thus, ICP produced the highest leaf area index (6.0) than all other crops. Cover cops VB, SS, and SF had similar LAI.

Light interception (Li): The intercepted PAR ranged from 51% for VB to 90.3% for Sunflower (Fig.1). Sunflower with an LAI of 0.94 intercepted significantly higher incident PAR than other crops, perhaps due to its relatively larger individual leaf size. The intercepted PAR by buckwheat was similar to that of SF, but significantly higher than other crops.

Cover crop biomass: The cover crops ICP, SS and SF produced significantly higher biomass (4.8 - 6.3 Mg ha^{-1}) than buckwheat. Velvet bean produced the least biomass perhaps due to poor crop establishment. (Fig. 2)

Weed biomass: Compared to fallow (3.5 Mg ha^{-1}), the weed biomass in VB (2.1 Mg ha^{-1}) and ICP (1 Mg ha^{-1}) was significantly lower. Weed biomass in SF, SS, BW was similar (1.3 Mg ha^{-1}) but was significantly lower than that in the Control, fallow (Fig. 2).

Coefficient of Correlation: The cover crop biomass was significantly correlated with intercepted PAR (L*i*) (Table 2), where as weed biomass was negatively correlated with Li. Leaf area was positively correlated with L*i.* Summer cover crop biomass and weed biomass were negatively correlated. (Table 2) . Thus, cover crops with higher percentage intercepted PAR (L*i*) produced greater biomass than weeds and appeared to suppress weeds as indicated by lower weed biomass in cover crop plots.

CONCLUSIONS

✓Summer cover crops with higher light interception and greater biomass also reduced weed biomass significantly.

✓Iron-clay peas and Sudan sorghum were the best in weed suppression and biomass contribution.

✓The study showed the potential of summer crops as a sustainable means of managing weeds in organic production system. Also, the cover crops evaluated provide a choice of summer cover crop to suit the needs of an organic farmer.

ACKNOWLEDGEMENT

The authors thank Dr. Suresh Kumar for assisting in preparation of this poster, Mr. Lewis Bingham, and Mr. Altyn Kadirov for their assistance with field work.

REFERENCES

Akemo, M. C., E. E. Regnier, and M. A. Bennett. 2000. Weed suppression in spring-sown rye Boydston, R. A. and A. Hang. 1995. Rapeseed (*Brassica napus*) green manure crop suppresses weeds in potato (*Solanum tuberosum*). Weed Technol. 9:669–675.

Di, H. J., and K. C. Cameron. 2002. Nitrate leaching in temperate agroecosystems: sources, factors and mitigating strategies. Nutr. Cycl. Agroecosyst. 64:237–256.

Wang, Koon-Hui,B. S. Sipes, and D. P. Schmitt. 2002. *Crotalaria* as a cover crop for nematodemanagement: a review. http://brokert10.fcla.edu/DLData/SN/SN00995444/0032_001/35_58.pdf (Dated: 10-02-2009)

McKenzie, B.A. and G.D. Hill. 1991. Intercepted radiation and yield of lentils (*Lens culinaris*) in Canterbury, New Zealand.

Sainju, U. M., B. P. Singh, and W. F. Whitehead. 2002. Long-term effects of tillage, cover crops, and nitrogen fertilization on organic carbon and nitrogen concentrations in sandy loam soils in Georgia, USA. Soil Tillage. Res. 63:167–179.