JDA International, Inc.
Joint Development Associates
2695 Patterson Road - Unit 2 #188 - Grand Junction - Colorado 81506
Tel: 970 773 9720 Toll Free: 888 759 4071 Fax: 800 779 1703
E-mail: info@jdainternational.org Web: www.jdainternational.org

Document Date: 01/04/11
Document Type: Technical Notes
Author: Peter How peter@jdainternational.org

Cover Crops Improve Resource Management in Field Crop / Vegetable Rotations in Northern Afghanistan

Key words: cover crops; green manure; soil quality; low input agriculture; sustainable agriculture; conservation agriculture; fertility management; vegetable rotations; soil organic matter; water conservation.

Summary

Twelve cover crops were grown in 48 plots and assessed for their impact on a subsequent tomato crop grown without fertility inputs. Half of the plots were harvested before preparation for the subsequent tomato crop and half were plowed in. Since each crop x cutting treatment was only replicated twice, JDA analyzed crops in four categories: high yielding legumes, legumes, biomass producing crops, and fallow. For un-harvested treatments the subsequent tomato crop yielded highest to lowest: high yielding legumes at 31t ha, legumes at 29t ha, biomass producing crops at 28t ha, and fallow at 26 t ha. Tomato crops grown on ploughed in green manures out-yielded those grown on harvested plots by 20% ($p<0.001$). Hairy vetch, local clover, winter rye, and oil seed radish all performed excellently. The September sowing date was too late for mungbean or cowpea to establish properly as cover crops or to provide much soil cover. JDA recommends growing and further assessing select cover crops in partnership with innovative farmers for the period leading up to vegetable rotations.

Further research is justified: 1) to explore the potential of cover crops for more severely water limited environments, 2) to better understand what aspect is benefiting the following crop and what carries on to subsequent crops, and 3) to assess establishment rates for planting of different cover crops at different times in the cropping calendar.

Introduction

Soil quality, fertility, and water limitations are significant challenges to agricultural productivity in Northern Afghanistan. Soils are typically very low in organic matter and fertility inputs are limited or poorly used. Cover crops can have a productive benefit in vegetable rotations and may contribute to improve as sustainable cropping in Northern Afghanistan.

The value of crop residues for building feed or fuel means that in the case of wheat, for example, straw prices can be higher than grain prices in dryer years. This coupled with traditional rights of pastoralists to graze land following harvest in rainfed and semi-irrigated areas, means that straw is harvested as rigorously as the grain and soils are left bare and without organic matter. In many locations, rotations are very limited in diversity. When water is scarce, fallows leave the soil surface almost entirely bare for an extended period. These complex problems and their underlying contexts require multiple approaches. Under consideration is conservation agriculture.

One goal of JDA's work with cover crops is to prolong the time that the soil is covered. But JDA wants to extend benefits of cover crops by careful selection of species and management strategies. Cover crop has been used to:

- Trap soil moisture and infiltration
- Reduce soil erosion
- Improve soil structure and organic matter
- Catch and/or fix nitrogen levels
- Reduce soil temperature fluctuations
- Manage weeds and soil pests
- Improve conditions for following seedbeds
- Improve overall soil biology and increase beneficial fauna and flora

Managing cover crops may include plowing into the ground entirely as a green manure, or killed on the surface and sown directly into conservation agriculture systems. Cover crop can also be harvested for food, feed, fuel or fibre, a productive aspect that is likely important for the success of cover cropping in Afghanistan.

Materials and Methodology

Table 1: Cover crops, plot sizes, seed rates and notes for 2009/10 trials at Dedadhi.

Cover Crop	Plot Size m2	Seed Rate kg/ha	Notes
Sweet Clover	30.75	5.53	Breaks up hard soil
Crimson Clover	30.75	9.11	A late summer, winter dormant clover
Oilseed Radish	30.75	9.11	Breaks up soil, will tolerate temperatures of -6.6 C. Can be worked in

			just before flowering for soil-borne pest control: cyst and sting nematodes, avoid cold crops as a following crop.
NZ White Clover	30.75	3.65	Can be sown into crops - e.g. under sown into wheat. Persistent.
Cowpeas	30.75	29.3	Use seed rates of up to 56 kg/ha drilled, or 135 kg/ha broadcast
Hairy Vetch	30.75	32.5	Can grow with rye or oats for bio-mass production. Also sown late summer with field peas. Has strong spring re-growth for N fixation - good for working in before veg as green manure.
Ryegrass	30.75	14.6	May winter kill: sow in early spring / late summer: sow and rake to work in.
Mammoth Red Clover	30.75	7.31	Could be sown with grass or grain, spring summer or fall.
Winter Rye	30.75	40	Sow in fall for mid-summer grain or straw, sow any time up to mid fall as a cover crop.
Local Mung Bean	30.75	50	Grown after Wheat as a grain crop - will winter kill, will not establish if sown too late.
Local Clover	30.75	3.64	
Fallow	30.75	N/A	

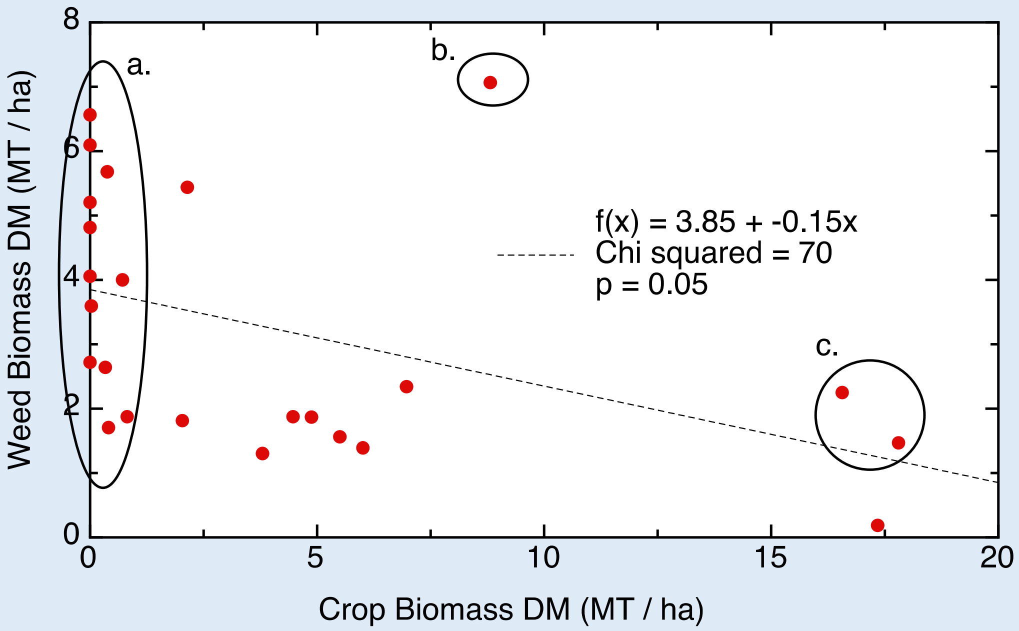
A number of cover crops (see table 1) were selected for growing in two observation blocks. For each crop, JDA measured: weeds, the rate of ground coverage, biomass production, and yield of the subsequent tomato crop.

Results and Discussion

The plotted linear regression (figure 1) shows that the weed biomass declined by 150 kg/ha of crop biomass increase. Variation in weed biomass at point a. where the crop failed to establish, a high weed value at b. which was for local clover and may have had weed contamination in the seed lot and the inclusion of root material for biomass of the crop at c. which are for oil seed radish account for a good deal of error and may underestimate the relationship. This relationship highlights the value of a managed crop for weed control between main crops; an important factor in fields where weeds are a major constraint.

Figure 1

Plot of Weed Biomass against Crop Biomass on a Dry Matter Basis



Replication of individual crops was not enough to analyse their direct and single effect on the following crop, so they were divided into four categories: biomass crops, fallow crops, high yielding legumes, and legumes. JDA can draw hypotheses about the value of the individual crops by evaluating the impact of biomass and nitrogen fixing separately, and for the four categories together. The 'fallow crops' included unsown treatment, cow peas and mung bean which were sown too late to establish and the yield resulted in significant amount of biomass from weeds.

The biomass of the four categories was as follows:

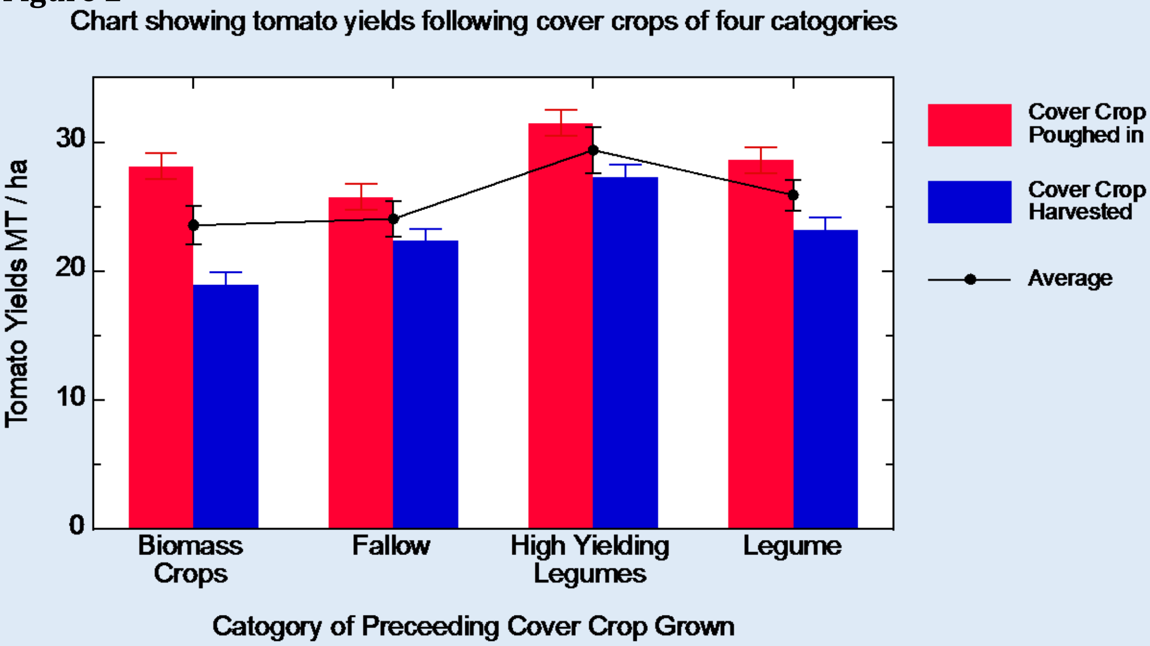
Category	MT / ha Biomass
Biomass	12.53
Fallow	4.91
High Yielding Legumes	9.57
Legumes	4.20

Yield of Subsequent Crop

Biomass

Tomato yields were consistently lower in cut rather than ploughed in cover crop plots $p<0.001$ across treatments, averaging nearly 20% less (figure 2).

Figure 2



Cover Crop Category

The type of cover crop impacted tomato yields at the p=0.031 level with high yielding legumes performing best, legumes, and then fallow and biomass crops, depending on whether the above ground crop is harvested or not (table 2). While the benefit of the biomass crop over a simple fallow is not shown here, it should be noted that the fallow plots had a good deal of weed enhanced by moisture seeping in from adjacent watered plots.

Individual Cover Crops and Discussion

Table 2: Tomato Yields for 12 Cover Crop Treatments: mt/ha

Cover Crop	Plowed In	Harvested	Average	Notes
Hairy Vetch	33.58	24.84	29.21	Excellent Biomass Produced
Local Clover	29.34	29.72	29.53	Excellent Biomass Produced
Sweet Crimson Clover	29.95	22.3	26.125	
Crimson Clover	28.93	24.76	26.845	
Mammoth Red Clover	28.34	20.04	24.19	
New Zealand Clover	27.18	25.63	26.405	
Winter Rye Grass	31.77	22.31	27.04	

Oil Seed Radish	30.93	16.65	23.79	Very quick establishment
Rye Grass	21.66	17.9	19.78	Needs improved killing
Local Mung Bean	29.72	21.42	25.57	Did not establish
Cow Pea	25.27	22.97	24.12	Did not establish
Fallow	22.23	22.65	22.44	

Two important and significant relationships were identified: 1) plowing in above ground biomass offered a very large yield advantage over harvesting for each category, and 2) the advantage of high yielding legumes over fallow plots was on average similarly important – around 20 % in both cases.

While replication did not allow rigorous statistical analysis directly on the individual cover crops, some findings are noteworthy:

Hairy Vetch, yielded higher than any other treatment when un-harvested. Oil seed radish established very rapidly and yielded more than 20% of the average yield when un-harvested. Winter rye and local clover also did well.

Suggested improvements in managing these cover crops include: earlier sowing, particularly for mung bean and cow pea and improved killing of the cover crop – particularly in relation to rye grass. Though the local clover plot had heavy weeds the biomass was high and tomato performed excellently. There may have been a problem with weed seed in the seed lot, otherwise, this is an excellent crop along with hairy vetch, oil seed radish, and rye.

Conclusions and Recommendations

In these tests only the simple effect of cover crops on the subsequent crop's yield was evaluated. Nitrogen dynamics, organic activity and weed control were likely part of the explanation for increased yields. Each of these will positively impact future crops as well as having other economic, environmental and human health benefits both short and long term.

More work is needed to improve our understanding of which crops work best in Northern Afghanistan; specifically the study of establishment speeds of different crops at various times of year, as well as the potential for these crops in semi-irrigated areas which are left fallow for one or two years at a time waiting for their turn to receive water.

Success of this work also demonstrates that it is ready to share with farmers for their own observations and development, particularly in the case of rotations that include spring vegetables.