Abstract presented at "XLVIII Convegno Nazionale della Società Italiana di Agronomia"
Perugia, 18-20 settembre 2019

Agronomic and Environmental Benefits of Cover Crops in Northern Italy

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Introduction

Cover crops have a number of benefits (reduction of nitrate leaching and of soil erosion, control of weed seed bank, increase of soil organic matter and increase of cash crop yield), but these were seldom quantified in cropping systems of Northern Italy. This experiment aimed to quantify some of these effects, by comparing cover crop species and their management techniques.

Materials and Methods

This two-year field experiment was carried out in four farms in the plain of Lombardia (Northern Italy). The farms differed for soil type, farm type, and tillage practices. The rotation was winter cover crops - maize - winter cover crops - maize and started in September 2017. In every farm, we compared pure cover crop species (and a control without cover crop), factorially combined in a split-plot or split-split-plot design with two replicates with other experimental factors (Table 1). For lack of space, we report only the average results of cover crop species.

Table 1. Farms and factors compared. DCM: Dairy cow, conservation agriculture, DCC: Dairy cow, conventional agriculture, CM1: Cereals, conservation agriculture, CM2: Cereals, conservation agriculture. Cover crop species: S: *Sinapis alba* (white mustard), A: *Avena strigosa* (black oat), R: *Raphanus sativus* (tillage radish), T: *Trifolium alexandrinum* (Egyptian clover), V: *Vicia benghalensis* (purple vetch).

Farm	Application (or not) of cow slurry before cover crop sowing	Disk harrowing or no-tillage before cover crop sowing	Cover crop species	Mechanic or chemical cover crop termination	Presence or absence of maize mineral N fertilization
DCM	X	X	S, A		
DCC	X	X	A, R		
CM1			T, V	X	X
CM2			A, S, T, V		X

To quantify cover crop effects we measured cover crop and maize above ground biomass (AGB), biomass N concentration (N-AGB), and soil mineral nitrogen concentration (SMN). We carried out these measurements at five dates: in autumn and at the end of winter we measured cover crop AGB (plus root biomass of tillage radish), N-AGB and SMN. At V6 maize stage, we measured AGB, N-AGB and SMN, and then AGB and N-AGB at maize harvest.

Results

Table 2 reports cover crop N uptake in late autumn when the cover crop biomass was at its maximum growth; N concentrations were (average of cover crop species and years): black oat (3.8%), control with no cover crop (2.6%), mustard (4.1%), tillage radish (3.6%), clover (3.6%), vetch (4.2%). These results show that mustard can uptake more than 100 kg N ha^{-1}. Black oat and tillage radish had variable results throughout locations and years but were never below 50 kg N ha^{-1}. The two legumes species had the

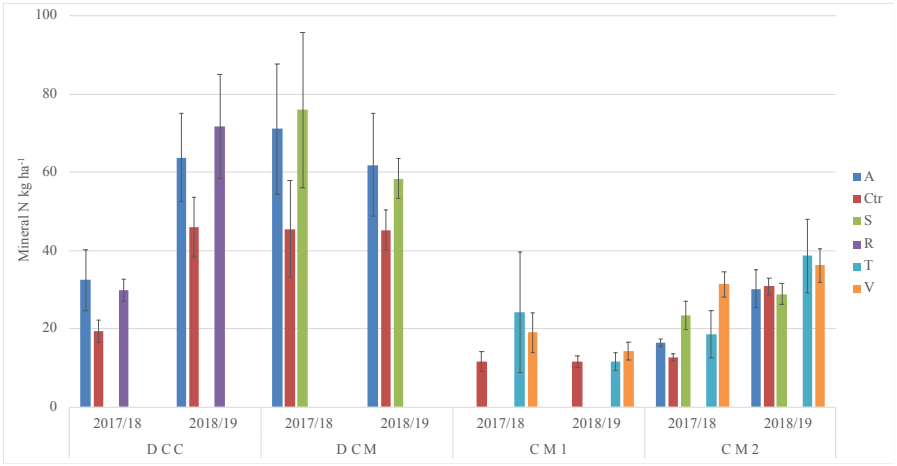
lowest N uptake except for CM2 where, in the second year, we corrected soil pH and added rhizobacteria before cover crop sowing, thus favoring vetch and clover N fixation. The low N uptake in the control treatment shows that cover crops can assimilate more N than weeds in fallow soil. Different tillage methods before cover crop sowing did not consistently influence their production. The SMN at the end of winter (Figure 1) was always lower in the control than in cover crop treatments, suggesting that part of cover crop N was released and made available before maize sowing. We did not find significant differences of maize AGB at harvest, except for the CM2 farm, where legume cover crop slightly increased the maize biomass.

Table 2. Cover crop nitrogen uptake in autumn (kg N ha^{-1}). Means with different letters within the same row are significantly different (P<0.05) according to the REGWQ significant difference test. For the abbreviations, see Table 1.

Farm/Year	No cover	A	S	R	T	V
DCC						
2017/18	23 a	115 b		140 c		
2018/19	10 a	62 b		63 b		
DCM						
2017/18	25 a	58 a	134 b			
2018/19	69 a	67 a	109 b			
CM1						
2017/18	5 a				14 a	34 b
2018/19	3 a				7 b	24 b
CM2						
2017/18	0	73 b	123 c		5 a	21 a
2018/19	3 a	58 b	51 b		54 b	61 b

Conclusions

In most cases, legume cover crops produced less biomass and took up less nitrogen than non-legume cover crops. In a different rotation – with a cash crop sown later in the spring – legume cover crops could continue their growth in spring and produce more biomass. In term of nitrogen dynamics, we make the hypothesis that some of the cover crop N uptake is made available at the end of winter and can be used during early maize stages, even though this effect depends on spring weather and on the timing of cover crop biomass degradation in soil. However, in the first year of the experiment we could not measure a cover crop effect on maize growth and nitrogen uptake.



Acknowledgments
BENCO project, funded by Regione Lombardia, PSR 2014-2020, Operation 1.2.01.