Conservation agriculture applied to temperate rice in Italy

Dario Sacco[1], Eleonora Cordero[1], Barbara Moretti[1], Gianluca Beltarre[2], Daniele Tenni[2], Marco Romani[2]

[1]Dept. of Agricultural, Forest and Food Sciences, University of Turin, Grugliasco, Italy

[2]Rice Research Centre, Ente Nazionale Risi, Castello d'Agogna, Italy

Introduction

Conservation agriculture (CA) is considered a best management practice for sustainable crop production (Zheng *et al.*, 2014). As for other cropping systems, CA techniques may be effective in rice cultivation, because of its potential benefits for labor saving and soil conservation (Huang *et al.,* 2015). Many studies have been undertaken to investigate the effect of CA and nitrogen (N) fertilization on rice yield and components (Huang *et al.,* 2015). However, environment and management conditions largely influence the obtainable results. The purposes of this study were to evaluate grain yield, yield components and N efficiency variability in Italian rice cropping systems related to: i) different conservation agriculture practices; ii) different N rates.

Materials and Methods

Two experiments have been tested in two different environmental conditions in Italy, aiming to introduce different conservation practices on temperate rice.

The first experiment was carried out from 2013 to 2016 in Crescentino (VC). Mean temperature recorded during the March-October growing season was 17.6°C, while total rainfall was 588 mm. The soil texture is loam. Three different tillage managements (sod seeding based on dry seeding and delayed flooding named sod dry seeding, sod seeding with water seeding, named sod wet seeding and conventional tillage with water seeding, named plowing) combined with three N levels (0-110-160 kg N ha^{-1}) were compared. The treatments were laid out in a split plot randomized complete block design replicated three times. The cultivar was CL 26, a long B grain variety.

The second experiment was established in Pieve Albignola (PV) from 2014 to 2016. Mean temperature was equal to Crescentino, while total rainfall was lower (454 mm). The soil texture is sandy loam. Three different tillage managements (conventional tillage named plowing, minimum tillage and sod seeding with water seeding named sod wet seeding), combined with three N rates (0-140-170 kg N ha^{-1}) were compared. The cultivar was Sole CL, a round grain variety.

In both experiments, grain yield normalized to a moisture content of 14% was determined at harvest. Moreover, yield components (i.e. panicle density, number of spikelets per panicle, 1000-grain weight and sterility) were calculated.

Results and discussion

In both experiments, a grain yield reduction was highlighted when sod seeding was applied (*Figure 1*). The yield reduction with respect to plowing was about 16% in Crescentino and 13% in Pieve Albignola. Minimum tillage in Pieve Albignola obtained instead a grain yield similar to conventional tillage.

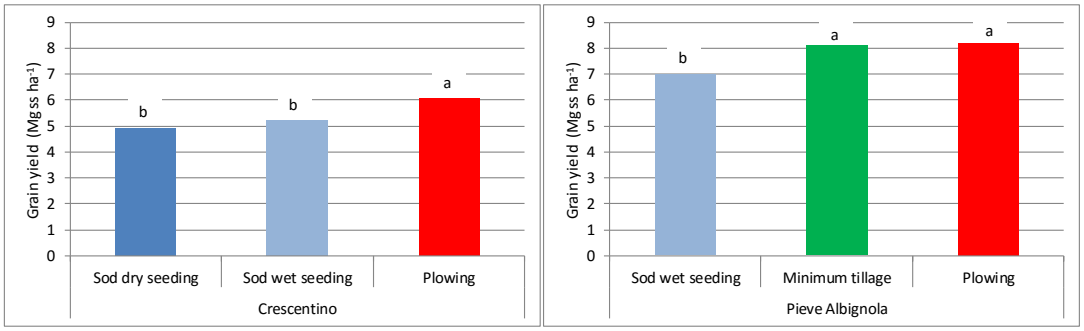

Figure 1: Effect of different tillage management on grain yield

Sod seeding generally provoked a lower panicle density. Consequently, rice developed a higher number of spikelets per panicle that, even if combined with the lower sterility, was not sufficient to avoid yield reduction (*Table 1*).

Table 1: Effect of different tillage management on grain yield components

Experimental site	Tillage management	Panicle density (Panicle m^{-2})	1000-grain weight (g)	Spikelets number per panicle (n°)	Sterility (%)
Crescentino	Plowing	668 a	22.2	95 b	14.9 b
	Sod dry seeding	428 c	22.1	139 a	24.5 a
	Sod wet seeding	530 b	22.3	110 b	16.9 b
Pieve Albignola	Plowing	486 a	24.4 b	145 b	16.1 a
	Minimum tillage	482 a	24.9 a	142 b	13.7 b
	Sod wet seeding	399 b	25.0 a	162 a	10.3 c

No differences were highlighted between the two different sod seeding techniques used in the Crescentino experiment, that showed similar grain yield levels. The higher number of spikelets per panicle in sod dry seeding was compromised by the higher sterility.
In Crescentino experiment, agronomic N supply did not significantly affect grain yield (*Figure 2*).

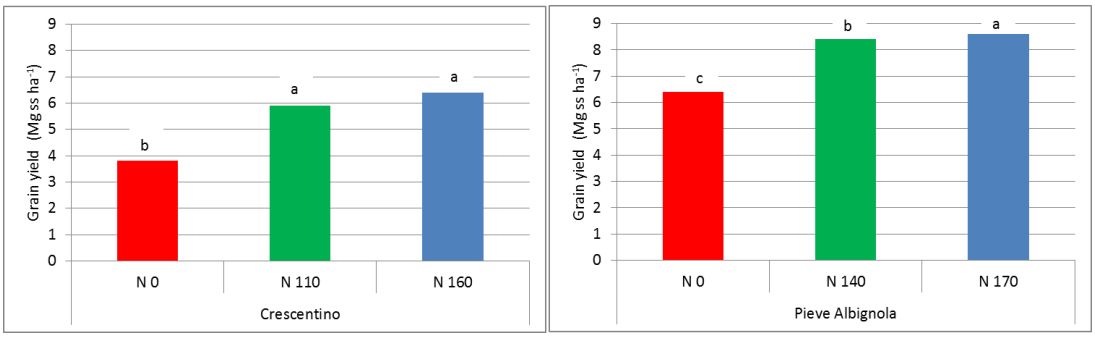

Figure 2: Effect of different N rates on grain yield

However, in Pieve Albignola experiment a higher amount of N supplied during the growing season lead to a grain yield increase. In both experiments no interaction between N fertilization and tillage management were highlighted.

Conclusions

Conservation agriculture techniques compared to conventional tillage showed similar grain yield levels with minimum tillage, but a grain yield reduction was detected with sod seeding (-14%). In this practice, the lower panicle density significantly compromised grain yield as was not sufficiently compensated by the higher number of spikelets per panicle.
Grain yield losses may be limited by increasing N fertilization related to pedoclimatic conditions. However this practice could reduce rice N efficiency.

References

Huang, M.; Zhou, x., Cao, F., Xia, B., Zou, Y. (2015). *No-tillage effect on rice yield in China: a meta-analysis.* Field Crops Research 183:126-137.

Zheng, C.; Jiang, Y., Chen, C., Sun, Y., Feng, j., Deng, A., Song, Z., Zhang, W. (2014). *The impacts of conservation agriculture on crop yield in China depend on specific practices, crops and cropping regions.* The crop journal 2:289-296.