Influence of tillage techniques on rice weed dynamics

F. Vidotto[(1)], S. Fogliatto[(1)], M. Milan[(1)], F. De Palo[(1)] and A. Ferrero[(1)]

(1) Università degli Studi di Torino, Dipartimento di Scienze Agrarie, Forestali e Alimentari. Largo Braccini, 2, 10095 Grugliasco (TO), Italy.
This work was supported by Regione Piemonte, Assessorato Agricoltura, Tutela della Fauna e della Flora.

***ABSTRACT** - Tillage practices may have a significant influence on weed presence in rice fields. The aim of the present study was to evaluate the influence of no tillage practice on the evolution of weed community composition and soil seedbank in rice. The following tillage systems were compared: conventional plowing with water seeding (CPW), no-tillage with water seeding (NTW) and no-tillage with dry seeding (NTD). The study was carried out in 2012-2014 at Crescentino, north-west of Italy, in a rice field divided in nine plots. Weed assessments were done in untreated areas of each plot. The adoption of different tillage systems showed an influence on weed infestations mainly in terms of total weed density with NTW showing the highest and CPW the lowest. The diversity indices highlighted a high diversity in the CPW plots, and the dominance of Echinochloa crus-galli and weedy rice in non-tilled plots. An increasing trend of the weed seed bank density was recorded particularly in NTW.*

***KEY WORDS** - no tillage; weed density; seedbank.*

INTRODUCTION

Conservation agriculture is a set of agricultural practices that aim to preserve soil structure as well as other natural resources (water, biodiversity), guaranteeing a profitable crop production [1]–[2]. These practices include different types of soil tillage, such as minimum tillage or no tillage [3].

Conservation agriculture is widely spread worldwide (about 155 million of hectares in 2013), especially in some areas such as Brazil and the US; in Italy its adoption is still limited mainly because the presence of small farm sizes and the farmers' concern about the crop productivity [4].

In rice cropping system, the adoption of conservation agriculture can reduce greenhouse gas emission, water and fuel consumption and improve soil degradation [5]. In Europe rice is totally direct-seeded and rice fields are mostly conventionally plowed. Tillage has an influence on rice weeds by changing the weed seed distribution along soil profile; the transition to minimum or no till conditions may concentrate weed seeds on the soil surface and stimulate some weed seeds to emerge and thus changing the weed species composition of the infestations [6]. The aim of the present study was to evaluate the influence of no tillage practice on the evolution of weed community composition and soil seedbank in rice.

MATERIAL AND METHODS

The study was carried out in the period 2012-2014 at Crescentino (VC) (north-west of Italy), in a rice field divided in nine plots (3 reps per system) of about 1600 m2 each.

The following tillage systems were compared: conventional plowing with water seeding (CPW), no-tillage with water seeding (NTW) and no-tillage with dry seeding (NTD). In the CPW plots, plowing was carried out in April of each year, while seeding was performed in all the plots in the middle of May.

Weed assessments, in terms of plant density, were performed in untreated areas randomly chosen within each plot three times during the growing seasons (tillering, stem elongation and flowering).

Weed seed bank was determined by taking 10 soil cores per plot at 0-20 cm depth. Soil samples were layered on plastic trays, kept moist in greenhouse and weed emergences were recorded for more than a year.

RESULTS AND DISCUSSION

The adoption of different tillage systems showed an influence on weed infestations mainly in terms of total weed density (Fig 1). The highest weed density was recorded in NTW particularly in 2013 and 2014, with plant density above 220 plants m-2; NTD showed a similar density even if slightly lower, while CPW recorded the lowest density every year.

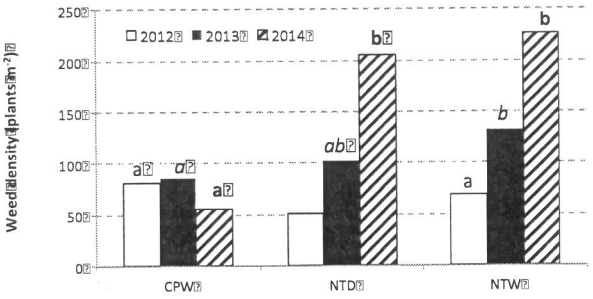

Fig. 1. Weed density (plants m-2) in the three tillage systems at 75 days after sowing across the years of experiment. Treatments sharing the same regular, italic, or bold letters showed no significant differences according to REGWF test (P≤0.05).

Over the years the weed density showed a growing trend both in NTD and NTW, while in CPW was more stable. The major weed species found in CPW were *Heteranthera reniformis*, *Ottelia alismoides*, and *Cyperus difformis*, while in NTD and NTW the most represented weeds were *Oryza sativa* (weedy rice), *Echinochloa crus-galli*, and *Cyperus difformis* particularly in NTW. Some weeds showed a density increase at the end of the experiment; in particular, E. crus-galli density in NTD

grew from 10 plants m-2 in 2012 to about 50 plants m-2 in 2014 and in NTW from less than 10 plants m-2 to more than 100 m-2 in the same years, while the density was stable at about 5 plants m-2 in CPW. Weedy rice density also increased, but only in NTW, where it increased from 20 plants m-2 to almost 80 plants m-2 at the end of experiment, while *H. reniformis* increased in density only in CPW.

In general, weed composition was more diversified in CPW, while a reduced number of weed species was found in the other systems (NTW and NTD). This was also confirmed by the calculation of the diversity indices (Simpson, Shannon-Weiner indices and transformation coefficient). In particular, Simpson index showed *a dominance of E. crus-galli in NTD and of E.* crus-galli and weedy rice in NTW, while Shannon-Weiner index revealed a higher diversity in CPW. The transformation coefficient highlighted that more than 60% of the species changed between the beginning and the end of the study in NTD and NTW, while only 20% of the species changed in CPW.

Initial weed seed bank was comprised between about 3650 seeds m-2 (NTW) and about 5170 seeds m-2 (NTD) (Fig. 2). After the experiment, seed bank density increased in all the tillage systems but particularly in NTW, reaching almost 8000 seeds m-2.

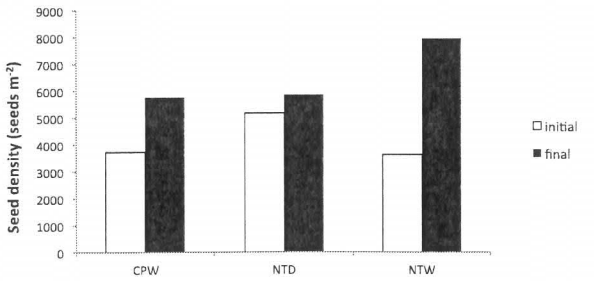

Fig. 2. Weed seed bank density (seeds m-2) in the three tillage systems at the beginning and at the end of the experiment at soil depth 0-20 cm.

The major seed bank weeds were: *Cyperus difformis*, *Lindernia dubia*, *Eleocharis* spp., *Echinochloa crus-galli* and *Ottelia alismoides*.

In general, weed composition resulted more diversified in CPW, while a reduced number of weed species characterized the other systems (NTW and NTD). Moreover, no tillage favoured the emergence of weedy rice and *E. crus-galli*, which are some of the most troublesome weeds in rice fields. Weed seed bank increased particularly in no tilled plots because weed seeds were concentrated on the soil surface.

The study highlighted that the rice weed community dynamics may vary under the different tillage techniques.

REFERENCES

[1] Knowler D and Bradshaw B 2007. *Farmers'adoption of conservation agriculture: a review and synthesis of recent research. Food Policy* **32** 25-48.

[2] FAO 2015. *What is conservation agriculture* [Online]. Available: http://www.fao.org/ag/ca/1a.html

[3] Palm C, Blanco-Canqui H, DeClerck F, Gatere L, and Grace P 2014. *Conservation agriculture and ecosystem services:an overwiew*. Agriculture, Ecosystems & Environment **187** 87-105.

[4] Kassam A, Friedrich T, Shaxson F, Bartz H, Mello I, Kienzle J and Pretty J 2014. The spread of conservation agriculture: policy and institutional support for adoption and uptake. Field actions **7** [Online]. Available: http://www.factsreports.revues.org/3720

[5] Metay A, Alves Moreira JA, Bernoux M, Boyer T, Douzet JM, *et al.* 2007. *Storage and forms of organic carbon in a no-tillage under cover crops system on clayey Oxisol in dryland rice production (Cerrado, Brazil). Soil and Tillage Research* **94** 122-132.

[6] Chauhan B S, Johnson D E 2009. *Influence of tillage systems on weed seedling emergence pattern in rainfed rice. Soil and Tillage Research* **106** 15-21.