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Short Communication

Influence of Zinc and Boron Application on Weed Dynamics in No Till and Plough Till Wheat

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Abstract

Tillage practices have strong impact on the weed infestation and weed dynamics in field crops. In this study, consisted of two independent experiments, influence of zinc (Zn) and boron (B) application on weed dynamics in wheat planted in long-term (maintained for the last seven years) no tillage (NT) and plough tillage (PT) systems was evaluated. In the first experiment, Zn was applied as foliar spray (0.025 *M*), soil application (10 kg ha^{-1}) and seed priming (0.5 *M*); while in second experiment, B was delivered as soil (1 kg ha^{-1}) and foliar applications (0.01 *M*) and seed priming (0.01 *M*). No Zn and B application were taken as control in first and second experiment, respectively. In both experiments, the most important weeds identified were sweet clover (*Melilotus indica* L.) and little seed canary grass (*Phalaris minor* L.). Application of Zn and B did not have significant effect on the weed infestation. In first experiment, NT wheat had less total weed density (40% and 48%) than PT wheat during 2016-2017 and 2017-2018, respectively. No tillage reduced the density of sweet clover by 54% and 29% and density of little seed canary grass by 22% and 30% during first and second years, respectively compared with PT system. In second experiment, density of total weeds was higher (30%) in PT than NT wheat during both years. Zero tillage had lower density of sweet clover (47 and 33%) and little seed canary grass (28 and 40%) during 2016-2017 and 2017-2018, respectively. In conclusion, switching from conventional tillage to conservation tillage may help reducing the weed infestation in wheat. However, application of Zn and B didn't influence the weed infestation in wheat established under conventional tillage (PT) and conservation tillage (NT) systems.

Keywords: Conservation tillage; Little seed canary grass; Micronutrients; Sweet clover

Introduction

Weeds pose threat to wheat production causing 40-50% reduction in grain yield (Avery, 2006; Oad *et al*., 2007). Although, the tillage helps manage weeds, it also brings the weed seeds on upper soil surface and expose seed to sunlight (Singh *et al*., 2012; Shahzad *et al*., 2016a). This triggers the germination of deeply buried weeds seed.

Conservation agriculture such as no tillage (NT) are getting momentum and has evolved as alternate sustainable production system (Haider *et al*., 2016; Shahzad *et al*., 2016b) for wheat in rice-wheat system (Mishra and Singh, 2012). However, heavy weeds infestation is serious constraint in NT system during initial years of adaptation (Sosnoskie *et al*., 2006). Difference in weed infestation in conventional and conservation production systems is attributed to change in emergence pattern of weeds over the growing seasons (Samarajeewa *et al*., 2005). In NT, crop residue of preceding crop is maintained on the soil surface that helps suppressing the weeds and improving the system productivity (Singh *et al*., 2015). Residue retention act as mulch, changes the soil microenvironment (Erenstein, 2003), prevent light stimulus, and avoid the soil temperature fluctuations and N mineralization (Franke *et al*., 2007) that causes weed suppression (Chhokar *et al*., 2007). Moreover, under NT, a crust layer is developed on the soil surface; increase the soil strength that impede weed seeds to emerge (Chhokar *et al*., 2007).

Widespread deficiency of zinc (Zn) and boron (B) in rice-wheat cropping system of Indo-Gangetic plains is another yield limiting factor in this region (Rehman *et al*., 2018a, b). While application of Zn and B may help tackle the deficiency issues of these micronutrients (Farooq *et al*., 2018; Rehman *et al*., 2018a, b), this may trigger the weed infestation. In our earlier studies, we monitored the weed spectrum and distribution in wheat planted in conventional and conservation tillage systems (Farooq and Nawaz, 2014; Shahzad *et al*., 2016b). However, to the best of our knowledge, information on the influence of Zn and B application on weed dynamics in wheat planted under

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long-term NT and PT systems is lacking. For this study, this was hypothesized that Zn and B application may influence the weed dynamics in wheat planted under long-term NT and PT systems in rice-wheat cropping systems.

Materials and Methods

Site and Soil

In this study, two independent field experiments were conducted at CMB Farm (longitude 74.53°E, 32.51°N), Sialkot, Pakistan during 2016-2017 and 2017-2018. The experimental soil was silt loam with pH 8.0, electrical conductivity (EC) 0.20 dS m^{-1}, total nitrogen 0.044%, available phosphorus 7 ppm, exchangeable potassium 110 ppm and total soil organic matter 0.69%.

The climate of the experimental site is humid sub-tropical with mean temperature ranged from 9°C to 33°C during the crop growth period whereas total rainfall of 325 mm and 267 mm were received during first and second crop growth period.

Experimental Details

Seed of wheat cultivar "Ujala-2016" were procured from Punjab Seed Corporation, Faisalabad Pakistan. Both experiments were laid down in split plot design with three replications. In both experiments, wheat was planted in NT and PT systems. For NT system, wheat seeds were drilled directly into the soil in the stubbles of previous crop. While in PT system, the field was prepared using tractor mounted cultivator (up to 20 cm depth) following planking and wheat was sown using drill method. In first experiment, Zn was applied as seed priming (0.05 *M*), soil application (10 kg ha^{-1}) and foliage spray (0.025 *M*) using $ZnSO_4$ as source. Whereas, in second experiment, B was delivered as soil application (1 kg ha^{-1}), seed priming (0.01 *M*) and foliar application (0.01 *M*) using source H_3BO_3. Foliage application was done at leaf boot stage. Whereas, no Zn and B application was taken as control in first and second experiment, respectively.

Crop Husbandry

The crop was sown on November 20, 2015 and November 24, 2016 during first and second years, respectively using seed rate of 100 kg ha^{-1} in 22.5 cm spaced rows. Fertilizers were applied, based on soil analysis report, at 100-90-75 N, P, K kg ha^{-1} using urea (46% N), diammonium phosphate (46% P, 18% N) and sulfate of potash (50% K), respectively as sources. One third N and whole amount of P and K were applied as basal dose, while the remaining N was applied in two equal splits with first and second irrigation. In total, four irrigations were applied during the crop growth period. At harvest maturity, wheat crop was harvested on April 22, 2016 and April 25, 2017 during first and second years, respectively.

Observations and Measurements

The experimental field was visited 45 days after sowing to record density and biomass of individual and total weed present in the field. At three different points each measuring 1 m × 1 m, weeds were collected, identified and counted to record weed density. The collected samples were dried in an electric oven, till constant weight, to record the weed dry weight. For each treatment in both experiments, sum of all weeds, density as well as dry weight, were recorded as total weed density and dry weight, respectively.

Results

Experiment 1

Analysis of variance indicated that tillage systems significantly affected the density and biomass of total weeds and density of sweet clover and little seed canary grass. However, Zn application methods did not influence any of the weed attributes significantly. The interaction of TS × Zn was also non-significant for the density and biomass of total weeds and density of sweet clover and little seed canary grass (Table 1). Density and biomass of total weeds and density of sweet clover and little seed canary grass were lower in NT than the PT during both growing seasons (Fig. 1 and 2). The density and biomass of total weeds were lower during 2016-2017 than 2017-2018 (Fig. 1).

Experiment 2

Analysis of variance indicated that tillage systems significantly affected the density and biomass of total weeds as well as densities of sweet clover and little seed canary grass. However, B application methods had no significant effect on the total and individual weed biomass and density during both growing seasons. Likewise, the interaction of TS × B for the density and biomass of total weeds and densities of sweet clover and little seed canary grass was also non-significant for (Table 2). The density and biomass of total weeds and density of sweet clover and little seed canary grass were lower in NT system than the PT systems during both years (Fig. 3 and 4).

Discussion

The hypothesis of this study was not accepted as Zn and B application didn't influence the weed dynamics in wheat planted under long-term NT and PT systems. Plausibly, application of Zn and B had similar effect on the wheat and weeds, in both tillage systems, thus the influence of these micronutrients on weeds was neutralized (data not given). However, tillage systems significantly differed for weed infestation.

Table 1: Analysis of variance for the influence of zinc application on density and biomass of total weeds, and density of sweet clover and little seed canary grass in wheat planted in conventional and conservation tillage systems

Source of variation	DF	Total weed density		Total weed biomass		Sweet clover density		Little seed canary grass density	
		2016-2017	2017-2018	2016-2017	2017-2018	2016-2017	2017-2018	2016-2017	2017-2018
Replication	3	23.28	58.25	2.52	0.05	7.54	4.86	10.03	31.86
Tillage system (TS)	1	913.78**	1081.12**	46.75*	5.79**	78.12*	108.78*	457.53**	504.03**
Error	3	4.28	16.87	3.51	0.15	3.70	8.28	6.61	10.03
Zinc application (Zn)	3	2.36ns	10.58ns	1.79ns	0.69ns	0.70ns	2.61ns	1.03ns	11.86ns
TS × Zn	3	16.86ns	3.37ns	2.33ns	0.35ns	1.70ns	1.86ns	11.78ns	1.86ns
Error	18	16.92	16.98	2.60	0.41	2.26	5.15	13.62	12.22
Total	31								

DF = Degree of freedom; ns = non-significant; ** = significant at $p \leq 0.01$; * = significant at $p \leq 0.05$

Table 2: Analysis of variance for the influence of boron application on density and biomass of total weeds, and density of sweet clover and little seed canary grass in wheat planted in conventional and conservation tillage systems

Source of variation	DF	Total weed density		Total weed biomass		Sweet clover density		Little seed canary grass density	
		2016-2017	2017-2018	2016-2017	2017-2018	2016-2017	2017-2018	2016-2017	2017-2018
Replication	3	18.083	1.365	1.127	0.198	7.791	7.583	16.541	3.531
Tillage systems (TS)	1	364.500**	185.281*	92.106**	101.033**	91.125*	24.500*	91.125**	75.031*
Error	3	9.750	5.615	0.942	0.962	6.791	1.416	0.708	4.781
Boron application (B)	3	23.417ns	6.865ns	1.852ns	2.686ns	8.750ns	8.583ns	24.125ns	10.114ns
TS × B	3	5.083ns	2.115ns	0.877ns	1.998ns	1.875ns	5.083ns	3.125ns	3.031ns
Error	18	14.361	4.045	0.601	0.875	4.486	3.277	10.180	4.322
Total	31								

DF = Degree of freedom; ns = non-significant; * = significant at $p \leq 0.05$; ** = significant at $p \leq 0.01$

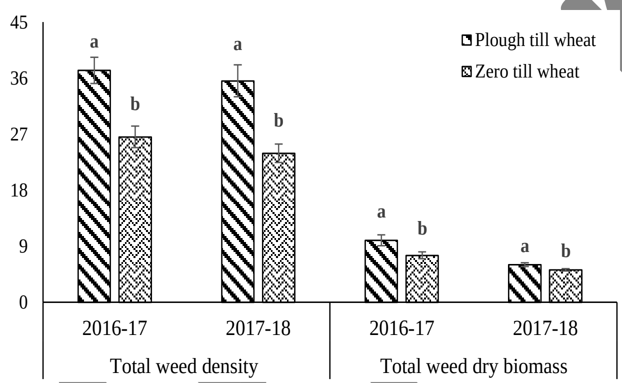

Fig. 1: Density (m^{-2}) and biomass (g m^{-2}) of total weeds in wheat planted in conventional and conservation tillage systems at 45 days after sowing

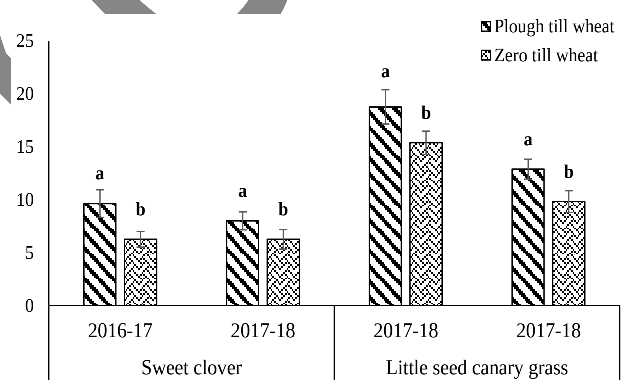

Fig. 2: Density (m^{-2}) of sweet clover and little seed canary grass biomass in wheat planted in conventional and conservation tillage systems at 45 days after sowing

Change in tillage methods strongly influences the weed spectra and distribution. Weed flora and their abundance changes while switches from PT to NT system as was observed in this study. Although tillage help to reduce the weeds population by uprooting, brings buried weed seeds back to upper soil surface and exposes to light and predators (Swanton *et al.*, 2000). However, tillage also improves the weeds emergence by providing suitable physical environment. However, NT system reduced the total and individual densities of weeds and total weed biomass as growth and germination of several weed species is inhibited due to residue retention of previous crop (Gupta and Seth, 2007), which affect the suitable condition for germination like temperature, moisture and light (Bhullied *et al.*, 2003). Zero tillage in wheat help to suppress 51.3% weeds; moreover, density of little seed canary grass was reduced by 10.5% in NT than PT system (Usman *et al.*, 2009). Weeds such as little seed canarygrass and sweet clover dominate under PT system (Fig. 1 and 3); while in case of zero tillage, these weeds disappear because tillage induce changes in weed seed distribution due to which seed may lose its viability. Chhokar *et al.* (2007), NT in wheat effectively suppress the infestation of little seed canary grass as observed in this study.

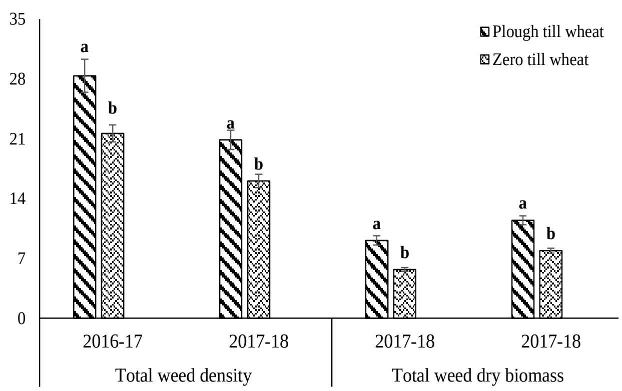

Fig. 3: Density (m^{-2}) and biomass (g m^{-2}) of total weeds in wheat planted in conventional and conservation tillage systems at 45 days after sowing

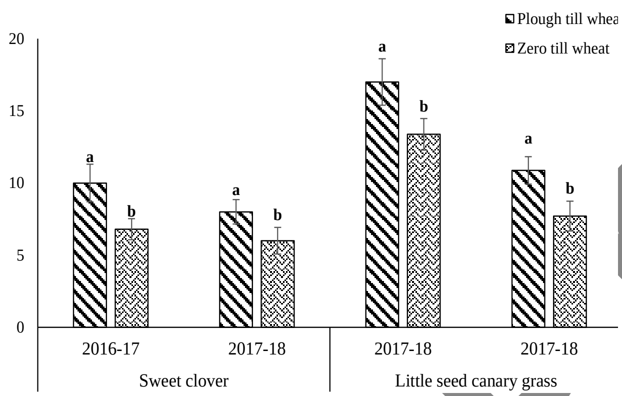

Fig. 4: Density (m^{-2}) of sweet clover and little seed canary grass biomass in wheat planted in conventional and conservation tillage systems at 45 days after sowing

Crop residue cover in NT systems act as physical barrier that prevent light penetration to weed seeds and their emergence. The unavailability of light because of residue layer suppress weed seedling emergence; as germinated seed search for light and deplete its energy reserves due to which it become more etiolated and weak (Crutchfield *et al.*, 1986). Moreover, the radicle of germinated weed experience difficulty to penetrate in no-tilled soil resulting in lethal germination (Mohler, 2001). Lower weed density in NT wheat may be due to allelopathic suppression (Jung *et al.*, 2004) of previous rice crop as wheat sown in rice residues have low weed pressure (Fig. 1; Sharma *et al.*, 2008). Surface residue retention changes the soil physical and chemical environment (more soil aeration, temperature fluctuations) that affect the weed seed germination (Mohler, 2001). On the other hand, tillage provide seed germination stimuli such as fluctuating temperature, scarification, light, high nitrate to break seed dormancy and ambient CO_2 concentration (Benech-Arnold *et al.*, 2000) that help weed seed to emerge as crop germination start.

Conclusion

In conclusion, Zn and B application in wheat planted in long-term NT and PT system did not influence the weed dynamics. However, shifting from conventional to conservation tillage caused significant reduction in weed infestation in wheat.

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