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Full Length Article

Seed Bank Density and Weed Flora Dynamics of Bindweed (*Convolvulus arvensis*) as Affected by Different Tillage Systems in Rainfed Wheat (*Triticum aestivum*)

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Abstract

Field bindweed (*Convolvulus arvensis* L.) is a troublesome weed of rainfed areas. Seed bank density, weed population dynamics and crop productivity were studied in wheat crop under different tillage treatments in a field experiment carried out during summer and winter seasons of 2012–2013 and 2013–2014. Different combinations of tillage, integrated with glyphosate herbicide were used in the fallow period (summer season). Results showed that tillage systems along with glyphosate in summer season controlled the establishment of seed bank density as observed in conventional tillage treatment. There was a positive and very week correlation between tillage intensity and seed bank density of *C. arvensis* L. Similarly the weed population dynamics with reference to importance value index of weed was minimum in 1 Disc harrowing + 4 cultivations that was not significantly different from no-till + glyphosate. Tillage intensity integrated with glyphosate showed negligible but negative correlation with the weed population dynamics. In crux, no tillage integrated with glyphosate is recommended for economical reduction of seed bank density and weed population of field bindweed in rainfed wheat areas.

Keywords: Deep tillage; Glyphosate; No-tillage; Field bindweed; Wheat

Introduction

Wheat (*Triticum aestivum* L.) being staple food of millions of peoples is a major winter crop of rainfed areas of Pakistan (Hayat and Ali, 2010). In 2014, it contributed 2.2% to GDP and 10.3% to the value addition in the agriculture of Pakistan (GOP, 2014). In Punjab, it was grown on an area of 9.039 m ha with production of 25.3 m tones having average yield of 2.797 t ha^{-1}; whereas, in rainfed areas, it was cultivated on an area of 0.5491 m ha with production of 0.4313 m tones having average yield of 1.005 t ha^{-1} in Punjab Province (GOP, 2013).

It is reported that wheat can yield more than 2.965 t ha^{-1} in rainfed areas (Ashraf *et al.,* 2007). However, average per hectare yield remains extremely low due to scarce soil moisture, low soil fertility and dense weed infestation (Razzaq *et al*., 2002; Naz *et al.,* 2010; Ahmad *et al.,* 2011). According to a survey, 28.8% of the farmers reported weeds as a major problem of wheat crop and 29% wheat yield can be increased by controlling weeds (Khan *et al*., 2011).

Among different weed species of rainfed areas, field bindweed (*Convolvulus arvensis* L.) is troublesome and to eradicate it repeated tillage remains insufficient (Jurado-Exposito *et al*., 2005). Just like other weeds it competes with crop plants for moisture, sunlight and nutrients. It's deep and extensive root system assimilates carbohydrates and proteins, which support it to sprout repeatedly from fragments and rhizomes even after removal of aboveground vegetation, therefore, it is difficult to eradicate this weed (Liebman *et al*., 2001).

Various weed control methods are being practiced to eliminate weeds in various crops in rainfed areas. Tillage is often used as a weed control system but with the development and widespread adoption of minimum and zero-tillage systems the effects of tillage on weed dynamics are becoming more important and weeds management problem is more expected in zero-till and reduced tillage systems (Ali *et al*., 2014). Although, conservation tillage conserves soil moisture, protects soil from erosion, increases the amount of rain harvested moisture and decreases soil evaporation (Gencsoylu and Yalcin, 2004). But weeds are still a big threat to adaptation of these tillage systems. In a study, Rusu *et al*. (2006) observed highest population of *C. arvensis* in minimum tillage system whereas; increase in the frequency of perennial weeds has been reported in no tilled fields for more than one year (Kobayashi *et al*., 2003). However, perennial weeds are significantly declined under conventional tillage (Demjanova *et al*., 2009). Moreover,

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tillage systems significantly affect the composition of weed flora and weed biomass. Jurado-Exposito *et al*. (2005) reported that the population growth rate of *C. arvensis* has a moderate degree of aggregation in patches that does not remain stable temporally. Keeping in view, weed population dynamics of *C. arvensis* under different tillage systems in our agro-ecological system of Pothwar Region in Pakistan seems to be very much important to design its future weed management strategies. Therefore, the objective of this study was to assess the effect of different tillage systems alone or integrated with glyphosate (a non-selective herbicide) applied at fallow period on seed bank and the population dynamics of *C. arvensis* under rainfed conditions in wheat. Ultimately, these findings could be used in future for better weed management strategies in rainfed areas.

Materials and Methods

Experimental Site and Design

The proposed study was conducted on sandy loam soil of Udic Haplustalfs group at Research Farm of Arid Agriculture University Rawalpindi (latitude 33°N, longitude 73° and altitude 500 masl), Pakistan. The experiment was carried out for two years during the summer and winter seasons of 2012–2013 and 2013–2014.The experimental soil possesses following properties (EC= 0.92 dS cm^{-1}; pH= 7.20; organic matter= 0.63%; saturation percentage= 36%; available phosphorus= 5.32 mg kg^{-1}; available potassium= 100 mg kg^{-1}). To select a representative and weed infested field, the experimental area was surveyed one year before experiment. Seed of wheat cv. Chakwal-50 (high yielding, drought tolerant and disease resistant) obtained from Barani Agricultural Research Institute Chakwal was sown on October 23, in 2012 and on October 28, in 2013 in 22.5 cm apart rows. N-P-K fertilizers were applied at the rate of 90-60-60 kg ha^{-1} respectively using urea (46% N), di-ammonium phosphate (DAP) (18%N, 46% P_2O_5) and sulfate of potash (50% K_2O) as sources respectively. Whole phosphorus and potash was applied at the time of seed bed preparation but nitrogen was applied in two splits, first at sowing and second at tillering stage (as per availability of rainfall). The experiment was laid out in randomized complete block design having four replications with a net plot size of 13.5 m × 13.5 m.

Experimental Treatments

Different combinations of tillage, integrated with glyphosate herbicide were used in this study. The experiment consisted of following treatment combinations viz. T_1 = 1 MB plowing + 8 cultivations, T_2 = 1 MB plowing + 4 cultivations, T_3 = 1 disc harrowing + 4 cultivations, T_4 = 1 chisel plowing + glyphosate, T_5 = 1 MB plowing + glyphosate, T_6 = 1 disc harrowing + glyphosate, T_7 = no-till + glyphosate.

In first treatment, deep tillage with moldboard plough at the onset of moon soon was done followed by eight shallow cultivations with cultivator applied after each rainfall including seedbed preparation. Likely, in second treatment, one moldboard plowing was done at the onset of monsoon followed with four cultivations including preparatory tillage. In third treatment, disc-harrowing was applied after the 1^{st} flush of weeds followed by four cultivations including preparatory tillage. Likely, in fourth treatment, one chisel plowing was done before the onset of monsoon and then fallow period weeds were controlled with two applications of glyphosate when needed. In fifth treatment moldboard plowing was done at monsoon initiation and then onward, the weeds were controlled by spraying twice glyphosate when needed. Disc-harrowing was done at the 1^{st} flush of weeds after monsoon rains and the fallow period weeds were controlled by using glyphosate two times as per requirement in sixth treatment. In seventh treatment, no-tillage practice was done before seeding of crop, but the weeds during fallow period were controlled with two applications of a non-selective herbicide (glyphosate). The glyphosate (Round up) was applied at the rate of 2.5 L per hectare in each case. Sowing was done with conventional seed-cum-fertilizer drill in other than conservation tillage treatments whereas, wheat was sown by direct drilling with no-till drill in all conservation tillage treatments.

Seed Bank Density

For reference collection seeds of different weeds were collected from experimental area and its surroundings one year before the experiment. Seed bank density of *C. arvensis* was determined with sieving method. For this purpose sampling of the soil was carried out before the sowing of wheat crop in W shape from five places randomly in a plot from three soil depths i.e. 0–10 cm, 10–20 cm and 20–30 cm. Soil samples were taken by using steel probe of 2.5 cm diameter. The soil cores of same depth were bulked and mixed to make composite soil samples. One 100 g weight of each sample was used as working sample from these composite soil samples for the determination of soil weed seed bank. The soil samples were then transported to laboratory and stored at room temperature until further processing. In sieving method, seeds were extracted from soil by sieving of soil sample through various sieves with different mesh sizes using method adopted by (Konstantinović *et al*., 2011). Each 100 gram soil sample was initially poured on sieve of 80 mesh size and placed in water for softening the soil clods. The sample was then immersed in the sodium hexa-metaphosphate solution (40 g L^{-1} of water) in order to disintegrate the soil particles. The soil samples were shifted to the bucket having tap water and shaked well to filter out all clay and silt particles and removed from sample. The remaining material on the sieves was air dried and transferred on the filter paper for complete drying of samples. These dried samples were then passed through a descending series of sieves i.e. mesh no. 10, 18, 30, 40, 50 and 80. Entire seeds remained on the sieves were collected for identification and further processing. Viability of seeds was determined by using crushing method, i.e. by applying gentle pressure to the seeds with the help of forceps and seeds showing resistance to this pressure were considered as viable. Viable seeds extracted from soil were compared with the reference seeds to identify seeds using high magnification lens (10X) and seeds of each species were counted.

Weed Population Dynamics

Weed population dynamics of *C. arvensis* were found through the integrated use of different weed indices (Stapper *et al*., 2003; Devasenapathy, 2008; Qureshi and Memon, 2008; Gupta *et al.*, 2011; Hassannejad and Ghafarbi, 2012). Absolute density per square meter of *C. arvensis* was recorded by dividing total number of plants in all quadrats to the total number of quadrats studied. Absolute frequency was recorded by dividing number of quadrats in which *C. arvensis* was present to the total number of quadrats studied. Absolute dry weight per square meter was recorded by dividing dry weight of all plants of *C. arvensis* in all quadrats to the total number of quadrats studied. Absolute coverage was recorded by dividing percent area covered by all plants of *C. arvensis* in all quadrats to the total number of quadrats studied. Relative density was recorded by dividing number of plants of *C. arvensis* per unit area to the number of plants of all weed species per unit area, multiplied by 100. Relative frequency was recorded by dividing absolute frequency of *C. arvensis* in a plot to the absolute frequency of all weed species in a plot multiplied by 100. Relative dry weight was recorded by dividing the dry weight per unit area of *C. arvensis* to the dry weight per unit area of all weed species multiplied by 100. Relative coverage was recorded by dividing percent area covered by *C. arvensis* per unit area to the percent area covered by all species per unit area multiplied by 100. Relative abundance (RA) was determined by summing up the relative density with relative frequency and then dividing the product by 2. Summed dominance ratio (SDR) was recorded by summing up the relative density with the relative dry weight and then dividing the product by 2. Importance value index (IVI) was recorded by summing up the relative density with relative frequency and relative coverage and then dividing its product by 3.

Statistical Analysis

Data collected on all parameters were analyzed statistically by using MSTAT-C software on computer (Crop and Soil Sciences Department of Michigan University of the United States). Least significance difference (LSD) test at 5% probability level was applied to compare the treatments means (Steel *et al*., 1997). Meteorological data are presented in Fig. 1.

Results

Seed bank density of *C. arvensis* was significantly affected by tillage systems, sowing years and soil depths. Lowest seed bank density of *C. arvensis* was found for single mould board ploughing integrated with glyphosate (1 MB plowing + glyphosate) which was significantly similar for no tilled treatments applied with glyphosate (No-till + glyphosate) and single MB ploughing following cultivation four times (1 MB plowing + 4 cultivations). Seed bank density was found highest for single disc harrowing integrated with glyphosate (1 Disc harrowing + glyphosate) followed by single disc harrowing following cultivation four times (1 Disc harrowing + 4 cultivations), single MB ploughing following cultivation four times (1 MB Plowing + 4 cultivations) and single chisel plowing integrated with glyphosate (1 Chisel Plowing + glyphosate) (Table 1; Fig. 2a, b). Among sowing years, overall average seed bank density was significantly higher in 2012–2013 (2028.0) as compared with 2013–2014 (1463.2); while, for soil depths, maximum seed density of *C. arvensis* was found at 0–10 cm soil depth followed by 10–20 cm and minimum under 20–30 cm depth which were significantly different from each other in both years (Table 1; Fig. 3, 4). The interaction between tillage systems, soil depths and sowing years was also significant. Highest seed bank density of *C. arvensis* was found at 0–10 cm soil depth during 2012–2013, where once disc harrowing was practiced integrated with glyphosate (1 Disc harrowing + glyphosate); whereas, it was lowest at 20–30 cm soil depth during 2013–2014, where once MB plowing was practiced following cultivations four times (1 MB + 4 cultivations). The regression between tillage systems and seed density depicted that the seed bank density of *C. arvensis* was not affected significantly by tillage combinations when integrated with glyphosate herbicide at fallow period (Fig. 5). There was a very week and positive correlation among tillage intensity and soil weed seed bank (Table 3). The seed bank was a little bit negatively affected by conservation tillage integrated with glyphosate herbicide. Similarly, maximum weed flora density of *C. arvensis* was recorded for single chisel plowing integrated with glyphosate (1 chiseling + glyphosate) and minimum for single mould board plowing following cultivations four times (1 MB plowing + 8 cultivations) followed by treatment, where no tillage was practiced integrated with glyphosate (no till + glyphosate) (Table 2). The regression between tillage systems and the density of *C. arvensis* flora depicted that the density of *C. arvensis* was not affected significantly by tillage combinations integrated with glyphosate herbicide at fallow period (Fig. 6). There was a very poor and negative correlation among tillage intensity and weed flora density (Table 3). Similarly, maximum relative density of weed was found for single MB ploughing integrated with glyphosate (1 MB plowing + glyphosate) and minimum for single disc harrowing following cultivations four times (1 disc harrowing + 4 cultivations) (Table 2). Likewise, maximum frequency of field bindweed was recorded for single MB ploughing integrated with glyphosate (1 MB + glyphosate) and minimum for single MB ploughing following cultivations eight times (1 MB plowing + 8 cultivations) (Table 2). Maximum dry weight of *C. arvensis* was recorded for single chisel ploughing integrated with glyphosate (1chiseling + glyphosate) and minimum for single MB ploughing following cultivations eight times (1 MB plowing + 8 cultivations) followed by single disc harrowing following cultivations four times (1 disc harrowing + 4 cultivations). In comparison to other weed species, highest dry weight of *C. arvensis* was found for the treatment where no tillage was practiced applied with glyphosate (no-till + glyphosate) as compared to other treatments (Table 2). Minimum dry weight of *C. arvensis* in comparison with other species was found for single MB ploughing following cultivations eight times (1 MB plowing + 8 cultivations). Data on soil coverage revealed that *C. arvensis* spread was profound on the soil surface in treatment, where single chisel ploughing was practiced integrated with glyphosate (1chiseling + glyphosate) followed by single MB ploughing following cultivations four times (1 MB plowing + 4 cultivations); and minimum was observed for single MB ploughing following cultivations eight times (1 MB plowing + 8 cultivations). In comparison to other weed species, relatively the maximum soil area was covered by *C. arvensis* for single MB ploughing following cultivations four times (1 MB plowing + 4 cultivations) followed by single MB ploughing integrated with glyphosate (1 MB plowing + glyphosate) and single disc harrowing integrated with glyphosate (1 disc harrowing + glyphosate); while, relatively minimum surface was covered by field bind weed in single chisel ploughing integrated with glyphosate (1 chiseling + glyphosate). The maximum summed dominance ratio (SDR) of *C. arvensis* was found for single MB ploughing integrated with glyphosate (1 MB plowing + glyphosate) followed by single MB ploughing following cultivations four times (1 MB plowing + 4 cultivations) and single chisel ploughing integrated with glyphosate (1 chiseling + glyphosate); whereas, the minimum SDR was found for single disc harrowing following cultivations four times (1disc harrowing + 4 cultivations) and single disc harrowing integrated with glyphosate (1 disc harrowing + glyphosate). The importance value index (IVI) of *C. arvensis* was significantly affected by tillage intensity and it was maximum for single MB ploughing integrated with glyphosate (1 MB plowing + glyphosate) followed by single MB ploughing following cultivations four times (1 MB plowing + 4 cultivations) and single chisel ploughing integrated with glyphosate (1 chiseling + glyphosate); whereas, the minimum IVI was recorded for single disc harrowing following cultivations four times (1 Disc harrowing + 4 cultivations) that was not significantly different from the treatment where no tillage was applied integrated with glyphosate (no-till + glyphosate) (Table 2).

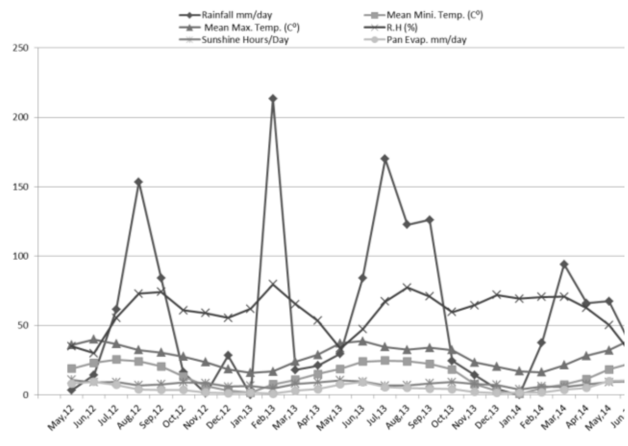

Fig. 1: Meteorological data of the experimental site during study period; Source (Meteorological Observatory, Soil And Water Conservation Research Institute, Chakwal)

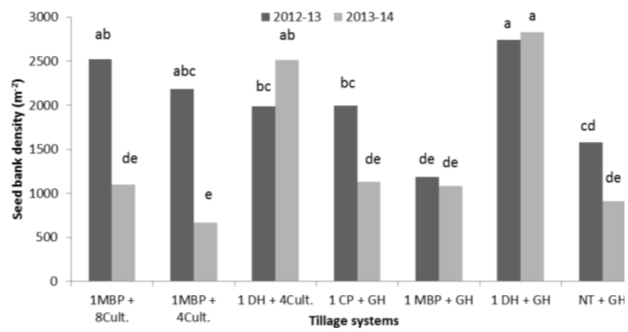

Fig. 2a: Seed bank density of *C. arvensis* at pre-sowing of wheat under different tillage systems and sowing years

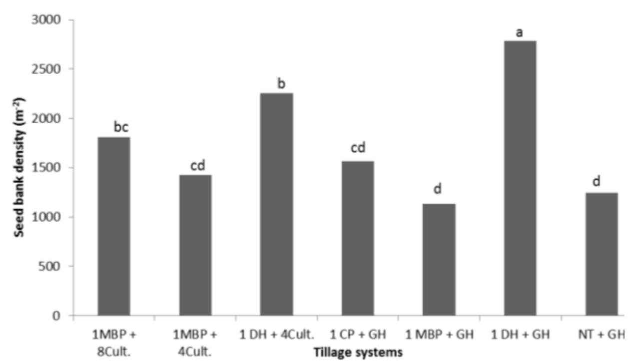

Fig. 2b: Seed bank density of *C. arvensis* at pre-sowing of wheat under different tillage systems (pooled for two years)

Discussion

This study observed the effect of tillage intensity integrated with glyphosate herbicide on the seed bank density and

Table 1: Pre-sowing wheat seed bank density (m^{-2}) of *C. arvensis* as affected by different tillage systems under three soil depths

Tillage Systems	0-10 (cm)		10-20 (cm)		20-30 (cm)	
	2012–2013	2013–2014	2012–2013	2013–2014	2012–2013	2013–2014
1MBP + 8 Cult.	4125 abc	1900 e-j	2785 def	1408 g-l	655 k-m	0 m
1MBP + 4 Cult.	3438 bcd	328 lm	1728 f-k	1355 g-l	1383 g-l	330 lm
1DH + 4 Cult.	2968 cde	4353 ab	2320 d-h	2503 d-g	683 jm	700 j-m
1CP + GH	4013 abc	2388 d-g	1660 f-k	683 j-m	325 lm	333 lm
1MBP + GH	1043 i-m	1065 i-m	1775 e-k	1813 e-k	740 j-m	365 lm
1DH + GH	4913 a	4215 ab	2315	2160 e-i	993 i-m	2105 e-i
NT + GH	2555 d-g	1420 g-l	1110 h-l	973 i-m	1065 i-m	335 lm

MBP = Mouldboard ploughing; DH = Disc harrowing; CP = Chisel ploughing; GH = Glyphosate herbicide; NT = No tillage; Cult. = Cultivations

Table 2: Weed population dynamics of *C. arvensis* as affected by different tillage systems and sowing years

Tillage systems	Density (m^{-2})		R Density (%)		Frequency (%)		R Frequency (%)		Coverage (%)	
	2012–2013	2013–2014	2012–2013	2013–2014	2012–2013	2013–2014	2012–2013	2013–2014	2012–2013	2013–2014
1MBP + 8Cult.	4.58 NS	1.3	13.75 ab	2.13 e	66.5 NS	50	13.64 NS	13.64	2.56 NS	0.77
1MBP + 4Cult.	7.92	4.1	19.92 a	6.14 cde	100	66.8	17.7	17.03	3.95	2.8
1 DH + 4Cult.	3.67	3.7	7.51 bcd	2.87 de	67	50	12.86	12.01	2.37	1.97
1 CP + GH	4.42	7.9	7.12 bcd	7.8 bcd	75.2	91.8	14.22	13.42	2.99	4.6
1 MBP + GH	7.09	4.5	19.21 a	12.06 ab	91.75	83.5	17.7	19.31	3.93	2.77
1 DH + GH	3.67	4.3	8.36 abc	5.17 cde	67	75	13.22	11.25	2.61	2.57
NT + GH	1.67	5.6	4.58 cde	7.01 bcd	50	83.5	8.2	14.52	1.81	3.07

Note: Any two means in a column showing an alphabetical letter in common do not differ significantly from each other; NS = Non-significant; R = Relative; SDR= Summed dominance ratio; IVI= Importance value index; MBP = Mouldboard ploughing; DH = Disc harrowing; CP = Chisel ploughing; GH = Glyphosate herbicide; NT = No tillage; Cult. = Cultivations

Table 2 continued: Weed population dynamics of *C. arvensis* as affected by different tillage systems and sowing years

Tillage systems	R Coverage (%)		Dry weight (g)		R Dry weight (%)		SDR (%)		IVI (%)	
	2012–2013	2013–2014	2012–2013	2013–2014	2012–2013	2013–2014	2012–2013	2013–2014	2012–2013	2013–2014
1MBP + 8Cult.	12.66 NS	2.95	3.94 NS	0.65	7.71 NS	0.47	10.73 NS	1.3	13.35 ab	2.13 e
1MBP + 4Cult.	12.56	9.65	5.26	2.9	5.5	2.55	12.71	4.34	16.73 a	7 d-e
1 DH + 4Cult.	9	4.64	4.22	1.28	5.97	0.92	6.74	1.89	9.79 b-e	3.27 de
1 CP + GH	6.88	13.92	5.56	3.68	3.69	6.95	5.4	7.37	9.4 b-e	10.65 ab
1 MBP + GH	12.91	9.28	6.01	2.43	6.35	2.5	12.78	7.28	16.61 a	8.28 c-e
1 DH + GH	7.09	6.58	5.02	2.08	3.3	2.53	5.83	3.85	9.55 b-e	5.21 de
NT + GH	8.4	8.05	4.36	2.08	7.86	3.13	6.22	5.07	7.06 cde	6.56 cde

Note: Any two means in a column showing an alphabetical letter in common do not differ significantly from each other; NS = Non-significant; R = Relative; SDR= Summed dominance ratio; IVI= Importance value index; MBP = Mouldboard ploughing; DH = Disc harrowing; CP = Chisel ploughing; GH = Glyphosate herbicide; NT = No tillage; Cult. = Cultivations

Table 3: Correlations

	GY	SB	TI
SB	-0.2941		
P-VALUE	0.5220		
TI	0.7339	0.0151	
	0.0604	0.9744	
WF	-0.2651	-0.4563	-0.0098
	0.5657	0.3034	0.9833

TI = Tillage intensity; SB= Soil weed seed bank density of *C. arvensis* (0–30 cm) L.; WF= Weed flora density of *C. arvensis*; GY= Grain yield of wheat

weed flora population dynamics of *C. arvensis*. The results showed that the tillage treatments along with glyphosate herbicide and alone applied in fallow period had similar relationship with seed bank density. The possible reason for this effect of tillage systems on seed bank may be attributed to the reduction of seed bank density of field bindweed in conventional tillage due to frequent plowings and resultantly maximum seed germinations in rainy seasons because the repeated tillage operations might have brought the seeds of field bind weed near the soil surface which emerged rapidly due to more soil aeration and availability of sunlight (Cardina *et al*., 2002). The reduction of seed bank in conservation tillage may be the effect of glyphosate herbicide on the population of field bind weed which ultimately reduced/diminished the seed setting thus resulting in less seed dispersal per unit area (Rusu *et al*., 2013; Ali *et*

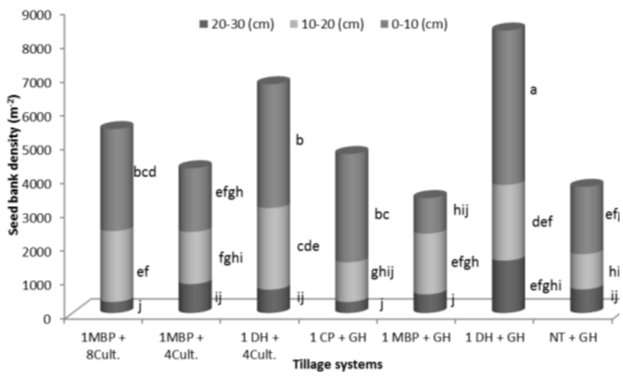

Fig. 3: Seed bank densities of *C. arvensis* in three depths of soil (i.e D1= 0-10, D2=10-20, D3=20-30cm) under seven tillage treatments at pre-sowing of wheat (pooled data of two years)

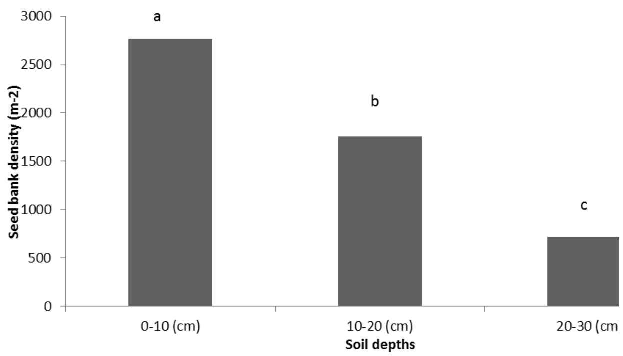

Fig. 4: Total seed bank density of *C. arvensis* under three soil depths

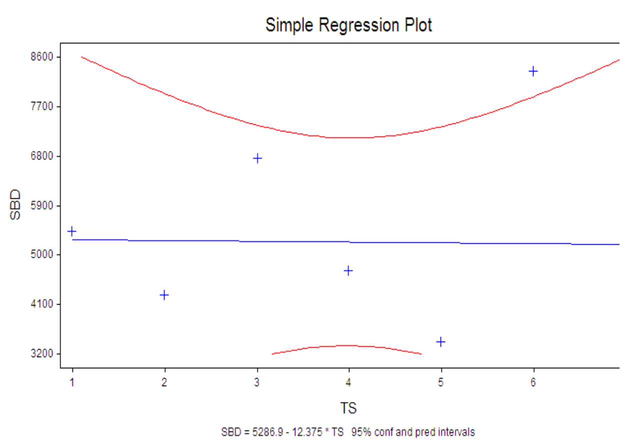

Fig. 5: Effect of tillage treatments on the seed bank density of *C. arvensis*

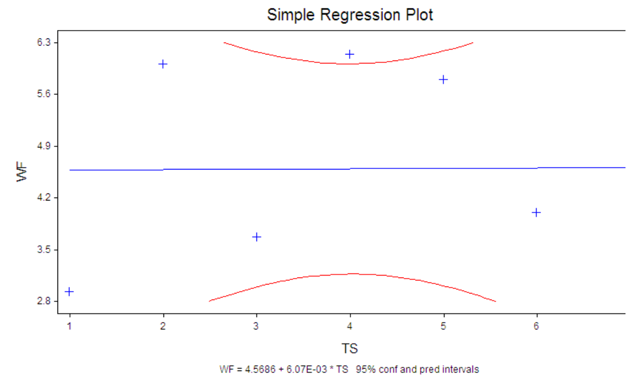

Fig. 6: Effect of tillage treatments on the above ground weeds flora density of *C. arvensis*

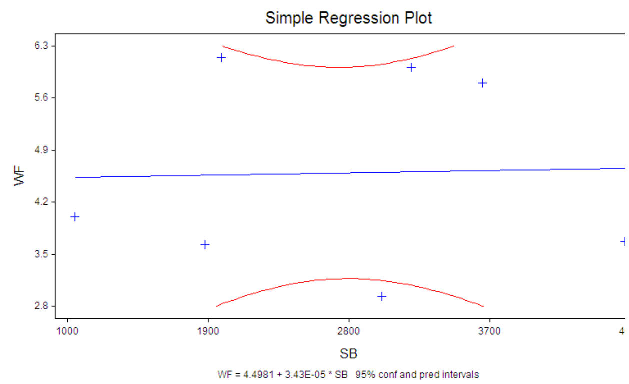

Fig. 7: Relationship between seed bank of 0–10 cm soil depth and above ground weed flora density

al., 2014). A very week and positive correlation between tillage intensity and soil weed seed bank of field bind weed found (Table 3; Fig. 5) suggest that glyphosate herbicide controlled this weed without spending a huge amount on intensive cultivation that was considered necessary for uprooting this weed. Seed bank was considerably reduced in 2nd year of study that may be attributed to the control of weeds under conservation tillage treatments integrated with glyphosate and comparatively higher germination of weed seeds in 2012–2013 that was probably due to higher rainfall in the early growing season of this year (Fig. 1 Ali *et al.* (2014). Relationship between the above ground flora density and seed bank of upper soil depth i.e. 0–10 cm (Fig. 7) was also weak suggesting that the seed in upper soil depth in conventional tillage had maximum germination whereas, the seed bank could not germinate well in upper soil depth in conservation tillage treatments (Cardina *et al*., 2002).

There was no significant effect of tillage treatments on the weed flora density of field bind weed that may be attributed to its control by intensive cultivation in conventional tillage and use of glyphosate herbicide in the conservation tillage treatments (Table 2; Fig. 6; Wiese *et al.* (1996); but the weed flora population was significantly reduced in the 2nd year of study that may be attributed to the use of glyphosate herbicide in the conservation tillage treatments and climatic effect on the germination of weeds, as there was significant variation in the weather data of two sowing years especially with reference to rainfall at the early growing period of wheat (Fig. 1. Ali *et al.* (2014) Maximum frequency of field bind was recorded in 1 MB plowing + glyphosate; and minimum in 1 MB plowing + 8 cultivations in the conventional tillage may be attributed to intensive cultivation, which provided control of the weed flora efficiently (Usman *et al*., 2009; Ali *et al*., 2014).

Maximum dry weight of *C. arvensis* was recorded in 1 chiseling + glyphosate and minimum dry weight in 1 MB plowing + 8 cultivations might also be attributed to the intensive cultivation under this tillage treatment where well established crop suppressed the field bind weed at vegetative growth stage. Data on soil coverage revealed that *C. arvensis* dispersed profoundly on the soil surface in the treatment 1 chiseling + glyphosate, while minimum spreading was observed in 1 MB plowing + 8 cultivations confirms the suppressing of this weed under well-established crop in conventional tillage. The minimum IVI in 1 Disc harrowing + 4 cultivations and No-till + glyphosate strongly suggests that *C. arvensis* could not be established in zero tillage (Wiese *et al*., 1996; Ali *et al*., 2014).

Conclusion

Conservation tillage system with no-till along with integrated use of glyphosate herbicide must be adopted for economical *C. arvensis* weed control under similar soil and climatic conditions while considering the economic, agronomic, and environmental impacts of these systems.

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