Azarian Journal of Agriculture

Azarian J. Agric. VOL (8) ISSUE 1, 2021: 29-37

http://dx.doi.org/10.29252/azarinj.050

www.azarianjournals.ir

Azarian Journals

Research article **ISSN:2383-4420**

The behavior of weed seed bank to different tillage and residue mulch treatments after three years of cropping in Bangladesh

Mohammad Mobarak Hossain[1*], Mahfuza Begum[1], Md. Moshiur Rahman [1]

Article Info

Accepted:
29 Feb. 2021

Keywords:
Annual weeds, crop residues, reduced tillage, Weed diversity, zero tillage

ABSTRACT

A three-year (2012 - 2015) longer wet rice-wheat-jute crop rotation experiment was sampled from the Rajbari district of Bangladesh. The objective was to study the effects of strip tillage (ST), bed planting (BP), and zero tillage (ZT) relative to conventional tillage (CT) with increased residues (20 vs. 50%) of previous crops on the composition of soil weed seed pool. The weed abundance at 0-15 cm soil profile was quantified following "seedling germination method" at the green-house of Bangladesh Agricultural University during January - December 2016. The year-round count of germinated weeds revealed the fewest number of species, and the lowest density of broadleaf, grass, and sedge weeds were found in ST, followed by CT, BP, and ZT with 50% crop residues. The diversity of weed flora having some specific weeds was the least at ST but the ZT was the most diversified followed by BP and CT. The ST plus 50% residue decreased the weed composition. Still, they increased the relative proliferation of perennial weeds compared to CT. Weed composition in ST was even smaller than BP and ZT. The ST, BP, and ZT enriched the abundance of perennial weeds: *Alternanthera sessilis, Leersia hexandra, Dentella repens, Jussia deccurence, Solanum torvum, Hedyotis corymbosa*. On the other hand, annual weeds: *Euphorbia parviflora, Cyperus iria, Monochoria hastata, Digitaria sanguinalis, Lindernia antipoda, L. hyssopifolia* and *Fimbristylis miliacea* were dominated the weed seedbank at 0-15 cm soil profile after three years of cropping in Bangladesh.

INTRODUCTION

Weed control is identified as one of the toughest issues while shifting to reduced tillage from conventional one (Nichols et al. 2015). In reduced tillage, weeds' distribution in the soil weed seed bank will change compared to conventional tillage (CT) that led to shifts in the weed communities (Pittelkow et al. 2015). Reduced tillage (RT) favors the emergence of perennial weeds like *Cyperus rotundus* L., *Saccharum spontaneum* L., and *Sorghum halepense* L. relative to annual weed species in the seed bank (Singh et al. 2015). Such weeds are generally reproduced from tubers and rhizomes present underground in soil and by not burying them to depths or failing to uproot and kill them (Aweto 2013). According to Woźniak (2018), annual grass populations usually increase in no-tillage systems concurrent with a decrease in dicotyledonous weeds populations. Moreover, Santín-Montanyá et al. (2013) reported annual and perennial grasses, perennial dicot species would increase, and annual dicot species would decrease in RT. Furhtermore, Restuccia et al. (2020) found fivefold higher weed proliferation in RT than CT supporting Mirsky et al. (2013), who observed the seedling density of *Amaranthus* spp. was much higher in zero-till soils than tilled soils. Notwithstanding the above effects of RT on the weed seed bank, there have been no comparable studies in the intensive, triple cropping systems where there is an annual period of soil submergence for wetland rice crops.

Despite the widespread promotion, in Bangladesh, the RT practice began in 2005 (Hossain et al. 2015) to validate its effect on small farm hold. But information is not available on weed species distribution in the field is expected to become a problem after several years of RT adoption. Tillage practices, crop rotation, and weed control practices change weed composition in the

[1] Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
* E-mail: dr.mobarakphd@gmail.com

soil, which affects the weed control efficacy for successful crop production. Changes in the weed spectrum due to crop production practices are essential in subsequent weed problems. Information on the RT effect, crop residue retention in the intensive cropping pattern on the weed emergence might be a useful tool for sustainable weed management in the field. Hence, in this ever the first-time study of soil weed seed bank was assessed from the previously practiced three years longer trial conducted at Rajbari district of the country to learn the trend of weed response to different tillage practices like strip planting, bed planting, and no-tillage relative to conventional tillage. By necessity, it was hoped that knowledge gained could be used to fill the gaps in weed seed bank information and the best managing of weeds to trigger the widespread adoption of RT.

MATERIALS AND METHODS

The experimental site and season

This green-house experiment was conducted at the Department of Agronomy, Bangladesh Agricultural University from January 02 - December 29, 2016. The geographic position of the site is 24.75º N and 90.50º E at 18 m above the mean sea level. This site is situated under sandy clay loam soil texture (50% sand, 23% silt, 27% clay), having a pH of 7.2. The maximum temperature of this area varies from 32.3 - 33.5 °C during April - June, while January was the coldest month. This site received about 95% rainfall and relative humidity during April - September. Sunshine hours differed much during the months of rains due to the cloudy weather.

Description of the three-year trial at Rajbari

A three-year longer trial was conducted at Baliakandi area situated at the Rajbari district of Bangladesh (N: 23°39′45″ N and E: 89°29′39″) during 2012 - 2015. Here, three crops were grown under wet rice-wheat-jute cropping pattern utilizing conventional tillage (CT), strip tillage (ST), bed planting (BP), and zero tillage (ZT). Standing 20 and 50% residues of previous crops were retained with four replications. Previous crops were harvested, keeping plants at 20 and 50% standing from the ground levels.

Tillage operations practiced at Rajbari

A two-wheel tractor (2WT) was used for CT, where four plowings prepared the land and cross plowings, afterward sun-drying for two days and leveling. Alternatively, Versatile Multi-crop Planter (VMP) machine did the ST in a single plowing process making four furrows, each 6 cm wide and 5 cm deep at a time. As per recommendation, to destroy the live weeds, glyphosate herbicide (3.7 L ha^{-1}) had sprayed three days before the VMP operation. In BP, lifted beds of 15 cm high and 90 cm wide with 60 cm tops and 30 cm furrows were prepared using a bed planter machine. In ZT, the soils were kept intact. The field layout and all the treatments were the same for three years in the field.

Weeding regimes adopted at Rajbari

In CT, weeds were controlled by hand weeding in all crops. Weeding at three times was done manually at 25, 45, and 65 DAT/S in rice and wheat, while two times weeding was done at 25 and 45 DAS in jute. On the other hand, in ST, BP, and ZT, weeds were controlled using different herbicides for different crops. Here, glyphosate @ 3.7 L and pendimethalin @ 2.7 L were applied three days before tillage operation and three DAT/S, respectively, in all crops. Ethoxysulfuron-ethyl @ 100 g and carfentrazone-ethyl+isoproturon @ 1.25 kg were applied in rice and wheat at 25 DAT/S, respectively. Fenoxaprop-p-ethyl @ 650 ml was used at 25 DAS in jute. The dose of all herbicides was their product per hectare.

Soil sampling procedure and experimental set-up at green-house

The soil was collected from the field from 0-15 cm soil depth. Five samples from each plot; hence, 64 samples were collected using a stainless-steel pipe of five cm diameter following the "*W*" shape pattern. After sampling, pieces were tagged and appropriately bagged for transportation to the green-house. After that, sub-samples from each plot were combined, and approximately one-kilogram soil was placed immediately in an individual round-shaped plastic tray of 33 cm in diameter at 3 cm depth. Trays were set in the green-house following a completely randomized design, replicated four times.

Weed seed emergence and data collection in green-house

The germinated weeds seedlings were named and counted, then discarded from each tray at 30 days intervals. Unnamed weeds were transferred to another tray and grown until flowering to identify. After removing each cohort of seedlings, soils were air-dried, thoroughly mixed, and re-wetted to permit further emergence. The number of seedlings emerged converted to the number m^{-2} using the formula as below:

$\text{Area} = \pi r^2$ where, π =3.1416, r = radius of the tray = 33 cm

The weed biomass was assessed by recording the dry matter in g m^{-2} after oven drying the weed samples at 70 °C for 72 hours.

Diversity Indices

The composition of weed communities and soil seed bank were analyzed using:

Shannon's diversity index: H'= − ∑(Pi) *ln (*Pi) (Shannon, 1948) and

Simpson's dominance index: SI = $\sum(Pi)^2$ (Simpson, 1949), where Pi is the probability of species occurrence in the sample.

Similarity Index

Sorensen's qualitative similarity index (%) = [2C/(A+B)] ×100 (Habich, 2001) was used to compare soil seedbank in the different treatments, where A: the number of species in one of the two communities compared, B: the number of species in the second community compared, C: the number of common species in the compared communities.

Data analysis

We used *STAR* software to analyze all data following the standard procedure of Analysis of Variance and Duncans' Multiple Range Test at $P \leq 0.05$.

RESULTS AND DISCUSSION

Floristic composition of weed species as affected by tillage types and residue levels

The CT plus 20% residue produced 14 species, of which eight broadleaf, three grass, and sedges each, consisting of 10 annuals and four perennials (Table 1). But at 50% residue, 12 species found having eight broadleaf, two grass, and sedge each, including nine annuals and three perennials. The ST plus 20% residue produced ten species consisting of seven broadleaf, two grass, and one sedge having four annuals and six perennials. But nine species were having an almost similar number of all types of weed except one with 50% residue. In BP with 20% residue, 17 species were found, including ten broadleaf, three grass, and four sedges. There were 16 annuals and one perennial. In 50% residue, 15 species were found with a similar amount of grass and sedge and fewer annual broadleaf. The ZT, with 20% residue, produced 19 weed species, belonged to 11 broadleaf and four grass and four sedges, having 15 annuals and four perennials. But in ZT with 50% residue, 16 species were found to have fewer number annual broadleaf, annual grass. There were four sedges and four perennial weeds.

Effect of tillage types and residue levels on weed species, density (plants m^{-2}) and biomass (g m^{-2})

The highest number of weed species (Figure 1) and plants m^{-2} (Table 2) was recorded in ZT, followed by BP and CT, while the lowest weed species and biomass was found in ST. Compared to CT (1668), ST had 560 fewer weeds but 386 and 2639 more weeds in BP and ZT, respectively (Table 2). On the other hand, 50% of residue produced 608 fewer weeds than 20% residue. In all types of tillage and residue levels, broadleaf led over sedges and grasses. Annuals were dominant over perennials in CT, but perennials led over annuals in ST, BP, and ZT (Figure 2). The highest weed biomass was recorded in the ZT followed by BP and CT. The ST produced the lowest biomass. Retention of 50 % residue produced overall 27-34% less biomass than that of 50% residue (Figure 1).

Analysis of weed seed pool

The greatest diversified weed seed pool composition was found in ZT followed by BP, CT and ST (Table 1). The highest number of weed seed species producing the highest number of plants being in the ZT. The highest value of Shannon's Diversity Index and a low value of Simpson's Domination Index, indicating the greatest diversified and the species rich weed seed bank composition. In ZT, we found the dominance of perennial species over annual species: *Alternanthera denticulate*, *Dentella repens*, *Solanum torvum*, *Cyperus rotundus* and *Eleusine indica* (Table 1).

Compared to ZT, the BP is less diversified having the lower value of indices 2.90 and 2.68, respectively (Table 1). The BP also favored the occurrence of perennial weeds over annual weed species: *Dentella repens*, *Jussia deccurence, Cyanotis axillaris, C. rotundus, Eleusine indica, Digitaria sanguinalis, Commelina benghalensis, Echinochloa colonum* and *Lindenia antipoda.*

The weed pool in ST was characterized by the lowest value of Shannon's diversity index and a high value of Simpson's domination index (Table 1), indicating the least diversified species composition with the dominance of specific perennial species over annual species: *Alternanthera denticulate, Leersia hexandra, Dentella repens, Jussia deccurence, Solanum torvum, Hedyotis corymbosa* and *Echinochloa colonum.*

The plough system of CT was distinguished by the diversity and dominance indices next to BP (Table 1), indicating the evenly distributed and decreased in species diversity of weed seedbank. It was difficult to indicate dominant species as and mostly annual species was found dominating the seedbank. *Euphorbia parviflora,* Cyperus iria, *Monochoria hastata, Jussia deccurence, Digitaria sanguinalis, Lindernia antipoda, L. hyssopifolia* and *Fimbristylis miliacea* found to be dominant weed species.

The combination of 50% residue mulch with all the tillage types decreased the diversity and

Table 1. Composition of weed species in different tillage types and residue levels after three years at Rajbari

Weed type, species, and life cycle			CT		ST		BP		ZT	
			R_{20}	R_{50}	R_{20}	R_{50}	R_{20}	R_{50}	R_{20}	R_{50}
Broad leaf	*Alternanthera sessilis* L.	Perennial	A	A	413^{i}	372^{i}	A	A	570^{i}	687^{i}
	Amaranthus spinosus L.	Annual	245	224	A	A	156	A	199	A
	Commelina benghalensis L.	Annual	A	210	A	A	171	284^{iii}	A	A
	Cyanotis axillaris Roem.	Annual	A	A	A	A	322^{iii}	112	328	A
	Dentella repens L.	Perennial	A	A	361^{iii}	343^{ii}	479^{i}	247	473^{ii}	502^{iv}
	Eclipta alba L.	Annual	210	231	A	A	230	A	126	179
	Euphorbia parviflora L.	Annual	219	346^{i}	A	A	140	195	A	125
	Hedyotis corymbosa (L.) Lamk.	Annual	A	A	151	287^{iii}	128	251	322	302
	Jussia deccurence Walt.	Perennial	299^{iii}	272^{v}	349^{iv}	280^{iv}	469^{ii}	A	449^{iv}	611^{ii}
	Lindernia antipoda Alston.	Annual	323	280^{iv}	219	171	84	269^{v}	349	364
	L. hyssopifolia L.	Annual	271^{iv}	267	287	223	207	128	336	278
	Monochoria hastata L.	Annual	309^{ii}	289^{iii}	A	A	210	201	A	A
	Rotala ramosior (L.) Koehne.	Annual	A	A	A	A	A	A	301	A
	Solanum torvum Sw.	Perennial	A	A	318^{v}	217	A	A	409^{v}	437^{v}
	Spilanthes acmella Murr.	Annual	270	A	A	A	139	A	85	A
Grass	*Digitaria sanguinalis* L.	Annual	212	343^{ii}	A	A	147	297^{ii}	190	380
	Echinochloa colonum L.	Annual	270	248	212	264^{v}	159	270^{iv}	348	359
	E. crusgalli L.	Annual	A	A	A	A	A	A	340	A
	Eleusine indica L.	Annual	213	A	A	A	265^{v}	189	474^{iii}	327
	Leersia hexandra L.	Perennial	A	A	372^{ii}	A	A	A	A	A
Sedge	*Cyperus difformis* L.	Annual	283	A	A	A	158	117	370	359
	C. iria L.	Annual	340^{i}	A	A	A	234	131	268	347
	C. rotundus L.	Perennial	A	A	284	208	309^{iv}	589^{i}	494^{ii}	521^{iii}
	Fimbristylis miliacea L.	Annual	264^{v}	246	A	A	146	147	245	286
	Sum		3708	2956	2966	2365	4153	3427	6881	6064
	Total number of species		14	11	10	9	17	15	19	16
	Shannon's Diversity Index (H')		2.61	2.38	2.28	2.17	2.90	2.68	2.93	2.76
	Simpson's Dominance Index (SI)		0.62	0.57	0.76	0.68	0.51	0.49	0.63	0.54

CT = Conventional tillage, ST = Strip tillage, BP = Bed planting, ZT = Zero tillage, R_{20} = 20% residue, R_{50} = 50% residue, i-v = five most dominant species, A = Absent

dominance of weed species at 0-15 cm soil profile (Table 1).

In this study, the soil seed pools in the tested tillage systems and crop residue levels were 33-96% similar (Table 3) in terms of species composition, as indicated by the qualitative Sorensen's Similarity Index. Most of the weeds of CT and BP was similar (96%) followed by CT and ZT (79%). BP produced 52 and 88% similar weeds of ST and ZT, respectively. ST produced 33% similar weeds of CT and 69% like ZT. The least similar weeds between ST and CT indicating the emergence of newer weeds in ST than CT and ZT. We also found, 86% similar weeds between 20% and 50% residue mulching at 0-15 cm soil depth.

In this study, the higher number of weeds composting broadleaf, grass, and sedge types was found in CT than ST. This phenomenon might be attributed to the emergence of more weed species in CT over ST. The earlier research suggests that about 80% of CT's disturbed soil (Dahlin and Rusinamhodzi 2019) bring up dormant weed seeds from the deeper soil layers to the upper, which fortunate the higher germination of weed seeds and the emergence of weeds. Travlos et al. (2018) concluded, tilled soils of CT offer better germination of weed seeds by making soils more aerated and warmer. CT also allows seedlings to emerge from deeper in the ground than reduced tilled soils in SP that may increase the weed species composition in the weed seed bank of CT than ST. Nkoa et al. (2015) quoted that dormant seeds in CT become viable to germinate by scarification, ambient CO_2 concentrations, and higher nitrate concentrations, leading to higher weed emergence of new weed species in CT. The research finding of Cordeau et al. (2020) also revealed the increase of

Table 2. Effect of tillage types and residue levels on the density (plants m^{-2}) of different weed types after three years at Rajbari

Treatments	Broadleaf		Grass		Sedges	
	R_{20}	R_{50}	R_{20}	R_{50}	R_{20}	R_{50}
CT	2019^{cd}	1317^{d}	650^{b}	497^{d}	446^{d}	671^{b}
ST	1405^{e}	1272^{de}	619^{b}	417^{d}	468^{d}	298^{de}
BP	1989^{d}	1613^{bc}	768^{b}	720^{b}	733^{b}	547^{bc}
ZT	2891^{a}	2854^{a}	1908^{a}	1376^{a}	983^{a}	866^{a}
Standard deviation	405.9	542.7	356.8	266.0	177.4	183.7
Co-efficient of variance (%)	18.6	28.4	43.4	40.6	26.7	31.5
Standard error	117.2	156.6	103.0	76.7	51.2	53.1

CT = Conventional tillage, ST = Strip tillage, BP = Bed planting, ZT = Zero tillage, R_{20} = 20% residue, R_{50} = 50% residue

weed species composition in CT offered from the higher rate of seed viability that occurred from weed seed burial in the soil profile. Such a higher rate of weed seed survivability might lead to an increase in weed composition in CT. By contrast, Feledyn-Szewczyk et al. (2020) found a higher proportion of seed banks will germinate in reduced tilled soil than CT due to the presence of a higher rate of germination stimulus near the soil surface and decreases with depth. That might lead to a greater diversified larger seed bank size in ZT than CT, followed by BP and SP in this study. The results of Conn (2006) also confirm the high abundance of common, annual weed species with small seeds under ZT planting making the systems more diversified having and less similar weeds in reduced tillage than plough system in CT. A greater diversified seed bank in the reduced tillage system compared to the traditional one was also observed by Piskier and Sekutowski (2013), whereas Krawczyk et al. (2008) observed a decreasing number of these weed species along with tillage simplifications.

The reduction of the number of weed species in ST might also be due to minimizing the weed seed bank status in the soil by increasing non-viable or dormant weed seeds in the seed bank. Due to minimal soil disturbance (only 20%) at the ST's upper soil layer, most of the weed seeds remain on the soil surface. They can lose viability due to desiccation and adverse climate, as Lim et al. (2015) reported. Losing of seed viability in ST may also be attributed to increased seed dormancy at an undisturbed deeper soil layer. Seeds that remain dormant at a deeper layer suffer from suffocation for less oxygen pressure and darkness for feeble light, as weed seeds required oxygen and light for maximum germination (Oziegbe et al. 2010).

Surface accumulation of weed seeds in ST would increase predator (ants, insects, rodents, and birds) access to weed seeds and increase their removal rates. For example, crickets and ground beetles are reported to reduce weed seed germination by 5 - 15% (White et al. 2007) via seed predation by increasing the availability of them and minimizing their rate, and forced relocation in reduced tilth soil like ST. The higher dispersal of weed seeds may also increase the seed bank in CT over ST, followed by BP and ZT. Barroso et al. (2006) found the weed seeds traveled 2–3 m in the direction of full tillage, while in reduced tillage, the distance is negligible. Reducing tillage in ST, BP, and absence in ZT, therefore, reduced the spread of weed seed both within and across fields. Thus, increased weed composition in ZT followed by BP and ST in this study. The reduced weeds in ST may also have occurred from more lavish weed seed burial as strips were made in the same location over the three years because the field layout and all the treatments were the same in the field study.

Furthermore, different herbicides might lead to fewer weeds in ST followed by BP and ZT. In the long-term trial, glyphosate and pendimethalin were used in all crops. Besides, ethoxysulfuron-ethyl in rice, carfentrazone-ethyl+isoproturon in wheat, and fenoxaprop-p-ethyl in jute. These herbicides are previously reported to reduce seed viability / induced seed dormancy in weed, which might reduce weed pressure in ST than CT. It was reported that a range of herbicides could reduce

Table 3. Effect of tillage practices and residue levels on the Sorensen's Qualitative Similarity Index (%) of seed pool after three years at Rajbari

Tillage practices	CT	ST	BP	ZT
CT	-	33	96	79
ST	33	-	52	69
BP	96	52	-	88
ZT	79	69	88	-
Residue levels	R_{20}	R_{50}		
R_{20}	-	86		
R_{50}	86	-		

CT = Conventional tillage, ST = Strip tillage, BP = Bed planting, ZT = Zero tillage, R_{20} = 20% residue, R_{50} = 50% residue

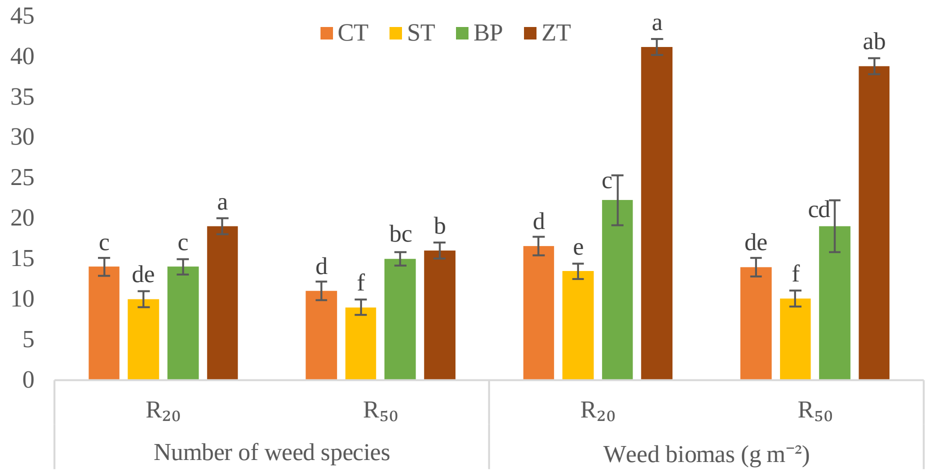

Figure 1. Effect of tillage types and residue levels on the number of species and biomass of weeds at Rajbari after three years at 0-15 cm soil depth, according to *ANOVA* test at $P \leq 0.05$.

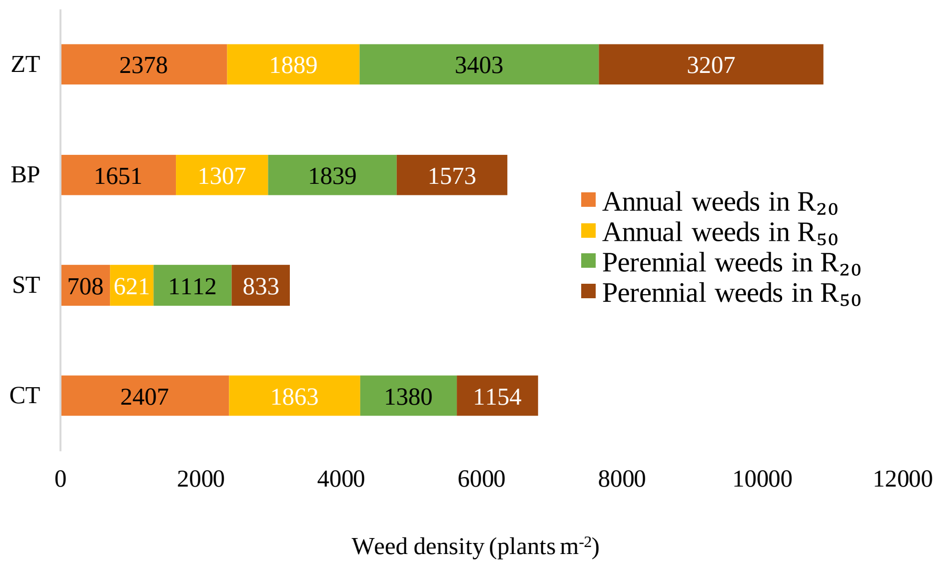

Figure 2. Distribution of annual and perennial weeds in different tillage and residue levels at Rajbari after three years at 0-15 cm soil depth.

seed production and germination by several folds depending on the biotypes. The glyphosate was found to affect the pollen and seed production almost 100% in *Ambrosia artemisiifolia* L. (Gauvrit and Chauvel 2010); pendimethalin herbicide hampered 30.57 % of seed germination of *Chenopodium album* L. (Tanveer et al. 2009), while ethoxysulfuron-ethyl killed 98-100 % seeds of *Echinochloa glabrescens* L. (Opeña et al. 2014). Moreover, fenoxaprop-p-ethyl wrecked 96.78% of seeds of *Phalaris minor* L. (Singh et al. 2017).

Reduction of weed species and density in ST than CT, BP and ZT might produce the lowest weed biomass in ST followed by CT, BP and ZT in this study. A higher weed species abundance and dry matter under ZT as compared to CT followed by BP and ST has been confirmed by earlier studies (Peigné et al. 2007, Gruber and Claupein 2009). Demjanová et al. (2009) indicated that no-tillage in maize was accompanied with significantly higher weed biomass compared to moldboard plowing and reduced tillage. Similarly, in the studies by Woźniak et al. (2018) and Vakali et al. (2011), a greater weed infestation of spring wheat and barley occurred in no-till than conventional tillage.

The results of these studies agree the findings of the present study demonstrated that herbicides could potentially reduce seed production and viability of weeds, thereby reducing seed bank size in ST than CT, followed by BP and ZT. On the other hand, herbicide-induced seed dormancy could contribute to the altered seed dormancy found in

Hordeum murinum L., *Bromus diandrous* Roth., and *Lolium rigidum* Gaud., as reported by Kleemann and Gill (2013) and Owen et al. (2015). The above-discussed reasons might decline the weed compositions in ST than CT followed by BP and ZT. Nandan et al. (2020) agreed with the present study's findings as stated the highest weed density at ZT, next to CT, BP, and ST because of the higher weed seedlings recruitment from the topsoil in ZT than other tillage types.

In the present study, annual weeds led over perennials in CT, but perennial weeds led over ST, BP, and ZT. Many studies support our research reporting that CT systems favor annuals, while reduced tillage systems favor perennial weeds Mashavakure et al. (2020). Ecological succession theory (Aweto 2013) agrees with our research finding suggesting the dominancy of perennials weeds in less disturbed systems. Because CT kills most of the underground vegetative reproduction structures (rhizomes, tubers, bulbs, runner, and stolon) of perennials weeds, hence, reserves only annuals weeds which reproduce mostly by seeds (matured ovules). On the other hand, the vice-versa phenomenon generally occurs in tillage was minimized in ST and BP while absent in ZT, which favored perennial weeds here in the soil.

The retention 50% crop residue had fewer above ground weed taxa than 20% residue in this study. This phenomenon might be due to the drastic effect of suppressing weed seed germination caused by a physical barrier, lowering soil temperatures, and allelochemicals released from decaying plant tissues, as suggested by Curran (2016). Moreover, reduced light penetration makes soil cooler that reduces weed seed germination or causing delays in germination (Gresta et al. 2010). Also, damage of weed seeds upon predation and decomposition by macro and microbial population (Lemessa and Wakjira 2014); delay the emergence of etiolated plants producing lower seeds as stated earlier (Begum et al. 2006) might have reduced weed proliferation by 50% residue over 20% residue.

CONCLUSIONS

A greater diversified composition of weed seed pool was found in zero-tillage and it was about three times higher than the strip tillage. The strip tillage reduced weed abundance by about 50% than bed planting and conventional tillage. Mulching 50% residues of previous crop was decreased about 50% of weed composition than that of 20% residues. Moreover, strip tillage, bed planting, and no-tillage increased perennial weeds: *Alternanthera sessilis, Leersia hexandra, Dentella repens, Jussia deccurence, Solanum torvum, Hedyotis corymbosa* while conventional tillage increased annual weeds: *Euphorbia parviflora, Cyperus iria, Monochoria hastata, Digitaria sanguinalis, Lindernia antipoda, L. hyssopifolia* and *Fimbristylis miliacea* in the seedbank at 0-15 cm soil depth.

ACKNOWLEDGMENTS

The authors highly acknowledge the funding support of the Australian Centre for International Agricultural Research (ACIAR) project at Bangladesh Agricultural University, Mymensingh, Bangladesh.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

ORCID

Mohammad Mobarak Hossain: 0000-0003-0640-3209

Mahfuza Begum: 0000-0003-2754-4692

Md. Moshiur Rahman: 0000-0001-6601-8682

REFERENCES

Aweto A.O. (2013) Shifting cultivation and secondary succession in the tropics. CABI, Wallingford, Oxford shire, UK.

Barroso J. Navarrete L. Sánchez Del Arco M.J. Fernandez-Quintanilla C. Lutman P.J.W. Perry N.H. Hull R.I. (2006) Dispersal of *Avena fatua* and *Avena sterilis* patches by natural dissemination, soil tillage and combine harvesters. Weed Research, 46(2): 118–128.

Begum M. Juraimi A.S. Rastan S.O.B.S. Amartalingam R. Man AB (2006) Seedbank and seedling emergence characteristics of weeds in rice field soils of the muda granary area in north-west peninsular Malaysia. Biotropia, 13(1): 11–21.

Conn J.S. (2006) Weed seed bank affected by tillage intensity for barley in Alaska. Soil and Tillage Research, 90: 156–161.

Cordeau S. Baudron A. Adeux G. (2020) Is tillage a suitable option for weed management in conservation agriculture? Agronomy, 10(11): 1-14.

Curran W.S. (2016) Persistence of herbicides in soil. Crops & Soils, 49(5), 16–21.

Dahlin A.S. Rusinamhodzi L. (2019) Yield and labor relations of sustainable intensification options for smallholder farmers in sub-Saharan Africa. A meta-analysis. Agronomy for Sustainable Development, 39(3): 1–18.

Demjanová E. Macák M. Dalovic I. Majernik F. Tyr S. Smatana S. (2009) Effects of tillage systems and crop rotation on weed density, weed species composition and weed biomass in maize. Agronomy Research, 7: 785–792.

Feledyn-Szewczyk B. Smagacz J. Kwiatkowski C.A. Harasim E. Woźniak A. (2020) Weed flora and soil seed bank composition as affected by tillage system in three-year crop rotation. Agriculture, 10(5): 1-20.

Gauvrit C. Chauvel B. (2010) Sensitivity of *Ambrosia artemisiifolia* to glufosinate and glyphosate at various developmental stages. Weed Research, 50(5): 503–510.

Gresta F. Cristaudo A. Onofri A. Restuccia A. Avola G. (2010) Germination response of four pasture species to temperature, light, and post-harvest period. Plant Biosystems, 144(4): 849–856.

Gruber S. Claupein W. (2009) Effect of tillage intensity on weed infestation in organic farming. Soil and Tillage Research, 105: 104–111.

Habich N. (2001) Ecological site inventory query (Inventory Data System), U.S. Department of the Interior, Bureau of Land Management, Denver, Colorado, USA.

Kleemann S.G.L. Gill G.S. (2013) Seed dormancy and seedling emergence in ripgut brome (*Bromus diandrus*) populations in southern Australia. Weed Science, 61(2): 222–229.

Krawczyk R. Kubsik K. Mrówczy´nski M. Kaczmarek S. (2008) Effect of soil variation and soil tillage systems on soil weed seedbank. Progress in Plant Protection, 48: 276–280. (In Polish)

Lemessa F. Wakjira M. (2014) Mechanisms of ecological weed management by cover cropping: A review. Journal of Biological Sciences, 14(7): 452–459.

Lim C.A. Awan T.H. Sta Cruz P.C. Chauhan BS (2015) Influence of environmental factors, cultural practices, and herbicide application on seed germination and emergence ecology *of Ischaemum rugosum* Salisb. PloS one, 10(9): e0137256.

Mashavakure N. Mashingaidze A.B. Musundire R. Gandiwa E. Svotwa E. (2020) Germinable weed seed-bank response to plant residue application and hand weeding under two contrasting tillage systems in a granite-derived clay loam soil in Zimbabwe. South African Journal of Plant and Soil, 37(2): 227–235.

Mirsky S.B. Ryan M.R. Teasdale J.R. Curran W.S. Reberg-Horton C.S. Spargo J.T. Wells M.S. Keene C.L. Moyer, J. W. (2013). Overcoming weed management challenges in cover crop–based organic rotational no-till soybean production in the Eastern United States. Weed Technology, 27(1): 193–203.

Nandan R. Singh V. Kumar V. Singh S.S. Hazra K.K. Nath C.P. Malik, R.K. Poonia S.P. (2020) Viable weed seed density and diversity in soil and crop productivity under conservation agriculture practices in rice-based cropping systems. Crop Protection, 136, 105210.

Nichols V. Verhulst N. Cox R. Govaerts B. (2015) Weed dynamics and conservation agriculture principles: A review. Field Crops Research, 183: 56–68.

Nkoa R. Owen M.D.K. Swanton C.J. (2015) Weed abundance, distribution, diversity, and community analyses. Weed Science, 63(1): 64–90.

Opeña J.L. Chauhan B.S. Baltazar A.M. (2014) Seed germination ecology of *Echinochloa glabrescens* and its implication for management in rice (*Oryza sativa* L.). PLoS ONE, 9(3): e92261.

Owen M.J. Goggin D.E. Powles SB (2015) Intensive cropping systems select for greater seed dormancy and increased herbicide resistance levels in *Lolium rigidum* (annual ryegrass). Pest Management Science, 71(7): 966–971.

Oziegbe M. Faluyi J.O. Oluwaranti A. (2010) Effect of seed age and soil texture on germination of some *Ludwigia* species (Onagraceae) in Nigeria. Acta Botanica Croatica, 69(2): 249-257.

Peigné J. Ball B.C. Roger-Estrade J. David, C. (2007) Is conservation tillage suitable for organic farming? A review. Soil Use and Management, 23: 129–144.

Piskier T. Sekutowski T.R. (2013) Effect of simplified tillage on the number and distribution of weed seeds in soil. Journal of Research and Applications in Agricultural Engineering, 58: 109–117.

Pittelkow C.M. Liang X. Linquist B.A. Van Groenigen L.J. Lee J. Lundy M.E. Van Gestel N. Six J. Venterea R.T. van Kessel C. (2015) Productivity limits and potentials of the principles of conservation agriculture. Nature, 517(7534): 365–368.

Restuccia A. Scavo A. Lombardo S. Pandino G. Fontanazza S. Anastasi U. Abbate C. Mauromicale G. (2020) Long-term effect of cover crops on species abundance and diversity of weed flora. Plants, 9 (11): 1–16.

Santín-Montanyá M.I. Martín-Lammerding D. Walter I. Zambrana E. Tenorio J.L. (2013) Effects of tillage, crop systems and fertilization on weed abundance and diversity in 4-year dry land winter wheat. European Journal of Agronomy, 48: 43–49.

Shannon C.E. (1948) A mathematical theory of communications. The Bell System Technical Journal. 27: 379–423.

Simpson E.H. (1949) Measurement of diversity. Nature, 168: 668.

Singh M. Bhullar M.S. Chauhan B.S. (2015) Influence of tillage cover cropping, and herbicides on weeds and productivity of dry direct-seeded rice. Soil and Tillage Research, 147: 39–49.

Singh R. Pramanick B. Singh A. Kumar S. Kumar A. Singh G. (2017) Bio-efficacy of fenoxaprop-p-ethyl for grassy weed control in onion and its residual effect on succeeding maize crop. Indian Journal of Weed Science, 49(1): 63–66.

Tanveer A. Nadeem M.A. Ali A. Tahir M. Zamir M.S.I. (2009) Germination behaviour of seeds from herbicide treated plants of *Chenopodium album* L. Annals of the Brazilian Academy of Sciences, 81(4): 873–879.

Travlos I.S. Cheimona N. Roussis I. Bilalis D.J. (2018) Weed-species abundance and diversity indices in relation to tillage systems and fertilization. Frontiers in Environmental Science, 6(11): 1-10.

Vakali C. Zaller J.G. Köpke U. (2011) Reduced tillage effects on soil properties and growth of cereals and associated weeds under organic farming. Soil and Tillage Research, 111: 133–141.

White S.S. Renner K.A. Menalled F.D. Landis D.A. (2007) Feeding preferences of weed seed predators and effect on weed emergence. Weed Science, 55(6): 606–612.

Woźniak A. (2018) Effect of tillage system on the structure of weed infestation of winter wheat. Spanish Journal of Agricultural Research, 16(4): 1-7.