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Research Article

Weed seed bank and weed population as influenced by weed management practices in rice *var* Co 54

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Abstract
Weed seed bank in soil serves as the reservoir of weed seeds which emerge whenever conditions become conducive and affects crop growth. In the present study, a field experiment was performed at Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, India, during *Kharif* 2021 and *Rabi* 2022 to determine weed seed bank present in soil by direct seed extraction using the sieving method at discrete depths of 0-5 cm, 5-10 cm and 10-15 cm after rice harvest with reference to different weed management practices imposed and its effect on weed population in succeeding crop. The average proportion of weeds that emerged in the field ranged from 9 to 38 % of the total weed seed bank. Weed management practices followed during the preceding crop greatly influenced weed seed germination. The higher weed seed reserve (1384 m^{-2}) and consequent weed population (528 no's m^{-2}) were found at a depth of 0-5 cm in unweeded plots. The lower weed seed density (536 m^{-2}) and weed population (94 no's m^{-2}) were found in pre emergence application of Pyrazosulfuron + Pretilachlor and early post emergence application of Bispyripac sodium. The results from the present study confirmed that herbicide treatment considerably minimized the weed seed density and population, which will assist in predicting weed infestation and appropriate timing of weed control.

Keywords: Herbicides, Seed density, Soil depth, Weed population

INTRODUCTION

Weeds are a unique group of plant species because of their ability to infest and thrive in intensively disturbed habitats, despite extensive efforts to eliminate them. Weeds are successful because they adapt and survive environmental changes (Takim *et al*., 2013). The weed seed bank is the reserve of viable weed seeds present on surface soil and scattered throughout the soil profile forming an important component of life cycle of weeds. It consists of both new weed seeds recently shed and older seeds that have persisted in the soil from previous years. Weeds generally depend on its seed bank in the soil for their persistence in agricultural systems. If all the weeds in a particular land germinate at once, there is a possibility that weeds will get rid of permanently. But unfortunately, weeds persist and the major cause behind the weed persistence is the maintenance of the weed seed bank in the soil (Borgy *et al.,* 2015). If weeds were not controlled, seed bank density increased to 90% of the original level (Burnside *et al*., 1986).Weed management, tillage operations and unpuddled saturated soil conditions are major components affecting weed seed banks present in surface and subsurface soil. In farmlands where herbicides were used, there was a change in weed seed bank spectrum than herbicides untreated lands (Ranjit *et al*., 2007). Estimating the effects of environmental factors and tillage operations on weed emergence can lead to the development of successful weed management practices (Travlos *et al.,* 2020). However, Chauhan *et al*., (2006) reported that tillage systems can significantly influence the vertical distribution of seeds in the weed seed bank since tillage operation is the major weed management tool in many cropping systems.

Weed seeds are major biological constraints for rice farmers and many weed species that occur in rice fields can produce a huge number of small seeds and vegetative propagules as a strategy to survive stresses imposed by control methods (Leck and Schutz, 2005). Mesquita (2017) discovered that, after dispersal, seeds may remain on the soil surface or buried by biotic and abiotic agents, thus forming a seed bank that becomes a major source of weeds in rice fields. As a survival strategy of colonization and persistence in communities, weeds have developed a number of features such as seed dormancy which enables discontinuous germination during growing seasons, ensuring viability of seeds in soil for a long period (Batlla and Arnold, 2014). Soil and crop management practices can directly influence the environment of seeds in the seed bank and can thus be used to manage seed longevity and germination behaviour (Kumar *et al*., 2019) Weed management, be it herbicide treatment or other cultural practices have more impact on weed seed production in rice field; weed management exposes more impact than tillage on weed seed production in maize-soybean rotation (Perron and Legere 2000). Herbicides are considered more effective in reducing weed populations and the number of seeds added to the weed seed bank (Hossain *et al*., 2015). It also inhibits the germination and growth of dominant weed species in top soil seed banks. The magnitude of weed seed banks in rice fields is highly variable and differences in the number of seeds or weed seedling density in the seed bank could be explained by several factors, including climate, relief position, soil moisture content, depth of sampling, history of the areas and management practices (Maia *et al*., 2004). The present study was focused on observing the effect of the application of herbicides and tillage operations on the available weed seed bank and resultant weed emergence for effective control of weeds in succeeding rice crops.

MATERIALS AND METHODS

Details of experimental site

Field experiments were conducted at TamilNadu Agricultural University, Madurai, India, during *Kharif* 2021 and *Rabi* 2022 in rice *var* Co 54 to study weed seed bank and weed population, respectively. The treatments were replicated thrice under seven weed management regimes (Table 1). The experimental field is geographically located in the southern part of Tamil Nadu (9º54′N, 78º54′E).

Collection of soil samples for analysis

Post-harvest soil samples were collected at a soil depth of 0-5 cm, 5-10 cm and 10-15 cm from all the treatments. Soil cores totalling 252 (4 spots × 3 depths × 7 weed management plots × 3 replication) representing an area of 1m^2 within each plot using soil auger at discrete depths were taken and the soil cores of the same depth were pooled. These composite soil samples were divided into three working sub samples of one hundred grams each for weed seed bank analysis. The soil samples were then transported to the laboratory and then stored in a dark place at room temperature.

Protocol for identification of weed seeds from soil sample

Weed seeds were extracted from the soil by direct seed extraction using the sieving method. Soil samples were allowed to pass through sieves of discrete mesh sizes (0.6, 0.8, 1.0, 1.2 and 1.4 mm). Initially, 150 g of soil was added to 250 ml beaker and sodium hexa-

Table 1. Weed management practices followed during the study

Weed management regimes		Dosage of herbicides
B1	PE Pretilachlor *fb* EPOE Bispyripac sodium.	0.45 kg a.i ha^{-1} + 25 g a.i ha^{-1}
B2	PE Pyrazosulfuron + Pretilachlor *fb* EPOE Chlorimuron + Metsulfuron.	10 kg a.i ha^{-1} + 20g a.i ha^{-1}
B3	PE Benzsulfuron + Pretilachlor *fb* EPOE Chlorimuron + Metsulfuron	0.6 kg a.i ha^{-1} + 20 g a.i ha^{-1}
B4	PE Pyrazosulfuron + Pretilachlor *fb* EPOE Bispyripac sodium.	10 kg a.i ha^{-1} + 25 g a.i ha^{-1}
B5	PE Benzsulfuron + Pretilachlor *fb* EPOE Bispyripac sodium	0.6 kg a.i ha^{-1} + 25 g a.i ha^{-1}
B6	Weed free check	-
B7	Unweeded control	-

PE - Pre emergence ; EPOE - Early post emergence

Table 2. Weed seeds observed in seed bank

	Scientific name	Common name	Family	Seed description
	Grass			
1.	*Echinochloa colona*	Jungle rice	Poaceae	White to hyaline with longitudinal ridges on the convex surface.
2.	*E. crusgalli*	Cockspur grass	Poaceae	Ovoid and brownish in colour.
	Sedge			
1.	*Cyperus iria*	Rice flat sedge	Cyperaceae	Nut type, dark brown and smooth surface
2.	*C. difformis*	Rice sedge	Cyperaceae	Nutlets and yellowish brown
	Broad Leaved Weed			
1.	*Ammania baccifera*	Monarch redstem	Lythraceae	Seeds are yellowish brown
2.	*Amaranthus viridis*	Green amaranth	Amaranthaceae	Black shiny, slightly compressed
3.	*Cleome viscosa*	Tick weed	Cleomaceae	Reddish brown, Cleft narrow
4.	*Eclipta prostate*	False daisy	Asteraceae	Light brown to black, Wedge shaped
5.	*Trianthema portulacastrum*	Horse purslane	Aizoaceae	Black kidney shaped ended by a beak.
6.	*Tridax procumbens*	Coat buttons	Asteraceae	Dark brown to black,Oblong shaped

metaphosphate solution (40g/lit of water) was added to disintegrate the soil particles and kept undisturbed for 30 minutes (Hussain *et al*., 2017). Then, the mixture was dispensed into sieves arranged in order of larger size sieve in the top to a smaller size at the bottom and placed under running tap water. Seeds and debris of related sizes persisted on sieves. After drying at room temperature, weed seeds were identified using a magnifying lens. The weed seeds collected were identified in comparison with those collected from the surrounding area for reference. Identified weeds were characterized into three groups; grasses, sedges and broad-leaved weeds.

Data analysis

Analysis of variance and R software was used to analyse the effect of treatments. Means were separated by $LSD_{(0.05)}$.

RESULTS AND DISCUSSION

Weed seed community

The present study showed that the weed seeds collected comprised 10 species belonging to 7 families (Table 2) *viz., Echinochloa colona, Echinochloa crusgalli, Cyperus iria, Cyperus difformis, Ammania baccifera, Amaranthus viridis, Cleome viscosa, Trianthema portulacastrum, Eclipta prostrata and Tridax procumbens*. Some species were dominant in each category, for instance, *E. colona* among grasses, *C. iria* among sedges and *T. portulacastrum*, *C. viscosa*, *A. viridis* among BLW while Dey *et al.,* (2018) observed that, the contribution of *C. viscosa* was highest among all the weed species at harvest stage of the crop and was followed by *Dactyloctenium aegypticum* in sweet corn.

Weed seed bank as influenced by soil depths

The total weed seed density has shown a decreasing trend with increasing soil depth from 0-20 cm. This corresponds to the finding of Ranjit *et al.*, 2007 in grasses, sedges and BLW in rice-wheat rotation. The weed seed count of grasses, sedges and BLW were found to be higher at a depth of 0-5 cm (Fig 1). Among the BLW, *T. portulacastrum* and *C. viscosa* dominated most at 0-5 cm depth. Weed seeds are viable in the upper part (0-5 cm) of soil profile, which determines the

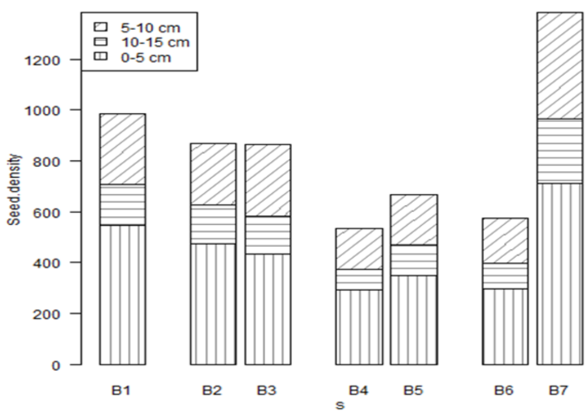

Fig. 1. *Effect of weed management practices on Post-harvest total weed seed density at various soil depths (* Refer to Materials and Methods for details of Weed management regimes)*

composition of weed flora in the upcoming season which was contrast to the findings of Zhang *et al*., (2019) who reported that, seed survival rate decreased to 5 %in shallow soil layer of 0-5 cm whereas in deeper soil layer (10-15) 20% of seed remained viable. The less weed population in the field in spite of higher weed seed density in the seed bank at 0-5 cm may be due to the dormancy of weed seeds but there was difference with observation of Dey *et al*., (2018) in which weed seeds of preceding crop were present in deeper layer of 10-15 cm. Buhler *et al*., (2001) reported that, seed densities of all species were affected by soil depth and crops cultivated over the year. Weed seeds are lower in deeper layers (10-15 cm) than in upper layers (0-5 cm), which might be caused due to tillage systems as well as other soil intervention methods (Olano *et al*., 2002). The present study revealed that, the number of weed seeds and weed density was lower in the deeper layers (10-15 cm).

Weed seed bank as influenced by weed management

The total weed seed density of grasses, sedges and BLW was lower in weed-free check and herbicide applied plots. Regarding grassy weed seeds, application of Pretilachlor + Pyrazosulfuron as pre-emergence (PE) followed by early post-emergence (EPOE) application of Bispyripac sodium effectively inhibited the germination of *E. colona* and *E. crusgalli* seeds. Next to this, the combination of Pretilachlor + Bensulfuron as PE and Bispyripac sodium as EPOE was also effective on grass weed seeds compared to other herbicide treatments and unweeded control whereas the outcome of Ranjit *et al*., (2007) showed that anilophos plus hand weeding and bispyribac-sodium was effective on the grass weeds associated with the rice crop (Table 3 and 4).

The combination of PE Pretilachlor + Pyrazosulfuron

Table 3. Effect of weed management practices on Post-harvest weed seed density (WSD) of *E.colona* in rice, 2021 and Field weed emergence (FWE) in succeeding rice, 2022

Treatments	*E.colona* Seed density m^{-2}			WSD	FWE (No's m^{-2})	Emergence percentage
	0-5 cm	5-10 cm	10-15 cm			
Weed management (B)						
B1*	79 b	45 b	27 b	151 b	34 b	23
B2	80 b	34 cd	19 c	133 c	27 c	20
B3	65 c	44 bc	18 c	127 c	23 d	18
B4	46 d	26 d	6 d	78 d	13 e	16
B5	61 c	30 d	10 d	101 d	21 d	20
B6	45 d	27 d	10 d	82 d	6 f	7
B7	102 a	56 a	35 a	193 a	68 a	35
LSD (0.05)	12.5	10.2	7.2	16.2	3.3	-†

* Refer to materials and methods for details of weed management regimes; † Data not statistically analysed; Means sharing the same letter, within a column, differ significantly at $p \leq 0.05$

Table 4. Effect of weed management practices on Post-harvest weed seed density (WSD) of *E.crusgalli* in rice, 2021 and Field weed emergence (FWE) in succeeding rice, 2022

Treatments	*E.crusgalli* Seed density m^{-2}			WSD	FWE (No's m^{-2})	Emergence percentage
	0-5 cm	5-10 cm	10-15 cm			
Weed management (B)						
B1*	78 b	42 b	13 c	133 b	11 cd	8
B2	62 c	40 b	19 b	121 bc	19 b	15
B3	54 d	34 c	12 c	100 c	12 c	12
B4	39 f	20 e	7 e	66 de	5 e	7
B5	45 e	23 d	11 cd	79 d	10 d	12
B6	38 f	17 f	9 de	64 e	3 f	4
B7	92 a	59 a	34 a	185 a	32 a	17
LSD (0.05)	1.8	1.9	2.2	14.94	1.05	-†

* Refer to materials and methods for details of weed management regimes;† Data not statistically analysed; Means sharing the same letter, within a column, differ significantly at $p \leq 0.05$

Table 5. Effect of weed management practices on Post-harvest weed seed density (WSD) of *C.iria* in rice, 2021 and Field weed emergence (FWE) in succeeding rice, 2022

Treatments	*C.iria* Seed density m^{-2}			WSD	FWE (No's m^{-2})	Emergence percentage
	0-5 cm	5-10 cm	10-15 cm			
Weed management (B)						
B1*	39 ab	27 b	17 b	83 b	30 b	36
B2	32 bc	22 bc	19 b	73 c	21 c	28
B3	27 cd	18 bc	16 bc	61 d	17 d	27
B4	21 d	12 c	10 d	43 f	10 f	23
B5	23 cd	15 c	13 cd	51 e	13 e	25
B6	20 d	12 c	10 d	42 f	9 f	21
B7	45 a	39 a	23 a	107 a	38 a	35
LSD (0.05)	9.7	10.8	3.2	7.4	1.6	-†

* Refer to materials and methods for details of weed management regimes; † Data not statistically analysed; Means sharing the same letter, within a column, differ significantly at $p \leq 0.05$

Table 6. Effect of weed management practices on Post-harvest weed seed density (WSD) of *C. difformis* in rice, 2021 and Field weed emergence (FWE) in succeeding rice, 2022

Treatments	*C. difformis* Seed density m^{-2}			WSD	FWE (No's m^{-2})	Emergence percentage
	0-5 cm	5-10 cm	10-15 cm			
Weed management (B)						
B1*	31 b	17 bc	20 b	68 b	14 b	20
B2	26 b	14 bc	15 c	55 c	10 c	18
B3	30 b	20 b	13 c	63 bc	8 d	12
B4	20 b	13 bc	5 d	38 d	3 e	7
B5	24 b	15 bc	10 cd	49 c	10 c	20
B6	19 b	11 bc	7 d	37 d	2 e	5
B7	52 a	41 a	28 a	121 a	29 a	23
LSD (0.05)	12.9	7.4	4.7	7.9	1.0	-†

* Refer to materials and methods for details of weed management regimes; †Data not statistically analysed; Means sharing the same letter, within a column, differ significantly at $p \leq 0.05$

and EPOE Bispyripac sodium suppressed the weed seed count of sedges significantly ($p \leq 0.05$) followed by PE Pretilachlor + Bensulfuron and EPOE Bispyripac sodium over unweeded control. But, Ranjit *et al*. (2007) reported that sedges seeds were found lower with mulch treatment (Table 5 and 6). The herbicide Chlorimuron ethyl + Metsulfuron methyl as EPOE was not effective in inhibiting the germination of sedges.

Different weed management treatments significantly ($p \leq 0.05$) affected the weed seed bank of BLW. Application of PE Pretilachlor + Pyrazosulfuron and EPOE Bispyripac sodium lowered weed seed density of BLW (Table 7, 8, 10 and 12). It effectively inhibited *T. portulacastrum* and *C. viscosa*, otherwise more dominant BLW species (Table 9 and 11). PE Pretilachlor + Bensulfuron and EPOE Chlorimuron + Metsulfuron stood next in controlling BLW. In contrary, BLW seeds were controlled by hand weeding at 20 and 40 DAS, atrazine 1000 g/ha *fb* tembotrione 120 g/ha and alone application of tembotrione 120 g/ha as reported by Dey *et al*. (2018). Weeds seeds are found to be lower in herbicide-applied plots. This may be due to the right time of application which induced dormancy of seeds affecting the viability and replenishment besides sterilizing the weed seeds (Benjamin, 2016). Xiuli Ge (2018) also reported that herbicides significantly reduced the weed seed density present in soil except for unweeded plots. The result of present research confirmed that the treat-

Table 7. Effect of weed management practices on Post-harvest weed seed density (WSD) of *A. baccifera* in rice, 2021 and Field weed emergence (FWE) in succeeding rice, 2022

Treatments	*A.baccifera* Seed density m^{-2}			WSD	FWE (No's m^{-2})	Emergence percentage
	0-5 cm	5-10 cm	10-15 cm			
Weed management (B)						
B1*	61 b	33 b	17 b	111 b	31 c	27
B2	54 c	31 bc	14 bc	99 bc	29 d	29
B3	58 bc	35 bc	11 cd	104 b	35 b	33
B4	32 d	19 d	8 de	59 d	15 f	25
B5	37 d	25 d	10 de	72 c	22 e	30
B6	33 d	29 c	7 e	69 cd	5 g	7
B7	67 a	40 a	21 a	128 a	59 a	48
LSD (0.05)	4.2	3.1	3.6	9.3	2.2	-†

* Refer to materials and methods for details of weed management regimes;† Data not statistically analysed; Means sharing the same letter,

Table 8. Effect of weed management practices on Post-harvest weed seed density (WSD) of *A.viridis* in rice, 2021 and Field weed emergence (FWE) in succeeding rice, 2022

Treatments	*A. viridis* Seed density m^{-2}			WSD	FWE (No's m^{-2})	Emergence percentage
	0-5 cm	5-10 cm	10-15 cm			
Weed management (B)						
B1*	65 b	24 c	12 bc	101 b	12 c	11
B2	50 c	25 c	9 cd	84 bc	9 d	10
B3	43 d	32 b	16 b	91 b	16 b	17
B4	21 f	13 f	7 d	41 e	5 e	12
B5	26 e	19 d	15 b	60 d	9 d	15
B6	22 f	16 e	8 cd	46 e	2 f	4
B7	95 a	42 a	25 a	162 a	35 a	21
LSD (0.05)	2.0	2.5	4.7	10.1	1.2	-†

* Refer to materials and methods for details of weed management regimes;†Data not statistically analysed; Means sharing the same letter, within a column, differ significantly at p ≤ 0.05

Table 9. Effect of weed management practices on Post-harvest weed seed density (WSD) of *C. viscosa* in rice, 2021 and Field weed emergence (FWE) in succeeding rice, 2022

Treatments	*C.viscosa* Seed density m^{-2}			WSD	FWE (No's m^{-2})	Emergence percentage
	0-5 cm	5-10 cm	10-15 cm			
Weed management (B)						
B1*	54 b	23 b	18 b	95 b	38 b	40
B2	52 bc	19 de	20 b	91 b	32 c	35
B3	50 cd	22 bc	13 c	85 bc	23 d	27
B4	45 f	16 e	9 cd	70 d	12 f	17
B5	48 de	20 cd	12 cd	80 c	19 e	23
B6	47 ef	21 bcd	8 d	76 cd	5 g	6
B7	65 a	34 a	22 a	121 a	63 a	52
LSD (0.05)	2.5	2.7	4.2	8.5	3.4	-†

* Refer to materials and methods for details of weed management regimes; † Data not statistically analysed; Means sharing the same letter, within a column, differ significantly at p ≤ 0.05

Table 10. Effect of weed management practices on Post-harvest weed seed density (WSD) of *E.prostrata* in rice, 2021 and Field weed emergence (FWE) in succeeding rice, 2022

Treatments	*E.prostrata* Seed density m^{-2}			WSD	FWE ($No's\ m^{-2}$)	Emergence percentage
	0-5 cm	5-10 cm	10-15 cm			
Weed management (B)						
B1*	15 cd	12 bc	6 bc	33 d	6 d	18
B2	18 bc	13 ab	7 bc	38 c	8 c	21
B3	20 b	16 ab	9 b	45 b	11 b	24
B4	12 d	6 d	3 c	21 e	3 e	14
B5	16 bcd	8 cd	6 bc	30 d	6 d	20
B6	13 d	7 d	4 c	24 e	4 f	16
B7	26 a	17 a	13 a	56 a	19 a	33
LSD (0.05)	4.5	4.0	3.9	3.4	1.1	-†

* Refer to materials and methods for details of weed management regimes; † Data not statistically analysed; Means sharing the same letter, within a column, differ significantly at $p \leq 0.05$

Table 11. Effect of weed management practices on Post-harvest weed seed density (WSD) of *T. portulacastrum* in rice, 2021 and Field weed emergence (FWE) in succeeding rice, 2022

Treatments	*T.portulacastrum* Seed density m^{-2}			WSD	FWE ($No's\ m^{-2}$)	Emergence percentage
	0-5 cm	5-10 cm	10-15 cm			
Weed management (B)						
B1*	118 b	53 c	18 f	189 b	78 b	41
B2	93 c	40 d	31 cd	164 c	71 b	43
B3	75 d	58 b	35 b	168 c	35 c	38
B4	54 f	32 f	25 e	111 d	25 cd	22
B5	63 e	41 d	34 bc	138 d	34 c	24
B6	56 f	35 e	30 d	121 d	12 d	9
B7	153 a	81 a	44 a	278 a	173 a	62
LSD (0.05)	3.9	3.1	3.2	19.4	9.2	-†

* Refer to materials and methods for details of weed management regimes;† Data not statistically analysed; Means sharing the same letter, within a column, differ significantly at $p \leq 0.05$

Table 12. Effect of weed management practices on Post-harvest weed seed density (WSD) of *T. procumbens* in rice, 2021 and Field weed emergence (FWE) in succeeding rice, 2022

Treatments	*T.procumbens* Seed density m^{-2}			WSD	FWE ($No's\ m^{-2}$)	Emergence percentage
	0-5 cm	5-10 cm	10-15 cm			
Weed management (B)						
B1*	9 b	7 bc	5 bc	21 d	4 e	19
B2	8 bc	9 bc	7 bc	24 c	8 b	33
B3	13 a	8 ab	6 b	27 b	6 c	22
B4	4 d	3 d	2 c	9 g	3 f	3
B5	6 cd	5 cd	5 bc	16 f	5 d	31
B6	5 d	6 bc	8 b	19 e	2 g	10
B7	12 a	10 a	11 a	33 a	12 a	36
LSD (0.05)	2.6	2.4	3.0	1.4	0.4	-†

* Refer to materials and methods for details of weed management regimes;† Data not statistically analysed; Means sharing the same letter, within a column, differ significantly at $p \leq 0.05$

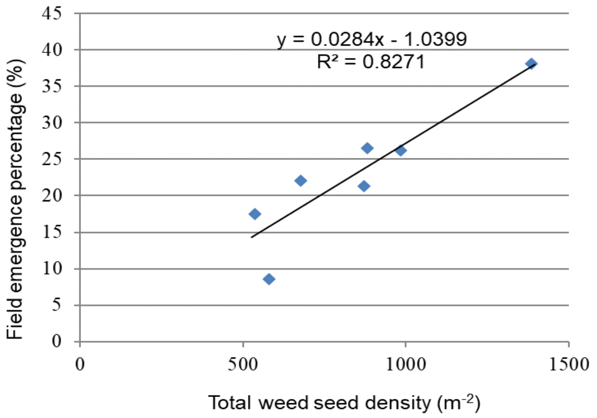

Fig. 2. *Relationship between total weed seed density and field emergence*

ment combination of Pretilachlor + Pyrazosulfuron and Bispyripac sodium herbicide was capable of inhibiting the germination of weed seeds of grasses, sedges and BLW, thereby reducing the weed seed density and ascertaining its broad spectrum of action.

Relationship between post-harvest weed seed bank and field weed population

The regression analysis between total weed seed density and field weed emergence obtained from post-harvest seedbank estimations indicated significant ($p \leq 0.05$) positive linear relationship with R^2 value of 0.82 (Fig. 2). The field weeds that emerged from the weed seed bank ranged from 9 to 38 % of the total weeds seeds. The average emergence of total grasses, sedges and broad-leaved weeds varied from 6 to 26 %, 11 to 67 % and 8 to 46 %, respectively. The current findings has higher emergence percentage of BLW and grass weed seeds over results of Rahman *et al*. (2006) who found an average of 2.1 - 8.2 % and 6.2 – 11.9 % of the seeds of broadleaf and grass weed species, respectively. Emerged weeds in the field provide the primary indication of the success of the weed management (Takim *et al*., 2013). The present study documented that the field emergence percentage of majority weeds *viz.*(*E.colona, E.crusgalli, C.iria, C.difformis, A.baccifera, A.viridis, C.viscosa, T.portulacastrum*) except *E.prostrata* and *T.procumbens* from weed seed bank was found to be lower in weed-free check followed by PE Pretilachlor + Pyrazosulfuron applied plots (Table 10 and 12). However, unweeded and other treatments noted a greater field emergence percentage.

Conclusion

In this study, though emerged weeds gave a reasonably good estimate of the possible field emergence, they represented only a small and variable fraction of the weed seed bank in the soil. It will be valuable in aiding the prediction of weed infestations, which also provides appropriate timing for weed control.

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Conflict of interest

The authors declare that they have no conflict of interest.

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