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Weed seed bank studies in the field of Fodder Cowpea [*Vigna unguiculata (*L.)]

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Abstract

This study evaluated the effect of herbicidal treatments on diversity of weed seed bank in fodder cowpea (Vigna unguiculata (L.) cropping field. Four weed species were common to all the experiments during the winter season. Weed diversity was greater in pendimethalin (1.34) at 0-15 cm depth and Quizalofop ethyl + oxyflorfen (1.09) at 15-30 cm depth. Considerably smaller size of soil seed bank was found in the 15-30 cm soil depth. About three-fourth of soil seed bank during winter season was accounted by Anagallis arvensis and Spergula arvensis in all the treatments. Build-up of very large seed bank of Anagallis arvensis and Spergula arvensis in all the treatments indicated that in future these species may become predominant weeds.

Key words: Weed seed bank, Seedling enumeration, Weed diversity index, Fodder cowpea.

I. INTRODUCTION

The reservoir of weed seeds in the soil or on the soil surface is literally referred as weed seedbank and it determines the pattern of weed seed germination, species composition and potential densities of weeds that interfere with crops during next cropping season (Rahman *et al.,* 1996). Annual weed populations are established every year because of persistent seed banks in arable soils. As most of the weed species in arable cropping systems are annuals, some knowledge of the seedbank may be a good starting point for an integrated weed management programme (Forcella 1993). Quantification of the weed density and diversity, pattern of weed seed germination and depth of weed seed viability in the 0-15 and 15-30 cm depth of soil is key to understand and devise suitable weed management plan. In order to exploit the potential of using the weed seed content, diversity and depth of seed viability in the soil could be useful to predict future weed problems and techniques to maintain weed population under economic threshold level. The present investigation was carried out to examine the distribution of arable weed seeds in surface and sub-surface areas of fodder cowpea field.

II. MATERIALS AND METHODS

A net house experiment was laid out in a completely randomized block design with four replications in January, 2014 at Central Research Farm of Indian Grassland and Fodder Research Institute, Jhansi to examine the weed seed potential of the field of fodder cowpea. The soil samples were collected from the ten treatments i.e. pendimethalin 30 % EC (T_1), imazethapyr 10 % SL (T_2), alachlor 50 % EC - quizalofop-ethyl 5% EC (T_3), imazethapyr 10 % SL + pendimethalin 30 % EC (T_4), propaquizafop 10 % EC (T_5), quizalofop-ethyl 5 % EC + oxyfluorfen 23.5 % EC (T_6), alachlor 50 % EC (T_7), imazethapyr 10 % SL + imazamox 35 % WDG (T_8), weed free check (T_9) and weedy check (T_{10}) after harvesting of fodder cowpea in August, 2013 by using core sampler and kept it for 4 months under shade condition to impose unfavourable conditions to prevent immediate germination of weed seeds. Plastic trays (23.5 × 19.5 × 4.5 cm) were half filled with sterile sand and thoroughly wetted by giving water. After removing plant debris and large pebbles, soil samples (1.25 kg) were placed above the sterile sand to a height of 2 cm (Rahman *et al.,* 1995). Soil moisture was

then maintained by sprinkling top water as required. The trays were maintained in the net house under natural light with day temperature of 17-19^{o}C and night temperature of 2-5^{o}C during the winter of 2013-14. Approximately one month after setting up the experiments, the emerged weed seedlings were identified, counted and completely removed. The soil was allowed to air dry before being thoroughly mixed by shaking in a polythene bag and being set out in the trays again for the next incubation, and the process repeated until seedling numbers emerging in each tray were less than 2. The observations on density, diversity and periodic germination were recorded and analysed by using the statistical procedure given by Sharma (2012).

A. Species Diversity Index (H):

The Shannon-Wiener's index was applied to determine the weed spp. diversity index according to the following formula (Shannon, 1948).

$$H = -\sum_{i=1}^{S} Pi \ln Pi$$

Where:
H= Shannon-Wiener's diversity index
S= the number of genera
Pi= ni/N as the proportion of type I (ni= the total number of individuals of microbe in total i type, N= the total number of all the individuals in total n)
The criteria adopted for interpreting the Shannon- Wiener's diversity (Feriantia-Fachrul *et al*., 2005) are as follows: H (<1) = low diversity, H (1-3) = fair diversity, and H (>3) = high diversity.

B. Simpson Index (D):

$$D = \frac{\sum n_i(n_i - 1)}{N(N-1)}$$

Where D= Simpson index
n_i = the total number of organisms of each individual species
N = the total number of organisms of all species
The value of **D** ranges from 0 to 1. With this index, 0 represents infinite diversity and, 1, no diversity. That is, the bigger the value the lower the diversity.

III. RESULTS AND DISCUSSION

A. Species composition and density:

Considerable numbers of weed species were found in the weed seed bank study, mostly annual broad leaves was recorded in the ten treatments (Table 1). Weed species composition are mostly common with different treatments and with depth of soil. During the net house study four species [*Spergula arvensis* (L), *Anagallis arvensis* (L), *Melilotus indica* (L.) ALL, and *Coronopus didymus* (L.) SM.] were common to all the treatments. Dominant weed species (0 to 15 cm soil depth) in all the treatments were *Anagallis arvensis* (51%) followed by *Spergula arvensis* (31%) and *Melilotus indica* (4 %) similarly, *Anagallis arvensis* (62%) followed by *Spergula arvensis* (23%) and *Melilotus indica* (4 %) at 15-30 cm depth. It has been reported that monocotyledonous grasses/sedges (C4 type) respond more rapidly than broad leaved forbs (C3 type) to warm and moist condition whereas during winter season grasses/sedges likely to decrease (Shad and Siddiqui, 1996; Srivastava and Singh, 2006). Other weeds/ off types was mustard, oat, *Vicia hirsuta* (L.) S.F. Gray., *Cichorium intybus* L. and *Sonchus oleraceus* L.

The weed seed bank population per 1.25 kg soil was low in some of the treatments because of excellent weed control during the last season. The highest total weed population was found in weedy check (57) followed by imazethapyr 10 % SL + imazamox 35 % WDG (50.75) and imazethapyr 10 % SL (43.75) and the lowest number of weed count was recorded in weed free (25.25) followed by propaquizafop 10 % EC (26.50) at 0-15 cm depth (Table 1). Whereas, quizalofop-ethyl 5 % EC + oxyfluorfen 23.5 % EC (51) followed by weedy check (45) and lowest number of weed count was recorded in pendimethalin 30 % EC (25.5) followed by alachlor 50 % EC (27) at 15-30 cm depth. Average population of *Spergula arvensis* at 0-15 cm soil depth was 12 and 15-30 cm was 7.65 whereas, *Anagallis arvensis* was recorded lowest at 0-15 cm (19.75) then 15-30 cm (21.65). Rajani Srivastava (2012) reported that the decline of soil seed bank density with increasing soil depths in both seasons, less downward movement of seeds and anaerobic condition in soil is increasing with increasing soil depth was related to decreased seed density.

B. Diversity of weed and seed bank:

Variations in richness, evenness and diversity of species and soil weed seed bank are shown in Table 2. Shannon-Wiener's index (H) at 0-15 cm (1.11) indicates that fair diversity of weeds was observed in all the treatments whereas, the lowest weed diversity was observed at 15-30 cm (0.99). Amongst the herbicidal treatments propaquizafop was recorded the lowest H value at both the soil depth (0.75 and 0.83 respectively) followed by imazethapyr at 0-15 cm (0.98) and pendimethalin at 15-30 cm (0.98). Low plant diversity appears to be typical of arable land and intensively managed grassland (Wilson *et al.*, 2003). Simpson index (D) also indicates that fair diversity was found at both the soil depths. The soil collected from propaquizafop treatment recorded highest D value (0.50) followed by weed free check (0.47), imazethapyr (0.41) and alachlor (0.41) at 0-15 cm depth whereas, at 15-30 cm weedy check (0.53) followed by alachlor +quizalofop ethyl (0.48) and imazethapyr (0.45). This result was due to their effective control of weeds in the previous season. Herbicidal treatment affects the total number of germinable seeds in the soil seed bank during the study. There was a strong relationship between the species composition of the seed bank and the composition of the aboveground vegetation. Annual broad leaved weeds accounted for most of the germinable seeds in the field of fodder cowpea seed banks.

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Table 1. Density of total weeds, *Spergula arvensis* (L.), *Anagallis arvensis* (L). *Melilotus indica* (L.) ALL. and *Coronopus didymus* (L.) SM. and other weeds in 0-15 and 15-30 cm soil depth of fodder cowpea field.

Treatments	Total weeds		*Spergula arvensis* (L.)		*Anagallis arvensis* (L)		*Melilotus indica* (L.)ALL.		*Coronopus didymus* (L.) SM.		Others	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	33	26	13	7	12	16	2	1	2	2	4.2	0.50
T_2	44	32	18	12	22	18	0	0	1	1	3.5	1.50
T_3	41	36	6	6	25	25	2	1	1	1	7.5	3.50
T_4	31	30	9	5	15	19	2	0	2	2	4.5	4.50
T_5	27	33	8	14	18	17	0	1	0	1	1.5	2.00
T_6	34	51	17	12	11	33	3	1	1	1	3.7	3.00
T_7	40	27	9	4	23	17	1	3	2	2	6.5	2.00
T_8	51	37	17	8	24	23	3	2	4	3	3.7	6.50
T_9	25	30	10	7	13	19	2	2	2	1	0.0	2.00
T_{10}	57	45	12	5	37	32	1	2	1	0	6.5	6.00
S.Em±	3.75	5.58	2.70	2.05	4.43	6.49	0.49	0.58	0.91	0.62	1.18	1.22
C.D. at 5 %	10.90	NS	7.85	5.95	12.86	NS	1.42	1.69	NS	NS	3.4	3.56

Table 2. Species diversity (Shannon-Wiener Index (H value) and Simpson Index (D Value)) of weed seed bank of 0-15 and 15-30 cm soil depth in fodder cowpea field

Treatments	0-15 cm soil depth		15-30 cm soil depth	
	D Value	H value	D Value	H value
Pendimethalin	0.28	1.34	0.42	0.98
Imazethapyr	0.41	0.98	0.45	1.09
Alachlor	0.41	1.11	0.51	0.90
Pursuit plus	0.29	1.26	0.43	1.01
Propaquizafop	0.50	0.75	0.40	0.83
Alachlor +Quizalofop ethyl	0.33	1.18	0.48	1.03
Quizalofop ethyl + oxyfluorfen	0.37	1.09	0.41	1.09
imazethapyr 10 % SL + imazamox 35 % WDG	0.33	1.22	0.41	1.07
Weed free	0.47	0.96	0.53	0.89
Weedy check	0.30	1.19	0.41	1.01
Total Mean Value	0.36	1.11	0.44	0.99