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Above Ground Emergence and Floristic Composition of Weeds in Relation to Tillage and Weed Management Practices in Maize and Cowpea

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ABSTRACT

Background: Weeds are one of the most important elements influencing crop productivity. Tillage practices have a significant effect on the weed seed bank and the appearance of weeds, both of which have a direct impact on farm productivity. Different tillage strategies based on ploughing depth, as well as weed control practices, change the dynamics of weed seeds in the soil. This research will aid in the development of integrated weed control methods by investigating the interaction between tillage and weed management practices.

Methods: Field trials were carried out in two seasons, Summer and *Kharif* 2022, using a split-plot design with three tillage methods and four weed management practices. The treatments were replicated three times.

Result: Among the different tillage treatmentsMouldboard plough *fb* Cultivator *fb* Rotovator recorded the lowest weed density. With respect to weed management methods, pre- and post-emergence herbicide application and hand weeding at 20 and 40 DAS recorded the lower weed density. Interaction effects of tillage and weed management practices resulted in lower weed density in Mouldboard plough *fb* Cultivator *fb* Rotovator with herbicide application and Mouldboard plough *fb* Cultivator *fb* Rotovator with hand weeding. Highest weed density was recorded under Cultivator *fb* Rotovator in unweeded control. With respect to relative density, among the broad-leaved weeds (BLW) *Trianthema portulacastrum* and *Dactyloctenium aegyptium* in grasses dominated among the weed species in 30 and 60 DAS respectively. From the present study it was concluded that the Mouldboard plough *fb* Cultivator *fb* Rotovator with hand weeding twice or herbicide application reduces the weed emergence from the soil weed seed bank.

Key words: Cowpea, Maize, Tillage, Weed density, Weed management practices.

INTRODUCTION

Weeds are one of the major challenges affecting the agriculture production significantly around the world. Crop yield losses due to weeds range from 20% to 80%, depending on the type of crop and weed. It is critical to understand how seed bank dynamics affect the communities of the major weed species in order to build more effective weed control techniques (Singh *et al*., 2023). Weed emergence varies according to environmental conditions, seed bank composition and farming practices such as tillage, crop rotation and weed management tactics. Among the agricultural practices the tillage method employed may significantly impact the weed seed burial depth, seed bank composition and total weed pressure. Altering the tillage system, according to Feledyn-Szewczyk *et al*. (2020), changes the distribution and density of weed seeds in soils. Tillage depth effectively suppresses BLW, grasses and sedges, which can vary depending on individual growth characteristics. Tillage may trigger weed seeds to emerge or be buried to a depth. Tillage changes the vertical distribution of weed seeds in a soil profile, which changes the soil environment around the seeds and affects weed seed germination (Singh *et al*., 2023). Weed species composition varies by geographic location, soil type and farming practices used in the maize-cowpea cropping system. Before applying

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targeted weed management strategies, it is necessary to know the dominant weed species and their emergence patterns in a given situation. Furthermore, weed species dominance and abundance in the maize-cowpea cropping system can be influenced by the effectiveness of weed management practices and the selection of weed control strategies. Hence, the current study was initiated to investigate weed density and the proportion of different types of weed emergence with regard to tillage and weed management practices.

MATERIALS AND METHODS

A field experiment was carried out to investigate the effects of various tillage methods and weed control strategies on the establishment of different weed categories such as BLW, grasses and sedges. The experiment was conducted at the Eastern Block, Department of Agronomy, Tamil Nadu Agricultural University. A split-plot design was used with 15 treatments (3 main plots and five subplots) replicated thrice. The experiment comprises three tillage treatments in the main plot *viz*., Disc plough *fb* cultivator *fb* Rotovator (M_1), Mouldboard plough *fb* Cultivator *fb* Rotovator(M_2) and Cultivator *fb* Rotovator (M_3). Whereas in the subplots five weed management practices *viz*., Hand weeding twice (20 and 40 DAS) (S_1), Atrazine 0.5 kg ai/ha as pre-emergence (PE) and Tembotrione as early post-emergence (EPOE) in Maize and Pendimethalin 0.75 kg ai/ha as PE and propaquizafop 2.5% +Imazethapyr 3.75% as post-emergence in cowpea (S_2), Mulching crop residue (S_3), Intercropping as cowpea in maize and Sunhemp in cowpea (S_4) and Unweeded check (S_5). Spacing adopted were 60×25 cm and 45×15 cm for maize and cowpea respectively. Weed flora and weed density and relative density was observed at 30, 60 and 90 DAS for groupwise species. Relative density was calculated using the formula given below:

$$\text{Relative density (\%)} = \frac{\text{Total number of individuals of spices}}{\text{Total number of individuals of all spices}} \times 100$$

Statistical analysis

Wide variations of weed density data were transformed for ANOVA using the square root transformation method $\sqrt{X + 0.5}$. The critical difference was calculated at a 5% probability level and the value of 'p' was listed in case of significant difference and non-significant difference (NS) (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Weed flora

Totally thirteen number of weed species were found in the experimental plot among which five species were BLW namely *Trianthema portulacastrum, Boerhavia erecta, Digeria arvensis, Parthenium hysterophorus, Amaranthus viridis,* six species of grasses namely *Dactyloctenium aegyptium, Dinebra retroflexa, Echinochloa colona, Cynadon dactylon, Chloris barbata* and *Cyprus rotundus*

Table 1: Weed density (no. m^{-2}) of BLW in maize influenced by tillage and weed management practices @ 30, 60 and 90 DAS.

Treatment	30 DAS				60 DAS				90 DAS			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	2.2 (4)	1.7 (2)	3.1 (9)	2.3 (5)	2.6 (6)	2.8 (8)	3 (9)	2.8 (8)	3.7 (13)	3.3 (11)	4.1 (16)	3.7 (13)
S_2	2.1 (4)	2.1 (4)	1.6 (2)	1.9 (3)	1.9 (3)	1.3 (1)	2.2 (4)	1.8 (3)	3.6 (12)	3.2 (10)	4.3 (18)	3.7 (13)
S_3	4.4 (20)	4.3 (19)	5.3 (28)	4.7 (22)	6.1 (37)	5.8 (34)	6.3 (40)	6.1 (37)	6.8 (46)	6.0 (36)	7.0 (48)	6.6 (43)
S_4	12.7 (161)	10.8 (116)	14.2 (202)	12.6 (160)	11.6 (134)	10.8 (117)	13.0 (171)	11.8 (141)	9.8 (97)	9.5 (91)	11.8 (140)	10.4 (109)
S_5	13.59 (184)	12.06 (145)	14.95 (223)	13.5 (184)	13.0 (170)	11.4 (129)	14.8 (218)	13.1 (172)	11.5 (133)	10.9 (118)	12.3 (152)	11.6 (134)
Mean	7.0 (75)	6.2 (58)	7.9 (93)		7.1 (70)	6.4 (58)	7.9 (89)		7.1 (60)	6.6 (53)	8.0 (75)	
	M	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**
S. Ed	0.25	0.35	0.60	0.57	0.29	0.36	0.63	0.65	0.34	0.29	0.57	0.69
CD (P=0.05)	0.68	0.73	1.13	1.20	0.81	0.75	NS	NS	0.95	0.60	NS	NS

from sedge. Kiran and Rao (2014) reported the same type of species observed in sandy and clay loam soils.

Effect of tillage and weed management practices on the density of broad-leaved weeds in maize

Tillage and weed control practices had a significant effect on the density of BLW at all growth stages of maize and cowpea (Table 1 and 3). Among the different tillage treatments, the mouldboard *fb* cultivator *fb* rotavator had a lower weed density of 57.5, 57.9 and 53.1 weeds m^{-2} in maize and 72.6, 72.5 and 59.1 weeds m^{-2} in cowpea, while the cultivator *fb* rotavator had a higher weed density at 30, 60 and 90 DAS.

The seeds present surface layer was buried into the deeper layer by mouldboard ploughing, reducing the appearance of weeds. Weed emergence was increased in cultivator + rotavator due to minimal soil disturbance once weed seeds broke dormancy (Haseeb *et al*., 2021). At 30, 60 and 90 DAS in maize and cowpea, higher weed densities were noticed in the unweeded (control) plot. Regarding the various weed management techniques, manual weeding showed decreased weed density that was comparable to the herbicide-applied treatment. Initial herbicide uses to control weed germination, along with manual weeding at 20 and 40 DAS to reduce weed density, resulted in a significant reduction of weed dry weight (Pathak *et al*., 2015 and Singh *et al*., 2023).

Weed density differed significantly when tillage and weed control practices were combined. In maize, the mouldboard *fb* cultivator *fb* rotavator with herbicide application had a lower weed density of 4.0 and 1.3 weeds m^{-2}, which was comparable to disc plough *fb* cultivator *fb* rotavator with hand weeding and disc plough *fb* cultivator *fb* rotavator with herbicide application in 30 and 60 DAS, respectively. At 90 DAS, the interaction effect in cowpea and maize was non-significant. In the unweeded control, cultivator *fb* rotavator had higher weed density (Emenky *et al*., 2010).

Effect of tillage and weed management practices on the density of grasses in Maize and cowpea

The density of grasses was affected significantly by the tillage and weed management practices at all the growth stages of crops (Table 2 and 4). The lower weed density of 15.1, 35.9 and 42.2 weeds m^{-2} in maize at 30,60 and 90 DAS and in cowpea 11.9 weeds m^{-2} at 30 DAS was recorded with the Mouldboard *fb* cultivator *fb* rotavator which was on par with the Disc plough *fb* cultivator *fb* rotavator and a higher weed density was recorded at cultivator *fb* rotavator at 30, 60 and 90 DAS respectively in maize and cowpea. At 60 and 90 DAS in cowpea tillage showed a non-significant difference. The reduced emergence of grasses may be attributed to deeper ploughing of soil, which causes seeds in the top soil layer to be buried in the deep layer. Furthermore, the dominance of the weed seed bank by the BLW *Trainthema portulacastrum* makes the density of grasses lower when compared to the BLW (Matloob *et al*., 2015; Hassan and Ahmed, 2005). Regarding the various weed management methods tested, manual weeding was found to reduce weed density by 3.6, 6.6 and 10.6 weeds m^{-2} in maize and 3.2, 3.2 and 97.4 weeds m-2 in cowpea at 30, 60 and 90 DAS, respectively. This was comparable to herbicide treatment at 30, 60 and 90 DAS, higher weed densities were observed in unweeded (Control). At 30 DAS in cowpea, mulching was on par with lower weed emergence. The removal of weeds by hand weeding at 20 and 40 DAS decreased the density. The results are in accordance with Ali *et al*. (2014). The interaction effect of tillage and weed control practices on grass weed density was non-significant at 30, 60 and 90 DAS (Haseeb *et al*., 2021).

Effect of tillage and weed management practices on weed density of sedges in maize and cowpea

The density of sedges in maize was significantly affected by tillage and weed management strategies (Table 5 and 6). The lower sedges density of 1.6 weeds m^{-2} and 3.1 weeds m^{-2} was recorded with the mouldboard *fb* cultivator *fb* rotavator which was on par with the disc plough *fb* cultivator *fb* rotavator. Higher weed density of 2.5 weeds m^{-2} and 4.5 weeds m^{-2} was recorded in cultivator *fb* rotavator in 30 and 90 DAS respectively with respect to tillage. While the impact of tillage methods on the emergence of sedges was insignificant at 60 DAS. However, in cowpea, tillage and the interaction between tillage and weed control methods had no significant impact on sedge weed density at 30, 60, or 90 DAS. It is in line with the findings of (Sasode *et al*., 2020). With regard to weed control methods in both maize and

Table 2: Weed density (no. m^{-2}) of grasses in maize influenced by tillage and weed management practices @ 30, 60 and 90 DAS.

Treatment	30 DAS				60 DAS				90 DAS			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	1.7 (3)	1.6 (2)	2.5 (6)	1.9 (4)	2.9 (8)	2.2 (4)	2.8 (7)	2.6 (6)	3.3 (10)	2.8 (7)	3.8 (14)	3.3 (11)
S_2	2.5 (6)	2.4 (5)	4.0 (16)	3.0 (9)	3.1 (9)	2.6 (6)	3.8 (14)	3.2 (10)	3.8 (14)	3.1 (9)	4.2 (17)	3.7 (13)
S_3	2.8 (7)	2.8 (8)	3.5 (12)	3.0 (9)	4.8 (23)	3.9 (15)	5.9 (35)	4.9 (24)	5.7 (32)	4.7 (21)	6.6 (43)	5.6 (32)
S_4	5.7 (32)	5.2 (26)	6.1 (37)	5.6 (31)	9.4 (89)	8.0 (63)	10.7 (114)	9.3 (89)	9.2 (85)	8.6 (74)	10.5 (110)	9.5 (90)
S_5	6.2 (39)	5.8 (34)	6.6 (43)	6.2 (39)	10.6 (113)	9.5 (91)	11.6 (134)	10.6 (113)	11.0 (121)	10.0 (99)	11.6 (134)	10.8 (118)
Mean	3.8 (17)	3.6 (15)	4.5 (23)		6.2 (49)	5.2 (36)	7.0 (61)		6.6 (52)	5.8 (42)	7.3 (64)	
	M	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**
S. Ed	0.19	0.19	0.37	0.43	0.20	0.41	0.67	0.55	0.30	0.26	0.51	0.61
CD (P=0.05)	0.51	0.40	NS	NS	0.56	0.85	NS	NS	0.84	0.54	NS	NS

cowpea, mulching had lower sedge weed densities than hand weeding and herbicide application while unweeded (Control) plots had greater weed densities during the 30, 60 and 90 DAS. At 30, 60 and 90 DAS, the interaction effect was non-significant.

In maize, deep tilling transformed the entire deep soil over time and brought it back to the top surface, which led to less sedge emergence in mouldboard ploughing *fb* cultivator *fb* rotavator operations. Additionally, soil disturbance only at the surface layer was the cause of the increased sedge emergence in the cultivator *fb* rotavator. When it comes to weed management techniques, mulching crop residue blocks light from reaching the soil surface, which prevents sedges from emerging in both cowpea and maize crops. However, in the case of cowpea, the thorough ploughing that is done before cowpea sowing, which lifts the soil to its top layers, stimulates the sedges to emerge by breaking their dormancy. Additionally, because rhizomes do not penetrate the soil as deeply as conventional weed seeds, particularly in heavy textured soil, sedges will usually remain in the top 15 cm of soil. The findings coincide with the results reported by Stoller and Sweet (1987).

Tillage and weed management effect on the relative density of weeds in maize and cowpea

The effect of tillage on the relative density of BLW, grasses and sedges were calculated and illustrated in the Fig 1 and 2.

Maize

Tillage methods at 30, 60 and 90 DAS exhibited lower relative densities of BLW, grasses and sedges in the mouldboard *fb* cultivator and greater relative densities in the cultivator *fb* rotavator. *Trianthema portulacastrum* emergence was higher among the BLW and dominated the weed flora at 30 DAS in all ploughing methods. At 60 DAS, the relative density of BLW was reduced in the disc plough *fb* cultivator *fb* rotavator and cultivator *fb* rotavator, however increased in the Mouldboard *fb* cultivator *fb* rotavator. The relative density of BLW increased from 30 DAS to 90 DAS with weed control strategies such as hand weeding, herbicide application and mulching, but decreased from 30 DAS in intercrop and unweeded treatments. Varsha *et al*. (2019) observed that as the number of days increased, correspondingly increased the relative density of BLW. *Dactyloctenium aegyptium* emerged as the most common and dominant grass species. When compared to broad-leaved weeds, relative density was lower at 30 DAS but increased at 60 and 90 DAS in all tillage regimes. The relative density of grasses increased in the Disc plough *fb* cultivator *fb* rotavator and cultivator *fb* rotavator at 60 DAS and decreased after 60 DAS, resulting in a lower relative density at 90 DAS, whereas it decreased at 60 DAS and increased at 90 DAS in the Mouldboard *fb* cultivator *fb* rotavator. In contrast to 30 DAS and 90 DAS, relative density at hand weeding, herbicide application and mulching exhibited a decreasing value at 60 DAS. However, intercrop and unweeded treatment exhibited a reverse impact. In Disc

Table 3: Weed density (no. m^{-2}) of BLW in cowpea influenced by tillage and weed management practices @ 30, 60 and 90 DAS.

Treatment	30 DAS				60 DAS				90 DAS			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	2.3 (5)	2.1 (4)	2.7 (8)	2.4 (6)	1.8 (3)	1.6 (2)	2.0 (4)	1.8 (3)	3.5 (12)	3.2 (10)	4.4 (19)	3.7 (13)
S_2	2.3 (5)	2.0 (3)	2.8 (7)	2.4 (5)	1.9 (3)	1.9 (3)	2.0 (4)	1.9 (3)	4.0 (15)	3.5 (12)	4.4 (19)	4.0 (15)
S_3	6.5 (42)	6.0 (35)	6.6 (42)	6.4 (41)	9.0 (82)	7.6 (58)	10.4 (109)	9.0 (83)	9.7 (93)	8.1 (67)	9.9 (98)	9.2 (86)
S_4	12.9 (169)	11.9 (141)	14.3 (203)	13.0 (171)	12.5 (158)	11.8 (140)	13.8 (190)	12.7 (162)	10.4 (109)	9.7 (93)	10.8 (117)	10.3 (106)
S_5	14.2 (203)	13.3 (179)	15.0 (225)	14.2 (203)	13.3 (179)	12.6 (160)	14.7 (217)	13.6 (185)	11.3 (129)	10.6 (114)	11.2 (126)	11.1 (123)
Mean	7.6 (85)	7.1 (73)	8.4 (98)		7.7 (85)	7.1 (72)	8.6 (105)		7.8 (72)	7.0 (59)	8.1 (76)	
	M	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**
S. Ed	0.34	0.48	0.81	0.78	0.25	0.49	0.80	0.67	0.20	0.36	0.59	0.51
CD (P=0.05)	0.93	0.98	NS	NS	0.68	1.01	NS	NS	0.55	0.75	NS	NS

plough *fb* cultivator *fb* rotavator and cultivator *fb* rotavator, the sedges produced the same relative density between 30 and 60 DAS, but during 90 DAS the density declined. However, in Mouldboard *fb* the cultivator and rotavator results were decreased at 30 and 60 DAS and higher at 90 DAS. Regarding weed management practices the relative density has been increased from 30 DAS to 90 DAS in hand weeding, herbicide application and mulching and decreased in intercrop and unweeded treatment.

Cowpea

When BLW, grasses and sedges were compared at 30, 60 and 90 DAS under different tillage strategies, the relative densities under the Mouldboard *fb* cultivator were higher whereas the relative densities under the cultivator *fb* rotavator were lower. *Trianthema portulacastrum* emergence was high among BLW at 30 DAS in all ploughing methods, where it dominated the weed flora. In contrast, it increased in the cultivator *fb* rotavator and decreased at 90 DAS. The relative density of BLW was decreased in the Disc plough *fb* cultivator *fb* rotavator and Mouldboard *fb* cultivator *fb* rotavator at 60 DAS and increased at 90 DAS. The relative density of BLW was reduced from 30 DAS to 60 DAS and increased during 90 DAS with weed management measures, including hand weeding and herbicide application. In the intercrop and unweeded (Control) treatments, it dropped

Table 4: Weed density (no. m^{-2}) of grasses in cowpea influenced by tillage and weed management practices @ 30, 60 and 90 DAS.

Treatment	30 DAS				60 DAS				90 DAS			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	1.4 (2)	2.1 (3)	2.0 (3)	1.8 (3)	1.9 (3)	1.6 (3)	2.0 (4)	1.8 (3)	2.5 (6)	2.1 (4)	3.0 (9)	2.5 (6)
S_2	2.0 (4)	2.0 (3)	2.3 (5)	2.0 (4)	2.2 (4)	1.9 (3)	2.3 (5)	2.1 (4)	2.9 (8)	2.7 (7)	3.6 (12)	3.0 (9)
S_3	2.3 (5)	6.0 (5)	2.5 (6)	3.6 (5)	5.3 (28)	7.6 (36)	5.9 (35)	6.2 (32)	6.1 (37)	5.7 (32)	6.2 (38)	6.0 (36)
S_4	4.7 (22)	11.9 (18)	5.2 (27)	7.2 (22)	7.9 (63)	11.8 (48)	7.8 (62)	9.2 (58)	8.9 (79)	7.8 (61)	10.0 (100)	8.9 (80)
S_5	6.4 (40)	13.4 (31)	5.9 (35)	8.6 (35)	8.5 (73)	12.6 (57)	8.5 (72)	9.9 (67)	9.5 (90)	9.6 (93)	10.4 (109)	9.8 (97)
Mean	3.3 (14)	7.1 (12)	3.6 (15)		5.2 (34)	7.1 (29)	5.3 (35)		6.0 (44)	5.6 (39)	6.6 (54)	
	M	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**
S. Ed	0.11	0.27	0.44	0.34	0.22	0.41	0.67	0.57	0.22	0.35	0.58	0.53
CD (P=0.05)	0.30	0.57	NS	NS	NS	0.84	NS	NS	0.61	0.72	NS	NS

Table 5: Weed density (no. m^{-2}) of sedges in maize influenced by tillage and weed management practices @ 30, 60 and 90 DAS.

Treatment	30 DAS				60 DAS				90 DAS			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	1.5 (2)	1.3 (1)	1.6 (2)	1.4 (2)	1.5 (2)	1.3 (1)	1.6 (2)	1.5 (2)	1.7 (2)	1.8 (3)	1.9 (3)	1.8 (3)
S_2	1.7 (2)	1.3 (1)	1.7 (2)	1.6 (2)	1.7 (2)	1.5 (2)	1.8 (3)	1.6 (2)	2.0 (4)	1.9 (3)	2.1 (4)	2.0 (4)
S_3	1.5 (2)	1.2 (1)	1.6 (2)	1.4 (2)	2.0 (4)	1.9 (3)	2.1 (4)	2.0 (4)	2.1 (4)	1.9 (3)	2.3 (5)	2.1 (4)
S_4	1.7 (2)	1.4 (2)	1.8 (3)	1.6 (2)	2.2 (4)	2.0 (4)	2.3 (5)	2.2 (4)	2.3 (5)	1.9 (3)	2.3 (5)	2.1 (4)
S_5	1.9 (3)	1.8 (3)	1.9 (3)	1.9 (3)	2.4 (5)	2.0 (4)	2.4 (5)	2.3 (5)	2.4 (5)	2.1 (4)	2.5 (6)	2.3 (5)
Mean	1.6 (2)	1.4 (2)	1.7 (2)		1.9 (3)	1.8 (3)	2.0 (4)		2.1 (4)	1.9 (3)	2.2 (4)	
	M	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**
S. Ed	0.08	0.10	0.17	0.17	0.10	0.13	0.22	0.22	0.08	0.12	0.20	0.19
CD (P=0.05)	0.18	0.19	NS	NS	NS	0.25	NS	NS	0.18	0.24	NS	NS

Table 6: Weed density (no. m^{-2}) of sedges in cowpea influenced by tillage and weed management practices @ 30, 60 and 90 DAS.

Treatment	30 DAS				60 DAS				90 DAS			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	1.3 (1)	1.2 (1)	1.3 (1)	1.3 (1)	1.1 (1)	1.5 (2)	1.2 (1)	1.2 (1)	1.6 (2)	1.9 (3)	1.9 (3)	1.8 (3)
S_2	1.7 (2)	1.5 (2)	1.6 (2)	1.5 (2)	1.0 (1)	1.0 (1)	1.4 (2)	1.2 (1)	1.9 (3)	1.9 (3)	2.0 (4)	1.9 (3)
S_3	1.2 (1)	1.0 (1)	1.2 (1)	1.2 (1)	1.3 (1)	1.2 (1)	1.1 (1)	1.2 (1)	1.9 (3)	1.5 (2)	2.1 (4)	1.8 (3)
S_4	1.7 (2)	1.5 (2)	1.8 (3)	1.6 (2)	1.7 (2)	1.6 (2)	2.0 (4)	1.8 (3)	2.0 (3)	1.9 (3)	2.2 (4)	2.0 (4)
S_5	1.9 (3)	1.7 (2)	2.0 (3)	1.8 (3)	2.0 (4)	2.1 (4)	2.1 (4)	2.1 (4)	2.5 (6)	2.1 (4)	2.7 (7)	2.4 (5)
Mean	1.5 (2)	1.4 (1)	1.6 (2)		1.4 (2)	1.5 (2)	1.5 (2)		1.9 (3)	1.8 (3)	2.2 (4)	
	M	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**
S. Ed	0.11	0.12	0.22	0.24	0.11	0.17	0.29	0.27	0.14	0.14	0.25	0.29
CD (P=0.05)	NS	0.25	NS	NS	NS	0.35	NS	NS	NS	0.28	NS	NS

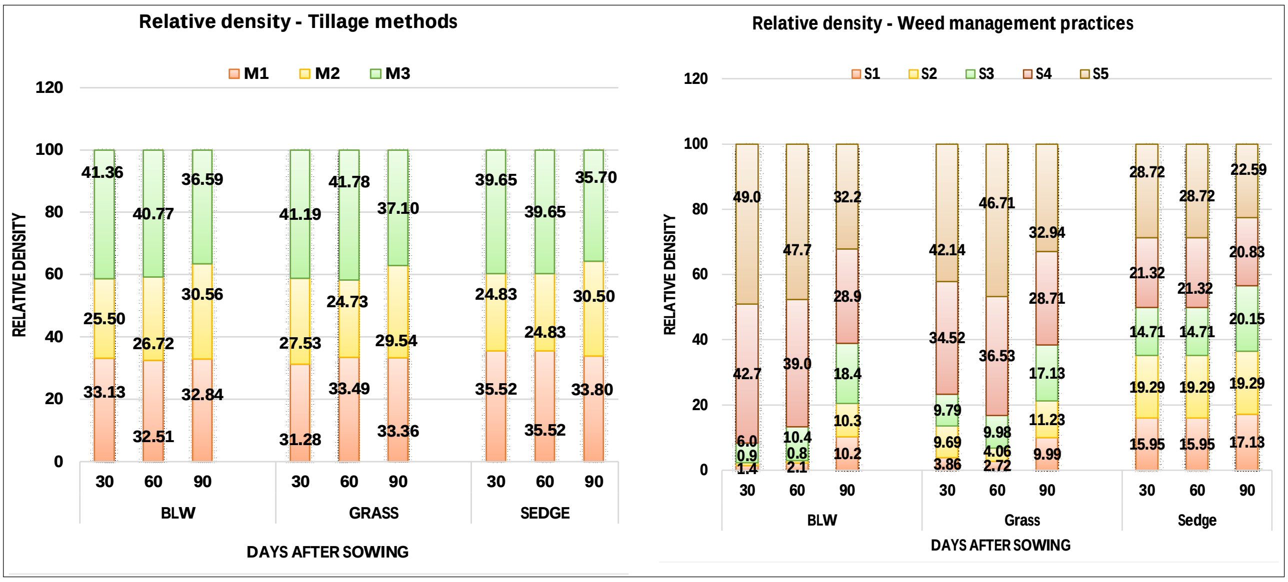

Fig 1: Relative density of broad-leaved weeds, grasses and sedges in maize due to tillage and weed management practices.

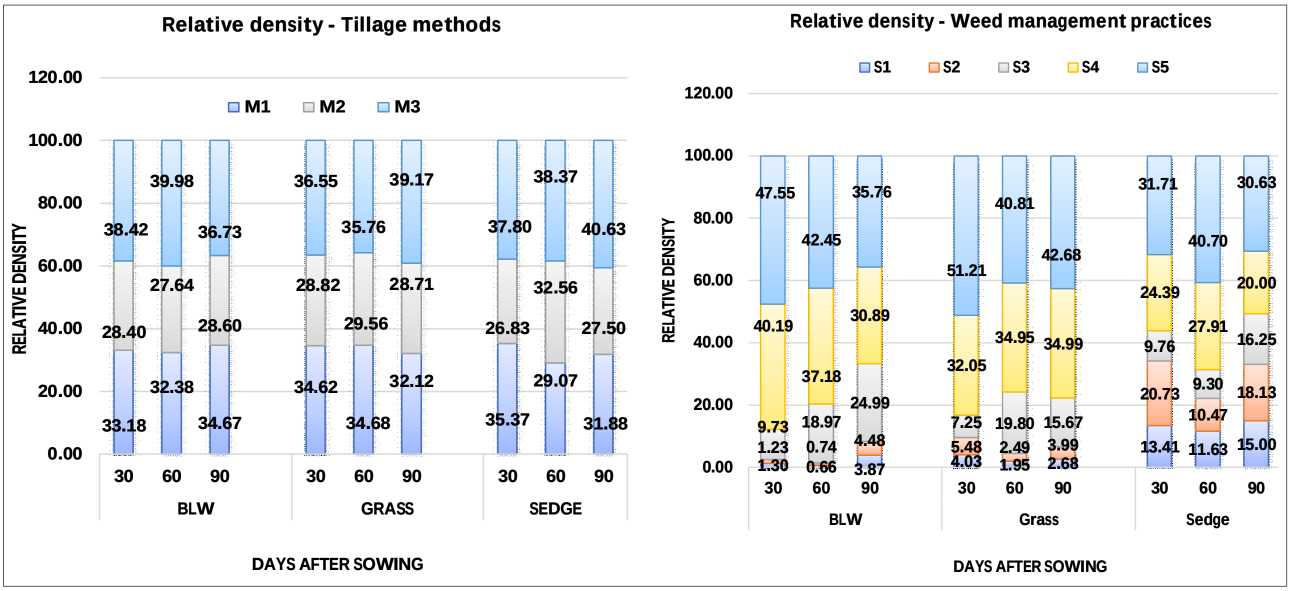

Fig 2: Relative density of broad-leaved weeds, grasses and sedges in cowpea due to tillage and weed management practices.

from 30 DAS to 90 DAS, but it increased from 30 DAS to 90 DAS in the mulching treatment. The Dactyloctenium aegyptium emergence was higher and more prevalent across grass species.

In the cultivator *fb* rotavator, the relative density of grasses increased at 60 DAS and decreased after 60 DAS, resulting in a decreased density at 90 DAS, whereas it decreased at 60 DAS and increased at 90 DAS in the disc plough *fb* cultivator *fb* rotavator and mouldboard *fb* cultivator *fb* rotavator. When compared to 30 DAS, the relative density at manual weeding, herbicide application and unweeded (Control) decreased at 60 DAS and then increased at 90 DAS. The relative density of sedges was lower in the mouldboard *fb* cultivator *fb* rotavator whereas the higher relative density was recorded under the cultivator *fb* rotavator. Among weed management practices the relative density has been decreased from 30 DAS to 60 DAS in hand weeding, herbicide application and mulching then it increased during 90 DAS. Whereas in intercrop and unweeded (control), it increased during 60 DAS and decreased at 90 DAS (Varsha *et al*., 2019).

CONCLUSION

From the present study, it was concluded that the mouldboard plough *fb* Cultivator *fb* rotovator with hand weeding and herbicide application controls the emergence of BLW, grasses and sedges from the weed seed bank in both the maize and cowpea crop.

Conflict of interest: None.

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