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Effects of Varying Levels of Fly Ash and Vermicompost Amendment on Floristic Composition of Weeds in Rice Nursery

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A B S T R A C T

A poly-bag experiment was carried out during March to May 2017 in 'West Central Table Land Zone', Odisha, India in complete randomized design with fly ash, vermicompost and virgin soil each at 0%, 20%, 40%, 60%, 80% and 100% by weight to study their effects on the floristic dynamics of the weeds in rice nursery soil. Fly ash and vermicompost at different levels in rice-nursery have their significant influences on the floristic composition of weeds. No broad leaf weed or grass or sedge could emerge in rice nursery in absence of vermicompost except in 100 % soil with only very limited weed flora. The maximum number of broadleaf weeds emerged in soil with 80 % vermicompost and the maximum number of grasses and sedges emerged in 100 % vermicompost and also in soil with 60 % vermicompost by weight. The highest dry matter of weeds was recorded in 100 % vermicompost.

Introduction

Fly ash, a necessary evil being produced to the tune of 200 MT in 2015 (Parab *et al.*, 2012) in 180 thermal power plants in India for generation of about 192,168.88 MW energy (Central Electricity Authority, 2016) needs safe, scientific and productive use in agriculture field like many developed and developing countries of the world. Researchers are in view of its application in lower concentrations only keeping in mind the adverse microbial activities and availability of plant nutrients at higher concentration. Its significance in ameliorating the physicochemical properties of soil is widely accepted by the researchers and hence the soil fertility and crop yield increase (Rautaray *et al.,* 2003).

Although a lot of research on the productivity and profitability of fly ash and vermicompost application at varying levels has already been done in many crops including rice but studies on the floristic dynamics of weeds were lagging behind. In this context, a poly-bag rice culture experiment was conducted to study the floristic dynamics of weeds with varying levels of fly ash and vermicompost amendments.

Materials and Methods

Experimental site and climate

The experiment was conducted during March to May 2017 in the campus of the College of Agriculture (OUAT), Chiplima, Sambalpur district, Odisha, India under Agro-climatic zone of 'West Central Table Land Zone' at around 365 km air distance from the Bay of Bengal at East. The experiment-site in particular was located at 83^0 53' E longitude, 21^0 21' N latitude and 150.75 m above the mean sea level experiencing tropical warm and dry climate with much rainier summers and normal to chilling winter. The long term average temperature is 26.8 ^oC and the average annual rainfall is 1638 mm.

Experimental design and treatments

The treatments consisted of 3 different types of substrates i.e. virgin soil, vermicompost and fly ash. (S, V and F) at 6 different concentrations i.e. 0%, 20%, 40%, 60%, 80% and 100% leading to a total of 21 different treatment combinations (Table 2) that were replicated thrice (R_1, R_2 and R_3) with complete randomized design in poly-bags of 15 cm (diameter) and 30 cm height. The physicochemical properties of the above 3 treatments are as details in Table 1.

Description of test-genotype used

The test paddy variety Vijetha (MTU-1001) was developed at ANGARAU, Andhra Pradesh by crossing Krishnaveni x IR-64 and subsequently released by the OSVRC and notified in 2005. It is a semi dwarf (115 cm), non-lodging and medium duration (135 days) with moderate tillering habit but tolerant to flash flood and excess water situations. It has non-shattering habit with long slender, non-aromatic translucent grains with good milling, cooking and eating qualities. The yield potential of this hybrid is 5 t ha^{-1} in *kharif* and 5.5 t ha^{-1} in *rabi*.

Manures and fertilizers applied

No inorganic or organic fertilizer was added to the experimental base material except the treatments (organic soil, vermicompost and fly ash) so as to exclude their effects on results. The site from where the soil was removed and brought for experimentation had no previous cropping for last five years and thus may be delineated under "Organic zone" as per the norms of National Programme on Organic Production (NPOP). Fly ash from the nearby HINDALCO industries Ltd., Hirakud, Sambalpur was used for this purpose at different levels along with the organic soil and vermicopmost. The vermicopmost prepared by using epigeic earthworms (*Eisenia fetida*) in tank from farm yard manure was used for this purpose at different levels.

Agronomic management practices

The moisture content of the substrates i.e. virgin-organic soil, vermicompost and fly ash was determined by using gravimetric method. The soil, vermicompost and fly ash were mixed by weight basis according to the proportions in each treatment combinations and put inside good quality black coloured HDPE poly-bags. One hole was made in each poly-bag so as to facilitate the drainage of excess water from the substrates. The bags were kept on the ground arranged according to the replications with proper labeling. 50 numbers of good quality rice seeds of cv. MTU-1001 were selected and sterilised with 0.1% mercuric chloride for 5 minutes to avoid fungal contamination and then cleaned with distilled water for 3 times and soaked in water for 5 hours. The soaked seeds were evenly sown in the poly-bags by using a dibbler and then covered with substrates. Immediately after sowing, 300 mL distilled water was sprinkled over it.

After 10 days, seedlings were uprooted leaving only 10 healthy seedlings per poly-bag at uniform distance so as to avoid over-crowding at later stages. Two hand weedings at 20 days intervals i.e. 20 and 40 DAS were carried out. Distilled water of 300 mL was applied to the poly bags daily during the entire experimental period and adequate precautions were taken to avoid excess irrigation resulting in water stagnation. No plant protection measure was taken intentionally to study the effect of the treatments on disease-pest incidence.

Methods of recording observations

Weed floristic composition

Floristic studies of weeds (grasses, sedges and broad leaf weeds) were studied at 20, 30 and 40 DAS in detail and their common and scientific names were noted down against each treatment.

Dry matter of weeds

Dry matter of weeds was measured by air drying of the weeds collected from each poly-bag separately from each treatment and replication by uprooting and washing carefully. Then the weeds were oven-dried inside paper envelopes at 70 ^{0}C for 48 hours. The final weight was measured and expressed in g m^{-2}.

Statistical analyses

All the data obtained were statistically analyzed using F-test as per the procedure suggested by Gomez and Gomez (1984). Least significant difference (LSD) values at p=0.05 were used to determine the significant differences between treatment means.

Results and Discussion

Studies on floristic composition and dry matter of weeds were carried out at 20, 30 and 40 DAS in all treatment combinations.

Number of broad leaf weeds

The number of broad leaf weeds m^{-2} counted at 20, 30 and 40 DAS have been presented in Table 3 and depicted in Figure 1. The population of broad leaf weeds was significantly the highest (640.9 ± 70.5) in $S_{40}F_0V_{60}$ at 20 DAS but at subsequent two dates of observations, the population of such type of weeds in $S_{20}F_0V_{80}$ increased and surpassed the former one with significant differences. No broad leaf weed was seen in $S_0F_{80}V_{20}$, $S_0F_{100}V_0$, $S_{20}F_{80}V_0$, $S_{40}F_{60}V_0$, $S_{60}F_{40}V_0$ and $S_{80}F_{20}V_0$ throughout the seedling growth. But, in $S_{20}F_{60}V_{20}$ and $S_{40}F_{40}V_{20}$ although no broad leaf weed was seen at 20 or 40 DAS but some of these weeds emerged at 30 DAS. Broad leaf weeds that were present in $S_0F_{60}V_{40}$ at 20 and 30 DAS perished at 40 DAS.

Number of grasses and sedges

The number of grasses and sedges m^{-2} other than rice seedlings at 20, 30 and 40 DAS have been presented in Table 4 and depicted in Figure 2. The population of grasses and sedges in $S_{60}F_0V_{40}$ (584.3 + 35.1) was although equal to $S_{40}F_0V_{60}$ (584.3 + 35.1) at 20 DAS but the population in former treatment combination reached at its peak (1036.8 ± 82.9) surpassing the latter one with significant difference at 30 DAS. However, such weed population at 40 DAS in $S_{60}F_0V_{40}$ reduced well below $S_{40}F_0V_{60}$ as the latter could accommodate significantly the highest number of grasses and sedges at this stage. No grass or sedge was seen in $S_0F_{100}V_0$, $S_{20}F_{80}V_0$, $S_{40}F_{60}V_0$, $S_{60}F_{40}V_0$ and $S_{80}F_{20}V_0$ at all 3 dates of observations except in the last one where 75.2 + 6.8 numbers of such weeds were seen at 40 DAS.

Total number of weeds

The total number weeds m^{-2} counted at 20, 30 and 40 DAS as presented in Table 5 and depicted in Figure 3 revealed that $S_{40}F_0V_{60}$ could accommodate significantly the highest number of weeds (1225.2 ± 123.1) followed by $S_{60}F_0V_{40}$ (904.5 ± 82.0) at 20 DAS but after 10 days elapse the latter surpassed the former one by accommodating significantly the highest numbers of weeds (1677.7 ± 134.2). Although the total weed population in $S_{40}F_0V_{60}$ decreased with the progress in rice seedling age from 20 to 40 days but at 40 DAS it had the highest population followed by $S_{20}F_0V_{80}$, $S_{40}F_{20}V_{40}$, $S_0F_0V_{100}$ and $S_{60}F_0V_{40}$ without any statistical difference between the two former and three latter combinations.

No broadleaf or grass or sedge was seen in $S_0F_{100}V_0$, $S_{20}F_{80}V_0$, $S_{40}F_{60}V_0$, $S_{60}F_{40}V_0$ and $S_{80}F_{20}V_0$ at all three dates of observations except in $S_{80}F_{20}V_0$ having some grasses and sedges only at 40 DAS.

Positive effect of vermicompost on weed population could be due to availability of favourable growing medium so also the weed propagules in it. But, in fly ash, due to unfavourable soil physicochemical properties and absence of such propagules, the weed population was either very marginal or absent.

Table.1 Physico-chemical properties of treatments

Type of substrates	pH	Sand (%)	Silt (%)	Clay (%)	Organic carbon (%)	EC (dS m^{-1})
Vermicompost	6.63	42.4	8.0	49.6	0.360	0.62
Fly ash	6.43	10.4	36.0	53.6	0.090	0.11
Virgin soil	6.71	22.4	8.0	69.6	0.018	0.18

Type of substrates	Available					
	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})	S (mg kg^{-1})	B (mg kg^{-1})	Zn (mg kg^{-1})
Vermicompost	231.2	280.3	598.4	204.730	9.657	2.92
Fly ash	115.3	277.4	348.9	89.526	0.577	2.98
Virgin soil	110.4	72.6	358.7	0.347	0.022	2.82

Table.2 Details of treatment combinations and symbols used

Sl. No.	Treatment combinations	Symbols used
1	Soil (0%) + Fly ash (0%) + Vermicompost (100%)	$S_0F_0V_{100}$
2	Soil (0%) + Fly ash (20%) + Vermicompost (80%)	$S_0F_{20}V_{80}$
3	Soil (0%) + Fly ash (40%) + Vermicompost (60%)	$S_0F_{40}V_{60}$
4	Soil (0%) + Fly ash (60%) + Vermicompost (40%)	$S_0F_{60}V_{40}$
5	Soil (0%) + Fly ash (80%) + Vermicompost (20%)	$S_0F_{80}V_{20}$
6	Soil (0%) + Fly ash (100%) + Vermicompost (0%)	$S_0F_{100}V_0$
7	Soil (20%) + Fly ash (0%) + Vermicompost (80%)	$S_{20}F_0V_{80}$
8	Soil (20%) + Fly ash (20%) + Vermicompost (60%)	$S_{20}F_{20}V_{60}$
9	Soil (20%) + Fly ash (40%) + Vermicompost (40%)	$S_{20}F_{40}V_{40}$
10	Soil (20%) + Fly ash (60%) + Vermicompost (20%)	$S_{20}F_{60}V_{20}$
11	Soil (20%) + Fly ash (80%) + Vermicompost (0%)	$S_{20}F_{80}V_0$
12	Soil (40%) + Fly ash (0%) + Vermicompost (60%)	$S_{40}F_0V_{60}$
13	Soil (40%) + Fly ash (20%) + Vermicompost (40%)	$S_{40}F_{20}V_{40}$
14	Soil (40%) + Fly ash (40%) + Vermicompost (20%)	$S_{40}F_{40}V_{20}$
15	Soil (40%) + Fly ash (60%) + Vermicompost (0%)	$S_{40}F_{60}V_0$
16	Soil (60%) + Fly ash (0%) + Vermicompost (40%)	$S_{60}F_0V_{40}$
17	Soil (60%) + Fly ash (20%) + Vermicompost (20%)	$S_{60}F_{20}V_{20}$
18	Soil (60%) + Fly ash (40%) + Vermicompost (0%)	$S_{60}F_{40}V_0$
19	Soil (80%) + Fly ash (0%) + Vermicompost (20%)	$S_{80}F_0V_{20}$
20	Soil (80%) + Fly ash (20%) + Vermicompost (0%)	$S_{80}F_{20}V_0$
21	Soil (100%) + Fly ash (0%) + Vermicompost (0%)	$S_{100}F_0V_0$

Table.3 Effect of treatment combinations on number of broad leaf weeds m^{-2} at different growth stages of rice seedlings

Treatment combinations	Sl. No.	Days after sowing		
		20	30	40
$S_0F_0V_{100}$	1	320.2 ±25.6	452.5±49.8	131.8±10.5
$S_0F_{20}V_{80}$	2	93.9 ±4.7	93.9 ±11.3	75.2 ±3.8
$S_0F_{40}V_{60}$	3	150.5 ±16.6	75.2 ±8.3	17.0 ±1.9
$S_0F_{60}V_{40}$	4	39.6 ±3.6	75.2 ±10.5	0.0 ±0.0
$S_0F_{80}V_{20}$	5	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0
$S_0F_{100}V_0$	6	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0
$S_{20}F_0V_{80}$	7	433.3 ±39.0	810.6 ±73.0	469.5±42.3
$S_{20}F_{20}V_{60}$	8	93.9 ±8.5	188.4 ±17.0	243.2 ±21.9
$S_{20}F_{40}V_{40}$	9	131.8 ±13.2	188.4 ±9.4	93.9 ±9.4
$S_{20}F_{60}V_{20}$	10	0.0 ±0.0	56.6 ±6.8	75.2 ±9.0
$S_{20}F_{80}V_0$	11	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0
$S_{40}F_0V_{60}$	12	640.9±70.5	640.9±57.7	358.1±39.4
$S_{40}F_{20}V_{40}$	13	37.3 ±3.4	188.4 ±15.1	244.9 ±22.0
$S_{40}F_{40}V_{20}$	14	0.0 ±0.0	18.7 ±1.1	0.0 ±0.0
$S_{40}F_{60}V_0$	15	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0
$S_{60}F_0V_{40}$	16	320.2±35.2	640.9±51.3	301.5±33.2
$S_{60}F_{20}V_{20}$	17	188.4 ±18.8	207.0 ±14.5	301.5 ±30.1
$S_{60}F_{40}V_0$	18	0.0 ±0.0	0.0±0.0	0.0 ±0.0
$S_{80}F_0V_{20}$	19	188.4±17.0	263.6 ±23.7	301.5±27.1
$S_{80}F_{20}V_0$	20	0.0 ±0.0	0.0±0.0	0.0±0.0
$S_{100}F_0V_0$	21	131.8±15.8	100.1±7.0	93.9±11.3
S.Em (+)		12.5	15.7	10.9
C.D. (0.05)		35.7	44.8	31.1
C.V. (%)		128.5	125.7	113.6

Table.4 Effect of treatment combinations on number of grasses and sedges m^{-2} at different growth stages of rice seedlings

Treatment combinations	Sl. No.	Days after sowing		
		20	30	40
$S_0F_0V_{100}$	1	301.5± 12.1	735.4±80.9	527.8±42.2
$S_0F_{20}V_{80}$	2	433.3± 26.0	339.4±40.7	320.2±16.0
$S_0F_{40}V_{60}$	3	301.5± 18.1	244.9±26.9	243.2±26.8
$S_0F_{60}V_{40}$	4	150.5± 7.5	207.0±29.0	188.4±17.0
$S_0F_{80}V_{20}$	5	37.3± 1.9	75.2±5.3	150.5±10.5
$S_0F_{100}V_0$	6	0.0± 0.0	0.0±0.0	0.0±0.0
$S_{20}F_0V_{80}$	7	433.3± 26.0	376.7±33.9	358.1±32.2
$S_{20}F_{20}V_{60}$	8	301.5± 18.1	301.5±27.1	320.2±28.8
$S_{20}F_{40}V_{40}$	9	75.2± 4.5	75.2±3.8	188.4±18.8
$S_{20}F_{60}V_{20}$	10	131.8± 9.2	93.9±11.3	75.2±9.0
$S_{20}F_{80}V_0$	11	0.0± 0.0	0.0±0.0	0.0±0.0
$S_{40}F_0V_{60}$	12	584.3± 35.1	527.8±47.5	527.8±58.1
$S_{40}F_{20}V_{40}$	13	489.9± 29.4	433.3±34.7	433.3±39.0
$S_{40}F_{40}V_{20}$	14	93.9± 3.8	150.5±9.0	207.0±24.8
$S_{40}F_{60}V_0$	15	0.0± 0.0	0.0±0.0	0.0±0.0
$S_{60}F_0V_{40}$	16	584.3± 35.1	1036.8±82.9	358.1±39.4
$S_{60}F_{20}V_{20}$	17	188.4±11.3	244.9±17.1	301.5±30.1
$S_{60}F_{40}V_0$	18	0.0±0.0	0.0±0.0	0.0±0.0
$S_{80}F_0V_{20}$	19	263.6±13.2	414.6±37.3	358.1±32.2
$S_{80}F_{20}V_0$	20	0.0±0.0	0.0±0.0	75.2±6.8
$S_{100}F_0V_0$	21	37.3±1.9	93.9±6.6	75.2±9.0
S.Em (+)		9.7	19.5	15.2
C.D. (0.05)		27.8	55.7	43.4
C.V. (%)		94.4	104.6	75.5

Table.5 Effect of treatment combinations on total number of weeds m^{-2} at different growth stages of rice seedlings

Treatment combinations	Sl. No.	Days after sowing		
		20	30	40
$S_0F_0V_{100}$	1	621.7±68.4	1187.9±130.7	659.6±52.8
$S_0F_{20}V_{80}$	2	527.2±56.7	433.3±52.0	395.4±19.8
$S_0F_{40}V_{60}$	3	452.0±49.7	320.2±35.2	260.2±28.6
$S_0F_{60}V_{40}$	4	150.5±21.1	282.3±39.5	188.4±17.0
$S_0F_{80}V_{20}$	5	74.7±5.2	75.2±5.3	150.5±10.5
$S_0F_{100}V_0$	6	0.0±0.0	0.0±0.0	0.0±0.0
$S_{20}F_0V_{80}$	7	866.6±78.0	1187.3±106.9	827.6±74.5
$S_{20}F_{20}V_{60}$	8	395.4±35.6	489.9±44.1	563.4±50.7
$S_{20}F_{40}V_{40}$	9	207.0±20.9	263.6±13.2	282.3±28.2
$S_{20}F_{60}V_{20}$	10	131.8±15.8	150.5±18.1	150.5±18.1
$S_{20}F_{80}V_0$	11	0.0±0.0	0.0±0.0	0.0±0.0
$S_{40}F_0V_{60}$	12	1225.2±123.1	1168.6±105.2	885.8±97.4
$S_{40}F_{20}V_{40}$	13	527.2±42.5	621.7±49.7	678.2±61.0
$S_{40}F_{40}V_{20}$	14	93.9±5.6	169.1±10.1	207.0±24.8
$S_{40}F_{60}V_0$	15	0.0±0.0	0.0±0.0	0.0±0.0
$S_{60}F_0V_{40}$	16	904.5±82.0	1677.7±134.2	659.6±72.6
$S_{60}F_{20}V_{20}$	17	376.7±32.0	452.0±31.6	603.0±60.3
$S_{60}F_{40}V_0$	18	0.0±0.0	0.0±0.0	0.0±0.0
$S_{80}F_0V_{20}$	19	452.0±40.7	678.2±61.0	659.6±59.4
$S_{80}F_{20}V_0$	20	0.0±0.0	0.0±0.0	75.2±6.8
$S_{100}F_0V_0$	21	169.1±18.4	194.0±13.6	169.1±20.3
S.Em (+)		26.9	34.0	25.3
C.D. (0.05)		76.8	97.2	72.2
C.V. (%)		100.2	107.2	83.2

Table.6 Effect of treatment combinations on dry matter (g m^{-2}) of weeds m^{-2} at different growth stages of rice seedlings

Treatment combinations	Sl. No.	Days after sowing		
		20	30	40
$S_0F_0V_{100}$	1	2.885±0.231	22.004±1.540	312.808±34.409
$S_0F_{20}V_{80}$	2	2.772±0.139	5.939±0.535	36.598±4.392
$S_0F_{40}V_{60}$	3	2.602±0.286	5.713±0.343	2.715±0.299
$S_0F_{60}V_{40}$	4	0.848±0.076	2.941±0.294	23.135±3.239
$S_0F_{80}V_{20}$	5	0.453±0.032	0.792±0.055	1.640±0.115
$S_0F_{100}V_0$	6	0.000±0.000	0.000±0.000	0.000±0.000
$S_{20}F_0V_{80}$	7	4.469±0.402	21.212±1.909	138.190±12.437
$S_{20}F_{20}V_{60}$	8	6.788±0.611	9.107±0.820	85.301±7.677
$S_{20}F_{40}V_{40}$	9	0.566±0.057	1.188±0.071	3.224±0.161
$S_{20}F_{60}V_{20}$	10	0.283±0.034	0.679±0.034	0.566±0.068
$S_{20}F_{80}V_0$	11	0.000±0.000	0.000±0.000	0.000±0.000
$S_{40}F_0V_{60}$	12	9.333±1.027	12.222±0.495	126.481±11.383
$S_{40}F_{20}V_{40}$	13	4.242±0.382	5.034±0.453	35.580±2.846
$S_{40}F_{40}V_{20}$	14	0.792±0.095	0.622±0.019	3.677±0.221
$S_{40}F_{60}V_0$	15	0.000±0.000	0.000±0.000	0.000±0.000
$S_{60}F_0V_{40}$	16	1.640±0.180	21.699±2.387	33.713±2.697
$S_{60}F_{20}V_{20}$	17	0.283±0.028	0.905±0.091	31.960±2.237
$S_{60}F_{40}V_0$	18	0.000±0.000	0.000±0.000	0.000±0.000
$S_{80}F_0V_{20}$	19	1.810±0.163	7.806±0.156	101.196±9.108
$S_{80}F_{20}V_0$	20	0.000±0.000	0.000±0.000	6.166±0.555
$S_{100}F_0V_0$	21	0.735±0.088	2.206±0.066	7.071±0.495
S.Em (+)		0.177	0.461	5.135
C.D. (0.05)		0.506	1.300	14.654
C.V. (%)		127.863	129.390	164.181

Table.7 Floristic composition of weed species as influenced by different treatment combinations at 40 DAS of rice seedlings

Treatment combinations	Sl. No.	Grasses	Sedges	Broadleaf
$S_0F_0V_{100}$	1	*Brachiaria reptans, Echinochloa colona, Echinochloa crusgali,*	*Cyperus difformis, Cyperus rotundus*	*Phyllanthus urinaria, Ludwigia parviflora, Ammannia baccifera, Scoparia dolcis,*
$S_0F_{20}V_{80}$	2	*Brachiaria reptans, Echinochloa colona, Echinochloa crusgali,*	*Cyperus difformis, Cyperus rotundus*	*Phyllanthus niruri, Phyllanthus urinaria, Ludwigia parviflora,, Scoparia dolcis,*
$S_0F_{40}V_{60}$	3	*Brachiaria reptans, Echinochloa colona, Echinochloa crusgali,*	*Cyperus difformis, Cyperus rotundus*	*Phyllanthus urinaria, Ludwigia parviflora,, Scoparia dolcis,*
$S_0F_{60}V_{40}$	4	*Echinochloa crusgali,*	*Cyperus difformis*	-
$S_0F_{80}V_{20}$	5	*Echinochloa crusgali,*	*Cyperus difformis*	-
$S_0F_{100}V_0$	6	-	-	-
$S_{20}F_0V_{80}$	7	*Cynodon dactylon, Brachiaria reptans, Echinochloa colona, Echinochloa crusgali,*	*Cyperus difformis, Cyperus rotundus*	*Phyllanthus niruri, Phyllanthus urinaria, Ludwigia parviflora, Ammannia baccifera, Scoparia dolcis, Chenopodium album*
$S_{20}F_{20}V_{60}$	8	*Cynodon dactylon, Brachiaria reptans, Echinochloa colona, Echinochloa crusgali,*	*Cyperus difformis, Cyperus rotundus*	*Ludwigia parviflora, Scoparia dolcis, Chenopodium album*
$S_{20}F_{40}V_{40}$	9	*Cynodon dactylon, Brachiaria reptans, Echinochloa colona, Echinochloa crusgali,*	*Cyperus difformis*	*Phyllanthus niruri, Ludwigia parviflora, Scoparia dolcis,*
$S_{20}F_{60}V_{20}$	10	*Brachiaria reptans, Echinochloa colona, Echinochloa crusgali*	*Cyperus difformis*	*Phyllanthus niruri, Phyllanthus urinaria, Scoparia dolcis*
$S_{20}F_{80}V_0$	11	-	-	-
$S_{40}F_0V_{60}$	12	*Cynodon dactylon, Brachiaria reptans, Echinochloa colona, Echinochloa crusgali,*	*Cyperus difformis, Cyperus rotundus*	*Phyllanthus niruri, Phyllanthus urinaria, Ludwigia parviflora, Ammannia baccifera, Scoparia dolcis, Chenopodium album*
$S_{40}F_{20}V_{40}$	13	*Brachiaria reptans. Echinochloa colona*	*Cyperus difformis*	*Phyllanthus niruri, Phyllanthus urinaria, Ludwigia parviflora, Ammannia baccifera, Scoparia dolcis, Chenopodium album*
$S_{40}F_{40}V_{20}$	14	*Brachiaria reptans. Echinochloa colona,*	-	-
$S_{40}F_{60}V_0$	15	-	-	-
$S_{60}F_0V_{40}$	16	*Brachiaria reptans. Echinochloa colona, Echinochloa crusgali,*	*Cyperus difformis, Cyperus rotundus*	*Phyllanthus niruri, Ludwigia parviflora, Scoparia dolcis, Chenopodium album*
$S_{60}F_{20}V_{20}$	17	*Brachiaria reptans, Echinochloa colona, Echinochloa crusgali,*	*Cyperus difformis*	*Phyllanthus niruri, Ludwigia parviflora, Ammannia baccifera, Scoparia dolcis,*
$S_{60}F_{40}V_0$	18	-	-	-
$S_{80}F_0V_{20}$	19	*Cynodon dactylon, Brachiaria reptans, Echinochloa colona, Echinochloa crusgali,*	*Cyperus difformis*	*Phyllanthus niruri, Ludwigia parviflora, Ammannia baccifera, Scoparia dolcis, Chenopodium album*
$S_{80}F_{20}V_0$	20	*Brachiaria reptans, Echinochloa crusgali,*	-	-
$S_{100}F_0V_0$	21	*Cynodon dactylon, Brachiaria reptans, Echinochloa crusgali,*	*Cyperus difformis*	*Phyllanthus urinaria, Scoparia dolcis, Chenopodium album*

Fig.1 Number of broad leaf weeds m^{-2} observed in rice seedlings as influenced by different treatments

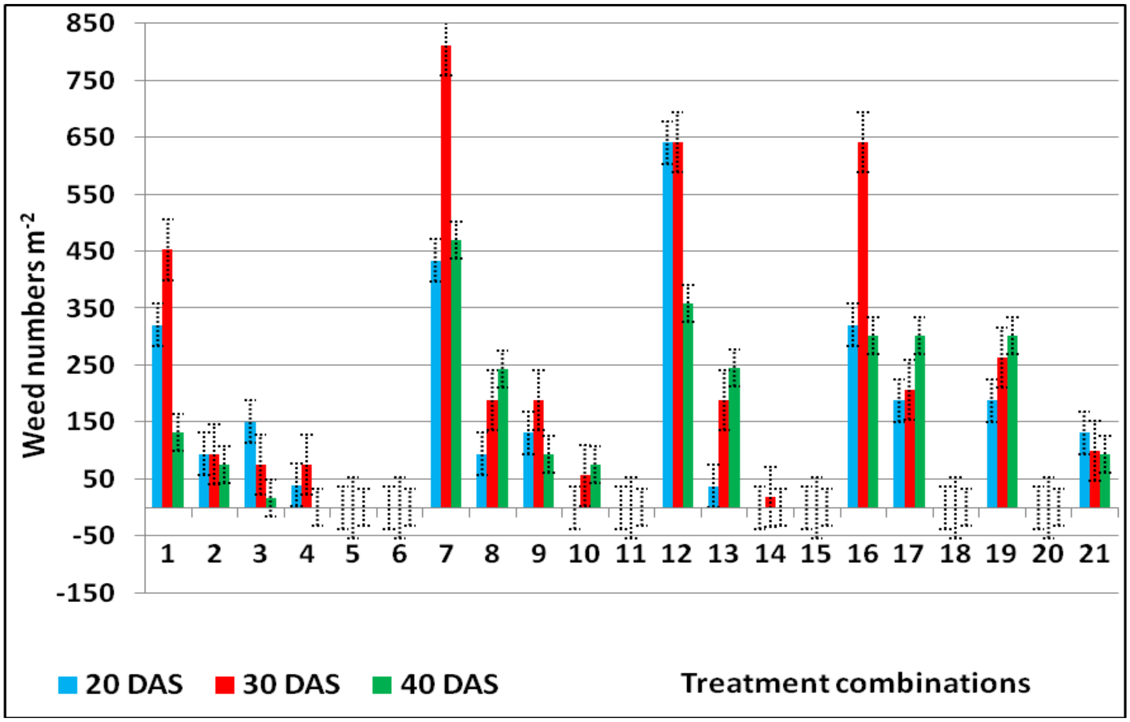

Fig.2 Number of grasses and sedges m^{-2} observed in rice seedlings as influenced by different treatments

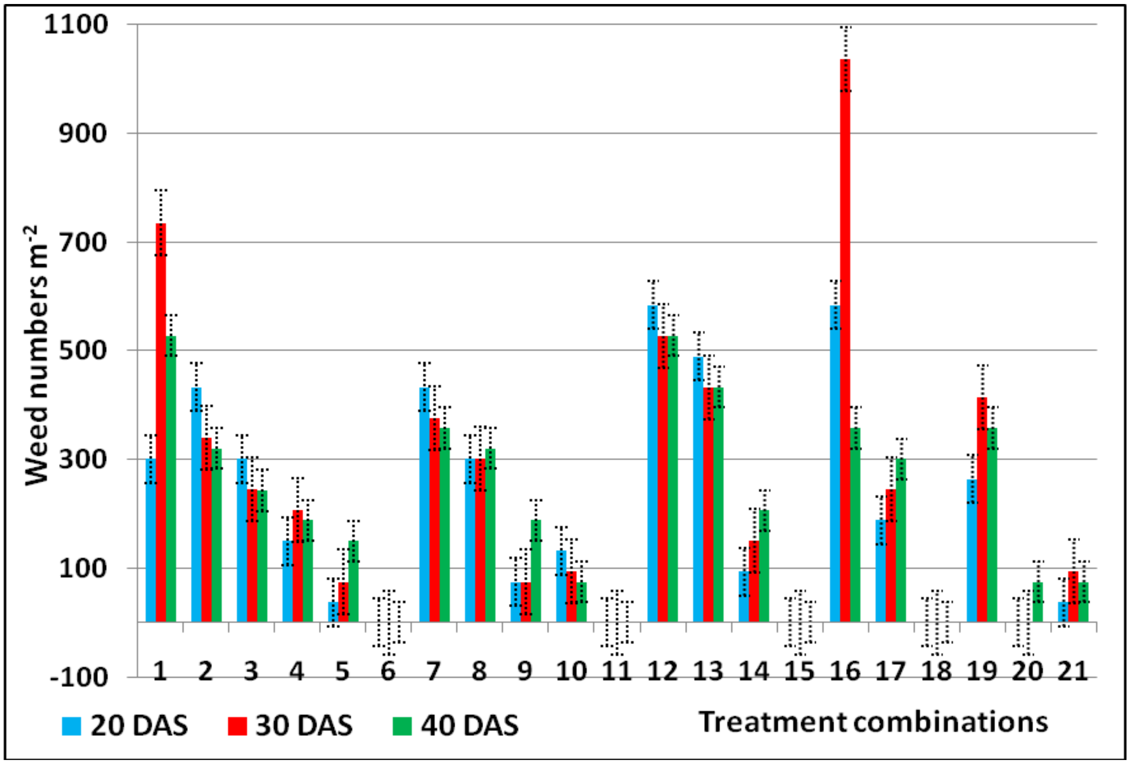

Fig.3 Total number of weeds m^{-2} observed in rice seedlings as influenced by different treatment combinations

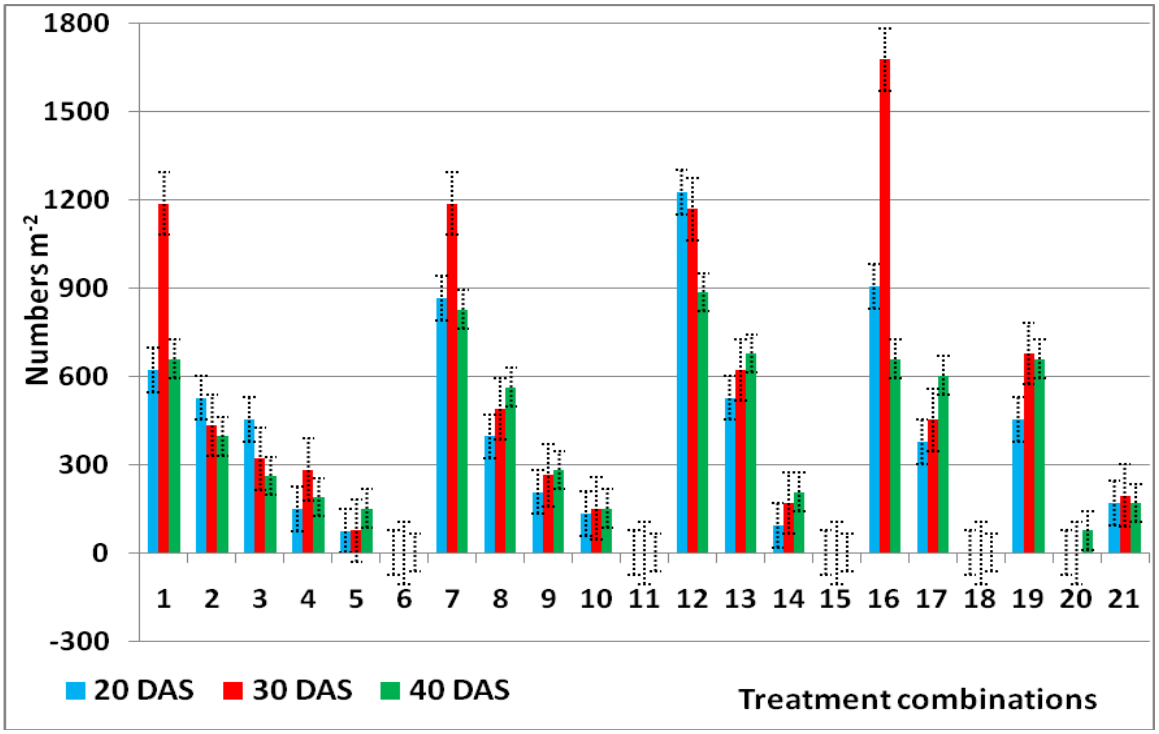

Fig.4 Total weed dry matter m^{-2} in rice seedlings as influenced by different treatment combinations

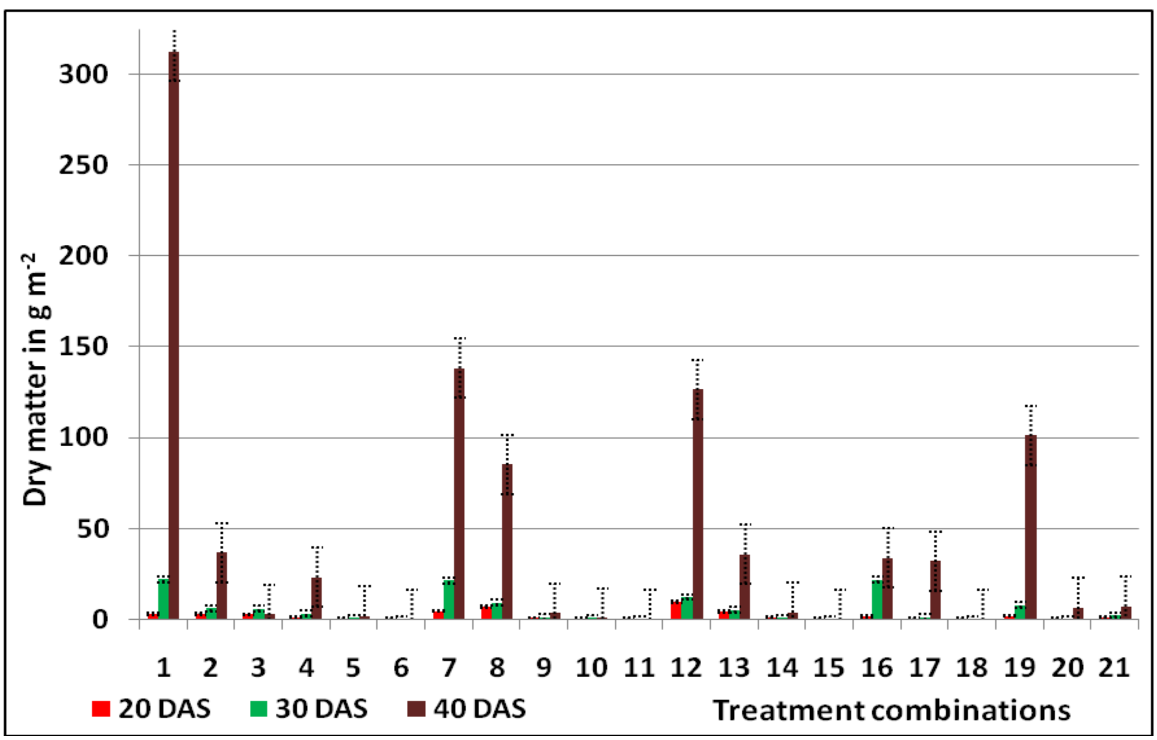

Plate.1 Floristic composition of weeds in experimental poly-bags

Bermuda grass (*Cynodon dactylon* L.)

Running grass (*Brachiaria reptans* Gard. & Hubb.)

Jungle rice (*Echinochloa colona* L.)

Barnyard grass (*Echinochloa crusgali* L.)

Flat sedge (*Cyperus difformis* L.)

Nut sedge (*Cyperus rotundus* L.)

Stone breaker (*Phyllanthus niruri* L.)

Chamber bitter (*Phyllanthus urinaria* L.)

Creeping Water Primrose (*Ludwigia parviflora* Roxb.)

Monarch Red stem (*Ammannia baccifera* L.)

Goat weed (*Scoparia dolcis* L.)

Goosefoot (*Chenopodium album* L.)

Dry matter of weeds

The dry matter of weeds m^{-2} recorded at 20, 30 and 40 DAS have been presented in Table 6 and depicted in Figure 4.

Similar to the total weed population, dry matter of weeds in $S_{40}F_0V_{60}$ was the highest with significant difference from the rest treatment combinations at 20 DAS.

But, the weed dry matter in $S_0F_0V_{100}$ surpassed it at 30 DAS (22.004 ±1.540 g m^{-2}) and reached at its maximum at 40 DAS (312.808 + 34.409 g m^{-2}).

Apart from the weed free treatment combinations viz. $S_0F_{100}V_0$, $S_{20}F_{80}V_0$, $S_{40}F_{60}V_0$ and $S_{60}F_{40}V_{0,}$ the lowest dry matter of weeds was seen in $S_{20}F_{60}V_{20}$ at 40 DAS.

Unlike rice seedling dry matter, the weed biomass followed a strict positive relationship with the levels of vermicompost that might be due to availability of plant nutrients in adequate quantities, in suitable proportions and also due to the ability of the weeds to preoccupy the rhizosphere well ahead of rice plants thereby suppressing the latter's growth rate.

Floristic composition of weeds

The floristic composition of different weed species of grasses, broadleaved and sedges in different treatment combinations at 40 DAS was studied. The common names and scientific names along with their photographs have been presented at Table 7 and Plate 1. *Cynodon dactylon* was absent in absence of soil and *Echinochloa sps* was the ruling type. *Brachiaria reptans* was absent with 60 and 80 % substitution of vermicompost by fly ash. *Cyperus difformis* was more adaptable compared to *Cyperus rotundus* due to its wider existence in test-substrates. Among broadleaf weeds *Phyllanthus sps.* were abundantly present.

From the results so obtained it might be concluded that fly ash and vermicompost at varying levels in rice-nursery have their significant influences on the floristic composition of weeds. No broad leaf weed or grass or sedge could emerge in rice nursery in absence of vermicompost except in 100 % soil with only very limited weed flora. The maximum number of broadleaf weeds emerged in soil with 80 % vermicompost and the maximum number of grasses and sedges emerged in 100 % vermicompost and also in soil with 60 % vermicompost by weight. The highest dry matter of weeds was recorded in 100 % vermicompost.

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Conflict of interest

There is no conflict of interest among the 5 authors.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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