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Effect of Fodder Crops on Weeds in Summer Rice Fallow

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Authors' contributions

This work was carried out in collaboration between both authors. Author BNB performed the study and statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author JJ designed the study, managed the analysis of the study. Author BNB managed the literature searches. Author JJ read and approved the final manuscript.

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ABSTRACT

In the summer rice fallow of double cropped low land rice filed, four different fodder crops were raised under varying nitrogen regimes with the objective of evaluating its effect on weeds, during 2017-18. The experiment was laid out in Randomized Block Design. The fodder crops were fodder cowpea (CO- 9), rice bean (Bidhan- 2), fodder maize (African tall), fodder sorghum (CO (FS) 31). The varying nitrogen regimes were 100, 75 and 50 per cent recommended dose of nitrogen (RDN). The weed composition in the experimental field included grasses, sedges and broadleaved weeds. Both at 20 and 40 days after sowing (DAS), the weed population was more in fallow treatment. The weed dry matter production was significantly more in the fallow plot. At 40 DAS, weed dry matter production was relatively less in fodder cowpea. Weed smothering efficiency (WSE) was relatively greater in all the fodder crops except fodder cowpea at 20 DAS. However, at 40 DAS the WSE in rice bean, fodder maize and fodder sorghum declined, while in fodder cowpea it increased. Nitrogen removal at 20 and 40 DAS was significantly more in fallow plot. At 40 DAS, both N and P removal by weeds was significantly less in fodder cowpea. At 40 DAS, K removal was significantly less in fodder cowpea especially at 100 and 75 per cent RDN.

Keywords: Weeds; fodder crops; nitrogen; summer rice fallows.

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1. INTRODUCTION

The cost-effective weed control measures are always a critical question in the rice-based cropping system. Improving cropping intensity of rice–fallows may in turn, help in meeting out fodder requirement during lean period [1] which can also act as a barrier for weed emergence during the fallow period. In India, there is almost 12 m ha of rice fallows are available [2], which is a major platform for the weeds to flourish. Bringing in cultivation into these rice summer fallows can reduce the weed menace and also enhance the sustainability of the cropping system. Weed population was more in *virippu* rice where the preceding summer crop was bhindi and cassava which was due to the farmyard manure liberally applied in these crops that served as a source of weed seeds (Varughese et al., 2007). Shrikant [3] observed significant variation in the composition of weed flora of summer crops and the succeeding rice crop. The succeeding rice crop was not significantly influenced by the summer crops with respect to yield and yield attributes. However, in a field study conducted in double cropped lowland rice fields during summer of 2016 observed that, among the weeds, grasses dominated followed by sedges and broadleaved weeds. The population of *Echinochloa colona* was the highest among garsses followed by *Isachne miliacea*, *Digitaria ciliaris* and *Eragrostis tenella*. Whereas, among broad leaved weeds, *Lindernia grandiflora* ranked first followed by *Phyllanthus niruri*, *Oldenlandia umbellate* and *Cleome rutidospermum*. Among sedges, *Fimbristylis miliacea* outnumbered others [4].

The objectives of the study were to evaluate the effect of fodder crops under varying nitrogen regimes on weed composition and dry matter production. Also, to evaluate absolute density of weeds and weed smothering efficiency of the fodder crops.

2. MATERIALS AND METHODS

The experiment was conducted during the period from February 2018 to October 2018 at the Integrated Farming System Research Station (IFSRS) of Kerala Agricultural University, Karamana, Thiruvananthapuram, Kerala.

In the summer rice fallow of double cropped low land rice filed, four different fodder crops were raised under varying nitrogen regimes with the objective of evaluating its effect on weeds, during 2017-18. The experiment was laid out in Randomized Block Design. The fodder crops were fodder cowpea (CO- 9), rice bean (Bidhan-2), fodder maize (African tall), fodder sorghum (CO (FS) 31). The varying nitrogen regimes were 100, 75 and 50 per cent recommended dose of nitrogen (RDN).

The experiment was laid out in Randomized Block Design (RBD) and comprised of twelve treatments and one control, replicated thrice.

Design:	Randomized Block Design
Treatment combinations:	12 + 1 (control)
Replication:	3
Plot size:	5 m x 4 m
Control:	Fallow during summer

Treatment combinations

T_1 : Fodder cowpea (100% *RDN)
T_2 : Fodder cowpea (75%RDN)
T_3 : Fodder cowpea (50%RDN)
T_4 : Rice bean (100%RDN)
T_5 : Rice bean (75%RDN)
T_6 : Rice bean (50%RDN)
T_7 : Fodder maize (100%RDN)
T_8 : Fodder maize (75%RDN)
T_9 : Fodder maize (50%RDN)
T_{10} : Fodder sorghum (100%RDN)
T_{11} : Fodder sorghum (75%RDN)
T_{12} : Fodder sorghum (50%RDN)
T_{13} : Fallow

*RD: For fodder crops, except rice bean, recommended dose as per TNAU recommendation and for rice bean, the recommendation of the AICRP on Forage crops is followed (20:40:0 kg NPK ha^{-1}).

The observations on weed composition, dry matter production and absolute density were recorded and weed smothering efficiency was calculated, both at 20 and 40 DAS. For recording weed composition, a quadrant of size 50 × 50 cm was placed at random at two sites in each net plot. The weed flora from the experimental site were identified and grouped into grasses, sedges and broadleaved weeds. Weeds in the quadrant area were pulled out along with roots, washed and dried under shade and oven dried at 60 ± 5° C to constant weight. The dry weight of the weeds was recorded and expressed as g m^{-2}. Weed smothering efficiency (WSE) was

Table 1. Methods of plant nutrient analysis

Parameter	Method used	Reference
N (%)	Modified micro kjeldahl method	Jackson, 1973 [5]
P (%)	Vanado-molybdo phosphoric yellow colour method using spectrophotometer	Jackson, 1973 [5]
K (%)	Flame photometry method	Jackson, 1973 [5]

computed using the given formula and was expressed in percentage.

$$\text{WSE} = \frac{\text{WC}-\text{WT}}{\text{WC}} \times 100$$ Mani and Gautham [6]

where,

WC – Dry weight of weeds in control (fallow) plot

WT – Dry weight of weeds in treated plots

Absolute density of the weeds was recorded from the quadrant, and expressed per m^{-2}.

Absolute density = Total number of weeds of a given species m^{-2} [7].

For analyzing the nutrient uptake by weeds, weed samples were collected at 20 and 40 DAS and analyzed for N, P and K content. The samples were dried under shade and to a constant weight in hot air oven at 60 ± 5^0 C and then powdered. Nutrient uptake was calculated by the formula:

Nutrient uptake = Nutrient content (%) × Dry matter (kg ha^{-1})

The experimental data were analyzed statistically by using Analysis of Variance technique for RBD [8] using Microsoft Excel software and the significance was tested using F test. The data which required transformation were appropriately transformed and analyzed. Wherever the F values were found significant, critical difference was calculated at five per cent probability level.

3. RESULTS AND DISCUSSION

The different weed species found in the experimental field during the study were collected, identified and classified into grasses, sedges and broadleaved weeds (Table 2). As the experimental field was a summer fallow of double cropped rice field, several weeds commonly noticed in rice were present in the fodder crops raised during summer. Rice plants which grew from the previous crop was also a major weed.

Among grasses, rice (*Oryza sativa),* blood grass (*Isachne miliacea),* barnyard grass (*Echinocloa crusgalli)* were the major weed species observed. Among sedges, umbrella sedge (*Cyperus difformis),* yellow nut sedge (*Cyperus iria),* globe finger rush (*Fimbristylis miliacea),* oval leaf pondweed (*Monochoria vaginalis)* were the major weed species observed. Among broad leaved weeds, penny wort (*Centella asiatica),* false daisy (*Eclipta postrata),* small flowered lindernia (*Lindernia parviflora),* perennial water primrose (*Ludwigia perennis),* Indian madder (*Oldenlandia umbellata),* stone breaker (*Phyllanthus niruri),* sweet broom weed (*Scoparia dulcis),* wedgewort (*Sphenoclea zeylanica)* were the major weed species observed.

At 20 DAS, in general, among the weeds present, sedges dominated in majority of the treatments (Table 3). There was no particular trend with regard to weed population in the different treatments.

The absolute density of grasses was significantly less in T_7 in fodder maize which was on par with other treatments of fodder maize, T_2 and T_3 (fodder cowpea), T_4 and T_6 (rice bean), T_{10} and T_{12} (fodder sorghum) and T_{13} (fallow treatment). There was no significant difference between treatments and control. The absolute density of sedges was significantly low in T_5 (rice bean) which was on par with other treatments of rice bean, T_1 (fodder cowpea), T_7 and T_9 (fodder maize) and T_{13} (fallow treatment). The absolute density of sedges did not differ significantly between treatment and control. The absolute density of broad leaved weeds was significantly low in T_5 (rice bean) which was on par with other treatments of rice bean, T_3 (fodder cowpea), T_7 and T_8 (fodder maize) and all the treatments fodder sorghum. There was significant difference between treatments and control with respect to absolute density of broad leaved weeds. The total absolute density was significantly less in T_7 in fodder maize which was on par with T_4 and T_6 (rice bean), T_{10} and T_{11} (fodder sorghum). The total absolute density differed significantly between treatments and the control at 20 DAS.

Table 2. Major weed composition observed in experimental field of fodder crops

Common name	Scientific name	Family
Grasses		
Rice (Nellu)	*Oryza sativa*	Poaceae
Blood grass (Naringa)	*Isachne miliacea*	Poaceae
Barnyard grass (Kavada pullu)	*Echinocloa crusgalli*	Poaceae
Sedges		
Umbrella sedge (Thalekkettan)	*Cyperus difformis*	Cyperaceae
Yellow nut sedge (Manjakkora)	*Cyperus iria*	Cyperaceae
Globe finger rush (Mung)	*Fimbristylis miliacea*	Cyperaceae
Oval Leaf Pondweed (Karinkuvvalam)	*Monochoria vaginalis*	Pontederiaceae
Broad leaved weeds		
Penny wort (Kodangal)	*Centella asiatica*	Apiaceae
False daisy (Kaiyunni)	*Eclipta postrata*	Asteraceae
Small flowered Lindernia	*Lindernia parviflora*	Linderniaceae
Perennial water primrose (Neerkarayambu)	*Ludwigia perennis*	Onagraceae
Indian madder (Nonganam pullu)	*Oldenlandia umbellata*	Rubiaceae
Stone breaker (Keezharnelli)	*Phyllanthus niruri*	Euphorbiacea
Sweet broom weed (Kallurukki)	*Scoparia dulcis*	Plantaginaceae
Wedgewort (Pongati)	*Sphenoclea zeylanica*	Sphenocleaceae

Table 3. Effect of treatments on absolute density of weeds at 20 DAS, number m^{-2}

Treatments	Grasses	Broad leaved weeds	Sedges	Total
T_1 : Fodder cowpea with 100 % N	40.33	29.00	24.00	93.33
T_2 : Fodder cowpea with 75 % N	17.67	26.67	32.33	76.67
T_3 : Fodder cowpea with 50 % N	20.67	24.00	45.00	89.67
T_4 : Rice bean with 100 % N	17.33	17.33	24.33	59.00
T_5 : Rice bean with 75 % N	66.33	12.00	10.67	89.00
T_6 : Rice bean with 50 % N	16.00	22.00	23.67	61.67
T_7 : Fodder maize with 100 % N	10.67	16.67	23.67	51.00
T_8 : Fodder maize with 75 % N	18.00	18.33	44.00	80.33
T_9 : Fodder maize with 50 % N	18.33	35.67	21.67	75.67
T_{10} : Fodder sorghum with 100 % N	12.33	13.33	27.00	52.67
T_{11} : Fodder sorghum with 75 % N	26.00	17.00	27.67	70.67
T_{12} : Fodder sorghum with 50 % N	20.33	19.00	40.33	79.67
T_{13} : Fallow during summer	18.67	73.33	20.33	112.33
SEm (±)	4.58	4.46	5.12	7.30
CD(0.05)	13.444	13.068	15.014	21.421
Treatment vs control	NS	S	NS	S

SEm – Standard error of mean

At 40 DAS, grasses dominated followed by sedges and broad leaved weeds (Table 4). At this stage also, there was no particular trend with respect to weed population between treatments. Both at 20 and 40 DAS, the variations in weed population had no specific relation with varying doses of N. In general, total weed population was more in the fallow plot. The absolute density of grasses was significantly less in T_{12} in fodder sorghum, which was comparable with other treatments of fodder sorghum, all treatments of fodder cowpea, T_4 and T_6 (rice bean), T_9 in fodder maize. The absolute density of grasses did not differ significantly between treatments and control. The population of sedges was significantly less in T_{12} in fodder sorghum, which comparable with T_1 in fodder cowpea, all treatments of rice bean and T_{10} in fodder sorghum. There was no significant difference between treatments and control in the case of the population of sedges. The absolute density of broad leaved weeds was significantly less in T_{12} in fodder sorghum, which was on par with all the treatments of fodder cowpea and T_4 in rice bean. The absolute density of broad leaved weeds did not differ significantly between treatments and control. The total absolute density of weeds was significantly less in T_{12} in fodder sorghum, which was on par with T_4 in rice bean. The treatments and control did not differ significantly in the case of total absolute density.

At 20 DAS, the dry matter of weeds was significantly less (Table 5) in T_7 (fodder maize with 100 % N), which was on par with all other treatments except fallow treatment (T_{13}). But, at 40 DAS, the dry matter production of weeds was significantly less in T_1 which was on par with T_2 (fodder cowpea with 100 and 75% N respectively). The weed dry matter production differed significantly between the control treatments both at 20 and 40 DAS. The weed dry matter production was significantly more in the fallow plot. There was no specific trend in weed dry matter production at 20 DAS. However, at 40 DAS weed dry matter production was relatively less in fodder cowpea. There was no marked variation in the weed dry matter production with varying doses of N.

The data on weed smothering efficiency is furnished in Table 5. At 20 DAS, the weed smothering efficiency was significantly higher in T_6 in rice bean which was on par with all other treatments, except in T_3 (fodder cowpea) and T_5 (rice bean). However, at 40 DAS, the weed smothering efficiency was significantly higher in T_1 which was on par with T_2 (fodder cowpea with 100 and 75% N respectively). Weed smothering efficiency was relatively greater in all the fodder crops except fodder cowpea at 20 DAS. However, at 40 DAS, the WSE in rice bean, fodder maize and fodder sorghum declined, while in fodder cowpea it increased. The enhanced canopy of fodder cowpea, especially at higher doses of N (75 and 100 % RDN) at 40 DAS, might have restricted the weed growth, thereby resulting in the higher WSE.

The data on nutrient removal by weeds are furnished in Table 6. At 20 DAS, the N removal by weeds was significantly low in T_2 in fodder cowpea, which was on par with all other treatments except, T_1 (fodder cowpea), T_9 (fodder maize) and T_{13} (fallow). At 40 DAS, N removal by weeds was significantly less in fodder cowpea. The N removal by weeds significantly differed between treatments and control, both at 20 and 40 DAS. N removal at 20 and 40 DAS was significantly more in fallow plot. At 20 DAS, N removal did not show any definite trend. At 40 DAS, N removal by weeds was significantly less in fodder cowpea.

The P removal by weeds, at 20 DAS, was significantly less in T_7 in fodder maize, which was comparable with T_8 in fodder maize, T_2 and T_3 in fodder cowpea, all the treatments of rice bean, T_{11} and T_{12} in fodder sorghum. However, at 40 DAS, significantly less P removal by weeds was in T_1 in fodder cowpea, which was on par with other treatments of fodder cowpea and T_7 in fodder maize. There was significant difference between treatments and control in case of P removal by weeds both at 20 and 40 DAS. P removal by weeds at 20 DAS did not reveal any definite trend. At 40 DAS, P removal was significantly less in fodder cowpea.

Table 4. Effect of treatments on absolute density of weeds at 40 DAS, number m^{-2}

Treatments	Grasses	Broad Leaved weeds	Sedges	Total
T_1 : Fodder cowpea with 100 % N	48.00	12.33	29.67	90.00
T_2 : Fodder cowpea with 75 % N	51.33	15.33	37.33	104.00
T_3 : Fodder cowpea with 50 % N	50.00	17.33	33.00	100.33
T_4 : Rice bean with 100 % N	44.67	13.00	24.67	82.33
T_5 : Rice bean with 75 % N	70.67	34.00	27.00	131.67
T_6 : Rice bean with 50 % N	45.67	24.00	24.67	94.33
T_7 : Fodder maize with 100 % N	61.33	30.67	31.33	123.33
T_8 : Fodder maize with 75 % N	62.00	20.33	51.33	133.67
T_9 : Fodder maize with 50 % N	50.67	31.67	44.33	126.67
T_{10} : Fodder sorghum with 100 % N	52.00	22.00	26.67	100.67
T_{11} : Fodder sorghum with 75 % N	46.33	35.33	50.67	132.33
T_{12} : Fodder sorghum with 50 % N	42.67	10.00	18.33	71.00
T_{13} : Fallow during summer	59.33	23.33	38.00	120.67
SEm (±)	5.06	3.18	4.31	7.10
CD(0.05)	14.848	9.328	12.631	20.814
Treatment vs control	NS	NS	NS	NS

Table 5. Effect of treatment on dry matter production of weeds and weed smothering efficiency

Treatment	Dry matter production (g m^{-2})		Weed smothering efficiency (%)	
	20DAS	40 DAS	20 DAS	40DAS
T_1 : Fodder cowpea with 100 % N	21.91	47.41	54.46	64.55
T_2 : Fodder cowpea with 75 % N	14.45	69.83	59.21	47.94
T_3 : Fodder cowpea with 50 % N	22.27	95.24	48.72	29.03
T_4 : Rice bean with 100 % N	17.40	113.39	54.86	17.20
T_5 : Rice bean with 75 % N	20.41	113.14	33.23	16.98
T_6 : Rice bean with 50 % N	19.71	105.77	69.94	22.67
T_7 : Fodder maize with 100 % N	14.28	106.23	65.64	22.28
T_8 : Fodder maize with 75 % N	17.01	89.31	55.00	34.10
T_9 : Fodder maize with 50 % N	19.09	75.58	57.76	44.94
T_{10} : Fodder sorghum with 100 % N	18.61	110.54	64.35	18.95
T_{11} : Fodder sorghum with 75 % N	19.29	101.38	61.75	25.29
T_{12} : Fodder sorghum with 50 % N	17.16	106.70	57.36	22.13
T_{13} : Fallow during summer	43.57	136.55	-	-
SEm (±)	3.32	8.46	5.39	5.90
CD(0.05)	9.746	24.800	15.720	17.231
Treatment vs control	S	S		

Table 6. Effect of treatments on N, P and K removal by weeds at 20 and 40 DAS, kg ha^{-1}

Treatments	N removal		P removal		K removal	
	20 DAS	40 DAS	20 DAS	40 DAS	20 DAS	40 DAS
T_1	28.86	26.07	12.52	4.05	30.61	21.90
T_2	16.48	33.33	9.06	6.12	17.65	35.16
T_3	18.15	37.50	8.45	5.40	20.40	40.71
T_4	23.21	75.24	8.87	8.64	23.77	50.68
T_5	25.77	58.02	8.68	8.73	27.97	57.54
T_6	17.00	56.40	8.42	7.70	19.63	42.28
T_7	23.85	76.74	5.64	6.31	23.27	56.86
T_8	21.64	54.17	9.55	8.20	18.15	48.54
T_9	30.87	63.51	11.92	8.34	26.37	48.05
T_{10}	24.88	71.33	11.67	10.60	21.69	64.91
T_{11}	25.45	58.84	10.91	10.36	19.91	47.20
T_{12}	18.52	64.92	9.01	10.35	15.48	48.04
T_{13}	56.98	106.48	18.90	11.63	35.43	55.36
SEm (±)	3.76	5.07	1.96	1.03	2.22	4.64
CD(0.05)	11.015	14.868	5.756	3.011	6.527	13.610
Treatment vs control	S	S	S	S	S	NS

At 20 DAS, the K removal by weeds was significantly less in T_{12} in fodder sorghum which was comparable with other treatments of fodder sorghum, T_2 and T_3 (fodder cowpea), T_6 (rice bean), T_8 (fodder maize). At 40 DAS, was significantly less K removal by weeds was in T_1 in fodder cowpea which was on par with T_2. The K removal by weeds differed significantly between treatments and control at 20 DAS but, not at 40 DAS. K removal at 20 DAS did not exhibit any specific pattern. At 40 DAS, K removal was significantly less in fodder cowpea especially at 100 and 75 per cent RDN. It was observed that, nutrient removal by weeds increased with weed dry matter production. The findings are in accordance with Singh et al. [9] who recorded that higher weed dry matter production resulted in higher nutrient removal.

4. CONCLUSION

The study evaluates the effect of fodder crops under varying nitrogen regimes on weed composition and dry matter production. Also, to evaluate absolute density of weeds and weed smothering efficiency of the fodder crops. The higher WSE of fodder cowpea during the later stages resulted in lesser dry matter production and consequently lesser removal of nutrients by weeds.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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