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Effect of tree species, *in situ* moisture conservation and nitrogen management practices on nutrient uptake, grain yield and post harvest soil nutrient status of sorghum + cowpea intercropping system under dryland Vertisols

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Abstract: **Field experiments conducted with moisture conservation and nitrogen management practices in sorghum + cowpea intercropping with different tree species revealed that sorghum + cowpea intercropping in the interspaces of *Emblica officinalis* registered higher N,P and K uptake and grain yield. Tied ridges significantly influenced the nutrient uptake and grain yield of crops during 1999, when the distribution of rainfall was normal. Combined application of goat manure and inorganic fertilizers recorded higher nutrient uptake and grain yield of sorghum and cowpea and improved the soil fertility status as compared to inorganic N alone.**

Keywords : Sorghum, Cowpea, Emblica Officinalis, Nutrient uptake, Yield, Residual nutrients.

Introduction

Moisture and nutrients are the major limiting factors under dryland situation. Decreased productivity of crops under dryland condition is mainly attributed to lack of moisture conservation and low rate of manure and fertilizer application. Even when the rainfall is high, it is often lost as runoff when the surface of the soil is not suitably formed. Nitrogen is the key element in crop production. All the dryland soils are deficient in nitrogen and heavy losses also occurs due to runoff and volatilization. In view of high cost of fertilizer nitrogen and due to the risk involved in application of fertilizers during inadequate rainfall years, dryland farmers are often not interested to use the fertilizers. According to Lal *et al.* (1988) environmentally sustainable dryland farming emphasise on the use of legumes and cover crops to improve soil nitrogen and in efficiently utilizing the cattle manure. Addition of organic manures to dryland improves not only the nutrient availability but also the water holding capacity of the soil. According to Singh and Rajat (1987) the combination of organic matter and fertilizer nitrogen increased the P and K uptake more than their application individually. Santhy *et al.* (1998) reported that application of FYM along with NPK increased the crop yield and nutrient uptake. The highest N,P and K uptak was recorded when FYM was applied to me 50 per cent N along with 50 per cent recommende dose of fertilizer in rainfed sorghum.

Livestock have a key role in ecologic sustainability and maintenance of soil fertilit Manure application increased crop yield an improved soil quality. Kathiresan and Bhask (1999) found that the residual nutrient conte was high when sheep manure was applie

For providing stability and sustainabilit tree cum crop farming will be the most appropriat one. According to Subbaian (1999) alternate land use systems are appropriate in areas where subsistence farming is practiced in fragile ecosystems. Studies on the role of moisture conservation and nitrogen management in tree cum crop farming under drylands are very meagre. Hence, the present investigation was conducted to find out the suitable moisture conservation and nitrogen management practices to improve the nutrient uptake and grain yield of sorghum + cowpea intercropping with tree seedlings and to estimate the post harvest soil fertility status under dryland situation.

Materials and Methods

Field experiments were conducted at Department of Agronomy, Tamil Nadu Agricultural

ble 1. Effect of treatments on total nutrient uptake of sorghum + cowpea intercropping

eatment	Nitrogen		Phosphorus		Potassium	
	1999	2000	1999	2000	1999	2000
1	79.6	36.0	10.69	4.65	70.3	32.9
2	68.0	36.0	9.28	4.67	66.2	33.3
3	87.1	40.1	11.79	5.37	81.3	37.4
Sd	2.07	0.61	0.41	0.28	1.72	1.42
D (P=0.05)	4.62	1.37	0.90	0.63	3.84	3.16
1	86.8	37.5	11.80	4.90	79.8	34.6
2	69.7	37.3	9.37	4.88	65.4	34.4
Sd	1.69	0.50	0.33	0.23	1.41	1.16
D (P=0.05)	3.77	NS	0.74	NS	3.13	NS
1	70.6	36.5	9.44	4.61	67.9	33.4
2	85.8	38.2	11.73	5.18	77.3	35.7
Sd	2.18	0.66	0.37	0.22	1.46	0.83
D (P=0.05)	4.74	1.43	0.80	0.48	3.17	1.82

nteraction non significant

- *Ailanthus excelsa*, T_2 - *Ceiba pentandra*, T_3 - *Emblica officinalis*

1 - Tied ridges, M_2 - Flat bed

- 100 per cent N through fertilizer, N_2 - 50 per cent N through fertilizer + 50 per cent N through goat manure

niversity, Coimbatore during North East Monsoon asons of 1999 and 2000. Amount of rainfall ceived during the years 1999 and 2000 were 22.6 and 291.2 mm, respectively. The soil of the experimental site was vertisol having ow available nitrogen (147 kg ha^{-1}), medium ivailable phosphorus (13.7 kg ha^{-1}) and high ivailable potassium (432 kg ha^{-1}). The pH of he soil was 7.9 with an EC of 0.37 dSm^{-1}.

The experiment was conducted in split plot design with three replications. Trees and moisture conservation measures were allotted to the main plot and nitrogen management practices were tried in sub plots. The main plot treatments included three tree species *viz.* *Ailanthus excelsa* (T_1), *Ceiba pentandra* (T_2) and *Emblica officinalis* (T_3) and two moisture conservation practices *viz.* Tied ridges (M_1) and Flat bed (M_2). The sub plot treatments are 100 per cent N through fertilizer (N_1) and 50 per cent N through fertilizer and 50 per cent N through goat manure (N_2). Tree seedlings were planted during the North East Monsoon of 1998 and established.

The crops were sown on 16.9.1999 during the first year and 12.9.2000 during the second year. The seeds were soaked in 2 per cent potassium dihydrogen phosphate for six hours and shade dried and then sown in the field. Paired row method of planting (60/30 x 15 cm) was adopted in sorghum (CO 26) + Cowpea (CO 4) intercropping. The seeds were sown before the onset of monsoon. Tied ridges were formed at third week after germination of the seeds as per the treatments. Recommended fertilizer schedule of 40:20 kg N and P ha^{-1} was adopted. Goat manure obtained from deep litter system of goat rearing was applied basally and incorporated as per the treatments assigned. Nitrogen was applied in two splits, 50 per cent as basal and the remaining 50 per cent at 30 DAS. Entire P was applied basally by making deep lines before sowing.

Observations with regard to nutrient uptake, grain and straw yield of sorghum and grain yield of cowpea were recorded and presented. After harvest of the crop, the soil N, P and K contents were estimated.

Table 2. Effect of treatments on yield of sorghum and cowpea

Treatment	Sorghum				Cowpea	
	Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Grain yield (kg ha^{-1})	
	1999	2000	1999	2000	1999	2000
T_1	740	144	4211	2879	347	140
T_2	677	138	3767	2746	309	131
T_3	778	149	4629	3078	349	166
SEd	495	2.72	18.29	31.31	1.45	1.70
CD (P=0.05)	11.03	6.05	40.75	69.78	3.24	3.79
M_1	783	142	4527	2905	349	145
M_2	680	145	3877	2897	321	147
SEd	4.04	2.21	14.93	25.57	1.19	1.38
CD (P=0.05)	9.00	NS	33.27	NS	2.65	NS
N_1	644	140	4094	2866	316	142
N_2	819	147	4310	2936	354	150
SEd	3.38	2.42	19.38	13.12	1.72	2.22
CD (P=0.05)	7.36	5.28	42.23	28.59	3.74	4.85

* Interaction non significant

T_1 - *Ailanthus excelsa*, T_2 - *Ceiba pentandra*, T_3 - *Emblica officinalis*

M_1 - Tied ridges, M_2 - Flat bed

N_1 - 100 per cent N through fertilizer, N_2 - 50 per cent N through fertilizer + 50 per cent N through goat manure

Results and Discussion

Effect of nutrient uptake

Significantly higher N, P and K uptake was recorded in the crops grown with *E.officinalis* in both the years. The increased total nutrient uptake of the crops with *E.officinalis* might be attributed to less competition from *E.officinalis* as compared to other trees. Moisture conservation practices had significant influence on nutrient uptake of sorghum and cowpea only during first year. Among the treatments, tied ridges recorded the highest N,P and K uptake. The possible reason might be the availability of higher moisture during all the growth stages which inturn might have increased the uptake of nutrients. Shaikh *et al.* (1995) reported that total N and P uptake were higher with ridges and furrow sowing as compared to normal sowing in rainfed pearlmillet. Similarly Bhan *et al.* (1998) also reported that ridging and furrowing increased the nitrogen uptake of rainfed sorghum. Non receipt of rainfall after the formation of tied ridges and also inadequate soil moisture at critical growth stages of the crop might have reduced the uptake of nutrients which inturn reduced the total nutrient uptake during the second year (Table 3)

The nutrient uptake was higher with application of 50 per cent N through fertilizer and 50 per cent N through goat manure than inorganic N alone. Higher nutrient uptake might be due to continuous and steady availability of nutrients due to chelation effect of organic matter as reported by Tomar *et al.* (1984). The addition of basal dose of nitrogen along with goat manure could have narrowed down the C:N ratio and increasing the N availability as reportd by Hofman *et al.* (1986). Higher P uptake is due to availability of moisture and also due to the increased solubilisation of insoluble phosphorus fraction in soil during humification and reduced phosphorus fixation

Table 3. Interaction effect of treatments on yield of sorghum and cowpea (1999)

Treatment	Sorghum grain yield (kg ha^{-1})					Sorghum straw yield (kg ha^{-1})					Cowpea grain yield (kg ha^{-1})				
	M_1	M_2	N_1	N_2	Mean	M_1	M_2	N_1	N_2	Mean	M_1	M_2	N_1	N_2	Mean
T_1	807	673	639	841	740	4674	3748	4101	4321	4211	350	343	330	363	347
T_2	720	637	629	725	677	3928	3607	3706	3828	3767	340	278	288	330	309
T_3	823	732	663	892	778	4980	4278	4476	4781	4629	356	343	331	368	349
M_1			667	900				4280	4775				325	372	
M_2			620	739				3909	3846				308	335	
Mean	783	680	644	819		4527	4877	4094	4310		349	321	316	354	
		SEd			CD		SEd		CD			SEd		CD	
T x M		7.00			15.89		25.9		57.6			2.05		4.58	
M x N		5.27			11.63		24.5		53.8			2.09		4.58	
N x M		4.78			10.41		27.4		59.7			2.98		6.48	
N x T		5.85			12.75		33.6		73.1			2.43		5.29	
T x N		6.45			14.24		30.0		65.8			2.56		5.61	

T_1 - *Ailanthus excelsa*, T_2 - *Ceiba pentandra*, T_3 - *Emblica officinalis*
M_1 - Tied ridges, M_2 - Flat bed
N_1 - 100 per cent N through fertilizer, N_2 - 50 per cent N through fertilizer + 50 per cent N through goat manure

in the soil particles due to the protective action of manure by releasing organic acids during the decomposition. Increased uptake of N and P might have helped to extract more K from the soil resulting in higher K uptake due to the application of goat manure.

Effect on yield of sorghum and cowpea

In general grain yield of sorghum was higher during North East Monsoon 1999 as compared to North East Monsoon 2000. The grain yield of sorghum was the highest (778 kg ha^{-1}) in association with *E.officinalis* during the first year whereas it was comparable with other tree species durng the second year (Table 2).

Roy and Gill (1991) reported that the best grain production of sorghum, wheat, gram and arhar was found in association with *E. officinalis* compared to *Leucaena* and *Acacia nilotica*. Seed yield of cowpea was the highest (349 and 166 kg, respectively) in *E.officinalis* in both the years. Tied ridges recorded the highest grain yield of sorghum (783 kg ha^{-1}) and cowpea (349 kg ha^{-1}) and straw yield of sorghum (4527 kg ha^{-1}) only during the first year. During second year, due to poor distribution and non receipt of rainfall after the formation of tied ridges, there was no significant difference with regard to the moisture conservation practices.

Application of 50 per cent N through fertilizer and 50 per cent N through goat manure recorded the highest grain yield and straw yield of sorghum

and grain yield of cowpea and it was significantly superior to inorganic N alone. Among the treatment combinations the yield of crops was the highest with *E.officinalis* under tied ridges with application of 50 per cent N through fertilizer and 50 per cent N through goat manure (Table 1 and 2).

Effect of post harvest soil nutrient status

Higher post harvest soil available nutrients with *E.officinalis* as compared to other tree species (Table 4) might be due to less removal of nutrients with this tree species. Application of goat manure recorded higher available nutrient content of soil due to higher contribution of nutrient to soil under combined source. The magnitude of loss of P was lowered with the application of goat manure, to supply 50 per cent of the recommended N, as compared to 100 per cent N through inorganic N alone. Less gain of nutrients under inorganic source might be due to loss of N by volatilization.

Thus sorghum + cowpea intercropping with *E.officinalis* under tied ridges recorded higher nutrient uptake by the crops and ultimately increased the grain yield of crops as compared to other tree species, under both normal and low rainfall years. Combined application of N through fertilizer and goat manure increased the nutrient uptake of crops and grain yield. Application of goat manure recorded higher soil fertility status as compared to inorganic N alone.

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Table 4. Effect of treatments on post harvest soil available nutrients (kg ha^{-1})

Treatment	Nitrogen		Phosphorus		Potassium	
	1999	2000	1999	2000	1999	2000
T_1	164.3	128.8	14.20	16.40	400.5	447.0
T_2	163.0	128.0	13.78	15.88	388.3	444.3
T_3	163.8	132.3	14.20	16.85	413.1	453.1
SEd	4.81	0.75	0.20	0.31	4.13	2.51
CD (P=0.05)	NS	1.67	NS	0.38	9.21	5.59
M_1	167.0	129.2	14.57	16.37	414.0	448.3
M_2	160.3	130.3	13.55	16.38	387.0	447.9
SEd	3.93	0.61	0.19	0.25	3.38	2.05
CD (P=0.05)	NS	NS	0.41	NS	7.52	NS
N_1	154.1	125.6	13.50	16.08	392.0	445.1
N_2	173.2	133.9	14.62	16.67	409.0	451.2
SEd	2.66	1.34	0.17	0.14	4.11	2.09
CD (P=0.05)	5.79	2.93	0.37	0.30	8.95	4.56

* Interaction non significant

T_1 - *Ailanthus excelsa*, T_2 - *Ceiba pentandra*, T_3 - *Emblica officinalis*

M_1 - Tied ridges, M_2 - Flat bed

N_1 - 100 per cent N through fertilizer, N_2 - 50 per cent N through fertilizer + 50 per cent N through goat manure

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