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Effect of tree species, moisture conservation and nitrogen management on yield and economics of sorghum (CO 26) + cowpea (CO 4) intercropping system under drylands

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Abstract: Field experiments were conducted at Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, to study the effect of trees, moisture conservation practices and nitrogen management on sorghum + cowpea intercropping system. The treatments included three tree species (*Ailanthus excelsa, Ceiba pentandra* and *Emblica officinalis*) and two moisture conservation practices (tied ridges and flat bed) in main plots and two nitrogen management practices (100 per cent N through fertilizer; 50 per cent N through fertilizer and 50 per cent N through goat manure) in sub plots. The results revealed that sorghum + cowpea intercropping with *E. officinalis* under tied ridges with combined application of 50 per cent N through fertilizer and 50 per cent N through goat manure recorded higher grain yield, net return and BC ratio in normal rainfall years.

Key words : Sorghum, Cowpea, Intercropping, Trees, Tied ridges and Goat manure.

Introduction

Dryland agriculture is practiced in most of the arid and semiarid areas. In drylands, the major resources are rainfall and soil. Due to vagaries of monsoon, the productivity levels of the dryland crops are very low and unstable. The rainfall is erratic and unpredictable. Apart from that the soils are often coarse textured and poor in fertility status. Present cropping in the drylands are characterized by low and unpredictable yield by an inefficient use of rain and the soil, rare use of fertilizers, high yielding varieties and improved soil conservation (Pathak and Laryea, 1995). Efficient resource management including improved water resource management, crop production technologies and alternate land use systems are the key to increase the productivity of the dryland areas (Singh, 1995).

Agroforestry is a part of alternate land use system. Due to low initial cost and ensured seasonal income through intercropping and supply of different kinds of raw materials to support cottage industries, tree keeping in dryland will certainly offset the risky farming under dryland condition (Sivakumar *et al.* 2000). Apart from that the offseason rainfall is utilized very effectively which otherwise goes waste as runoff. Keeping this in mind, a study was conducted to evaluate the effect of moisture conservation and nitrogen management on the growth and yield of sorghum and cowpea which are grown in between the tree species under dryland condition.

Materials and Methods

Field experiments were conducted at Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore during North East monsoon seasons of 1999 and 2000. Amount of rainfall received during the years 1999 and 2000 were 422.6 and 291.2 mm, respectively. The soil of the experimental site was vertisol having low available nitrogen (147 kg ha^{-1}), medium available phosphous (137 kg ha^{-1}) and high available potassium (432 kg ha^{-1}). The pH of the 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 practies 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

Table 1. Effect of treatments on growth and yield parameters and ...

Treatment	DMP of sorghum (kg ha^{-1}) at 60 DAS		No. of grains per earhead		1000 grain weight (g)		Grain yield (kg ha^{-1})		Stover yield (kg ha^{-1})	
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
T_1	2727	1314	321	73	22.0	20.8	740	144	42.11	2879
T_2	2604	1391	301	73	23.8	20.9	677	138	3767	2746
T_3	2790	1564	436	81	23.8	21.0	778	149	4629	3078
SEd	43.2	13.9	6.08	2.03	0.17	0.20	4.95	2.72	18.29	31.31
CD (P=0.05)	96.2	30.9	13.55	4.54	0.38	NS	11.03	6.05	40.75	69.78
M_1	2760	1421	382	76	24.2	20.9	783	142	4527	2905
M_2	2655	1425	323	75	22.1	20.9	680	145	3877	2897
SEd	35.2	11.3	4.97	1.06	0.14	0.16	4.04	2.21	14.93	25.57
CD (P=0.05)	78.5	NS	11.07	NS	0.31	NS	9.00	NS	33.27	NS
N_1	2583	1389	302	73	22.3	20.9	644	140	4094	2866
N_2	2832	1457	403	78	24.1	21.0	819	147	4310	2936
SEd	32.8	13.1	6.54	1.32	0.16	0.18	3.38	2.42	19.38	13.12
CD (P=0.05)	71.5	28.5	14.26	2.88	0.35	NS	7.36	5.28	42.23	28.59

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

were 100 per cent N through fertilizer (N_1) and 50 per cent N through fertilizer + 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 was applied basally and incorporated as per the treatments assigned. Nitrogen was applied in two splits *viz.* 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 such as Dry

Table 2. Interaction effect of treatments on DMP, grain and stover yield of sorghum and grain yield of cowpea (1999)

Treatment	Sorghum																			
	Dry matter production (kg ha^{-1})					Grain yield (kg ha^{-1})					Stover 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	M_1	M_2	N_1	N_2	Mean
T_1	2711	2743	2602	2853	2727	807	673	639	841	740	4674	3748	4101	4321	4211	350	343	330	363	347
T_2	2643	2565	2390	2818	2604	720	637	629	725	677	3928	3607	3706	3828	3767	340	278	288	330	309
T_3	2925	2656	2756	2825	2790	823	732	663	892	778	4980	4278	4476	4781	4629	356	343	331	368	349
M_1			2604	2916				667	900				4280	4775				325	372	
M_2			2562	2748				620	739				3909	3846				308	335	
Mean	2760	2655	2583	2832		783	680	644	819		4527	4877	4094	4310		349	321	316	354	

	SEd	CD	SEd	CD	SEd	CD	SEd	CD
T x M	8.60	NS	7.00	15.59	25.9	57.6	2.05	4.58
M x N	8.22	19.17	5.27	11.63	24.5	53.8	2.09	4.58
N x M	9.25	20.16	4.78	10.41	27.4	59.7	2.98	6.48
N x T	11.33	24.70	5.85	12.75	33.6	73.1	2.43	5.29
T x N	10.06	22.11	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 goat manure

Matter Production (DM of sorghum and cowpe number of grains per e head, test weight, grai and stover yield of sorghu and grain yield of cowpe were recorded.

Results and Discussio

Effect of trees

The results reveale that the tree specie significantly influenced th growth and yield o sorghum both in 1999 an 2000. Sorghum grown wit *E.officinalis* recorde higher DMP, no.of grain per ear head, 1000 grai weight, grain and stov yield as compared to i association with other tree Distribution of rainfall an adequate soil moistur availability during the crop growth period might have caused little competition between the trees and crops for moisture and nutrients which in turn might have increased the growth and yield of sorghum during the first year. Non receipt of rainfall after the vegetative phase in the second year, might have created competition between the trees and crops which resulted in decreased crop growth and yield. Roy and Gill (1991) reported that the best grain production of sorghum was in association with *E.officinalis* as compared to *Leucaena* and *Acacia*. Growth and yield of intercropped cowpea was better in association with *E.officinalis* in both the years. The dry matter production of

ible 3. Effect of treatments on growth and yield of intercrop cowpea

eatment	DMP (kg ha^{-1}) at 60 DAS		Seed yield (kg ha^{-1})		Haulm yield (kg ha^{-1})	
	1999	2000	1999	2000	1999	2000
	747	505	347	140	529	211
	675	475	309	131	455	205
	728	546	349	166	573	236
d	9.67	6.05	1.45	1.70	2.01	2.02
) (P=0.05)	21.60	13.4	3.24	3.79	4.49	4.51
	738	508	349	145	566	218
	696	509	321	147	472	217
d	7.90	4.94	1.19	1.38	1.64	1.65
) (P=0.05)	17.59	NS	2.65	NS	3.66	NS
	650	486	316	142	490	207
	784	532	354	150	548	228
d	14.55	4.50	1.72	2.22	1.81	2.49
) (P=0.05)	31.69	9.81	3.74	4.85	3.94	5.42

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

Table 4. Econmic analysis (Rs. ha^{-1}) of the sorghum + cowpea intercropping system

Treatments	Net return (Rs ha^{-1})		BC ratio	
	1999	2000	1999	2000
$T_1 M_1 N_1$	4442	-2539	1.69	0.61
$T_1 M_1 N_2$	6900	-2037	2.10	0.67
$T_1 M_2 N_1$	3891	-2296	1.62	0.63
$T_1 M_2 N_2$	5778	-1775	1.94	0.70
$T_2 M_1 N_1$	3495	-2307	1.54	0.64
$T_2 M_1 N_2$	5593	-1933	1.89	0.69
$T_2 M_2 N_1$	2712	-2070	1.44	0.67
$T_2 M_2 N_2$	4110	-1634	1.68	0.73
$T_3 M_1 N_1$	4276	-1804	1.66	0.72
$T_3 M_1 N_2$	7385	-1485	2.18	0.76
$T_3 M_2 N_1$	4125	-1531	1.66	0.75
$T_3 M_2 N_2$	5253	-1651	1.87	0.73

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

intercropped cowpea in both grain and fodder sorghum was higher in *A.excelsa* but was comparable with *E.officinalis* during the first year (Table 1, 2 and 3). The possible reason might be due to better growth of sorghum which might have utilized more moisture and nutrients than cowpea. Similar results were also reported by Chittapur *et al.* (1994), who reported lesser cowpea forage yield in maize + cowpea intercropping due to vigorous growth of maize and consequent shadowing due to availability of more moisture.

Effect of moisture conservation practices

Higher growth and yield attributes of sorghum and grain yield of cowpea were recorded under tied ridging only during first year. The possible reason might be higher availability of soil moisture which in turn increased the uptake of moisture and nutrients by the crops. Higher and uniform availability of soil moisture throughout the crop growth period helped in better development of panicle without stress. The increased DMP have favoured the accumulation of more assimilates and increased the yield attributes and yield. The yield increase under tied ridges was 15.1 and 8.7 per cent for sorghum and cowpea, respectively compared to flatbed method of sowing. Similar results were reported by Kolekar *et al.* (1998), who reported better growth and yield of rainfed sorghum under tied ridges due to optimum soil moisture availability during critical growth stages. Growth and yield parameters of the crops were not influenced by the different moisture conservation practices during the second year. Low available soil moisture caused moisture stress during flowering and grain filling which inturn affected the grain setting and development.

Effect of nitrogen management practices

Application of 50 per cent N through fertilizer and 50 per cent N through goat manure recorded better growth attributes and was superior to application of 100 per cent N through fertilizer alone. Combined application of inorganic fertilizer and organic manure resulted in 27.2 per cent increase in yield of sorghum. This might be due to matching of nutrient supply according to the nutrient requirement of the crop at the peak demand stage of the crop. In addition, the soil moisture was also higher at all the growth stages which consequently increased the DMP, grain and stover yield of the crops during the first year. Inadequate moisture supply limited the nutrient uptake and plant growth and ultimately reduced the yield of crops during the second year (Table 1 and 2). Madhavi *et al.* (1995) reported an increased plant height and DMP with 50 per cent recommended rate of NPK with 4.5 t ha^{-1} of poultry manure in maize. Interaction effect on drymatter production, grain and stover yield was found to be significant during 1999. The treatment combination sorghum + cowpea intercropping with *E.officinalis* under tied ridges with 50 per cent N through fertilizer and 50 per cent N through goat manure recorded higher dry matter production, grain and stover yield than other treatment combinations.

Economics of intercropping

Among the treatment combinations, sorghum + cowpea with *E.officinalis* under tied ridges and application of 50 per cent N through fertilizer and 50 per cent N through goat manure recorded the highest net return and BC ratio followed by *Ailanthus excelsa* under the same treatment combination during the first year. During the second year, due to poor rainfall the yield was reduced which inturn affected the net return and BC ratio (Table 4).

Sorghum (CO 26) + Cowpea (CO 4) intercropping with *E.officinalis*, under tied ridges and applicaton of 50 per cent N through fertilizer and 50 per cent N through goat manure recorded higher growth and yield of sorghum and cowpea, net return and BC ratio during normal rainfall years.

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