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Influence of Trees, Moisture conservation and Nitrogen management practices on yield, nutrient uptake and economics of fodder sorghum (CO 27) + Cowpea (CO 4) intercropping system

S. RADHAMANI AND A. BALASUBRAMANIAN

Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore - 3

Abstract : Field experiments were conducted at the Department of Agronomy, Tamil Nadu Agricultural University Coimbatore, to study the effect of moisture conservation and nitrogen management practices in fodder sorghum + cowpea intercropping system with different tree species. 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 and 50 percent 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 percent N through goat manure recorded higher DMP, nutrient uptake and straw yield. The gross return, net return and BC ratio were also high under this treatment combination in normal rainfall year.

Key words : Fodder sorghum, intercropping, nutrient uptake, economics.

Introduction

The low productivity of fodder crops in the dryland agriculture can be attributed to lack of moisture and fertilizer application. In drylands it is very much essential to include moisture conservation practices to improve the soil moisture status, which in turn increases the fodder yield. Maintenance of soil fertility is also equally important. Dryland soils are deficient in nitrogen and heavy losses occur due to runoff and volatilization. Because of high fertilizer nitrogen cost and the risk involved in fertilizing crops during inadequate rainfall years, dryland farmers are often not interested to use the fertilizers. Addition of organic manures to dryland crops not only improves the nutrient availability but also the water holding capacity of the soil. Niranjan and Arya (1992) recorded an increaed drymatter production of fodder sorghum with the application of 6 t ha^{-1} of FYM compared to farm residues at the same rate of application. Similarly, Arya *et al* (2000) also reported that half inorganic fertilizer with half organic manure gave significantly higher grain and straw yield of sorghum under rainfed condition. Limited studies are available on the effect of goat manure on the fodder yield of sorghum under dryland situation. Keeping this in mind, an experiment was conducted to study the effect of *insitu* moisture conservation practices and nitrogen management on the yield of sorghum + cowpea intercropping.

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 (soils with mixed or inverted upper horizons formed in alternating wet and dry climates and composed of swelling clays) having low available nitrogen (147 kg ha^{-1}), medium

available phosphorus (13.7 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 d Sm^{-1}.

The experiment was conducted in split plot design with three replications. The main plot treatments included combinations of 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 were 100 percent N through fertilizer (N_1) and 50 percent N through fertilizer + 50 percent N through goat manure (N_2). The tree seedlings were planted during the North East Monsoon of 1998 and established. The tree species were selected based on the suitability to grow under drylands and their economical value.

The crops were sown on 16.9.1999 during the first year and 12.09.2000 during the second year. The seeds were soaked in 2 percent 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 27) + Cowpea (CO 4) inter cropping. 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. The nutrient content of the goat manure from the deep litter system was 1.72 percent N, 0.97 percent P_2O_5 and 0.86 percent K_2O. Nitrogen was applied in two splits *viz.*, 50 percent as basal and the remaining 50 percent at 30 DAS. Entire P was applied basally by making small furrows before sowing. Sorghum was harvested at 50 per cent flowering and cowpea was cut at 55 DAS, field dried and the dry fodder yield was recorded. Observations such as plant height, Dry Matter Production (DMP) of sorghum and cowpea were recorded. Nutrient uptake of sorghum and cowpea were estimated and the total nutrient uptake was worked out. Parameters such as cost of cultivation, gross return, net return and BC ratio were worked out and expressed in Rs ha^{-1}.

Results and Discussion

Growth attributes

The results revealed that, among the tree species, the plant height and drymatter production (DMP) of sorghum were higher in *E. officinalis* as compared to other trees (Table 1). This might be due to decreased competition posed by the *E. officinalis* for moisture and nutrients. During the first year, the DMP of sorghum in *E. officinalis* and *A.excelsa* were comparable whereas the total DMP of the system was higher in *A. excelsa* (Table 1). The possible reason might be the contribution of higher DMP of cowpea under *A. excelsa* during the first year. Distribution of rainfall (422.6 mm) and adequate soil moisture availability during the crop growth period might have caused little competition between the tree species and crops for moisture and nutrients during the first year. Non receipt of rainfall (only 291.2 mm during North - East Monsoon period) after the vegetative phase in the second year might have created competition between trees and crops, resulting in decreased plant height and DMP of sorghum and cowpea which in turn reduced the total DMP of the system. Higher growth attributes were recorded under tied ridging as compared to flat bed only during first year. The possible reason might be higher availability of soil moisture which in turn might have increased the uptake of moisture and nutrients by the crops. Similar results were earlier reported by Kolekar *et al.* (1998) and Selvaraju *et al.* (1999). Decreased plant height and DMP of sorghum and total DMP of the system during the second year might be due to poor rainfall after the formation of tied ridges

Table 1. Effect of treatments on growth parameters and yield of fodder sorghum(CO 27) and total drymatter production (kg ha^{-1}) and total nutrient uptake (kg ha^{-1}) of the fodder sorghum+ cowpea intercropping system

Treatments	Plant height (cm) of sorghum at 60 DAS		DMP (kg ha^{-1}) of sorghum at 60 DAS		Fodder yield of sorghum (kg ha^{-1})		Total drymatter production of the system (kg ha^{-1})		Total nutrient uptake (kg ha^{-1}) of the system: N		P		K	
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
A. excelsa	193.5	142.5	5803	2862	8251	5755	8649	5725	77.4	47.4	12.12	7.54	70.3	52.4
C. pentandra	180.8	152.0	4943	2948	7687	5671	7778	5561	68.0	45.4	10.32	7.83	61.9	51.2
E. officinalis	195.4	163.0	5803	3825	8202	6688	8316	6586	76.6	55.8	12.92	9.43	75.6	62.6
CD (P=0.05)	4.14	4.89	35.9	102.5	238	125	176	169	6.70	4.27	1.56	0.90	4.04	2.76
Tied ridges	194.7	153.8	5846	3196	8392	6000	8697	5941	80.5	50.2	12.94	8.02	77.1	55.4
Flat bed	185.1	151.2	5186	3227	7701	6076	7999	5973	67.6	48.9	10.64	8.51	61.4	55.4
CD (P=0.05)	3.38	NS	23.3	NS	194	NS	144	NS	5.47	NS	1.27	NS	3.30	NS
100% fertilizer N	183.7	149.0	5166	3079	7832	5926	7916	5814	69.7	47.6	10.80	7.81	63.2	52.5
50% N through fertilizer + 50% N through goat manure	196.1	156.0	5866	3344	8262	6150	8580	6101	78.3	51.5	12.77	8.71	75.3	58.3
CD (P=0.05)	4.06	2.98	75.6	52.9	191	176	97	188	3.76	2.19	1.21	0:79	2.72	2.17

which did not increase the growth of crops to a significant level.

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. Arya *et al* (2000) also reported increased dry matter yield of fodder sorghum with combined application of organic and inorganic source of nutrients.

Nutrient uptake and yield

The dry fodder yield of sorghum was higher under *A. excelsa*, but it was comparable with *E. officinalis* during 1999, whereas during the second year *E. officinalis* recorded higher dry fodder yield (Table 1). The decreased growth and yield attributes and yield of sorghum with *A. excelsa* during the second year might be due to competition between trees and crops for moisture and nutrients. The total nutrient uptake was higher with *E. officinalis*, which showed the feasibility of growing *E. officinalis* under rainfed situation with agricultural crops. Significantly higher nutrient uptake was recorded with tied ridges than flat sowing during the first year, owing to greater availability of moisture during all the growth stages. Similar results were also reported by Shaikh *et al*. (1995) and Bhan *et al*. (1998).

The nutrient uptake increased with application of 50 per cent N through fertilizer and 50 per cent N through goat manure due to continuous

Table 2. Effect of treatments on economics of the sorghum + cowpea intercropping system

Treatments	Gross return (Rs ha^{-1})		Net return (Rs ha^{-1})		BC Ratio	
	1999	2000	1999	2000	1999	2000
$T_1M_1N_1$	5034	3104	904	-1026	1.22	0.75
$T_1M_1N_2$	5146	3236	1216	-694	1.31	0.82
$T_1M_2N_1$	4763	3056	858	-849	1.22	0.78
$T_1M_2N_2$	4857	3232	1152	-473	1.31	0.87
$T_2M_1N_1$	4659	3093	529	-1037	1.13	0.75
$T_2M_1N_2$	5224	3163	1294	-767	1.33	0.80
$T_2M_2N_1$	4454	3076	549	-829	1.14	0.79
$T_2M_2N_2$	4440	3191	735	-514	1.20	0.86
$T_3M_1N_1$	4887	3590	757	-540	1.18	0.87
$T_3M_1N_2$	5484	3763	1554	-167	1.40	0.96
$T_3M_2N_1$	4361	3576	456	-329	1.12	0.92
$T_3M_2N_2$	4710	3408	1005	-297	1.27	0.92

T_1 - A. excelsa, M_1 - Tied ridges N_1 - 100% N through fertilizer
T_2 - C. pentandra, M_2 - Flat bed N_2 - 50% N through fertilizer + 50% N through goat manure
T_3 - E. officinalis

and steady availability of nutrient which in turn might be due to chelation effect of organic matter. Increased P uptake may be attributed to the increased solubilization of insoluble P fraction during humification and reduced P fixation in the soil particle due to the protective action of manures by releasing organic acids during decomposition. Increased P uptake coupled with N uptake in sorghum plant was also reported by Roy and Wright (1974). Increased N and P uptake might have helped to extend more K from the soil resulting in higher K uptake under the application of goat manure.

Economics

The gross return (Rs.5484), net return (Rs.1554), and return per rupee invested (1.40) was higher with the treatment combination of sorghum + cowpea intercropping with *E. officinalis* with tied ridges and application of 50 per cent N through fertilizer and 50 per cent N through goat manure during the first year. This was followed by the same treatment combination under *C. pentandra* (Table 2). During the second year, due to poor and improper distribution of rainfall the fodder yield was very much affected which in turn reduced the net return and BC ratio. Even with less rainfall the yield reduction was low under the above treatment combination with *E. officinalis*.

From the above results it could be inferred that intercropping of 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 would be the ideal management practice for getting higher fodder yield and profit during normal rainfall years.

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