

Effect of manurial schedules on growth and yield of different cropping systems under rainfed alley system

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ABSTRACT

A field experiment was conducted during the rainy season of 1993–94 to 1995–96 at Jhansi, to study the different food–fodder cropping systems and manurial schedules under rainfed conditions. Significantly higher grain and stover yields of sorghum [*Sorghum bicolor* (L.) Moench] were obtained in sorghum + pigeonpea [*Cajanus cajan* (L.) Millsp.] intercropping system as compared with other intercropping systems. Sorghum + cowpea [*Vigna unguiculata* (L.) Walp.] intercropping gave significantly more green fodder and dry-matter yields and sorghum grain-equivalent yield than the other intercropping systems. Among the different manurial schedules, combined application of organic and inorganic sources of plant nutrients resulted in significantly higher grain and stover yields of sorghum, green fodder and dry-matter yields of fodder crops and sorghum grain-equivalent yield as compared to 100% through inorganic fertilizers application.

Key words : Manurial schedules, cropping systems, *leucaena leucocephala*, Alleys, Rainfed

In the semi-arid area under rainfed conditions, soil moisture and fertility are the major limiting factors. Due to erratic and uneven distribution of rainfall, monocropping is commonly practised. Inclusion of short-duration fodder crops in the existing systems, increases the possibilities of double cropping under rainfed conditions. This system is aimed at increasing productivity per unit area and assuring against total crop failure,

particularly under aberrant weather conditions. Further the productivity of crops/cropping systems in alley cropping where arable crops are grown between hedge rows of shrubs and trees which are lopped at convenient intervals to reduce the competition for light between tree and crop components (Kang and Wilson, 1987).

The productivity and sustainability of food–fodder systems could be stabilized by the judicious use of organic sources of plant

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nutrients through FYM and leaf green manuring. In order to impart stability and provide sustainability, an attempt was made to study the productivity of different manurial schedules in different cropping systems under rainfed conditions.

MATERIALS AND METHODS

A field experiment was carried out during 1993–94 to 1995–96 at the Indian Grassland and Fodder Research Institute, Jhansi. The treatment combinations comprising 3 cropping systems, viz. sorghum ('CSH 5') + cowpea ('EC 4216') in additive series of 1:1, sorghum + pigeonpea ('Bahar') in replacement series of 2:1 and sorghum + grass strips of *Cenchrus setigerus* at 4 m apart, and 3 manurial schedules, viz. 100% recommended dose through inorganic fertilizers (60 kg N + 40 kg P₂O₅/ha), 50% through inorganic fertilizers + 50% through organic manure (5 tonnes FYM/ha) and 50% inorganic fertilizers + 50% through leaf manuring (3 tonnes *Leucaena* leaves/ha). The design of experimental field was randomized block design with 3 replications. The texture of soil was gravelly coarse with pH 7.25. The soil was low in organic matter (0.38%), available N (166.0 kg/ha) and available P (6.7 kg/ha) and medium in available K (158.0 kg/ha). The crops were sown in second week of July. The *Leucaena* seedlings were transplanted in August 1993 and gap-filling was done on August 1994 to maintain optimum plant population of hedge. The harvesting of fodder crops, viz. cowpea in first week of September and grass in last week of September was done in all the years. Pigeonpea was harvested in

the first week of April in the respective year. Pruning of *Leucaena* was done at 1 m height. The experimental plot was kept 18 m × 16 m (gross) and 16 m × 14 m (net). Recommended seed rate of all the crops was used and fertilizers were applied as per treatments. The spacing of sorghum, cowpea, pigeonpea and grass were kept 50 cm apart. However, alley width was maintained 8 m line-to-line and 0.5 m plant-to-plant distance. One cutting of grass was taken during first and second year, while 2 cuttings in third year. During 1994–95 there was no grain formation in sorghum and pigeonpea because of low amount of rainfall received during the entire crop-growth period. It was observed that from 33rd standard meteorological week (13–19 August) onwards there was very little (< 20 mm/week) or no amount of rainfall received due to 'break' in south-west monsoon. This critical dry period coincides with the vegetative growth period of all crops under experimentation. Therefore flowering and grain formation could not take place. Rainfall received during the crop-growth season were 668, 456 and 787 mm during 1993–94, 1994–95 and 1995–96 respectively.

RESULTS AND DISCUSSION

Growth attributes

Sorghum + grass strips of *Cenchrus setigerus* produced significantly higher plant height, leaves/plant, dry-matter accumulation/plant and root weight/plant than sorghum + cowpea intercropping system (Table 1). Sorghum + pigeonpea intercropping also increased significantly growth attributes and nodulation/plant than the sor-

Table 1. Growth attributes as affected by different cropping systems and manurial schedules under alley system (average data of 3 years)

Treatment	Plant population/m		Plant height (cm)		Leaves/plant		Dry matter/plant (g)		Root weight/plant (g)		Nodulation/plant
	Main	Inter	Main	Inter	Main	Inter	Main	Inter	Main	Inter	
<i>Cropping system</i>											
Sorghum + cowpea	9.1	9.7	142.6	87.1	9.7	4.9	18.8	68.5	6.1	0.6	35.1
Sorghum + pigeonpea	9.2	9.6	150.5	139.0	9.9	31.6	21.6	103.1	7.5	14.4	95.6
Sorghum + <i>Cenchrus setigerus</i>	10.4	7.3	154.5	87.3	11.4	3.7	23.0	89.5	8.3	0.7	-
CD (P = 0.05)	NS	1.26	3.91	8.19	0.75	3.69	2.67	3.54	0.81	1.50	4.74
<i>Manurial schedules</i>											
100% inorganic fertilizers	8.2	7.16	138.7	93.17	9.6	10.0	18.1	72.5	6.4	3.7	38.8
50% inorganic fertilizers + 50% organic manure (6 tonnes FYM/ha)	9.6	9.1	150.9	106.18	10.4	13.9	21.4	89.0	7.5	5.6	43.0
50% inorganic fertilizers + 50% leaf manuring (3 tonnes <i>Leucaena</i> leaves/ha)	11.0	9.9	155.0	113.0	11.1	16.1	23.8	99.7	8.0	6.4	49.5
CD (P = 0.05)	1.44	1.26	3.91	8.19	0.75	3.69	2.67	3.54	0.81	1.50	4.74

ghum + cowpea intercropping. Application of 50% recommended dose of inorganic fertilizers + 50% through organic manure (6 tonnes FYM/ha) produced significantly more plant population/m, plant height, leaves/plant, dry-matter accumulation/plant, root weight/plant and nodules/plant than 100% recommended dose of inorganic fertilizers. Increase in growth attributes with the combined use of organic and inorganic sources of fertilizers might be owing to availability of plant nutrients throughout the maturity period.

Grain and stover yields of sorghum

Significantly higher pooled grain and stover yields of sorghum were obtained under sorghum + pigeonpea intercropping than sorghum + cowpea intercropping system (Table 2). Sorghum + grass strips of *Cenchrus setigerus* also registered significantly more grain and stover yields of sorghum than sorghum + cowpea intercropping. Intercropping systems increases the total productivity in addition to stability in production under rainfed conditions (Reddy and Willey, 1980). Umrani (1981) and Jadhav *et al.* (1991) reported that intercropping is more stable and remunerative than sole cropping during rainy (*kharif*) season. Significantly more pooled grain (4.91 q/ha) and stover yields were obtained in the combined application of recommended dose of plant nutrients, viz. 50% through inorganic fertilizers + 50% through leaf green manuring (*Leucaena* leaves @ 3 tonnes/ha) than 100% inorganic fertilizers. The 50% recommended dose through inorganic fertilizers + 50% through organic manure

(6 tonnes FYM/ha) also resulted in significantly more grain and stover yields than 100% inorganic fertilizers. Prakash and Bhusan (1987) reported that in alley cropping, 14–23% increase of yield by incorporation of *Leucaena* leaves before sowing of crop.

Green and dry fodder yields

Sorghum + cowpea intercropping gave significantly more green fodder and dry-matter yields than sorghum + grass strips of *Cenchrus setigerus*. Poor fodder yield of grass during the first and second years was obtained due to its establishment and poor plant stand.

Application of recommended dose of plant nutrients, 50% through inorganic fertilizers + 50% through 3 tonnes *Leucaena* leaves/ha resulted in significantly higher green fodder and dry-matter yields than 100% through inorganic fertilizers. Combined application of 50% through inorganic fertilizers + 50% through organic manure (6 tonnes FYM/ha) ranked second best treatment for providing higher green fodder and dry-matter yields than 100% inorganic fertilizers.

Sorghum grain-equivalent yield

Significantly highest pooled sorghum grain-equivalent yield was obtained in sorghum + cowpea and sorghum + pigeonpea intercropping systems compared with sorghum + grass strips of *Cenchrus setigerus*. Among the different manurial schedules, combined application of inorganic and organic sources of plant nutrients resulted in significantly more sorghum grain-equivalent yield than 100%

Table 2. Productivity of different cropping systems with manurial schedules under alley system

Treatment	Yield (q/ha)																		
	Grain			Stover				Green fodder				Dry-matter				Sorghum equivalent			
	1993-94	1995-96	Poo-led	1993-94	1994-95	1995-96	Poo-led	1993-94	1994-95	1995-96	Poo-led	1993-94	1994-95	1995-96	Poo-led	1993-94	1994-95	1995-96	Poo-led
<i>Cropping system</i>																			
Sorghum + cowpea	8.0	4.1	6.0	48.3	58.3	51.1	52.5	132.2	100.0	109.0	113.7	39.7	20.0	21.8	27.2	30.9	22.9	26.5	26.8
Sorghum + pigeonpea	10.1	4.2	7.2	41.4	76.5	54.3	57.4	(2.5)	(0.5)	(2.3)					43.9	11.6	23.8	26.4	
Sorghum + <i>Cenchrus setigerus</i>	9.1	4.3	6.7	38.8	71.9	52.9	54.5	2.0	24.1	129.8	52.0	1.0	7.3	32.5	13.6	13.5	7.9	29.5	23.0
CD (P = 0.05)	0.18	0.09	0.30	3.15	6.93	2.46	3.27	2.91	4.65	6.27	3.51	0.51	0.75	0.80	1.06	2.37	1.44	1.50	1.99
<i>Manurial schedules</i>																			
100% inorganic fertilizers	7.7	3.6	3.8	37.8	55.8	47.4	47.0	43.9	38.8	75.7	52.8	13.3	8.5	17.2	30.0	30.2	12.9	24.5	22.5
50% inorganic fertilizers + 50% organic manure (6 tonnes FYM/ha)	9.4	4.6	4.6	42.1	70.4	52.8	55.1	44.8	40.5	79.7	55.0	13.6	8.9	18.1	13.5	36.3	14.0	26.6	25.6
50% inorganic fertilizers + 50% leaf manure (3 tonnes/ <i>Leucaena</i> leaves/ha)	10.0	4.6	4.9	48.5	80.5	58.1	62.3	45.7	44.9	83.7	58.1	13.8	9.9	19.0	14.2	39.7	15.5	28.8	28.1
CD (P = 0.05)	0.18	0.09	0.30	3.15	6.93	2.46	3.27	2.91	4.65	6.27	3.51	0.51	0.75	0.80	1.06	2.37	1.44	1.50	1.99

Figures in parentheses are the grain yield of pigeonpea

through inorganic fertilizers application. Goyal *et al.* (1991) reported that higher equivalent yield was obtained under pigeonpea + sesame intercropping system compared with sole pigeonpea under rainfed conditions. Incorporation of *Leucaena* leaves available from hedge rows can be substitution for fertilizer N to the extent of 10–30 kg/ha, thereby cost of cultivation of sorghum can be reduced (Subba Reddy *et al.*, 1990).

Fodder yield from alleys

Tree survival was not affected due to crop mixture. Among fertilizer doses, plot receiving 100% inorganic fertilizers was found better for seeding survival. The overall survival of *Leucaena* seedlings was poor. Thus, the production of forage from the hedge was 0.08 tonne dry/row after 8 months of its growth. Ong and Daniel (1990) reported that perennial pigeonpea/*Leucaena leucocephala* as alley is truly multipurpose species. It provides food, fuel, fodder and shelter material to farmers.

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