Indian J. Agron. **38** (4) : 536–540 (December 1993)

Effect of fertility levels on yield, protein content and economics of pearl millet (*Pennisetum glaucum*) + castor (*Ricinus communis*) or cowpea (*Vigna unguiculata*) intercropping under rainfed condition

RAJENDER KUMAR, R. C. GAUTAM AND S.K. KAUSHIK

Division of Agronomy, Indian Agricultural Research Institute, New Delhi 110 012

Received: March 1992

ABSTRACT

A field experiment was carried out during the rainy (*kharif*) seasons of 1989 and 1990 to study the effects of 2 cultivars of pearl millet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz] and 2 intercrops, viz. castor (*Ricinus communis* L.) and cowpea [*Vigna unguiculata* (L.) Walp.], at various fertility levels under 2 planting systems in terms of yield, protein content and economics. Among the main effects, hybrid 'MBH 151' of pearl millet, castor as intercrop, paired-row planting system and fertility levels of 25 kg N + 12.5 kg P_2O_5/ha + *Azospirillum* were found superior in term of grain yield of pearl millet to other main effects. Increasing fertility levels significantly improved the protein content and protein yield over the control. Data on economics of various fertility levels revealed that maximum net returns could be achieved by inoculating *Azospirillum* in addition to fertilizers at 25 kg N + 12.5 kg P_2O_5/ha in pearl millet + castor intercropping under rainfed condition.

Adoption of intercropping is one of the ways to produce more per unit area per unit time. The concept of use of biofertilizer and organic manure is also gaining importance due to acute energy crisis, prohibitive cost of chemical fertilizers and probable substitution of chemical fertilizers. Use of organic manures in one of the forms as farmyard manure not only enriches the soil but also improves its structure and water-holding capacity. Products of biological origin can advantageously be blended to replace a part of the energy-intensive market-purchased inputs. It is in this context, biofertilizers like *Azospirillum* can provide (to the small and marginal farmers) an economically viable lever for realizing the ultimate goal of increasing productivity (Tilak, 1991). The problem of malnutrition has attracted world-wide attention and has made all the nations quality conscious. In the recent past, the necessity of quantitative and qualitative studies in pearl millet were emphasized in dryland research.

Therefore the present investigation was carried out to have a comparative study in terms of yield, protein content and economics of organic, inorganic and bio-fertilizers in the intercropping systems of pearl millet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz] + cowpea [*Vigna unguiculata* (L.) Walp.] or castor (*Ricinus communis* L.) under rainfed condition.

MATERIALS AND METHODS

The investigation was carried out during

the rainy *(kharif)* seasons of 1989 and 1990 at New Delhi. The soil was sandy loam, neutral in reaction (pH 7.1), medium in nitrogen (organic carbon 0.63%), high in available phosphorus (36 kg P_2O_5/ha) and fairly rich in available potassium (286 kg K_2O/ha). The treatments comprised intercropping systems (involving 2 entries, 2 planting systems and 2 intercrops) in the main plots and 4 levels of fertility in subplots (Table 1). Treatment combinations were tested in split-plot design with 3 replications. Nitrogen doses were applied in 2 splits, half as basal and the remaining half side-dressed and incorporated into the soil 3 weeks after sowing. Treatment-wise farmyard and P levels were applied well in advance of sowing.

The crop was sown on 9 August in 1989 and 6 July in 1990. Pearl millet plant population of 200,000 plants/ha was maintained at each planting system. Seeds of cowpea or castor were interplanted simultaneously in between the uniform rows in uniform row system and in between the paired rows in paired-row planting systems. Biofertilizer *Azospirillum brasilense* specific to pearl millet was sprinkled over seed coated with sticker carboxy methyl cellulose @ 6 g/500 ml water and simultaneously mixed well. The seeds of cowpea were also treated with *Rhizobium* culture specific to cowpea. Total ranifall received during the crop season was 192.8 and 690.4 mm during 1989 and 1990 respectively.

The total cost of cultivation was Rs 3,458/ha.

RESULTS AND DISCUSSION

Yield

The main effects (Table 1), viz. entries, planting systems and fertility levels, significantly influenced the grain yield of pearl millet. Hybrid 'MBH 151' proved significantly superior to composite 'ICMS 7703', as it gave 6.69 and 12.24 q higher grain yield in 1989 and 1990 respectively. For stover production the trend was identical. In 1989 season, hybrid produced significantly more stover, whereas composite produced more stover in 1990. Pooled analysis showed superiority of composite to hybrid in this regard. Gautam (1989) also reported similar results. But in case of stover production, it might not be true as it is attributed by other factors.

Paired-row planting system of 30/70 cm was superior, as the grain yield was significantly increased over uniform row spacing of 60 cm in both the years. Pooled data of stover yield on the other hand showed the superiority of uniform row planting to paired row planting.

Castor as an intercrop significantly influenced the grain yield of pearl millet in 1990 and in the pooled analysis. Cowpea favoured more pearl millet stover production in the same analysis. But neither cowpea nor castor affected the grain yield of pearl millet under the moisture stress in 1989. Grain-yield levels of castor as an intercrop were too low, whereas cowpea as an intercrop failed during growth period itself in both the years. Singh (1980) reported higher grain yield and net profits due to legumes or oilseed intercropping. Chetty (1986) reported that pearl millet could be intercropped profitably with castor in 4 : 1 ratio.

Fertility levels played a significant role, as there was linear response in both the seasons. Application of farmyard manure or fertilizer significantly increased the grain yield of pearl millet over the control. Biofertilizer *Azospirillum* also showed its superiority in both the years, as it gave 6 and

Table 1. Mean grain yield (q/ha), protein content (%) in grain and protein yield of pearl millet as influenced by intercropping system and fertility levels

Treatment	Grain yield (q/ha)			Protein content (%) in pearl millet grain		Pearl millet protein yield (kg/ha)		Stover yield (q/ha)		
	1989	1990	Pooled	1989	1990	1989	1990	1989	1990	Pooled
Entry										
'MBH 151'	25.83 (0.51)	30.73 (0.41)	28.25	8.43	7.89	217.75	242.46	71.30	73.68	72.40
'ICMS 7703'	19.14 (0.48)	18.49 (0.42)	18.79	7.95	7.26	152.16	134.24	61.73	92.88	77.21
CD (P = 0.05)	1.125	1.814	1.019	NS	NS			2.432	3.310	1.961
Planting system										
60 cm URS	20.09 (0.60)	23.13 (0.50)	21.59	8.29	7.75	166.55	179.26	71.01	84.42	77.63
30/70 cm PRS	24.88 (0.39)	26.09 (0.34)	25.46	8.08	7.40	201.03	193.07	62.02	82.13	71.99
CD (P = 0.05)	1.125	1.814	1.019	NS				2.432	NS	1.961
Intercrop										
Cowpea	22.71 (–)	23.25 (–)	22.95	8.13	7.64	184.63	177.63	66.93	87.22	76.98
Castor	22.27 (0.49)	25.97 (0.42)	24.09	8.24	7.51	183.50	195.03	66.10	79.34	72.63
CD (P = 0.05)	NS	1.814	1.019	NS	NS			NS	3.310	1.961
Fertility level										
Control	14.82 (0.37)	19.60 (0.31)	17.20	7.37	6.89	109.22	135.04	47.93	71.93	59.89
FYM @ 5 tonnes/ha	19.10 (0.44)	23.44 (0.37)	21.26	8.19	7.50	156.43	175.80	63.10	78.68	70.85
25 kg N/ha + 12.5 kg P_2O_5/ha	25.01 (0.54)	26.71 (0.45)	25.84	8.55	7.99	213.84	213.41	75.77	89.60	82.63
25 kg N/ha + 12.5 kg P_2O_5/ha + *Azospirillum*	31.07 (0.62)	28.76 (0.54)	29.90	8.65	7.92	268.76	227.78	79.43	93.10	86.22
CD (P = 0.05)	1.582	1.478	1.069	0.445	0.339			2.678	2.808	1.916

Figures in parentheses indicate seed yield of castor (q/ha)
FYM, Farmyard manure; URS, Uniform row system; PRS, paired row system

Table 2. Economics of various fertility levels under pearl millet + castor intercropping system

Treatment	Added cost due to treatment* (Rs/ha)	Interest on working capital (Rs/ha)	Total cost of cultivation (Rs/ha)	1989		1990	
				Gross returns (Rs/ha)	Net returns (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)
F_0 (control)	3,458.00	115.27	3,774.06	2,733.84	− 840.22	4,132	558.38
F_1 (FYM @ 5 tonnes/ha)	3,608.00	120.26	3,728.26	3,725.95	− 2.31	5,044	1,316.76
F_2 (25 kg N + 12.5 kg P_2O_5/ha)	3,660.00	122.00	3,782.00	4,885.39	1,103.39	5,399	1,617.76
F_3 (25 kg N + 12.5 kg P_2O_5/ha + *Azospirillum*)	3,672.50	122.42	3,794.92	6,206.75	2,411.83	5,785	1,990.03

FYM, Farmyard manure

2 additional increase in the grain yields of 1989 and 1990 seasons respectively. Superiority of application of organic manure, chemical fertilizer and biofertilizer to the control might be due to release of more amounts of essential nutrients. According to Singh *et al.* (1981) application of farmyard manure @ 12 tonnes/ha gave 4.5 q/ha additional grain yield of pearl millet which was almost equal to yield obtained at 30 kg N/ha. Brar *et al.* (1980) reported that pearl millet generally showed response to low rates of N and P when applied in combination. Emphasizing the importance of *Azospirillum* as biofertilizer, Subba Rao (1981) reported additional gain in grain yield of pearl millet, contributing equal to 10 kg N/ha.

Protein content of pearl millet grain did not vary statistically due to cultivars, planting systems and intercropping. Fertility levels, on the other hand, showed significant variation in protein content. Application of 25 kg N + 12.5 kg P_2O_5/ha brought maximum increase in protein content which was also significantly superior to the control treatment. *Azospirillum* as biofertilizer did not show its effect on protein content of pearl millet. Coaldrake *et al.* (1987) reported increase in protein content due to N and P fertilization. Protein yield in the present study was the maximum at the fertility level of 25 kg N + 12.5 kg P_2O_5/ha + *Azospirillum*.

Economics

During the favourable moisture season of 1990 more than double the net returns were obtained merely due to incorporation of farmyard manure @ 5 tonnes/ha over the control. Almost three-and-half times of net returns obtained at 25 kg N/ha + 12.5 kg P_2O_5/ha + *Azospirillum* over the control. Application of biofertilizer *Azospirillum* in addition to N and P fertilizers showed extra net returns in both the seasons.

REFERENCES

Brar, J. S., Rama, D. S., Sharma, K. N., Meelu, O. P. and Sodhi, J. S. 1980. Effect of N, P and K application on yield of *bajra* and gram under rainfed conditions. *Annals of Arid Zone* **19** : 19–28.

Coaldrake, P. D., Pearson, C. J. and Saffigna, P. G. 1987. Grain yield of *P. americanum* adjusts

to nitrogen supply by changing rate of nitrogen. *Journal of Experimental Botany* **38** : 558–566.

Chetty, C. K. R. 1986. Research on intercropping systems in drylands. *Project Bulletin No.* 7, All-India Co-ordinated Research Project on Dryland Agriculture, pp. 50–52.

Gautam, R. C. 1989. Suitability of pearlmillet cultivars to planting systems and fertility levels under rainfed conditions. *Annals of Agricultural Research* **10** (4) : 424–425.

Singh, R. P. 1980. Cropping systems for drylands of the Indian arid zone. *Annals of Arid Zone* **19** (4) : 437–443.

Singh, B. P., Chahal, R. S. and Singh, M. 1981. Fertilizer management through organic and inorganic fertilizers in bajra-wheat sequence. *Fertiliser News* **26** (8) : 16–19.

Subba Rao, N. S. 1981. Contribution of biofertilizer in supplementing N requirements. *Indian Farming* **31** (7) : 13–16.

Tilak, K. V. B. R. 1991. Azospirillum inoculant. (*In*) *Bacterial Fertilizers*, pp. 40–46. Indian Council of Agricultural Research, New Delhi.