Legume Research, 38 (4) 2015: 503-508
Print ISSN:0250-5371 / Online ISSN:0976-0571

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
www.arccjournals.com/www.legumeresearch.in

Intercropping of legumes and oil seed crop in summer pearlmillet [*Pennisetum glaucum* (L.) R. Br. Emend. Stuntz]

B.L. Yadav*, B.S. Patel, Shaukat Ali and S.K. Yadav

Department of Agronomy, C. P. College of Agriculture,
S. D. Agricultural University, Sardarkrushinagar - 385 506, India.
Received: 12-03-2014 Accepted: 18-08-2014 DOI:10.5958/0976-0571.2015.00068.5

ABSTRACT

Thirteen treatments of sole crops and intercropping systems *viz.*, T_1 - pearlmillet sole, T_2- cowpea sole, T_3 - greengram sole, T_4 - mothbean sole, T_5 - sesame sole, T_6 - pearlmillet + cowpea (1:1), T_7 -pearlmillet + cowpea (1:2), T_8 - pearlmillet + greengram (1:1), T_9 - pearlmillet + greengram (1:2), T_{10} - pearlmillet + mothbean (1:1), T_{11} - pearlmillet + mothbean (1:2), T_{12} - pearlmillet + sesame (1:1) and T_{13} - pearlmillet + sesame (1:2) were evaluated in a randomized block design with three replications. Pearlmillet intercropped with greengram at 1:2 and 1:1 row ratios were produced significantly higher pearlmillet equivalent yield than sole pearlmillet. The highest net return (₹ 53,122) was obtained when pearlmillet intercropped with greengram at 1:2. But in case of BCR, significantly higher BCR (1:2.48) was recorded in sole greengram followed by pearlmillet + greengram at 1:2 row ratio. Intercropping system of pearlmillet + greengram at 1:2 row ratio was distinctly superior over sole pearlmillet and found most profitable. Pearlmillet + greengram intercropping system at 1:2 row ratio gave significantly higher values of LER than 1:1 row ratio and sole crop.

Key words: Cropping system, Cowpea, Greengram, LER, Mothbean, Net returns, Pearlmillet, Pearlmillet equivalent yield, Sesame

INTRODUCTION

Pearlmillet is one of the most important food grain cereal crop of India and ranks fourth in area after rice, wheat and sorghum. It is one of the major cereal crop grown in the arid and semi-arid regions of the world. In India, particularly in Gujarat, Rajasthan, Maharashtra, Madhya Pradesh, Uttar Pradesh and Andhra Pradesh where it is grown comparatively on large scale. Intercropping means growing of subsidiary crops between two widely spaced of main crop. The main objective of intercropping is to utilize the space left between two rows of main crop and to produce more grain per unit area. The basic concept of intercropping system involves growing together two or more crops with the assumption that two crops can exploit the environment better than one and ultimately produce the higher yield (Reddy and Willy, 1981) because the component crops differ in resources use and when grown together they complement each other and make overall better use of resources. This practice leads to some benefit like yield advantage as compared to sole cropping and greater stability of yield over different seasons.

MATERIALS AND METHODS

A field experiment was conducted during the summer season 2010 at Agronomy Instructional Farm, Department of Agronomy, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushi Nagar (Gujarat) to study the intercropping in summer pearlmillet [*Pennisetum glaucum* (L.) R. Br. Emend. Stuntz] in randomized block design with Thirteen treatments of sole crops and intercropping systems *viz.*, T_1 - pearlmillet sole, T_2- cowpea sole, T_3 - greengram sole, T_4 - mothbean sole, T_5 - sesame sole, T_6 - pearlmillet + cowpea (1:1), T_7 -pearlmillet + cowpea (1:2), T_8 - pearlmillet + greengram (1:1), T_9 - pearlmillet + greengram (1:2), T_{10} - pearlmillet + mothbean (1:1), T_{11} - pearlmillet + mothbean (1:2), T_{12} - pearlmillet + sesame (1:1) and T_{13} - pearlmillet + sesame (1:2) were evaluated in a randomized block design with three replications in replacement series. The soil was loamy sand, neutral (pH 7.0) having low in organic carbon (0.17%), available nitrogen (149 kg/ha), medium in available phosphorus (46 kg/ha) and high in potassium (281 kg /ha). The recommended fertilizer schedule (120 kg N/ha and 60 kg P_2O_5/ha) for pearlmillet, (20 kg N/ha and 40 kg P_2O_5/ha) for cowpea, greengram and mothbean, but (50 kg N/ha and 25 kg P_2O_5/ha) for sesame. Recommended cultivars like 'GHB 558' of pearlmillet, 'GC 5' of cowpea, 'GM 4' of greengram, 'GM 2' of mothbean and 'GT 2' of sesame were used as test material in the experiment. The final plant-to-plant distance in pearlmillet was maintained at 15 cm.

*Corresponding author' e-mail: babuagri.2010@gmail.com.

intercrops planted in inter-rows of pearlmillet were also thinned to keep the plant-to-plant distance at 15 cm in cowpea, greengram, mothbean and sesame respectively. There was no rainfall during crop growth period as well as no severe attack of insect and pest on the base of visual observation. Eight irrigations were given to crop for satisfactory growth. Observations on growth and yield attributes of both main and intercrops were taken at appropriate time. Economics was calculated according to market price of each crop. The pearlmillet equivalent yield was calculated on the basis of formula given below.

$$\text{PMEY (kg/ha)} = \frac{\text{Yield of pearlmillet crop X Price of pearlmillet} + \text{Yield of inter crop X Price of inter crop}}{\text{Price of pearlmillet (₹/kg)}}$$

Yield of different crops grain and bi-products was summed up to the yield of pearlmillet crop grain and straw yield, respectively and pearlmillet equivalent was obtained (Anjeneyula *et al*., 1982).

LER is the relative size of land under a sole crop system which will be necessary for obtaining the same yield as in intercropping system. Land equivalent ratio (LER) was computed using the following formula described by (Willey, 1979).

$$\frac{Yab}{Yaa} \quad \frac{Yba}{Ybb}$$

Where,

Yab = Yield of 'a' grown in mixture (a and b)

Yba = Yield of 'b' grown in mixture (a and b)

Yaa = Yield of 'a' in pure stand

Ybb = Yield of 'b' in pure stand

RESULTS AND DISCUSSION

Effect of intercrops on pearlmillet: The results of the experiment indicated that maximum value of plant growth characters *viz.*, plant height recorded in sole pearlmillet and its intercropping with pulses and sesame did not show any marked influence.

Plant height of pearlmillet at maturity was statistically equal, but found higher in sole pearlmillet as compared to pearlmillet with intercrops (Table 1) which might be attributed to higher cell elongation due to auxin accumulation in plants (Malik and Srivastava, 1982) and (Choudhary, 2009) moreover, light availability was comparatively lesser due to higher plant densities under sole crop. In sole cropping of pearlmillet, plant height increased due to competition for sunlight among the plants. The shorter plants of pearlmillet were found when intercropped at 1:1 and 1:2 row ratios with pulses and sesame. This was due to interspecies and cooperative interaction of intercrops with pearlmillet for non-renewable resources like water, nutrients and light. These results corroborated with the finding of Baldevram *et al*. (2005).

The effect of different treatments on number of effective tillers per plant had significant and higher number was observed in intercropping with 1:2 row ratio followed by 1:1 row ratio and minimum in sole pearlmillet (Table 1). This was might be due to development of better complementary relationship and non-renewable resources like water, nutrients and incoming sunlight. These results are also conformity with those reported by Rathore and Gautam (2003) and Choudhary (2009) who observed that significantly higher number of effective tillers per plant was obtained under pearlmillet crop sown with greengram or cowpea.

Length and girth of pearlmillet ear head and 1000-grain weight showed lack of significant effect regarding the effects of different treatments. Higher values of length and girth of pearlmillet ear head as well as 1000-grain weight were registered when pearlmillet grown with cowpea, greengram, mothbean and sesame each at 1:2 row ratio (Table 1). This might be due to development of better complementary effect of pulses on pearlmillet and non-renewable resources like water, nutrients, space and incoming solar radiation. Rathore and Gautam (2003) and Choudhary (2009) who observed that intercropping of pearlmillet with cowpea and greengram gave higher 1000-grain weight.

Significantly higher grain yield per plant was recorded at 1:2 row ratio intercropping system as compared to sole pearlmillet which could be attributed to higher and optimum plant densities in sole cropping system.

Significantly the highest grain and straw yields were recorded by sole pearlmillet than rest of the intercropping treatments, which could be attributed to higher and optimum plant densities in sole cropping system. Lower significant grain and straw yields were noticed under pearlmillet with cowpea, greengram, mothbean and sesame at 1:2 row ratio intercropping system (Table 1).

This might be due to lower plant densities of pearlmillet and also higher competition offered by intercrops for natural resources like space, plant nutrient, moisture and incoming sun radiation. The results are corroborating with the finding of Yadav and Yadav (2001), Baldevram *et al*. (2005), Kumar *et al*. (2006) and Choudhary (2009). Harvest index of pearlmillet was lower, but found higher with intercrops as compared to in sole pearlmillet (Table 1).

Effect of pearlmillet on intercrops: All the intercrops noticed higher plant height as compared to their sole cropping

TABLE 1: Growth and yield attributes as influence by different intercropping treatments

Treatments	Plant height (cm) at maturity	No. of effective tillers/ branches per plant	Length of earhead /pod (cm)	1000-grain/seed weight (g)	Grain/seed yield per plant (g)	Grain/seed yields (kg/ha)	Straw/ haulm /stover yields (kg/ha)	Harvest index (%)
T_1 : Pearlmillet sole	170.3	2.31	21.5	7.08	23.27	3854	8748	30.6
T_2 : Cowpea sole	45.2	4.93	11.35	74.64	8.27	1181	1973	37.5
T_3 : Greengram sole	46.4	4.11	7.11	45.57	8.42	1250	2051	37.9
T_4 : Mothbean sole	39.5	6.33	5.15	31.46	7.26	885	1478	37.5
T_5 : Sesame sole	91.7	3.85	—	3.73	1.73	296	1258	19.0
T_6 : Pearlmillet + Cowpea (1:1)	155.5	2.75	22.2	7.13	27.68	2368	5045	31.9
	(46.7)	(4.27)	(10.08)	(69.43)	(7.39)	(467)	(878)	(34.7)
T_7 : Pearlmillet + Cowpea (1:2)	152.8	3.07	25.3	7.27	36.18	2079	3847	35.1
	(43.3)	(4.69)	(10.25)	(71.38)	(7.46)	(630)	(1122)	(36.0)
T_8 : Pearlmillet + Greengram (1:1)	162.3	2.86	22.5	7.19	28.45	2445	5355	31.3
	(52.8)	(3.35)	(6.32)	(40.68)	(7.50)	(485)	(926)	(34.4)
T_9 : Pearlmillet + Greengram (1:2)	156.5	3.35	25.6	7.29	38.95	2248	4428	33.7
	(48.1)	(3.95)	(6.82)	(42.95)	(7.77)	(695)	(1188)	(36.9)
T_{10} : Pearlmillet + Mothbean (1:1)	157.9	2.69	22.3	7.15	27.53	2353	4965	32.2
	(44.6)	(5.39)	(4.82)	(27.84)	(6.58)	(307)	(599)	(33.9)
T_{11} : Pearlmillet + Mothbean (1:2)	153.1	3.30	25.2	7.25	36.09	2073	3981	34.2
	(41.2)	(5.72)	(4.89)	(28.61)	(6.73)	(465)	(818)	(36.2)
T_{12} : Pearlmillet + Sesame (1:1)	154.7	2.65	21.9	7.17	26.98	2298	4710	32.8
	(96.3)	(3.41)	(—)	(2.98)	(0.41)	(69)	(336)	(17.0)
T_{13} : Pearlmillet + Sesame (1:2)	148.5	2.97	24.7	7.23	35.66	2044	3618	36.1
	(93.7)	(3.68)	(—)	(3.55)	(0.60)	(102)	(467)	(17.9)

*Data presented in parenthesis indicates intercrops values

which attributed to shedding effect of taller plants of pearlmillet on pulses and competition for sun light resulted into elongation of their main stem (Table 1). These results were in agreement with finding of Kulkarni and Sojitra (1986) and Choudhary (2009) who observed that tall growing cereals had a shedding effect on the greengram and groundnut crop canopy and increased height.

The differences in number of branches per plant were reduced in both the row ratios of intercropping systems as compared to their sole cropping which perhaps due to the fact that competition offered by pearlmillet for natural resources, resulted in poor development of intercrops and also due to less space available for horizontal spread of plants and intraspecific competition for incoming sun radiation (Table 1). These results are in conformity with findings of Parmar (1989) and Choudhary (2009) who observed that intercropping of pearlmillet reduce the number of branches per plant of greengram and pigeonpea.

Length of the pod and 1000-seed weight of all intercrops was reduced in both the row ratios of intercropping system than their sole cropping (Table 1). This might due to fact that intra-specific competition for space, soil moisture, plant nutrients and sunlight. These results are in agreement with finding of Gadhia (1991) and Choudhary (2009).

Number of pods per plant, seeds per pod and seed yield per plant of intercrops were reduced in intercropping systems as compared to their sole cropping (Table 1) which might be due to the fact that competition offered by pearlmillet for natural resources, resulted in poor development of intercrops and also due to less space available for horizontal spread of plants and intra-specific competition for solar radiation. The results are corroborate with the findings of Patel and Parmar (1988) and Choudhary (2009), who observed that intercropping of pearlmillet reduce the pods per plant of pigeonpea and greengram.

Seed and haulm yield per hectare of cowpea, greengram, mothbean and sesame were reduced in intercropping systems in comparison to their respective sole cropping systems. Such variation could be ascribed due to decrease in plant densities when grown as intercrops with pearlmillet and higher competition among pearlmillet and intercrops for natural resources like soil moisture, plant nutrient, space and sunlight responsible for higher photosynthesis rate resulting lower accumulation of dry matter per plant in comparison of sole crop. These results are supported by Yadav and Yadav (2001), Kumar *et al.* (2006) and Choudhary (2009).

Effect of different treatments on pearlmillet equivalent yield: Apart from the competitive effects, prevailing price become an additional important factor in choosing the components of intercropping system and so intercrop yields were converted into pearlmillet equivalent yield added with pearlmillet grain yield. Pearlmillet equivalent yield was significantly higher in two intercropping combinations than that of sole pearlmillet. The highest pearlmillet equivalent yield was recorded with pearlmillet + greengram in 1:2 row ratio and found comparable with pearlmillet + greengram in 1:1 row ratio, because of additional advantage of intercrop yield and higher yield of pearlmillet with greengram due to better complementary relationship resulted in highest pearlmillet equivalent yield.

Economics of different treatments: A monetary return as elucidated by net income was significantly higher in different intercropping systems as compared to sole pearlmillet. Looking to overall economics all pulses and pearlmillet with pluses and oilseed intercropping treatments gave significantly higher net returns over sole pearlmillet. This could be attributed to higher yield advantage with sole pulses and intercropping systems. Pearlmillet + greengram (1:2) combination gave the maximum net returns (₹53,122) per hectare and significantly higher benefit cost ratio of 1:2.41 followed by sole greengram which gave net returns of (₹ 47,464) per hectare with 1:2.48 benefit cost ratio (Table 2) which confirmed the superiority of sole greengram and pearlmillet with greengram at 1:2 row ratio over other treatments. Kunadia *et al.* (1997) observed that pearlmillet + clusterbean at 2:2 row ratio gave highest net return and benefit cost ratio. Yadav and Jat (2005) reported that higher net return and benefit cost ratio was found in pearlmillet + mothbean at 2:1 row ratio intercropping systems.

Effect of different treatments on land equivalent ratio (LER): Intercropping systems had exhibited their significant effect on LER. Some intercropping situation recorded more than 1.00 LER value as compared to sole crop, which indicated greater biological efficiency of the systems. Significantly higher value of LER was observed in the treatment T_9 - pearlmillet + greengram (1:2) which established its superiority by recording LER of 1.14. However, its land equivalent ratio was found at par with treatments T_7 - pearlmillet + cowpea (1:2), T_{11} - pearlmillet + mothbean (1:2), T_8 - pearlmillet + greengram (1:1) and T_6 -pearlmillet + cowpea (1:1) having the LER of 1.07, 1.06, 1.02 and 1.01, respectively (Table 2).

This might be due to higher yield of pearlmillet in intercropping systems and also intercropping systems gave higher land utilization as compared to sole crop.

TABLE 2: Economics of different sole and intercropping treatments

Treatments	PMEY (kg/ha)	Gross returns (₹/ha)	Net returns(/ha)	BCR	LER
T_1 : Pearlmillet sole	6240	68635	44386	1.83	1.00
T_2 : Cowpea sole	3581	39387	19757	1.01	1.00
T_3 : Greengram sole	6057	66622	47464	2.48	1.00
T_4 : Mothbean sole	2682	29506	10931	0.59	1.00
T_5 : Sesame sole	2210	24309	5128	0.27	1.00
T_6 : Pearlmillet + Cowpea (1:1)	5178	56953	34276	1.51	1.01
T_7 : Pearlmillet + Cowpea (1:2)	5052	55568	33240	1.49	1.07
T_8 : Pearlmillet + Greengram (1:1)	6279	69066	46625	2.08	1.02
T_9 : Pearlmillet + Greengram (1:2)	6831	75136	53122	2.41	1.14
T_{10} : Pearlmillet + Mothbean (1:1)	4653	51188	29039	1.31	0.96
T_{11} : Pearlmillet + Mothbean (1:2)	4576	50341	28716	1.33	1.06
T_{12} : Pearlmillet + Sesame (1:1)	4099	45094	23222	1.06	0.83
T_{13} : Pearlmillet + Sesame (1:2)	3793	41728	20614	0.98	0.65
S. Em.±	191	2349	1403	0.07	0.04
C. D. (0.05)	559	6855	4095	0.20	0.12
C. V. (%)	7.04	7.85	7.97	8.21	7.19

Sale price
Pearlmillet : Seed = ₹11 per kg, Straw = ₹3 per kg
Cowpea : Seed = ₹30 per kg, Straw = ₹2 per kg
Greengram : Seed = ₹50 per kg, straw = ₹2 per kg
Mothbean : Seed = ₹30 per kg, Straw = ₹2 per kg
Sesame : Seed = ₹80 per kg, Straw = ₹0.5 per kg

This was due to extra yield obtained from intercrop and makes the combination higher advantageous over sole crops. This might be due to development of better complementary relationship. These resulted corroborated with the finding of Patel *et al.* (1998), Kumar *et al.* (2006) and Choudhary (2009).

REFERENCES

Anjeneyula, V.R., Singh S.P. and Paul M. (1982). Effect of competition free period and techniques and patterns of pearl millet planting on growth and yield of mungbean intercropping system. *Indian J. Agron.* **27**(23): 219-226.

Baldevram ; Chaudhary, G. R.; Jat, A. S. and Jat, M. L.(2005). Effect of integrated weed management and intercropping system on growth and yield of pearlmillet. *Indian J. Agron.* **50** (3) : 210-213.

Choudhary, R.A. (2009). Intercropping in pearlmillet [*Pennisetum glaucum* (L.) R. Br. Emend. Stuntz] with pluse crops in rainfed conditions. M. Sc. (Agri.) Thesis submitted to Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar.

Gadhia, D.S. (1991). Intercropping in pearlmillet with different grain legumes and oilseed crop under rainfed conditions. M.Sc. (Agri.) Thesis Submitted to Gujarat agricultural University, Sardarkrushinagar.

Kulkarni, J.H. and Sojitra, U.K. (1986). Nodulation, growth and pod yield of groundnut under six intercropping system. *Madras Agricultural Journal*. **73** (7) : 366-369.

Kumar, R.; Hooda,R. S.; Singh, H. and Nanwal, R. K. (2006). Performance of intercropping and strip cropping systems of pearlmillet – legume association. *Indian J. Agric. Sci.* **76** (5) : 319-321.

Kunadia, B.A.; Patel, I.S.; Patil, R.G.; Patel, S.K.; Patel, S.M.; Patel, S.I. and Bhatiya, V.J. (1997). Imparting stability to pearlmillet-clusterbean intercropping system through adopting suitable variety. *Annals of Arid Zone*. **36** (4): 349-352.

Malik, C.P. and Srivastava, A.K. (1982). Text Book of Plant Physiology. Kalyani Publishers, New Delhi. : 442.

Parmar, G.M. (1989). Intercropping in pearlmillet with different grain legumes and oilseed crop under rainfed conditions. M.Sc. (Agri.) Thesis Submitted to GAU, Sardarkrushinagar.

Patel, J.R. and Parmar, M.T. (1988). Studies on intercropping of compatible crops with pigeonpea under rainfed conditions. *Indian J. Agron.* **33** (3) 253-256.

Patel, M.R.; Kalyansundaram, N.K.; Patel, I.S.; Patel, J.M.; Patel, S.I.; Patel, B.M. and Patel, R.G. (1998). Effect of additive and replacement series in intercropping system with pearlmillet. *Annals of Arid Zone*. **37**: 69-74.

Rathore, S.S. and Gautam, R.C. (2003). Agro-techniques to improve the productivity of pearlmillet + cowpea intercropping system under dryland conditions. *Annals of Agricultural Research*. **24**: 971-975.

Reddy, M.S. and Willy, R.W. (1981). Growth and resource use studies in an intercrop of pearlmillet/groundnut. National Symposium. Indian Society of Agronomy, *CSSRI*, Karnal. 3-5 April, 1980, New Delhi.

Willey, R.W. (1979). Intercropping-its importance and research needs. Part-1. Competition and yield advantages. *Agron. J.* **71**(2): 115-119.

Yadav, G.L. and Jat, B.L. (2005). Intercropping of mothbean varieties with pearlmillet for sustainable crop production in arid ecosystem. *Indian J. Pulse Research*. **18** (2) : 252-253.

Yadav, R.S. and Yadav, O.P. (2001). The performance of cultivar of pearlmillet and clusterbean under sole cropping and intercropping systems in arid zone c nditions in India. *Experimental Agriculture*. **37** (2): 231-240.