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Effect of Intercropping and Fertility Levels on Yield Attributes, Yield and Economics of Summer Pearlmillet (*Pennisetum glaucum* L.) under South Gujarat Condition

K. R. Patel*, J. D. Thanki and P. H. Kalal

Department of Agronomy Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari, India

**Corresponding author*

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A B S T R A C T

A field experiment was conducted at College Agronomy Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during summer, 2019 and 2020 comprising four intercropping treatments *i.e*. pearlmillet sole, pearlmillet+greengram, pearlmillet+cowpea, pearlmillet+clusterbean and three fertility levels *viz*., 75 % RDF, 100 % RDF and 125 % RDF. Significantly higher number of tillers per hill, dry matter accumulation per plant at 60 DAS and at harvest, number of earheads per hill, earhead length, grain and straw yields of pearl millet were noted in pearl millet + green gram intercropping in both the years of investigation as well as in pooled analysis. Whereas pearl millet equivalent yield was significantly highest in pearl millet + green gram (I_2) intercropping system. In case of fertility levels, significantly higher values of plant height, number of tillers per hill at 60 DAS and harvest, dry matter accumulation per plant at 60 DAS and harvest, number of ear heads per hill, ear head girth, grain yield, straw yield, pearl millet equivalent yield were recorded in 100 % RDF(F_2) treatment.

Introduction

Pearlmillet, locally called as *bajra* is an important dual purpose crop as its grain is used for human consumption and its fodder as cattle feed. It ranks fourth after rice, wheat and sorghum and is grown in almost all the states of the country. Limited availability of land resources and the decline in the soil fertility has increased the importance of the ability of agriculture to sustain the increasing demand of the population both globally and locally. To counter the demand, we have to look for ways which enhance the use of currently available resources than in the past. Intercropping is one promising practise which is effective to

augment the total productivity per unit area of the land per unit time by growing more than one crop in the same field with an objective of better utilization of environmental resources. The basic concept of intercropping involves growing together two or more crops with the assumption that two crops can exploit the environment better than one and ultimately produce higher yield (Reddy and Willy, 1981). Cereal- pulses intercropping has attracted the attention of agronomists, possibly as a result of the established and theoretical advantages of intercropping systems (Ofori and Stern, 1978). Intercropping with pulses is a practice in which N fixed by latter enhances the qualitative and quantitative traits of the former to finally reach food security and sustainability (Swaminathan, 1998). Pulses such as cowpea, clusterbean and greengram are known to fix the atmospheric nitrogen with the help of rhizobium bacteria and it supplies the cereal crop with the required nitrogen. Fertilizer management is one of the important cost effective factors known to augment the crop production. Hence, inclusion of pulses in any intercropping system has becomes imperative with the overall view of maintaining soil fertility and for economizing fertilizer use.

Experimental materials and methods

The field experiment was conducted during summer season of both the years 2019 and 2020 at N. M. College of Agriculture, Navsari Agricultural University, Navsari. The soil of the experimental field was clayey in texture, low in organic carbon content (0.41 %) and available nitrogen (199.86 kg/ha), medium in available phosphorus (39.43 kg/ha) and fairly high in available potassium (302.88 kg/ha). The soil was slightly alkaline in reaction (pH 7.9). The experiment was laid out in factorial randomized block design with 12 combinations comprising of four intercropping treatments (pearlmillet sole, pearlmillet + greengram, pearlmillet + cowpea and pearlmillet + clusterbean) and three fertility levels (75%, 100% and 125% of RDF) replicated three times. The pearlmillet variety GHB-558, greengram variety GM-6, cowpea variety GC-5 and clusterbean Gujarat Guar - 1were used as a test varieties. Pearl millet was sown in paired rows at 30 cm keeping 60 cm distance between 2 pairs to adjust 1 row of intercrop. Fertilizer application was done on area basis as per treatment to only pearlmillet crops (RDF is 120-60-00 kg NPK/ha for pearlmillet). The plant height was measured using a metre scale from ground level to the tip of the main shoot randomly selected five tagged plants from each plot at 30, 60 DAS and at harvest and the mean values of height at each stage was expressed in cm. The number of earheads in each of the tagged plants in all the plots were counted and averaged. Top, middle and bottom ear head girth were measured from five ear head of tagged plants by using vernier calliper and mean value was computed for each ear head of each treatment then average value per ear head was worked out for treatments. The length from the base to the apex of the ear head of main ear head of the five randomly selected plants for all the plots were measured with the help of scale. The mean value of five plants was worked out and registered. After harvesting in each net plot, the grains were threshed, cleaned and dried. The weight of grains in each plot was measured and expressed as kg/ha. After threshing, the weight of dried straw from each plot was recorded and expressed as kg/ha. The harvest index was calculated by dividing the economic yield by the biological yield and expressed as percentage (%).

$$Harvest\ index = \frac{\text{Economic yield}}{\text{Biological yield}} \text{ x } 100$$

Analysis of variance for factorial randomized block design and significance of variance was tested by F-test (Gomez and Gomez, 1984).

Critical difference for examining treatmental means for their significance was calculated at 5% significance.

Results and Discussion

Yield Attributes of Pearlmillet

The yield attributes for pearlmillet which were studied during our experiment during both the years were plant height, number of tillers per hill at 60 DAS and harvest, dry matter accumulation per plant at 60 DAS and harvest, number of ear heads per hill, ear head girth, number of earheads per hill, earhead girth and length (Table 1). The treatment I_2 (pearlmillet + greengram) recorded significantly taller pearlmillet plants which was at par with I_3 (pearlmillet + cowpea). Similar results have also been reported Yadav *et al.,* (2015) as well as Prathiksha and Dawson (2019) in pearlmillet based intercropping systems. These results were also in conformity with the findings of More number of ear head per hill in pearlmillet was obtained under sole pearlmillet treatment (I_1), it remained statistically at par with the treatments I_2 (pearlmillet + greengram).

These results were also in conformity with the findings of Kaluram and Meena (2014), Kumar *et al.,* (2017). In case of fertility levels Significantly higher value of number of ear head per hill at harvest was observed with application of 125 % RDF (F_3) which remained at par with treatments F_2 (100% RDF). Vari and Sadhu (2013) and Gaina (2014) reported that number of earhead per hill of pearlmillet increased with increase in N and P doses in intercropping system with pulses. Treatment with sole pearlmillet (I_1) produced significantly higher values of dry matter, it remained at par with treatments I_2 (pearlmillet + greengram). Yield indices such as earhead girth and 1000 grain weight was not significantly influence by intercropping but in case of earhead length was significantly higher in sole pearlmillet and which was at par with I_2 (pearlmillet + green gram).

This might be due to amount of nitrogen fixed by the component crop greengram which was fully utilized by the main crop pearlmillet for better growth and development resulted in expression of higher values of these yield indices. These results were also in conformity with the findings of Kumar *et al.,* (2017), Baldev *et al.,* (2018) and Goswami *et al.*,(2020). Pearlmillet crop are ferilized with 125% RDF recored significantly higher value of plant height, dry matter accumulations, earhead girth and length and which was at par with pearlmillet crop fertilized with 100 % RDF. The similar result were obtained by Parihar *et al.,* (2012) and Gaina (2014).

Grain and straw yield of crops

Effect of intercropping observed that the grain and straw yield of pearlmillet was significantly higher recorded with sole crop pearl millet (I_1) intercropping system, it remained statistically at par with the treatments I_2 (pearlmillet + greengram). Similar results found that with Vari and Sadhu (2013), Kaluram and Meena (2014) and Goswami *et al.,* (2020). Among the different fertility levels examined, significantly higher grain and straw yield of pearlmillet were recorded with application of 125 % RDF (F_3) to pearlmillet crop.

Further, it remained statistically at par with the treatments 100 % RDF (F_2). Higher dose of fertilization made the plants more efficient in photosynthetic activity and thereby enhancing carbohydrate metabolism in the plant. Finally the beneficial effects of all the attributes were reflected on the grain and straw yield per hectare. The result corroborate with the finding of Vari and Sadhu (2013), Gaina (2014).

Table.1 Plant height, dry matter accumulations per plant, Number of ear head per hill, earhead girth, earhead length and test weight of pearlmillet as influenced by intercropping and fertility levels (Pooled data of two year)

Treatments	Plant height		Dry matter accumulation (g)		Number of Earheads per hill	Earhead Girth (cm)	Earhead length (cm)	Test weight (g)
	At 60 DAS	At harvest	At 60 DAS	At harvest				
Intercropping								
I_1: sole crop pearl millet	130.33	158.00	27.44	49.27	3.77	8.70	23.09	**7.42**
I_2: pearl millet + green gram	140.89	170.39	26.75	48.37	3.56	8.50	22.28	**7.45**
I_3: pearl millet + cowpea	138.44	169.67	26.06	46.06	3.36	8.32	21.58	**7.15**
I_4: pearl millet + cluster bean	129.17	158.17	24.82	45.14	2.96	8.20	20.84	**7.05**
SEm ±	2.27	2.75	0.44	0.79	0.083	0.17	0.522	**0.15**
CD (P=0.05)	6.47	7.84	1.26	2.25	0.24	NS	1.49	**NS**
Fertilizer levels								
F1: 75 % RDF	128.67	156.88	25.21	45.38	2.86	8.04	20.58	**7.17**
F2: 100 % RDF	137.46	166.71	26.26	47.18	3.60	8.42	22.45	**7.15**
F3: 125% RDF	138.00	168.58	27.35	48.95	3.80	8.83	22.82	**7.49**
SEm ±	1.97	2.38	0.38	0.68	0.07	0.14	0.45	**0.13**
CD (P=0.05)	5.60	6.79	1.09	1.95	0.20	0.41	1.29	**NS**
Interaction effect (I × F)								
SEm ±	3.93	4.76	0.76	1.37	0.143	0.29	0.903	**0.26**
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	**NS**
Sig. interactions with Y	NS	NS	NS	NS	NS	NS	NS	**NS**
CV (%)	**7.15**	**7.11**	**7.13**	**9.14**	**10.27**	**8.33**	**10.08**	**8.70**

Table.2 Grain yield, straw yield and Pearlmillet grain equivalent yield of pearlmillet yield as influenced by intercropping and fertility levels (Pooled data of two year)

Treatments	Pearlmillet		Intercrop		Pearlmillet grain equivalent yield	Net return (₹ /ha)	BCR
	Grain Yield (kg/ha)	Straw yield (kg/ha)	Seed yield (kg/ha)	Stover yield (kg/ha)			
A. Intercropping							
I_1: sole crop pearl millet	3002	5381	-	-	3002	30982	**2.02**
I_2: pearl millet + green gram	2978	5359	508	747	5575	66246	**2.98**
I_3: pearl millet + cowpea	2474	4741	405	630	3646	44874	**2.33**
I_4: pearl millet + cluster bean	2269	4097	281	795	3019	25189	**1.76**
SEm ±	42.89	90.68	-	-	52.42	-	-
CD (P=0.05)	122.26	258.46	-	-	149.43	-	-
B. Fertility levels							
F1: 75 % RDF	2560	4671	288	523	3725	39916	**2.26**
F2: 100 % RDF	2741	4930	295	549	3770	42702	**2.31**
F3: 125% RDF	2743	5081	312	556	3938	42852	**2.27**
SEm ±	37.15	78.53	-	-	45.40	-	-
CD (P=0.05)	105.88	223.84	-	-	129.41	-	-
Interaction effect (I × F)							
SEm ±	74.29	157.06	-	-	90.80	-	-
CD (P=0.05)	212	447.67	-	-	258.82	-	-
Sig. interactions with Y	**NS**	**NS**	-	-	**NS**	-	-

Table.3 Pearlmillet grain equivalent yield as influenced by interaction I X F

Intercropping (I)	Pearlmillet grain equivalent yield (kg/ha)		
	2019		
	Fertility levels (F)		
	F_1	**F_2**	**F_3**
I_1	2911	3007	3115
I_2	5500	5551	5600
I_3	2933	3884	3973
I_4	3434	2588	2962
CD (P=0.05)	354.35		
	2020		
	F_1	**F_2**	**F_3**
I_1	2955	2906	3119
I_2	5550	5601	5650
I_3	3033	3983	4073
I_4	3484	2638	3012
CD (P=0.05)	397.74		
	Pooled		
	F_1	**F_2**	**F_3**
I_1	2933	2957	3117
I_2	5525	5576	5625
I_3	2983	3934	4023
I_4	3459	2613	2987
CD (P=0.05)	258.82		

Table.4 Economics of pearlmillet and intercropped crops as influenced by different treatment combinations (Average of 2019 and 2020)

Sr. No.	Treatment combination	Total cost of cultivation	Pearlmillet		Intercrops		Gross return	Net return	BCR
			Grain yield (kg/ha)	Straw yield (kg/ha)	Seed yield (kg/ha)	Stover yield (kg/ha)			
1	I_1F_1	29048	2933	5186	-	-	59553	30505	2.05
2	I_1F_2	30195	2957	5353	-	-	60414	30219	2.00
3	I_1F_3	31341	3117	5603	-	-	63564	32223	2.02
4	I_2F_1	32287	2908	5166	501	709	97378	65091	3.01
5	I_2F_2	33424	2912	5322	507	762	98565	65141	2.94
6	I_2F_3	34570	3115	5591	516	769	103078	68508	2.98
7	I_3F_1	32455	2358	4533	390	600	75069	42614	2.31
8	I_3F_2	33593	2755	4141	400	638	80619	47026	2.39
9	I_3F_3	34738	2310	5549	425	650	79722	44984	2.29
10	I_4F_1	31991	2040	3799	264	784	53445	21454	1.67
11	I_4F_2	33129	2339	4908	272	796	61551	28422	1.85
12	I_4F_3	34274	2430	3583	305	804	59967	25693	1.74

Pearlmillet grain equivalent yield

Pearlmillet grain equivalent yield was Significantly the highest was produced when pearlmillet was intercropped with greengram (I_2) as compared to other intercropping systems and sole pearlmillet. The highest pearlmillet equivalent yield due to pearlmillet + greengram system could be attributed to the higher market price of greengram. These finding are in conformity with those reported by Vari and Sadhu (2013), Ghilotia *et al.,* (2015), Yadav *et al.,* (2015) and Goswami *et al.,* (2020). Among the different fertility levels examined, significantly higher grain equivalent yield of pearlmillet were recorded with application of 125 % RDF (F_3) to pearlmillet crop. Further, it remained statistically at par with the treatments 100 % RDF (F_2) in both the year. These finding are in conformity with those reported by Vari and Sadhu (2013) and Gaina (2014).

Data in Table 4 indicated that treatment combination with pearlmillet + greengram (I_2) and 125% RDF to pearlmillet (I_2F_3) applied to pearlmillet registered the highest grain equivalent yield of pearlmillet. But it was found statistically at par with treatment combinations I_2F_2 and I_2F_1. These results are in accordance with the results of Vari and Sadhu (2013) and Kumar *et al.,* (2017).

Economics

Among the different intercropping treatments, pearlmillet + greengram (I_2) secured the maximum net realization of ₹ 66246/ha and BCR of 2.98. Amongst the fertility levels, pearlmillet fertilized with 125 % RDF (F_3) secured highest net returns of ₹ 42852/ha with BCR of 2.27.

The results of present experiment it can be concluded that for achieving higher yield and net returns, intercropping of pearl millet + green gram (2:1 row ratio) along with 75 % recommended dose of fertilizers (90-45-00 $N+P_2O_5+K_2O$ kg/ha) to pearl millet crop should be followed during summer season under south Gujarat condition.

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