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Original Research Article

Production and Economics of Clusterbean [*Cyamopsis tetragonoloba (L.)* Taub] and Pearlmillet (*Pennisetum glaucum)* Intercropping System as Affected by Weed Management Practices in Arid and Semi Arid Areas of Madhya Pradesh

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A B S T R A C T

A field experiment was conducted during rainy (*kharif*) season of 2013-14 and 2014-15 to study the effect of weed management practices on clusterbean [*Cyamopsis tetragonoloba* (L.)] + pearlmillet (*Pennisetum glaucum*) based intercropping system under arid and semi arid conditions on a sandy loam soil at college of Agriculture, RVSKVV, Gwalior (M.P.). All the growth parameters(plant height and tillers/ row length) and yield attributes of clusterbean and pearlmillet (number of pods/plant, pod length, no. of seed/pod, test weight, plant height, effective tillers/row length, ear head length and ear head girth of pearlmillet) were significantly influenced by intercropping systems. The yield attributes and yields of pearlmillet increased by legumes effect in intercropping system as compared to sole stand of pearlmillet. However, intercropped stand of clusterbean recorded its lower productivity (2853 kg ha-^{1}) when compared to its sole stand (5145 kg ha-^{1}), but intercropping system recorded statistically similar to clusterbean equivalent yield as compared to sole stand. Significantly improvement in all the yield attribute characters and yield under weed management practices with the application of pendimethalin 1.5 kg ha-^{1} as pre emergence + one hand weeding at 25 DAS, followed by two hand weeding at 25 and 45 DAS over the other weed management practices in arid and semi arid conditions.

Keywords

Intercropping system, Weed management practices, Clusterbean, Pearlmillet

Introduction

Pearlmillet is a major, cereal crop in the arid and semi arid regions of India. Today, it is getting more attention due to increasing evidence of less seasonal rainfall, frequent occurrence of extreme weather events coupled with scanty water resources (Singh *et al.*, 2010). It occupies a distinct position in the agricultural economy of the country. Clusterbean or Indian guar is one of the most drought tolerant annual *kharif* legumes in India. The popular guar gum, which is issued in mining, petroleum drilling and textile manufacturing sectors, is obtained from the endosperm of the seed of plant. Under clusterbean cultivation, India occupied 23.30 lakh ha. area with production of 11.98 lakh

tonnes. with productivity of 316 kg ha-^{1}. In Madhya Pradesh clusterbean cultivated as pure crop in 12576 ha. Area with productivity of 316 kg ha-^{1}, which is predominantly grown on small lands and is usually intercropped with cereals under arid and semi arid conditions. It should be justifiable to accept that intercropping system will attract increasing attention to overcome ecological constraints.

Expectation remain high that legumes have considerable potential to contributes to soil fertility and substantial yield increases in dryland farming system. Therefore, any plan for increasing pulse production in the country should be based on an efficient approach for improved productivity of these crops under arid and semi arid environmental conditions, rather than only the use of efficient management practices. Intercropping is the potential system of crop production and it provides biological insurance against risk under aberrant monsoon on dryland upland ecosystem. Besides other production constraints, in arid and semi arid region, weed infestation is considered as one of the most important constraints to limit the yield in the clusterbean based intercropping systems.

Being the rainy season cropping systems, it may be infested severely with different kind of weeds which may reduce the yield of clusterbean and intercrops. Keeping this in view, the present study was conducted to find out appropriate row pattern of clusterbean and pearlmillet intecropping systems and suitable weed management practices in arid and semi arid regions of Madhya Pradesh.

Materials and Methods

Field experiments were conducted during *kharif* season of 2013-14 and 2014-15 under agro climate condition of Research Farm under AICRP on Arid Legumes, at College of Agriculture, RVSKVV, Gwalior, Madhya Pradesh. The soil of experimental site contained 59.90% sand, 17.40% clay and 22.70% silt with a electrical conductivity of 0.19 mmhos/cm at 25^{0}c and pH 8.0. The soil was low in organic carbon (0.45%), available nitrogen (212.5 kg ha-^{1}), available phosphorus (14.7 kg ha-^{1}) and medium in available potassium (227 kg ha-^{1}). The rainfall received during cropping season was 824 and 888 mm during first and second year, respectively.

The experiment was laid out in factorial randomized block design with twenty combination from four intercropping pattern *viz*. sole clusterbean, sole pearlmillet, paired row of clusterbean + one row of pearlmillet (2:1), paired row of clusterbean + paired row of pearlmillet (2:2), five weed management practices *viz*. weedy check, two hand weeding at 25 and 45 DAS, pendimethalin @ 1.5 kg ha-^{1} as pre- emergence + one hand weeding at 25 DAS, pendimethalin @ 1.5 kg ha-^{1} as pre- emergence + one hand hoeing at 25 DAS, pendimethalin @ 1.5 kg ha-^{1} as pre-emergence + imazethapyr @ 40 g ha-^{1} as post –emergence. Clusterbean variety HG - 563 and pearlmillet variety JBV - 3 were sown in rows 45 cm apart using 20 kg ha-^{1} seed for clusterbean and 5 kg ha-^{1} for pearlmillet on 14 and 21 July 2013 and 2014 respectively.

The recommended dose of 20kg N, 40 kg P_2O_5 and 20 kg K_2O ha^{-1} for clusterbean and 80 kg N, 40 kg P_2O_5 and 20 kg K_2O ha^{-1} for pearlmillet were applied in the form of urea, single super phosphate and murate of potash as per the row ratio in intercropping and sole stands.

Half of N and full dose of P_2O_5 and K_2O in pearlmillet and full dose of N, P_2O_5 and K_2O in clusterbean were applied as basal dose; remaining half dose of N was top dressed in

pearlmillet crop at the tillering stage with the availability of adequate moisture. All other package of practices was followed as per recommendations. Weed control efficiency of various treatments was worked out by applied treatment for controlling the weeds in comparison to weedy check. Clusterbean equivalent seed yield and economics were calculated by considering the prevailing market price of both the crops.

Results and Discussion

Clusterbean

On an average, intercropping of clusterbean and pearlmillet in 2:1 row ratio recorded significantly highest plant height, pods/plant, pod length, seeds/pod and test weight was on par with clusterbean + pearlmillet 2:2 row ratio and sole stand respectively.

The higher plant height and yield attributes with intercropping of clusterbean + pearlmillet in 2:1 and 2:2 row ratio could be due to increased shading effect of pearlmillet plant on clusterbean plants which resulted in low moisture losses due to evapotransipiration leading to more moisture availability as well as better plant growth of clusterbean plants under intercropping system.

Mean data of two years revealed that seed yield and stover yield of clusterbean varied significantly due to the effect of different treatments (Table 1). The maximum seed yield (2323 kg ha-^{1}) and stover yield (5145 kg ha-^{1}) was obtained with sole clusterbean, but remained at par with intercropping of clusterbean + pearlmillet in 2:1 and 2:2 row ratio. Increase in seed yield of clusterbean under sole crop was attributed to higher number of rows in sole crop compared to intercropping systems. Among the intercrops, growing of clusterbean + pearlmillet in 2:1 row ratio gave significantly higher seed and stover yield followed by intercropping of clusterbean + pearlmillet in 2:2 row ratio. The result exhibit the importance of plant population of a components crop in the intercropping system. (Sarkar *et al*., 2004)

Under weed management practices the application of pendimethalin 1.5 kg ha-^{1} as pre emergence + one hand weeding at 25 DAS had obtained significantly highest plant height, pods/plant, pod length, seeds/pod and test weight followed by two hand weeding at 25 and 45 DAS and pendimethalin 1.5 kg ha-^{1} as pre emergence + one hand hoing at 25 DAS respectively.

All weed control treatments significantly increased the seed and stover yield of clusterbean over weedy check (Table 2).The maximum seed yield (2440 kg ha-^{1}) and stover yield (4979 kg ha-^{1}) was obtained with treatment of pendimethalin 1.5 kg ha-^{1} as pre emergence + one hand weeding at 25 DAS followed by two hand weeding at 25 and 45 DAS and pendimethalin 1.5 kg ha-^{1} as pre emergence + one hand hoing at 25 DAS respectively.

Pearlmillet

The highest plant height, tillers/row length, ear head length, ear head girth and test weight were recorded in the intercropping of clusterbean and pearlmillet when grown in 2:1 row ratio followed by 2:2 row ratio and sole cropping of pearlmillet (Table 2). Mean grain yield was significantly highest in sole prealmillet (3710 kg ha-^{1}) over the intercropping of clusterbean + pearlmillet in 2:2 and 2:1 row ratio, respectively.

This could be due to increased rows of pearlmillet per unit area. Among the intercropping system, clusterbean + pearlmillet in 2:2 row ratio produced

maximum grain (2309 kg ha-^{1}) and stover yield (5632 kg ha-^{1}) over the intercropping of clusterbean + pearlmillet 2:1 row ratio.The higher plant height and yield attributes with intercropping of clusterbean + pearlmillet in 2:2 and 2:1 row ratio could be due to increased legume effect of clusterbean on pearlmillet plants.

Under weed management practices the application of pendimethalin 1.5 kg ha-^{1} as pre emergence + one hand weeding at 25 DAS had recorded significantly highest plant height, tillers/row length, ear head length, ear head girth and test weight followed by hand weeding twice at 25 and 45 DAS and pendimethalin 1.5 kg ha-^{1} as pre emergence + one hand hoing at 25 DAS respectively.

All weed control treatments significantly increased the grain and stover yield of pearlmillet over weedy check. The maximum grain yield (3102 kg ha-^{1}) and stover yield (7101 kg ha-^{1}) was obtained with treatment pendimethalin 1.5 kg ha-^{1} as pre emergence + one hand weeding at 25 DAS followed by hand weeding twice at 25 and 45 DAS and pendimethalin 1.5 kg ha-^{1} as pre emergence + one hand hoing at 25 DAS, respectively.

Clusterbean equivalent seed yield

Mean of clusterbean equivalent seed yield (CEY) was significantly influenced due to intercropping pattern (Table 3). The sole cropping of clusterbean was obtained highest CEY (2374 kg ha-^{1}) and being statistically at par with intercropping of clusterbean + pearlmillet in 2:1 row ratio had CEY (2310 kg ha-^{1}) over the intercropping of clusterbean + pearlmillet in 2:2 row ratio respectively.

The lowest CEY (1074 kg ha-^{1}) was recorded with sole pearlmillet. Increase in CEYwas attributed to additional yield due to better utilization of resources (moisture, nutrient and light) and complementary effect on each other compared to sole stands of both the crops. Significant increase in the equivalent yield in intercropping of clusterbean and pearlmillet then sole pearlmillet was also reported by Tetarwal *et al.,* (2006).

All the weed control treatments significantly increased the CEY over weedy check. The treatment pendimethalin 1.5 kg ha-^{1} as pre emergence + one hand weeding at 25 DAS recorded maximum CEY (2532 kg ha-^{1}) followed by hand weeding twice at 25 and 45 DAS.

Significantly higher clusterbean equivalent seed yield (CEY) was obtained in pendimethalin 1.5 kg ha-^{1} as pre emergence + one hand hoing at 25 DAS and pendimethalin 1.5 kg ha-^{1} as pre emergence + imezathapyr 40 g ha-^{1} as post emergence at 25 DAS treated plots over to weedy check but, these weed management practices produced significantly lower yield than pendimethalin 1.5 kg ha-^{1} as pre emergence + one hand weeding at 25 DAS and hand weeding twice at 25 and 45 DAS, inspite of good weed control.

Economics

Under Intercropping systems the sole crop of clusterbean with combination of pendimethalin 1.5 kg ha-^{1} as pre emergence + one hand weeding at 25 DAS fetched higher net returns and benefit cost ratio compared to their sole crop with cobmbination of other weed management pracrtices (Table 4). The highest net return (136936 □ ha-^{1}) and benefit: cost ratio (6.39) was obtained with sole clusterbean combination with pendimethalin 1.5 kg ha-^{1} as pre emergence + one hand weeding at 25 DAS followed by intercropping of clusterbean + pearlmillet 2:1 with combination of pendimethalin 1.5 kg ha-^{1} as pre emergence + one hand weeding at 25 DAS.

Table.1 Effect of intercropping system and weed management practices on yield attributes and yield of clusterbean

S. no.	Treatments	Yield attributes						
		Clusterbean						
		Pooled						
		Plant height (cm)	Number of pods per plant	Pod length (cm)	Number of seeds per pod	Test weight (g)	Seed yield per ha (kg)	Stover yield per ha (kg)
A	**INTERCROPPING SYSTEM**							
1	CB+PM (2:1)	120.57	57.48	5.39	6.58	34.79	1789	3854
2	CB+PM (2:2)	117.63	56.63	5.21	6.54	34.60	1308	2858
3	Sole clusterbean	107.63	53.15	5.03	6.42	33.55	2323	5145
4	Sole Pearlmillet	-	-	-	-	-	-	-
	SEm+	**1.14**	**0.70**	**0.06**	**0.08**	**0.38**	**45**	**96**
	CD at 5%	**3.23**	**2.00**	**NS**	**0.23**	**1.09**	**128**	**276**
B	**WEED MANAGEMENT PRACTICES**							
1	Weedy check	102.21	37.91	4.61	5.73	30.63	938	2255
2	Two hand weeding at 25 and 45 DAS	121.26	64.14	5.41	6.83	35.77	2214	4722
3	Pendimethalin @ 1.5 kg a.i./ha PE + One hand weeding at 25 DAS	125.16	67.02	5.48	6.97	36.90	2440	4979
4	Pendimethalin @ 1.5 kg a.i./ha PE + One hand hoeing at 25 DAS	115.92	58.03	5.31	6.60	34.82	1872	4162
5	Pendimethalin @ 1.5 kg a.i./ha PE + Imazethapyr @ 40 g a.i./ha PoE	112.34	51.67	5.24	6.43	33.45	1569	3630
	SEm+	**1.47**	**0.91**	**0.08**	**0.11**	**0.50**	**58**	**124**
	CD at 5%	**4.17**	**2.59**	**0.23**	**0.31**	**1.41**	**165**	**354**
	INTRECTION							
	SEm+	**2.54**	**1.58**	**0.14**	**0.18**	**0.86**	**101**	**216**
	CD at 5%	**7.23**	**4.48**	**0.40**	**0.53**	**2.45**	**286**	**613**

Table.2 Effect of intercropping system and weed management practices on yield attributes and yield of pearlmillet

S. no.	Treatments	Yield attributes and Yield						
		Pearlmillet						
		pooled						
		Plant hight(cm)	Effective tillers/row length	Ear head length(cm)	Ear head girth(mm)	1000 seed weight(g)	Grain yield (Kg/ha)	Stover yield(kg/ha)
A	**Intercropping system**							
1	CB+PM (2:1)	236.55	40.30	34.56	2.46	8.35	1675	4034
2	CB+PM (2:2)	222.77	38.87	32.38	2.43	8.13	2309	5632
3	Sole clusterbean	-	-	-	-	-	-	-
4	Sole Pearlmillet	211.17	36.67	31.57	2.38	7.74	3710	9163
	SEm+	**2.95**	**0.93**	**0.50**	**0.03**	**0.11**	**71**	**175**
	CD at 5%	**8.39**	**2.63**	**1.41**	**0.09**	**0.31**	**201**	**496**
B	**Weed management**							
1	Weedy check	195.40	32.22	28.33	2.27	7.28	1928	5100
2	Two hand weeding at 25 and 45 DAS	234.79	41.50	35.06	2.51	8.53	2884	6860
3	Pendimethalin @ 1.5 kg a.i./ha PE + One hand weeding at 25 DAS	244.59	42.94	36.26	2.58	8.86	3102	7101
4	Pendimethalin @ 1.5 kg a.i./ha PE + One hand hoeing at 25 DAS	226.17	40.22	33.94	2.45	8.17	2676	6603
5	Pendimethalin @ 1.5 kg a.i./ha PE + Imazethapyr @ 40 g a.i./ha PoE	216.54	36.17	30.59	2.31	7.52	2234	5718
	SEm+	**3.81**	**1.19**	**0.64**	**0.04**	**0.14**	**91**	**225**
	CD at 5%	**10.83**	**3.40**	**1.82**	**0.12**	**0.40**	**260**	**641**
INTERACTION								
	SEm+	**6.60**	**2.07**	**1.11**	**0.07**	**0.25**	**158**	**390**
	CD at 5%	**NS**	**5.89**	**3.15**	**0.20**	**0.70**	**450**	**1110**

Table.3 Seed equivalent yield (kg/ha) & economics as influenced by clusterbean based different intercropping systems with weed management practices

S. no.	Treatments	Seed equivalent yield (kg/ha)			Net income (`/ha)	B:C Ratio
		2013-14	2014-15	Pooled		
		Seed equivalent yield per ha (kg)	Seed equivalent yield per ha (kg)	Seed equivalent yield per ha (kg)	46700	3.54
A	**Intercropping system**				115390	5.38
1	CB+PM (2:1)	2395	2225	2310	124933	5.96
2	CB+PM (2:2)	2103	1903	2003	99116	5.47
3	Sole clusterbean	2425	2324	2374	77043	4.45
4	Sole Pearlmillet	1132	1016	1074	39668	3.17
	SEm+	**49**	**69**	**42**	93721	4.57
	CD at 5%	**136**	**190**	**117**	104920	5.19
B	**Weed management**				83704	4.80
1	Weedy check	1186	1102	1144	64995	3.93
2	Two hand weeding at 25 and 45 DAS	2393	2243	2318	45648	3.45
3	Pendimethalin @ 1.5 kg a.i./ha PE + One hand weeding at 25 DAS	2566	2498	2532	115574	5.34
4	Pendimethalin @ 1.5 kg a.i./ha PE + One hand hoeing at 25 DAS	2123	1909	2016	136936	**6.39**
5	Pendimethalin @ 1.5 kg a.i./ha PE + Imazethapyr @ 40 g a.i./ha PoE	1801	1583	1692	98760	5.41
	SEm+	**55**	**77**	**47**	81057	4.59
	CD at 5%	**152**	**213**	**131**	23661	2.32
	INTERACTION				33783	2.30
	SEm+	**110**	**154**	**94**	39295	2.59
	CD at 5%	**305**	**425**	**262**	33313	2.54
					26324	2.20

However, sole cropping of pearlmillet with combination of all weed management practices exhibited lowest monetary returns.

Decreasing the competition for essential resources due to appropriate row arrangement and complementary effect of both the component crops boosted the growth and yield attributes of the crops but sole cropping of both crops includes increased rows of plant population per unit area which resulted increase in net returns and benefit : cost ratio.

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