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Response of pearl millet based intercropping systems on growth, yield attributes, nutrient content and uptake of clusterbean

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Abstract
A field experiment was undertaken to study the intercropping of important legume in pearl millet [*Pennisetum glaucum* (L.) Br. emend Stuntz] under hyper arid conditions during the *kharif* season, 2014 at Agronomy Farm, College of Agriculture, Bikaner. The experiment comprising 7 treatment combinations with three replications and the experiment was laid out in randomized block design with combination of PM+CB intercropping systems (*viz.*, 1:1, 1:2, 1:3, 2:1, 3:1, 2:2 and 3:3 row ratios) respectively. Results showed that maximum plant height of clusterbean at harvest was recorded in PM+CB (1:3 row ratio) intercropping system. Maximum number of branches plant^{-1} at harvest was recorded in PM+CB (2:2 row ratio) as compared to rest of the treatments, which was at par with PM+CB (1:1, 1:2, 1:3) row ratio. However, pods plant^{-1} was obtained in PM+CB (1:3 row ratio). Further maximum seeds pod^{-1} of clusterbean was recorded in PM+CB (1:3 row ratio). However, there was no significant influence of different intercropping systems on test weight and harvest index of clusterbean. Maximum seed and straw yield were recorded with PM+CB (1:3) intercropping system. Further, highest biological yield was obtained by PM+CB (1:3) which was statistically at par with PM+CB (1:2) intercropping systems.

Keywords: Intercropping systems, clusterbean, growth and yield attributes, yield

Introduction
Cluster bean [*Cymopsis tetragonoloba* (L.) Jacq.] is very important crop in north-western Rajasthan. It is annual legume of dry and warm habitat and characterized as the most drought hardy annual legume in arid region. Clusterbean with deep fast penetrating root system in conjunction with drought avoidance capabilities can survive and thrive for considerable period in open field, exhibiting fast depletion of soil moisture with very high atmospheric temperature. The multi adaptive and adjusting nature of the crop has enabled to become an integral part of all type of cropping and farming system of the arid region. Optimum nutrient supply especially nitrogen is one of the important factor affecting the yielding potentiality of different crops. It is most important primary plant nutrient and plays important roles in various physiological processes of plant and acts as a constituent of protoplasm. Since nitrogen is one of the costlier inputs in crop production, the potential of using legumes to increase soil nitrogen becomes most suitable alternative. Lipman (1913) [4] was the first to suggest that soluble nitrogen compounds were utilized by adjoining porous root walls of non-legumes when grown in association with legume. Legumes offer excellent compatible combination for mixing with cereals to minimize the competition and to confer a symbiotic association to achieve the prime aim of maximization of available resources. Hence, the practice of intercropping pearlmillet with other leguminous crop of kharif season seems to be a good alternative to economies applied nitrogen. Application of nitrogen not only improves the growth, yield and attributes of pearlmillet + legumes intercropping system but also improves the quality of pearlmillet produce. The spatial arrangement in intercropping has important effects on growth and development of component crops, their productivity, economics and soil fertility status etc. The area of polygonal space occupied by the plant in a crop influences yield of an individual plant in a non linear fashion, (Willey and Heath, 1969) [12] and biological advantage due to intercropping may result from complementary use of growth resources, or where interspecific competition for growth resources is less than intraspecific competition. Information regarding geometrical requirement of pearlmillet based intercropping system which suits to the farmers of arid region was scanty.

Materials and Methods
A field experiment was undertaken to study the intercropping of important legume in pearl millet [*Pennisetum glaucum* (L.) Br. emend Stuntz under hyper arid conditions during the

kharif season, 2014 at Agronomy Farm, College of Agriculture, Bikaner. The experiment comprising 7 treatment combinations with three replications and the experiment was laid out in randomized block design. The soil of experimental site was shallow having pH 8.5, low in organic carbon (0.08 %), low in nitrogen (86.41 kg ha^{-1}), medium in phosphorus (21.91 kg ha^{-1}) and rich in potassium (234 kg ha^{-1})The recommended fertilizer schedule 40 kg N + 20 kg P_2O_5 per hectare was applied for intercropping systems. The recommended cultivars like RHB-177 of pearl millet, RGC-1066 of clusterbean were used in the experiment. The recommended plant spacing *i.e*. 30 cm x 10 cm was adopted and in intercropping systems. The crops were sown in last week of July in season of experimentation. The total rainfall received during crop growth period in 2014 was 417 mm. The crop season was normal for crop growth.

Results and Discussion

Growth attributes

Intercropping of pearlmillet with clusterbean had significant effect on plant population at 20 DAS and at harvest, plant height at harvest, total number of branches $plant^{-1}$ of clusterbean [Table 1]. The highest number of plants ha^{-1} was recorded under PM+CB (1:3 row ratio). Significant difference among various systems of intercropping in plant stand was due to the virtue of the row ratio of intercropping system. Yadav and Jat (2005) [13] reported similar results. Clusterbean sown at PM+CB (1:3 row ratio) significantly enhanced number of branches $plant^{-1}$. Yadav *et al.* (2005) [14] reported similar results on growth parameters of clusterbean in intercropping. Bangali (1987) [1] and Kiroriwal (2009) [3] also reported similar results. The plant height at harvest was found significantly higher in PM+CB (1:3 row ratio). Which was at par with PM + CB (2:2, 3:3 row ratio). These results are inclosing conformity with those of Bangali (1987) [1] and Yadav *et al.* (2005) [14].

Yield attributes

Intercropping system of PM+CB (1:3 row ratio) produced significantly higher number of pods $plant^{-1}$ that was found superior to all other intercropping treatments [Table 1]. Higher number of pods in these treatments may be due to lower number of pearlmillet density and wider space available for more growth and development of clusterbean. Better environment particularly the light interception by pearlmillet in these row ratio lead to higher pods $plant^{-1}$ in these intercropping systems. There is no significant effect on test weight of clusterbean of intercropping system. Pal *et al*. (2000) [6] and Singh and Agrawal (2004) [8] also reported that test weight of clusterbean were not influenced by intercropping systems.

A significant reduction in seed, straw and biological yield of clusterbean was observed under intercropping treatments. The reduction in yield of clusterbean, in the intercropping system was mainly due to reduction in plant stand of clusterbean in different intercropping treatment as replacement type of intercropping system was followed in the present study. These results are supported with those of Kumar *et al*. (2006) [2] who have reported the highest seed and straw yields of clusterbean in sole system over inter and strip cropping systems. Mishra (1996) also reported similar reduction in seed yield of base crop in intercropping treatments thereby corroborating the present finding. The grain yield of clusterbean was very much positively correlated with yield attributes *i.e*. final plant stand and pods $plant^{-1}$ in case of clusterbean.

The seed, straw and biological yield of clusterbean in different intercropping treatments particularly in PM+CB (1:3, 1:2 row ratio), respectively recorded higher recovery of seed yield in comparison to PM+CB (2:1, 3:1row ratio), respectively which had 33 and 25 percent plant stand but had only 30 and 22 percent recovery of clusterbean yield while the recovery of yield was around 45 and 46 percent with 50 percent of plant stand in PM+CB (1:1, 2:2 and 3:3 row ratio), respectively [Table 2] These results were supported by the results of Tiwari (2012) [11].

Table 1: Effect of different intercropping systems on growth and yield attributes of clusterbean

Treatments	Plant stand ('000 ha^{-1})		Plant height (cm)					
	20 DAS	at harvest	30 DAS	at harvest	Branches $plant^{-1}$ at harvest	Pods $plant^{-1}$	Seed pod^{-1}	Test weight (g)
PM+CB (1:1)	164.00	159.00	20.63	82.40	1.20	31.20	5.93	31.73
PM+CB (1:2)	218.00	212.33	21.40	82.10	1.07	32.47	6.13	31.97
PM+CB (1:3)	245.67	240.67	21.43	80.73	1.13	32.94	6.20	32.67
PM+CB (2:1)	109.00	103.33	21.07	81.53	1.07	31.60	5.90	31.27
PM+CB (3:1)	81.33	76.33	20.30	80.80	1.13	32.60	6.00	30.93
PM+CB (2:2)	162.00	157.00	20.63	81.40	1.20	32.27	6.10	32.77
PM+CB (3:3)	164.67	159.67	21.13	81.27	1.13	33.07	5.80	31.23
S.Em.±	1.20	1.10	0.80	0.91	0.09	0.83	0.13	0.65
C.D. (p=0.05)	3.65	3.35	NS	NS	NS	NS	0.38	NS

NS: - Non significant

Table 2: Effect of different intercropping systems on yield, nitrogen content and nitrogen uptake of clusterbean

Treatments	Seed yield (Kg ha^{-1})	Straw yield (Kg ha^{-1})	Biological yield (Kg ha^{-1})	Harvest index (%)	Nitrogen content (%)		Protein Content (%) in seed	Nitrogen uptake (Kg ha^{-1})		Total Uptake (Kg ha^{-1})
					Seed	Straw		Seed	Straw	
PM+CB (1:1)	637	1906	2544	25.03	3.50	2.77	21.90	22.37	52.77	75.14
PM+CB (1:2)	888	2641	3529	25.17	3.51	2.77	21.92	31.15	73.16	104.30
PM+CB (1:3)	1007	2988	3995	25.21	3.49	2.81	21.83	35.18	83.90	119.08
PM+CB (2:1)	444	1286	1730	25.77	3.51	2.82	21.94	15.61	36.26	51.87
PM+CB (3:1)	329	923	1252	26.29	3.51	2.77	21.77	11.46	24.90	36.35
PM+CB (2:2)	629	1860	2489	25.25	3.52	2.82	22.00	22.18	52.51	74.69
PM+CB (3:3)	641	1900	2541	25.22	3.54	2.86	22.05	22.67	54.27	76.94
S.Em.±	34	67	82	1.01	0.41	0.05	0.08	1.19	1.31	1.68

C.D. (p=0.05)	102	203	250	NS	NS	NS	NS	3.62	3.96	5.10

NS: - Non significant

Nutrient content and uptake

Intercropping system failed to show any significant influence on nitrogen content in seed and straw of clusterbean [Table 2]. This may due to the minimum competition for nutrients between the two diversified rooting pattern crops as clusterbean has deep root system and pearlmillet with advantageous root system and thus improved rhizosphere environment. Thakur and Bohra (1987) [10] also reported similar results. Since the nutrient uptake by the crop is a function of dry matter accumulation of cellular level and therefore, increased uptake of nitrogen was recorded by PM+CB (1:3 and 1:2 row ratio), respectively this may be due to seed and stover yield of pearlmillet + clusterbean combination increased the total uptake of nutrients. Singh (1992) also reported similar results. These results are closed conformity with those of Tetarwal and Rana (2007) [9].

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