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Effect of Different Row Ratios on Growth, Yield and Quality of Pearlmillet and Clusterbean Intercropping Under Agri-horti System of Vindyan Region

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An experiment was conducted during *kharif* season of 2011-12 at Agricultural research farm of RGSC, BHU, Barkachha (Utter Pradesh). The maximum plant height, number of leaves per plant and number of tillers of pearlmillet crop was observed 205.23, 26.64 and 3.37 cm at harvest under Pearlmillet+clusterbean (6:1) intercropping system. The maximum no. of grains ear^{-1}, ear girth (cm), ear length (cm) and weight of ear were observed as 1416.75, 10.55 cm, 23.82 cm and 24.75 g under Pearlmillet+clusterbean (6:1) intercropping. The maximum test weight 9.89 g was observed under Pearlmillet + clusterbean (6:1) in intercropping. The maximum grain yield 1554.53 kg ha^{-1} recorded under pearlmillet sole was significantly higher over rest of the treatments. The maximum straw yield 5104.11 kg ha^{-1} recorded under pearlmillet sole was significantly superior over rest of the treatments. The maximum biological yield 6658.64 kg ha^{-1} recorded under pearlmillet sole was significantly superior over rest of the treatments. The highest value of harvest index was recorded under Pearlmillet+clusterbean (4:1) 23.47 (%) in intercropping.

Key words: Pearlmillet, clusterbean, yield, quality, agrihorti-system, row ratios

The maximum plant height and number of branches plant^{-1}of clusterbean 118.73 and 4.62 at harvest was observed under Pearlmillet:clusterbean (6:1) intercropping system, respectively. The maximum number of clusters plant^{-1}, number of pod plant^{-1}, number of grain pod^{-1} and test weight (g) were observed as 8.94, 34.05, 7.69 and 31.97 under pearlmillet:clusterbean (6:1), respectively in intercropping. The maximum grain yield 1606.67 kg ha^{-1} recorded under clusterbean sole was significantly higher over rest of the treatments. The maximum straw yield 3312.44 kg ha^{-1} recorded under clusterbean sole was significantly superior over rest of the treatments. The maximum biological yield of 4919.11 kg ha^{-1} which was significantly higher clusterbean sole over all other intercropping patterns. The highest value of harvest index was recorded under Pearlmillet: clusterbean (2:1) 32.80 percent significantly superior over rest of the treatments. In intercropping treatment improved protein content in grain significantly. Pearlmillet: clusterbean (6:1) recorded significantly higher grain protein content (11.94%) in pearlmillet and clusterbean (25.23%).

Pearlmillet (*Pennisetum glaucum* L.) with a popular name *Bajra* ranks sixth in importance,

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followed by wheat, rice, corn, barley and sorghum. However, in India, it is fourth most important cereal crop after rice, wheat and sorghum. It has the greatest potential among all the millets. India is the largest producer of pearlmillet with an annual production of 8.52 million tonnes from an area of 8.91 million ha and productivity of 9.57 q ha^{-1} (AICPMIP, 2008). Millet is a staple food for more than 500 million people. Areas planted with pearlmillet are estimated at 15 million hectares annually in Africa and 14 million hectares in Asia. Global production exceeds 10 million tonnes a year (National Research Council, 1996). The food value of pearlmillet is high. Trials in India have shown that pearlmillet is nutritionally superior from human growth when compared to maize and rice. The protein content of pearlmillet is higher than maize and has a relatively high vitamin A content. It is a dual purpose crop, its grain is used for human consumption and its fodder as cattle feed. Pearlmillet is a small seeded caryopsis. The nutrient content of pearlmillet compares very well with other cereals and millets. It has high protein content with slightly superior amino acid profile. Pearlmillet grain contains 13-14 per cent protein, 5-6 per cent fat, 74 per cent carbohydrate and 1-2 per cent minerals. It also contains higher amount of carotene, riboflavin (Vit B_2) and niacin (Vit B_4).

Clusterbean (*Cyamopsis tetragonoloba* L.) is being grown in India since ancient time for vegetable and fodder purposes. Among leguminous crops, it is comparatively more drought hardy crop. It is popularly known by its vernacular name '*Guar*' and it is grown during rainy season in semi arid and arid regions of India for various purposes *viz*., vegetables, green fodder, green manuring and seeds. In the recent years, besides its conventional uses, it has emerged as an industrial crop, due to presence of galactomannan (gum) in its endosperm, which is around 30-35 per cent of seed weight. Guar gum has several diversified uses in textile, food processing, cosmetics, mining, explosive, oil and pharmaceutical industries, printing, toilet goods etc. India occupies top position in the world trade for guar gum and earn crores of foreign exchange by its export. Guar meal, a by product of gum industries, forms concentrate animal feed for immense value, as it contains more than 42 per cent protein against 31 per cent in guar seed.

Intercropping of cereals with legumes is an effective approach for boosting herbage yield, utilization of land efficiently and providing stability to production (Verma *et al*., 2005). Yield, utilization of land efficient and providing stability to production. Intercropping of legumes in pearlmillet was found more production and remunerative (Ram *et al*., 2005; Sharma, 2008) when compared with their sole. The types of intercrop and spatial arrangement in intercropping have important effect on balance of compaction between component crop and their of completion between component crop and their productivity (Sarkar and Pal, 2004). Hence, to get best result, a ratio approach row proportion of fodder pearlmillet and legumes in intercropping system. Multiple cropping in the form of intercropping is predominant in the arid and semi-arid tropics. Intercropping is a feasible and viable option for stepping up the production of pulses and oilseed in our country. Clusterbean is a major rainfed crop of arid zone, grown mostly as a mixed crop with, mothbean, but its productivity is low (Faroda *et al*., 2007). Plant population and spatial arrangement in intercropping have important effect on the balance of completion between the component crop and their product. Intercropping of cereal and pulse crops is one of the ways to increase their production because intercropping is more advantage than sole cropping of either of these crop (Padhi and Panigrahi, 2006.

Intercropping of clusterbean in pearlmillet was found more productive and remunerative than pearlmillet + cowpea or greengram (Ram *et al*., 2005). But the information on row proportions of multi-cut fodder pearlmillet and clusterbean in intercropping system in hot arid region is not available.

Agroforestry is a land use system which involves mixture of trees or other woody perennials with agricultural crop/ grass and /or animals simultaneously or sequentially. In general there are 4 or 5 basic sets of components in agroforestry system (Dhyani *et al*., 2009). Agri-horti system is one of the important components of agroforestry in which the integration of fruit crops in croplands is practiced. Aonla, ber, guava, citrus etc. are major promising fruit crop suitable for agri-horti system. Fruit crops are first preference of farmers under agroforestry system on account of short gestation period, regular income, risk cover and aesthetic

value (Anon, 2000). Agri-horti system is an improved indigenous cropping system in India for full utilization of the growing season and markedly increasing the return per unit area per unit time. This study was undertaken to assess the growth, yield and quality of different intercropping system of pearlmillet with legumes at different row proportion during summer season.

MATERIAL AND METHOD

The experiment was carried out in Agriculture Research Farm situated at Rajiv Gandhi South Campus, (B.H.U.), Barkachha Mirzapur (U.P.) during *kharif* season of 2011. The district Mirzapur lies in the tropical, subtropical to dry vindhyan region of Uttar Pradesh and it is a part of the Vindhyan soil (red laterite). Geographically, experimental site falls under the sub-tropical zone and located on 25º 10' latitude, 82º 37' longitude and altitude of 427 meters above mean sea level. According to "Agro-ecological region map" brought out by the National Bureau of Soil Survey and Land Use Planning (NBSS&LUP). It is occupying over an area of more than 1000 ha where variety of crops like agricultural, horticultural, medicinal and aromatic plants are grown. Vindhyan soil comes under rain fed and invariably poor fertility status. This region comes under agro-climatic zone III A (semi-arid eastern plain zone). The treatments consisted of 6 row pattern system *viz.*, T_1-Pearlmillet sole, T_2 - Pearlmillet: clusterbean (2:1), T_3 - Clusterbean sole, T_4 –Pearlmillet: clusterbean (4:1), T_5-Pearlmillet: clusterbean (6:1) and T_6-Pearlmillet: clusterbean (8:1). Cultivar was used pearlmillet variey B-855 (Hybried Bajara) and clusterbean variety muskan (guar).

RESULT AND DISCUSSION

Effect of different row ratios

Growth parameters

Planting pattern was significantly influenced by different growth parameters such as plant height, number of leaves and number of tillers in pearlmillet at harvest. Highest plant height, number of leaves and number of tillers were observed under pearlmillet: clusterbean (6:1) which were on par with pearlmillet+clusterbean(4:1) intercropping system (Table 1). Lowest plant

Table 1. Effect of planting pattern on grain, straw, biological yields and harvest index of pearlmillet

Treatment	No. of Grains ear^{-1}	Test wt. (g)	Ear girth (cm)	Ear length cm	Ear wt. (g)	Plant height (cm)	Number of tillers	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Pearlmillet (%)	Harvest index (%)
T_1	1275.61	8.35	9.98	20.57	21.28	188.82	2.93	1554.53	5104.11	11.06	23.35
T_2	-	-	-	-	-	-	-	-	-	-	-
T_3	1347.32	9.25	10.27	21.77	22.11	198.04	3.18	1120.24	3663.20	11.35	23.42
T_4	1391.36	9.52	10.46	22.03	23.67	201.33	3.28	1302.19	4245.17	11.46	23.47
T_5	1416.75	9.89	10.55	23.82	24.75	205.23	3.37	1505.40	4937.70	11.94	23.36
T_6	1315.77	8.91	10.18	21.16	21.67	192.45	3.09	1441.11	4726.83	11.24	23.36
SEm+	64.70	0.39	0.09	1.11	0.82	1.80	0.04	2.53	15.82	0.02	0.05
C.D. (P=0.05)	NS	NS	0.26	NS	2.39	5.27	0.11	7.58	46.30	0.07	NS

T_1 -Pearlmillet sole
T_2 -Clusterbean sole
T_3 -Pearlmillet+Clusterbean (2:1)
T_4 –Pearlmillet+Clusterbean(4:1)
T_5 –Pearlmillet+Clusterbean(6:1)
T_6–Pearlmillet+Clusterbean(8:1)

height, number of leaves and number of tillers were observed under pearlmillet sole followed by pearlmillet+clusterbean(8:1) intercropping system. Highest plant height and number of branches was observed in clusterbean at harvest under pearlmillet+clusterbean (6:1) which was on par with pearlmillet: clusterbean (4:1) intercropping system (Table 3). Lowest plant height and number of branches was observed in clusterbean at harvest under sole pearlmillet. The increase in height may be attributed to more competition between clusterbean due to reduction in inter-row spacing from 40 to 10 cm and component crop for sunlight and others growth resources which compelled the plants to grow more pronounced. This might be due to the fact that legume intercrops were competitive with clusterbean for nutrients and environmental resources. Both the crops utilized the nutrients from the same fertilizer given to base crop under intercropping situation. Similar finding was observed by Sharma (1997) intercropping of clusterbean, cowpea and mungbean with pearlmillet and reported that intercropping significantly enhanced plant height, dry matter accumulation and branches per plant of clusterbean, cowpea and mungbean at all the successive stages. Khateek *et al.,* (1999) reported that intercropping increased plant height of pearlmillet. Ram *et al.,* (2003) observed that the maximum plant height of pearlmillet was recorded under sole pearlmillet being at par with pearlmillet + clusterbean, significantly higher compared to pearlmillet intercropped with cowpea and greengram. Yadav *et al.,* (2005) reported similar results on growth parameter of clusterbean in intercropping system.

Yield and yield attributes

The different intercropping system did not differ significantly differences on number of grains ear^{-1}, test weight, ear length while, significantly influenced the ear girth, ear weight. The higher values of these characters were recorded under pearlmillet : clusterbean 6:1 (T_5) (Table 2). The pearlmillet: clusterbean 6:1 (T_5) system which was at par with pearlmillet+clusterbean 4:1 (T_4) in case of ear girth while, all the treatments were statistically at par to each other in case of ear weight. Whereas, plant grain yield, straw yield, and biological yield were recorded pearlmillet sole (4.6) as discussed earlier it might be due to the fact

Table 2. Effect of planting pattern on growth parameters of clusterbean at harvest

Treatment	Plant height (cm)	No.of Branches	Clusters plant^{-1} (No.)	Pods plant^{-1} (No.)	Grains pod^{-1} (No.)	Test weight (g)	Seed yield (kgha^{-1})	Straw yield (kgha^{-1})	Harvest Index (%)	Cluster bean (%)
T_1	-	-	-	-	-	-	-	-	-	-
T_2	106.62	2.66	7.03	31.18	6.99	31.09	1606.67	3312.44	32.66	23.43
T_3	114.50	4.23	8.73	33.49	7.50	31.79	1568.00	3211.77	32.80	24.80
T_4	115.73	4.38	8.84	33.80	7.59	31.93	1508.00	3093.42	32.77	24.95
T_5	118.73	4.62	8.94	34.05	7.69	31.97	1458.67	2997.11	32.74	25.23
T_6	111.73	3.31	8.57	33.24	7.11	31.55	1395.67	2837.91	32.97	24.76
SEm+	1.04	0.13	0.51	0.73	0.18	0.69	2.58	11.21	0.07	0.45
C.D. (P=0.05)	3.06	0.37	1.49	2.73	0.52	NS	7.55	32.81	0.19	1.33

that legume intercrops were competitive with pearlmillet for nutrients and environmental resources. Among the different systems the sole pearlmillet was recorded significantly higher grain yield (1554.53 kg ha^{-1}) as well as straw yield (5104.11 kg ha^{-1}) over remaining intercropping system (Table 3). Seed and straw yields are largely a function of better growth and improvement in yield attributes which contribute to the seed and straw yields of the crop.

The different intercropping system had significantly influence on yield attributes of clusterbean *viz.,* Pod's parameter and pods $plant^{-1}$, no of cluster $plant^{-1}$, no of grains $pods^{-1}$ of these characters were recorded higher under pearlmillet:clusterbean (6:1) (Table 4). The different intercropping system had significant influence on yield of clusterbean *viz.,* grain yield, straw yield, biological yield, were recorded significantly higher under sole clusterbean (Table 5). As discussed earlier it might be due to the fact that legume intercrops were competitive with clusterbean for nutrients and environmental resources. Seed and straw yields are largely a function of better growth and improvement in yield attributes which contribute to the seed and straw yields of the crop. Sharma and Gupta (2001) also reported decrease in the yield attributes, grain and straw yield of intercrops as compared to sole crop system. Bangali (1987) observed that number of ear per meter row length increased significantly in paired pearlmillet intercropped with cowpea over sole pearlmillet but test weight, grain weight per ear and ear length remained unaffected. Tiwana and Tiwana (1995) at Bathinda (Punjab) found the highest total seed/grain yield in 3:1 clusterbean + pearlmillet ratio. Singh and Joshi (1997) observed that row intercropping of pearlmillet with clusterbean (1:1) and strip cropping (4:4) with 50 per cent of the sole pearlmillet population produced 35.4 per cent lower pearlmillet yield in the moisture season and 37.4 per cent lower pearlmillet yield in the moisture stressed season. Pal *et al.,* (2000) observed that the growth and yield attributes of pearlmillet did not vary significantly due to intercropping treatments. Ram *et al.,* (2003) observed that the sole pearlmillet gave significantly more ear length, grain per ear, grain (20.8 q ha^{-1}) straw (54.9 q ha^{-1}) and biological (75.6 q ha^{-1}) yield compared to rest of the intercropping systems, while highest pearlmillet grain equivalent yield was recorded under pearlmillet + clusterbean (39.1 q ha^{-1}) followed by pearlmillet+greengram over pearlmillet + cowpea and sole pearlmillet. Singh and Agrawal (2004) observed that yield attributed (length of ear, grain weight/ear and 1,000-grain weight) of pearlmillet were not influenced by intercropping system.

Quality of pearlmillet and clusterbea

The data relating to the protein content of pearlmillet and clusterbean grain have been presented in Table 6. In intercropping treatment improved protein content in grain significantly. Pearlmillet+clusterbean (6:1) recorded significantly higher grain protein content (11.94%) in pearlmillet and clusterbean (25.23%). Sharma, *et al.,* (2009) showed that pearl millet + cowpea (2:2) recorded significantly crude protein yield (1.36 t/ha). Hooda, *et al.,* (2005) reported sole pearlmillet recorded significantly the highest protein yield (125.1 and 123.33 kg/ha, respectively) than inter (2:1) and strip (4:2) and (6:3) cropping systems. Among the legumes, the highest protein content (10.31%) was recorded in strip-cropping of pearlmillet with cowpea in 6:3 ratio. However, the highest protein yield was recorded in sole mungbean (119.27 kg/ha) and sole cluster bean (73.70 kg/ha) during the first and second year, respectively.

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