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EFFECT OF INTERCROPPING SYSTEMS AND FERTILITY LEVELS ON GROWTH AND YIELD OF SUMMER PEARL MILLET (*Pennisetum glaucum* L.) UNDER MIDDLE GUJARAT CONDITIONS

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ABSTRACT

A field experiment was conducted during summer season of 2022 at Agronomy farm, B.A. College of Agriculture, Anand Agricultural University, Anand, to evaluate the effect of intercropping systems and fertility levels on growth and yield of summer pearl millet under middle Gujarat conditions. The soil of experimental plot was loamy sand with low in organic carbon content (0.36%), available N (223.43 kg/ha), available P (31.52 kg/ha) and high in available K (270 kg/ha). The soil reaction (pH) was slightly alkaline (7.92). The experiment was laid out in a factorial randomized block design with fifteen treatment combinations comprising different intercropping systems and fertility levels with three replications which included five intercropping systems: I_1 (Sole pearl millet at 45 cm recommended row spacing), I_2 (Paired planting of pearl millet at 30/60 cm), I_3 (Pearl millet + cluster bean: paired planting of pearl millet at 30/60 cm + one row of cluster bean), I_4 (Pearl millet + green gram: paired planting of pearl millet at 30/60 cm + one row of green gram) and I_5 (Pearl millet + black gram: paired planting of pearl millet at 30/ 60 cm + one row of black gram) and three fertility levels: F_1 (120 kg N + 60 kg P_2O_5), F_2 (100 kg N + 50 kg P_2O_5) and F_3 (80 kg N + 40 kg P_2O_5). Result revealed that sole pearl millet recorded significantly higher yield attributes *viz.,* effective tillers per plant, ear head length as well as grain yield (4288 kg/ha) and straw yield (7083 kg/ha) and remained at par with paired planting of pearl millet at 30/60 cm and pearl millet + cluster bean intercropping system. While, significantly highest pearl millet equivalent yield (4901 kg/ha) observed under pearl millet + cluster bean. Among fertility levels, application of F_2 (100 kg N + 50 kg P_2O_5) recorded higher yield attributes as well as grain yield (4128 kg/ha), straw yield (6871 kg/ha) and pearl millet equivalent yield (4353 kg/ha), although differences were statistically non-significant.

Keywords **:** Pearl millet, intercropping systems, fertility levels, pearl millet equivalent yield, legumes

Introduction

Pearl millet (*Pennisetum glaucum* L.) is one of the major millet crops of India and holds significant importance among cereal crops. Among millets, pearl millet stands second to sorghum in terms of area and production. In India, Rajasthan occupies the leading position in both area and production of pearl millet. Pearl millet commonly referred to as 'Bajra' or 'bajri' is an essential staple food crop. It is cultivated during both *kharif* and summer seasons in Gujarat. During the summer season, pearl millet is usually grown after vegetable crops like chili, brinjal, cauliflower and cabbage as well as early sown wheat. Under such conditions, transplanting of seedlings has been reported to improve productivity and help offset yield losses caused by delayed sowing (Upadhyay *et al*., 2001). Pearl millet occupies area of 7.41 m ha with annual production of 10.3 m t and productivity of 1391 kg/ha in India (Anonymous, 2020-21).

The paired planting method of pearl millet (30/60 cm) has been reported to be more advantageous than the traditional uniform row system, as it enables the integration of legume intercrops without negatively affecting the yield of the main crop (Gautam,1989).

This approach improves efficient utilization of space and available resources compared to the conventional uniform row arrangement. Moreover, intercropping of cereals with legumes is widely recognized as a productive practice that enhance yield, increases land use efficiency and provides greater stability in agricultural production systems (Verma *et al*., 2005). Cereal-millet based intercropping systems tend to offer greater yield stability across seasons along with improved utilization of solar radiation (Willey *et al*., 1983). Legume crops such as cluster bean (*Cyamopsis tetragonoloba* L.), green gram (*Vigna radiata* L.) and black gram (*Vigna mungo* L.) have the ability to fix atmospheric nitrogen through symbiotic association, thereby improving soil nutrient status and reducing the need for chemical fertilizers (Goyal *et al.,* 2021).

Nitrogen, being a key nutrient in cereal production is often deficient in Indian soils, particularly in light textured soils. It plays a vital role in plant physiological processes and is a major component of essential biomolecules such as amino acids, proteins and nucleic acids. Phosphorus plays a crucial role in promoting the development of an extensive root system, which enhances the plant's ability to efficiently absorb moisture and essential nutrients. It significantly contributes to increased crop productivity by improving overall crop quality and imparting resistance against diseases.

Materials and Methods

A field experiment was conducted at Agronomy farm, B. A. College of Agriculture, Anand Agricultural University, Anand during summer 2021-22 to study the performance of intercropping systems and fertility levels on growth and yield of summer pearl millet (*Pennisetum glaucum* L.) in middle Gujarat condition. The soil of experimental plot was loamy sand with low in organic carbon content (0.36%), available N (223.43 kg/ha), available P (31.52 kg/ha) and high in available K (270 kg/ha). The soil reaction (pH) was slightly alkaline (7.92). The experiment was arranged in a randomized block design (factorial), comprising fifteen treatment combinations of different intercropping systems and fertility levels with three replications which included five intercropping systems: I_1 (Sole pearl millet at 45 cm recommended row spacing), I_2 (Paired planting of pearl millet at 30/60 cm), I_3 (Pearl millet + cluster bean: paired planting of pearl millet at 30/60 cm + one row of cluster bean), I_4 (Pearl millet + green gram: paired planting of pearl millet at 30/60 cm + one row of green gram) and I_5 (Pearl millet + black gram: paired planting of pearl millet at 30/ 60 cm + one row of black gram) and three fertility levels: F_1 (120 kg N + 60 kg P_2O_5), F_2 (100 kg N + 50 kg P_2O_5) and F_3 (80 kg N + 40 kg P_2O_5).

The field preparation included ploughing, harrowing and planking to achieve a fine tilth suitable for sowing. Pearl millet, green gram, black gram and cluster bean varieties GHB-1129, GAM-5, GAU-4 and GG-2 were tested in the investigation. The sowing was carried out on 22nd February, 2022 with the recommended seed rates for each crop and fertilizers were applied based on the respective treatment requirements. Sole pearl millet was planted at 45 x 10 cm, while paired planting of pearl millet and intercrops were spaced at 30 x 10 cm. Observations of base crop were recorded at different growth stages including plant population, plant height at 30, 60 DAS & at harvest, dry matter accumulation at 30 & 60 DAS. The crops were harvested in May 2022 and yield attributes such as effective tillers per plant, ear head length, test weight, harvest index, grain yield, straw yield, pearl millet equivalent yield were measured. Crop growth and yield characteristics were collected from the five tagged plants in each plot. The net plot area was used to calculate grain and straw yield, which was then converted into kilograms per hectare. On the basis of current market price, seed yield of different intercrops and by products were converted and summed up to the yield of pearl millet crop yield and pearl millet equivalent yield was obtained.

The expenditure on inputs such as seeds, fertilizers, irrigation and management practices was estimated based on prevailing local prices. Economic evaluation was carried out by calculating the gross return per hectare using the grain and straw yield of pearl millet at current market rates. Net return was obtained by deducting the total cost of cultivation from the gross income. The benefit-cost ratio (BCR) was also worked out to evaluate economic efficiency, where higher values indicate better profitability. Statistical analysis was conducted using the methods as described by (Cochran and Cox, 1967) and the significance of differences was tested using the 'F' test. The experimental data were subjected to standard analysis of variance (ANOVA) to evaluate the effect of different treatments. The analysis focused on growth and yield parameters to identify the most suitable intercropping system for pearl millet in the region.

Results and Discussion

Effect on yield attributes and yield of pearl millet

The yield attributes *viz.,* effective tillers per plant (4.46), ear head length (24.03 cm) as well as grain yield (4288 kg/ha) and straw yield (7083 kg/ha) of pearl millet were recorded significantly higher under sole pearl millet (I_1) and remained at par with paired row planting of pearl millet (I_2) and pearl millet +

cluster bean intercropping system (I_3). This may be attributed to better availability of resources such as space, light, nutrients and water along with minimal disturbance in the cropping system. Moreover, the beneficial interaction between intercrops and pearl millet plays an important role as legumes fix atmospheric nitrogen, which utilized by pearl millet, thereby enhancing its growth and yield. Similar findings have also been reported by Ram *et al.* (2003), Patel & Sadhu (2013), Ghilotia *et al.* (2015), Kamani & Arvadiya (2023), Shiyal *et al.* (2023) and Kumar *et al.* (2024) in pearl millet-pulse intercropping systems. Significantly highest pearl millet equivalent yield (4901 kg/ha) observed under pearl millet + cluster bean (I_3) intercropping system among different intercropping systems, while significantly lowest pearl millet equivalent yield recorded under pearl millet + black gram (I_5) intercropping system. This improvement may be attributed to efficient use of available resources, beneficial interactions between component crops and the additional yield along with higher market value of cluster bean. Similar trends have also been reported by Ram *et al.* (2003), Patel *et al.* (2021) and Shiyal *et al.* (2023). Test weight and harvest index did not reached to the level of significant.

Among fertility levels, treatment F_2 (100 kg N + 50 kg P_2O_5) recorded comparatively higher values for yield attributes, including grain yield (4128 kg/ha), straw yield (6871 kg/ha) and pearl millet equivalent yield (4353 kg/ha); however, these differences were found to be statistically non-significant. The improved performance under higher fertilization may be attributed to enhanced photosynthetic efficiency and better nutrient availability, which supported plant growth and assimilate partitioning. Similar results have also been reported by Vari & Sadhu (2013), Gaina *et al.* (2014), Patel *et al.* (2021), Kamani & Arvadiya (2023) and Shiyal *et al.* (2023). No significant variation was observed in test weight and harvest index.

Table 1: Effect of intercropping systems and fertility levels on yield attributes of pearl millet

	Treatments	Effective tillers per plant	Ear head length (cm)	Test weight (g)
	A. Intercropping systems			
I_1	Sole pearl millet (45 cm recommended row spacing)	4.46	24.03	7.02
I_2	Paired planting of pearl millet at 30/60 cm	4.10	22.66	6.82
I_3	Pearl millet + cluster bean: paired planting of pearl millet at 30/60 cm + one row of cluster bean	4.29	23.94	6.94
I_4	Pearl millet + green gram: paired planting of pearl millet at 30/60 cm + one row of green gram	3.92	22.27	6.90
I_5	Pearl millet + black gram: paired planting of pearl millet at30/ 60 cm + one row of black gram	3.88	22.21	6.77
	S.Em±	0.14	0.54	0.19
	CD (P=0.05)	0.41	1.55	NS
	B. Fertility Levels (kg/ha)			
F_1	120 kg N + 60 kg P_2O_5	4.17	23.14	6.88
F_2	100 kg N + 50 kg P_2O_5	4.26	23.33	7.01
F_3	80 kg N + 40 kg P_2O_5	3.95	22.59	6.77
	S.Em±	0.11	0.41	0.14
	CD (P=0.05)	NS	NS	NS
Interaction effect (I×F)				
	S.Em±	0.24	0.92	0.32
	CD (P=0.05)	NS	NS	NS
	CV (%)	10.24	6.97	8.15

Table 2: Effect of intercropping systems and fertility levels on yield of pearl millet

	Treatments	Grain yield (kg/ha)	Straw yield (kg/ha)	Pearl millet equivalent yield (kg/ha)	Harvest index (%)
	A. Intercropping Systems				
I_1	Sole pearl millet (45 cm recommended row spacing)	4288	7083	4288	37.83
I_2	Paired planting of pearl millet at 30/60 cm	4190	6971	4190	37.59
I_3	Pearl millet + cluster bean: paired planting of pearl millet at 30/60 cm + one row of cluster bean	4256	7052	4901	37.62

I_4	Pearl millet + green gram: paired planting of pearl millet at 30/60 cm + one row of green gram	3970	6532	4207	37.83
I_5	Pearl millet + black gram: paired planting of pearl millet at30/ 60 cm + one row of black gram	3870	6289	4067	38.07
	S.Em±	108	172	107	0.92
	CD (P=0.05)	314	501	312	NS
	B. Fertility Levels (kg/ha)				
F_1	120 kg N + 60 kg P_2O_5	4114	6745	4321	37.89
F_2	100 kg N + 50 kg P_2O_5	4128	6871	4353	37.58
F_3	80 kg N + 40 kg P_2O_5	4102	6740	4318	37.89
	S.Em±	84	133	83	0.72
	CD (P=0.05)	NS	NS	NS	NS
Interaction effect (I×F)					
	S.Em±	188	299	187	1.59
	CD (P=0.05)	NS	NS	NS	NS
	CV (%)	7.92	7.65	7.48	7.33

Conclusion

In view of the field experiment results, it can be concluded that grain and straw yield recorded significantly higher in sole pearl millet, while highest pearl millet equivalent yield recorded under pearl millet + cluster bean intercropping system. In fertility levels, application of 100 kg N + 50 kg P_2O_5 recorded higher pearl millet equivalent yield. Pearl millet + cluster intercropping system recorded higher gross income, net income and BCR. Thus, pearl millet + cluster bean intercropping system is a productive and economically viable option for summer cultivation under middle Gujarat conditions.

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