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Effect of cultivars and fertility levels on yield and economics of pearl millet under rainfed condition of Jammu region

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Abstract
A field experiment entitled "Growth and yield potential of Pearl millet (*Pennisetum glaucum*) cultivars as affected by fertility levels" was conducted at the Research Farm of Advance Centre for Rainfed Agriculture, Rakh Dhinsar of Sher-e-Kashmir University of Agriculture Sciences and Technology of Jammu, during kharif season of 2020 to find out suitable cultivars with optimum fertility level for rainfed condition of Jammu. The experiment consisted of fifteen treatment combinations comprising three cultivars (Puas composite 383, MBC-2 & local variety) with five fertility levels (F_1- Control, F_2- 25 kg N through FYM, F_3- 50:30:15 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM, F_4- 65:40: 20 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM, F_5- 80:50:25 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM), laid out in Factorial Randomized Block Design replicated thrice.
Pearl millet cultivar MBC-2 recorded significantly higher grain and stover yield as compared to Pusa Composite-383 and local variety. Whereas, among the fertility levels F_5 - 80:50:25 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM to recorded significantly higher grain and stover yield over lower fertility levels but remained at par with fertility level F_4 (65:40:20 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM). On the basis of one year finding it is concluded that under rainfed conditions of Jammu, pearl millet cultivar MBC 2 when fertilized with F_4 (65:40:20 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM) marked its superiority by recording higher B:C ratio besides producing grain and stover yield statistically at par with fertility level F_5 (80:50:25 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM).

Keywords: FYM, cultivars, fertility levels, pearl millet, rainfed

1. Introduction
Pearl millet (*Pennisetum glaucum*) is traditionally the hardiest warm season dryland crop [1], cultivated mostly in arid or semi-arid regions, characterized by low rainfall, sandy soils with low fertility [2]. It is successfully cultivated in the areas where agro-climatic conditions are adverse for crop production and even crops like sorghum and maize fail to produce economic yield. Contrarily, it is also known to perform well under favourable environment conditions as it has short developmental stages and capacity for high growth rate [3]. These characteristics with improved crop management practices make it an excellent crop for short growing seasons. Pearl millet hybrid is cultivated as an irrigated summer season crop which produces food and fodder within a short period of 80-85 days [4]. Bajra being a C4 plant, posses high photosynthetic efficiency and more dry matter production capacity. It is also known by various common names such as Bajra, Bajri, Sajja, combo or kambam [5]. It is staple food grain with a high nutritional value and also used as a feed, fodder, construction material and bio-fuel. The nutritional value of Bajra offers much scope for development of value added products in new health conscious consumer segments [6], as it contains more fibre and is good for diabetic and heart patients. It is richest source of nutrition, especially iron (2.8%), calcium and zinc among cereals and hence can provide all the nutrients at much lesser cost as compared to the staple food like wheat and rice [7]. It is also good source of protein (11.6%), fat (5%), carbohydrate (67%) and minerals [8]. The main causes of low productivity of pearl millet are prevailing abiotic stresses like drought, poor soil fertility, high soil pH and high temperature. These factors limit the uptake of applied nutrients by roots and are also not able to turn over the nutrients compatible with crop nutritional requirement at different growth stages. Balanced nutrition played an imported role in boosting the productivity of pearl millet [9]. Under rainfed conditions, application of balanced nutrients showed increase in growth, yield attributing characters and yield of bajra [10].

Cereals generally require a good supply of major nutrients particularly N during most of their growth period. Nitrogen applications help plants in better vegetative growth and improve the quality of grains. Balance application of potassium along with nitrogen and phosphorus not only gave higher yield of pearl millet but also increased its quality [11]. Manure application in the crop not only increases crop yield but also improves soil health and productivity. It has a significant influence on physical, biological and chemical properties of soil. Farmyard manure being the source of all essential elements, improves soil organic matter and humus of the soil. It increases cation exchange capacity and improve water holding capacity of soil. FYM also plays important role in inhabitation of beneficial bacteria and retain soil moisture upto some constraint thus, making the nutrients available during entire crop growth period [12]. Integrated use of farm yard manure (FYM) with chemical fertilizers (N, P and K) is an effective way to compensate soil deficiency and inability of soil to transfer nutrients to the plants to maintain high productivity of undernourished crop.

Pearl millet is predominantly gaining more importance in the world due to increasing population and uncertainties of climate [13]. Adaptability of new pearl millet cultivars in different agro-climatic regions of our country, other than the traditional areas is more important in fulfilling the needs of increasing population as well as fodder demand of domestic animals. A suitable technology with low cost which gives maximum production is always preferred by farmers, as it is reduces production cost. So it is necessary to find out a treatment combinations for pearl millet which shows an excellent performance by producing higher grain as well as green fodder yield. In Jammu region of UT Jammu and Kashmir, negligible work has been carried out on pearl millet under sub-tropical rainfed conditions. Sufficient information for this region, regarding pearl millet production is not available. Therefore, the present investigation was conducted to identification of pearl millet cultivars along with optimum NPK level with or without FYM under rainfed conditions of Jammu region.

2. Material and Methods

The experiment carried out during the *kharif* season of 2020 at the Research Farm of Advanced Centre for Rainfed Agriculture (ACRA), Rakh Dhinsar of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. A field experiment trial, was laid out in a factorial randomized block design with three replications. In the experiment three cultivars of pearl millet (Pusa composite 383, MBC 2 and local variety) were used with five fertility levels *viz.* F_1 (control), F_2 (25 kg N through FYM), F_3 (50:30:15 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM), F_4 (65:40:20 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM), F_5 (80:50:25 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM). There was total 15 treatment combination. The soil of experimental trial was sandy loam in texture, neutral in reaction (pH 6.9) and having EC 0.17 dS/m. Experimental site also low in organic carbon (2.7 g/ha), available nitrogen (167.31 kg/ha) and potassium (98.64 kg/ha) and medium in available phosphorous (12.4 kg/ha).

Pearl millet crop was sown in rows, keeping row to row distance of 45 cm with recommended seed rate of 5 kg/ha. The total number of rows in each plot was 8. The gross plot size of individual treatment was 3.6 x 3.0 m. Pearl millet grain yield from each net plot after threshing was recorded separately as kg/plot and then converted in kg/ha as per the different treatments combinations. The Stover yield of pearl millet crop was calculated by subtracting the total biomass from the grain yield of respective treatments. Harvest index (HI) is a ratio between economic yield and biological yield. It is computed using following formula for each treatment [14].

$$\text{Harvest Index} = \frac{\text{Economic yield (grain)}}{\text{Biological yield (grain + stover)}} \times 100$$

Statistical analysis of various data recorded during the period of investigation was carried out through adoption of appropriate method of analysis of variance as described by Fisher, 1950 [15]. Calculation of critical difference was done to compare the treatments; the F test was found to be statistically significant at a 5% level of significance in all cases. The experimental site of ACRA, Rakh Dhiansar received 1050 mm to 1115 mm mean annual rainfall and its 75 per cent rainfall was received from June – September showed.

3. Result and Discussion

3.1.1 Effect of cultivars on yield and economics

In the present study, data elucidate that cultivar MBC 2 showed its superiority over Pusa Composite 383 and local variety by recording grain yield of (2363.69 kg/ha). It was also excelled from data that cultivar MBC 2 registered 20.54 and 46.27 per cent higher grain yield over Pusa composite 383 and local variety. The stover yield also shared significant variation due to different cultivars (Table 1). Maximum stover yield was recorded in MBC 2 (4041.33 kg/ha), which was significantly higher over Pusa composite 383 (3780.47 kg/ha) and local variety (3563.53 kg/ha). It also cleared from figure 1. The data revealed that cultivars had non- significant effect on the harvest index. Cultivar MBC 2 recorded maximum harvest index (36.70%) whereas minimum harvest index was recorded (30.44%) in local variety. Cultivar MBC 2 produced significantly higher grain and stover yield. The grain and stover yield are sum of all growth contributing factors by both agronomical and genetic manipulation. The higher grain and stover yield in MBC 2 cultivar seems to be on account of overall improvement in growth as evinced from higher leaf area index, number of tillers/m^2 and dry matter accumulation which ascribes to be because there were greater availability of growth inputs matching with formation and development of grain and stover yield component. The variant in these parameters might be due to differential capacity of cultivars in utilizing the available resources. These results confirm the earlier finding of Prasad *et al.* and Kaur and Goyal [16, 5].

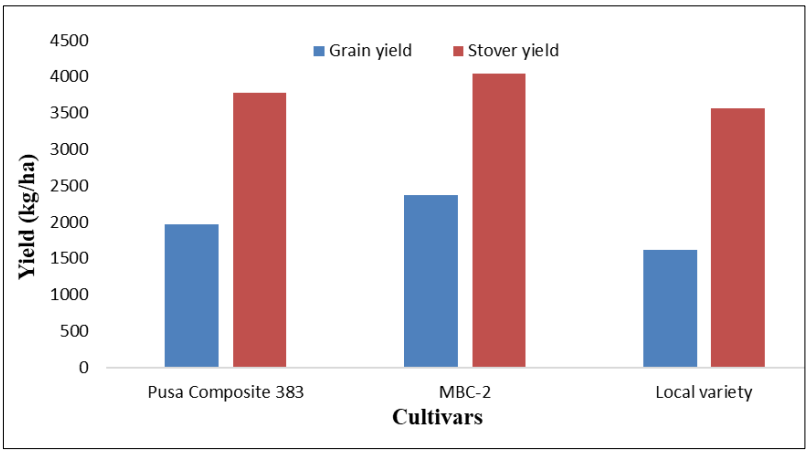

Fig 1: Effect of cultivars on yield (kg/ha) of pearl millet

The data presented in Table 2 showed that the highest B:C ratio (1.88) was registered with the cultivar MBC 2, followed by Pusa composite 383 and local variety. Lowest B:C ratio 1.12 observed in local variety. Cultivar MBC 2 fetched more gross returns (62827 ₹/ha), local variety showed lowest gross return (44874 ₹/ha). Data in table 1 clearly explained that cultivars significantly influenced the net return and registered maximum net return with cultivar MBC 2 (₹ 41160), which was higher over Pusa composite 383 and local variety. Different genotypes have their potential to produced different crop yield resulting in different gross returns, net returns, B:C ratio. Similar findings were reported by Sheoran *et al.* [17].

3.1.2 Effect of fertility levels on yield and economics

Regarding fertility levels maximum grain yield (2502.67 kg/ha) was observed with the application of 80:50:25 + 25 kg N through FYM which was significantly higher over rest of fertility levels but at par with the 65:40:20 + 25 kg N through FYM (2393.89 kg/ha). Similarly maximum stover yield was produced by the F_5 - 80:50:25 kg/ha of $N:P_2O_5:K_2O$ + 25 kg N through FYM fertility level with the yield of 4459.78 kg/ha, which was significantly higher over rest of fertility levels but remained statistically at par with F_4 - 65:40:20 kg/ha of $N:P_2O_5:K_2O$ + 25 kg N through FYM with stover yield of 4347.67 kg/ha. The effect clearly showed by figure 2. The effect of fertility levels on the harvest index was non-significant. Fertility level F_5 – 80:50:25 kg/ha of $N:P_2O_5:K_2O$ + 25 kg N through FYM showed maximum harvest index while F_1 (control) recorded minimum (30.78%) harvest index. Fertilizer levels upto 80:50:25 + 25 kg N through FYM significantly increased stover and grain yield which might be due to better nutritional status of the crop in the soil, which was earlier low in N, K and medium in P. This was proved by their uptake in the plant (Table 1). The increased supply of fertilizers and their higher uptake by plants might have stimulated the rate of various physiological processes in crop. The results of present study with the combined application of fertilizers are in line with those of Malik *et al.*, Kumar *et al.* and Girase *et al.* [18, 19, 20].

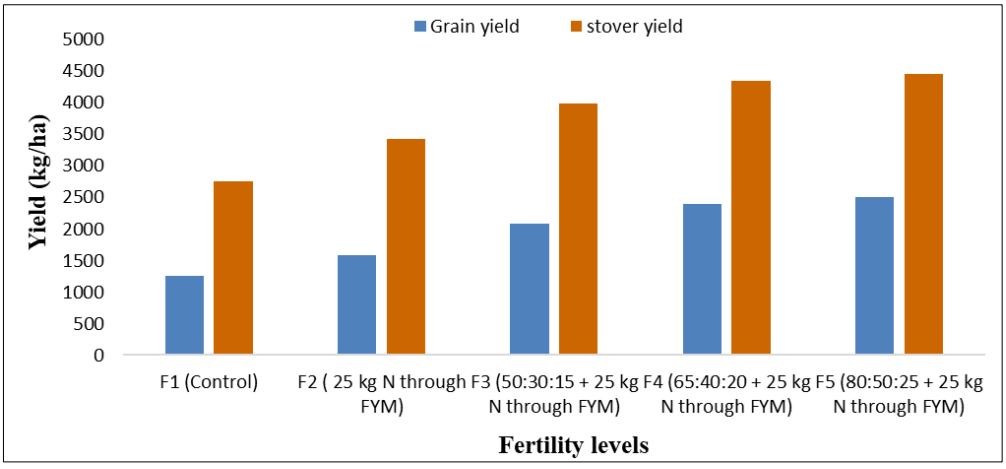

Fig 2: Effect of fertility levels on yield (kg/ha) of pearl millet

Application of 80:50:25 kg/ha of $N:P_2O_5:K_2O$ + 25 kg N through FYM F_5 fetched net returns of (42478 ₹/ha) i.e. proved 6.4 per cent higher over F_4 -65:40:20 kg/ha of $N:P_2O_5:K_2O$ + 25 kg N through FYM (40832 ₹/ha). The fertility level F_5 – 80:50:25 kg/ha of $N:P_2O_5:K_2O$ + 25 kg N through FYM showed maximum gross return (67249 ₹/ha) which was significantly higher over rest of fertility levels. Lowest gross return 35246 ₹/ha was fetched with F_1 (control). Among fertility levels F_4 showed maximum B:C ratio (1.72), which was higher over rest of fertility levels. Lowest B:C ratio 1.18 recorded in F_2 fertility level. Fertility levels show significant variation in gross returns, net returns and B:C ratio. The results showed that increasing fertility levels up to 80:50:25 kg/ha of $N:P_2O_5:K_2O$ + 25 kg N through FYM (F_5) increased the gross return, net return and B:C ratio due to higher grain and straw yields of pearl millet. Similar

observation was also recorded by Bhanuprakash in paddy and Ganapati and Guggari in pearl millet [21, 22].

3.2.1 Effect of cultivars on nutrient uptake

Perusal of data in Table 1 and Figure 3 indicated that the highest N uptake (40.49 kg/ha) by grains were recorded in the cultivar MBC 2, which was significantly higher over Pusa composite 383 and local variety with the value 32.09 and 26.31 kg/ha, respectively. MBC 2 recorded higher P uptake (5.34), which significantly superior than Pusa composite 383 and local variety by 29.61 and 43.93 per cent. The highest K uptake (14.44) by grain was seen in the cultivar MBC 2, which was significantly higher over Pusa composite 383 and local variety by 32.36 and 60.80 percent.

Perusal of data in table 1 and figure 4 indicated that the highest N uptake (21.94 kg/ha) by stover was recorded in the cultivar MBC 2, which was significantly higher over Pusa composite 383 and local variety with the value 19.78 and 19.72 kg/ha, respectively. Stover of MBC 2 recorded higher P uptake (10.76 kg/ha), which was superior over Pusa composite 383 and local variety by 16.83 and 26.14 per cent. The highest K uptake (57.03 kg/ha) was recorded in the stover of cultivar MBC 2, which was significantly higher over Pusa composite 383 and local variety by 23.4 and 34.1 percent.

The plant analysis indicates that cultivar MBC 2 recorded higher N, P and K uptake in stover and grain. Plant portions with improved nutritional status in cultivar MBC 2 may be attributed to their genetic makeup. The significant increase in N, P and K uptake of grain and stover seems to be on account of potential of the cultivars for efficient absorption, translocation and utilization of mineral nutrients. Moreover, the increased dry matter accumulation, opined that adequate supply of metabolites from root to shoot decides proliferation and facilitate higher nutrients extraction from soil environment. These findings are close agreement with the finding of Kumar and Chaplot and Meena *et al.* [23, 24].

3.2.2 Effect of fertility levels on nutrient uptake

Data explicate (Table 1 and Figure 3) that maximum N (44.51 kg/ha), phosphorus (5.97 kg/ha) and K (15.83 kg/ha) uptake by grain was registered with the fertility level F_5 – 80:50:25 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM, but it was found statistically at par with fertility level F_4 – 65:40:20 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM with the value 41.74, 5.48 and 14.62 kg/ha, respectively. Phosphorus uptake in fertility level F_5 registered an increase of 136.2, 74.9, 27.5 and 8.2 per cent over fertility level F_1, F_2, F_3 and F_4, respectively.

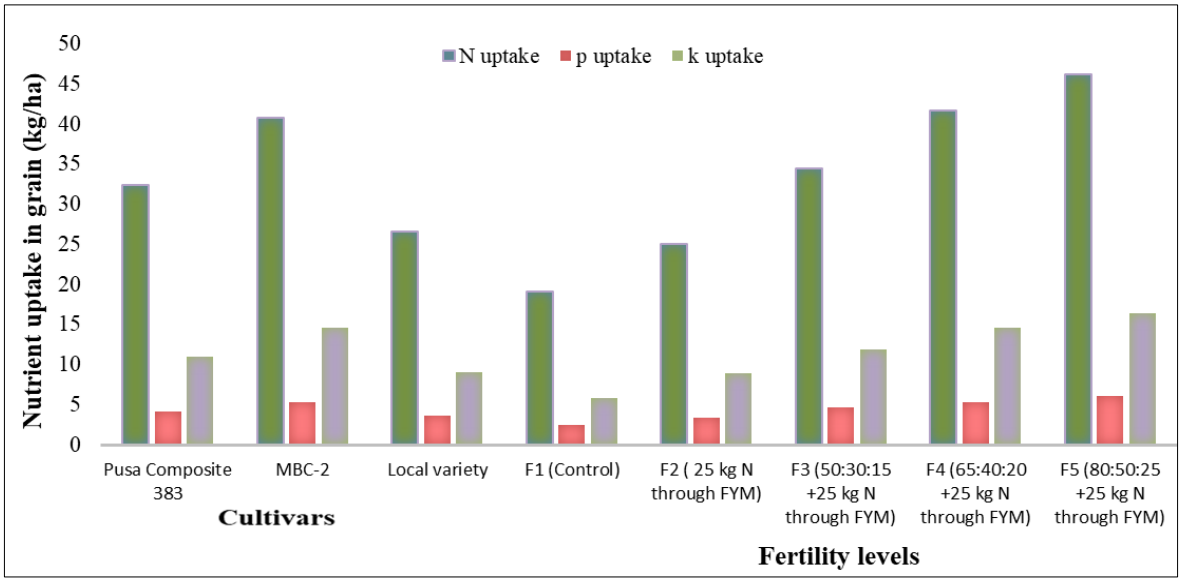

Fig 3: Effect of cultivars and fertility levels on nutrient uptake in grain of pearl millet

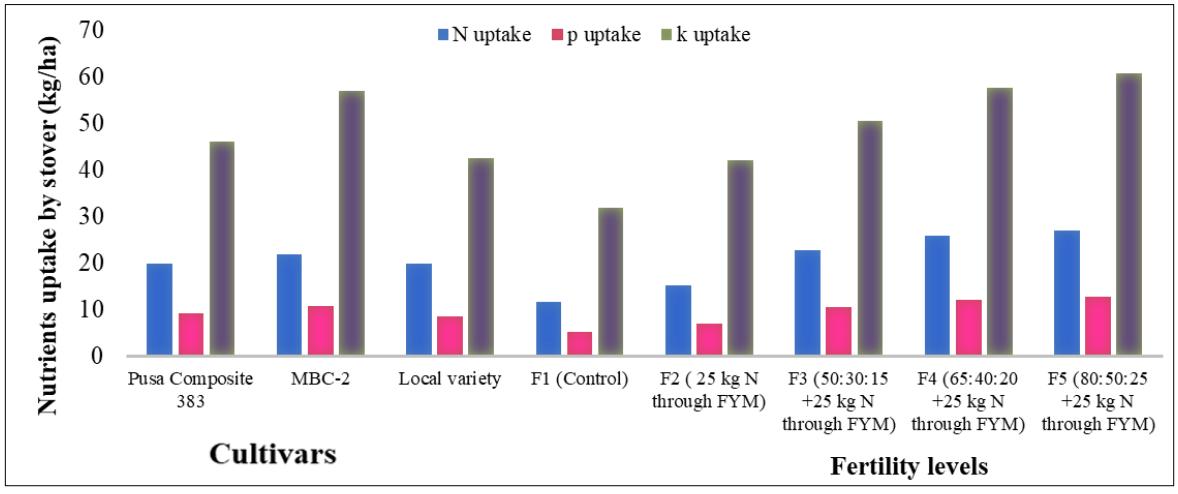

Fig 4: Effect of cultivars and fertility levels on nutrient uptake in stover of pearl millet

Data presented (Table 1 and Figure 4) that maximum N (26.91 kg/ha), phosphorus (12.77 kg/ha) and K (60.30 kg/ha) uptake by stover was registered with the fertility level F_5 - 80:50:25 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM, but it was found statistically similar with fertility level F_4 - 65:40:20 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM with the value 25.90, 12.15 and 57.73 kg/ha. In Phosphorus uptake fertility level F_5 registered an increase of 149.9, 84.5, 20.9 and 5.1 per cent over fertility level F_1, F_2, F_3 and F_4, respectively.

Results revealed that application of higher levels upto 80:50:25 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM significantly increased N,P and K uptake in both grain and stover of pearl millet at harvest over rest of fertility levels. This is attributed to improved nutritional environment in the rhizosphere and in the plant system leading to enhanced translocation of nitrogen, phosphorus and potassium in plant parts. Study of Kar *et al.* and Singh *et al.* [25, 26] reported similar results.

4. Interaction effect of cultivars and fertility levels on stover yield (kg/ha) of pearl millet: Data presented in table 3 revealed that the interaction effect between various cultivars and fertility levels on stover yield was found significant. Maximum stover yield was produced by cultivar MBC 2 (4889 kg/ha) when crop was fertilized with 80:50:25 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM (V_2F_5) and it was closely followed by V_2F_4. Significantly minimum stover yield (2639.67 kg/ha) was noted under treatment V_3F_1.

Table 1: Yield, harvest index and nutrients uptake by grain and stover of pearl millet as affected by cultivars and fertility levels

Treatments	Yield			Nutrients Uptake by grain (kg/ha)			Nutrients Uptake by stover (kg/ha)		
	Grain (kg/ha)	Stover (kg/ha)	Harvest index (%)	N	P	K	N	P	K
Cultivars									
Pusa Composite 383	1953.93	3780.47	33.74	32.09	4.12	10.91	19.79	9.21	46.21
MBC 2	2350.60	4041.33	36.54	40.49	5.34	14.44	21.94	10.76	57.03
Local variety	1594.27	3563.53	30.17	26.31	3.71	8.98	18.53	8.53	42.52
S.Em (±)	61.60	50.33	0.77	0.96	0.13	0.39	0.34	0.23	0.96
CD (5%)	178.44	144.58	NS	2.77	0.37	1.14	0.99	0.66	2.80
Fertility levels (N: P_2O_5: K_2O kg/ha)									
F_1 (Control)	1257.44	2757.11	30.78	19.10	2.51	5.83	11.65	5.11	32.38
F_2 (25 kg N through FYM)	1589.22	3421.33	31.08	25.04	3.39	8.94	15.15	6.92	42.06
F_3 (50:30:15 + 25 kg N through FYM)	2088.11	3990.43	34.04	34.43	4.65	11.98	22.80	10.56	50.47
F_4 (65:40:20 + 25 kg N through FYM)	2393.89	4347.67	35.58	41.74	5.48	14.62	25.90	12.15	57.73
F_5 (80:50:25 + 25 kg N through FYM)	2502.67	4459.78	35.94	44.51	5.97	15.98	26.91	12.77	60.30
S.Em (±)	79.52	64.55	2.30	1.23	0.16	0.51	0.44	0.30	1.25
CD (5%)	230.36	187.69	NS	3.57	0.47	1.30	1.27	0.86	2.95

*RDF= 50:30:15 kg/ha of N: P_2O_5: K_2O

Table 2: Economics of pearl millet as affected by cultivars and fertility levels

Treatments	Cost of Cultivation	Gross Returns (₹/ha)	Net Returns (₹/ha)	B:C Ratios
Cultivars				
Pusa Composite 383	21667	53344.32	31677.32	1.44
MBC 2	21667	62826.87	41159.87	1.88
Local variety	20977	44873.58	23896.58	1.12
Fertility levels (N: P_2O_5: K_2O kg/ha)				
F_1 (Control)	15384	35245.83	19861.83	1.28
F_2 (25 kg N through FYM)	20385	44465.06	24080.06	1.18
F_3 (50: 30: 15 + 25 kg N through FYM)	23007	56977.86	33970.86	1.47
F_4 (65: 40: 20 + 25 kg N through FYM)	23638	64470.39	40832.39	1.72
F_5 (80: 50: 25 + 25 kg N through FYM)	24771	67248.81	42477.81	1.71

*RDF= 50:30:15 kg/ha of N: P_2O_5: K_2O

Table 3: Interaction effect of cultivars and fertility levels on stover yield (kg/ha) of pearl millet

Fertility levels (N: P_2O_5: K_2O kg/ha)	Cultivars		
	Pusa Composite 383 (V_1)	MBC 2 (V_2)	Local variety (V_3)
F_1 (Control)	2704.33	2928.73	2639.67
F_2 (25 kg N through FYM)	3389.21	3675.52	3182.10
F_3 (50:30:15 +25 kg N through FYM)	3965.67	4179.33	3758.42
F_4 (65:40:20 +25 kg N through FYM)	4313.74	4535.05	4098.11
F_5 (80:50:25 +25 kg N through FYM)	4454.13	4889.00	4125.84
S.Em (±)	117.00		
CD (5%)	323.35		

5. Conclusion

From the above study, it is concluded that under rainfed conditions of Jammu, pearl millet cultivar MBC 2 when fertilized with F_4 (65:40:20 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM) marked its superiority by recording higher B:C ratio besides producing grain and stover yield statistically at

par with fertility level F_5 (80:50:25 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM).

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