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Growth and yield attributes of pearl millet as influenced by cultivars and fertility levels under rainfed condition of Jammu Region

PRAKRATI MALAKAR[1], MEENAKSHI GUPTA[1], VIKAS GUPTA[1] AND NANA LAL MALI[2]

[1]Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu-180009
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ABSTRACT

A field experiment entitled "Growth and yield potential of Pearl millet (Pennisetum glaucum L.) cultivars as influenced by fertility levels" was conducted during kharif season of 2020 at Rakh Dhinsar, SKUAST, Jammu. In this experiment three cultivars (Puas composite 383, MBC-2 & local variety) was combined with five fertility levels. Totally there were fifteen treatment combinations and laid out in Factorial Randomized Block Design with three replications. Pearl millet cultivar MBC-2 recorded significantly higher growth parameters viz., dry matter accumulation (615.37), number of tillers/m^2 (23.47), leaf area index (2.41) and crop growth rate (3.95) and yield attributes viz., ear head/m^2 (22.13), 1000 grain weight (7.05g), number of grains/ear head (1593.41) 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 growth parameters and yield attributes 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). Hence, 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 marked its superiority by recording higher growth parameters and yield attributes statistically at par with fertility level F_5.

Key words: Yield attributes, Cultivars, Fertility levels, Growth parameters, Pearl millet.

INTRODUCTION

Globally, pearl millet production is mainly concentrated in the developing countries which accounts for over 95% of the total area and production. It is cultivated in more than 30 counties around the world accounting for about 30 mha of the total area. Africa has maximum area under pearl millet (about 18 mha) followed by Asia (about 10 mha). However, its cultivation is also being expanded to some non-traditional areas like Brazil (2mha) (Yadav and Rai, 2013; Sannagoudar *et al.*, 2020). It is sixth most significant cereal of the world and fourth important food grain in India after rice, wheat and maize (Wadile *et al.*, 2009). In India, the area under pearl millet was decreased by 26 % between 2014 and 2015 compared to the 1980s, but production climbed by 19% as a result productivity gain of 48% (Anonymous, 2016). India is still the world;s top-ranked producer of pearl millet, producing 11.64 million tonnes from an area of 9.18 million hectares. Major pearl millet growing states in India are Rajasthan, Uttar Pradesh, Gujarat and Maharashtra etc. which account for more than 90 per cent acreage (Anonymous, 2018). To fulfill the fodder need of growing animal population, pearl millet stover forms an important source of fodder during lean period particularly in dry regions and is often the only source of feed in dry months (Ramesh *et al.,* 2006; Sannagoudar *et al.*, 2021). Quality of pearl millet fodder is better than sorghum and maize because its green fodder does not contain hydrocyanic acid and also contains more crude protein. The cultivation of pearl millet for fodder purpose is recently being emphasized due to its profuse tillering, multicut nature, absence of poisonous prussic acid and good performance under poor is fertile soils. In our country, under rainfed conditions, pearl millet offers both food and fodder security. Although pearl millet is grown on low fertility soils but being an exhaustive cereal crop, it responds well to nitrogen fertilization (Sheoran *et al.*, 2016). Present investigation was conducted at Jammu to find out suitable pearl millet cultivars for Jammu region which give better option for food and fodder to local community.

MATERIAL AND METHODS

Factorial randomized block design lay out with three replications. In the experiment Pusa composite 383, MBC 2 and local variety of pearl millet cultivars 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

[2]*Agriculture Research Officer, Department of Agriculture, Rajasthan, India-312202,*
(Corresponding author E-mail – prakrati905@gmail.com)

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). Statistical analysis of various data through adoption of appropriate method of analysis of variance as described by Fisher, 1950.

Soil

The experiment carried out at the Research Farm of Advanced Centre for Rainfed Agriculture (ACRA), Rakh Dhinsar, Jammu. The soil of experimental site 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).

Climate and Weather

The climate of the experimental site was mainly sub-tropical type in the nature. The weather data for crop season was recorded at the metrological observatory located near experimental area and has been presented graphically in Fig. 2.1. The mean temperature varied from 31.8 to 35.1°C as maximum temperature and 14.9 to 25.89°C as minimum temperature during the crop growth period (22nd July to 24nd October), 2020. Both the respective temperature showed the fluctuations throughout the crop growth period. The mean relative humidity varied from 80.3 to 90.6 per cent (morning) and 53 to 69 per cent (evening) depicted in Figure 2.2. The total rainfall received during the crop season was 636 mm. Mostly maximum rainfall events occurred during July and first fortnight of August (Fig. 1). However, there were two dry spells of 12 days (18–29 August) and 8 days (15–22 September) observed during the reproductive stages which were more crucial from production point of view. Evaporation reading taken from the Lysimeter which is also represented graphically in the Figure 2.2.

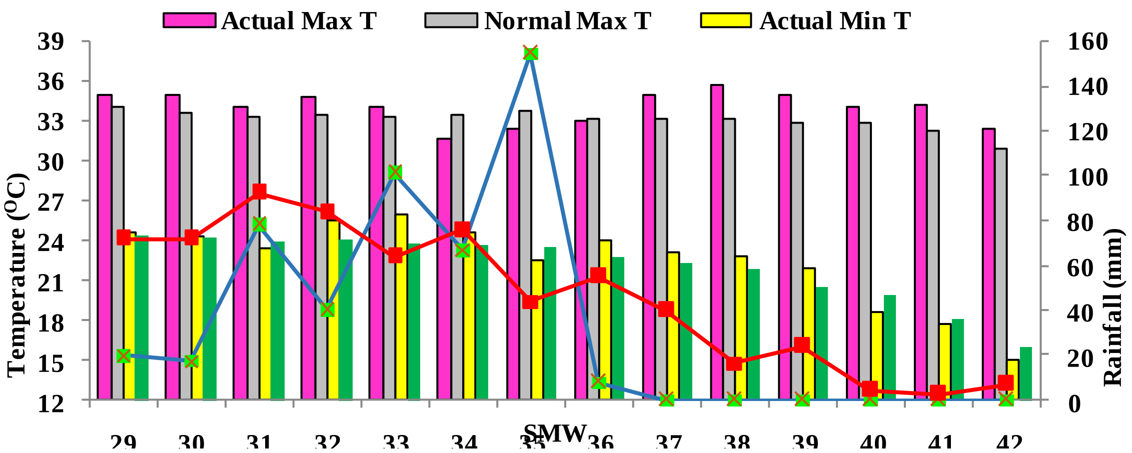

Figure 2.1: Weekly weather data of temperature and rainfall along with normal during the growing period of pearl millet in *Kharif*, 2020

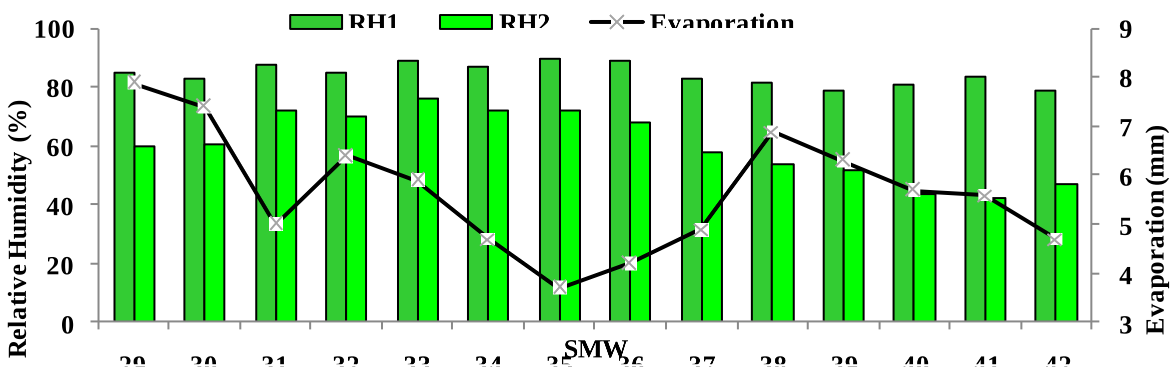

Figure 2.2: Weekly weather data of relative humidity and pan evaporation during the growing period of pearl millet in *Kharif*, 2020

RESULTS AND DISCUSSION

Growth Parameters

The growth of pearl millet crop was measured in term of plant height, leaf area index number of tillers/m^2, dry matter accumulation/m^2 and crop growth rate.The data on the results of the effect of cultivars and fertility levels on various growth parameters of pearl millet have been presented in Table 1,2 and 3.

Table 1: Plant Height (cm) and Dry matter accumulation (g/m^2) of pearl millet as affected by cultivars and fertility levels

Treatments	Plant Height (cm)				Dry matter accumulation (g/m^2)			
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest
Cultivars								
Pusa Composite 383	35.87	65.53	108.24	138.18	94.17	337.36	458.64	529.47
MBC 2	37.23	69.39	117.60	145.28	107.56	383.24	529.16	615.37
Local variety	38.39	78.08	132.33	162.79	88.46	303.97	429.93	499.31
SEm(±)	0.69	0.95	1.78	1.98	1.74	4.72	6.25	8.02
CD (5%)	1.99	2.77	5.17	5.75	5.04	13.67	18.11	23.25
Fertility levels (N: P_2O_5: K_2O kg/ha)								
F_1 (Control)	30.58	58.27	102.29	123.53	67.56	235.12	341.34	389.55
F_2 (25 kg N through FYM)	33.36	64.13	110.98	133.71	81.63	284.17	392.29	458.66
F_3 (50:30:15 + 25 kg N through FYM)	37.76	71.39	121.44	150.85	103.24	368.80	505.28	581.01
F_4 (65:40:20 + 25 kg N through FYM)	40.54	80.22	128.49	165.54	113.47	401.94	554.39	640.61
F_5 (80:50:25 + 25 kg N through FYM)	43.58	80.98	133.76	170.11	117.75	417.60	570.76	670.42
S.Em(±)	0.89	1.23	2.30	2.56	2.25	6.09	8.07	10.36
CD (5%)	2.57	3.57	6.68	7.42	6.51	17.65	23.38	30.01

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

Effect of cultivars on growth parameters

Plant height is a reliable index of growth and development. During initial growth stage *i.e.* 20 DAS significantly more plant height was recorded in local variety (38.39 cm) as compared to MBC 2 and Pusa composite 383. At 40 DAS significantly maximum plant height (78.08 cm) was recorded in local variety. At later growth stages, 60 DAS and at harvest, plant height showed similar trend as that of 40 DAS. It is represented in Table 1.

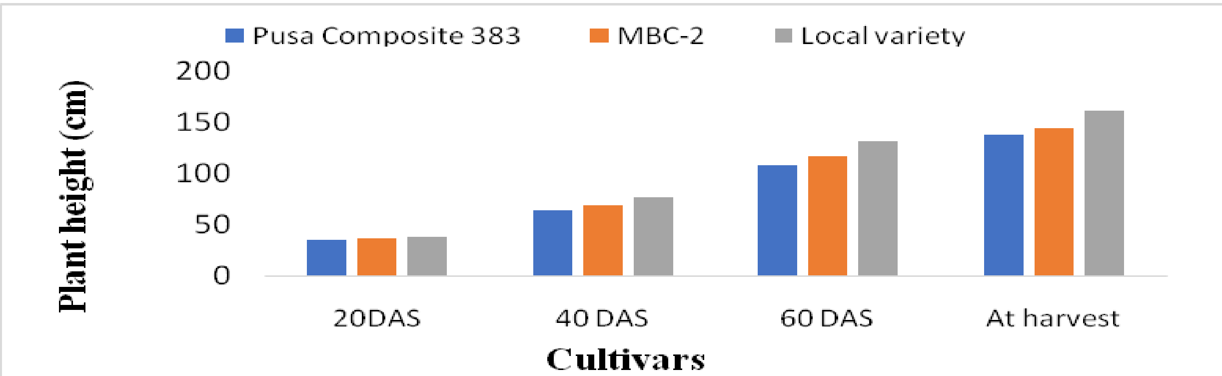

Figure 1: Effect of cultivars on plant height (cm) of pearl millet

Leaf area index is one of the important plant growth parameter used to determine the capacity of plants to trap solar energy for photosynthesis and crop yield. The leaf area index increased with the advancement of the crop age from 20 DAS up to 60 DAS then decreased at harvest stage and conspicuous increase in the values of LAI was observed between 40 and 60 DAS (Table 2). Higher values of LAI were observed in MBC 2 is 0.64, 1.78, 2.91 and 2.41 at 20, 40, 60 DAS and at harvest, respectively. MBC 2 remained significantly superior to rest of cultivars under experiment. Data in table 2 indicated that cultivars significantly influenced number of tillers/m^2 at all the growth stages. Number of tillers shared increase with the advancement of the crop age up to 60 DAS, than decreased at harvest stage. At 20 DAS, significantly higher number of tillers/m^2 was recorded in cultivar MBC 2 than Pusa composite 383 which is turn were significantly higher than local variety. Same trend was followed at all the growth stages up to harvest.

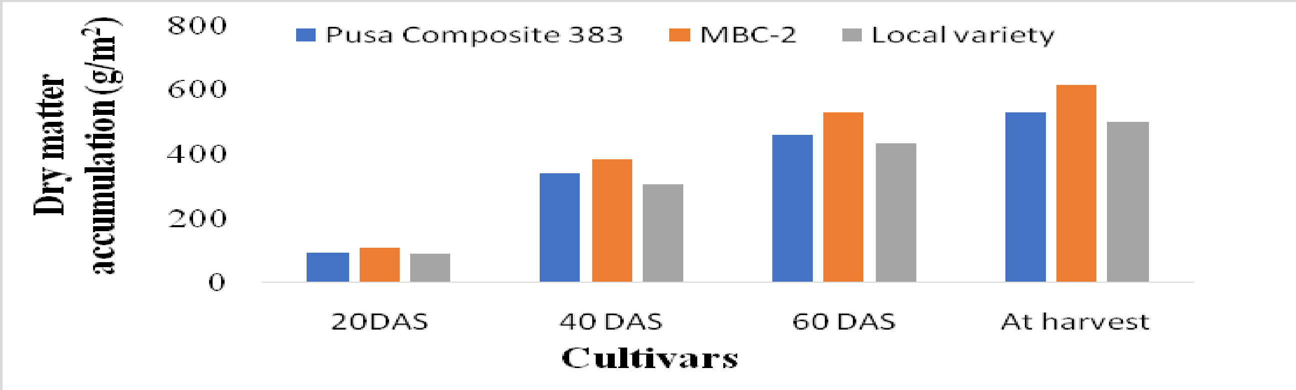

Figure 3: Effect of cultivars on dry matter accumulation (g/m^2) of pearl millet

The data impressed upon that significant increase in plant dry matter accumulation of pearl millet per meter square was observed in all the cultivars at different growth stages, till harvest. Cultivar MBC 2 proved significantly better over Pusa composite 383 and local variety. Maximum dry matter accumulation in MBC 2 was 107.5, 383.2, 529.1 and 615.3 g/m^2 at 20, 40, 60 DAS and at harvest, respectively. Showing an increment of 21.6, 26, 23 and 23.2 per cent in dry matter accumulation over local variety which accumulated lowest dry matter at 20 days interval upto harvest. The data presented in Table 1 explained that cultivar MBC 2 recorded higher crop growth rate at all the stages of growth, which was significantly higher over rest of cultivars under test. Maximum CGR (13.78 g/m^2/day) observed in MBC 2 at interval of 20-40 DAS. Pearl millet cultivar MBC 2 exhibited that the significantly increase in plant height, leaf area index, crop growth rate and number of tillers/m^2 at various growth stages and at harvest stage due to interception, absorption and utilization of radiant energy. It results in higher accumulation of photosynthates and finally higher dry matter accumulation at 20, 40, 60 DAS and at harvest. The differences in plant height, CGR, number of tillers/m^2, LAI and dry matter accumulation (g/m^2) might be due to the variation in their genetic character and inter-nodal length (Sannagoudar *et al.*, 2023; Biradar *et al.*, 2023; Baradwal *et al.*, 2022). Interaction effect is found in dry matter accumulation at harvest. Similar finding were also reported by Kaur and Goyal (2019) and Wankhede *et al.* (2018).

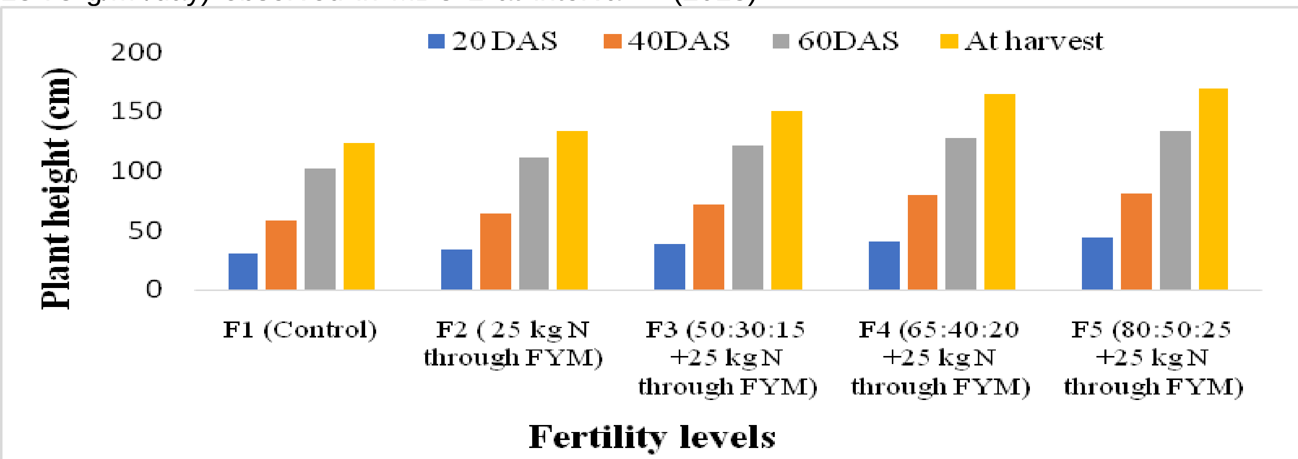

Figure 2: Effect of fertility levels on plant height (cm) of pearl millet

Effect of fertility levels on growth parameters

Plant height was significantly affected with varying fertility levels. At 20 DAS, significantly higher plant height (43.58 cm) was observed with fertility level of F_5 over lower fertility levels but remained at par with fertility level, F_4. Similar trend in plant height was seen at later growth stages *i.e,* 40, 60 DAS and at harvest stages. It is clear from the data (Table 2) that application of different fertility levels proved instrumental increasing in LAI of pearl millet. Among the different fertility levels, significantly maximum LAI (2.91) was recorded in F_5 at 60 DAS than other fertility levels but was at par with F_4 with the value of 2.89.Similar trend was obtained at 20, 40 DAS and at harvest. LAI at fertility level F_5 and F_4 remained statistically at par at all the growth intervals and at harvest. Lowest LAI was recorded in fertility level F_1 (control) at all the growth stages.

Table 2: Leaf area index and Tillers/m^2 of pearl millet as affected by cultivars and fertility levels

Treatments	Leaf Area Index				Tillers/m^2			
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest
Cultivars								
Pusa Composite 383	0.53	1.70	2.79	2.26	19.87	21.20	22.60	21.67
MBC 2	0.64	1.78	2.91	2.41	21.13	22.46	24.53	23.47
Local variety	0.44	1.55	2.55	2.16	18.13	19.60	21.00	20.33
S.Em (±)	0.02	0.02	0.03	0.03	0.41	0.42	0.43	0.45
CD (5%)	0.05	0.06	0.09	0.09	1.19	1.23	1.24	1.29
Fertility levels (N: P_2O_5: K_2O kg/ha)								
F_1 (Control)	0.28	1.48	2.53	2.04	16.44	17.11	18.78	17.56
F_2 (25 kg N through FYM)	0.38	1.57	2.65	2.17	18.22	19.22	20.56	19.56
F_3 (50:30:15 + 25 kg N through FYM)	0.58	1.69	2.77	2.29	19.78	20.89	22.56	21.67
F_4 (65:40:20 + 25 kg N through FYM)	0.69	1.79	2.89	2.41	21.44	23.56	25.56	24.56
F_5 (80:50:25 + 25 kg N through FYM)	0.74	1.83	2.91	2.47	22.67	24.56	26.11	25.78
SEm(±)	0.02	0.03	0.04	0.04	0.53	0.55	0.55	0.58
CD (5%)	0.07	0.08	0.10	0.11	1.54	1.59	1.61	1.67

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

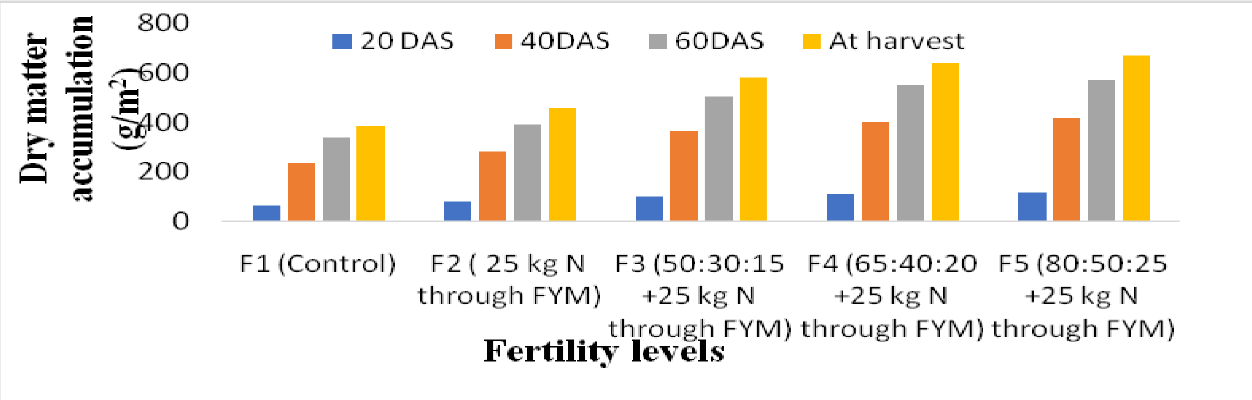

Figure 4: Effect of fertility levels on dry matter accumulation (g/m^2) of pearl millet

Further perusal of data depicted that fertility levels showed significant difference in number of tillers at all the growth stages. Among the applied fertility levels, at harvest stage it was seen that significantly higher number of tillers/m^2 (25.26%) was recorded inF_5 then lower fertility levels but remained at par withF_4. Similarly, at 20, 40 and 60 DAS number of tillers/m^2 same trend was followed. However, F_1 (control) recorded lowest number of tillers/m^2at all the growth stages. Various fertility levels shared significant effect on CGR at all the stages of growth. The crop growth rate increased with the advancement of the crop age up to 20-40 DAS shown in Table 3. Data depicted CGR at interval of 20-40DAS, 40-60 DAS and 60 DAS-harvest stage. Significantly higher CGR (14.99 g/m^2/day) at interval of 20-40 DAS was recorded inF_5 in comparison to other fertility levels. However, it was at par withF_4 with the values 14.42 g/m^2/day. Fertility level F_1 (control) recorded lowest value of crop growth rate at all the growth stages.

Table 3: Yield attributes and Crop Growth Rate of pearl millet as affected by cultivars and fertility levels

Treatments	Yield attributes			Crop Growth Rate (g/m^2/Day)		
	Ear heads/ m^2	1000 grain Weight (g)	Grains/ ear head	20-40 DAS	40-60 DAS	60 DAS-At harvest
Cultivars						
Pusa Composite 383	19.60	5.51	1488.71	12.16	6.50	2.44
MBC 2	22.13	7.05	1593.41	13.78	7.33	3.95
Local variety	17.27	5.06	1381.19	10.77	6.09	1.98
SEm (±)	0.38	0.08	17.37	0.19	0.13	0.07
CD (5%)	1.09	0.25	52.31	0.55	0.37	0.21
Fertility levels (N: P_2O_5: K_2O kg/ha)						
F_1 (Control)	15.78	4.99	1237.55	8.38	5.30	1.67
F_2 (25 kg N through FYM)	17.33	5.56	1349.61	10.13	6.13	2.23
F_3 (50: 30: 15 + 25 kg N through FYM)	19.89	5.97	1461.08	13.28	6.82	2.77
F_4 (65: 40: 20 + 25 kg N through FYM)	22.33	6.35	1574.17	14.42	7.63	3.08
F_5 (80: 50: 25 + 25 kg N through FYM)	23.00	6.49	1613.26	14.99	7.49	3.23
SEm (±)	0.49	0.11	31.47	0.24	0.16	0.09
CD (5%)	1.41	0.32	94.21	0.70	0.47	0.27

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

The results showed that application of 80:50:25 kg/ha (N:P_2O_5:K_2O) + 25 kg N through FYM have positive impact on growth parameters *viz*., plant height, leaf area index, dry matter accumulation, crop growth rate, number of tillers raised linearly with increasing in fertility levels. This increment in growth characteristic was statistically significant over control, 25 kg N through FYM and 50:30:15 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM but was at par with 65:40:20 kg/ha of N:P_2O_5:K_2O + 25 kg N through FYM (Tables 6,7,8,9 and 11). It seems that increased nitrogen supply favored increase in amount of growth substandard and naturally occurring phyto-hormones. Probably higher levels of nitrogen resulted in increased auxin availability, which led to an increase in dry matter accumulation. Similarly, Phosphorus is a major element of all living organisms, and it plays a critical role in the conservation and transmission of energy in metabolic activities of living cells, including biological energy transformations (Gupta *et al.*, 2020; Rajanna *et al.*, 2023; Ghosh *et al.*, 2020). The stored energy (ATP and ADP) that is received from photosynthesis and carbohydrate metabolism is for the later use in growth and development of plant. Whereas, potassium is a necessary for carbohydrate metabolism, osmotic-regulation, efficient use of water, nitrogen uptake, protein synthesis and translocation of assimilates etc. in plant. Besides, it also plays important role in improving quality of crop, reducing the lodging and reducing plant disease incidence (Bansal *et al.*, 2000; Sannagoudar and Murthy, 2018).Moreover, the results of Narayan and Joshi (2000), Kumar *et al.* (2008), Ghosh *et al.*, (2021), Singh *et al.* (2010) and Ashok and Shivdhar (2010) in pearl millet supports the observation of the present study.

Yield attributes

The data on the results of the effect of cultivars and fertility levels on various yield attributes of pearl millet have been presented in Table 3.

Effect of cultivars on yield attributes

Ear head count per metre square is an important parameter for determining the effect of any treatment on growth and yield of pearl millet. Number of ear heads was counted at harvest. A perusal of data depicted (Table 3) revealed that cultivars markedly influenced ear heads/m^2 at harvest. Cultivar MBC 2 recorded significantly higher number (22.13) of ear heads/m^2 than

Pusa Composite 383 and local variety. Number of grains /ear head and 1000 grain weight of pearl millet was also significantly influenced by cultivars. It was clearly visible that MBC 2 recorded significantly higher number of grains /earhead (1593.41) and test weight (7.05 g) over other two cultivars in comparison. Yield attributes *viz*., number of ear heads/m^2, 1000 grain weight and number of grains/ear head increased significantly with cultivar MBC 2 of pearl millet (Table 3). Extensive variation in yield attribute due to cultivars genetic capabilities, potential and adaptability to soil and climatic conditions to available resources. These results confirm the earlier finding of Prasad *et al.* (2014) and Kaur and Goyal (2019).

Effect of fertility levels on yield attributes

Fertility levels, F_5 - 80: 50: 25 kg/ha of $N:P_2O_5:K_2O$ + 25 kg N through FYM recorded significantly higher (23.00) number of ear heads/m^2,test weight (6.49 g) and number of grains /earhead (1613.26)than control and other fertility levels in comparison. However, it was found to be at par with fertility level F_4 - 65: 40: 20 kg/ha of $N:P_2O_5:K_2O$ + 25 kg N through FYM. Lowest values in all parameters were recorded in F_1 (Control).Data showed in Table 3.

Application of successive fertility levels upto 80:50:25 kg/ha of $N:P_2O_5:K_2O$ + 25 kg N through FYM significantly increased the yield attributes *viz*., number of ear heads/m^2, 1000 grain weight and number of grains/earhead (Table 3). Improvement in vigour and crop growth due to adequate supply of nitrogen early in the life of a plant is considered significant in blooming The fact that phosphorus is an energy source and it is essential for root formation, proliferation, enhanced microbial activity and development, with the excess being transferred to storage components and also enabled in more efficient metabolite partitioning and enough photosynthates and nutrient transfer to establish reproductive structures. Remobilization and translocation of carbohydrates, nitrogenous compounds, phosphorus and other mobile nutrients to grains (current plant sinks) occurs during leaf senescence results in bold grain formation leading to higher test weight. The results of present study with the combined application of fertilizers are in line with those of Malik *et al.* (1990), Kumar *et al.* (2008) and Girase *et al.* (2009).

Table 4: Interaction effect of cultivar and fertility level on dry matter accumulation (g/m^2) at harvest 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)	360.22	451.23	357.27
F_2 (25 kg N through FYM)	443.90	532.57	404.50
F_3 (50:30:15 +25 kg N through FYM)	548.60	616.42	520.33
F_4(65:40:20 +25 kg N through FYM)	638.23	711.76	572.57
F_5(80:50:25 +25 kg N through FYM)	645.40	765.93	599.93
S.Em (±)		17.94	
CD (5%)		51.27	

Interaction effect of cultivars and fertility levels on dry matter accumulation at harvest of pearl millet

Data presented in Table 4 revealed that the interaction effect between various cultivars and fertility levels on dry matter accumulation at harvest was found significant. Maximum dry matter accumulation was produced by cultivar MBC 2 (747.93 g/m^2) 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 was closely followed by V_2F_4. Whereas, minimum dry matter accumulation (357.27) was noted under treatment V_3F_1.

CONCLUSION

The study concluded that 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) show superiority in all growth and yield attribute except plant height. Its 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). Local variety showed superiority in plant height. On the basis of study the pearl millet cultivar MBC 2 is recommended for rainfed condition of Jammu region.

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