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Growth, yield, economics and microbiological properties of pearl millet as influenced by different production factors under irrigated condition

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Abstract
The field experiment was conducted in RBD with three replications at the research farm of ICAR-AICRP on Pearl Millet, Project Coordinating Unit, Jodhpur during *Kharif* 2021 for the quantification of individual production factors of management towards productivity of pearl millet. The performance of hybrid MPMH 17 was evaluated with 8 treatments *viz*., T_1: Full package & practices of the location [(RDF+ $ZnSO_4$ @ 25 kg/ha+ $FeSO_4$ @ 0.5-0.75% at 20-25 DAS + bioinoculant seed treatment + thinning & gap filling + weeding & hoeing (3 & 5 Weeks after sowing)+ Irrigation], T_2: T_1- RDF, T_3: T_1- $ZnSO_4$ @ 25 kg/ha, T_4: T_1- $FeSO_4$ @ 0.5-0.75% at 20-25 DAS, T_5: T_1- bioinoculant seed treatment, T_6: T_1- thinning & gap filling, T_7: T_1- weeding & hoeing (3 & 5 Weeks after sowing) and T_8: T_1-Irrigation. The data revealed that the grain yield was reduced by 14.6, 19.8, 21.3, -5.5, 22.7, 15.6 and 12.8% when RDF, $ZnSO_4$, $FeSO_4$, Bioinoculant, thinning & gap filling, weeding & hoeing and irrigation were not applied. The stover yield was reduced by 14.7, 18.3, 21.2, -5.8, 20.2, 15.0 and 12.1%, respectively. The gross returns across the treatments reduced from 12.5 to 21.9% as compared to full package and practices whereas, the net returns reduction was between 0.72 to 27.7%.

Keywords: Pearl millet, production factors, yield, economics, microbial properties

Introduction
The pearl millet is gaining lot of popularity among health-conscious people all over the globe. It can play a vital role in overcoming malnutrition to ensure food and nutritional security. Due to its excellent nutritional properties, pearl millet is designated as nutri-cereal (Gazette of India, No. 133 dated 13th April, 2018) for production, consumption, trade and was included in Public distribution system. To bring millets into mainstream for exploiting the nutritional rich properties and promoting their cultivation, Govt. of India has declared Year 2018 as the "Year of Millets" and UN declared the Year 2023 is as "International Year of Millets".

The selection of a hybrid/variety plays a vital role that affects production and productivity of pearl millet. The chemical fertilizers are presently used to boost up crop production and productivity. The most of the pearl millet growing areas in the country are having light textured soils, low water holding capacity and lower soil fertility coupled with short supply or imbalance use of nutrients. The approach of full package of practices could be one of the answer to bridges this gap. The fertilizer is one of the key inputs in augmenting food grain production. Its alone contributes towards 55 per cent of additional food grain production (Kaleeswari, 2013) [3]. The integrated use of chemical fertilizers with other fertilizers has found to improve the soil status and productivity and sustain the crop production (Nambiar and Abrol, 1992 and Singh and Yadav, 1992) [5, 9]. The zinc is an important nutrient for growth and development of plant, plants require a proper balance of all the essential nutrients for normal growth and optimum yield. It is required as a structural component of a large number of proteins, such as transcription factors and metallo enzymes (Singh and Kumar, 2009)[8]. Zinc also helps for the formation of chlorophyll and auxins. It is most common deficient micronutrient in the soil in various parts of the world and more than 50 per cent of Indian soils are deficient in Zn (Kumar *et al*., 2016) [4]. Micronutrients have not only cured nutritional disorder in plants but also they are known to improve the yield and quality (Jakhar *et al*., 2006) [2]. Pearl millet is also grown with supplemental irrigation with high input and management condition in small pockets scattered throughout the pearl millet growing regions.

The environmental resources in such block are sufficient enough to support high levels of productivity to obtain a maximum return for the input supplied. Hence, maximization of yield under high crop management is also an important research priority. So there is a need to develop location specific package of practices including selection of variety/hybrid, irrigation management, special and improved fertilizers formulation including micronutrients based on soil status crop need and area for different parts in the country (Rakshit *et al.*, 2012) [6]. The development of area specific package of practices and the role of each specific practice should be scientifically proved as more efficient and fulfill the demand of crop and also increase productivity.

Material and Methods

The field experiment was conducted in RBD with three replications at the research farm of ICAR-AICRP on Pearl Millet, Project Coordinating Unit, Jodhpur during *Kharif* 2021 for the quantification of individual production factors of management towards productivity of pearl millet. The performance of hybrid MPMH 17 was evaluated with 8 treatments *viz.*, T_1: Full package & practices of the location [(RDF+ $ZnSO_4$ @ 25 kg/ha+ $FeSO_4$ @ 0.5-0.75% at 20-25 DAS + bioinoculant seed treatment + thinning & gap filling + weeding & hoeing (3 & 5 Weeks after sowing)+ Irrigation], T_2: T_1- RDF, T_3: T_1- $ZnSO_4$ @ 25 kg/ha, T_4: T_1- $FeSO_4$ @ 0.5-0.75% at 20-25 DAS, T_5: T_1- bioinoculant seed treatment, T_6: T_1- thinning & gap filling, T_7: T_1- weeding & hoeing (3 & 5 Weeks after sowing) and T_8: T_1-Irrigation. The meteorological data recorded during the crop season is presented in Graph 1.

Results and Discussion

The data (Table 1) revealed that the grain yield was reduced by 14.6, 19.8, 21.3, -5.5, 22.7, 15.6 and 12.8% when RDF, $ZnSO_4$, $FeSO_4$, Bioinoculant, thinning & gap filling, weeding & hoeing and irrigation were not applied. Shekhawat and Kumawat (2017) [7] at SKRAU, Bikaner also reported that application of 20 kg ZnSO4/ha, showed significant improvement over control and enhanced length of ear head and test weight by 12.8, 31.1 and 9.5, 21.7% over control. Seed and straw yield also showed same tune of results as per ancillary character of pearl millet. The stover yield was reduced by 14.7, 18.3, 21.2, -5.8, 20.2, 15.0 and 12.1%, respectively. The gross returns across the treatments reduced from 12.5 to 21.9% as compared to full package and practices whereas, the net returns reduction was between 0.72 to 27.7%. The actinobacterial population and alkaline phosphatases properties were not influenced due to production factors (Table 2), however, dehydrogenase, acid phosphatases, urease, bacterial population, fungal population and actinobacterial population were recorded maximum by T_6 (T_1-Thinning &gap filling). Earlier workers reported that application of nutrients from organic and inorganic fertilizers combinedly sources were able to improve soil microbial load and yield of pearl millet (Bhargavi *et al.* 2021) [1].

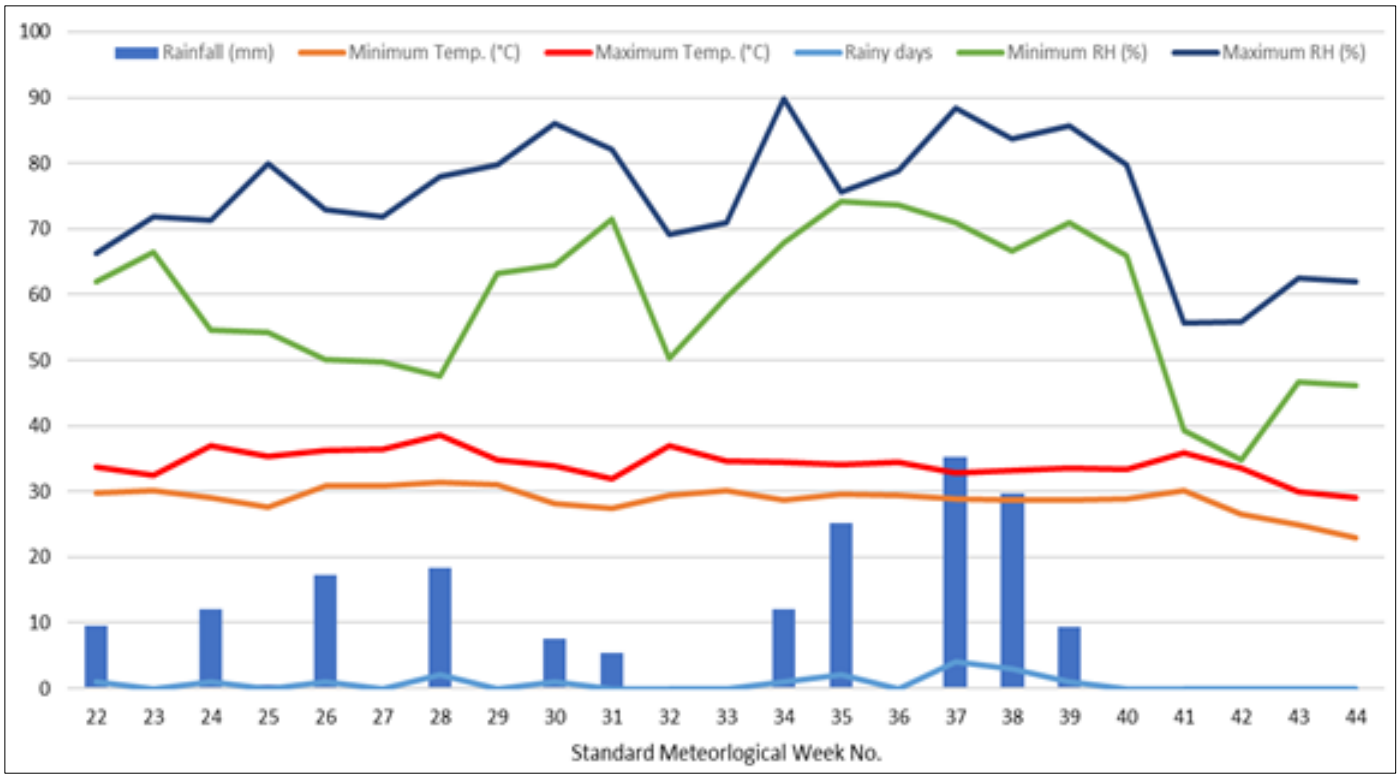
Table 1: Influence of production factors on the growth, yield and economics of pearl millet under irrigated condition

Treatment	Plant population ('000/ha)	Plant height (cm)	Total tillers/ plant	Effective tillers/ plant	Test wt. (g)	Grain yield (q/ha)	Stover yield (q/ha)	Gross Return (Rs/ha)	Net Return (Rs/ha)	BC Ratio
T_1: 100% RDF+ZnSO4 (25 Kg/ha) + FeSO4 @ 0.5-.75% (foliar spray) at 20-25 DAS + Bioinoculant-Azoteeka + Thinning &gap filling + weeding & hoeing (3-5 weeks after sowing) + Irrigation	2.3	10.8	54183	2.3	10.8	30183	2.3	54183	30183	2.3
T_2: T1- RDF	2.1	10.5	46267	2.1	10.5	29967	2.8	46267	29967	2.8
T_3: T1- ZnSO4 @ 25 Kg/ha	2.0	10.4	43700	2.0	10.4	22950	2.1	43700	22950	2.1
T_4: T1- FeSO4@0.5-.75 at 20-25 DAS	1.9	10.9	42675	1.9	10.9	19205	1.8	42675	19205	1.8
T_5: T1- Bioinoculant seed treatment (Azoteeka)	2.2	10.8	57208	2.2	10.8	33308	2.4	57208	33308	2.4
T_6: T1-Thinning &gap filling	1.6	10.2	42317	1.6	10.2	21817	2.1	42317	21817	2.1
T_7: T1-weeding & hoeing (3-5 weeks after sowing)	1.3	10.3	45842	1.3	10.3	28842	2.7	45842	28842	2.7
T_8: T1-Irrigation	1.8	10.5	47392	1.8	10.5	23892	2.0	47392	23892	2.0
CD at 5%	0.6	NS	8867	0.6	NS	8867	0.4	8867	8867	0.4
CV (%)	18.3	3.9	10.6	18.3	3.9	19.1	10.2	10.6	19.1	10.2

Table 2: Effect of production factors on soil microbiological properties of pearl millet under irrigated conditions

Treatment	Dehydrogenase µg TPF/g soil/day	Alkaline phosphatases µg/g soil/hr	Acid phosphatases µg/g soil/hr	Urease (µ moles ammonia released/g/hr)	MBC µg g-1 soil	Bacterial population (log10 CFU/g soil)	Fungal population (log10 CFU/g soil)	Actinobacterial population (log10 CFU/g soil)
T_1	1.78	3.72	1.92	8.64	132.2	7.55	4.22	6.68
T_2	1.60	3.27	1.70	9.28	114.2	7.48	4.03	6.54
T_3	1.64	3.42	1.47	7.72	122.4	7.52	4.19	6.65
T_4	1.64	3.69	1.47	8.49	125.2	7.49	4.17	6.58
T_5	1.53	3.61	1.62	8.17	122.6	7.39	4.21	6.56
T_6	1.89	3.89	1.42	9.72	133.2	7.57	4.29	6.64
T_7	1.74	3.38	1.50	9.51	133.0	7.49	4.25	6.64
T_8	1.70	3.87	1.07	9.71	129.9	7.45	4.15	6.65
CD at 5%	0.08	NS	0.44	0.75	6.89	0.08	0.05	NS
CV (%)	2.66	10.55	16.39	4.74	3.08	0.63	0.71	1.03

T_1: 100% RDF+ZnSO4 (25 Kg/ha)+FeSO4@ 0.5-.75% (foliar spray at 20-25 DAS) + Bioinoculant-Azoteeka + Thinning &gap filling + weeding & hoeing (3-5 weeks after sowing) + Irrigation; T_2: T1- RDF; T_3: T1- ZnSO4@25 Kg/ha; T_4: T1- FeSO4@0.5-.75 at 20-25 DAS; T_5: T1- Bioinoculant seed treatment; T_6: T1-Thinning &gap filling; T_7: T1-weeding & hoeing (3-5 weeks after sowing); T_8: T1-Irrigation



Graph 1: Graphical presentation meteorological data recorded during the crop season

Conclusion

The selection of a variety/hybrid, nutrients, irrigation, thinning and weeding and seed treatments greatly affect the performance of pearl millet. It is evident from the present study that full package of practice including T_1: 100% RDF + $ZnSO_4$ (25 Kg/ha) + $FeSO_4$ @ 0.5-.75% (foliar spray) at 20-25 DAS + Bioinoculant-Azoteeka + Thinning & gap filling + weeding & hoeing (3-5 weeks after sowing) + Irrigation recorded significantly higher growth and yield of pearl millet. The findings suggest that full package of practices should be followed for higher yields in pearl millet under irrigated condition.

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