Original Research Article

Influence of Different Fertility Levels on Growth and Quality of Pearl millet in Mid Hills of Himachal Pradesh

ABSTRACT

Present study was conducted atShoolini University, Solan during *Kharif*season 2022 to evaluateInfluence of Different Fertility Levels on Growth and Quality of Pearl millet in Mid Hills of Himachal Pradesh. Soil of experimental site was fertile with uniform sandy loam texture, medium in N andK but high in phosphorus availability. The experimentwas laid out in RBD comprising of ten treatments (T_1) Control, (T_2) 100%RDF,(T_3)120%RDF,(T_4)50%RDF+FYM@10tha^{-1},(T_5)75%RDF+FYM@5tha^{-1}),(T_6)100% RDF + FYM @ 5 t ha^{-1}, (T_7) 50% RDF + Vermicompost @ 2.5 t ha^{-1}, (T_8) 75% RDF +Vermicompost @ 2.5 t ha^{-1}, (T_9) 100% RDF + Vermicompost @ 2.5 t ha^{-1} and (T_{10}) 75% RDF + FYM@ 5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1} and replicate thrice. Pearl millet cultivar PHB-2884 was sownatspacingof 45×15 cmwith theseed rateof 4Kgha^{-1}. Plant population, plant height,nitrogen content& uptake and protein yieldwererecorded significantly higher with application of (T_3) 120% RDF which wasstatistically at par with(T_9) 100% RDF + Vermicompost @ 2.5 t ha^{-1}, (T_6) 100% RDF + FYM @ 5 t ha^{-1} and (T_2) 100% RDF. However, least values of these characters were recorded under (T_1) controltreatment. Findings can be concluded as the significantly higher Growth, and quality produce by pearl millet were observed with application of (T_3) 120% RDF and was at par with (T_2) 100% RDF, (T_9) 100% RDF + Vermicompost @ 2.5 t ha^{-1} and (T_6) 100% RDF + FYM @ 5 t ha^{-1} over rest of the treatments.

1. INTRODUCTION

Pearlmillet(*Pennisetumglaucum*L.),is theworld'shardiestwarmseasoncerealcrop(Patel*et al.,* 2014). It is largely grown for fodder and grain purposes. It is also known as Bajra, Bajri,Sajja, combo or Kambam (Kaur and Goyal, 2019). It is an erect annual grass, reaching up to 3 mheight with a profuse root system. Culms are slender, 1-3 cm wide. Leaves are alternate, simple,blade liner, minutely serrated. The inflorescence is a panicle which is 12-30 cm long. Nutritionalrichness of this crop provides ample opportunity for the creation of value-added goods in newmarket sectors with a focus on health as due to its higher fiber content and benefits for diabeticsand heart patients (Prasad *et al*., 2014). The grain is more nutrient-dense and has a considerablequantity of phosphorus and iron in addition to 11 to 19 per cent protein, 60 to 78 per cent carbs,and3.0percentto4.6percentfat(Divya*etal*.,2017).Additionally,itincludesmorebeta-carotene,riboflavin(vitamin B_2),and niacin (vitaminB_4).It is an important crop in India and parts of Africa and India ranked first in the world interms of area (7.55 m ha), production of 9.22 million Tones, productivity (1,374 kgha^{-1}) during2021-22(Anonymous,2021-22a).

InHimachalPradeshareaunderpearlmilletproductionis5haand production is 4.5 ton and productivity is 900 kg ha^{-1} (Anonymous, 2021-22b).Nitrogen is an important nutrient for the growth and development of plants. It is avery important constituent composed of cellular parts. Numerous additional cellular molecules,includingalkaloids,amides,aminoacids,proteins,DNA,RNA,enzymes,vitamins,andhormones, include nitrogen as one of its constituent parts. It is the constituent of several enzyme systemswhichregulatevarious metabolic reactions inthe plant (Khinchi*et al*.,2018).Phosphorus plays key roles in many plant processes such as energy metabolism, thesynthesis of nucleic acids and membranes, photosynthesis, respiration, nitrogen fixation andenzymeregulation.Adequatephosphorusnutritionenhancesmanyaspectsofplantgrowthdevelopment including flowering, fruiting, roots growth and yield components of different crops.Phosphorus is essential for all living organisms. Potassiumis responsibleforopeningand closingof stomataand also playsamajorroleintranslocation of nutrients and water throughout the plant parts. Potassium increase the potentialandimprovingthe qualityofgrains (Kumar*et al*.,2014).Efficiencies of organic manures like vermicompost not only improve or build up soilfertility but also increase the efficiency of chemical fertilizers. Vermicompost is a potent sourceof both macro and micro nutrients for plants. Additionally, it boosts soil microbial activities andincreases the microbiological availability of nitrogen and phosphorus. It has been suggested thatvermicompostis an excellent sourceof organic manure.Farm yard manure refers to the decomposition of farm animals waste such as mixture ofdung and urine along with litter and leftover roughage or fodder material fed to the cattle. Thereis 0.5 per cent N, 0.2 per cent P2O5 and 0.5 per cent K2O in the decomposed farmyard manure. Ittransforms inaccessible soil nutrients into usable form and thus the nutrient requirement can bereducedtomediumtohighlevelsofavailablenutrientstatus.FYMboostthesoil'sabilitytoabsorbcations and anions, especially phosphates and nitrates. For the advantage of the current crop aswell as following crops, these adsorbed ions are slowly released (Amarghade and Singh, 2021).Therefore,inviewoftheaboveconsiderationsthepresentinvestigation was conducted tostudythe effect of different fertilitylevelson growth and productivityof PearlmilletinMidHillsofHimachalPradesh.

2. *MATERIALS AND METHODS*

Theinvestigationreportedherewascarriedoutduring*kharif*seasonof2022atChameltiAgricultureFarm,ShooliniUniversity,Solan,HimachalPradeshwhichissituated30kmawayfromSolancityatanelevationof1,270 metersabovemeansealevellyingbetweenlatitude30^{0}85’67.30Nandlongitude77^{0}13’20.38E.Thisregionfallsundermoistsubhumidzoneof HimachalPradesh.Climate of this region is generally categorized as sub-humid, sub temperate with coolwinters. Generally, December and January months are the coldest while, May and June are thehottest. The average annual rainfall of this is 1039.5 mm.The meteorological data with respect torainfall, temperature and relative humidity acquired from Automatic Weather Station, ShooliniUniversity of Biotechnology and Management Sciences, Solan.

The experimentwas laid out in randomized block design, comprising of ten treatments (T_1) Control, (T_2) 100%RDF,(T_3)120%RDF,(T_4)50%RDF+FYM@10tha^{-1},(T_5)75%RDF+FYM@5tha^{-1}),(T_6)100% RDF + FYM @ 5 t ha^{-1}, (T_7) 50% RDF + Vermicompost @ 2.5 t ha^{-1}, (T_8) 75% RDF +Vermicompost @ 2.5 t ha^{-1}, (T_9) 100% RDF + Vermicompost @ 2.5 t ha^{-1} and (T_{10}) 75% RDF + FYM@ 5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1} and replicate thrice. Pearl millet cultivar PHB-2884 was sownatspacingof 45×15 cmwith theseed rateof 4Kgha^{-1}. Soil of experimental field was fertile with uniform texture. Soil was medium in N andK but high in phosphorus availability.Theinitialplantstandwasrecordedat20DASandfinalstandatharvestofcrop, thiswasdonebycountingthenumberof plants m^{-2}areain linesown plot.To record plant height, height of the fivetagged plants in net plotwas recorded from the base to the tipof the main shoot at 30, 60, 90 DAS and at harvest stage.To record dry matter accumulation, tenplantsrandomlyselectedfrom eachplotandwerepulledoutat30,60,90DASandatharvest stage. The plants were washed out and were allowed to sun dried first and finally ovendriedat65^{0}Cfor24 hours up to dryandconstantweightand recordedaccordingly. Nitrogen content (%) in grain was estimated by Micro-kjeldahl method (Bouyoucos, 1966) and multiplied by conversion factor *i.e.* 6.25 suggested by A.O.A.C (1970) to obtain protein content (%) in grain. Proteinyieldingrain(kgha^{-1})wascalculatedbymultiplyingtheproteincontent(%)ingrainwith theirrespectiveyields.In order to test the significance of result, standard statistical method based on the analysisof variance technique as suggested by Gomez and Gomez (1984) were employed. The treatmentsdifferenceswerecomparedwiththecriticaldifference(CD)at5%levelofsignificancetoascertain theirsignificance.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

PlantPopulation(m^{-2})

Plant population wasrecordedat20DAS andat harvest, the data indicated that numbers of plants per net plot at initial stage and at were found to be non-significant, during the course of investigation where maximum plant population was recordedunder(T_3) and minimum was under(T_1) control treatments.

Plantheight(cm)

Thedataonplantheightatdifferentstagesofobservationsunderdifferentfertilityindicates that irrespective of treatments,height of pearlmillet plant increased with the advancement of the crop age. Tallest plantswas recorded with application of (T_3) 120% RDF at 30 DAS which was statistically at par withapplication of (T_9) 100% RDF + Vermicompost @ 2.5 t ha^{-1}, (T_6) 100% RDF + FYM @ 5 t ha^{-1}and(T_2)100%RDF.Moreover,treatments(T_{10}),(T_8)and(T_5)werefoundstatisticallyatparwith(T_2) 100% RDF. Similar trend was observed at 60, 90 DAS and at harvest. However, the lowestplantheightwasrecordedundercontroltreatment.It might be due to the positive effect of nutrients on plant height throughout the crop growth period. Nitrogen has essential functions in plant life *viz*., its role in rapid multiplication and expansion of plant cells and increase in amount of growth substances such as naturally occurring Phytohormones, photosynthesis rate and increase level of auxin supply, Phosphorus stimulates root development and increase stalk and stem strength and potassium regulates the opening and closing of stomata and also plays a major role in the regulation of water and nutrients in plants, with higher level of nitrogen, phosphorus and potassium might have brought about a significant increase in plant height. It was also reported that increase in plant height with nitrogen fertilizer was due to the fact that nitrogen promotes number of internodes and increase length of the internodes which results in progressive increase in plant height. Similar were also reported by Kumawat*et al.* (2016); Kumar *et al.* (2017) and Khinchi*et al.* (2018).

Table 1: Plant population (m^{-2}) of pearl millet as influenced by different fertility levels

Treatments	Plantpopulation(m^{-2})	
	20DAS	**Atharvest**
T_1: Control	14.51	14.16
T_2: 100%RDF	14.69	14.34
T_3: 120%RDF	14.73	14.38
T_4: 50% RDF+FYM(10 t ha^{-1})	14.52	14.17
T_5: 75%RDF+FYM(5t ha^{-1})	14.57	14.22
T_6: 100% RDF+FYM(5 t ha^{-1})	14.69	14.35
T_7: 50% RDF+Vermicompost(2.5 t ha^{-1})	14.56	14.21
T_8: 75% RDF+Vermicompost(2.5 t ha^{-1})	14.59	14.25
T_9: 100% RDF+Vermicompost(2.5 t ha^{-1})	14.70	14.36
T_{10}: 75%RDF+FYM (5t ha^{-1}) +Vermicompost (2.5 t ha^{-1})	14.63	14.28
SEm($\pm$)	0.05	0.05
CD(p=0.5)	**NS**	**NS**

Table 2: Plantheight(cm)ofpearl milletasinfluencedbydifferentfertilitylevelsatperiodicintervals

Treatments	Plant height (cm)			
	30DAS	60DAS	90DAS	Atharvest
T_1: Control	30.47	84.60	180.82	181.63
T_2: 100%RDF	41.80	129.67	209.70	216.90
T_3: 120%RDF	44.50	136.86	223.18	226.00
T_4: 50% RDF+FYM(10 t ha^{-1})	37.51	119.79	191.47	196.45
T_5: 75%RDF+FYM(5t ha^{-1})	38.42	123.52	198.56	201.90
T_6: 100% RDF+FYM(5 t ha^{-1})	43.97	134.30	219.21	220.25
T_7: 50% RDF+Vermicompost(2.5 t ha^{-1})	39.17	121.10	195.42	198.69
T_8: 75% RDF+Vermicompost(2.5 t ha^{-1})	38.78	123.60	200.80	202.39
T_9: 100% RDF+Vermicompost(2.5 t ha^{-1})	43.98	134.49	221.99	223.20
T_{10}: 75%RDF+FYM (5t ha^{-1}) +Vermicompost (2.5 t ha^{-1})	39.37	124.36	201.88	203.90
SEm(±)	1.38	3.51	6.83	7.03
CD(p=0.5)	4.11	10.42	20.29	20.91

Table 3: Dry matter accumulation (g m^{-2}) of pearl millet as influenced by different fertility levels at periodic intervals

Treatments	Dry matteraccumulation(gm^{-2})			
	30DAS	60DAS	90DAS	Atharvest
T_1: Control	27.54	173.82	259.50	288.10
T_2: 100%RDF	61.08	282.20	455.30	510.56
T_3: 120%RDF	70.00	308.28	515.60	579.18
T_4: 50% RDF+FYM(10 t ha^{-1})	35.86	210.76	310.10	345.50
T_5: 75%RDF+FYM(5t ha^{-1})	56.51	253.23	425.73	478.61
T_6: 100% RDF+FYM(5 t ha^{-1})	66.58	297.54	492.14	550.15
T_7: 50% RDF+Vermicompost(2.5 t ha^{-1})	39.87	212.60	337.78	373.24
T_8: 75% RDF+Vermicompost(2.5 t ha^{-1})	57.67	256.65	426.26	479.95
T_9: 100% RDF+Vermicompost(2.5 t ha^{-1})	68.50	304.21	508.50	571.10
T_{10}: 75%RDF+FYM (5t ha^{-1}) +Vermicompost (2.5 t ha^{-1})	58.68	261.85	431.90	483.72
SEm($\pm$)	3.01	8.78	10.75	13.11
CD(p=0.5)	8.95	26.10	31.95	38.95

Table 4: Nitrogen content (%) and their uptake (kg ha^{-1}) of pearl millet as influenced by different fertility levels

Treatments	Nitrogencontent(%)		Nitrogenuptake(kg ha^{-1})		
	Grain	Stover	Grain	Stover	Total
T_1: Control	1.43	0.99	8.88	30.44	39.32
T_2: 100%RDF	2.03	1.28	31.20	66.54	97.74
T_3: 120%RDF	2.08	1.32	35.20	71.40	106.60
T_4: 50% RDF+FYM(10 t ha^{-1})	1.77	1.02	16.28	38.69	54.98
T_5: 75%RDF+FYM(5t ha^{-1})	1.98	1.23	26.52	61.53	88.05
T_6: 100% RDF+FYM(5 t ha^{-1})	2.04	1.29	32.75	68.55	101.30
T_7: 50% RDF+Vermicompost(2.5 t ha^{-1})	1.84	1.05	18.37	42.80	61.17
T_8: 75% RDF+Vermicompost(2.5 t ha^{-1})	1.99	1.24	26.96	61.81	88.76
T_9: 100% RDF+Vermicompost(2.5 t ha^{-1})	2.06	1.31	33.45	70.30	103.75
T_{10}: 75%RDF+FYM (5t ha^{-1}) +Vermicompost (2.5 t ha^{-1})	2.00	1.25	27.71	61.82	89.54
SEm($\pm$)	0.02	0.01	1.35	2.35	3.12
CD(p=0.5)	0.07	0.05	4.02	7.01	9.29

Table 5: Qualitative characters of pearlmillet as influenced by different fertility levels

Treatments	Qualitative characters	
	Proteincontent (%)	**Protein yield (kgha^{-1})**
T_1: Control	8.92	55.50
T_2: 100%RDF	12.69	195.01
T_3: 120%RDF	13.00	220.00
T_4: 50% RDF+FYM(10 t ha^{-1})	11.06	101.78
T_5: 75%RDF+FYM(5t ha^{-1})	12.38	165.74
T_6: 100% RDF+FYM(5 t ha^{-1})	12.75	204.68
T_7: 50% RDF+Vermicompost(2.5 t ha^{-1})	11.50	114.81
T_8: 75% RDF+Vermicompost(2.5 t ha^{-1})	12.44	168.47

T_9: 100% RDF+Vermicompost(2.5 t ha^{-1})	12.85	209.0 6
T_{10}: 75%RDF+FYM (5t ha^{-1}) +Vermicompost (2.5 t ha^{-1})	12.50	173.2 1
SEm($\pm$)	0.15	8.45
CD(p=0.5)	0.46	25.13

Drymatteraccumulation (gm^{-2})

Applicationof120%RDFresultedin significantly higher dry matter accumulation was statistically at par with application of (T_9) 100% RDF + Vermicompost @ 2.5 t ha^{-1},(T_6)100%RDF+FYM@5tha^{-1}and(T_2)100%RDF.Moreover,treatments(T_{10}),(T_8) and(T_5)were found statistically at par with (T_2) 100% RDF. Similar trend was observed at 60, 90 DASandatharvest. However,thelowestdrymatteraccumulationwasrecordedundercontroltreatmentduring thecourseofstudy. Nitrogen, phosphorus and potassium might have helped the crop for maximum utilizationof available nutrients which enhanced the vegetative growth of pearl millet leading to maximumutilizationofsolarradiationcontributingtothehigherrateofphotosynthesiswhichhadfavourableinfluenceonhigheraccumulationofphotosynthatesandfinallydrymatteraccumulation.Theresultsareincloseconformitywiththefindingsof Ayub*etal*.(2009) and Ganapati and Guggari (2018) who reported that, forage and dry matter yields of pearl millet were increased significantly with each increased rate of nitrogen.

3.2 QualitativeCharacters

Nutrientcontent (%)andtheiruptake (kgha^{-1})

Nitrogencontentingrainandstoverwereaffectedsignificantlybyvariousfertility levels. Application of (T_3) treatment 120% RDF gained maximum nitrogen content ingrain (2.08 %) and stover (1.32 %) which was statistically at par with treatment T_9, T_6andT_2.However, the lowest nitrogen content in grain and straw (1.43 and 0.99 %, respectively) wasrecordedwith control treatment (T_1).Nitrogencontentingrainandstoverwereaffectedsignificantlybyvariousfertility levels. Application of (T_3) treatment 120% RDF gained maximum nitrogen content ingrain(2.08%)andstover(1.32%)whichwasstatisticallyatparwithtreatment(T_9),(T_6)and(T_2).However, the lowest nitrogen content in grain and straw (1.43 and 0.99 %, respectively) wasrecordedwith control treatment (T_1).This could be due to the fact that the nitrogen fertilization increases the cation exchangecapacity of plant roots and makes them more efficient to absorb the nutrients and exert favorableeffects of nitrogen on growth parameters and yield attributes, which resulted in higher grain andstoveryieldsandconsequentlymorenitrogenuptakebythecrop.Also,applicationofhigherdoseof Nitrogen and Phosphorus is responsible for better root and shoots development, which in turnincreased potash uptake. The findings are in accordance with those of Chaudhary andGautam(2007); Rao *etal.* (2007); ChoudharyandPrabhu (2014);and Khinchi*etal*. (2018).

Proteincontent(%)andprotein Yield(kgha^{-1})

Proteincontentingrainandproteinyieldwasinfluencedbydifferentfertilitylevels during both the year of study.Highestproteincontentingrain(13%)andproteinyieldwasrecordedwiththeapplicationof(T_3)120%RDFanditwasfoundstatisticallyatparwith(T_9),(T_6)and(T_2).However, the control treatment recorded lowest value of protein content in grain (8.92%) andproteinyield.Protein content in grain and protein yield was influenced by different fertility levels, higher protein content in grain (13%) was recorded with the application of (T_3) 120% RDF and was statistically at par with (T_2) 100% RDF. Higher protein yield (220 Kg ha^{-1}) was recorded with the application of (T_3) 120% RDF and was statistically at par with (T_9) 100% RDF + Vermicompost @ 2.5 t ha^{-1}. However, the control treatment recorded lowest value of protein content in grain (8.92%) and protein yield (55.50 Kg ha^{-1}). Nitrogen had positive effect on protein content of grain. Nitrogen is an important constituent of protein, which always gives a marked promoting influence on protein synthesis by way of promoting synthesis of amino acid, which are constituent building blocks of protein. The results are in accordance with those reported by Ayub *et al*. (2002); Rathore *et al.* (2006); Jadhav *et al*. (2011) and Prasad *et al*. (2014b).

4. CONCLUSION

On the basis of finding of the experiment, it can be concluded that the significantly higher Growth, and quality produce by pearl millet were observed with application of (T_3) 120% RDF and was at par with (T_2) 100% RDF, (T_9) 100% RDF + Vermicompost @ 2.5 t ha^{-1} and (T_6) 100% RDF + FYM @ 5 t ha^{-1} over rest of the treatments.

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