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Effect of land configurations and nutrient management on productivity, nutrient uptake and water use efficiency of pearl millet (*Pennisetum glaucum* L.) under rainfed conditions

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Abstract

A field experiment was conducted during *kharif* season of the year 2016 at Bajra Research Scheme, College of Agriculture, Dhule (Maharashtra), to study the effect of land configuration and nutrient management on growth, yield attributes, yield, nutrient uptake and water-use efficiency of rainfed pearl millet. Broad bed furrow and ridges furrow land configurations recorded significantly higher growth, yield, nutrient uptake and water-use efficiency of pearl millet than flat bed. The maximum grain yield, nutrient uptake and water-use efficiency (WUE) were recorded in broad bed furrow than flat bed followed by ridges furrow. Application of RDF (60:30:30 kg NPK ha⁻¹) + 5 t FYM ha⁻¹ registered significantly higher values of growth and yield attributes consequently, grain (41.43 q ha⁻¹) and stover yields (76.81 q ha⁻¹) of pearl millet than rest of the nutrient management treatments. The performance of nutrient management treatments in terms of grain yield, nutrient uptake and WUE followed the order of RDF (60:30:30 kg NPK ha⁻¹) + 5 t FYM ha⁻¹ > 50% RDF + 50% RDN through FYM > RDF > 100% RDN through FYM.

Keywords: Pearl millet, land configurations, INM, productivity, water use efficiency

Introduction

Pearl millet is most preferred crop of dryland and rainfed area owing to its drought-escaping mechanism coupled with comparatively higher production ability under low soil fertility, soil-moisture deficit, intense heat and minimum managerial inputs. Despite its higher production potential, soil-moisture deficit, often coinciding with critical growth stages of crop is the most important reason of low productivity of pearl millet. Among agronomic management practices, selection of suitable planting method (Kaushik and Gautam, 1994) [7] and nutrient management comprising INM approach (Bellaki *et al.*, 1999) [1] are essential to make best use of limited available water. In rainfed areas, farmers usually apply low quantity of FYM, other organic manure and chemical fertilizers. Among the various reasons, less fertilization is the main reason for low productivity of pearl millet. At present productivity level, pearl millet removes about 72 kg of N + P₂O₅ + K₂O ha⁻¹, whereas only 10–12 kg ha⁻¹ of these nutrients are applied. Integrated nutrient management approach involves judicious and integrated use of chemical fertilizers along with FYM can improve crop productivity, sustain soil health and fertility (Choudhary and Gautam, 2007) [2]. Since information on land configurations and nutrient management in relation to moisture conservation in term of water-use efficiency and productivity of pearl millet is meagre, the present investigation was carried out on these aspects.

Materials and Methods

Field experiment was conducted at Bajra Research Scheme Farm, College of Agriculture, Dhule (M.S.) during *kharif* season of the year 2016. The soil of experimental plot was clayey in texture and slightly alkaline in reaction, having bulk density 1.36 Mg m⁻³ and porosity 48.67%. The pH of soil was 7.8 having low in available nitrogen (156.25 kg ha⁻¹), medium in available phosphorus (15.78 kg ha⁻¹) and very high in available potassium (382.13 kg ha⁻¹). The experiment involving hybrid 'Aadishakti (DHBH 9071)' was laid out in split-plot design

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replicated thrice, comprising three land configuration (L₁. flat bed, L₂. ridges and furrow and L₃. broad bed furrow) as a main plot and four nutrient management levels (N₁. RDF (60:30:30 kg NPK ha⁻¹), N₂. RDF + 5 t FYM ha⁻¹, N₃. 50% RDF + 50% RDN through FYM and N₄. 100% RDN through FYM as a sub-plots. Seeds treated with *Azospirillum* and PSB each @ 25 g kg⁻¹ common to all treatments. The respective species of *Azospirillum* and PSB employed in the present investigation were *Azospirillum brasilense* and *Pseudomonas striata*. The total rainfall receiving during crop growing period of Kharif season 2016 was 334.6 mm in 24 rainy days.

Results and Discussion

Effect of land configurations

Growth characters

Growth parameters of pearl millet, viz., plant height, dry matter plant⁻¹ and total number of tillers plant⁻¹, were influenced by different planting methods. Broad bed furrow land configurations registered maximum and significantly higher growth attributing characters than flat bed but, on par with ridges and furrow. The plant height (216.12 cm), dry matter (125.92 g) and total number of tillers plant⁻¹ (3.42) at harvest were recorded significantly higher in broad bed furrow land configuration followed by ridges and furrow. Significantly the lowest values were recorded in flat bed. This improvement in growth attributes could be assigned to higher moisture availability for crop owing to better moisture conservation under these modified planting methods. These results corroborate the findings of Parihar *et al.*, (2012) ^[11] and Deshmukh *et al.*, (2013) ^[4].

Yield attributes and yield

The important yield contributing characters like, number of effective tillers plant⁻¹ (1.73), earhead length (22.84 cm), earhead girth (11.45 cm), weight of earhead (61.58 g), grain weight earhead⁻¹ (49.78 g), 1000 seed weight (12.33 g), grain yield (39.97 q ha⁻¹), and stover yield (74.89 q ha⁻¹) were significantly more in broad bed furrow land configuration followed by ridges and furrow. Significantly the lowest values were recorded in flat bed land configuration. The higher yield obtained under broad bed furrow land configuration might be owing to cumulative effect of higher number of effective tillers per plant and yield attributes due to improved soil-moisture availability. These results are in conformity with those reported by Tumbare and Bhoite (2003) ^[14], Chiroma *et al.*, (2008) ^[3], Parihar *et al.*, (2012) ^[11] and Mahita *et al.*, (2014) ^[9] in maize.

Nutrient uptake

Total N, P and K uptake by pearl millet (87.92, 36.55 and 134.63 kg ha⁻¹, respectively) were significantly increased in broad bed furrow followed by ridges and furrow and significantly decreased in flat bed land configuration. This might be due to better availability of moisture in broad bed furrow and ridges and furrow resulted in better uptake of nutrients. These results are in line with those reported by Rathore *et al.*, (2006) ^[12] and Parihar *et al.*, (2009) ^[10].

Harvest index (%)

Maximum harvest index of 34.79 per cent was observed in broad bed furrow sowing followed by ridges and furrow sowing of land configurations. Similar results were reported by Parihar *et al.*, (2012) ^[11] and Kanwar *et al.*, (2015) ^[6].

Rain water use efficiency

Significantly maximum rain water use efficiency was noticed

when the crop sown on broad bed furrow (11.95 kg ha⁻¹-mm) followed by ridges and furrow (11.55 kg ha⁻¹-mm). Whereas, the minimum water use efficiency was recorded in flat bed (10.38 kg ha⁻¹-mm). Higher moisture availability and increased grain yield might be responsible for increased WUE under these land configurations. These results are in accordance with those reported by Kanwar *et al.*, (2015) ^[6] and Singh *et al.*, (2016) ^[13].

Effect of nutrient management

Growth characters

The significantly higher growth parameters viz., plant height, dry matter accumulation and total number of tillers plant⁻¹ were observed in application of RDF + 5 t FYM ha⁻¹ than rest of the treatments followed by 50% RDF + 50% RDN through FYM. At harvest, the plant height (216.54 cm), dry matter (125.69 g) and total number of tillers per plant (3.49) were maximum under the application of RDF + 5 t FYM ha⁻¹ followed by 50% RDF + 50% RDN through FYM and RDF treatment. Significantly the lowest values were recorded due to application of 100% RDN through FYM. This might be due to greater availability of most of the macro and micro nutrients in appropriate quantity and balanced proportion that led to higher uptake of the nutrients. These results are in conformity with the findings of Kumar and Gautam (2004) ^[8], Chaudhari and Gautam (2007) ^[2] and Parihar *et al.*, (2012) ^[11].

Yield attributes and yield

The yield contributing characters viz., number of effective tillers plant⁻¹ (1.76), earhead length (23.20 cm), earhead girth (11.60 cm), weight of earhead (64.34 g), grain weight earhead⁻¹ (52.09 g), 1000 grain weight (12.68 g) were significantly maximum under the application of RDF + 5 t FYM ha⁻¹ followed by 50% RDF + 50% RDN through FYM. Significantly the lowest values for yield attributes were recorded with application of 100% RDN through FYM. The grain (41.43 q ha⁻¹) and stover (76.81 q ha⁻¹) were significantly maximum under the application of RDF + 5 t FYM ha⁻¹ than rest of the nutrient management treatments. Significantly the lowest grain (34.32 q ha⁻¹) and stover (65.29 q ha⁻¹) were registered in application of 100% RDN through FYM. The beneficial effect on yield attributes due to the increased supply of all the essential nutrients by FYM that might have resulted in manufacture of food and its subsequent partitioning towards sink. These results are in conformity with the findings of Kumar and Gautam (2004) ^[8], Chaudhari and Gautam (2007) ^[2], Girase *et al.*, (2010) ^[5] and Parihar *et al.*, (2012) ^[11].

Nutrient uptake

The N, P and K uptake by pearl millet (97.06, 39.09 and 148.70 kg ha⁻¹, respectively) were recorded significantly maximum with application of RDF + 5 t FYM ha⁻¹ as compared to rest of nutrient management treatments. These results are in line with those reported by Choudhary and Gautam (2007) ^[2].

Harvest index (%)

The highest harvest index of 35.04 per cent was recorded with the application of RDF + 5 t FYM ha⁻¹ followed by 50% RDF + 50% RDN through FYM. This might be due to higher absorption and translocation of nutrients leading to increased production of photosynthates by the crop resulting in increased biomass accumulation and portioning of these photosynthates towards sink that resulted in significant increase in harvest index. These results are in agreement with the findings of Kumar and Gautam (2004) ^[8].

Rain water use efficiency

The rain water use efficiency was significantly higher in application of RDF + 5 t FYM ha⁻¹ (12.38 kg ha⁻¹-mm) than rest of the nutrient management treatments followed by 50% RDF + 50% RDN through FYM. This increased value of WUE might be

ascribed to higher grain yield coupled with more proportionate increase in grain yield due to higher availability of N, P and K to crop under aforesaid treatments. These results are in line with those Rathore *et al.*, (2006) [12].

Table 1: Growth and yield attributes of pearl millet as influenced by land configurations and nutrient management

Treatments	Plant height (cm)	Total Dry matter plant ⁻¹ (g)	No. of total tillers plant ⁻¹	No. of effective tillers plant ⁻¹	Earhead length (cm)	Earhead girth (cm)	Earhead weight (g)	Grain weight earhead ⁻¹ (g)	1000 grain weight (g)
L: Land configurations									
L ₁ -Flat bed	204.17	107.32	2.90	1.32	21.58	10.85	55.48	44.31	11.53
L ₂ -Ridges and furrow	211.33	119.44	3.17	1.58	22.44	11.14	58.95	47.92	12.01
L ₃ -Broad bed furrow	216.12	125.92	3.42	1.73	22.84	11.45	61.58	49.78	12.33
S. E. (m) ±	1.71	3.04	0.07	0.05	0.24	0.08	0.91	0.61	0.09
C.D. at 5%	6.74	11.94	0.28	0.18	0.94	0.31	3.59	2.42	0.35
N: Nutrient management									
N ₁ -RDF (60:30:30 kg NPK ha ⁻¹)	208.62	115.92	3.04	1.49	21.95	11.08	57.42	47.04	11.80
N ₂ -RDF + 5 t FYM ha ⁻¹	216.44	125.69	3.49	1.76	23.20	11.60	64.34	52.09	12.68
N ₃ -50%RDF + 50% RDN through FYM	212.02	119.48	3.27	1.58	22.62	11.32	60.17	48.58	12.16
N ₄ -100% RDN through FYM	205.07	109.14	2.84	1.36	21.39	10.59	52.75	41.63	11.20
S. E. (m) ±	1.45	1.78	0.07	0.05	0.17	0.10	0.89	0.52	0.17
C.D. at 5%	4.31	5.29	0.21	0.15	0.52	0.29	2.66	1.55	0.51
Interactions (L X N)									
S. E. (m) ±	2.51	3.08	0.12	0.09	0.30	0.17	1.55	0.90	0.30
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

RDF: Recommended dose of fertilizers, RDN: Recommended dose of nitrogen, FYM: Farm yard manure

Table 2: Yield, harvest index, nutrient uptake and rain water use efficiency of pearl millet as influenced by land configurations and nutrient management

Treatments	Grain yield (q ha ⁻¹)	Stover yield (q ha ⁻¹)	Harvest index (%)	Total N uptake (kg ha ⁻¹)	Total P uptake (kg ha ⁻¹)	Total K uptake (kg ha ⁻¹)	Rain WUE (kg ha ⁻¹ -mm)
L: Land configurations							
L ₁ -Flat bed	34.72	65.43	34.66	69.25	27.75	108.44	10.38
L ₂ -Ridges and furrow	38.64	72.63	34.72	81.12	33.83	126.25	11.55
L ₃ -Broad bed furrow	39.97	74.89	34.79	87.92	36.55	134.63	11.95
S. E. (m) ±	0.96	1.85	0.08	1.77	0.88	2.71	0.29
C.D. at 5%	3.76	7.30	NS	6.98	3.46	10.67	1.13
N: Nutrient management							
N ₁ -RDF (60:30:30 kg NPK ha ⁻¹)	36.56	69.13	34.59	72.87	31.15	113.82	10.93
N ₂ -RDF + 5 t FYM ha ⁻¹	41.43	76.81	35.04	97.06	39.09	148.70	12.38
N ₃ -50%RDF + 50% RDN through FYM	38.81	72.70	34.81	82.75	34.72	132.31	11.60
N ₄ -100% RDN through FYM	34.32	65.29	34.45	65.05	25.88	97.60	10.26
S. E. (m) ±	0.81	1.37	0.07	2.33	1.06	2.89	0.24
C.D. at 5%	2.40	4.10	0.22	6.93	3.16	8.57	0.72
Interactions (L X N)							
S. E. (m) ±	1.40	2.70	0.13	4.04	1.84	4.99	0.42
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS

Conclusion

Based on the results it could be concluded that sowing of *kharif* pearl millet on broad bed furrow or ridges furrow and fertilized with 100% RDF (60:30:30 kg NPK) + 5 t FYM ha⁻¹ for achieving maximum grain yield, stover yield, nutrient uptake and water use efficiency in medium black soils.

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