The Pharma Innovation Journal 2022; 11(5): 385-388

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(5): 385-388

www.thepharmajournal.com
Received: 13-03-2022
Accepted: 22-04-2022

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Effect of nutrient management and moisture conservation practice on roots and yield attributes of Pearl millet (*Pennisetum glaucum* L.) under light textured soil

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Abstract
A field experiment was conducted during consecutive two years of 2019-20 & 2020-21 entitled "Effect of nutrient management and moisture conservation practice on roots and yield attributes of Pearl millet (Pennisetum glaucum L.) Under light textured soil." at Soil Conservation and Water Management Farm of *Chandra Shekhar Azad University of Agriculture and Technology*, Kanpur. The experiment was comprised total eighteen treatment combination of six nutrient management *viz*. N_1) Control, N_2) 100% NPK 80:40:40 kg ha^{-1} through RDF, N_3) Green manuring + 75% NPK through RDF, N_4) Green manuring + FYM 10 t ha^{-1}, N_5) FYM @ 10 t ha-^{1} + 75% NPK through RDF and N_6) FYM@ 10 t ha^{-1} + 50% NPK through RDF) and three moisture conservation practices *viz*. M_1) Control, M_2) inter-row water harvesting and M_3) Ridge making at 25 DAS. The conducted field experiment was framed in Factorial Randomized Block Design with three replication. The results of conducted field experiment revealed that treatment N_5 (FYM @ 10 t ha-^{1} + 75% NPK through RDF) among the nutrient management and treatment M_3 (Ridge making at 25 DAS) among the moisture conservation practices were found significantly superior and recorded significantly maximum root and yield attribute parameters. The treatment N_5 treated with FYM @ 10 t ha-^{1} + 75% NPK through RDF was recorded significantly maximum length of ear (21.45, 21.6 cm), No. of grains ear^{-1} (1623.9, 1627.5), no. of ears (4.86, 4.97), grain weight plant^{-1} (14.58, 14.88) and test weight (8.98, 9.02 g) and root parameters *viz*. depth of roots (17.2, 19.8 cm) and number of roots (59.8, 61.6) and similarly treatment M_3 of moisture conservation practices (Ridge making at 25 DAS) was also recorded significantly maximum length of ear (19.67, 19.81 cm), no. of grains ear^{-1} (1565.2, 1569.8), no. of ears (4.45, 4.55), grain weight plant^{-1} (13.44, 13.5) and test weight (8.57, 8.65 g) and root parameters *viz*. depth of roots (16.8, 19.0 cm) and number of roots (58.1, 60.3) than rest of treatments in experimental crop during the both years of experimental studies.

Keywords: Green manuring, moisture conservation practice, nutrient and pearl millet

Introduction
Pearlmillet is commonly known as Bajra belongs to Family- Gramineae (Poaceae) and origin place is Africa. Pearlmillet is one of the major coarse grain crops and is to be considering a poor men's food. Pearl millet became cheaper alternative sources (Reddy *et al.*, 2013) [7]. Further, the nutritional value of this crop offers much scope to development of value added products in new health conscious consumer segments (Yadav *et al.*, 2011) [3] as it contains more fibre and is good for diabetic and heart patients. Its grains are rich in protein (11.6%), minerals particularly, iron (8.8%), fat (5%) and carbohydrates (67%). Pearlmillet is predominantly grown in North West India and accounts for 42% of total world area under pearl millet and shares 24% of coarse grains production (Anonymous, 2018-19) [1]. Plant have tall and vigorous with exceptional grain and fodder yielding potential. It is generally cultivated in *Kharif* as coarse grain crop with rainfall from 150-660mm. It can also be stand in drought condition to a great extent. India is one of the main producers of pearlmillet. It provides cheap food, comparatively rich in various nutrients, protein, fat, carbohydrates and minerals for poor masses and feed for poultry birds as well as green fodder for cattle. It is grown in about 40 countries. In India it grown western part of the country in the states of Rajasthan followed by Gujarat, Uttar Pradesh and Haryana. These are covering about 87 per cent of the total important growing state area of pearlmillet and about 73.6 percent. (Anonymous, 2019) [2].

In India is the largest producer of this crop both in term of area 9.1 mha and production (7.12 mha) and production (8.06 mt) with an average productivity of 1132 kg ha-^{1} based on (ICRISAT – *bred material in India*). The major pearlmillet growing states in India are Rajasthan, UP, Haryana, Gujarat, and Maharashtra. In area of the pearlmillet is Rajasthan fallowed by Maharashtra, Gujarat and Uttar Pradesh about 3.2 mha, 1.55 mha, 0.94 mha, and 0.7 mha respectively but in productivity Haryana fallowed by Gujarat and Uttar Pradesh about 1331 kg ha-^{1}, 1277 kg ha-^{1} and 1235 kg ha-^{1} respectively. In Uttar Pradesh, Pearlmillet occupies an area about 0.7 mha. From which about 95 percent is under rainfed area. Mathura, Agra, Bulandshahar, Aligarh, Farrukhabad and Kanpur are the important pearmillet growing districts. However, It enhances growth, various yield attributing characters and ultimate yield of crop. The needy nutrients through chemical fertilizers have deleterious effect on soil health leading to unsustainable yields.

Materials and Methods

A field experiment entitled "Effect of nutrient management and moisture conservation practice on roots and yield attributes of Pearl millet (*Pennisetum glaucum* L.) Under light textured soil." was conducted during *Kharif* season of 2019-20 and 2020-21 at Soil Conservation and Water Management Farm of the Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. The materials used and methods employed during field experimentation and laboratory estimations.

Yield Attributes

The number of ears plant^{-1} was counted after full flowering of the crop in three randomly selected and tagged plants in each plot and then average no. of ears plant was worked out No. of grains ear^{-1} was collected from the 3 tagged plants and counted separately. After that average no. of grains ear^{-1} was worked out. Total number of ear plant^{-1} in Pearlmillet was counted in tagged sample plants in each treatment and finally the average value of each treatment was worked out. Three ear head from each plant were taken randomly. All threshed together and seeds were separated and cleaned. The seeds were counted on manually to recorded seeds Ear head^{-1}. Exactly 1000-grains were counted and weighed on electronic balance. Finally the 1000 seed weight for each treatment was recorded, during field experimentation years and laboratory estimations.

Root Studies

Root studies were made only at maturity stage in one replication. A pit of around from the plant shoot up to 40 cm depth was dug. Then root of each plant was opened by washing of the adhered soil with the help of fine jet of spray of water. Due care was taken to adjust the force of water in such a way was that the roots were not damaged and washed away smoothly. By this method about 90 to 95% roots of each plant were recovered. The exposed roots were finally washed in running water keeping then in a sieve. The observations regarding depth of roots, roots plants^{-1} and weight of roots plants^{-1} were taken, after harvesting of crop in one replication.

Result and Discussion

Yield attributes

Result on yield attributes at maturity stage of data given in table-1

Effect of nutrient management

Application of nutrient through chemical fertilizer, farm yard manure and green manure at the time of sowing effect on yield attributes and of pearlmillet significantly produced highest number of ear plant^{-1} (4.86 and 4.97), length of ear (cm) (21.45 and 21.61), number of grain ear^{-1}(1623.9 and 1627.5) counted, number of ear plant^{-1} (4.86 and 4.97), grain weight plant^{-1} (14.58 and 14.88) and 1000, grain weight (8.98 and 9.02) of pearlmillet which was at (N_5) FYM@ 10 t ha-^{1} + 75% NPK through RDF during both the experimental year. Lowest number of ear plant^{-1} (3.71 and 3.63), length of ear (cm) (16.20 and 16.24), number of grain ear^{-1}(1433.6 and 1443.7) counted, number of ear plant^{-1} (3.63 and 3.71), grain weight plant^{-1} (10.99 and 11.53) and 1000, grain weight (7.63 and 7.70) of pearlmillet. The data recorded during 2019-20 and 2020-21 were subjected statistical analysis and summarized in the table-1. as similar Lal *et al.* (2017) [4], Shekhawat *et al.* (2015) [8], Rajput and Bhadouriya (2019) [7].

Table 1: Effect of different treatments on Yield attributes

Treatment	Length of Ear		No. of Grains Ear^{-1}		No. of Ears		Grain weight Plant^{-1}		1000 grain weight	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
Nutrient Management										
N_1: Control	16.2	16.16	1433.7	1443.6	3.63	3.71	10.99	11.53	7.63	7.7
N_2: 100% NPK 80:40:40 kg ha^{-1} through RDF	19.14	19.29	1537.9	1551.2	4.33	4.44	13.02	13.58	8.45	8.63
N_3: Green manuring + 75% NPK through RDF	20.07	20.23	1551.5	1552.3	4.54	4.62	13.65	14.05	8.79	8.86
N_4: Green manuring+FYM 10 t ha^{-1}	16.16	16.29	1447.5	1448.9	3.66	3.73	11.04	11.8	7.59	7.66
N_5: FYM@ 10 t ha-^{1} + 75% NPK through RDF	21.45	21.6	1623.9	1627.5	4.86	4.97	14.58	14.88	8.98	9.02
N_6: FYM@ 10 t ha^{-1} + 50% NPK though RDF	17.27	17.41	1454.3	1458.4	3.91	3.98	11.75	12.7	8.07	8.11
SE±(d)	0.586	0.675	22.196	24.912	0.134	0.141	0.499	0.555	0.259	0.259
CD at (0.05%)	1.191	1.371	45.12	50.641	0.272	0.286	1.015	1.127	0.526	0.527
Moisture Conservation Practices										
M_1: Control	16.9	17.03	1458.6	1458.8	3.82	3.9	11.49	11.88	7.85	7.923
M_2: Inter-row water harvesting	18.58	18.64	1505.6	1507.3	4.19	4.28	12.58	12.98	8.33	8.38
M_3: Ridge making at 25 DAS	19.67	19.81	1565.2	1569.8	4.45	4.55	13.44	13.5	8.57	8.65
SE±(d)	0.414	0.477	15.69	17.61	0.095	0.1	0.353	0.392	0.183	0.183
CD at (0.05%)	0.843	0.97	31.904	35.81	0.192	0.203	0.717	0.797	0.372	0.372

Effect of moisture conservation practice

Maximum data of pearlmillet was measured under treatment where (M_3) ridge making at 25 DAS during both the experimental year on number of ear plant^{-1} (4.45 and 4.55),

length of ear (cm) (19.67 and 19.81), number of grain ear^{-1} (1565.2 and 1569.8) of pearlmillet was counted under treatment, number of ear plant^{-1} (4.46 and 4.55), grain weight plant^{-1} (13.44 and 13.50) and 1000, grain weight (7.85 and 7.92) clearly reveals that moisture conservation practice significantly affects the length of ear of pearlmillet. Length of ear (cm) (19.67 and 19.81) and maximum length of ear (cm) also counted under these treatments at maturity stage of crop growth. Minimum length of ear (cm) (16.90 and 17.03) number of ear plant^{-1}(3.83 and 3.90), number of grain ear^{-1} (1458.6 and 1458.8) counted, number of ear plant^{-1} (3.82 and 3.90), grain weight plant^{-1} (11.49 and 11.88) and 1000, grain weight (7.85 and 7.92) measured under the (M_1) control treatment during both 2019-20 and 2020-21

Root studies

Result on depth of root (cm) at maturity stage of data given in table-2

Table 2: Effect of roots studies under different treatments.

Treatment	Depth of roots (cm)		Number of roots	
	2019-20	2020-21	2019-20	2020-21
Nutrient Management				
N_1: Control	14.2	16.1	54.5	56.2
N_2: 100% NPK 80:40:40 kg ha^{-1} through RDF	15.8	18.3	56.6	58.3
N_3: Green manuring + 75% NPK through RDF	16.5	18.6	57.3	59.5
N_4: Green manuring + FYM 10 t ha^{-1}	14.7	16.8	55.01	57.4
N_5: FYM@ 10 t ha^{-1} + 75% NPK through RDF	17.2	19.8	59.8	61.6
N_6: FYM@ 10 t ha^{-1} + 50% NPK though RDF	15.3	17.2	55.9	58.1
SE±(d)	-	-	-	-
CD at (0.05%)	-	-	-	-
Moisture Conservation Practices				
M_1: Control	16.02	17.9	56.1	58.2
M_2: Inter-row water harvesting	16.5	18.3	57.3	59.5
M_3: Ridge making at 25 DAS	16.8	19.0	58.1	60.3
SE±(d)	-	-	-	-
CD at (0.05%)	-	-	-	-

Effect of nutrient management

Number of roots, fresh roots weight plant^{-1} and dry roots weight plant^{-1} clearly revealed that nutrient management significantly affect depth of roots (cm) of pearlmillet. Highest depth of roots (cm) (17.2 and 19.8) of pearlmillet was measured under treatment where (N_1) control following by (N_4) green manuring with FYM @10 t/ha during both the year of experimentation Minimum depth of root (cm) (14.2 and 16.1) measured under the (N_5) application of FYM @10 t/ha NPK through chemical fertilizer treatment during 2019-20 and 2020-21respectively.

Data on number of roots plant^{-1} clearly revealed that nutrient management significantly affect number of roots plant^{-1}of pearlmillet. Maximum number of roots plant^{-1} (59.8 and 61.6) of pearlmillet was counted under treatment where (N_5) FYM applied @ of 10 tones/ha with 75% NPK through chemical fertilizers followed by (N_3) green manuring with 75% NPK through chemical fertilizers during both the year of experimentation. Minimum number of roots plant^{-1} (54.5 and 56.2) under the (N_1) control treatment during the both the years.

Maximum fresh weight (g) (173.71 and 177.62) and dry weight (g)of roots plant^{-1} (80.79 and 82.61) of pearlmillet was weighted under treatment (N_5) where FYM applied @ of 10 tones/ha with 75% NPK through chemical fertilizers during both 2019-20 and 2020-21, respectively. Minimum fresh weight (g) (123.22 and 126.44) and dry weight (g) of roots plant^{-1} (56.24 and 57.71) weighted under the (N_1) control treatment during the both the years.

Effect of moisture conservation practice

Data clearly showed that moisture conservation practice significantly effect on depth of roots (cm) of pearlmillet. Maximum depth of roots (cm) (16.8 and 19.0) of pearlmillet was measured under treatment where (M_1) control during both the experimental years. Minimum depth of root (cm) (16.02 and 17.9) measured under the (M_3) ridge making at 25 days after sowing treatment during both the years.

Data on number of roots plant^{-1} clearly reveals that moisture conservation practice significantly affect number of roots plant^{-1} of pearlmillet. Maximum number of roots plant^{-1} (58.1 and 60.3) of pearlmillet was counted under treatment (M_3) where ridge making at 25 days after sowing during both the year of experimentation. Minimum number of roots plant^{-1} (56.1 and 58.2) counted under the (M_1) control treatment during 2019-20 and 2020-21.

Maximum fresh weight (g) (158.99 and 162.84) and dry weight (g) of roots plant^{-1} (72.32 and 75.10) of pearlmillet was weighted under treatment (M_3) where ridge making at 25 DAS during both the experimental year. Minimum fresh weight (g) (141.36 and 145.10) and dry weight (g) of roots plant^{-1} (65.00 and 66.72) weighted under the (M_1) control treatment during both the years. Kumar *et al*. (2018) [10]; Singh *et al.* (2018) [10]; Shekhawat *et al.* (2015) [8, 9]

Conclusion

"Effect of nutrient management and moisture conservation practice on roots and yield attributes of Pearl millet (*Pennisetum glaucum* L.) Under light textured soil" are they concluded results of present investigation could be concluded in the light of set objectives of the study as given below:

Significantly maximum yield attributes *viz*., length of ear, number of grain ear^{-1}, number of ear plant^{-1}, grain weight plant^{-1} and 1000 grains weight, and root studies *viz*., depth of root (cm), number of roots plant^{-1} and fresh weight (g) and dry weight (g) of the crop will be analyzed from following produced with the results of the present investigation summarized above it can be concluded the nutrient management treatment (N_5) FYM applied @ of 10 tones/ha with 75% NPK through RDF (application of nutrient dose

through chemical fertilizer and farm yard manure) and minimum yield attributes *viz*., length of ear, number of grain ear^{-1}, number of ear plant^{-1}, grain weight plant^{-1} and 1000 grains weight, and root studies *viz*., depth of root (cm), number of roots plant^{-1} and fresh weight (g) and dry weight (g) under N1 control treatments as compared to remaining treatments during 2019-20 & 2020-21.

Significantly maximum yield attributes *viz*., length of ear, number of grain ear^{-1}, number of ear plant^{-1}, grain weight plant^{-1} and 1000, grains weight, and root studies *viz*., depth of root (cm), number of roots plant^{-1} and fresh weight (g) and dry weight (g) of roots plant^{-1}, soil were produced more significant with moisture conservation practices given at (M_3) ridge making at 25 DAS then other moisture conservation practices during both the experimental year. Significantly minimum yield attributes *viz*., length of ear, number of grain ear^{-1}, number of ear plant^{-1}, grain weight plant^{-1} and 1000, grains weight, and root studies *viz*., depth of root (cm), number of roots plant^{-1} and fresh weight (g) and dry weight (g) of roots plant^{-1}, soil were produced less significant with moisture conservation practices under (M_1) control treatment then other moisture conservation practices during 2019-20 and 2020-21.

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