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Performance of Rainfed Pearlmillet (*Pennisetum glaucum*) as Influenced by Intercropping, Fertility and Moisture Conservation Practices

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A B S T R A C T

A field experiment was conducted during *kharif* season of 2007 and 2008 at Kanpur, Uttar Pradesh to evaluate the effect of two cropping systems (Sole pearlmillet and pearlmillet + cowpea intercropping), two fertility levels ($N_{40}+P_{20}+K_{20}$ and $N_{80}+P_{40}+K_{20}$ kg/ha) and three moisture conservation practices (control, organic mulching, ridging and furrowing) on productivity and profitability of pearlmillet. The pearlmillet gave higher grain yield in intercropping system (26.67 and 26.98 q/ha) along with additional yield of cowpea intercrop (7.19 and 7.25 q/ha) against 24.85 and 25.49 q/ha grain yield of sole pearlmillet. Intercropping system produced 48.23 and 48.73q/ha pearlmillet equivalent yield (PMEY) and earned Rs. 21942 and 22180/ha net return with 2.90 and 2.92 B: C ratio against only Rs. 9322 and 9785/ha net return and 1.90 and 1.94 B: C ratio of sole pearlmillet. The application of $N_{80}+P_{40}+K_{20}$ fertility recorded 38.82 and 39.31 q/ha PMEY against 34.26 and 34.93 q/ha obtained at $N_{40}+P_{20}+K_{20}$ fertility, and earned Rs. 16643 and 17004/ha net return against Rs. 14621 and 14970/ha at $N_{40}+P_{20}+K_{20}$ level. Among moisture conservation practices, ridging and furrow produced significantly highest of 40.21 and 40.12 q/ha PMEY and earned maximum of Rs. 18578 and 18495/ha net return with 2.80 and 2.79 B:C ratio followed by control with Rs. 14576 and 15225/ha net return and 2.54 and 2.61 B:C ratio during 2007 and 2008 years, respectively.

Introduction

Pearlmillet *(Pennisetum glaucum)* is an important cereal crop of rainfed areas. It is efficient in utilization of soil moisture and has a greater level to heat tolerance. It thrives well on light textured and well drained soils. However, crop yields are very poor in rainfed condition perhaps because of non-adaptation of proper agronomic practices. Rainfed pearlmillet crop is seldom fertilized while it responds well to fertilizer application. Fertilization of crop in rainfed condition does not provide nutrients only but also enhances water use efficiency, controls soil erosion by promoting rapid and heavier crop growth, checks run-off and increases water holding capacity of soil. Intercropping of pulses in pearlmillet makes the system more productive through efficient utilization of natural resources viz. solar radiation, soil moisture, space, nutrients and other inputs applied. It helps in giving additional production and return per unit area and time. Soil moisture availability to the crop is main problem of rainfed agriculture, thus use of soil moisture conservation practices have been proved useful to take the proper advantage of other inputs applied. Keeping these points in view the present study was undertaken to find out

the significance of intercropping, increasing fertility levels and moisture conservation practices in rainfed pearlmillet crop under central Uttar Pradesh condition.

Materials and Methods

The field experiment was conducted during *kharif* seasons of 2007 and 2008 at soil conservation and water management farm of C.S. Azad University of Agriculture and Technology, Kanpur. The soil of experimental site was sandy loam in texture, almost nuetral in reaction (pH 7.2) having 0.29% O.C., 16.6 kg/ha available P_2O_5 and 192 kg/ha available K_2O. Experimental crops received total rainfall of 254.4 mm and 258.6 mm during 2007 and 2008, respectively. The experiment was layout in 3 times replicated split plot design with 12 treatment combinations having the combinations of 2 cropping systems (sole pearlmillet and PM + Cowpea intercropping) and 2 fertility levels (N_{40}+P_{20} and N_{80}+P_{40} kg/ha) in main plots and 3 soil moisture conservation practices (control, organic residue mulch, and ridging and furrowing) in sole-plots. Intercropping was done in additive series by way of paired row sowing (30/70 cm) of pearlmillet against sole pearlmillet sown in 50 cm uniform row spacing. A uniform dose of 20 kg K_2O/ha was applied as Basel application in all treatment plots along with N and P applied as per treatment. In organic mulch plots, paddy straw @ 10t/ha was used at 3 weeks after sowing. Ridging and furrowing in respective plots was also done same day of sowing. The pearlmillet variety 'Samrat-131' and cowpea 'CL-367' were sown @ 5 kg/ha and 15 kg/ha seed, respectively as per treatment plot on 8 August 2007 and 2008 during two years. Sowing of crop seeds was done through funnel below seed. The observations were recorded on growth and yield attributes and yield of component crops, pearlmillet equivalent yield (PMEY) and net return. The PMEY was worked out by converting the yield of cowpea into the yield of pearlmillet on the basis of prevailing market price of the crops. The net return was calculated by deducting the total cost of cultivation from the gross return of respective treatment.

Results and Discussion

Growth and yield attributes of pearlmillet

Ridging and furrowing practice of moisture conservation produced significantly taller plants than organic residue mulch and control (Table-1). Cropping systems or fertility levels had no significant affect on plant height. Number of tillers/plant was recorded significantly higher in intercropping system than sole pearlmillet and with N_{80} P_{40} than N_{40} P_{20} fertility level. Among moisture conservation practices, ridging and furrowing produced significantly maximum tillers/plant followed by organic mulch whereas minimum number of tillers was recorded in control treatment plots. Higher plant height and more number of tillers/plant in ridging and furrowing plots might be due to efficient conservation of rain water in furrows which increased the availability of soil moisture to plants for better growth. Almost similar results were reported by Kumar and Gautam (2004). More number of tillers/plant in intercropping than sole pearlmillet might be associated with symbiotic N fixation in cowpea roots and availability of more space for pearlmillet plants in paired row sowing. Yield indices such as ears/plant, ear length grains/ear and grain weight/ear were significantly higher in intercropping system (Table-1). This might be due to amount of nitrogen fixed by the component crop cowpea which was fully utilized by the main crop pearlmillet for better growth and development resulted in expression of higher values of these yield indices. All these yield indices and 1000-grain weight with harvest index also recorded significantly higher values at higher fertility level of N_{80} P_{40} than lower fertility level of N_{40} P_{20}.

Table.1 Effect of intercropping, fertility and moisture conservation practices on growth and yield attributes of pearlmillet

Treatments	Plant height (cm)		No. of tillers per plant		No. of ears per plant		Ear length (cm)		No. of grains per ears		Grain weight per ear (g)		1000-grain weight (g)		Harvest index (%)	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Cropping systems																
Sole pearlmillet	192.44	194.29	4.15	4.58	2.50	2.58	28.10	28.71	1712.1	1740.0	16.50	15.63	11.16	11.33	25.43	25.84
Pearlmillet + cowpea	193.40	195.52	4.62	4.79	2.92	3.29	28.83	29.85	1815.7	1806.7	17.65	17.33	11.17	11.52	25.57	25.94
S.Ed. ±	0.68	0.93	0.12	0.07	0.06	0.05	0.11	0.41	16.3	9.8	0.13	0.35	0.09	0.06	0.16	0.16
C.D. (P=0.05)	NS	NS	0.28	0.18	0.16	0.13	0.28	1.01	39.8	23.9	0.32	0.86	NS	0.15	NS	NS
Fertility levels																
40 kg N + 20 kg P_2O_5/ha	192.66	194.67	4.26	4.56	2.59	2.80	27.98	28.55	1706.1	1741.7	16.49	15.95	11.15	11.31	25.30	25.84
80 kg N + 40 kg P_2O_5/ha	193.18	195.14	4.51	4.81	2.83	3.06	28.95	30.01	1821.7	1805.0	17.66	17.01	11.59	11.54	25.70	25.95
S.Ed. ±	0.68	0.93	0.12	0.07	0.06	0.05	0.11	0.41	16.3	9.8	0.13	0.35	0.09	0.06	0.16	0.16
C.D. (P=0.05)	NS	NS	NS	0.18	0.16	0.13	0.28	1.01	39.8	23.9	0.32	0.86	0.23	0.15	0.39	NS
Moisture conservation																
Control	191.08	193.05	3.60	4.45	1.93	2.41	27.48	27.17	1668.6	1697.5	16.10	15.66	10.50	11.09	25.00	25.61
Organic residue mulch	192.50	194.48	4.53	4.72	2.91	3.05	28.51	29.65	1769.1	1782.5	16.96	16.55	11.53	11.46	25.61	25.96
Ridging and furrowing	195.19	197.19	5.02	4.90	3.28	3.33	29.40	31.02	1854.0	1840.0	18.16	17.23	12.07	11.73	25.89	26.12
S.Ed. ±	0.98	1.19	0.11	0.09	0.05	0.08	0.22	0.43	25.0	11.8	0.25	0.46	0.10	0.09	0.31	0.17
C.D. (P=0.05)	2.08	2.52	0.22	0.20	0.11	0.16	0.47	0.91	52.9	25.0	0.53	0.98	0.20	0.18	0.67	0.37

Table.2 Effect of intercropping, fertility and moisture conservation practices on yield and economics of pearlmillet + cowpea system

Treatments	Grain yield (q/ha)		Stover/straw yield (q/ha)		Pearlmillet equivalent yield (q/ha)		Net return		Benefit: cost ratio	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Cropping systems										
Sole pearlmillet	24.85	25.49	72.52	73.95	24.85	25.49	9322	9785	1.90	1.94
Pearlmillet + cowpea	26.67 (7.19)	26.98 (7.25)	77.81 (15.96)	77.47 (16.18)	48.23	48.73	21942	22130	2.90	2.92
S.Ed. ±	0.69	0.48	2.13	0.94	0.97	0.88	365	329	0.03	0.04
C.D. (P=0.05)	1.69	1.17	5.21	2.30	2.38	2.16	892	805	0.07	0.09
Fertility levels										
40 kg N + 20 kg P_2O_5/ha	24.86 (6.27)	25.43 (6.33)	73.28 (14.50)	73.34 (14.66)	34.26	34.93	14621	14970	2.38	2.42
80 kg N + 40 kg P_2O_5/ha	26.66 (8.11)	27.04 (8.18)	77.06 (17.42)	78.08 (17.70)	38.82	39.31	16643	17004	2.47	2.50
S.Ed. ±	0.69 (0.06)	0.48 (0.43)	2.13 (0.08)	0.94 (0.47)	0.97	0.88	365	329	0.03	0.04
C.D. (P=0.05)	1.69 (0.25)	1.17 (0.97)	NS (0.34)	2.30 (1.04)	2.38	2.16	892	805	0.07	0.09
Moisture conservation										
Control	23.94 (5.65)	24.95 (5.70)	71.85 (13.27)	72.79 (13.48)	32.41	33.50	14576	15225	2.54	2.61
Organic residue mulch	25.81 (7.46)	26.46 (7.53)	74.82 (16.53)	75.94 (16.88)	37.00	37.75	13744	14248	2.05	2.09
Ridging and furrowing	27.54 (8.45)	27.31 (8.54)	78.84 (18.07)	78.40 (18.19)	40.21	40.12	18578	18495	2.80	2.79
S.Ed. ±	1.25 (0.21)	0.61 (0.53)	2.55 (0.44)	1.27 (0.57)	1.50	1.32	545	523	0.04	0.06
C.D. (P=0.05)	2.64 (0.49)	1.29 (1.18)	5.41 (1.01)	2.69 (1.28)	3.18	2.80	1155	1108	0.08	0.13

Note: Figures given in parenthesis are for cowpea intercrop.

Use of moisture conservation practices improved all yield indices significantly over control while out of two moisture conservation practices, ridging and furrowing proved significantly superior to organic mulch, perhaps because of more efficient moisture conservation in soil which increased regular availability of moisture throughout reproductive phase. These results are in close conformity to the findings of Gargi and Gautam (2003).

Grain and stover yield of crops

Pearlmillet yielded significantly higher in intercropping system than sole pearlmillet by the margins of 6.58 per cent in grain yield and 6.01 per cent ink Stover yield on mean basis of two years (Table-2). It might be attributed to improved growth and yield attributes in intercropping system.

Higher fertility of N_{80} P_{40} increased grain and Stover yield of pearlmillet over N_{40} P_{20}level by the margins of 6.78 and 5.38 per cent, respectively on mean basis of two years. Both moisture conservation practices increased pearlmillet yield significantly over control where ridging and furrowing practice gave significantly higher yields than organic mulching. It increased grain and Stover yield over control and organic mulch by the margins of 12.21 and 4.93 per cent in grain and 8.71 and 4.30 per cent in Stover yield, respectively in mean data of two years.

The moisture conservation practices of organic mulch and ridging and furrowing increased PMEY over control by the margins of 4.42 q/ha or 13.4 per cent and 7.21 q/ha or 21.9 per cent, respectively in mean of 2-years data.

The practice of ridging and furrowing earned significantly maximum net return with higher B: C ratio followed by control whereas organic mulch recorded lowest net return and B: C ratio. It might be due to higher cost was involved in organic mulching which could not be compensated in organic mulching which could not be compensated even by significantly higher PMEY in organic mulching.

Ridging and furrowing practice earned Rs. 3636/ha or 24.4 per cent and Rs. 4541/ha or 32.4 per cent higher net return along with 8.5 and 35.0 per cent higher B: C ratio than control and practice of organic mulching, respectively on mean basis of two year results.

PMEY and economics of cultivation may be well supported by yields of both component crops under different treatments as both crops proved their compatability in intercropping system. Almost similar results have been reported by Tetarwal and Rana (2006).

The results of present experiment could be concluded that the cultivation of pearlmillet in intercropping of field cowpea with 80 kg N+40 kg P_2O_5 + 20 kg K_2O/ha and ridging and furrowing practice of soil moisture conservation is more productive and profitable under rainfed condition of central Utter Pradesh.

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