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Effect of Fertility Levels on Production of Pearlmillet Cultivars Under Rainfed Condition

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Abstract

A field experiment was conducted during kharif seasons of 2013 and 2014 on light textured soil at Kanpur to find out the effect of fertility levels and moisture conservation practices on growth behaviour, yield, WUE, root development and economics of rainfed pearlmillet cultivars. Results revealed that the cultivar 'Kaveri supper boss' considered to be the most promising in terms of growth, grain as well as stover yield, WUE, root development, net return and B:C ratio. Application of 80 kg N + 40 kg P_2O_5 + 40 K_2O/ha gave significantly higher growth, yield attributes and yield. In addition, total water use, WUE and net return were also noticed more. Ridging and furrowing in between crop rows after 20 days of sowing brought out significant improvement in growth, yield attributes and yield over farmer's practice (one weeding and hoeing by khurpi). Total water use was the higher under farmer's practice plot over ridging and furrowing practice. The trend was reverse for WUE. However, ridging and furrowing treatment resulted in higher net return and B : C ratio.

Key words : *Fertility levels, moisture conservation practices, ears, girth, yield, harvest index, net return.*

Introduction

Research priorities need to focus on how to increase and sustain the crop productivity in rainfed areas. Pearlmillet is most preferred crop of dryland and rainfed areas 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 pearlmillet. Among agronomic management practices, selection of suitable variety as well as moisture conservation practice and nutrient management are essential to make best use of limited available moisture. As the information on suitable variety, moisture conservation practice and optimum fertilizer requirement for pearlmillet is very meager for Central Uttar Pradesh conditions, the present experiment was initiated to fill this gap.

Materials and Methods

A field experiment was conducted during *kharif* seasons of 2013 and 2014 at Soil Conservation and Water Management Farm of the C.S. Azad University of Agriculture and Technology, Kanpur. The experiment site had a slope of 1.3% with the top soil washed out by water erosion. However, the area was made cultivable by bunding. 12 treatment combinations comprising 2 cultivars, i.e. (i) Pioneer (ii) Kavari supper boss; 3 fertility levels i.e. (i) 40 kg N + 20 kg P_2O_5 + 20 kg K_2O/ha (ii) 60 kg N + 30 kg P_2O_5 + 30 kg K_2O/ha (iii) 80 kg N + 40 kg P_2O_5 + 40 kg K_2O/ha and 2 moisture conservation practices i.e. (i) farmer's practice (one weeding and hoeing by khurpi at 20 DAS (ii) ridging and furrowing in between the crop rows at 20 DAS was tested in factorial randomized block design with 3 replications. The gross plot size was 5.0 x 3.6 m and the net plot size was 4.0 x 2.7 m. The experimental soil was moderately deep, sandy loam, well drained having pH 7.8, organic carbon 0.28%, low in total-N (0.027%), medium in P_2O_5 (15.0 kg/ha) and medium in K_2O (200.9 kg/ha), field capacity 18.3% and bulk density 1.38 Mg/m3. The sowing of pearlmillet crop was done on August 27 and July 27 in two respective years. Recommended package of cultural practices was followed. The available soil moisture in 100 cm soil profile at sowing time was 240.5 and 245.3 mm during 2013 and 2014, respectively. Rainfall during crop growing season was 321 and 324 mm during first and second year, respectively. The crop was harvested on November 30 and 6 during 2013 and 2014, respectively.

Thesoil moisture was determined thermogravi-metrically using the samples collected from 0-25, 25-50, 50-75 and 75-100 cm depths at different growth stages. The moisture use by the crop was computed by summing up the value to soil moisture depletion from the profile during the entire crop period. WUE of the crop was calculated by the formula (WUE = Y/ET) as expressed by (1). Root studies were made at harvest by selecting 2 plants at random from each plot. The roots were freed with a fine jet of water spray so that the delicate rootlets were not broken. Studies on water use and root development were made in one replication only where the

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plant stand was most uniform. Net return was computed by difference method when cost of cultivation of given treatment plot was subtracted from gross return of respective plot. The balance was recorded as net return (Rs./ha). The net return value of a treatment plot was divided by cost of cultivation of respective treatment and figure so obtained was recorded as benefit : cost ratio for different treatment plots.

Results and Discussion

Growth and yield : Grain and stover yields of pearlmillet were recorded significantly higher in cultivar 'Kaveri supper boss' than 'Pioneer' (Table-2). These might be attributed to higher growth parameters and yield attributes in cultivar 'Kaveri supper boss' (Table-1). Yield cultivars between pearlmillet geno- types have already been reported by (2, 3). Out of two cultivars under test, 'Pioneer' took significantly lesser number of days for 50% flowering and maturity than 'Kaveri supper boss'. It might be due to genetic effect of cultivars as they differ from each other in various characters. Various fertility levels adopted in the experiment differed significantly in respect of growth, yield attributes and yield during both the years. Application of 80 kg N + 40 kg P_2O_5 + 40 kg K_2O/ha recorded the highest grain anstover yields. Growth and yield parameters i.e. plant height, number of tillers/plant, number of ears/plant, length of ear, girth of ear and 1000-grain weight were also highest with the application of 80 kg N + 40 kg P_2O_5 + 40 kg K_2O/ha treatment, due to availability of proportionally balanced nutrients to plants. Fertility levels resulted in slightly delayed flowering and maturity of the crop (Table-1). Application of 80 kg N + 40 kg P_2O_5 + 40 kg K_2O/ha recorded the highest values in respect of growth and yield attributing characters which have been collectively responsible for the increase in grain and stover yields up to the marked extent over other fertility combinations. These results are in close conformity with the findings of (3, 4). Ridging and furrowing practice brought about significant improvement in growth as well as yield attributes and grain as well as stover yield of pearlmillet over farmer's practice (control) during both the years. On mean basis, the increase in grain yield with this treatment was 1.94 q/ha (11.60%) over farmer's practice probably due to higher soil moisture during vegetative and reproductive stages of the crop (3, 5). Effect of ridging and furrowing practice was also significantly better than farmer's practice in respect of days to 50% flowering and maturity during both the years due to greater availability of moisture for a longer period.

Total water use : Cultivar 'Kaveri supper boss' registered higher total water use (TWU) than cultivar 'Pioneer' during both the years (Table-2). It might be attributed to more plant canopy and comparatively longer crop duration in

Table-1 : Effect of cultivars, fertility levels and moisture conservation practices on growth and yield attributes of pearlmillet crop.

Treatment	Plant height (cm)		No. of tillers/plant		Days to 50% flowering		Day to maturity		No. of ears/plant		Length of ear (cm)		Girth of ear (cm)		1000-grain weight (g)	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
Cultivars																
Pioneer	179.9	183.9	3.7	4.0	50.7	53.9	83.4	82.4	2.4	2.5	23.9	23.7	8.3	8.7	7.6	7.7
Kaveri supper boss	186.7	192.0	4.2	4.1	51.8	55.1	87.9	86.7	2.7	2.7	24.7	24.8	8.8	9.1	7.8	8.0
C.D. (P=0.05)	6.1	6.4	0.2	0.2	0.8	0.6	1.6	1.4	0.2	0.1	0.7	0.8	0.2	0.1	NS	NS
Fertility levels (kg/ha) N : P_2O_5 : K_2O in																
40 : 20 : 20	175.3	178.4	3.4	3.6	48.8	51.5	83.3	82.1	1.9	2.1	22.6	22.8	7.7	8.4	7.0	7.2
60 : 30 : 30	183.5	188.6	4.0	4.1	51.8	55.4	85.8	84.8	2.6	2.7	24.4	24.5	8.8	9.0	7.8	8.0
80 : 40 : 40	191.1	196.8	4.4	4.5	53.2	56.5	87.8	86.7	3.0	3.0	25.8	25.6	9.2	9.3	8.3	8.4
C.D. (P=0.05)	7.4	7.9	0.3	0.3	1.0	1.0	1.9	1.7	0.3	0.2	1.2	1.0	0.3	0.2	0.4	0.3
Moisture cons. practices																
Farmer's practice (one weeding & hoeing by khurpi)	180.0	183.8	3.6	3.8	50.2	54.0	83.2	82.8	2.4	2.4	23.9	23.7	8.4	8.8	7.6	7.6
Ridging and furrowing in between the crop rows	186.6	192.1	4.3	4.2	52.2	55.0	88.1	86.3	2.7	2.8	24.7	24.8	8.7	9.0	7.8	8.1
C.D. (P=0.05)	6.1	6.4	0.2	0.2	0.8	0.6	1.6	1.4	0.2	0.1	0.7	0.8	0.2	0.1	NS	NS

Y_1 = 2013, Y_2 = 2014

Table-2 : Effect of cultivars, fertility levels and moisture conservation practices on yield, total water use and water use efficiency of pearlmillet crop.

Treatment	Grain yield (q/ha)		Stover yield (q/ha)		Harvest index (%)		Total water use (mm)		Water use efficiency (kg grain/ha/mm of water)	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Cultivars										
Pioneer	17.12	15.75	57.76	50.45	22.86	23.79	341	344	5.02	4.58
Kaveri supper boss	20.24	17.91	62.76	56.08	24.39	24.21	349	355	5.80	5.05
C.D. (P=0.05)	0.56	0.85	1.60	1.52	NS	NS	-	-	-	-
Fertility levels (kg/ha)										
N : P_2O_5 : K_2O										
40 : 20 : 20	16.41	15.58	53.75	49.72	23.39	23.86	340	344	4.83	4.53
60 : 30 : 30	19.03	16.87	61.42	53.49	23.65	23.98	346	350	5.50	4.82
80 : 40 : 40	20.61	18.04	65.45	56.59	23.95	26.17	349	354	5.91	5.10
C.D. (P=0.05)	0.68	1.04	1.96	1.85	NS	NS	-	-	-	-
Moisture cons. practices										
Farmer's practice (one weeding & hoeing by khurpi)	17.73	15.85	57.46	50.65	23.58	23.83	348	344	5.09	4.61
Ridging and furrowing in between the crop rows	19.64	17.81	62.95	55.96	23.78	24.14	342	355	5.74	5.02
C.D. (P=0.05)	0.56	0.85	1.60	1.52	NS	NS	-	-	-	-

Table-3 : Effect of cultivars, fertility levels and moisture conservation practices on root development and economics.

Treatment	Root depth (cm)		No. of primary roots/plant		No. of secondary roots/plant		Weight of dry roots/plant (g)		Net return (Rs./ha)		Benefit : cost ratio	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Cultivars												
Pioneer	22.3	23.8	19.7	20.9	72.2	80.0	20.1	21.9	13421	11304	1.95	1.85
Kaveri supper boss	25.1	25.9	22.2	24.0	75.1	82.5	22.4	23.3	16058	14523	2.17	2.11
Fertility levels (kg/ha)												
N : P_2O_5 : K_2O												
40 : 20 : 20	21.5	23.0	18.6	20.1	70.0	77.0	19.4	21.4	11966	11139	1.90	1.86
60 : 30 : 30	24.5	25.5	21.3	22.3	74.1	82.3	21.5	22.9	15544	12986	2.13	1.99
80 : 40 : 40	25.1	26.0	23.0	24.9	76.8	84.5	22.8	23.5	16709	14615	2.15	2.10
Moisture cons. practices												
Farmer's practice (one weeding & hoeing by khurpi)	25.3	26.6	18.5	19.2	71.4	78.5	20.0	21.7	13284	11797	2.02	1.92
Ridging and furrowing in between the crop rows	22.1	23.2	23.4	25.7	75.9	84.0	22.5	23.5	16195	14028	2.10	2.04

cultivar 'Kaveri supper boss' which increased transpiration, thus used more amount of water than cultivar 'Pioneer'. These results are in agreement with the findings of (6, 7). Fertility levels influenced TWU by the plants. Moisture utilization was higher under application of 80 kg N + 40 kg P_2O_5 + 40 kg K_2O/ha over other fertility levels during both the years. This might be due to more vegetative and reproductive growth which in turn increase TWU (3). With moisture conservation practices, the higher TWU was observed in farmer's practice treatment over ridging and furrowing practice during both the years. The reduction in TWU due to moisture conservation practice may be ascribed to eradication of weeds and more collection of water in furrows as a result sufficient moisture conserved in the soil which in turn made it possible to utilize moisture by the crop more efficiently over farmer's practice. These results support the findings of (3).

Water use efficiency (WUE) : WUE was also recorded higher in cultivar 'Kaveri supper boss' than cultivar 'Pioneer' (Table-2). It might be ascribed to increased grain

yield of 'Kaveri supper boss' over that of cultivar 'Pioneer' by the margin of 16.06% while TWU was increased only by 2.77%. It showed that cultivar 'Kaveri supper boss' utilized water more efficiently than other cultivar 'Pioneer'. These results are supported by the findings of (3, 6). WUE was observed to improve with the application of 80 kg N + 40 kg P_2O_5 + 40 K_2O/ha treatment. Relatively much higher yield with slight increase in water use resulted in maximum WUE. These results are in agreement with those of (3, 8). WUE of the crop raised with ridging and furrowing practice was much higher as compared with farmer's practice. Higher WUE in this treatment may be attributed to higher grain yield and lower TWU.

Root development : Cultivar 'Kaveri supper boss' exhibited an all-round better root development as measured by root depth, number of roots and their dry weight/plant, while the poorest root development was observed of cultivar 'Pioneer' (Table-3). Better root development of cultivar 'Kaveri supper boss' may be attributed, firstly, to its slightly long duration and secondly to its genetic makeup. Development of roots were observed to be the highest with application of 80 kg N + 40 kg P_2O_5 + 40 kg K_2O/ha followed by 60 kg N + 30 kg P_2O_5 + 30 kg K_2O/ha during both the years. Application of 40 kg N + 20 kg P_2O_5 + 20 kg K_2O/ha treatment gave the poorest root performance. These are in conformity with the findings of (3). Root depth of pearlmillet was recorded deeper under one weeding and hoeing practice (farmer's practice) than the ridging and furrowing practice during both the years. It might be due to reason that in farmer's practice, pearlmillet root penetrated deeper in search of water as soil moisture in surface layer was not sufficient. Contrary to it, under ridging and furrowing practice sufficient moisture was available relatively in upper soil, thus roots utilized more moisture and developed horizontally. Number roots and their dry weight/plant were recorded lower in farmer's practice plot. It might be effect of more moisture availability relatively in upper soil under ridging and furrowing practice, while farmer's practice, roots could not develop properly due to stress of soil moisture. (3) opined similar view.

Economics : Net return and B:C ratio were recorded higher in cultivar 'Kaveri supper boss' than cultivar 'Pioneer'. These might be attributed to higher grain and stover yields of cultivar 'Kaveri supper boss'. As the cost of cultivation was exactly same in both cultivars, higher yield of 'Kaveri supper boss' are responsible for higher economic parameters than other cultivar 'Pioneer'. Application of 80 kg N + 40 kg P_2O_5 + 40 kg K_2O/ha recorded the highest net return and B : C ratio followed by 60 kg N + 30 kg P_2O_5 + 30 kg K_2O/ha and the lowest under 40 kg N + 20 kg P_2O_5 + 20 kg K_2O/ha during both the years. These results are in conformity with the findings of (4). Similarly, ridging and furrowing practice recorded maximum net return and B : C ratio during both the years over farmer's practice.

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