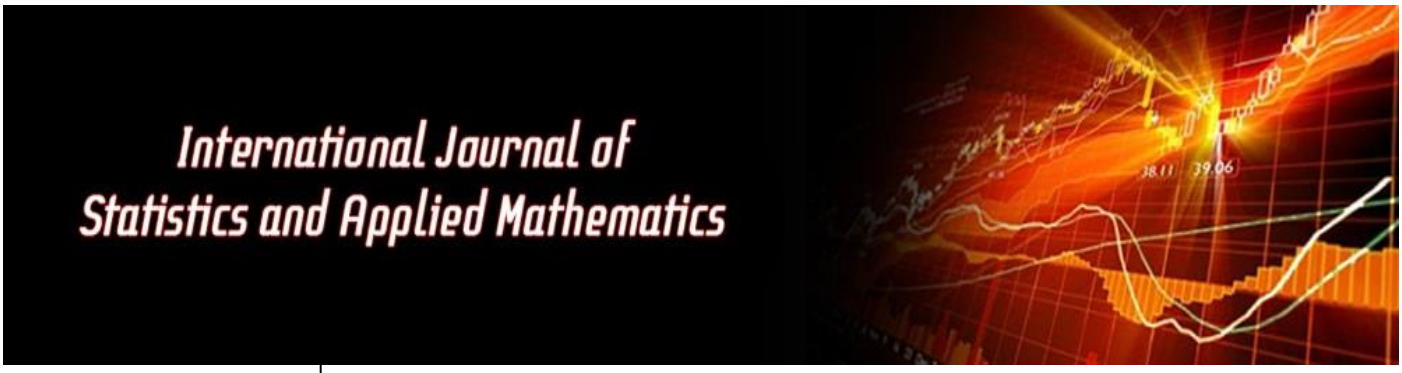
International Journal of Statistics and Applied Mathematics 2024; SP-9(4): 87-89



ISSN: 2456-1452
Maths 2024; SP-9(4): 87-89

https://www.mathsjournal.com
Received: 13-04-2024
Accepted: 17-05-2024

Amar Kant Verma
Department of Soil Conservation and Water Management, C. S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

RP Singh
Department of Soil Conservation and Water Management, C. S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Corresponding Author:
Amar Kant Verma
Department of Soil Conservation and Water Management, C. S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Productivity of rain water harvesting techniques on production efficiency, leaf area index and moisture use rate of pearl millet (*Pennisetum glaucum* L.) under rainfed condition

Amar Kant Verma and RP Singh

Abstract
A field experiment was conducted at Kanpur, Uttar Pradesh during two *Kharif* seasons to assess the relative productivity and profitability of Pearlmillet (*Pennisetum glaucum* L.) as influenced by different low cost water harvesting techniques. The soil of the experimental field was sandy loam in texture with average fertility. Water harvesting techniques tested in the experiment were compartmental bunding, deep ploughing, raised and sunken bed, inter row water harvesting, inter-paired row water harvesting, scooping and flat sowing as control. The result revealed that different rain water harvesting techniques showed significant response over control in respect to yield, protein and starch. Among different water harvesting techniques, inter-paired row water harvesting (IPRWH) produced highest production efficiency of 23.56 and 21.90 q ha^{-1} fetching 4.67 and 4.78 Leaf Area Index (LAI) which exhibited maximum Moisture Use Rate (MUR) of 4.36 and 3.63 mm $days^{-1}$ during these two seasons respectively.

Keywords: Rain water harvesting, Consumptive use, LAI, Production efficiency, MUR, IRWH, IPRWH

Introduction
Bajra is efficient in its utilization of soil moisture and has a higher level to heat tolerance than sorghum and maize. It thrives on light textured and well drained soil, but does not tolerances water logging like sorghum. Water stress decreases leaf water potential rate of stomatal conductance, photosynthesis and transpiration efficiency in flag leaves. The stomata conductance, photosynthesis and transpiration quicker in Pearl millet. It is important drought tolerant crop grown extensively in arid and semi-arid region under rainfed conditions. Consequently, drought is the most important factor in limiting its production. *Bajra* cultivation is very commonly practiced in rainfed area where the use of fertilizers in *kharif* crop rarely is done by the farmers in moisture stress condition. However, the application of fertilizers affects the yield due to presence of balance nutrients and their better utilization under moisture scare condition. The fertilizers application to *bajra* has great importance in rising the production. It enhances growth, various yield attributing characters and ultimate yield of crop. The problem of rainfed areas is manifolds and complex in nature. However, the main problem to be which the other problems are associated is that of uncertainly of rainfall and its poor control and management in the field which leads to low and unstable agriculture production. Short span of rainy season and poor moisture retention of soil due to topographical and textural problems further make the problem difficult. Excess loss of water through runoff lead to water stress at the critical stages of crop growth which effects the yield adversely. Minimizing the risk factor *in-situ* moisture conservation and adoption of suitable crop varieties and agronomical practices are therefore, vital for the success of dry land agriculture (Shiyal *et al.*, 2023) [].
The average annual rainfall of country is 1197 mm and this quantity of rainfall is fluctuated in different parts of country. Some regions have higher rainfall and some regions receive low rainfall. In the areas where annual rainfall is <800 mm, is much more shortage of moisture availability for the crop. So, in these regions, there is a great need for *in-situ* rain water conservation for long time soil moisture availability to crop production. Soil moisture conservation is the main problem in arid and semi-arid condition.

The moisture conservation practices have been well recognized means of conservation of moisture through furrow sowing method under rainfed condition (Saharan *et al.*, 2023) [6].

Materials and Methods

An experiment was conducted during two consecutive *Kharif* seasons at Soil Conservation and Water Management Farm of C S Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh. The soil of experimental field was sandy loam in texture with organic carbon 0.32%, total nitrogen 0.03%, available P_2O_5 17.8 kg ha^{-1}, available K_2O 155 kg ha^{-1}, pH 7.8, electrical conductivity 0.37 dS m^{-1}, wilting point 6.2%, field capacity 18.6%, water holding capacity 29.6%, bulk density 1.46 Mg m^{-1}, particle density 2.56 Mg m^{-1} and porosity 42.96%. The experiment was conducted in randomized block design with three replications having seven treatments *viz.* T_1 - Flat sowing, T_2 - Compartmental bunding, T_3 - Deep ploughing, T_4 - Raised and sunken bed, T_5 - Inter Row Water Harvesting (IRWH), T_6 - Inter-Paired Row Water Harvesting (IPRWH), and T_7 - Scooping. The mean annual rainfall of the area is about 800 mm and more than 80% rainfall occurs during the monsoon season (July to September). The crop pearlmillet cv 'Tata hybrid super boss' was sown on August 08 and August 27 during 2012 and 2013, respectively. Recommended package of practices and fertilizer doses were applied in different treatments. Crop was harvested on November 2 and December 4 during first and second year of experimentation.

Protein content in grains was determined by multiplying the total nitrogen content by empirical factor 6.25 Mckenzie and Wallace (1954). Starch content was estimated by anthrone reagent method as described by Clegg (1956). Leaf area index (LAI) was calculated by using the following formula Watson (1947) [12]:

LAI = Total leaf area per unit area / Land area per unit area

Production efficiency was calculated by following given formula below (Kumawat et al., 2012) [4]:

Production efficiency (Kg ha^{-1} day^{-1}) =
Grain yield (Kg ha^{-1}) / Total duration taken crop (Days)

Moisture Use Rate (MUR) are computed using the following formula:

MUR (mm day^{-1}) = Consumptive use (mm) / Crop duration (days)

Results and Discussion

Plant stand (000 ha^{-1}), Number of functional leaf and grain weight ear $head^{-1}$ (g) (Table-1) were maximized in the treatment of (T_6) Inter Paired Row Water Harvesting Technique (IPRWH), the minimum values of these parameters recorded under flat sowing (T_1). The similar results have also been reported by Verma *et al.*, (2016) [11] and Saharan *et al.*, (2023) [6].

The yield (q ha^{-1}), protein (%), starch (%), leaf area index and production efficiency (Kg ha^{-1} day^{-1}) was found highest in the treatment of (T_6) Inter Paired Row Water Harvesting Technique (IPRWH) followed by Inter Row Water Harvesting (IRWH) Table-2. The lowest values were recorded under flat sowing (T_1). Such observation have also been recorded by Bashir *et al.*, (2014) [2], Kumawat *et al.*, (2018) [3], Verma *et al.*, (2017) [10] and Shekhawat *et al.* (2018) [8].

Consumptive use (mm), water use efficiency and moisture use rate (mm $days^{-1}$) (Table-3) were maximized in the treatment of (T_6) Inter Paired Row Water Harvesting Technique (IPRWH), the minimum values of these parameters recorded under flat sowing (T_1). These results are in conformity with those of Ansari & Rana, (2012) [1], Saraswat & Krishna (2019) [7] and Shiyal *et al.*, (2023) [9].

Table 1: Effect of rain water harvesting techniques on plant stand, number of functional leaf and grain weight ear $head^{-1}$ under different treatments.

Treatments	Plant Stand (000 ha^{-1})				Number of functional leaf						Grain Weight ear $head^{-1}$ (g)	
	Y_1		Y_2		Y_1			Y_2			Y_1	Y_2
	Initial	Final	Initial	Final	30 DAS	60 DAS	At Harvest	30 DAS	60 DAS	At Harvest		
T_1 Flat sowing (Control)	143.40	142.50	142.40	141.50	5.75	9.10	8.79	8.22	11.54	15.99	14.98	15.00
T_2 Compartmental bunding	145.50	144.50	145.50	144.50	6.83	10.68	10.32	11.10	15.55	16.99	16.54	16.98
T_3 Deep ploughing	145.20	144.60	144.50	143.60	6.78	10.60	10.24	10.78	16.66	17.99	18.34	18.67
T_4 Raised and sunken bed	147.00	146.10	148.40	147.40	6.87	10.74	10.37	11.33	17.33	18.66	19.56	19.78
T_5 IRWH	147.95	147.00	148.50	147.40	7.01	10.96	10.59	11.10	18.10	19.66	20.12	20.34
T_6 IPRWH	148.25	147.90	148.60	148.10	7.10	11.10	10.72	11.44	18.55	19.99	20.65	20.10
T_7 Scooping	146.10	145.20	147.20	146.30	6.84	10.70	10.34	10.44	16.66	18.44	19.00	19.23
SE (d)	2.75	3.41	6.99	6.83	0.32	0.40	0.48	0.70	0.94	0.62	0.89	0.92
CD (P=0.05)	N.S.	N.S.	N.S.	N.S.	0.72	0.90	1.06	1.52	2.06	1.36	1.67	1.85

IRWH : Inter Row Water Harvesting.
IPRWH : Inter-Paired Row Water Harvesting.

Table 2: Effect of rain water harvesting techniques on yield, protein, starch, LAI and production efficiency under different treatments.

Treatments	Seed yield (q ha^{-1})		Protein (%)		Starch (%)		Leaf Area Index (LAI)		Production efficiency (Kg ha^{-1} day^{-1})	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
T_1 Flat sowing (Control)	15.25	16.85	10.02	10.12	45.85	46.76	4.00	4.02	17.52	16.58
T_2 Compartmental bunding	17.80	19.58	10.80	10.86	48.67	49.07	4.05	4.09	20.45	19.58
T_3 Deep ploughing	17.50	19.33	10.78	10.70	47.56	48.65	4.03	4.07	20.11	19.33
T_4 Raised and sunken bed	18.85	21.15	11.23	11.30	50.65	51.67	4.34	4.48	21.66	21.15
T_5 IRWH	19.59	21.45	11.76	11.79	52.10	52.53	4.46	4.56	22.51	21.45

T_6 IPRWH	20.50	21.90	11.80	11.89	52.34	53.08	4.67	4.78	23.56	21.90
T_7 Scooping	18.36	20.10	11.00	11.06	49.06	50.45	4.12	4.15	21.10	20.10
SE (d)	1.01	0.89	-	-	-	-	-	-	-	-
CD (P=0.05)	2.21	1.95	-	-	-	-	-	-	-	-

IRWH : Inter Row Water Harvesting.
IPRWH : Inter-Paired Row Water Harvesting.

Table 3: Effect of rain water harvesting techniques on CU, WUE and MUR under different treatments.

Treatments	Consumptive use (CU) (mm)		Water Use Efficiency (WUE) (kg ha^{-1} mm^{-1})		Moisture Use Rate (MUR) (mm days^{-1})	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
T_1 Flat sowing (Control)	300.00	341.45	5.08	4.93	3.44	3.41
T_2 Compartmental bunding	335.55	345.58	5.30	5.74	3.85	3.45
T_3 Deep ploughing	340.40	352.89	5.14	5.47	3.91	3.52
T_4 Raised and sunken bed	350.80	355.98	5.37	5.94	4.03	3.55
T_5 IRWH	375.95	360.39	5.21	5.95	4.32	3.60
T_6 IPRWH	380.10	363.87	5.38	6.01	4.36	3.63
T_7 Scooping	360.50	362.48	5.09	5.54	4.14	3.62

IRWH : Inter Row Water Harvesting.
IPRWH : Inter-Paired Row Water Harvesting.

Conclusion

The result of the present study very clearly brought out that among rain water harvesting techniques, inter-paired row water harvesting (IPRWH) significantly produced maximum seed yield of Pearlmillet (20.50 and 21.90 q ha^{-1}) and subsequent earning of leaf area index (4.67 & 4.78) exhibiting highest production efficiency (23.56 & 21.90 Kg ha^{-1} day^{-1}), water use efficiency as well as moisture use rate during the two years, respectively. Thus, the crop can be grown successfully by adopting low cost rainwater harvesting techniques (IPRWH) under rainfed alluvial soil of Uttar Pradesh.

References

1. Ansari MA, Rana KS. Effect of transpiration suppressants and nutrients on productivity and moisture-use efficiency of pearl millet (*Pennisetum glaucum*) – pigeonpea (*Cajanus cajan*) intercropping system under rainfed conditions. Indian Journal of Agricultural Sciences. 2012;82(8):676-80.
2. Bashir U, Ali T, Qureshi F. Effect of integrated nutrient management on growth, yield and quality of maize (*Zea mays* L.) in temperate conditions. Indian Journal of Soil Conservation. 2014;42(3):276-281.
3. Kumawat A, Yadav RS, Pareek NK. Residual effect of FYM and fertilizers on soil fertility, productivity and economics of pearl millet (*Pennisetum glaucum* L.). Journal of Soil and Water Conservation. 2018;17(1):102-106.
4. Kumawat N, Singh RP, Kumar R, Kumari A, Kumar P. Response of intercropping and integrated nutrition on production potential and profitability on rainfed pigeonpea. Journal of Agricultural Science. 2012;4(7):154-162.
5. McKenzie HH, Wallace HS. The Kjeldahl determination of nitrogen: a critical digestion condition temperature, catalyst and oxidizing agent. Australian Journal of Chemistry. 1954;7:55-70.
6. Saharan B, Yadav RS, Kantwa SR, Kumar R. Integrated nutrient management in pearl millet (*Pennisetum glaucum* L.) - wheat (*Triticum aestivum*) cropping system. Indian Journal of Agronomy. 2023;68(1):30-36.
7. Saraswat S, Krishna S. Bajra (Pearl millet) The Millennium Food. The Indian Journal of Nutrition and Dietetics. 2019;56(3):325-34.
8. Shekhawat PS, Kumawat N, Shekhawat RS. Effect of in-situ moisture conservation practices on growth, yield and economics of pearl millet under dryland conditions. Journal of Soil and Water Conservation. 2015;14(4):306-309.
9. Shiyal VN, Patel VM, Gamit MK, Patel KK, Kotadiya PL. Effect of pearl millet (*Pennisetum glaucum* L.) pulses intercropping system with nutrient management on growth and yield of pearl millet. International Journal of Environment and Climate Changes. 2023;13(11):1950-1959.
10. Verma AK, Awasthi UD, Ranjan R, Kishor N. Influence of rain harvesting techniques on yield, root development and profitability of pearl millet (*Pennisetum glaucum* L.) under rainfed condition. International Journal of Current Microbiology and Applied Sciences. 2017;6(12):1705-1709.
11. Verma AK, Singh RP, Yadav PN, Awasthi UD, Katiyar AK. Effect of in-situ rainwater harvesting techniques on growth, yield and economics of pearl millet (*Pennisetum glaucum* L.) under rainfed ecosystem. Progressive Research – An International Journal. 2016;11(Special-IX):5740-5743.
12. Watson DJ. Comparative physiological studies on the growth of field crops. Variation in net assimilation rate and leaf area between species and varieties and within and between years. Annals of Botany. 1947;11(2):41-76.