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Influence of Rain Water Harvesting Techniques on Yield, Root Development and Profitability of Pearl millet (*Pennisetum glaucum* L.) Under Rainfed Condition

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A B S T R A C T

A field experiment was conducted at Kanpur, Uttar Pradesh during two *Kharif* seasons of 2012 and 2013 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, root development and monetary return. Among different water harvesting techniques, inter-paired row water harvesting (IPRWH) produced highest seed yield of 20.50 and 21.90 q ha^{-1} fetching Rs. 17512 and 20557 ha^{-1} which exhibited maximum B:C ratio of 1.04 and 1.22 during 2012 and 2013, respectively.

Introduction

Rainfed agriculture plays an important role in contributing world food security. In India, area under rainfed agriculture is about 85 m ha representing 60 per cent net cultivated area and supports 40 per cent population of the country. Water is one of the most essential resource in day to day life is becoming scarce due to various reasons. The need to conserve water and its resources assumes more importance than ever before in the present scenario. With the improvement of agricultural production technology and industrial growth, the demand of water has increased manifold. India is endowed with rich diversity of natural resources. However, the need for food and nutritional security is increasing due to expanding population. One of the emerging situations, however is water shortage, either as a result of over exploitation for limited localized purposes or because of adequate management strategies. Rainfed agriculture is facing problems of decelerating growth coupled with sustainability concerns. The deceleration in yields and production is mainly due to failure of rainfed farming. The most effective means of achieving sustainable crop production is through rain water conservation (Mishra *et al.,* 2010). Rain is the

cheapest available source of water for crop production in arid and semi-arid regions. It has been possible to grow crops successfully in areas receiving low average rainfall through water harvesting system developed over the years (Singh *et al.,* 2010). Water stress occurs when roots cannot satisfy enough water to evaporative demand of water transpiring from leaves (Gupta *et al.*, 2011). Rain water harvesting is a century old technique to capture runoff from rainwater. The main objective is to create feasibility and resilience of rainfed farming to droughts and other environmental shocks and to increase water availability for growing crops and other human needs.

Pearlmillet (*Pennisetum glaucum* L.) is one of the most important rainy season crop of south west Uttar Pradesh. Moisture deficiency and low soil fertility are the main factors limiting crop production. It is possible to harvest good yield of pearlmillet, by ensuring adequate moisture conservation to meet out crop requirement during moisture stress condition where rainfall distribution is cause of concern for farmers (Singh and Verma, 1996).

The role of water harvesting technique is well known, however such information is lacking in the sub-tropical agro-ecosystem of Uttar Pradesh. Henceforth, keeping these problems in view, an attempt has been made under present sandy which may be quite helpful in planning suitable conservation measures.

Materials and Methods

An experiment was conducted during two consecutive *Kharif* seasons of 2012 and 2013 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.

The cost of cultivation was calculated by taking in to account the prevailing prices of the input and application cost of the relevant treatments.

Economics of different treatments was worked out to assess the most viable and remunerative water harvesting technique under rainfed condition. Economic efficiency in terms of Rs ha^{-1} day^{-1} was worked out by dividing the total net monetary returns by total duration of the crop.

Root study was done at harvest by selecting three plants from each treatment randomly. The roots were subjected to wash with a jet of water spray so that the fine rootlets are not broken. Observations were made on depth of root penetration, number of root $plants^{-1}$ and dry weight of root $plants^{-1}$.

Table.1 Effect of rain water harvesting techniques on root development, yield and yield response under different treatments

Treatments	Root depth (cm)		Dry weight of root plant^{-1}		Number of roots plant^{-1}		Seed yield (q ha^{-1})		Yield response (%)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
T_1 Flat sowing (Control)	36.81	37.25	15.18	15.90	236	239	15.25	16.85	15.25	16.85
T_2 Compartmental bunding	37.50	37.86	16.67	17.00	240	245	17.80	19.58	16.72	16.20
T_3 Deep ploughing	37.00	37.68	16.00	16.47	238	242	17.50	19.33	14.75	14.71
T_4 Raised and sunken bed	38.90	39.00	17.14	17.90	241	249	18.85	21.15	23.60	25.51
T_5 IRWH	39.00	39.92	17.69	18.10	248	259	19.59	21.45	28.45	27.29
T_6 IPRWH	39.85	40.00	17.85	18.83	252	262	20.50	21.90	34.42	29.97
T_7 Scooping	38.42	38.67	17.02	17.65	244	252	18.36	20.10	20.39	19.28
SE (d)	0.83	0.62	0.57	0.49	2.82	1.56	1.01	0.89	-	-
CD (P=0.05)	1.83	1.37	1.27	1.09	6.23	3.44	2.21	1.95	-	-

Table.2 Effect of rain water harvesting techniques on economics under different treatments

Treatments	(Cost of cultivation ha^{-1})		Gross return (Rs. ha^{-1})		Net return (Rs. ha^{-1})		B:C ratio		Economic efficiency (Rs ha^{-1} day^{-1})	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
T_1 Flat sowing (Control)	16078	16078	28902	30225	12824	14147	0.81	0.87	128.24	141.47
T_2 Compartmental bunding	17096	17096	32262	34075	15166	16979	0.88	0.99	151.66	169.79
T_3 Deep ploughing	16927	16927	31347	33741	14420	16814	0.85	0.99	144.20	168.14
T_4 Raised and sunken bed	16969	16969	32245	36319	15276	19350	0.90	1.14	152.76	193.50
T_5 IRWH	16841	16841	33112	36712	16271	19871	0.96	1.17	162.71	198.71
T_6 IPRWH	16841	16841	34353	37398	17512	20557	1.04	1.22	175.12	205.57
T_7 Scooping	16715	16715	31921	34737	15206	18022	0.90	1.07	152.06	180.22

Results and Discussion

Root growth

Developments of roots in terms of root depth, dry weight of roots plant^{-1} and number of roots were maximized in the treatment of inter paired row water harvesting technique, the minimum values of these parameters recorded under flat sowing (T_1). These results are in accordance with those of Kumar *et al.*, (2004).

Yield and yield response

The yield and yield response was found highest in the treatment of IPRWH followed by IRWH (Table 1). The lowest values were recorded under flat sowing Angadi *et al.*, (2004).

Economics

Cost of pearlmillet cultivation due to application of different low cost water harvesting techniques ranged from Rs. 16078 to Rs. 17096. Compartmental bunding increased the cost of application (Table 2). The application of water harvesting techniques increased the cost of cultivation which were compensated by gross and net return indicating higher B:C ratio The highest gross (Rs. 34353 and 37398) and net return (Rs. 17512 and 20557) as well as benefit cost ratio (1.04 and 1.22) were recorded from the treatment getting IPRWH. The lowest values of these economic parameters were recorded under flat sowing (Control). Thus, technique of IPRWH was beneficial not only from crop productivity but more so from profitability point of view. Moreover, it is clear from the result shown by economic efficiency which exhibited similar trend of efficacy. The highest value was recorded (175.12 and 205.57 Rs. ha^{-1} day^{-1}) during the two different years.

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 Rs. 17512 and 20557 ha^{-1} exhibiting highest B:C ratio, root development as well as economic efficiency 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.

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