

Efficient Rain Water Harvesting with Land Modules and Green Manuring under Irrigated Conditions in Sunflower in *Vertisols* of Malaprabha Command in Northern Karnataka, India

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Abstract A field experiment was conducted during 2014-15 and 2015-16 to compare different land modules (i.e., farmers practice, raised bed and flat bed) and rainfed and irrigated ecosystems (0.8 IW/CPE and 0.6 IW/CPE) under sunflower crop. Land modules and rainfed and irrigated ecosystems significantly influenced the sunflower grain yield. Sunflower grain yield was on par with scheduling of irrigation at 0.8 IW/CPE ratio (17.05 q/ha) and 0.6 IW/CPE ratio (16.78 q/ha) and it was significantly increased with rainfed ecosystems (14.27 q/ha). Among the land modules broad bed furrows with sunhemp green manuring has realized highest grain yield of sunflower (17.11 q/ha) with water use efficiency (5.15 kg/ha-mm) compared to Furrows with sun hemp green manure (16.64 q/ha) and Compartment bunding with sun hemp green manure (15.11 q/ha) treatments.

Keywords IW-Irrigation Water, CPE-Cumulative pan evaporation, WUE-Water use efficiency.

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Introduction

Agriculture in India depends heavily on south west monsoon. This dependence is more severe under rainfed and canal commands. The deficit of water due to unpredictable rainfall in the catchment area often results in reduced water release periods/durations in Malaprabha command of Northern Karnataka. This stresses the need to harvest rain water in the beginning of the *kharif* season which is available. Though the usual rainfall during the months of June and July is meager and often just sufficient to establish crops like green gram, onion, chilli and cotton. In the event of late release of water from the reservoir there is a need for *insitu* harvesting of the rain water to protect the crops from total failure. In Malaprabha command area maize-chickpea and sunflower-chickpea are the established cropping system for varied release of canal water. Soil and water conservation (compartment bunding) and various modifications to land modules like broad bed furrows and furrows are found to reduce the cost of production and other constraints associated with land preparation. Conservation tillage practices, such as zero and minimum tillage practices, various modifications to land lay outs like raised bed and flat beds are found to reduce the cost of production and other constraints associated with land preparation [1]. Yield advantages of zero till maize or permanent raised bed cultivation of maize in farmers fields on participatory mode is found to be promising [2]. Karnataka is the major producers of sunflower in

Table 1. Average height (cm), head diameter (cm), grain yield (q/ha) and water use efficiency (kg/ha.mm) of sunflower as influenced by irrigation and land modules and their interaction (pooled of the years 2014–15 and 2015–16).

Treatments	Plant height (cm)				Head diameter (cm)			
	I ₁ = Rain- fed	I ₂ = 0.8 IW/ CPE	I ₃ = 0.6 IW/ CPE	Mean	I ₁ = Rain- fed	I ₂ = 0.8 IW/ CPE	I ₃ = 0.6 IW/ CPE	Mean
T ₁ – Compartment bunding without sun hemp	167.6	174.3	173.5	171.8	15.3	16.1	15.7	15.7
T ₂ – Compartment bunding without sun hemp	168.7	176.1	174.2	173.0	16.4	17.2	16.2	16.6
T ₃ – Broad bed furrows without sun hemp	171.2	181.0	183.1	178.4	16.4	17.8	17.3	17.2
T ₄ – Broad bed furrows with sun hemp	178.2	183.3	185.6	182.4	17.5	18.0	18.2	17.9
T ₅ – Furrows without sun hemp	169.9	180.8	181.5	177.4	17.1	17.3	17.6	17.3
T ₆ – Furrows with sun hemp	177.1	180.3	183.5	180.3	17.0	17.8	17.8	17.5
Mean	172.1	179.3	180.0	177.2	16.6	17.4	17.1	17.0
	SEm±		CD (0.05)		SEm±		CD (0.05)	
Irrigation	0.835		3.281		0.060		0.236	
Land modules	0.520		1.503		0.132		0.381	
I × L	1.173		3.386		0.217		NS	

Table 1. Continued.

Treatments	Grain yield (q/ha)				Water use efficiency (kg/ha.mm) pooled			
	I ₁ = Rain- fed	I ₂ = 0.8 IW/ CPE	I ₃ = 0.6 IW/ CPE	Mean	I ₁ = Rain- fed	I ₂ = 0.8 IW/ CPE	I ₃ = 0.6 IW/ CPE	Mean
T ₁ – Compartment bunding without sun hemp	12.68	15.67	14.97	14.44	5.12	4.04	3.95	4.37
T ₂ – Compartment bunding without sun hemp	13.58	16.35	15.40	15.11	5.56	4.17	4.07	4.60
T ₃ – Broad bed furrows without sun hemp	14.72	17.70	17.42	16.61	6.01	4.44	4.48	4.98
T ₄ – Broad bed furrows with sun hemp	15.35	17.97	18.00	17.11	6.29	4.44	4.70	5.15
T ₅ – Furrows without sun hemp	14.47	17.23	17.15	16.28	5.90	4.22	4.44	4.85
T ₆ – Furrows with sun hemp	14.83	17.38	17.72	16.64	6.06	4.17	4.58	4.93
Mean	14.27	17.05	16.78	16.03	5.82	4.25	4.37	4.81
	SEm±		CD (0.05)		SEm±		CD (0.05)	
Irrigation	0.126		0.496		0.112		0.438	
Land modules	0.160		0.463		0.052		0.149	
I × L	0.283		NS		0.138		0.399	

Table 2. Average water saving in percentage for the *khariif* sunflower crop for the years 2014-15 and 2015-16.

Treatments	Depth of irrigation water (mm)			Saving of water (Percentage)
	2014-15	2015-16	Mean	
I ₁ = Rainfed	300.3	198.6	–	–
I ₂ = 0.8 IW/CPE	412.7	378.6	396	–
I ₃ = 0.6 IW/CPE	420.3	318.6	369	6.81

the country. Sunflower crop is highly sensitive to water stress between flowering and grain filling stages. The information on the suitability of compartment bunding, compartment bunding with sunhemp, broad bed, broad bed with sunhemp, furrows, furrows with sunhemp under varied rainfed and irrigated ecosystems is lacking in the Malaprabha Command area. Hence, the sustainable management of Vertisols of Malaprabha Command, there is a need to evaluate different land modules under rainfed and irrigated ecosystem with sunflower crop research was taken.

Materials and Methods

A field experiment was conducted at Irrigation Water Management Research Center, Belvatagi during 20014-15 and 2015-16. The experiment consisted of three main plots (I₁–rainfed, I₂–0.8 IW/CPE and I₃–0.6 IW/CPE) and land modules (T₁–Compartment bunding without sun hemp, T₂–Compartment bunding with sun hemp, T₃–Broad bed furrows without sun hemp, T₄–Broad bed furrows with sun hemp, T₅–Furrows without sun hemp, T₆–Furrows with sun hemp) as sub plots. Experiment was laid out in split plot design with three replications. The initial status of the soil of the experimental plot (0–20 cm depth) had pH–8.30 dS/m, Organic carbon 0.52%, available nitrogen 225 kg/ha, available P₂O₅ 33 kg/ha, available K₂O 768 kg/ha, bulk density 1.25 Mg/m³, field capacity 33.0%, and permanent wilting point 20.5%. Farm yard manure was applied to all the treatments @ 8 t/ha. Sunflower received 90 kg N, 90 kg P₂O₅ and 60 kg K₂O/ha. All other necessary package of practices was

followed as per the Recommended Package of Practices of University of Agricultural Sciences, Dharwad. Soil and plant analysis were carried out by using standard procedures.

Results and Discussion

The results of effect of rainfed and irrigated ecosystems and six combinations of land modules with and without green manure sunhemp indicated that the sunflower plant height, head diameter, grain yield and stalk yield were significantly influence with irrigation and land modules (Table 1). Pooled data of the years 2014-15 and 2015-16 indicated that irrigation @ 0.8 IW/CPE ratio (17.05 q/ha) and @ 0.6 IW/CPE (16.78 q/ha) significantly increased grain yield as compared to rainfed ecosystem (14.23 q/ha). Between irrigation treatments irrigation @ 0.8 IW/CPE ratio on par with irrigation at 0.6 IW/CPE under different land modules.

Among the different *insitu* moisture conservation systems, significantly higher pooled sunflower plant height (182.4 cm), head diameter (17.9 cm), grain yield (17.11 q/ha), straw yield (48.35 q/ha) and water use efficiency (5.15 kg/ha.mm) with the broad bed furrows with sun hemp (T₄) as compared to rest of the treatments. Similarly highest WUE was noticed with raised bed with chickpea crop [3]. Between two irrigation treatments (0.8 IW/CPE and 0.6 IW/CPE) the average (2014 and 2015) amount of water saving is 6.81% (Table 2). Significantly higher gross return, net return and B : C ratio found between rainfed and irrigated ecosystems (Table 3). Similarly significantly more gross return (Rs 41,702), net return (Rs 21260) and B : C ratio (Rs 2.04) found in broad bed furrows with sunhemp as compared to other land modules. Similarly maize grain yield was (60.70 q/ha) significantly superior in respect of land configuration with 120 cm wide raised bed when compared with the normal sowing (58.70 q/ha) and 60 cm raised bed (56.70 q/ha) [4].

Conclusion

Irrigation @ 0.8 IW/CPE ratio and @ 0.6 IW/CPE significantly increased grain yield as compared to rainfed

Table 3. Plant height (cm), head diameter (cm), grain yield (q/ha) and water use efficiency (kg/ha.mm) of sunflower as influenced by irrigation and land modules and their interaction (pooled of the years 2014-15 and 2015-16).

Treatments	Gross income (Rs)				Net income (Rs)			
	I ₁ = Rain- fed	I ₂ = 0.8 IW/ CPE	I ₃ = 0.6 IW/ CPE	Mean	I ₁ = Rain- fed	I ₂ = 0.8 IW/ CPE	I ₃ = 0.6 IW/ CPE	Mean
T ₁ – Compartment bunding without sun hemp	30675	38527	36873	35358	11607	17085	15578	14757
T ₂ – Compartment bunding with sun hemp	32965	39860	37650	36825	13803	18552	16648	16335
T ₃ – Broad bed furrows without sun hemp	36143	43242	42433	40606	16768	21773	21432	19991
T ₄ – Broad bed furrows with sun hemp	37200	43955	43950	41702	18132	22767	22882	21260
T ₅ – Furrows without sun hemp	34995	42335	41458	39596	16113	14627	20523	17088
T ₆ – Furrows with sun hemp	35892	42545	431312	40523	16890	21263	22370	20174
Mean	34645	41744	40916	39101	15552	19344	19906	18267
	SEm±	CD (0.05)		SEm±	CD (0.05)			
Irrigation	318.2	1249.5		634.5	2491.8			
Land modules	347.8	1004.5		922.0	2662.8			
I × L	635.4	NS		1590.0	NS			

Table 3. Continued.

Treatments	B : C ratio			Mean
	I ₁ = Rainfed	I ₂ = 0.8 IW/CPE	I ₃ = 0.6 IW/CPE	
T ₁ – Compartment bunding without sun hemp	1.60	1.83	1.76	1.73
T ₂ – Compartment bunding with sun hemp	1.72	1.89	1.81	1.81
T ₃ – Broad bed furrows without sun hemp	1.87	2.06	2.03	1.99
T ₄ – Broad bed furrows with sun hemp	1.95	2.09	2.10	2.04
T ₅ – Furrows without sun hemp	1.84	2.00	1.99	1.94
T ₆ – Furrows with sun hemp	1.88	2.02	2.07	1.99
Mean	1.81	1.98	1.96	1.92
	SEm±		CD (0.05)	
Irrigation	0.016		0.061	
Land modules	0.018		0.052	
I × L	0.032		NS	

ecosystem. Average (2014 and 2015) amount of water saving is 6.81% between the two irrigation levels @ 0.8 IW/CPE and @ 0.6 IW/CPE ratio. Among the different *insitu* moisture conservation systems, significantly higher pooled grain yield and water use efficiency was found with broad bed furrows with sun hemp as compared to rest of the treatments. Significantly higher gross return, net return and B : C ratio

found between rainfed and irrigated ecosystems as well as with different land modules.

References

1. Paliwal S (2003) Quality protein maize in zero tillage. In: Addressing resource conservation issues in rice-wheat systems of South Asia—A res book, pp 240—242.

- Rice–Wheat Consortium for the Indo-Gangetic plains and International maize and wheat Improvement Center, New Delhi, India.
2. Jat ML, Singh Ravi G, Saharawat YS, Gathala MK, Kumar V, Sidhu HS, Gupta Raj (2009) Innovations through conservation agriculture: Progress and Prospects of Participatory Approach in the Indo-Gangetic Plains. 4th World Cong on Conserv Agric, New Delhi, India, Feb 4—7, 2009.
 3. Pramanik SC, Singh NB, Singh KK (2009) Yield economics and water use efficiency of chickpea (*Cicer anietinum*) under various irrigation regimes of raised bed planting system. *Int J Agron* 54 : 315—318.
 4. Neelakanth JK, Gundlur SS, Ashoka P, Dasar GV, Rajakumara S (2015) Yield, economics and water use efficiency of maize (*Zea mays* L.) under various irrigation regimes on raised bed planting system. *Environ Ecol* 33 : 1151—1154.