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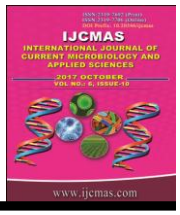

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Evaluation of *In-situ* Moisture Conservation Practices for Sustainable Productivity of Major Crops in Vidarbha Region

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A B S T R A C T

Water stress periods are common in rainfed agriculture therefore the activities aimed at conserving the rainwater should be adopted for improving the productivity of dryland crops. The major crops in Vidarbha region of Maharashtra are cotton, soybean and sorghum. It was observed that the drought situation may arise during crop growth period which may result in partial failure of crops. It was therefore felt worthwhile to adopt the proper methods of *in-situ* moisture conservation so as to partially meet out the adverse effect of water stress in standing crop. The experiment was undertaken at the experimental field of AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The treatments adopted were T_1- Furrow opening (F), T_2- Crop residue mulch (M), T_3 -Thinning (T), T_4- Combination of furrow opening, crop residue mulch and Thinning (FMT) and T_5- Control. The three major crops of Vidarbha region i.e. cotton (AKH-84635), soybean (JS-335) and sorghum (CSH-9) are considered for the study. The results regarding yields and soil moisture at different stages of crop growths since 2007-08 to 2010-11 were presented here. The economic evaluation of these practices has been done and is discussed in this paper.

Introduction

The success of dryland farming mainly depends on the evenly distributed rainfall during crop growing period. The root zone soil moisture is utilized for transpiration, when the rainfall becomes insufficient to meet the potential needs to transpiration. This causes depletion in soil moisture storage and a situation which may be designated as agricultural drought. Even after achieving the full irrigation potential, nearly 50% of the net cultivated dryland area will remain dependent on rainfall. In terms of crop groups, 77% of pulses, 66% of oilseeds and 45% of cereals are grown under rainfed conditions.

Therefore, a breakthrough in rainfed agriculture is an imperative for poverty alleviation, livelihood promotion and food security in India (Abrol, 2011). The most effective form of erosion control or prevention is to practice good land management techniques. Approaches to protect the top soil from splash effects of rainfall and sheet flow are best centered on good *in-situ* conservation practices (C. George Thomas, 2010). For any form of land use to be sustainable, production must be combined with conservation of resources. In Vidarbha region, about 89% land is under

rainfed farming. The major crops are cotton, soybean and sorghum. Soil conservation is the only way to protect the productive lands. Rainfed farming plays an important role in agricultural economy of Vidarbha. It was observed that the drought situation may arise during crop growth period which may result in partial failure of crops. Drought situations caused due to aberrant weather and erratic rainfall has been routine crises in dryland agriculture. To cope up with such crunch, it is necessary to find out the possibilities to survive the crop under contingent conditions by using some of the simple methods of *in-situ* moisture conservation (Padmanabhan, 2008). It was therefore, felt worthwhile to adopt the proper methods of *in-situ* moisture conservation so as to partially meet out the adverse effect of water stress in standing crops. The positive effects of moisture conservation practices like ridges and furrows; in enhancing the plant height and yield attributes of sorghum, cowpea, bengalgram and sunflower have been observed (Somasundaram *et al.,* 2000). *In-situ* moisture conservation practices viz., ridges and furrows + mulch, imparted beneficial effect on cluster bean for getting good growth and higher yields; which subsequently led to higher net returns and B: C ratio (Allolli *et al.,* 2008). In order to study the effect of contingency *in-situ* moisture conservation measures on productivity and to find out suitable combination of *in-situ* moisture conservation measures to cope up with water stress in standing crops, the experiment was conducted on the experimental field during 2007-08 to 2010-11.

Materials and Methods

The experiment on *in-situ* moisture conservation practices for sustainable productivity of major crops was conducted on the experimental farm of Dryland Agriculture, Dr. PDKV, Akola. The experiment was laid out in RBD design with four replications. The treatments adopted were T_1- Furrow opening (F), T_2- Crop residue mulch (M), T_3-Thinning (T), T_4- Combination of furrow opening, crop residue mulch and Thinning (FMT) and T_5-Control. The three major crops of Vidarbha region i.e. cotton (AKH-84635), soybean (JS-335) and sorghum (CSH-9) are considered for the study. The observations regarding yields and soil moisture at different stages of crop growths were recorded since 2007-08 to 2010-11.

Results and Discussion

Based on the observations the results of yields and soil moisture were presented here. Accordingly, the GMR and NMR are calculated for each crop based on the existing market prices and discussed individually for each crop (Annual Reports 2008 to 2011).

Crop – Cotton

The productivity of cotton as influenced by different *in-situ* moisture conservation treatments (2007-08 to 2010-11) is presented in table 1. The total rainfall received during the crop growing period was 887.3mm as against the normal rainfall of 741.8mm. The *in-situ* moisture conservation treatments showed significant difference in seed cotton and stalk yield in cotton.

The highest seed cotton (2352kg ha^{-1}) yield was recorded in crop residue mulching treatment (T_2) and found at par with the treatment combination of furrow opening, mulching and thinning, T_4 (2151kg ha^{-1}). However, the highest stalk yield (4372kg ha^{-1}) was recorded in treatment combination of furrow opening, mulching and thinning (T_4) and it was at par with crop residue mulching treatment (T_2). In pooled data of four seasons, seed cotton yield was found to be non-significant.

Economics of cotton cultivation

The data showing effect of various *in-situ* moisture conservation treatments on economics of cotton cultivation (pooled) is given in table 2. The highest gross monetary returns (Rs. 55025) was obtained in crop residue mulching treatment (T_2) and found at par with the treatment combination of furrow opening, mulching and thinning (T_4) and furrow opening treatment (T_1). The highest net monetary returns (Rs. 37391) and B: C ratio (2.73) was obtained in crop residue mulching treatment (T_2).

Soil moisture

The soil moisture at the depths of 0-15 and 15-30cm is given in table 3. The soil moisture status observed to be better in crop residue mulching treatment at early stages of crop growth followed by thinning and other treatments. However at the final stages of crop, the soil moisture content was observed maximum in the treatment of furrow opening followed by treatment combination of furrow opening, mulching and thinning.

Crop – Soybean

Productivity

The data on yield of soybean during 2007-08 to 2010-11 and pooled yields are given in table 4. The total rainfall received during the crop growing period was 807.3 mm as against the normal rainfall of 669.5mm.

The *in-situ* moisture conservation treatments showed no significant differences in grain and straw yield of soybean. In pooled data of four seasons, grain yield was found to be non-significant. Numerically highest grain yield (2513kg ha^{-1}) was recorded in crop residue mulching treatment (T_2) followed by thinning treatment (T_3) and highest straw yield (3678kg ha^{-1}) was recorded in control treatment (T_5) followed by crop residue mulching treatment (T_2).

Economics of soybean cultivation

The data showing effect of various *in-situ* moisture conservation treatments on economics of soybean cultivation (pooled) is given in table 5. The highest gross monetary returns (Rs. 55677) were obtained in crop residue mulching treatment (T_2) followed by thinning treatment (T_3). The highest net monetary returns (Rs. 38939) were obtained in thinning treatment (T_3) followed by crop residue mulching treatment (T_2). The highest B: C ratio (3.59) was obtained in control treatment (T_5).

Soil moisture

The soil moisture at the depths 0-15 and 15-30cm is given in table 6. The soil moisture status observed to be better in crop residue mulching treatment at early stages of crop growth followed by treatment combination of furrow opening, mulching and thinning and then by other treatments. However at the final stages of crop the soil moisture content was observed maximum in the treatment of furrow opening and treatment combination of furrow opening, mulching and thinning.

Crop – Sorghum

Productivity

The data of yield of sorghum during 2007-08 to 2010-11 and pooled yields are presented in table 7. The total rainfall received during the crop growing period was 847.8mm as against the normal rainfall of 689.5mm. Due to high intensity of rainfall distribution over the crop period, the *in-situ* moisture conservation treatments showed non-significant differences for grain and fodder yield of sorghum.

Table.1 Productivity of cotton as influenced by different *in-situ* moisture conservation treatments (2007-08 to 2010-11)

Treatments	Seed cotton yield (kg ha^{-1})				
	2007-08	**2008-09**	**2009-10**	**2010-11**	**Pooled**
T_1	2560	1308	1041	1916	1706
T_2	2426	1254	1078	2352	1778
T_3	2259	1130	1006	1919	1579
T_4	2391	1193	1097	2151	1708
T_5	2224	1109	998	1971	1576
S. E. (m) ±	102	104	51	99	51
C.D. at 5%	287	NS	NS	307	NS
C.V. %	8.63	17.37	9.77	9.67	12.22
Stalk yield (kg ha^{-1})					
T_1	6423	3906	4819	3601	4687
T_2	6011	4665	5076	4308	5015
T_3	5729	3634	4562	3344	4317
T_4	5381	4014	4947	4372	4679
T_5	5425	3634	4434	3537	4257
S. E. (m) ±	261	187	216	228	119
C.D. at 5%	735	525	NS	702	368
C.V. %	9.03	9.42	9.07	11.89	10.38

Table.2 Economics of cotton as influenced by different *in-situ* moisture conservation treatments (Pooled)

Treatments	Yield (kg ha^{-1})		GMR (Rs. ha^{-1})	NMR (Rs. ha^{-1})	B:C Ratio
	Seed cotton	**Stalk**			
T_1	1706	4687	51275	33376	2.56
T_2	1778	5015	55025	37391	2.73
T_3	1579	4317	48103	30189	2.35
T_4	1708	4679	52397	32561	2.31
T_5	1576	4257	48216	30812	2.42
S. E. (m) ±	51	119	1600	1600	-
C.D. at 5%	NS	368	4932	NS	-
C.V. %	12.22	10.38	12.55	19.47	-

Market value of seed cotton @ Rs. 4000q^{-1} stalk @ Rs. 50q^{-1}

Table.3 Soil moisture content (cm^3/cm^3) at different crop growth stages of cotton recorded at 0-15 and 0-30cm depth

Treatments	Depth (cm)	Soil moisture content (cm^3/cm^3)			
		Vegetative growth	Flowering	Boll formation	Picking
T_1	0-15	33.86	36.73	33.42	30.13
	15-30	35.28	41.27	37.93	36.09
T_2	0-15	38.91	37.39	32.21	29.20
	15-30	41.42	38.82	35.31	32.99
T_3	0-15	35.54	38.17	33.10	30.22
	15-30	38.89	41.16	35.57	32.92
T_4	0-15	36.50	37.83	32.97	30.46
	15-30	37.57	39.99	35.44	33.20
T_5	0-15	32.21	34.66	29.22	26.47
	15-30	33.88	36.61	34.92	32.06

Table.4 Productivity of soybean as influenced by different *in-situ* moisture conservation treatments (2007-08 to 2010-11)

Treatments	Grain yield (kg ha^{-1})				
	2007-08	**2008-09**	**2009-10**	**2010-11**	**Pooled**
T_1	3231	2116	1471	2578	2349
T_2	2893	2319	1748	3093	2513
T_3	3028	2155	2069	2769	2505
T_4	2941	2199	1831	2611	2396
T_5	2884	2240	1812	2755	2423
S. E. (m) ±	122	135	109	134	69
C.D. at 5%	NS	NS	336	NS	NS
C.V. %	8.18	12.28	12.23	9.71	11.26
Straw yield (kg ha^{-1})					
T_1	4437	2774	2756	3864	3458
T_2	5015	2849	2686	3967	3629
T_3	5015	2677	2827	3828	3587
T_4	4437	2735	3090	4077	3584
T_5	5015	2785	2956	3958	3678
S. E. (m) ±	354	137	160	205	104
C.D. at 5%	NS	NS	NS	NS	NS
C.V. %	14.80	9.91	11.23	10.41	11.65

Table.5 Economics of soybean as influenced by different *in-situ* moisture conservation treatments (Pooled)

Treatments	Yield(kg ha^{-1})		GMR (Rs. ha^{-1})	NMR (Rs. ha^{-1})	B:C
	Grain	**Straw**			
T_1	2349	34.58	51798	36018	3.45
T_2	25.13	36.29	55677	38466	3.40
T_3	25.05	35.87	55405	38939	3.48
T_4	23.96	35.84	53050	35022	3.14
T_5	24.23	36.78	53722	38060	3.59
S. E. (m) ±	0.69	1.04	1466	1466	-
C.D. at 5%	NS	NS	NS	NS	-
C.V. %	11.26	11.65	10.87	15.72	-

Market value of soybean grain @ Rs. 2183q^{-1} and straw @ Rs. 50.00 q^{-1}

Table.6 Soil moisture content (cm^3/cm^3) at different crop growth stages recorded At 0-15 and 0-30cm depth

Treatments	Depth (cm)	Soil moisture content (cm^3/cm^3)		
		Vegetative growth	Pod development	Harvesting
T_1	0-15	37.47	36.80	35.68
	15-30	39.68	39.39	37.96
T_2	0-15	40.90	35.70	32.71
	15-30	41.63	36.62	37.30
T_3	0-15	38.74	39.23	32.64
	15-30	38.60	40.09	36.33
T_4	0-15	39.96	33.05	34.94
	15-30	40.79	40.32	39.73
T_5	0-15	35.78	31.91	26.33
	15-30	37.00	33.00	35.81

Table.7 Productivity of sorghum as influenced by different *in-situ* moisture conservation treatments (2007-08 to 2010-11)

Treatments	Grain yield (kg ha^{-1})				
	2007-08	2008-09	2009-10	2010-11	Pooled
T_1	5324	6034	4387	3138	4721
T_2	5434	6298	4327	3286	4836
T_3	5173	6373	4244	2881	4667
T_4	5264	6493	4595	3286	4909
T_5	4818	6019	4928	3318	4771
S. E. (m) ±	435	274	251	613	183
C.D. at 5%	NS	NS	NS	NS	NS
C.V. %	16.74	8.80	11.15	11.96	15.32
Fodder yield (kg ha^{-1})					
T_1	13695	10513	10344	7156	10427
T_2	15432	12345	9766	7240	11195
T_3	12924	12828	8481	7066	10324
T_4	13310	13020	10152	7118	10900
T_5	13696	10898	8995	7298	10221
S. E. (m) ±	1124	477	469	405	279
C.D. at 5%	NS	1341	NS	NS	NS
C.V. %	16.28	8.01	9.83	11.28	10.51

Table.8 Economics of sorghum as influenced by different *in-situ* moisture conservation treatments (Pooled)

Treatments	Yield(kg ha^{-1})		GMR (Rs. ha^{-1})	NMR (Rs. ha^{-1})	B:C ratio
	Grain	Fodder			
T_1	4721	10427	46761	29803	2.88
T_2	4836	11195	48411	30126	2.80
T_3	4667	10324	46187	29187	2.76
T_4	4909	10900	48757	30234	2.68
T_5	4771	10221	47214	31050	2.90
S. E. (m) ±	183	279	1439	1439	-
C.D. at 5%	NS	NS	NS	NS	-
C.V. %	15.32	10.51	12.13	20.49	-

Market value (APMC, Akola) of sorghum grain @ Rs. 875q^{-1} fodder @ Rs. 100q^{-1}

Table.9 Soil moisture content (cm^3/cm^3) at different crop growth stages recorded at 0-15 and 0-30cm depth

Treatments	Depth (cm)	Soil moisture content (cm^3/cm^3)		
		Flag leaf	Grain maturity	Harvesting
T_1	0-15	34.41	37.79	33.16
	15-30	39.85	40.73	37.40
T_2	0-15	37.36	38.17	32.28
	15-30	41.65	40.08	36.44
T_3	0-15	37.14	39.12	32.97
	15-30	38.18	40.72	36.20
T_4	0-15	37.71	33.02	34.52
	15-30	41.82	40.88	37.54
T_5	0-15	35.70	31.85	26.26
	15-30	37.28	32.89	34.49

In pooled data of four seasons, grain and fodder yield were found to be non-significant. Numerically highest grain yield (4909Kg ha^{-1}) was recorded in treatment combination of furrow opening, mulching and thinning (T_4) followed by crop residue mulching treatment (T_2). Numerically highest fodder yield (11195 kg ha^{-1}) was recorded in crop residue mulching treatment (T_2).

Economics of sorghum cultivation

The data showing effect of various *in-situ* moisture conservation treatments on economics of sorghum cultivation (pooled) is given in table 8. The highest gross monetary returns (Rs. 48757) were obtained in treatment combination of furrow opening, mulching and thinning (T_4) followed by crop residue mulching treatment (T_2). The highest net monetary returns (Rs. 31050) were obtained in control treatment (T_5) followed by treatment combination of furrow opening, mulching and thinning (T_4). The highest B: C ratio (2.90) was obtained in control treatment (T_5).

Soil moisture

The soil moisture at the depths 0-15 and 15-30cm is given in table 9. The soil moisture status observed to be better in treatment combination of furrow opening, mulching and thinning at early stages of crop growth followed by crop residue mulching treatment and then by other treatments. However, at the final stages of crop the soil moisture content was observed maximum in the combination treatment of furrow opening, mulching and thinning followed by treatment of furrow opening?

For cotton crop, the highest gross monetary returns (Rs. 55025), net monetary returns (Rs. 37391) and B: C ratio (2.73) were obtained in crop residue mulching treatment (T_2). The soil moisture status observed to be better in crop residue mulching treatment (T_2) at vegetative growth stage of crop however at the boll formation stage the soil moisture content was observed maximum in the treatment of furrow opening (T_1).

For soybean crop, the highest gross monetary returns (Rs. 55677) were obtained in crop residue mulching treatment (T_2). The highest net monetary returns (Rs. 38939) were obtained in thinning treatment (T_3). The soil moisture status observed to be better in crop residue mulching treatment at vegetative growth stage of crop however at the pod development stage the soil moisture content was observed maximum in the thinning treatment.

For sorghum crop, the highest gross monetary returns (Rs. 48757) were obtained in treatment combination of furrow opening, mulching and thinning (T_4) followed by crop residue mulching treatment (T_2). The soil moisture status was better in treatment combination of furrow opening, mulching and thinning at flag leaf and grain maturity stage.

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