CONTEMPORARY RESEARCH IN INDIA
ISSN 2231 - 2137

EFFECT OF DIFFERENT HORIZONTAL SPACING OF *CENCHRUS CILIARIS* VEGETATIVE BARRIER ON SOIL MOISTURE CONSERVATION AND YIELD OF *RABI* SORGHUM UNDER DRYLAND AGRICULTURE

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Received: 03/01/2018 | **Edited: 17/01/2018** | **Accepted: 30/01/2018**

Abstract: *A field experiment was carried out on medium black soil of dry farming research station, Solapur during the year 2004-2005 to 2008-2009 to find out optimum horizontal spacing of Cenchrus ciliaris vegetative barriers for better moisture conservation and yield of rabi sorghum and convenient for carrying out the cultivation practices. The five treatments consisted of Absolute control and Vegetative barriers at 15 meter, 30 meter, 45 meter and 60 meter interval. The pooled results indicated that the vegetative barriers of Cenchrus ciliaris at different horizontal spacing were superior over control in respect of soil moisture and crop yield. The vegetative barrier of Cenchrus ciliaris at 15 meter horizontal interval recorded significantly superior mean grain yield (8.39 q ha^{-1}) over rest of the treatments except vegetative barriers of 30 meters horizontal interval (8.17 q ha^{-1}). Similar trend was also noticed incase of mean fodder yield of rabi sorghum. The mean soil moisture was higher (129 mm) in vegetative barriers treatment of Cenchrus ciliaris at 15 meter horizontal interval compared to absolute control (75 mm). Amongst the various horizontal spacing vegetative barriers, the vegetative barrier of 15 meters horizontal spacing conserved higher mean periodical soil moisture (129 mm) followed by the vegetative barriers of 30 meter horizontal interval (113 mm) as compared to other vegetative barriers of 45 and 60 meters interval.*

Key words: *crop yield; rabi sorghum; soil moisture; vegetative barriers.*

The use of vegetative barriers of grass species for soil and water conservation has drawn attention since last three decades. *Cenchrus ciliaris* grass forms effective barrier, which can obstruct the movement of rainwater as result of which, soil particles will settle near live bund and allowing only the clear water to ooze out through barriers. It also increases soil moisture availability in root profiles, which have immense importance in package of technology generated for raising dryland crops. The vegetative barriers are cheap and effective as mechanical measures on milder slopes. When there is wide spacing between two mechanical bunds, soil loss and runoff occur within the inter bund area. Under such conditions, vegetative barriers can play a vital role for *in-situ* soil and water conservation as an inter bund measure. Hence, close spacing of 15 meters horizontal intervals between two vegetative bunds may helps in prevention of the soil erosion and runoff. But closed spacing of 15 meters interval creates problems for preparatory tillage operations. Under such condition, the optimum horizontal spacing between two vegetative barriers play vital role for soil and water conservation as well as convenient for carrying out cultivation practices of crop production. For this purpose, vegetative barrier should be established along contour at optimum horizontal interval. They are cheap and equally effective as compared to mechanical bund on milder slope (Gupta *et al.,*1992). But more information is not available on optimum horizontal spacing between two vegetative barriers without creating the problem for cultivation practices of raising the crop production. Hence, the present study was planned to find out optimum horizontal spacing between two vegetative barriers for enhancing *in-situ* rainwater conservation as well as augmenting production and productivity of *rabi* sorghum without creating troubles for preparatory tillage operations.

Materials and Methods:

The non-replicated field trial was initiated in July 2004-2005 at Dry Farming Research Station, Solapur (M.S.) on 0.66 ha to find out optimum horizontal spacing of *Cenchrus ciliaris* (Madras anjan) vegetative barrier for moisture conservation and higher yield of *rabi* sorghum on Inceptisol soil having depth 50-55 cm. The plot size of each treatment was 110 x 12 m^2. The average annual rainfall of study area was 723 mm. The average minimum and maximum temperature ranges between 13.3 to 19.9 ^{0}C and 29.8 to 40.9^{0}C, respectively. The soil physic-chemical properties of experimental site are given in table 1. The five treatments *viz.,* 1. Absolute control 2. Vegetative barrier at 15 meter horizontal interval 3. Vegetative barrier at 30 meter horizontal interval 4. Vegetative barrier at 45 meter horizontal interval 5.Vegetative barrier at 60 meter horizontal interval were imposed as per treatment details (Fig.1). The vegetative barriers of *Cenchrus ciliaris* (Madras anjan) grass consisting three rows of 15 cm apart across the slope was established as per treatment details. The Madras anjan grass was obtained from local nursery and cut into small slip with root intact. The slip of Madras anjan was planted at 5 cm distance within row. The distance between two key line was 15 cm for establishment of various horizontal spacing of vegetative barriers. Thus, vegetative barriers were established under favorable rainfall condition and effective management of vegetative barriers within the crop season. The soil moisture was determined by screw auger method at center between two vegetative barriers at 15 days interval from sowing of *rabi* sorghum. The cultivar M 35-1 was used. Grain and fodder yield data was recorded at harvest. Fodder yield of vegetative barriers was also recorded periodically. For recording of yield of *rabi* sorghum 3x3 meters plot size was marked and five plots or spots were selected from each treatment. The data obtained was analysed by using procedure as given for simple rondomised block design by Panse and Sukhatme (1985). The following formulas were used for calculating the soil moisture

$$\% \text{ moisture} = \frac{(\text{Wet wt of sample}) - (\text{Dry wt of sample})}{\text{Dry wt of sample}}$$

$$\text{mm moisture} = \frac{\% \text{ moisture} \times \text{Bulk density of soil} \times \text{Depth of soil (mm)}}{100}$$

Results and Discussion:

Rainfall pattern:

Rainfall pattern given in table –2 indicated that the total actual rainfall received was 638.1 mm (-85.3 mm) in 43 rainy days in 2004, 758.9 mm (+32.5 mm) in 49 rainy days in 2005, 684.2 mm (-39.2 mm) in 43 rainy days in 2006, 523.00 mm (-200.4 mm) in 33 rainy days in 2007 and 693.2 mm (-30.2 mm) in 41 rainy days in year 2008. The figure in parenthesis indicates the deficient or surplus rainfall received in respective year as compared with average rainfall. The maximum rainfall during growth period of *rabi* sorghum 128.9 mm was received during the year 2006 followed by 84.4 mm rainfall during the year 2008 followed by 78.00 mm rainfall during the year 2005.

Soil Moisture:

The data on periodical soil moisture was recorded at 15 days interval from sowing of sorghum and the mean data relating to periodical soil moisture of five years are given in table 3. From table it is revealed that soil moisture was higher at the time of sowing of sorghum and decreased with advancement of crop age in all the treatments. The soil moisture was higher in vegetative barrier treatments than control during throughout growth period of *rabi* sorghum. The magnitude of mean soil moisture was higher (129 mm) in vegetative barriers at 15 meter

horizontal interval followed by vegetative barriers of 30 meter interval (113 mm) as compared to other remaining vegetative barriers treatments. Similar results were also reported by Bhanavase *et al.,*(2007), Pawar *et al.,* (1999) and Chunale (2004).

Grain and Fodder Yield:

The vegetative barriers of different horizontal spacing treatments had shown significant variation in grain and fodder yield of *rabi* sorghum during all the year of experimentation. Pooled results indicated that vegetative barriers of 15 meters horizontal interval recorded significantly superior mean grain yield (8.39 q ha^{-1}) over rest of the treatments except vegetative barriers of 30 meters horizontal interval (8.17 q ha^{-1}) (Table 7). Similar trend was noticed in case of fodder yield of *rabi* sorghum as well as fodder yield of live bund of *Cenchrus ciliaris*. This might be due to higher moisture conservation in vegetative barriers treatments. The efficacy of various horizontal spacing of vegetative barriers in conserving soil moisture and enhancing crop yield have also reported by Reddy *et al.,* (1992), Singh and Venkataraman (1990) and Prasad *et al.,* (2005).

The vegetative barriers of 15 meters horizontal interval recorded highest mean fodder yield (258 kg ha^{-1}) among all vegetative barrier treatments. These results are in accordance with Bhanavase *et al.,* (2007) and Katyal *et al.,* (1992).

Economics:

The data pertaining gross, net monetary return and B:C ratio of different horizontal spacing treatments or vegetative barriers are given in Table 4 to 6. Pooled mean (Table 7) showed that, the vegetative barriers of 15 meters horizontal interval recorded higher gross monetary return (Rs 15214 ha^{-1}), net monetary return (Rs. 7153 ha^{-1}) and B:C ratio (1.86) which is at par with vegetative barriers at 30 meters horizontal interval and superior over other remaining vegetative barriers treatments of *Cenchrus ciliaris.*

From the study, it is suggested that the vegetative barriers of *Cenchrus ciliaris* at 30 meters horizontal spacing consisting three rows of 15 cm apart across the slope should be adopted on medium deep soil (50-55 cm) having 2 % land slope for better moisture conservation, higher *rabi* sorghum yield and easy and more feasible for cultivation practices of crops in rainfall zone 1 and 4 scarcity zone of Maharashtra.

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Fig. 1: Layout of the experimental plot

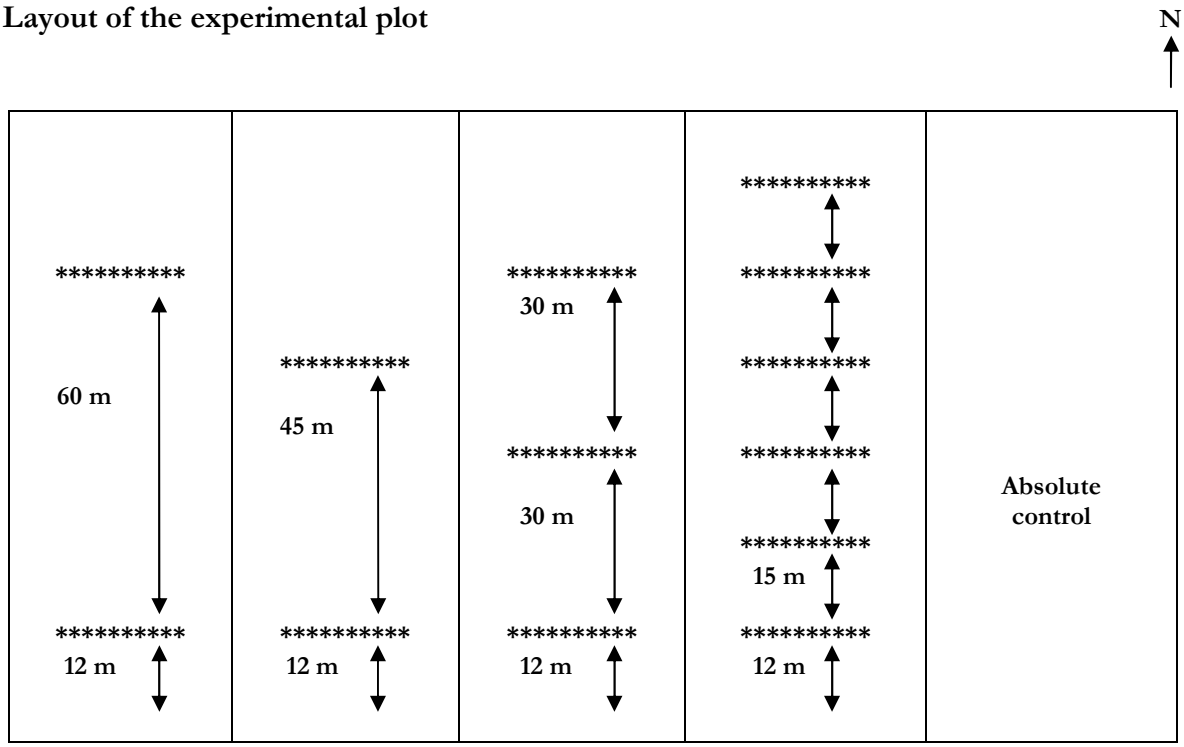

Table 1: Soil properties of experimental site

Sr. No.	Particulars	Value
1.	Soil texture	Silty clay
2.	Land Slope (%)	2
3.	Bulk density (Mg m^{-3})	1.18
4.	Infiltration rate (cm hr^{-1})	0.45
5.	EC (dS m^{-1})	0.11
6.	Organic Carbon (%)	0.42
7.	Available N (kg ha^{-1})	160
8.	Available P (kg ha^{-1})	15.60
9.	Available K (kg ha^{-1})	398

Table 2: Rainfall (mm) distribution received during the experimental years (Average: 723.4 mm)

Years	2004-05	2005-06	2006-07	2007-08	2008-09
Kharif	425.1	546.3	324.9	411.9	492.7
Rabi	81.7	104.8	233.9	109.8	128.2
Total Rainfall	638.1	758.9	684.2	523.0	693.2
Rainy days	43	49	43	33	41
Rainfall during crop growth period	13.9	78	128.9	3.5	84.4

Table 3: Periodical and mean soil moisture (mm) as influenced by different horizontal spacing of vegetative barriers (2004-05 to 2008-09)

Days From Sowing	Control						Vegetative Barrier at 15 m interval						Vegetative Barrier at 30 m interval						Vegetative Barrier at 45 m interval						Vegetative Barrier at 60 m interval					
	04-05	05-06	06-07	07-08	08-09	Mean	04-05	05-06	06-07	07-08	08-09	Mean	04-05	05-06	06-07	07-08	08-09	Mean	04-05	05-06	06-07	07-08	08-09	Mean	04-05	05-06	06-07	07-08	08-09	Mean
0	95	110	116	104	97	104	164	170	185	160	150	166	153	150	156	145	139	149	135	132	138	125	110	128	113	113	125	111	99	112
15	80	101	115	90	70	91	156	160	164	152	135	153	142	144	145	150	138	144	122	128	140	121	115	125	107	107	113	101	90	104
30	76	99	98	86	81	88	135	145	155	148	111	139	128	136	141	130	101	127	120	127	124	111	96	116	92	103	109	92	76	94
45	71	91	115	82	105	93	147	150	165	148	140	150	121	128	138	125	110	124	101	119	138	104	95	111	76	94	120	83	94	93
60	60	78	88	71	82	76	120	115	155	135	126	130	120	124	137	105	101	117	99	105	130	96	90	104	66	81	110	78	80	83
75	55	60	80	54	84	67	130	135	145	130	128	134	105	110	118	102	99	107	88	92	101	85	81	89	58	71	88	65	75	71
90	41	48	78	48	78	59	110	105	126	115	112	114	82	95	104	94	85	92	78	85	90	76	70	80	37	63	72	60	61	59
105	38	45	69	46	69	53	85	95	106	83	105	95	75	90	95	90	72	84	65	65	75	78	68	70	36	50	56	43	62	49
120	28	31	53	44	65	44	95	70	73	85	72	79	70	62	75	85	68	72	65	62	70	71	60	66	34	34	43	38	55	41
Mean	60	75	91	65	72	75	127	127	142	128	120	129	111	115	123	114	101	113	97	102	112	96	87	99	69	80	93	70	77	78

Table 4: Mean gross monetary returns (Rs ha^{-1}) of *rabi* sorghum as influenced by different horizontal spacing of vegetative barriers

Tr. No.	Treatments	Year					Pooled Mean
		2004-05	2005-06	2006-07	2007-08	2008-09	
1	Control	6725	10373	12762	13153	8548	10312
2	V.B. at 15 m interval	7575	15353	19390	18328	15424	15214
3	V.B. at 30 m interval	7157	13899	18586	17095	14330	14213
4	V.B. at 45 m interval	5908	11894	15396	14687	11794	11936
5	V.B. at 60 m interval	5752	11255	14061	13816	10638	11104
	SE±	-	-	-	-	-	440
	CD at 5 %	-	-	-	-	-	1318
	CV %	-	-	-	-	-	7.82

Table 5: Mean net monetary returns (Rs ha^{-1}) of *rabi* sorghum as influenced by different horizontal spacing of vegetative barriers

Tr. No.	Treatments	Year					Pooled Mean
		2004-05	2005-06	2006-07	2007-08	2008-09	
1	Control	1025	3765	5462	4983	48	3056
2	V.B. at 15 m interval	1125	7970	11155	9340	6174	7153
3	V.B. at 30 m interval	1120	7004	10651	8625	5520	6584
4	V.B. at 45 m interval	57	5167	7930	6389	3059	4520
5	V.B. at 60 m interval	35	4602	6711	5599	1988	3787
	SE±	-	-	-	-	-	429
	CD at 5 %	-	-	-	-	-	1286
	CV %	-	-	-	-	-	19.1
Market prices							
Grain (Rs. q^{-1})		900	700	1050	1500	1000	
Fodder (Rs. q^{-1})		250	250	250	250	250	
V.B.Fodder (Rs.q $^{-1}$)		300	300	300	300	300	

Table 6: Mean B: C ratio as influenced by different horizontal spacing of vegetative barriers

Tr. No.	Treatments	Year					Pooled Mean
		2004-05	2005-06	2006-07	2007-08	2008-09	
1	Control	1.18	1.57	1.75	1.61	1.01	1.42
2	V.B. at 15 m interval	1.17	2.08	2.35	2.04	1.67	1.86
3	V.B. at 30 m interval	1.19	2.02	2.34	2.02	1.63	1.84
4	V.B. at 45 m interval	1.01	1.77	2.06	1.77	1.35	1.59
5	V.B. at 60 m interval	1.01	1.69	1.91	1.68	1.23	1.50
	SE±	-	-	-	-	-	0.047
	CD at 5 %	-	-	-	-	-	0.142
	CV %	-	-	-	-	-	6.47

Table 7: Pooled mean yield (grain, fodder and vegetative barrier's fodder) and economics of *rabi* sorghum as influenced by different horizontal spacing of vegetative barriers (2004-05 to 2008-09)

Tr. No.	Treatment	Grain yield (q ha $^{-1}$)	Fodder yield (q ha $^{-1}$)	V.B.Fodder yield (q ha $^{-1}$)	Cost of cultivation (Rs ha $^{-1}$)	Gross monetary returns (Rs ha $^{-1}$)	Net monetary returns. (Rs ha $^{-1}$)	B: C ratio
1	**Control**	6.03	17.08	-	7256	10312	3056	1.42
2	**V.B. at 15m interval**	8.39	24.17	2.58	8061	15214	7153	1.86
3	**V.B. at 30m interval**	8.17	22.87	1.44	7629	14213	6584	1.84
4	**V.B. at 45m interval**	6.67	20.08	0.85	7415	11936	4520	1.59
5	**V.B. at 60m interval**	6.30	18.42	0.72	7317	11104	3787	1.50
	SE±	0.25	0.77	-	34	440	429	0.047
	CD at 5 %	0.76	2.31	-	101	1318	1286	0.142
	CV %	7.97	8.41		1.0	7.82	19.1	6.47