Karnataka J. Agric. Sci.,26 (4) : (502-505) 2013

Response of rainfed sorghum (*Sorghum bicolor*) to moisture conservation techniques and sowing dates in *rabi* season

A. H. KALHAPURE AND B. T. SHETE

Department of Agronomy
Mahatma Phule Krishi Vidyapeeth, Rahuri- 413 722 (Maharashtra), India
Email: aniketmpkv@gmail.com

(Received: October, 2012 ; Accepted: December, 2013)

Abstract: A field experiment was conducted at the Breeder Seed Production Farm of Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra) for three consecutive *rabi* seasons of the years 2009, 2010 and 2011 to study the effect of *in situ* moisture conservation techniques and dates of sowing on growth and yield of *rabi* sorghum under rainfed condition. Four *in situ* moisture conservation techniques (*viz.* sowing on flat bed and opening of furrow after each alternate row of crop, compartmental bunding, sowing on flat bed and sowing on ridges and furrows) as main plot treatments and three sowing dates (*viz.*15th September, 30th September and 15th October) were included as sub plot treatment in split plot design replicated thrice. The compartmental bunding of size 6m x 5m with 15 cm bund height was found to be superior in respect of various growth and yield attributes (*viz.* plant height, dry matter of plant and 100 seed weight). It also produced higher grain yield (2095 kg ha^{-1}), dry fodder yield (4780 kg ha^{-1}) and net return (₹ 77190 ha^{-1}). The B:C ratio of rainfed sorghum in *rabi* season and the soil moisture content at various depths of soil profile were also found to be maximum in compartmental bunding. In respect of various sowing dates, sowing of sorghum on 15th September resulted in higher plant height (187.21 cm), plant dry matter (47.85 g), 100 seed weight (3.86 g), grain yield (2179 kg ha^{-1}), dry fodder yield (4902 kg ha^{-1}), net return (₹ 80098 ha^{-1}) and B:C ratio (2.50). Ad0ption of compartmental bunding as *in situ* moisture conservation technique and early sowing of *rabi* sorghum on 15th September was found to be more efficient in increasing the yield under rainfed condition.

Key words: Compartmental Bunding, Economics, Moisture conservation, *Rabi* sorghum,

Introduction

The area and production of sorghum (*Sorghum bicolor*) in India for the year 2011 were 7.3 million hectares and 7.4 million tonnes, respectively with average productivity of 1013 kg /ha (Anon., 2011). Grain sorghum is used as food for human and feed for poultry and piggery. Sorghum plant is nutritious fodder for dairy animals which is used as both green and dry fodder. Grains are also used in production of alcoholic beverages and biodiesel. Being drought and heat tolerant, it is especially important in arid regions. It is the main food grain for over 750 million people in the semi-arid tropics of Africa, Asia, and Latin America. Sorghum is a rich source of carbohydrates, proteins, minerals and vitamin B_1 and B_2 (Bender and Bender 2005).

Rabi sorghum is the most important post rainy season (*rabi*) cereal crop in peninsular India, grown predominantly under rainfed conditions. The area under *rabi* sorghum is mainly concentrated in semi arid region of Deccan plateau consisting the states like Maharashtra, Karnataka and Andhra Pradesh. There is decline in the productivity of *rabi* sorghum under rainfed areas. Limited and erratic rainfall in the rainfed area creates moisture stress conditions during the various critical growth stages of crop life, resulting in severe yield reduction. Even when the rainfall is high, it is often lost as runoff, when the surface of the soil is not suitably formed. Moisture conservation therefore plays a key role in the successful crop production of *rabi* sorghum in the vertisols of peninsular India. Adequate soil moisture is the key to successful crop production in dryland areas.

Along with the conservation of soil moisture, its utilization for crop at proper time has tremendous importance. Sowing date is the considerable yield contributing factor in *rabi* sorghum because it determines temperature and photoperiod along with soil moisture (Biradar and Gollagi, 2006).

Hence, the present investigation was conducted to find out most efficient and adoptable *in situ* moisture conservation technique and proper sowing date for increasing the productivity of *rabi* sorghum under rainfed condition.

Material and methods

A field experiment to study the effect of *in situ* soil moisture conservation and sowing dates on the growth and yield of *rabi* sorghum under rainfed condition was conducted during 3 consecutive *rabi* seasons of year 2009, 2010 and 2011 at Breeder Seed Production Farm, Seed Cell Unit, Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra) located at 19^{0}23' N lattitude and 74^{0}42' E longitude having average annual rainfall of 520 mm. The soil of experiment field was deep black with 0.43 % organic carbon, 420 kg available N, 45.8 kg available P, 312 kg available K per hectare and soil pH was 7.8. The experiment was laid out in split plot design and replicated three times, which consisted of four in situ moisture conservation techniques as main plots *viz.* Sowing on flat bed and opening of furrow in each alternate row of crop, Compartmental bunding, Sowing on flat bed and Sowing on ridges and furrows. Sub plot consisted of three sowing dates *viz.* 15th September, 30th September and Sowing on 15th October. Sorghum variety 'Phule Anuradha' was sown at the spacing of 45 cm x 15 cm. The recommended dose of fertilizer (80:40:40 kg NPK per ha) was applied to crop and all other intercultivation operations were followed regularly. In the treatment sowing on flat bed and opening of furrow after each alternate row of crop, sorghum seed was sown on flat bed and furrows of 15 cm depth were opened after each alternate row of

Table 1. Rainfall record during the experimental period

Month	Met. Week	Year					
		2009		2010		2011	
		Rainfall (mm)	Rainy days	Rainfall (mm)	Rainy days	Rainfall	Rainy days
September	36	30.3	3	46.3	3	27.2	2
	37	29.7	3	0.0	0	15.6	2
	38	0.0	0	105.8	5	5.2	1
	39	0.0	0	103.4	5	29.1	3
October	40	57.6	1	1.5	0	1.0	0
	41	7.2	2	1.0	0	3.5	1
	42	0.0	0	8.6	1	17.2	2
	43	0.0	0	3.2	1	0.0	0
	44	0.0	0	0.0	0	0.0	0
November	45	64.5	3	3.8	0	0.0	0
	46	63.3	4	58.5	2	0.0	0
	47	0.0	0	1.0	0	0.0	0
	48	0.0	0	0.0	0	0.0	0
December	49	0.0	0	0.0	0	0.0	0
	50	0.0	0	0.0	0	0.0	0
	51	0.0	0	0.0	0	0.0	0
	52	0.0	0	0.0	0	0.0	0
Total		252.6	16	333.1	17	98.8	11

crop with the help of Balram plough at 30 days after sowing. In the treatment compartmental bunding, check basins of 6 m x 5 m size with 15 cm bund height were prepared by bullock drawn bund former before sowing. Seeds were sown at regular spacing on flat beds in the treatment sowing on flat bed. Sorghum was sown by dibbling at 15 cm spacing on ridges and furrows of 45 cm in treatment of sowing on ridges and furrows. Total rainfall received during the experimental period was 252.6 mm in 16 rainy days, 333.1 mm in 17 rainy days and 98.8 mm in 11 rainy days for the years 2009, 2010 and 2011, respectively. The biometric observations were recorded at regular time intervals and data were subjected to the statistical analysis by the procedure suggested by Panse and Sukhatme (1967). Similar trend of results were observed during all the three years of

Table 2. Effect of *in situ* moisture conservation techniques and dates of sowing on soil moisture content (at 0- 30 cm soil depth)

Treatment	Soil moisture content at 0- 30 cm soil depth (cm m^{-1} depth of soil)											
	36th meteorological week			41st meteorological week			46th meteorological week			51st meteorological week		
	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
In situ Moisture Conservation Techniques												
T_1	38.2	42.2	31.8	22.4	35.6	25.0	38.2	35.4	19.8	15.8	15.8	13.6
T_2	39.6	47.5	35.6	30.3	38.4	33.0	46.2	40.2	23.6	19.8	17.9	19.7
T_3	31.6	38.8	26.4	18.4	33.0	21.1	38.2	31.6	15.8	10.5	11.9	5.28
T_4	36.9	42.4	30.3	23.7	35.6	26.4	39.6	36.6	18.4	15.8	15.5	11.8
SEm ±	0.76	0.53	0.96	0.76	0.53	0.76	0.46	0.66	0.53	0.43	0.76	0.5
C.D.(P=0.05)	2.3	1.6	2.9	2.3	1.6	2.3	1.4	2.0	1.6	1.3	1.4	1.5
Dates of Sowing												
S_1	34.4	41.9	28.2	22.3	33.5	23.5	38.6	33.7	17.5	13.2	13.1	11.4
S_2	36.7	41.7	31.1	23.6	35.5	26.5	40.3	35.8	19.1	15.2	14.9	12.5
S_3	38.4	44.5	33.7	25.2	37.8	28.9	42.6	38.2	21.6	17.8	16.4	13.6
SEm ±	1.46	0.95	2.02	1.06	1.58	1.98	1.46	1.65	1.50	1.69	1.21	0.80
C.D.(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (TxS)												
SEm ±	1.30	1.69	1.53	0.84	1.53	0.99	1.66	1.73	1.73	1.11	1.53	1.07
C.D.(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

(T_1- Sowing on flat bed and opening of furrow after each alternate row of crop, T_2- Compartmental bunding, T_3- Sowing on flat bed, T_4- Sowing on ridges and furrows; S_1- Sowing on 15th September, S_2- Sowing on 30th September and S_3- Sowing on 15th October)

Table 3. Effect of *in situ* moisture conservation techniques and date of sowing on soil moisture content (at 30- 60 cm soil depth)

Treatment	Soil moisture content at 30- 60 cm soil depth (cm m^{-1} depth of soil)											
	36th meteorological week			41st meteorological week			46th meteorological week			51st meteorological week		
	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
In situ Moisture Conservation Techniques												
T_1	44.8	50.1	36.7	29.0	40.7	33.2	50.1	39.6	26.5	23.7	26.3	21.7
T_2	47.2	52.0	40.9	36.9	43.5	39.8	54.2	48.8	29.1	26.4	29.4	22.4
T_3	38.3	44.8	30.3	26.4	38.2	26.4	44.8	26.4	21.1	15.8	21.3	10.5
T_4	46.2	48.5	36.8	29.2	40.9	34.3	48.4	40.9	25.0	21.1	25.5	19.8
SEm ±	0.96	0.56	0.83	0.93	0.9	0.63	0.86	0.5	0.96	0.76	0.4	0.76
C.D.(P=0.05)	2.9	1.7	2.5	2.8	2.7	1.9	2.6	1.5	2.9	2.3	1.2	2.3
Dates of Sowing												
S_1	42.2	47.5	33.2	28.3	39.3	31	47.9	37.5	23.3	19.8	23.3	16.4
S_2	43.9	48.6	36.7	30.5	40.4	33.8	49.2	38.5	25.3	21.2	25.7	18.5
S_3	46.2	50.3	38.4	32.1	42.7	35.4	50.8	40.7	27.6	24.1	27.8	20.9
SEm ±	1.46	1.02	1.91	1.39	1.24	1.61	1.06	1.17	1.58	1.58	1.65	1.65
C.D.(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (TxS)												
SEm ±	1.66	1.77	1.27	2.12	1.53	0.84	1.53	1.07	2.01	1.46	1.30	1.69
C.D.(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

experiment for plant growth and yield attributing characters, yield and economics of sorghum. Hence pooled analysis was done for these characters for presentution of results and discussion.

Results and discussion

Moisture content of soil was observed to vary with the rainfall received in meteorological weeks in different years of the experiment. The moisture content of soil at various depths was also affected with different *in situ* moisture conservation techniques (Table 2 and 3). Higher soil moisture content was recorded in compartmental bunding at 0- 30 cm and 30- 60 cm depths of soil for all the years. This might be due to the reduced runoff and greater soil water retention in this type of land layout. However, the numerical value of percent moisture content observed was different in various experimental years due to the variation in rainfall received. The effect of various dates of sowing on soil moisture content at different depth was found to be nonsignificant for all the years of experiment. It was also found that the combined effect of *in situ* moisture conservation techniques and dates of sowing did not significantly influence the moisture content in soil at different depths for all the years.

Table 4. Effect of different *in situ* moisture conservation techniques and sowing dates on growth and yield attributing characters, yield and economics of sorghum (pooled)

Treatment	Plant height at harvest (cm)	Plant dry matter at harvest (g)	100 seed weight (g)	Grain yield (kg ha^{-1})	Dry fodder yield (kg ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
In situ Moisture Conservation Techniques							
T_1	167.06	35.15	3.48	1563	3640	57831	1.80
T_2	183.28	46.44	3.77	2095	4780	77190	2.40
T_3	154.58	25.77	3.16	1078	2736	40560	1.26
T_4	172.61	39.89	3.58	1748	4156	64910	2.02
SEm ±	3.35	2.7	0.07	141	259	5007	—
C.D. (P=0.05)	10.07	8.11	0.22	423	777	15043	—
Dates of Sowing							
S_1	187.21	47.85	3.86	2179	4902	80098	2.50
S_2	174.60	39.44	3.55	1741	4097	64521	2.01
S_3	146.33	23.16	3.08	942	2485	35748	1.11
SEm ±	3.52	2.40	0.08	130	225	4597	—
C.D. (P=0.05)	10.55	7.23	0.25	393	678	13824	—
Interaction (TxS)							
SEm ±	6.70	4.62	0.16	254	431	8923	—
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	—

Similar results were reported by Selvaraju and Balasubramanian (2001). Sowing on flat bed recorded the lowest soil moisture content.

Compartmental bunding (T_2) produced taller plants and highest dry matter over rest of the treatments (Table 4). However, it was on par with sowing on ridges and furrows (T_4) in respect of dry matter content of plant. Higher weight of 100 seed was observed in compartmental bunding (T_2). However compartmental bunding (T_2) was found to be on par with sowing on ridges and furrows (T_4), which was on par with sowing on flat bed and opening of furrow in each alternate row of crop (T_1). This might be due to the proper growth and development of crop as a result of increased availability of water and its efficient utilization in the root zone of crop because of application of *in situ* moisture conservation practices. Sowing on flat bed (T_3) produced significantly lower plant height, dry matter content of plant and 100 seed weight of sorghum.

Highest grain yield (2095 kg ha^{-1}), dry fodder yield (4780 kg ha^{-1}) and net return (₹ 77190 ha^{-1}) were observed in compartmental bunding (T_2). However it was on par with sowing on ridges and furrows (T_4) which was on par with sowing on flat bed and opening of furrow after each alternate row of crop (T_1) with respect to all these characters. Numerically higher B:C ratio (2.40) was observed in compartmental bunding (T_2). Significantly lower values of all these yield and economic parameters in sorghum were observed in sowing on flat bed (T_3). This is in conformity with the results of Nalatwadmath *et al*. (2008).

All the growth attributes of sorghum *viz*. height of plant, dry matter production and weight of 100 seed were found significantly higher with sowing on 15th September (S_1), whereas all these parameters were found lower, when sorghum was sown on 15th October (S_3). This might be due to, in early sowing sorghum crop can take the advantage of showers in last period of monsoon for germination, growth and development. Waghmare *et al.* (2010) also has reported better growth and development of sorghum due to the favorable temperature, humidity, photoperiod and soil moisture condition when crop was sown at early *rabi* season.

Sorghum produced significantly higher grain yield, dry fodder yield and net return, when sown on 15th September (S_1) (2179 kg ha^{-1}, 4902 kg ha^{-1} and ₹ 80098 ha^{-1}, respectively.) Maximum B:C ratio (2.50) was also observed when sorghum was sown on 15th September (S_1). Contrary of all these, yield parameters were observed lower in sowing on 15th October (S_3). Similar findings were reported by Mokashi *et al.* (2008).

The interaction effect of *in situ* moisture conservation practices and dates of sowing of *rabi* sorghum were found to be nonsignificant in influencing the various growth and yield attributes under rainfed condition.

From the three years experimentation the conclusion can be drawn that adoption of compartmental bunding is the best suitable and efficient technique for *in situ* moisture conservation and sowing of *rabi* sorghum on 15th September produced higher seed and dry fodder yield and net return under rainfed condition.

References

Anonymous, 2011, http://www.biocircle-project.eu

Bender, D. A. and Bender, A. E., 2005, A Dictionary of Food and Nutrition. New York: Oxford University Press. pp: 126.

Biradar, B. D. and Gollagi, S. G., 2006, Performance of *rabi* sorghum under different sowing dates and nutrient management practices. *Crop Res.,* 32(2): 165-167.

Mokashi, D. D., Jadhav, J. D., Khadatare, S. V. and Deshpande, A. N., 2008, Crop weather relationship in rabi sorghum. *Int. J. Agric. Sci.*, 4(1): 138- 141.

Nalatwadmath, S. K., Rao, M. S., Rama Mohan and Husenappa, V., 2008, Impact of inter- terrace conservation measures on sorghum yield in vertisols of semi arid tropics of south India. *Indian J. Dryland Agric. Res. and Development,* 23(1): 36- 41.

Panse, V. G. and Sukhatme, P. V., 1967, Statistical Methods for Agricultural Workers, ICAR publications, New Delhi; pp 152-65.

Selvaraju, R. and Balasubramanian, T. N., 2001, Effect of moisture conservation practices on water use, microclimate and productivity of intercropping in dryland vertisols. *J. Agric. Physics,* 1(1): 112-116.

Waghmare, P. K., Wghmode, D. B., Kedar, P. B., Ashalata, K. Zote and Shelake, V.B., 2010, Effect of different sowing dates on growth and yields of *rabi* sorghum (M- 35-1). *Int. J. Forestry and Crop Improvement,* 1(2): 112- 114.