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Yield and yield components of *rabi* sorghum (*Sorghum bicolor*) as influenced by *in situ* moisture conservation practices and integrated nutrient management in vertisols of semi-arid tropics of India

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ABSTRACT

A field experiment was conducted during winter (*rabi*) seasons of 1994–95 and 1995–96 to study the effect of *in situ* moisture-conservation practices, organic sources and nitrogen levels on yield and yield components of sorghum [*Sorghum bicolor* (L.) Moench] in the vertisols of Bijapur. The formation of compartmental bunds and ridges and furrows improved the yield components significantly over flat bed due to increased availability of moisture and nutrients. Application of subabul @ 2.5 t/ha proved beneficial in increasing the yield and yield components over farmyard manure (FYM) @ 2.5 t/ha and vermicompost @ 1.0. t/ha. Application of nitrogen up to 50 kg increased the yield, water-use efficiency (WUE) and yield components.

***Key words*:** Sorghum, Soil conservation, Yield components, Nutrient management

In situ moisture-conservation practices not only reduce the run-off, soil and nutrient losses but also improve soil-physical properties, nutrient status and moisture content, thereby improving sustaining the crop yields. Further, dryland soils are not only thirsty but also hungry. Supplementing the nutrient, especially nitrogen, through organic and inorganic sources not only supplies the required nutrients for crop growth but also improves the efficiency of applied fertilizer. Adequate availability of nutrients with conserved moisture through various *in situ* moisture-conservation practices helps in improving the crop growth and productivity. Sorghum is an important staple food crop of the region, with an overall average of 65% area with only

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44% of production grown during winter season (*rabi*) in Karnataka. However, there is limited information on the effect of soil and moisture-conservation practices with response to added nutrients through organic and inorganic sources on sorghum during *rabi* under dryland conditions of northern dry zone. Hence the present investigation was undertaken.

MATERIALS AND METHODS

The field experiment was conducted on lands having 1.0% slope in the deep black clayey soils at the Regional Research Station, Bijapur for two consecutive *rabi* seasons of 1994–95 and 1995–96. The study aimed to determine the effect of *in situ* moisture–conservation practices and integrated nutrient management on yield and yield components of sorghum. The soil of experimental site had organic carbon 0.36%, available N 128 kg/ha, available P_2O_5 28 kg/ha, available K_2O 402 kg/ha, pH 8.5 and electrical conductivity (E.C.) 0.27 dS/m. *In situ* moisture-conservation practices, viz. compartmental bunds of size 3 m x 3 m and the ridges and furrows at 60 cm were formed with bund Former and bullock-drawn ridger respectively. Subabul loppings @2.5 t/ha and farmyard manure (FYM) @ 2.5 t/ha were applied and covered manually. The recommended dose of phosphorus (25 kg/ha) was applied common to all the treatments at the time of sowing. Maladandi 'M 35-1', a *rabi* sorghum cultivar, was sown on 4 October 1994 and 14 September 1995 to a depth of 5 cm, 15 cm apart in rows of 60 cm and harvested on 15 February 1995 and 25 January 1996 respectively. The experiment was laid out in split/split plot design with three replications.

At sowing available soil moisture in the top 60 cm profile was 21.0 and 13.7 cm during 1994 and 1995 respectively. Rainfall during the crop-growing season was 384.2 and 412.4 mm during 1994–95 and 1995–96 respectively. The soil moisture was determined gravimetrically. Soil moisture utilized was computed as the difference of soil moisture at sowing, 30, 60 and 90 days after sowing (DAS) and at harvest. The consumptive use of water was worked out by taking the difference in the values of soil-moisture content (cm) in top 60 cm soil depth between two stages and further adding the rainfall and subtracting the run–off that occurred during the above period. This procedure was repeated from sowing till harvest at every stage and added to arrive at consumptive use of water (cm). Economic yield (kg/ha) was divided by water utilized (cm) to work out water–use efficiency and expressed in kg/ha–cm. The data collected from the experiment were subjected to statistical analysis as described by Gomez and Gomez (1984) using MSTAT software package of Michigan University for individual year's data as well as pooled analysis.

RESULTS AND DISCUSSION

Moisture-conservation practices

Compartmental bunding and ridges and furrows outyielded the flat bed during 1994–95, 1995–96 and in the pooled analysis (Table 1). In the pooled data, grain and straw yields of *rabi* sorghum increased significantly by 22.8% with formation of compartmental bunding and further

Table 1. Grain yield (kg/ha), straw yield (kg/ha), harvest index, consumptive use (cm) and water–use efficiency (kg/ha-cm) as influenced by *in situ* moisture-conservation practices, organics and nitrogen levels (pooled data of 1994–95 and 1995–96)

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index	Consumptive use (cm)	Water–use efficiency (kg/ha–cm)
In situ *moisture-conservation practice*					
FB	1,276	1,568	0.448	272	46.79
CB	1,567	1,924	0.449	273	57.22
R & F	1,603	1,950	0.450	275	58.36
CD (P=0.05)	1247	1346	NS	020	4.78
Organics					
FYM @ 2.5 t/ha	1,472	1,823	0.448	274	53.74
VC @ 1.0 t/ha	1,405	1,735	0.449	274	51.09
Sub @ 2.5 t/ha	1,570	1,885	0.459	273	57.55
CD (P=0.05)	913	806	NS	NS	3.22
N level (kg/ha)					
0	1,268	1,570	0.446	267	47.53
25	1,522	1,862	0.449	273	55.88
50	1,655	2,011	0.451	281	58.97
CD (P=0.05)	690	716	NS	027	2.63

FB = Flat bed; CB = compartmental bunding; R& F = ridges and furrows

improved to 25.6 and 24.4% with ridges and furrows compared with flat bed. *In situ* moisture–conservation measures improved the soil moisture in 0–15, 15–30 and 30–60 cm soil depths and in the top 60 cm profile from sowing till harvest, especially with ridges and furrows, causing the difference in yield in the present study. Robinson *et al.* (1986) observed the increase in *rabi* sorghum yield due to the formation of compartmental bunding, broad bed and furrows, and ridges and furrows over control. The reason for increased yield was mainly the higher availability of moisture. Higher yields with adoption of *in situ* moisture-conservation measures, as also reported by More *et al.* (1996) and Velayudham *et al.* (1997).

Higher WUE was observed with compartmental bunding (57.22 kg/ha-cm) and ridges and furrows (58.36 kg/ha-cm) over flat bed (46.79 kg/ha-cm). Fairbourn and Gardner (1974) also reported similar observations.

Higher grain yield in compartmental bunding and ridges and furrows was due to higher grain weight/plant, viz. 31,397 and 31,398 g/plant, which were statistically significant over flat bed (23,610 g/plant). The increase in grain weight/plant was due to higher 1,000-grain weight. The higher grain weight/plant is further supported by increased grains/ear. Compartmental bunding and ridges and furrows increased the number of grains/ear over flat bed. The increase in the values of above–mentioned yield components with *in situ* moisture–conservation practices over flat bed was supported by the development of larger ear size, viz. ear length and ear girth, which might have provided sufficient space for the increased number of grains/ear and development of individal grain. Increased ear length and girth was observed in compartmental bunded plots and in the plots laid out with ridges and furrows over flat bed.

The grain yield was significantly and positively correlated with yield components, viz. grain weight/plant (r=0.669*), 1,000–grains weight (r=0.509), grains/ear (r=0.604*), ear length (r=0.717*) and ear girth (r=0.651*). In these soils, formation of compartmental bunds and ridges and furrows improved the yield and yield components in sorghum over flat bed was also reported by previous workers (Radder *et al.*, 1991; Surkod, 1993).

Organics

Application of subabul increased the grain and straw yields significantly by 11.7 and 8.6% over vermicampost, and it was on a par with that of FYM. Higher yields with subabul applications compared with the rest of the organics was reported by earlier workers (Bellakki and Badanur, 1993; Durgude and Patil, 1997). The higher yields under subabul loppings compared with FYM or crop residues may be due to lower C:N ratio, faster rate of mineralisation, more moisture conservation and higher availability of nutrients. Subabul produced significantly higher water-use efficiency (WUE) of 57.55 kg/ha-cm over FYM (53.74 kg/ha-cm) and vermicompost (51.90 kg/ha-cm), clearly indicating higher grain-yield production with every unit of water used. Application of FYM with fertilizer improved the WUE to a geater extent over fertilizer alone (Sharma and Thukral, 1992; Patil *et al.*, 1996). Higher WUE may be due to improved soil/ moisture status especially during drought years. Sorghum yield was positively correlated with WUE (r=0.961*).

Subabul incorporation produced higher grain weight of 30.218 g/plant, which was significantly superior to vermicompost (27.340 g/plant). Higher grain weight/plant with subabul application was due to increased 1,000-grain weight and grains/ ear. Increased grain weight/plant is also associated with increased ear size, viz. higher values of ear length and girth in subabul-applied plots compared with the rest of the organics. These results are in conformity with the findings of previous workers, who also reported higher yield components either with application of subabul/green manure compared with stubbles or higher rate of organics application over lower doses or control (Patil *et al.*, 1996; Bhakher *et al.*, 1997).

Nitrogen levels

Increase in N dose up to 50 kg/ha increased the grain and straw yields significantly during both the years and in the pooled data, except during 1994–95 where

Table 2. Ear length (cm), ear girth (cm), grain weight/plant (g), 1,000-grain weight (g) and grains/ear as influenced by *in situ*, moisture-conservation practices, organics and nitrogen levels (pooled data of 1994–95 and 1995–96)

Treatment	Ear length (cm)	Ear girth (cm)	Gain weight/ plant (g)	1,000-grain weight (g)	Grains/ ear
In situ *moisture–conservation practice*					
FB	12.6	11.8	23.610	25.383	932
CB	15.6	14.1	31.397	28.413	1,073
R & F	16.3	14.2	31.968	29.022	1,102
CD (P=0.05)	0.65	0.68	2.312	0.763	54.5
Organics					
FYM @ 2.5 t/ha	14.9	13.2	29.416	27.496	1,046
VC @ 1.0 t/ha	14.5	13.0	27.340	26.841	1,003
Sub @ 2.5 t/ha	15.1	13.8	30.218	28.481	1,059
CD (P=0.05)	0.46	0.64	2.589	0.741	NS
N level (kg/ha)					
0	12.8	12.0	23.946	24.981	958
25	15.2	13.5	30.095	27.935	1,048
50	16.5	14.6	32.933	29.902	1,101
CD (P=0.05)	0.55	0.50	2.326	0.923	72.1

straw-yield response varied only up to 25 kg N/ha. In the pooled data application of 25 kg N (1,522 kg/ha) and 50 kg N increased the grain yield (1,655 kg/ha) compared with the control (1,265 kg/ha). Similar trend was noticed in straw yield also. The increase in crop yield with increase in N dose up to 50 kg/ha was due to increased availability of N in the soil. Similar trend was noticed by Rama Mohan Rao *et al.* (1995) and Patil *et al.* (1997) in the vertisols of Bellary under dryland conditions. Higher grain yield with application of 50 kg N/ha compared with 25 and 0 kg N/ha was mainly due to higher values of yield components, viz. ear length, ear girth, 1,000-grain weight, grains/ear and grain weight/plant (Table 2). Application of 50 kg N/ha produced superior grain weight/plant than of lower doses due to higher 1,000-grain weight and grains/ear and larger ear size, viz. ear length and girth. Bigger ear size not only provided sufficient space for more number of grains to be developed per ear but also provided sufficient space to increase their dry matter, which is rightly revealed by higher 1,000-grain weight. The present findings are in accordance with the results of Mulik *et al.* (1996) and Patil *et al.* (1997).

None of the interactions due to *in situ* moisture-conservation practices, organic sources and N levels were significant for yield and yield components.

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