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**Original Research Article**

# Rabi Sorghum Varieties Productivity Enhancement through Drip Irrigation

**D.C. Lokhande*, U.M. Khodke and A.G. Mundhe**

AICRP on Irrigation Water Management, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani -431 402, Maharashtra, India
**Corresponding author*

**A B S T R A C T**

With the advent need of food security, it is necessary to explore maximum yield potential of important cereal *rabi* sorghum. Owing to multifarious advantages of drip fertigation along with non-availability of water during dry spell in semi-arid regions of the country; justifies enormous potential for drip irrigation even for close growing crops like sorghum with some modification in crop geometry. Field experiments were conducted to assess the effect of drip irrigation on productivity of *rabi* sorghum on two sorghum varieties Viz., 'Parbhani Jyoti' (SPV 1595) and 'Akola Kranti' (AKSV 18R) with five irrigation schedules Viz., $I_1$-drip at 100% ETc, $I_2$-drip with 75% ETc, $I_3$-drip at 100% ETc during critical growth stages and compared with $I_4$- border check basin irrigation at 0.8 IW/ CPE, and $I_5$-rainfed (control) at AICRP on Water Management, VNMKV Parbhani, Maharashtra, India. Soil was medium and texturally clayey. It was low in nitrogen and phosphorus and calcareous in nature. The soil reaction was slightly alkaline. The experiment was laid out in factorial randomized block design with three replications. The inline 16 mm diameter drip laterals having drippers of 2.54 lph discharge and 30 cm spacing were laid for paired rows at 120 cm. Results indicated that drip irrigation schedule produced significantly highest *rabi* sorghum grain yield, fodder yield and 100 grain weight. The variety 'Akola Kranti' (AKSV 18R) gave higher sorghum grain and fodder yields, as compared to 'Parbhani Jyoti' (SPV 1595). Thus, it is concluded that drip irrigation is economically feasible for *rabi* sorghum which also ensure water security. Nutshell, on the basis of yield and economics, *rabi* sorghum planted in paired row at 45x15-75 cm spacing should be irrigated with drip irrigation at $I_1$ (1.0 or 100% ETc) every third day.

**Keywords**

Crop evapo-transpiration, Crop co-efficient, Drip irrigation, Economics, Rabi sorghum, Varieties, Water use efficiency, Yield

## Introduction

In central and southern Indian semi-arid and arid climate zones, sorghum (*Sorghum bicolar* L. Monech) is the third main crop in terms of cultivated area, next to paddy and wheat. It is one of the important food and fodder crop grown in *kharif* (rainy), *rabi* (post-rainy or winter) and summer seasons. *Rabi* sorghum covers an area of 3.5 M ha alone in Maharashtra (Epitome of Agriculture, 2004) with an equal area in adjoining Karnataka and Andhra Pradesh states. Despite the decrease in the cultivated area of *kharif* sorghum over the years, the area under *rabi* sorghum is increasing. The adoption of improved varieties and hybrids [International Crop Research Institute for Semi Arid Tropics (ICRISAT), 2012] could have increased the production levels in recent years. The semi-arid region of Central Maharashtra (India) receives rainfall from

the south-west monsoon, out of which 80% occurs within the period from June until October (rainy season), whereas the winter (November to March) is almost dry. The soils of the region are predominantly *vertisols* which remain thirsty due to uneven, low and erratic monsoon rainfall. *Rabi* sorghum mostly is grown under rainfed conditions with some protective irrigation if available. Yield and quality of the sorghum crop often suffers due to presence of insufficient soil moisture during its growth period. The water stress during the critical growth stages of crops necessitates the efficient use of irrigation water so as to minimize significant loss of crop yields. *Rabi* sorghum fetches higher prices compared to *kharif* sorghum due of its special quality grains. For the food security and to enhance the low average yields of *rabi* sorghum, it is necessary to explore its maximum yield potential. Hence, one of the measures for the improved production technology of *rabi* sorghum can be the adoption of drip irrigation. Keeping this view in mind, the present study was undertaken to study the feasibility of growing *rabi* sorghum under drip irrigation.

## Materials and Methods

Field experiments were consisted of two sorghum varieties viz., $V_1$-'Parbhani Jyoti' (SPV 1595) and $V_2$ –'Akola Kranti' (AKSV 18 R) with five irrigation schedules Viz., $I_1$-drip at 100% ETc (crop evapotranspiration), $I_2$-drip with 75% ETc, $I_3$- drip at 100% ETc during critical growth stages; $I_4$- border check basin irrigation at 0.8 IW/ CPE, and $I_5$-rainfed (control). The experiment was laid at 45x15 -75 cm for paired crop row in factorial randomized block design with three replications. The inline 16 mm diameter drip laterals having drippers of 2.54 lph discharge and 30 cm spacing were laid for paired rows at 120 cm. Soil was medium and texturally clayey. It was low in nitrogen and phosphorus and calcareous in nature. The soil reaction was slightly alkaline with the gravimetric moisture content at FC and PWP were 32.0 and 16.0 per cent, respectively. The bulk density was 1330 kg m/m$^3$. The experiment was conducted during three growing *rabi* seasons 2009-10, 2010-11 and 2011-12. The ETc was based on the three days cumulative pan evaporation (CPE) and developed Kc (Gundekar and Khodke, 2007). The in-line drip laterals 16 mm, 2.54 lph and 30 cm dripper spacing were placed for paired crop rows at 120 cm apart. The surface irrigation at four critical growth stages mostly at 0.8 IW/CPE ratio was applied through basins placed at 2 m apart. For the treatment under rainfed, irrigation was applied for germination if required. Recommended seed treatment was given before sowing (*Azotobactor* and *PSB*) and dose of fertilizer - 80:40:40 N, P and K kg/ha was used. In drip irrigated plots, N was applied in 3 splits (40, 20 and 20 kg/ha at 15, 30 and 60 DAS), phosphorous was applied in 2 splits (20 kg/ha at sowing and 30 DAS), whereas K was applied in three splits (20, 10 and 10 kg/ha at sowing and at 30 and 60 DAS). In surface irrigated plots, N in 2 splits (40 kg/ha each at sowing and 30 DAS) and P and K at the time of sowing was applied. Water soluble fertilizers of different grades were used for drip fertigation (19:19:19, 0:50:34 and Urea). There was no serious problem of incidence of pests and diseases. However, one spraying of *Chloropyriphos* was taken up as preventive and protective measures against *shoot fly* before 45 DAS and one spraying of *Rogor*. The biometric and yield observations were taken periodically.

## Results and Discussion

Data on yield attributes of *rabi* sorghum during three crop seasons 2009-10, 2010-11 and 2011-12 were subjected to pooled analysis.

**Table.1** Grain yield, fodder yield, 100 grain weight, WUE and economics of *rabi* sorghum under different treatments (Pooled)

| Treatment | Grain yield (kg/ha) | Fodder yield (kg/ha) | 100 grain weight (g) | Total water use (mm) | WUE (kg/ha-mm) | GMR (Rs./ha) | NMR (Rs./ha) | B:C ratio |
|---|---|---|---|---|---|---|---|---|
| **Irrigation Schedule:** | | | | | | | | |
| $I_1$- Drip at 1.0 ETc | 5767 | 8857 | 3.88 | 320.7 | 17.98 | 136080 | 103260 | 3.15 |
| $I_2$- Drip at 0.75 ETc | 5378 | 8583 | 3.68 | 261.1 | 20.60 | 128030 | 95214 | 2.90 |
| $I_3$- Drip at CGS | 3988 | 6968 | 3.27 | 233.0 | 17.12 | 98810 | 65990 | 2.10 |
| $I_4$-Surface at CGS | 3349 | 6146 | 3.01 | 363.3 | 9.21 | 80781 | 58344 | 2.49 |
| $I_5$- Rainfed | 1592 | 3551 | 2.76 | 103.3 | 15.41 | 41438 | 23642 | 1.33 |
| SEm ± | 1.47 | 3.02 | 0.09 | - | - | 2745 | 2744 | 0.108 |
| CD (P=0.05) | 4.39 | 8.96 | 0.28 | - | - | 8142 | 8142 | 0.321 |
| **Variety:** | | | | | | | | |
| $V_1$-SPV 1595 | 3844 | 6702 | 3.40 | - | - | 93512 | 65773 | 2.25 |
| $V_2$-AKSV 18R | 4185 | 6940 | 3.24 | - | - | 100540 | 72805 | 2.51 |
| SEm ± | 0.93 | 1.91 | 0.06 | - | - | 1738 | 1735 | 0.069 |
| CD (P=0.05) | 2.77 | NS | 0.17 | - | - | 5149 | 5149 | 0.203 |
| **Interaction:** | | | | | | | | |
| SEm ± | 2.09 | 8.86 | 0.13 | - | - | 3881 | 3881 | 0.153 |
| CD (P=0.05) | NS | NS | NS | - | - | NS | NS | NS |
| **Season x Treatment:** | | | | | | | | |
| SEm ± | 6.74 | 29.65 | 9.19 | - | - | - | - | - |
| CD (P=0.05) | NS | NS | NS | - | - | - | - | - |
| **GM** | **4015** | **6823** | **3.34** | **-** | **-** | **97,027** | **69,290** | **2.39** |

The error of seasons was tested with Barlett's test of homogeneity. Sorghum grain yield, fodder yield and 100 g seed weight during three crop seasons are presented in Table 1. Pooled results showed that sorghum grain yield (q/ha) was significantly influenced by different irrigation schedules (Table 1). Irrigation schedule $I_1$ (Irrigation at 1.0 ETc) recorded significantly higher sorghum grain yields (5767 kg/ha), as compared to other irrigation schedules, however, $I_1$ was at par with $I_2$ (0.75 ETc=5378 kg/ha). On the other hand, there was a significant difference of variety on sorghum grain yield was observed wherein variety 'Akola Kranti' (AKSV 18R) recorded significantly higher grain yield (4185 kg/ha) than 'Parbhani Jyoti' (SPV 1595) (3844 kg/ha). The interaction of irrigation schedules and variety on sorghum grain yield was not significant during all the seasons. Similar trend of results were observed in respect of sorghum fodder yield (kg/ha) and 100 grain weight (g). Except that, throughout there were no significant differences of varieties on sorghum fodder yields (kg/ha) were observed. The data presented in Table 1 also indicate that the highest water use efficiency was under irrigation schedule $I_2$ (drip at 0.75 ETc),

followed by $I_1$ (drip at 1.0 ETc) schedule, while the lowest was observed under $I_4$ (surface irrigation). Among the treatment combinations, highest water use efficiency was under $I_2V_2$, followed by $I_2V_1$, $I_1V_2$ and $I_3V_2$. The cost economics of various treatments was worked out considering the cost of cultivation and grain and fodder yield of *rabi* sorghum (Table 1). The irrigation schedule $I_1$ showed significantly highest gross monetary returns (GMR) (1,36,080 Rs./ha) and net monetary returns (NMR) (1,03,260 Rs./ha) and B:C ratio (3.15), as compared to other irrigation schedules, but it was at par with $I_2$. While, the irrigation schedule $I_3$ showed significantly higher GMR (98,810 Rs./ha) and NMR (65,990 Rs./ha) than $I_4$, but B:C ratio was higher in $I_4$ (2.49) than $I_3$ (2.10). Between the varieties, significantly highest GMR (1,00,540 Rs/ha), NMR (72,805 Rs./ha) and B:C ratio (2.51) were recorded by variety 'Akola Kranti' (AKSV 18 R), as compared to 'Parbhani Jyoti' (SPV 1595). Among the various treatments, highest GMR, NMR and B: C ratio are expected from $V_2$ $I_1$ treatment (Variety 'Akola Kranti' with drip at 1.0 ETc).

From the three years of study, it is concluded that *rabi* sorghum variety 'Akola Kranti' (AKSV 18 R) planted in paired row at 45x 15 - 75 cm spacing should be irrigated with drip irrigation at 1.0 or 100 % ETc every third day for realizing higher growth, yield, net returns and water use efficiency.

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