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# Performance of *Rabi* Crops in Relation to Stored Soil Moisture at Sowing

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**Abstract** Investigation on response of different *rabi* crops to the stored soil moisture level (125, 200 and 275 mm) at sowing revealed that sorghum, sunflower, wheat and gram could extract the soil moisture only from 0 to 60 cm soil depth and only sunflower could extract the soil moisture from 60 to 100 cm soil depth. At low soil moisture level (125 mm), sorghum utilized the highest soil moisture. While, at high soil moisture level (275 mm) safflower utilized more moisture and recorded the highest per cent increase in total drymatter and grain yield. However, irrespective of soil moisture level, sorghum recorded the highest grain yield, water use efficiency, crop equivalent yield and net income. Results lead to the conclusion that *rabi* sorghum at low soil moisture level (125 mm) and safflower and sunflower at medium (200 mm) and higher (275 mm) stored soil moisture levels gave higher grain yield and net income.

**Key words** Stored soil moisture level

In low rainfall areas *rabi* (October to February) crops suffer due to moisture stress at later stages of crop growth as little or no rains are received after sowing. Under such circumstances, stored moisture in the soil profile can be the only insurance against crop failure. Scanty information is available on the relative performance of *rabi* crops viz., sorghum, safflower, sunflower, chickpea and wheat and their soil moisture utilization patterns under dryland conditions of Karnataka. Keeping this in view, study was undertaken on medium to deep black soils to evaluate the performance of different *rabi* crops in relation to the pre-sowing stored soil moisture levels.

## Materials and Methods

The experiment was conducted at Agricultrual Research Station, Bijapur for two seasons (1988-89 and 1989-90) on Vertisols. It consisted of three stored soil moisture in 1 m soil depth at sowing (125, 200 and 275 mm) as three main treatments and rabi sorghum (*Sorghum bicolor*), wheat (*Triticum durum*), safflower (*Carthemus tinctorius*), sunflower (*Helianthus annuus*) and chickpea (*Cicer arietinum*) as five sub-plot treatments. The experiment was laid out in a split-plot design with three replications. After thorough land preparation, the plots (of 3x3m gross size) were laid out randomly and small bunds were made around each plot to avoid entry of rain water from one plot to another. The soil samples were taken after each rainfall event upto 1 m depth to work out available soil moisture. When the available soil moisture level reached the required level, the soil surface of that treatment plot was completely covered with thick polythene sheet to maintain same level of moisture at sowing. A day before sowing, polythene sheets were removed. Sowing of seeds, fertilizer application and plant protection measures were taken up as per the recommended package of practices for the region.

The soil moisture utilized was computed by determining the moisture content of soil samples collected from 1 m depth before sowing and at harvest by drying the samples at 105°C for 48 h. The soil moisture utilized upto 1 m soil depth was computed as the difference of soil moisture at sowing and at harvest. The total soil moisture utilized was calculated by adding the soil moisture utilized from different soil depths and the effective rainfall during crop growth period. The crop equivalent yield $ha^{-1}$ was calculated as the product of the crop yield and price of that crop divided by the price of the standard crop (*rabi* sorghum). The prevailing market rates at the time of harvest and two months later were obtained from Agricultural Produce

**Table 1** *Soil moisture at different depths (cm) in soil profile at harvest and utilization as influenced by stored soil moisture (mm) at sowing.*

| | Stored soil moisture (mn $m^{-1}$) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 125 | | | | 200 | | | | 275 | | | | Mean | | | |
| | 0–30 | 30–60 | 60–100 | Total | 0–30 | 30–60 | 60–100 | Total | 0–30 | 30–60 | 60–100 | Total | 0–30 | 30–60 | 60–100 | Total |
| **Soil Moisture at bervest** | | | | | | | | | | | | | | | | |
| Sorghum | 5.4 | 5.9 | 6.2 | 17.5 | 6.5 | 7.4 | 11.3 | 25.2 | 8.3 | 8.9 | 17.3 | 34.5 | 6.8 | 7.4 | 11.6 | 25.8 |
| Wheat | 5.7 | 6.3 | 6.5 | 18.5 | 6.5 | 7.0 | 11.8 | 25.3 | 8.3 | 8.8 | 18.3 | 35.4 | 6.8 | 7.4 | 12.2 | 26.4 |
| Safflower | 5.4 | 5.8 | 6.2 | 17.4 | 6.4 | 7.0 | 11.2 | 24.5 | 7.8 | 8.4 | 16.7 | 32.9 | 6.5 | 7.0 | 11.3 | 24.8 |
| Sunflower | 5.8 | 6.1 | 6.5 | 18.2 | 6.8 | 7.4 | 12.0 | 26.2 | 8.5 | 8.8 | 17.6 | 34.9 | 7.0 | 7.4 | 12.0 | 26.4 |
| Chickpea | 5.5 | 6.0 | 6.5 | 18.0 | 6.9 | 7.9 | 13.2 | 27.2 | 8.5 | 9.0 | 19.6 | 37.1 | 7.0 | 7.5 | 13.1 | 27.6 |
| Mean | 5.5 | 6.0 | 6.4 | 17.9 | 6.6 | 7.3 | 11.9 | 25.8 | 8.3 | 8.8 | 17.9 | 35.0 | 6.8 | 7.3 | 12.0 | 26.1 |
| **Moisture Utilization** | | | | | | | | | | | | | | | | |
| Sorghum | 4.0 | 4.5 | 0.2 | 8.7 (15.2)* | 4.7 | 8.9 | 3.4 | 15.0 (21.4) | 6.7 | 7.9 | 5.8 | 20.4 (26.9) | 5.1 | 6.4 | 3.1 | 14.8 (21.1) |
| Wheat | 3.7 | 4.1 | – | 7.8 (14.2) | 4.7 | 7.2 | 2.9 | 14.8 (21.2) | 6.8 | 8.0 | 4.8 | 196 (26.0) | 5.1 | 6.4 | 2.6 | 14.1 (20.5) |
| Safflower | 4.0 | 4.6 | 0.3 | 8.9 (15.3) | 4.9 | 7.3 | 3.5 | 15.7 (22.1) | 7.2 | 8.4 | 6.5 | 22.1 (28.5) | 5.4 | 6.4 | 3.4 | 15.6 (22.0) |
| Sunflower | 3.8 | 4.3 | – | 8.1 (14.5) | 4.4 | 6.8 | 2.7 | 13.9 (20.3) | 6.6 | 8.0 | 5.5 | 20.1 (26.5) | 4.9 | 6.4 | 2.8 | 14.1 (20.4) |
| Gram | 3.9 | 4.4 | – | 8.3 (14.70) | 4.3 | 6.7 | 1.5 | 12.5 (18.9) | 6.6 | 7.8 | 3.5 | 17.9 (25.3) | 5.2 | 6.3 | 1.7 | 13.2 (19.3) |
| Mean | 3.9 | 4.4 | 0.1 | 8.4 (14.8) | 4.6 | 7.0 | 2.8 | 14.4 (20.4) | 6.8 | 8.0 | 5.2 | 20.0 (26.6) | 5.1 | 6.3 | 2.7 | 14.3 (20.7) |

*Figures in the parentheses indicate the total moisture utilization alongwith effective rainfall.

**Table 3** *Water use efficiency and crop equivalent yield of different rabi crops as influenced by stored soil moisture (mm) at sowing*

| | Water use efficiency (kg cm$^{-1}$) | | | | Crop equivalent yield (kg ha$^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|
| | 125 | 200 | 275 | Mean | 125 | 200 | 275 | Mean |
| Sorghum | 125.1 | 111.4 | 108.1 | 114.9 | 1888 | 2375 | 2900 | 2387 |
| Wheat | 53.4 | 51.2 | 49.9 | 51.5 | 805 | 1151 | 1380 | 1112 |
| Safflower | 48.2 | 45.5 | 45.2 | 46.3 | 1397 | 1971 | 2380 | 1869 |
| Sunflower | 50.4 | 46.3 | 45.7 | 47.5 | 1450 | 1876 | 2412 | 1913 |
| Chickpea | 50.5 | 45.3 | 43.3 | 46.4 | 1214 | 1396 | 1723 | 1444 |
| Mean | 65.5 | 59.9 | 58.4 | 61.3 | 1346 | 1734 | 2159 | 1746 |
| For comparing | SEm ± | CD at 5 % | | | | | | |
| Moisture (M) | 23.3 | 67.9 | | | | | | |
| Crops (C) | 23.7 | 69.2 | | | | | | |
| Interaction of | | | | | | | | |
| M at same C | 41.1 | 11.9 | | | | | | |
| C at same M | 43.5 | 130.5 | | | | | | |

to be the most productive and efficient in moisture use, producing 1.56 t ha$^{-1}$ grain with 75.7 kg cm$^{-2}$ of water used. The higher water use efficiency may be attributed to a dense and prolific root system (Bloodworth *et al.* 1958), ability to maintain stomatal opening at low levels of leaf water potential (Turner 1974), possibly through osmotic adjustment (Jones & Turner 1979) and an ability to delay reproductive development (Hsiao *et al.* 1976).

Wheat was found to be next efficient utilization of (51.5 kg cm$^{-1}$ of water) which is contrary to the reports, that wheat was less productive and less efficient in utilizing stotred soil moisture compared to other crops (Umrani *et al.* 1981). However, the crop equivalent yield was lowest in wheat (1112 kg ha$^{-1}$) as compared with other crops (Table 3).

Increased crop growth, drymatter and grain yield with increase in soil moisture level could be due to increased turgidity of whole plant system coupled with higher photosynthetic rate. The turgidity of plant helps in efficient translocation of photosynthetes from vegetative parts to the economically useful parts of the plant. The data on crop equivalent yield (Table 3) indicates that *rabi* sorghum, sunflower and safflower are better performing crops in *rabi* season as compared with chickpea and wheat.

The net income (data not given) was the highest in rabi sorghum (Rs 6212 ha$^{-1}$) followed by sunflower (Rs 4488 ha$^{-1}$) and safflower (Rs 4421 ha$^{-1}$), when the prices of them were considered at Rs 300, 650 and 600 100 kg$^{-1}$, respectively.

To conclude, it may be inferred that, *rabi* sorghum performed better in all levels of stored soil moisture, specially in low level (125 mm) indicating its better suitability at lower levels of soil moisture. Whereas, safflower and sunflower responded better than *rabi* sorghum at medium (200 mm) and high (275 mm) levels of stored soil moisture.

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