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# Physiological basis of growth and yield variation in sorghum genotypes under shallow medium soils

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## ABSTRACT

**A field experiment was conducted on shallow and medium deep soils at Regional Agricultural Research Station, Bijapur, University of Agricultural Sciences, Dharwad (Karnataka). In general all the genotypes gave higher grain yield when they were grown in medium deep black soil compared to that grown under shallow soil. The production and translocation of photosynthates from source to sink was efficient in case of high yielder when compared to medium and low yielder. Days to 50 per cent flowering and maturity, leaf dry weight, LAI, relative water content (RWC), panicle dry weight, harvest index and other parameters have favoured in high yielders. Less number of parameters in moderate and only few in case of low yielders have favoured the yield.**

**Key words :** Sorghum, Dry matter production, Harvest index

## INTRODUCTION

Sorghum is a dry land crop. It is an important subsistence food source for small scale farmers in semiarid regions. It stands fourth the area under cultivation after wheat, rice, maize in the country amongst cereals. Due to its relative drought tolerance, it is best for dry regions with uncertain and scanty rainfall areas (Chimmad and Kamtar 2003).

*Rabi* sorghum is confined to Maharashtra, Karnataka and Andhra Pradesh. It is normally grown under stored and receding soil moisture conditions with increasing temperatures. It experiences both soil and atmospheric drought. An effort was made to compare the morpho-physiological characters of some rabisorghum genotypes grown under shallow and medium soils. To understand the drought tolerance.

## MATERIALS AND METHODS

A field experiment was conducted on shallow and medium soils at Regional Agricultural Research Station, Bijapur, University of Agricultural Sciences, Dharwad (Karnataka). during *Rabi* season of the year 2006. The experiment was laid out in a Randomized Block Desing (RBD) with three replications. The genotypes used were RSLG1119, RSLG871, RSV423, PVR616, PVR617, IS23399, PVR624, SSV84, CRS9, CRS10, CRS11, SPV1546(2), Maulee (C), M35-1(C) and CSV216R(C). The seeds were hand dibbled at the spacing of 60 x 15 cm during fourth week of September. The observations recorded were plant height (cm), days to 50% flowering, days to physiological maturity, LAI, leaf dry weight, stem dry weight, Total chlorophyll, RWC, Total biomass, yield and yield components. The LAI was computed by adopting the formula of stickler (1961). The relative water content was estimated by using Barrs and Weatherly's (1962) formula.

The depth of the shallow soil is less than 30 cm and the clay content ranges from 35 to 40 per cent. The infiltration rate is moderate to high (2 to 5 cm/h). The available water holding capacity varies between 3 to 4 cm per 30 cm soil depth. The soil has an alkaline pH of 8.1 and electrical conductivity of 0.38 dS/m. The available nitrogen, phosphorous and potassium are 160, 16.0 and 308 kg/ha, respectively. It has 0.24 per cent organic carbon and 20 per cent of calcium carbonate. The shallow soil has a maximum water holding capacity of 42 per cent and the available water is 14.5 per cent.

The medium black soil depth varies from 45 to 60 cm. The clay content of soils is around 50 per cent with low to moderate infiltration rate (0.8 to 1.0 cm / h). The available water holding capacity of soil is around 5 cm per 30 cm soil depth. The soils are base saturated and alkaline in reaction (pH 8.5). The $CaCO_3$ content increases with depth and it ranges from 10 to 12 per cent. Soils are low in nitrogen and phosphorus and rich in potassium. Soils are also showing deficiency of Fe and Zn in patches.

### *Seasonal conditions:*

During 2006, at Regional Agricultural Research Station, Bijapur rainfall of 802 mm was received in 48 rainy days which is above the normal rainfall of 594.3 mm in 38 rainy days. Above rainfall was received during May, June and September. Rainfall was normal during October and November and other months had recorded

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deficit rainfall (Anonymus, 2006).

## RESULTS AND DISCUSSION

In general all the genotypes gave higher grain yield when they were grown in medium deep black soil compared to that if grown under shallow soil. Among the genotypes RSLG1119, RSLG871, RSV 423and PVR616 have given high yields, the genotypes Maulee, CSV 216R, M35-1 and CRS10 have give moderate yields and the remaining genotypes have given lower yields both in medium deep back soils and shallow soils(Table 3).

Yield was a complex phenomenon and it was favoured by different growth parameters in different genotypes. There was a variation in percent incrase in grain yield of genotypes grown in shallow to medium deep black soils. Among the high yielders it ranged between 17.90(RSLG871) to 28.95 (RSV423), in moderate yielders the range was 12.96 (M35-1) to 63.80 (CSV216 R) and in low yielders it randes between 3.88 (CRS11) to 38.64 (PVR 624). Among the high yielders the percent increase was narrow when compared to other two groups.

The high yielders grown in medium deep black soils have taken more number of days for 50 per cent flowering and physiological maturity. In high yielders grown in medium deep black soils 50 per cent flowering ranged between 74.3 to 76.0 days when grown in shallow soils it was 72-75 days. The physiological maturity ranged between 114.6 to 119.6 days and 112.6 to 117.0 days respectively. This means that more time was available to the genotypes for dry matter accumulation when they were grown in medium deep black soils when compared to grown in shallow soils. The high yielding genotypes were taller than moderate and low yielders. This indicates the availability of space for dry matter accumulation (Table 1).

Similarly, The leaf area index (LAI) in the genotypes RSLG1119 and RSLG871 grown in medium deep black soils (4.00 and 3.86, respectiovely) was higher compared to those grown in shallow soils (3.86 and 3.10 respectively) when compared to other genotypes in high yielding genotypes. The leaf dry weight and relative water content (RWC) were high in genotypes grown in medium deep black soils when compared to that grown in shallow soils. RSLG1119 at 50 per cent flowering had recorded 156.3 g/m$^2$ when grown in medium deep black soils where as it was 132.3 g/ m$^2$ when it was grown in shallow soils (Table 2). This means that more photosynthetic tissue was available to harvest solar energy coupled with this it had recorded higher RWC of 86 per cent. More water was available for leaf metabolism. Higher RWC helps to translocate more dry matter from source (leaf) to sink (pancle). The Translocation efficiency was reflected in higher panicle dry weight. RSLG1119 had recorded a highest panicle dry weight of 274.3 g / m$^2$ when compared

**Table 1 : Physiological basis of growth and yield variation in sorghum genotypes under shallow and medium soils**

| Sr. No. | Entry name | Plant height (cm) | | Days to 50% flowering | | Days to physiological maturity | | Leaf area index | | Leaf dry wt. at 50% fl. (g/m$^2$) | | Leaf dry wt. at maturity (g/m$^2$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S.S | M.S | S.S | M.S | S.S | M.S | S.S | M.S | S.S | M.S | S.S | M.S |
| 1. | RSLG 1119 | 195.0 | 210.0 | 73.6 | 76.0 | 112.6 | 114.6 | 3.26 | 4.00 | 132.3 | 156.3 | 105.0 | 88.3 |
| 2. | RSLG 871 | 185.0 | 198.3 | 73.0 | 76.0 | 113.0 | 115.0 | 3.10 | 3.86 | 142.3 | 137.0 | 90.0 | 82.0 |
| 3. | RSV-423 | 179.3 | 192.6 | 72.0 | 74.3 | 114.6 | 116.6 | 2.83 | 3.96 | 101.6 | 112.6 | 84.0 | 70.0 |
| 4. | PVR-616 | 183.3 | 194.6 | 75.0 | 78.0 | 117.0 | 119.6 | 2.70 | 3.63 | 130.6 | 145.0 | 93.4 | 85.0 |
| 5. | PVR-617 | 192.0 | 199.3 | 71.6 | 74.0 | 112.6 | 116.0 | 2.83 | 3.86 | 86.6 | 115.0 | 70.0 | 70.1 |
| 6. | IS 23399 | 133.3 | 143.3 | 66.0 | 68.3 | 103.6 | 106.0 | 2.60 | 3.50 | 103.3 | 123.0 | 89.3 | 80.0 |
| 7. | PVR-624 | 189.3 | 200.0 | 84.0 | 85.0 | 119.3 | 121.6 | 2.80 | 3.93 | 124.0 | 145.0 | 93.3 | 90.3 |
| 8. | SSV-84 | 118.0 | 128.0 | 71.6 | 75.0 | 115.3 | 117.6 | 2.60 | 3.60 | 95.6 | 113.6 | 77.0 | 68.6 |
| 9. | CRS-9 | 173.0 | 183.6 | 68.3 | 71.3 | 108.0 | 109.6 | 2.80 | 3.66 | 107.3 | 127.0 | 85.0 | 75.0 |
| 10. | CRS-10 | 180.3 | 192.0 | 66.0 | 68.0 | 103.6 | 106.0 | 2.90 | 3.56 | 112.3 | 129.3 | 91.6 | 89.3 |
| 11. | CRS-11 | 153.6 | 163.6 | 69.0 | 71.3 | 105.6 | 107.6 | 2.60 | 4.00 | 116.0 | 130.0 | 88.6 | 97.6 |
| 12. | SPV-1546 | 181.3 | 190.0 | 71.0 | 73.0 | 106.6 | 110.0 | 2.36 | 3.16 | 116.6 | 137.0 | 95.0 | 91.6 |
| 13. | Maulee (C) | 178.6 | 188.6 | 72.0 | 72.0 | 107.0 | 113.6 | 2.90 | 3.76 | 110.6 | 133.3 | 90.0 | 86.6 |
| 14. | M 35-1 (C) | 177.0 | 186.0 | 73.6 | 79.0 | 115.0 | 120.6 | 2.76 | 3.63 | 105.6 | 193.3 | 85.0 | 83.0 |
| 15. | CSV 216 R(C) | 185.3 | 196.0 | 75.6 | 81.0 | 117.6 | 121.3 | 2.73 | 3.96 | 97.6 | 117.3 | 77.0 | 76.0 |
| | S.E.± | 1.51 | 2.05 | 0.43 | 0.50 | 0.48 | 0.55 | 0.17 | 0.16 | 2.3 | 0.28 | 2.90 | 4.20 |
| | C.D. (P=0.05) | 4.52 | 6.14 | 1.29 | 1.51 | 1.44 | 1.61 | 0.51 | 0.48 | 6.9 | 12.60 | 8.71 | 12.60 |

**Table 2 : Physiological basis of growth and yield variation in sorghum genotypes under shallow and medium soils**

| Sr. No. | Entry name | Stem dry wt. at 50% fl. ($g/m^2$) | | Stem dry wt. at maturity ($g/m^2$) | | Penicle dry wt. 50% fl. ($g/m^2$) | | Penicle dry wt. at maturity ($g/m^2$) | | Total biomass at 50% fl. ($g/m^2$) | | Total biomass at maturity ($g/m^2$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S.S | M.S | S.S | M.S | S.S | M.S | S.S | M.S | S.S | M.S | S.S | M.S |
| 1. | RSLG 1119 | 290.0 | 387.3 | 191.0 | 281.6 | 70.0 | 76.6 | 249.3 | 274.3 | 492.3 | 614.0 | 545.0 | 654.3 |
| 2. | RSLG 871 | 263.3 | 341.6 | 170.0 | 244.3 | 64.0 | 72.0 | 238.3 | 265.0 | 439.6 | 556.0 | 498.3 | 592.0 |
| 3. | RSV-423 | 230.0 | 321.6 | 140.0 | 213.3 | 66.6 | 68.3 | 231.6 | 258.3 | 398.3 | 504.3 | 535.6 | 541.6 |
| 4. | PVR-616 | 253.3 | 351.6 | 158.3 | 248.3 | 60.0 | 63.3 | 231.1 | 265.0 | 444.0 | 568.3 | 488.3 | 598.3 |
| 5. | PVR-617 | 221.6 | 301.6 | 160.0 | 200.0 | 51.6 | 63.6 | 201.6 | 235.0 | 360.0 | 480.3 | 401.6 | 520.0 |
| 6. | IS 23399 | 231.6 | 315.6 | 155.3 | 217.6 | 62.0 | 68.3 | 204.0 | 239.0 | 404.3 | 514.0 | 434.0 | 555.0 |
| 7. | PVR-624 | 223.3 | 319.6 | 110.0 | 218.3 | 62.3 | 62.3 | 218.3 | 255.0 | 402.3 | 527.0 | 438.3 | 565.3 |
| 8. | SSV-84 | 213.3 | 291.6 | 110.0 | 187.0 | 62.3 | 71.6 | 235.0 | 267.0 | 371.3 | 476.3 | 422.0 | 522.6 |
| 9. | CRS-9 | 231.6 | 315.0 | 133.3 | 207.0 | 49.0 | 60.0 | 231.6 | 251.6 | 413.0 | 502.3 | 451.0 | 533.6 |
| 10. | CRS-10 | 238.3 | 327.0 | 140.0 | 220.0 | 62.3 | 72.6 | 231.1 | 265.0 | 413.0 | 528.3 | 470.0 | 574.3 |
| 11. | CRS-11 | 248.3 | 333.3 | 141.6 | 214.0 | 62.3 | 74.6 | 220.0 | 263.3 | 418.0 | 536.3 | 450.3 | 579.6 |
| 12. | SPV-1546 | 220.0 | 320.0 | 156.6 | 216.6 | 59.3 | 70.0 | 226.6 | 251.6 | 396.0 | 527.0 | 545.0 | 560.0 |
| 13. | Maulee (C) | 246.6 | 352.6 | 145.0 | 245.0 | 61.0 | 71.0 | 238.3 | 266.0 | 411.6 | 556.0 | 473.3 | 597.6 |
| 14. | M 35-1 (C) | 235.0 | 345.0 | 136.0 | 241.6 | 59.3 | 64.6 | 226.6 | 260.0 | 400.0 | 539.6 | 446.6 | 582.6 |
| 15. | CSV 216 R(C) | 225.0 | 325.0 | 121.6 | 217.6 | 55.0 | 62.6 | 205.0 | 242.6 | 396.0 | 504.6 | 403.6 | 537.0 |
| | S.E.± | 3.20 | 3.80 | 3.00 | 3.60 | 2.70 | 2.8 | 2.90 | 2.1 | 10.4 | 11.3 | 11.6 | 13.5 |
| | C.D. (P=0.05) | 9.61 | 11.40 | 9.10 | 10.81 | 8.11 | 8.4 | 8.71 | 6.3 | 30.9 | 33.9 | 34.8 | 39.4 |

to other genotypes. The high panicle weight has helped grainsto become bold with higher weight (32.9g/ 1000 grains). Higher leaf dry weight, RWC, Panicle dry weight, HI and 1000 grain weight favoured the high yield in case of RSLG1119 when grown in medium deep black soils compared to that grown in shallow soil. The same trend was followed in other high yielding genotypes.

The moderate yielders had recorded medium duration for 50 per cent flowering and physiological maturity. The parameters ranged in betweem high and low yielders. In

**Table 3 : Physiological basis of growth and yield variation in sorghum genotypes under shallow and medium soils**

| Sr. No. | Entry name | R.W.C. at 50% fl. (%) | | Total chlorophyll at 50% fl. (mg/g Fr. Wt) | | Chlorophyll stability index at 50% fl. | | Grain No. per penicle (No.) | | 1000 grain wt. (g) | | Harvest index (%) | | Grain yield (kg/ha) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S.S | M.S | S.S | M.S | S.S | M.S | S.S | M.S | S.S | M.S | S.S | M.S | S.S | M.S |
| 1. | RSLG 1119 | 79.0 | 86.0 | 2.26 | 3.03 | 0.06 | 0.090 | 1396.6 | 1503 | 29.9 | 32.9 | 37.1 | 41.3 | 1620 | 2080 |
| 2. | RSLG 871 | 77.0 | 82.3 | 2.10 | 2.70 | 0.10 | 0.120 | 1328.3 | 1421 | 27.1 | 30.0 | 33.7 | 37.7 | 1553 | 1843 |
| 3. | RSV-423 | 77.6 | 85.0 | 1.90 | 3.00 | 0.76 | 0.096 | 1386.6 | 1490 | 28.3 | 31.3 | 34.9 | 41.0 | 1416 | 1885 |
| 4. | PVR-616 | 75.6 | 82.2 | 1.76 | 2.60 | 0.18 | 0.196 | 1277.3 | 1379 | 24.8 | 27.3 | 32.2 | 37.3 | 1340 | 1706 |
| 5. | PVR-617 | 73.0 | 75.3 | 1.60 | 2.30 | 0.20 | 0.223 | 1160.0 | 1260 | 21.1 | 23.4 | 29.6 | 30.9 | 893 | 1093 |
| 6. | IS 23399 | 73.3 | 76.6 | 1.43 | 1.93 | 0.35 | 0.383 | 1084.0 | 1190 | 21.6 | 24.8 | 31.6 | 33.9 | 938 | 1091 |
| 7. | PVR-624 | 75.3 | 82.0 | 1.33 | 2.50 | 0.17 | 0.190 | 1163.0 | 1263 | 23.6 | 26.8 | 30.0 | 35.0 | 1120 | 1446 |
| 8. | SSV-84 | 75.0 | 84.0 | 1.46 | 2.60 | 0.40 | 0.466 | 1085.6 | 1185 | 20.9 | 23.7 | 26.4 | 30.2 | 1356 | 963 |
| 9. | CRS-9 | 73.0 | 78.6 | 1.30 | 2.56 | 0.16 | 0.176 | 1110.0 | 1203 | 24.2 | 26.8 | 31.4 | 38.0 | 1391 | 1483 |
| 10. | CRS-10 | 77.3 | 81.0 | 1.56 | 2.90 | 0.11 | 0.133 | 1148.6 | 1246 | 24.9 | 26.6 | 34.8 | 40.3 | 1313 | 1535 |
| 11. | CRS-11 | 78.0 | 77.1 | 1.66 | 3.00 | 0.14 | 0.160 | 1183.3 | 1283 | 25.6 | 28.3 | 30.8 | 35.6 | 1310 | 1373 |
| 12. | SPV-1546 | 76.0 | 77.0 | 1.56 | 2.60 | 0.09 | 0.110 | 1150.0 | 1249 | 22.9 | 25.8 | 32.1 | 37.6 | 1333 | 1460 |
| 13. | Maulee (C) | 26.6 | 82.0 | 1.93 | 2.93 | 0.10 | 0.123 | 1298.3 | 1398 | 28.0 | 31.0 | 33.9 | 38.3 | 1410 | 1676 |
| 14. | M 35-1 (C) | 75.6 | 79.6 | 1.73 | 2.76 | 0.14 | 0.163 | 1270.0 | 1374 | 26.7 | 30.2 | 33.1 | 37.1 | 1296 | 1506 |
| 15. | CSV 216 R(C) | 73.0 | 79.6 | 1.60 | 2.56 | 0.19 | 0.213 | 1153.3 | 1256 | 24.9 | 27.8 | 30.2 | 35.6 | 498 | 1533 |
| | S.E.± | 0.90 | 1.10 | 0.41 | 0.50 | 0.32 | 0.10 | 6.1 | 6.8 | 1.1 | 0.50 | 0.52 | 0.38 | 14.1 | 15.2 |
| | C.D. (P=0.05) | 2.70 | 3.32 | 1.20 | 1.56 | 0.90 | 0.31 | 18.3 | 20.4 | 3.2 | 1.51 | 1.56 | 1.14 | 42.3 | 45.6 |

case of Maulee, when grown in shallow and medium deep black soils, the parameters range was as follows. They were physiological maturity (107.0 to 113.6 days), LAI (2.91 to 3.76), RWC (76 to 82 %), chlorophyll (1.93 to 2.93 mg/ g fresh wt) and panicle dry weight at maturity (238.3 g/ $m^2$ to 266.0 g/ $m^2$, respectively). Incase of CRS10 genotype 50 per cent flowering and maturity ranged between 66 to 67 days and 103.6 to 106 days when grown in shallow and medium deep black soils, respectively. Theleaf area index (3.56), leaf dry weight at maturity (265g/$m^2$ ) and harvest index (40.3%) of CRS10 was high when it was grown in medium deep black soils than when it was grown in shallow soils.

Among the genotypes PVR 617and IS23399 had recorded low yields when grown in shallow and medium deep soils. Only few factor have favoured the yield. Leaf dry weight at 50 per cent flowering and maturity, panicle dry weight at maturity, 1000 grain weight and harvest index were low in both the genotypes when they were grown in shallow as well as medium deep soils. In IS23399 the leaf dry weight 50 per cent flowering (86.7 and 115 g/$m^2$, respectively), at maturity (70.0 and 70.1 g/$m^2$, respectively), stem dry weight at maturity (160 and 200 g/$m^2$, respectively), panicle dry weight at maturity (201.6 and 235 g/$m^2$, respectively), 1000 grain weight (21.1 and 23.4 g) and harvest index (29.6 and 30.9 %) were low when compared to other genotypes. As a result it yielded less among the genotypes. Similarly the genotype PVR 617 had recorded lower leaf dry weight, Stem dry weight, panicle dry weight and 1000 grain weight. Therefore, it recorded lowest yield among the genotypes.

## REFERENCES

**Anonymus (2006).** All India Co-ordinated Research Project for dryland Agriculture, Bijapur centre, Annual Report-2006-07.Page-3

**Bapat, D.R., Wankaokar, R. S. and Balaiah, K. (1975).** New promising *rabi* sorghum hybrids. *Sorghum Newletter*, **8**:41-42.

**Barrs, H.D. and Weatherly, P.E. (1962).** A re-examination of relative turgidity for estimating water deficits in leaves. *Australian J. Biol. Sci.*, **15** : 413-428.

**Chimmad, V. P. and Kamatar, M.Y. (2003).** Physiological characterization of sorghum parents for *kharif* and *rabi* seasons. Paper presented in *2nd International Congress of Plant Physiology*, New Delhi, 8-12 January, 2003.

**Stickler, F. C., Wearden, S. and Pauli, A. (1961).** Leaf area determination in grains sorghum, *Agronomy J.*, **17**: 187-188.

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