**1. Screening castor germplasm and pistillate lines for water use efficiency (WUE) and root traits**:

**(2009-10 to 2011-12)**

Root studies were conducted by growing plants in specially constructed raised structures on the ground. The height of the structure varies with the crop and depends on the depth to which the roots of the crop can penetrate. Castor genotypes were screened in 30 x 2.4 x 1.5m (L x B x H) structure which can accommodate 33 castor genotypes on either side. The structure has one central permanent wall with side collapsible walls that are constructed with hollow cement bricks and is secured by erecting wooden poles on either side which are held together tightly with a wire. Once the structure is filled with soil, it is watered regularly to allow compaction. When the bulk density of the structure reaches the bulk density of that of field, sowings were done and the castor plants were allowed to grow for 90-100days which coincide with the maximum root growth. On the day of harvest, the side walls were carefully removed and with a jet of water the roots were washed and various shoot observations like SCMR, SLA, LAI, TDM, plant height, leaf number, stem girth and root traits like length, volume, weight were recorded.

Leaf samples were sent for 13C and 18O estimation after drying as these characters give an idea about WUE. Promising genotypes for each of these characters were identified. Stem girth and TDM showed positive correlation (>0.70) with root volume and root dry weight. Hence lines with better root volume, dry weight, stem girth, LAI and TDM are considered as best lines for WUE and root traits. Based on an index developed using principal component analysis with these root and shoot characters, genotypes possessing best characters were identified. During 2009-2011, 160 genotypes of castor were evaluated for root characters. A total of 33 genotypes (23 germplasm, 10 breeding lines) with good root and WUE traits were selected. The list of germplasm and breeding lines selected from 2006-2011 along with their root growth (root volume, root dry weight) and shoot growth characters is given in Table 1a&b.

Table 1a: Root and shoot growth of selected germplasm lines (2006-2011)

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| **Selected germplasm lines for root and WUE traits** |
|  | **Entry name** | **Year** | **Root volume (cm3)** | **Root dry weight (g/pl.)** | **LAI** | **Stem girth (cm)** | **TDM(g/pl.)** |
| 1 | RG 27 | 2009-10 | 216.5 | 40.6 | 1.44 | 8.7 | 218 |
| 2 | RG 72 | 2010-11 | 545 | 91.9 | 3.17 | 11.9 | 609 |
| 3 | RG 82 | 2006-07 | 279 | 41.1 | 2.50 | 8.8 | 371 |
| 4 | RG 89 | 2006-07 | 203 | 33.9 | 2.40 | 8.9 | 286 |
| 5 | RG 111 | 2010-11 | 404 | 68.4 | 2.76 | 11.5 | 503 |
| 6 | RG 122 | 2006-07 | 233 | 39.7 | 3.30 | 10.1 | 341 |
| 7 | RG 152 | 2006-07 | 265 | 59.1 | 2.70 | 10.1 | 389 |
| 8 | RG 211 | 2006-07 | 206 | 35.7 | 3.30 | 9.8 | 362 |
| 9 | RG 240 | 2006-07 | 355 | 57.7 | 5.30 | 10.7 | 351 |
| 10 | RG 272 | 2006-07 | 273 | 48.0 | 3.10 | 11 | 384 |
| 11 | RG 282 | 2006-07 | 211 | 33.8 | 2.00 | 9.4 | 315 |
| 12 | RG 289 | 2010-11 | 429 | 79.6 | 3.04 | 9.8 | 523 |
| 13 | RG 298 | 2006-07 | 255 | 38.1 | 2.8 | 9.7 | 281 |
| 14 | RG 328 | 2010-11 | 330 | 56.3 | 2.25 | 9.5 | 441 |
| 15 | RG 373 | 2010-11 | 405 | 71.8 | 0.44 | 11.1 | 404 |
| 16 | RG 415 | 2010-11 | 432 | 78.9 | 3.42 | 11.2 | 468 |
| 17 | RG 539 | 2006-07 | 317 | 49.4 | 3.50 | 11.4 | 412 |
| 18 | RG 627 | 2006-07 | 279 | 47.4 | 3.20 | 11.1 | 354 |
| 19 | RG 786 | 2006-07 | 334 | 46.5 | 2.80 | 10.7 | 333 |
| 20 | RG 941 | 2006-07 | 209 | 41.3 | 2.20 | 8.6 | 281 |
| 21 | RG 1437 | 2008-09 | 355 | 63.5 | 2.78 | 11.9 | 448 |
| 22 | RG 1450 | 2007-08 | 310.5 | 55.6 | 4.94 | 10.0 | 422 |
| 23 | RG 1463 | 2008-09 | 314 | 54.5 | 4.47 | 10.4 | 421 |
| 24 | RG 1464 | 2007-08 | 135.0 | 24.2 | 1.61 | 7.8 | 181 |
| 25 | RG 1494 | 2008-09 | 310 | 122.0 | 2.54 | 10.4 | 465 |
| 26 | RG 1611 | 2007-08 | 246.5 | 44.2 | 4.57 | 9.3 | 395 |
| 27 | RG 1614 | 2008-09 | 584 | 89.0 | 3.71 | 11.1 | 500 |
| 28 | RG 1617 | 2010-11 | 616 | 99.7 | 2.20 | 11.3 | 472 |
| 29 | RG 1618 | 2009-10 | 226.0 | 34.7 | 1.74 | 8.9 | 145 |
| 30 | RG 1645 | 2008-09 | 380 | 63.6 | 3.08 | 10.0 | 429 |
| 31 | RG 1661 | 2007-08 | 377.3 | 41.7 | 2.85 | 10.0 | 357 |
| 32 | RG 1667 | 2006-07 | 202 | 28.2 | 1.7 | 9.1 | 258 |
| 33 | RG 1673 | 2009-10 | 225.0 | 37.0 | 1.55 | 8.4 | 250 |
| 34 | RG 1759 | 2010-11 | 585 | 101.6 | 3.34 | 10.9 | 502 |
| 35 | RG 1826 | 2007-08 | 268.8 | 51.6 | 4.30 | 9.2 | 427 |
| 36 | RG 1922 | 2008-09 | 411 | 65.9 | 2.27 | 10.7 | 433 |
| 37 | RG 1941 | 2008-09 | 487 | 85.3 | 2.64 | 11.5 | 629 |
| 38 | RG 1963 | 2009-10 | 216.5 | 37.1 | 1.80 | 7.4 | 213 |
| 39 | RG 2048 | 2006-07 | 307 | 45.6 | 2.20 | 9.7 | 313 |
| 40 | RG 2058 | 2008-09 | 276 | 44.7 | 7.64 | 10.0 | 497 |
| 41 | RG 2059 | 2007-08 | 181.0 | 28.4 | 3.31 | 8.1 | 230 |
| 42 | RG 2074 | 2009-10 | 258.5 | 43.2 | 2.43 | 8.9 | 226 |
| 43 | RG 2094 | 2009-10 | 231.5 | 38.0 | 2.66 | 8.2 | 210 |
| 44 | RG 2113 | 2008-09 | 429 | 71.2 | 3.29 | 12.2 | 409 |
| 45 | RG 2122 | 2007-08 | 328.0 | 54.6 | 4.08 | 9.9 | 453 |
| 46 | RG 2124 | 2009-10 | 371.5 | 56.7 | 2.70 | 8.5 | 341 |
| 47 | RG 2127 | 2008-09 | 546 | 94.8 | 3.22 | 11.7 | 501 |
| 48 | RG 2139 | 2008-09 | 557 | 92.9 | 4.57 | 11.0 | 502 |
| 49 | RG 2147 | 2009-10 | 282.5 | 31.1 | 2.02 | 8.4 | 212 |
| 50 | RG 2149 | 2007-08 | 391.3 | 69.3 | 5.50 | 11.2 | 638 |
| 51 | RG 2153 | 2009-10 | 204.5 | 37.6 | 3.05 | 8.4 | 316 |
| 52 | RG 2155 | 2009-10 | 244.0 | 46.6 | 3.83 | 8.3 | 372 |
| 53 | RG 2169 | 2009-10 | 304.5 | 50.3 | 4.10 | 8.9 | 277 |
| 54 | RG 2439 | 2010-11 | 450 | 68.0 | 3.16 | 10.2 | 397 |
| 55 | RG 2714 | 2007-08 | 374.8 | 54.2 | 4.01 | 10.0 | 415 |
| 56 | RG 2779 | 2010-11 | 392 | 62.2 | 2.10 | 8.8 | 340 |
| 57 | RG 2797 | 2007-08 | 262.5 | 47.9 | 2.69 | 10.5 | 312 |
| 58 | RG 2826 | 2007-08 | 254.0 | 46.9 | 2.63 | 9.9 | 317 |
| 59 | RG 2850 | 2007-08 | 263.0 | 49.9 | 3.29 | 10.2 | 379 |
| 60 | RG 3063 | 2007-08 | 353.0 | 62.4 | 4.87 | 10.8 | 430 |

Table 1b: Root and shoot growth of selected breeding lines (2006-2011)

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| **Selected breeding lines for root and WUE traits** |
|  | **Entry name** | **Year** | **Root volume (cm3)** | **Root dry weight (g/pl.)** | **LAI** | **Stem girth (cm)** | **TDM(g/pl.)** |
| 1 | DCS 78  | 2009-10  | 248 | 43.1 | 1.94 | 8.7 | 300 |
|  |  | 2010-11  | 132 | 21.5 | 1.94 | 6.9 | 218 |
|  |  | 2011-12  | 167 | 29 | 2.98 | 7.1 | 227 |
| 2 | DCS-99 | 2009-10 | 219 | 36.9 | 3.11 | 9.1 | 261 |
| 3 | DCS 107 | 2011-12 | 157 | 29.2 | 2.41 | 7.3 | 204 |
| 4 | DPC 19 | 2011-12 | 167 | 29.0 | 2.98 | 7.1 | 227 |
| 5 | DPC 20XDCS102 | 2011-12 | 135 | 22.5 | 2.29 | 6.6 | 266 |
| 6 | DPC 9 X DCS 9 | 2011-12 | 198 | 34.1 | 3.26 | 7.7 | 309 |
| 7 | DPC 9X DCS 78 | 2011-12 | 120 | 18.6 | 1.28 | 6.7 | 188 |
| 8 | DPC 9X RG1582 | 2011-12 | 140 | 24.8 | 1.81 | 6.6 | 216 |
| 9 | PBMC 2 | 2011-12 | 175 | 32.5 | 4.16 | 6.8 | 219 |
| 10 | PBMC 5 | 2011-12 | 155 | 28.4 | 2.37 | 7.7 | 251 |
| 11 | AVHT-109(GCH-5) | 2007-08 | 336 | 54.5 | 3.55 | 10.5 | 438 |
|  | GCH-5 | 2009-10 | 269 | 42.3 | 2.98 | 8.9 | 312 |
|  | GCH-5 | 2010-11 | 145 | 23.5 | 0.86 | 7.6 | 185 |
| check | AVHT-112(48-1) | 2007-08 | 314 | 54.4 | 2.50 | 10.7 | 399 |
|  | 48-1 | 2008-09 | 184 | 26.4 | 1.64 | 8.6 | 144 |
|  | 48-1 | 2009-10 | 350 | 58.1 | 5.45 | 10.5 | 452 |
|  | 48-1 | 2010-11 | 572 | 95.8 | 3.88 | 12.7 | 817 |
|  | 48-1 | 2011-12 | 107 | 18.7 | 1.37 | 6.3 | 186 |
| **Poor root genotypes used as checks for field screening** |
| 1 | RG 1520 | 2009-10 | 59 | 8.0 | 0.49 | 4.9 | 111 |
| 2 | RG 1628 | 2009-10 | 63 | 11.5 | 0.29 | 6.8 | 83 |
| 3 | RG 2068 | 2007-08 | 94 | 15.2 | 1.42 | 6.7 | 101 |