**II. Productivity of safflower genotypes in response to soil moisture gradients**

This study was initiated to quantify the response of spiny and non-spiny cultivars of safflower to various soil moisture gradients. Eight genotypes were sown on each soil depth in RBD with three replications. During *kharif* season, greengram was grown. Safflower crop was grown after harvesting of greengram with zero tillage.

**2009-10:** An amount of 998 mm of rainfall was received during 2009. During cropping season 992 mm of rainfall was received. During *kharif* season, 842 mm of rainfall was received. An amount of 150 mm of rainfall was received after sowing of the safflower.

In deep Vertisols, NARI-NH-1 recorded the significantly the highest seed yield which was on par with A1, Sharda, Bhima, NARI-38 and NARI-H-15. The seed yield of NARI-6 was significantly low and was on par with that of PBNS-40. In medium deep Vertisols, Sharda recorded the highest seed yield which was on par with that of Annigeri 1, Bhima, NARI-38 and NARI-H-15. All the three non-spiny genotypes recorded the significantly low seed yield. In shallow Vertisols, safflower was suffered due to moisture stress. The highest seed yield was recorded with Annigeri 1 which was on par with that of Sharda, Bhima, NARI-38 and NARI-H-15. All the three non-spiny genotypes (NARI-6, PBNS-40 and NARI-NH-1) recorded significantly low seed yield.

**2010-11:** During *kharif* season, 982 mm of rainfall was received. An amount of 140 mm of rainfall was received after sowing of safflower.

In deep Vertisols, the seed yield of NARI-H-15 was on par with Annigeri 1, Sharda, Bhima, NARI-38 and NARI-NH-1. The seed yield of PBNS-40 and SSF-658 were significantly low compared to all other genotypes. The harvest index of non-spiny genotypes NARI-NH-1, SSF-658 and PBNS-40 was low when compared to spiny varieties and hybrids.

In medium deep Vertisols, the seed yield of NARI-H-15 was on par with that of Annigeri 1, Bhima, NARI-38 and Sharda. Three non-spiny genotypes (NARI-NH-1, PBNS-40 and SSF-658) recorded significantly lower seed yield than that of all other genotypes. Non-spiny genotypes recorded low harvest index (NARI-NH-1, PBNS-40 and SSF-658) compared to spiny genotypes.

In shallow Vertisols, significantly the highest seed yield was recorded with Annigeri 1 which was on par with that of Sharda, Bhima and NARI-38. Two non-spiny genotypes (PBNS-40 and SSF-658) recorded significantly lower seed yield than all other genotypes. Non-spiny genotypes recorded low harvest index (NARI-NH-1, PBNS-40 and SSF-658) compared to spiny genotypes.

**2011-12:** During *kharif* season, 478 mm of rainfall was received. An amount of 47 mm of rainfall was received after sowing of safflower.

Safflower crop was suffered from moisture stress and low seed yields were recorded. In deep Vertisols, the seed yield all genotypes was found to be on par to each other except PBNS-40. The PBNS-40 performance was found to inferior to all other genotypes studied. Under medium deep Vertisols, the seed yield of Annigeri 1, Bhima, NARI-H-15, NARI-38 and Sharda was on par to each other and found to be significantly superior to NARI-NH-1, PBNS-40 and NARI-6. Under shallow Vertisols, the seed yield of Annigeri 1, Bhima and NARI-H-15 was found to on par to each other and found to be significantly superior to NARI-NH-1, PBNS-40, NARI-6 and Sharda.

Conclusion: When soil profile was saturated there was no difference between spiny and non-spiny cultivars. Under severe soil moisture stress conditions spiny cultivars viz., Annigeri1, Bhima and hybrid NARI-H-15 were found to be superior.

**Table 5. Response of safflower cultivars to soil moisture gradients (2009-10)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cultivars** | **Seed yield (kg/ha)** | | | **Stalk yield (kg/ha)** | | | **Biological yield (kg/ha)** | | |
|  | **Deep**  **Soils** | **Medium deep soils** | **Shallow**  **soils** | **Deep soils** | **Medium deep soils** | **Shallow soils** | **Deep soils** | **Medium deep soils** | **Shallow soils** |
| Annigeri 1 | 1652 | 1543 | 854 | 3928 | 3593 | 1936 | 5580 | 5136 | 2790 |
| Sharda | 1671 | 1595 | 764 | 3786 | 3541 | 1656 | 5457 | 5136 | 2420 |
| NARI-6 | 1249 | 920 | 538 | 4874 | 3154 | 1857 | 6123 | 4074 | 2395 |
| Bhima | 1657 | 1491 | 763 | 4244 | 3077 | 1904 | 5901 | 4568 | 2667 |
| NARI-38 | 1695 | 1365 | 778 | 3934 | 3029 | 1814 | 5630 | 4395 | 2593 |
| PBNS-40 | 1368 | 736 | 509 | 4681 | 2523 | 1615 | 6050 | 3259 | 2124 |
| NARI-NH-1 | 1886 | 750 | 649 | 5472 | 2706 | 2166 | 7358 | 3457 | 2815 |
| NARI-H-15 | 1738 | 1566 | 775 | 3990 | 3792 | 1793 | 5729 | 5358 | 2568 |
|  |  |  |  |  |  |  |  |  |  |
| *SEm±* | *91* | *85* | *65* | *265* | *182* | *210* | *334* | *208* | *262* |
| *C.D (P=0.05)* | *277* | *255* | *197* | *805* | *552* | *NS* | *1013* | *631* | *NS* |

**Table 6. Response of safflower genotypes to various soil moisture gradients (2010-11)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cultivars** | **Seed yield (kg/ha)** | | | **Stalk yield (kg/ha)** | | | **Biological yield (kg/ha)** | | |
|  | **Deep**  **soils** | **Medium deep soils** | **Shallow soils** | **Deep soils** | **Medium deep soils** | **Shallow soils** | **Deep soils** | **Medium deep soils** | **Shallow soils** |
|  |  |  |  |  |  |  |  |  |  |
| Annigeri 1 | 1550 | 1247 | 735 | 3617 | 2650 | 1636 | 5167 | 3897 | 2371 |
| Bhima | 1412 | 1151 | 630 | 3631 | 2562 | 1470 | 5043 | 3713 | 2100 |
| NARI-H-15 | 1658 | 1308 | 652 | 3523 | 2911 | 1324 | 5181 | 4219 | 1976 |
| NARI-NH-1 | 1615 | 786 | 458 | 4366 | 2125 | 1304 | 5981 | 2911 | 1762 |
| PBNS-40 | 1022 | 668 | 435 | 2502 | 1718 | 1238 | 3524 | 2386 | 1673 |
| SSF-658 | 850 | 587 | 392 | 1892 | 1587 | 1060 | 2742 | 2174 | 1452 |
| NARI-38 | 1320 | 1057 | 615 | 3757 | 2466 | 1307 | 5077 | 3523 | 1922 |
| Sharda | 1570 | 1028 | 646 | 3495 | 2517 | 1373 | 5065 | 3545 | 2019 |
|  |  |  |  |  |  |  |  |  |  |
| *Mean* | *1375* | *979* | *570* | *3348* | *2317* | *1339* | *4722* | *3296* | *1909* |
| *SEm±* | *120* | *96* | *52* | *225* | *171* | *126* | *328* | *215* | *225* |
| *C.D (0.05)* | *362* | *289* | *156* | *675* | *512* | *378* | *984* | *645* | *675* |

**Table 7. Response of safflower cultivars to soil moisture gradients (2011-12)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cultivars** | **Seed yield (kg/ha)** | | | **Stalk yield (kg/ha)** | | | **Biological yield (kg/ha)** | | |
|  | **Deep**  **Soils** | **Medium deep soils** | **Shallow**  **soils** | **Deep soils** | **Medium deep soils** | **Shallow soils** | **Deep soils** | **Medium deep soils** | **Shallow soils** |
| Annigeri 1 | 760 | 340 | 280 | 2280 | 874 | 887 | 3040 | 1214 | 1167 |
| Sharda | 670 | 320 | 120 | 1811 | 783 | 342 | 2481 | 1103 | 462 |
| NARI-6 | 800 | 150 | 130 | 1700 | 319 | 303 | 2500 | 469 | 433 |
| Bhima | 590 | 300 | 300 | 1679 | 668 | 900 | 2269 | 968 | 1200 |
| NARI-38 | 640 | 360 | 200 | 2027 | 926 | 490 | 2667 | 1286 | 690 |
| PBNS-40 | 400 | 150 | 125 | 1267 | 334 | 338 | 1667 | 484 | 463 |
| NARI-NH-1 | 760 | 160 | 120 | 1954 | 411 | 380 | 2714 | 571 | 500 |
| NARI-H-15 | 580 | 360 | 260 | 1491 | 881 | 669 | 2071 | 1241 | 929 |
|  |  |  |  |  |  |  |  |  |  |
| *SEm±* | 53 | 40 | 24 | 261 | 130 | 128 | 292 | 185 | 180 |
| *C.D (P=0.05)* | 160 | 120 | 72 | 790 | 391 | 384 | 882 | 554 | 542 |

Table 8. **Effect of soil moisture gradients on yield attributes of safflower (2009-10)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cultivars** | **Deep soils** | | | | **Medium deep soils** | | | | **Shallow soils** | | | |
|  | **Total plant weight (g/plant)** | **No. of capitula/plant** | **Seed weight (g/plant)** | **HI** | **Total plant weight (g/plant)** | **No. of**  **capitula/**  **plant** | **Seed weight (g/plant)** | **HI** | **Total plant weight (g/plant)** | **No. of capitula/plant** | **Seed weight (g/plant)** | **HI** |
| Annigeri 1 | 95 | 32 | 31 | 0.33 | 62 | 28 | 20 | 0.32 | 34 | 14 | 12 | 0.35 |
| Sharda | 91 | 30 | 26 | 0.29 | 55 | 27 | 16 | 0.29 | 32 | 11 | 9 | 0.28 |
| NARI-6 | 124 | 42 | 33 | 0.27 | 65 | 38 | 18 | 0.28 | 38 | 21 | 10 | 0.26 |
| Bhima | 94 | 34 | 29 | 0.31 | 58 | 25 | 18 | 0.31 | 30 | 13 | 11 | 0.37 |
| NARI-38 | 85 | 28 | 27 | 0.32 | 66 | 26 | 21 | 0.32 | 40 | 18 | 12 | 0.30 |
| PBNS-40 | 62 | 39 | 15 | 0.24 | 34 | 32 | 9 | 0.26 | 25 | 20 | 6 | 0.24 |
| NARI-NH-1 | 135 | 44 | 35 | 0.26 | 75 | 40 | 20 | 0.27 | 45 | 28 | 12 | 0.27 |
| NARI-H-15 | 81 | 30 | 25 | 0.31 | 78 | 27 | 25 | 0.32 | 31 | 15 | 11 | 0.35 |

Table 9. **Effect of soil moisture gradients on yield attributes of safflower (2010-11)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cultivars** | **Deep soils** | | | | **Medium deep soils** | | | | **Shallow soils** | | | |
|  | **Total plant weight (g/plant)** | **No. of capitula/plant** | **Seed weight (g/plant)** | **HI** | **Total plant weight (g/plant)** | **No. of**  **capitula/**  **plant** | **Seed weight (g/plant)** | **HI** | **Total plant weight (g/plant)** | **No. of capitula/plant** | **Seed weight (g/plant)** | **HI** |
| Annigeri 1 | 81 | 30 | 24 | 0.30 | 56 | 24 | 18 | 0.32 | 37 | 15 | 11 | 0.29 |
| Sharda | 80 | 32 | 25 | 0.31 | 51 | 25 | 13 | 0.25 | 32 | 16 | 11 | 0.34 |
| SSF-658 | 43 | 42 | 12 | 0.28 | 33 | 24 | 8 | 0.24 | 23 | 20 | 6 | 0.26 |
| Bhima | 79 | 30 | 25 | 0.32 | 60 | 22 | 16 | 0.27 | 33 | 18 | 10 | 0.30 |
| NARI-38 | 80 | 26 | 26 | 0.33 | 55 | 24 | 17 | 0.31 | 30 | 22 | 9 | 0.30 |
| PBNS-40 | 56 | 40 | 13 | 0.23 | 35 | 26 | 7 | 0.20 | 26 | 24 | 5 | 0.19 |
| NARI-NH-1 | 94 | 43 | 23 | 0.24 | 42 | 35 | 10 | 0.23 | 28 | 30 | 7 | 0.25 |
| NARI-H-15 | 81 | 34 | 24 | 0.30 | 62 | 26 | 19 | 0.30 | 31 | 18 | 9 | 0.29 |

**Table 10. Effect of soil moisture gradients on yield attributes of safflower (2011-12)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cultivars** | **Total plant weight (g/plant)** | **No. of capitula/plant** | **Seed weight (g/plant)** | **HI** | **Total plant weight (g/plant)** | **No. of**  **capitula/**  **plant** | **Seed weight (g/plant)** | **HI** | **Total plant weight (g/plant)** | **No. of capitula/plant** | **Seed weight (g/plant)** | **HI** |
| Annigeri 1 | 42 | 20 | 13 | 0.30 | 48 | 22 | 8 | 0.16 | 22 | 11 | 4.8 | 0.22 |
| Sharda | 40 | 18 | 12 | 0.30 | 51 | 19 | 9 | 0.18 | 20 | 10 | 3.1 | 0.16 |
| NARI-6 | 60 | 30 | 12 | 0.20 | 62 | 29 | 7 | 0.12 | 34 | 18 | 2.4 | 0.10 |
| Bhima | 45 | 20 | 14 | 0.31 | 52 | 22 | 8 | 0.15 | 19 | 12 | 4.1 | 0.22 |
| NARI-38 | 38 | 23 | 11 | 0.29 | 48 | 21 | 10 | 0.21 | 24 | 14 | 5.3 | 0.22 |
| PBNS-40 | 28 | 26 | 6 | 0.21 | 32 | 24 | 6 | 0.18 | 24 | 12 | 4.1 | 0.17 |
| NARI-NH-1 | 72 | 32 | 17 | 0.24 | 68 | 30 | 8 | 0.12 | 32 | 17 | 3.2 | 0.10 |
| NARI-H-15 | 51 | 22 | 16 | 0.31 | 55 | 19 | 10 | 0.18 | 22 | 13 | 5.2 | 0.24 |

**Table 11. Drymatter production of safflower (g/plant) at different stages of crop growth (2009-10)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cultivars** | **Deep soils** | | | | **Medium deep soils** | | | | **Shallow soils** | | | |
|  | Days after sowing | | | | | | | | | | | |
|  | 50 | 75 | 95 | 120 | 50 | 75 | 95 | 120 | 50 | 75 | 95 | 120 |
| Annigeri 1 | 34.5 | 56.8 | 72.6 | 95 | 25.7 | 40.1 | 52.4 | 62 | 15.4 | 22.4 | 28.6 | 34 |
| Sharda | 39.4 | 49.5 | 65.9 | 91 | 24.3 | 32.6 | 41.8 | 55 | 14.1 | 21.8 | 29.4 | 32 |
| NARI-6 | 41.2 | 71.1 | 95.4 | 124 | 19.0 | 41.6 | 55.8 | 65 | 16.5 | 22.9 | 34.8 | 38 |
| Bhima | 38.1 | 51.4 | 69.6 | 94 | 21.8 | 42.0 | 54.6 | 58 | 14.1 | 24.8 | 26.8 | 30 |
| NARI-38 | 34.8 | 50.2 | 64.6 | 85 | 24.6 | 41.7 | 48.6 | 66 | 14.6 | 21.8 | 30.8 | 40 |
| PBNS-40 | 24.5 | 34.5 | 45.6 | 62 | 15.6 | 27.1 | 34.5 | 34 | 9.6 | 17.9 | 22.2 | 25 |
| NARI-NH-1 | 41.5 | 75.6 | 92.6 | 135 | 20.1 | 48.9 | 64.3 | 75 | 14.8 | 19.8 | 34.1 | 45 |
| NARI-H-15 | 37.8 | 51.2 | 76.8 | 81 | 24.1 | 44.0 | 51.4 | 62 | 14.1 | 23.6 | 24.8 | 31 |

**Table 12. Drymatter production of safflower (g/plant) at different stages of crop growth (2010-11)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cultivars** | **Deep soils** | | | | **Medium deep soils** | | | | **Shallow soils** | | | |
|  | Days after sowing | | | | | | | | | | | |
|  | 50 | 75 | 95 | 120 | 50 | 75 | 95 | 120 | 50 | 75 | 95 | 120 |
| Annigeri 1 | 38.9 | 55.2 | 73.1 | 81.4 | 30.5 | 42.2 | 54.0 | 56.3 | 20.5 | 26.0 | 32.0 | 37.3 |
| Sharda | 34.8 | 53.6 | 71.2 | 79.8 | 30.9 | 42.0 | 47.1 | 51.2 | 19.1 | 24.2 | 28.0 | 31.8 |
| SSF-658 | 24.0 | 35.6 | 34.4 | 43.2 | 18.7 | 24.6 | 26.9 | 33.1 | 10.3 | 16.7 | 18.5 | 22.9 |
| Bhima | 40.1 | 53.8 | 71.2 | 79.4 | 29.1 | 41.0 | 55.1 | 59.6 | 19.8 | 23.2 | 29.6 | 33.1 |
| NARI-38 | 32.4 | 51.2 | 71.3 | 80.0 | 26.7 | 40.6 | 45.8 | 54.5 | 19.8 | 23.9 | 28.2 | 30.3 |
| PBNS-40 | 26.7 | 39.4 | 46.4 | 55.5 | 22.5 | 28.8 | 33.7 | 34.5 | 12.7 | 17.9 | 22.2 | 26.3 |
| NARI-NH-1 | 36.6 | 56.2 | 84.0 | 94.2 | 27.3 | 34.9 | 40.5 | 42.0 | 14.7 | 19.8 | 21.8 | 27.8 |
| NARI-H-15 | 38.9 | 55.2 | 73.1 | 81.4 | 31.1 | 45.0 | 61.7 | 61.9 | 19.8 | 23.6 | 26.9 | 31.1 |

**Table 13. Drymatter production of safflower (g/plant) at different stages of crop growth (2011-12)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cultivars** | **Deep soils** | | | | **Medium deep soils** | | | | **Shallow soils** | | | |
|  | Days after sowing | | | | | | | | | | | |
|  | 50 | 75 | 95 | 120 | 50 | 75 | 95 | 120 | 50 | 75 | 95 | 120 |
| Annigeri 1 | 22.2 | 28.4 | 36.2 | 42.2 | 16.4 | 22.1 | 42.4 | 48.4 | 12.1 | 16.1 | 20.1 | 22.4 |
| Sharda | 18.4 | 31.6 | 34.4 | 40.4 | 17.1 | 23.1 | 45.4 | 51.5 | 10.3 | 14.4 | 19.2 | 20.1 |
| NARI-6 | 19.8 | 39.4 | 44.2 | 60.9 | 15.4 | 22.4 | 55.8 | 62.6 | 9.5 | 15.1 | 28.3 | 34.3 |
| Bhima | 20.3 | 27.7 | 39.4 | 45.4 | 18.1 | 18.7 | 49.1 | 52.7 | 10.4 | 14.4 | 17.4 | 19.4 |
| NARI-38 | 19.4 | 32.1 | 40.9 | 38.7 | 16.4 | 21.6 | 46.4 | 48.8 | 12.4 | 18.1 | 22.4 | 24.4 |
| PBNS-40 | 14.3 | 21.4 | 25.8 | 28.7 | 10.2 | 14.3 | 29.6 | 32.1 | 9.1 | 12.3 | 21.6 | 24.3 |
| NARI-NH-1 | 21.7 | 42.6 | 53.4 | 72.8 | 14.4 | 28.4 | 60.7 | 68.4 | 12.2 | 15.4 | 28.7 | 32.1 |
| NARI-H-15 | 23.9 | 30.2 | 41.7 | 51.4 | 16.7 | 24.4 | 49.1 | 55.4 | 12.2 | 17.1 | 21 | 22 |