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# Performance of Intercropping Systems with *In-situ* Rainwater Conservation Practices in Assured Rainfall Zone of Marathwada Region, Maharashtra

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**ABSTRACT:** The climate of Marathwada region experiences wide inter district and intra district variability. The region comes under assured rainfall zone with mean annual rainfall of 890 mm. Occurrence of frequent droughts and unseasonal rains are the features of climate variability in the region. The soils of the region are medium black. The productivity of all crops decreases with either deficiency of rainfall and its distribution or due to moisture stress in critical growth period due to dry spells in July and August. Thus, *in-situ* rainwater conservation plays an important role in maintaining the required soil moisture in stress period. The research experiment on evaluation of *in-situ* rainwater conservation techniques with various cropping systems was undertaken for 6 years on experimental field of Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani under dryland condition. Soybean + pigeonpea (4:2) intercropping system was found superior with respect to gross monetary returns, net monetary returns and B:C ratio, followed by cotton + soybean (1:1). Conservation furrow after 6 rows was found significantly superior over control. Conservation furrow after 12 rows and 4 rows were found at par with conservation furrow after 6 rows with respect to gross and net monetary returns. Highest soil moisture use and moisture use efficiency was observed in conservation furrow after 6 rows followed by conservation furrow after 12 rows and opening of furrow after 4 rows. Conservation furrow after 6 rows in cotton + soybean, soybean + pigeonpea and sorghum + pigeonpea intercropping systems was found effective for *in-situ* rainwater conservation and thereby enhancing productivity and moisture use efficiency in medium and deep Vertisol in assured rainfall zone of Marathwada region.

**Key words:** Cropping systems, *in-situ* rainwater conservation, moisture use efficiency



## Introduction

Marathwada region is one of the four regions of Maharashtra state, comprising eight districts with cultivable area of 5.6 Mha and 85 per cent of cultivated land is rain dependent. Majority of population living in Marathwada region depend upon rainfed agriculture. South-west monsoon is the major source of rainfall in the region, accounting for about 90 per cent of annual rainfall. The region receives annual rainfall in the range of 500 to 1100 mm and comes under assured rainfall zone (60%). Rainfall is uncertain and erratic in this region. Occurrence of frequent dry spells is a common feature in the region. The prominent cropping systems adopted in the region are, *kharif* sorghum + pigeonpea, soybean + pigeonpea, cotton + pigeonpea and cotton + greengram / blackgram / soybean. The soils in the region are medium black. The productivity of all crops decreases with either deficiency of rainfall and its uneven distribution or due to moisture stress in critical growth period due to dry spells in July and August. Thus, the crop suffers from moisture stress and the crop productivity is lowered by 30 to 40 per cent (Pendke *et al.,* 2000). The most important aspect of sustainable rainfed agriculture in the region is availability of sufficient soil moisture during crop growth period of *kharif* crops. *In-situ* rainwater conservation plays an important role in maintaining the required soil moisture in stress period. Hence, an experiment was planned for evaluating the performance of various *in-situ* rainwater conservation techniques on various cropping systems.

## Materials and Methods

The research experiment on various cropping systems with *in-situ* rainwater conservation techniques was undertaken for 6 years (2013 to 2018) on experimental field of Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani under rainfed/dryland condition. The experiment was planned with split plot design with three replications following the crop rotation. The crops were sown at a spacing of 45 cm row spacing in medium to deep black soil. Recommended dose of fertilizer was applied to all intercropping systems. The opening of furrows was undertaken 30 to 35 days after sowing.

## Treatments

***Main plot treatments: Cropping systems - 03***

$C_1$ - Sorghum + pigeonpea (4:2)

$C_2$ - Soybean + pigeonpea (4:2)

$C_3$ - Cotton + soybean (1:1)

***Sub plot treatments: In-situ* rain water conservation techniques - 05**

$T_1$ - Opening of furrow after 2 rows

$T_2$ - Opening of furrow after 4 rows

$T_3$ - Conservation furrow after 6 rows

$T_4$ - Conservation furrow after 12 rows

$T_5$ - Control

## Results and Discussion

### Rainfall and dry spells

The annual rainfall and crop seasonal rainfall during the year 2013 to 2018 is presented in Table 1. The mean annual rainfall of the station is 880.9 mm. Out of the 6 years, above normal rainfall occurred during 3 years and below normal rainfall was observed in 3 years. The years 2014 and 2015 were recorded as dry years where 40 to 50 per cent less rainfall was observed.

Every year, 1 to 4 dry spells were observed in the month of June to September. Mid-season dry spells were observed almost in every year. The data on duration and period of dry spells is presented in Table 2.

Most of the dry spells were observed during flowering and pod initiation stage or during grain filling stage in soybean and in vegetative stage of pigeonpea which created moisture stress during crop growth.

### Crop yield

Data on crop yield, seed cotton equivalent yield, gross monetary returns, net monetary returns and B:C ratio during the period from 2013 to 2018 were subjected to pooled analysis. The error during the experimentation period was tested with Bartlett's test. The error was heterogeneous and the interaction between season and treatments, with respect to all yield parameters, was significant. Hence, simple pooled means have been considered.

Pooled data on main crop yield and inter crop yield during the period from 2013 to 2018 are presented in Table 3 and Table 4.

The data indicated that mean main crop yield was significantly higher in sorghum + pigeonpea ($C_1$) than soybean + pigeonpea ($C_2$) and cotton + soybean ($C_3$). Similarly, mean main crop yield of soybean + pigeonpea ($C_2$) was significantly higher than that of cotton + soybean ($C_3$). Among *in-situ* rain water conservation techniques, mean main crop yield was significantly higher in conservation furrow after 6 rows ($T_3$) as compared to control.

### Intercrop yield

Mean yield of intercrop (Table 4) was significantly higher in cotton + soybean ($C_3$) than that of sorghum + pigeonpea ($C_1$). Among *in-situ* rain water conservation techniques, mean

**Table 1: Annual and crop seasonal rainfall during 2013 to 2018**

| Year | Annual rainfall, mm | Crop seasonal rainfall, mm |
|---|---|---|
| 2013 | 1216.1 | 1172.6 |
| 2014 | 560.2 | 393.6 |
| 2015 | 574.8 | 408.1 |
| 2016 | 1159.5 | 1130.0 |
| 2017 | 995.7 | 886.0 |
| 2018 | 812.1 | 802.4 |

**Table 2: Dry spells during 2013 to 2018**

| Year | Number of dry spells | Duration | Period |
|---|---|---|---|
| 2013 | 2 | 13 | 27/08/2013 to 08/09/2013 |
| | | 10 | 22/09/2013 to 02/10/2013 |
| 2014 | 1 | 10 | 12/08/2014 to 21/08/2014 |
| 2015 | 1 | 45 | 20/06/2015 to 04/08/2015 |
| 2015 | 1 | 18 | 05/08/2016 to 22/08/2016 |
| 2017 | 4 | 16 | 25/06/2017 to 10/07/2017 |
| | | 13 | 26/07/2017 to 07/08/2017 |
| | | 09 | 31/08/2017 to 08/09/2017 |
| | | 16 | 17/09/2017 to 02/10/2017 |
| 2018 | 2 | 25 | 22/07/2018 to 15/08/2018 |
| | | 33 | 28/08/2018 to 30/09/2018 |

**Table 3: Main crop yield as affected by cropping systems and *in-situ* rainwater conservation techniques during 2013 to 2018**

| Treatments | Main crop yield, kg ha$^{-1}$ | | | | | | Pooled mean |
|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | |
| **Cropping systems** | | | | | | | |
| $C_1$ Sorghum + Pigeonpea (4:2) | 3069 (9979)* | 2719 (8385)* | 1919 (2932)* | 719 (1423)* | 2210 (3690)* | 1963 (9105)* | 2100 (5919)* |
| $C_2$ Soybean + Pigeonpea (4:2) | 882 | 1057 | 1716 | 618 | 1274 | 1577 | 1187 |
| $C_3$ Cotton + Soybean (1:1) | 566 | 847 | 1139 | 689 | 1235 | 486 | 827 |
| SE ± | 79 | 137 | 76 | 44 | 122 | 43 | 106 |
| CD at 5% | 228 | 337 | 220 | NS | 366 | 126 | 293 |
| ***In-situ* rain water conservation techniques** | | | | | | | |
| $T_1$ Opening of furrow after 2 rows | 1443 | 1507 | 1443 | 652 | 1772 | 1290 | 1351 |
| $T_2$ Opening of furrow after 4 rows | 1427 | 1567 | 1766 | 540 | 1586 | 1422 | 1401 |
| $T_3$ Conservation furrow after 6 rows | 1785 | 1738 | 1697 | 813 | 164 | 1526 | 1533 |
| $T_4$ Conservation furrow after 12 rows | 1656 | 1388 | 1858 | 752 | 1651 | 1295 | 1433 |
| $T_5$ Control | 1217 | 1503 | 1193 | 519 | 1417 | 1176 | 1171 |
| SE ± | 102 | 177 | 98 | 57 | 77 | 56 | 137 |
| CD at 5% | 295 | NS | 284 | 166 | 226 | 162 | 378 |
| Interaction (CS x IRWCT's) | | | | | | | |
| SE ± | 176 | 307 | 170 | 99 | 95 | 97 | 236 |
| CD at 5% | 510 | NS | 492 | NS | 285 | NS | NS |
| Interaction (season x treatment) | | | | | | | |
| SE ± | | | | | | | 228 |
| CD at 5% | | | | | | | 660 |
| Mean | 1506 | 1541 | 1591 | 675 | 1573 | 1342 | 1371 |
| CV | 20 | 35 | 19 | 25 | 19 | 13 | 24 |

*Stover yield

**Table 4: Intercrop yield as affected by cropping systems and *in-situ* rainwater conservation techniques during 2013 to 2018**

| Treatments | Intercrop yield, kg ha$^{-1}$ | | | | | | Pooled Mean |
|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | |
| **Cropping systems** | | | | | | | |
| $C_1$ Sorghum + Pigeonpea (4:2) | 389 | 651 | 668 | 946 | 743 | 458 | 643 |
| $C_2$ Soybean + Pigeonpea (4:2) | 551 | 946 | 794 | 1112 | 877 | 432 | 785 |
| $C_3$ Cotton + Soybean (1:1) | 676 | 1034 | 1788 | 531 | 533 | 1140 | 950 |
| SE ± | 34 | 52 | 73 | 35 | 42 | 57 | 63 |
| CD at 5% | 97 | 150 | 210 | 100 | 126 | 166 | 173 |
| ***In-situ* rain water conservation techniques** | | | | | | | |
| $T_1$ Opening of furrow after 2 rows | 576 | 849 | 1070 | 799 | 660 | 614 | 662 |
| $T_2$ Opening of furrow after 4 rows | 520 | 898 | 1135 | 850 | 715 | 729 | 808 |
| $T_3$ Conservation furrow after 6 rows | 611 | 1025 | 1075 | 1116 | 762 | 857 | 908 |
| $T_4$ Conservation furrow after 12 rows | 559 | 925 | 1136 | 1077 | 760 | 620 | 846 |
| $T_5$ Control | 429 | 688 | 1000 | 473 | 677 | 561 | 638 |
| SE ± | 44 | 67 | 94 | 45 | 55 | 75 | 81 |
| CD at 5% | NS | 194 | NS | 129 | 165 | 214 | 224 |
| Interaction (CS x IRWCT's) | | | | | | | |
| SE ± | 75 | 116 | 162 | 77 | 81 | 128 | 140 |
| CD at 5% | NS | NS | NS | 224 | 244 | NS | NS |
| Interaction (season x treatment | | | | | | | |
| SE ± | | | | | | | 143 |
| CD at 5% | | | | | | | 414 |
| Mean | 537 | 877 | 1083 | 863 | 718 | 677 | 793 |
| CV | 24 | 23 | 26 | 16 | 19 | 33 | 25 |

intercrop yield was significantly higher in conservation furrow after 6 rows than after two rows ($T_1$) and control ($T_5$).

**Seed cotton equivalent yield**

***Cropping systems***

Pooled data on seed cotton equivalent yield are presented in Table 5. Data indicated that among cropping systems no significant difference was observed with respect to mean seed cotton equivalent yield. However, higher mean seed cotton equivalent yield was recorded in soybean + pigeonpea ($C_2$) followed by cotton + soybean ($C_3$). The results agree with the previous findings (Dhoble *et al.,* 1990, Gund *et al.,* 1998 and Kale *et al*., 1992) which reported that all intercropping systems resulted in yield advantage over sole crop.

***In-situ rain water conservation techniques***

Among *in-situ* rain water conservation techniques significantly higher mean seed cotton equivalent yield was recorded in conservation furrow at 2.7 m. ($T_3$) over opening of furrow after two rows ($T_1$) and control ($T_5$). The results verified the previous findings as (Barai *et al.,* 1991, Pendke *et al.,* 2000 and Ranade *et al*., 2017) and reported that all *in-situ* moisture conservation practices resulted in yield advantage over control.

**Table 5: Seed cotton equivalent yield as affected by cropping systems and *in-situ* rainwater conservation techniques during 2013-14 to 2018-19**

| Treatments | Seed cotton equivalent yield, kg ha$^{-1}$ | | | | | | Pooled Mean |
|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | |
| **Cropping systems** | | | | | | | |
| $C_1$ Sorghum + Pigeonpea (4:2) | 1759 | 1740 | 1027 | 1291 | 1287 | 1270 | 1396 |
| $C_2$ Soybean + Pigeonpea (4:2) | 1236 | 1872 | 1570 | 1704 | 1347 | 1357 | 1514 |
| $C_3$ Cotton + Soybean (1:1) | 1124 | 1582 | 2168 | 1100 | 1467 | 1136 | 1430 |
| SE ± | 41 | 68 | 52 | 58 | 30 | 60 | 63 |
| CD at 5% | 118 | 197 | 151 | 168 | 85 | 174 | NS |
| ***In-situ* rain water conservation techniques** | | | | | | | |
| $T_1$ Opening of furrow after 2 rows | 1362 | 1739 | 1549 | 1275 | 1320 | 1181 | 1404 |
| $T_2$ Opening of furrow after 4 rows | 1400 | 1768 | 1588 | 1325 | 1374 | 1325 | 1463 |
| $T_3$ Conservation furrow after 6 rows | 1533 | 1984 | 1706 | 1725 | 1427 | 1516 | 1649 |
| $T_4$ Conservation furrow after 12 rows | 1475 | 1754 | 1732 | 1630 | 1437 | 1187 | 1536 |
| $T_5$ Control | 1095 | 1411 | 1366 | 870 | 1278 | 1064 | 1181 |
| SE ± | 53 | 88 | 67 | 75 | 38 | 78 | 81 |
| CD at 5% | 153 | 254 | 195 | 217 | NS | 224 | 225 |
| Interaction (CS x IRWCT's) | | | | | | | |
| SE ± | 92 | 152 | 117 | 130 | 66 | 134 | 141 |
| CD at 5% | NS | NS | NS | 376 | NS | NS | NS |
| Interaction (season x treatment) | | | | | | | |
| SE ± | | | | | | | 146 |
| CD at 5% | | | | | | | 423 |
| Mean | 1373 | 1731 | 1588 | 1365 | 1368 | 1254 | 1447 |
| CV (%) | 11 | 15 | 13 | 16 | 12 | 19 | 16 |
| Season rainfall (mm) | 787 | 719 | 493 | 641 | 887 | 637 | 694 |

***Interaction***

The interaction between cropping systems and *in-situ* rain water conservation techniques was found non-significant. The interaction between season and treatment was significant.

**Gross monetary returns**

***Cropping systems***

Pooled data on gross monetary returns (Table 6) indicated that among cropping systems, no significant difference was observed with respect to mean gross monetary returns. However, higher mean gross monetary returns was recorded in soybean + pigeonpea ($C_2$) followed by cotton + soybean ($C_3$).

***In-situ rain water conservation techniques***

Among *in-situ* rain water conservation techniques significantly higher mean gross monetary returns was recorded in conservation furrow at 2.7 m ($T_3$) than control.

**Table 6: Gross monetary returns as affected by cropping systems and *in-situ* rainwater conservation techniques during 2013 to 2018**

| Treatments | Gross monetary returns, Rs/ha | | | | | | Pooled Mean |
|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | |
| **Cropping systems** | | | | | | | |
| $C_1$ Sorghum + Pigeonpea (4:2) | 29645 | 36011 | 28758 | 38735 | 57970 | 41906 | 38838 |
| $C_2$ Soybean + Pigeonpea (4:2) | 20826 | 38742 | 43961 | 51114 | 60900 | 44784 | 43388 |
| $C_3$ Cotton + Soybean (1:1) | 18934 | 32755 | 60710 | 33002 | 65960 | 37477 | 41473 |
| SE ± | 690 | 1409 | 1461 | 1744 | 1383 | 1984 | 1798 |
| CD at 5% | 1994 | 4076 | 4224 | 5043 | 4002 | 5738 | NS |
| ***In-situ* rain water conservation techniques** | | | | | | | |
| $T_1$ Opening of furrow after 2 rows | 22945 | 36003 | 43382 | 38259 | 59398 | 38976 | 39827 |
| $T_2$ Opening of furrow after 4 rows | 23592 | 36590 | 44470 | 39748 | 62345 | 43737 | 41747 |
| $T_3$ Conservation furrow after 6 rows | 25836 | 41062 | 47773 | 51764 | 62222 | 50003 | 46443 |
| $T_4$ Conservation furrow after 12 rows | 24853 | 36317 | 48490 | 48886 | 64670 | 39141 | 43726 |
| $T_5$ Control | 18449 | 29205 | 38261 | 26096 | 57425 | 35087 | 34087 |
| SE ± | 890 | 1820 | 1886 | 2251 | 1790 | 2562 | 2321 |
| CD at 5% | 2574 | 5262 | 5452 | 6510 | NS | 7408 | 6423 |
| Interaction (CS x IRWCT's) | | | | | | | |
| SE ± | 1542 | 3152 | 3266 | 3899 | 3095 | 4437 | 4020 |
| CD at 5% | NS | NS | NS | NS | NS | NS | NS |
| Interaction (season x treatment) | | | | | | | |
| SE ± | | | | | | | 4167 |
| CD at 5% | | | | | | | 12067 |
| Mean | 23135 | 35836 | 44475 | 40952 | 61610 | 41389 | 41233 |
| CV(%) | 11 | 15 | 13 | 16 | 12 | 19 | 16 |

***Interaction***

Interaction between cropping systems and *in-situ* rain water conservation techniques was found non-significant. Interaction between season and treatment was significant. .

**Net monetary returns**

***Cropping systems***

Pooled data with respect to net monetary returns (Table 7) indicated that no significant difference was observed in mean net monetary returns with respect to cropping systems. However, higher mean net monetary returns was recorded in soybean + pigeonpea ($C_2$) followed by sorghum + pigeonpea ($C_1$).

***In-situ rain water conservation techniques***

Among *in-situ* rain water conservation techniques, mean net monetary returns in conservation furrow at 2.7 m ($T_3$) was significantly higher than control ($T_5$). Mean net monetary returns in opening of furrow after 4 rows ($T_2$) and conservation furrow at 5.4 m ($T_4$) was at par with that of conservation furrow at 2.7 m ($T_3$).

***Interaction***

Interaction between cropping systems and *in-situ* rain water conservation techniques was found non-significant. Interaction between season and treatment was significant.

**Table 7: Net monetary returns as affected by cropping systems and *in-situ* rainwater conservation techniques during 2013 to 2018**

| Treatments | Net monetary returns, Rs/ha | | | | | | Pooled Mean |
|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | |
| **Cropping systems** | | | | | | | |
| $C_1$ Sorghum + Pigeonpea (4:2) | 18971 | 25341 | 18027 | 31260 | 39970 | 23805 | 26229 |
| $C_2$ Soybean + Pigeonpea (4:2) | 9332 | 27248 | 32428 | 43333 | 40900 | 26494 | 29956 |
| $C_3$ Cotton + Soybean (1:1) | 5950 | 18665 | 46950 | 22344 | 40960 | 16987 | 25309 |
| SE ± | 689 | 1397 | 1461 | 1740 | 1690 | 1922 | 1799 |
| CD at 5% | 1993 | 4039 | 4224 | 5033 | NS | 5558 | NS |
| ***In-situ* Rain Water Conservation Techniques** | | | | | | | |
| $T_1$ Opening of furrow after 2 rows | 11715 | 23785 | 31317 | 29519 | 38398 | 20019 | 25792 |
| $T_2$ Opening of furrow after 4 rows | 11200 | 24454 | 32402 | 31016 | 41345 | 24504 | 27487 |
| $T_3$ Conservation furrow after 6 rows | 14054 | 28783 | 35707 | 42955 | 41222 | 30520 | 32207 |
| $T_4$ Conservation furrow after 12 rows | 13133 | 24188 | 36425 | 40201 | 43670 | 20213 | 29638 |
| $T_5$ Control | 6985 | 17546 | 26489 | 17873 | 36425 | 16887 | 20368 |
| SE ± | 890 | 1803 | 1886 | 2247 | 2050 | 2482 | 2323 |
| CD at 5% | 2573 | 5215 | 5452 | 5452 | NS | 7176 | 6429 |
| Interaction (CS x IRWCT's) | | | | | | | |
| SE ± | 1541 | 3123 | 3266 | 3892 | 3545 | 4298 | 4024 |
| CD at 5% | NS | NS | NS | 11254 | NS | NS | NS |
| Interaction (season x treatment) | | | | | | | |
| SE ± | | | | | | | 4114 |
| CD at 5% | | | | | | | 11915 |
| Mean | 11418 | 23751 | 32469 | 32312 | 40610 | 22428 | 27165 |
| CV (%) | 23 | 23 | 17 | 21 | -- | 33 | 24 |



## B:C ratio

Pooled data on B:C ratio have been presented in table 8. Pooled data indicated that mean B:C ratio was significantly higher in soybean + pigeonpea ($C_2$) than cotton + soybean ($C_3$). Among *in-situ* rain water conservation techniques, significantly higher B:C ratio was recorded in conservation furrow at 2.7 m ($T_3$) than control ($T_5$).

Interaction between cropping systems and *in-situ* rain water conservation techniques was found non-significant. Interaction between season and treatment was significant. Dikey *et al*., (2013) conducted experiment on various stress management practices for soybean and found similar results. Jadhav *et al.,* 2012 conducted experiment on various land configurations for *in-situ* moisture conservation in soybean and found similar type of B:C ratio and yield enhancement.

**Table 8: B:C ratio as affected by cropping systems and *in-situ* rainwater conservation techniques during 2013 to 2018**

| Treatments | B:C ratio | | | | | | Pooled Mean |
|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | |
| **Cropping systems** | | | | | | | |
| $C_1$ Sorghum + Pigeonpea (4:2) | 1.78 | 2.37 | 1.68 | 4.16 | 2.22 | 1.31 | 2.25 |
| $C_2$ Soybean + Pigeonpea (4:2) | 0.81 | 2.36 | 2.81 | 5.55 | 2.05 | 1.44 | 2.50 |
| $C_3$ Cotton + Soybean (1:1) | 0.46 | 1.32 | 3.41 | 2.09 | 1.64 | 0.82 | 1.62 |
| SE ± | 0.06 | 0.12 | 0.11 | 0.22 | 0.13 | 0.09 | 0.19 |
| CD at 5% | 0.18 | 0.35 | 0.33 | 0.64 | 0.39 | 0.28 | 0.52 |
| ***In-situ* rain water conservation techniques** | | | | | | | |
| $T_1$ Opening of furrow after 2 rows | 1.02 | 2.0 | 2.51 | 3.53 | 1.83 | 1.07 | 1.99 |
| $T_2$ Opening of furrow after 4 rows | 0.99 | 2.07 | 2.63 | 3.73 | 1.97 | 1.29 | 2.11 |
| $T_3$ Conservation furrow after 6 rows | 1.24 | 2.42 | 2.89 | 5.23 | 1.96 | 1.58 | 2.55 |
| $T_4$ Conservation furrow after 12 rows | 1.17 | 2.07 | 2.95 | 4.93 | 2.08 | 1.08 | 2.38 |
| $T_5$ Control | 0.64 | 1.54 | 2.18 | 2.24 | 1.73 | 0.94 | 1.55 |
| SE ± | 0.08 | 0.16 | 0.15 | 0.29 | 0.14 | 0.13 | 0.24 |
| CD at 5% | 0.23 | 0.45 | 0.42 | 0.83 | 0.42 | 0.37 | 0.67 |
| Interaction (CS x IRWCT's) | | | | | | | |
| SE ± | 0.14 | 0.27 | 0.25 | 0.49 | 0.22 | 0.22 | 0.42 |
| CD at 5% | NS | NS | NS | 1.43 | 0.66 | NS | NS |
| Interaction (season x treatment) | | | | | | | |
| SE ± | | | | | | | 0.37 |
| CD at 5% | | | | | | | 1.06 |
| Mean | 1.01 | 2.02 | 2.63 | 3.93 | 1.97 | 1.19 | 2.12 |
| CV (%) | 23 | 23 | 17 | 22 | 21 | 32 | 24 |
| Season rainfall (mm) | 786 | 719 | 493 | 641 | 887 | 637 | 694 |

### Moisture use efficiency

Data on moisture use efficiency (Table 9) indicated that highest mean moisture use efficiency of 3.83 kg $ha^{-1}mm^{-1}$ was observed in soybean + pigeonpea. Similarly, highest mean moisture use efficiency of 4.10 kg $ha^{-1}mm^{-1}$ was observed in conservation furrow at 2.7 m followed by conservation furrow at 5.4 m.

**Table 9: Mean moisture use efficiency (kg $ha^{-1}mm^{-1}$) during 2013 to 2018**

| Treatments | *In-situ* rain water conservation techniques | | | | | Mean |
|---|---|---|---|---|---|---|
| | Opening of furrow after 2 rows | Opening of furrow after 4 rows | Conservation furrow after 6 rows | Conservation furrow after 12 rows | Control | |
| $C_1$ Sorghum + Pigeonpea (4:2) | 3.12 | 3.42 | 3.94 | 3.58 | 2.53 | 3.32 |
| $C_2$ Soybean + Pigeonpea (4:2) | 3.57 | 3.78 | 4.50 | 4.22 | 3.06 | 3.83 |
| $C_3$ Cotton + Soybean (1:1) | 3.58 | 3.58 | 3.85 | 3.55 | 3.18 | 3.55 |
| Mean | 3.42 | 3.59 | 4.10 | 3.78 | 2.92 | - |

## Conclusions

Soybean + pigeonpea (4:2) intercropping system was found superior with respect to gross monetary returns, net monetary returns and B:C ratio, followed by cotton + soybean (1:1) intercropping system in medium to deep black soil of assured rainfall zone of Marathwada region. Conservation furrow after 6 rows was found significantly superior over control. Highest moisture use efficiency was observed in adoption of conservation furrow after 6 rows followed by conservation furrow after 12 rows and 4 rows.

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