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# STANDARDIZATION OF *IN-SITU* MOISTURE CONSERVATION METHOD FOR ESTABLISHMENT OF AONLA ORCHARDS ON SLOPPY DEGRADED WASTELANDS

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**ABSTRACT:** A study was carried out in Krishi Vigyan Kendra, Deendayal Research Institute, Satna for two consecutive years to evaluate the effect of various *in-situ* moisture conservation measures on establishment and growth of aonla (*Emblica officinalis*) in sloppy degraded lands. *In-situ* moisture conservation measures included for the study were preparation of circular ring basin + mulching the basin with black polythene, staggered contour trenching (45 cm width and 3 m length) on upper side of the plant basin, placement of one submerged pitcher in one side of the plant for rainwater harvesting, setting the seedling in a depression of 1 m width and 15 cm deep, surrounded by a ring-shaped ridge with 25 cm width and 15 cm height and a 30 cm opening on the higher side to harvest rain water + filling the depression with straw + mulching with black polythene and control (no micro- catchment or mulch). The results revealed that all the *in-situ* moisture conservation methods showed improvements in survival, establishment and growth of aonla plants. However, preparation of micro catchment area of one meter width surrounded by ring shaped ridge of 25 cm width and 15 cm height and having a 30 cm opening at the higher side and mulching in depressed area with straw and cover with black polythene was found to be the most effective moisture conservation method in increasing the survival and growth of aonla seedlings/budlings among all the conservation treatments.

***Keywords:*** *Aonla, in-situ moisture conservation, laterite soil, staggered contour trenching.*

The concept of rehabilitation of waste/forest lands through plantations of economic plants on degraded soils for meeting the ever increasing demands of food, fruits, fodder and fuel, has gained widespread attention in India. In recent years, the Central Government of India, as well as some state governments, has expressed their support for bringing degraded lands, which cannot be used for food production, under fruit cultivation. India has vast tracts of wastelands, which have been lying barren for ages. Most of these lands are suitable for growing trees and thus could be put to socially productive uses (Balooni and Singh, 1). However, the major constraint on the pace of expansion of rehabilitation programmes is the non-availability of suitable location specific technologies. Several workers have emphasized the need for development of rehabilitation technology in order to prevent good land from degrading into wastelands, and it has been reported that waste and degraded forest lands can be economically utilized for growing certain economic plants by employing suitable technologies. Hegde (3) reported that soil and water conservation measures and growing trees could effectively rehabilitate such sloppy wastelands. Similarly, attempts to rehabilitate degraded lands in the western Himalayas, Khybri *et al.* (4) found that *in-situ* moisture conservation techniques along with use of grasses, plantation of fuel, fodder and fruit trees were quite effective in rehabilitating denuded lands. Singh (8) studied the performance of certain fruit trees on wastelands in the Bundelkhand region and found that the abundant hilly wastelands available in the region could be successfully developed for the plantation of fruits.Tyagi and Yadava (9), while working on rehabilitation of wastelands, observed that wastelands can be rehabilitated to a greater extent by employing suitable soil-water conservation measures; planting

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of fruit, fodder and fuel tree species, and grafting of improved varieties of fruits on native root stocks. Pareek *et al.* (7) suggested the requirement of soil and water conservation treatments for production of horticultural crops on undulating hilly lands and degraded forest lands.

The aonla (*Emblica officinalis* Gaertn) is one of the most important minor fruits that has bright prospects for extending its cultivation, especially in waste/forestlands where the cultivation of other crops is arduous and less profitable. During the recent years, this crop is fast gaining ground on account of its drought hardiness, high medicinal and nutritional value, non-perishable nature of the fruit, readily available market and high remuneration. Due to its increasing demand in *Ayurvedic* medicines, an expansion of the area under its cultivation has become necessary to meet the demands of pharmaceutical companies. Keeping in view the diverse medicinal use of aonla and its increasing commercial significance in the country, there is an urgent need to give immediate attention towards problems and prospects in its cultivation. However, the greatest bottleneck in its expansion is the poor survivability of plants on waste/forestland. The poor establishment of plants after transplanting is a major problem in the expansion of area under cultivation as heavy mortality (up to 50 %) occurs after transplanting from nursery to field at distant places. Although, aonla is a drought hardy fruit crop, yet the plants require watering during the initial stage of orchard establishment (Pareek, 6). But providing irrigation is neither practical nor economical in the sloppy wastelands. Harvesting of rainwater and *in-situ* moisture conservation is the only viable alternative to artificial irrigation. Scientific information to establish a standard method of rainwater harvesting technology for aonla is inadequate, especially for the sloppy lands. Therefore, an experiment was laid out to study the effect of different models of rain water harvesting on plant survival and growth ratios.

## MATERIALS AND METHODS

The experiment was conducted during two consecutive years of 2005-06 and 2006-07 at instructional farm of Krishi Vigyan Kendra, Satna on sloppy wastelands with five *in-situ* moisture conservation methods. The experiment was laid out in a Randomized Block Design with three replications and 20 plants in each replication. The experiment site was cleared off all the shrubs/bushes in the month of May during both the years. Pits of 90 x 90 x 90 $m^3$ size were dug out during May. The pits were filled with a mixture of good soil and FYM in the ratio of 1:1. Experiment was laid out in a triangular system at a planting distance of 5x5m. The seeds extracted from matured *desi* aonla after treatment with carbendazim (0.25%) were sown in polythene bags (25x10 cm size) filled with a mixture containing soil, sand and FYM in equal proportion for raising seedlings/rootstocks in the last week of June. 2-3 healthy seeds were sown in each polybag. After germination only one healthy seedling was retained per poly bag. After one month the seedlings raised in polybags were transplanted in pits subjected to different *in-situ* moisture conservation measures. These transplanted seedlings were patch budded with NA-7 during the last week of June in the following year. The observations on seedlings growth (height and diameter), survival, time taken for initiation of bud sprout, time taken for completion of 50% buds sprouting, per cent bud sprouting and survival of budlings were recorded. The data on seedlings height and diameter were recorded at monthly interval after transplanting until June of the following year (the time of performing budding operations). The height was measured from the surface of soil to the terminal bud of the main axis, and expressed as average height per seedling in cm. The diameter was recorded at a height of 5 cm from the ground level with the help of a slide vernier caliper, and was expressed as average diameter per seedling in cm. The number of seedlings surviving in each treatment until June of the following year was considered as survival of seedlings. The data on bud sprout were recorded daily after one week of budding. The number of buds sprouted in each treatment were counted and expressed in percentage on the basis of the number of buds sprouted out of the seedlings budded. The period from the date of budding/grafting to the sprouting of first bud was considered as the time taken for initiation of bud sprout and the period from the date of budding/grafting to the sprouting of 50% buds was considered as the time taken for completion of 50 per cent bud sprouting. The number of budlings surviving in each treatment until 24 weeks after budding were considered as bud survival and expressed in percentage. The data in percentage were transformed to *arc sine* values for calculating the analysis of variance. The details of treatments used are given in Table 1.

**Table 1: Treatment details and specification of *in-situ* moisture conservation measures.**

| Treatments | Specifications |
|---|---|
| $T_1$ : Polythene mulching | Preparation of circular ring, and mulching the basin with black polythene. |
| $T_2$ : Trench + straw mulching | Staggered trenches of 3m length, 0.45 m width and depth across the slope were prepared in a aligned contour. Half of the trench was filled with straw and the plants were planted on the downstream side of the trench bund. |
| $T_3$ : Submerged pitcher | Placement of one submerged pitcher on upper side of the plant for rainwater harvesting. |
| $T_4$ : Pit depression | Seedlings were set in a depression of 1 m width and 15 cm depth, surrounded by a ring-shaped ridge with 25 cm width and 15 cm height and a 30 cm opening on the higher side to harvest rainwater. The depression was filled with straw and covered with black polythene as mulch. |
| $T_5$ : Control | Control (no micro-catchments and no mulch). |

## RESULTS AND DISCUSSION

### Seedling Growth

The data on the effect of different *in-situ* soil moisture conservation treatments on plant growth and survival over the years are presented in Table 2. The pooled analysis of variance for plant height, diameter and survival percentage revealed significant differences among different soil moisture conservation methods, and strongly indicated the significance of rainwater harvesting and *in-situ* moisture conservation The results of the present studies revealed that rainwater harvesting and *in-situ* moisture conservation is a must for better establishment and development of aonla seedlings/budlings particularly in sloppy degraded soils, as the growth and survival of aonla plants was markedly improved when the seedlings/budlings were subjected to different *in-situ* moisture conservation methods.

In the present studies, the seedling growth in terms of height and diameter was influenced significantly by different *in-situ* moisture conservation treatments. Among all the treatments, transplanting of seedlings in pit depression ($T_4$) resulted in the maximum seedling height (89.54 cm) and diameter (1.11 cm), which was significantly greater than the other treatments. The next best treatment in respect of seedling growth was *in-situ* moisture conservation by staggered trench + straw mulching (81.24 and 1.05 cm) and submerged pitcher (77.23 and 1.02 cm). The control plants recorded significantly lowest plant height (66.44 cm) and diameter (0.96 cm). The difference in the response of growth parameters to various *in-situ* moisture conservation treatments was purely due to differences in the moisture holding and retaining efficiency of treatments. Better growth of the seedlings planted in a pit depression may be due to more soil moisture available for longer periods. These findings are in conformity with the results of Ghosh *et al.* (2), where they also noted better growth of the aonla plants in pit like depressions.

The data further revealed that the trend in increase in seedling's height and diameter in response to different *in-situ* moisture conservation techniques was almost similar during both the years of investigations.

**Seedling Survival**

Another beneficial effect of *in-situ* moisture conservation was significant improvement in plant survival. All the treatments except polythene mulching recorded significantly higher plant survival percentage over the control. The treatments, planting the seedlings in pit depression, and just below the staggered contour trench, were found to be more effective in increasing the survival percentage of seedlings than other treatments. The treatment establishing seedlings in pit depression ($T_4$), recorded the mean maximum plant survival (93.75 per cent), which was statistically at par with staggered trench + straw mulching (89.38 per cent). The lowest plant survival was recorded under polythene mulching (69.38 per cent), which was at par with control.

These results are in conformity with the findings of Manivannan and Desai (5), who also recorded the maximum survival of plants (89.4 per cent) with staggered contour trenching method of rainwater harvesting, as against 52 per cent under control and observed that the treatments which enhanced growth also improved the survival rate of the plants.

**Bud Sprout and Bud Survival**

The data on the effect of different rainwater harvesting and moisture conservation techniques on bud sprouting and bud survival percentage are presented in Table 3. The bud sprouting and bud survival percentage were influenced significantly by the different methods of soil moisture conservation. The maximum sprouting (83.75 per cent) as well as bud survival (80.82 per cent) was recorded in seedlings set in pit depression, followed by seedlings planted just below the staggered trench and submerged pitcher methods of moisture conservation. These observations thus indicate that the survival of budlings can be improved greatly by employing *in-situ* moisture conservation methods. These observations are in conformity with the findings of Manivannan and Desai (5), who reported that bud sprouting and survival of plants was improved by moisture conservation methods.

**Table 2: Effect of *in-situ* moisture conservation methods on height, diameter and per cent survival of Aonla seedlings.**

| Treatment | Seedling Height (cm) | | | Seedling Diameter(cm) | | | Survival (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2005-06 | 2006-07 | Mean | 2005-06 | 2006-07 | Mean | 2005-06 | 2006-07 | Mean |
| $T_1$ : Polythene mulching | 68.92 | 74.04 | 71.48 | 0.92 | 0.98 | 0.95 | 73.75 (59.18) | 76.25 (60.83) | 75.00 (60.00) |
| $T_2$ : Trench + straw mulching | 75.74 | 86.74 | 81.24 | 0.99 | 1.09 | 1.05 | 87.50 (69.29) | 91.25 (72.79) | 89.38 (70.98) |
| $T_3$ : Submerged pitcher | 71.97 | 82.50 | 77.23 | 0.95 | 1.08 | 1.02 | 87.50 (69.29) | 87.50 (69.29) | 87.50 (69.29) |
| $T_4$ : Pit depression | 84.67 | 94.41 | 89.54 | 1.04 | 1.17 | 1.11 | 92.50 (74.11) | 95.00 (77.08) | 93.75 (75.52) |
| $T_5$ : Control | 64.73 | 68.16 | 66.44 | 0.85 | 0.96 | 0.91 | 68.75 (56.01) | 70.00 (56.79) | 69.38 (56.40) |
| CD (P=0.05) | 4.64 | 3.51 | 2.49 | 0.11 | 0.06 | 0.06 | 6.98 | 7.95 | 5.11 |

**Table 3: Effect of *in-situ* moisture conservation methods on bud sprouting and bud survival in Aonla.**

| Treatment | Bud Sprouting (%) | | | Bud Survival (%) | | |
|---|---|---|---|---|---|---|
| | 2006 | 2007 | Mean | 2006 | 2007 | Mean |
| $T_1$ : Polythene mulching | 77.50 (61.68) | 67.50 (55.24) | 72.50 (58.37) | 58.48 (49.88) | 63.10 (52.59) | 60.79 (51.23) |
| $T_2$ : Trench + straw mulching | 82.50 (65.27) | 72.50 (58.37) | 77.50 (61.68) | 69.45 (56.45) | 75.89 (60.59) | 72.67 (58.48) |
| $T_3$ : Submerged pitcher | 85.00 (67.21) | 70.00 (56.79) | 77.50 (61.68) | 71.53 (57.75) | 72.77 (58.54) | 72.15 (58.15) |
| $T_4$ : Pit depression | 90.00 (71.57) | 77.50 (61.68) | 83.75 (66.23) | 78.27 (62.21) | 83.38 (65.94) | 80.82 (64.03) |
| $T_5$ : Control | 70.00 (56.79) | 55.00 (47.87) | 62.50 (52.24) | 53.57 (47.05) | 55.00 (47.86) | 54.29 (47.46) |
| CD (P=0.05) | 10.59 | 6.53 | 5.03 | 7.73 | 7.89 | 5.09 |

The data further reveal that the trend in bud sprouting and bud survival percentage in response to the different rainwater harvesting and *in-situ* moisture conservation methods was similar during the two years.

### Time taken for Initiation of Bud Sprouting and 50 per cent Sprouting of Bud

The data pertaining to the effect of different *in-situ* moisture conservation treatments on the time taken for initiation of bud sprouting are presented in Table 4. In the present studies, in-situ moisture conservation methods were observed to cause earlier initiation and earlier completion of 50 % bud sprouting as compared to the control. The minimum time for initiation of bud sprouting (14.0 days) was taken by planting the seedlings in pit depression ($T_4$) followed by planting seedlings just below the staggered trench. The treatment which resulted in earlier initiation of bud sprouting also caused earlier completion of bud sprouting. The mean minimum time of 24.01 and 24.08 days for sprouting of 50 per cent buds were taken under the plant set in depression ($T_4$) and staggered trench + straw mulching ($T_2$), respectively. The earlier bud sprouting and relatively higher bud success in seedlings planted in pit depression and just below the staggered trench may be attributed to better sap flow in these seedlings, which enables the bud to heal quickly and make a strong union. Relatively lower budding success and delayed bud burst in control may be attributed to decreased sap flow and less seedling diameter, which must have ultimately interfered with the process of bud union and its healing.

## CONCLUSION

From the results of these studies, it may be concluded that *in-situ* moisture conservation is must for better establishment and development of aonla plants on degraded sloppy lands, as the seedling growth in terms of height and diameter, survival percentage of seedlings, bud sprout and survival percentage of budlings were significantly improved when the plants were subjected to different *in-situ* moisture conservation methods. Among the different methods of *in-situ* moisture conservation, the treatment of planting one month old polythene raised seedlings in a pit depression of 1 m width and 15 cm deep, surrounded by a ring-shaped ridge with 25 cm width and 15 cm height and a 30 cm opening on the higher side to harvest rain water and filling the depression with straw and covering the pit with black polythene and performing patch budding next year during end of June, which resulted in maximum seedling

**Table 4: Effect of *in-situ* moisture conservation methods on time taken for sprouting of buds in Aonla.**

| Treatment | Time taken for initiation of bud sprout | | | Days taken for 50% sprouting of buds | | |
|---|---|---|---|---|---|---|
| | 2006 | 2007 | Mean | 2006 | 2007 | Mean |
| $T_1$ : Polythene mulching | 14.75 | 16.25 | 15.50 | 25.13 | 26.55 | 25.84 |
| $T_2$ : Trench + straw mulching | 12.75 | 16.00 | 14.38 | 22.45 | 25.70 | 24.08 |
| $T_3$ : Submerged pitcher | 13.00 | 15.75 | 14.38 | 22.75 | 25.78 | 24.26 |
| $T_4$ : Pit depression | 12.50 | 15.50 | 14.00 | 22.53 | 25.50 | 24.01 |
| $T_5$ : Control | 16.00 | 16.75 | 16.38 | 25.48 | 27.05 | 26.26 |
| CD (P=0.05) | NS | NS | NS | 2.48 | NS | NS |

growth and plant survival found to be the best *in-situ* moisture conservation method and may be recommended for rehabilitation of degraded sloppy lands.

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