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EFFECT OF *IN-SITU* MOISTURE CONSERVATION ON PLANT GROWTH AND NUTRIENT UPTAKE IN AONLA (*Emblica officinalis Gaertn*) IN SLOPPY DEGRADED LANDS

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ABSTRACT: A field experiment was conducted 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 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 data on growth parameters (scion shoot length and diameter; number of branchlet, number of leaves, leaf area, fresh and dry weight of shoots and roots) and nutrient content of leaves of budlings under the five treatments were recorded. The results revealed that 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 budling growth, and nutrients uptake observed to be the best in situ moisture conservation method and may be recommended for rehabilitation of degraded sloppy lands.

Keywords: *Aonla, in-situ moisture conservation, trenching, submerged pitcher, nutrient uptake.*

Aonla, on account of its drought hardiness and wider adaptability appear to be a better choice for rehabilitating wastelands (Singh, 11). This minor fruits has bright prospects for extending its cultivation 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 and growth of plants on wastelands. The poor establishment and growth 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, 9). But providing regular irrigation is neither regular 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

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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 2005-06 and 2006-07 at Krishi Vigyan Kendra, Satna on sloppy wastelands with five in-situ moisture conservation methods. The experimental site lies between 24° 51' 15" to 24° 57' 30" N latitude and 80° 43' 30" to 80° 54' 15" E longitude. The annual rainfall of the experimental area varies from 600 mm to 850 mm. July to September are the wettest months accounting for about 80% of the total precipitation in the area. Temperature rises to 45-48°C in May and falls to 3-5°C during December/January. The soil of the experimental site was stony, gravelly and the gravel content of the soil varied from 46-58%. 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 cu. m. 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. One month old seedlings raised in poly bags were transplanted in pits subjected to different *in-situ* moisture conservation measures with the onset of monsoon during 2005 and 2006. Under each replication, out of 20 transplanted seedlings, 10 seedlings were patch budded with NA-7 during the last week of June in the following year *i.e.* 2006 and 2007. For taking observations on growth parameters and nutrient content of leaves, five plants in each replication were marked permanently. The data on length and diameter of scion shoot; number of branchlets and number of leaves were recorded at monthly interval after 45 days of budding till the cessation of growth took place. The height was measured from the bud union to the terminal bud of the main axis. Whereas, the diameter was measures just above the bud union with the help of vernier calliper. The data on number of branchlets were recorded during September. The leaf area was recorded during October. Ten leaves were collected at random from each budding, and out of the pooled leaves, ten leaves were further selected at random for measuring the leaf area. The leaf area was measured with the help of LICOR 6100 Leaf Area Meter and expressed in cm2. The observations on fresh shoot and root weights were recorded during December, at the end of growing season. The plants were dug out carefully without disturbing the primary roots and were washed in water. The stem portions and

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).

root portions were severed from the point of transition of shoot and root. The weight was measured with the help of an electronic balance and expressed as average weight of root and shoot in gm. After recording fresh weight, the roots and shoots portions were dried in an electric oven at 65°C for 72 hours. For determining the dry weight, shoot and root portions were weighed in an electronic balance and the data expressed as average weight of root and shoot in gm. For calculating the nutrient content in leaves, the physiologically mature leaves (3-4 months old) from the middle portion of shoots were collected (Awasthi *et al.,* 1). The leaves were washed and dried in the electric oven at 65°C till a constant weight was obtained. The samples were then grounded and analyzed for nitrogen, phosphorus and potassium contents and the data expressed in percent. The nitrogen content in the leaves was determined by Kjeltec N- autoanalyzer as advocated by Singh *et al.* (11). The phosphorus content in the leaves was determined by wet digestion method developing vanadomolybdo colour as suggested by Singh *et al.* (10). The potassium content in the leaves was estimated by wet digestion with the help of a flame photometer as described by Jackson (7).

RESULTS AND DISCUSSION

Budlings Growth

The data on the effect of different moisture conservation methods on length of scion shoot, diameter of scion shoot just above the graft union and number of branchlets per budding are presented in Table 2.

Several workers have demonstrated the beneficial effects of in-situ moisture conservation methods on plants growth (Ghosh *et. al.,* 5; Badhe and Magar, 2) in aonla. In the present studies also, all the treatments were observed to enhance the growth of budlings in terms of length of scion shoot, diameter of scion shoot just above the graft union, and number of branchlets per budling. The maximum length of scion shoot (40.70 cm), diameter just above the bud union (0.58 cm), and number of branchlets (21.25), was recorded in budlings growing in pit depression method of in-situ moisture conservation. The next best treatments in respect of growth were staggered trench + straw mulching (38.78 cm, 0.56 cm, 18.75) and submerged pitcher (37.47 cm, 0.52 cm and 17.50) methods of water harvesting. The treatment of mulching with black polythene recorded the mean minimum values of growth parameters (32.56 cm, 0.45 cm, 16.17 branches).

Increased growth of budlings under in-situ moisture conservation treatments might have been due to more moisture and nutrients available in the soil during the active growth period. Thus in the present study, pit depression method of moisture conservation was observed to be a more effective method for enhancing budlings growth. The higher growth of budlings under the pit depression method of moisture conservation may be attributed to higher available soil moisture for longer periods

Table 2: Effect of in-situ moisture conservation methods on growth of Aonla budlings.

Treatment	Scion shoot length (cm)			Scion shoot diameter (cm)			No. of Branchlets/ budling		
	2006	2007	Mean	2006	2007	Mean	2006	2007	Mean
T_1 : Polythene mulching	31.51	33.60	32.56	0.43	0.46	0.45	16.00	16.33	16.17
T_2 : Trench + straw mulching	38.14	39.41	38.78	0.54	0.57	0.56	18.67	18.83	18.75
T_3 : Submerged pitcher	37.33	37.62	37.47	0.51	0.53	0.52	17.25	17.75	17.50
T_4 : Pit depression	38.92	42.47	40.70	0.56	0.59	0.58	20.58	21.92	21.25
T_5 : Control	28.31	28.94	28.63	0.39	0.41	0.40	14.67	14.91	14.79
CD (P=0.05)	1.97	3.17	2.42	0.03	0.04	0.04	1.72	2.10	1.84

Table 3: Effect of in-situ moisture conservation methods on number of leaves and leaf area of Aonla budlings.

Treatment	Number of Leaves			Leaf Area (cm^2)		
	2006	2007	Mean	2006	2007	Mean
T_1 : Polythene mulching	446.63	437.60	442.11	0.36	0.35	0.36
T_2 : Trench + straw mulching	505.59	501.16	503.37	0.47	0.44	0.46
T_3 : Submerged pitcher	505.73	491.63	498.68	0.43	0.39	0.41
T_4 : Plant set in depression	631.15	592.78	611.96	0.49	0.46	0.48
T_5 : Control	383.25	376.89	380.07	0.33	0.31	0.32
CD (P=0.05)	57.41	47.05	50.34	0.03	0.05	0.02

due to a bigger micro-catchments area, and better moisture conservation through combined mulching of straw and polythene. These results are in conformity with the findings of Ghosh *et. al.* (5) who also recorded better growth of the plants in custard apple under pit depression method of moisture conservation.The trend observed in increase in all the growth parameters as influenced by different moisture conservation methods was almost similar during 2006 as well as 2007.

No. of Leaves and Leaf Area

The data on the effect of different *in-situ* moisture conservation treatments on leaf number and leaf area are presented in Table 3. A perusal of the data reveals that all the in-situ moisture conservation treatments resulted in significant increase in leaf number and leaf area over control during the year 2006 and 2007 as well as when pooled analysis of variance was carried out. Among the different *in-situ* moisture conservation treatments, the maximum leaf number and leaf area was obtained under pit depression treatment (611.96, 0.48 cm^2), which was significantly higher than other treatments. The next best treatment was found to be staggered trench + straw mulching (503.37, 0.46 cm^2). The treatment polythene mulching recorded the lowest values (442.11, 0.36 cm^2).

Fresh Weight of Shoot and Root

The data on the effect of different *in-situ* moisture conservation methods on fresh shoot and root weight and dry shoot and root weight (Table 4) reveals that different *in-situ* moisture conservation treatments had a significant effect on fresh shoot and root weight. The mean fresh weight of shoot and root per plant ranged between 16.35 g to 23.14 g, and 16.28 g to 22.07 g respectively. The mean maximum fresh weight of shoot and root (23.14 g and 22.07 g) was recorded with budlings raised under pit depression method of moisture conservation which was significantly higher than all the other treatments, except staggered trench + straw mulching. The lowest mean fresh shoot and root weight (16.35 g and 16.28 g) was recorded under control, which was significantly lower than all other treatments.

Dry Weight of Shoot and Root

The mean dry shoot and root weight of budlings ranged between 7.33 g to 10.40 g, and 8.30 g to 11.80 g, respectively. All the treatments were observed to increase the dry shoot and root weight significantly over the control. Among the different treatments, the mean maximum dry shoot and root weight was recorded under pit depression (10.40 g and 11.80 g). The second highest values (9.93 g and 11.25 g) of dry shoot and root weights were observed under staggered trench + straw mulching treatment, but were statistically at par with pit depression and submerged pitcher method of moisture conservation. Furthermore, the dry weight of shoot and root was observed to follow the same pattern as fresh weight in respect of the effect of in-situ moisture conservation methods.

Table 4: Effect of *in-situ* moisture conservation methods on fresh and dry weight of shoot and root in Aonla.

Treatment	Shoot Fresh Weight (g)			Root Fresh Weight (g)			Shoot Dry Weight (g)			Root Dry Weight (g)		
	2006	2007	Mean	2006	2007	Mean	2006	2007	Mean	2006	2007	Mean
T_1 : Polythene mulching	18.84	20.09	19.47	17.93	19.11	18.52	8.07	8.61	8.34	9.14	9.75	9.44
T_2 : Trench + straw mulching	21.80	22.53	22.17	21.56	22.28	21.92	9.77	10.10	9.93	11.06	11.43	11.25
T_3 : Submerged pitcher	21.33	21.49	21.41	21.24	21.40	21.32	9.56	9.63	9.60	10.83	10.91	10.87
T_4 : Pit depression	22.12	24.16	23.14	21.17	22.97	22.07	9.97	10.83	10.40	11.29	12.32	11.80
T_5 : Control	16.17	16.52	16.35	16.11	16.46	16.28	7.25	7.41	7.33	8.21	8.39	8.30
CD(P=0.05)	2.01	1.98	1.68	2.11	1.76	1.37	0.95	0.90	0.75	1.01	1.00	0.62

The increase in the dry and fresh matter content of shoots and roots under moisture conservation treatments could be attributed to the better sap flow, nutrient uptake and their directional flow, as the treatment which produced higher dry and fresh weight of shoots, also recorded higher content of NPK in leaves.

Nutrient Uptake

The data pertaining to the effect of different methods of *in-situ* moisture conservation on nutrient content of leaves (Table 5) revealed that all the moisture conservation treatments significantly improved the nutrient uptake of the roots. The different *in-situ* moisture conservation treatments resulted in a significant increase in NPK content of the leaves over the control. Among the different methods of *in-situ* moisture conservation, the pit depression method of rainwater harvesting, along with black polythene mulching proved to be the most beneficial for increasing the NPK content of leaves and. gave the highest values of NPK content (2.36, 0.27, 1.41 per cent) in leaves. The next best treatments, in respect of leaves NPK content were staggered trench (2.22, 0.24, 1.39 per cent) and submerged pitcher (2.07 per cent). Whereas, the lowest NPK content was recorded under polythene mulching treatment (1.74, 0.20, 1.21 per cent). Chandra (4) also reported that moisture conservation techniques increase the nutrient content of leaves in aonla. He advocated that the nutrient move into the wet volume in a manner consistent with the flux of water in the soil, thereby ensuring adequate availability to plants. Furthermore, the N, P and K content of leaves was observed to follow the same pattern in respect of the effect of *in-situ* moisture conservation methods on nutrient content of leaves.

The better nutrient uptake under *in-situ* moisture conservation treatments may be due to enhanced availability of nutrients and moisture in soil for longer duration and the higher content of NPK in leaves may be attributed to increased availability of soil moisture which might have facilitated higher uptake of nutrient and establishment of better soil-water-air relationship.

In the present investigations, mulch was found more effective in increasing seedling as well budlings growth (height, diameter, number of leaves and branchless, fresh and dry weight of root and shoot), when used in combination with in-situ rain water harvesting module, as compared to when used alone. The beneficial effect of black polythene and straw mulching on plant growth has also been reported in guava (Borthakur and Bhattacharya, 3). Higher growth of aonla plants under different *in-situ* moisture conservation treatments can be attributed to the better moisture conservation for

Table 5: Effect of *in-situ* moisture conservation methods on leaf nutrient content in Aonla.

Treatment	Nitrogen Content (%)			Phosphorus Content (%)			Potassium Content (%)		
	2006	2007	Mean	2006	2007	Mean	2006	2007	Mean
T_1 : Polythene mulching	1.89 (7.90)	1.91 (7.94)	1.90 (7.92)	0.21 (2.63)	0.19 (2.50)	0.20 (2.56)	1.19 (6.26)	1.22 (6.34)	1.21 (6.30)
T_2 : Trench + straw mulching	2.21 (8.55)	2.23 (8.59)	2.22 (8.57)	0.23 (2.75)	0.24 (2.81)	0.24 (2.78)	1.37 (6.72)	1.40 (6.80)	1.39 (6.76)
T_3 : Submerged pitcher	2.04 (8.21)	2.09 (8.31)	2.07 (8.27)	0.22 (2.69)	0.23 (2.75)	0.23 (2.72)	1.27 (6.47)	1.33 (6.62)	1.30 (6.55)
T_4 : Pit depression	2.33 (8.78)	2.38 (8.87)	2.36 (8.84)	0.27 (2.98)	0.26 (2.92)	0.27 (2.95)	1.44 (6.89)	1.38 (6.75)	1.41 (6.82)
T_5 : Control	1.73 (7.56)	1.75 (7.60)	1.74 (7.58)	0.19 (2.50)	0.17 (2.36)	0.18 (2.43)	1.02 (5.80)	1.11 (6.05)	1.07 (5.93)
CD (P = 0.05)	0.42	0.35	0.29	0.14	0.16	0.11	0.41	0.32	0.27

longer period of growth, which improved the nutrient uptake by the plant. These results conforms the findings of several workers, who also reported enhanced growth of fruit plants due to better conservation of soil moisture following mulching (Hegde and Srinivas, 6; Mishra, 8).

CONCLUSION

From the results of these studies, it may be inferred that *in-situ* moisture conservation is a must for better establishment and development of aonla plants on degraded sloppy lands, as the growth and NPK content of the leaves 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 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 growth and plant nutrient uptake found to be the best *in-situ* moisture conservation method and may be recommended for rehabilitation of degraded sloppy lands.

REFERENCES

1. Awasthi, O.P.; Pathak, R.A. and Pathak, R.K. (1993). Effect of age and position of shoot on mineral composition of aonla. *Indian J. Hort.,* **50**(2): 134- 138.
2. Badhe, V.T. and Magar, S.S. (2004). Influence of different conservation measures on run off, soil and nutrient loss under cashewnut in lateritic soils of south Konkan region. *Indian J. Soil Cons.,* **32** (2): 143-147.
3. Borthakur, P.K. and Bhattacharya, R.K. (1992). Organic mulches in guava orchards. *Indian Hort.,* **37** (2) : 43-44.
4. Chandra, S. (2000). Efficacy of drip irrigation and mulching on aonla ber cropping system in sodic soil. *Ph. D thesis* submiited to N D U A&T, Faizabad.
5. Ghosh, S.N.; Mathew, B. and Manna, S. (2002). Effect of *in-situ* moisture conservation on growth, yield and fruit quality of custard apple. *J. Maharashtra Agric. Universities,* **27**(3): 263-265.
6. Hedge, H.M. and Srinivas, K. (1989). Effect of mulches and anti transpirants on growth, yield and water use of banana. *Prog. Hort.*, **21** (1-2): 44.47.
7. Jackson, M.L. (1973). *Soil chemical analysis.* Prentice Hall of India Pvt. Ltd. New Delhi.

8. Mishra, L.N. (1998) Effect of mulching on the conservation of soil moisture and plant growth in aonla + guava cropping system. *M.Sc.(Ag) thesis,* Department of Horticulture, NDUA&T, Kumarganj, Faizabad.
9. Pareek, O.P. (1993). Water management in fruit crops. In: *Advances in Horticulture* Vol. **2,** Fruit crops Eds. K.L. Chadha and O.P. Pareek, Malhotra Publishing House, New Delhi, pp. 725-762.
10. Singh, D., Chhonkar, P.K. and Pandey, R.N. (1999). Soil–plant–water analysis – *A methods manual.* Pp. 57-67.
11. Singh, R.K. (1992). Research strategies at national level for fruit cultivation and utilisation of wastelands. *Agric. Situation in India,* **47**(5): 359-364.