Indian J. Hort. 67(Special Issue), November 2010: 124-128

Efficacy of organic mulches on soil properties, earthworm population, growth and yield of aonla cv. NA7 in semi- arid ecosystem

A.K. Singh*, Sanjay Singh, V.V. Appa Rao, B.G. Bagle and T.A. More
Central Horticultural Experiment Station (CIAH), Vejalpur (Godhra), Gujarat 389340

ABSTRACT

The influence of different organic mulches viz, paddy straw, maize straw, rice husk, grasses, *subabul* loppings on soil properties, earthworm population, growth, yield and fruit quality attributes was studied. Various organic mulches significantly increased the soil moisture status at various soil depths. Paddy straw mulch recorded the maximum soil moisture content followed by maize straw and grasses, among the different evaluated organic mulches. The findings of the study indicated that paddy straw mulch followed by maize straw and grasses had given favourable results with regards to soil moisture and physico-chemical attributes of soil and earthworm population in basin soil. Paddy straw mulches were found to be more effective in producing maximum growth than rest of the mulching treatments. Plants treated with paddy straw mulch recorded highest yield 09.00 kg/plant and 42.15 kg/plant during 2005 and 2006. TSS, total sugar, total phenols and vitamin C were observed maximum with paddy straw followed by maize straw mulch. Among the evaluated organic mulches, paddy straw had showed better response followed by maize straw. In view of the superiority over other organic mulches, use of paddy straw as mulch material over long period needs to be popularized for increasing the productivity of aonla orchards in rainfed condition under semi-arid ecosystem.

Keywords: Soil moisture, mulching, aonla, pH, EC and hydraulic conductivity.

INTRODUCTION

Aonla or Indian gooseberry (*Emblica officinalis* Gaertn) is one of the important fruits from Ayurvedic consideration as well as nutritional point of view. Now, it has become important fruit crop of arid and semi- arid region of the country owing to its hardiness, high productivity, suitability for growing varied agro-climatic conditions and its utilization in cosmetic, pharmaceutical and processing industry, which attracts the growers for its cultivation under rainfed condition, where growth and development of the plant depend upon rain received during Monsoon, organic mulches play significant role in such region. In spite of no assurance of irrigation in these regions, the moisture conservation technique is not in practice. The organic mulches not only conserve the soil moisture but also add nutrition in soil, which is useful for profitable cultivation of fruit crop under dry land condition. Mulches impart manifold beneficial effect, like extreme fluctuation of soil temperature, reduced water loss through evaporation, resulting more stored soil moisture (Shirugure *et al.*, 12), maintenance of soil fertility (Thakur *et al.*, 14), suppression of weed growth (Bhutani *et al.,* 2), improvement in growth and yield (Pande, 8). Continuous use of organic mulches is helpful in improving the soil physico-chemical properties, microbial flora and soil aeration, which ultimately resulted into better growth and yield of plant (Rao and Pathak 9). Keeping the beneficial effect of organic mulches in back ground, this experiment was undertaken to assess the organic mulches on soil properties, earthworm population, growth, yield and quality attributes of *aonla* under rainfed condition of semi- arid ecosystem.

Corresponding author's present address: Central Horticultural Experiment Station, Vejalpur, Panchamahals Godhra 389340, Gujarat, E mail: aksbicar@yahoo.co.in

MATERIALS AND METHODS

A study was carried out on four- years- old plants of 'NA-7'aonla which were planted in 2001 at distance of 10 m x 10 m was treated with various types of organic mulches at Central Horticultural Experiment Station, Vejalpur, during the year's 2005 to 2006. The treatments were: paddy straw, maize straw, rice husk, grasses, *subabul* lopping and control (no mulch). The experiment was set on in randomized block design with 6 treatments and 4 replications considering two plants as unit to present one treatment. All mulching treatments each in 20 kg quantity were imposed uniformly on the basin over a surface of 4 m^2 in September. These mulching materials

were thoroughly incorporated in the basin soil at the end of Monsoon The soil type was clay-to-clay loam with available N (150.25 kg/ha), P (6.23 kg / ha) and K (145.50 kg /ha) and organic carbon (0.31%), while EC and p^H, bulk density and hydraulic conductivity of soil were 0.14 dSm^1, 7.95, 1.43 g/c and 0.27 cm/hr, respectively. The soil depth ranges from 0.75 to 1.0 m, derived from mixed alluvial basalt, quartzite, granite and layers of limestone, and falls under semi-arid hot climate. The NPK doses were applied @ 400g, 200g and 300g/ tree during 2005 and 500g, 250g and 375 g/ during 2006, respectively. The uniform cultural practices were applied to the experimental trees, which were grown purely under rainfed condition.

RESULTS AND DISCUSSION

Increase in soil moisture content from 50 to 260 days after mulching treatment was significant at both the depth of soil (0-15 cm and 15-30 cm). The higher soil moisture content was recorded in all the organic mulches than control at 0-15 cm and 16-30 cm depth during the year 2005 and 2006 after 50 days of mulching at both depths (Table 1). Amongst the organic mulches evaluated, soil moisture content was recorded highest with paddy straw mulch followed by and showed significant increase in soil moisture at both the depth (0-15 cm-16 – 30 cm).This confirms with the results in aonla of Rao and Pathak (9) and (Pande *et al.*,8). Increased soil moisture content below the mulches in various organic mulching treatments might be due to reduction in soil surface evaporation, increased infiltration percolation capacity of soil, suppression in extreme fluctuation of soil temperature thus retaining the soil moisture in the soil for longer duration.

The data pertaining to soil properties presented in Table 2 indicate that the various types of organic mulches influenced these parameters over control. All the organic mulches exhibited significant improvement as compared to control. Amongst the organic mulches evaluated, paddy straw showed better response followed by maize straw, grasses and subabul lopping. The bulk density showed reverse trend and as result control (no mulch) exhibited maximum bulk density (1.42g/cc) followed by rice husk (1.37g/cc) and it was recorded minimum with paddy straw (1.27g/cc). Maximum hydraulic conductivity was recorded with paddy straw (0.45 cm/hr) followed by maize straw (0.40 cm/ hr) and *subabul* loppings (0.39 cm/ hr), while it was recorded minimum with control (0.31 cm/hr). It was observed that paddy straw; maize straw, grasses and *subabul* loppings decomposed almost after rainy season and added lot of humus to the soil (Borathakur and Bhattacharya, 3).

Considerable improvement was also observed in

Table 1. Soil moisture content at 0-15 cm and 16-30 cm below soil surface (2005-2006)

Mulching treatments	Soil moisture content under the mulches (%) Days after mulching (DAM)															
	50DAM		80 DAM		110 DAM		140 DAM		170 DAM		200 DAM		230 DAM		260 DAM	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Maize straw	21.15	23.35	19.76	20.59	18.69	19.60	16.70	17.33	15.57	16.25	14.66	15.22	14.00	14.66	13.55	14.60
Paddy straw	21.42	23.60	20.18	20.57	19.89	20.00	18.00	18.26	17.52	18.68	16.47	16.67	16.20	16.45	14.53	15.66
Rice husk	18.15	19.31	18.74	18.68	18.78	18.25	16.09	16.66	15.63	15.57	14.88	13.09	13.60	13.85	13.58	12.49
Grasses	20.25	21.37	19.42	20.35	17.30	18.06	16.40	16.97	15.67	16.66	14.68	15.00	14.09	14.61	13.14	14.50
Subabul loppings	20.35	22.58	19.45	20.49	18.35	19.09	16.00	16.84	15.29	15.33	13.94	14.85	13.77	13.09	12.25	13.25
Control	17.68	18.59	17.19	17.37	16.04	16.11	15.59	15.84	14.29	13.47	13.15	13.13	12.58	12.80	12.00	12.25
CD (P=0.05)	2.10	1.95	1.60	1.45	1.30	1.35	1.82	1.37	1.60	2.00	1.15	1.06	1.55	1.65	1.35	1.45
At 15-30 cm below soil surface																
Maize straw	22.68	23.58	21.25	23.40	19.75	22.55	18.90	21.45	17.73	20.22	17.09	19.00	16.25	18.00	16.06	17.11
Paddy straw	23.24	24.24	21.64	23.95	20.06	22.68	19.25	21.95	18.15	20.49	18.00	19.29	17.00	18.55	17.44	17.25
Rice husk	19.34	20.36	19.41	19.51	19.19	18.67	18.33	17.85	16.85	17.83	17.55	16.35	16.10	15.19	15.99	14.00
Grasses	22.39	23.80	21.52	23.35	19.62	22.20	18.50	21.22	17.18	19.96	16.32	17.37	16.00	16.33	15.60	15.80
Subabul loppings	22.34	23.59	21.35	20.26	19.35	19.55	18.49	19.00	17.00	19.60	16.30	17.00	15.95	15.838	15.45	15.65
Control	17.79	18.49	17.06	18.49	16.74	18.09	16.97	17.98	16.36	16.00	16.28	16.16	15.33	16.77	15.09	15.67
CD (P= 0.05)	2.10	2.21	1.86	2.12	1.95	2.00	1.50	2.11	1.84	2.06	1.62	1.15	0.95	1.10	1.00	1.30

DAM= Days after mulching, NS= Non Significant

chemical properties of soil by the application of mulches. The soil *pH* and EC of the tree basin exhibited some reduction in their values, but the difference were non significant. Organic carbon, N, P and K were recorded highest in paddy straw while lowest was recorded with control. These findings are with the agreement of the results as reported by Shirgure *et al.* (12), Pande *et al.* (8) and Kamal *et al.* (4).

Earthworm population increased in the basin soil by applying the various types of organic mulches than control (Fig.1). Earthworm population were recorded maximum in the paddy straw mulch (55.77 and 66.66) followed by maize straw (52.77 and 55.55) and grasses (44.44 and 55.55) and it was recorded lowest under control (33.33 and 44.44) during the both the years of experimentation (2005 and 2006) in 0.3 m^3 volume of the basin soil. The increase in the earthworm population in the soil may be due to increase in soil moisture and organic carbon in the soil colloidal complex.

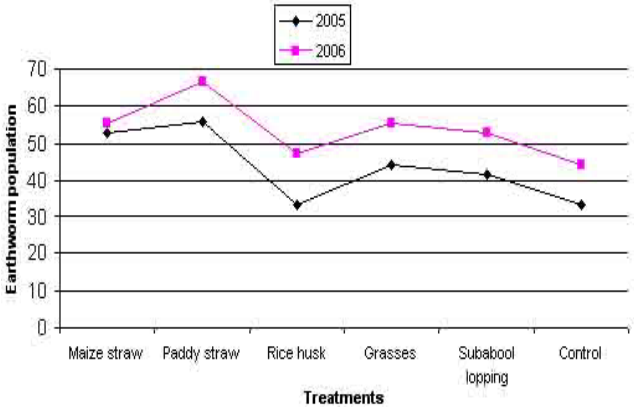

Fig. 1. Effect of organic mulchs on earthworm population in 0.3 m^3 soil

Table 3 indicated that different types of organic mulches influenced the growth of NA-7 aonla in terms of plant height, rootstock, growth, scion girth and plant spread than control. The increase in plant height, rootstock, growth, scion girth and plant spread was recorded significantly highest in paddy straw mulch followed by maize straw, but the differences between two treatments could not reach the level of significance. The increase in growth of plant may be due to increase in availability of soil moisture, nutrients and moderate evaporation from soil surface (Shirgure *et al*, 12). The lowest growth was recorded under control (no mulch) followed by rice husk in all the evaluated organic mulches. High evaporation and less nutrient availability to the plant might have caused less growth in the plants (Rao and Pathak, 9 and Reddy and Khan, 11). Mulching with maize straw, *subabul* loppings, grasses were found to be intermediate in their influence on plant growth. These findings are in close conformity with the results

Table 2. Effect of mulching on physico-chemical properties of soil (Average of 2005-2006).

Treatments	*pH*	EC (dSm^{-1})	BD (g/cc)	H.C. (cm/hr)	OC (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)
Maize straw	7.15	0.10	1.28	0.40	0.55	165.20	10.45	155.00
Paddy straw	7.10	0.09	1.27	0.45	0.58	170.15	11.10	158.18
Rice husk	7.60	0.10	1.37	0.34	0.37	156.00	10.00	151.00
Grasses	7.50	0.10	1.30	0.37	0.48	161.00	10.25	152.15
Subabul loppings	7.45	0.10	1.29	0.39	0.53	163.00	10.45	154.87
Control	7.80	0.13	1.42	0.31	0.33	150.00	7.50	150.00
CD (P=0.05)	NS	NS	0.10	0.04	0.05	15.95	1.05	06.75

BD= Bulk density, H C = Hydraulic Conductivity, EC= Electrical conductivity, OC= Organic Carbon NS= Non significant

Table 3. Effect of mulches on vegetative growth of Aonla (2005-2006).

Treatments	Plant height (m)		Root stock girth (cm)		Scion girth (cm)		Plant spread (m)		Plant spread (m) N-S	
	2005	2006	2005	2006	2005	2006	E-W 2005	N-S2006	2005	2006
Maize straw	3.95	4.80	24.15	35.00	19.00	28.15	2.60	3.30	2.40	3.15
Paddy straw	4.00	4.87	25.46	37.47	20.45	29.45	2.65	3.35	2.41	3.20
Rice husk	3.80	4.65	22.00	32.16	15.15	25.13	2.50	3.00	2.25	3.00
Grasses	3.90	4.75	23.12	33.17	17.17	26.13	2.58	3.25	2.35	3.10
Subabul loppings	3.92	4.78	24.00	34.15	18.14	27.16	2.58	3.28	2.35	3.12
Control	3.70	4.55	20.00	29.19	14.40	22.16	2.40	2.95	3.15	2.90
CD (P=0.05)	0.21	0.19	1.61	2.73	1.26	2.09	0.15	0.22	0.19	0.15

of Rao and Pathak (10 and 9) in aonla. The higher soil moisture availability, addition of nutrients, increase in earthworm population in tree basin soil and less weed growth associated with mulches can be attributed to higher extension of growth under various mulching treatment. The positive response of organic mulches on growth characteristics may be attributed to improved physico-chemical properties of soil and congenial environment to the root zone. More or less similar results have been reported by Autio *et al.* (1), Borathakur and Bhattacharya (4) Pande *et al.* (8) and Shukla *et al.* (13).

The fruit yield and yield-attributing parameters of NA-7 aonla were greatly influenced by different organic mulches (Table 4). Plants treated with various mulches were more pronounced for fruit yield as compared to control. Mulching with paddy straw recorded maximum growth, resulting in increased yield. The maximum fruit yield was recorded with paddy straw (9.00 kg and 41.50 kg/ plant) followed by maize straw (8.90 kg and 40.00 kg/ plant), while lowest was recorded in control (8.00 kg and 37.50 kg plant) during both the years (2005-2006). The differences between maize and paddy straw could not reach the level of significance. Yield with mulches by using maize straw, grasses and *subabul* loppings were found to be intermediate, but superior to control (no mulch), and they were statistically at par among themselves with respect to fruit yield. The increase in yield was mainly attributed to increase in availability of soil moisture and nutrients for longer duration to the plant. Similar results of increased yield due to mulches were reported in citrus and apple fruit crops (Nielsen *et al*, 7 and Shirgure *et al*, 12).

Table 4. Effect of mulches on fruit yield and quality attributes of Aonla (2005-2006).

Treatments	Yield/plant (kg)		Yield/ha (Q)		Fruit weight (g)		Fruit diameter (cm)		Fruit length (cm)		TSS (%)		Totalsugar (%)		Total phenols (mg/100g)		Acidity (%)		Vitamin C (mg/ 100g)	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Maize straw	8.90	40.00	8.9	40.00	49.15	41.15	4.30	4.18	4.20	3.85	7.90	8.10	4.90	5.00	170.15	170.12	2.15	2.10	492.15	494.15
Paddy straw	9.00	41.50	9.00	41.50	50.00	43.16	4.50	4.25	4.30	4.00	8.00	8.25	5.00	5.15	172.50	173.45	2.00	1.98	497.70	498.00
Rice husk	8.15	38.10	8.15	38.10	47.00	40.00	4.25	4.00	4.10	3.80	7.80	7.90	4.45	4.90	165.00	166.66	2.30	2.25	474.10	476.14
Grasses	8.52	39.50	8.52	39.50	48.15	41.15	4.20	4.15	4.05	4.05	7.90	8.15	4.65	4.95	168.12	169.10	2.25	2.70	492.15	493.00
Subabul lopping	8.50	39.00	8.50	39.00	47.15	41.00	4.15	4.05	4.00	3.95	7.85	8.00	4.60	4.85	166.00	167.80	2.30	2.25	487.15	490.10
Control	8.00	37.50	8.00	37.50	46.00	39.00	4.00	3.95	3.80	3.70	7.80	7.85	4.40	4.75	165.12	165.70	2.32	2.30	472.80	478.40
CD (P=0.05)	0.25	1.50	—	—	1.75	1.42	0.10	0.05	0.25	0.21	0.12	0.11	0.20	0.22	3.15	3.85	NS	NS	15.50	14.48

The fruit quality attributes were also influenced by different organic mulching (Table 4). Highest fruit weight (50.00 g and 43.16 g), fruit diameter (4.50 cm and 4.25 cm) and length (4.30 and 4.00 cm), TSS (8^0 and 8.25^0Brix), total phenols (172.50 and 173.450 mg/100g), vitamin C (497.70 and 498.00 mg/ 100g) were recorded with paddy straw closely followed maize straw and grasses. The chemical attributes of aonla fruits were found to be moderate in maize straw, grasses and *subabul* lopping and they were found non significant for quality attributes. The lowest fruit weight (46.00 g and 39.00 g), fruit diameter (4.00 cm and 3.95 cm), length (3.80 cm and 3.70 cm), TSS (7.8^0 and 7.85^0 Brix), total phenols (165.12 mg and 165.70 mg/100g) and vitamin C (472.80 mg and 478.40 mg/100g) were observed under control (no mulch) during both the years. However, acidity was found non significant. These findings are in agreement with results of Shirgure (12) in Nagpur mandarin and Reddy and Khan (11) in sapota, Moor *et al,* (6) in strawberry.Thus, paddy straw mulch was found

most effective for improvement of soil properties and yield of aonla with quality fruits.

REFERENCES

1. Autio, W.R., Greene, D.W., Cooby, D.R. and Schopp, J.R. 1991. Improving the growth of newly planted apple trees. *Hort. Sci.* **28**: 840-43.
2. Bhutani, V.R., Khokhar, U.U. and Raina, V.P. 1994. Effect of herbicides, mulching and clean cultivation on weed population growth and cropping of apple trees. *Hort. J.* **7**: 7-13.
3. Borathakur, P.K. and Bhattacharya, R.K. 1992. Organic mulches in Guava orchards. *Indian Hort.* **37**: 43-44.
4. Kamal, K.K., Dimri, D.C. and Singh, S.C. 2006. Effect of mulching on soil and leaf nutrient status of apple (*Malus domestica* Borth). *Progressive Hort.* **38**: 91-95.
5. Mandal, A. and Chattopadhyay, P.K. 1994. Growth and yield of Custard Apple as influenced by soil cover. *Indian J. Hort.* **51**: 146-49.
6. Moor, U. Karp, K. and Poldma, P. 2004. Effect of mulching and fertilizers on the quality of strawberry. *Agric. Food Sci.* **13**: 256-57.
7. Neilsen, G. H., Hogue, E.J., Forge, T. and Neilsen, D. 2003. Mulches and biosolides affect vigour, yield and leaf nutrition of fertigated high density apple. *Hort. Sci.* **38**: 41-45.
8. Pande, K.K., Dimri, D.C. and Prashant Kamboj. 2005. Effect of various mulches on growth, yield and quality of Apple. *Indian J. Hort.* **62**:145-47.
9. Rao, V.K. and Pathak, R.K. 1998. Effect of mulches on Aonla (*Emblica officinalies* Gaertn) orchard in sodic soil. *Indian J. Hort.* **55**: 27-37.
10. Rao, V.K. and Pathak, R.K. 1996. Effect of mulches on soil properties in Aolna orchards established on sodic soil. *Indian J. Hort.* **53**: 251- 254.
11. Reddy, Y.T.N. and Khan, M.M. 1998. Effect of mulching treatment on growth and water relation and fruit yield of Sapota (*Monilkara achras*). *Indian J. Agri. Sci.* **68**: 657-60.
12. Shirgure, P. S, Sonkar, R. K, Singh, S. and Panighrah, P. 2003. Effect of different mulches on (*Citrus reticulata*). *Indian J. Agri. Sci.* **73**:148-52.
13. Shukla, A.K., Pathak, R.K., Tiwari, R.P. and Nath Vishal. 2000. Influence of irrigation and mulching on plant growth and leaf nutrient status of aonla under sodic soil. *J. Applied Hort.* **2**:37-38.
14. Thakur, G.C., Chadha, T.R., Kumar, J. and Verma, H.S. 1997. Effect of clean cultivation, mulching and sod culture on mineral nutrition and root growth of apple cv. Red Delicious. *Indian J. Agri. Sci.* **54**:53-57.

Received: August, 2008; Revised: April, 2010
Accepted: August, 2010