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Efficacy of organic and inorganic mulching materials on weed count, growth, and yield of aonla (*Emblica officinalis*) cv. NA 7

MUDASIR IQBAL[1], PARSHANT BAKSHI[2], V K WALI[3], RAKESH KUMAR[4], DEEPJI BHAT[5] and AMIT JASROTIA[6]

Sher-e-Kashmir University of Agricultural Sciences and Technology-Jammu, Jammu and Kashmir 180 009

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ABSTRACT

Studies were carried out in NA 7 cultivar of aonla (*Emblica officinalis* Gaertn) to assess the efficacy of organic and inorganic mulching materials on growth, flowering and yield during 2013 and 2014. Treatments consisted of mulching materials, viz. black polythene, white polythene, paddy straw, saw dust, sarkanda, dry grass with control (unmulched). The results indicated that maximum increase in tree height (0.55 m), tree spread in north-south (0.23 m) and east-west (0.17 m) and tree volume (11.11 cm^3) was recorded in black polythene mulch, while it was minimum in control. The black polythene mulch reduced the weed growth in terms of count and weight by cent per cent. As far as floral characteristics, plant with black polythene mulch were the first to flower (11 April 2013), with maximum duration of flowering (23 days) and male : female flower ratio (22:1). Black polythene mulch was superior to all other mulching treatments in terms of yield attributes as it registered maximum fruit set (56.15%), minimum fruit drop (55.87%) and higher yield/tree (72.77 kg/tree). Thus, it can be concluded that black polythene improved the tree growth, flowering, fruit production and lowered weed population of aonla cv. NA 7 as compared to control in rainfed areas.

Key words: Aonla, Flowering, Growth, Mulching, Weed count, Yield

Mulching is a practice, which helps in proper growth and development of the plants by modifying soil temperature, providing better nutrient availability and better moisture conservation (Kher *et al.* 2010). The uses of mulches help to reduce water consumed (Keramat *et al*. 2011). The main functions that mulches provide include: weed suppression, soil water conservation, moderation of soil temperature fluctuations (daily and seasonal), increased infiltration of water droplets from precipitation or irrigation, soil protection from traffic compaction, improved soil structure for organic mulches and the slow release of nutrients. Mulches not only conserve soil moisture but also impart manifold beneficial effects, like suppression of extreme fluctuation of soil temperature and reduction of water loss through evaporation, resulting is more stored soil moisture (Shirgure *et al*. 2003), maintenance of soil fertility (Slathia and Paul 2012). The requirement of water through mulch can further be reduced by using locally available organic materials as mulches which not only save irrigation water but also conserves soil moisture. Various studies have indicated that in fruit crops like apple, sapota and acid lime, mulching improves soil moisture status, growth, yield and quality of these fruits, besides reducing weed growth (Shirgure *et al*. 2005, Abouziena *et al*. 2008). Continuous uses of organic mulches are helpful in improving the physic-chemical, microbial flora and soil aeration (Rao and Pathak 1998). Moreover, mulching with plastic polyethylene is found effective in conserving the soil moisture and increasing the growth, yield and quality in different citrus cultivars (Lal *et al*. 2003, Shirgure *et al*. 2005). Considering the beneficial effect of mulching, the present investigation was undertaken to assess the effect of organic and inorganic mulches on weed count, growth, flowering, and yield of aonla (*Embilca officinalis* Gerent) under rainfed conditions.

MATERIALS AND METHODS

The present investigation was carried at Rainfed Research Sub-station for Sub-tropical Fruits, Raya, Jammu and Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu during 2013 and 2014. The experimental field is situated at an elevation of 332 m above mean sea level and lies between 32°39" North latitude and 74°53" East longitude. The climate of experimental site is sub-tropical with hot and dry summer, hot and humid, rainy season and cold winter months. The maximum temperature rises up to 45°C during summer and minimum temperature falls to 3.16^{0}C during winter. The

[1]Research Scholar (e mail: mudasirkas111@gmail.com), [2]Associate Professor (e mail: bakshi_parshant@rediffmail.com), [3]Professor (e mail: vinod_wali@hotmail.com), [4]Junior Scientist (e mail: rakesh_sangwal@yahoo.com), [5]Assistant Professor (e mail: mailme_deepji@rediffmail.com, [6]Assistaant Professor (e mail: jasrotiaamit2k1@rediffmail.com), Divsion of Fruit Science.

mean annual rainfall is about 1 000-1 200 mm. Soil of the experimental field was sandy loam in texture, having pH: 6.50, organic carbon: 0.50%, available N: 174.50 kg/ha, available P: 15.80 kg/ha and available K: 140.00 kg/ha. Experiment was laid out in a Randomized Block Design with seven treatments, viz. T_1 (black polythene), T_2 (white polythene), T_3 (paddy straw), T_4 (saw dust), T_5 (sarkanda), T_6 (dry grass) and T_7 control (unmulched). All the treatments were replicated four times. Application of treatments was done during the spring season, viz. 19 February both during 2013 and 2014. During the course of study, all the trees were given uniform cultural operations as per the package of practices for fruit crops of SKUAST-Jammu. The data were subjected to statistical analysis as per the method of Gomez and Gomez (1996). Critical Difference (CD) at 5% level was used for finding the significance differences if any, among the treatment means.

Permanent one square meter quadrants was randomly fixed in the basin of each treatment in the month of November and numbers of weed/m^2 were recorded. Then, fresh weight of weeds was recorded immediately after removal. The dry weight was noted after drying the weeds in an oven at 65^0C for 48 hr. The results were expressed as dry weight in gram. Height and spread (east-west and north-south) of the tree (before the start of the experiment and nine months after the mulching treatments) was recorded with the help of a marked bamboo stick expressed in meters. The tree volume was calculated from height and spread of tree by using the following formula of Westwood (1993):

$$\text{Volume (v)} = 4/3\ \pi r^2 h$$

where, r, tree spread from east-west (m) and north-south (m); h , height of the tree (m); π , 3.14.

The first appearance of flower on any branch was considered as the date of start of flowering. Observations were recorded regularly from tagged branches. The male and female flower ratio of each treatment was determined on tagged branchlets up to 8 cm from the base. The day on which more than 70% flowers were opened was considered as date of full bloom. The record was made date-wise for each treatment. The date of end of flowering was recorded when almost all the flowers of a tree were opened and there after no more flowering takes place. The duration of flowering was calculated by counting the total number of days required from commencement of flowering to end of flowering. Fruits of different treatments matured at different dates after the fruit attained the specific gravity above one and transparency in pulp and the corresponding dates were recorded accordingly. Days taken from full bloom to maturity were calculated by counting the total number of days required from full bloom to maturity for each treatment. During fruit development, the numbers of fruit on the tagged branches were counted to determine per cent fruit set. Per cent of fruit set was computed by using formula suggested by Westwood (1978).

$$\text{Fruit set (\%)} = \frac{\text{Total number of fruit set}}{\text{Total number of female flowers}} \times 100$$

Number of fruits present on the randomly selected branches of the trees at the time of fruit set was recorded and number of fruits retained on these branches till maturity was recorded. The recorded data was expressed as per cent fruit drop.

$$\text{Fruit drop (\%)} = \frac{\text{Final fruit retention}}{\text{Initial fruit set}} \times 100$$

Total number of fruits in each replication were counted. The counting was made two to three times for minimizing the counting error. The fruits harvested from each tree were weighed on electronic balance. The crop load removed from the tree during harvesting season of 2013 was recorded as yield/ tree and expressed in kg/plant.

RESULTS AND DISCUSSION

Weed count and tree growth

In the present investigations (Table 1) black polythene mulch showed significant superiority in reducing weed population by cent per cent followed by paddy straw mulch (82/m^2). The highest weed population (105/m^2) was observed in control. The less number of weed population/density under black polyethylene mulching might be due the preventive effect of mulch on light penetration that acted as physical barrier affecting the growth of most of the annual and perennial weeds. It might create partially anaerobic conditions for the survival of weed species and thus finally resulting in very low weed density. These findings are in agreement with the work of Shirgure *et al*. (2003) who reported cent per cent control of weeds in Nagpur mandarin by black polythene mulch. Similarly, Yadav *et al*. (2004) also observed 80-90% control of weeds in ber with black polythene mulch. The significant effect of different mulching materials observed in the present study is also in conformity with the work of Kaur and Kaundal (2009), and Sharma and Kathiravan (2009). In the present study (Table 1) black polythene mulch showed no fresh and dry weight of weeds as it provides cent per cent weed control while, the significant minimum fresh weight (70.10 g/m^2) and dry weight (2.09 g/m^2) of weeds was observed under paddy straw mulch. The maximum weed fresh weight (173 g/m^2) and dry weight (8.90 g /m^2) was observed under control. Similar results

Table 1 Effect of mulching on number of weeds, fresh weight and dry weight of weed population of aonla cv. NA 7

Treatment	Number of weeds	Fresh weight of weeds (g)	Dry weight of weeds (g)
T_1 : Black polythene	0	0	0
T_2 : White polythene	89.00	138.33	7.10
T_3 : Paddy straw	82.00	70.10	2.09
T_4 : Saw dust	83.00	81.13	3.01
T_5 : Sarkanda	85.00	93.33	4.86
T_6 : Dry grass	86.66	105.00	6.16
T_7 : Control	105.00	173.33	8.90
CD (P=0.05)	3.01	18.73	0.04

regarding dry weight of weeds was reported by Rao and Pathak (1998) in aonla plants under sodic soil. They observed that black polythene mulch showed minimum dry weight as compared to other mulches and control.

The perusal of data (Table 2) revealed that maximum increase in tree height (0.55 m) was recorded under black polythene, followed by paddy straw mulch (0.43 m) as against minimum increase in height of 0.31 m in control. Increase in plant height with mulching of black polythene has also been reported in Nagpur mandarin (Gaikwad *et al*. 2002), strawberry (Sharma and Khokhar 2006, Singh *et al*. 2007), guava (Das *et al*. 2010) and acid lime (Shirgure 2012). The effect of different mulching materials on tree spread (Table 3) was found to be non-significant. However, the tree spread of east-west direction was maximum in black polythene mulch (0.17 m) and paddy straw mulch (0.16 m), while it was minimum in control (0.13 m). The tree spread of aonla cv. NA 7 in north-south direction was maximum in black polythene (0.23 m) followed by paddy straw mulch (0.22 m) and minimum in control (0.18 m). A similar variation in plant spread of mango was observed by (Bal 1995). The maximum increase in tree volume (Table 4) of 11.11 m^3 was recorded under black polythene mulch which was found at par with paddy straw mulch (10.68 m^3). The minimum increase in tree volume of 7.38 m^3 was recorded in control. The enhancement of growth in the present study may be attributed to better hydrothermal regimes, better moisture conservation, enhancement in photosynthesis and other metabolic activities, suppression of weed growth and increased availability of nutrients under black polythene mulch than other treatments.

Table 2 Effect of mulching on tree height of aonla cv. NA 7

Treatment	Tree height (m)		Increase in tree height (m)
	Before mulching (18-02-2013)	9 months after mulching	
T_1 : Black polythene	5.24	5.79	0.55
T_2 : White polythene	5.67	6.04	0.37
T_3 : Paddy straw	5.27	5.70	0.43
T_4 : Saw dust	5.53	5.90	0.37
T_5 : Sarkanda	5.31	5.64	0.33
T_6 : Dry grass	5.43	5.78	0.35
T_7 : Control	5.61	5.92	0.31
CD (P=0.05)	0.07	0.03	0.04

Table 3 Effect of mulching on tree spread of aonla cv. NA-7

Treatment	Tree spread (m)					
	Before mulching (18-02-2013)		9 months after mulching (18-11-2013)		Increase in tree spread (m)	
	North-South	East-West	North-South	East-West	North-South	East-West
T_1 : Black polythene	3.04	2.41	3.27	2.58	0.23	0.17
T_2 : White polythene	3.21	2.65	3.42	2.80	0.21	0.15
T_3 : Paddy straw	3.06	2.42	3.28	2.58	0.22	0.16
T_4 : Saw dust	3.14	2.52	3.36	2.68	0.22	0.16
T_5 : Sarkanda	3.09	2.44	3.28	2.58	0.19	0.14
T_6 : Dry grass	3.11	2.48	3.32	2.63	0.21	0.15
T_7 : Control	3.17	2.60	3.35	2.73	0.18	0.13
CD (P=0.05)	0.02	0.04	0.03	0.02	NS	NS

Flowering and fruiting behaviour

The data regarding effect of mulching on commencement of flowering, date of end of flowering, duration of flowering and male: female flower ratio is presented in Table 5. Flowering commenced earliest with black polythene (11 April) closely followed by paddy straw and saw dust (12 April). The start of flowering was delayed in control, which was observed on 15 April. Similar results were also obtained in strawberry (Singh and Asrey, 2005), ber (Singh, 2007) and strawberry (Singh *et al*. 2007). Among different treatments, sarkanda, white polythene and unmulched control were first to complete flowering phase (1 May). The date of end of flowering in paddy straw mulch (3 May) and black polythene mulch (4 May) was delayed. The results obtained are also in conformity with the findings of Pande *et al*. (2005). Maximum bloom duration (23 days) was observed under black polythene mulch followed by paddy straw mulch (21 days), while control recorded minimum bloom duration (16 days). Similar findings were reported in strawberry (Ali and Gaur 2007) and ber (Bal and Singh 2011). Black polythene mulch produced least male: female flower ratio (22.17: 1) followed by paddy straw mulch (22.96: 1). The maximum male: female flower ratio was found in unmulched control (25.04: 1). These results are in agreement with the findings of Karale *et al*. (1991). Banik *et al*. (2011) who reported the minimum hermaphrodite flowers per panicle with control. The increase in soil temperature and availability of soil moisture for longer duration under black polythene mulch might be responsible for the enhanced plant growth and development, which lead to early and longer flower durations.

The data regarding date of fruit maturity and days taken

Table 4 Effect of mulching on tree volume of aonla cv. NA 7

Treatment	Tree volume (m^3)		Increase in tree volume
	Before mulching (18-02-2013)	9 months after mulching (18-11-2013)	
T_1 : Black polythene	40.66	51.77	11.11
T_2 : White polythene	50.87	60.02	9.15
T_3 : Paddy straw	41.35	52.03	10.68
T_4 : Saw dust	46.28	56.23	9.95
T_5 : Sarkanda	42.42	50.59	8.17
T_6 : Dry grass	44.33	53.46	9.13
T_7 : Control	48.79	56.17	7.38
CD (P=0.05)	0.04	0.02	1.52

Table 5 Effect of mulching on date of first flowering, date of end of flowering, duration of flowering and male : female ratio of aonla cv. NA 7

Treatment	Date of first flowering	Date of end of flowering	Duration of flowering (Days)	Male : Female ratio
T_1 : Black polythene	2nd week of April (11)*	1st week of May (4)	23	22.17:1
T_2 : White polythene	2nd week of April (14)	1st week of May (1)	17	23.03:1
T_3 : Paddy straw	2nd week of April (12)	1st week of May (3)	21	22.96:1
T_4 : Saw dust	2nd week of April (12)	1st week of May (2)	20	23.95:1
T_5 : Sarkanda	2nd week of April (13)	1st week of May (1)	18	24.13:1
T_6 : Dry grass	2nd week of April (13)	1st week of May (2)	19	23.37:1
T_7 : Control	3rd week of April (15)	1st week of May (1)	16	25.04:1

*Figures in parenthesis are respective dates.

from full bloom to maturity is presented in Table 6. The earliest full bloom (25 April) was observed in black polythene mulch closely followed by paddy straw mulch (26 April), whereas it was delayed in control (29 April). The present findings are also in agreement with those of Singh (2007) who reported earliest full bloom of ber under black polythene mulch. The fruit maturity was noted earlier in black polythene mulch (15 December) followed by paddy straw mulch (20 December), whereas the date of fruit maturity was delayed under control (30 December). The minimum number of days for fruit maturity were observed in black polythene mulch (234 days), followed by paddy straw mulch (238 days) whereas, the maximum number of days from full bloom to maturity were recorded in unmulched control (245 days). This may be attributed due to differed soil hydrothermal regimes, better moisture conservation and higher soil temperature with the use of black polythene mulch. These results are in consonance with the findings of Singh and Asrey (2005) and Singh *et al*. (2007) in strawberry.

Yield of aonla

The data on the effect of mulching materials on fruit set, fruit drop and yield of aonla cv. NA 7 presented in Fig 1, revealed that maximum fruit set of 56.15% was recorded under black polythene mulch followed by 55.42% in paddy straw mulch, while least fruit set (51.86%) was recorded in control. These results are in conformity with the findings of (Thakur *et al*. 1997, Kumar *et al.* 1999, Mukherjee *et al*. 2004). Maximum fruit drop (59.01%) was recorded under control (unmulched) followed by 59.32% in dry grass mulch, whereas the minimum fruit drop of 55.87% was recorded under black polythene mulch. These findings are in association with those of Ali and Gaur (2007), Pande *et al*. (2005), Ghosh and Bera (2006) and Das *et al*. (2010). Maximum fruit yield of 72.77 kg/plant was recorded under black polythene mulch followed by paddy straw mulch (70.35 kg/plant), whereas the minimum fruit yield was found in control (63.76 kg/plant). These results are also in line with those of Ghosh and Bauri (2003), Shirgure *et al*. (2003), Ali and Gaur (2007), Kumar *et al.* (2008); Kaur and Kaundal (2009), and Sharma and Kathiravan 2009).

From the study it can be inferred that the performance of various organic as well as inorganic mulches was better than control. However, black polythene mulch resulted in maximum growth, improved flowering characteristics and yield as well as reduction in weed population. Thus, it can be concluded that among all the different mulching treatments, the application of black polythene is most suitable under the sub-tropical rainfed conditions of Jammu.

Table 6 Effect of mulching on full bloom, date of maturity and days taken from full bloom to maturity of aonla cv. NA 7

Treatment	Full bloom	Date of maturity	Days taken from full bloom to maturity
T_1 : Black polythene	25 April	15 December	234
T_2 : White polythene	28 April	26 December	242
T_3 : Paddy straw	26 April	20 December	238
T_4 : Saw dust	27 April	22 December	239
T_5 : Sarkanda	28 April	25 December	241
T_6 : Dry grass	27 April	23 December	240
T_7 : Control	29 April	30 December	245

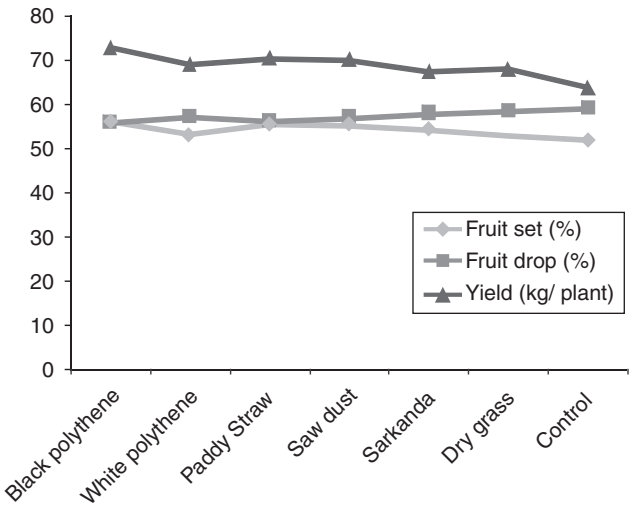

Fig 1 Effect of various mulching materials on fruit set, fruit drop and yield of aonla cv. NA 7.

REFERENCES

Abouziena H F, Hafez O M, El-Metwally I M, Sharma S D and Singh M. 2008. Comparison of weed suppression and mandarin fruit yield and quality obtained with organic mulches, synthetic mulches, cultivation, and glyphosate. *Hort Science* **43**(3): 795–9.

Agarwal S and Chopra C S. 2004. Studies on changes in ascorbic acid and total phenols in making aonla products. *Beverage and Food World* **31**: 32–4.

Ali A and Gaur G S. 2007. Effect of mulching on growth, fruit yield and quality of strawberry (*Fragaria* x *ananassa* Duch). *Asian Journal of Horticulture* **2**(1): 149–51.

Bal G S. 1995. 'Effect of mulching on tree growth, yield and fruit quality of mango cv. Dashehari.' M Sc thesis, Punjab Agricultural University, Ludhiana.

Bal J S and Singh S. 2011. Effect of mulching material and herbicides on tree growth, yield and fruit quality of ber. *Indian Journal of Horticulture* **68**(2): 189–92.

Banik B C, Singh S R and Irenaeus K S T. 2011. Effect of irrigation and organic mulching on flowering and fruit setting in mango cv. Amrapali. *Environment and Ecology* **29**(2): 517–9.

Das B C, Maji S and Mulieh S R. 2005. Response of soil covers on guava cv. L-49. *Journal of Crop and Weed* **6**(2): 10–4.

Gaikwad S C, Ingle H V and Panchbhai D M. 2002. A note on the effect of different types of mulches on growth, yield and quality of Nagpur mandarin. *Orissa Journal of Horticulture* **30** (1): 137–8.

Ghosh S N and Bauri F K. 2003. Effect of mulching on yield and physiochemical properties of mango fruits cv. Himsagar grown in rainfed laterite soils. *Orissa Journal of Horticulture* **31**(1): 78–81.

Ghosh S N and Bera B. 2006. Effect of watering and mulching on yield and fruit quality of jackfruit grown in laterite soil. *(In) Proceedings of the National Symposium on Production, Utilization and Export of Underutilized Fruits with Commercial Potentialities*, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, India, pp 150–3.

Gomez A K and Gomez A A. 1996. *Statistical Procedures for Agricultural Research,* 2ndEdn. John Willey and Sons Inc., New York.

Goyal R K, Patil R T, Kingsly A R P, Walia H and Kumar P. 2008. Status of postharvest technology of aonla in India-A review. *American Journal of Food Technology* **3**(1): 13–23.

Karale A R, Keskar B E, Dhanwale B S, Shele M B and Kale P N. 1991. Flowering, sex expression and sex ratio in Banarasi aonla seedling trees. *Journal of Maharastra Agricultural University* **16**: 270–2.

Kaur K and Kaundal G. 2009. Efficacy of herbicides, mulching and sod cover on control of weeds in plum orchards. *Indian Journal of Weed Science* **104**: 110–2.

Keramat A, Marivani B and Samsami M. 2011. Climatic change, drought and dust crisis in Iran. *World Academy of Science Engineering and Technology* **57**: 10–3.

Kher R, Jahangeer B and Bakshi P. 2010. Influence of planting time and mulching material on growth and fruit yield of strawberry cv. Chandler. *Indian Journal of Horticulture* **67**(4): 441–4.

Kumar D, Pandey V and Nath V. 2008. Effect of organic mulching and irrigation schedule through drip on growth and yield of 'Lal Sundari' mango (*Mangifera indica*) in eastern region of India. *Indian Journal of Agricultural Sciences* **78**: 385–8.

Kumar J, Rana S S, Rehalia A S and Verma H S. 1999. Long term effects of orchard soil management practices on growth, yield and fruit quality of apple (*Malus domestica* Borkh.). *Indian Journal of Agricultural Sciences* **69**: 355–8.

Lal H, Samra J S and Arora Y K. 2003. Kinnow mandarin in Doon Valley. 2. Effect of irrigation and mulching on water use, soil temperature, weed population and nutrient losses. *Indian Journal of Soil Conservation* **31**(3): 281–6.

Mukherjee S, Paliwal R and Pareek S. 2004. Effect of water regime, mulch and kaolin on growth and yield of ber. *Journal of Horticulture Science and Biotechnology* **79**(6): 91–9.

Pande K K, Dimri D C and Kamboj P. 2005. Effect of various mulches on growth, yield and quality of apple. *Indian Journal of Horticulture* **62**:145–7.

Rao V K and Pathak R K. 1998. Effect of mulches on aonla (*Emblica officinalis* Gaertn) orchard in sodic soil. *Indian Journal of Horticulture* **55**(1): 27–32.

Sharma C L and Khokhar U U. 2006. Effect of different mulches and herbicides on growth, yield and quality of strawberry (*Fragaria* × *ananassa* Duch.) cv. Chandler. (*In*) *Temperate Horticulture*: *Current Scenario,* pp 313–20. New India Publishing Agency, New Delhi.

Sharma J C and Kathiravan G. 2009. Effect of mulches on soil hydrothermal regimes and growth of plum in mid hill region of Himachal Pradesh. *Indian Journal of Horticulture* **66**(4): 465–71.

Shirgure P S. 2012. Sustainable acid lime fruit production and soil moisture conservation with different mulches. *Agricultural Engineering Today* **36**(3): 21–6.

Shirgure P S, Sonkar A K, Singh S and Panighrah P. 2003. Effect of different mulches on soil moisture conservation, weed reduction, growth and yield of drip irrigated Nagpur mandarin (*Citrus reticulata*). *Indian Journal of Agricultural Sciences* **73**(3): 148–52.

Shirgure P S, Singh S, Panighrah P and Sonkar R K. 2005. Evaluation of mulches for improving bearing acid lime. *Indian Journal of Soil Conservation* **33**(1): 62–6.

Singh I S. 1997. Aonla. *An Industrial profile.* N D University Agricultural and Technology, Faizabad.

Singh R and Asrey R. 2005. Growth, earliness and fruit yield of micro-irrigated strawberry as affected by planting time and mulching in semi arid regions. *Indian Journal of Horticulture* **62**(2): 148–51.

Singh R, Sharma R R and Goyal R K. 2007. Interactive effects of planting time and mulching on Chandler strawberry (*Fragaria* × *ananassa* Duch.). *Scientia Horticulturae* **111**: 344–51.

Singh S. 2007. *'Effect of mulching on tree growth, yield and fruit quality of 'Umran' ber'*. M Sc thesis, Punjab Agricultural University, Ludhiana.

Slathia P S and Paul N. 2012. Traditional practices for sustainable livelihood in Kandi belt of Jammu. *Indian Journal of Traditional Knowledge* **11**(3): 548–52.

Tanote P S and Singh S. 2006. Practical Action Technical Brief, pp 1–3.

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 Journal of Agricultural Sciences* **54**(1): 53–7.

Yadav A, Balyan R S, Malik R K, Bhatia S K and Banga R S. 2004. Management of weeds in ber (*Zizyphus rotundifolia*) nursery. *Haryana Journal of Horticultural Sciences* **33**(3–4): 202–3.