



Weed management in stone fruit nectarine orchard with inorganic mulches and herbicides

Sumeet Sharma* and D.P. Sharma

Department of Fruit Science, Dr YS Parmar University of Horticulture and Forestry,

Nauni, Solan, Himachal Pradesh 173 230, India

*Email: sumeetpomology@gmail.com

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ABSTRACT

The study has assessed the efficacy of different orchard floor management treatments on weed management in 'Snow Queen' nectarine. The experiment was carried out in a randomized block design consisted of seven treatments having four replicates during the years 2016 and 2017. It has been found that the different orchard floor management treatments had a significant effect on weed density, weed fresh and dry weight, fruit quality and fruit yield of nectarine. All inorganic mulches (black polythene mulch, bicolour polythene mulch and nylon mulch mat) showed their superiority and provide complete elimination of weeds. Bicolour polythene mulch recorded maximum fruit size, weight, volume and TSS, whereas black polythene mulch recorded maximum fruit yield during both the years of study.

INTRODUCTION

Nectarine [*Prunus persica* (L.) Batsch var. *nucipersica*] is one of the emerging stone fruit crops of Himachal Pradesh. The lack of skin fuzz make nectarine skin appears more reddish than those of peaches, providing fruit's plum-like appearance. It can be cultivated all over the state except, dry and cold region of Lahul and Spiti and Kinnaur districts. However, mid hill zone, especially Rajgarh and Kullu valley areas are the main centers of nectarine cultivation because of highly congenial agro climatic conditions. In Himachal Pradesh, among stone fruits, peach/nectarine ranks next only to plum with an area and production of 5090 ha and 4097 MT, respectively (Anonymous 2017). However, no separate area and production data is available on the commercial level of nectarine.

Weed management is one of the various problems faced by the nectarine growers in the state. Weed interference has been reported to affect tree growth, fruit yield and fruit quality in nectarine by competing for light, water and nutrients (Negi 2015) and also provide potential breeding niche for various insect/pests and diseases. Weeds are also known to secrete root exudates in soil which adversely affect the plant growth and ultimately the yield. However, the magnitude of the effect on fruit yield and size depends on the weed species (Tworkoski and Glenn 2001).

Proper orchard floor management is one of the most important and effective tools in successful orcharding of nectarine. It controls weeds, conserves soil moisture, prevents soil erosion, maintains soil organic matter and structure, improves water infiltration and nutrient retention, and thereby enhances the fruit quality (Derr 2001). Among the different components of orchard floor management, hand weeding is the traditional method of controlling the weeds. But this method has always vexed the growers, being expensive and time consuming in addition to continuous damage to feeder root system of fruit trees. So, the recent trend has been shifted to chemical weed control without damaging the feeder roots. But being economic and effective method of weed control, it tends to damage main crop if not properly applied and also tend to decrease soil porosity by hardening the upper layers of soil. Also, the increased pressure to reduce herbicide applications and new interests in organic farming underline the importance of alternative approaches for orchard weed suppression (Goh *et al.* 2001). Hence, to meet the multiple objectives of efficient weed control and quality fruit production mulches should be used. Mulch may be organic or inorganic in nature, and their use depends upon their availability in a particular area. Mulches create congenial condition for plant growth by temperature moderation, moisture conservation, salinity reduction and weed control. They also exert decisive effects on earliness, yield and quality of crop (Bhardwaj 2013).

Keeping in view the need of weed management the present study was conducted to study the efficacy of different orchard floor management treatments on weed management in nectarine cv. Snow Queen.

MATERIALS AND METHODS

The present study was carried out on 10 years old plants of 'Snow Queen' nectarine which were planted at a spacing of 5×5 m in the experimental orchard of Department of Fruit Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh ($30^{\circ} 51'N$ latitude and $76^{\circ} 11'E$ longitude with 1250 m above mean sea level), during the years 2016 and 2017. The soil of the experimental site has a pH of 6.65, organic carbon of 1.51%, available nitrogen, phosphorus and potassium content of 312.6 kg/ha, 31.7 kg/ha and 320.6 kg/ha, respectively. The experiment was laid out in a randomized block design with seven treatments and four replications. Different orchard floor management treatments, viz. black polythene mulch (100 μ), bicolour polythene mulch (100 μ), nylon mulch mat (90 GSM), grass mulch (10-12 cm; local hay), chemical weed control (glyphosate at 3.25 l/ha), hand weeding and control (no orchard floor management treatment) were uniformly imposed in the first week of March. Spray of glyphosate and hand weeding was repeated at two- and one-month interval, respectively. Nutritional management practices were carried out as per standard package of practices of the university (Anonymous 2014).

The predominant weed flora of experimental orchard was identified and broadly grouped into monocot and dicot weeds. For recording weed density, permanent quadrants of 1.0 m^2 were randomly fixed at one location of each experimental plot (tree basin) before the emergence of weeds. Weed density was recorded at monthly interval of 30, 60, 90, 120 and 150 days after application of treatment of orchard management and results were expressed in number of weeds/ m^2 . For recording fresh and dry weight of weeds, the weeds were uprooted and washed to remove soil adhered to it, weight of fresh sample was recorded to get initial weight or fresh weight and dried it in hot air oven at $65 \pm 2^{\circ}\text{C}$ for 48 hours, then weighed again to get dried weight. The data on dry weight of weed was analysed statistically and were expressed in g/ m^2 . Weed control efficiency was expressed in percentage and calculated by using the following formula:

$$\frac{\text{Dry matter of weeds in control} - \text{Dry matter of weeds in treatment}}{\text{Dry matter of weeds in control}} \times 100$$

Dry matter of weeds in control

For fruit size ten randomly selected fruits from each experimental tree were recorded in terms of

length and breadth with the help of digital Vernier Calliper (Mitutoyo, Japan). The average values of fruit length and breadth were expressed in millimetre (mm). For fruit weight, selected fruits taken for recording the fruit size data were weighed on electronic top pan balance and the average fruit weight was expressed in gram (g). Total soluble solids content was determined by Erma hand refractometer (0-32 °Brix) by putting a few drops of fruit juice on its prism. The two years data was statistically analyzed with the standard procedure as suggested by Gomez and Gomez (1984). The level of significance for different variables was tested at 5% value of significance.

RESULTS AND DISCUSSION

Predominant weed species

The nectarine orchard was found to be infested with 8 monocot and 13 dicot weed species. The weed flora consisting mainly of *Cynodon dactylon*, *Cyperus rotundus*, *Chenopodium album* and *Euphorbia hirta* etc. have been presented along with their common names in **Table 1**. Among grasses and sedges, *Cynodon dactylon* and *Cyperus rotundus*, respectively were the most predominant species. Apart of these, *Chenopodium album* and *Oxalis latifolia* were other predominant species during the whole course of study. Similar type of weed flora was also observed by Negi (2015) in nectarine orchard.

Weed density

The orchard floor management treatments had a significant effect on weed density in nectarine during both the years of study (**Table 2**). Inorganic mulches, viz. black polythene mulch, bicolour polythene mulch and nylon mulch mat were equally effective in controlling weeds as there was no weed growth observed under these mulches. Maximum weed density after 30 days (298.00, 77.25 weeds/ m^2), 60 days (477.50, 313.50 weeds/ m^2), 90 days (526.50, 438.25 weeds/ m^2), 120 days (453.25, 513.25 weeds/ m^2) and 180 days (237.00, 260.25 weeds/ m^2) was observed in T₇ (control) during 2016 and 2017, respectively.

No weed growth was observed under inorganic mulches might be due the preventive effect of these mulches 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 no weed density (Iqbal *et al.* 2016). Maximum weed control under inorganic mulches was also observed by Shirgure *et al.* (2003) in Nagpur mandarin, Kaur and Kaundal (2009) in plum and Marak (2012) in plum.

Table 1. Predominant weed species in experimental nectarine orchard

| Botanical name | Family | English name | Common name |
|-----------------------------------|----------------|--------------------------|---------------|
| <i>Grasses</i> | | | |
| <i>Agropyron repens</i> L. | Poaceae | Quack grass | - |
| <i>Avena fatua</i> L. | Poaceae | Wild oat | Jai |
| <i>Cynodon dactylon</i> L. | Poaceae | Bermuda grass | Doob |
| <i>Digitaria sanguinalis</i> L. | Poaceae | Crab grass | Takrigahas |
| <i>Echinochloa oryicola</i> L. | Poaceae | Common barnyard grass | - |
| <i>Setaria glauca</i> (L.) Beauv. | Poaceae | Yellow fox tail | Banara |
| <i>Sedge</i> | | | |
| <i>Cyperus rotundus</i> L. | Cyperaceae | Nut sedge | Dila |
| <i>Others</i> | | | |
| <i>Ageratum conyzoides</i> L. | Asteraceae | Bill goat weed | Mahakana |
| <i>Amaranthus viridis</i> L. | Amaranthaceae | Pig weed | Chaoli |
| <i>Bidens pilosa</i> L. | Asteraceae | Beggars stick | Lumb |
| <i>Cannabis sativa</i> L. | Moraceae | Hemp | Bhang |
| <i>Chenopodium album</i> L. | Chenopodiaceae | Dowlamp bat | Bathu |
| <i>Commelina benghalensis</i> L. | Commelinaceae | Day flower | - |
| <i>Convolvulus arvensis</i> L. | Convolvulaceae | Wind weed | Hiran khur |
| <i>Euphorbia hirta</i> L. | Euphorbiaceae | Pod spurge | Bariduhi |
| <i>Fumaria parviflora</i> Lam. | Papaveraceae | Fineleaf fumitory | Pitpapra |
| <i>Galinsoga parviflora</i> Cav. | Borgariaceae | Gallant soldier | Piphe |
| <i>Medicago sativa</i> L. | Papilionaceae | Alfalfa | Maiha |
| <i>Oxalis latifolia</i> Kunth | Oxalidaceae | Garden pink-sorrel | Tipatiya |
| <i>Oxalis corniculata</i> L. | Oxalidaceae | Procumbent yellow-sorrel | Khatti meethi |
| <i>Sonchus arvensis</i> L. | Asteraceae | Field milk thistle | Daudhi |

Table 2. Effect of orchard floor management treatments on weed density (no. of weeds/m²) in nectarine

| Treatment | 30 Days | | 60 Days | | 90 Days | | 120 Days | | 150 Days | |
|--------------------------|---------|------|---------|-------|---------|-------|----------|-------|----------|-------|
| | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| Black polythene mulch | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bicolour polythene mulch | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nylon mulch mat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grass mulch | 36.5 | 16.7 | 128.5 | 74.5 | 135.2 | 95.0 | 42.5 | 76.5 | 107.7 | 54.0 |
| Chemical weed control | 20.5 | 18.0 | 174.2 | 149.2 | 28.5 | 26.0 | 174.5 | 154.0 | 47.5 | 45.7 |
| Hand weeding | 220.2 | 46.0 | 433.7 | 260.5 | 491.2 | 362.2 | 257.0 | 457.2 | 198.5 | 211.5 |
| Control | 298.0 | 77.2 | 477.5 | 313.5 | 526.5 | 438.2 | 453.2 | 513.2 | 237.0 | 260.2 |
| LSD (p=0.05) | 80.8 | 25.0 | 132.7 | 98.2 | 119.8 | 96.3 | 106.6 | 107.0 | 58.7 | 52.6 |

Fresh and dry weight of weeds

The orchard floor management treatments significantly influenced both fresh and dry weight of weeds in 2016 and 2017, respectively (**Table 3 and 4**). Among all treatments all inorganic mulches, *viz.* black polythene mulch, bicolour polythene mulch and nylon mulch mat recorded lowest value of both fresh and dry weed weight during the present course of study. Maximum value of after 30 days (227.38, 63.25 and 34.63, 15.50 g/m² respectively), 60 days (395.75, 452.63 and 83.75, 99.13 g/m² respectively), 90 days (624.63, 611.00 and 113.13, 131.75 g/m² respectively), 120 days (1075.75, 1118.88 and 225.88, 230.88 g/m², respectively) and 180 days (501.25, 508.63 and 123.00, 138.25 g/m² respectively) was observed in control during 2016 and 2017, respectively.

Inorganic mulches maintained their superiority in terms of low fresh and dry weed weight as they suppressed the weed growth by acting a surface

barrier. Low weed density (or no weed growth) under these mulches (**Table 2**) is responsible for lower values of fresh and dry weed weight as compared to all other treatments. The results of present study are in consonance with the findings of Iqbal *et al.* (2016) in 'NA-7' aonla, Negi (2015) in 'Snow Queen' nectarine, Thakur *et al.* (2012) in 'Earli Grande' peach and Marak (2012) in pecan.

Weed control efficiency

Among all orchard floor management treatments, inorganic mulches, *viz.* black polythene mulch, bicolour polythene mulch and nylon mulch mat showed maximum weed control efficiency of 100% and minimum of 0% as compared to all other treatments during the present course of study **Table 5**. High weed control efficiency under inorganic mulches might be due to their shading property which will suppress the weed growth below these mulches. Maximum weed control efficiency under inorganic (plastic) mulches was also recorded by Thakur *et al.*

(2012) in ‘Earli Grande’ peach. The results were also in accordance with the findings of Kaundal *et al.* (1995), Buban *et al.* (1997) and Shylla *et al.* (2003) in different fruit crops.

Fruit quality

The orchard floor management treatments had a significant effect on fruit quality in nectarine (**Table 6**). The maximum fruit size (length- 52.8, 57.3 mm, breadth- 51.2, 55.0 mm), fruit weight (77.9, 89.4 mm) and total soluble content (12.8, 12.9 °B) were recorded under bicolour polythene mulch during both the years of study which was closely followed by black polythene mulch. Maximum fruit size, fruit weight and TSS of nectarine fruits under bicolour polythene mulch were attributed to reflective property of bicolour mulch to reflect back the light in tree canopy which resulted increase in photosynthesis and ultimately increase in fruit size, weight and TSS. The present study confirmed the findings of Shiukhy *et al.* (2015), Sharma *et al.* (2013) and Posada *et al.* (2011) who also observed increased fruit size and fruit weight in strawberry by

using bicolour mulches. These results were also supported by the findings of Sharma *et al.* (2017) who recorded increased fruit quality of ‘Snow Queen’ nectarine under bicolour polythene mulch.

Fruit yield

Black polythene mulch recorded the maximum fruit yield (16.98, 21.85 t/ha) during 2016 and 2017, respectively. Minimum fruit yield (9.00 and 15.32 t/ha respectively) was recorded under control (**Table 6**). The highest yield under black polythene mulch might be due to good hydrothermal regimes and efficient weed control during the fruit development period as compared to all other treatments which contributed for increased fruit set and lesser fruit drop and ultimately results to highest yield. The present findings for fruit yield were similar to the findings of several other workers who have also reported that black polythene mulches greatly influenced the yield (Sharma and Sharma 2018, Sharma and Kathiravan 2009 and Szewczuk and Gudarowska 2006) in different fruit crops.

Table 3. Effect of orchard floor management treatments on fresh weed weight (g/m²) in nectarine

| Treatment | 30 Days | | 60 Days | | 90 Days | | 120 Days | | 150 Days | |
|--------------------------|---------|-------|---------|--------|---------|--------|----------|---------|----------|--------|
| | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| Black polythene mulch | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bicolour polythene mulch | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nylon mulch mat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grass mulch | 60.75 | 18.25 | 72.00 | 76.00 | 138.88 | 94.50 | 123.13 | 105.25 | 99.00 | 47.63 |
| Chemical weed control | 17.00 | 31.75 | 171.88 | 153.87 | 14.00 | 18.25 | 150.50 | 208.75 | 25.75 | 27.75 |
| Hand weeding | 178.25 | 62.63 | 372.13 | 396.38 | 616.75 | 541.63 | 505.38 | 707.25 | 193.00 | 268.00 |
| Control | 227.38 | 63.25 | 395.75 | 452.63 | 624.63 | 611.00 | 1075.75 | 1118.88 | 501.25 | 508.63 |
| LSD (p=0.05) | 70.44 | 22.72 | 87.45 | 107.25 | 175.07 | 126.59 | 377.51 | 272.71 | 250.81 | 192.44 |

Table 4. Effect of orchard floor management treatments on dry weed weight (g/m²) in nectarine

| Treatment | 30 Days | | 60 Days | | 90 Days | | 120 Days | | 150 Days | |
|--------------------------|---------|-------|---------|-------|---------|--------|----------|--------|----------|--------|
| | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| Black polythene mulch | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bicolour polythene mulch | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nylon mulch mat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grass mulch | 6.00 | 1.25 | 7.88 | 10.75 | 29.25 | 11.00 | 21.63 | 14.88 | 15.63 | 11.50 |
| Chemical weed control | 2.38 | 6.50 | 33.50 | 23.38 | 2.50 | 3.50 | 33.50 | 34.36 | 6.50 | 5.13 |
| Hand weeding | 27.50 | 15.25 | 70.75 | 77.63 | 109.50 | 116.63 | 104.00 | 161.13 | 50.38 | 87.63 |
| Control | 34.63 | 15.50 | 83.75 | 99.13 | 113.13 | 131.75 | 225.88 | 230.88 | 123.00 | 138.25 |
| LSD (p=0.05) | 7.62 | 2.47 | 23.38 | 25.27 | 28.92 | 34.39 | 75.19 | 62.76 | 66.29 | 62.34 |

Table 5. Effect of orchard floor management treatments on weed control efficiency (%) in nectarine

| Treatment | 30 Days | | 60 Days | | 90 Days | | 120 Days | | 150 Days | |
|--------------------------|---------|-------|---------|-------|---------|-------|----------|-------|----------|-------|
| | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| Black polythene mulch | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Bicolour polythene mulch | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Nylon mulch mat | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Grass mulch | 82.67 | 91.94 | 90.59 | 89.15 | 74.14 | 91.65 | 90.42 | 93.56 | 87.29 | 91.68 |
| Chemical weed control | 93.13 | 58.06 | 60 | 76.41 | 97.79 | 97.34 | 85.17 | 85.11 | 94.71 | 96.29 |
| Hand weeding | 20.58 | 1.61 | 15.52 | 21.69 | 3.21 | 11.47 | 53.96 | 30.21 | 59.04 | 36.61 |
| Control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 6. Effect of orchard floor management treatments on fruit quality and fruit yield quality in nectarine

| Treatment | Fruit length (mm) | | Fruit breadth (mm) | | Fruit weight (g) | | TSS (°B) | | Fruit yield (t/ha) | |
|--------------------------|-------------------|-------|--------------------|-------|------------------|-------|----------|-------|--------------------|-------|
| | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| Black polythene mulch | 52.03 | 56.71 | 50.59 | 54.32 | 77.22 | 88.78 | 12.62 | 12.80 | 16.98 | 21.85 |
| Bicolour polythene mulch | 52.85 | 57.27 | 51.21 | 55.04 | 77.86 | 89.41 | 12.78 | 12.92 | 16.05 | 21.37 |
| Nylon mulch mat | 51.15 | 55.99 | 50.20 | 53.79 | 74.10 | 87.62 | 12.49 | 12.69 | 14.98 | 20.09 |
| Grass mulch | 50.69 | 55.03 | 49.55 | 52.94 | 72.81 | 86.69 | 12.34 | 12.51 | 13.46 | 18.78 |
| Chemical weed control | 49.75 | 54.61 | 48.32 | 52.68 | 70.69 | 81.99 | 12.15 | 12.31 | 11.37 | 16.67 |
| Hand weeding | 48.56 | 53.98 | 47.35 | 51.53 | 69.58 | 81.11 | 12.08 | 12.20 | 10.33 | 16.38 |
| Control | 47.07 | 51.16 | 45.91 | 49.28 | 66.93 | 77.38 | 11.48 | 11.71 | 9.00 | 15.32 |
| LSD (p=0.05) | 1.20 | 1.32 | 0.95 | 0.97 | 1.91 | 1.48 | 0.64 | 0.56 | 1.02 | 1.15 |

It was concluded that efficacy of inorganic mulches was superior to all other treatments in terms of weed density, fresh and dry weed weight and weed control. Black polythene mulch was the best treatment for fruit yield while fruits with best fruit quality were recorded under bicolour polythene mulch. Keeping in view of weed control efficacy, fruit quality and fruit yield, use of black and bicolour polythene mulches is the best orchard floor management treatment in nectarine orchard.

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