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Weed management in guava orchards

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ABSTRACT

The comparative efficacy of orchard soil management practices like mulching (paddy straw, white polythene, black polythene) and weed control methods (mechanical and chemical) were evaluated for managing weeds growth in guava orchard. A weedy plot was also kept as control for comparative assessment of different orchard floor management practices. The results revealed a significant effect of different treatments on grassy as well as broad-leaf weeds in the orchard. Although the black polythene mulch kept the area weed free throughout the season, the paddy straw mulch exhibited promising results, with 69.1 and 93.2% reduction in total weed biomass during first and second year of application, respectively. The white polythene was poor performer as it resulted in heavy weed growth under the mulch and tearing of polythene sheet. Chemical weed management as well as mechanical weeding also reduced the intensity of weeds but resurgence of weeds resulted significantly higher weed biomass compared to paddy straw mulch. The paddy straw mulch exhibited potential to manage weeds in guava orchard.

Key words: Guava, Mulching, Orchard, Weed biomass, Weed management

Weeds are considered major obstacle in agricultural production systems particularly in fruit crops. It is estimated that losses caused by weeds exceeded the losses from any category of agricultural pests (Abouziena and Haggag 2016). On a global scale, the potential crop yield loss without weed control was estimated as 43% (Oerke 2006). However, Rao (2000) reported the annual loss of agricultural produce due to weeds as 45%, insects as 30%, diseases as 20% and other pests as 5%. In cultivated crops and established orchards, the weeds can be suppressed by various methods such as chemical, mechanical, manual, biological and by mulching etc. Although the chemical weed management is most effective, it has its own constraints like the injury to non-target vegetation, crop injury, residues in soil and water, toxicity to non-target organisms. The conventional method of managing weeds through manual method is very expensive and labour intensive. Mechanical control of weeds in established orchards is rather difficult and less effective due to spreading canopies of trees, limited coverage of the implements and potential damage to root and shoots of fruit trees. Mulching or covering the soil with organic or synthetic materials has been recorded as a safe method to control weeds in comparison to herbicides application (Ramakrishna 2006). The paddy straw mulch is easily available and cheap, while, the plastic mulch is costly affair for management of weeds in established orchards. Covering or mulching the soil surface can check the germination of weed seeds or physically suppress weed emergence (Stout 1985). Organic mulches reported to be beneficial for plant growth and fruit yield and quality in addition to weed suppression (Childers *et al*. 1995). There was a substantial reduction of weed growth with organic mulches in avocado and citrus over a period of four year (Faber *et al*. 2001). Transparent or white mulch and green covering had slight effect on weeds, while, the coloured mulches such as brown, black, blue or double colored films reduce the weed emergence (Bond and Grundy 2001). Abouziena *et al*. (2008) obtained the greatest control (94-100%) of weeds occurred with the plastic mulch (200 or 150 µm) and three mulch layers of rice straw.

The guava is major fruit crop of India having ranked fifth among all fruit crops with respect to acreage. Presently, India is producing 2.68 mMT guava fruits from 2.54 million hectare plantation (NHB 2015). In Punjab, except citrus, this fruit crop has highest area amidst all fruit crops and total of 0.176 mMT produce is being obtained from 8160 hectare area (Anon 2016). The profusely grown weeds in orchards compete for water and nutrients with fruit plants. The higher soil and canopy temperature under clean cultivation lead to excessive flower and fruit drop in guava. Therefore, the floor management in orchards is of utmost importance. The present study was undertaken to evaluate the response of weed population and biomass to different orchards soil management treatments.

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MATERIALS AND METHODS

The experiment was laid in Punjab Agricultural University, Ludhiana (India) during 2015 and 2016 on ten year old guava plants grown at 6.0 x 3.0 m spacing. Under various orchard soil management treatments, different type of mulches, *viz*. paddy straw mulch (PSM), white polythene mulch (WPM) and black polythene mulch (BPM) were applied under the canopy of the trees. The chemical weed management, mechanical control and a weedy field were also kept for comparative assessment to ascertain their effects on weed growth and population in established guava orchard. The paddy straw mulch was applied at about 10 t/ha by spreading under the tree canopy leaving 40% area in between the rows of trees. The black as well as white polythene mulch of 30 µ thickness was also applied in similar manner. Under chemical floor management treatment, glyphosate 4.0 l/ha was sprayed as post-emergence (PoE) herbicide during May and July prior to flowering and seed set in weeds. The mechanical weeding was done using disc harrow at the same time.

The treatments were initiated in the month of May after cleaning the orchard and application of recommended doses of organic manures as well as inorganic fertilizers. Three replicated plots were kept for each treatment and control. The weed density was estimated by using quadrat (1 x 1 m) placed randomly in all the replications of each treatment and control. The grasses and sedges were counted separately from broad-leaf weeds. The counting of weeds was done at monthly interval from June to September. The weed biomass was recorded by drying the weeds of each treatment at monthly interval in hot air oven at 65 ^{0}C temperature. The weeds were removed from the orchard after placing the quadrat at random places under each treatment by cutting the weeds at ground level. The dry weight of weeds was expressed in g/m^2.

RESULTS AND DISCUSSION

The experimental site was infested with diverse weed flora comprising of grasses, broad-leaf weeds and sedges (**Table 1**). The weed density data in different treatment showed that all the orchard soil management practices exhibited significant reduction in weed density and biomass as compared to control during both years of investigations (**Figure 1** and **2**). Although, no weed growth occurred under black polythene mulch but, white polythene mulch and paddy straw mulch also resulted 79.12 and 73.09% reduction in weed biomass as compared to control during first year and 46.44 and 92.68% reduction during second year, respectively (**Figure 3**). Mechanical and chemical weed management practices also exhibited significant reduction in weeds in summer and rainy season in guava orchard. After treatments, weed emergence occurs at faster rate during first month and rather slower rate from July to September except under mechanical and chemical weed control treatments as these treatments were

Table 1. Weed flora in the experimental site during 2015 and 2016

Grasses and Sedges (GS)	Broad-leaf weeds (BLW)
Grasses	
Cynodon dactylon	*Cannabis sativa*
Sorghum halepense	*Parthenium hysterophorus*
Eleusine indica	*Trianthema portulacastrum*
Eragrostis tenella	*Solanum nigrum*
Cenchrus catharticus	*Cleome viscosa*
Digitaria sanguinalis	*Ipomoea pestigridis*
Commelina benghalensis	*Boerhaavia diffusa*
Echinochloa colonum	*Digera arvensis*
Dactyloctenium aegyptium	*Physalis minima*
Eragrostis pilosa	*Amaranthus viridis*
Acrachne racemosa	*Euphorbia hirta*
Sedges	*Euphorbia microphylla*
Cyperus rotundus	*Phyllanthus niruri*
Cyperus compressus	

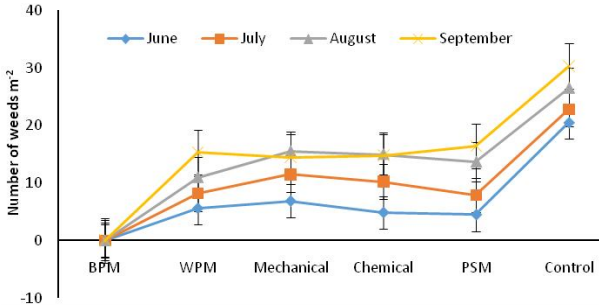

Figure 1. Weed density (no./m^2) under different orchard floor management treatments during 2015. Vertical bars represents mean S.E. of three replications

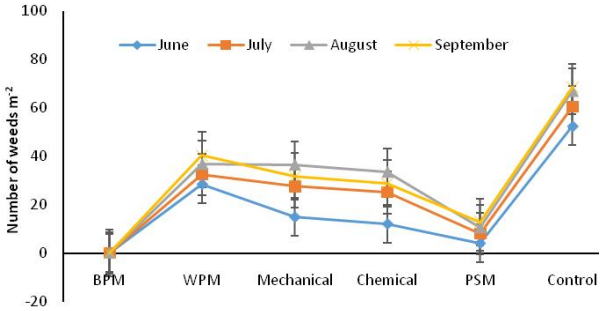

Figure 2. Weed density (no./m^2) under different orchard floor management treatments during 2016. Vertical bars represents mean S.E. of three replications

repeated in July-August, however, the biomass increases constantly from May to September. Higher biomass of sedges and grass weeds was recorded than broad-leaf weeds throughout the season (**Table 2**). In second year, the weed pressure under all treatments was higher as compared to first year except black polythene and paddy straw mulch. The paddy straw mulch was effective to the maximum extent in managing the weeds next to BPM during second year of study. Merwin *et al.* (1995) also reported that the loose materials such as straw, bark and composted waste can provide effective weed control, but, the thickness of mulch layer should be enough to suppress weed emergence.

All the orchard floor management treatments reduced the sedges, grasses and broad-leaf weed density with maximum reduction with PSM followed by chemical weed management after one month of treatment application. Highest weeds density was in control (20.50) and least (4.50) under PSM. The weed density increased significantly upto September under all treatments, while, under mechanical and chemical treatments it was reduced from August to September due to second spray of herbicide and mechanical weeding (**Figure 1**). The minimum weed density was recorded in treatment of pendimethalin as post-planting herbicide in guava nursery three months after treatment (Boora *et al.* 2014). The average weed density from May to September during first year under all treatments ranged from 0 to 30.30 weeds per square meter area. Highest weed density (30.3 m^2) was recorded in control plots, which was significantly highest than PSM, WPM, chemical and mechanical soil management treatments. The minimum average weed count (0/m^2) was recorded under BPM followed by 10.02 under WPM, 10.60 under PSM, 11.23 under chemical and 12.09 under mechanical soil management treatment, while, the highest average weed density (25.02/m^2) was recorded under control treatment.

During second year, the weed density in the first month was increased abruptly under control with 52.5 weeds/m^2 of different species followed by 28.5/ m^2 under white polythene mulch which was ripped due to excessive weed growth beneath the polythene sheet (**Figure 2**). Minimum number of weeds were emerged under paddy straw mulch (4/m^2) followed by chemical (12/m^2) and mechanical (14.87/m^2) methods of orchard management, although it was nil under BPM. During second month, the weeds density was almost doubled under chemical, mechanical and PSM treatments, while under control and WPM, less number of weeds were emerged (**Figure 1**). In last month of observations, the weed density was significantly at par under mechanical and chemical treatments while, it was significantly highest (68.50/ m^2) under control followed by WPM (40.30/m^2) treatment. The mean periodic weed density from May to September during second year in all treatments ranged from 0 to 62.09 per square meter area. The minimum average weed density (0.0/m^2) was recorded under BPM followed by WPM (34.52/m^2), mechanical (27.63/m^2), chemical (24.84/m^2) and paddy straw mulching (8.84/m^2). The average weed density was highest (62.09/m^2) under control treatment. The monthly weed density under various

Table 2. Effect of different treatments on weed biomass (g/m^2) in different months of year 2015 and 2016*

Treatment	June		July		August		September	
	GS	BLW	GS	BLW	GS	BLW	GS	BLW
2015								
PSM	2.99 (8.0)	1.46 (1.0)	3.88 (14.0)	1.59 (2.0)	4.33 (18.0)	1.75 (2.0)	4.46 (19.0)	1.86 (3.0)
WPM	2.77 (7.0)	1.42 (1.0)	3.32 (10.0)	1.56 (1.0)	3.79 (13.0)	1.71 (2.0)	3.95 (15.0)	1.89 (3.0)
BPM	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)
Mechanical	3.44 (11.0)	1.59 (2.0)	4.10 (16.0)	1.79 (2.0)	4.53 (20.0)	1.85 (2.0)	5.22 (26.0)	1.93 (3.0)
Chemical	2.99 (8.0)	1.32 (0.7)	4.13 (16.0)	1.60 (2.0)	4.55 (20.0)	1.71 (2.0)	5.24 (26.0)	1.92 (3.0)
Control	5.92 (34.0)	1.97 (3.0)	7.35 (53.0)	2.29 (4.0)	8.13 (65.0)	2.59 (6.0)	8.83 (77.0)	2.89 (7.0)
LSD (p=0.05)	0.09	0.04	0.13	0.05	0.21	0.05	0.28	0.11
2016								
PSM	2.80 (7)	1.45 (1)	3.60 (12)	1.82 (2)	4.37 (18)	2.21 (4)	5.01 (24)	2.23 (4)
WPM	6.93 (47)	3.00 (8)	9.55 (90)	4.16 (16)	11.86(140)	5.08 (25)	13.14(172)	5.44 (29)
BPM	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)
Cultivation	4.89 (23)	2.79 (7)	6.37 (40)	3.80 (14)	8.49 (71)	5.06 (25)	9.13 (82)	5.07 (25)
Chemical	4.50 (19)	2.62 (6)	5.82 (33)	3.62 (12)	8.08 (64)	4.89 (23)	8.20 (66)	4.76 (22)
Control	9.92 (98)	3.21 (9)	13.0 (168)	4.77 (22)	16.54(273)	5.81 (33)	18.61(346)	6.03 (35)
LSD (p=0.05)	0.42	0.12	0.47	0.22	0.70	0.46	0.83	0.31

*Values represent the square root transformation of actual data (in parentheses).GS: Grasses and sedges, BLW: Broad-leaf weeds, PSM: Paddy straw mulch, WPM: White polythene mulch, BPM: Black polythene mulch

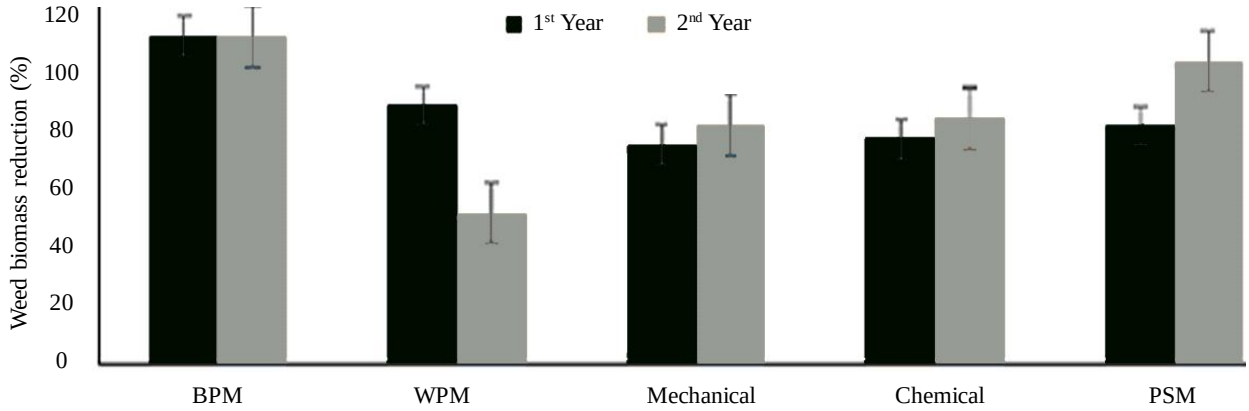

Figure 3. Reduction (%) in weed biomass under different orchard floor management treatments *vs* control during 1st and 2nd year of treatments. Vertical bars represents mean S.E. of three replications

treatments demonstrated effectiveness of BPM and PSM for weed suppression. Plastic mulches should not be used where creeping perennials are present (*e.g.*, nutsedge), since these weeds can puncture the plastic, providing light to stimulate germination of additional weeds (Smeda and Weston 1995). Shirgure *et al*. (2013) also achieved better soil-moisture conservation and weed reduction with black polyethylene mulch and grass mulching in drip irrigated Nagpur mandarin.

Covering soil under mandarin trees with two layers of cattail or rice straw mulch gave 85 to 98% weeds control (Abouziena *et al.* 2008). The inhibitory effect of organic mulch on weeds may be due to both the physical (the reduced passage of solar radiation and temperature range on soil superficial layer) effect of suppression in emergence and the possible chemical effects arising from allele chemicals released by straw that may have contributed to reduction in emergence (Oliveira *et al.* 2014). It can be concluded that the paddy straw mulching holds potential for weed management in guava orchards.

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