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EFFECT OF ORGANIC AND INORGANIC MULCHES ON APHID POPULATION AND YIELD OF TOMATO

N.S. SENANAYAKE, K.P. SOMACHANDRA, T.K.A.I. HADJI AND A.U.K. BANDARA

Regional Agriculture Research and Development Centre, Department of Agriculture, Bandarawela, Sri Lanka

ABSTRACT

An experiment was conducted to evaluate the effect of mulching materials on aphid population and yield of tomato during *yala* 2011 and *maha* 2012/13 seasons at Regional Agricultural Research and Development Centre (RARDC), Bandarawela. During both seasons, five mulching treatments were evaluated, namely straw, *Pinus* leaves, white polyethylene, UV reflective polyethylene and untreated control. Weekly aphid counts, plant growth and fruit quality parameters and late blight incidence were recorded. Results revealed that use of UV reflective mulching material reduced aphid population dynamics on tomato while increasing fruit yield parameters through modification of crop growing environment and suppressing the competition between weeds and tomato plants. However, one of the disadvantages of reflective mulch was increased late blight incidence in rainy season. Since high aphid population build up in *yala* season, it is advisable to use reflective mulch in *yala* season and not in the *maha* season.

KEYWORDS: Aphid population, Late blight, Reflective mulch, Tomato, Yield parameters

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is an important commercial vegetable crop grown all over Sri Lanka. Sucking pests (Aphids, Whiteflies, Mites and Thrips) can be considered as the main threat to quality tomato production in the country. These tiny insects suck sap from tender parts of the plant, encourage sooty mold growth and transmit several vector borne virus diseases which in turn greatly hamper the quality and quantity of tomato yield. Among them, aphids are responsible for transmission of many viruses and due to the existence of large colonies at a time; they can devastate a tomato crop within a short period of time. In year round production of tomato, especially during drier periods of the year, the polyphagous feeding behaviour of the insect and existence of wide range of host plants makes control of aphids is challenging. Therefore, farmers respond to the threat of aphids by applying broad-spectrum insecticides on a calendar basis. However, this approach is costly, highly hazardous to workers and the environment and disruptive to the natural ecosystem. Some researchers suggest that use of mulches reduces aphids on plants growing above the mulch (Black and Rolston, 1972; Nawrocka *et al.*, 1975) and increases growth and fruit yield of tomato (Awodoyin *et al.*, 2007; Rajablariani *et al.*, 2012). However, reports in the efficacy of mulches in aphid management in tomato under up country intermediate zone condition and its effect on tomato yield are limited. Therefore, the present study was formulated to assess the effect of various organic and inorganic mulch materials on aphid population and yield of tomato.

MATERIAL AND METHODS

The experiment was carried out during *yala* 2011 and *maha* 2012/2013 seasons at the Regional Agricultural Research and Development Centre, Bandarawela in the Up-country Intermediate Zone. The experiment was set up within a Randomized Complete Block Design, where five mulching treatments were evaluated. Each treatment was replicated three times and distributed randomly to minimize the effect of the difference between the plots. The mulching materials tested were: (T1) straw, (T2) dried pines leaves, (T3) white polyethylene, (T4) grey or black UV reflective polyethylene and (T5) no mulch. Each plot was 4 m x 3.5 m and a 0.5 m wide buffer zone was maintained around each plot. Twenty day old seedlings of open field tomato variety "Thilina" were transplanted at a spacing of 80 cm x 35 cm. The polyethylene mulch treatments were imposed before transplantation to cover the whole bed and transplanting holes were made by cutting a circular area. Organic mulches were applied on the beds one week after transplanting to make a 2.5 cm thick layer over the soil surface, at a rate of 20 kg of dried pines leaves and 15 kg of straw per plot. Fertilizer and crop management were done following the Department of Agriculture recommendations (DOA, 2010).

Parameters evaluated included aphid counts, tomato fruit yield and quality of tomato fruit, biomass accumulation and late blight incidence. Aphids were counted weekly from upper three leaves per plant in randomly selected five plants from each plot. Fruit yields were measured in each harvest and cumulative yield was used for analysis. Firmness, total soluble solids (TSS), juice content and fruit sizes were recorded. Firmness was measured using a penetrometer with a sample of five fruits per plot and TSS was measured using a refractometer from three fruits per plant in randomly selected five plants per each plot. Juice content and fruit sizes were recorded from three fruits per plant in randomly selected five plants per plot. Fruit sizes were measured with a vernier caliper. Late blight incidence was measured using 0-5 scale developed by British Mycological Society (1947). Aphid population count data were square-root transformed before the analysis. Data were subjected to ANOVA procedure to obtain treatment means using SAS 9.1.3 statistical software for Windows. The statistical differences among treatment means were tested by Fisher's least significant difference (P=0.05) test.

RESULTS AND DISCUSSION

Aphid population

A significantly lower number of aphids were counted in plots mulched with UV reflective polyethylene, in both seasons. The aphid population in this treatment was low at all stages of the crop (Tables 1 and 2). Then, it is clear that a UV reflective mulch prevents primary infestation of aphids in tomato plants and consequent colonization. The lowest aphid population observed in the UV reflective mulch in this study confirms the earlier results of Fanigliulo *et al.* (2009) who explained that UV reflective mulch is very effective in delaying and reducing colonization of aphids in tomato cultivation. UV reflective mulch may disorient aphids and disturb their landing and feeding behaviour in plants. Aphids are very sensitive to light in their flight habit; therefore they become less active with decreased light densities (particularly UV wave length). As reflective mulches reflect UV radiations, plants mulched with reflective polyethylene become less attractive to aphids (Fanigliulo *et al.*, 2009).

Controlling aphids in tomato cultivation is further important due to transmission of viruses which are threats to tomato production. Use of UV reflective mulch to prevent primary infestation of aphids in tomato cultivations is more economical than insecticidal control of vectors as viruses can be transmitted to plants before insects are killed by insecticides.

Table 1. Aphids population of tomato plants mulched with different materials in *yala* 2011

Treatments	Number of Aphids per leaf				
	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP
Straw mulch	1.4^{ab}	1.7^{bc}	2.8^{b}	3.6^{ab}	5.3^{b}
Pinus leaves	1.7^{a}	3.1^{a}	4.8^{a}	5.2^{a}	8.6^{a}
White polyethylene	0.8^{ab}	1.4^{bc}	3.0^{ab}	3.8^{ab}	3.7^{bc}
Reflective mulch	0.8^{b}	0.9^{c}	0.7^{c}	1.7^{b}	1.6^{c}
Control	1.5^{ab}	1.9^{b}	2.8^{b}	4.6^{a}	5.7^{b}
CV (%)	45.7	34.0	45.2	36.6	36.3

Notes: WAP=Weeks after planting. Means followed by the same letter in each column are not significantly different at 5% level of probability.

Tomato fruit yield

Effect of mulches on tomato fruit yield was also evaluated in the *maha* season of 2012/13. Numbers of fruits per plant was significantly higher in mulched plots when compared to non-mulched plots while average fruit weight, yield per plant and marketable yield obtained were also higher (Table 3). It is therefore clear that mulches positively affect fruit yields of tomato plants. This can be attributed to the suppression of weed growth, conservation of moisture and reduction of temperature in the top soil by the mulches (Awodoyin *et al.*, 2007). Higher retention and availability of moisture near root zone also lead to increased fruit yield by enhancing nutrient uptake from soil (Parmar *et al.*, 2013).

Table 2. Aphids population of tomato plants mulched with different materials in *maha* 2012/13.

Treatments	Number of Aphids per leaf				
	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP
Straw mulch	2.7^{c}	2.5^{b}	3.1^{ab}	6.3^{a}	06.5^{bc}
Pinus leaves	3.2^{bc}	2.2^{b}	3.5^{ab}	7.3^{a}	09.9^{ab}
Reflective mulch	2.9^{bc}	2.2^{b}	2.2^{b}	1.7^{b}	03.2^{c}
White polyethylene	3.5^{ab}	2.6^{b}	3.4^{ab}	6.7^{a}	07.3^{ab}
Control	3.9^{a}	4.5^{a}	4.5^{a}	8.4^{a}	10.4^{a}
CV (%)	14.6	32.2	31.9	37.4	33.4

Note: WAP=Weeks after planting. Means followed by the same letter in each column are not significantly different at 5% level of probability.

The best tomato fruit yield obtained from UV reflective mulch in this study is agreed with studies of Awodoyin (2007) who observed similar phenomenon with mulched tomato plants. This might have been influenced by favourable hydro-thermal regime of soil, lower insect populations and weed suppression by the UV reflective mulch (Parmar *et al.*, 2013). Rajablariani (2012) suggested that it may be due to the ability of these mulches to reflect sunlight back into the plant canopy, thereby increasing the potential photosynthesis.

Among different mulching treatments, the highest degree of weed control was observed in plots treated with UV reflective polyethylene. It may be due to the reflection and interception of solar radiation by this mulch. Therefore, zero survival of weed seedlings can be obtained due to absence of solar radiation that induces germination of weed seeds and supports production of assimilate by the seedlings (Awodoyin *et al.*, 2007).

Tomato fruit quality

Firmness of fruits was significantly higher in mulched plots when compared to the control. Highest Total Soluble Solids (TSS) was recorded in plots mulched with reflective polyethylene. Juice content was significantly higher in plots mulched with pinus leaves and reflective materials (Table 4). Parmar (2013) obtained similar results with watermelon and suggests that UV reflective mulch produce more physiologically active plants and accumulate sufficient food stock for fruits.

Table 3. Yield performance of tomato plants mulched with different materials in *maha* 2012/13.

Treatments	Number of fruits per plant	Average fruit weight (g)	Yield per plant (kg/plant)	Marketable yield (mt/ha)
Straw mulch	33.4[a]	63.8[a]	2.1[ab]	53.3[ab]
Pinus leaves	30.7[a]	63.0[a]	1.9[ab]	47.9[ab]
Reflective mulch	39.1[a]	63.3[a]	2.5[a]	62.2[a]
White polyethylene	30.8[a]	54.3[ab]	1.7[bc]	41.3[bc]
Control	17.2[b]	52.5[b]	0.9[c]	22.4[c]
CV%	27.3	10.8	28.2	28.3

Note: Means followed by the same letter in each column are not significantly different at 5% level of probability

Table 4. Fruit quality parameters of tomato plants mulched with different materials in *maha* 2012/13.

Treatments	Firmness (cm)	TSS	Juice content (ml)	Length (cm)	Width (cm)
Straw mulch	0.77[a]	3.9[b]	16.8[ab]	5.61[a]	5.46[a]
Pinus leaves	0.78[a]	3.9[b]	18.7[a]	5.54[a]	5.40[a]
Reflective mulch	0.71[ab]	4.4[a]	18.4[a]	5.34[a]	5.12[a]
White polyethylene	0.69[b]	3.9[b]	15.5[ab]	5.45[a]	5.24[a]
Control	0.53[c]	4.0[ab]	13.9[b]	4.73[b]	4.35[b]
CV%	6.4	6.7	13.6	5.7	6.1

Note: Means followed by the same letter in each column are not significantly different at 5% level of probability.

Plant dry weight

In *maha* 2012/13 season, the highest per plant dry weights of roots, shoots and leaves were recorded in plots mulched with reflective materials. Higher growth and development of plants may be due to the favourable micro climate that was created by UV reflective mulch that enhances nutrient uptake (Parmar *et al.*, 2013).

Late blight incidence

Late blight is a serious threat to tomato production in the wet season (Gleason *et al.*, 2006) and mulched plots showed different levels of late blight severity. In *maha* 2012/13 plots mulched with straw and Pinus leaves recorded the lowest late blight score showing few scattered diseased plants. The highest late blight incidence (about fifty spots per plant) was recorded in plots mulched with reflective materials and up to 1 in 5 leaflets were infected (Table 5) and it was similar to the score recorded in the control. *Maha* season is the wet season and rains present throughout the day. Water retained on polyethylene surfaces will increase humidity in the surrounding environment and create suitable conditions for the development of late blight pathogen *Phytophthora infestans*.

Table 6. Plant dry weight of tomato plants mulched with different materials in *Maha* 2012/13.

Treatments	Root (g)	Stem (g)	Leaves (g)
Straw mulch	4.8^{ab}	38.5^{b}	13.8^{b}
Pinus leaves	4.1^{ab}	30.9^{bc}	12.8^{b}
Reflective mulch	5.0^{a}	54.1^{a}	20.1^{a}
White polyethylene	3.7^{b}	32.6^{bc}	13.0^{b}
Control	3.6^{b}	24.8^{c}	08.7^{b}
CV%	18.2	21.9	28.4

Note: Means followed by the same letter in each column are not significantly different at 5% level of probability (Fisher's LSD test).

Table 5. Late blight incidence of tomato plants mulched with different materials in *maha* 2012/13.

Treatments	Late blight score
Straw mulch	1c
Pinus leaves	1c
Reflective mulch	4a
White polyethylene	2b
Control	3a
CV (%)	21.5

Note: 0-5 scale developed by British Mycological Society (1947). Means followed by the same letter in each column are not significantly different at 5% level of probability.

CONCLUSIONS

UV reflective mulch can be successfully used to control aphids in tomato cultivation. Plants grown on reflective mulch produced a highest yield, highest TSS, increased plant dry weight and help to minimize weeds. However, one of the disadvantages of the reflective mulch was increased late blight incidence in rainy season. Since high aphid population build up in dry periods, (*yala*) it is advisable to use reflective mulch in this season and not in the wet (*maha*) season.

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