

SHORT COMMUNICATION

EFFECT OF UV TREATED SILVER ON BLACK POLYTHENE MULCH ON THE GROWTH AND YIELD OF *Capsicum annuum* L. (CHILLI) VAR. MI2 AND MI3

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ABSTRACT

Weed infestation is one of the limiting factors in the production of chilli (*Capsicum annuum* L.). Weeds reduce the availability of nutrients and water for the main crop reducing the fruit yield. The application of herbicides is not an environmentally friendly method. Therefore, there is a movement to use alternative methods for weed management. Polythene mulches have many benefits such as soil temperature modification, soil conservation by preventing runoff, nutrient addition, and improvement in soil structure in addition to minimizing weed infestation. Therefore polythene mulches are a popular method to reduce weed infestation in various crops. UV treated silver on black polythene mulch is one such polythene mulch introduced to the Sri Lankan market recently. Therefore, this research was conducted with the objectives to study the effect of UV treated silver on black polythene mulch on growth and yield parameters and weed infestation of chilli. The possibility of the reduction of the amount of recommended fertilizer with the application of UV treated silver on black polythene soil cover was also tested. The experiment was laid out in a Randomized Complete Block design with four replications. Two local chilli varieties (MI2 and MI3) popular among farmers were used for the study. The four treatments comprised UV treated polythene mulch with different percentages of the recommended fertilizer dosage (100%, 75%, and 50%) for chilli. Recommended fertilizer mixture without polythene mulch was the control treatment. Yield and weed parameters such as time taken to 50% of flowering, time taken to first picking, fruiting span, and yield per plant, number of weeds per unit area and fresh weight of weeds per unit area were evaluated. Plants in the treatments with UV treated polythene mulch exhibited a significantly higher growth and yield in both chilli varieties along with a significantly lower weed infestation. The plants grown with 100% and 75% fertilizer levels with polythene mulch did not show a significant difference in total yield, indicating the possibility of reducing 25% of recommended fertilizers. Therefore, the UV treated biodegradable silver on black polythene mulch can be recommended to obtain high production with less fertilizer and zero levels of herbicides.

Keywords: Silver on black, Mulch, UV treated polythene, Yield, Weed infestation

INTRODUCTION

Chilli (*Capsicum annuum* L.), is a widely used spice in Sri Lanka. This belongs to the family Solanaceae. The green chilli production in the 2018/19 maha season in Sri Lanka was 33838 MT (Department of Senses and Statistics, 2021). Sri Lanka was self-sufficient in chilli during the '70s and '80s. However, with the infection of the leaf curl complex, the chilli yield and cost of production increased. Chillies are integral and the most important ingredient in different dishes around the world as it adds spiciness, taste, flavour, and colour.

Chilli is a long duration and energy-rich crop that requires appropriate manuring and balanced fertilizers along with sufficient moisture levels for elevated yield and quality products (Prasad *et al.* 2009). Weed infestation is one of the limiting factors in the production of chilli. Weeds in the field reduce the availability of nutrients and water for the main crop reducing the yield. The extent of reduction in yield of chilli has been reported to be in the range of 60% to 70% depending on the weed density in standing crops (Patel *et al.* 2004). According to them, the proper management of weeds during the initial stage of the chilli plants after transplanting (30 - 60

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days) is critically important for higher yield. Therefore, weed control in chilli cultivations is important and using mulch is a cost-effective and eco-friendly method to keep the field with low weed infestations.

Mulch is a covering placed over the soil around the plants. Mulch materials can be categorized as organic or inorganic. Organic mulch materials are originated from plant and animal sources. The most frequently used organic mulch materials are plant residues such as straw, leaf mold, wood products such as sawdust, wood chips, and shavings and animal manures. Mulching is practiced for various reasons. Water conservation, erosion control and minimizing weed infestation are the most important objectives for its use in agriculture. Overall organic mulching improves the physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of the crops. However organic mulch materials are difficult to find in large quantities for commercial cultivations. Organic mulch materials may consist of toxic compounds, pests and diseases, residues of agrochemicals and other compounds which may consequently affect the cultivation. Since it needs in large quantities, transportation and handling are also not easy. The phytotoxins released when organic materials decompose may inhibit the growth of crop plants.

Out of various inorganic mulching materials, plastic mulch is widely used in commercial crop production around the world. The plastic materials used as mulch are polyvinyl chloride or polythene films. Polythene mulch is being increasingly used in agriculture since the middle of the 20th century. Plastic and polythene mulches are in different types and colours such as black, grey, infrared transmitting brown (IRT-brown), IRT-green, white and white-on-black, biodegradable UV treated polythene mulch, *etc.* Weed suppression, soil conservation, moisture conservation and soil worming are the major objectives of the use of polythene mulches in vegetable production. Photodegradable and biodegradable plastic mulches are more effective as those are not lead to pollutions.

Several researchers have reported increased growth and yield performances of various vegetables with the use of polythene mulches (Palada *et al.* 2000; Ashrafuzzaman 2011; Bucki and Siwek 2019; Maida *et al.* 2019; Kefelegn and Desta 2021). In some countries, there is a trend in using different types of polythene mulches for vegetable production including chilli.

Biodegradable UV treated silver on black polythene mulches are now available in the markets and farmers tend to use those mainly to reduce weed infestation. Not like other biodegradable polythene mulches, UV treated mulch are thicker, durable and start biodegradation after about 4 years. Therefore, the objectives of this study were to investigate the effect of biodegradable UV treated silver on black polythene mulches as a soil cover on the growth and yield of two local chilli varieties. At the same time, the degree of infestation of weed and the possibility of reducing the level of fertilizers were investigated.

MATERIALS AND METHODS

The experiment was conducted during the Maha season from 2018 September to 2019 February at an experimental site of Keppetipola in Badulla District, Sri Lanka. The experimental site was situated in an upcountry wet zone (WL1) agro-ecological zone. The average annual temperature is 23°C and the average rainfall is 1885 mm in the area. The soil of the experimental field was red-yellow podzolic.

The most popular two chilli varieties among Sri Lankan farmers named MI2 and MI3 were used for the study. Both varieties are moderately resistant to leaf curl complex disease. Seeds were taken from the Department of Agriculture, Peradeniya and a nursery was established in a land closer to the experimental site according to the guidelines given by the Department of Agriculture, Sri Lanka. Manual weeding was done whenever necessary. Seedlings with retarded growth were removed from the nursery. One week before establishment watering to the nursery

was limited to avoid transplanting shock and harden the seedlings. Thirty days old seedlings, 12-15 cm in height with 5-6 leaves, free from pests and diseases were transplanted.

The recommended level of fertilizer with bare soil was the control treatment of this experiment (T1). UV treated polythene mulch was used for all other treatments with different levels of fertilizer viz. 100 % (T2), 75% (T3) and 50% (T4) of the recommended levels.

The study was carried out as two separate experiments for MI2 and MI3 varieties. Each experiment was established in a Randomized Complete Block Design with four replications. Raised beds were prepared after ploughing and harrowing the land. One raised bed in the size of 1.2 x 3.2 m which consisted of 12 plants was considered as one replicate. The spacing within the row was 45 cm and between rows was 60 cm. Polythene mulching was carried out according to the treatment allocation for selected beds.

UV treated polythene mulch manufactured in Israel was obtained through the main importer and distributor to Sri Lanka. The polythene mulch was anchored in the soil approximately 10-15 cm after laying it over the bed. A sharp tin with a handle was used to cut the holes on tightly laid mulched, and then transplanting was done. A week after the initial transplanting, gap filling was carried out. Fertilizer was added after removing the sheet from either side of the bed, and then again, it anchored to the soil. The plants were irrigated with an equal amount of water using a bucket whenever required.

Morphological and yield parameters such as plant height, time taken to 50% flowering of the plot, fruiting span, time taken for first picking, yield per plant and data on weed parameters such as the number of weeds, fresh weight of weeds were collected throughout the experimental period.

Data were analyzed with SAS 9.1 version and means were separated according to Duncan's multiple range test.

RESULTS AND DISCUSSION

The use of polythene mulch as a soil cover resulted in enhanced growth and yield of both chilli varieties (Fig. 1). As an example, 4-5 days and 3-4 days early flowering occurred in variety MI2 and MI3 respectively than those grown in bare soil (Fig. 1 A & B). Similarly, UV treated polythene soil cover triggered first fruit picking from 5 days in MI2 and 8 days in MI3 (Fig. 1 C & D). Further, there was no significant difference among the days to 50% flowering and first fruit picking in all treatments with UV treated polythene mulch with different amount of fertilizer. These results imply that there is a possibility to reducing the amount of fertilizer than the recommendation with the use of UV treated silver on black polythene mulch in both chilli varieties MI2 and MI3. Iftikhar *et al.* (2011) have also reported that the plastic mulch materials reduced the number of days to the first harvest of chilli is supporting the present investigation.

The effect of the UV- treated polythene mulch on the yield per plant (Fig. 1 E & F) and fruiting span (Fig. 1 G & H) were significantly higher than the control plants. All treatments with polythene mulch led to the increment of the yield per plant and fruiting span irrespective of the level of fertilizer in both varieties. In both varieties, significantly higher yield per plant and fruiting span was observed in T2 (UV-treated polythene mulch plus 100% recommended fertilizer) and T3 (UV-treated polythene mulch plus 75% recommended fertilizer), over T1 (100 % recommended level of fertilizer without polythene mulch). Yield increments observed were 5.77 and 3.54 times over in MI2 and MI3, respectively with T2 compared to T1. It was 5.74 and 3.44 times over in MI2 and MI3, respectively in T3 compared to T1. UV treated polythene mulch with 50 % recommended fertilizer (T4) also gave 3.80 and 1.56 times yield increment per plant for MI2 and MI3, respectively, compared to the T1.

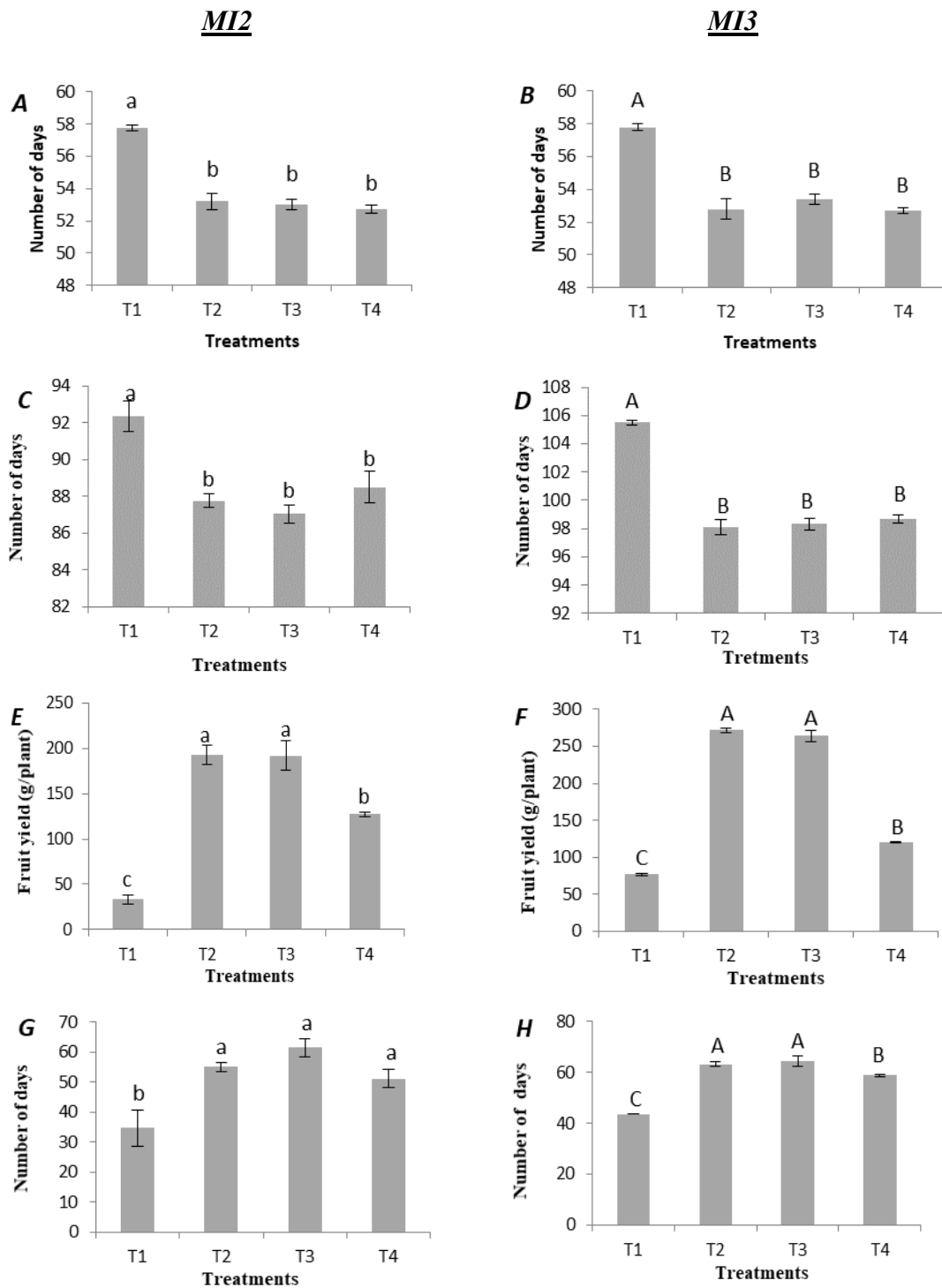


Figure 1: Effects of different treatments on the (A & B) number of days to 50% flowering; (C & D) number of days for first picking; (E & F) fruit yield per plant and (G & H) fruiting span. Treatments with different letters are significantly different at $P \leq 0.05$. (T1: 100% recommended level of fertilizer without polythene mulch, T2: Polythene mulch with 100% recommended level of fertilizer, T3: Polythene mulch with 75% recommended level of fertilizer, T4: Polythene mulch with 50% recommended level of fertilizer)

The extended fruiting span has resulted in the treatment T3 which was around 62 days in MI2. There was no significant difference among the treatments T2, T3 and T4 in the sense of fruiting span. However, in T1, the fruiting span was recorded as 35 days which is significantly lower than all other treatments in MI2 (Fig. 1G).

In MI3, the fruiting span of the treatment without soil cover was around 44 days. The extended fruiting span has resulted from the T3 which was around 65 days. There was no significant difference among the treatments T3 and T2. The fruiting span of the T4 was significantly lower than T3 and T2 but significantly greater than T1 (Fig. 1H).

According to the studies carried out by Lourduraj *et al.* (1996), polythene mulch has significantly increased all yield parameters of chilli (plant height, fruits per plant, fresh fruit girth, fresh fruit length, and fresh fruit yield) in comparison with the non-mulched control and organic mulch. Kwabiah (2004) in his studies pointed out that the plastic film mulch promoted root growth and more roots were distributed in mid and deep soil so that the plants can uptake water from the deep soil and increase the yield. Nagalakshmi *et al.* (2002) have reported that the yield per plant, the number of fruits per plant and the quality of chilli have increased with the plastic mulch compared to the non-mulched treatments. According to the studies carried out by Ashrafuzzaman, *et al.* (2011), black plastic mulch had the maximum number of fruits and highest yield, indicating the mulching is a viable tool to increase chilli production.

Weed control and/ or soil warming are the main objectives of using polythene mulches in vegetable production. The polythene soil covers decrease the amount of light transmitted to the soil and prevent weed seed germination and their growth. In this experiment also a significant effect on the number of weeds (Table 1) and their fresh weight per square meter (Table 2) by UV treated polythene mulch was observed throughout the study period. The results shown in the present study revealed that the

UV treated polythene soil cover was fully effective in controlling the weed population as compared to the non-mulched treatment during the experimental period.

Moreover, Prakash *et al.* (2003) have reported that weed infestation is the major limiting factor in realizing the potential yield of Capsicum, resulting in a heavy reduction in the yield.

It believes that UV treated polythene mulch reflect solar radiation and those radiations can increase the photosynthetic rate of the plant by increasing the amount of radiation intercepted on the crop canopy and effective distribution throughout the canopy. Further polythene soil cover can conserve soil moisture and nutrient which leads to proper conditions for root growth. It is also believed that the reflective radiation discourages insect-transmitted diseases and whiteflies thereby reduce pest attacks (Charles *et al.* 2005; Vos *et al.*, 2012). The low number of weeds also discourage pests to attract cultivation due to the absence of host plants.

Weeds compete with crops for mineral nutrients, water, solar energy and space and they hinder crop cultivation operations. Therefore, the less crop-weed competition provides better nutrient and moisture conditions for the growth of the crop plants. Hence the control of weeds immediately after transplanting, during the entire vegetative stage and early reproductive stages of chilli is a must for higher production (Isik *et al.* 2009). If UV treated silver on black polythene soil cover use, weed emerges only through the punch and no weed was found under the mulch, due to a complete block of light penetration. However, some weeds like *Cyperus rotundus*, *Coronopus didymus*, *Dactyloctenium aegyptium*, *Amaranthus viridis* can emerge through the cover if the cover is damaged.

Polythene soil cover can also conserve moisture in the soil. Evaporated soil moisture is entrapped beneath the polythene soil cover, condenses underside, and provides back to the soil. Thus, reduced soil moisture losses and

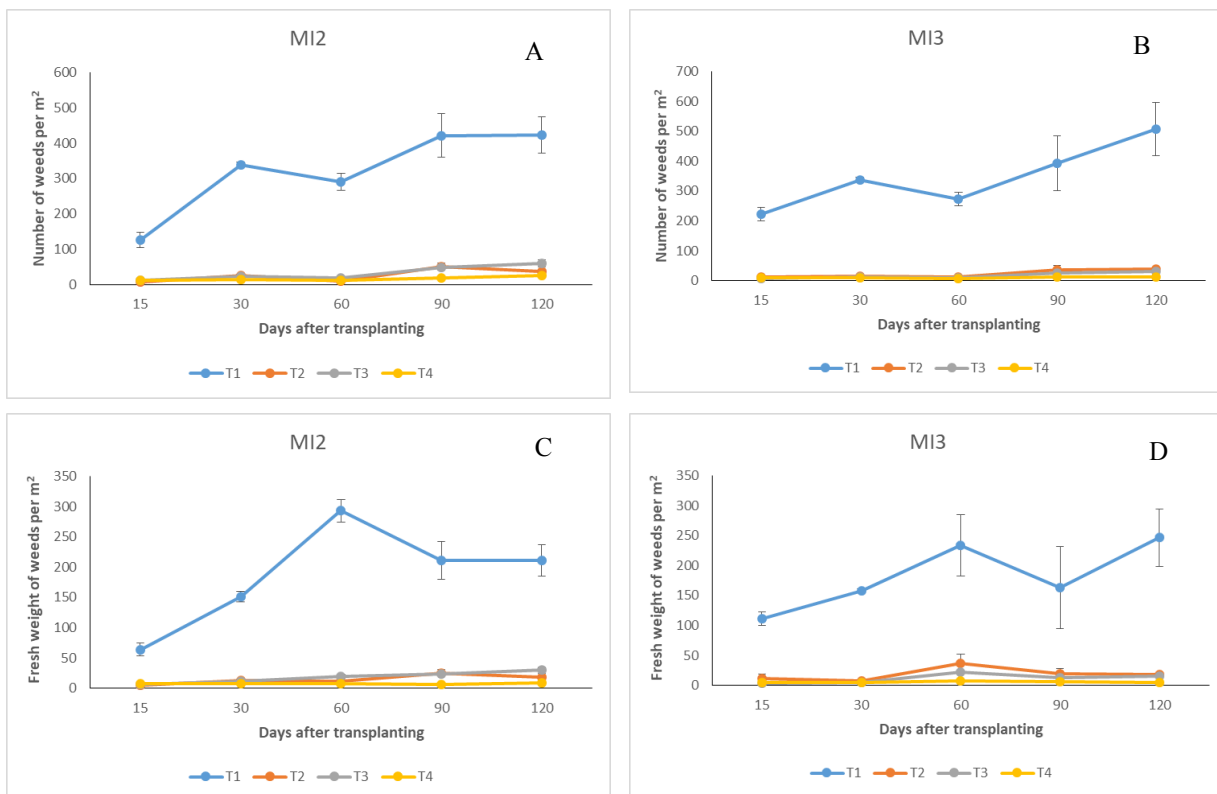


Figure 2: Effects of different treatments on the number of weed plants per m² (A and B) and fresh weight of weeds per m² (C and D) in chilli variety MI2 and MI3 over 120 days after transplanting. (T1: 100% recommended level of fertilizer without polythene mulch, T2: Polythene mulch with 100% recommended level of fertilizer, T3: Polythene mulch with 75% recommended level of fertilizer, T4: Polythene mulch with 50% recommended level of fertilizer)

enhanced circulation under the soil cover may have increased the availability of nutrients present in the soil in the vicinity of roots. Moreover, less nutrient volatilization facilitates the use of the available nutrients for the growth of the plant.

The absence of weeds to some extent would also have eliminated the weed competition for nutrients and moisture. According to the results given in the chapter, the application of UV treated polythene soil cover was effective in weed control in chilli. Several vegetable farmers in the area used the polythene much and we could observe that it can be reused up to four crop cycles as mentioned by the manufacturer. After one crop season, they rolled the sheet in a pole until finish land preparation and reuse.

Black polythene is one of the most common soil covers used in the world. However, it creates serious environmental problems. Biodegradable films such as UV treated silver on black polythene soil covers are alternatives for this issue. These soil covers are reusable for up to four crop cycles. However, farmers are reluctant to adopt them due to the high market price, as they do not have a proper idea of the cost-effectiveness and benefits of long-term usage.

CONCLUSIONS

The results of this study revealed significant positive effects of the use of the UV treated silver on black polythene mulch for chilli varieties MI2 and MI3. Among the different fertilizer levels with polythene mulch, the maximum performance was observed in the 75% fertilizer level. Therefore, it can be

concluded that the use of biodegradable UV treated polythene mulch would be benefited to enhance plant growth and yield and to cut the fertilizer requirement for chilli by 25% from the recommendation given by the Department of Agriculture, Sri Lanka and complete elimination of herbicide application for the tested varieties is advisable. However, further studies in commercial cultivations under different environmental, geographical, and agronomic conditions should be performed to understand the long-term effect on the environment, soil structure, texture, organic matter content, microbial population and cost.

AUTHOR CONTRIBUTION

WAGCPW, DLW, DABNG and HKMSK conceptualized and designed the study. WAGCPW performed the experiments. WAGCPW, DABNG and HKMSK analyzed and interpret the data. WAGCPW and DLW contributed in drafting the manuscript and DLW critically revised the manuscript.

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