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Soil cover with rice husk, polyethylene and biodegradable film in bell pepper (*Capsicum annum* L.) cultivation

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ABSTRACT

A field trial regarding the effect of different types of soil cover on the characteristics of bell pepper (*Capsicum annuum* L. Yolo Wonder) fruit and incidence of weeds was conducted at the facilities of the Department of Agrarian Sciences (UNITAU), Taubaté -SP at 23º02'34" S and 45º31'02" W, with an average elevation of 577 m in a medium-textured dystrophic Yellow Red Latosol. The experimental design was a randomized block with five replicates and four treatments: 1) coat of rice husk (CRH); 2) black polyethylene film (BPF); 3) black biodegradable film (BBF); and 4) soil without cover (SWC), with five replicates. The treatments were distributed in flower beds with 1.2 m wide, 0.3 m high and 10 m long. Drip irrigation was placed on the surface of the beds, with a pipe line (dripping distance 0.4 m, measured flow rate of 1.67 $L.h^{-1}$, service pressure of 1.6 kPa). Harvesting occurred 90 days after planting the seedlings, and the length, number and weight of the bell pepper fruits were determined. The weed plants in the plot were evaluated in five samples of 0.25 m^2 randomly obtained per plot. The coverings had a significant effect on fruit length, number and weight, and black polyethylene film and biodegradable film obtained better results, compared to the coat of rice husk and soil without cover. In the coverings with polyethylene film and biodegradable film, the fruit length was above 12 cm, the number of fruit exceeded 10 fruit per plant and the weight of the fruit was superior to 1 kg per plant. Polyethylene film and biodegradable film reduced weed infestation by 75.4% on average when compared to soil without cover. It can be concluded that the biodegradable film presented the same efficiency as the polyethylene film as regards the productivity of the pepper crop and the reduction of weeds.

Keywords: cultivation system, mulching, weed plant.

Cobertura do solo com casca de arroz, polietileno e filme biodegradável no cultivo do pimentão (*Capsicum annum* L.)

RESUMO

Avaliou-se o efeito de diferentes tipos de cobertura do solo sobre as características dos frutos do pimentão (*Capsicum annuum* L. cv. Yolo Wonder) e incidência de plantas infestantes num ensaio de campo nas instalações do Departamento de Ciências Agrárias (UNITAU), em Taubaté-SP, a 23º02’34” S e 45º31’02” W, com altitude média de 577 m, em um Latossolo

Vermelho Amarelo distrófico de textura média. O delineamento experimental utilizado foi de blocos casualizados com cinco repetições e quatro tratamentos: 1-cobertura de casca de arroz (CRH), 2-filme de polietileno preto (BPF), 3-filme de biodegradável preto (BBF) e 4-solo sem cobertura (SWC). Os tratamentos foram distribuídos em canteiros, com 1,2 m de largura, 0,3 m de altura e 10 m de comprimento. A irrigação por gotejamento foi colocada sobre a superfície dos canteiros, com gotejadores distanciados 0,4 m, caudal de 1,67 $L.h^{-1}$, pressão de serviço de 1,6 kPa. A colheita ocorreu aos 90 dias após a plantação, e foram avaliados o comprimento, número e pesos dos frutos. As espécies de plantas infestantes foram avaliadas em cinco amostras de 0,25 m^2 obtidas aleatoriamente por parcela. As coberturas apresentaram um efeito significativo para o comprimento, número e peso dos frutos, tendo o BPF e o BBF obtido melhores resultados em comparação com a cobertura de casca de arroz e solo sem cobertura. Nas coberturas com filmes de polietileno e biodegradável o comprimento dos frutos foi superior a 12 cm, o número de frutos excedeu os10 por planta e o peso dos frutos superior a 1 kg por planta. Os filmes de polietileno e biodegradável reduziram em média a infestação das plantas daninhas em 75,4% quando comparado com o solo sem cobertura. Pode-se concluir que o filme biodegradável apresentou a mesma eficiência do filme de polietileno quanto à produtividade da cultura do pimentão e a redução das plantas infestantes.

Palavras-chave: mulching, plantas infestantes, sistema de cultivo.

1. INTRODUCTION

In the cultivation of fruits and vegetables, the presence of weeds is one of the factors responsible for the reduction of productivity because they compete for sun, nutrients, and water. The predominant control of weeds in vegetable production systems is carried out through the application of herbicides, but this technique has been questioned due to the increase in production costs and the consumer's demand for healthy food. Thus, soil covering with plant remains and polyethylene film has been adopted for weed control because it reduces weed infestation by creating a physical barrier that blocks sun's rays (McGraw and Mostes, 2007; Minuto *et al.*, 2008). Tt also provides other benefits such as the maintenance of organic matter in the soil, reduction of erosion, decrease of nutrient leaching, and reduction of soil water loss (Silva *et al.*, 2009). Traditionally the most used cover is polyethylene film and plant materials such as wood shavings, carnauba straw, rice husks, and maize straw (Queiroga *et al.*, 2002; Teófilo *et al.*, 2012). Several authors have found that soil cover with polyethylene film has led to an increase in growth and productivity of fruits and vegetables, in the number and average weight of fruits, insoluble solids content, higher harvesting speed, and increase in the dry mass of fruits (Medeiros *et al.*, 2007; Yuri *et al.*, 2012). Regarding the use of mulch, studies have found that the increase in productivity of vegetables and fruits is related to soil shading, decreased water loss by evaporation, and the release of chemicals by straw decomposition that inhibits the germination of weeds (Queiroga *et al.*, 2002; Coelho *et al.*, 2013). The use of biodegradable film in soil cover has intensified in countries such as Portugal, Spain, and Italy, and the results have shown that the use of biodegradable film in soil cover has increased the productivity of crops with values similar to those observed with polyethylene, but with the advantage of decomposing in the soil equal to plant remains used as a soil cover (Minuto *et al.*, 2008; Martín-Closas *et al.*, 2008; Carvalho *et al.*, 2012; Saraiva *et al.*, 2012; Kasirajan and Ngouajio, 2012).

In Brazil, little or no work is performed with biodegradable film as ground cover. This study therefore evaluates the effect of different types of ground cover on the characteristics of bell pepper (*Capsicum annuum* L. cv. Yolo Wonder) and the incidence of weeds.

2. MATERIAL AND METHODS

The experiment was conducted in an area near the Department of Agricultural Sciences of the Universidade deTaubaté - UNITAU - the municipality of Taubaté, SP, with geographical coordinates 23º02'34" S and 45º31'02" W and with an average altitude of 577m. The local climate, according to the classification of Köppen (1948), is of type Cwa (Subtropical), with summer rains and average annual precipitation of 1,300 mm. The soil in the area has been classified as Red Yellow Dystrophic Latosol with medium texture (Embrapa, 1999) and the following chemical composition: pH (H_2O) = 5.8; MO = 21 g dm^{-3}; P = 30 mg dm^{-3}; K = 3.5 mmolc dm^{-3}; Ca = 30 mmolc dm^{-3}; Mg = 14 mmolc dm^{-3}; H + Al = 18 mmolc dm^{-3}; SB = 47.5 mmolc dm^{-3}; T = 65.5 mmolc dm^{-3} and V = 73%.

The experimental design used was that of randomized blocks, with five blocks and four treatments: 1) coat of rice husk (CRH); 2) black polyethylene film (BPF); 3) black biodegradable film (BBF); and, 4) soil without cover (SWC). The soil preparation consisted of making beds (1.2 m wide, 0.3 m high and 10 m long), spaced 2.0 m apart between rows, then installing the drip irrigation system on the surface of the beds with a drip line with a measured flow rate of 1.67 L h^{-1} and service pressure of 1.6 kPa, with emitters every 40 cm. Then the rice straw (4 cm thick) and the polyethylene (30 µm) and bioplastic (15 µm) films were installed. The liming and basic fertilization corresponded to the application of 0.6 Mg ha^{-1} dolomite limestone, 40 Mg ha^{-1} vermicomposts (dry base), 40 kg ha^{-1} N, 160 kg ha^{-1} P_2O_5, and 60 kg ha^{-1} K_2O, incorporated into the soil at the time of construction of the beds with the manual hoe. After 30 days, bell pepper plants of the variety "Yolo Wonder" were planted at 1 x 0.6 m spacing. The N fertilization in cover was applied in the amount of 80 kg ha^{-1}, parcelled in four times, with 15-day intervals between the applications.

The evaluation of the bell pepper yield was performed at 90 days after planting, and to measure the number of fruit per plant, length of fruit (cm), and fresh mass of fruit (kg $plant^{-1}$), the plants were collected in the central line of the beds.

The main species of weeds in the beds were evaluated in five samples of 0.25 m^2 obtained randomly at 30, 60, and 90 days. The weeds were identified by family, genus, and species (Fey *et al.*, 2013).

The data obtained were submitted to analysis of variance and in cases of significance, for comparison of means, the Tukey test was used at the 5% probability level.

3. RESULTS AND DISCUSSION

3.1. Bell Pepper Yield

The number of bell peppers harvested on the beds with and without cover is shown in Figure 1. Concerning this characteristic, it can be seen that ground coverings, in general, have significantly influenced the number of fruit when compared to the value of the number of fruits determined on the bed without cover. Among the coverings, biodegradable film provided the highest number of fruit per plant, followed by polyethylene and rice husk. The number of fruit in the bed coated with biodegradable film was 58.3% higher than the value obtained in the crop without coverage, 29.7% higher than that determined with the coating of rice husk, and 5.7% higher than that verified with the polyethylene coating. With the polyethylene coating, the quantity of fruit was 55.7% higher than that found on the bed without coating and 18.2% higher than that found on the bed with rice husk coating. On the rice-husk bed, the number of fruit was 45.8% higher than the number determined on the ground with no covering. The superiority of the cover in the number of fruit per plant with the soil without cover demonstrates the positive influence of the cover on the conservation of soil moisture and inhibition of weed growth, thus providing more favorable conditions for fruit development (McGraw and Mostes, 2007; Coelho *et al.*, 2013).

The length of the sweet pepper fruit was significantly influenced by the cover when compared to the ground without cover (Figure 1). The highest average was observed in the bed with biodegradable film, although it did not differ significantly from the beds with polyethylene and rice husk coverings. Fruit length values varied from 9.7 cm on the bed without cover to 12.2 cm on the bed with biodegradable film cover; this corresponds to an increase of 20.5% in the length of bell pepper fruit.

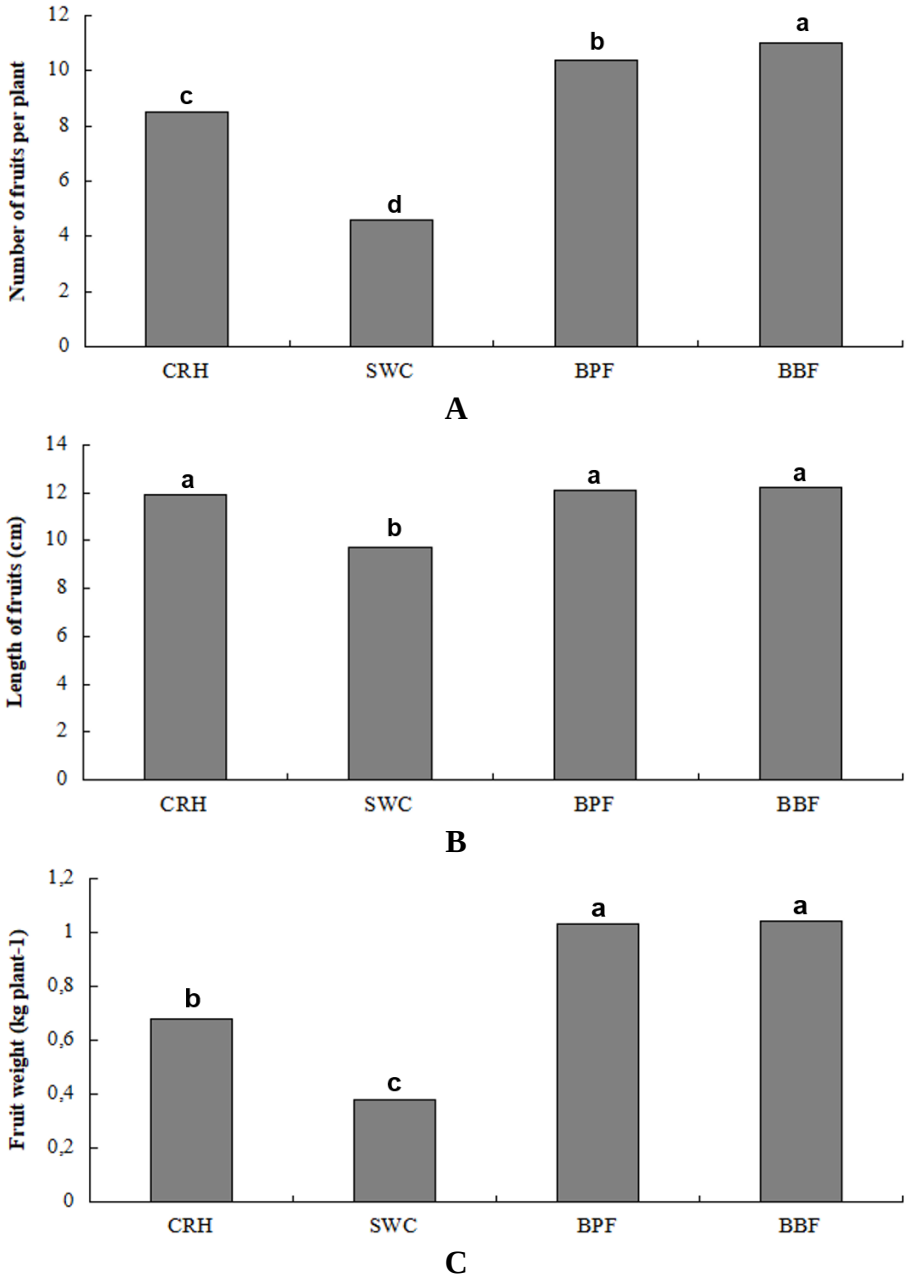

Figure 1. (A) number, (B) length and (C) fruit weight, grown with coat of rice husk (CRH), black polyethylene film (BPF), black biodegradable film (BBF) and soil without cover (SWC). Averages followed by the same letter do not differ statistically at 5% probability by Tukey's test.

The mass of the fruit was significantly affected by the types of toppings, where it was possible to verify a certain superiority of the biodegradable toppings, polyethylene, and rice husk concerning the soil without topping (Figure 1). The fruit mass production in the biodegradable film and polyethylene roofs was 63.4% higher than the mass determined in the

unpeeled ground and 34.6% in the rice husk. This result can be explained by the higher number and length of fruits per plant observed in crops with biodegradable film and polyethylene, as these coverings provided less competition with weeds and because they were waterproof they reduced water losses in the soil, providing a more favorable condition for fruit development (Queiroga *et al.* 2002; Silva *et al.*, 2009; Yuri *et al.*, 2012).

3.2. Weed Identification

The number of weeds in the soil of beds cultivated with pepper, with and without cover, was generally significantly controlled by the type of cover (Figure 2).

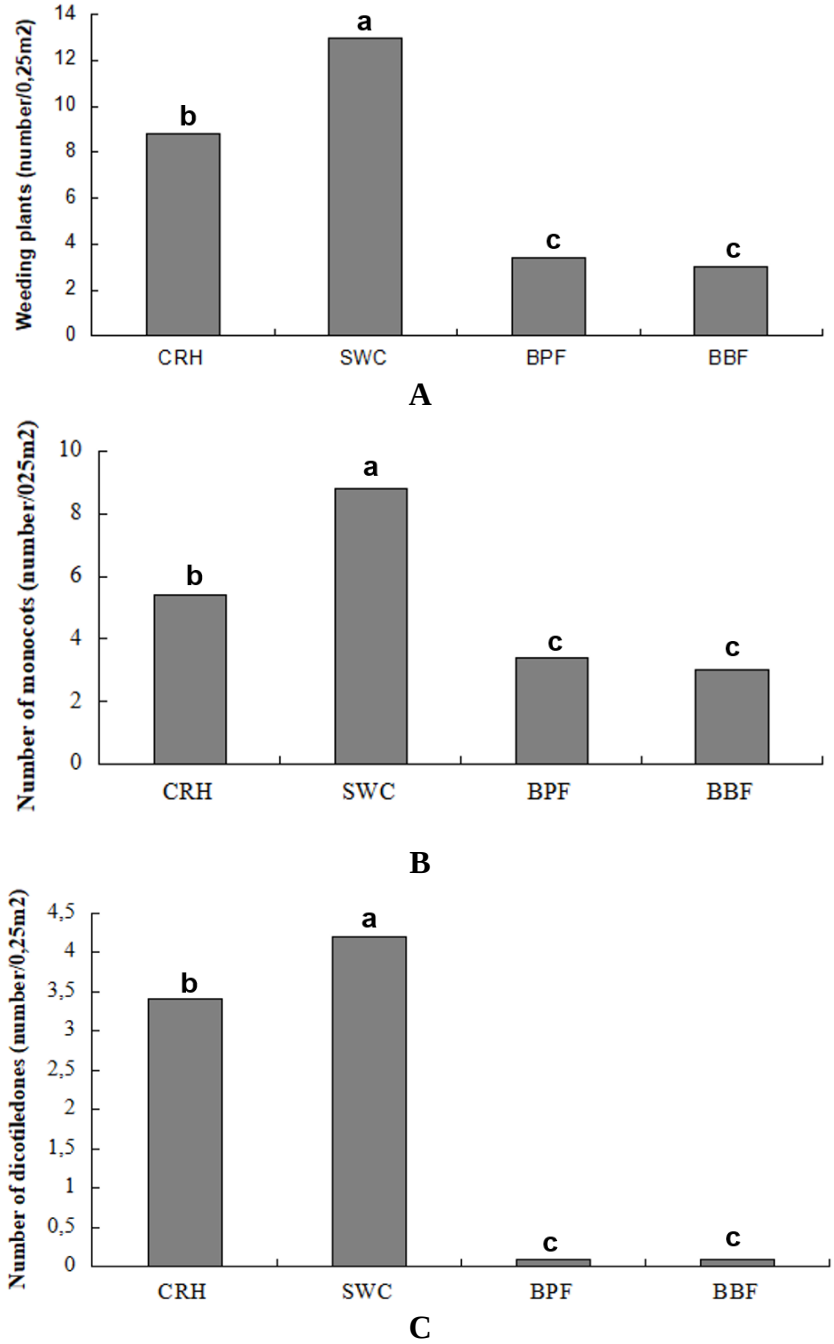

Figure 2. (A) number, (B) length and (C) fruit weight, grown with coat of rice husk (CRH), black polyethylene film (BPF), black biodegradable film (BBF) and soil without cover (SWC). Averages followed by the same letter do not differ statistically at 5% probability by Tukey's test.

It is noticeable that weed control was efficient in the soil with polyethylene and biodegradable film toppings when compared with the soil without cover and with a coat of rice husk.

When comparing the numbers of weeds determined in the soil without cover and with polyethylene and biodegradable film mulch, it can be seen that polyethylene and biodegradable reduced weed infestation by 75.4%. When analyzing the efficiency of controlling the ground cover with polyethylene and biodegradable film with a coat of rice husk, it can be seen that the reduction was 30.6% in weed control during the bell pepper cycle. Weeds were separated into monocot and dicot and a predominance of monocot concerning dicot was found in all treatments (Figure 2). The polyethylene and biodegradable film coverings controlled dicot infestation 100%, and were also more efficient in controlling monocot as compared to soil without cover and coat of rice husk. The predominant species among monocot was the crow's *Eleusine indica* L and *Cyperus rotundus* L, but in the polyethylene and biodegradable coverings, the *Cyperus rotundus* L prevailed, which due to its morphology and position of the leaves were able to perforate the polyethylene and biodegradable film.

Analyzing Figure 2, it is observed that, with regard to the soil without covering, the polyethylene and biodegradable film reduced the infestation of monocot by about 63.8% and with the covering of rice husk the control was 40.7%. During the development of crops, it was found that *Cyperus rotundus* L and crow's foot Eleusine indica L were the predominant species among monocot and dicot, the prevailing species were *Amaranthus hybrids* L, *Portulaca olereacea* L and *Cenchurs echinatus* L. In general, it was found that the coverings of the beds with coating of rice husk, polyethylene, and biodegradable film were efficient in controlling the weeds. This was evident because these materials block solar radiation that is necessary for the germination of the seeds and development of weed seedlings (McGraw and Mostes, 2007; Minuto *et al.*, 2008; Coelho *et al.*, 2013).

4. CONCLUSIONS

Given the results, it can be concluded that the pepper productivity and the efficiency in weed control obtained with the covering of soil with biodegradable film was similar to that verified with the covering with pole film. The use of polyethylene and biodegradable film provided an average increase of 55% in the number of fruits and a higher bell pepper yield when compared with the soil without cover. Regarding fruit length, no significant differences were observed between polyethylene, biodegradable film, and coat of rice husk. Polyethylene and biodegradable film coverings on average reduced the weeds by 75.4% when compared to the soil without cover, while rice husk cover reduced the weeds by30.6%.

5. ACKNOWLEDGMENTS

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