Plant Growth and Yield in Sweet Corn (Zea Mays convar. *saccharata* var. *rugosa*) on Colored Plastic Film Mulches

Juan C. Diaz-Perez*[1], Gvozden Dumicic[2], Juan A. Alvarado-Chavez[1], and Jesús Bautista[1]

[1]Dept. of Horticulture, University of Georgia, Tifton, GA 31793, [2]Institute of Adriatic Crops and Karst Reclamation, 21000 Split, Croatia

Abstract. Plastic mulches are widely used for production of solanaceous and cucurbit crops, resulting in significant increments in earliness, and fruit yield and quality. Plastic mulches also provide excellent weed control which may be useful particularly in organic production. Transparent mulch has been used to enhance seed germination and reduce earliness in sweet corn. Little is still known, however, about production of sweet corn on other plastic film mulches. Objective was to determine the effect of colored mulches on sweet corn (*Zea mays* L.) yield. Study was conducted in Tifton, Ga, during fall of 2011, in a Tifton Sandy Loam. Plastic film mulches (low density PE) evaluated were black, blue, gray (gray-on-black), red, silver (silver-on-black), and white (white-on-black). Sweet corn 'Merit' was direct-seeded manually in two rows per bed (36 cm apart) with a distance of 30 cm between seed within the row. Root zone temperature (RZT) was measured by determining soil temperature midway between plants at 10 cm below the mulched soil surface. Plastic film mulches differed in their soil-warming ability, with midday RZTs being highest in black and blue mulches and lowest in silver and white mulches. Plant height was higher on silver and white mulch and bare soil and lower on black mulch. Marketable and total yields and ear weight were among the highest on silver and white mulches and among the lowest on black, blue, and red mulches. Both, plant height and marketable yield showed no change below 26 °C midday RZT and decreased with increasing midday RZTs above 26 °C. Reduced plant height and sweet corn yields in black, blue and red mulches were probably due to increased RZTs that resulted in increased plant heat stress conditions. In conclusion, colored plastic film mulches influenced root zone temperature and plant growth and yield in sweet corn.

Key Words: Plastic mulch, Plasticulture, Heat stress, Soil temperature, Sweetcorn

Crecimiento de Planta y el Rendimiento de Maíz Dulce (Zea Mays convar. *saccharata* var. *rugosa*) con Acolchado de Colores

Juan C. Diaz-Perez*[1], Gvozden Dumicic[2], Juan A. Alvarado-Chavez[1], y Jesús Bautista[1]

[1]Dept. de Horticultura, Universidad de Georgia, Tifton, GA 31793, [2]Instituto of Cultivos Adriáticos, 21000 Split, Croacia

Resumen. Los acolchados plásticos aportan beneficios como precocidad del cultivo y un alto rendimiento y calidad del producto cosechado; además, proporcionan un excelente control de malezas, lo cual es muy favorable en sistemas orgánicos. El acolchado transparente se utiliza para estimular la germinación de maíz dulce en zonas de clima templado o frío. Sin embargo, existe poca información sobre el uso de acolchado de colores en maíz dulce. El objetivo fue determinar los efectos de los acolchados de colores en el crecimiento de planta y rendimiento de maíz dulce.

El estudio se realizó en Tifton, Ga. durante el otoño de 2011, en un suelo limo-arenoso tipo Tipo Tifton. Los acolchados plásticos (PE de baja densidad) evaluados fueron: blanco, gris, negro, plateado y rojo; el suelo desnudo fue utilizado como testigo. Maíz dulce 'Merit' fue sembrado manualmente, en dos hileras (36 cm de separación) por cama (1.8 m de separación) a 30 cm de distancia entre semillas. La temperatura de la zona radical (TZR) se midió colocando termopares (10 cm de profundidad) de cobre-constantán en medio de dos plantas de una misma hilera. La TZR al mediodía fue mayor en suelos con acolchado negro y azul y menor en suelos con acolchado blanco y plateado. La altura de planta fue mayor bajo acolchado blanco y plateado y en suelo desnudo, y menor bajo acolchado negro. Los rendimientos comercial y total y el peso de mazorca mostraron valores altos en los acolchados blanco y plateado, y valores bajos en los acolchados azul, negro y rojo. La altura de planta y el rendimiento comercial disminuyeron con valores de TZR al mediodía superiores a 26 °C; valores típicos en los acolchados azul, negro y rojo. En conclusion, los acolchados de colores afectaron la TZR, así como el crecimiento y el rendimiento del maíz dulce.

Palabras clave: Acolchados, Plasticultura, Estrés por calor, Temperatura del suelo, Maíz dulce

Introduction

Plastic film mulches are widely used for production of tomatoes, peppers, muskmelons, cucumbers, watermelon, etc., resulting in significant increments in earliness, yield and fruit quality (Lamont, 1993). In the Southeast U.S., growers often double-crop on the same plastic mulch as a means to reduce crop production costs (Ibarra-Jimenez et al., 2012; Lamont and Poling, 1987; Rouse et al., 1996; Simms et al., 2006). As a first crop, profitable crops such as tomato, bell pepper or watermelon are grown; these crops are followed by a second crop such as sweet corn. Transparent mulch has been used to enhance seed germination and reduce earliness in sweet corn (Zhang et al., 2007). In other crops, such as tomato, bell pepper, tomatillo and broccoli plastic mulch color has been found to affect plant growth and yield. Little is still known, however, about the production of sweet corn on plastic film mulch (Ells et al., 1994; Kwabiah, 2004; Mahajan et al., 2007; Zhang et al., 2007). The objective was to determine the effect of colored mulches on sweet corn plant growth and yield.

Materials and Methods

Study was conducted at the Horticulture Farm, Univ. of Georgia, Tifton, Georgia, U.S., during the fall of 2011. Soil was a Tifton Sandy Loam with a pH of about 6.5. Design was a randomized complete block with seven treatments (plastic film mulch) and four replications. Plastic mulches were black, blue, gray (gray-on-black), red, silver (silver-on-black), and white (white-on-black). Experimental plot consisted of a 6.1-m long, 0.76-m wide bed formed on 1.8-m centers. All mulches were made out of low density polyethylene, 1.52 m wide, 25 µm thick, and their surface texture was slick. On 26 Aug. 2011, sweet corn 'Merit' was direct-seeded manually in two rows per bed (36 cm apart) with a distance of 30 cm between seed within the row. Total amount for each, N, P, and K received by the plants was 162, 26, and 134 kg•ha^{-1}, respectively. Plants were drip-irrigated with an amount of water equivalent to 100% crop evapotranspiration.

Root zone temperature. Root zone temperature was measured by determining soil temperature midway between the plants at 10 cm below the mulched soil surface. RZT over the growing season was measured either manually or with copper-constantan thermocouples (Model

107, Campbell Scientific, Logan, Utah) connected to a data logger (CR10X, Campbell Scientific) and an AM416 Relay Multiplexer (Campbell Scientific). The data logger was programmed to record readings every 10 min and store hourly averages for each plot.

Plant height. Plant height was measured (4 plants/plot) weekly starting three weeks after planting.

Harvest. Sweet corn ears were harvested manually on 8, 16 and 18 Nov. Ears were graded as marketable and culls, counted, and weighed.

Statistical analysis. Data were analyzed using the Analysis of the Mixed Procedure of SAS (SAS version 9.4, SAS Inst.).

Results and Discussion

Root zone temperature. Plastic film mulches differed in their soil-warming ability, with midday RZTs being highest in black and blue mulches and lowest in silver and white mulches (Fig. 1).

Plant height. Mean seasonal plant height was highest on silver and white mulch and bare soil and lower on black mulch (Fig. 2).

Fruit yields. Marketable and total yields and ear weight were among the highest on silver and white mulches and bare soil, and among the lowest on black, blue, and red mulches (Fig. 3). Cull yields were unaffected by plastic mulch treatments.

Both, plant height and marketable yield showed no change below 26 °C midday RZT and decreased with increasing midday RZTs above 26 °C. Reduced plant height and sweet corn yields in black, blue and red mulches were probably due to increased RZTs that resulted in increased plant heat stress conditions.

Conclusions

In sweet corn grown in the fall season, plastic mulch color affected root zone temperature and plant growth and yield. Plants grown in bare soil, together with silver and white mulches, produced among the highest yields. Reduced plant height and sweet corn yields in black, blue and red mulches were probably due to increased RZTs, and thus higher heat accumulation, that resulted in higher plant heat stress conditions compared to silver and white mulches and bare soil. Use of plastic mulch in this study provided no significant yield increase compared to bare soil.

Literature Cited

- Ells, J.E., A.E. McSay, E.G. Kruse, and G. Larson. 1994. Root distribution and proliferation of field-grown acorn squash as influenced by plastic mulch and water. HortTechnology 4:248-252.
- Ibarra-Jimenez, L., L. Alonso Valdez-Aguilar, A. Cardenas-Flores, H. Lira-Saldivar, J. Lozano-del Rio, and C. Lozano Cavazos. 2012. Influence of double cropping on growth and yield of dry beans with colored plastic mulches. Chilean Journal of Agricultural Research 72:470-475.
- Kwabiah, A.B. 2004. Growth and yield of sweet corn (Zea mays L.) cultivars in response to planting date and plastic mulch in a short-season environment. Sci. Hort. 102:147-166.
- Lamont, J.W.J. 1993. Plastic mulches for the production of vegetable crops. HortTechnology 3:35-39.

- Lamont, W.J.and E.B. Poling. 1987. A fresh way of looking for profits - Double cropping strwaberries and muskmelons on black plastic mulch. HortScience 22:1099-1099.
- Mahajan, G., R. Sharda, A. Kumar, and K.G. Singh. 2007. Effect of plastic mulch on economizing irrigation water and weed control in baby corn sown by different methods. African Journal of Agricultural Research 2:19-26.
- Rouse, R.J., M.J. Newell, C.A. McClurg, and J.C. Bouwkamp. 1996. Double cropping drip irrigated plastic mulch at the University of Maryland Wye Research and Education Center. Proceedings of the 26th National Agricultural Plastics Congress and the American Greenhouse Vegetable Growers Association Conference 26:93-96.
- Simms, T., J. Bantle, W. Hrycan, and D. Waterer. 2006. Potential to double crop vegetables on plastic mulch, Canadian Journal of Plant Science Vol. 86, pp.1435-1435.
- Zhang, T.Q., C.S. Tan, and J. Warner. 2007. Fresh market sweet corn production with clear and wavelength selective soil mulch films. Canadian Journal of Plant Science 87:559-564.

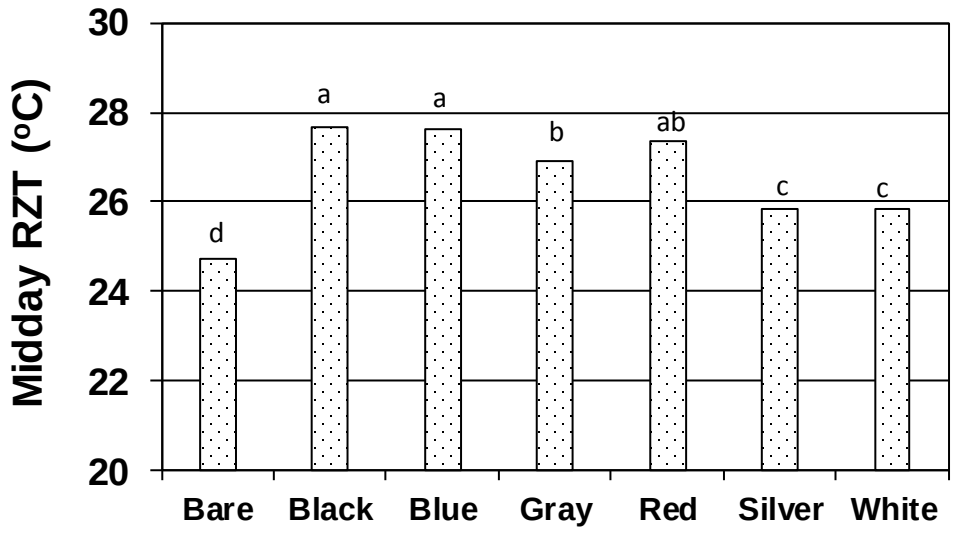

Figure 1. Average midday root zone temperature at midday as affected by color of plastic film mulch in sweet corn. Tifton, GA, fall 2011. Means separated among plastic mulch treatments using Fisher's protected least significant difference test ($P \leq 0.05$).

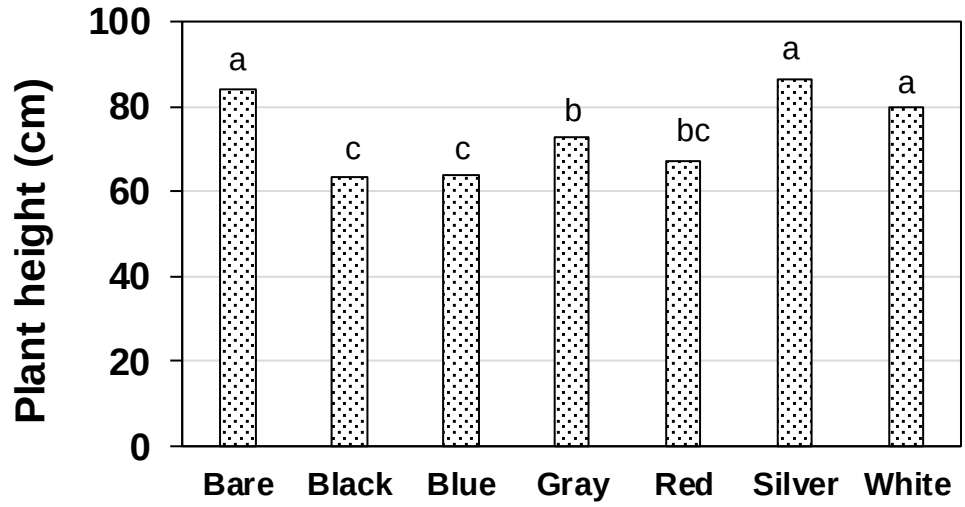

Figure 2. Sweet corn plant height as affected by color of plastic film mulch in sweet corn. Tifton, GA, fall 2011. Means separated among plastic mulch treatments using Fisher's protected least significant difference test ($P \leq 0.05$).

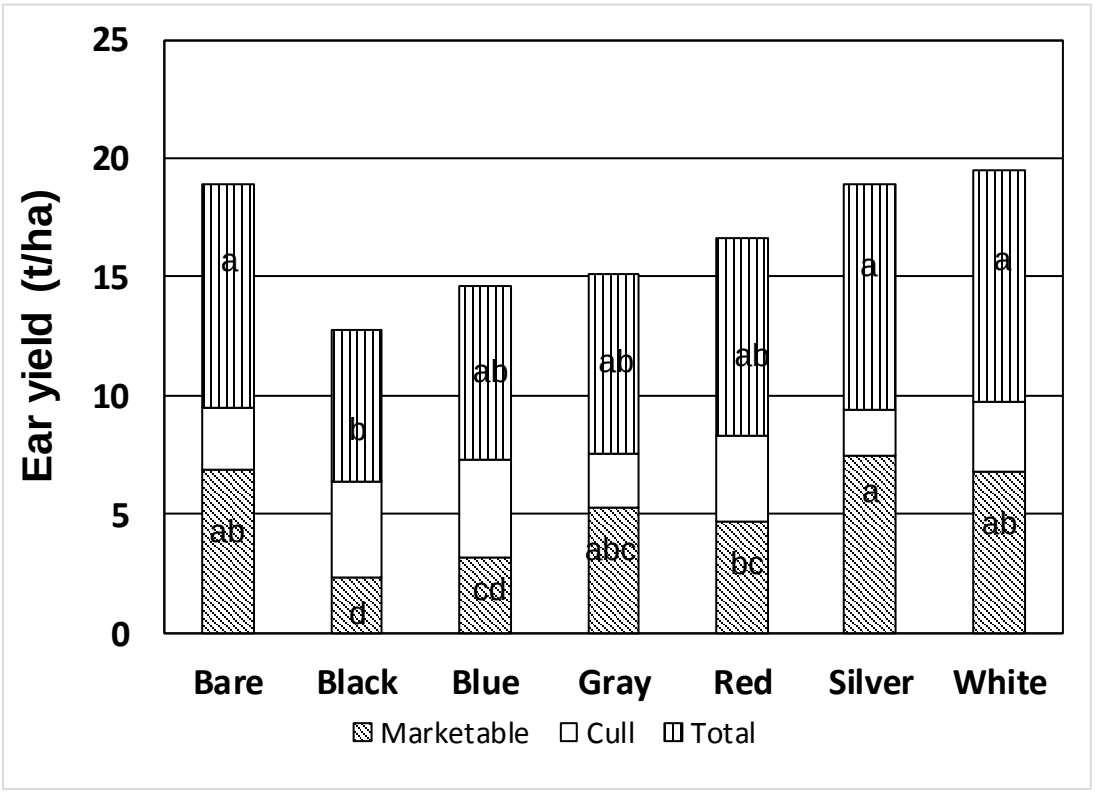

Figure 3. Sweet corn yields as affected by plastic film mulch color. Tifton, GA, fall 2011. Means separated among plastic film mulches, within each yield category, using Fisher's protected least significant difference test ($P \leq 0.05$).