Growth of Sweet Corn and Weeds in Response to Colored Plastic Mulches

H. R. Rajablariani and M. Sheykhmohamady
Department of Agronomy/College of Agriculture/Varamin-Pishva Branch/Islamic Azad University, Varamin, P.O.Box:33817-74895, Iran
Email: larijani2004@gmail.com; meisamsheikhmohamadi@ymail.com

M. AghaAlikhani
Tarbiat Modares University, Dept. of Agronomy, Tehran, P.O.Box: 14115-336 Iran
Email: maghaalikhani@modares.ac.ir

***Abstract*—There are limitations for use to herbicide in sweet corn production. In addition, organic standards prohibit the use of synthetic herbicides. Mulching has long been used as a non-chemical weed control practice suitable for organic farms. Field experiment was conducted during the period of July to September in 2010 at the research farm of the faculty of agriculture on the Varamin-Pishva branch, Islamic Azad University, Varamin, Iran. The experimental setup was a randomized complete block with six treatments of clear, black, blue and white on black plastic film, unmulched weed control and weedy check with three replications. Although the differences among plastic mulches were not significant, the highest weed dry weight recorded in clear plastic. The black, white on black and blue polyethylene mulches resulted in complete elimination of weeds. The highest plant height, stem diameter, LAI, total dry matter and fresh-kernel yield was recorded for plants grown on white/black plastic mulch. Dry weight of tillers significantly increased in mulched treatment. In areas where soil warming is not beneficial, co-extruded white on black plastic mulch can be used to establish crops in the summer.**

***Index Terms*—polyethylene mulch, tiller, weed**

I. Introduction

Loss of agricultural products due to weed competition is one of the main concerns for organic growers. The ability to control weeds is considered a major limiting factor for farmers wishing to transition to organic production systems [1]. Mulching has long been used as a non-chemical weed control practice suitable for organic farms [2]. Different colored plastic mulches resulted in a reduction of 84-98% weeds in tomato. The black plastic mulch controlled 100% of the weeds in plantings of tomato and corn [3].

Several studies have shown that response of plants to color of mulches has been variable. Tomatoes grown over white mulch received more reflected photosynthetic light and had greater shoot weights (27%), root weights (32%), and leaf area (20%) than plants grown over black mulch [4]. Plant height depends on phytomer formation and growth in length of the internodes. Under in vitro conditions, phytomers developed best under red light, worst under far-red, and blue gave an intermediate response [5]. The light reflected from the surface of plastic mulch can have a phytoregulatory role in growth of young tomato (*Lycopersicon esculentum)* plants [6]. Yield of bell pepper (*Capsicum annuum*) with an aluminium-painted mulch, and they suggested that the increase was due to an increased amount of reflected photosynthetically [7].

The use of colored mulched has been has been able increase growth and yield in some plants. For example, red mulch resulted in larger and higher number of strawberries (*Fragaria ananassa* Dutch) as compared to black mulch [8]. Trials conducted with cucumber using four mulch types (transparent polyethylene, silver polyethylene, black polyethylene, paraffin wax coated craft paper) showed that best vegetative growth was under black and the wax coated craft paper [9].

The objective of this research was to determine the effects of mulch surface color on the growth of field-grown sweet corn and weed suppression.

II. Materials and Methods

Field experiment was conducted during the period of July to september in 2010 at the research farm of the Faculty of Agriculture on the Varamin-Pishva Branch, Islamic Azad University, Varamin, Iran (35°17′N, 51°40′E). The experimental setup was a randomized complete block with six treatments of clear, black, blue and white on black plastic film, an unmulched weeded control (hereafter referred to as "control") and an unmulched unweeded control (hereafter referred to as "weedy") with three replications. All the plastic mulches were 120 cm in width and 30 μm in thickness. The seed beds were prepared by bed shaper and the mulches were laid on the raised beds two days before planting. Plot size was 6 m by 6 m. Each plot consisted of four beds 75 cm apart, with two rows of sweet corn (*Zea mays* L. var. *saccharata* Sturt, SC.403) planted in each bed. The sweet corn was seeded by hand through the mulches or into bare soil. The crop was sown at 66 500 seeds ha^{-1}, with 30-35 cm between rows in a bed and 20 cm between plants within

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the rows. Herbicides were not applied to the control treatments; weeds were controlled by bi-weekly manual weeding. The site was fertilized with manure based on the recommendations of a soil test, and all crops were drip irrigated. Weed density and biomass were assessed by throwing two quadrates 50×50 cm in size two times over the plots at two stages (35 days after planting and harvest). Six plants at 50% silk emergence and 12 adjacent plants at maturity were cut at the soil surface from each plot for determining biological traits and yields. Leaf area was determined with a CI-202 Area Meter (CID, Inc). Data were analyzed using Proc GLM procedure in the Statistical Analysis System (SAS Institute, Inc. 2009).

III. Results and Discussion

A. Weed Control

The heavy weed infestation was observed in weedy plots (Fig. 1). Although the differences among plastic mulches were not significant, the highest weed dry weight recorded in clear plastic. The highest number of weeds per m^2 recorded in transparent plastic mulch (186.5) and the lowest was in black plastic mulch (54.25) [10]. The light transmission increases soil temperature and creates a microclimate conducive to weed germination [11]. Weed control was satisfactory provided by all mulches from 98 to 100% compared to weedy plots (Fig. 2). There was complete elimination of weeds under black and white/black plastic mulch, whereas in unmulched plots (control) weeding was done manually five times during of experimentation. The black plastic mulch reduced weed dry weights by 94.7% in sweet corn [12].

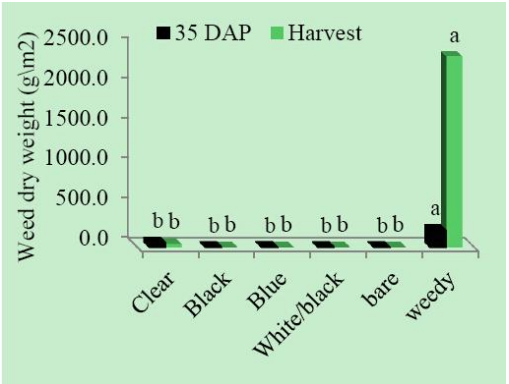

Figure. 1. Effects of mulched and unmulched treatments on weed dry weight 35 days after planting and harvest

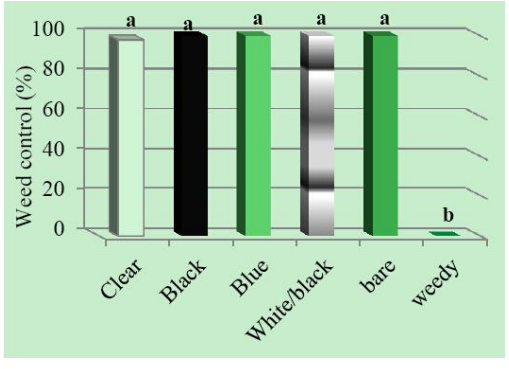

Figure. 2. Effects of mulched and unmulched treatments on weed control

B. Tillers

Although tillers or suckers were commonly removed in the past, research has shown that they do not reduce yield and need not be removed. The effect of large numbers of suckers in the plasticulture sweet corn has not been fully researched, however [13]. In our study, dry weight of tillers was significantly ($P < 0.05$) influenced by mulch treatments (Table I). The plants sown on blue plastic mulch produced the highest dry weight of tillers (4830 kg ha^{-1}), followed by the white on black (4114 kg ha^{-1}). The leaf area, root weight and fresh-ear weight of sweet corn increased and unfilled ear tips reduced in tiller-keeping compared with tiller-removing cultivation [14]. Their results confirmed that tiller-keeping cultivation results in effective light-intercepting characteristics to produce high yield and quality in sweet corn.

C. Plant Height and Stem Diameter

The effect of different mulches on height of plant at silking stage was significant ($P < 0.01$). Whereas, that no significant on stem diameter. The highest plant height (162 cm) and stem diameter (28.4 mm) were recorded in white on black plastic, although the differences between this mulch and other plastic mulches were not statistically significant (Table I). The plastic mulches resulted in a plant height approximately 38-54% higher than the weedy treatment. The various level of mulch led to significant increase in height of maize relative to unmulched treatment [15]. It seems likely that polyethylene mulches improve the soil temperature and moisture, prevent the loss of nutrients and develop soil micro climate favorable for growth and development of the crop.

D. Leaf Area Index (LAI)

The results showed that mulch treatments significantly affected LAI at silking stage (Table I). The highest LAI for white on black mulch (2.8), followed by black (2.7) and blue (2.6) mulch. Leaf area in these mulches was significantly greater than control treatment. Tomatoes grown over white mulch received more reflected photosynthetic light and had greater leaf area (20%) than plants grown over black mulch [4]. This increase was attributed to the lower ratio of R to FR light reflected into the plant canopy from the white mulch treatments as compared with the black treatments. The average absorbed photosynthetic active radiation (PAR) by leaf area at reproductive stage was the determining factor of corn yield and the decrease in yield had a high correlation with the decrease in corn leaf area [16].

E. Total Dry Matter

It is evident from Table I that colored mulches had significant effects on total dry matter of sweet corn. The maximum value of plant dry biomass (11570 kg ha^{-1}) was reduced in white on black mulch, followed by blue (10868 kg ha^{-1}) and black (10020 kg ha^{-1}), which were 107%, 94% and 79%, respectively higher than in the control treatment. It seems that the more and greater tillers have a large role to increase total dry matter. The lowest plant biomass was obtained in weedy plots (3113 kg ha^{-1}). Dry matter production and plant canopy were significantly higher

under clear polythene mulch compared to black polythene mulch and bare soil treatments [17].

TABLE I. EFFECTS OF MULCHED AND UNMULCHED TREATMENTS ON MORPHOLOGICAL TRAITS AT 50% SILKING AND FRESH-KERNEL YIELD OF SWEET CORN

Treatment	DWT (kg ha^{-1})	Plant height (cm)	Stem diameter (mm)	LAI	TDM (kg ha^{-1})	FKY (kg ha^{-1})	Kernel sugar (%)	Kernel Protein (%)
	*	**	NS	*	*	*	**	**
Clear	2257bcd	146a	24.3a	2.2c	7217abc	12100a	8.4d	10d
Black	3381abc	146a	26.8ab	2.7ab	10020abc	10850a	10.4b	13b
White on black	4114ab	162a	28.4a	2.8a	11570a	13850a	12.9a	14.7a
Blue	4830a	139a	26.4ab	2.6abc	10868ab	10950a	9.2c	11.3c
control	1208dc	145a	25.0ab	2.3bc	6651bc	10600a	7.6e	9.3e
Weedy	756d	105b	23.1b	2.1c	5582c	6300b	7.5e	8.2f
$LSD_{(0.05)}$	2289	25.16	3.91	0.41	3113	3949	0.17	0.2
CV (%)	45.61	9.85	8.38	9.23	19.77	20.14	11.03	15.99

*, ** Significant at 0.05 and 0.01 probability levels, respectively and **NS** not significant. Different letters in columns indicate significant differences. DWT, dry weight of tillers; LAI, leaf area index; TDM, total dry matter; FKY, Fresh-kernel yield.

F. Fresh-Kernel Yield

The use of plastic mulches significantly ($P < 0.05$) increased the fresh kernel yield compared to non-mulched plots (Table I).The highest fresh kernel yield produced on white/black mulch, although the difference between this mulch and the other plastic mulches was not statistically significant. Higher yield in mulch treatments might be due to its effects on soil temperature, soil moisture and weed suppression. The white/black plastic mulch resulted in 119% elevation in fresh kernel yield relative to control treatment. The marketable-ears yield of sweet corn was 1.5-2.0 times greater in plastic reflective mulch plots than from unmulced plots [18]. The maize yield in polythene mulch treatment was 127.5 % than those of direct sown maize [19].

G. Kernel Sugar and Protein

Total sugar was significantly influenced by mulch treatments (Table I). Between mulches, white on black had the highest sugar content and clear had the lowest. While weeds decreased sugar content by 40% in weedy plots compared to white on black plastic. In a field trial at Aspee foundation on sweet corn was reported that significantly highest sugar content in sweet corn was under polythene mulch than no mulch and paddy straw treatments [20]. Table I indicates significant difference (P=0.01) among treatments kernel protein. However, kernel protein increased by 37% in white on black plastic relative to the bare ground. The lowest protein percentage was recorded in weedy treatment. The results of a field experiment on sweet corn planted on polyethylene mulches indicated that the sugar content, protein content and fiber content were significantly superior under polythene mulch than no mulch during both years and in the mean of two years [21].

IV. CONCLUSION

The polythene mulches help to improve soil structure and soil micro-flora reduces fertilizer leaching, evaporation and weed problem. Therefore, polythene mulch has a positive effect on growth, yield and quality of crops. In the other hand, color of surface mulch has multiple effects on the growth and development of crops According to the growing season, climate and crop, can apply different colors. For example, in areas where soil warming is not beneficial, Coextruded white on black plastic mulch can be used to establish crops in the summer. That helps cool the soil (white) while controlling weeds (black).

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Hamid Reza Rajablarijani was born in Iran. He was awarded his Bachelor's and Master's Degrees in Agronomy from the Department of Agronomy, Faculty of Agriculture, Varamin-Pishva Branch, Islamic Azad University, Iran in 1995 and 2003, respectively. He was PhD student at Tabriz Branch, Islamic Azad University, Department of Agronomy and plant breeeding, Faculty of Agriculture. He is now assistant professor within Department of Agronomy, Faculty of Agriculture, Varamin-Pishva Branch, Islamic Azad University. His research interests are mulching, weed biology, ecology and management.

Majid AghaAlikhani (Tehran, Iran, 30th JUN 1967), received B.Sc. in Agronomy and plant Breeding, Ferdowsi Univ. of Mashhad, Iran (1990), M.Sc. in Crop production, Tarbiat Modares Univ., Tehran, Iran, 1993, Ph.D. in Crop Physiology, Tarbiat Modares University, Tehran, Iran, 2001. Major field of study: Weed-crop eco physiology.
He is Associate Professor of the agronomy department of TMU since 2001 till now.

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His current research interests are weed-crop Ecophysiology, intercropping, Agronomy of Medicinal and aromatic plants.
Dr. Majid AghaAlikhani is a member of European weed research society (EWRS) and Iranian weed science society (IWSS).

Meysam Sheykhmohamady was born in Iran. He was earned his Bachelor's and Master's Degrees in Agronomy from the Department of Agronomy, Faculty of Agriculture, Varamin-Pishva Branch, Islamic Azad University, Iran in 2008 and 2012, respectively.

