Effects of inorganic mulching on morphological features, quality and yield of banana

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Abstract

Banana is the only tropical species produced profitably in Turkey, even though it is produced well beyond major banana production zones. Banana production's popularity in Turkey could be due to fruiting being in the same year as planting, lower labour costs compared to many other alternative species, and ease of marketing with stable pricing. Yields and quality of bananas produced out of the main production zone are significantly affected by cultivar choice, cultural practices and growth conditions (greenhouse or open field production). While organic mulching is a commonly applied cultural practice in the tropics, inorganic mulch usage is much rarer. The effects of using clear plastic and white net (19 g m^{-2}) mulches on banana morphology, fruit characteristics and yield of 'Dwarf Cavendish' have been investigated. Mulching increased the number of fingers per hands, bunch weight, yield per square cm of stem and yield per area but did not affect stem height, leaf number, bunch stalk circumference and hand number. Best values for yield components were obtained from using white net. Bunch weights and yield per area values for control (no mulch), plastic and white net mulching treatments were found to be 24, 26 and 28 kg $bunch^{-1}$ and 38.7, 41.7 and 45.2 t ha^{-1} $year^{-1}$, respectively. Besides improving fruit quality, mulching shortened fruit-maturing period in terms of days from flowering to harvest. It also significantly increased soluble solids, peel thickness, pulp ratio and peel color (achieved by a smaller Hue angle value).

Keywords: clear plastic mulch, 'Dwarf Cavendish', subtropical conditions, white net, yield

INTRODUCTION

Banana is successfully grown on a commercial basis in Turkey, despite being produced a long way from even subtropical banana production zones. Yield and quality enhancement in banana grown in these circumstances is very much affected by selected cultivar, cultural practices and growth conditions (greenhouse or open field production). While organic mulching is a common cultural practice in the tropics, using in organic mulch is very rare. During banana cultivation in Turkey, inorganic clear plastic mulch is used to promote earliness, by soil warming and prevention of water loss through restriction of evapotranspiration. However restriction of water infiltration to soil through clear plastic creates a bottleneck. To increase water-holding capacity, in addition to clear plastic, a rain-permeable 'white net' (19 g m^{-2}) has been used as mulching in this research.

Although there are many reports highlighting the advantages of using organic mulch in banana production (Bananuka et al., 1996; McIntyre et al., 2003), no studies have been made on either organic or inorganic mulch use in Turkey's banana plantations. Commonly used organic mulch materials include litter from banana, sugar cane and coffee plantations, straw, grass, and wood shavings, while black or clear polyethylene film, or plastic fertilizer bags are used as inorganic mulch. Inorganic mulch provides many benefits to banana cultivation, including weed control, preventing water loss and soil erosion, and accelerating root growth due to stored water around the rooting region. Organic mulching on the other hand helps to increase and stabilize the soil temperature that reduces winter soil temperature fluctuations and increases the soil organic matter during its decaying process

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(Robinson and Galan-Sauco, 2011).

The main purpose of this study was not only to show the advantages of inorganic mulch over bare-soil production, but also to determine if there are any further effects of white net over clear plastic mulch.

MATERIALS AND METHODS

This project was carried out with 'Dwarf Cavendish' in Gazipaşa, Antalya (altitude 159 m, latitude 36°28'N) between 2012-2014. The average mean yearly minimum and maximum temperatures recorded for open field cultivation were 13.51-27.37°C, and with a relative humidity range of 30-90%. Soil analysis recorded a soil pH of 7.8 with 12.1% lime content, a loamy texture, and 2% organic matter. Irrigation and fertilization were applied according to normal recommended practices (Pekmezci et al., 1998). Both clear plastic and white net (19 g m^{-2}) were assessed as mulching materials during March to February (beginning to end of the season). Some of the morphological (leaf numbers, stem circumference, stem height), fruit maturation length, yield and physicochemical fruit parameters (finger weight, finger circumference, finger length, peel thickness, flesh hardiness, peel ratio, soluble solid content (SSC) and colouring) and yield components (bunch numbers, number of fingers on bunches and bunch weight, yield ha^{-1} and yield per stem section area) were determined. The yield per stem section area indicates the yield ratio to stem, or in other words the yield effect of pseudostem thickness. In addition, the effects of production systems on physicochemical features of banana were also evaluated at stage 6 ripening (Kader, 2005; Gübbük et al., unpublished).

The experiment was set as randomized blocks comprising 3 replicates and 10 plants $plot^{-1}$ 15 $fruits^{-1}$ for morphological parameters, and physical-chemical parameters, respectively.

RESULTS AND DISCUSSION

Although mulching had no effect on morphological features, it shortened the fruit maturation length, measured as shooting to harvest date, without affecting the yield values (Tables 1-4). Mulching, specifically white net, improved yield components, the yield ha^{-1}, by increasing the length and numbers of the fingers (Tables 3-4).

Table 1. The effects of mulching on pseudostem height and circumference.

Treatments	Pseudostem height (cm)	Pseudostem circumference (cm)
Control	112.80	72.80
Clear plastic	110.08	72.50
White net	112.50	74.00
$LSD_{\%5}$	N.S.	N.S.

N.S. indicates non-significant.

Table 2. The effects of mulching on some morphological parameters and period from shooting to harvest.

Treatments	Total leaf number	Active leaf number	Bunch stalk circumference (cm)	Days from shooting to harvest
Control	29.02	14.00	20.22	152.33 a[1]
Clear plastic	30.58	14.83	20.77	147.67 ab
White net	28.83	13.50	19.83	143.67 b
$LSD_{\%5}$	N.S.	N.S.	N.S.	5.767

[1]Mean comparisons were significantly different at the 5% level according to the LSD test ($P \leq 0.05$). N.S. indicates non-significant.

Table 3. The effects of mulching on yield features.

Treatments	Hand number	Finger number	Finger circumference (cm)	Finger length (cm)
Control	10.11	193.10 b[1]	11.06	19.12 b
Clear plastic	10.87	196.19 ab	11.32	19.08 b
White net	10.16	200.14 a	11.23	20.21 a
$LSD_{\%5}$	N.S.	6.861	N.S.	0.370

[1]Mean comparisons were significantly different at the 5% level according to the LSD test (P≤0.05). N.S. indicates non-significant.

Table 4. The effects of mulching on bunch weight, yield per stem section and yield.

Treatments	Bunch weight (kg)	Yield per stem section (g cm^{-2})	Yield (t ha^{-1})
Control	24.05 c[1]	62.14 b	3.84 c
Clear plastic	26.10 b	63.30 ab	4.17 b
White net	28.30 a	65.42 a	4.52 a
$LSD_{\%5}$	1.337	3.068	0.052

[1]Mean comparisons were significantly different at the 5% level according to the LSD test (P≤0.05).

Furthermore, mulching improved some fruit quality after ripening. It reduced peel ratio by reducing the peel thickness while it increased soluble solids and finger weight (Table 5). This shows mulching had not increased only yield, but also fruit flesh accumulation rate that will help to satisfy consumer demand. Mulching has also improved peel colour (determined by smaller Hue angle value) yielding a deeper peel colour (Table 6).

Table 5. The effects of mulching on finger weight, peel thickness, flesh hardiness, peel ratio and soluble solid content.

Treatments	Finger weight (g)	Peel thickness (mm)	Fruit firmness (kg cm^{-2})	Peel ratio (%)	Soluble solid content (%)
Control	100.62 b	3.25 a[1]	1.65	37.94 a	19.13 b
Clear plastic	104.26 a	3.21 a	1.80	35.58 b	19.60 a
White net	106,04 a	3.02 b	1.75	34.77 b	19.60 a
$LSD_{\%5}$	1.915	0.117	N.S.	1.377	0.133

[1]Mean comparisons were significantly different at the 5% level according to the LSD test (P≤0.05). N.S. indicate non-significant.

Table 6. The effects of mulching on chroma value and *h*° angle.

Treatments	Before ripening		After ripening	
	C	*h*°	C	*h*°
Control	29.50	112.14 a[1]	41.90	85.19 a
Clear plastic	28.05	105.30 b	40.26	82.59 b
White net	27.62	105.55 b	39.24	82.20 b
$LSD_{\%5}$	N.S.	3.846	N.S.	2.061

[1]Mean comparisons were significantly different at the 5% level according to the LSD test (P≤0.05). N.S. indicate non-significant.

Mulching is currently only applied in open field cultivated banana plantations of Turkey. Moreover, the only mulch material currently used is clear plastic, for its influence in enhancing soil temperature and water retention. This study for the first time compares clear plastic mulch, with white net (19 g m^{-2}) as an alternative (Anamur and Bozyazi in Mersin province, Alanya in Antalya province). Both inorganic mulches help to accelerate

decomposition speed of banana residues that are more rapidly converted into a useful form compared to non-mulched contexts. We suggest that white net will not only enhance soil temperature stability but also will help to diffuse rain water through it, resulting in even higher water retention than that observed in clear plastic using plantations. As a result, white net application has shortened fruit maturation and also positively affected the fruit physical properties, including the yield and soluble solid content. Similar studies were carried on in banana production zones using organic mulching materials such as different plant residues, straw, weeds and wood chips (Bananuka et al., 1996; Rukazambuga et al., 2002). These studies revealed that besides effects on fruit yield and quality, mulching had positive effects on water holding capacity, temperature and physical and chemical properties of soil by decomposing the organic mass used as organic mulch (Bananuka et al., 1996; McIntyre et al., 2003; Gold et al., 2006; Robinson and Galan-Sauco, 2011).

CONCLUSION

This is the first study presenting the effects of white net as mulching material used in banana production. Furthermore, it is also the first study which reports inorganic mulch use beyond the main banana production zones (semi-arid subtropical conditions). Keeping these in mind, both mulching treatments tested in this research resulted in significant yield increases compared to that found in the control plants. Furthermore, they shortened the fruit maturation length, as measured in days from flowering to harvest. Mulching has also improved fruit quality, including, soluble solids, peel thickness, finger weight and peel colour (determined by smaller Hue angle value). White net performed better than clear plastic for most of the measured criteria and thus is recommended over clear plastic mulch and non-mulch usage (control treatment) for practical application in banana plantations outside of main banana production zones, namely in such subtropical conditions as prevail in Turkey.

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