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PLASTIC MULCH AND 4-CHLORO-PHENOXYACETIC ACID (CPA) INTERACTION ON GROWTH AND YIELD OF EGGPLANT (*SOLANUM AETHIOPICUM* L.)

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Asbtract

Plastic mulch (200 μm/0.2 mm thick) and 4-CPA interaction on growth and yield of African eggplant (*Solanum aethiopicum* L.) cultivar 'Legon Prolific' were investigated in the field during two summer seasons, 1994 and 1995. Four mulch treatment; black, black and white (white on the upper surface), transparent and control and three 4-CPA concentrations; 0 ppm, 15 ppm and 30 ppm were used. Plant height (cm) was highest in the transparent mulch treatment and lowest in the control in both years. Plastic mulch and 4-CPA independently had significant effects ($P < 0.05$) on fruit yield and number of eggplants. Significant differences between plastic mulch × 4-CPA interaction were observed in fruit yield, number and fruit size. Plants treated with transparent mulch and 4-CPA produced the highest fruit yield and number in both years. The experiment indicated that eggplant productions is best under the combination of plastic mulch and 4-CPA hormone application. The combination of transparent mulch and the low rate (15 ppm) of 4-CPA produced the highest fruit yield.

Résumé

NKANSAH, G. O.: *Paillis plastique et 4-ACP (acide chlorophénoxyacétique) interaction sur la croissance et le rendement d'aubergine,* Solanum aethiopicum *L.* Paillis plastique (200 μm/0.2 mm d'épaisseur) et 4-ACP interaction sur la croissance et le rendement d'une variété d'aubergine africaine (*Solanum aethiopicum* L.) 'Legon Prolific' étaient étudiées dans le champ pendant les deux saisons d'été, de 1994 et 1995. Quatre traitements de paillis; noir, noir et blanc (blanc à la surface supérieure), transparent et le contrôle et trois concentrations de 4-ACP: 0 p.p.m. 15 p.p.m. et 30 p.p.m. étaient utilisées. Taille de plante (cm) était plus élevée dans le traitement de paillis transparent et plus basse dans le contrôle pendant les deux années. Paillis plastique et 4-ACP indépendamment avaient des effets considérables sur le rendement de fruit et nombre d'aubergine. Des différences considérables entre le paillis plastique × 4-ACP interaction étaient observées en rendement, nombre et dimension de fruit. Les plantes traitées avec le paillis transparent et 4-ACP produisaient les plus élevés de rendement et nombre de fruit pendant les deux années. L'expérience indiquait que la production d'aubergine est meilleure sous la combinaison de paillis plastique et l'application d'hormone 4-ACP. La combinaison de paillis transparent et la faible proportion (15 p.p.m.) de 4-ACP produisaient le rendement de fruit le plus élevés.

Introduction

Independent effects of plastic mulch and tomatotone (4-CPA) studies on tomatoes, peppers and other crops have been documented. Black or transparent polyethylene mulches are preferred for spring production because of their ability to warm normally cool soils in the early spring (Taber, 1983). A white or aluminium mulch is preferred for summer and fall production when additional soil warming is often not beneficial for plant growth and development (Cook *et al.*, 1982; Schalk & Robins, 1987). Other beneficial aspects

of polyethylene mulch culture include reduced weed pressures (Smith, 1968), effects on the microclimate, reduced leaching of nutrients (Locasio *et al.,* 1985), and more consistent and efficient use of moisture (Sweeney *et al.*, 1987).

The use of hormones, for instance 4-CPA, to boost fruit set and yield is of practical importance in the tropics areas with summer conditions where adverse temperature conditions has been found to affect fruit set and size of tomatoes due to low auxin levels in the generative tissues (Iwahori, 1967; Watanabe *et al.*, 1988). Vorayos *et al.* (1992) and Torre, Leandri & Imbrogline (1992) observed that 4-CPA increased fruit set and yield of tomatoes. Witter, Stallworth & Howell (1948) reported that 4-CPA increased both early and main crop yield of tomatoes but Buitelaar (1989) reported that 4-CPA had no effect on fruit yield, average number, weight and seed number of mini-aubergine.

The African eggplant, *Solanum aethiopicum* L. is one of the two cultivated species of *Solanum* grown widely in West Africa and other tropical and sub-tropical areas for its white fruits used in soups and stews with other spices. The plant is believed to have originated from Africa, although it is grown in the Far East where it is called Chinese eggplant (Norman, 1974).

A critical review of the literature indicates that little research pertaining to polyethylene mulch culture and 4-CPA on African eggplant or garden egg has been carried out. This study was, therefore, conducted to investigate 1) plastic mulch and 4-CPA independent (main effects), and 2) plastic mulch × 4-CPA interaction effects on growth and yield of the African eggplant (*Solanum aethiopicum* L.) in the field during two summer seasons, 1994 and 1995.

Experimental

The experiments were conducted at Chiba University, Japan, during 1994 and 1995. The eggplant, *Solanum aethiopicum* cv "Legon Prolific" obtained from the Crop Science Department, Faculty of Agriculture, University of Ghana, Legon were used. Seeds of this cultivar were sown on April 10 of each year. Seedlings were transplanted to the mulch treatments in the field on June 13 each year. Three plastic mulch materials of thickness 200 μm or 200 mm, black, black and white (white on the upper surface), transparent, and no mulch (control), randomly assigned were adopted in both experiments. The hormone, 0.15% chlorophenoxyacetic acid (4-CPA) treament were 0 ppm, 15 ppm and 30 ppm. The hormone treatments were superimposed on the mulch treatment a the flowering stage. The hormone was individually sprayed onto the flowers. Hormone treatment began a day after flower opening. A 3 × 4 hormone × mulch factorial in randomized complete block design was used. There were three replications in each experiment.

Plant spacing was 1 m × 1 m (between and within rows) and each mulch treatment plot had 32 plants. The inner 30 plants per mulch treatment, that is 10 plants per 4-CPA treatment per replication were used for data collection. Total plot size was 18 m × 32 m.

Fertilizer was applied at the rates of 150 kgha^{-1} each of N, P_2O_5 and K_2O. Ordinary thermometers were used to measure soil temperatures at 10 cm depth in all plots during noon each day (Table 1). Weeds were handpicked in the control and the transparent mulch plots. Plants were watered to field capacity every 2 days (except on rainy days) to avoid any water stress condition. Mean day

TABLE 1
Mean soil and air temperatures during the experimental periods

	Temperature (°C)	
Mulch	*1994*	*1995*
Black	37.2	35.4
Transparent	34.4	30.6
Black/ White	29.5	28.2
Control	28.0	26.2
Day/Night *(°C)* temperature	32/21±1.5	30/20±1.0

TABLE 2
Effect of plastic mulch on plant height (cm) of eggplant

Mulch	*July*	*August*	*September*
		1994	
Black	35.2	64.3	87.6
Trasparent	42.1	77.2	105.8
Black/White	34.3	66.3	95.3
Control	29.0	41.3	74.2
LSD ($P < 0.05$)	2.68	1.94	2.85
		1995	
Black	33.2	60.4	80.2
Trasparent	40.0	71.2	96.4
Black/White	33.2	62.0	86.4
Control	25.0	39.2	70.5
LSD ($P < 0.05$)	2.22	2.00	2.52

and night temperatures (Table 1) were measured with thermocouples at plant height for the entire growing seasons in both years, 1994 and 1995.

Plant height was measured at monthly intervals from the mulch surface (ground level) to the highest growing point. Fruit number and weight (g) were determined at each harvest. Fruits were harvested between July and September in both years. Data were subjected to analysis of variance (ANOVA) and the means separated by LSD test.

Results and discussion

Temperature

Results in Table 1 indicate that the highest soil temperature was recorded for the black mulch treatment and the lowest for the control in both 1994 and 1995. Air temperature was higher in 1994 than in 1995 (Table 1.)

General observation

It was generally observed that fruits harvested in the control treatment contained many seeds compared to the little or no seeds in fruits of the 4-CPA treated plots. The little or no seeds of fruits treated with 4-CPA may be of importance to the consumer since fewer seeds are preferred. No major outbreak of disease/pest was found throughout the experimental periods. Weeds were suppressed in the black and white plastic mulch plots as reported by Smith (1968).

Effect of mulch on plant growth

There was no significant effect ($P < 0.05$) of 4-CPA and mulch × 4-CPA interaction on plant height after flowering hence only plastic mulch effect is presented. Plant height (cm) at monthly intervals was affected by mulch treatments (Table 2). Plant height was significantly ($P < 0.05$) higher in the mulch treatments compared to the control, in both years. The transparent mulch treatment had the highest plant height and the control, the lowest ($P < 0.05$). Plant height can be used to characterize shoot development in relation to soil temperature. Menhenett & Wareing (1975) measured an increase in the concentration

TABLE 3
Effect of plastic mulch and 4-CPA on fruit weight (g/plant) of eggplant

Mulch/4-CPA	*Control*	*30 ppm*	*15 ppm*
		1994	
Black	1400.5	1490.4	1832.3
Trasparent	1687.3	2149.3	2452.5
Black/White	1488.5	1800.5	1870.4
Control	1466.2	1760.4	1817.2
LSD ($P < 0.05$)			
Mulch	249.6		
4-CPA	237.4		
		1995	
Black	1500.2	1520.5	1924.0
Trasparent	1750.2	2250.0	2642.5
Black/White	1550.2	1952.4	1975.2
Control	1500.2	1830.4	1900.5
LSD ($P < 0.05$)			
Mulch	249.6		
4-CPA	237.4		

TABLE 4
Effect of plastic mulch and 4-CPA on fruit number (No./plant) of eggplant

Mulch/4-CPA	*Control*	*30 ppm*	*15 ppm*
	1994		
Black	22.6	23.8	27.5
Trasparent	25.2	29.6	37.2
Black/White	20.8	28.5	28.0
Control	16.0	18.6	23.2
LSD ($P < 0.05$)			
Mulch	1.92		
4-CPA	3.20		
	1995		
Black	25.0	28.2	34.4
Trasparent	27.4	34.2	39.0
Black/White	24.2	30.0	32.0
Control	20.0	24.5	26.2
LSD ($P < 0.05$)			
Mulch	1.85		
4-CPA	2.25		

TABLE 5
Effect of plastic mulch and 4-CPA on fruit size (g) of eggplant

Mulch/4-CPA	*Control*	*30 ppm*	*15 ppm*
	1994		
Black	61.6	62.8	66.6
Trasparent	67.2	72.6	66.4
Black/White	62.6	63.4	64.0
Control	100.2	94.6	79.2
LSD ($P < 0.05$)			
Mulch	10.91		
4-CPA	ns		
	1995		
Black	60.0	54.3	55.6
Trasparent	64.8	66.2	67.8
Black/White	64.0	65.1	61.7
Control	75.0	74.7	72.5
LSD ($P < 0.05$)			
Mulch	10.91		
4-CPA	ns		

ns = non significance at $P < 0.05$

of gibberellins and a reduction in the root exudate of tomato plants maintained at high root temperatures of about 35 °C. This could explain the larger shoot development (height) observed in the transparent plots. At high soil temperatures above 35 °C, plant height may be inhibited due to reduction in root growth caused by higher gibberellic acid content (Menhenett & Wareing, 1975) hence the reduction in plant height as seen in the black mulch treatment which recoded the highest soil temperature (Table 1). The differences in plant height observed between the 2 years may be attributed to differences in air temperatures. Plant height was higher in 1994 than in 1995.

Effect of mulch and 4-CPA on yield and yield components

Results in Table 3 indicate that, the transparent mulch treatment produced the highest yield (fruit weight) compared to the other treatments at all 4-CPA concentrations ($P < 0.05$) and the control, the lowest ($P < 0.05$) in both years. Vigorous growth rate (Table 2) in terms of plant height recorded for the transparent mulch may have led to greater yields compared to the other treatments. Generally, fruit yield (g) increased as 4-CPA was

TABLE 6
Mean squares of mulch and 4-CPA interaction on fruit weight, number and fruit size of eggplant

	Fruit weight	*Fruit number*	*Fruit size*
	1994		
Mulch (M)	463197.00**	357.68**	1876.60*
4-CPA	688416.00**	817.60**	328.80ns
M× 4-CPA	68380.00**	70.21**	903.97**
	1995		
Mulch (M)	625348.80*	648.21*	2541.22*
4-CPA	886822.00**	654.25*	875.24ns
M× 4-CPA	88154.25**	100.00*	1054.20**

(*), (**) denote significance at $P < 0.05$ and $P < 0.01$ respectively and ns = non significance at $P < 0.05$>

diluted from 30 ppm to 15 ppm in all the mulch treated plots and the control (Table 3). The significant ($P < 0.05$) increase in fruit yield with the application of 4-CPA is in contrast with the results obtained by Buitelaar (1989) but agrees with those obtained by Witter, Stallworth & Howell (1948), Schott, Will & Schelberger (1989) and Torre, Leandri & Imbroglini (1982). It was observed that fruit yield in 1995 was higher thant that obtained in 1994 and this may be due to the lower air and soil temperatures recorded in 1995 (Table 1).

Significant differences ($P < 0.05$) in fruit number was found among the mulch and 4-CPA treatments (Table 4). The transparent mulch had a significantly ($P < 0.05$) greater fruit number at 15 ppm 4-CPA application compared to the other treatments ($P < 0.05$) in both years. Fifteen parts per million (15 ppm) 4-CPA increased fruit number in all the mulch and control plots. Fifteen parts per million (15 ppm) 4-CPA resulted in greater fruit numbers ($P < 0.05$) compared to the control and 30 ppm in both years.

Results in Table 5 show that fruit size differed significantly ($P < 0.05$) between the mulch-treated and the control-treated plots while 4-CPA treatments had no significant effect ($P < 0.05$). No consistent trend of increase in fruit size was observed at all 4-CPA concentrations in both years. The greater fruit size of the control plots may be due to its lower fruit numbers compared to the mulch-treated plots. The absence of significant effect of 4-CPA on fruit size agrees with the finding by Buitelaar (1989), who reported that 4-CPA did not enhance average weights of the white-fruited mini-aubergines.

Interaction of mulch and 4-CPA on yield and yield components

The analysis of variance presented in Table 5 indicates that mulch and 4-CPA did not exert independent influence on fruit yield, number and fruit size of eggplants, that is, mulch and 4-CPA interacted to produce a significant effect ($P < 0.05$). The highest fruit yield was produced by the combination of 15 ppm 4-CPA and the transparent mulch treatment while the lowest was recorded for the control, that is no mulch and no hormone in both years, 1994 and 1995.

Conclusion

The results of the studies showed an interaction between plastic mulch and 4-CPA in the eggplant (*Solanum aethiopicum*). The data, therefore, indicate that for a high production of eggplants, plants should be treated with transparent mulch and 15 ppm 4-CPA should be applied to the flowers. In general, a combination of mulch and 4-CPA is better than using either mulch or 4-CPA alone in the production of eggplants.

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