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Research Paper

EFFECTS OF PLASTIC MULCH COLOUR AND CUCUMBER CULTIVARS (*Cucumis sativus)* ON ROOT-GALL NEMATODE (*Meloidogyne spp*) INFECTION IN A NIGERIAN ULTISOL

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Abstract

The effects of plastic mulch and cucumber cultivars (*Cucumis sativus*) on root-gall nematode (*Meloidogyne spp*) infection in a Nigerian ultisol were studied at the Center for Agricultural Research and Extension, Federal University of Technology, Owerri in 2015 cropping season. The study was conducted in a sandy loam soil naturally infested with root-gall nematode (*Meloidogyne incognita)*. The experiment was laid out in a 3 x 3 Factorial in Randomized Completely Block Design (RCBD) with four replications. The treatments comprised of cucumber cultivars: cucumber 020, cucumber 765, cucumber 999 and Plastic mulch: black plastic mulch, white plastic mulch and no mulch as the control. The result showed that plastic mulch was significantly ($p< 0.05$) effective in the control of root-gall nematode infection on cucumber. Growth and yield parameters of the cucumber plants under black plastic mulch were higher than those under white plastic mulch which differed significantly from those of the un-mulched plants (control). Conversely, highest root-gall severity occurred on the control cucumber plants. There was no significant interactive effect between cucumber cultivar and plastic mulch type. However, cucumber cultivar 765 and cucumber cultivar 999 were highly susceptible than cucumber cultivar 020 under no mulch condition.

Key words: *Meloidogyne spp, Cucumis sativus*, Plastic mulch, root- galls, cultivars.

INTRODUCTION

Cucumber (*Cucumis sativus L.*) is an important vegetable crop grown in the temperate and tropical zones of the world. It belongs to the Cucurbitaceae family, which comprises 90 genera and 700 spices (1).

Cucumber is a very important vegetable widely consumed in Nigeria (2). The impressive health benefit of cucumber contents makes it great importance to man (3).It is a major ingredient in combination with other vegetables such as pepper, cabbage and carrot for the preparation of salad.

The crop has gained increased demand in the humid tropical area of South Eastern Nigeria (4). The bulk of cucumber consumed in South Eastern Nigeria is produced in the Northern part of the country like Zaria, Kano, Maiduguri, Sokoto and Jos and has led to

an increase in the price of this crop since they are transported from various production areas at a very high cost.

Production of cucumber in the South Eastern Nigeria is however, associated with problems that hinder the realization of the full potentials of the crop. Root-gall nematodes have been identified as a major constraint in production of cucumber (5). They infect roots, establish polyploidy feeding cells, and elicit a metabolic sink reaction in which nutrients produced in the shoots are redirected to the roots (6).

A number of approaches have however, been used in the control of root-gall nematode problems. These included: inclusion of non-hosts in rotation sequence (7), introduction of resistant varieties (8); heat and chemical treatments (9); use of biological control agents (10), use of botanicals (11) and the use of organic manures (12, 13).

Mulching is one of the profitable agronomic measures of protecting crop from the vagaries of weather. It helps in conserving soil moisture, controlling weed infestations, regulate soil temperature and most importantly control soil borne diseases of crop (14).

The use of plastic mulch is one of the measures of protecting vegetable crops from the attack of root-knot nematode *(Meloidogyne spp*). (15), posited that beneficial yield of some vegetable crops to plastic mulches have traditional been attributed to altered soil temperatures, enhanced moisture conservation and weed control under the plastic mulch. Black plastic is often used in the spring to warm root zones temperatures.

This study was therefore undertaken to ascertain the effect of different colours of plastic mulch on root-gall nematode disease of cucumber in nematode endemic Ultisol.

MATERIALS AND METHODS

The experiment was conducted at the Centre for Agricultural Research and Extension, Federal University of Technology, Owerri, Imo state, Nigeria; located at latitude 5025 North and longitude 7000`E, with a mean annual rainfall of 2334.40 mm, mean temperature of 310C and relative humidity of 89 % with altitude of 90.91 m above sea level.

The soil was sandy loam (90.24 % sand, 4.0 % silt and 5.7 % clay) with pH: 5.03, organic matter content: 1.157 %, total nitrogen: 0.099 %, available phosphorous: 12.31 ppm, total exchangeable acidity: 0.92, calcium: 2.4, magnesium: 0.167, potassium: 0.416, sodium: 0.074, aluminum: 0.48, hydrogen: 0.44 and total exchangeable base: 3.057 all in cmol kg-1. Soil temperatures were monitored weekly with a soil thermometer.

The experimental site was manually cleared, stumped and debris removed before soil pulverization. Four blocks, each measuring 19 x 15 m and separated by 1.0 m pathways were made. Each block was further partitioned into nine (9) seed beds of 3.5 x 1.0 m each and separated by 0.5 m furrows. Black, white and no plastic mulches were randomly assigned to the nine (9) seed beds in each block. The same was true for the three cucumber cultivars (Cu-020, Cu-765 and Cu-999) used. Hence, the experiment was laid out in a 3 x 3 factorial in Randomized Complete Block Design (RCBD) with 4 replications. The cucumber seeds were sown two per hole at 50 x 50 cm spacing within 20 cm radius of round openings made on plastic materials on the seed beds. Two weeks (14 days) post planting thinning to one plant per stand gave a plant population of 80,000 plants/per ha.

Plant root infection assessment was done by uprooting the plants and adhering soils gently removed from the roots. Root systems were individually scored according to (16) in which 0 = no infection (no gall present); 1= rare infection (1-3 galls present); 2 =light infection (4-10 galls present); 3 = moderate infection (11-30 galls present) and 4 = severe infection (> 30 galls present).

The following growth and yield parameters were measured, number of leaves per plant, Leaf area per plant, number of days to 50% flowering, number of fruits per plot, weight of fruit per plot (g), Fresh shoot weigh per plot (g), Fresh root weight per plot (g). These data were subjected to analysis of variance procedure for RCBD using Genstat 7.2(Discovery Edition 3), mean separation was carried out using Fisher's Least Significant Difference Method (17) at 5% level of significance.

RESULTS AND DISCUSSION

Weekly soil temperatures for mulched and un-mulched plots were as shown in Table 1. Mulched plots had higher temperatures than the un-mulched. This agreed with the reports of (18) and (19) which stated that solarized mulched soils had higher temperatures than solarized un-mulched soils.

Table 1: Weekly soil temperature data under coloured plastic mulch at 10 cm soil depth between 1-2 pm.

PLASTIC MULCH	WEEKS	TEMPERATURE (°C)		
		CU 020	CU 765	CU 999
BLACK	1	32.40	32.20	32.00
	2	33.60	32.40	32.40
	3	32.40	32.00	32.40
	4	32.10	31.90	32.60
	5	33.30	33.10	33.60
	6	33.60	33.10	33.40
	7	33.00	33.13	32.92
	8	33.10	32.95	32.30
WHITE				
	1	31.16	30.90	31.10
	2	31.10	31.40	31.30
	3	31.10	31.00	31.40
	4	29.80	30.10	29.90
	5	31.30	31.50	31.40
	6	32.10	32.00	32.15
	7	32.10	32.40	32.10
	8	32.10	32.00	32.00
CONTROL				
	1	29.05	28.40	28.60
	2	27.60	28.20	29.90
	3	27.15	29.00	29.20
	4	27.60	27.70	28.02
	5	27.60	27.00	27.40
	6	27.40	27.82	28.00
	7	28.60	28.20	29.90
	8	27.80	28.00	27.40

Effects of plastic mulch and cucumber cultivars on number of leaves as affected by *Meloidogyne incognita* are shown in Table 2. Mulched cucumber cultivars had reduced root-galls and consequently produced significantly ($P < 0.05$) higher number of leaves than the severely galled un-mulched controls. This was more so on black plastic mulch which produced the highest number of leaves. This may be due to increased soil

temperature associated with the plastic mulch (Table 1) which possibly was non-lethal but inhibited the nematode activity. (20) reported increased okro yield on less root-galled plants. This according to (21) was due to less xylem vessels disruption in less infected roots causing less interruption of nutrient and water translocation to the shoot.

Table 2: Effects of plastic mulch and cucumber cultivars on number of leaves as affected by *Meloidogyne incognita*.

	Plastic mulch							
	Root-gall index (0-4)				No of leaves			
Cultivars	Black	White	Control	Mean	Black	White	Control	Mean
CU-020	0.59	1.43	3.24	1.75	43.4	31.9	23.0	32.8
CU-765	1.24	1.78	4.00	2.29	34.2	24.8	17.1	25.4
CU-999	0.85	1.75	4.00	2.15	37.9	33.4	21.0	30.8
Mean	0.89	1.65	3.65		38.5	30.1	21.0	
$LSD_{0.05}$ (cultivar)				NS				NS
$LSD_{0.05}$ (plastic mulch)				0.42				8.51
$LSD_{0.05}$ (cultivar x plastic mulch)				NS				NS

NS=Non significant

Cucumber cultivars planted on plastic mulched plots produced significantly ($P < 0.05$) higher leaf areas and lower root-gall severity than the control plots (Table 3). These higher leaf areas showed that plastic mulch was able to suppress the infectivity of the root-gall nematodes by increasing the soil temperature. These results support similar reports by (22) and (23). (24) reported decreases in soybean leaf areas at higher root-gall severities.

Table 3: Effects of plastic mulch and cucumber cultivars on leaf area (cm^2) as affected by *Meloidogyne incognita*.

	Plastic mulch							
	Root-gall index (0-4)				Leaf area (cm^2)			
Cultivars	Black	White	Control	Mean	Black	White	Control	Mean
CU-020	0.59	1.43	3.24	1.75	164.2	135.1	94.2	131.2
CU-765	1.24	1.78	4.00	2.29	168.8	140.5	97.0	135.4
CU-999	0.85	1.75	4.00	2.15	160.8	105.0	63.3	109.7
Mean	0.89	1.65	3.65		164.6	126.8	84.8	
$LSD_{0.05}$ (cultivar)				NS				NS
$LSD_{0.05}$ (plastic mulch)				0.42				28.56
$LSD_{0.05}$ (cultivar x plastic mulch)				NS				NS

NS=Non significant

Number of days (27.69) to 50% flowering was least for cucumber cultivars treated with black plastic mulch. This was followed by those on white plastic mulch (31.33 days) and then the control that took 33.25 days to attain 50% flowering. All these, differed significantly ($P < 0.05$) and could be attributable to significant differences in root galls and soil temperatures (Tables 4 and 1). (25), reported that long, hot, sunny days are needed to reach the soil temperatures required to kill soil borne pests, thus promoting efficient growth.

Table 4: Effects of plastic mulch and cucumber cultivars on number of days to 50% flowering as affected by *Meloidogyne incognita*.

	Plastic mulch							
	Root-gall index (0-4)				Number of days to 50% flowering			
Cultivars	Black	White	Control	Mean	Black	White	Control	Mean
CU-020	0.59	1.43	3.24	1.75	29.75	31.50	34.50	31.92
CU-765	1.24	1.78	4.00	2.29	30.00	31.50	32.25	31.25
CU-999	0.85	1.75	4.00	2.15	23.25	31.00	33.00	29.08
Mean	0.89	1.65	3.65		27.67	31.33	33.25	
$LSD_{0.05}$ (cultivar)				NS				NS
$LSD_{0.05}$ (plastic mulch)				0.42				4.32
$LSD_{0.05}$ (cultivar x plastic mulch)				NS				NS

NS= Non significant

Table 5 showed how root-gall nematode pathogencity at different plastic mulches and cucumber cultivars affected fruit length. Significant decreases in cucumber root-gall responses caused by either plastic mulch or cucumber variety resulted in significant increases in cucumber fruit length. Fruits with the longest length were recorded on black plastic mulched plots (19.28 cm) and differed significantly ($P < 0.05$) from those on white plastic mulched plots (17.58 cm) and the control. The shortest fruit lengths obtained on the control plots could be attributed to the severe root-galls on the roots of the cucumber plants which hampered proper absorption and translocation of water and nutrients from the roots to other parts of the plants (26). (27) also reported that reduced growth was observed in all the inoculated plants when compared with uninoculated plants and attributed it to some basic physiological processes such as absorption of water and mineral nutrients which got impaired due to attack on roots by *M. incognita*.

Table 5: Effects of plastic mulch and cucumber cultivars on fruit length (cm) as affected by *Meloidogyne incognita*.

	Plastic mulch							
	Root-gall index (0-4)				Fruit length (cm)			
Cultivars	Black	White	Control	Mean	Black	White	Control	Mean
CU-020	0.59	1.43	3.24	1.75	21.47	16.87.	11.25	16.53
CU-765	1.24	1.78	4.00	2.29	19.12	16.37	8.90	14.80
CU-999	0.85	1.75	4.00	2.15	1723	19.51	11.59	16.11
Mean	0.89	1.65	3.65		19.28	17.58	10.58	
$LSD_{0.05}$ (cultivar)				NS				NS
$LSD_{0.05}$ (plastic mulch)				0.42				4.24
$LSD_{0.05}$ (cultivar x plastic mulch)				NS				NS

NS= Non significant

Produced numbers of fruits as affected by root-gall infections in different plastic mulch types and cucumber cultivars are shown in Table 6. Cucumber cultivars when mulched with plastic significantly ($P < 0.05$) produced higher number of fruits than the un-mulched (control). This was more so when black plastic mulch was used and root-gall infection significantly reduced. The reduction in the root-gall index obtained in plots covered with the black plastic mulch might be attributed to the conservation of heat in the root zone which affected adversely the reproduction and distribution of the second stage juvenile of the root-gall nematode which are the most infective stages (28). (29) also reported that mulch colour alters the plants response to root-gall nematode infections by changing the distribution of eggs in auxiliary shoots.

Table 6: Effects of plastic mulch and cucumber cultivars on number fruits per plot as affected by *Meloidogyne incognita*.

	Plastic mulch							
	Root-gall index (0-4)				Number fruits			
Cultivars	Black	White	Control	Mean	Black	White	Control	Mean
CU-020	0.59	1.43	3.24	1.75	27.66	23.96	15.47	22.36
CU-765	1.24	1.78	4.00	2.29	33.92	28.51	28.51	26.95
CU-999	0.85	1.75	4.00	2.15	21.69	19.02	19.02	18.00
Mean	0.89	1.65	3.65		27.76	23.83	23.83	
$LSD_{0.05}$ (cultivar)				NS				2.56
$LSD_{0.05}$ (plastic mulch)				0.42				2.56
$LSD_{0.05}$ (cultivar x plastic mulch)				NS				NS

NS= Non significant

On the fresh root weights, Table 7 showed that the highest fresh root weights were observed on un-mulched (control) plots which significantly ($P < 0.05$) differed from the black and white plastic mulches. This might be attributed to the biomass of the galled tissues. (30) stated that galled roots represented most of the total weight of the root system.

The black plastic mulch which recorded the least fresh root weights was able to reduce the damage on the cucumber roots caused by the root-gall nematode by increasing the soil temperature.

Table 7: Effects of plastic mulch and cucumber cultivars on number fresh root weight (g) as affected by *Meloidogyne incognita*.

	Plastic mulch							
	Root-gall index (0-4)				Fresh root weight (g)			
Cultivars	Black	White	Control	Mean	Black	White	Control	Mean
CU-020	0.59	1.43	3.24	1.75	6.61	7.66	11.77	8.68
CU-765	1.24	1.78	4.00	2.29	6.24	7.44	11.24	8.30
CU-999	0.85	1.75	4.00	2.15	4.42	7.61	11.20	7.74
Mean	0.89	1.65	3.65		5.76	7.57	11.40	
$LSD_{0.05}$ (cultivar)				NS				1.56
$LSD_{0.05}$ (plastic mulch)				0.42				NS
$LSD_{0.05}$ (cultivar x plastic mulch)				NS				NS

NS= Non significant

CONCLUSION

Results obtained in this investigation showed that plastic mulch was significantly effective in the control of root-gall nematode disease on cucumber than un-mulched or control plots. It is therefore, recommended as a potential non-chemical measure in controlling root-gall nematode infestation and maximizing cucumber yields in soils where root-gall nematode is endemic.

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