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Full Length Research Paper

Effect of soil solarization using plastic mulch in controlling root-knot nematode (*Meloidogyne* spp.) infestation and yield of lettuce at Anse Boileau, Seychelles

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A field experiment was conducted from February to May, 2004 and 2005 planting seasons at the Vegetable Evaluation and Research Station Farm located at Anse Boileau, Seychelles to evaluate the effect of soil solarization using plastic mulch in controlling root-knot nematode infestation and yield of lettuce. The experiment consisted of two treatments (solarized mulched plot and solarized non-mulched plot) laid out in a randomized complete block design with four replications. The results obtained showed that the number of root-galls from lettuce roots produced under solarized mulched plot was significantly ($P \leq 0.05$) reduced by 72.0 and 72.6%, respectively, in the year 2004 and 2005 compared to that obtained from the non-mulched plot. Similarly, the number of leaves, leaf length, leaf width, biological weight, economic weight and yield of lettuce were significantly ($P \leq 0.05$) increased by 15.6, 40.0, 24.0, 4.7, 8.5 and 19.8% respectively in the year 2004 and by 8.0, 40.0, 28.5, 7.7, 9.9 and 15.4% respectively in the year 2005. The implication of this study showed that planting lettuce on solarized mulched plot was better and could therefore be recommended as a potential non-chemical measure in the control of root-knot nematode infestation and in maximizing lettuce yield in the Seychelles.

Key words: Solarization, root-knot nematode, lettuce.

INTRODUCTION

Root-knot nematodes (*Meloidogyne* spp.) are small microscopic roundworm organisms grouped as a major pathogen of vegetable crops throughout the world, affecting the quantity and quality of marketable vegetable yields (Kingland, 2001). They infest plant roots by producing galls through their feeding habits (Nesmith, 2000).

Lettuce (*Lactuca sativa* L.), a short season and shallow-rooted crop, is a member of the sunflower or compositae family and native of the Mediterranean Basin (Valenzuela et al., 1993). It ranked second amongst the salad vegetable crops in Seychelles following cabbage with the average yield of 25 t/ha (Tindall, 1993).

In Seychelles, lettuce is subjected to intensive cropping due to its high demand by consumers. Reports of root-knot nematode infestation have become more common with increasing lettuce acreages grown either under shelter as well as in the open field (Hartman, 2002). Research investigations worldwide have addressed different methods in controlling root-knot nematode infestation in vegetable crops. One of such popular method is the use of recommended chemicals as control measure. These chemicals are however expensive for farmers, in addition to their increased toxic effects in the soil over the years (Vawdrey and Stirling, 1997).

The need to use a non-chemical measure (plastic) as a mulching material in controlling root-knot nematode infestation and maximize lettuce yield is yet to be explored under Seychelles field conditions. This study was therefore designed to achieve the purpose.

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Table 1. Soil temperature levels from mulched and non-mulched plots at the specified days of plastic coverage (DPC) at Anse Boileau, Seychelles for the year 2004 and 2005.

Treatments	Soil temperature level (°C)			
	2004		2005	
	30 DPC	60 DPC	30 DPC	60 DPC
Solarized mulched Plot	37.8	38.8	37.3	37.7
Solarized Non-mulched plot	32.7	33.8	33.0	33.6
Means	35.3	36.3	35.2	36.7
LSD (P = 0.05)	0.8	0.7	0.5	1.8
Cv (%)	5.62	7.20	8.10	7.42

DPC: Days of plastic coverage.

MATERIALS AND METHODS

The experiment was conducted from February to May, 2004 and 2005 at the vegetable evaluation and research station farm located at Anse Boileau, Seychelles to evaluate the effects of soil solarization using plastic mulch in controlling root-knot nematode infestation and yield of lettuce. The variety of lettuce used was 'Minetto'. It is commonly grown by farmers and shows a better yield potential compared to other local varieties.

Seedlings were developed in the nursery in which watering, application of starter fertilizer, handpicking of weeds and thinning were carried out. The seedlings were raised in the nursery for a period of three weeks.

The experimental area (88.2 m^2) which consisted of sandy-loam soil noted to be infested with root-knot nematode (*Meloidogyne* spp.) over the years was cleared, ploughed, harrowed and divided into ten plots. Each plot had an area of 2.9 m^2. The experiment consisted of two treatments laid out in a randomized complete block design with four replications. The treatments consisted of using plastic material as mulch to cover the soil for the length of 60 days before the transplant of lettuce. Plots that were not covered served as the control. Each plot consisted of four rows, in which 12 seedlings per row were transplanted at a spacing of 30 x 20 cm giving a total plant population of 48 plants per plot (166,665 plants per hectare equivalent).

Well-decomposed poultry manure at the rate of 430 g per plot, following the recommendation by Sunassee (2001) was initially applied by broadcast. The manure was incorporated into the soil and watered immediately using the microsprinkler irrigation at the rate of 25 l of water per plot per day, following the formula of Estico (2000).

The plots were later covered with transparent polyethylene plastic of 300 microns thickness for the duration of 60 days following the recommendation of Katan (2000).

The plots were fertilized at five days after transplanting, using the spot method with Nitrophoska (12:12:17) at the rate of N: 100; P_2O_5: 100 and K_2O: 150 Kg/ha following the recommendation by Rijpma (1991). This translated into 120 g equivalent of the fertilizer applied to each plot. The fertilizer was applied about 7.5 cm away from the plant stand and placed at a depth of about 5 cm, covered well with soil and watered immediately. Weeding was done as the need arose. Harvesting was done in mid-May.

Data taken included soil temperature level at 30 and 60 days of plastic coverage (DPC), number of root-galls at 14, 21 and 28 days from transplanting, number of leaves per plant before heading, leaf length per plant before heading, leaf width per plant before heading, biological weight per plant (taken as weight of plant with roots), economic weight per plant (taken as weight of plant without roots) and yield (t/ha). The data were subjected to Analysis of Variance (ANOVA) while the Least Significant Difference (LSD) was used to separate treatment means, following the method of Steel and Torrie (1980).

RESULTS AND DISCUSSION

In Table 1, the soil temperature level from mulched and non-mulched plots at the specified days of plastic coverage at Anse Boileau, Seychelles for the year 2004 and 2005 is given. Temperatures recorded generally from solarized mulched plots were significantly ($P \leq 0.05$) higher than those recorded from the non-mulched plots. Chellemi (2002) and Singh (1998) in their works on solarization concluded that temperatures recorded from solarized mulched soils were observed to be higher than those obtained from solarized non-mulched soils. At 60 days of plastic coverage (DPC), the solarized mulched plot recorded a higher temperature of 38.8 and 37.7°C respectively for the year 2004 and 2005 compared to that recorded from the non-mulched plots.

The number of root galls produced on lettuce roots from the solarized mulched plot was lower compared to that produced from the non-mulched plot (Table 2). This result agreed with a similar experiment of Abdulhadi et al. (1989), to which they reported that solarized mulched soils significantly reduced root-galling of cucumber. At 28 days after transplanting (DAT) lettuce, the number of root-galls produced from solarized mulched plot was significantly ($P \leq 0.05$) reduced by 72.0 and 72.6% respectively in 2004 and 2005 compared to that obtained under the non-mulched plot.

In Table 3, the yield performance of lettuce as affected by soil solarization at Anse Boileau, Seychelles during the 2004 and 2005 planting seasons is given. The solarized mulched plot produced greater number of leaves, which was significantly ($P \leq 0.05$) increased by 15.6 and 8.0%, respectively, in 2004 and 2005 compared to that obtained from the non-mulched plot.

The solarized mulched plot also produced a greater leaf length and leaf width for both years. The high temperatures recorded for the solarized mulched plot could have produced a lethal effect on the soil-borne pests, thereby promoting conducive environment for the utiliza-

Table 2. Effect of soil solarization on mean number of lettuce root galls at the specified days after transplanting at Anse Boileau, Seychelles for the year 2004 and 2005.

Treatment	Mean number of root galls					
	2004			2005		
	14DAT	21DAT	28DAT	14DAT	21DAT	28DAT
Solarized mulched plot	0.15	3.53	4.83	0.20	3.25	5.60
Solarized Non-mulched plot	0.95	10.12	17.28	0.98	17.00	20.46
Means	0.55	4.83	6.1	0.59	10.1	12.00
LSD (P = 0.05)	0.90	1.24	2.43	0.82	1.93	3.15
Cv (%)	5.42	7.63	8.54	6.20	7.84	9.21

DAT: Days after transplanting.

Table 3. Yield performance of lettuce as affected by soil solarization at Anse Boileau, Seychelles during the 2004 and 2005 planting seasons.

Treatment	Number of lettuce leaves per plant before heading		Leaf length per plant before heading (cm)		Leaf width per plant before heading (cm)		Biological weight per plant (g)		Economic weight per plant (g)		Yield (t/ha)	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
Solarized mulched plot	18.0	16.3	14.3	13.5	12.5	13.0	430.0	441.0	415.1	420.3	25.7	27.2
Solarized non-mulched plot	15.2	15.0	8.6	8.1	9.5	9.3	410.0	407.0	380.0	378.6	20.6	23.0
Means	16.6	15.7	11.5	10.8	11.0	11.2	420.0	424.2	397.6	399.5	23.2	25.1
LSD (P = 0.05)	1.06	1.10	4.20	4.13	2.01	2.45	10.2	12.6	15.4	17.0	3.42	2.60
Cv (%)	7.86	5.42	12.40	10.26	8.75	10.42	4.82	6.24	10.20	14.72	7.50	5.73

Biological weight: Weight of plants with roots.
Economic weight: Weight of plants without roots.

tion of growth resources. This view supports Hartman (2002), who reported that long, hot, sunny days are needed to reach the soil temperatures required to kill soil-borne pests, thus promoting efficient growth.

Similarly, for both years, lettuce produced from solarized mulched plot gave a greater biological weight, economic weight and better yield compared to those obtained from the non-mulched plot. Its biological weight, economic weight and yield were significantly ($P \leq 0.05$) higher by 4.7, 8.5 and 19.8%, respectively, in 2004 and by 7.7, 9.9 and 15.4% respectively in 2005 compared to those obtained from the non-mulched plot. The result contradicts the findings of Lamberti et al. (1997), who reported no significant difference in lettuce yield produced from the solarized mulched soils compared to that obtained from non-mulched soils. The reason for the contradiction could probably be due to the different nature of the soil type used at the different locations of study which in this case was the sandy-soil with no sufficient water holding capacity to maintain sufficient heat transfer to deeper soil horizons.

Conclusion

From the results obtained, it can be concluded that planting lettuce on solarized mulched plot was better in the control of root-knot nematode infestation. It is therefore, recommended as a potential non-chemical measure in controlling root-knot nematode infestation and in maximizing lettuce yield under field conditions in Seychelles. This is associated with a reduced number of root-galls and a higher number of leaves, leaf length, leaf width, biological weight, economic weight and yield respectively. It is however, recommended that further investigation be evaluated across different locations with varied soil types in the Seychelles.

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