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Studies on The Effects of Inter-Cropping Coriander, Caraway, and Aniseed on The Population of *Bemisia Tabaci*(Genn.).

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Abstract: *Large-scale usage of pesticides has become a source of great concern due to their possible adverse effect on human health and non target components of the environment, there for in present study we used some medicinal plants i.e. coriander, caraway, and aniseed were inter – cropped with the tomato varieties (Omdurman and Peto86) to reduce the whitefly population. The experiments were carried out in the field of University of Gezira, during winter and summer of 2000.The results showed that during winter the two tomato varieties harbored almost the same number of whiteflies, but in summer an apparent build–up of the pest population was shown to peak in the middle and then declined progressively towards the end of the season. Significant variations in the numbers of whitefly encountered on tomato plants within all treatments were more apparent during the summer than the winter season. During winter season tomato plants in the coriander treatment harbored the least number of whiteflies (1.009) followed by caraway (1.029) and aniseed (1.032) compared to the control (1.044 adults / leaf). Similarly, in summer season the whitefly population within coriander treatment was the lowest (1.044) compared to both caraway and aniseed (1.068) and the control (1.097 adults / leaf).*

INTRODUCTION

Tomato, ***lycopersicon esculentum*** Miller, is ranked as the most important vegetable crop in the Sudan (Yassin,1994 a,b; Ahmed, 1995). More than a hundred different pest species have been recorded on tomato crops (Talekar *et al*, 1983) . The whitefly, *Bemisia tabaci* and the disease, tomato yellow leaf curl virus (TYLCV) are major limiting factors in tomato production and losses are paramount. TYLCV may result in more quantitative yield reduction (Yassin, 1994a, b and Ahmed, 1995).

Tomato growers resort to extensive use of pesticides, mainly insecticides, to control *B. tabaci* and hence TYLCV in the absence of other control measures. El Zorgani and Abbadi (1978) recorded that large-scale usage of pesticides has become a source of great concern because of their possible effects on human health and on non-target components of the environment. Residues of pesticides were detected in human blood, soil, food, air and water. The presence of these substances constitutes certain risks to human health and increasing efforts therefore have been primarily directed towards minimizing the amount of residues in the environment. Besides, the frequent application of insecticides caused a high selection pressure, which may accelerate development of pest resistance to pesticides.

Integrated pest management (IPM) strategies were directed towards implementation of cultural and chemical practices, in order to manage the whitefly and the disease by using less toxic chemicals and reducing the number of sprays to minimize the cost of tomato production (**Wessal Y. H .A** *et al*, 2019).

Obviously the research needed is to find alternative methods of control, complementary and not antagonistic to chemical control. IPM options are based on prophylactic methods such as using proper cultural practices, soil solarization, optimal fertilizer rates, inter-cropping, proper irrigation frequencies, replacement of preventive spraying with curative sprayings after pests are observed on crop, heat tolerant and TYLCV resistant varieties (**Wessal Y. H .A** *et al*, 2019).

In the Sudan, the search for suitable plant species to be inter-planted with tomato to keep away the whitefly, and there by check the spread of TYLCV dominates inter-cropping research work (Mohamed, 1994).This paper reported on the efficacy of inter-cropping three plant species. i.e. Coriander (*Coriandrum sativum*), Aniseed (*pimpinella anisum*) and caraway (*Carum carvi*), within tomato field to divert whitefly away from the crop to minimize the TYLCV in the field without the need for heavy use of pesticides.

MATERIALS AND METHODS

The importance of some medicinal and aromatic plants inter-planted with tomato as repellents of the white fly (*Bemisia tabaci* Genn.), was investigated. From the family Umbelliferae, coriander (*Coriandrum sativum*), caraway (*Carum carvi*) and aniseed (*Pimpinella anisum*) inter-cropped with each of two commercial varieties of tomato (i.e. Omdurman and peto86) were used in this experiment during both winter and summer production seasons of the year 2000.

Experimental area:

In each season an area of 880 m2 (0.088 hectar) was reserved at the University of Gezira experimental farm, Wad Medani (14^o 24" N, 33^o 39" E, 407 meter above sea level). Each area was prepared according to the recommended land preparation method adopted for proper tomato production. Then each area was divided into 40 mustabas (wide ridge, 6 m long and I m wide). The distance between the mustabas was about 1 m.

Treatments and cultural practices:

The following four treatments were included in each test:

a) Caraway inter-cropped with tomato.
b) Coriander inter-cropped with tomato.
c) Aniseed inter-cropped with tomato.
d) Control (tomato only).

Each tomato variety in each treatment was represented by one mustaba. Caraway, Aniseed and Coriander were sown first on lines at both edges along the treatment mustaba. After 10 days 2-5 seed of tomato were deposited per hole at a distance of 30 cm between holes in two rows in the middle of each mustaba, After germination seedlings were thinned to 2-3 plants/hole. All other cultural practices were carried out as recommended for tomato production.

Experimental Design:

Each experiment was arranged in a randomized complete block design (RCBD) with 5 replications for each treatment and each variety.

Insect count:

At weekly intervals throughout the tomato growing season, five plants were randomly selected from each mustaba. From each plant five grown leaves (2 upper, 1middle and 2 lower) were selected and the number of whitefly adults found on each leaf was recorded. Counts were regularly carried out early in the morning when adults were still inactive. Average number of whitefly per leaf for each treatment on each sampling date was obtained.

Data analysis:

Data collected was subjected to the appropriate transformation. The insect counts were transformed using the log (Xó +10) scheme (Gomez and Gomez, 1984). The transformed data was then analyzed using analysis of variance and the means were subjected to comparison using the least significantly difference (LSD) and Duncan multiple range test (DMRT). The final results were given in tabular.

RESULTS AND DISCUSSION

Assessment of whitefly population:

Table I presented the mean numbers of adult whiteflies encountered throughout the winter season on each of the two tomato varieties within the different treatments. It is apparent from these results that the two tomato varieties harbored almost the same whitefly populations, however, highly significant differences ($p< 0.01$) between the treatments and between the sampling dates were indicated. The population of the whitefly encountered on each tomato variety within each treatment throughout the summer season was presented in table 2. During this season an apparent buildup of the population of the Whitefly from the start of the growing season was shown.

Table 1.The effect of inter-cropping caraway, coriander and aniseed with two tomato varieties on the population of the whitefly (winter 2000).

Data	Variety	Insect numbers*			
		Treatments			
		Caraway	Coriander	Aniseed	Control
17.1.2000	Omd.	1.0018	1.007	1.019	1.036
	Peto86	1.019	1.004	1.019	1.046
24.1.	Omd.	1.027	1.012	1.030	1.050
	Peto86	1.035	1.012	1.023	1.042
31.1.	Omd.	1.030	1.004	1.036	1.042
	Peto86	1.028	1.004	1.033	1.050
7.2.	Omd.	1.027	1.003	1.033	1.035
	Peto86	1.028	1.010	1.028	1.038
14.2.	Omd.	1.033	1.005	1.027	1.036
	Peto86	1.025	1.025	1.039	1.038
22.2.	Omd.	1.038	1.025	1.039	1.055
	Peto86	1.044	1.015	1.053	1.058
SE± 0.005					

***Means were calculated from the transformed data** .

Table 2. The effect of inter-copping caraway, coriander and aniseed with two tomato varieties on the population of the whitefly (summer 2000).

Data	Variety	Insect numbers*			
		Treatments			
		Caraway	Coriander	Aniseed	Control
21.4.2000	Omd.	1.014	1.033	1.015	1.027
	Peto86	1.007	1.007	1.014	1.019
28.4.	Omd.	1.042	1.020	1.028	1.035
	Peto86	1.038	1.009	1.038	1.030
5.5.	Omd.	1.109	1.083	1.106	1.168
	Peto86	1.105	1.070	1.081	1.126
12.5.	Omd.	1.162	1.091	1.038	1.201
	Peto86	1.120	1.101	1.116	1.175
19.5.	Omd.	1.084	1.049	1.103	1.155
	Peto86	1.070	1.059	1.091	1.145
26.5.	Omd.	1.039	1.015	1.050	1.050
	Peto86	1.031	1.018	1.035	1.041
SE± 0.0137					

***Means were calculated from the transformed data.**

The population then continued to decline progressively toward the end of the season. This trend was practically followed on both tomato varieties especially within coriander and the control treatments. Significant differences ($p < 0.05$) between the two tomato varieties in the mean numbers of whitefly encountered were indicated. Similarly high significant differences ($p < 0.01$) were found between the treatments and between the sampling dates. It is worth mentioning here that the whitefly numbers recorded on tomato during the summer were always greater than those encountered during the winter season. This may be either due to the better growth of these crops (winter crops) compared to that in summer. Or to the lack of other alternative host plants for the pest during the summer season. The significant variations between the treatments in the mean number of whiteflies encountered on tomato plants as presented in Table 3 indicated that tomato plus the coriander treatment during winter harbored the least number of whiteflies (1.009) followed by caraway (1.029), aniseed (1.032) compared to the control. Also during the summer season the whitefly number within the coriander treatment was the lowest (1.044) compared to both caraway and aniseed (1.068). This indicated that coriander could be regarded as the best of the repellent plants tested when inter-planted with tomato.

During the summer season, progressive increase in whitefly numbers was shown from the beginning of the season to reach a peak on the 12th May on both varieties and declined towards the end of the season. This population trend was not observed during the winter season. Significant variations in the numbers of whitefly encountered on tomato plants within all treatments were more apparent during the summer than during the winter season (Table 4).

Table 3. The numbers of whitefly on tomato inter-cropped with caraway, coriander and aniseed during each of the growing seasons (winter and summer 2000).

Treatments	Insect numbers*	
	Winter	Summer
Caraway	1.029 c	1.068 b
Coriander	1.009 d	1.044 c
Aniseed	1.032 b	1.068 b
Control	1.044 a	1.097 a
SE±	0.0015	0.0040

***Means were calculated from the transformed data**.

- Means in the same column followed by the different letter(s) are significantly different.

Table 4. Treatment means of whitefly numbers per leaf on tomato throughout winter and summer season 2000.

Data	Insect number*	
	Winter	Summer
1st	1.021 c	1.013 d
2nd	1.029 b	1.030 c
3rd	1.028 b	1.105 b
4th	1.025 bc	1.138 a
5th	1.027 b	1.095 b

6th	1.041 a	1.035 c
SE±	0.0018	0.0048

***Means were calculated from the transformed data**.

Table 5 showed that the number of whitefly during the summer started low on both varieties, then increased progressively to reach a peak at 4th sampling date and again declined steadily towards the end of the season. These trends were not followed during the winter season. Only through summer season that the variety Omdurman was shown to harbour more whitefly numbers throughout the growing season compared to peto86. Variation in the number of whitefly were very minor on the two varieties during winter season. Table 6, which summarized the whitefly numbers encountered in each treatment, regardless of the variety and season, clearly indicated that the coriander treatment as an interplant always harboured significantly low whitefly numbers compared to the other treatment.

Seasonal as well as varietal effects on whitefly numbers as summarized in Table 7 indicated the continued superiority of Omdurman over peto86 which harbored higher whitefly numbers in both seasons. However, the whitefly numbers on peto86 were significantly low in summer than those in the winter season.

Similarly, comparison of the numbers of the whitefly in the different treatments in both seasons revealed that coriander remained the significantly leading repellent plant in reducing the whitefly numbers particularly during winter season compared to the other treatments (Table8).

Table 5. Effect of inter-cropping coriander, caraway and aniseed on the number of *B. tabaci* on two tomato varieties at winter and summer seasons.

Season	Variety	Insect numbers*					
		Data					
		1st	2nd	3rd	4th	5th	6th
Winter	Omd.	1.020	1.030	1.028	1.0.24	1.025	1.039
	Peto 86	1.022	1.028	1.029	1.026	1.028	1.043
Summer	Omd.	1.015	1.031	1.115	1.0148	1.098	1.039
	Peto 86	1.012	1.029	1.096	1.128	1.091	1.031
SE± 0.0052							

* **Means were calculated from transformed data.**

Table 6. Numbers of whitefly per leaf on two tomato varieties inter-cropped with caraway, coriander and aniseed during winter and summer seasons 2000.

Data	Insect number*			
	Treatment			
	Caraway	coriander	Aniseed	Control
1st	1.041 hi	1.005 i	1.017 ghi	1.032 fgh
2nd	1.035 fgh	1.013 hi	1.030 fgh	1.039 fg
3rd	1.068 cd	1.040 fg	1.064 cde	1.096 ab
4th	1.084 bc	1.052 def	1.076 bc	1.112 a
5th	1.053 def	1.031 fgh	1.065 cde	1.093 ab
6th	1.038 fg	1.018 ghi	1.044 ef	1.051 def
SE± 0.0052				

* **Means were calculated from transformed data.**

- Values followed by different letter (s) are significantly different (DMRT) in both column and row .

Table 7. The population of *B. tabaci* on tomato varieties during winter and summer 2000.

Variety	Insect numbers*	
	Season	
	Winter	Summer
Omdurman	1.028 c	1.029 c
Peto 86	1.074 a	1.064
SE± 0.0021		

*** Means were calculated from the transformed data.**

- Values followed by different letter(s) are significantly deferent (LSD).

Table 8. Numbers of whitefly per leaf on tomato inter-cropped with caraway, coriander and aniseed during both winter and summer seasons 2000.

	Insect numbers*

Season	Treatments			
	Caraway	coriander	Aniseed	Control
Winter	1.029 d	1.009 e	1.032 d	1.044 c
Summer	1.068 b	1.044 c	1.068 b	1.097 a

- **Means were calculated from transformed data.**
- **Values followed by different letter(s) are significantly different (DMRT).**

CONCLUTION AND RECOMMENDATIONS:

Results of this study have clearly indicated that all the three crops inter-cropped with tomato have resulted in reduction of *Bemisia tabaci* (Genn.) numbers. However, effects of these repellent plants were more apparent during winter than summer season. It is therefore recommended to intensify the use of these crops with tomato grown during winter season.

To maintain the effects of these plants throughout the long tomato growing season, it is recommended that these plants be planted at least twice during the season. The first sowing is to commence 10 days before transplanting tomato, and the other to follow 45 days later.

In order to reduce the completion exerted by some of those repellent plants, particularly caraway, it is recommended to avoid planting caraway in the same mustaba of the tomato crop. Also results of the study have indicated the clear superiority of coriander, over caraway and aniseed during both seasons in repelling *Bemisia tabaci*. In addition, coriander is an available, cheap and more popular crop than caraway and aniseed. Consequently, it is recommended that coriander is to be inter-cropped with tomato during either winter and summer season.

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