Efficacy of Intercropping Aromatic Plants and Spraying Volatile Oils on Population Density of The Main Pests Attacking Common Bean (*Phaseolus Vulgaris* L.) and Their Effects on Some Crop Parameters

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ABSTRACT: The aim of this study was to compare the effects of spraying the volatile oils of *Ocimum basilicum* L. and *Pelargonium graveolens* L., two aromatic plants and intercropping these plants with *P. vulgaris* L. var. Morgan, on the population of *Bemisia tabaci* and *Tetranychus urticae*. The results demonstrated that *B. tabaci* and *T. urticae* (eggs and adults) populations were lowered by intercropping with *P. graveolens* and *O. basilicum*. The populations of the *B. tabaci* in the two seasons varied significantly between the different treatments. Citronello (28.99%) and Geraniol (14.8%) were the principal volatile chemicals found in geranium. The volatile chemicals found in basil were beneol (16.56%) and linalool (77.96%). Low populations of *B. tabaci* nymphs were observed in intercropping with geranium and spraying geranim oil in two seasons. The intercropping with geranium had the lowest mean population of *T. urticae* in two seasons. The basil oil was more effective on *T. urticae* than on *B. tabaci* nymphs; the oil was better than intercropping with basil on eggs and adults of *T. urticae* and *B. tabaci*. The essential oils that produced a stronger repellent effect on *T. urticae* compared to control were *O. basilicum* and *P. graveolens*. The intercropping with geranium caused a reduced population of *T. urticae*. All growth parameters of the crop were improved by intercropping with basil or geranium. Chlorophyll was increased by intercropping compared with other treatments. Also, the highest yield was achieved by intercropping in two seasons.

Keywords : *intercropping, essential oils, Phaseolus vulgaris, Tetranychus urticae, Bemisia tabaci.*

INTRODUCTION

The common bean, *Phaseolus vulgaris* (Fam.: Fabaceae), is one of the most important edible leguminous crops widely grown in all geographical areas, including South America, Europe, and Africa (Bevilacqua et al., 2021). It is the second most important source of protein and the third most important source of calories in the human diet. It is a valuable source of carbohydrates, dietary fiber and phytonutrients, and provides neuroprotective properties (Jha et al., 2015). It serves as a critical plant protein source of vitamins, zinc, iron, and fiber for urban and rural areas, and it is a staple food crop in many developing countries due to its high nutritional value. It is cultivated for fresh and dry pods for local consumption and exportation (Abdou et al., 2019). Common bean is attacked by a vast array of insect pests such as flea beetles, leaf miners, stem fly, aphids, white fly, thrips, defoliators and spider mites in field conditions and is causing considerable economic damage (Amit et al., 2017). The whitefly, *Bemisia tabaci* Gennadius (Hemiptera: Aleyrodidae), is a highly polyphagous pest of many agricultural and horticultural crops. It causes extensive economic damage directly by feeding on the plant foliage, resulting in the weakening of plant growth and causing chlorosis (Perring et al., 2018). *B. tabaci* decreases the photosynthetic rate of a plant through excretion and accumulation of honeydew during feeding, thereby reducing plant growth and marketable produce (Sani et al., 2020). *B. tabaci* also acts as a super vector and transmits more than 300 deadly plant viruses (Kanakala and Ghanim, 2015). Another pest which causes damage to common beans, is the two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae). This is a cosmopolitan pest mite species that feeds on a wide variety of plants (Liburd et al., 2020). This mite feeds by piercing leaf tissues and structures and infects the host plant, causing destruction of chloroplasts and consequently reduced chlorophyll (Ziaee and Nikpay 2016). Repeated application of pesticides, in addition to polluting the environment and degrading the natural environment, has caused *B. tabaci* to develop resistance to many pesticides (Ail-Catzim et al., 2015). Therefore, there is a need to develop biopesticides or natural enemies with biopesticides to control airborne and field vegetable pests and spider mites. Today, the latest control technologies and appropriate methods are used to ensure effective management of environmental problems both in vitro and in the field (Elnahal, et al., 2022). Natural plant products and their derivatives have great promise for the advancement of human well-being and the creation of sustainable food production systems. These products have been around for a while as insect repellents and antimicrobials (da Silva and Ricci-Júnior, 2020). In both developed and developing countries, there is a growing interest in using plant-based essential oils as an alternative to conventional pesticides. The global bio insecticide market is expected to reach $4.6 billion by 2025, up from $2.2 billion in 2020 (Mossa, 2016). Essential oils are complex mixtures of different bioactive chemicals, including monoterpenes, sesquiterpenes, and their oxygenated derivatives, that are volatile secondary metabolites of plants (Mossa, 2016). Multi-cropping is an additional technique for enhancing the agricultural ecosystem. It involves growing two or more crops in one field using ecological principles (Petrie and Bates, 2017). The primary distinctions between mono- and multi-cropping farming are the duration of the growing season and the biological and agronomic traits of the crops being grown. Multi-cropping lowers the number of pathogens and weeds as well as nutrient loss into deeper soil layers (Lizarazo et al., 2020). Therefore, the likelihood of reducing the need for pesticides and fertilizers increases with the strength of the ecosystem. In the meantime, mixed-cropping systems might produce more, have better grain quality, and be more resilient to pests and illnesses. **(**Meijuan Li et al., 2019). Thus, the aim of the current study was to assess the effects of intercropping sweet basil (*Ocimum basilicum* L.) and geranium (*Pelargonium graveolens* L.) plants and spraying their essential oils against the population density of major pests on common bean plants like *B. tabaci* and *T. urticae*. In addition, the best treatment for managing these pests should be selected from those that have been tried and proven, as well as the host's appropriateness, to ensure safe use within the framework of integrated pest management. Additionally, consider the impact of the tested treatments on common bean yield, fruit physical metrics, and growth characteristics.

MATERIALS AND METHODS

Experimental Design

The study was conducted at the Agricultural Experiment Station, Faculty of Agriculture, Cairo University, Giza, Egypt. In a randomized complete block design was applied, (RCBD) in two consecutive seasons of 2022 and 2023 to study the impact of intercropping sweet basil (*O. basilicum L.*) and geranium (*P. graveolens* L.) plants on the density of primary pests on common bean plants, *P. vulgaris* L. var. Morgan, in field conditions. The common bean seeds culture (*P. vulgaris* L. var. Morgan), purchased from the Horticulture Research Institute, Agric. Res. cent., Egypt, was planted in the first section of the experimental intercropping area during the last week of September 2022 and 2023 at a depth of 5 cm. Basil and geranium plants (15–20 cm in height) grown in plastic pots were purchased from the greenhouse nursery at the Agricultural Experiment Station when the seedlings were at the four to six true leaves stage, and they were transplanted in the field in October 2022 and 2023. The experiment included 12 plots, each measuring 1 m by 12 m, with 2 m between each two plots plot for the intercropping areas of geranium and sweet basil. Common bean plants were planted into two rows 40 centimeters apart. Each intercropping plot's outer boundaries were planted with sweet basil and geranium plants, spaced 30 cm apart from the common bean and 40 cm apart in rows (Ben Issa, et al., 2017). Common bean solitary culture, common bean intercropping with basil, and common bean intercropping with geranium are the three planting methods that were alternately represented throughout the six plots of each (Figs. 1 and 2). The plots were hand-weeded and subjected to weekly flood irrigation, following the custom of the area. In every plot, green bean plants in the vegetative growth stage received 150 kg/ha of nitrogen fertilizer. There was not any pesticide used in the trials. Essential oils of geranium and sweet basil, which were purchased from the National Research Center's oils extract section, were sprayed during the second phase of the experiment. To create O/W emulsion formulations, oils are typically mixed with an emulsifying agent to enable the oil to mix with water. This mixture is typically employed at a ratio of roughly 2 milliliters to 1 litter of water. Two sprays were applied to the treatment: the first on October 15 and the second on November 12. To avoid treatments that overlap, untreated rows were employed to divide the treated plots from one another. The prepared concentrate was sprayed into a 10-liter backpack sprayer right before each treatment. Every experimental plot was subjected to the same standard agricultural techniques.

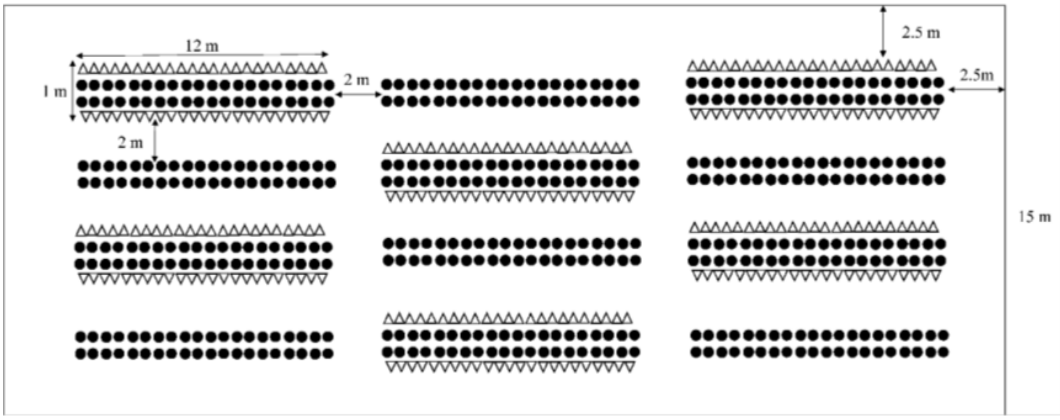

Fig. 1. Schematic representation of the experimental area.

Identification of the essential oil by GC-MS:

Gas chromatography-mass spectrometry (GC-MS) analysis was used to determine the chemical composition of basil oil and geranium oil. GC-2010 Shimadzu capillary gas chromatography was directly coupled to the mass spectrometer system, and the identification of the GC peaks corresponding to the components of the essential oil was based on computer matching with the NIST NBS54K library, direct comparison of the retention times and mass spectral data was done with those for standard compounds, and comparison of the fragmentation patterns of the mass spectra was done with those reported by Adams (1995).

Sampling technique:

Ten leaves (upper, middle, and lower) were randomly selected from various plant levels and picked up from each treatment after three weeks of cultivation for common bean plants. The leaves were then kept in closed paper bags and brought to the Plant Protection Department's laboratory on the same day for analysis and identification using a stereomicroscope. For all treatments, the sampling was done at intervals of seven days up to ten weeks.

The analysis of chlorophyll content in the leaves was conducted as follows:

A pigment used in photosynthetic processes and the source of colour for plants, chloroplasts create chlorophyll. By absorbing sunlight, it also makes it possible for photosynthesis to proceed effectively. Chlorophyll comes in a variety of forms; After 75 days, the amount of photosynthetic pigments (chlorophyll measured in mg/g.) in leaves was removed and concentrated. Chlorophyll content was recorded by SPAD (Soil-Plant Analyses Development) meter (SPAD model 502, Minolta Co, Osaka, Japan) (Shibaeva, et al., 2020).

A.

B.

C.

Fig.2. A. Intercropping with geranium, B Intercropping with basil, and C. Sole culture of common bean plants

Yield and its components

Over the course of the two ensuing fall seasons (2022 and 2023), the yield of common beans in each treatment was observed. Plant height and pod length (measured in centimeters) and the number of leaves and branches were determined. The following method was used to calculate the pods' total yield: At harvest yield of fruit per plant (g) was determined. After calculating the early yield per Fadden, the total yield was split into two groups: marketable yield (ton/fed) and unmarketable yield (ton/fed). From them, the overall yield was computed.

Statistical analysis

Data were statistically analyzed by one-way analysis of variance as described by Snedecor & Cochran (1967). Mean values were tested for differences using Tukey's test with $P \leq 0.05$ level of significance for each season

RESULTS

1. Essential Oil Composition

Tables 1 and 2 present the essential oil compositions extracted from the two aromatic plants using GC-MS. Thirteen elements were found in the geranium oil. Citronello (28.99%), Geraniol (14.8%), Alpha-Pinene (10.18%), Selinenol (9.69%), and Citronellyl Formate (9.60%) were the principal volatile components of geranium (Table 1). Eleven components were found in the sweet basil oil according to the predominant volatile constituents identified in basil were linalool (77.96%) and berneol (16.56%) (Table 2).

2. Effect of treatments on populations of *B. tabaci* nymphs.

The weekly population of *B. tabaci* nymphs infesting common bean plants is displayed in Figs. 3 and 4. There was significant variation in the weekly populations of *B. tabaci* nymphs in the monoculture of common bean in the two seasons and all tested treatments. In the first season, *B. tabaci* nymphs were found in high populations during the third, sixth, and eighth sampling weeks. In the second season, however, high populations of this insect were found in monoculture during the second and fifth sampling weeks. There were significant variances in the population density of *B. tabaci* nymphs for intercropped basil during weekly sampling in the 2022 season and the mean of the 2023 season. In the second season, low populations of *B. tabaci* nymphs were seen in intercropped geranium and geranium oil. The mean numbers of *B. tabaci* nymphs in the first season were 2.1, 3.6, 2.65, 2.57, and 15.18 nymphs/plant, for the intercropped basil, basil oil, geranium, and monoculture, respectively; in the second season, those numbers were 5.29, 3.68, 1.46, 1.42, and 11.08 nymphs/plant. The population numbers of *B. tabaci* nymphs varied significantly between tested treatments during the two seasons.

Table (1): Chemical constituents of Geranium oil, (*Pelargonium graveolens* L.) by (GC/MS) analysis

	Components	Geranium oil %	R_t min
1	alpha-Terpinene	1.19	6.37
2	Alpha-Pinene	10.18	8.11
3	(+)-Linalool	8.49	11.79
4	Citronello	28.99	18.59
5	Geraniol	14.8	19.45
6	Citronellyl formate	9.60	19.93
7	Geranyl ethanoate	4.23	20.80
8	Germacrene-d	1.97	26.2
9	Caryophyllene	1.59	26.40
10	Cubenene	1.40	27.45
11	Selinenol	9.69	30.45
12	-(-)trans-Myrtanyl acatate	0.93	34.05
13	Cyclohexanone, 5-methyl-2-(1-methylethyl)-, cis-	6.92	16.12

Table (2): Chemical constituents of sweet basil oil (*Ocimum basilicum* L.) by (GC/MS) analysis

	Components	Basil oil %	R_t min
1	Styrene	0.90	12.14
2	1,8 cineole	0.19	17.41
3	**Berneol**	**16.56**	**19.63**
4	Terpinen	0.44	22.27
5	**linalool**	**77.96**	**22.91**
6	Neral	0.25	24.88
7	Caryophyllene	0.37	29.43
8	Comphor	0.83	29.59
9	Geranyl acetate	1.30	32.27
10	Methyl cinnamate	0.24	33.09
11	Caryophyllene oxide	0.96	33.26

2. Effect of the tested treatments on populations of *T. urticae* Koch

The effects of intercropping with basil, basil oil, and geranium and geranium oil on *T. urticae* eggs and adults were investigated. The mean adult populations of *T. urticae* varied significantly between the two seasons for every treatment (Figs. 5 and 6). The average number of *T. urticae* adults in the first season were 8.13, 2.1, 0.0, 2.2, and 19.6 adults /plant for intercropping with basil, intercropping with geranium, geranium oil, and monoculture, respectively. The mean number of *T. urticae* adults were 6.28, 0.48, 0.0, 1.64, and 22.36 adults /plant for intercropping with basil, intercropping with geranium, geranium oil, and monoculture, respectively, in the second season (Fig. 6 and Table 3).

Lower numbers of *T. urticae* adults appeared in two seasons of intercropping with geranium, but the highest number of adults was observed in monoculture. The population of *T. urticae* eggs seemed to high in the first week of the two seasons, and then progressively dropped during the studied periods in the mono culture. For every tested treatment, there was a highly significant difference in the mean number of *T. urticae* eggs between the weekly populations (Fig. 7 and Table 3). Near the end of the two seasons, the monoculture had the largest mean number of *T. urticae* eggs (28.6 and 29.45 eggs/plant) in the first and second seasons respectively. The geranium intercropping produced the lowest mean population of *T. urticae* eggs (Figs. 7, 8, and Table 3).

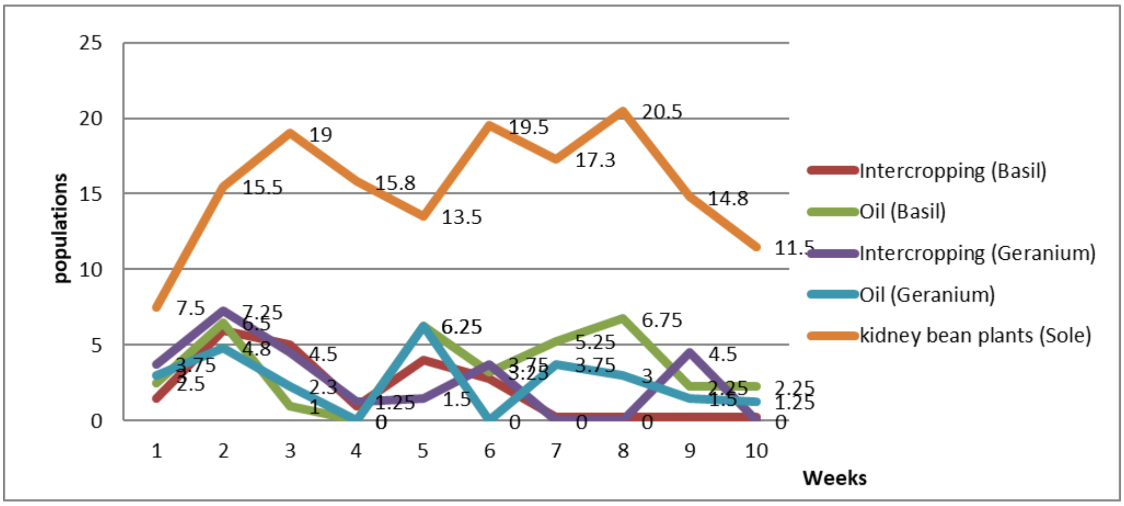

Fig. (3): Effect of intercropping with basil and Geranium and their essential oils on *Bemisia tabaci* nymph populations during first seasons (2022).

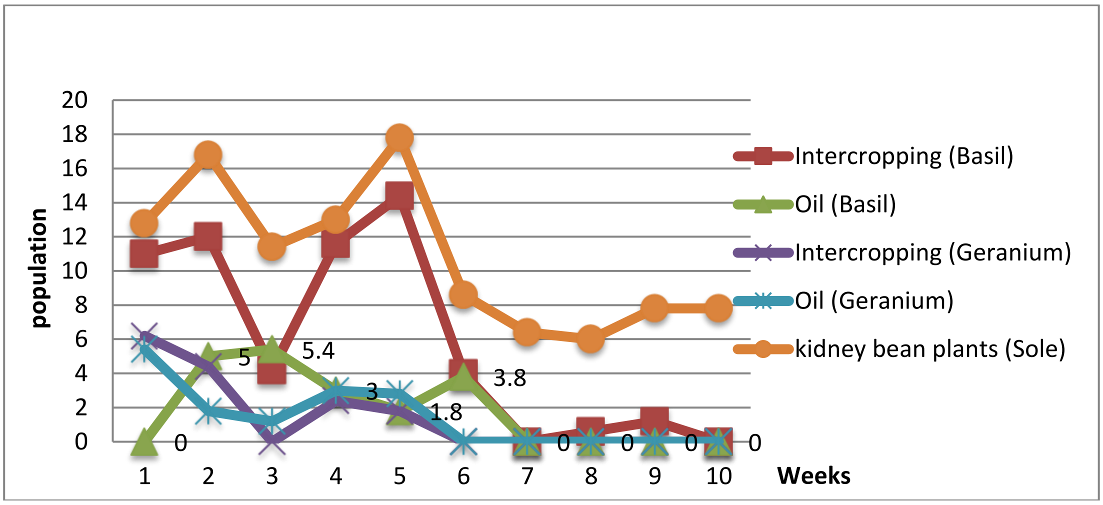

Fig. (4) Effect of intercropping with basil and Geranium and their essential oils on *Bemisia tabaci* nymph populations during second seasons (2023).

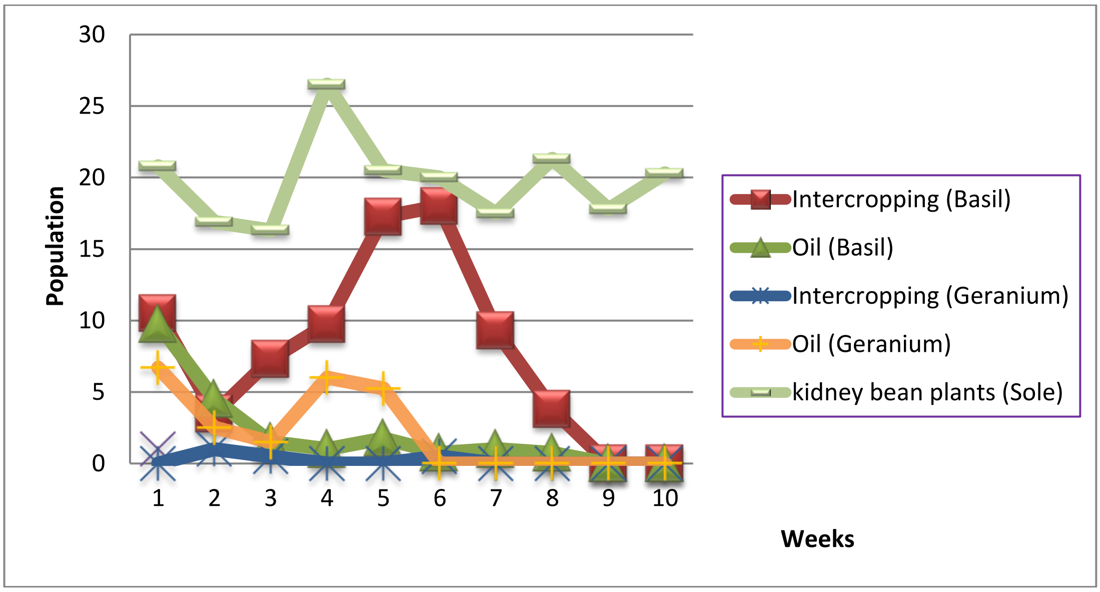

Fig. (5): Effect of intercropping with basil and Geranium and their essential oils on *Tetranychus urticae* adult populations during first season (2022).

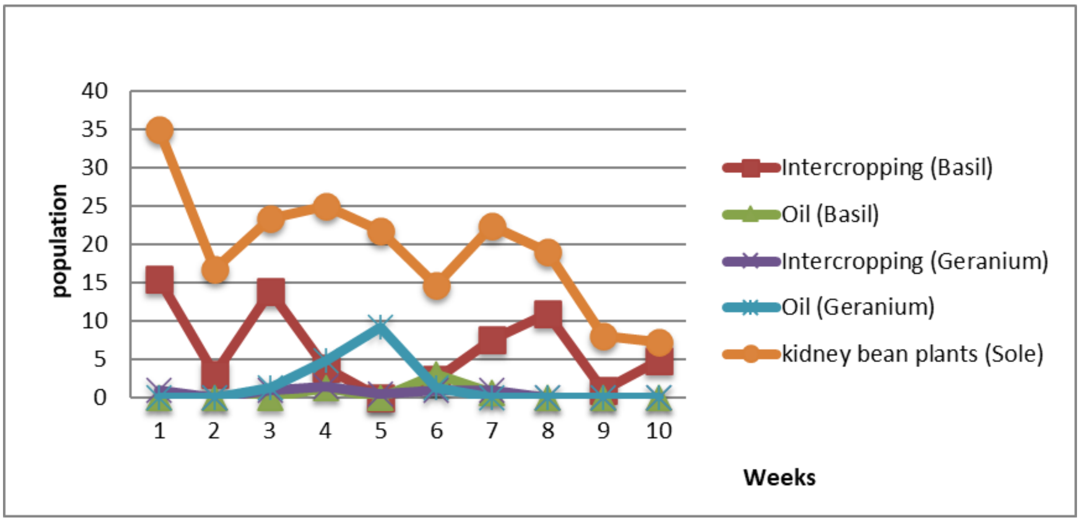

Fig. (6): Effect of intercropping with basil and Geranium and their essential oils on *Tetranychus urticae* adult populations during second season (2023).

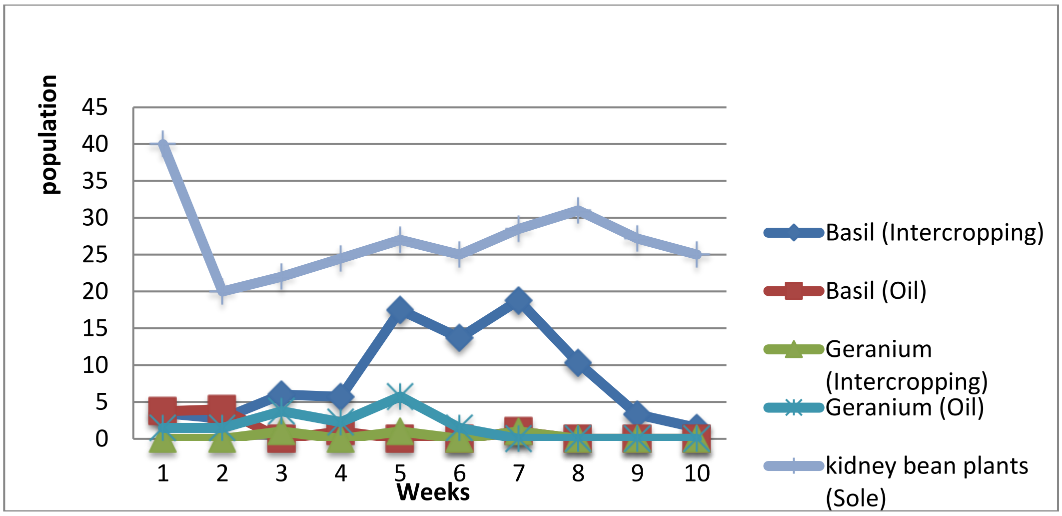

Fig. (7): Effect of intercropping with basil and Geranium and their essential oils on egg of *Tetranychus urticae* populations during first season (2022).

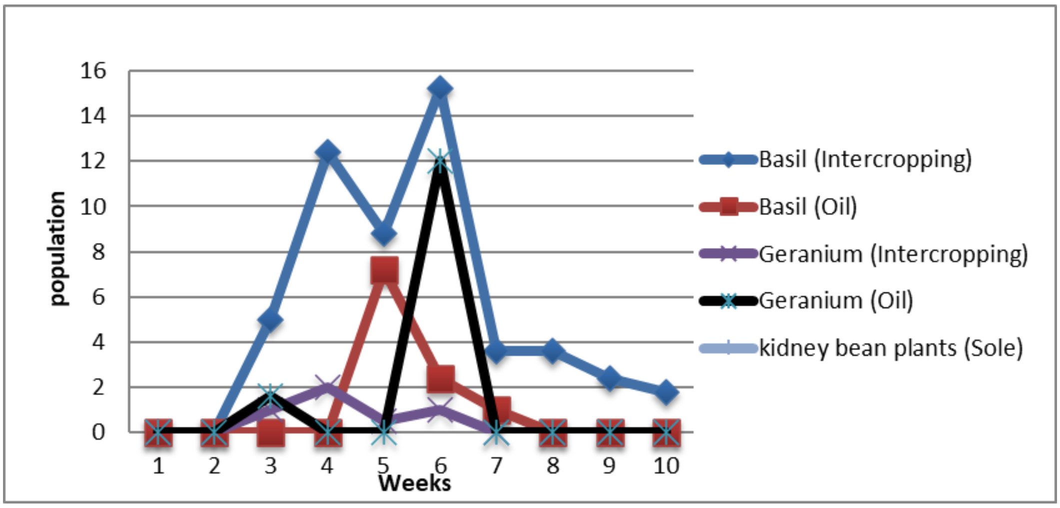

Fig. (8): Effect of intercropping with basil and Geranium and their essential oils on egg of *Tetranychus urticae* populations during second season (2023).

3. Effect of the tested treatments on growth parameters and yield of common bean

a. Chlorophyll of all treatments of common bean

Every treatment showed a significant impact on chlorophyll (Table 4). When comparing intercropped plants to treatments in the first and second seasons, there was a significant variation in chlorophyll content due the treatments comparing to the mono culture treatment (Table 4). Intercropped Basil had the maximum chlorophyll content. All treatments showed significant increase in chlorophyll, comparing to the mono culture treatment. The results obtained indicated that intercropped basil outperformed all other treatments in both seasons.

Table (3): The mean populations of *B. tabaci* nymphs, *T. urticae* (adults and eggs) on all treatments in 2022 and 2023 seasons.

	Seasons	Basil		Geranium		Common bean (Sole culture)	F valu	P value
		Intercropping	Oil	Intercropping	Oil			
B. tabaci nymphs	**First**	2.2 ±0.66b	3.6±1.22b	2.65±0.93b	2.57±1.21b	15.18±3.68a	45.877	0.00
	Second	5.29 ±1.88b	3.86±1.41b	1.46±0.69c	1.42±0.58c	11.08±1.15a	30.171	0.00
***T. urticae* adult**	**First**	8.13 ±1.95b	2.1±0.75 c	0.0 ± 0.0 c	2.2 ± 0.61c	19.6±3.27a	83.899	0.00
	Second	6.28 ±1.71b	0.48±0.31c	0.0 ± 0.0 c	1.64±0.96c	22.36±5.31a	14.822	0.00
***T. urticae* eggs**	**First**	8.25±1.44b	0.78 ±0.31c	0.0 ± 0.0 c	1.81±0.81c	28.6±4.79a	385.23	0.00
	Second	5.28±1.64b	1.06±0.73c	0.0 ± 0.0c	1.4±1.23c	29.45±9.66a	8.531	0.00

Means followed by the same letters are not significantly different; small letters represent differences between data in rows based on least significant difference tests at the 5% level (LSD 5%).

Table 4: Chlorophyll (mg/g) **of common bean plants as affected with all treatments during the 2022 and 2023 seasons.**

	Intercropping Basil	Intercropping Geranium	Basil Oil	Geranium Oil	Common bean (Sole culture)	F_{value}	P_{value}
First season 2022	39.2 ± 0.51a	36.77±0.39b	37.87±0.38b	36.77±0.38b	32.43±0.12c	49.621	0.00
Second season 2023	41.73±0.82a	40.17±1.59ab	34.9 ± 0.71c	37.8 ± 0.44b	30.37±0.03d	30.498	0.00

Means followed by the same letters are not significantly different; small letters represent differences between data in rows based on least significant difference tests at the 5% level (LSD 5%).

b. Common bean seed yield and yield attributes

Table 5 shows that all treatments had a significant impact on plant height, number of leaves, number of branches, length of the pod (cm), mean weight of pod (g), number of pods/plant, yield (g/plant), and yield (ton/fad.) in the 2022 and 2023 seasons. In both seasons plant height increased significantly compared to the monoculture treatment. In the first season, plant height was 49.3, 44.03, 51.3, 48.23 and 35.93 cm found in the second season it was 53.23, 45.9, 53.7, 49.2 and 37.8 cm.

The number of leaves were 21.87, 13.53, 21.47, 19.8, and 11.13 in the first season, and 23.6, 14.3, 23.9, 21.1, and 9.33 in the second season for intercropped basil, intercropped geranium, basil oil, geranium oil and monoculture, respectively. The number of branches planted was 4.2, 4.3, 4.3, 4.2 and 3.33 in the first season, but second season was 5.4, 4.9, 5.2, 4.9 and 3.17 for intercropped basil, intercropped geranium, basil oil, geranium oil and monoculture, respectively.

The data showed that length of pod was 17.07, 15.17, 12.77, 11.83, and 10.6 in the first season, but second season was 15.4, 14.0, 10.67, 9.93, and 8.93. Mean weight of pod was 4.63, 3.83, 3.6, 3.3 and 2.87 in the first season, but second season was 5.83, 5.07, 5.13, 4.57, and 3.67 pods. The number of pods/plants was 25.77, 17.83, 18.47, 17.3 and 13.67 in the first season, but second season was 23.3, 15.97, 16.13, 15.57 and 11.3 pods for intercropped basil, intercropped geranium, basil oil, geranium oil and monoculture, respectively.

In the first season, yield (g/plant) was 79.27, 68.63, 66.67, 59.97, and 42.4 g, but in second season, 87.47, 71.13, 70.17, 62.2, and 45.9g. Yield (t /fad.) was 5.35, 5.18, 4.7, 3.96 and 2.95t in the first season, but second season was 6.37, 5.47, 5.53, 5.6 and 4.3t for intercropped basil, intercropped geranium, basil oil, geranium oil and monoculture, respectively.

Table 5: The impact of intercropping basil and geranium with their essential oils on common bean yield and growth characteristics in the 2022 and 2023 growing seasons.

Parameters	Intercropping Basil	Intercropping Geranium	Basil Oil	Geranium Oil	common bean plants (Sole culture)	F_{value}	P_{value}
				First season 2022			
Plant height(cm)	49.3±0.61a	44.03±1.18b	51.3±0.70a	48.23±0.37a	35.93±1.75c	40.189	0.00
Number of leaves	21.87±0.87a	13.53±1.24b	21.47±0.15a	19.8 ±0.29a	11.13±0.68b	35.218	0.00
Number of branches	4.5 ±0.06 a	4.27±0.07b	4.3 ± 0.1b	4.2 ±0.0 b	3.33±0.03c	57.906	0.00
Length of the pod (cm)	17.07± 0.29a	15.17±0.2b	12.77±0.32c	11.83±0.48d	10.6±0.31e	157.629	0.00
Mean weight of pod	4.63 ± 0.29a	3.83±0.18b	3.6 ± 0.1b	3.3± 0.1bc	2.87±0.07c	12.209	0.00
Number of pods/plant	25.77 ±0.64a	17.83±0.2b	18.47±0.26b	17.3 ±0.4b	13.67±0.17c	115.910	0.00
Yield (g/plant)	79.27±5.99a	68.63±3.95ab	66.67±2.03b	59.97±2.79b	42.4± 0.58c	12.873	0.00
Yield (t /fad.)	5.35 ±0.04a	5.18 ±0.05a	4.7 ± 0.08b	3.96±0.08c	2.95 ±0.09d	162.444	0.00
				Second season 2023			
Plant height(cm)	53.23±0.86a	45.9±0.91c	53.7 ± 0.58a	49.2± 0.35b	37.8±1.68d	40.294	0.00
Number ofleaves	23.6±0.92a	14.3± 1.13c	23.9 ± 0.38a	21.1 ± 0.41b	9.33± 0.88d	80.760	0.00
Number of branches	5.4 ± 0.12a	4.91±0.06a	5.2 ± 0.44a	4.9 ± 0.38a	3.17 ±0.16b	20.381	0.00
Length of the pod (cm)	15.4±0.42a	14.0±0.29b	10.67±0.37c	9.93 ±0.38c	8.93 ± 0.28d	146.289	0.00
Mean weight of pod	5.83±0.33a	5.07±0.09bc	5.13 ± 0.21b	4.57±0.07c	3.67±0.17d	21.865	0.00
Number of pods/plant	23.3±0.72a	15.97±0.24b	16.13± 0.57b	15.27±0.33b	11.3±0.61c	58.036	0.00
Yield (g/plant)	87.47±4.77a	71.13±2.47b	70.17±1.41bc	62.2±2.47c	45.9 ± 0.4d	31.825	0.00
Yield (t /fad.)	6.37±0.47a	5.47± 0.08b	5.53±0.08b	5.6 ± 0.15b	4.3± 0.11c	16.937	0.001

Means followed by the same letters are not significantly different; small letters represent differences between data in rows based on least significant difference tests at the 5% level (LSD 5%).

DISCUSSION

Biopesticides produced from plants are an alternative to chemical pesticides; some of these have been shown to be successful in managing insect pests (Deleito and Borja 2008; Suwannayod et al. 2018). Many environmentally friendly control strategies have been developed to reduce the damage that insect pests cause to field vegetable crops. One such strategy is the use of essential oils (EOs), which have been suggested to be a good substitute for synthetic pesticides due to their low mammalian toxicity and various pests for which they have lethal or sub-lethal effects, such as oviposition deterrent, repellent, and miticidal effects. Utilizing botanical sources for pest control requires an understanding of the ability to recognize these intricate interactions (Benelli, et al., 2017; Tak, et al., 2016). Certain oils can also function as poisons in specific situations by reacting with the insect's fatty acids and disrupting its regular metabolism. Essential oils act at various levels in insects and have been shown by certain researchers to have neurotoxic, citotoxic, phototoxic, and mutagenic effects in a variety of organisms. As a result, the likelihood of developing resistance is low (Bakkali et al., 2008). As a result, very little study has done on common beans intercropped with ocimum or geranium.

The results showed that the berneol (16.56%) and the terpene with the alcohol group linalool (77.96%) constituted the majority of the main components obtained in sweet basil oil. These findings were similar to those reported by Kim et al. (2015) and Souza et al. (2016), which are known to have both toxic and repellent properties against certain insects. The genus *Ocimum* has been studied for its insecticidal properties against a variety of insect pests. The effects of the sweet basil oil on *T. urticae* eggs and adults were greater than those on *B. tabaci* nymphs. In the first and second seasons, the oil outperformed intercropping with basil on *T. urticae* eggs and adults (Table 3). Citronellol and geraniol (trans-geraniol) are the main compounds present in *P. graveolens* geranium that have been shown to have pesticidal activity (Bouzenna and Krichen 2013). In this study, we examined the bioactivity of *P. graveolens* (Geraniaceae) essential oil and a few related monoterpenes against a whitefly, *B. tabaci*, and an adult two-spotted spider mite, *T. urticae*,, on common beans. When compared to sweet basil oil, *P. graveolens* oil significantly decreased the population of *B. tabaci* nymphs on common beans. Geranium oils outperformed geranium intercropping for the population of *B. tabaci* nymphs, whereas intercropping outperformed geranium oils and mono culture for the population of *T. urticae*, both for adults and eggs. According to Eldoksch et al. (2012), the most efficient way to *T. urticae* mortality was through the vapours of clove essential oil, whereas the least successful ways were with basil and peppermint. Additionally, Awad et al., (2022) study demonstrated that the essential oils of clove, basil, and peppermint were more effective against adult *T. urticae* than on immature stages due to a lower LC_{50} versus adults. Regarding this, Mahmoud and Kassem (2022) discovered that clove essential oil had a significant impact on *T. urticae*, demonstrating that mortality was elevated 24 hours and 3 days after treatment, while no mortality was observed in the control group. When treated with clove essential oil, the death rate of adult female "*T. urticae*" rose with concentration. Basil oil has the smallest number of effects against *T. urticae,* and no research has examined its anticardia impact, according to our findings. Enan (2001) proposed a mechanism of action for plant essential oils and their bioactive constituents, suggesting that the octopaminergic nervous system of insects may play a role in the toxicity of essential oil constituents against insect pests. Its functional group is thought to be able to obstruct the target mite's mitochondrial respiration as a possible mechanism of action (Tewary et al., 2006; Dias and Moraes, 2014; and Awad et al., 2022) found a correlation between the toxicity of monoterpenes, their capacity to inhibit acetylcholine esterase (AChE), and their capacity to mortality insects or ticks. Another theory is that certain monoterpenes may inhibit cytochrome P450-dependent monooxygenases. Overall, the results obtained suggest that when *T. urticae* was raised on Toshka (SC 349) treated with abamectin and essential oils in vitro, there were differences in the immature stages of *T. urticae*. According to Yildirim and Ekinci (2017), intercropping is the attainment of a high and steady production that not only produces complementary items locally but also lessens the negative impacts of diseases and pests, avoids pollution, and leads to efficient resource use. The results demonstrated that geranium intercropping decreased the numbers of *T. urticae* (adults and eggs) and whiteflies.

According to certain research, *Ocimum* species are good companion or repellent plants that help reduce pest populations on crops. Schader et al. (2005) found that intercropping *Gossypium barbadense* L. (Malvaceae) and *O. basilicum* decreased the abundance of pests. Research on the medicinal effects of the *Ocimum* genus (Lamiaceae) and its biocidal activity against different pest species is of significant interest (Yarou, et al., 2020). Similar to this, *O. gratissimum* and *O. basilicum* were shown to decrease *Tuta absoluta* oviposition on tomato plants (Lepidoptera: Gelechiidae) (Yarou, et al., 2017a). When *O. cimums* pecies was intercropped with the crop, a repellent effect was also observed against cabbage pests, such as *Phyllotreta sinuate* Steph. (Coleoptera: Chrysomelidae), *Hellula undalis* F. (Lepidoptera: Crambidea), *Spodopter alitura* F. (Lepidoptera: Noctuidae), and *Spodoptera littoralis* F. (Yarou, et al., 2017b). Planting *O. cimum* species between trees has been shown to improve the orchard ecology by lowering pest levels and attracting natural enemies from the families Phytoseiidae, Syrphidae, Chrysopidae, and Coccinellidae (Beizhou, et al., 2013 and Tang, et al., 2013). According to Yarou, et al., (2020) *O. basilicum* and *O. gratissimum* were also found to have repellent properties against *Aphis craccivora* K. and *Aphis fabae* S and *Myzus persicae.*

This will make it possible to evaluate the efficacy of essential oils derived from *ocimum* in natural settings prior to recommending its usage for pest management in open fields.

The findings demonstrated that each treatment had a significant impact on chlorophyll (Table 4). When comparing intercropped plants to treatments in the first and second seasons, chlorophyll was rising. When geranium or basil is intercropping instead of having their oils sprayed, the output of common beans increases. Furthermore, utilizing *Ocimum* in the intercropping system might be the best course of action. When it comes to controlling pests and increasing crop output, crop association seems to be a beneficial agro-ecological technique for farmers in many situations (Yarou, et al., 2021). Since *occimum* is a vegetable that is frequently consumed in this region of Africa (Kpètèhoto et al., 2017; Yarou et al., 2021), integrating it into crop association systems shouldn't present any challenges. Additionally, the existence of several groups of entomophagous beneficials on *O. cimum* crops may be valued in terms of ecosystem services like pollination to increase productivity and biological control supplied by natural enemies (Beizhou et al., 2011; Yarou et al., 2018).

CONCLUSIONS:

This research suggested that essential oils and intercropping with basil or geranium had appropriate protective effects against certain arthropod pest populations. Thus, *B. tabaci* and *T. urticae* on common beans could be controlled by essential oils extracted from geranium and sweet basil. Under field conditions, the species of essential oils that produced a higher repellent effect on *T. urticae* (egg and adults) compared to control were *O. basilicum* and *P. graveolens.* The population of *T. urticae* (adults and eggs) was less affected by the geranium intercropping. Addition the intercropping with geranium or basil were improved yield characters.

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الملخص العربى

فعالية زراعة التحميل للنباتات العطرية ورش الزيوت العطرية على تعداد الافات الرئيسية التى تهاجم الفاصوليا وتاثيرها على بعض الخصائص المحصولية

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هدفت الدراسة إلى مقارنة بين تأثيرالتحميل و الرش ببعض الزيوت العطرية لكل من الريحان *Ocimum basilicum* L. و العتر *Pelargoniumhg graveolens* L. على تعداد الآفات الرئيسية التى تصيب نبات الفاصوليا *P. vulgaris* هما الذبابة البيضاء *Bemisia tabaci* والعنكبوت الاحمر *Tetranychus urticae*, . أظهرت النتائج انخفاض فى أعداد الذبابة البيضاء والعنكبوت الاحمر (البيض والحشرة الكاملة) من خلال زراعة التحميل مع العتر و الريحان. هناك كان تاثير معنوي فى تعداد الذبابة البيضاء فى المعاملات المختبرة للموسمين. تم تقدير المواد الكيميائية المتطايرة الرئيسية الموجودة في نبات العتر كان Citronello بنسبة 28.99٪ وGeraniol بنسبة 14.8 ٪، بينما كانت المواد الكيميائية المتطايرة الموجودة في الريحان هي beneol بنسبة 16.56٪ وlinalool بنسبة 77.96٪ . لوحظ ايضا انخفاض أعداد حوريات الذبابة البيضاء عند التحميل الفاصوليا مع نبات العتر وزيت العتر في كلا الموسمين .كان متوسط تعداد العنكبوت الاحمر في زراعة تحميل نبات العتر هو الأقل في الموسمين .كان زيت الريحان أكثر فعالية على حوريات العنكبوت الاحمر من الذبابة البيضاء ، وكان تاثير الزيت أفضل من زراعة التحميل مع الريحان على بيض و الحشرة الكاملة لكلا من العنكبوت الاحمر و الذبابة البيضاء . كانت الزيوت العطرية تأثيرًا طاردًا على العنكبوت الاحمر مقارنة بالكنترول .أدى الزراعة االتحميل لنبات العتر إلى انخفاض في تعداد والعنكبوت الاحمر بالاضافة الى ذلك تم تحسين جميع خصائص نمو المحصول من خلال زراعة التحميل مع نباتى الريحان و العتر .وقد زادت نسبة الكلوروفيل و زادت إنتاجية المحصول عند زراعة التحميل مقارنة بالمعاملات الأخرى في كلا موسمين.