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Effect of Crude Oil and Carbofuran on Insect Pests, Nematodes, Growth and yield of Nsukka Yellow Pepper (*capsicum annum*) in Enugu Area of Southeastern Nigeria

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***Abstract*—** *A field experiment to evaluate the effect of crude oil and Carbofuran on insect pests, Nematodes, growth and yield of Nsukka yellow pepper (capsicum annum) was conducted in the Faculty of Agriculture and Natural Resources Management Teaching and Research Farm, Enugu State University of Science and Technology Enugu during the 2018 cropping season. The experiment was carried out using a 4 x 3 factorial in a complete randomized design (CRD) with twelve (12) treatments replicated three (3) times. The result of the experiment showed a significant interaction effect (p=0.05) of crude oil and carbofuran on the number of aborted fruits per plant, number of root knot nematodes per plant and fruit yield (kg)per pot. The result of the experiment also showed non-significant interaction effect (p=0.05) of crude oil and Carbofuran on the number of dead plants, plant height, number of leaves per plant, number of curled leaves per plant, insect infestation and number of fruits per plant. Furthermore, there was non-significant main effect (p=0.05) of both crude oil and carbofuran on the number of plants that died 73 and 86 days after planting, plant height, number of grasshoppers per plant, whereas the main effect of both crude oil and Carbofuran on the number of root knot nematodes was significant (p=0.05). The result of the experiment further showed a significant main effect of crude oil on the number of aborted fruits per plant while the main effect of carbofuran on the number of aborted fruits was non-significant (p=0.05). Again, the result of the experiment showed a non-signification main effect (p=0.05) of crude oil and carbofuran on fruit yield (kg) per pot.*

***Keywords*—Nsukka yellow pepper (Capsium annum) crude oil, carbofuran, Interaction effect, main effect.**

I. INTRODUCTION

Nsukka yellow pepper belongs to the family *solanaceae* and the genus *capsicum* (Uguru and Obieri 2008). Nsukka yellow pepper is a vegetable fruit consumed either fresh or dehydrated/dried. It is an indispensable commodity and an integral component of many cuisines in the world due to its appealing flavour, taste and pungency, (Bosland and Votava 2000). *Capsicum* species is grown in most countries of the world such as China, Turkey, Mexico, Spain, U.S.A., among which Nigeria is ranked third producer of pepper in the world (Uguru andObieri 2008). Pepper occupies the third position of importance among cultivated vegetables after onion and tomatoes (Uzo, 1983). Pepper is an ancient vegetable crop whose production is presently on the increase (Uzo, 1983). *Capsicum anuum* is an indigenous vegetable of Nigeria and as such, its production is an important component of both subsistence and commercial farming system generally practiced in Nigeria especially Enugu State (Tanko, 1995). In Nigeria, Pepper accounts for 20 percent of the average daily vegetable intake either as soups or as condiments in the diets of Nigerians. Nigeria is one of the most important countries in the world for Pepper genetic resources since it accounts for 50% out of million tonnes believed to be produced in Africa, following the world estimated area of 1.6 million hectares with China being the largest producer and 1 million tonnes believed to be produced in Africa (FAOSTAT 2013).

Nsukka yellow pepper is characterized by its yellow colour at fruit ripening and a unique aroma, which distinguish it from other pepper varieties. It is very nutritious and has medicinal value and is a recognized source of vitamin A, C and E. In addition, it is a sources of antioxidants, nutrients, as well as bioactive compounds such as flavonoids, phenolic acids, carotenoids and also rich in natural colour and aroma. The key bioactive compounds in peppers such as flavonoids, capsaicinoids and capsicinoids have been linked to biochemical and pharmacological effect including anti-oxidation and anti-inflammation activities. Capsaicinoids provide the pungent sensation in hot peppers whereas capsicinoids are

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non-pungent compound present in sweet peppers. Capsicinoids have been reported to have anti-inflammatory activities as well as to promote energy consumption and to suppress fat accumulation, increase body temperature in humans. The activities of capsicinioids and their lack of pungency, make them attractive for potential application in food and pharmacology.Other major bioactive compounds of peppers include ascorbic acid, carotenoids, and other antioxidants. The culinary properties and biological effects of bioactive compounds make them extremely important not only for nutrition, but also as pharmacological substrate that are used in prevention of cardiovascular diseases, cancers and cataracts. In addition it is used for preservation of cowpea and other grains against weevil attack (Echezona, 2006).

In Nigeria, pepper production has not attracted the same research patronage like other crops such as cassava, cocoa, Rice, Cowpea etc. (Awoke and Okorji 2004). As a result, a few or no research has been conducted to find out why Nsukka yellow pepper is not grown in many parts of Nigeria especially in oil producing states.

Again, a lot of pests and diseases attack peppers at various stages of growth and development which motivated me to carry out a research work that aimed at evaluating the effect of crude oil and carbofuran on nematodes, insect pests, growth and yield of Nsukka yellow pepper in Enugu area of Southeastern Nigeria.

II. MATERIALS AND METHODS

A field experiment to evaluate the effect of crude oil and carbofuran on insect pests, nematodes, growth and yield of Nsukka yellow pepper (*Capsicum annum*) was carried out during the 2018 cropping season at the Faculty of Agriculture and Natural Resources Management Teaching and Research Farm of Enugu State University of Science and Technology Enugu, Southeastern Nigeria. The University lies between latitude $06^{0}50'$N -$06^{0}57'$N and longitude $07^{0}15'$E - $07^{0}15'$E with a mean elevation of 450 m above sea level.

Experiment design

The experiment was carried out using a 4 x 3 factorial in a complete randomized design (CRD) with twelve (12) treatments replicated three (3) times. Each experimental pot/unit (replicate) contained 10kg soil. The pepper seedlings were raised in a nursery before they were transplanted into the various experimental pots. Each pot contained one pepper plant.

Treatments

Treatments were; Four (4) rates of crude oil viz; 0ml, 20ml, 40ml and 60ml (Factor A). Threerates of carbofuran viz, 0g, 10g and 20g (Factor B)

Treatment Combinations

0ml crude oil + 0g carbofuran	A_1B_1
0ml crude oil + 10g carbofuran	A_1B_2
0ml crude oil + 20g carbofuran	A_1B_3
20ml crude oil + 0g carbofuran	A_2B_1
20ml crude oil + 10g carbofuran	A_2B_2
20ml crude oil + 20g carbofuran	A_2B_3
40ml crude oil + 0g carbofuran	A_3B_1
40ml crude oil + 10g carbofuran	A_3B_2
40ml crude oil + 20g carbofuran	A_3B_3
60ml crude oil + 0g carbofuran	A_4B_1
60ml crude oil + 10g carbofuran	A_4B_2
60ml crude oil + 20g carbofuran	A_4B_3

Data Collection

Data were collected on the number of plants that died 73 and 86 days after planning (DAP), plant height, number of leaves per plants, number of fruits per plant, number of aborted fruits per plant, curled leaves per plants, insect pests infestation per plants, number of root knot nematodes per plant and fruit yield(kg) per pot.

Data Analysis

The data collected were subjected to analysis of variance for factorial experiment as outlined by Obi 2001 using Genstat Release 10.3DE (PC windows) 2012 software. Differences between treatment means were detected using Fisher's least significant difference (F-LSD) as outlined by steel and Torrie (1980).

III. RESULTS

Effect of crude oil and carbofuran on the number of plants that died 73 and 86 Days After Planting (DAP).

The result of the experiment showed a non-significant interaction effect (p=0.05) of crude oil and carbofuran on the number of plants that died 73 and 86 days after planting. Also there was a non-significant

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(p=0.05) main effect of both crude oil and carbofuran on the number of plants that died 73 and 86 days after planting. This result however shows that Nsukka yellow pepper can survive crude oil pollution up to 60ml per 10kg of soil (Table 1). However, 20ml crude oil + 0g carbofuran, 40ml crude oil + 0g carbofuran and 60ml crude oil + 0g carbofuran each recorded the highest number of 1.052 dead plants 86 days after planting.

Table.1: Effect of crude oil and carbofuran on the number of plants that died 73 and 86 days after planting (DAP).

Treatments		Number of plant that died 73 days after planting	Number of plant that died 86 days after planting
0ml crude oil + 0g carbofuran	0.707	0.707	
0ml crude oil + 10g carbofuran	0.707	0.707	
0ml crude oil + 20g carbofuran	0.707	0.707	
20ml crude oil + 0g carbofuran	0.880	1.052	
20ml crude oil + 10g carbofuran	0.707	0.880	
20ml crude oil + 20g carbofuran	0.880	0.880	
40ml crude oil + 0g carbofuran	0.880	1.052	
40ml crude oil + 10g carbofuran	0.880	0.880	
40ml crude oil + 20g carbofuran	0.707	0.880	
60ml crude oil + 0g carbofuran	0.880	0.880	
60ml crude oil + 10g carbofuran	0.707	0.707	
60ml crude oil + 20g carbofuran	0.880	1.052	
F – $LSD_{0.05}$	**NS**	**NS**	

Effect of crude oil and carbofuran on plant height (cm) and number of leaves per plant 73 DAP.

The result of the experiment showed a non-significant interaction and main effect (p=0.03) of crude oil and carbofuran on plant height and number of leaves per plant 73 days after planting. However, 20ml of crude oil and 10g of carbofuran produced the highest mean plant height of 71.30cm whereas 60ml produced the highest mean number of 207 leaves per plant (Table 2).

Table.2: Effect of crude oil and carbofuran on plant height and number of leaves per plant 73 DAP.

Treatment	Plant height (cm)	Number of leaves per plant
0ml crude oil + 0g carbofuran	58.40	154.00
0ml crude oil + 10g carbofuran	49.70	69.00
0ml crude oil + 20g carbofuran	46.30	119.00
20ml crude oil + 0g carbofuran	48.20	155.00
20ml crude oil + 10g carbofuran	71.30	201.00
20ml crude oil + 20g carbofuran	45.00	134.00
40ml crude oil + 0g carbofuran	45.00	135.00
40ml crude oil + 10g carbofuran	58.38	139.00
40ml crude oil + 20g carbofuran	65.60	191.00
60ml crude oil + 0g carbofuran	47.00	120.00
60ml crude oil + 10g carbofuran	67.70	207.00
60ml crude oil + 20g carbofuran	61.30	204.00
F – $LSD_{0.05}$	**NS**	**NS**

Effect of crude oil and carbofuran on the number of fruits per plant and aborted fruits per plant 73 days after planting.

The result of the experiment showed non-significant interaction effect (p=0.05) of crude oil and carbofuran on the number of fruits per plant 73 days after planting, whereas the interaction effect of crude oil and carbofuran on the number of aborted fruits per plant was significant (p=0.05). There was non-significant main effect (p=0.05) of crude oil and carbofuran on the number

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of fruits per plant. Again, there was a significant main effect (p=0.05) of crude oil on the number of aborted fruits per plant, whereas the main effect of carbofuran on the number of aborted fruits was non-significant (p=0.05). However, 0ml of crude oil and 0g of carbofuran produced the least number of 11.00 fruits per plant while 60ml of crude oil and 20g of carbofuran produced the highest number of 1.386 aborted fruit per plant (Table 3).

Table.3: Effect of crude oil and carbofuran on the number of fruits and aborted fruits per plant 73 days after planting.

Treatments	Number of fruits per plant	Number of aborted fruits per plant
0ml crude oil + 0g carbofuran	11.00	0.707
0ml crude oil + 10g carbofuran	10.70	0.880
0ml crude oil + 20g carbofuran	18.00	0.707
20ml crude oil + 0g carbofuran	33.00	0.707
20ml crude oil + 10g carbofuran	33.00	1.052
20ml crude oil + 20g carbofuran	24.00	0.707
40ml crude oil + 0g carbofuran	16.70	0.707
40ml crude oil + 10g carbofuran	12.30	0.707
40ml crude oil + 20g carbofuran	13.30	0.998
60ml crude oil + 0g carbofuran	33.90	1.179
60ml crude oil + 10g carbofuran	33.00	0.998
60ml crude oil + 20g carbofuran	14.00	1.386
F – $LSD_{0.05}$	**NS**	**0.638**

Effect of crude oil and carbofuran on the number of grasshoppers and curled leaves per plant.

Statistical analysis of the experiment showed a non-significant effect (p=0.05) of crude oil and carbofuran on the number of grasshoppers and curled leaves per plant. The result of the experiment further showed a non-significant main effect (p=0.05) of both crude oil and carbofuran on the number of grasshoppers and curled leaves per plant. However, 20ml of crude oil + 0g of carbofuran and 40ml of crude oil + 0g of carbofuran recorded the highest number of 3.06 and 2.09 curled leaves respectively, whereas 20ml of crude oil + 0g of carbofuran and 40ml of crude oil + 0g of carbofuran recorded the highest number of 1.179 and 1.171 grasshopper per plant respectively (Table 4).

Table.4: Effect of crude oil and carbofuran on the number of grasshoppers and curled leaves per plant.

Treatments	Number of grasshopper per plant	Number of curled leaves /plants
0ml crude oil + 0g carbofuran	0.707	1.89
0ml crude oil + 10g carbofuran	0.880	1.57
0ml crude oil + 20g carbofuran	0.880	1.54
20ml crude oil + 0g carbofuran	1.179	3.06
20ml crude oil + 10g carbofuran	0.707	0.71
20ml crude oil + 20g carbofuran	0.707	1.10
40ml crude oil + 0g carbofuran	1.171	2.09
40ml crude oil + 10g carbofuran	0.707	1.65
40ml crude oil + 20g carbofuran	0.707	0.71
60ml crude oil + 0g carbofuran	0.707	0.71
60ml crude oil + 10g carbofuran	0.880	1.32
60ml crude oil + 20g carbofuran	0.707	1.00
F – $LSD_{0.05}$	**NS**	**NS**

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Effect of crude oil and carbofuran on the number of root knot Nematodes per plant and fruit yield (kg) per pot.

The result of the experiment showed a significant interaction effect (p=0.05) of crude oil and carbofuran on the number of root knot Nematodes per plant and non-significant interaction effect (p=0.05) on fruit yield (kg) per pot. Plants treated with no crude oil + no carbofuran recorded the highest mean number of 3.794 root knot Nematodes, which differed significantly from all the treatment combinations. This was followed by plants treated with 0ml crude oil + 10g carbofuran that recorded a mean number of 0.998 root knot Nematode which did not differ from the remaining treatment combinations.

Furthermore, there was significant interaction effect (p=0.05) of crude oil and carbofuran on fruit yield (kg) per pot. Plants treated with 60ml crude oil + 10g carbofuran recorded the highest yield of 0.0874kg per pot which differed significantly (p=0.05) from the other treatment combinations which were statistically the same. There was a significant main effect of both crude oil and carbofuran on the number of root knot Nematodes per plant and fruit yield (kg) per pot of Nsukka yellow pepper (Table 5).

Table.5: Effect of crude oil and carbofuran on the number of root knot Nematodes per plant and fruit yield (kg) per pot.

Treatments	Number of root knot Nematodes per plant	fruit yield (kg) per pot
0ml crude oil + 0g carbofuran	3.794	0.0130
0ml crude oil + 10g carbofuran	0.998	0.0145
0ml crude oil + 20g carbofuran	0.707	0.0152
20ml crude oil + 0g carbofuran	0.707	0.0211
20ml crude oil + 10g carbofuran	0.707	0.0383
20ml crude oil + 20g carbofuran	0.707	0.0232
40ml crude oil + 0g carbofuran	0.707	0.0368
40ml crude oil + 10g carbofuran	0.707	0.0276
40ml crude oil + 20g carbofuran	0.707	0.0564
60ml crude oil + 0g carbofuran	0.707	0.0441
60ml crude oil + 10g carbofuran	0.707	0.0874
60ml crude oil + 20g carbofuran	0.707	1.0127
F – LSD ($_{0.05}$)	**0.452**	**0.0747**

IV. DISCUSSION

A non-significant effect of crude oil and carbofuran on the number of plants that died 73 and 86 DAP therefore means that crude oil and carbofuran could not have a negative interaction effect on the life of Nsukka yellow pepper, so also, the main effect of crude oil and carbofuran. Therefore, Nsukka yellow pepper could be used as a photoremedial plant in oil polluted areas. The result also showed that Nsukka yellow pepper could survive in crude oil polluted areas having not more than 60ml of crude oil per 10kg of soil. Odu in 1981 had almost the same observation when he stated that crude oil pollution up to 1% could easily be degraded by natural rehabilitation in soils, as the oil could be expected to increase organic matter in the soil and improve the fertility, physical and chemical properties of the soil. A significant main effect (P=0.05) of crude oil on fruit yield per pot tends to supports the observation of Agbogidi and Akparobi (2007) who stated that small amount of crude oil in the soil is not harmful but could actually help the plant. However, the result of this experiment disagrees with the observation of Ohanmu*et al* (2014) who reported that crude oil polluted soil adversely affected the growth and survival of *capsicum annum* plant at various concentrations of treatments, and that the pepper plants that survived were stunted, chlorotic and leafless.

A non-significant main effect (p=0.05) of carbofuran on the mean plant height and number of leaves per plant supports the observation of Jada (2011) who stated that carbofuran had no significant effect on plant height and number of leaves per plant when he applied it to control nematodes in Bambara groundnut. Therefore, farmers should not apply carbofuran to crops if the aim is to improve vegetative growth. Crude oil having a significant main effect on the number of aborted fruits per plant may be due to stoppage of water and minerals supply to some fruits as a result of death of some plant roots emanating from anaerobic condition produced by crude oil. This result supports the report of Ohanmu*et al*. 2014 who stated that spillage of crude oil on soil makes it

unsatisfactory for plant growth as a result of insufficient aeration of the soil as air is displaced from the space between the soil particles by crude oil. This study therefore reveals that Nsukka yellow pepper could survive various concentrations of crude oil pollution up to 60ml per 10kg of soil, but a high rate of fruit abortion may be recorded during fruiting. Therefore there is need to protect arable farm land from crude oil spillage to avoid economic fruit waste during crop production.

V. RECOMMENDATION

I recommend a further investigation on the effect of crude oil on the growth and yield of Nsukka yellow pepper (*Capsicum annum*) where higher volumes of more than 60ml of crude oil per 10kg of soil will be applied to be sure if Nsukka yellow pepper can be recommended as a photoremedial plant in oil polluted areas. I also recommend crude oil to be used as a nematicide in crop production.

In order to improve photoremedialactivities of Nsukka yellow pepper in oil polluted soils, carbofuran could be applied to the soil. Farmers are advised not to apply carbofuran to the soil if the aim is to improve vegetative growth of crops.

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