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A comparative evaluation of the effect of bio and non-bio pesticides on the control of pests, growth and yield of watermelon (*citrullus lanatus*) in Enugu, southeastern Nigeria.

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ABSTRACT

A field experiment to comparatively evaluate the effect of bio and non-bio pesticides on the control of pests, growth and yield of watermelon (*ciltrullus lanatus*) in Enugu, Southeastern Nigeria 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 2019 cropping season between April and June.

The experiment was carried out in a complete randomized design (CRD) with 12 treatments replicated three (3) times. Parameters assessed/measured were number of days to 50% flowering, Vine length, number of fruits per plant, number of rotten fruits per plant and fruit yield per pot. The result of the experiment showed significant ($p \leq 0.05$) treatment effect on the mean number of fruits per plant, mean number of rotten fruits per plant, mean number of curled leaves per plant and mean fruit yield per pot. Also, the result of the experience showed non-significant ($p \leq 0.05$) treatment effect on the mean number of days to 50% flowering, mean vine length and mean the number of root galls per plant.

1.0 Introduction

Watermelon (*Citrullus lanatus)* belongs to the family of Cucurbitaceae. It is one of the most common types of melons and a vine-like flowering plant that originated from South-Africa. Its fruit which is also called watermelon is a special kind referred to by botanists as 'pepo', which has a thick rind (exocarp). It has a juicy sweet interior, usually red or yellow, sometimes orange in colour and even green if not ripe (Awere and Omeje (2019).

Watermelon plays a significant role in the preparation of different kinds of food items such as salad. Also, it is often served fresh as sliced, chunks, (often in a fruit salad), as juice, candy and as edible seeds. It is an economically important fruit crop and a valuable alternative source of water in a desert area. Watermelon fruit contains 93% water with a small amount of protein, fats, mineral and vitamins. It can also be cultivated for its vegetative parts Schippers (2001.)

The flavour of watermelon is best enjoyed raw because heating diminishes the flavour and softens the texture FAOSTAT (2010). It is a good source of lycopene, carotenoids, fibre, citrulline and has antioxidant properties which improve health, controlling blood pressure and properties which improves health. It also contains potassium which helps in controlling blood pressure and probably stroke (Edison *et al*. 2013). In Nigeria, *Citrullus lanatus* is a crop of commercial importance. It is not only produced to overcome nutritional deficiency but also a good source of income for farmers (Awere and Omeje 2019)

The largest production of watermelon in Nigeria comes from the northern part of Nigeria where suitable agro-ecology is found. The potentials of watermelon as cash crop are enormous for farmers, especially those near urban areas (gore *et al.* 2007)

The most important factors that cause poor yield of watermelon are the incidence of insect pests and fungal diseases (web 2010). Because of the succulent nature of both fruit and vegetative parts of the watermelon, it is attacked by some insect pests and diseases.

In the Southeastern part of Nigeria and in the rainforest regions, the production of this crop has been low despite its nutritional and commercial value. This low production is due to the susceptibility of the crop to several foliar and fruit diseases and insect pests whose severity is encouraged by high humidity, temperature and rainfall, that lead to reduced crop quality and yield. The insect pests do not only reduce growth and yield of the crop but transmit pathogenic diseases which include fungal, viral and bacterial diseases. Such diseases can reduce or eliminate the ability of the plant cells and tissues to perform their normal physiological functions which may lead to yield reduction or even death of the plant. Due to huge losses encountered in the southeast and other rain forest regions in Nigerian where weather conditions favor the growth and development of insects and disease pathogens, most farmers are discouraged from continuous production of the crop. If disease control practices are not followed, some losses can be obtained yearly from foliage, stem, bud, flowers and fruit diseases.

It was reported that in South Carolina (U.S.A), the number and weight of marketable watermelon was increased by 61% with full-season fungicide programs. Richardson (2011) has also shown that using insecticide and fungicide combinations is an effective way to prevent yield losses due to foliar diseases and insect pests.

Since watermelon has become a cash crop of great importance in Nigeria today, the need for the yield improving factors such as pesticides cannot be overemphasized. Therefore, the objective of this study was to comparatively evaluate the effect of bio and non-bio pesticides on the control of pests, growth and yield of watermelon (*Citrullus lanatus*) in Enugu, Southeastern Nigeria which would surely help to provides useful information on how to reduce or eliminate insect pests and fungal diseases attack that is prevalent in the rain forest regions particularly in Southeastern Nigeria.

2.0 Materials and methods

A filed experiment to comparatively evaluate the effect of bio and non-bio pesticides on the control of pests, growth and yields of watermelon (*Citrullus lanatus*) was carried out at the Faculty of Agriculture and Natural Resources Management Teaching and Research Farm of Enugu State University of Science and Technology, Enugu, Southeastern Nigeria, during the 2019 cropping season between April and July. The University lies between latitude 06^0 $50^'$N_$06^0 57^'$ and longitude $07^0 15^'$ E_$07^0 18^'$E with a mean elevation of 450 m above sea level and an annual rainfall of 1800 to 2100 mm. The soil is of shale parent materials and is classified as typic paleudult and is sandy clay textural class (Anikwe *et al* ., 2005). The area for the experiment was cleared with a cutlass and traditional hoe

2.1 Experimental Design.

The experiment was carried out using a complete randomized design (CRD) with twelve (12) treatments replicated three (3) times. Each experimental plot/ unit (replicate) contained 10kg soil on which a pair of watermelon seeds was planted.

2.2 Treatments

Treatments consisted of;

Three (3) rates of Garlic emulsion (O ml, 500 ml, 1000 ml)
Three (3) rates of Ginger Emulsion (O ml, 500 ml, 1000 ml)
Three (3) rates of Carbofuran (O g, 5 g, 10 g)
Three (3) rates of Mancozed 80% W.P. (0 g, 1 g, 2 g)

2.3 Preparation of Bio-pesticides

2.4 Garlic Emulsion.

Add 85g of garlic paste to 50 ml of mineral oil (kerosene). Allow this to stay for 24 hours, then mix it with 450 ml of water to which 10 ml of liquid soap is added. Shake this mixture and filter it through a fine cloth and store in a container. For application dilute one part of the emulsion with 19 parts of water. For example, 50 ml of garlic emulsion should be diluted with 980 ml of water. Shake well before application. Vijayalakshi *et al*., (1996) cited by Gabriele (2000).

2.5 Ginger Emulsion

I kg of ginger rhizomes made into a paste was added to 15 litres of water, allowed to stay for 24 hours and then filtered. Emulsion such as liquid soap was added at a rate of 4ml/litre. Vijayalakshi *et al*, (1997) cited by Gabriele (2000)

2.6 Treatment Application

Garlic, ginger and Mancozeb emulsions were applied weekly starting from one week after germination till harvest using a hand-operated sprayer, whereas Carbofuran was applied once by ring method around each plant one week after germination.

2.7 Variety and Source of Watermelon Seeds.

The watermelon seeds (crimson sweet) used for the experiment were obtained from Molon agro-services, bank avenue Enugu Nigeria.

2. 8 Data Collection

Data were collected on the number of days to 50% flowering, number of fruits per plant, vine length (cm), number of rotten fruits per plant, number of root galls per plant and fruit yield (kg/pot). The Vine length was measured with a measuring tape.

2.9 Data Analysis

Data collected were subjected to analysis of variance for complete randomized design (CRD) experiment as outlined by Obi (2001) using gen stat Release 10.3 DE (PC window 2012 software). Differences between treatment means were detected using fisher's least significant difference (F-LSD) as outlined by steel and Torrie (1980)

3.0 Results

The effect of garlic, ginger, (Bio-pesticides), Carbofuran and Mancozeb (non-bio-pesticides) on the number of days to 50% flowering, number of fruits per plant and vine length (cm)

The result of the experiment showed non-significant ($p \leq 0.05$) treatment effect on the mean number of days to 50% flowering, although 500 ml of ginger recorded the highest mean number of 29.00 days to 50% flowering, whereas there was significant ($p \leq 0.05$) treatment effect on the mean number of fruits per plant. Plants treated with 1000 ml of ginger recorded a significant ($p \leq 0.05$) higher mean number of 1.67 fruits per plant, followed by plant treated with 10 g of carbofuran that recorded a mean number of 1.50 fruits per plant and lastly plants with zero treatment that recorded a mean number of 0.50 fruit per plant.

On mean vine length, the result of the experiment also showed a non-significant ($p \leq 0.05$) treatment effect, although plants treated with 500 ml of garlic recorded the highest mean vine length of 187.000 cm, followed by plants treated with 1000 ml ginger that recorded a mean of 178.30 cm and lastly plants treated with 5 g of carbofuran that recorded a mean of 142.30 cm (table 1).

3.1 Effect of garlic, ginger, (Bio-pesticides), Carbofuran and Mancozeb 80% WP (Non-bio-Pesticides) on the number of rotten fruits per plant, number of cu rled leaves per plants, number of root galls per plant and fruit yield (kg/pot).

The result of the experiment revealed a significant ($p \leq 0.05$) treatment effect on the mean number of rotten fruits per plant, mean number of curled leaves per plants and mean fruit yield (kg/pot). Again, the result of the experiment also revealed a non-significant ($p \leq 0.05$) treatment effect on the mean number of root galls per plant.

On a mean number of rotten fruits per plant, plants with zero treatment recorded the highest mean number of 1.88 rotten fruits per plant followed by plants treated with 5 g of carbofuran that recorded a mean number of 1.21 rotten fruits per plant and lastly plants treated with 1000 ml garlic and 1000 ml ginger that recorded the mean number of 0.69 rotten fruit each per plant. Concerning the mean number of curled leaves, plants treated with 2 g of mancozeb had the highest mean number of 29.01 curled leaves per plant, followed by plants treated with 1g of mancozeb that recorded a mean of 26.41 curled leaves per plant and lastly plants treated with 10 g of carbofuran which recorded a mean of 0.71 curled leaf per plant.

Concerning the mean number of root galls, plants with zero treatment recorded the highest mean number of 1.06 root galls per plant, although there was non-significant ($p \leq 0.05$) treatment effect. On fruit yield, plants treated with 1000 ml of garlic recorded the highest mean fruit yield of 1.10 kg /pot followed by plants treated with 1000 ml of ginger that recorded a mean fruit yield of 1.00 kg/pot and lastly plants with zero treatment that recorded a mean of 0.74 kg/pot (table 2).

Table 1. Effect of garlic, ginger, Carbofuran 5 g and Mancozeb 80% W.P on the number of days to 50% flowering, the mean number of fruits per plant and mean vine length (cm).

treatment	days to 50% flowering	number of fruits per plant	vine length (cm)
0 g carbofuran	23.00	0.50	173.80
5 g carbofuran	23.00	0.67	142.30
10 carbofuran	17.00	1.50	155.20
0 g mancozeb	23.00	0.50	172.30
1 g mancozeb	23.00	0.83	163.80
2 g mancozeb	23.00	1.00	151.50
0 ml garlic	23.00	0.50	148.20
500 ml garlic	23.00	1.07	187.00
1000 ml garlic	17.00	1.17	145.00
0 ml ginger	23.00	0.50	152.20
500 ml ginger	29.00	0.83	165.80
1000 ml ginger	17.00	1.67	178.30
F-LSD $_{0.05}$	N.S	0.96*	N.S

Tables 2. Effect of garlic, ginger, Carbofuran 5 g and Mancozeb 80% W.P on the mean number of rotten fruits per plant, mean number of curled leaves per plant, mean number of root galls per plant and fruit yield (kg/pot)

treatment	number of rotten fruits/plants	number of curled leaves/plant	number of root galls/ plant	Fruit yields (kg/pot)
0 carbofuran	2.21	24.41	1.04	0.71
5 g carbofuran	1.21	1.41	0.71	0.76
10 g carbofuran	0.70	0.71	0.71	0.77
0 g mancozeb	1.71	20.01	1.04	0.71
1 g mancozeb	0.88	26.41	1.71	0.81
2 g Mcozeb	0.88	29.01	0.71	0.88
0 ml garlic	1.38	19.01	1.04	0.77
500 ml garlic	0.88	3.01	0.71	0.92
1000 ml garlic	0.69	2.02	0.71	1.10
0 ml ginger	2.21	22.01	1.10	0.76
500 ml ginger	0.88	4.01	0.71	0.90
1000 ml ginger	0.69	2.01	0.71	1.00
F-LSD $_{0.05}$	1.24*	16.40*	N.S	0.39*

4.0 Discussion and Recommendation

A non-significant ($p \leq 0.05$) treatment effect on days to 50% flowering may therefore suggest that watermelon producers in Enugu, Southeastern Nigeria whose aim is to minimize the number of days to 50% flowering to reduce maturity period of the crop should not apply any of the tested pesticides. This finding does not agree with that of Awere and Omeje (2019), Awere and Egekwu (2017), who stated that insecticide application to watermelon helped in flower bud initiation which induced early fruiting of the crop and that early application of fungicide could prolong its maturity period as there was no significant difference between the treated and untreated plants with a fungicide. The finding however confirmed with their observation that fungicides application to watermelon did not promote early flowering of the crop.A significant ($p \leq 0.05$) different effect between treatment means of higher and zero rates of Carbofuran, garlic and ginger on the number of fruits per plant was an indication that watermelon producers/farmers in Enugu may be encouraged to apply them to increase fruit production per plant. Furthermore, a non-significant ($p \leq 0.05$) different effect between treatment means of treated and not treated with fungicide on fruit production per plant showed that fungicide application is not needed if watermelon producer aims to increase fruit production per plant. This result agreed with Awere and Omeje (2019) who observed that insecticide-fungicide combination is not needed if the watermelon producer aims to obtain a maximum number of fruits per plant (Table 1). Again, a non-significant ($p \leq 0.05$) treatment effect on the mean vine length (cm) may therefore suggest that it will be a waste of resources to apply these pesticides by farmers if the crop is grown as a forage crop because there will be no variation in leaf production as the number of leaves per plant varies directly with vine length. However, this result disagreed with the finding of Awere and Egekwu (2017), who stated that watermelon producers in Enugu area whose emphasis is on the production of forage should apply Chloronicotinyl (insecticides) and Carbendazim (fungicide) combination on the crop to obtain a higher leaf yield because the higher the vine length, the higher the number of leaves that will be produced from it.

A significant ($p \leq 0.05$) treatment effect of Carbofuran Garlic, ginger and Mancozeb on the mean number of rotten fruits per plant was an indication that these pesticides could be used to control fruit rot of watermelon. Again, non-significant ($p \leq 0.05$) different effect between treatment means of garlic Ginger and mancozeb on the mean number of rotten fruits per plant showed that Garlic and Ginger could act as fungicides. This result is in line with the observation of Richardson (2011), Awere and EGekwu (2017) who stated that using insecticide and fungicide combination is an effective way to prevent yield losses due to foliar and fruit disease of watermelon.

A significant ($p \leq 0.05$) different effect between treatment means of Garlic, ginger and Zero treatment on the number of curled leaves per plant was an indication that garlic and ginger have insecticidal properties since they controlled insect pests which act as vectors of viruses that cause leaf curls.

A non-significant ($p \leq 0.05$) treatment effect on the mean number of root galls per plant could suggest that watermelon is either resistant or not attacked by nematodes since Carbofuran act as both insecticide and nematicide.

Since plants treated with Garlic and ginger yielded significantly ($p \leq 0.05$) higher than plants treated with Carbofuran and Mancozeb, the use of these bio-pesticides by growers of watermelon in Enugu, Southeastern Nigeria maybe encourage because bio-pesticides are usually inherently less toxic than conventional (synthetic) pesticides. This recommendation agrees with Karla and Khanyan (2007) who stated that bio-pesticides generally affect only the target pests and closely related organism in contrast to broad-spectrum conventional pesticides that may affect different types of organisms such as birds, insects and mammals. They are often effective in small quantities and decompose quickly thereby resulting in lower exposure and largely avoiding the pollution problem caused by conventional pesticides.

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