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Effect Of Different Rates Of Insecticide And Fungicide Combinations On The Growth And Yield Of Watermelon (*citrullus Lunatus)* In Enugu Area, Southeastern Nigeria.

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Abstract

The experiment to evaluate the effect of insecticide (chilli pepper aqueous extract) and fungicide (carbendazim 12% W.P. + Mancozeb 63% W.P.) combinations on the growth and yield of watermelon (*citrullus lunatus*) in Enugu area southeastern Nigeria was conducted during the 2016 cropping season. The research 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. The experimental design was 3x2 factorial in a randomized complete block (RCB) replicated three (3) times, using “crimson sweet” watermelon as a test crop. Parameters measured were days to 50% flowering, vine length (cm) number of fruits per plant, number of marketable fruits per plants, number of rotten fruits per plant and fruit yield (tonha^{-1}). The result of the experiment showed a significant (P = 0.05) interaction effect of insecticide (Chilli Pepper aqueous extract) and fungicide (Carbendazim 12% W.P. + Mancozeb 63% W.P.) combinations on all the parameters measured except on the number of fruits per plant.

Keywords: Watermelon (*Citrullus lunatus*), insecticide, fungicide, interaction effect.

INTRODUCTION

Water melon (*Citrullus lunatus*) belongs to the family of cucurbitaceae. It is a tender, warm season vegetable and the most common melon that originated from south –America. It produces a special type of fruits known by botanist as 'Pepo' which has a thick rind (exocarp). It has a fleshy interior, usually red or yellow, sometimes orange in colour and even green if not ripe.

Watermelon plays significant role in the preparation of different kinds of food items such as salad. Also, it is often served fresh as slices, chunks (often in fruit salad), as juice, candy and as edible seeds. It is an economically important fruit crop and valuable alternative source of water in desert area. Watermelon fruits contain 93% water with small amount of protein, fats, minerals and vitamins. It can also be cultivated for its vegetative parts (Schipper, 2001). The importance of watermelon as part of human food cannot be over emphasized. It was even mentioned in the Bible as a food eaten by the ancient Israelites while they were in bondage in Egypt. The flavour of watermelon is best enjoyed raw because heating diminishes the flavour and softens the texture (FAOSTAT 2010).

Watermelon is a good source of lycopoene, carotnoid, fibre, citrulline and has antioxidant properties which improves health. It also contains potassium which helps in controlling blood pressure and probably stroke (Edeson *et al.* 2013). In Nigeria, *Citrullus lunatus* is a crop of commercial importance. It is not only produced to overcome nutritional deficiency but also good sources of income for farmers. The largest production of the crop in Nigeria comes from the Northern part where suitable agro-ecology is found. The potentials of watermelon as cash crop are enormous for farmers, especially those near urban area (Gore *et al.* 2007). The most important factors that cause poor yield of watermelon are the incidence of insect pests and fungal diseases (Webb 2010).

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 susceptibility of the crop to several foliar and fruit diseases and insect pests whose severity is encouraged by high humidity, temperature and rainfall, that leads to reduced crop quality and yield. The insect pests infestation does not only reduce growth and yield of the crop, but transmit pathogenic diseases which include fungal, viral and bacterial diseases. Such disease can reduce or completely eliminate the ability of the plant cells and tissues to perform their normal physiological function which may lead to reduced yield or death of the plant. Due to huge losses encountered in the southeast and other rain forest regions in Nigeria where weather conditions favour the growth and development of insect 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, flower and fruit diseases.

Studies have shown 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 infective way to prevent yield losses due to foliar diseases and insect pests.

Due to the fact that watermelon has become a cash crop of great importance in Nigeria today, the need for the use of yield improving factors such as insecticides and fungicides should not be neglected. Therefore, the objective of this study was the evaluate the effect of botanical insecticide and synthetic fungicide combinations on the growth and yield of watermelon which would definitely help to provide useful information on how to reduce or completed eliminate insect pest and fungal diseases attacks prevalent in the rain forest regions particular in southeastern Nigeria.

Materials and Methods

A field experiment to evaluate the effect of different rates of botanical insecticide (Chili Pepper extract and synthetic fungicide) (carbendazim 12% W.P. + Mancozeb 63% W.P.) Combinations on the growth and yield of watermelon (*citrullus lunatus*) was carried out at the Teaching and Research Farm of Faculty of Agriculture and Natural Resources Management, Enugu State University of Science and Technology, Southeastern Nigeria during the 2016 cropping season.

Preparation of Insecticide (Chili Pepper aqueous extract)

Twenty five grams (25g) of ground Chilli Pepper and one hundred and twenty grams (120g) of common salt (NaCl) were mixed together and left for twelve hours (12hrs.) before filtering the emulsion. The filtered emulsion was made up to Sixteen (16) litres with water, kept in the refrigerator and used within 14days (Gabriele 2000).

Insecticide (Chilli Pepper aqueous extract) Rates.

0 litre ha^{-1}	(A1)	FACTORS “A”
500 litre ha^{-1}	(A2)	
550 litres h^{-1}	(A3)	

Fungicide (Carbendazim 12% W. P. + Mancozeb 63% W. P.) Rates

0 kg ha^{-1}	(B1)	FACTOR “B”
1kg ha^{-1}	(B2)	

Treatment Combinations

0 litre ha^{-1} of insecticide + 0kgha^{-1} of fungicide (A_1B_1)

0 litre ha^{-1} of insecticide + 1kgha^{-1} of fungicide ($A_1 B_2$)

500 litres ha^{-1} of insecticide + $0kgha^{-1}$of fungicide (A_2B_1)

500 litres ha^{-1} of insecticide + $1kgha^{-1}$of fungicide (A_2B_2)

550 litres ha^{-1} of insecticide + $0kgha^{-1}$of fungicide (A_3B_1).

550 litres ha^{-1} of insecticide + $1kgha^{-1}$of fungicide (A_3B_2)

Experimental Design

The experiment was carried out using 3 x 2 factorial in a randomized complete block design (RCBD) replicated three (3) times. The experimental area measured 14.6m x 6.8m (99.28m^2).The experimental units (plots) measured 1.6m x 1.6m (2.56m^2) and were separated by 1m pathway. Three seeds were sown per hole at a spacing of 50cm x 50cm and later thinned down to two (2) plants per hole at seven (7) days after germination.

Treatment Schedule

Spraying of insecticide (chilli pepper aqueous extract) and fungicide (carbendazin 12% W.P + Mancoze 63% W.P) combinations started at one week after the germination of watermelon and repeated weekly until final harvest.

Data Collection

Data were collected on

- Days to 50% flowering
- Vine length (cm)
- Number of fruits per plant
- Number of marketable fruits per plant
- Number of rotten fruits per plant
- Fruit yield ($tonha^{-1}$).

Statistical Analyses

The data collected were analyzed using the genstat release (2012), Rothamster experimental station and analysis of variance outlined by Ob (2001).

RESULTS

Effect of different rates of insecticide (Chilli pepper aqueous extract) and fungicide (carbendazim 12% W.P. + Mancozeb 63% W.P.) combinations on the number of days to 50% flowering, vine length (cm) and number of fruits per plants.

The result of the experiment showed a significant (P = 0.05) interaction effect of insecticide (Chilli pepper aqueous extract) and fungicide (carbendazim 12% W.P. + Mancozeb 63% W.P.) on the number of days to 50% flowering and vine length (cm) whereas there was no significant (P = 0.05) interaction effect on the number of fruits per plant.

On the number of day to 50% flowering, plots treated with no insecticide and no fungicide recorded the highest means number of 57days to 50% flowering followed by plots treated with no insecticide and $1kgha^{-1}$ of fungicide which recorded mean number of 56 days to 50% flowering, whereas the least mean number of 48.33 days to 50% flowering was recorded on plots treated with $550Lha^{-1}$ of insecticide and no fungicide combination.

On the vine length (cm), the highest mean vine length of 242.7 cm was obtained from plots treated with 550 Lha^{-1} of insecticide and $1kgha^{-1}$ of fungicide combination followed by plots treated with $500Lha^{-1}$ of insecticide and $1kgha^{-1}$ of fungicide combination which recorded mean vine length of 216.00cm, while the least means vine length of 156.00cm was recorded on plots treated with no insecticide and no fungicide combination.

Although there was no significant (P = 0.05) interaction effect on the mean number of fruits per plant, plots treated with $550Lha^{-1}$ of insecticide and no fungicide combination recorded the highest mean number of 4.27 fruits per plant followed by plots treated with $500Lha^{-1}$ of insecticide and no fungicide combination which recorded mean number of 4.23 fruits per plant, whereas plots treated with no insecticide and no fungicide combination has the least means number of 4.07 fruits per plant.

Table 1. Interaction effect of insecticide (chilli pepper aqueous extract) and fungicide (carbendazim 12% w.p. + mancozeb 63% w.p.) Combinations on the number of days to 50% flowering, vine length (cm) and number of fruits per plants.

Insecticide (Lha-1) + Fungicide (Kgha-1)	Mean number of days to 50% flowering	Mean vine length (cm)	Mean number of fruits per plant
0 insecticide + 0 Fungicide	57.00	158.00	3.83
500 insecticide + 0 fungicide	50.67	168.70	4.23
550 insecticide + 0 fungicide	48.33	186.70	4.27
0 insecticide + 1 fungicide	56.00	208.70	4.07
500 insecticide + 1 fungicide	50.60	216.00	4.17
550 insecticide + 1 fungicide	48.63	242.70	4.18
F - LSD 0.05	5.21	47.57	N.S

Effect of insecticide (Chilli Pepper aqueous extract) and fungicide (Carbendazim 12% W.P + Mancozeb) combinations on the number of marketable fruits per plants, number of rotten fruits per plant and fruit yield (tonha^{-1})

The result of the experiment showed a significant (P = 0.05) interaction effect of insecticide (Chilli Pepper aqueous extract) and fungicide (Carbendazim 12% W.P. and Mancozeb 63% W.P.) combinations on the number of marketable fruits per plant with plots treated with 550L ha^{-1} of insecticide and 1kg ha^{-1} of fungicide recording the highest mean number of 7.67 marketable fruits per plant, followed by plots treated with 500 L ha^{-1} of insecticide and 1kg ha^{-1} of fungicide which recorded means number of 6.67 fruits per plant whereas plots treated with no insecticide and no fungicide recorded the least mean number of 1.33 fruit per plant.

The result of the experiment also showed a significant (P = 0.05) interaction effect of insecticide and fungicide combinations on the mean number of rotten fruits per plant with plot treated with 550 Lha^{-1} of insecticide and 1kg ha^{-1} of fungicide having the lowest mean number of 3.67 rotten fruits per plant followed by plots treated with 500 Lha^{-1} of insecticide and 1kgha^{-1} of fungicide which recorded a mean number of 9.33 rotten fruits per plant, whereas plots treated with no insecticide and no fungicide recorded the highest mean number of 13.67 rotten fruits per plant.

Furthermore, there was a significant (P = 0.05) interaction effect of insecticide and fungicide on the fruit yield with plots treated with 550Lha^{-1} insecticide and 1kgha^{-1} fungicide having the highest mean fruit yield of 23.5 tonsha$^{-1,}$ followed by plots treated with 500Lha^{-1} insecticide and 1kgha^{-1} fungicide that recorded mean fruit yield of 22.00tonsha^{-1}, whereas the lowest means fruit yield of 14.20 tonsha^{-1} was obtained from plots treated with no insecticide and no fungicide (Table 2).

Note: Any fruit that weighed from 1.7kg is regarded as marketable and below this is not marketable. (Pincaco *et al.* 2006)

Table 2: Effect of insecticide (chilli pepper aqueous extract) and fungicide (carbendazim 12% W.P. + mancozeb 63% W.P.) Combinations on the number of marketable fruits per plant, number of rotten fruits per plant and fruit yield (tonha^{-1}).

Insecticide (Lha-1) + Fungicide (Kgha-1)	Mean number of marketable fruits Per plant	Mean number of rotten fruits per plant	Mean fruit yield(tonha-1)
0 insecticide + 0 Fungicide	1.33	13.67	14.20
500 insecticide + 0 fungicide	20.00	11.00	15.20
550 insecticide + 0 fungicide	4.00	10.00	16.60
0 insecticide + 1 fungicide	4.00	10.33	21.10
500 insecticides + 1 fungicide	6.67	9.33	22.00
550 insecticides + 1 fungicide	7.67	3.67	23.50
F - LSD 0.05	1.96	4.46	6.52

DISCUSSION

The result of the experiment showing a significant (P= 0.05) decrease from 57.00 to 48.33 days to 50% flowering when the highest rate of 550Lha^{-1} of insecticide (Chilli pepper aqueous extract) was used without fungicide (Carbendazim 12% W.P + Mancozeb 63% W.P) may therefore suggest that early application of insecticides to watermelon is required in order to induce early flowering which may lead to early maturity of the crop. The result of the experiment may also suggest that insecticide application to watermelon helped in flower bud initiation which induced early fruiting of the crop. Furthermore, this result indicated that fungicide application to watermelon did not promote early flowering but rather had a negative interaction with insecticide that led to the reduction of the efficacy of insecticide in reducing the number of days to 50% flowering. This was observed in the result of the experiment as the number of days to 50% flowering increased from 48.33 to 48.63 days when fungicide was combined with the highest rate of $550Lha^{-1}$ of insecticide (Table 1). This result may also suggest that fungicide application at early stage of the crop growth could prolong its maturity periods. This result supports Awere and Egekwu (2017) who stated that the application of insecticide (chloronicotinyl) to watermelon induced early flowering which lead to early maturity, whereas the application of fungicide (carbendazim) increased the number of days to 50% flowering, thereby prolonging its maturity period.

A significant (P =0.05) positive interaction effect of insecticide and fungicide combinations on the vine length may therefore suggest that watermelon producers in Enugu Area whose emphasis is on the production of forage should apply both insecticide and fungicide on the crop in order to obtain a higher leaf yield because the longer the vine length, the higher the number of leaves that will be produced.

A higher mean number of 4.27 fruits per plants obtained in plots treated with a higher level of insecticide combined with no fungicide may suggest that fungicide treatment is not needed if the aim of a watermelon farmer is to obtain a maximum number of fruits per plant. This was evident from the result of a decrease from 4.27 – 4.18 mean number of fruits per plant when the same highest value of $550Lha^{-1}$ of insecticide was combined with fungicide (Table 1).

The highest level of $550Lha^{-1}$ of insecticide and $1kgha^{-1}$ of fungicide recording the highest mean number of 7.67 marketable fruits per plants was an indication that both insecticide and fungicide application is needed if the aim of a watermelon farmer is to obtained a maximum number of marketable fruits per plant (Table 2).

A significant (P = 0.05) interaction effect of insecticide and fungicide combinations on the number of rotten fruits per plant may suggest the possibility of insects (fruit borers/worms) contributing to fruit rot of this crop. This is because, sugary exudates produced at points of attack of the fruit borers/worms could serve as substrate to fungal pathogens that rotten fruits (Table 2). So the application of insecticide and fungicide combinations is an effective way to prevent yield losses to foliar and fruit diseases of watermelon. This finding agrees with the observation of Gabriele (2000), Richardson (2011), Awere and Egekwu (2017), who stated that using insecticide and fungicide combination is an effective way to prevent yield losses to foliar and fruit diseases of watermelon.

A significant (P = 0.05) positive interaction effect of insecticide and fungicide combinations on fruit yield showed that both insecticide and fungicide should be applied to watermelon in order to achieve a maximum fruit yield but further research should be conducted to find out the maximum rates of both the insecticide and fungicide to apply for a maximum fruit yield.

CONCLUSION AND RECOMMENDATION

To achieve a reduction in the maturity period of watermelon in Enugu Southeastern Nigeria, farmers should not apply a combination of insecticide and fungicide but insecticide only. To achieve a maximum fruit yield, a combination of insecticide and fungicide application is necessary in watermelon production in Enugu Southeastern Nigeria, but further experiment should be conducted to determine the maximum rates of insecticide and fungicide to apply. To reduce fruit decay in the farm, watermelon farmers in Enugu Area Southeastern Nigeria should apply a combination of insecticide and fungicide from one week after germination until final harvest, but further experiments should be carried out the determine the maximum rates of insecticide and fungicide to apply. Again, farmers whose emphasis is on the maximum production of leaves for forage should apply both insecticide and fungicide combination on watermelon from one week after germination.

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