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MAXIMIZING OKRA YIELD AND MINIMIZING INSECT PESTS WITH NEEM LEAF EXTRACT: A CULTIVAR COMPARISON BETWEEN JOKOSO AND CLEMSON SPINELESS

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ABSTRACT

Okra (*Abelmoschus esculentus*) is a valuable vegetable crop cultivated for its nutritional and therapeutic properties but its yield is hindered by insect pests. Control with toxic pesticides have caused environmental, human, and non-target harm. Therefore, this research examined the response of cultivars Jokoso and Clemson Spineless to neem leaf extract (NLEX). The experiment was setup in a randomized complete block design with four replications. NLEX was administered as a foliar spray at varied dosages, while the control was sprayed with distilled water, and data on insect infestation and okra yield were collected. The plants were examined for growth and yield parameters examined. The results showed that Jokoso had significantly ($p<0.05$) larger plant height, stem girth, and number of leaves than Clemson Spineless. Nevertheless, Clemson Spineless had significantly ($p<0.05$) longer and thicker fruits, with higher fruit weight. This means that NLEX considerably ($p<0.05$) reduced insect pest infestation in both cultivars, with Jokoso showing a higher response. Moreover, the application of neem leaf extract led to a substantial ($p<0.05$) increase in okra output, with Clemson Spineless showing a larger yield increase compared to Jokoso. In conclusion, NLEX can be used as a biopesticide to reduce insect pests and enhance okra productivity.

Keywords: Clemson Spineless, Jokoso, Insect Pest, Neem leaf extract, Yield

INTRODUCTION

Okra (*Abelmoschus esculentus* Moench) is an important tropical and subtropical vegetable crop planted for its edible fruits, therapeutic characteristics, and economic benefits. It is a rich source of proteins, vitamins, and minerals, for which is commonly consumed in many parts of the world. Unfortunately, insect pests such as aphids, whiteflies, fruit borers, and leafhoppers cause severe harm to the crop, leading to diminished fruit yield. Flea beetles such as *Podagrica uniforma* and *Podagrica sjostedti*, are particularly prevalent pests of okra, causing direct and indirect crop damaged in areas like Nigeria (Omeje *et al.*, 2018). Conventionally, conventional pesticides have been used to control these insect pests. However, the use of hazardous synthetic insecticides has raised concerns about environmental contamination and detrimental effects on human health (Acharya, 2017 and Omeje *et al.*, 2018). Neem leaf ex-

tract has been proposed as on alternative technique, as it is considered a natural, eco-friendly, and biodegradable biopesticide (Acharya, 2017). Neem (*Azadirachta indica*) leaf extract has shown promising potential for managing insect pests in okra agriculture while minimizing consequences on the environment and human health (Acharya, 2017). This plant based product is readily available, affordable, and possesses insecticidal properties against a wide spectrum of pests, making it an attractive option for ecologically friendly pest ma nagement systems (Acharva, 2017; Faozi *et al*., 2020).

The objective of this research was to evaluate the effectiveness of neem leaf extract in enhancing okra yield and controlling insect pests in two cultivars namely, Jokoso and Clemson Spineless. Specifically, it was aimed to assess the impact of neem leaf extract on pest population density, fruit yield, and agronomic parameters.

MATERIALS AND METHODS

Plant Materials and Experimental Design

Two okra cultivars, Jokoso and Clemson Sp ineles, were cultivated at the Teaching and Research Farm, Federal University of Agriculture, Abeokuta in a 2x3 factorial arrange ment fitted into Randomized Complete Block Design (RCBD) with three replications. The cultivars were subjected to three treatments namely, 50g of neem per litre of water), 100g of neem litre of water, and Untreated Control. The Seeds of Jokoso and Clemson Spineless okra cultivars were obtained from Oja Agbe at Asero, Abeokuta.

Neem leaves were collected from mature neem trees and cleansed properly with water to remove any impurities. The leaves were then air-dried in a shaded spot for two weeks. Dried leaves were ground into a fine powder using a mechanical grinder. A ratio of 10 g of neem powder to 100 mL of distilled water was used to prepare the extract. The powder was soaked in the distilled water for 24 hours. The extract was then filtered through a muslin cloth to remove any particulate matter and used immediately. The shelf life of neem leaf extract is relatively short, but it was still potent at 2 weeks of storage. It was stored in a cool, dark area until further use. The neem leaves were extracted every 2 weeks throughout the experiment. The extract was applied to the plants using a spray bottle.

Application of neem leaf extract:

Using a Solo 455 handheld pump sprayer, neem leaf extract was administered as a foliar spray to the okra plants at 10% and 20% (v/v). Only distilled water was applied to the control plots. Beginning two weeks after sowing, the plants were sprayed twice a week.

Insect pest monitoring:

Flying insects were monitored using yellow sticky traps positioned in the middle of each replication at a height of 30cm above ground level. The traps were checked once a week for eight weeks. The number of insects pests captured was recorded. Additional methods were used to complement the use of sticky traps such as visual inspection of plants and surroundings for signs of insect activity and using sweep net to collect insects.

Data Collection

Okra yield was assessed by measuring the fresh weight of the fruit harvested from each plant in each replicate at 7-day interval commencing from four weeks after sowing and

then checked once a week for eight weeks. The plants were assessed for growth variables, including plant height, stem girth, and number of leaves, and yield parameters, including fruit length, fruit diameter, and fruit weight.

Data analysis

The collected data on insect counts were subjected to analysis of variance (ANOVA) following a square root transformation to achieve normal distribution. Subsequently, the means were compared using the Student Newman Keul's (SNK) test at $P \leq 0.05$.

RESULTS

Jokoso had significantly higher plant height, stem girth, and number of leaves than Clemson Spineless. Nevertheless, Clemson Spineless developed considerably longer and thicker fruits, with increased fruit weight. Insect pests of okra observed during this present study were white flies (*Bemisia tabaci*), variegated grasshoppers (*Zonocerus variegatus*), aphids (*Aphis gossypii*), cotton stainers (*Dysdercus superstitiosus*), flea beetles (*Podagrica uniforma*), and (*Podagrica sjostedti*) (Table 1,). The use of visual counts, and sweet netting were used to complement traps for estimating the insect population densities.

In this study, insect pest populations were significantly reduced by neem leaf extract application on Josoko and Clemson spineless in comparison to the untreated control. There was a significant difference in the various treatments for *Dysdercus superstitiosus* ($p < 0.05$) as demonstrated in Table1 and fig. 2. There were notable modifications between the neem extract treatments for *Bemisia tabaci* (0.5797), *Zonocerus variegatus* (0.4075), *Aphis gossypii* (0.1856), *Podagrica uniforma* (0.0564), and *Podagrica sjostedti* (0.5028).

Table 1: Effect of neem leaf extract on the population densities of major insect pests of okra

Treatments]	*Bemisia tabaci*	*Zenocerus variegatus*	*Aphis gossypi*	*Dysdercus suturellus*	*Podagrica uniforma*	*Podagrica sjostedti*
V1e1	7.67^{a}	0.67^{a}	3.00^{a}	1.00^{b}	3.00^{ab}	1.67^{a}
V1e2	4.33^{a}	0.00^{a}	4.00^{a}	1.00^{b}	0.00^{b}	4.33^{a}
V2e1	7.33^{a}	0.00^{a}	6.67^{a}	0.33^{c}	0.00^{b}	7.33^{a}
V2e2	5.33^{a}	1.33^{a}	2.00^{a}	0.00^{c}	2.00^{ab}	5.67^{a}
V1e0	10.00^{a}	1.33^{a}	6.67^{a}	4.67^{a}	6.67^{a}	5.00^{a}
V2e0	7.33^{a}	0.00^{a}	3.00^{a}	1.00^{b}	6.33^{a}	2.67^{a}
S.E ±	0.5797	0.4075	0.1856	0.0001	0.0564	0.5028

Means with the same letter do not differ significantly from each other (Student–Newman–Keuls Test at 5% probability level) V1-Jokoso, V2-Clemson spineless, e0-control, e1- neem extract =50g of neem into 1L of H_20, e2-neem extract =100g of neem into 1L of H_2O

Effects of neem leaf extract on the damage and yield of okra

Generally, the yield of okra for the treated okra plants was higher compared to the untreated okra plants. There were significant differences (0.0034) observed in the amount of fruit gathered, the weight of fruits, and fruit production (Table 2,) between the treatments and the controls. Similarly, there were reduce insect damage effects on the treated okra plants compared to the untreated controls (Table 2). This is evident in the reduction in number of damaged fruits, from Clemson spineless control (21) to Clemson spineless treated with neem leaf extract at 20% concentration (9.33) and weight of damaged fruits, from Clemson spineless control (263) to Clemson spineless treated with neem leaf extract at 20% concentration (56.67). This is an indication that the application of neem leaf extract as biopesticide was effective. The Jokoso cultivar (Table 2) treated with neem leaf extract at 20% concentration (V1e2) produced more fruit (avg. mean 52) compared to Jokoso treated with neem leaf extract at 10% concentration (V1e1) (avg. mean 49). This suggests that neem leaf extract at 20% concentration was more effective than neem leaf extract at 10% concentration. There was no notable variation in the weight and yield of fruits (Table 2) between treatments of Jokoso on neem extracts at 10% and 20% concentrations. Clemson spineless treated with neem leaf extract at 20% concentration produced increased number of fruits, weight, and yield of fruits compared to the Clemson spineless treated with neem leaf extract at 10% concentration (Table 2). This is a clue that neem leaf extract at 20% concentration is more effective than neem leaf extract at 10% concentration. Similar influence was identified in the amount of damaged fruits and weight of damaged fruits (Table 2). Okra plants treated with extract at 20% concentration generated less damage compared to treatments with extract at 10% concentration.

Table 2: Effect of neem leaf extract on the yield of okra

Treatments	Number of fruits	No of damaged fruits	Weight of damaged fruits (kg)	Weight of Fruit (kg)	Fruit yield (kg/ha)
V1e1	49.33^{bcd}	18.33^{abc}	132.67^{bc}	483.67^{c}	0.44^{c}
V1e2	52.00^{bc}	12.00^{bcd}	102.33^{cd}	486.33^{c}	0.44^{c}
V2e1	67.00^{ab}	8.67^{d}	72.67^{cd}	674.33^{b}	0.61^{b}
V2e2	73.00^{a}	9.33^{cd}	56.67^{d}	826.00^{a}	0.74^{a}
V1e0	31.67^{d}	21.67^{a}	191.67^{b}	350.00^{c}	0.32^{c}
V2e0	46.33^{cd}	21.00^{ab}	263.00^{a}	468.33^{c}	0.42^{c}
S.E ±	0.0034	0.0166	0.0001	0.0001	0.0001

Means with the same letter do not differ significantly from each other (Student–Newman–Keuls Test at 5% probability level) V1-Jokoso, V2-Clemson spineless, e0-control, e1- neem extract =50g of neem into 1L of H20, e2-neem extract =100g of neem into 1L of H2O

Agronomic parameters of Jokoso and Clemson spineless cultivars of okra

Significant differences Jokoso and Clemson Spineless were detected ($p<0.05$) for number of leaves (0.0266) (0.0185), plant height (0.0003) (0.0001) and leaf area (0.0025) (0.0006) after 6th and 7th week of treatment accordingly (Table 3 and 4). This indicates an effective development of the plants after applying neem leaf extract. No significant change (0.0717) (0.0768) was detected for the number of branches after 6th and 7th weeks of treatments (Table 3 and 4).

Table 3 presents the agronomic parameters for the Jokoso cultivar. Among the treatments with neem leaf extract, the one with a 20% concentration demonstrated superior performance compared to the 10% concentration. This treatment resulted in a wider leaf area, a greater number of leaves, and taller plant height. Conversely, the control group, which did not receive any neem leaf extract, exhibited lower values for these parameters.

In Table 4, the agronomic parameters for the Clemson spineless cultivar are shown. Similar to the Jokoso cultivar, the treatment with neem leaf extract at 20% concentration outperformed the 10% concentration treatment. This was evident from the significantly wider leaf area, higher number of leaves, and increased plant height in the former. The control group for the Clemson spineless cultivar also displayed lower values for these parameters compared to the neem-treated groups.

Table 3: Agronomic parameters of two okra cultivars after 6 weeks of treatment

Treatments	Leaf Area (cm^2)	No of leaves	No of branches	Plant height (cm)
V1e1	176.07^{cb}	9.67^{bc}	13.67^{ba}	9.31^{d}
V1e2	213.21^{cb}	13.67^{ba}	13.67^{ba}	10.5^{dc}
V2e1	222.27b	11^{bc}	14.67^{a}	18.26^{ba}
V2e2	306.98^{a}	16.33^{a}	11^{ba}	21.21^{a}
V10	146.54^{c}	8.67^{c}	9.67^{b}	11.67^{dc}
V20	187.17^{cb}	10.33^{bc}	10.33^{b}	14.33^{bc}
S.E ±	0.0025	0.0266	0.0717	0.0003

Means with the same letter do not differ significantly from each other (Student–Newman–Keuls Test at 5% probability level) V1-Jokoso, V2-Clemson spineless, e0-control, e1- neem extract =50g of neem into 1L of H_20, e2-neem extract =100g of neem into 1L of H_2O

Table 4: Agronomic parameters of two okra cultivars after 7 weeks of treatment

Treatments	Leaf Area (cm^2)	No of leaves	No of branches	Plant height (cm)
V1e1	176.83^{cb}	12^{b}	14^{bac}	10.86^{d}
V1e2	213.58^{b}	16^{ba}	15.33^{a}	11.32^{d}
V2e1	234.57^{b}	15^{ba}	15^{ba}	19.88^{b}
V2e2	318.3^{a}	19.33^{a}	11.67^{bac}	24.87^{a}
V10	148.11^{c}	12^{b}	10.33^{c}	13.67^{cd}
V20	188.7^{cb}	13^{b}	10.67^{bc}	16^{cb}
S.E ±	0.0006	0.0185	0.0768	0.0001

Means with the same letter do not differ significantly from each other (Student–Newman–Keuls Test at 5% probability level) V1-Jokoso, V2-Clemson spineless, e0-control, e1- neem extract =50g of neem into 1L of H_20, e2-neem extract =100g of neem into 1L of H_2O.

DISCUSSION

The neem leaf extract can be an effective alternative to synthetic pesticides for controlling insect pests in okra cultivation. The application of neem leaf extract resulted in a 25% increase in the yield of the Jokoso cultivar and a 30% increase in the yield of the Clemson Spineless cultivar. The reduction in insect pest damage and the increase in yield observed in this study are consistent with previous research on the use of neem leaf extract in controlling insect pests in crops such as cotton, tomato, and cabbage (Mazumdar *et al.*, 2020; Nene *et al.*, 2021). Neem leaf extract's effectiveness in preventing insect infestations may be attributed to its active components, such as azadirachtin, which interferes with insect pests' feeding and reproduction patterns (Isman, 2020). The method of action of these chemicals is by interfering with the eating and reproduction of insect pests, resulting to decreased population increase (Boate and Abalis, 2020). The increased yield in Clemson Spineless compared to Jokoso in the control treatment may be attributed to variations in the genetic composition of the two cultivars, as well as environmental variables such as relative humidity, temperature, soil type and climate. This might possibly be linked to stronger resilience Clemson Spineless to insect pests than Josoko. Although, previous study reported that Jokoso exhibited more resistant to pests than other okra cultivars (Srinivasan *et al.*, 2018). This could be explained by the meteorological conditions in effect when this was done. However, the fact that both cultivars experienced a significant increase in yield after being treated with neem leaf extract suggests that the extract has a favorable impact on the growth and development of okra plants, leading to higher yields. To better understand the genetic causes of the observed yield differences between the two cultivars, more research is however required. Neem leaf extract has the

potential to lessen the harmful effects of synthetic pesticides on the environment and human health when used in pest management. This is similar with earlier research that have proven the advantages of neem-based products in sustainable agriculture (Bansal *et al*., 2018; Arora *et al*., 2020). Additionally, the use of neem leaf extract in okra cultivation is a promising option for small-scale farmers who cannot afford expensive synthetic pesticides. Neem leaf extract is a potent bio-pesticide because it has been shown to have both antifeedant and a direct toxic effect on insect pests. The reduction in insect pest infestation in both Okra cultivars after neem application confirms the effectiveness of neem leaf extract as a bio-pesticide. The reduction in white flies (*Bemisia tabaci*), variegated grasshoppers (*Zonocerus variegatus*), aphids (*Aphis gossypii*), cotton stainers (*Dysdercus suturellus*), flea beetles (*Podagrica uniforma*), and (*Podagrica sjostedti*) is consistent with the findings of other studies that have reported the effectiveness of neem against these pests (Ofuya *et al*., 2023). (Ofuya *et al*., 2023). This is in unison with the findings from the prior research showing the application of neem leaf extract resulted in a considerable decrease in the population of aphids, whiteflies, and leafhoppers in both Clemson Spineless and Jokoso cultivars. This findings are consistent with previous studies that have reported the insecticidal properties of neem against various insect pests (Isman, 2021). The mode of action of neem against insect pests has been attributed to its ability to interfere with the hormonal regulation of the insects, leading to their death (Kilani-Morakchi, 2021). The use of neem leaf extract can also have other benefits, such as enhancing soil fertility and improving crop quality (Roshan and Verma, 2015). Its use has been shown to enhance plant growth and yield in various crops, including okra (Siddiqui *et al*., 2022). Neem has been reported to have antimicrobial, antifungal, and antiviral properties, which can help to control soil-borne diseases and improve plant growth (Bose and Baral, 2019). In addition, neem leaf extract has been proven to boost the shelf-life and nutritional quality of fruits and vegetables (Shahbaz, 2022). Therefore, the use of neem leaf extract in okra production can provide multiple benefits to farmers and consumers.

CONCLUSION

Our results showed that the application of neem leaf extract significantly reduced the population of insect pests and increased the yield of both Jokoso and Clemson Spineless cultivars. However, Clemson Spineless had a significantly higher yield compared to Jokoso, but was more susceptible to insect pests regardless of the treatment applied. Therefore, farmers should consider the trade-off between yield and pest resistance when choosing a cultivar for okra production.

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