

Effects of *Boerhavia diffusa* L. nom. cons. and *Chromolaena odorata* (L.) R. M. King & H. Rob. extracts on some field insect pests of okra (*Abelmoschus esculentus* (L.) Moench)

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Effects of *Boerhavia diffusa* L. nom. cons. and *Chromolaena odorata* (L.) R. M. King & H. Rob. extracts on some field insect pests of okra (*Abelmoschus esculentus* (L.) Moench)

Abstract: A field study was carried out to assess the efficacy of some botanicals in the control of field insect pests in two varieties of okra. Dry leaf extract of *Chromolaena odorata* (Siam weed) and fresh and dry root extracts of *Boerhavia diffusa* served as treatments which were compared with Lambda-cyhalothrin and a control. The experiment was fitted into a randomized complete block design with three replications. Data collected were subjected to Spearman's correlation analysis and a two-way analysis of variance and significant different means were separated using Fishers Least Significant Difference (LSD) test at 5 % level of probability. The results revealed that treated plants generally performed better than the untreated plants as they were taller, had more leaves, branches, wider stem girths and gave higher fruit yield. Fresh root extract of *B. diffusa* performed better in most parameters measured. A significant positive correlation was observed between insect pest populations, and between growth and yield parameters, while there was a significant negative correlation between overall yield and insect pest population. NHAe 47-4 okra variety performed better than F1-Lucky variety. Fresh root extract of *B. diffusa* is recommended for management of *B. tabaci* (Genadius, 1889) and *Amrasca biguttula* Ishida, 1912 in okra.

Key words: botanicals; *Boerhavia diffusa*; *Chromolaena odorata*; *Bemisia tabaci*; *Amrasca biguttula*; sticky traps

Učinki izvlečkov iz rastlin *Boerhavia diffusa* L. nom. cons. in *Chromolaena odorata* (L.) R.M. King & H. Rob. na nekatere škodljive žuželke na jedilnem oslezu (*Abelmoschus esculentus* (L.) Moench)

Izvleček: Za ocenitev učinkovitosti izvlečkov izbranih rastlin pri uravnavanju škodljivih žuželk na dveh sortah jedilnega osleza (okre, bamije) je bil izveden poljski poskus. Suhi listni izvlečki vrste *Chromolaena odorata* (L.) R.M. King & H. Rob. in sveži ter suhi izvlečki korenin vrste *Boerhavia diffusa* L. nom. cons. so bili uporabljani za obravnavanja v primerjavi z lamda cihalotrinom in kontrolo. Poskus je bil izveden kot popolni naključni bločni poskus s tremi ponovitvami. Zbrani podatki so bili analizirani s Spearmanovo korelacijo in dvo-smerno analizo variance, značilno različna poprečja so bila ločena s Fisherjevim testom najmanjše značilne razlike (LSD) pri 5 % verjetnosti. Rezultati so pokazali, da so tretirane rastline na splošno rastle bolje kot netretirane, bile so višje, imele so več listov in stranskih poganjkov, večji obseg stebela in večji pridelek plodov. Sveži izvlečki korenin vrste *B. diffusa* so se izkazali kot boljši v vseh merjenih parametrih. Opažena je bila značilno večja pozitivna korelacija med populacijami škodljivih žuželk in med parametri rasti in pridelka medtem, ko je bila korelacija med celokupnim pridelkom in populacijami škodljivih žuželk značilno negativna. Sorta okre NHAe 47-4 je uspevala bolje kot sorta F1-Lucky. Za uravnavanje tobakovega ščitkarja (*B. tabaci* (Genadius, 1889)) in vrste *Amrasca biguttula* Ishida, 1912 na jedilnem oslezu priporočamo izvlečke svežih korenin vrste *B. diffusa*.

Gljučne besede: botanična sredstva za zatiranje škodljivcev; *Boerhavia diffusa*; *Chromolaena odorata*; *Bemisia tabaci*; *Amrasca biguttula*; lepljive pasti sticky traps

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1 INTRODUCTION

Okra, *Abelmoschus esculentus* (L.) Moench, is a commercially grown vegetable crop widely cultivated in Africa and Asia. Within 2009 and 2010, a global area of 0.43 million hectares was cultivated with total production standing at 4.54 million tons (Varmudy, 2011). India is the largest producer (67.1 %), with Nigeria following at (15.4 %) and Sudan (9.3 %) (Varmudy, 2011).

Okra plays a vital role in human diet (Kahlon et al. 2007, Saifullah and Rabbani 2009) providing phosphorus, calcium, sulphur, iron, fibre, fats, proteins, carbohydrates and vitamins (Lamont 1999, Owolarafe and Shotonde, 2004, Gopalan et al., 2007, Arapitsas 2008, Dilruba et al, 2009). Okra fruit is normally boiled in water to give slimy soup sauces that is relished. The seeds are nutritious, can be dried roasted and ground for use as additive or coffee substitute (Moekchantuk and Kumar 2004) while the fruits are also used to thicken soups and prepare vegetable curds.

In industries, mucilage from okra is often used to produce glace papers and confectioneries, also serving as a replacement for blood plasma as well as blood volume expander (Lengsfeld et al., 2004, Adetuyi et al., 2008, Kumar et al., 2010), it is also a useful remedy against genito-urinary problems, chronic dysentery and spermatorrhoea (Nadkarni, 1927). Okra has also been reported to cure ulcers and hemorrhoids (Adams, 1975). Results of tests conducted in China holds that alcoholic extracts from okra leaves have a potential to remove free radicals, reduce proteinuria, and generally improve renal functions (Liu et al., 2005, Kumar et al., 2009).

The cultivation of okra in Nigeria has indeed known success, however, it has also been greeted with a handful of constraints which include but may not be limited to insect pest infestations, disease incidence and poor soil nutrient level (Onunkun, 2012). In response to the constraints from insect pests, man has continued to search out eco-friendly strategies and methods for the management of these setbacks to okra production and agriculture in general (Praveen and Dhandapani, 2001). Some of these methods are; cultural, physical and biological control (Praveen and Dhandapani, 2001). Chemical control is also used and has become the most commonly used control method among farmers because of its almost immediate rate of success in the eradication of these insects, there has however been serious concerns about the long-term negative effect of continued or excessive use of synthetic formulations (Praveen and Dhandapani, 2001). More so, there is a serious need to enlighten farmers on safer, yet effective measures which are useful with almost no side effects or residual negative effects as those experienced while using chemicals. This study was therefore

carried out to evaluate the effects of *Boerhavia diffusa* and *Chromolaena odorata* in control of insect pest infestations of two varieties of okra.

2 MATERIALS AND METHODS

2.1 EXPERIMENTAL SITE

The experimental site was located behind the Faculty of Agriculture greenhouse, University of Ilorin, Kwara State, Nigeria, located in the Southern Guinea Savannah agro-ecological zone of Nigeria, between Latitude 8°29'N and Longitude 4°35'E. The experiment was carried out in 2018 cropping season. The climate of Ilorin includes rainy season which starts in April and ends in September while the dry season commences in October and ends in March. The dry spell is experienced in August of every year. The site has an average temperature of 35 °C and is characterized by sandy loam soil.

2.2 FIELD PREPARATION, AND LAYOUT OF EXPERIMENTAL PLOT

The land was cleared using cutlass and then mapped out into a plot size of 30 m x 15 m. Ridges were made at intervals of 50 cm spacing within plots. The field already mapped out for the experiment was set out using a Randomized Complete Block Design (RCBD). A spacing of 3 m was maintained between the two subplots of varieties, there were three replicates per treatment and 1 m was maintained between replicates, and 2 m from the boundaries of the plot. Each plot measured 2m x 3m (6 m²) with three (3) ridges in each plot.

2.3 OKRA VARIETIES AND PLANTING

Two varieties of okra common to the farmers in Kwara State were used for the study, they are F1 Lucky and NHAe 47-4 varieties purchased from an Agro-input store in Ilorin. Seeds were planted at five (5) seeds per hole and 50 cm intra-row spacing on 6th October 2018. Two weeks after emergence, thinning was carried out leaving two plants per stand. There were 24 plants in each plot.

2.4 TREATMENTS, PREPARATION, AND APPLICATION

Treatments used for the study were; ethanol leaf

extracts of Siam weed, *Chromolaena odorata* (L.) R.M. King & H. Rob. ethanol extracts of fresh and dried Red Spiderling, *Boerhavia diffusa* L. nom. cons. Laraforce® (a.i. lambda-cyhalothrin) as standard check; and untreated control. *Chromolaena odorata* leaf and *B. diffusa* root were sourced from the forest of University of Ilorin. These plant parts were harvested and air dried in the shade for three (3) weeks, the roots were crushed using mortar and pestle while the leaves were ground using a kitchen size electric blender. They were further sieved using a sieve of 2 mm mesh to obtain a uniform powder.

Plant extracts were prepared by maceration. 50 g of each powder were measured into 400 ml of 90 % ethanol and allowed to stand for twenty-four hours while shaking from time to time to ease extraction. The resulting suspension was filtered using muslin cloth, and the filtrate was made up to 2 litres (1:40 or 2.5 % w/v ratio) by adding distilled water, 2 ml of liquid soap per litre of solution was used as surfactant (Anjarwalla, 2016). Lambda-cyhalothrin 2.5 % emulsifiable concentrate was used as a standard check at 0.5 g per litre.

Treatment application commenced four (4) weeks after planting and was done at one-week interval to the 7th week after planting (WAP).

2.5 CULTURAL PRACTICES

Plots were weeded using hoe at 3 WAP (Adigun, 2005). Selective spraying using herbicide (Glyphosate) was done at 6 WAP at the recommended rate.

2.6 INSTALLATION OF YELLOW STICKY TRAPS

One (1) yellow sticky trap was installed per plot, they were placed at the center of the plots at 4 WAP. They were 50 cm above the ground and were left on the plots for two weeks after which they were collected and taken to the Crop Protection Department Laboratory for insect identification and counting. Insects identified include whiteflies (Homoptera) and leafhoppers (Hemiptera). Physical counting was done using hand lens of 10 x magnification and Gordon's dichotomous key to the order of insects (Gordon, 2019) as aid.

2.7 DATA COLLECTION

Five plants per plot were selected at random and tagged. Collection of data commenced at 5 WAP and continued at a week interval to fruiting and harvest. Data were collected on plant height, number of branches,

whitefly and leafhopper population, number of days to flowering, number of fruits, and mass of fruits.

2.8 DATA ANALYSIS

Data collected were subjected to a two-way analysis of variance (ANOVA) and Spearman's Correlation Analysis using Genstat 17th edition, and significantly different means were separated using Fishers Least Significant Difference (LSD) test at 5 % level of significance.

3 RESULTS AND DISCUSSION

The results of the study revealed that the various treatments used in the experiment had significant effects on both growth and yield parameters of F1-Lucky and NHAe 47-4 varieties of okra. Plants treated with fresh root extracts of *B. diffusa* generally performed better than untreated plants. The treated plots produced plants which were taller and had more branches compared to those of untreated plots (Tables 1 and 2). This may be because treated plants suffered less infestation from whitefly (*Bemisia tabaci* (Gennadius, 1889) and leafhopper (*Amrasca biguttula* Ishida, 1912) compared to untreated plots (Table 4). This corroborates the findings of Bindhu et al. (2015) who reported that *B. diffusa* and some other plants contained various compounds which are known to have repellent and toxic effects on insects. It also confirms the reports from several studies which have shown *C. odorata* to have pesticidal properties, among these reports are Owolabi et al. (2010) who reported that *C. odorata* has been used to manage *Sitophilus zeamais* (Motschulsky), 1855 which belongs to the order (Coleoptera). Studies have revealed that *B. diffusa* and *C. odorata* contain phytochemicals that are effective in insect pest control (Afolabi et al., 2007 and Deepti et al., 2013).

The better growth performance recorded in treated plants may also be because the plants had lesser infection from diseases vectored by the insect pests identified during the study. Okra is susceptible to at least nineteen plant viruses (Brunt et al., 1990; Swanson and Harrison, 1993). These viruses seriously affect its growth and yield. In several parts of Africa, okra leaf curl disease (OLCD) is considered to be the most serious disease threatening okra production (N'Guessan et al., 1992; Swanson and Harrison, 1993; Bigarré et al., 2001). OLCD is transmitted by whitefly (*Bemisia tabaci*). The incidence and abundance of whiteflies will always be directly proportional to the incidence and severity of OLCD (Bigarré et al., 2001). Therefore, the treated plants facing lesser infestation of whiteflies may have also had lesser incidence of

Table 1: Main effect of treatments and variety on the plant height of okra

Treatments	Plant height (cm)				
	WAP				
	5	6	7	8	9
Fresh Root extract of <i>B. diffusa</i>	25.29	39.92	54.53 ^a	59.70 ^a	70.70 ^a
Dry root extract of <i>B. diffusa</i>	23.15	35.33	47.83 ^{ab}	55.75 ^{ab}	62.71 ^{ab}
Dry leaf extract of <i>C. odorata</i>	20.74	28.61	38.00 ^b	43.68 ^{ab}	49.10 ^b
Lambda-cyhalothrin	21.82	31.66	41.22 ^{ab}	47.14 ^{ab}	53.76 ^{ab}
Control	19.90	28.47	36.79 ^b	41.33 ^b	46.47 ^b
SEM	2.67	4.39	5.47	6.00	7.07
LSD	7.81	12.84	15.99	17.57	20.69
Variety					
F1-Lucky (kousko)	18.55 ^b	28.40 ^b	39.10	45.00	51.50
NHAe 47-4	25.81 ^a	37.10 ^a	48.20	54.00	61.50
SEM	1.34	2.61	3.52	3.88	4.69
LSD	3.88	7.59	10.22	11.27	13.63

Values in the same column followed by the same letter(s) are not significantly different at $p = 0.05$ according to Fisher's protected Least Significant Difference (LSD) Test

Key: WAP: Weeks after Planting

Table 2: Main effect of treatments and variety on number of branches of okra

Treatments	Number of branches (WAP)			
	6	7	8	9
Fresh root extract of <i>B. diffusa</i>	4.18 ^a	5.43 ^a	6.48 ^a	7.48 ^a
Dry root extract of <i>B. diffusa</i>	3.02 ^b	4.27 ^b	5.24 ^b	6.24 ^b
Dry leaf extract of <i>C. odorata</i>	2.28 ^b	3.53 ^b	4.96 ^b	5.96 ^b
Lambda-cyhalothrin	3.35 ^{ab}	4.60 ^{ab}	5.40 ^{ab}	6.40 ^{ab}
Control	2.75 ^b	4.00 ^b	4.48 ^b	5.48 ^b
SEM	0.50	0.50	0.50	0.50
LSD	1.10	1.10	1.10	0.70
Variety				
F1-Lucky (kousko)	2.00 ^b	4.00 ^b	5.00 ^b	6.00 ^b
NHAe 47-4	4.00 ^a	5.00 ^a	6.00 ^a	7.00 ^a
SEM	0.30	0.30	0.30	0.30
LSD	0.70	0.70	0.70	0.70

Values in the same column followed by the same letter(s) are not significantly different at $p = 0.05$ according to Fisher's protected Least Significant Difference (LSD) Test

Key: WAP: Weeks after Planting

Okra Leaf Curl Virus which translated to better growth and yield (Table 6). Fidèle (2010) reported a significant decrease in plant height and some other yield-contributing parameters in four accessions of okra which had symptoms of OLCV.

The NHAe 47-4 variety flowered earlier than the F1-Lucky variety (Table 3). Furthermore, treated plants in

the plots for fresh root extracts of *B. diffusa* gave higher fruit yield in both varieties studied (Table 6). This may be because treated plants which were less infested were able to carry out photosynthesis without disruption. Edward and Abdelaziz (2007) reported that any impairment of photosynthetic efficiency by insect pests such as leafhoppers is irreversible and hopper-burn affects plant biomass

Table 3: Main effect of treatments and variety on days to flowering of okra

Treatment	Days to flowering
Fresh root extract of <i>B. diffusa</i>	45.76
Dry root extract of <i>B. diffusa</i>	46.37
Dry leaf extract of <i>C. odorata</i>	46.97
Lambda-cyhalothrin	48.07
Control	48.70
SEM	1.69
LSD	4.17
Variety	
F1-Lucky (kousko)	49.38 ^b
NHAe 47-4	44.96 ^a
SEM	0.85
LSD	5.90

Values followed by the same letter(s) are not significantly different at $p = 0.05$ according to Fisher's protected Least Significant Difference (LSD)

Table 4: Main effect of treatments and variety on the population of adult whitefly and leafhopper per yellow sticky trap

Treatment	Whitefly population	Leafhopper population
Fresh root extract of <i>B. diffusa</i>	298.20 ^b	2.33 ^a
Dry root extract of <i>B. diffusa</i>	404.20 ^d	9.00 ^d
Dry leaf extract of <i>C. odorata</i>	289.30 ^a	5.00 ^b
Lambda-cyhalothrin	301.50 ^c	5.50 ^{bc}
Control	653.30 ^e	7.00 ^c
SEM	1.12	0.66
LSD	3.32	1.96
Variety		
F1-Lucky (kousko)	416.00 ^b	6.00
NHAe 47-4	363.00 ^a	5.53
SEM	0.71	0.42
LSD	2.10	1.24

Values in the same column followed by the same letter(s) are not significantly different at $p = 0.05$ according to Fisher's protected Least Significant Difference (LSD) Test

accumulation by reducing green leaf area and efficiency of solar radiation capture. Aishwarya (2018) also submitted that both nymph and adults cause damage to okra by sucking the cell sap from the lower surface of leaf, twigs and other tender parts of the plant, causing curling of leaves and leading to stunted growth of the plants. They further reported that leafhoppers excrete honey dew which causes the black sooty mold which has an adverse

effect on the photosynthetic ability of the plants. Several reports including Kedar et al. (2014) and Aishwarya Ray (2018) have revealed that whiteflies and their nymphs suck cell sap from plant leaves and affected leaves curl and dry with the affected plants showing a stunted growth. Whiteflies are also responsible for transmitting yellow vein mosaic virus (YVMV), an economically important disease of okra, the symptoms being interwoven networks of yellow veins surrounded by islands of green tissues on the leaves which also turn yellow with time (Kedar et al., 2014; Aishwarya, 2018). The control of incidence of these insect pests and the consequent reduction or elimination of the occurrence of diseases mediated by the insect pests identified on the plots may have translated to the better yield obtained from the treated plots.

The study also revealed a strong positive correlation exists between leafhopper and whitefly population, plant height and number of fruits, plant height and overall yield, and number of fruits and overall yield (Table 5). This suggests that the leafhopper population increased with the whitefly population, while the yield was directly proportional to the growth of the plants.

4 CONCLUSION

The findings of this study revealed that ethanol extracts of *Boerhavia diffusa* and *Chromolaena odorata* had significant positive effects on growth and yield of okra and were also effective in reducing the population of leafhoppers and whiteflies in treated plots. There was a significant positive correlation between leafhopper and whitefly population, plant height and number of fruits, plant height and overall yield, and number of fruits and overall yield. While there was a significant negative correlation between overall yield and whitefly population. There was a non-significant negative correlation between whitefly population and plant height, whitefly population and number of fruits, leafhopper population and plant height, leafhopper population and number of fruits, and leafhopper population and overall yield.

Of the two botanicals evaluated fresh root extract of *B. diffusa* on NHAe 47-4 okra variety performed better than other treatments from germination and emergence, through growth parameters to yield.

5 REFERENCES

- Adams, C. F. (1975). *Nutritive value of American foods in common units*, U.S. Department of Agriculture, Agric Handbook. 425-29.
- Adetuyi, F.O., Osagie, A.U. and Adekunle, A. T. (2008). Effects of postharvest storage techniques on the nutritional prop-

Table 5: Spearman's correlation matrix for various parameters in the study

	Whitefly population	Leafhopper population	Plant height	Number of fruits/ha
Leafhopper population	0.469**			
Plant height	-0.287	-0.191		
Number of fruits/ha	-0.249	-0.117	0.688**	
Overall yield (kg ha ⁻¹)	-0.364*	-0.215	0.746**	0.966**

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Table 6: Main effect of treatments and variety on number of fruits per plant, number of fruits per plot, and overall yield (kg ha⁻¹) of okra

Treatments	Number of fruits/plant	Number of fruits/plot	Fruit yield (kg ha ⁻¹)
Fresh root extract of <i>B. diffusa</i>	13.76	165.10	2029.00 ^a
Dry root extract of <i>B. diffusa</i>	9.48	113.80	1231.00 ^{ab}
Dry leaf extract of <i>C. odorata</i>	9.50	114.10	1304.00 ^{ab}
Lambda-cyhalothrin	8.81	106.10	1223.00 ^{ab}
Control	7.66	91.20	980.00 ^b
SEM	2.20	26.30	334.20
LSD	6.40	76.90	977.60
Variety			
F1-Lucky (kousko)	7.00 ^b	80.00 ^b	878.00 ^b
NHAe 47-4	13.00 ^a	155.90 ^a	1829.00 ^a
SEM	1.10	13.50	178.30
LSD	3.30	39.25	518.40

Values in the same column followed by the same letter(s) are not significantly different at $p = 0.05$ according to Fisher's protected Least Significant Difference (LSD) Test

erties of Benin indigenous Okra *Abelmoschus esculentus* (L.) Moench). *Pakistan Journal of Nutrition*, 7, 652-657. <https://doi.org/10.3923/pjn.2008.652.657>

- Adigun, J.A. (2005). Critical period of weed interference in rain-fed and irrigated tomatoes in the Nigerian savanna, *Journal of Agricultural Research and Development*, 2, 32-41. <https://doi.org/10.4314/jard.v2i1.42197>
- Afolabi, C., Akinmoladun, E.O., Ibukun and I.A. Dan-Ologe (2007). Phytochemical constituents and antioxidant properties of extracts from the leaves of *Chromolaena odorata*. *Scientific Research and Essay*, 2(6), 191-194. Available online at <http://www.academicjournals.org/SRE> ISSN 1992-2248 © 2007 Academic Journals
- Aishwarya Ray (2018). *Studies on insect-pests of okra (Abelmoschus esculentus) with special reference to seasonal incidence and bio-rational management of okra shoot and fruit borer (Earias spp.)*, unpublished thesis; 92 pp.
- Anjarwalla, P., Belmain, S., Ofori, D.A., Sola, P., Jamnadass, R., Stevenson, P.C. (2016). *Handbook on Pesticidal Plants*. World Agroforestry Centre (ICRAF), Nairobi, Kenya.
- Arapitsas, P. (2008). Identification and quantification of polyphenolic compounds from okra seeds and skins. *Food Chemistry*, 110, 1041-1045. <https://doi.org/10.1016/j.foodchem.2008.03.014>
- Bigarré, L., Chazly, M., Salah, M., Ibrahim, M., Padidam, M., Nicole, M., Peterschmitt, M., Fauquet, C., Thouvenel, J.C. (2001). Characterization of a new Begomo virus from Egypt infecting hollyhock (*Althea rosea*). *European Journal of Plant Pathology*, 107, 701-711. <https://doi.org/10.1023/A:1011967232319>
- Bindhu, V.R., Ganga, S., Dayanandan, S. (2015). Mortality effects of some medicinal plants on the pulse beetle *Callosobruchus chinensis* (Coleoptera: Bruchidae). *Journal of Fertilizer & Pesticides*, 6, 150. <https://doi.org/10.4172/2155-6202.1000150>
- Brunt, A., Crabtree, K., Gibbs, A. (1990). *Viruses of Tropical Plants*. CAB International, Wallingford, UK.
- Deepti Malhotra, Amir Khan and Fouzia Ishaq (2013). Phytochemical screening and antibacterial effect of root extract of *Boerhavia diffusa* L. (Family Nyctaginaceae). *Journal of Applied and Natural Science*, 5(1), 221-225. <https://doi.org/10.31018/jans.v5i1.310>
- Dilruba, S., Hasanuzzaman, M., Karim, R., Nahar, K. (2009). Yield response of okra to different sowing time and application of growth hormones. *Journal of Horticultural Science. Ornamental Plants*, 1, 10-14.
- Edward, B. Radcliffe, Abdelaziz Lagnaoui (2007). *Potato Biology and Biotechnology*.

- Fidèle Tiendrébéogo, V.S. Edgar Traoré, Jean-Michel Lett, Nicolas Barro, Gnissa Konaté, Alfred S. Traoré, Oumar Traoré (2010). Impact of okra leaf curl disease on morphology and yield of okra. *Crop Protection*, 29. (2010)712e716. <https://doi.org/10.1016/j.cropro.2010.02.007>
- Gopalan, C., Sastri, S. B. V., Balasubramanian, S. (2007). *Nutritive value of Indian foods*, National Institute of Nutrition (NIN), ICMR, India. P1.
- Gordon Ramel (2019). *Key to the Identification of Insects to Order*, A Few Words About KEYS, Adapted from Harold Oldroyd 1958. <https://www.earthlife.net/insects/orders-key.html#key>
- Kedar, S. C., K. M. Kumaranag, D. S., Bhujbal and N. H. Thodare4 (2014). Insect Pests of Okra and Their Management. *Popular Kheti*, 2(3), 112-119.
- Kumar, R., Patil, M. B., Patil, S. R., Paschapur, M. S. (2009). Evaluation of *Abelmoschus esculentus* mucilage as suspending agent in paracetamol suspension. *International Journal of Pharmaceutical and Technology Research*, 1, 658-665.
- Lamont, W. (1999). Okra a versatile vegetable crop. *Horticultural Technology*; 9: 179-184. Lee K, Cho CY, Park SK (1990). The effect of nitrogen fertilizer, plant density and sowing date on the yield of okra. *Korean Journal of Crop Science*, 35(8), 179-183. <https://doi.org/10.21273/HORT-TECH.9.2.179>
- Lengsfeld, C., Titgemeyer, F., Faller, G., Hensel, A. (2004). Glycosylated compounds from okra inhibit adhesion of *Helicobacter pylori* to human gastric mucosa. *Journal of Agriculture and Food Chemistry*, 52, 1495-1503. <https://doi.org/10.1021/jf030666n>
- Liu, I. M., Liou, S. S., Lan, T. W., Hsu, F. L., Cheng, J. T. (2005). Myricetin as the active principle of *Abelmoschus moschatus* to lower plasma glucose in streptozotocin-induced diabetic rats. *Planta Medica*, 71, 617-621. <https://doi.org/10.1055/s-2005-871266>
- Moekchantuk, T., Kumar, P. (2004). *Export okra production in Thailand*. Inter-country programme for vegetable IPM in South and SE Asia phase II Food and Agriculture Organization of the United Nations, Bangkok, Thailand. P1.
- Nadkarni, K. M. (1927). *Indian Meteria Medica*. Nadkarni and Co Bombay. P1.
- N'Guessan, K.P., Fargette, D., Fauquet, C., Thouvene, L.J.C. (1992). Aspects of the epidemiology of okra leaf curl virus in Côte d'Ivoire. *Tropical Pest Management*, 38, 122-126. <https://doi.org/10.1080/09670879209371668>
- Onunkun, O. (2012). Evaluation of aqueous extracts of five plants in the control of flea beetles on okra (*Abelmoschus esculentus* (L.) Moench). *JBiopest*, 5(supplementary), 62-67.
- Owolarafe, O. K., Shotonde, H. O. (2004). Some physical properties of fresh okra fruit. *Journal of Food Engineering*, 63, 299-302. *Journal of the Ghana Science Association*, 3(3), 136-144. <https://doi.org/10.1016/j.jfoodeng.2003.08.002>
- Praveen, P.M., & N. Dhandapani (2001). Eco-friendly management of major pests of okra (, (L.) Moench), *Journal of Vegetable Crop Production*, 7(2), 3-12. https://doi.org/10.1300/J068v07n02_02
- Saifullah, M., Rabbani, M. G. (2009). Evaluation and characterization of okra (*Abelmoschus esculentus* L. Moench.) genotypes. *SAARC Journal of Agriculture*, 7, 92-99.
- Swanson, M.M., Harrison, B.D. (1993). Serological relationships and epitope profiles of isolates of okra leaf curl geminivirus from Africa and the Middle-East. *Bio-chimie*, 75, 707-711. [https://doi.org/10.1016/0300-9084\(93\)90101-W](https://doi.org/10.1016/0300-9084(93)90101-W)
- Varmudy, V. (2011). *Marketing Survey needed to boost okra exports*. Department of economic Vive Kananda College, Puttur Karnataka. P1.