



## A Review on Response of *Neem* Seed and Leaf Extract on Crop Protection and Production

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### Authors' contributions

This work was carried out in collaboration among all authors. Author SV designed the study, wrote the protocol, and wrote the first draft of the manuscript, Authors P, SKS, SSP and AS critical analysis of the study and author SSP managed the literature searches. All authors read and approved the final manuscript.

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### ABSTRACT

*Neem* products including conventional preparations and formulations have been used widely for improving the growth, yield, and management of insect pests attacking especially on field crops. Phytochemicals are extracted from distinguish parts of the *neem* plant vary significantly due to abiotic and biotic factors from collection of the raw material to extract preparation and product formulation. Content of highly active ingredient, insect species and growth stage, type of formulation, and combined of products with another control method. In this manuscript, the direct and indirect actions of *neem* extract on growth, yield, and insect pests are delineated and realistic implications for future strategies are discussed.

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## 1. INTRODUCTION

The *neem* tree (*Azadirachta indica* A. Juss), well-known on the Indian subcontinent for 4000 years. The insecticidal action of most parts of the *neem* tree is due to some important ingredients like limonoids, azadirachtin A and B, nimbin, salannin but most evidence points to azadirachtin as being the most significant active principle. *Neem*-based products including traditional preparations and formulations have been used extensively for the production and control of insect pests of agricultural crops. Content of phytochemicals extracted from different parts of the *neem* plant varies considerably due to abiotic and biotic factors from collection of the raw material to extract preparation and product formulation. Likewise, effectiveness of crude or synthesized material used in the field or laboratory may be influenced by storage conditions, content of active ingredient, insect species and its growth stage, type of formulation and synergism of products with other control measures. Due to indiscriminate use of pesticides persist chemical residue in crop, soil and plant that harmful for environment as well as human being. By the use of *neem* products is best alternative for ecological farming and avoiding such harmful effects. Azadirachtin is not persistent in the environment, mainly because of rapid degradation by sunlight. The chemistry, environmental behaviour and biological effects of *neem* products have been the subject of several reviews. In this manuscript attempt to review on recent progress of *neem* extract and its products on growth, yield attributes, yield and their bio-efficacy against of pests and diseases of agricultural crops worldwide is discussed with the purpose of higher production of crops and reduce the pests and diseases without polluting the environment and also to encourage research to further improve the potential of *neem* and its products.

## 2. METHODS

This review focuses on production and protection of crop, the current literature on *neem* and its extracts, highlighting the importance of the compounds found via several extraction methods and from different parts of the plant like seed, leaf, bark etc. We also illustrate through, how the different extracts are currently being benefit on crop growth parameters, yield attributes, yield, insect and diseases.

For the development of this literature review, we conducted searches using both scientific databases e.g., PUBMED, Science Direct, and Elsevier for scientific studies, as well as, commercial search engines such as Google to search for commercial applications. For current research based literature we used terms and Boolean operators: "*Neem*" AND "Effect of *neem* on growth" OR "Effect of *neem* on yield" AND/OR "Effect of *neem* extract on crop production" OR "Effect of *neem* extract on insect and disease", and "Effect of *neem* seed on crop production" AND "*Neem* cake" AND/OR "Effect of *neem* extract on protection" For commercial applications we used terms such as "*Neem*-derived products", or "*Neem*", or "*Neem* industrial applications". After careful deliberation of the literature obtained, we took only those that would fit within the scope of our working review and proceeded to extend our database, and the production of this review.

## 3. EFFECT OF NEEM EXTRACT

### 3.1 Effect of *Neem* Extract on Growth

The extracts *neem* leaf, wood ash, and modified *neem* leaf were applied at the rate of 1200 litres per hectare each, NPK 15-15-15 at 300 kg ha<sup>-1</sup>, and poultrymanure was applied at 6 t ha<sup>-1</sup>. The results showed that modified *neem* leaf extract resulted in higher plant height, stem girth, leaf area, and number of branches of tomato plants compared to the poultry manure, *neem* leaf, and wood ash extract (sole application). Modified *neem* leaf extract increased the plant height, stem girth, number of branches and leaf area by 13.2%, 9.5%, 17.3%, and 30% respectively compared to *neem* leaf extract but in comparisons to NPK 15-15-15 fertilizer, it enhanced plant height, stem girth, number of branches and leaf area of tomato plants by 2%, 5.4%, 3.4% and 31% [1]. Moyin-Jesu [2] concluded that the highest values of plantain growth, yield parameters, and soil nutrients (soil N, P, K, Ca, Mg, and Mo) was observed with the application of mixed extract of *neem* leaf + wood ash treatment as compared to NPK 15-15-15 fertilizer, *neem* leaf and wood ash extracts (sole forms) respectively. It is also observed by Singh and Chauhan [3] that the application of mixed extract of *neem* leaf + wood ash at 833.3 L ha<sup>-1</sup> is appropriate for better performance of growth, plant bunch weight, finger weight, finger diameter and length, and improvement in soil fertility

status. The aqueous extract of *neem* plant parts showed significant germination of okra (*Abelmoschus esculentus*) may be due to the presence of different plant hormones, micro and macro nutrients. Among the different combinations of fertilizer and organic formulations applied to pigeonpea, the treatment 100% RDF + *neem* seed extract @100 l/ha, showed higher plant height, number of primary and secondary branches, leaf area index and dry matter accumulation as compared to the other treatments, such as 100% RDF + fish wash @100 l/ha, 100% RDF + normal water @1000 l/ha, 75% RDF + vermiwash @100 l/ha, 75% RDF + cow urine @100 l/ha, 75% RDF + *neem* seed extract @100 l/ha, 75% RDF + fish wash @100 l/ha, 75% RDF + normal water @1000 l/ha, 50% RDF + vermiwash @100 l/ha, 50% RDF + cow urine @100 l/ha, 50% RDF + *neem* seed extract @100 l/ha, 50% RDF + fish wash @100 l/ha and 50% RDF + normal water @1000 l/ha, respectively [7].

### 3.2 Effect on Yield Attribute and Yield

*Neem* leaf and seed powder or extracts significantly increased grain yield in treated cowpea and obtained ( $409 \text{ kg ha}^{-1}$ ) as compared to control ( $301 \text{ kg ha}^{-1}$ ) [4-5]. Liquid extracts from *neem* leaf (NLE), wood ash [WAE], and their modified forms (modified *neem* leaf MNLE) as fertilizer sources for improving soil fertility, growth, and yield of garden egg were demonstrated. Six treatments were tested, namely *neem* leaf extract, wood ash extract (WAE), modified *neem* leaf extract, poultry manure, N P K 15-15-15 fertilizer (NPK), and control (no fertilizer or extract). Results revealed significant improvement in plant height, leaf area, leaf population, number of branches, fruit length and weight, fruit diameter, soil N, P, K, Ca, and Mg, content and soil acidity under different fertilizer extracts over control treatment. NLE yield increased plant height, leaf area, and stem girth of garden egg by 19.8%, 21.5%, and 5% respectively compared to wood ash treatment [WAE]. As compared to NPK, NLE also yielded enhanced plant height and stem girth, while, NPK yielded improved leaf area and number of branches compared to NLE. NLE treatment increased Plant height and leaf area by 15% and 11% respectively compared to poultry manure. For yield parameters, modified NLE yielded increased garden egg fruit weight, fruit length and fruit diameter by 37.5%, 41.55% and 31.3% respectively as compared to WAE, and fruit weight, length, and diameter by 42%, 24% and

12.5% respectively as compared to NPK. Moyin-Jesu [1] conducted a trial with *neem* leaf extracts, wood ash, and modified *neem* leaf applied at  $1200 \text{ L ha}^{-1}$  each, NPK 15-15-15 at  $300 \text{ kg ha}^{-1}$  and poultry manure was applied at  $6 \text{ t ha}^{-1}$ . Lokanadhan et al. [6] also reported that *neem* seed cake performs the dual function of both fertilizer and pesticide, acts as a soil enricher, reduces the growth of soil pest and bacteria, provides macronutrients essential for all plant growth, helps to increase the yield of plants in long run, biodegradable and environmentally friendly and serves as an excellent soil conditioner. Verma et al. [7] also observed significantly higher pods/plant, grains/pod, test weight, grain yield and stalk yield with application of 100% RDF + *neem* seed extract @100 l/ha as compared to control, 100% RDF + fish wash @100 l/ha, 100% RDF + normal water @1000 l/ha, 75% RDF + vermi wash @100 l/ha, 75% RDF + cow urine @100 l/ha, 75% RDF + *neem* seed extract @100 l/ha, 75% RDF + fish wash @100 l/ha, 75% RDF + normal water @1000 l/ha, 50% RDF + vermiwash @100 l/ha, 50% RDF + cow urine @100 l/ha, 50% RDF + *neem* seed extract @100 l/ha and 50% RDF + fish wash @100 l/ha ( $95.91 \text{ g}$ ), respectively.

### 3.3 Effect on Insects

*Neem* leaf and seed powder or extracts controlled weevils in stored maize and cowpea, enhanced germination percentage, and seedling vigour [4-5]. Dela et al. [8] reported that *neem* leaves extract reduced survival and reproductive potential of the green peach aphid *M. persicae* and induced mortality of nymphs throughout ingestion. These extracts showed interesting aphicide properties to *M. persicae* with dose response relationships well correlated. Podder et al. [9] observed that *neem*, mahogany, biskatali, pithraj extract-treated plots showed significant variation over untreated control in aspects of percent population reduction of Epilachna beetle, *neem* oil at 13% concentration was the most effective among them. Anam et al. [10] observed the mortality, growth and feeding responses of epilachna beetle under *neem* oil treatment and also showed that all the larval instars were susceptible. The  $LC_{50}$  values were higher at 3rd and lowest on 1<sup>st</sup> instar, respectively. The  $LT_{50}$  values of oil increase proportionately with increasing larval age and with decreasing oil concentration. Javed et al. [11] reported that *neem* formulations form was *neem* leaves and *neem* cakes and one of the *neem* refined products was "aza". The soil application of the

formulations has both protective and curative effects which significantly reduced the number of egg masses and eggs per egg mass on tomato roots. Protective application of *neem* crude formulations did not reduce the invasion of juveniles whereas aza at 0.1% w/w did. Curative application of *neem* formulation significantly reduced the number of egg masses and eggs per egg mass over control. Effects of *neem* oil and water extracts of *neem* seed and leaf each on African bollworm, *Helicoverpa armigera* were studied at three concentration levels (2.5%, 5%, and 10%) under laboratory conditions. In the square dip experiment, high mortalities were statistically recorded from larvae treated with concentration levels of seed extract and the two lower concentration levels of leaf extracts as compared to mortalities from control larvae. In the larval immersion experiment, larvae treated with a higher concentration of both seed and leaf extracts resulted higher mortalities compared to control. Three days after treatment application, significantly low numbers of squares were damaged by the larvae treated with the three concentration levels of seed extracts as compared to the control. Significant reductions in feeding on artificial diet were also observed from larvae treated with various concentration levels of Nimbecidine, seed, and leaf extracts at 6 and 9 days after treatment application in larval immersion experiment [12]. Sharma and Khan [13-14] studied *Schistocerca gregaria* and adults treated with different concentrations of *neem* produce viz. leaves, green *neem* seed coat, yellow *neem* seed coat and *neem* seed kernel. The concentrations used to dip the maize leaves, upon which the insect feeds, were 0.005%, 0.01%, 0.025%, 0.05%, 0.1%, 0.25%, 0.5% and 1.0% (v/v) respectively, and results showed that the *Schistocerca gregaria* F. adults showed highest mortality of 73.00% at 1.0% concentration of *neem* seed kernel. The mortality showed a decreasing trend with the decrease in the concentration of *Neem* products. The lowest mortality was found against the yellow *neem* seed coat, which is zero.

### 3.4 Effect on Diseases

Leaf extract of *neem* can inhibit the aflatoxin production as well as the growth of *Aspergillus parasiticus*. Antifungal effects of *neem* leaf extract also reported from south America against *Crinipellis pernicioso* and *Phytophthora* species

causing Witches broom and Pot Not of cocoa [15]. Salako et al. [4-5] observed that *neem* leaf and seed powder or extracts reduced fungal attack and infection on stored seeds and crops on the field. Moslem et al. [16] also observed the antifungal effect of *neem* leaves and seed extracts against all tested fungi but *F. oxysporum* and *R. solani* were the most sensitive fungi. Aqueous leaf extract of *neem* exhibited considerable control of *Fusarium oxysporum* disease development in banana and also, many researches showed that the application of some plant extracts can induce systemic resistance in many plants through accumulations of pathogenesis related proteins (PR-proteins) [17]. Hanaa et al. [18] in an experiment found that pre-treatment with *neem* aqueous extracts and willow aqueous extracts decrease the percentage of disease incidence from 25% in control to 10% and 15% after 2 weeks of infection, from 35.9% to 22% and 17.4% after 4 weeks of infection, from 65.5% to 25.5% and 27.8% after 6 weeks of infection. Aqueous extract of *neem* seems to be more efficient than aqueous extract of willow after six weeks of infection.

## 4. CONCLUSION

From the above study, it can be concluded that *neem* extract could be a potent source to enhance protection from insect pests and diseases and ultimately improve the productivity and quality of produce. This can also be a potential substitute for pesticide which is becoming most common in various crops. Combined with manures and fertilizer frequent use of *neem* extracts can address many challenges of agriculture and will be a way for sustainable agriculture. Therefore, it seems that *neem* extract under ITK-based formulation is the better supplement for insect pest, disease, and nutrient management. Given the multiple benefits of *neem*-based products in agriculture seems very significant in this regard as more and more useful products are being prepared. Future research should focus on the interaction of other endorsed inputs in organic farming with *neem* extract to enable the integrating of *neem* extract for enhanced productivity and profitability of crops.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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