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Effect of Vermicompost and Neem Seed Kernel Extract (NSKE) on Growth and Yield of Chickpea: A Non-Pesticide Management (NPM) Approach for Chickpea Cultivation



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ABSTRACT

Non-Pesticide Management (NPM) is now becoming a promising sustainable agricultural practice which positively influences the capital cost as well as yield of the crop. In our study, we have evaluated the effect of organic manure (vermicompost) on growth and yield of chickpea. Also, we evaluated the insecticidal activity of Neem Seed Kernel Extract (NSKE) on larvae of *Helicoverpa armigera* and *Spodoptera exigua*. Vermicompost @ 10t/ha and 5% NSKE was applied in all experimental pots. Organic manure vermicompost significantly increased the plant growth and yield of chickpea compared to synthetic fertilizer. Further, NSKE was showed high anti insecticidal activity on larvae of *Helicoverpa armigera* and *Spodoptera exigua* compared to the synthetic pesticide. Organic manure (vermicompost) significantly increased chickpea yield an organic pesticide (NSKE) lowered the *Helicoverpa armigera* and *Spodoptera exigua* larvae number.

INTRODUCTION

Non-Pesticide Management (NPM) is an alternative pest control approach in which biological or natural products are used to increase the soil fertility as well as to control the pest. It is becoming an alternative method/source to conventional agriculture that uses synthetic or chemical fertilizers and pesticides. Over usage of synthetic fertilizers not only cause the environmental pollution but also influence the agricultural productivity and quality. Soil with the high content of organic matter and active biological activity had shown good soil fertility and may act as habitat for beneficial predators that prevent infections¹. Ramesh et al² reported that that organic crops showed more tolerant as well as resistant to insect attacks compared to plants cultivated with synthetic fertilizers. Organic manure such as vermicompost had shown to influence chickpea crop yield compared to chemical fertilizers³.

Several important and active biological compounds have been isolated and characterized from neem plant. These compounds such as triterpenoids, azadirachtin⁴ and melantriol⁵ are widely known insecticides. These components reduce the feeding of insect thereby affecting insect development. Azadirachtin-E had been found to be an effective insect growth regulator⁶. It belongs to tetranortriterpenoid plant limonoid which undergoes oxidization with several reactive functional group⁷. It acts as a natural chemical defense agent (chemoreception) that affects the feeding behavior of the insect⁸. Insect growth regulation of azadirachtin is achieved by disruption of hormone system which regulates the metamorphosis and moulting⁹. These disruption further result in some changes in hormone levels like hemolymph ecdysteroid and juvenile hormone release from neurohaemal organs¹⁰. Previously, several studies reported that Neem Seed Kernel Extract (NSKE) significantly inhibited the larval growth of several insects^{11,12}.

Chickpea, a second most important leguminous food grain cultivated mainly as the rainfed crop in Telangana state. Among other pulses, chickpea is the major source of dietary protein in Indians diet. The previous report suggested that soil fertility and other sustainable agricultural practices may influence the chickpea yield¹³. In our study, we aimed to evaluate the effect of organic manure like vermicompost on plant growth and yield of chickpea. Also, we aimed to analyze the effect of NSKE on larvae of *Helicoverpa armigera* and *Spodoptera exigua*.

MATERIALS AND METHODS

Preparation of plot for the experiment:

Two separate plots with 5×4 sq. mt was selected for the experiments. In one plot vermicompost @ 10t/ha was applied and another plot was not applied with any type of organic manures. A seed variety of “Swetha” was used in all experimental conditions. A standard dose of (25 kg of Nitrogen, 125 kg of Phosphorous and 125 kg of Potassium (NPK) per Ha was used as synthetic fertilizer. Chloropyriphos 20EC was used as the synthetic pesticide.

Preparation of Neem Seed Kernel Extract

Neem Seeds were collected from Limboor village of Nizamabad district, Telangana State, India. Neem Seed Kernels were separated from the Pods and subjected to the powder using the electric blender. 1000 g powder was extracted with four liters of distilled water in a Soxhlet apparatus at room temperature. Further, the extract was mixed thoroughly and filtered through Whatman filter paper and used for the experiment. Neem extract at 5% concentration was applied to all experiments at four different time intervals.

Statistical analysis

Data were analyzed using SPSS software (19.0 version). All values were presented in mean and standard deviation (Mean ±SD). ANOVA test and t-test were performed to evaluate the significance between groups.

RESULTS

Effect of organic manure (vermicompost) and synthetic fertilizer on growth and yield of chickpea

Chickpea plants that were supplemented with vermicompost showed early flowering initiation (61.20 ± 29.24) compared to plants grown with synthetic fertilizers and without any organic/synthetic fertilizers (82.05 ± 38.59 ; 98.29 ± 45.36 , $p = 0.04$). Further, the mean height of the plant also showed a significant increase in the plot with organic manure compared to plot with synthetic fertilizer and control plot (18.21 ± 15.29 ; 13.85 ± 7.56 ; 12.89 ± 6.64 , $p = 0.05$). The similar trend was also observed with respect to plant yield where the mean values for

Pods for a plant, seeds per plant, yield per plant and yield per plot were elevated in the plot with organic manure compared to plot with synthetic and control plot (Table 1).

Effect of organic manure, NSKE and synthetic pesticide on larval count, growth, and yield of chickpea

The number of larvae (*Helicoverpa armigera*) and (*Spodoptera exigua*) were significantly reduced in NSKE applied plot (15.21 ± 7.21 ; 18.35 ± 9.25 , $p = 0.02$) compared to plot with synthetic pesticides (27.56 ± 13.54 , 29.20 ± 14.89 , $p = 0.04$). Mean differences of other growth and yield parameters of plants were also showed variation between two plots (Table 2).

Effect of organic manure, NSKE and synthetic pesticide on nutrition levels of chickpea

Nutrient components of chickpea like calories total carbohydrates and proteins were found to be higher in seeds collected from a plot with organic manure+ NSKE compared to seeds collected from a plot with synthetic fertilizer (Table 3). Though the mean difference was statistically not significant, other nutrient components of chickpea from different plots were also showed the significant difference (Table 3).

Table 1: Effect of organic manure and synthetic fertilizer on growth and yield of chickpea

Parameters	Plot with vermicompost	Plot with synthetic fertilizers	Plot without organic/synthetic fertilizers (Control)
Days to initiation of flowering and podding	61.20 ± 29.24 P= 0.04	82.05 ± 38.59	98.29 ± 45.36
Plant height (In inches)	18.21 ± 15.29 P= 0.05	13.85 ± 7.56	12.89 ± 6.64
Days to maturity of a pod	21.20 ± 11.34 P= 0.12	22.15 ± 13.69	24.19 ± 15.26
Plant stand at harvest	9.63 ± 4.56 P= 0.24	8.34 ± 4.21	7.99 ± 3.12
Pods per plant	66.32 ± 32.54 P= 0.03	42.21 ± 21.23	33.45 ± 17.21
Seeds per plant	130.12 ± 62.30 P= 0.04	80.32 ± 39.23	$61.30.1428 \pm$
Yield per plant (In grams)	201 ± 99.32 P=0.01	140.25 ± 68.65	121.24 ± 60.28
Yield per plot (In grams)	1804.45 ± 904.24 P=0.02	1325.24 ± 625.02	1154.47 ± 587.45

Table 2: Effect of organic manure, NSKE and synthetic pesticide on larval count, growth, and yield of chickpea

Parameters	Plot with vermicompost + Neem Seed Kernel Extract (NSKE)	Plot without organic manures + synthetic pesticide
No of larvae (<i>Helicoverpa armigera</i>)	15.21±7.21 P= 0.02	27.56±13.54
No of larvae (<i>Spodoptera exigua</i>)	18.35±9.25 P= 0.04	29.20±14.89
Days to initiation of flowering and podding	55.10±27.24 P= 0.05	71.15±34.14
Plant height (In inches)	19.41±9.15 P= 0.04	14.45±7.51
Days to maturity of a pod	19.12±9.21 P= 0.17	23.44±11.68
Plant stand at harvest	9.11±4.25 P= 0.35	9.32±4.89
Pods per plant	72.56±34.16 P= 0.04	44.96±20.63
Seeds per plant	122.19±61.15 P= 0.03	75.74±34.41
Yield per plant (In grams)	195.31±95.86 P=0.05	131.41±69.11
Yield per plot (In grams)	1758.41±845.25 P=0.04	1389.78±695.69

Table 3: Comparison between nutrition values of chickpea seeds that were cultivated with vermicompost + NSKE and without vermicompost + synthetic pesticides.

Nutrition information on chickpea seeds (Amount per 100gm of the chickpea)	Plot with vermicompost + Neem Seed Kernel Extract (NSKE)	Plot without vermicompost and with synthetic pesticide
Calories	325±145.58 P= 0.04	212.32±110.29
Total fat (In grams)	6.1±2.89 P=0.13	5.10±2.21
Total carbohydrates (In grams)	58.32±26.35 P= 0.05	37.25±16.32
Protein (In grams)	19.25±9.35 P= 0.02	3.21±6.28
Sodium (In milligrams)	11.2±5.8 P= 0.06	9.28±4.25
Potassium (In milligrams)	470.52±231.56 P= 0.18	462.54±235.21
Calcium	79.54±32.24 P=0.06	61.89±29.35

DISCUSSION

Nonpesticide management is becoming an alternative method to control various agricultural pests that uses naturally available phytotoxins as insecticides. It minimizes the cost of cultivation and considered as nontoxic for the environment. In our study, we evaluated the effect of organic manure (vermicompost) and natural insecticide Neem Seed Kernel Extract (NSKE) on chickpea growth, yield and the larval population of two different pests. We observed that organic manure like vermicompost significantly influenced the growth of chickpea with respect to flowering initiation, plant height. Chau et al 2005 reported that rice plant height was found to be increased when plants were supplemented with organic fertilizers. Further, the yield of chickpea was observed to be elevated when plants are grown with vermicompost compared to chemical fertilizers. Increased yield of pigeon pea and chickpea was achieved by using non-pesticide management and other IPM methods^{14,1}. Singh et al ¹⁵ reported that application of organic manure as if vermicompost was significantly increased the yield of chickpea compared to synthetic fertilizers. It was postulated that organic matter can enhance the essential nutrients in the soil and suggested to be an indigenous source of soil phosphorus, nitrogen, and sulfur. Organic matter like cattle dung or vermicompost may improve the soil fertility thereby influencing the plant growth characteristics. In our experiment use of vermicompost as an organic matter might increase the yield of chickpea.

Further, topical application of NSKE to larvae significantly reduced the number of larvae on chickpea plant. The lower number of larvae might be due to the abnormal development of larval stages when they directly exposed to the NSKE. NSKE might act as an antifeedant for *H. armigera* larvae. Hassan et al ¹⁶ reported that topical application of NSKE had resulted in mortality of eggs and abnormal growth of *H. armigera* larvae. Increased rate larval mortality had also been reported as the concentration of neem seed oil increased and suggested that concentrated neem seed oil may act as potentially toxic to a pest.

In conclusion, our study suggests that Non-Pesticide Management approaches like the application of vermicompost may improve the yield of chickpea compared to synthetic fertilizers. Application of NSKE significantly reduces the *H. armigera* larvae population compared to the synthetic pesticide.

Conflicts of interest: None

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