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Effect of botanical insecticides on the population of Maize cob borer *Helicoverpa armigera* Hubner

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Abstract
The present study was conducted during kharif 2015-16 at the Research cum Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.).The minimum cob borer larvae was recorded in plots sprayed with Indoxacarb (0.23) which was at par with NSKE 5% @ 25 litres/ha, (0.27), followed by Neem oil 2% @ 10 litres/ha, (0.33), Karanj oil 2% @ 10 litres/ha, (0.37), Karanj seed powder @ 25 kg/ha, (0.33) and Chilli-Garlic solution @ 9 kg/ha (0.33) treated plots. The maximum cob borer larvae was recorded (0.40) with Chilli solution of @ 10 kg/ha, significantly superior over untreated control (0.87 larvae/cob). The maximum grain yield was recorded in plots treated with Indoxacarb 14.5 SC (30.05 q ha-1) The descending order among the botanical insecticides with regard to yield was Neem oil 2 % (26.03 q/ha), Karanj oil (25.50 q/ha), NSKE (24.83 q/ha), Karanj seed powder (23.58 q/ha) and chilli-garlic solution (21.91 q/ha), respectively. Whereas, chilli solution and chilli-garlic solution recorded lowest yield of 21.91 and 21.08 grain yield, respectively.

Keywords: Botanicals, cob borer, *Helicoverpa armigera,* Maize.

Introduction
Maize (*Zea mays* L.) known as queen of cereals due to its diverse usages. Depending on the regions and socio-economic conditions of the population, the maize grain is used for various purposes including food, feed, fodder, green cobs, popcorn, starch and several industrial products (Kumar *et al.* 2014) [7]. In Chhattisgarh, it is cultivated in an area of 107.23 million ha with production of 207.50 million tonnes and productivity is 1.93 tonnes ha -1 (Anonymous 2013) [1].

One of the important constraints responsible for low yield of maize is undoubtedly the attack of various insect pests particularly the stem borer and cob caterpillar which hence gained major importance in this state by inflicting greater loss to the crop. Very little information is available on the insect pests of maize in Chhattisgarh and India. In particularly except of some stray reports on the incidence of the major insect like pink stem borer, cob borer and *Euproctis* spp. (Deole *et al.* 2015) [5]. The cob borer, *Helicoverpa armigera* Hubner was found as a devastating pest of maize. On maize, young larvae tended to feed on silks and interfered with pollination but eventually they usually gained access to the kernels. Feeding was almost always confined to the top of the ear. (Uddin *et al*. 2009 a) [11]. The larva, *Helicoverpa armigera* Hubner is a major agricultural pest and polyphagous in nature attacking more than 182 plant species. (Boyd, 2008) [3]. Globally botanical pest management is gaining appreciation because of multiple mode of action such as antifeedant which inhibit normal development of insects, repellent, antijuvenile hormone activity, oviposition/ hatching deterrence, antifertility or growth disrupters and chemosterilants. Azadirachta indica (Neem) and their products are considered as effective botanical pesticides due to controlling wide variety of insect pest including Helicoverpa armigera (Lulie and Raja, 2012). [8]

Material and Methods
The present study was conducted during kharif 2015-16 at the Research cum Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.)

Methods for recording the observations
Seven botanical insecticides were evaluated for the management of *H. armigera,* botanical insecticides was applied twice *viz.,* at silk emergence stage about 60 days and 15 days after silk emergence. Pre-treatment observation was recorded on one day before insecticide application

and post treatment observation was taken after 1, 3,7,10 days of spraying of botanicals. In these experiments, larvae per cob and per cent cob damage were counted on randomly selected 10 plants from each plot.

Following observations was also recorded in the experimental plots.

1. Total cob length.
2. Length of infested part of the cob.
3. Percentage of length of infestated cob.
4. Percentage of kernels damaged.
5. Yield /plot.

Yield data was analyzed and yield differences among different treatments was calculated. While comparing the yield among different treatments, the per cent increase in yield over control was calculated using the following formula given by Mazurek *et al.* 2005 [9].

$$\text{Increase in yield over control (\%)} = \frac{T - C}{C} \times 100$$

Where,

T=Yield from treated plot.

C=Yield from control plot.

The cob infestation was subjected to square root transformation (These transformed values were analyzed statistically by using the techniques of analysis of variance for randomized block design and significance was tested by "F" test (Cochran and Cox 1957) [4].

Seven different botanical insecticide treatments were evaluated including untreated control for the assessment of their comparative performance against cob borer of maize. The details of tested botanical insecticides which were applied on maize are presented in the Table 1.

Table 1: Different botanicals tested against cob borer.

Treatments	Botanicals	Dose	Quantity /ha
T_1	Neem oil	2%	10 litres/ha
T_2	NSKE	5%	25 litres/ha
T_3	Karanj oil	2%	10 litres/ha
T_4	Karanj seed powder	25 kg/ha	25 kg/ha
T_5	Chilli-Garlic solution- (Green Chillies–7.50kg/ha,Garlic–1.50 kg/ha,Kerosene oil – 625 ml/ha,Surf – 250 gm/ha)	9 kg/ha	9 kg/ha
T_6	Chilli solution- (Green Chillies – 10 kg/ha,Kerosene oil– 25ml/ha, Surf – 25 gm/ha)	10 kg/ha	10 kg/ha
T_7	Indoxacarb 14.5 SC	300 ml/ha	300 ml/ha
T_8	Untreated control	----------	Plain water spray

Methodology adopted during preparation of plant products

Neem oil – Under the process 40 ml of crude neem oil was added in two litre of water to make a solution of 2 % for application. Afterwards, teepol at the rate of 1 ml/litre of water was added to this solution for the better spreading and sticking effect of the prepared solution.

NSKE- Before preparing the solution, 100 gram of neem seed kernels was soaked overnight in 100 ml of water one day before the spraying of botanicals. The kernels were then grind and extract was filtered using a fine cotton cloth. Thereafter, 100 ml of filtered extract was poured and mixed in 2 litres of water for making a solution of 5% for application.

Karanj oil- 40 ml of crude karanj oil was added in two litre of water to make an emulsion of 2%. Thereafter, thoroughly mixed with teepol liquid soap @1ml/ litre of water as an emulsifying agent for its spreading and sticking effect of botanicals.

Karanj seed extract- Under this, one day before spraying of botanicals, 100 gram of karanj seed was soaked in 100 ml of water. Thereafter, the seed was grinded and extract was filtered with a cotton cloth. The filtered 100 ml extract of karanj seed was added to 2 litres of water and 2 gm of detergent soap thoroughly by mixing the extract properly for the spray of botanicals.

Chilli -Garlic solution- 50 gm of chilli and garlic paste was made and mixed in 50 ml of water and extract was filtered using a cotton cloth. The extract was added in 2 litres of water and 2 ml of each kerosene oil and liquid detergent was added for increasing the insecticidal property of chilli- garlic solution. Chilli solution- 50 gm of chilli paste was made and mixed in 50 ml of water and extract was filtered using a cotton cloth. The extract was added in 2 litres of water and 2 ml of each kerosene oil and liquid detergent was added for increasing the
insecticidal property of chilli solution.

Precautions of chilli-garlic solution and chilli solution-

- Apply oil over the body after preparing this decoction.
- Cover your body while spraying.
- Apply this solution not more than two times in a season.
- Do not store the solution.

Chemical insecticide- During first and second spray, Indoxacarb 14.5 SC was applied @ 1ml /liter of water for control of maize cob borer in the maize field.

Statistical analysis

The data obtained from the experimental field were analyzed statistically after appropriate transformation. The infestations of cob borer data obtained were converted into angular transformation and square root transformation, by using the formula (Sin-1 $\sqrt{x}$) and ($\sqrt{x}$ +0.5). This transformed data was then analyzed by the method of analysis of variance as described by Gomez and Gomez (2010) [6]. The "F" test was used at 5 per cent level of significance.

Result and Discussion

All the tested botanical insecticides were found significantly superior over untreated control in reducing the cob borer larvae. Among the treatments Indoxacarb 14.5 SC proved to be the best in comparison to other tested botanical insecticides

to reduce incidence of cob borer at the each observation days with the significantly highest grain yield (30.05 q ha-1). Among the botanical insecticides Neem oil 2% was the most effective for the management of cob borer with a grain yield of 26.03 q ha-1.

Population of cob borer, *Helicoverpa armigera* (Hubner) larvae before and after spray of the botanical insecticides All the tested botanical insecticides were found significantly superior over untreated control in reducing the cob borer larvae at each observation days after spray.

Cob borer larvae population after first spray

Data in respect of pre-treatment and post treatment observations on cob borer, *Helicoverpa armigera* larvae after first spray are presented in Table 2. The pre-treatment data pertaining to the cob borer *Helicoverpa armigera* larval population showed uniform distribution in all the treatments ranging between 0.50 to 0.80 larvae per cob.

It is clear that in post treatment observation after 1st day of spraying, there were significant differences among all the treatments with respect to the population of cob borer larvae. All the treatments were significantly superior over untreated control. Among the foliar treatment with Indoxacarb 14.5 SC @ 300 ml/ha was most effective treatment with the minimum cob borer larvae/cob (0.23), followed by NSKE 5% @ 25 litres/ha, (0.27), Neem oil 2% @ 10 litres/ha, (0.33), Karanj seed powder @ 25 kg/ha, (0.33), Chilli-Garlic solution @ 9 kg/ha (0.33) and Karanj oil 2% @ 10 litres/ha, (0.37) per plant, respectively. However, spray of Chilli solution @ 10 kg/ha against cob borer larvae was least effective (0.40 larvae/ cob) but significantly superior over untreated control (0.87 larvae/cob). Post treatment observation on the cob borer larvae after 3rd days of first spray of botanical insecticide showed that all the treatments were significantly reducing the population of cob borer larvae over control. The plots treated with Indoxacarb 14.5 SC depicted minimum cob borer larvae (0.13) which was at par with Karanj oil 2% @ 10 litres/ha, (0.33) followed by Neem oil 2% @ 10 litres/ha, (0.47) NSKE 5% @ 25 litre/ha, (0.47), Chilli-Garlic solution @ 9 kg/ha (0.50) and Chilli solution @ 10 kg/ha (0.50) larvae per cob, respectively. However, spray of Karanj seed powder @ 25 kg/ha was least effective against cob borer larvae (0.60/ cob) but significantly superior over untreated control having 1.03 larvae per cob.

Post treatment observation on the cob borer larvae after 7th days of first spray of botanical insecticide, showed that all the treatments were significantly reducing the population of cob borer larvae over control. The plots treated with Indoxacarb 14.5 SC depicted minimum cob borer larvae (0.30/cob) which was at par with Neem oil 2% @ 10 litres/ha, (1.03), Karanj oil 2% @ 10 litres/ha, (1.13), followed by NSKE 5% @ 25 litres/ha, (1.27), Karanj seed powder @ 25 kg/ha, (1.33) and Chilli solution @ 10 kg/ha(1.40) larvae per cob, respectively. However, spray of Chilli-Garlic solution @ 9 kg/ha was least effective against cob borer larvae (1.53/cob) but significantly superior over untreated control (2.00 larvae/ cob).

After 10 days of first spray of botanical insecticides, the plot treated with foliar treatment with Indoxacarb 14.5 SC once again proved to be most effective with minimum cob borer larvae/cob (0.13) which was at par with Neem oil 2% (1.53). Chilli solution was the least effective treatment with the maximum cob borer larvae 1.70/cob but significantly superior over untreated control (2.20/cob).

Population of cob borer larvae after second spray

In the 1 st day after second spray, all the tested doses of botanical insecticide exhibited significant differences over control. Among the foliar treatments, Indoxacarb 14.5 SC @ 300 ml/ha recorded as the best effective treatment with minimum cob borer larvae (0.17/cob), followed by NSKE 5% @ 25 litres/ha, (0.40), Karanj oil 2% @ 10 litres/ha, (0.47), Karanj seed powder @ 25 kg/h (0.47), Neem oil 2% @ 10 litres/ha, (0.50), and Chilli-Garlic solution @ 9 kg/ha, (0.53), larvae per cob, respectively. However, spray of Chilli solution @ 10 kg/ha was least effective against cob borer larvae (0.57) but significantly superior over untreated control (1.17 larvae/cob) (Table 2). Post treatment observation on the cob borer larvae after three days of second spray of botanical insecticides, showed that all the treatments were significantly reducing the infestation of cob borer larvae over control. The plots treated with Indoxacarb 14.5 SC @ 300 ml/ha depicted minimum cob borer larvae/ cob (0.10) which was at par with NSKE 5% @ 25 litre/ha, (0.50), Karanj oil 2% @ 10 litres/ha, (0.50), followed by Neem oil 2% @ 10 litres/ha, (0.53) Karanj seed powder @ 25 kg/ha, (0.57) and Chilli-Garlic solution @ 9 kg/ha, (0.67) larvae per cob, respectively. However, spray of Chilli solution @ 10 kg/ha was least effective against cob borer larvae (0.77) but significantly superior over untreated control (1.43 larvae/cob).

Post treatment observation on the cob borer larvae after seven days of second spray of botanical insecticides, showed that all the treatments were significantly reduced the cob borer larvae over control. The plots treated with Indoxacarb 14.5 SC @ 300 ml/ha depicted minimum cob borer larvae/cob (0.10) which was at par with NSKE 5% @ 25 litres/ha, (0.57), Karanj seed powder @ 25 kg/ha, (0.57) followed by Neem oil 2% @ 10 litres/ha, (0.67) Karanj oil 2% @ 10 litres/ha, (0.67), and Chilli-Garlic solution @ 9 kg/ha, (0.70) larvae per cob, respectively. However, spray of Chilli solution @ 10 kg/ha was least effective against cob borer larvae (0.83) but significantly superior over untreated control (1.33 larvae/cob).

After ten days of second spray of botanical insecticides, the plots treated with Indoxacarb 14.5 SC once again proved to be most effective with minimum cob borer larvae/cob (0.00) which was at par with Neem oil 2% @ 10 litres/ha (0.30), Chilli solution @ 10 kg/ha was the least effective treatment with the maximum cob borer larvae (0.67) per cob but significantly superior over untreated control (1.27/cob).

Present findings are in confirmation with finding of Bajpai *et al.* (2000) [2] reported that the seven botanical insecticides, including Neem, Karanj, *Pongamia pinnata* and tobacco formulations were compared with endosulfan for control of pod borer on chickpea Endosulfan gave the highest pod borer control (40.2% pod damage) and yield of the botanicals, pod damage at maturity was lowest with karanj oil followed by the Neem product Green Mark or nicotine sulfate, and yield was highest with karanj oil.

Sarangi *et al*. (2005) [10] reported that the application of endosulfan @0.350 kg a.i. /ha proved quite effective in achieving distinct reduction in pod damage (71.86%) enhancing the grain yield by 43.43%, followed by botanical insecticide. Khanna *et al*. (2009) observed that the treatment of NSKE 5%+endosulfan 35 EC @ 1.25 litre/ha (half the recommended dose) showed the least larval population, followed by endosulfan @ 2.5 litre/ha alone.

4.3.2 Per cent cob damage The minimum cob damage was recorded with Indoxacarb 13.33%) per cob which was at par with Neem oil (43.33) followed by Karanj oil (46.67), NSKE

(50.00), Karanj seed powder (56.67), Chilli-Garlic solution (66.67), treated plots.

The maximum cob damage was recorded with Chilli solution (70.00) and untreated control (76.67) per cent respectively, the grain yield was also significantly influenced by Indoxacarb 14.5 SC, followed by Neem oil, karanj oil, NSKE, Karanj seed powder, Chilli-Garlic solution, and Chilli solution (Table 4.9). Similar, findings were reported by Uddin *et al*. (2009 a) [11] and their results revealed that the cob damage increased gradually and the percent of cob damage ranged from 4.40% to 7.40% in BARI Hybrid Bhutta-5 and 4.45% to 7.62% in BARI Bhutta-7, respectively. Similarly, Uddin *et al.* (2009 b) [12] also evaluated that the efficacy of three insecticide at 3 DAT, 7 DAT 12 DAT. At 3 DAT the lowest cob infestation was 1.72% in Decis 0.3% treated plot and highest mean per cent cob infestation was 6.00% in control plot followed by 5.35% and 5% in 0.1% Lebaycid and 0.1% Decis treated plot, respectively. At 7 DAT highest mean cob infestation was 7.05% in control plot and the lowest per cent cob infestation was 1.90% in Decis 0.3% treated plots. The second and third lowest cob per cent infestation was 3.5 % in 0.2% Decis and 4.25% in 0.3% Lebaycid treated plots respectively. After applying insecticides at 12 DAT the lowest mean cob infestation 2.75% in Decis 0.3% treated plots and highest cob infestation was 7.50% in control plot followed by 6.97% and 6.85 % in 0.1% Decis and 0.1% Lebaycide treated plot, respectively. In the control plot the highest cob infestation was observed with different time intervals.

Total cob length

The total cob length Indoxacarb (18.94 cm/cob) was recorded in plots treated which was at par with Neem oil (18.72) followed by Karanj oil (18.93), NSKE (18.56), Karanj seed powder (18.70), Chilli-Garlic solution (18.84), treated plots. The maximum total cob length was recorded with Chilli solution (19.02) and untreated control (19.02), respectively. The grain yield was also significantly highly influenced by Indoxacarb 14.5 SC, followed by Neem oil, Karanj oil, NSKE, and Karanj seed powder, Chilli-Garlic solution, and Chilli solution (Table 3).

Present findings are in agreement with Uddin *et al.* (2009 a) [11] who stated that the mean total cob length was 12.95 cm in the BARI Hybrid Bhutta-5, while 12.35 cm. in BARI Bhutta-7.

Per cent length of infested cob

The minimum per cent length of infested cob Indoxacarb 14.5 SC (5.92%) per cob was recorded in plots treated which was at par with Neem oil (20.34) followed by Karanj oil (20.65), NSKE (20.96), Karanj seed powder (21.02), Chilli-Garlic solution (22.81), treated plots. The maximum infested cob per cent length was recorded with Chilli solution (24.80) and untreated control (35.75), respectively. The grain yield was also significantly highly influenced by Indoxacarb 14.5 SC, followed by Neem oil, Karanj oil, NSKE, and Karanj seed powder, Chilli-Garlic solution, and Chilli solution (Table 2). Present findings are corroborate with finding of Uddin *et al.* (2009 a) [11] who recorded that the mean per cent length of infestated cob of BARI Hybrid of Bhutta-5 and BARI Bhutta-7 were 24.90 and 25.07%, respectively. (Table 3)

Per cent damage of kernel

The minimum kernel damaged Indoxacarb 14.5 SC (1.44%) per cob was recorded in plots treated which was at par with Neem oil (3.96) followed by Karanj oil (4.09), NSKE (4.36), Karanj seed powder (4.47), Chilli-Garlic solution (5.21), treated plots. The maximum kernel damage was recorded with Chilli solution (5.23) and untreated control (7.88), respectively. The grain yield was also significantly highly influenced Indoxacarb 14.5 SC, followed by Neem oil, Karanj oil, NSKE, and Karanj seed powder, Chilli-Garlic solution, and Chilli solution. (Table 3)

Present findings are in confirmation with finding of Uddin *et al.* (2009 a) [11] who observed that in the BARI Hybrid Bhutta-5, the mean number of kernel damage was 24.30 and in BARI Bhutta-7, it was 25.43 which were slightly higher than BARI Hybrid Bhutta-5.

Similarly Uddin *et al.* (2009 b) [12] also reported that the lowest mean number of kernel damage (2.10) was observed in 0.3% Decis treated plot followed by 3.01, and 5.02 in 0.2% Dursban treated plot respectively, while highest mean number of kernel damage 24.80 was in control plot.

Grain yield (q ha-1)

The data regarding the grain yield revealed that among the treatments Indoxacarb 14.5 SC recorded with highest grain yield (30.05 q/ha). The descending order among the botanical insecticides with regard to yield was Neem oil 2 % (26.03 q/ha), Karanj oil (25.50 q/ha), NSKE (24.83 q/ha), Karanj seed powder (23.58 q/ha) and chilli-garlic solution (21.91 q/ha), respectively. Whereas, chilli solution and chilli-garlic solution recorded lowest yield of 21.91 and 21.08 grain yield, respectively. Present findings are corroborate with finding of Uddin *et al.* (2009 b) [12] who recorded lowest yield loss 1.40 Kg/ha were found with 0.3% Decis 2.5 EC treated plots. (Table 4)

Table 2: Efficacy of botanicals and insecticide against cob borer on maize

S. No	Treatment	Dose	No. of larvae/cob							
			Pre-treatment	Post treatment						
				First application				Second application		
				1 DAT	3 DAT	7 DAT	10 DAT	1 DAT	3 DAT	7 DAT	10 DAT
1	Neem oil	2%	0.57(1.25)	0.33(1.15)	0.47(1.21)	1.03(1.42)	1.53(1.59)	0.50(1.22)	0.53(1.23)	0.67(1.29)	0.30(1.14)
2	NSKE	5%	0.50(1.22)	0.27(1.12)	0.47(1.21)	1.27(1.49)	1.63(1.62)	0.40(1.18)	0.50(1.22)	0.57(1.25)	0.30(1.14)
3	Karanj oil	2%	0.57(1.25)	0.37(1.16)	0.33(1.15)	1.13(1.45)	1.60(1.61)	0.47(1.21)	0.50(1.22)	0.67(1.29)	0.30(1.14)
4	Karanj seed powder	25 kg/ha	0.50(1.22)	0.33(1.15)	0.60(1.26)	1.33(1.52)	1.57(1.60)	0.47(1.21)	0.57(1.25)	0.57(1.25)	0.40(1.18)
5	Chilli-Garlic solution-	9kg/ha	0.50(1.22)	0.33(1.15)	0.50(1.22)	1.53(1.58)	1.67(1.63)	0.53(1.23)	0.67(1.29)	0.70(1.30)	0.43(1.19)
6	Chilli solution-	10 kg/ha	0.57(1.25)	0.40(1.18)	0.50(1.22)	1.40(1.54)	1.70(1.64)	0.57(1.25)	0.77(1.32)	0.83(1.35)	0.67(1.28)
7	Indoxacarb 14.5 SC	300 ml/ha	0.53(1.23)	0.23(1.11)	0.13(1.06)	0.30(1.13)	0.13(1.06)	0.17(1.08)	0.10(1.04)	0.10(1.04)	0.00(1.00)
8	Untreated control	---------	0.80(1.34)	0.87(1.36)	1.03(1.42)	2.00(1.72)	2.20(1.78)	1.17(1.47)	1.43(1.56)	1.33(1.52)	1.27(1.50)
	SE (m) ±			0.025	0.130	0.060	0.036	0.025	0.019	0.016	0.023
	CD at (5%)		NS	0.075	0.042	0.185	0.111	0.078	0.058	0.050	0.070

Table 3: Extent of cob damage caused by *Helicoverpa armigera* larvae on maize

S. No.	Treatment	Dose	Per cent cob damaged*	Total length of cob (cm)**	Length of cob infestation part of the (cm)**	Per cent length of infested cob*	Per cent damage of kernel*
1	Neem oil	2%	43.33 (41.05)	18.72 (4.44)	3.92 (2.20)	20.34 (26.77)	3.96 (11.46)
2	NSKE	5%	50.00 (44.98)	18.56 (4.42)	3.90 (2.21)	20.96 (27.07)	4.36 (11.98)
3	Karanj oil	2%	46.67 (43.06)	18.93 (4.46)	4.69 (2.38)	20.65 (26.86)	4.09 (11.51)
4	Karanj seed powder	25 kg/ha	56.67 (48.82)	18.70 (4.43)	3.83 (2.19)	21.02 (27.26)	4.47 (12.14)
5	Chilli-Garlic solution	9kg/ha	66.67 (54.76)	18.84 (4.45)	3.89 (2.20)	22.81 (28.50)	5.21 (13.17)
6	Chilli solution	10 kg/ha	70.00 (56.97)	19.04 (4.49)	4.34 (2.31)	24.80 (29.81)	5.23 (12.80)
7	Indoxacarb 14.5 SC	300 ml/ha	13.33 (21.13)	18.94 (4.47)	1.12 (1.45)	5.92 (14.04)	1.44 (6.87)
8	Untreated control	--------	76.67 (61.19)	19.02 (4.47)	6.81 (2.78)	35.75 (36.60)	7.88 (16.20)
	SE (m) ±		3.239	0.023	0.075	1.270	0.720
	CD at (5%)		9.918	0.614	0.230	3.890	2.205

*Figures in parentheses are angular transformed values
**Figures in parentheses are square root transformed values

Table 4: Effect of different botanicals and insecticide ongrain yield of maize

Treatments	Botanicals Insecticides	Dose	Grain yield (q/ha)
T1	Neem oil	2%	26.03
T2	NSKE	5%	24.83
T3	Karanj oil	2%	25.50
T4	Karanj seed powder	25 kg/ha	23.58
T5	Chilli-Garlic solution	9kg/ha	21.91
T6	Chilli solution	10 kg/ha	21.08
T7	Indoxacarb 14.5 SC	300 ml/ha	30.05
T8	Untreated control	----------	10.41

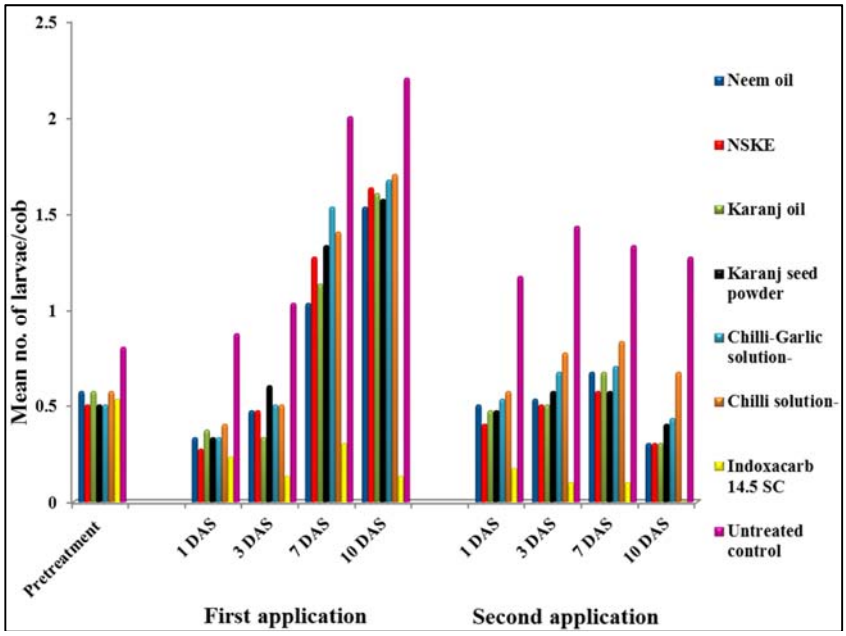

Fig 1: Relative efficacy of botanicals and insecticide against cob borer on maize

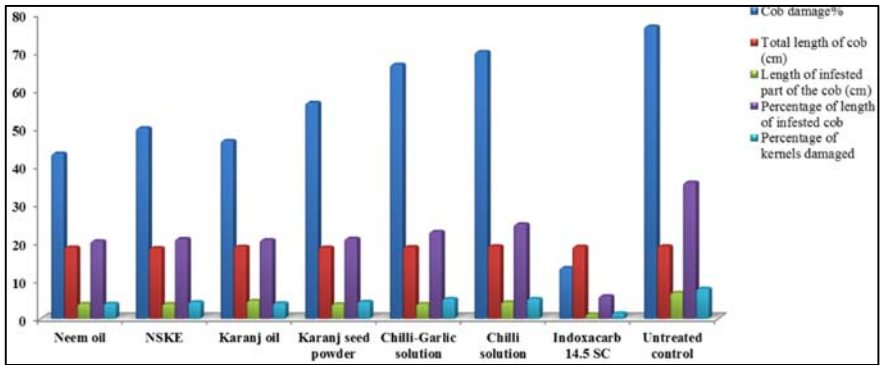

Fig 2: Per cent cob damage caused by *Helicoverpa armigera* larvae on maize

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