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Eco-friendly management of maize stem borer with botanical and chemical insecticides

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Abstract
Karanj oil, neem oil, *Bt*, imidacloprid and their combination were tested against maize stem borer (Chilo partellus) in the field during Kharif 2010. The combination of karanj oil+imidacloprid (10ml+2ml/l) was significantly reduced the stem borer damage i.e. Dead heart (2.8%), plant infestation (14.1%), stem tunneling (2.7%), number of exit hole/plant (0.6). The next best treatment was neem oil +imidacloprid (10ml+2ml/l) and imidacloprid (2ml/l). Grain yield was also maximum in karanj oil +imidacloprid (39.5 q/ha) closely followed by neem oil +imidacloprid (37.5q/ha).

Keywords: maize stem borer, karanj Oil, neem oil, *Bt* (*Bacillus thuringiensis*), imidacloprid and management

Introduction
Maize (*Zea mays* L) is referred to as the "Queen of Cereal" due to its intrinsic high genetic yield potentials. As the statement of maize monthly research report (Anonymous, 2011) [1]. It is the third most important crop after rice and wheat in India with 21.3 million metric tons of maize production during the year 2010-11. Maize is a very dynamic crop for manufacturing various items of food as well as fodder by the different plant parts like grain, leaves, stalk, tassel and cob (Singh *et al.*, 2006) [11]. More than 130 insect pests have been reported to cause damage to maize in India but only about a dozen cause economic loss (Sarup *et al.* 1978, Zaidi & Singh 2005) [8, 13]. Among them, the most damaging insect is Lepidopteran insect stem borer (*Chilo partellus* Swinhoe). It can potentially minimize the production of the maize by infesting throughout the growth period from seedling to maturity of the crop. Bhanukiran and Panwar (2000) [3] reported that this key pest causes 24.3 and 36.3 % yield loss of maize in different agro-climatic areas of India. According to Khan *et al*. (1997) [5], stem borer damages about 25-40% of the crop growth and yield in various regions.
Insecticides are the most effective and quick method of insect control (Shamas and Afzal, 1989) [9] but have so many adverse effects like mortality of biological control agents, environmental and water pollution, biohazards to human beings and animals. So, for sustainable low-cost maize production, it is necessary to have a low-cost technology and eco-friendly management of pests. Hence attempts were made to utilize karanj oil, neem oil, *Bt*. and imidacloprid to minimize pests of maize crop.

Materials and Methods
The field experiment was conducted randomized block design (RBD) during *Kharif* season of 2010 at the Birsa Agricultural University maize research field Kanke, Ranchi. There were three replications and nine treatments. Each plot contained five rows, distance between plant to plant, row to row and replication to replication was 20cm, 60cm and 90cm respectively. The path size was 1m and 4m of row length. The treatment were T_{1}- neem oil @ 10ml/l, T_{2}- karanj oil @ 10ml/l, T_{3}- imidacloprid @ 2ml/l, T_{4}- *Bt* @ 3 gm/l, T_{5}- neem oil + imidacloprid (10ml + 2ml/ l), T_{6}- neem oil + *Bt* (10ml + 3 gm/l), T_{7}- karanj oil + imidacloprid (10ml + 2ml/l), T_{8}- karanj oil + *Bt* (10ml + 3 gm/l) and T_{9}- Control.
The observations of plant infestation and dead heart due to *Chilo partellus* were recorded after each spray. The leaf injury rating scale 1-9 Sarup *et al.* (1979) [7] was used for evaluating different treatments against damage of maize stem borer. For record stem tunnel and exit hole made by stem borer, five randomly selected plants were uprooted from each plot at the time of harvesting. The stem were split open and the total length of stem and length of tunnel made by larvae of stem borer, number of exit holes present on entire stem was measured and recorded.

Finally grain and stover yields were also recorded plot wise and converted into quintal per hectares.

Result and Discussion

The data obtained were subjected to statistical analysis and result presented below:

Plant infestation and dead heart

The application of combination of karanj oil+imidacloprid was found to be the most effective in reducing the incidence of stem borer plant infestation (14.1%) and dead heart (2.8%) closely followed by neem oil+imidacloprid (24.2% & 3.9% respectively) and significantly superior over control with plant infestation (84.9%) and dead heart (48.7%) (Table 1). Sharma and Bhatnagar (1993) [10] also tested karanj and neem oil and observed that both the oil decreased the feeding habit of *C. partellus* due to their oviposition deterrent and reduced egg laying.

Stem tunneling and exit hole

All the treatments significantly reduced the mean per cent stem tunnel and mean number of exit hole per plant when compared with control (18.3 & 12.3), respectively. The highest reduction in stem tunneling per cent was recorded in treatment T_7 karanj oil+imidacloprid @ 10ml+2ml/l (2.7) followed by T_5 neem oil+imidacloprid @ 10ml+2ml/l (5.4), T_6 neem oil+*Bt* @ 10ml + 3 gm/l (6.3) and T_3 imidacloprid @ 2ml/l (7.5). Treatment T_7 (karanj oil+imidacloprid @ 10ml+2ml/l) was significantly superior to T_5 (neem oil+imidacloprid @ 10ml+2ml/l). The other treatments proved better in reducing exit holes caused by stem borer *i.e. Bt* @ 3gm/l (3.6/plant) which was significantly at par with imidacloprid @ 2ml/l (4.2/plant), neem oil + *Bt* @ 10ml+3gm /l (4.9/plant) and karanj oil + *Bt* @ 10ml + 3gm /l (5/plant) (Table 2). Srinivas and Panwar (2003) [12] also reported efficacy of neem, *Bt* formulation and endosulfan alone and in combination with one another against *C. partellus.* Btk, endosulfan (systemic insecticide) as well as their combination reduced stem tunneling.

Plant height, number of cob and yield of maize

The maximum plant height, number of cob and yield were recorded in karanj oil+imidacloprid treatment (10ml+2ml/l) i.e. 230cm, 1.8/plant and 39.5q/ha respectively. It was closely followed by neem oil+imidacloprid @ 10ml+2ml/l plant height (225cm), cobs per plant (1.4) and yield (37.5q/ha) respectively (Table 3). The lowest plant height (190.0cm), mean number of cob per plant (0.51) and yield (31.5q/ha.) were recorded in control. Various workers also tested chemical and botanicals separately with varying degree of response (Pal *et al.*, 2009; Srinivas and Panwar, 2003; Jose *et al.*, 2008 and Aswal *et al.*, 2010) [6, 12, 4, 2].

Table 1: Effects of different eco-friendly insecticides against stem borer (*Chilo partellus* Swinhoe) infesting maize (cv. HQPM-1)

Treatment	Dose	Mean Dead Heart (%)	Mean Plant Infestation (%)
T_1- Neem Oil	10 ml/l	8.5 (16.95)	41.2 (39.93)
T_2- Karanj Oil	10 ml/l	11.4 (19.73)	56.2 (48.56)
T_3- Imidacloprid	2 ml/l	4.5 (12.25)	35.5 (36.57)
T_4- *Bt*	3 gm/l	22.5 (28.32)	39.6 (39.00)
T_5- Neem Oil + Imidacloprid	10 ml+2 ml/l	3.9 (11.39)	24.2 (29.47)
T_6- Neem Oil + *Bt*	10 ml+3 gm/l	6.5 (14.77)	45.0 (42.13)
T_7- Karanj Oil + Imidacloprid	10 ml+2 ml/l	2.8 (9.63)	14.1 (22.06)
T_8- Karanj Oil + *Bt*	10 ml+3 gm/l	8.9 (17.36)	70.3 (56.98)
T_9- Control	_	48.7 (44.25)	84.9 (67.13)
SEm (±)	_	0.96	1.77
CD (P=0.05)	_	2.89	5.35
CV (%)	_	8.47	7.42

*Figures in parentheses are the values of angular transformation

Table 2: Effects of different eco-friendly insecticides on the intensity of stem borer (*Chilo partellus* Swinhoe) in maize (cv. HQPM-1)

Treatment	Dose	Mean stem tunneling (%)	Mean number of exit hole/plant
T_1- Neem Oil	10 ml/l	11.8 (20.09)*	7.5 (2.83)**
T_2- Karanj Oil	10 ml/l	10.7 (19.09)	8.2 (2.95)
T_3- Imidacloprid	2 ml/l	7.5 (15.89)	4.2 (2.17)
T_4- *Bt*	3 gm/l	10.2 (18.63)	3.6 (2.02)
T_5- Neem Oil + Imidacloprid	10 ml+2 ml/l	5.4 (13.44)	1.5 (1.41)
T_6- Neem Oil+ *Bt*	10 ml+3 gm/l	6.3 (14.54)	4.9 (2.32)
T_7- Karanj Oil+ Imidacloprid	10 ml+2 ml/l	2.7 (9.46)	0.6 (1.05)
T_8- Karanj Oil+ *Bt*	10 ml+3 gm/l	13.4 (21.47)	5.0 (2.34)
T_9- Control	_	18.3 (25.33)	12.3 (3.58)
SEm (±)	_	0.98	0.76
CD (P=0.05)	_	2.98	2.29
CV (%)	_	10.06	10.51

* Figures in parentheses are the values of angular transformation.
** Figures in parentheses are the value of $\sqrt{X+0.5}$ transformation

Table 3: Effects of different eco-friendly insecticides on plant growth and yield attributing parameters of maize (cv. HQPM-1)

Treatment	Dose	Plant height (cm)	Mean number of cob/plant	Yield (q/ha.)
T_1- Neem Oil	10 ml/l	201.0	0.72 (1.10)	32.5
T_2- Karanj Oil	10 ml/l	209.0	0.95 (1.20)	33.5
T_3- Imidacloprid	2 ml/l	221.5	1.12 (1.27)	37.0
T_4- *Bt*	3 gm/l	206.5	0.89 (1.18)	33.0
T_5- Neem Oil + Imidacloprid	10 ml+2 ml/l	225.0	1.4 (1.38)	37.5
T_6- Neem Oil + *Bt*	10 ml+3 gm/l	218.0	0.98 (1.22)	35.0
T_7- Karanj Oil+ Imidacloprid	10 ml+2 ml/l	230.0	1.80 (1.52)	39.5
T_8- Karanj Oil+ *Bt*	10 ml+3 gm/l	195.0	0.69 (1.09)	34.0
T_9- Control	_	190.0	0.51 (1.00)	31.5
SEm (±)	_	8.53	0.08	1.64
CD (P=0.05)	_	25.79	0.23	4.96
CV (%)	_	7.01	11.06	8.16

*Figures in parentheses are the value of $\sqrt{X+0.5}$ transformation

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