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Effect of new insecticide molecule on growth and seed yield parameters in maize (*Zea mays* L.)

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Abstract
A field experiment was conducted at National Seed Project, UAS, GKVK, Bengaluru during the year 2018-19, to know the effect of new insecticide molecule called Chlorantraniliprole on growth, insect management and seed yield in maize inbred line CAL 1443. The experiment was laid out in RCBD, replicated three times with ten treatment combinations, Chlorantraniliprole 0.1, 0.2, 0.3 ml / kg (ST), Chlorantraniliprole 0.1, 0.2, 0.3 ml / kg (ST)and spray with chlorpyrifos 2 ml at 45 DAS, Chlorantraniliprole 0.1, 0.2, 0.3 ml / kg (ST)and spray with quinolphos 2 ml at 45 DAS and Control. The results revealed that Chlorantraniliprole 0.3 ml / kg (ST)and spray with quinolphos 2 ml at 45 DAS recorded highest plant growth and seed yield attributes *viz.*, plant height at harvest (208 cm), cob length (14.40 cm), cob diameter (13.96 cm), number of seeds per row (21.33), number of rows per cob (18.33), seed yield per plot (4.99 kg), seed yield per hectare (60.03 q ha^{-1}) over control (194.00 cm, 23.40 %, 12.33 cm, 13.23 cm, 18.33, 17.33, 3.67 kg, 46.73 q ha^{-1}respectively).

Keywords: Planting windows, growth and seed yield

Introduction
Maize (*Zea mays* L.) is the important cereal crop in the world after wheat and rice. It is much significant crop in United States of America like rice and wheat are in India. Maize is known as corn, belongs to the family *Poaceae*. It was originated in Mexico. Even if the total production of maize is more, little of maize is consumed directly by humans as most of it is used for production of corn ethanol, animal feed and other maize products such as corn starch and corn syrup. Maize has spread to the rest of the world because of its ability to grow in diverse climatic conditions, immense potentiality and nutritive value. Maize is highly rich in starch, 71 to 72 per cent and it has a protein content of 9 to 10 percent, fat (4 to 45 percent), fibre (9 to 10 percent) and sugar (2 to 3 percent). Maize is also known as 'Queen of cereals'.
The United States produces more than 35 percent of world's maize. Other top maize producing countries are China, Brazil, Mexico, Argentina and India. The world maize production during 2017-18 is 1,134 million tonnes. In India, total maize production in 2017-18 was 25 million tonnes in a sown area of 95 lakh hectares. In Karnataka, maize production is 5.4 million tonnes. About 2 percent of the total maize is being produced in India, and Karnataka is in top position accounting for about 16 percent of total maize production in India. Among maize growing states Karnataka followed by Telangana, Bihar, Maharashtra are the top producers. In India about 71 per cent of maize crop is grown in *Kharif* (Anon., 2017) [1].
Maize is a C_4 plant it has got greater yield potential as compared to other cereals. However insect infestation at different stages of crop from sowing to maturity poses a serious limitation in getting the expected yield. The multiple pest complex of maize crop poses serious limitations in the maize cultivation in different agro climatic regions of India. Siddiqui and Marwaha (1994) [6] reported that, out of all the pests causing varying degree of damage to maize crop, only a dozen are quite serious and they need to be controlled.
Among all the pests that attack maize, *Chilo partellus* (swinhoe), *Sesamia inferens* and *Atherigona soccata* are of major importance during different seasons in India (Kumar *et al.* 2005) [3]. The other pests like Bihar hairy caterpillar, aphids, leafhoppers, white backed plant hoppers, semilooper etc. also attack this crop. A new insecticide class, the anthranilic diamides, includes products that are long lasting, mainly against Lepidoptera and have safe environmental profile than previous ones Hannig *et al*. (2009), Lai and Su (2011) [2, 4].

This class of chemical has not been extensively tested against *Helicoverpa zea* under field but lack of damage control using pyrethroid insecticides makes evaluation of Chlorantraniliprole as a spray treatment in controlling the insect damage Shelton *et al*. (2013) [5].

The fall armyworm (*Spodoptera frugiperda*), a species belongs to the order of Lepidoptera. *Spodoptera frugiperda* is widely distributed in Eastern and Central North America and in South America. *Spodoptera frugiperda* was first reported in Africa, where it has caused significant damage to the maize crop and in 2018 it has been spotted in Southern India. Remarkable trait of this larva is that, they practice cannibalism. It is regarded as a pest and can damage a wide range of crops, which causes large economic losses. Because of its ability to cause immense destruction, possible crop protection measures is being studied in depth.

There is considerable increase of pest infestation on maize in the recent years, which inturn is affecting the seed yield and quality of maize causing huge losses to the farmers. Keeping this in view, the effect of new insecticide molecule on insect management, seed yield and quality in maize is studied during *Rabi*, 2018.

Material and Methods

The study on effect of new insecticide molecule on growth, insect management and seed yield in maize inbred line CAL 1443 was studied at NSP, UAS, GKVK, Bengaluru. Sowing was taken up in the month of October, with seed treatment at different concentrations prior to sowing and spraying of different chemicals was carried out at 45 days after sowing. The experimental site is situated between 12° 15' N latitude and 77° 35' E longitude at an altitude of about of about 930 m above Mean sea level. The experiment was laid out in randomized complete block design and replicated in three times with ten treatments, T_1- Chlorantraniliprole 0.1 ml / kg (ST), T_2-Chlorantraniliprole 0.2 ml / kg (ST), T_3- Chlorantraniliprole 0.3 ml / kg (ST), T_4- Chlorantraniliprole 0.1 ml / kg (ST) and spray with chlorpyrifos 2 ml at 45 DAS, T_5- Chlorantraniliprole 0.2 ml / kg (ST) and spray with chlorpyrifos 2 ml at 45 DAS, T_6-Chlorantraniliprole 0.3 ml / kg (ST) and spray with chlorpyrifos 2 ml at 45 DAS, T_7- Chlorantraniliprole 0.1 ml / kg (ST) and spray with quinolphos 2 ml at 45 DAS, T_8- Chlorantraniliprole 0.2 ml / kg (ST) and spray with quinolphos 2 ml at 45 DAS, T_9- Chlorantraniliprole 0.3 ml / kg (ST) and spray with quinolphos 2 ml at 45 DAS, T_{10}- Control.

Five tagged plants were used for getting results on growth and seed yield parameters.

Results and Discussion

The growth parameters of maize *viz*., Highest plant height at 60 DAS and at harvest, insect infestation at 60 DAS and at harvest, days taken to 50 per cent tasseling, 50 per cent silking and maturity as influenced by seed treatment followed by spray are represented in Table 1.

Plant height (cm)

Among different treatments no significant difference was observed. The highest (128.72 cm) plant height at 60 DAS was seen in T_9 which is on par with T_6 (127.43 cm). While, the lowest (120.02 cm) was observed in T_{10}. The highest (208.00 cm) plant height at harvest was seen in T_9 which is on par with T_6 (206.67 cm) and the lowest (194.00 cm) was seen in T_{10}.

Table 1: Influence of new insecticide on growth parameters of maize

Treatments	Plant height (cm)		Days to 50% tasseling	Days to 50% silking	Days to maturity
	60 DAS	At harvest			
T_1: Chlorantraniliprole 0.1 ml / kg (ST)	124.67	198.00	62.33	66.00	121.33
T_2: Chlorantraniliprole 0.2 ml / kg (ST)	125.72	197.33	62.00	65.33	121.00
T_3: Chlorantraniliprole 0.3 ml / kg (ST)	127.14	205.33	61.67	64.67	120.00
T_4: Chlorantraniliprole 0.1 ml / kg (ST) and spray with chlorpyrifos 2 ml at 45 DAS	125.63	202.67	62.33	66.00	121.33
T_5: Chlorantraniliprole 0.2 ml / kg (ST) and spray with chlorpyrifos 2 ml at 45 DAS	126.67	204.00	61.67	64.67	121.00
T_6: Chlorantraniliprole 0.3 ml / kg (ST) and spray with chlorpyrifos 2 ml at 45 DAS	127.43	206.67	61.33	64.33	120.00
T_7: Chlorantraniliprole 0.1 ml / kg (ST) and spray with quinolphos 2 ml at 45 DAS	125.89	195.00	62.33	65.67	121.00
T_8: Chlorantraniliprole 0.2 ml / kg (ST) and spray with quinolphos 2 ml at 45 DAS	126.27	200.33	61.67	64.67	120.67
T_9: Chlorantraniliprole 0.3 ml / kg (ST) and spray with quinolphos 2 ml at 45 DAS	128.72	208.00	61.00	64.33	120.00
T_{10}: Control	120.02	194.00	62.67	66.00	121.67
S.Em±	6.38	9.34	1.34	2.28	0.76
CD (P=0.05)	NS	NS	NS	NS	NS
CV (%)	8.78	8.04	3.76	6.07	1.08

Days to 50 per cent tasseling

No significant difference was observed among the treatments. The lowest (61.00) number of days taken for 50 per cent tasseling was seen in T_9 which is followed by T_6 (61.33). While, the highest (62.67) was observed in untreated control T_{10}.

Days to 50 per cent silking

There was no significant difference obtained among the treatments. The lowest number of days taken for 50 per cent silking (64.33) was seen in T_9 and T_6 which is followed by T_3, T_5 and T_8 (64.67). While, the highest (66.00) is in recorded T_1 and untreated control T_{10}.

Days to maturity

Non-significant difference was observed among the treatments. The lowest number of days taken for maturity (120.00) was seen in T_9, T_6 and T_3 which is followed by T_8 (120.67). While, the highest (121.67) is in untreated control T_{10}.

The seed yield attributes of maize*viz*., cob length, cob diameter, number of seeds per row, number of rows per cob,

seed yield per plot and seed yield per hectare as influenced by the planting windows are represented in Table 2.

Cob length (cm)

Cob length did not differ significantly among the treatments. Highest cob length (14.40 cm) was observed in T_9 which was on par with T6 (14.25 cm). Whereas, the lowest (12.33 cm) was observed in untreated control T_{10}.

Cob diameter (cm)

Cob diameter did not differ significantly within the treatments. Highest cob diameter (13.96 cm) was observed in T_9 which was on par with T_6 (13.94 cm). Whereas, the lowest (13.23 cm) was observed in untreated control T_{10}.

Number of seeds per row

There was no significant difference observed in number of seeds per row among the treatments. Highest number of seeds per row (21.33) was observed in T_9 which is on par with T_6 (20.67). Whereas, the lowest (18.33) was observed in untreated control T_{10}.

Table 2: Influence of new insecticide on seed yield attributes of maize

Treatments	Cob length (cm)	Cob diameter (cm)	Number of rows per cob	Number of seeds per row	Seed yield per plot (kg)	Seed yield (q ha $^{-1}$)
T_1: Chlorantraniliprole 0.1 ml / kg (ST)	12.60	13.32	17.67	18.67	3.76	47.33
T_2: Chlorantraniliprole 0.2 ml / kg (ST)	13.60	13.45	17.67	19.00	4.03	51.30
T_3: Chlorantraniliprole 0.3 ml / kg (ST)	14.00	13.80	18.00	20.33	4.63	58.67
T_4: Chlorantraniliprole 0.1 ml / kg (ST) and spray with chlorpyrifos 2 ml at 45 DAS	12.97	13.33	17.67	18.67	3.87	49.07
T_5: Chlorantraniliprole 0.2 ml / kg (ST) and spray with chlorpyrifos 2 ml at 45 DAS	13.71	13.71	17.67	20.00	4.27	54.67
T_6: Chlorantraniliprole 0.3 ml / kg (ST) and spray with chlorpyrifos 2 ml at 45 DAS	14.25	13.94	18.33	20.67	4.73	60.03
T_7: Chlorantraniliprole 0.1 ml / kg (ST) and spray with quinolphos 2 ml at 45 DAS	13.23	13.38	17.67	18.67	3.93	50.00
T_8: Chlorantraniliprole 0.2 ml / kg (ST) and spray with quinolphos 2 ml at 45 DAS	13.82	13.79	17.67	20.00	4.40	56.67
T_9: Chlorantraniliprole 0.3 ml / kg (ST) and spray with quinolphos 2 ml at 45 DAS	14.40	13.96	18.33	21.33	4.99	63.17
T_{10}: Control	12.33	13.23	17.33	18.33	3.67	46.73
S.Em±	0.85	1.04	1.25	1.50	0.23	3.08
CD (P=0.05)	NS	NS	NS	NS	0.68	9.14
CV (%)	10.98	13.19	12.20	13.25	9.31	9.91

Number of rows per cob

Number of rows per cob did not differ significantly among the treatments. Highest number of rows per cob (18.33) was observed in T_9 and T_6 which is on far with all other treatments except control. Where, the lowest (17.33) was observed in untreated control T_{10}.

Seed yield per plot (kg)

Seed yield per plot differed significantly due to the effect of new insecticide molecule. Highest seed yield per plot (4.99 kg) was observed in T_9 which is on par with T_6 (4.73 kg). Whereas, the lowest (3.67 kg) was noticed in untreated control T_{10}.

Seed yield per hectare (q ha^{-1})

Seed yield per hectare differed significantly due to the effect of new insecticide molecule. Highest (60.03 q ha^{-1}) seed yield per hectare was observed in T_9 which is on par with T_6 whereas, the lowest (46.73 q ha^{-1}) was observed in untreated control T_{10}.

There was significant difference observed in seed yields between the treatments and it is least in the control, the probable reason may be that higher concentration of the Chlorantraniliprole molecule was able to effectively control the insect infestation, reduce the leaf injury level due to its high trans laminar action, instant cessation of feeding of insects and long lasting potency and thus increase the yield levels compared to control. These results are similar to the findings obtained by Singh (2014) [7].

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