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Research article

Effect of imidacloprid pesticide on vegetative growth of selected plants

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Abstract: The present study to assess the effect of imidacloprid treatment on seed germination and seedling growth parameters including shoot length, root length and biomass shows that optimum concentration increases all the investigated parameters. Seed germination, as well as seedling parameters, were adversely affected with increasing concentrations. As the pesticide was sprayed over the seeds of *Celosia cristata* and *Chrysanthemum, growth* in terms of shoot length, root length, and fresh & dry weight were significantly reduced as compared to the control. The study suggested that imidacloprid is a broadly used insecticide, usage of this insecticide's optimum dosage is helpful for good agricultural practices.
Keywords: Imidacloprid - *Celosia cristata* - *Chrysanthemum* - Seedling growth parameters.

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INTRODUCTION

Integrated pest management (IPM) was use of biological control, biorational insecticides and conventional insecticides as tactics to control pests. The side effects on the compatibility of insecticides and biological control organisms were provided on the website (Koppert Biological Systems 2005) in which foliar imidacloprid is not compatible with biological control. Whereas systemic imidacloprid is considered more compatible. Foliar applications of imidacloprid killed foraging predators and parasitoids when they came in contact with residue on foliage (Mizell & Sconyers 1992, Boyd & Boethel 1998, Scalar *et al*. 1998).

Imidacloprid is a widely used insecticide with many formulations for different commodities and sites. It replaced organophosphates in ready-to-use products for homeowners (Bayer Advanced All-in-one Rose and Flower Care and Bayer Advanced season Long Grub Control), as well as landscape greenhouse and nursery insecticides (Merit, Marathon, and Imicide) and agricultural products (Admire, Provado and Gaucho). It is applied as a foliar spray, soil drench, soil granular, seed treatment, injected into irrigation systems, or injected directly into trees. Imidacloprid is a broad-spectrum insecticide that kills most insect species (Lind *et al*. 1998a, b). As a systemic insecticide, imidacloprid's effect on the behaviour and mortality of beneficial insects is not well researched. Cockscomb (*Celosia cristata* L.), belongs to Amaranthaceae which is mostly grown for use in landscape and some hybrid land racers are commercially used as cut flowers too.

Chrysanthemum is both a source of beautification and possesses high medicinal characteristics (Shahrajabian *et al*. 2019). *Chrysanthemum* of family Asteraceae, is said to be one of the most attractive and charming flowering plant. It is the world's second most important floriculture crop after Rose (Kalia 2015). The flower is commonly called as "queen of east", guldaudi in India. The study have following objective as to detect the efficiency of the selected pesticide on morphological attribute such as germination percentage of seed, plant height and biomass.

MATERIALS AND METHODS

Raising of Cultivars

Seeds of *Cockscomb* (*Celosia cristata* L.) and *Chrysanthemum* were purchased from seed market, Tenkasi,

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Tamil Nadu. Healthy and viable seeds were surface sterilized with 0.1% mercuric chloride for one minute and washed with running tap water, followed by rinsing with distilled water.

The seeds were soaked in distilled water for overnight and sown in poly cups and pots containing uniformly mixed red, loamy and sandy soils in 1:1:1 ratio as control, whereas experimental sets contained diluted solution of imidacloprid (Brand name: Victor) pesticide. All the sets were kept in diffused light at room temperature and watered every day. On the Tenth day both the sets of plants were taken for analysis. The percentage of seed germination was calculated by using the formula:

$$\text{Seed germination (\%)} = \frac{\text{Number of seeds germinated}}{\text{Total Number of seeds}} \times 100$$

Percentage of Seed vigour index

Vigour is the expression of a plant's response to its environment: to water supply, nutrition and temperature, to consider three of the more important elements. The seed vigour index is calculated by multiplying germination (%) and seedling length (cm) and the higher seed vigour index is considered to be more vigorous (Abdul-Baki & Anderson 1973).

$$\text{Vigour index} = \text{Germination (\%)} \times \text{Total seedling length (cm)}$$

Moisture content of seedlings

The moisture content of fifteen days old seedlings of Cockscormb and *Chrysanthemum* were calculated. Mean values of three seedlings were taken into account. Wet weight and dry weight was calculated and recorded as moisture content.

$$\text{Moisture content} = \text{F} - \text{D}$$

Growth Parameters

For all the growth characteristics, three seedlings were taken from each pot of experimental and control sets to measure the length of shoots and roots.

RESULT AND DISCUSSION

Days to Seed Germination

The results revealed that days taken to seed germination of *Celosia cristata* and *Chrysanthemum* as influenced by sowing dates has been demonstrated in table 1 and 2. The analysis showed a significant influence of sowing dates on seed germination of *Celosia cristata* and *Chrysanthemum.* Fallouts of *Celosia cristata* took minimum days to seed germination (2 to 3 days) whereas for seed germination took 5 days to as sown in poly cups respectively. The treatment interaction indicated that this variation might be due to environmental conditions where the temperature was high (33±2° C) in April as compared to March.

Table 1. Effect of Imidacloprid on seed germination percentage in selected plants.

S.N.	Plant Source	Treatment	Number of Seed Sown	Number of Seed Germinated	Percentage of Germination	Number of Days taken	Seed Vigour
1	*Chrysanthemum*	Control	10	6	60	2	411.0
		Treatment of pesticide	10	7	70	2	418.6
2	*Celosia cristata*	Control	10	7	70	3 to 4	458.5
		Treatment of pesticide	10	8	80	3 to 4	487.2

Table 2. Effect of Imidacloprid on morphological parameters in selected plants.

S.N.	Plant Source	Treatment	Root Length (cm)	Shoot Length (cm)	Total Height of the Plant	Fresh Weight	Dry Weight	Moisture Content
1	*Chrysan themum*	Control	1.75	5.10	6.85	0.06	0.005	0.037
		Treatment of pesticide	1.38	4.60	5.98	0.04	0.003	0.027
2	*Celosia cristata*	control	2.05	4.50	6.55	0.03	0.003	0.007
		Treatment of pesticide	1.96	4.13	6.09	0.01	0.001	0.009

The result of present study is following the findings of Akinbode *et al*. (2013) who reported that the germination was prompt in seed of *Amaranthus cruentus* L. (3–2 days) and *Corchorus olitorius* L. (4.4 days) under late sowing 25th March, while the seeds of *Delonix regia* (Boj. ex Hook.) Raf. germinated most on 10th

April, whereas germination of *Celosia argentea* L. and *Abelmoschus esculentus* (L.) Moench at early sowing 15th February had no main effect.

After 5 to 6 days of seed germination they were sprayed with insecticide (Brand name: Victor). Within 2 days exposure of different concentrations of insecticide (1.0 ppm, 2.5 ppm, 5.0 ppm and 7.5 ppm), the germination rate was decreased in *Celosia cristata* and *Chrysanthemum* seedlings respectively. The most effect (8%) of growth was imposed to imidacloprid (Victor) insecticide on seed germination was found at the highest concentration 2.5 ppm.

These results are in accordance with Santhoshkumar *et al.* (2016) evaluated the phytotoxic of chlorpyritos on *Celosia cristata* where the germination percentage negatively affect with increasing chlorpyritos level. Recently Bassey *et al*. (2015) studied the seed germination of soyabean (*Glycine max* L.) in the treatments of chlorpyriphos and ridomil. They found that seed germination was declined over treatment of pesticides.

Effect of Morphological Parameters

The effect of different concentrations of Insecticide (Victor) on shoot length shown in table 3. As the pesticide was sprayed over the seeds of *Celosia cristata* and *Chrysanthemum*, growth in terms of shoot length, root length, fresh and dry weight were significantly reduced as compared to the control (Table 3 & 4). In this line Irino *et al*. (2004) reported that 40% of the *Dryobalanops lanceolata* Burck seedlings died within 30 days after treated with chemical fertilizer due to foliar and root necrosis. Previous study concluded that dipterocarp seedlings were less responsive to easily soluble / liquid fertilizers since most of the dipterocarp species are characterized by relatively slow growth (Turner *et al.* 1993, Lee & Alexander 1994).

Table 3. Influence of different concentrations of Imidacloprid on morphological parameters of *Chrysanthemum.*

Plant Source	Planting Date	Conc. of pesticide	Initial stage of plants			After 10 days		After 20 days				
			Shoot length	Root length	Leaf lets	Shoot length	Leaf lets	Shoot length	Leaf lets	Buds	Flowers	Lateral branches
Chrysanthemum	22-2-2022	Control	8.50	5.75	6	11.25	10	30	44	1	1	4
		1.0 ppm	9.00	4.65	6	10.25	10	46	57	1	-	9
		2.5 ppm	8.50	3.00	5	9.25	8	44	55	1	-	11
		5.0 ppm	9.75	4.25	8	11.00	11	53	57	1	1	10
		7.5 ppm	10.25	4.75	7	10.75	10	62	62	2	2	13

Table 4. Influence of different concentrations of Imidacloprid on morphological parameters of *Celosia cristata* L.

Plant source	Conc. of pesticide	Initial stage of plants			After 10 days				After 20 days				
		Shoot length	Root length	Leaves	Shoot length	Lateral branches	Leaves	Buds	Shoot length	Lateral branches	Leaves	Buds	Flowers
Celosia cristata	Control	7.25	3.00	8	9.50	-	8	1	23	2	46	1	1
	1.0 ppm	7.25	2.75	7	8.00	-	9	1	28	3	64	1	1
	2.5 ppm	8.00	3.00	8	9.50	1	12	2	29.5	3	62	1	-
	5.0 ppm	6.50	2.75	7	8.25	-	9	-	30	3	60	1	1
	7.5 ppm	7.25	4.00	6	7.50	-	6	-	19	2	43	1	1

Some of weeds (e.g. Grasses, *Amaranthus*) were grown in *Chrysanthemum* and *Celosia cristata* planted fields. While the Insecticide (Victor) sprayed on the seedlings to control the growth of larvae, after a week period complex fertilizer *i.e.*, Profex super, All 19, Sprint powder as combinations also sprayed over the field. In later days, the growth of weeds and larvae were inhibited.

Our results are positively correlated with Coburn *et al*. (2018) evaluated the efficiency of selected post-emergence herbicides (Glyphosate, Dicamba, Clopyralid, Quinclorae and Triclopyr) on greenhouse-grown creeping bellflower.

Moechnig *et al*. (2007) observed that Triclopyr provides suppression of creeping bellflower but not an effective control. But victor insecticide sprayed on *Chrysanthemum* and *Celosia cristata* seedlings in field trails, pot studies and poly cups resulted in injury symptoms such as curled leaves, reduce growth, burning of seedlings were observed as the concentration of insecticide (ranged from 0.5 ppm to 2.5 ppm) increased. Whitson (2003) and Panke *et al.* (2012) suggested that Glyphosate and Dicamba as options for chemical control of creeping bellflower.

Imidacloprid was replaced by organophosphates in ready-to-use products for homeowners (Bayer Advanced All in One Rose and Flower Care and Bayer Advanced season Long Grub Control), as well as landscape, greenhouse and nursery insecticides (Merit, Marathon and Imicide) and agricultural products (Admire, Provado and Gaucho). It is applied as a foliar spray, soil drench, soil granular, seed treatment, injected into irrigation

system / injured directly into trees. Imidacloprid is a broad-spectrum insecticide that kills wide range of insect species (Lind *et al.* 1998a, b). As a systemic insecticide imidacloprid's affect on behaviour and mortality of beneficial insects is not well researched.

Krischik *et al.* (2007) suggested that imidacloprid applied as a soil granual is translocated to rectar in flowers and causes parasitoids to tremble and die. Imidacloprid induces over stimulation of the synapses, which results in hyperexcitation, convulsions, paralysis and death (Nagata *et al.* 1997, Bloomquist 2001).

The effect of different concentrations of imidacloprid (Brand name Victor) ranged from 1.0 to 7.5 ppm. An increase in on-shoot length was observed at a concentration of 2.5 ppm in *Celosia cristata* and *Chrysanthemum* seedlings with a comparison of control respectively. Thereafter, the shoot length was slightly increased with increasing the concentration of pesticide (Table 3 & 4).

The most destructive effect was recorded at a concentration of 7.5 ppm on shoot length was measured as 7.5 cm and 19 cm in 10 to 20 days old seedlings of *Celosia cristata* as compared to control respectively (Table 3).

The effect of root length of imidacloprid are depicted in table 2. The highest reduction of root length (1.38 cm and 1.96 cm) were observed at the higher concentration of treatments in 7 to 10 days old seedlings of *Chrysanthemum* and *Celosia cristata* respectively.

Increased concentrations of imidacloprid affect the fresh weight, the most destructive effect was observed in 7.5 ppm concentration in 7 to 10 days of *Chrysanthemum* (0.04 mg / plant) and *Celosia cristata* old seedlings (0.01 mg / plant) respectively.

Dry weight was gradually declined with increased imidacloprid dosage level 7.5 ppm 0.003 mg / plant of *Chrysanthemum* and 0.001 mg / plant of *Celosia cristata* respectively (Table 2) as compared to the control. Similar result was observed (Prasertsup & Ariyakanon 2011) that plant biomass was increased in the lowest concentration decreased in plant biomass in both *Pistia stratiotes* L. and *Lemna minor* L. As the increase of deltamethrin inhibits the radicle length of root is likely relation to the abnormally of chromosome (Duran *et al*. 2015).

In a study of Baig *et al*. (2003) reported that the application of glyphosate gradually declined the germination of seed and shoot fresh weight in pea plant. In the experiment of Stevens *et al*. (2008), showed that a higher dose of imidacloprid significantly affects the germination of rice seedlings. The study found that pesticides can reduce the germination percentage and seedling height in barley (Srivastava & Singh 2009). An earlier report (Kim & Ahn 2009) suggests that excessive and frequent use of chloropyrifos might have accumulated in agricultural crops.

The previous result reported that chloropyrifos toxicity in *Brassica chinensis* L. and concluded that chloropyrifos significantly inhibit the germination percentage, fresh weight and root length of *Vigna radiata* (L.) R. Wilczek. It has been earlier reported that dimetholate insecticide is a toxic effect on plant growth, photosynthetic pigments and photosynthetic activity in *Glycine max* L. (Panduranga *et al*. 2005). Recently, Santhoshkumar *et al*. (2016) examined the phytotoxicity of chlorpyrifos in green gram. Seedling growth prohibition might be due to the inhibition of hydrolytic enzyme synthesis or blocking of enzyme pathway in seed during germination (Gange *et al*. 1992).

The study suggested that Imidicloprad is a broadly used insecticide, usage of this insecticide optimum dosage is helpful for good agricultural practices. It will help to determine the phytoremediation potential of *Celosia cristata* and *Chrysanthemum* plant with response to Imidicloprad contaminated soil.

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