



Determination on growth and development of *Zingiber officinale* with the effect of triazole compounds

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Abstract

In the present investigation evaluated the ability of two triazole compounds viz. hexaconazole (HEX) and Uniconazole (UNI), in the enhancement of tuber production and quality in Ginger (*Zingiber officinale*). Among the treatments triazole showed beneficial growth by increasing the biomass of root system than the control plant. The morphometric parameters analysed in every 20, 40 and 60 days, the growth is slightly increase the shoot length, root length, plant height, leaf length, leaf width, no. of leaves, no. of hairy roots and shoot girth. This research finding suggested that the triazole compounds showed a great significant for the cultivation of rhizome medicinal plants which is helpful to meet the needs of the root growth and development in the plant system.

Keywords: *Zingiber officinale*, hexaconazole and uniconazole

Introduction

Ginger (*Zingiber officinale*) is an important spice crop with a variety of nutritional and medicinal uses. It is native to tropical Asia and is widely grown in tropical and subtropical regions. Potentially, it may be suitable for ethnic production on the Delmarva (Delaware, Maryland, Virginia) Peninsula of the United States if transplants can be successfully established from rhizome propagules (Leonard Kibet, 2007) [17]. Ginger has been traditionally used for treatment of headaches, nausea, colds (Grant and Lutz, 2000) [8], arthritis, rheumatism, muscular discomfort (Blumenthal and Werner, 1999) [4] and inflammation (Kiuchi *et al.*, 1982) [15]. Ginger therapeutic effects such as anti-inflammatory activities and moderate pungency have been attributed to the mixture of gingerol derivatives in oleoresins (Mustafa *et al.*, 1993) [18]. Triazoles are the active ingredient of fungicides (propiconazole, penconazole, epixiconazole) and the growth regulator paclobutrazol. The fungicidal properties of triazoles depend on inhibition of the C4-demethylase reactions in sterol biosynthesis of fungi (Allingham 2005) [2]. However, triazole-based fungicides induce a suite of morphological and physiological adaptations that allow plants to tolerate a broad range of environmental stresses including drought, herbicide treatment and elevated temperatures (Fletcher *et al.*, 1986, Kraus and Fletcher 1994, Jaleel *et al.*, 2006) [6, 16, 9]. Triazole compounds have both fungitoxic and plant growth-regulating properties (Jaleel *et al.*, 2006) [9]. In addition, they can also protect plants against various environmental stresses (Jaleel *et al.*,

2007, Jaleel *et al.*, 2008a) [13, 1]. Triazoles affect the isoprenoid pathway and alter the levels of certain plant hormones by inhibiting gibberellins synthesis, reducing ethylene evolution and increasing cytokinin levels (Jaleel *et al.*, 2008b) [11].

Materials and Methods

Collection of Rhizome of *Zingiber officinale* and triazole
Healthy *Z. officinale* rhizome was collected from Local market, Thanjavur, Tamilnadu, India. The triazole compound was purchased from Agricultural market, Thanjavur, Tamilnadu.

Pot Culture Experiments

The pot culture experiment was carried out Indian Biotrack Research Institute, Thanjavur, Tamilnadu, India. The pots were filled with the mixture of red soil + sand + farm yard manure in 1:1:1 ratio and each pot were filled with 25 kg mixture. 5 ginger segments were sown in each pot and triplicates were maintained under shade net.

Treatment combination:

T1 - Control

T2 - Foliar spray of Hexaconazole @ 25mg/L

T3 - Foliar spray of Hexaconazole @ 50mg/L

T4 - Foliar spray of Uniconazole @ 25mg/L

T5 - Foliar spray of Uniconazole @ 50mg/L

T6 - Foliar spray of Hexaconazole + Uniconazole @ 25:25 mg/L

T7 - Foliar spray of Hexaconazole + Uniconazole @ 50:50 mg/L

Every 20 days interval to analysis morphometric parameters of shoot length, root length, plant height, leaf length, leaf width, no. of leaves, shoot girth.

Table 1: Morphometric analysis of *Zingiber officinale* with triazole compounds on the growth and development 20 days treatments

Growth parameters	Treatments						
	Control	Hexaconazole (25mg)	Hexaconazole (50mg)	Uniconazole (25mg)	Uniconazole (50mg)	Hexaconazole+ Uniconazole (25:25mg)	Hexaconazole+ Uniconazole (50:50mg)
Shoot length (cm)	02.7±0.81	05.0±0.17	12.5±0.51	06.7±0.51	18.2±0.31	04.0±0.24	08.2±0.08
Root length (cm)	07.4±0.52	03.9±0.07	06.5±0.05	07.5±0.04	06.8±0.15	08.4±0.62	15.6±0.18
Plant height (cm)	04.5±0.33	09.8±0.65	19.7±0.32	14.1±0.56	25.6±0.94	07.1±0.32	14.2±0.06
Leaf length (cm)	09.5±0.01	14.2±0.45	14.1±0.14	06.9±0.57	19.5±0.21	09.6±0.54	12.8±0.34
Leaf width (cm)	0.40±0.11	0.80±0.55	01.1±0.67	0.56±0.06	0.91±0.08	0.52±0.60	0.40±0.07
No of leaves (nos)	05.0±0.56	08.0±0.33	11.0±0.03	08.0±0.87	12.0±0.05	05.0±0.20	09.0±0.65
No of hairy roots (nos)	12.0±0.00	31.0±0.54	43.0±0.66	37.0±0.68	20.0±0.38	20.0±0.97	25.0±0.54
Shoot girth(cm)	0.20±0.32	0.90±0.65	01.8±0.09	0.81±0.14	1.90±0.62	0.42±0.12	0.64±0.39

The values are expressed in terms of (Mean ± Standard deviation)

Table 2: Morphometric analysis of *Zingiber officinale* with triazole compounds on the growth and development 40 days treatments

Growth parameters	Treatments						
	Control	Hexaconazole (25mg)	Hexaconazole (50mg)	Uniconazole (25mg)	Uniconazole (50mg)	Hexaconazole+ Uniconazole (25:25mg)	Hexaconazole+ Uniconazole (50:50mg)
Shoot length(cm)	06.2±0.09	09.5±0.16	20.0±0.86	09.9±0.11	29.9±0.89	09.0±0.33	14.2±0.65
Root length(cm)	07.6 ±0.52	04.8±0.34	07.9±0.65	08.4±0.32	07.2±0.21	04.3±0.54	10.2±0.05
Plant height (cm)	08.9±0.05	15.4±0.52	29.4±0.32	18.5±0.68	37.6±0.50	14.5±0.45	09.7±0.09
Leaf length(cm)	09.7±0.65	14.4±0.84	14.3±0.74	07.1±0.50	19.6±0.23	09.8±0.14	10.7±0.47
Leaf width(cm)	0.90±0.02	01.2±0.16	01.8±0.12	0.80±0.59	1.61±0.71	0.74±0.12	0.60±0.02
No of leaves (nos)	06.0±0.35	09.0±0.54	12.0±0.71	09.0±0.08	13.0±0.47	06.0±0.16	10.0±0.41
No of hairy roots (nos)	14.0±0.12	33.0±0.76	45.0±0.51	39.0±0.64	23.0±0.19	17.0±0.57	20.0±0.64
Shoot girth(cm)	0.21±0.15	0.92±0.49	1.81±0.64	0.83±0.17	1.91±0.24	0.43±0.04	0.65±0.15

The values are expressed in terms of (Mean ± Standard deviation)

Table 3: Morphometric analysis of *Zingiber officinale* with triazole compounds on the growth and development 60 days treatments

Growth parameters	Treatments						
	Control	Hexaconazole (25mg)	Hexaconazole (50mg)	Uniconazole (25mg)	Uniconazole (50mg)	Hexaconazole+ Uniconazole (25:25mg)	Hexaconazole+ Uniconazole (50:50mg)
Shoot length (cm)	10.3±0.12	13.1±0.09	31.0±0.06	14.8±0.48	40.6±0.15	14.0±0.13	20.6±0.71
Root length (cm)	10.8±0.47	05.0±0.15	08.1±0.04	08.6±0.51	07.5±0.87	04.6±0.02	16.4±0.57
Plant height (cm)	16.2±0.07	18.5±0.13	39.4±0.54	23.8±0.24	48.6±0.41	16.2±0.07	27.0±0.27
Leaf length (cm)	12.2±0.21	14.5±0.14	14.4±0.53	7.13±0.88	19.7±0.42	9.84±0.13	12.8±0.04
Leaf width (cm)	1.70±0.57	1.80±0.83	2.00±0.15	1.70±0.17	2.10±0.16	1.90±0.42	1.80±0.67
No of leaves (nos)	07.0±0.77	10.0±0.23	13.0±0.45	11.0±0.76	14.0±0.16	07.0±0.25	11.0±0.85
No of hairy roots (nos)	16.0±0.41	35.0±0.63	47.0±0.11	41.0±0.05	25.0±0.55	19.0±0.47	21.0±0.48
Shoot girth (cm)	0.22±0.49	0.93±0.24	1.82±0.31	0.84±0.52	1.93±0.94	0.45±0.42	0.67±0.10

The values are expressed in terms of (Mean ± Standard deviation)

Result and Discussion

In the present investigation suggested that the effect of triazole compounds on the growth and development of *Zingiber officinale* with different time intervals of 20, 40 and 60 days were measured. The different treatment of triazole compounds of Hexaconazole, uniconazole and combined of hexaconazole and uniconazole (25, 50mg concentration) and maintained without triazole compound as control. The morphometric parameters of *Zingiber officinale* (without triazole compounds) were 02.7±0.81cm, 07.4±0.52cm, 04.5±0.33cm, 09.5±0.01cm, 0.40±0.11cm, 05.0±0.56nos, 12.0±0.00nos and 0.20±0.32cm found to be recorded with respective parameters such as shoot length, root length, plant height, leaf length, leaf width, no of leaves, no of hairy roots and shoot girth were recorded after 20 days treatment respectively. Triadimefon treatment increased the root growth in *Catharanthus roseus* (Jaleel *et al.*, 2008b) [11]. Triazole compounds increased the root

growth in *Catharanthus roseus* (Jaleel *et al.*, 2007) [13] and *Withania somnifera* Dunal (Jaleel *et al.*, 2008a) [1]. Paclobutrazol promoted root length in *Catharanthus roseus* (Jaleel *et al.*, 2009) [10]. This stimulation of root growth may be related to the increased partitioning of assimilates towards the roots due to a decreased demand on the shoot in triazole treated plants (Glavier *et al.*, 1991) [7]. Whereas the effective doses of triazole compounds such as hexaconazole and uniconazole were performed. The morphometric analysis of *Zingiber officinale* was minimum growth in treatment. It was 06.2±0.09, 07.6 ±0.52, 08.9±0.05, 09.7±0.65, 0.90±0.02, 06.0±0.35, 14.0±0.12 and 0.21±0.15 with shoot length, root length, plant height, leaf length, leaf width, no of leaves, no of hairy roots and shoot girth were to be recorded after 40 days of the treatments. In the case of 60 days of control was 10.3±0.12, 10.8±0.47, 16.2±0.07, 12.72±0.21, 1.70±0.57, 07.0±0.77, 16.0±0.41 and 0.22±0.49 with shoot length, root length, plant height,

leaf length, leaf width, no of leaves, no of hairy roots and shoot girth were represented with respective treatment. The treatment of triazole compounds of combination was with growth parameters such as shoot length, root length, plant height, leaf length, leaf width, no of leaves, no of hairy roots and shoot girth were analysed with sole growth of *Zingiber officinale*. A decreased leaf size was observed in the triazole treated *Catharanthus roseus* (Jaleel *et al.*, 2009) ^[10]. Tebuconazole treatment resulted in significant reduction of total leaf area in *Brassica napus* (Child *et al.*, 1993) ^[5]. Triazole treated plants have exhibited thickened fleshy roots with increased root diameter and weight in *Catharanthus* (Abdul Jaleel *et al.*, 2008) ^[1] and *Vigna unguiculata* (L.) Walp (Paramasivam Manivannan *et al.*, 2008). A significant enhancement in fresh weight was noted in paclobutrazol treated *Catharanthus* plants (Jaleel *et al.*, 2007b) ^[14]. Triazoles acts as antigibberellins, controls shoot growth by inhibiting the production of gibberellins, which are responsible for the cell elongation of shoots and leaves (Barrett *et al.*, 2001) ^[3]. Triazoles reduce the cell number, length, and width of the xylem cells (Jaleel *et al.*, 2008) ^[1]. Triazole induced a marked reduction in stem DW, and this may be attributed to the reduced GA level by triazole treatment. The stimulation of root growth may be related to the increased partitioning of assimilates towards the roots due to decreased demand in the shoot (Tekalign *et al.*, 2005) ^[20]. Inhibition of gibberellin biosynthesis and increase in cytokinin content induced by triazoles (Kishorekumar *et al.*, 2007) ^[14] may be a reason for increased root growth in the triazole-treated cassava plants. Toda *et al.* (2021) reported that the helpful to understand the reasons behind the large increases in triazole fungicides. Because both triazoles and *A. fumigatus* can travel in the environment, exposure and resistance selection should be considered beyond the sites of application at agricultural fields.

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References

1. Abdul Jaleel C, Gopi R, Panneerselvam R. Growth and photosynthetic pigments responses of two varieties of *Catharanthus roseus* to triadimefon treatment. *Comptes Rendus Biologies*,2008:331:272-277.
2. Allingham R. The effect of the growth retardant paclobutrazol on the *in vitro* growth and development of *Betula* and *Populus* species. M.Sc. Thesis, University of Central Lancashire, UK, 2005, 12-14.
3. Barrett J. Mechanism of action, in: M. Gaston (Ed.), *Tips on Regulating Growth of Floriculture Crops of a Services, Inc.*, Columbus, 2001, 32-41.
4. Blumenthal M, Werner BR. *The complete German Commission E monographs: therapeutic guide to herbal medicines*. Austin, Tex: American Botanical Council; Boston, MA: Integrative Medicine Communications, 1999.
5. Child RD, Evans DE, Allen J, Arnold GM. Growth responses in oil seed rape (*Brassica napus* L.) to combined applications of triazole chemicals triapenthenol and tebuconazole interactions with gibberellin. *Plant Growth Regul*,199313:203-212.
6. Fletcher RA, Hofstra G, Gao J. Comparative fungitoxic and plant growth regulating properties of triazole derivatives. *Plant Cell Physiol*,1986:27:367-371.
7. Glavier V, Perez-Alfocea F, Bourgeois-Chaillou P, Guerrier G., 1991. Influence of cotyledon upon sucrose metabolism in axis of germinating pea. *J. Plant Physiol*,1986:138:421-428.
8. Grant KL, Lutz RB. *Alternative therapies: ginger*. *Am J Health Syst Pharm*,2000:57:945-947.
9. Jaleel CA, Gopi R, Alagu Lakshmanan GM, Panneerselvam R. Triadimefon induced changes in the antioxidant metabolism and ajmalicine production in *Catharanthus roseus* (L.) G. Don. *Plant Sci*,2006:171:271-276.
10. Jaleel CA, Gopi R, Gomathinayagam M, Panneerselvam R. Traditional and non- traditional plant growth regulators alter phytochemical constituents in *Catharanthus roseus*. *Process Biochem*,2009:44:205-209.
11. Jaleel CA, Lakshmanan GMA., Gomathinayagam M, Panneerselvam R. Triadimefon-induced salt stress tolerance in *Withania somnifera* and its relationship to antioxidant defense system. *S. Afr. J. Bot*,2008:74:126-132.
12. Jaleel CA, Gopi R, Kishorekumar A, Manivannan P, Sankar B, Panneerselvam R. Interactive effects of triadimefon and salt stress on antioxidative status and ajmalicine accumulation in *Catharanthus roseus*. *Acta Physiol. Plant*,2008:30:287-292.
13. Jaleel CA, Gopi R, Manivannan P, Panneerselvam R. Responses of antioxidant defense system of *Catharanthus roseus* (L.) G. Don. to paclobutrazol treatment under salinity. *Acta. Physiol. Plant*,2007:29:205-209.
14. Kishorekumar A, Abdul Jaleel C, Manivannan P, Sankar B, Sridharan R, Panneerselvam R. Comparative effects of different triazole compounds on growth, photosynthetic pigments and carbohydrate metabolism of *Solenostemon rotundifolius*. *Colloids and Surfaces B: Biointerfaces*,2007:60:207-212.
15. Kiuchi F, Iwakami S, Shibuya M, Hanaoka F, Sankawa U. Inhibitors of prostaglandin biosynthesis from ginger. *Chem. Pharm. Bull*,1982:30:754-757.
16. Kraus TE, Fletcher RA. Paclobutrazol protects wheat seedlings from heat and paraquat injury. Is detoxification of active oxygen involved? *Plant Cell Physiol*,1994:35:45-52.
17. Leonard Kibet. *Influence of Poultry Compost Mixes and Mycorrhizae on Growth and Development*. *Hortscience*, 2007, 42(4).
18. Mustafa T, Srivastava KC, Jensen KB. *Drug development report: 9. pharmacology of ginger, Zingiber officinale*. *J Drug Dev*,1993:6:25-39.
19. Paramasivam Manivannan, Abdul Jaleel C, Kishorekumar A, Sankar B, Somasundaram R, Panneerselvam R. Protection of *Vigna unguiculata* (L.) Walp. Plants from salt stress by paclobutrazol. *Colloids and Surfaces B: Biointerfaces*,2008:61/2:315-318.
20. Tekalign T, Hammes S, Robbertse J. Paclobutrazol induced leaf stem and root anatomical modifications in potato. *Hort. Sci*,2005:40(5):1343-1346.