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ARTICLE

Differential effects of hexaconazole and paclobutrazol on the foliage characteristics of Chinese potato (*Solenostemon rotundifolius* Poir., J.K. Morton)

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ABSTRACT In the present investigation, the impact of hexaconazole (HEX) and paclobutrazol (PBZ), triazole fungicides, on the leaf anatomy of Chinese potato (*Solenostemon rotundifolius* Poir., J.K. Morton) was studied. The thickness of leaf, upper and lower epidermis, number of palisade and spongy cells per unit area, number of chloroplast per palisade and spongy cells, number of stomata in upper and lower epidermis, stomatal pore length and width were observed in both control and treatments. Leaves treated with HEX and PBZ showed several variations in the anatomical characteristics. **Acta Biol Szeged 50(3-4):127-129 (2006)**

KEY WORDS

Solenostemon rotundifolius
hexaconazole
paclobutrazol
anatomy
stomata

Solenostemon rotundifolius Poir., Morton is one of the important vegetable crops belongs to the family Labiatae and cultivated in many parts of the world for its edible tubers. In the phylogenetic and taxonomic studies of the higher plants, anatomical characteristics have a profound role. The structure and ontogeny of stomata in different plants will vary with the application of different growth regulators (Gupta et al. 2004). Leaf anatomy is an important feature for internal water balance of the plants. The anatomical characteristics were found changed due to the application of growth regulators. Triadimefon treated mulberry plants showed great variations in the stomatal structure and functions (Sreethar 1991). Triazole compounds are systemic fungicides, which have plant growth regulating properties (Fletcher and Hofstra 1990).

The impact of triazole plant growth regulators on hormonal changes (Ye et al. 1995; Fletcher et al. 2000), photosynthetic rates (Panneerselvam et al. 1997) and enzyme activities (Muthukumarasamy and Panneerselvam 1997) have been reported. The plant growth regulating properties of triazoles are mediated by their inference with isoprenoid pathway and shift in the balance of plant hormones (Fletcher et al. 2000). Paclobutrazol (PBZ) increased the leaf thickness in rape plant due to elongated palisade cells (Zhou et al. 1993) and wheat leaves (Sopher et al. 1999). The triazole compounds protect plants from chilling stress (Feng et al. 2003), salt stress (Muthukumarasamy et al. 2000) as well as exhibit powerful fungicidal properties (Davis and Curry 1991). Previous works proved the ability of triazole compounds such as triadimefon (TDM) in enhancing the antioxidant potential in plants like *Catharanthus roseus* (Jaleel et al. 2006). The information available so far about the effect of triazole on leaf anatomy in plants is less. Hence it is aimed to understand the effect of triazole compounds such as hexaconazole (HEX) and PBZ in *S. rotundifolius*. The objectives of the present investigation were to study the impact of HEX and PBZ on leaf thickness, thickness of upper and lower epidermis, number of palisade and spongy cells per unit area, number of chloroplast per palisade and spongy cells and number of stomata and stomatal pore length in *S. rotundifolius* plants.

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Materials and Methods

The tubers of *S. rotundifolius* were obtained from Central Tuber Crop Research Institute (CTCRI), Kerala and planted in the Botanical Garden of Annamalai University, Tamil Nadu. In the present investigation, a field experiment was conducted in Randomized Block Design (RBD) with 7 replicates in *S. rotundifolius* during 2004-2005. Each plant was treated with 10 mg l^{-1} (active principles) of HEX and PBZ on vegetative stages like 80, 100 and 140 days after planting (DAP). The treatments were given by soil drenching. The fully expended mature leaves of plants, which emerged after the treatments were collected randomly on 90, 120 and 150 DAP from each concentration and control.

The leaves were washed thoroughly with water and fixed them in formalin: acetic acid: ethyl alcohol (5:5:90 v/v/v). Thin transverse-sections were taken, stained and observed under calibrated light microscope and the thickness of leaf was measured by precalibrated ocular micrometer. Epidermal peels were taken out from the basal, middle and apical regions by adopting direct peel method. The epidermal peels were stained with 1% Delafield's haematoxylin and mounted in 50% glycerin (Dwivedi and Singh 1990). The observations were taken on 90, 120 and 150 DAP in seven replicate peels in each treatments. The leaf, upper and lower epidermis thickness expressed in micrometers and number of stomata in upper and lower epidermal cells per unit area were calculated by using the generally followed formula of Metcalfe and Chalk (1979). The length and width of stomatal pores were measured randomly in each treatment on the lower surface. The number of spongy cells per unit area and chloroplast per palisade and spongy cells were also calculated separately to find out the relative effect of triazole compounds.

Statistical analysis

The data were analysed using the analysis of variance (ANOVA) as described by the method outlined by Ridgman (1975). Means were compared between treatments from the error mean square by Least Significant Difference (LSD) at the P≤0.05 and P≤0.01 confidence level using Tuckeys (1953) test.

Results and Discussion

Thickness of leaves treated with triazoles was increased to a level higher than that of control leaves in *S. rotundifolius* plants. Among the triazole treatments there is no significant variation in thickness of leaf, upper and lower epidermis (Table 1). TDM treatments increased the thickness of leaf in plants (Asami et al. 2000).

The number of cells per unit area in the palisade spongy layers and chloroplast number per cells in the leaves increased by the HEX and PBZ treatments when compared to control leaves (Table 2). Among the triazole treatments, there was no significant difference in these characters. Increased mesophyll thickness, chloroplast size and level were reported in wheat with TDM (Gao et al. 1988). Triazoles increased the cytokinin levels in various plants like cucumber (Fletcher and Arnold 1986). The increased cytokinin level also can accelerate chloroplast differentiation and chlorophyll production and also protect the integrity of chlorophyll molecule (Fletcher et al. 2000).

Several variations like stomatal pore length, width and unequal accessory cells were observed in treated leaves. In the case of untreated leaves all stomata are open and have large stomatal pore length but width of stomata gradually decreased in the leaves of treated plants (Table 2). Triazole treatments caused the closure of stomata in bean (Fletcher and Hofstra 1988). Thiapenthenol reduced stomatal opening and reduced water consumption in mesophyll, a transient raise in the ABA content in bean (Asare-Boamah et al. 1986). This increased ABA content might have induced the stomatal closure as observed in uniconazole treated *Phaseolus vulgaris* (Mackay et al. 1990).

From the above observations it is clear that the triazole compounds affected stomatal pore length and width, stomatal pore size, thickness of upper and lower epidermis and the number of stomata, palisade, spongy cells, chloroplast per palisade and spongy cells. This is in accordance with the previous reports of Bora et al. (2002) and Gupta et al. (2004). It is previously reported that the application of PBZ can in-

Table 1. Effect of triazole fungicides on leaf anatomical characteristics of *S. rotundifolius.*

Growth stages (DAP)	Control	HEX 10 mg l^{-1}	PBZ 10 mg l^{-1}	LSD
		Leaf thickness (μ meter)		
90	62.18*	74.4*	66.13*	0.87
120	88.48*	89.40*	88.33*	1.24
150	89.61*	89.91*	86.15*	1.31
		Thickness of upper epidermis (μ meter)		
90	11.83*	14.36*	14.15*	0.67
120	12.24*	13.04*	14.31*	0.62
150	13.02*	16.03*	13.67*	0.58
		Thickness of lower epidermis (μ meter)		
90	8.43NS	7.19NS	7.11NS	0.14
120	9.56*	8.94*	9.94*	0.12
150	9.99*	10.12*	9.99*	0.18
		Number of palisade cells per unit area		
90	21.54NS	22.71NS	21.61NS	0.18
120	22.61*	23.41*	24.48*	0.20
150	23.13*	25.67*	25.01*	0.21
		Number of spongy cells per unit area		
90	37.04**	42.10**	41.41**	0.86
120	38.99**	45.61*	44.31*	0.94
150	41.67**	49.41*	49.01*	1.02

HEX – hexaconazole; PBZ – paclobutrazol; LSD – least significant difference; NS – non significant; *significant at 0.05 level; **significant at 0.01 level

Table 2. Effect of triazole fungicides on leaf anatomical characteristics of *S. rotundifolius.*

Growth stages (DAP)	Control	HEX 10 mg l^{-1}	PBZ 10 mg l^{-1}	LSD
		Number of chloroplast per palisade cells		
90	12.14*	13.11*	13.01*	0.18
120	14.15NS	14.30NS	14.90*	0.26
150	14.17NS	14.20NS	14.84*	0.22
		Number of chloroplast per spongy cells		
90	11.50NS	11.36NS	12.95*	0.14
120	12.51*	14.49*	14.34*	0.15
150	13.34*	15.42*	15.59*	0.28
		Number of stomata in lower epidermis (nos/mm^2 leaf area)		
90	10.61*	11.59*	11.65*	0.17
120	12.41**	15.34**	15.50**	0.21
150	14.41**	17.45**	17.20**	0.26
		Lower stomatal pore length (μ meter)		
90	12.04**	10.51**	10.35**	0.12
120	13.01*	12.34*	11.75**	0.16
150	13.99*	12.98*	12.90*	0.18
		Lower stomatal pore width (μ meter)		
90	3.41*	2.52*	2.63*	0.08
120	3.50*	2.93*	3.00*	0.09
150	3.67*	3.10*	3.21*	0.09

HEX – hexaconazole; PBZ – paclobutrazol; LSD – least significant difference; NS – non significant; *– significant at 0.05 level; **– significant at 0.01 level crease the xylem water potentials (Thakur et al. 1998) and can increase the cytokinins under drought conditions (Zhu et al. 2004). The judicious application of triazole like HEX and PBZ may prove to be a useful tool for decreasing transpiration and inturn inducing drought avoidance mechanisms. It can be concluded that triazole such as HEX and PBZ may be useful to trigger drought avoidance mechanisms in plants like *S. rotundifolius*.

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