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Triazoles : Their Effects on Net Photosynthetic Rate, Transpiration Rate and Stomatal Resistance in *Setaria italica* Plants grown in *vivo*

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Abstract : The effects of different concentration of triazoles [Triademefon (TDM) and Paclobutrazol (PBZ)] on net photosynthetic rate, transpiration rate and stomatal resistance were studied in *Setaria italica* plants grown under field conditions. Net photosynthetic rates (Pn), transpiration rates (Tr) and stomatal resistances (Sr) were recorded after second and fifth day of third treatment. Plants treated with triadimefon (5 and 10mg/liter) and paclabutrazol (5 and 20 mg/liter). Highest Pn was observed in TDM (5mg/liter) whereas lowest Pn in PBZ (5mg/liter) after second and fifth day. Tr increased with increasing concentrations of both treatments. After second treatment, Sr increased with higher concentration of TDM and PBZ whereas after fifth day Sr enhanced with increasing concentration of TDM but decreased with of PBZ.

Key words : Triazoles, Triadimefon, Paclobutrazole, Net photosynthetic rate, Transpiration rate, and Stomatal resistance.

Introduction

Triazoles are the most potent groups of growth retardants with multiple effects. These are commercially important for example (Triadimefon) [1-(4-chlorophenoxy) -3, 3 dimethyl-1-(1,2,4-triazol-1yl)-2-butanol] is highly active systemic fungicide used against several economically important disease and named "Bayleton". Some triazoles like Paclobutrazol {[2RS, 3RS]-1-[4-chlorophenyl]-4,-4-dimethyl- 2-[1,2,4-triazol-1-yl] pentane-3-ol, also known as pp333}are active inhibiting extension growth.

Plant growing with paclobutrazol generally has little effect on rates of net photosynthetic rate (De Jong and Doyle, 1984; Wample and Culver, 1983; Wood, 1984; Marquar, 1985; Wieland and Wample, 1985). However, because the compound reduces leaf area, net photosynthesis on a per plant basis is probably reduced. They have exhibited growth regulating, fungicidal, herbicidal, apicidal and antibacterial activities (Seigal, 1981; Kato, 1982; Fletcher and Hofstra, 1988; Devis and Sankhla, 1988; Hickman *et al*., 1989; Basarab *et al*., 1991; Morrow, 1991; Simmon *et al*., 1992; Gilley and Fletcher, 1997).

Setaria italica (SIA 326) belongs to family poaceae. It commonly known as Foxtail-millets, kagni, a most common small millet. It is largely used as human food. The seeds have an agreeable taste with nutty flavour, different from cereals, and are well liked by tribal.

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However, very few experiments have been carried out to study the influence of physiological parameters like photosynthesis, transpiration and stomatal resistance in *S. italica* plants. It has been suggested that photosynthesis efficiency may be directly related to biomass production (Sanker *et al*., 1991; Chen, 1992; Bisht *et al*., 2000).

The present study, analyzes the effect of triazoles on physio-biochemical parameters so that results could be used for further improvement in crop production.

Material and Methods

Setaria italica plants were used for the present study. For field studies seeds of *S. italica* were grown in 12" earthenware pots. Seven to nine seeds were sown but only four seedlings per pot were kept after the selection. Pots were watered regularly. Different concentrations of triadimefon (5 and 10 mg/liter) and paclobutrazol (5 and 20 mg/liter) were given to plants. For this 500 ml of required concentrations of chemical were given to each pot. The treatment was repeated every week. Pots treated with water throughout without any chemical served as control. Top terminal leaves served as plant material for measurements.

Measurements of net photosynthetic rate(Pn), transpiration rate(Tr) and stomatal resistance (Sr) on intact leaves were obtained by using CID leaf chamber attachment in conjunction with the C1-301 portable Co_2 gas analyzer. The Co_2 gas analyzer determines net photosynthetic rate by measuring the photosynthetic rate at which a known leaf area assimilates a Co_2 concentration in a given time. The net photosynthetic rate is thus obtained is expressed in mol/m^2/s. Transpiration rate is measured by the water vapour flux per one sided leaf area and is expressed as mol/m^2/s. Stomatal resistance is obtained by measuring transpiration and leaf surface temperature and is measured as m^2s/mol. All these measurements were taken in open system measurement mode of the analyzer. Two measurements were taken on second and fifth day respectively in the normal condition. The data on net photosynthetic rate, transpiration rate and stomatal resistance have been summarized in Table 1 and 2.

Result and Discussion

In the present investigation, *S. italica* plants grown under field condition showed variables rate of net photosynthetic rate, transpiration rate and stomatal resistance (Gadi and Bohra, 2005). Triazoles are more potent than most other growth retardants and relatively low concentrations are required to inhibit shoot growth (Clifford and Lenton, 1979; Kaufman and Song, 1988; Davis and Sankhla, 1988; Raghava and Raghava, 1998; Bisht *et al*., 2000).

Paclobutrazol-treated leaves of the Indian cultivars exhibited higher chlorophyll content and remained intact on plants for a longer period than the control, as was found in Chinese cultivars (Zhou and Xi, 1993), barley (Forster *et al*., 1980a,b). The pronounced effect of triazoles on plant is a reduction in height, with the treated plants being greener and more compact (Fletcher and Hofstra, 1988). The same morphological effects were found in *S. italica* plants (Table 1 and 2).

Triadimefon treatment is known to improve the survival of plants during period of drought (Fletcher and Hofstra, 1988). Similarly, *S. italica* plants treated with different concentrations of triadimefon

Table 1: Effect of triazoles on net photosynthetic rate, transpiration rate and stomatal resistance after second day of III treatment in *Setaria italica* plants grown in *vivo*.

Treatment	Net Photosynthetic Rate (Pn) [mmole/m2/s]	Transpiration Rate (Tr) [milimol/m2/s]	Stomatal Resistance (Sr) [m2s/mol]
Control	35.4 ± 2.33	0.8 ± 0.129	30.7 ± 3.628
Triadimefon 5 mg/liter	33.2 ± 2.088	0.9 ± 0.059	50.3 ± 2.129
Triadimefon 10 mg/liter	30.0 ± 1.255	1.05 ± 0.027	48.1 ± 1.223
Paclobutrazol 5 mg/liter	19.5 ± 1.725	0.9 ± 0.069	31.2 ± 2.42
Paclobutrazol 20 mg/liter	21.1 ± 1.464	1.1 ± 0.082	19.5 ± 1.024

Table 2: Effect of triazoles on net photosynthetic rate, transpiration rate and stomatal resistance after fifth day of III treatment in *Setaria italica* plants grown in *vivo*.

Treatment	Net Photosynthetic Rate (Pn) [mmole/m^2/s]	Transpiration Rate (Tr) [milimol/m^2/s]	Stomatal Resistance (Sr) [m^2s/mol]
Control	18.6 ± 0.924	2.8 ± 0.176	10.5 ± 0.247
Triadimefon 5 mg/liter	20.3 ± 1.294	0.9 ± 0.094	22.9 ± 2.712
Triadimefon 10mg/liter	18.5 ± 1.071	1.12 ± 0.137	35.2 ± 3.114
Paclobutrazol 5 mg/liter	9.6 ± 0.824	0.8 ± 0.742	37.1 ± 2.765
Paclobutrazol 20mg/liter	10.9 ± 0.126	3.4 ± 0.321	21.3 ± 1.948

showed higher net photosynthetic rates after III treatment on second day whereas, paclobutrazol-treated plants exhibited lower net photosynthetic rate as compared to control. The highest net photosynthetic rate was recorded in plants treated with 5 mg/liter of triadimefon after III treatment (Table 1). Like paclobutrazol, even triadimefon has been reported to increase chlorophyll content, activity of RUBP-carboxylase, and photosynthetic rates in peanut (Yan and Pan, 1992). It reduced transpiration rates, increase relative water content and significantly increase yield in crop plants under moisture stress (Sairam *et al*., 1995; Gadi *et al*., 2001).

The foliage of triazole-treated plants typically exhibits intense dark color compare to untreated controls. In most cases, this is due to enhanced chlorophyll content (Devis and Sankhla, 1988; Sankhla *et al*., 1985 and more densely packed chloroplasts in a smaller leaf area (Khalil, 1995).

Measurements, which were taken on fifth day after III treatment (Table 2) showed increased net photosynthetic rate in plants treated with different concentrations of triazoles as compared with the results obtained in table 1. But decreased net photosynthetic rates were found in triadimefon and paclobutrazol treated plants when compared to control plants (Table 2). Highest net photosynthetic rates were recorded in control plants after III treatment. However, in general triazoles have little effect on net photosynthetic rates on a leaf area basis, but indirectly, by inhibiting leaf expansion. They may decrease whole plant photosynthesis (Davis and Sankhla, 1988; De Jong and Doyle, 1984; Wample and Culver, 1983; Wood, 1984; Marquar, 1985; Wieland and Wample, 1985).

Transpiration rates and stomatal resistance offered by guard cells showed definite trend of increase or decrease with the rates of net photosynthetic rates. Inhibitory effective rates of net photosynthesis were coupled with high stomatal resistance and low transpiration rate and vice-versa condition was prevalent in high rates of net photosynthesis.

Triazoles significantly reduced height and modified structure by enhancing the number of branches (Setia *et al*., 1995; Richardson and Quinlan, 1986). The seed yield per plant was also increased. Leaves exhibited higher chlorophyll content and remained intact on plants for a longer period than the controls (Mc Arther and Eaton, 1987).

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