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Transpiration and Photosynthesis as Affected by Triazoles in Mulberry (*Morus alba* L.)

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ABSTRACT
Mulberry (Morus alba L.) belongs to the family moraceae. Mulberry is the basis for commercial sericulture since mulberry leaf is a natural and sole food for silkworms (Bombyx mori L.). Triazoles compounds are widely used systematic fungicides to control diseases in plants and animals. The fungicides triademefon (TDM) 15 mg L^{-1} and paclobutrazol (PBZ) 12 mg L^{-1} were used by soil drenching on 70, and 120 days after planting. The effects of different concentration of triazoles (TDM and PBZ) compounds increased total chlorophyll, carotenoid content, intercellular CO_2 concentration, net photosynthetic rate (P_N), water use efficiency, total root length, dry weight, and moisture content. On the other hand, petiole length, total leaf area, stomatal conductance, transpiration rate (T_R) were decreased. Among the triazole compounds PBZ showed higher effectiveness than the other two triazole compounds. It is concluded that triazoles are able to protect plants from the environmental stress conditions in mulberry varieties.

Key words: *Triazoles, Net photosynthetic rate, Transpiration rate, Stomatal resistance.*

1. INTRODUCTION

Mulberry is an important crop plant in sericulture, and its foliage is the exclusive food of domesticated silkworm *Bombyx mori* L. which produces the natural silk used in textile industries. To a great extent, increasing the production of raw silk depends on higher yield and quality in mulberry leaves. Leaf yield in mulberry is a polygenic character influenced by several quantitative characters [1], and is the cumulative consequence of various physiological processes. Earlier studies were conducted to investigate the interrelationship of yield components from a mainly morphological point of view [2,3]. The literature shows that photosynthesis, the prime physiological parameter and basis for biological yield, is correlated for exchange and thus has a direct effect on crop production.

The triazole compounds are the largest and most important group of systemic compounds developed for the control of fungal diseases in plants. Many of the triazole compounds have both fungi toxic and plant growth regulating properties. However, work on the use of these triazole compounds to increase the yield of the crop is scanty. More recently it was found that the triazole compounds are able to protect plants from the environmental stress conditions. The triazole mediated stress protection is often explained in terms of hormonal changes such as an increase in cytokinins, a transient rise in ABA, and decrease in ethylene.

2. MATERIALS AND METHODS

2.1. *Plant Material*

V_1, S_{13}, S_{36}, M_5 and Anantha Mulberry plants were used for the present study. Based on high, medium and low yield potential for 3-4 inches stem cutting mulberry varieties were selected from the RSRS regional sericulture station, Anantapur India. Plant material raised Under irrigated conditions standard fertilizer (300:120:120 kg NPK ha^{-1} $year^{-1}$), and manure application (20 t compost ha^{-1} $year^{-1}$) as described by [4]. The garden soil was red loamy (pH - 7.25-7.65) with electrical conductivity ranging from 0.11 to 0.13 S cm^{-1}. Pots were regularly watered. Different concentrations of triademefon (TDM) 15 mg L^{-1} and paclobutrazol (PBZ) 12 mg L^{-1} and were given to plants. For this of chemical were given to each pot. The treatment was repeated every week. Pots have been treated without any chemical served as plant material for measurements.

Measurements of net photosynthetic rate (P_N), transpiration rate (T_R) and stomatal resistance (S_R)

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on intact leaves were obtained by using portable photosynthetic system IRGA LI-COR CO_2 gas analyzer. The CO_2 gas analyzer determines net 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 vapor 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^2 s/mol. These measurements were taken in open system measurement mode of the analyzer. Two measurements were on 70 days (days after planting [DAP]) and 120 days (DAP) respectively in a normal condition. The data on net photosynthetic rate, transpiration rate and stomatal resistance have been summarized in Tables 1 and 2 & Figures 1 and 2.

2.2. *Growth Parameters*

Total root length, petiole length, leaf area and dry weight of root measured. Moisture content was calculated by subtracting the dry weight from the fresh weight.

2.3. *Photosynthetic Pigments Determination*

Total chlorophyll and carotenoids in the second leaf of the mulberry plants were extracted in 80% acetone. The amount of pigments was determined spectrophotometrically after centrifugation at 3000 rpm for 10 min [5].

2.4. *Gas Exchange Measurements*

Net photosynthetic rate (P_N), transpiration rate (T_R) intercellular CO_2 concentration (C_i) and stomatal conductance were measured on fully expanded leaves of three individual plants for each treatment at the respective intervals. Gas exchange measurements were done using IRGA LI-COR. Measurements of P_N, T_R, C_i, and stomatal conductance were done at CO_2 concentration of 340 μ mol^{-1} leaf to air vapor pressure difference of 2.5-3.5 kpa and photosynthetically active irradiance of 1400 ± 50 μmol m^{-2} s^{-1}. Water use efficiency represents the ratio of carbon assimilated to water lost by transpiration [6]. It was calculated by dividing P_N, by T_R [7].

3. RESULTS AND DISCUSSION

Our results indicated that total root length increased significantly with triazole treatment

Table 1: Triazoles-induced changes in growth and photosynthetic parameters of mulberry 70th DAP.

Parameters	Control	TDM	PBZ
Total root length (cm $plant^{-1}$)	450.2	794.6	627.2
Petiole length (cm $plant^{-1}$)	38.6	30.5	27.2
Total leaf area (cm^2 $plant^{-1}$)	36.54	28.5	26.80
Dry weight of whole plants (g $plant^{-1}$)	91.3	168.7	162.8
Moisture content of whole plants (g $plant^{-1}$)	289.1	407.2	390.2
Carotenoids (mg g^{-1} FW)	0.012	0.042	0.032
Net photosynthetic rate (P_N) (μmol CO_2 m^{-2} s^{-1})	17.5	20.6	22.8
Transpiration rate (T_R) (μmol H_2O m^{-2} s^{-1})	12.15	8.8	9.36
Intercellular CO_2 concentration (μmol s^{-1})	214	273	267
Stomatal conductance (μmol H_2O m^{-2} s^{-1})	82.1	72.9	71.8
WUE (μmol CO_2 m^{-2} s^{-1}/ μmol CO_2 m^{-2} s^{-1})	1.5	2.1	2.12

DAP = Days after planting; TDM = Triademefon; PBZ = Paclobutrazol

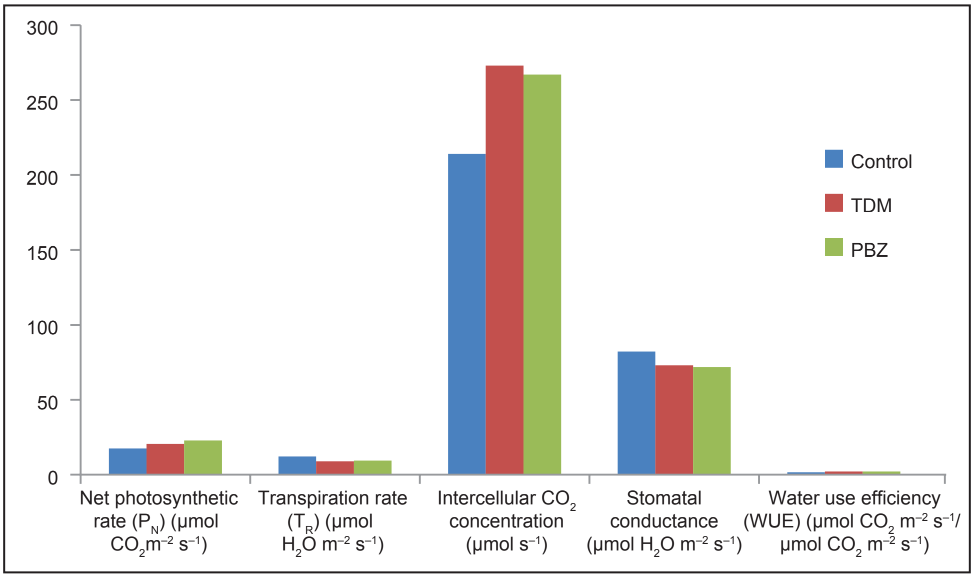

Figure 1: Triazoles induced changes in growth and photosynthetic parameters of mulberry 70 days after planting.

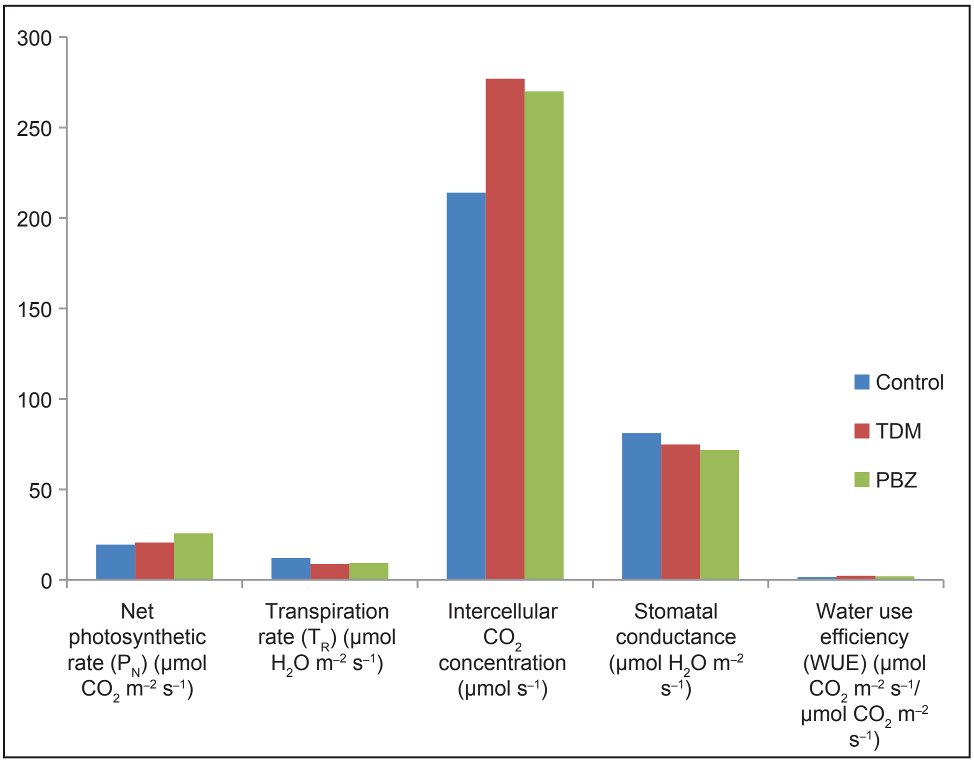

Figure 2: Triazoles induced changes in growth and photosynthetic parameters of mulberry 120 days after planting.

Table 2: Triazoles induced changes in growth and photosynthetic parameters of mulberry 120 DAP.

Parameters	Control	TDM	PBZ
Total root length (cm $plant^{-1}$)	450.3	794.4	620.62
Petiole length (cm $plant^{-1}$)	38.9	28.21	28.2
Total leaf area (cm^2 $plant^{-1}$)	35.5	25.56	24.71
Dry weight of whole plants (g $plant^{-1}$)	93.33	172.73	168.2
Moisture content of whole plants (g $plant^{-1}$)	291.5	402.09	395.5
Carotenoids (mg g^{-1} FW)	0.0328	0.042	0.049
Net photosynthetic rate (P_N) (μmol CO_2 m^{-2} s^{-1})	19.46	20.68	25.8
Transpiration rate ($T_{R)}$ (μmol H_2O m^{-2} s^{-1})	12.15	8.81	9.36
Intercellular CO_2 concentration (μmol s^{-1})	214	277	270
Stomatal conductance (μmol H_2O m^{-2} s^{-1})	81.15	74.9	71.81
WUE (μmol CO_2 m^{-2} s^{-1}/ μmol CO_2 m^{-2} s^{-1})	1.52	2.302	1.97

DA*P* = Days after planting; TDM = Triademefon; PBZ = Paclobutrazol; WUE = Water use efficiency

794.6 cm $plant^{-1}$. Among the triazoles, TDM showed the strongest effect, followed by PBZ and triazole treatment was found to increase the root growth in cucumber, and this was associated with increased levels of endogenouous cytokine's [8]. The stimulatory effect of TDM in rooting may be due to an inhibition of gibberellin (GA) synthesis, and this effect was entirely blocked by the addition of GA [9,10]. Triazole treatment decreased the petiole length in mulberry plants 30.5 cm $plant^{-1}$. In the mulberry, triazoles causes decrease in shoot length and number of shoots. TDM causes several pronounced side-effects in plants including the development of shorter and more compact shoots in wheat plants [11,12].

The possible reason for the shorter stem could be attributed to the inhibition of cell elongation of the sub apical meristem [13]. It was shown that S-3307 retarded the plants height in rice plants [14]. The growth retarding effects of triazoles could probably be due to an inhibition of inhibition of GA biosynthesis [15]. Triazole treatment decreased significantly the total leaf area when Compared to the respective controls 28.5 and 25.56 cm^2 $plant^{-1}$. PBZ treatment was found to reduce the total number of leaves and leaf size in citrus [16]. The inhibition of GA biosynthesis as well as increased ABA content induced by triazole treatment could be the reason for the inhibition of leaf expansion in the triazole- treated *Morus alba* plant. PBZ-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 [17]. TDM treatment is known to improve the survival of plants during the period of drought [18].

4. CONCLUSION

From the results of this investigation, it can be concluded that the application of triazole compounds could be well used as a potential tool to increase alter the photosynthetic content of *M. alba*. However, the data presented here reflect the importance of a physiological analysis of plant response to fungicides treatments that must accompany field experiments and evaluation.

5. REFERENCES

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***Bibliographical Sketch**

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