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REGULAR ARTICLE

CHANGES IN GROWTH AND PIGMENT CONTENT IN SWEET POTATO BY TRIADIMEFON AND HEXACONAZOLE

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SUMMARY

Triadimefon and hexaconazole are triazole group of fungicides have plant growth regulating properties. The present investigation aimed to study the growth regulating effect of these compounds on sweet potato (*Ipomoea batatas* L.). Each plant was treated with one litre of aqueous solutions containing 15mg L^{-1} triadimefon and 10mg L^{-1} hexaconazole on 40 and 70 days after planting (DAP) by soil drenching. The growth parameters of the plants were estimated on 45, 60, 75, 90 and 105 DAP. Among the triazole, hexaconazole inhibited the number of leaves, total leaf area, stem length, internodal length, leaf and stem dry weight, relative shoot growth rate significantly when compared to triadimefon. Triazole (chiefly available and plant control and yield production) treatments increase the root length, root and tuber dry weight, relative tuber growth rate, net assimilation rate root/shoot ratio, leaf dry weight per unit area, chlorophyll and carotenoid content.

Keywords: Triazole, *Ipomoea batatas*, growth, pigment content.

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1. Introduction

The major use of sweet potato is as a food, especially in developing countries e.g. Papua New Guinea, South Pacific etc, the sweet potato (Ipomoea batatas (L)) is the 7th most important food crop in the world (FAO 1997) and is among the crops selected by the U. S. National. Aeronautics and Space Administration to be grown in a controlled ecological life-support system as a primary food source (Hoff and others 1982). Sweet potato cultivars whose roots are used for a beverage, a paste, a powder, an alcohol drink, and a natural colorant have been developed in this decade (Yoshimoto 2001; Islam and Jalaluddin 2004).

A number of plant growth retardants interfere with the endogenous levels of plant growth regulators. Plant growth regulators play an important role in modifying plant structure and partitioning of photosynthates to the economically useful organs of plants (Panneerselvam et al., 1997). Among the triazole, hexaconazole decreased the number of leaf when compared to triadimefon. Triadimefon causes several pronounced side effects in plants including the development of shorter and more compact shoots in wheat plants (Buchenauer and Rohner, 1981; Fletcher and Nath, 1984; Fletcher, 1985). Paclobutrazol act as a growth retardant and has been shown to induce flowering and reduce stem elongation in number of fruit crops like citrus (Aron et al., 1985) and mango (Sing and Saini, 2000; Shinde et al., 2000). Triazoles are group of compounds of systemic fungicides developed for the control of fungal diseases in plants and animals. These compounds have fungitoxicity and also have plant growth regulating properties. Their primary action is mediated by a reduction of gibberellic acid synthesis and a shift in the hormonal balance which is beneficial to the plant (Fletcher et al., 2000). Triazole treatments reduced the stem elongation in grape vines (Hunter and Procter, 1992), citrus (Mehouachi et al., 1996) and maize seedlings (Fletcher et al., 2000).

Triazole reduce plant height, decrease shoot growth and increase root growth and increased the partitioning of photosynthates from root to shoot and also protect plants from various environmental stresses in radish plants (Panneerselvam et al., 1997). The sweet potato tubers are used as food, animal feed and industrial raw material in India. Tuber crops are grown in over 1.7 million hectares and have a production of 30.55 million tones of tuber every year (FAO report 2000).

2. Materials and methods

The stem cuttings of *Ipomoea batatas* L. (sweet potato) CV. CO2 were obtained from Tamil Nadu Agricultural University Coimbatore (TNAU) India. The vines arising from the sprouting of tubers are used as seed materials. 30 cm cuttings of uniform thickness with 3 nodes were used for planting. 1.5m by 1.5m plot was prepared for each plant and 90 plots were used for this study. Completely randomized block design (CRBD) was used for this experiments. Each plant was treated with one litre of aqueous solutions containing active ingredient (a.i.) of 15mg L^{-1} triadimefon and 10mg L^{-1} hexaconazole on 40 and 70 days after planting (DAP) by soil drenching. The effects of these chemicals were used to determine on the growth and pigment content of sweet potato. The Electrical conductivity (EC) of the soil before the treatment was 0.21 dS m^{-1} and pH was 6.8. Each time five plants were randomly harvested on 45, 60, 75, 90 and 105 DAP and separated into leaf, stem and tuber used for determining growth and photosynthetic pigments.

Growth parameters

Total leaf area: Total leaf area of the plants was measured using LICOR photoelectric area meter (Model L1-3100, Lincoln, USA) and expressed in cm-2 per plant.

Stem length: The stem length of main vine and its branches upto the tip was measured and recorded as total stem length. The internodal length was calculated by measuring the length of the stem from the seventh node to fourteenth nodes and it is divided by number of nodes. The length of all roots was measured from the origin to tip and summed up and as recorded to total root length per plant. The root with pigmentation is recorded as tuber and not taken into account with the root system.

Relative growth rate: Using the dry weight and leaf area, the following parameters were analyzed (Williams 1946).

Pigments

Chlorophyll and carotenoid content: Chlorophyll and carotenoids were extracted from the leaves and estimated according to the method of Arnon (1949).

Extraction and estimation of pigments.

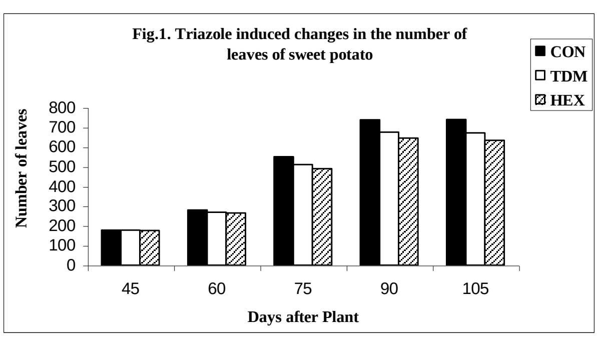
Extraction: Leaf discs (0.8 am diameter) were taken from the third leaf on either side of the mid rib at the intra venal region for the determination of chlorophyll and carotenoid contents. Five hundred milligrams of fresh leaf discs were ground with 10ml of 80 % acetone at 4oC in a pestle and mortar and centrifuged at 2,500 g for 10 minutes, at 4^{o}C. The residue was re-extracted with 80 % acetone until the green colour disappears in the residue and the extracts were pooled and transferred to graduated tube and made upto 20 ml with 80 % acetone and assayed immediately. Three ml of extract was transferred to a cuvette and the absorbance was read at 645, 663 and 480nm in a spectrophotometer against 80 % acetone as blank. The entire experiment was done at walk in cooler with the temperature of 4oC.

Statistical analysis

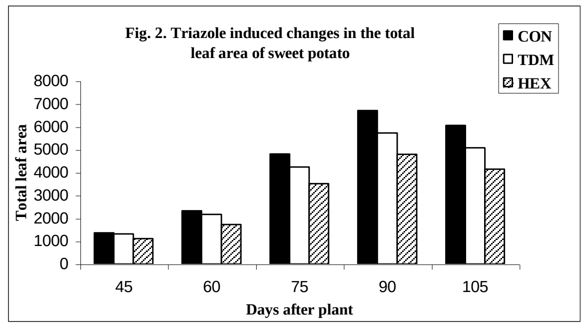
The data was analyzed using the analysis of variance (ANOVA) as described by the method outlined by Ridgman (1975).

3. Results

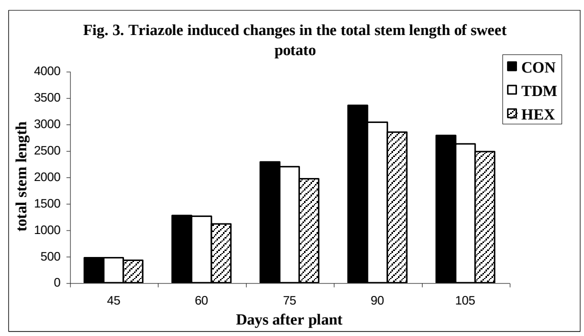
The mean values of the number of leaves per plant decreased with triazole treatments. The reduction in the number of leaves was higher in the hexaconazole treated plants when compared to triadimefon treatment and it was 632.02 and 670.8 when compared to control 738.15 on 105 days after planting are shown in the fig.1.



The total leaf area increased with the age in the control and treated plants. Triadimefon and hexconazole treatments inhibited the leaf expansion and the mean values of total leaf area was 5080.92 and 4143.17 respectively when compared to control 6054.79 on 105 DAP as shown in the fig. 2 cm^{-2} per plant.



The total stem length increased with the age in the control and treated plants. Triadimefon and hexconazole treatements inhibited the growth of the vine when compared to control and the mean length was 2625.5 and 2478.34 cm and the control 2784.28 cm respectively on 105 DAP as shown in the fig. 3.



Triazole treatment increased the root growth significantly when compared to control. Triadimefon treatment significantly increased the total root length when compared to hexaconazole and the mean length was 702.92 and 678.37 cm over control 657 cm on 105 DAP as shown in the fig. 5.

The relative growth rate of sweet potato was high at 60 DAP although later it declined, gradually in the control and treated plants.

Triazole compounds increased the relative growth rate of sweet potato after 75 DAP as shown in the fig. 6 (i.e.) phase of tuber and enlargement. Among the triazole treatments there is no significant variation in (Relative Growth Rate) RGR however the triazole treated plants showed a higher growth rate at later stages of growth (i.e. during tuber enlargement and maturation) as compared to control

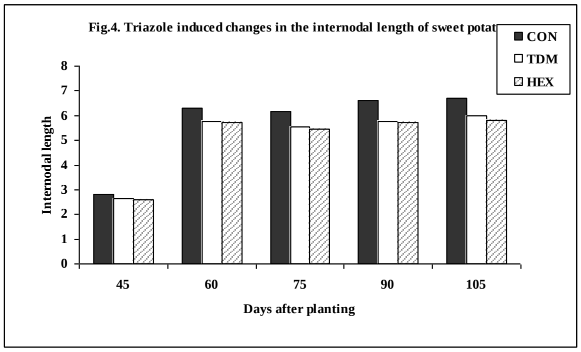


Fig.4. Triazole induced changes in the internodal length of sweet potat

The relative shoot growth rate increase in the control and treated plants upto 90 DAP later it declined as shown in the fig. 7. Triazole compounds induced a lower relative shoot growth rate when compared to control in sweet potato.

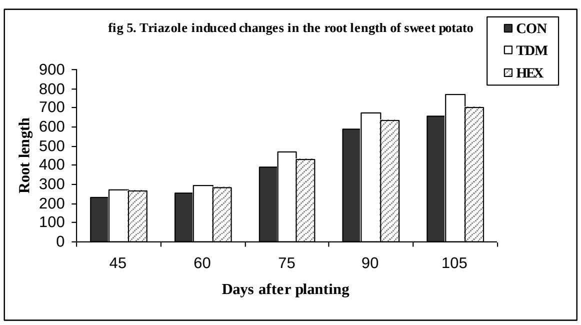


fig 5. Triazole induced changes in the root length of sweet potato

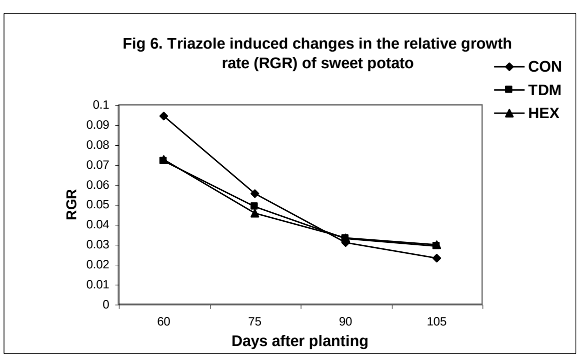


Fig 6. Triazole induced changes in the relative growth rate (RGR) of sweet potato

The triazole treated plants showed higher tuber growth rate when compared to control. Hexaconazole treated plants showed an increased tuber growth rate when compared to triadimefon as shown in the fig. 8.

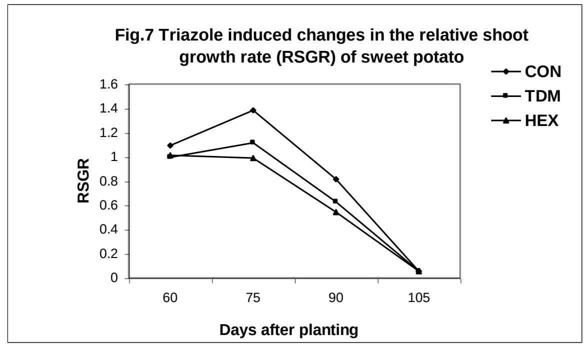


Fig.7 Triazole induced changes in the relative shoot growth rate (RSGR) of sweet potato

Plants treated with hexaconazole showed a higher photosynthetic efficiency which is followed by triadimefon and control plants. The net assimilation rate was high during the early period of growth and it gradually declined upto 105 DAP in control as shown in the fig. 9. However the triazole treated plants showed a sudden increase the net assimilation rate between 90 and 105 DAP (i.e. during the period of tuber maturation).

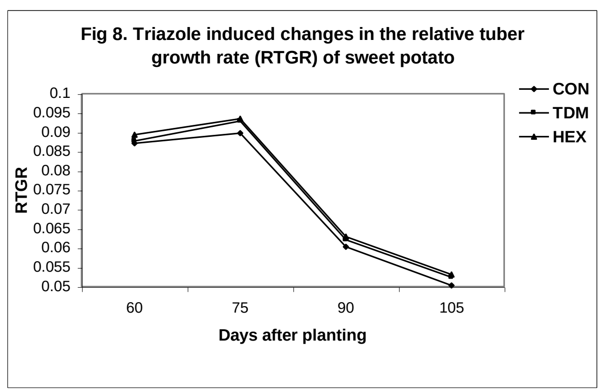
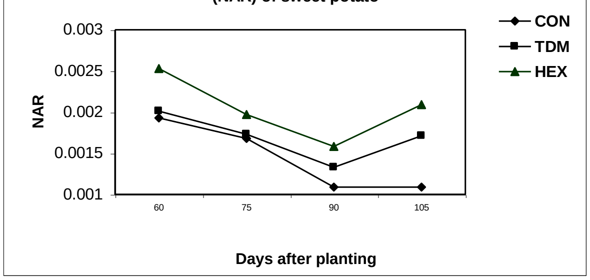


Fig 8. Triazole induced changes in the relative tuber growth rate (RTGR) of sweet potato

The root/shoot ratio was high during the early stage growth control and treated plants later it declined. The declined root/shoot ratio in the triazole treated plants increase root dry weight as compared to shoot as shown in the fig. 10.

The leaf dry weight per unit area was consistently lower in the control plant at all stages in the growth. However the triazole treated plant showed an increased leaf dry weight per unit area as compared to control as shown in the fig. 11. Among the triazole, hexaconazole increased the leaf dry weight to higher level when compared to triadimefon treatement.

Fig 9. Triazole induced changes in the net assimilation rate (NAR) of sweet potato



The total chlorophyll content of the leaves increased with the age in the control and treated plant. Triazole treatments increased the total chlorophyll content to larger extent when compared to control.

Fig.10 Triazole induced changes in the root/shoot ratio in sweet potato

Chlorophyll 'a', 'b' content in the sweet potato leaves increased with the age in the control and treated plants. Triazole treatments increased the chlorophyll 'a' and chlorophyll 'b' content to a higher level. There was no significant variation in chlorophyll 'a' and 'b' content within the triazole treated plants as shown in the fig. 12.

Triazole treatments significantly increased in the carotenoid content of the leaves when compared to control as shown in the fig.13. Triadimefon the leaves when compared to control. Triadimefon and hexaconazole treatments increased the carotenoid content to 120.99 and 118.69 percent over the control on 105 DAP respectively.

Fig 11. Triazole induced changes in the leaf dry weight per unit area in sweet potato

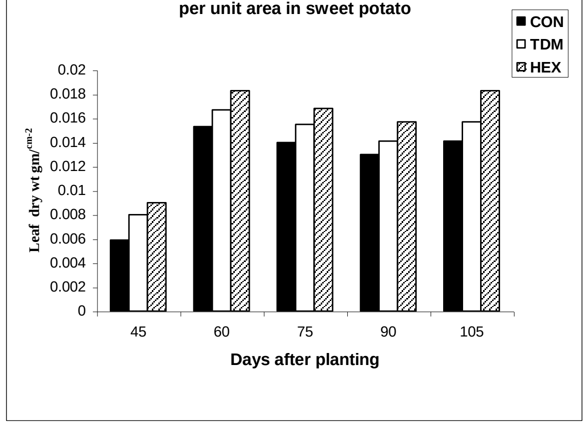


Fig 12. Triazole induced changes in the pigment content of sweet potato

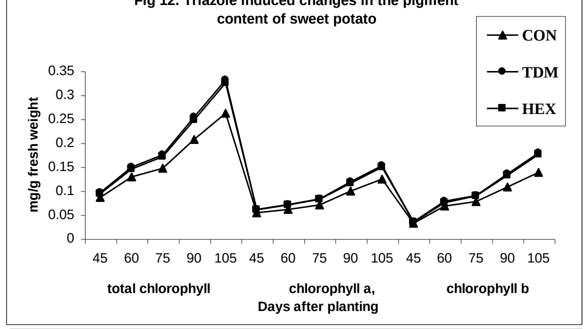
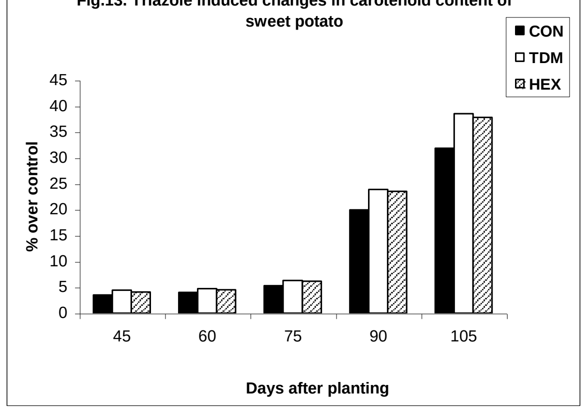


Fig.13. Triazole induced changes in carotenoid content of sweet potato



4. Discussion

Triazole treatment decreased the number of leaf. Among the triazole, hexaconazole decreased the number of leaf when compared to triadimefon. Triadimefon causes several pronounced side effects in plants including the development of shorter and more compact shoots in wheat plants (Buchenauer and Rohner, 1981: Fletcher, 1985). Triadimefon treatment increased the ABA content and decreased the GA in beans (Asare-Boamah et al.,1986). Among these, hexaconazole treatment lowered the leaf area to a larger than triadimefon. Similar observations were also made in triadimefon treated bean (Asare-Boamah and Fletcher, 1986) maize (Khalil et al., 1990) and pigeonpea (Karikalan and Panneerselvam, 1999).

Hexaconazole treatment decreased the internodal length when compared to triadimefon. Triazole treatment reduced stem elongation, plant height in grape vines, maize seedlings (Hunter and Procter, 1992; Fletcher et al., 2000). The root length increased significantly with triazole treatments. Among the triazole, triadimefon treatment increased it to a higher level than hexaconazole. Triadimefon has stimulated adventitious root formation in bean hypocotyls, wheat seedlings (Berova et al., 2002).

Triazole are efficient growth retardants and retard shoot growth efficient in various species, however, it increased the growth of the root system especially in storage roots like beat root and radish (Jaggard et al., 1982; Muthukumarasamy and Panneerselvam, 1997). The relative shoot growth rate of the *Ipomoea batatas* L. was high at early stages of growth and later it declined in control and treated plants. Triazole treatment inhibited the shoot growth in various plants like *Glycine max* (Davis and Sankhla 1987), *Euphorbia pulcherrima* (Davis et al., 1986). The relative root growth rate was higher at early period of growth, later it declined in the control as well as treated plants. Triazole compounds like triadimefon, paclobutrazol and uniconazole have promoted rooting in various plants like bean, radish (davis et al., 1985; Muthukumarasamy and Panneerselvam, 1997a). Inhibition of gibberellin biosynthesis and increase in the cytokinin content induced by triazole may be the reason for increased root growth and inhibited shoot growth in the triazole treated plants. There is a strong mutual interaction between auxin production in the shoots and cytokinin production in the roots, which may be important in regulating the balance between root and shoot growth (Bangerth et al., 2000).

The net assimilation rate was higher at during the early stages of growth, later it declined in the control and treated plants. Triazole treatments increased the net assimilation rate to a larger extent. Triazole treated leaves were dark green in colour and had sun type chloroplasts, which allows a high photosynthetic quantum conversion (Lichtenthalar, 1979). Shoot-to-root ratio increased with age in the control and treated plants. A reduction in shoot growth increased root production leading to increased root/shoot ratio has been observed with triazole treated plants like corn seedlings (Pinhero and fletcher, 1994) and Pine seedlings (Barnes and South, 2004).

Leaves dry weight per unit area increased gradually upto 60 DAP and later it slightly declined. Triazole treatment slightly increased the leaf dry weight per unit area while decreasing the leaf area. Triazole reduced the leaf area more than the leaf dry weight, hence leaf dry weight per unit area has been increased by triazole treatment as observed in soybean (Sankhla et al., 1985). Triazole reduced the leaf area but increased the epicuticular, leaf width and thickness of leaves by inducing additional layers of palisade and mesophyll cells in wheat (Gao et al., 1988 and Burrows et al., 1992).

Triazole treatments increased the total chlorophyll and chlorophyll 'a' and 'b' content in the leaves of sweet potato. Increased chlorophyll content with triadimefon treatment was observed in barley (Forster, 1978), wheat (Sairam et al., 1998) maize seedlings (Fletcher et al., 2000 and Feng et al., 2003). Triazole treated sweet potato leaves showed an increased in carotenoid content. Triadimefon treatement induced higher level of carotenoid content in cucumber cotyledons (Feng et al., 2003).

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