

## **CHANGES IN STOMATAL CONDUCTANCE AND TURGOR PRESSURE IN *Gossypium hirsutum* L. IN RESPONSE TO FOLIAR APPLICATION OF FOUR HERBICIDES**

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### **ABSTRACT**

Foliar application of four herbicides (15ppm each), resulted in obvious reductions in stomatal conductance in the leaves of cotton. Percentage reductions (compared to controls) amounted to 13, 5, 18 and 33 with 2, 4-D,  $KClO_3$ , goal and stomp respectively.

Turgor pressure followed a similar trend, and percentage decrements (compared to controls) were 23, 6, 20 and 35 with 2, 4-D,  $KClO_3$ , goal and stomp respectively.

The negative effect of these herbicides on stomatal conductance and turgor pressure could be attributed to the documented drastic effects of many herbicides on biochemical and physiological processes in non target plants.

### **INTRODUCTION**

Uncontrolled use of herbicides is known to cause morphological, anatomical, physiological and biochemical changes, and could drastically affected plant growth, and even lead to death on non target plants.

Four different herbicides chosen for their widespread use were selected and used in this study. 2,4-dinitrophenol, a phenoxy herbicide which is often used for broad leaf control is well known as an uncoupler of electron transport phosphorylation (Gage and Neidhardt, 1993). Chlorates (represented by potassium chlorate ( $KClO_3$ )) are considered phytotoxic to all green plants, and could provoke severe damages to the exodermis, endodermis, cortex cells, root cells, root hairs and could provoke diminishments in some physiological and biochemical parameters (Eltahir, 2010). Oxyflourfen (goal) is a selective pre and post emergent herbicide used to control certain annual broad leaf and grassy weeds in vegetables, fruits, cotton and ornamentals. The herbicide is reported to cause necrosis and sometimes cholorsis when applied to foliage, while pre emergence application inhibits seed germination, early seedling growth and meristem activity (Mohamed, 1995). Pendimethalin (stomp), a selective dinitroaniline that effectively controls a wide spectrum of annual grasses and broad-leaved weeds is registered for use in over 60 countries in 70 crops (Anon, 1993).

The objective of this study was to examine the effect of four foliary applied herbicides on stomatal conductance and turgor pressure in the leaves of cotton.

## MATERIALS AND METHODS

### Plant culture:

Seeds of *Gossypium hirsutum*, L. var. *hirsutum* medium stable cotton, variety Barakat 90, were obtained from the Genzera Scheme (Sudan). The seeds were surface sterilized for 10 min. with 1% hydrogen peroxide, rinsed several times with distilled water and germinated in deep plastic trays containing sand and clay (1:1), and watered every other day. Seedling of comparable size aged three weeks were used in this study. The herbicides (15ppm each) were foliary applied with suitable sprayers, and great care was taken to prevent the herbicides from coming into direct contact with the soil.

Stomatal conductance and turgor were measured in the leaves after 10 days treatments with the herbicides.

### Measurement of stomatal conductance:

The stomatal conductance was measured using a portable photosynthesis meter (infrared gas analyzer, Licor 6200, Licor USA) at 09.00 a.m. on the fourth mature leaf of the shoots. Results were presented as percentage of control.

### Measurement of turgor pressure:

Turgor pressure was measured using a thermocouple psychrometer (RH-33T, Wescor, USA) on discs of the fourth mature leaf at 09.00 a.m. Results were presented as percentage of control.

## RESULTS AND DISCUSSION

The results presented in Figure 1 show the effect of the four herbicides on stomatal conductance in cotton. It is obvious that the herbicides negatively affected stomatal conductance with various degrees. Decrements ranged between 5% and 33% compared to controls. Results obtained in this study are consisted with those of Dear. *et al* (1995), who observed decline in water use and stomatal conductance in *Trifolium subterraneum* L. after 10-20 days following spraying with broad-leaf herbicides. Similar conclusions were drawn by Earl *et al* (2004), who demonstrated that three herbicides triggered reductions in carbon assimilation, stomatal conductance and water use in *Cyperus esculentus* L. Also, Bigot *et al* (2007), showed that the herbicide flumioxazin drastically affected the non-target plant *Vitis vinifera* L. in lowering stomatal conductance, net photosynthetic activity and carboxylation velocity. These results are further substantiated by those obtained by Ivanova *et al* (1999), who showed that the herbicide atrazine inhibited the growth of the trifoliolate leaves of beans, decreased photosynthetic and respiration rates and stomatal conductance.

Results presented in Figure 2 show the influence of the four herbicides on turgor pressure. Again, a similar pattern was observed, and all the herbicides reduced the turgor pressure with various decrements that ranged between 6% and 35% . Turgor pressure is generated when the osmotic pressure of the cell sap exceeds that of the apoplast.

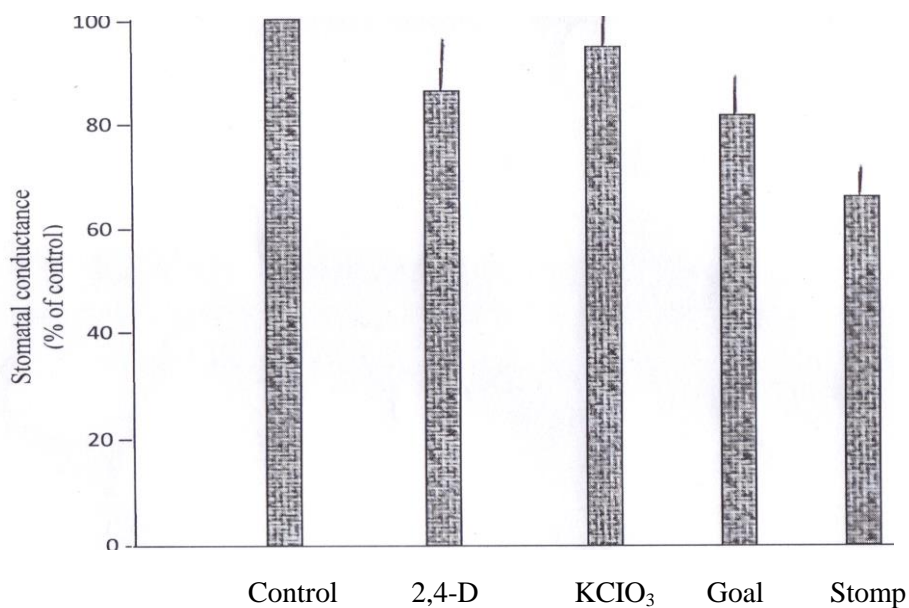


Fig.1. Effect of four herbicides (15ppm) on the percentage of stomatal conductance reductions (compared with the controls) of cotton seedling. Vertical bars represent mean values of three measurements + SE.

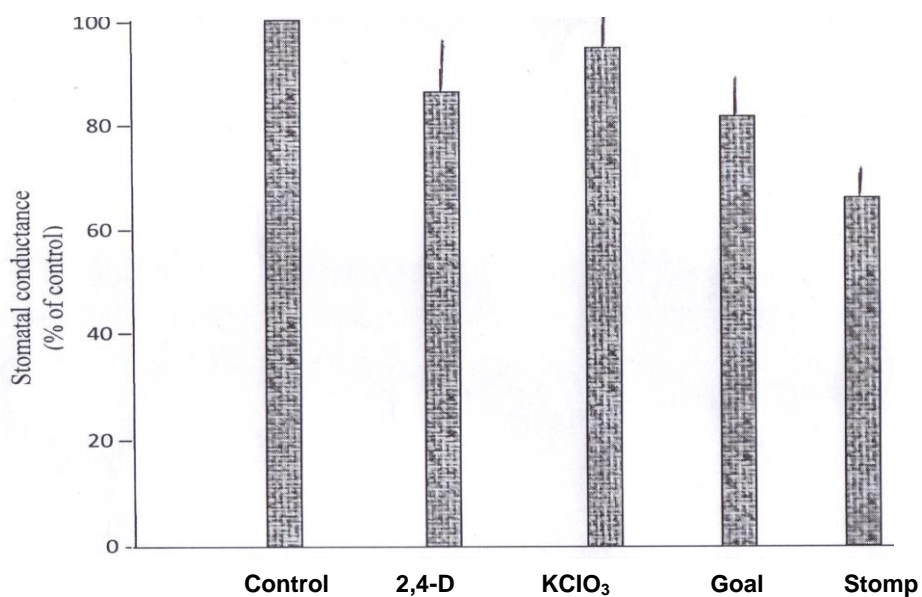


Fig.2. Effect of four herbicides (15ppm) on the percentage of turgor pressure (compared with the controls) of cotton seedling. Vertical bars represent mean values of three measurements + SE.

The establishment of such an osmotic gradient depends on membrane integrity and on ATP to fuel the synthesis or accumulation of protoplasmic solutes (O'Looney and Fry, 2005). Any of a wide range of herbicides that disrupt steps in basic cell metabolism is expected to cause damage to the cells, leading to loss of turgor. Gorske and Hopen (1978), have showed that the two herbicides nitrofen and oxyflurofen decreased the water potential in two varieties of cabbage by about two bars, whereas O'Looney and Fry (2005) have reported that a novel herbicide oxaziclomefone inhibited cell expansion in maize without affecting turgor pressure or wall acidification. Many physiological, biochemical and growth parameters were negatively affected by foliar application of five herbicides in cotton and maize seedlings (El Tahir, 2010).

Therefore, it is concluded that, herbicides used in this study reduced gas exchange (stomatal conductance), and water use (turgor pressure) in cotton leaves *via* deterioration of physiological, biochemical and growth parameters which are closely related to gas exchange and water use. Also, it should be mentioned that the type of the herbicide (chemical structure ), concentration of the dose, mode of application and duration of treatments are essential factors influencing changes in physiological and biochemical parameters in target and non-target plants.

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### المتغيرات فى التوصيل الثغرى وضغط الإمتلاء فى نبات القطن نتيجة الرش بأربعة مبيدات عشبية.

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رش أربعة مبيدات بتركيز ١٥ جزء فى المليون على نبات القطن أحدث إنخفاضاً فى التوصيل الثغرى على الأوراق، نسبة الإنخفاض المئوية مقارنة مع النباتات الضابطة كانت ١٣، ٥، ١٨ و ٣٣ مع ثنائى النتروفينول ، كلوريت البوتاسيوم ، جول ستومب بالتتالى. حدث إنخفاض مماثل لضغط الإمتلاء وكانت النسبة المئوية مقارنة مع النباتات الضابطة ٢٣، ٦، ٢٠، ٣٥ مع ثنائى النتروفينول ، كلوريت البوتاسيوم ، جول ستومب بالتتالى. التأثير السلبى للمبيدات العشبية على التوصيل الثغرى وضغط الإمتلاء يمكن مرده إلى الآثار السالبة الموثقة لكثير من المبيدات على العمليات الحيوية والفسىولوجية للنباتات غير المستهدفة.

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