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# EFFECT OF SOME INDUCERS ON WHEAT LEAF RUST SEVERITY AND YIELD COMPONENTS

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**ABSTRACT:** *Leaf rust of wheat (Triticum aestivum L.), caused by Puccinia triticina Eriks, is one of the most important diseases of wheat in Egypt and worldwide causing significant losses in grain yield. Four inducers were used to increase systemic resistance against biotic damage on three susceptible wheat cultivars differing in there rust severity comparing with fungicide the recommended fungicide (Sumi-eight 5Ec). These inducers were Fulvic acid, Bion, Salicylic acid and Ascorbic acid . This work was carried out at Gemmeiza Agriculture Research Station during 2011/12 and 2012/13 growing seasons, wheat cultivars were Sakha 93, Gemmeiza 7and Gemmeiza 11. Artificial inoculation was performed using a mixture of urediospores and talcum powder (1:20 V.V). Foliar spray was applied before artificial inoculation with the fungus, infected untreated control was also used. Grain yield , rust severity and Area Under Disease Progress Curve (AUDPC) were determined. Results indicated that all treatments reduced the severity of rust disease, area under disease progress curve comparing with the untreated control and increased grain yield . Regarding to disease severity, salicylic acid was the most effective one during the two seasons which gave the lowest values of severity (Trs -20s) followed by the fungicide (Sumi-eight 5Ec) which gave (5s– 20s %). Also, area under disease progress curve parallel to the disease severity. The highest values of grain yield per plot was observed with Fulvic acid during the two seasons followed by Bion.*

***Key words:*** *Wheat, leaf rust, Inducers, Resistance.*

## INTRODUCTION

Strategy of wheat breeders and pathologists in Egypt aims to increase wheat production through genetically improvement of wheat cultivars ,agricultural practice application and protective wheat plants against pests and diseases. Among these diseases, wheat leaf rust caused by *Puccinia. triticina*, is considered a widespread disease in wheat growing area. In Egypt, it occurs annually at booting stage and thereafter (Nazim *et.al.*,1983). When the disease appears at booting stage and lasts at high level of disease severity to plant maturity, the loss in grain yield reaches the maximum level (El Dauodi *et al.*, 1984). For this reason, many wheat genotypes have been discarded due to their susceptibility (Rao *et.al.*, 1989). Genetic resistance is the best approach for controlling wheat leaf rust ( Wamishe and Milus 2004). However, resistance of provides ephemeral protection, because the population of leaf rust pathogen respond to selective pressure of resistant host cultivars and produced more virulent phenotypes ( Lehman *et al.*, 1997). The changes in the pathogen population, have been directed primarily toward identifying new control measures that could be effective, reliable and safe for the environment.

Fulvic acid as a foliar spray, increases the plant's oxygen uptake capacity with an associated increase in chlorophyll production and an increase in the permeability of plant membranes, improving the uptake of nutrients. Fulvic acid directly influences numerous enzymatic processes and stimulates the plant's immune system. (Henritte,2009). The best characterized signal pathway for systemically induced resistance is SAR (systemic acquired

resistance) that is activated by localized infections with necrotizing pathogens. It is characterized by protection against a broad range of pathogens, by a set of induced proteins. Various chemicals have been discovered that seem to act at various points in these defense activating networks and mimic all or parts of the biological activation of resistance. Of these, only few have reached commercialization. Bion (acibenzolar-5-methyl), salicylic acid (SA) and ascorbic acid ( Michael, O. *et al.* 2001).

The main objectives of this work were to study the effect of some inducers on leaf rust severity and yield components of three susceptible wheat cultivars under field conditions, as well as the economic importance of these inducers comparing with the recommended fungicide.

## MATERIALS AND METHODS

During 2011/12 and 2012/2013 seasons at Gemmeiza Experimental Research Station, three susceptible bread wheat cultivars, i.e. Sakha 93 Gemmeiza-7 and Gemmeiza-11were used to study the effect of four inducers and recommended fungicide on leaf rust severity and yield components. Randomized Complete Block design with four replicates was used , 72 plot (3x1.2 m =3.6 $m^2$.) each plot contained 6 rows with 3m. and 20 cm. between rows. The experiment was planted 15 days after the regular sowing date (the first half of December) to expose the plants to suitable environment of rust incidence and development. The experiment was surrounded by a border of highly susceptible wheat genotypes i.e Morroco, *Tiriticum spelta saharences* and Thatcher. Recommended fungicide Sumi-eight 5Ec (CE) -1- (2,4 – Dichlaro phenyl) was used at the rat 35 cm /100 litter water, fulvic acid at the rat 1gm./ 6 liter water, bion at 0.5 gm./ liter water, salicylic acid and ascorbic acid at (500 and 1000 ppm, respectively). Foliar spray was don 10 days before artificial inoculation. Rust severity was recorded every 7 days intervals from rust appearance along with the stages of plant growth according to (Peterson *et al.,* 1948) . Data on rust severity were scored as severity of infection. Yield components 1000 grain weight and yield per plot were estimated.

Area under disease progress curve(AUDPC) was assessed for each cultivar according to the equation adopted by (Pandy *et al.,* 1989)

AUDPC = D[ 1/2 ($Y_1$ + $Y_k$ ) + ( $Y_2$ + $Y_3$ + - - - - + $Y_{k-1}$)] , where

D = days between two consecutive recording (time intervals)

$Y_1$ + $Y_k$ = Sum of the first and last scores.

$Y_2$ + $Y_3$ + - - - - - + $Y_{k-1}$ = Sum of all in between disease scores.

### Disease assessment:

Adult plant reaction was recorded as rust severity for each cultivar, when rust appeared until the early dough stage (Large, 1954). Rust severity of each cultivar was recorded every ten days after the initial infection occurred using the modified Cobbe Scale (Peterson *et al.,* 1948).

Statistical analysis, least significant differences (L.S.D at 5%)was used to compare yield components according to (Snedecor,1957). Also correlation coefficient was used to detect the relationship between yield loss and rust severity( AUDPC).

## RESULTS AND DISCUSSION

This investigation aimed to study the effect of four inducers on leaf rust severity , Area Under Disease Progress Curve (AUDCP) and yield components of three susceptible wheat cultivars. Disease severity was determined during 2012-2013 growing seasons under field conditions.

### Leaf rust severity:

The tested inducers showed different disease severity ranged from 5-30 % comparing with the recommended fungicide 10-20% (Table 1) during 2011/12 season whereas the infected untreated control gave disease severity (40-80%). The lowest values of disease severity was recorded with salicylic acid 5s on Gemmeiza 11, meanwhile ascorbic acid showed the highest disease severity 30s. Fulvic acid and bion were in between (10s-20s) disease severity. Regarding the results in the same table, Area Under Disease Progress Curve

(AUDCP) runs in a parallel line with disease severity . The lowest value of (AUDCP) was obtained with salicylic acid (55) on Gemmeiza 11, followed by bion and the fungicide (130), compared with the untreated control (525-1125).

**Table (1): Disease severity and Area Under Disease Progresses Curve of the treatments on three wheat cultivars during 2012-13 seasons.**

| Treatment | 2011/12 season / Cultivar | | | | | | 2012/13 season / Cultivar | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sakha 93 | | Gemmieza 7 | | Gemmieza 11 | | Sakha 93 | | Gemmieza 7 | | Gemmieza 11 | |
| | D.S | AU. | D.S | AU. | D.S | AU. | D.S | AU. | D.S | AU. | D.S | AU. |
| Fulvic acid | 20s | 250 | 20s | 150 | 10s | 165 | 10s | 150 | 10s | 150 | 5s | 55 |
| Bion | 10s | 130 | 20s | 180 | 10s | 130 | 5s | 55 | 10s | 100 | Trs | 30 |
| salicylic acid | 20s | 265 | 10s | 130 | 5s | 55 | 5s | 55 | Trs | 30 | Trs | 30 |
| ascorbic acid | 30s | 280 | 30s | 315 | 20s | 180 | 10s | 130 | 5s | 55 | 5s | 55 |
| Sumi-eight | 10s | 130 | 20s | 150 | 10s | 130 | 5s | 55 | 5s | 55 | Trs | 30 |
| Infected control | 80s | 1125 | 80s | 925 | 40s | 525 | 60s | 825 | 80s | 1125 | 20s | 215 |

D.S = Disease severity AU.= AUDCP

In 2012/13 season disease severity was lower than previous season , the lowest values of disease severity was observed on Gemmeiza 7 and Gemmeiza 11with salicylic acid (Trs).

Meanwhile the infected control showed the highest disease severity on cv. Gemmeiza 7 . Regarding these data, area under disease progress curve is negatively correlated with disease severity, the least AUDPC values were recorded with salicylic acid and bion . Abd-El Karim 2007 reported that the harmful effect of Humic acid and Fulvic acid was du to the increase in chitinase activity on rust disease of *Faba been* plants. Zhang, 1997 showed that foliar application of Humic acid and Fulvic acid enhanced antioxidants such as alpha-tocopherol and B- carotenes concentrations in Turf grass spices, these antioxidants may play a role in regulating plant development and chilling of disease resistance. Michil *et al.*, 2001 found that the best- studied resistance activator is acibenzolar-5-methyl (BION) at low rates it activates resistance in many crops against a broad spectrum of diseases, including fungi, bacteria and viruses . Also they reported that, resistance inducing chemicals that are able to induce broad disease resistance offer an additional option for the farmer to complement genetic disease resistance and the use of fungicides such as salicylic acid. Jayaraj, *et al.*,2004 found that Pre-treatment of wheat plants with SA and JA significantly reduced (up to 56 %) the incidence of leaf blotch disease incited by *S. nodorum* compared with untreated control plants. Minaas E. A. Sallam *et, al.,* 2012 reported that application three inducers i.e. Homopolymer, Pur acrylate and Styrene Co-- polymer cause partial resistance in treated plants measured as increase in latent period and pustule number and size.

## yield components :

Data in Tables (2&3) showed the relationship between the tested inducers and yield components,1000 grain weight and yield per plot compared with untreated and fungicidal treated wheat plants during the two seasons.

Data in such tables showed significant differences between treatments, applying Fulvic acid led to the highest weight of $10^3$ grains and yield/plot compared with the untreated control, followed by Bion (acibenzolar-5-methyl) on the three wheat cultivars. During 2011/12 season Fulvic acid showed the highest values of yield per plot on Gemmieza 7 followed by Gemmieza 11 (3.42 k.gm -3.11 k.gm) respectively, meanwhile the least values was observed with ascorbic acid (2.8 k.gm) on Sakha 93.On the other hand 1000 grain weight was in the sam trend. During the second season 2012/13 Bion showed the hieghtest values of grain yield per plot on cv. Gemmieza 11 (3.4k.gm ) followed by Fulvic acid on the

same cv.(3.36 k.gm ).This increase of weight might be due to increases the plant's oxygen uptake capacity with an associated increase in chlorophyll production and an increase in the permeability of plant membranes, improving the uptake of nutrients (William *et al.*, 2004) . Ascorbic acid and the recommende fungicide gaves the least values of grain yield during the two seasones. Lubomir *et, al.* 2009 reported that, application of Bion and salicylic acid had halted disease progress by 27 d after the application also, he found that induced resistance was long-lasting and the severity of the disease, when compared with the untreated control, was decreased to between 2% and 53%, depending upon the year.

Data in Tables 2&3 revealed that the effect of wheat leaf rust infection on grain yield which affect the grain yield on the three susceptible wheat cvs. Sakha 93 , Gemmieza 7 and Gemmieza 11 during the two successive seasons comparing with the recommended fungicies.Also, these results reveled that, all inducers gave the same trend on the tested cultivars, so that there is no significant differences between genetic background of the cultivar.

**Table (2): Effect of inducers on yield components, under field conditions during 2011/2012 growing season.**

| Treatment | Cultivar / Yield components | | | | | |
|---|---|---|---|---|---|---|
| | Sakha 93 | | Gemmieza 7 | | Gemmieza 11 | |
| | 1000 grain weight (g) | Plot weight (kg) | 1000 grain weight (g) | Plot weight (kg) | 1000 grain weight (g) | Plot weight (kg) |
| Fulvic acid | 50.00 | 3.10 | 58.31 | 3.42 | 59.50 | 3.11 |
| Bion | 47.00 | 2.92 | 57.00 | 3.36 | 55.00 | 3.08 |
| salicylic acid | 46.81 | 2.83 | 55.50 | 3.30 | 53.10 | 3.00 |
| ascorbic acid | 45.80 | 2.80 | 55 | 3.27 | 53.50 | 3.00 |
| Sumi-eight | 46.11 | 2.80 | 55 | 3.26 | 53.00 | 2.91 |
| Infected control | 44.80 | 2.50 | 46.80 | 3.13 | 48.00 | 2.71 |
| **L.S.D at 5%** | 1.9١ | 0.45 | 2.21 | 0.49 | 2.33 | 0.51 |

**Table (3): Effect of inducers on yield components, under field conditions during 2012/2013 growing season.**

| Treatment | Cultivar / Yield components | | | | | |
|---|---|---|---|---|---|---|
| | Sakha 93 | | Gemmieza 7 | | Gemmieza 11 | |
| | 1000 grain weight (g) | Plot weight (kg) | 1000 grain weight (g) | Plot weight (kg) | 1000 grain weight (g) | Plot weight (kg) |
| Fulvic acid | 50.50 | 3.31 | 56.30 | 3.21 | 58.80 | 3.36 |
| Bion | 46.70 | 2.94 | 55.80 | 3.11 | 59.10 | 3.40 |
| salicylic acid | 47.00 | 2.91 | 58.10 | 3.36 | 58.50 | 3.35 |
| ascorbic acid | 46.50 | 2.90 | 55.10 | 3.00 | 58.00 | 3.31 |
| Sumi-eight | 46.31 | 2.90 | 55.00 | 3.00 | 56.00 | 3.12 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Infected control | 44.88 | 2.80 | 50.00 | 2.92 | 50.00 | 2.93 |
| **L.S.D at 5%** | 1.98 | 0.43 | 2.43 | 0.48 | 2.52 | 0.5 |

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# تأير بعض المستحثات علي شدة الاصابة بصدأ الاوراق فى القمح ومكونات المحصول

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## الملخص العربي

يعتبر صدا الاوراق فى القمح المتسبب عن الفطر بكسينيا تريتسيا من اهم الامراض التى تصيب القمح فى مصر والعالم مسببا خسائر فى محصول الحبوب. استخدمت اربعة مستحثات لتقليل الضرر الناتج على ثلاثة اصناف قمح حساسه وهى سخا ٩٣ وجميزة٧ وجميزة١١ مقارنة بمبيد السومى ايت. هذه المستحثات هى الفولفك اسيد والبيون والسلسلك اسيد والاسكوربك اسيد , تمت هذه الدراسه فى محطة البحوث الزراعيه بالجميزة فى موسمى ٢٠١٢/٢٠١١ و٢٠١٣/٢٠١٢ .

تم الرش بالمعملات المختلفه قبل اجراء العدوى الصناعيه , تم تقدير شدة الاصابه و المساحه الواقعه تحت المنحنى المرضى ومكونات المحصول .

اوضحت النتائج ان كل المعاملات ادت الى تقليل شدة الاصابه والمساحه الواقعه تحت بالمنحنى المرضى مقارنة بالكنترول بينما ادت الى زيادة مكونات المحصول. بالنسبه الى شدة الاصابه كان السلسيلك اسيد هو الاكثر كفاءة فى مقاومة المرض متبوعا بالمبيد حيث كانت تراوحت شدة الاصابة ما بين ( ٠–٢٠%) , كما اوضحت النتائج ايضا ان المساحه الواقعه تحت المنحى المرضى فى نفس اتجاه شدة الاصابة. الفولفك اسيد كان اكثر المعاملات زياده فى المحصول متبوعا بالبيون.