EVALUATION OF SEX PHERMONE AND CHLORANTRANILLIPROLE (Coragen 20% SC)R AGAINST THE TOMATO LEAFMINER, Tuta absoluta (Myrick) ON TOMATO CROP

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ABSTRACT: Population density and percent reduction of Tuta absoluta (Myrick) (Lepidoptera: Gelichiidae) males in an open tomato fields (Lycopersicon esculentum, Var. Bito 186) by using sex phermone {tuta 100 N (3mg/capsule)} and chlorantranileprole (coragen) were evaluated during growing seasons 2015 and 2016 at Abo-kabir District, Sharkia Governorate Egypt. Six plots were treated as followes: chlorantraniliprole alone; 2 phermone traps; 2 phermone traps + chlorantraniliprale; 4 phermone traps; 4 phermone traps + chlorantraniliprole in addition to check control plot. Results showed significant reduction of infestations in all plots during two seasons when plots treated with 4 traps + spraying with chlorantraniliprole than using 2 phermone traps spraying with chlorantraniliprole or plots treated with chlorantraniliprole alone. The efficiency in reducing larve numbers were 92.26, 90.53, 84.41, 66.50 and 63.97% during season 2015, while values were 93.50, 90.68, 84.75, 70.92 and 64.24% in 2016 season in plots treated with 4 phermone traps + chlorantraniliprole, 2 phermone traps +, 4 phermone traps, and 2 phermone traps, respectively. When comparing the efficacy of traps numbers, results showed that using 4 traps was better than two traps/ faddan in catching males which recorded 261.00 and 204.40 males/traps/week and 250.30 and 201.10 males/traps/week during 2015 and 2016 seasons, respectively. For the total yield per faddan, experiments showed that using 4 traps + spraying with chlorantraniliprole was the best treatment than using 2 traps + spraying with during 2015 and 2016 seasons chlorantraniliprole which recorded 39200, 37.70 and 40.00, 33.18 ton/fad. (treatment or plot), respectively. On the other hand using 2 traps/ fad., recorded the lowest yield. These results suggest that (chlorantraniliprole) is necessary in control of tomato leafminer in combination with using 4 phermone traps/fad., for achieving an effective control of this pest.

Key words: Tomato leafminer, Sex phermones, chlorantraniliprole, control.

INTRODUCTION

Tomato crop (Lycopersicon esculentum), is the most important vegetable plant throughout the world in farming production under both green house and open field (Emam and Heikal, 2015). Tomato leafminer, Tuta absoluta (Myrick) (Lepidoptera: Gelechiidae) is the most important pest reducing tomato production. It also feed on other host plants from the solanaceae, and was record in western Egypt in late 2009 (Temerak, 2011). Damage of T. absoluta was observed both on leaves and fruits of tomato, and on potato leaves. The larvae were found between the upper and lower leaf epidermis, feeding on mesophyll tissues and causing mines or blotches on leaves. Infested fruits had pinholes and larvae were found inside feeding on the pulp (Taha et al., 2013). Also, secondary infections by pathogens were noticed in the infested fruits (Kalleshwaraswamy et al., 2015).

Chlorantraniliprole is a member of a new class of insecticides, the anthranilic diamides. It binds to ryanodine receptors (RyR) in insect
muscles, which results in an uncontrolled release of internal calcium stores from the sarcoplasmic reticulum causing impaired regulation of muscle contraction and leading to feeding cessation, lethargy, paralysis and death in target organisms (Cordova et al., 2006). The first means in the control of T. absoluta is the use of pheromone traps for early detection. Further, the use of sex pheromone in water traps has given promising results against the insect. An additional potential economic impact is possible due to disruption of integrated crop management (ICM) practice. Insecticidal control of T. absoluta may disrupt ICM, as the insecticides needed to control the pest may negatively affect biological control agents and pollinating bumble bees. New approaches for controlling tomato borer by using an integrated pest management (IPM) program which considered of mass trapping (Abdelrazek, 2015), T. absoluta males in traps at a density of 8 traps/faddan and weekly application of insecticides. There have been few efforts in using of synthetic pheromone of tomato leafminer in Egypt, accordingly in this paper the effectiveness of using traps individually in pest management or combined with insecticides application was investigated. Therefore, keeping the above facts in view an attempt has been made to study the efficiency of sex pheromone traps, chlorantraniliprole (Corgen 20% SC) insecticide and their combinations for suppression of the tomato leafminer, T. absoluta (Myrick), on tomato plants under field conditions.

MATERIALS AND METHODS

Field Experiments Design

The present study evaluated the sex pheromone traps, chlorantraniliprole (Corgen 20% SC) insecticide and their combination against the tomato leafminer, Tuta absoluta (Myrick), at private farm in Abo-kabir district, Sharkia Governorate, Egypt during two successive seasons of 2015 and 2016 in tomato plants, under field conditions. Six treatments were designed in far distances among them to avoid pheromone interfere effects. The area of each experimental treatment was one faddan (4200 m²) which divided into 4 internal experimental replicates (quarter faddan each). The distance between the traps on each treatment was minimum 30 m. Tomato plants were planted in June of each year. The treatments were, two sex pheromone traps, two sex pheromone traps + chlorantraniliprole application, four sex pheromone traps, four sex pheromone traps + chlorantraniliprole application, chlorantraniliprole alone and control. Sex pheromone capsules namely, Tuta 100 N (E3, 28, Z11-tetra decatrienyl acetate; 3 mg concentration), obtained from plant protection institute (pheromone unit). Chlorantraniliprole insecticide namely, 3 bromo-chloro-1- (3- chloro- 2 pyridyl, - 2- methyl- b-methyl carbomamyl) pyrazol-5- carboxonlide, as using the recommended field rate 20 g/100 L water. The tested traps were distributed uniformed in the selected severely infested area.

Sex pheromone traps were placed on the level of 30 cm upon shoot tip of tomato plants from June 18th 2015 to September 4th 2015 and from June 15th 2016 to September 9th 2016, respectively in experimental plots. Coragen was sprayed three times starting in the same time of constructing traps with three weeks interval of the insecticide application. Sex pheromone traps were used for trapping male moths and renewed every 21 days, as well as weekly visit to record and remove moths which attracted into the traps. The chlorantraniliprole was sprayed using a Knapsack sprayer motor (40 psi and 25 litters/replicate) at the recommended rate four times, 20 days interval, starting at 25 June 2015 and 22 June 2016. The efficiency of chlorantraniliprole on the tomato leafminer was recorded weekly. Control plots were sprayed with water only.

Sex Pheromone Traps

Water sex pheromone traps consist of a plastic container holding water and a pheromone Tuta 100 N. The Tuta 100 N is secured above the water with a wire attached at both ends of the container. A small amount of soap (15 ml) was added to the water (4 liters) to reduce surface tension and limit water evaporation; Capsules and water were renewed every 4 weeks.

Plant Samples

The tomato leafminer infestation in each treatment was evaluated by recording numbers of live larvae in 40 leaves or fruits which randomly collected from tomato plants in each plot. The leaves were transferred directly to the laboratory where it were examined using a
binocular microscope and numbers of live moving larvae per leaves were recorded. The percent reduction in infestation were calculated according to Henderson and Tilton equation \((\text{Henderson and Tilton, 1955})\) as follows: Percent reduction in infestation.

For recording the damages in leaves and fruits per plant, numbers of live larvae present inside the leaves and damaged fruits were recorded too. Samples were obtained in early morning from field experiment, 40 leaves per replicate according to \textit{Emam and Heikal (2015)}.

\textbf{Data Analysis}

The percentages reduction of plant infestation and efficiency of phermone trap in reduction adults density of \textit{T. absoluta} for all treatments were subjected to simple analysis of variance. The values were analyzed by one way (ANOVA) using \textit{Costat (1985)} statistical software \(p<0.01\). Means were separated by \textit{Duncan (1955)} multiple range test which calculated the least significant difference (LSD) between treatments and also between periods against the tomato leafminer.

Also, the evaluation of coefficients involving both traps and sprays were calculated all the bases of the average decrease in the larval population of leaves and the average male population of the treated traps.

\textbf{RESULTS AND DISCUSSION}

\textbf{Efficiency of Tuta 100 N Phermone and Chlorantraniliprole against \textit{Tuta absolutae}}

\textbf{Season 2015}

Results presented in Table 1 show that number of larvae of tomato leaf miner increased gradually as time elapsed till the end of season but decreased gradually in both treatments (2 traps + coragen and 4 traps + coragen) till 3\textsuperscript{rd} week from application (July 7\textsuperscript{th}) while was continuous effect in treatments (2 and 4 traps) till July 16\textsuperscript{th} which record catch male moths numbers (209, 190) and (273, 398) individually, respectively. Also, the mean numbers of trapped males were, 261, 204.4, 174.27 and 166.36 for 4 traps, 2 traps, 2 traps + coragen and 4 traps + coragen, respectively. Significant reduction in \textit{T. absoluta} damage was observed after 2\textsuperscript{nd}, 3\textsuperscript{rd} and 4\textsuperscript{th} spray of chlorantraniliprole alone. The present study also revealed that two sex phermone traps, 2 sex phermone traps + chlorantraniliprole, 4 sex phermone traps, and 4 sex phermone traps + chlorantraniliprole and control recorded 204.4, 174.27, 261.00, 166.36 and 77.36 males/trap, respectively. The percentage of infested plants with \textit{T. absoluta} ranged from 7.74 to 77.36\% (Table 1).

The highest percentage of infestation was recorded in June (62.23 and 58.10\%) for 2 sex phermone traps and 4 sex phermone traps treatments, respectively. The results showed significant differences in four sex phermone traps/faddan which recorded the highest number of captured males and the lowest infested tomato plants followed by two phermone traps per faddan. Increasing number of phermone traps/lead to increase the captured number of tomato borer males. The percentage of infested tomato plants that recorded were 15.59\%, 36.03, 9.47, 33.43 and 7.74\% for 2 sex phermone traps, 2 sex phermone traps + chlorantraniliprole, 4 sex phermone traps, 4 sex phermone traps + chlorantraniliprole, chlorantraniliprole, respectively. Using phermone water traps during the period June-September, showed that, the highest trap counts of \textit{T. absoluta} was recorded in June. The increase of male catches in phermone traps during spring (March-April) could be due to temperature increases, as it was recorded previously by \textit{Lacordaire and Feuvrier (2010)} and \textit{Cherif et al. (2013)}. Also, the results showed significant differences in percentage of efficiency 63.97, 90.53, 66.57,92.26 and 84.41\%, respectively against the tomato borer during first season 2015.

Chlorantraniliprole and sex phermone were able to overwhelm the pest population until 14 day after treatment which ranged from 48.69 – 71.10\% as efficiency percentage. Four sex phermone traps + chlorantraniliprole recorded the same percentage of infested tomato plants and higher percentage of efficiency than 2 sex phermone traps with chlorantraniliprole as compared with control. Statistical analysis showed significant differences between the treatments. Chlorantraniliprole 20% SC showed in a previous report to provide excellent control against \textit{T. absoluta}, in comparison with a bio-pesticide \textit{Bacillus thuringiensis} which provides moderate control (\textit{Cherif et al., 2013}). The present finding is in corroborates with \textit{Soliman (2015)} who showed that six phermone traps/ faddan recorded the highest number of
Table 1. Effect of Tuta 100 N pheromone with and without chlorantraniliprole application the tomato leafminer in tomato plants at Abo-kabir district, Sharkia Governorate during 2015 season

| Date (week) | Mean No. of larvae/trap | Efficiency (%) | Count catching adult | Infestation (%) | Efficiency (%) | Count catching adult | Infestation (%) | Efficiency (%) | Count catching adult | Infestation (%) | Efficiency (%) |
|------------|-------------------------|----------------|---------------------|----------------|----------------|---------------------|----------------|----------------|---------------------|----------------|----------------|
| 25/6       | 50.9                    | 49.1           | 236                 | 62.2            | 37.77          | 250                 | 51.15          | 48.85          | 397                 | 58.1           | 41.90          |
| 2/7        | 8.39                    | 92.71          | 255                 | 51.31           | 48.69          | 204                 | 13.06          | 86.94          | 351                 | 41.50          | 58.50          |
| 9/7        | 13.6                    | 86.4           | 249                 | 30.15           | 69.85          | 209                 | 10.5           | 89.50          | 337                 | 35.05          | 64.95          |
| 16/7       | 16.0                    | 84.0           | 273                 | 29.3            | 70.70          | 165                 | 3.1            | 96.90          | 298                 | 30.10          | 96.9          |
| 23/7       | 7.45                    | 92.55          | 203                 | 30.81           | 69.19          | 191                 | 0.5            | 99.50          | 253                 | 35.89          | 64.11          |
| 30/7       | 12.1                    | 87.9           | 203                 | 35.15           | 64.85          | 167                 | 0.75           | 99.25          | 248                 | 29.71          | 70.29          |
| 6/8        | 18.5                    | 81.5           | 200                 | 2915            | 70.85          | 198                 | 1.51           | 98.49          | 241                 | 23.41          | 76.59          |
| 13/8       | 5.91                    | 94.19          | 190                 | 34.42           | 65.58          | 150                 | 3.51           | 96.49          | 188                 | 29.35          | 70.65          |
| 20/8       | 13.25                   | 86.75          | 149                 | 28.21           | 71.79          | 120                 | 10.05          | 89.95          | 185                 | 28.31          | 71.69          |
| 27/8       | 16.25                   | 83.75          | 130                 | 36.8            | 63.20          | 134                 | 3.51           | 96.49          | 190                 | 31.25          | 68.75          |
| 4/9        | 9.45                    | 9.62           | 137                 | 28.9            | 71.10          | 129                 | 5.99           | 49.01          | 183                 | 25.1           | 74.90          |
| Total      | 17.9                    | -              | 2249                | -               | -              | 1926                | -              | -              | 2871                | -              | 851.02         |
| Mean       | 15.59 j                 | 84.41 f        | 204.4b              | 36.03 t         | 63.97 h        | 174.2c              | 9.47k          | 90.53e         | 261.00a             | 33.43i         | 66.57h         |
| Yield      | 32450 c                 | 25950 e        | 35700 b             | 30550 d         | 39200 a        | 15100f               |                |                |                     |                |                |

By Duncan's Multiple Range Test (DMRT), reduction percentages followed by the same litters are not significant at 5% level*=

Captured males and the lowest infested tomato fruits while two pheromone traps per faddan recorded the least numbers of males and the highest percentage of infesting tomato fruits. Abdelrazek (2015) found that T. absoluta attacked all aerial parts of tomato in all growing stages of the crop causing from 80 - 100 % yearly yield lost. Also, Taha et al. (2013) conducted an experiment toward the development of integrated control program against the tomato leafminer in the summer growing season of 2012 at Manawat village, Giza Governorate, Egypt. They used IPM consisting of mass trapping of T. absoluta males in red plastic basin trap at a density of 8 sex pheromone traps/ faddan. Percent fruit damage was lower in the field treated with pheromone baited water traps.

Season 2016

In 2016, high levels of T. absoluta by naturally occurring were detected in the tested traps as shown in Table 2. Results showed the significant differences in the number of captured males which recorded 201.1, 178.3, 196.55, 250.3 and 78.44 male/trap for 2 sex pheromone traps, 2 sex
pheromone traps + chlorantraniliprole, 4 sex pheromone traps, 4 sex pheromone traps + chlorantraniliprole and control, respectively. The percentage of infested plants with *T. absoluta* ranged from 9.32 to 78.44% (Table 2). The mean percentages of moth's numbers in two plant traps under spray with chlorantraniliprole were less than that obtained under four sex pheromone traps. The mean number of moths which have been cached after 12 weeks were recorded 78.44 moths in check treatment, 16.64 moth's when treated with chlorantraniliprole and recorded 178.30 and 196.55 moths when treated with 2 sex pheromone traps and 4 sex pheromone traps/faddan together + chlorantraniliprole, respectively.

Also, the results showed that four sex pheromone traps used was better than 2 sex pheromone traps/faddan in the two tested seasons. Chlorantraniliprole and sex pheromone were able to overwhelm the pest population until the 14 day after treatment ranged 51.85–88.85% (in both of coragen and 2 traps + coragen) as efficiency percentages. Significant differences in chlorantraniliprole together with six pheromone traps are effective against *T. absoluta*. In the current control practice these insecticides with two or four sex pheromone traps are commonly applied at the end of the cultivation period in order to end with a low pest density.

In conclusion, overall results of the present study provided evidence of existing correlations between number of sex pheromone traps and number of moths catched which positive and significant by increasing number of phermone traps. Using of chlorantraniliprole insecticide with sex pheromone traps decreasing population density and infestation percentage of *T. absoluta* in tomato fields.

### Table 2. Effect of Tuta 100 N phermone with and without chlorantraniliprole application the tomato leafminer in tomato plants at AbokKabir District, Sharkia Governorate during 2016 season

| Date (weekly) | Mean No. of larvae/4replcats | Efficiency (%) | Count catching adult | Infestation (%) | Efficiency (%) | Count catching adult | Infestation (%) | Efficiency (%) | Count catching adult | Infestation (%) | Efficiency (%) | Count catching adult | Infestation (%) | Efficiency (%) | Count catching adult | Infestation (%) | Efficiency (%) | Count catching adult | Infestation (%) | Efficiency (%) |
|--------------|-----------------------------|----------------|--------------------|----------------|----------------|--------------------|----------------|----------------|--------------------|----------------|----------------|--------------------|----------------|----------------|--------------------|----------------|----------------|--------------------|----------------|----------------|
| 22/6         | 53.25                       | 46.95          | 276                | 49.91          | 50.19          | 235                | 56.22          | 43.78          | 342                | 51.25          | 48.75          | 362                | 48.61          | 51.39          | 362                | 48.61          | 51.39          |
| 29/6         | 11.15                       | 88.85          | 246                | 48.15          | 51.85          | 208                | 48.15          | 51.85          | 333                | 42.91          | 57.09          | 321                | 46.65          | 56.35          | 321                | 46.65          | 56.35          |
| 6/7          | 13.45                       | 86.55          | 255                | 40.91          | 59.09          | 200                | 10.99          | 89.01          | 327                | 38.25          | 61.75          | 260                | 30.00          | 70.00          | 260                | 30.00          | 70.00          |
| 13/7         | 15.3                        | 84.7           | 249                | 38.89          | 61.11          | 198                | 13.5           | 86.50          | 298                | 35.09          | 64.91          | 220                | 28.85          | 71.15          | 220                | 28.85          | 71.15          |
| 20/7         | 8.0                         | 92.0           | 230                | 36.81          | 63.19          | 171                | 2.81           | 97.19          | 253                | 30.28          | 69.71          | 199                | 22.68          | 77.32          | 199                | 22.68          | 77.32          |
| 27/7         | 9.99                        | 90.4           | 217                | 38.19          | 61.81          | 188                | 3.5            | 96.50          | 253                | 31.15          | 68.85          | 157                | 19.89          | 80.11          | 157                | 19.89          | 80.11          |
| 4/8          | 16.42                       | 83.58          | 199                | 36.75          | 63.25          | 191                | 0.25           | 99.75          | 215                | 25.99          | 74.01          | 123                | 11.50          | 88.50          | 123                | 11.50          | 88.50          |
| 11/8         | 6.42                        | 93.68          | 173                | 30.15          | 69.85          | 175                | 0.15           | 99.85          | 247                | 24.21          | 75.79          | 119                | 10.45          | 89.55          | 119                | 10.45          | 89.55          |
| 18/8         | 12.5                        | 87.5           | 181                | 29.89          | 70.11          | 169                | 0.11           | 99.89          | 201                | 19.99          | 80.01          | 115                | 10.00          | 90.00          | 115                | 10.00          | 90.00          |
| 25/8         | 16.25                       | 83.75          | 164                | 27.35          | 72.65          | 148                | 3.15           | 96.85          | 198                | 18.15          | 81.85          | 101                | 10.00          | 90.00          | 101                | 10.00          | 90.00          |
| 2/9          | 11.38                       | 88.72          | 122                | 28.25          | 71.75          | 131                | 2.0            | 98.00          | 176                | 15.85          | 84.15          | 79                 | 4.50           | 95.50          | 79                 | 4.50           | 95.50          |
| 9/9          | 8.99                        | 91.01          | 101                | 23.99          | 76.01          | 125                | 2.51           | 97.49          | 140                | 15.91          | 84.09          | 86                 | 4.85           | 95.15          | 86                 | 4.85           | 95.15          |
| Total        | -                           | -              | 2139               | -              | -               | 3003               | -              | -              | 2162               | -              | -              | 79.58               | -              | 95.15          | -                  | 79.58           | 95.15          |
| Mean         | 15.25                       | 84.75          | 201.1b             | 35.76          | 64.24i         | 178.3d             | 9.32n          | 90.68e         | 250.3a             | 70.92h          | 196.55c         | 20.41l               | 93.50e         | 78.44g         | 20.41l               | 93.50e         | 78.44g         |
| Yield        | 31150                       | 25500          | 33180b             | 31100          | 40000a         | 47300              | 47300          | 47300          | 47300              | 47300          | 47300          | 47300              | 47300          | 47300          | 47300              | 47300          | 47300          |

*By Duncan’s Multiple Range Test (DMRT), reduction percentages followed by the same letters are not significant at 5% level = Count No. before treatment

LSD 0.05% (mean) = 4.174

LSD 0.05% (Yield) = 541.458
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تقني استخدام فرمن جنسي واحد المبيدات الحشرية ضد ذكور فراشات حافرة أوراق الطماطم

Tuta absoluta

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تم تقييم استخدام الورقون الحشرية في فحص تعداد حشرة مصابة أوراق الطماطم في الحقول المفتوحة للطماطم باستخدام مبيد الكيربين والورقون N 3 ملليجرام/كيلوغرام tuta 100N و N 2015 و 2016 (العوادة الصيفية)، تم تصميم خمسة علاجات تشمل فيها الورق بالكيربين و نصافين مع مبيد الكيربين بكمية تزيد عن رش مبيد الكيربين في الجدول التالي:

لكل فدان كان أفضل من وضع مبيد الكيربين فقط بالإضافة إلى الورق بالكيربين بالي ذلك الفأة للكيربين فقط ثم استخدام ثمانية مصابدين مصابدين فقط كل فدان وأخيرا استخدام مصابدين فقط كل فدان حيث أظهرت نسبة ثمانية مصابدين في النتائج ب 93.6، 92.4، 91.2، 77.4، 68.5من حشرة خلال موسم 2015، و 81.4، 72.6، 63.8، 55.9من حشرة خلال موسم 2016، على التوالي، عند مقارنة فاعلية عدد المصابدين أظهرت النتائج أن

استخدام + مصابد أفضل من استخدام مصابد فدان لصيد ذكور الفراشات حيث سجلت متوسط وقفة 271.3، 260.8، 250.5، 240.1، 230.6، 220.2، 210.8، 200.4، 190.0، 180.6، 170.2، 160.8، 150.4، 140.0، 130.6، 120.2، 110.8، 100.4، 90.0، 80.6، 70.2، 60.0، 50.6، 40.2، 30.8، 20.4، 10.0، 0.0 من حشرة خلال موسم 2015، و 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0 من حشرة خلال موسم 2016، على التوالي، حيث سجلت 39.2، 38.0، 36.8، 35.6، 34.4، 33.2، 32.0، 30.8، 29.6، 28.4، 27.2، 26.0، 24.8، 23.6، 22.4، 21.2، 20.0، 18.8، 17.6، 16.4، 15.2، 14.0، 12.8، 11.6، 10.4، 9.2، 8.0، 6.8، 5.6، 4.4، 3.2، 2.0، 0.8 من حشرة خلال موسم 2015، و 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0، 0.0 من حشرة خلال موسم 2016، على التوالي، حيث كانت النتائج لم تظهر فائدة مثبتة للاستعمالات المصابدين في الفاصل أوراق الطماطم بالإضافة إلى استخدام

نظهر نتائج هذه الدراسة أن الكيربين فعال وضروري في مكافحة صادفة أوراق الطماطم بالإضافة إلى استخدام

فمن المصابدين المائم بالفروق الجنسي/فدان للحصول على فائدة فعالة لهذه الافا في نفس الوقت معدل إنتاجية

علي.

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