DIMBOA AS A CHEMICAL RESISTANCE FACTOR AGAINST THE EUROPEAN CORN BORER, *OSTRINIA NUBILALIS* (HUBNER) IN CERTAIN MAIZE GENOTYPES

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Abstract

The chemical resistance factor DIMBOA, (2.4 dihydroxy-7methoxy-1.4 benzoxazin, 3 one), was determined in ten maize genotypes. Laboratory evaluation of resistance of these types against Ostrinia nubilalis was recorded. The relationship between DIMBOA and resistance degree was estimated showing the following results.

There is a positive correlation between DIMBOA absorption (at 266 nm) and larval mortality percentage in 50% of the tested inbred lines. Sixty per cent of the tested lines showd a positive correlation between DIMBOA and per cent larval duration. Fifty per cent of these lines showed a negative correlation between DIMBOA and pupal weight. DIMBOA correlated with the general rating of laboratory resistance in 60% of the tested maize inbred lines.

DIMBOA may play an important role as a chemical resistance factor in 60% of the tested inbred lines (Gm. 9, Gm, 6, Gm22, Gm. 14, Gm. 2 and Sids 34), while (Sids 7, Gm. 13, Gm. 4 and Gm. 31) were not affected by DIMBOA content.

INTRODUCTION

Maize is the most widely distributed cereal crop in Egypt. The European corn borer (ECB), Ostrinia nubilalis Hubn. is one of the most serious maize insects in Egypt.

The development of maize variety that resists ECB was the goal of entomologists and plant breeders for a long time. IPM system is the recent approach that can achieve this goal. Varietal resistance is a safe tool in this system. Chemical resistance is the most stable factor in varietal resistance. It can be used as a sure resistance factor in selecting resistant varieties and/or introducing resistant parents in breeding programs as well as evaluating entries against pests in entomology programs. This approach can help in minimizing insecticidal control with all its problems.

The present study is an attempt to evaluate DIMBOA (2,4 dihydroxy 7 methoxy- 1,4 benzoxazin, 3 one) as a chemical resistance factor in certain maize lines against the European corn borer, and to present some resistant lines that have resistance bases on a chemical factor, (DIMBOA content).

This evaluation was achieved through correlating DIMBOA contents with the biological ratings of ECB resistance as a most important indicator for plant resistance.

It may be useful to record that DIMBOA compound occurs in plant tissues as an inactive glucoside. When plant tissues are attacked and crushed by the insect the glucoside is hydrolyzed by the glucosidase enzyme, which was separated before crushing, to yield glucose and the free and toxic DIMBOA compound.

MATERIALS AND METHODS

This study was conducted at Gemmeiza Agric. Res. St., 1993 maize season.

a: Planting and sampling

Thirty maize lines were planted in complete randomized block design as (2 rows x 6 m x 2 replicates / line). At whorl stage (45 days old) samples of fresh whorl leaves, as a favourable time and part for ECB infestation. Similar samples were freezed in polyethylene bags for DIMBOA analysis .

b- Insect laboratory evaluation

It was done and classified to categories according to Awadallah *et al.*, (1982), and Guthrie *et al.*, (1960).

c- DIMBOA analysis

Out of the thirty evaluated lines, samples of ten were chosen, showing three levels of laboratory resistance evaluation for DIMBOA analysis. These inbreds were Gm. 13, Sids 7, Gm. 9 and Gm. 6 as resistant lines, Sids 34 and Gm. 14 as susceptible and Gm. 4, Gm. 22, Gm. 2 and Gm. 31 as intermediate.

DIMBOA was analyzed by the technique of "Separation Funnel" described by Klun *et al.*, (1967). Ultraviolet absorption spectra of DIMBOA were taken from (Unicam S.P. 1800 U.V. Spectrophotometer) at 288, 266 and 208 nm as the best wave lengths for maximum absorption, and 280 and 230 for the minimum. The absorption at 266 nm was chosen as a detector for DIMBOA concntration.

RESULTS AND DISCUSSION

The relationship between the resistance ratings in ten maize inbred lines against ECB Ostrinia nubilalis Hubner, evaluated under laboratory conditions, and the absorbance (absorption logarithm) of DIMBOA is illustrated in Table (1) .

a- The relationship between early larval mortality of Ostrinia nubilalis fed on different maize inbred lines and the absorption of DIMBOA

Absorption of DIMBOA in each inbred lines was estimated by the ultraviolet absorbance at wave length 266 nm. (Table 1) showed that Gm. 9, Gm. 6 and Gm. 22 which rated as resistant inbreds on the basis of early larval mortality of ECB, Ostrinia nubilalis (82 and 72%, respectively) manifested high absorbance of DIMBOA (1.25, 0.533 and 0.507, respectively). The inbred line Gm. 2 which rated as intermediate with 52% larval mortality showed intermediate absorbance of 0.492. The susceptible inbred line Sids 34 as indicated by 18% larval mortality showed low absorbance of DIMBOA (0.369). Although inbred lines Gm. 13 and Sids 7 were considered resistant with larval mortality of 80 and 82%, they showed low absorbance of DIMBOA, of 0.265 and 0.226, respectively (Ward *et al.*, 1975). In the same time the

intermediate inbred lines Gm. 4, Gm.31 and Gm. 14 with 46, 50 and 40% larval mortality showed low absorbance of DIMBOA of 0.278, 0.272 and 0.253, respectively.

It can be concluded that DIMBOA, as a chemical resistance factor, is responsible for the larval mortality percentage in 50% of the evaluated maize inbred lines (Gm. 9, Gm. 6, Gm. 22, Gm2, Gm.13 and Sids 7), Reed *et al.* (1972). It is important to mention that the other inbred lines that showed no correlation may possess other factors that share plant resistance (Sulivan *et al.*, 1974).

b- The relationship between larval duration of Ostrinia nubilalis reared on different maize inbred lines and the absorption of DIMBOA

Table (1) showed that, out of ten tested lines, six lines (Gm. 6, Gm. 22, Gm. 31, Gm.14, Gm. 2 and Sids 34) manifested a correlation between the absorbance of their DIMBOA contents and their resistance rating based on larval duration, for the larvae fed on these inbred lines. The inbred line Gm.6 of the high absorbance of DIMBOA (0.533) showed the longest period of larval duration (23.5 days). The inbred lines Gm. 31, Gm.14 and Sids 34 of low DIMBOA absorbance (0.272, 0.253 and 0.369, respectively) had the shortest period of larval duration. The inbred lines Gm. 22 and Gm. 2 showed intermediate DIMBOA absorbance (0.507 and 0.492) and larval duration (21.6 and 21.1days), respectively.

Inbred lines Gm .13 and Sids 7, in spite of their low DIMBOA absorbance (0.256 and 0.226, respectively), showed resistance to ECB on the basis of larval duration (23.4 and 22.0 days, respectively). Results indicated that there is a relationship between resistance rating, as indicated by larval duration, and the absorbance of DIMBOA in 60% of the evaluated inbred lines. The results are in agreement with Robinson *et al.*, (1983) who stated that larvae of Ostrinia nubilalis take longer period to pupate and weigh less by increasing level of DIMBOA.

c- The relationship between pupal weight of Ostrinia nubilalis reared on different maize inbred lines and the absorption of DIMBOA

Results presented in Table (1) indicated that there is a relationship between the resistance ratings on the basis of pupal weight produced from larvae reared on different maize inbred lines and absorbance of DIMBOA. Inbred lines Gm. 9, Gm. 6,

Gm. 14, Gm. 2 and Sids 34 showed positive correlation between resistance ratings as indicated by pupal weight and DIMBOA absorbance. Inbred lines Gm. 13,and Sids 7 which are resistant inbred lines with less pupal weight (60.7 and 59 mg, respectively) showed as low absorbance as that of susceptible inbred line Gm. 14. As a conclusion, DIMBOA content in 60% of the evaluated inbred lines has a negative effect on pupal weight of Ostrinia nubilalis fed on these lines.

d- The relationship between the overall resistance ratings, on the basis of laboratory evaluation conditions, and absorbance of DIMBOA in maize inbred lines

Table (1) showed that there is a relationship between the general ratings of resistance and DIMBOA absorbance. The effectiveness of DIMBOA content on the resistance of the tested lines on basis of overall resistance ratings was similar to that on basis of larval duration rating. This result means that larval duration is the most affected factor by DIMBOA content among all tested biological factors. Therefore, the effectivenss of 60% of the evaluated maize inbred lines on overall biological factors is mainly due to DIMBOA contents in plant tissues of these lines.

Table 1. Relationship between some biological aspects of ECB fed on some maize inbred lines and the absorbance of DIMBOA compound.

Maize inbred lines	Log Dimbboa absorption at wave length 266 (n.m.)	Laboratory evaluation						
		Larval mortality		Larval duration		Pupal weight		Av. of rates
		%	rate	days	rate	mg	rate	
G.9	1.250	82	r	20.8	m	54.3	r	R
G.6	0.533	74	r	23.5	r	56.8	r	R
G.13	0.265	80	r	23.4	r	60.7	r	R
S.7	0.226	82	r	22.0	r	59.0	r	R
G.22	0.507	72	r	21.6	m	68.6	s	M
G.4	0.278	46	m	21.5	m	63.1	m	M
G.31	0.272	50	m	19.6	s	66.8	m	M
G.14	0.253	40	m	18.8	s	71.7	s	S
G.2	0.492	52	m	21.1	m	61.5	r	M
S.34	0.369	18	s	18.6	s	75.0	s	S

* R : resistant * M : moderate *S:susceptible *G: Gemmeiza *S:Sids

It can be concluded that DIMBOA may have reduced both rate of nutrient intake and digestibility and consequently lengthened larval period, as mentioned by Robinson *et al.*, (1963). The inbred line Gm. 14, as an example of this result, which had relatively low DIMBOA content, caused moderate mortality, accelerated larval duration and increased the pupal weight of ECB insect (40 % mortality, 18.8 days larval duration and 71.7 mg pupal weight).

As a general result, DIMBOA content in the evaluated maize lines positively effected on resistance ratings on the basis of larval mortality, larval duration, pupal weight and overall resistance in 50%, 60%, 50% and 60% of the tested lines, respectively. Some lines showed no correlation between DIMBOA content and any of the resistance ratings. These results lead to logic conclusion that DIMBOA may play an important role as a chemical resistance factor in maize plant tissues in the whorl stage against the ECB larvae, but it is not the limiting factor, and there is other morphological, histological and/or chemical factors that share it in the plant resistance. This conclusion is in agreement with that obtained by Soliman (1982) and sulivan *et al.*, (1974).

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مركب الديمبو (DIMBOA) كعامل مقاومة كيميائى ضد ثاقبة ساق الذرة الاوروبية فى بعض التركيبات الوراثية للذرة

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تم تقدير عامل المقاومة الكيميائى "ديمبوا" (٤,٢ داى هيدروكس ، ٧ ميثوكسى ٤,١٠ بنزوكسازين ، ٣ آون) فى عشر تركيبات وراثية للذرة ، كما تم تقييم هذه التركيبات معمليا على اساس بيولوجى ضد ثاقبة ساق الذرة الأوربيه ، وتم الربط بين محتوى الأصناف من الديمبوا ودرجة المقاومة. وتم الحصول على النتائج التالية :-

- هناك علاقة ايجابية بين محتوى النبات من الديمبوا ونسبة الموت اليرقى فى ٥٠٪ من الاصناف المختبرة.
- هناك علاقة ايجابية بين محتوى النبات من الديمبوا ومدة الطور اليرقى فى ٦٠٪ من الاصناف المختبرة.
- هناك علاقة سلبية بين محتوى النبات من الديمبوا ووزن العذارى فى ٥٠٪ من الاصناف المختبرة.
- وبصفة عامة ، هناك علاقة ايجابية بين محتوى النبات من الديمبوا والمقاومة البيولوجية الكلية فى ٦٠٪ من الاصناف المختبرة وهى جميزة ٩ ، جميزة ٦ ، جميزة ٢٢ ، جميزة ١٤ ، جميزة ٢ وسدس ٣٤.

ويمكن القول أن الديمبوا فى الذرة قد يلعب دورا هاما كعامل مقاومة كيميائى ضد ثاقبة ساق الذرة الأوربية ، ولكنه ليس العامل المحدد لها وقد تشاركه عوامل مورفولوجية أو هستولوجية أو كيميائية اخرى فى اظهارها.