Comparing three Methods of Calculation Economic Threshold and Injury Levels for Land Snail *Monacha cantiana* (Montagu) on Sugarbeet in Nubaryia, Egypt

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Abstract. This investigation is the first to determine *Monacha cantiana*'s EIL and ETL. This study was accomplished during two seasons to identify EIL and ETL of *M. cantiana* in West Nubaryia region in Egypt. Four infested techniques (SnP, SnM, ILnP and ILnP %) and three methods (i.e. 1WRB, Chi-square and the equation of Pedigo *et al.* 1986) were applied to calculate EIL and ETL.

Generally, at SnP, SnM, ILnP and ILnP%, the EIL values for RWL and RYL ranged from 5.0 to 6.4, 35.1 to 44.7, 14.9 to 18.3 and 48.4 to 55.0, respectively. The EIT values for SYL at the techniques infested above ranged from 5.9 to 8.7 SnP, 41.4 to 58.7 SnM, 16.7 to 26.7 ILnP and 53.1 to 73.1 ILnP%.

For RWL and RYL, range ETL values were 3.8 to 5.3, 22.4 to 38.4, 8 to 14.6 and 32.5 to 44.0 at SnP, SnM, ILnP and ILnP%, respectively. Nonetheless the corresponding values for RYL were 4.4-5.1, 22.4-35.8, 8-11.9 and 32.5-38.7. On the other hand, the aforementioned SYL treatment values were 4.0 to 7.0, 26.8 to 46.9, 10.3 to 21.4 and 37.0 to 58.0, respectively.

Chi-square were only significant for root weight and their losses, therefore, it was neglected. The ranges in SnP expression were very closely. So, It could be inferred that SnP with Pedigo *et al.* 1 or 1WRB is an effective technique for EIL or ETL determination.

Abbreviation:

EIL= Economic Injury Levels, ETL= Economic Threshold Levels, RWL/RYL=Root weights/yields or their losses, SYL=Sugar yields or their losses, SnP=snails numbers/plant, SnM=Snail numbers/m², ILnP= infested leaves numbers/plant, = ILnP%= % infested leaves numbers/plant, 1WRB = one-way randomized blocks

Highlights:

- Four infested techniques (snails numbers/plant, Snail numbers/m², infested leaves numbers/plant and % infested leaves numbers/plant) were used as infestation with the land snail, *Monacha cantiana*
- Three methods (i.e. one-way randomized blocks (1WRB), Chi-square and the equation of Pedigo *et al.*¹) were applied to calculate Economic Injury (EIL) and Threshold Levels (ETL).

Introduction

Recently, sugarbeet becomes the first source for sugar production in Egypt, where the sugar production from beets has 62.2 % of Egypt's total sugar production². Sugarbeet yields were affected by insects, diseases, weed and snails, therefore, control such pest is necessary.

Land snails are dangerous agricultural pests which classified under phylum Mollusca, Class Gastropoda. These snails have increased rapidly causing economic damage to the field crops, vegetables as well as horticultural crops³. In Egypt, land snails have been increased and distributed rapidly in most Governorates. They caused considerable damage especially in most areas where they found the optimum conditions for survival and dispersion⁴. In addition, they have a role as intermediate hosts for many parasitic diseases which infected human, animals, and birds. Some of them have been identified as disseminators of the spores of phytopathogenic fungi³.

In recent times, the snails invade sugarbeet fields in Nubaryia⁵, Kafr El-Sheikh⁶ and Sharkia⁷. Increasing invasions of this pest gave attention to control it. The recent method was used to control *M. cartusiana* in Egypt by applying *Zingiber officinale* extract as an ecofriendly molluscicide^{8,9}. Thus to harness maximum benefits from sugarbeet, there is a need to determine the economic threshold and economic injury levels of insect pests such as snails. There are several methods to calculate these parameters such as Chi-square (χ^2)^{10,11,12,13} the equation of **Pedigo *et al.***¹ and defoliation¹⁴ who modified the equation of ETL percentages by adding natural mortalities and parasitism percentages.

Entomologists and economists have defined thresholds differently. Entomologists revealed that Economic Injury Level (EIL) is lowest pest population density that will cause economic damage. Economic Threshold (ETL) is pest population density at which control measures should be initiated to prevent an increasing pest population from reaching the EIL¹⁵. While the economic terminology coincides with that of Headley¹⁶, who mentioned that, ETL is the population that produces incremental damage equal to the cost of preventing that damage. Edwards and Heath¹⁷ reported that Action Threshold (ETL) is pest population large enough to cause damages valued at the cost of practical control.

The aim of the study is to calculate EIL and ETL for land snail *M. cantiana* (Montagu) by different methods to select the suitable one under Egyptian conditions. The profits of the results of this study are selection the best expression to such snail for controlling it.

Material & Methods

In West Nubaryia area (30 ° 42'51"N30 ° 44'32"E), the field with high land snails infested, to determine the EIL. The snails were named by Department of Zoology, Faculty of Agriculture, University of Mansoura, Egypt. Three species (*Monacha cantiana*, *Theba pisana*, and *Helicell vestalis*) were found, the most dominated snail in this region was *M. cantiana*, therefore, such species was chosen (an experimental area of one feddan (= acre)) in the 1st season. In the same region, another field was chosen in the 2nd season with the same conditions. The studied plots could be grouped according to the previous natural infestation with land snail *M. cantiana* into 12 levels as shown in Table (1) according to fore information⁵ and our observations.

Each level was divided into three replicates. Each replicate was 2 m². The snail numbers were recorded to each replicate from Jan till Apr (harvest time) half-month. The average of each plot was calculated at harvest date. The control was selected in the same region; this control field was planted by the same sugarbeet cultivar, the same soil texture, similar infection/infestation levels with other pests and free infestation with such snail. The soil textures of experimental and control areas were sand soil in both seasons.

For determination quantitative studies of land slug populations, South¹⁸ suggested three categories: absolute (number of individuals per unit area), relative (the number of individuals per unit effort or the relation to non-standardized traps) and indirect methods (sizes of population in terms of traces left or the effects produced by land snails). These methods were also used for snails (http://www.usc.es/export9/sites/webinstitucional/gl/investigacion/grupos/malaterra/publicaciones/Proyect_UE_FP7/FP7_Proyecto_UE_Castillejo.pdf Page 11).

Four infested techniques for expressing the infestation with snails, which were, snail numbers/ m²¹⁹ and snail numbers/ plant²⁰, and two other methods were added, the number of infested leaves/ plant and % number of infested leaves/plant.

$$\text{Snails No./Plant} = \frac{\text{Snails No/m}^2}{\text{Plant No/m}^2}$$

$$\text{Infested No leaves\%} = \frac{\text{Infested No Leaves/Plant}}{\text{Total No Leaves/Plant}} \times 100$$

At harvest time, these traits were determined to root weight and yield as well as their losses.

$$\text{Root yields} = \frac{\text{Root Weights/plant} \times \text{Plant No/m}^2 \times 4000}{1000}$$

Where, the actual area which was planted = 4000 m²

Sugar yields = Root Yield × % sucrose

Percentage of sucrose was determined using Saccharimeter according to the method described in A.O.A.C. ²¹

The losses of root weights/yields and sugar yield were calculated as follow:

$$\text{Losses} = \frac{(\text{Control} - \text{Treatment})}{\text{Control}} \times 100$$

For evaluation, the losses in sugar yield, the average % of sucrose in sugarbeet was 18.2% ². Therefore, the estimated price of sucrose ton was LE ($= \frac{100}{18.2} \times 379.37 = 2084.45$ LE).

Where the price of root ton was 379.37 LE.

Estimation of economic injury level (EIL) and the economic threshold level (ETL)

Both measurement methods, EIL and ETL, have been implemented according to previous definitions:-

1) Entomologist definition (Statistical variations)

1.1) One way randomized blocks (1WRB). In this analysis, the first significant difference was used as EIL ²²

1.2) Chi-square (χ^2)^{10,11,12,13}

2) Economist definition:

2.1) The equation of **Pedigo *et al.***¹ for determination EIL which was modified by **Goebel**²³ was applied. The management control cost was calculated using the cost of molluscicide (metaldehyde 5 kg/ha), labour charge for the application which accounted to 1680 LE/fed. The gain threshold (GT) was calculated by using the formula,

$$\text{Gain threshold (GT)} = \frac{C}{VK} = \frac{1680}{379.37} = 4.43 \text{ tones/fed}$$

$$\text{EIL} = \frac{[\text{GT} - a]}{b}$$

K = K is the reduction of injury due treatment (K = 1 for no loss)

Where

C = Cost of the management control per unit of production (e.g. 1680 LE/Fed)

V = Market value (utility) per unit of the produce (e.g. 379.37 LE/Ton)

From the linear regression equation parameters between infestation technique and root weights/yields, sugar yields or their losses, a (intercept) and b (slope) were used.

Calculation of ETL

ETL was set at 75% of ETL²⁴ or 80%²⁵

Statistical analysis

One way randomized blocks (1WRB), correlation coefficients and least significant difference (LSD) at p < 0.05 were done according to the techniques outlined by **Steel and Torrie**²⁶ using Costat under window version 6.311. Arcsin (angular) transformation was done for % number of infested leaves/ plant. Chi-square was calculated as mentioned by **Zaghloul *et al.***¹³.

Results and Discussion

Infested Techniques with the snail, *M. cantiana* (Montagu),

Table (1) revealed that the range of infestation by this snail was 27.5 to 70.7 and 39.3 to 71.3 snails/m² in the 1st and 2nd seasons, respectively. Where SnP were 4.3-9.4 SnP in the 1st season and was 5.82- 10.1 SnP in the 2nd one. Also, the ILnP was ranged from 10.7 to 31.0 and 11 to 33 ILnP in the 1st and 2nd seasons, respectively. On the other hand, in the 1st and 2nd seasons the ranges of ILnP% were 43.3-84.8 and 38.1-85.9%, respectively.

Table 1: Four infested techniques by snails during two successive seasons 2014/15 and 2015/16.

Snail No /m2* (SnM)					Snails No./Plant (SnP)	infested leaves numbers/plant (ILnP)	% infested leaves numbers/plant (ILnP%)
January	Feb	Mar	Apr	Mean			
1 st season							
28.5	30.7	32.7	27.5	29.8	4.3	10.7	43.3
31.7	35.5	38.2	35.0	35.1	5.0	15.0	53.6
35.7	40.5	45.0	44.5	41.4	5.9	16.7	55.7
38.5	42.7	47.7	40.3	42.3	7.0	17.3	57.9
39.3	47.5	55.0	50.3	48.0	6.9	19.7	59.9
43.3	48.2	56.8	51.3	49.9	7.1	24.3	67.8
46.0	48.8	60.2	56.5	52.9	7.6	19.0	59.3
49.5	54.8	61.5	58.8	56.2	8.0	22.7	66.5
51.8	56.2	60.8	53.5	55.6	9.3	25.0	71.6
54.2	58.8	62.0	58.3	58.3	8.3	26.3	73.9
58.3	63.5	68.7	67.2	64.4	9.2	29.0	79.2
62.2	64.2	70.7	67.0	66.0	9.4	31.0	84.8
2 nd season							
34.3	41.7	47.6	39.3	40.7	5.8	11.0	38.1
35.5	44.8	48.5	44.3	43.3	6.2	14.7	46.3
37.8	48.3	50.7	49.0	46.5	6.6	18.3	53.1
39.7	53.3	55.3	51.3	49.9	7.1	17.0	55.6
40.3	50.7	58.2	53.8	50.8	7.3	20.0	59.6
42.0	53.3	61.3	57.3	53.5	7.6	21.0	60.2
45.7	53.3	63.7	59.8	55.6	7.9	25.7	69.0
46.0	49.3	58.0	59.7	53.3	8.9	23.7	72.8
52.5	57.5	62.8	60.2	58.3	8.3	26.3	75.2
54.0	58.8	63.8	64.3	60.3	9.1	26.0	76.5
57.5	63.2	70.0	67.8	64.6	9.2	31.3	80.5
62.2	64.5	71.3	69.0	66.8	10.1	33.0	85.9

*Average of two intervals/month (1st and mid of month)

To select the best expression for this snail, correlation coefficients were calculated for all tested techniques and RWL, RYL and SYL (Table 2).

It is interesting to mention that the correlation coefficients of each parameter and its losses have obtained the same values. Nonetheless, each parameter's correlation coefficients (RWL, TYL or SYL) were negative and were positive for their losses.

All correlation coefficients of the tested infested techniques had significant differences in the two seasons except for SYL in the 2nd season. Besides, all correlation coefficients were slightly higher in the 1st season than the 2nd one, except the correlation coefficient between RYL and SnP or SnM. In comparison among the tested techniques, the highest correlation coefficient was recorded for ILnP% and RYL (0.949) in the 1st season. In addition, the correlation coefficients for arcsin (angular) transformation of ILnP% were slightly lower than not translated values, therefore, in this study, ILnP% without transformation was used.

Table 2: Estimated correlation coefficients between the four **infested techniques** with *M. cantiana* or arcsin transformation of % Infested leaves No/plant and root weights/yields or sugar weights/yields.

Infested techniques	Root weights or their losses (RWL)		Root yields or their losses (RYL)		Sugar yields or their losses (SYL)	
	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season
SnP	0.900***	0.888***	0.898***	0.927***	0.850***	-0.429
SnM	0.888***	0.899***	0.842***	0.873***	0.782**	-0.465
ILnP	0.955***	0.910***	0.915***	0.874***	0.842***	-0.428
ILnP %	0.949***	0.939***	0.912***	0.909***	0.835***	-0.521
ILnP% (Arcsin Transformation)	0.944***	0.935***	0.908***	0.904***	0.831***	-0.517

Note: Coefficients of correlation of root yields, root weights and yields of sugar were negative and were positive for losses for previous parameters.

, * Significant differences in probability, respectively, at 1 and 0.1 percent.

In general, the variations among the four infestation techniques and RWL or RYL correlation coefficients were not clearly observed. However, the SYL were varied from the 1st season to the 2nd one. Therefore, all tested techniques were used in this study and they were written in all tables. SYL may be sensitive to change meteorological parameters²⁷, they mentioned that the sugarcane is very sensitive to temperature, rainfall, solar radiations etc. Consequently, the findings of SYL became less attention in this study. The arbitrary economic threshold usually reflects schedules of the farmer and applicator, weather, equipment, farm size, the farmer's intuition and any number of such factors that are difficult to model²⁸.

Evaluation of EIL and ETL of snail, *M. cantiana* (Montagu) on sugarbeet

A) Entomologist definition (Statistical variations)

1) 1WRB

The results of EIL values were similar for both RWL and RYL, so these results were combined in Table (3). In comparison with the control, control treatments values of RWL or RYL were not statistically significant than up to 4.3 and 6.2 SnP in the 1st 2nd seasons, respectively. However, in both tested seasons, SYL were not statistically significant than up to 5.0 SnP in the 1st season and 6.2 SnP in the 2nd one.

Table 3: Comparison among infestation levels with *M. cantiana* and root weight & yields, sugar yields and their losses using 1WRB during two successive seasons.

Snails No./Plant	Root Weights (g)	Root Weight losses (g)	Root Yield (Tons/Fed)	Root Yield losses (Tons/ Fed)	Sugar yield (Tons/Fed)	Sugar yield Losses (Tons/Fed)
1 st season						
0.0	973.0*		27.2*		4.6*	
4.3	975.3*	-2.3*	26.0*	1.2*	4.5*	0.1*
5.0	872.7	100.3	24.4	2.8	4.3*	0.3*
5.9	798.0	175.0	22.3	4.9	2.9	1.7
7.1	745.5	227.5	18.9	8.3	2.5	2.1
6.9	835.3	137.7	22.5	4.7	3.6	1.0
7.1	541.3	431.7	23.4	3.8	2.3	2.3
7.6	802.7	170.3	16.5	10.7	2.9	1.7
8.0	590.3	382.7	15.2	12.0	2.5	2.1
9.3	525.0	448.0	12.6	14.6	1.5	3.1
8.3	543.7	429.3	15.2	12.0	1.8	2.8
9.2	483.0	490.0	13.5	13.7	2.0	2.6
9.4	466.7	506.3	13.1	14.1	1.7	2.9
LSD _{0.05}	68.9	71.7	1.9	2.0	0.37	0.5

Snails No./Plant	Root Weights (g)	Root Weight losses (g)	Root Yield (Tons/Fed)	Root Yield losses (Tons/Fed)	Sugar yield (Tons/Fed)	Sugar yield Losses (Tons/Fed)
2 nd season						
0.0	879.7*		24.6*		3.2*	
5.8	807.3*	72.4*	22.6*	2.0*	3.1*	0.06*
6.2	849.3*	30.4*	23.78*	0.8*	3.2*	0.03*
6.6	638.2	241.5	17.9	6.7	2.5	0.73
7.1	695.3	184.4	19.5	5.1	2.4	0.80
7.3	645.7	234.0	18.1	6.5	2.3	0.90
7.6	470.2	409.5	13.2	11.4	2.6	0.63
8	389.7	490.0	9.4	15.2	2.6	0.56
8.9	471.3	408.4	13.2	11.4	2.6	0.63
8.3	406.0	473.7	10.8	13.8	2.0	1.16
9.1	354.7	525.0	9.9	14.7	2.1	1.08
9.2	385.0	494.7	10.3	14.3	2.6	0.65
10.1	324.3	555.4	8.9	15.7	2.4	0.80
LSD _{0.05}	105.2	107.9	2.9	3.0	0.37	0.39

* not significant than control

In this investigate, RWL, RYL and SYL were higher (> 10 percent) than those reported by **Shalaby *et al.*⁶** in the governorate of Kafr El-Sheik they found that the overall mean of root weight and sugar yield reduction (10-50 SnP) was 0.128-3.46 and 1.06-12.23%, respectively. Additionally, the examined sugarbeet cultivar was more susceptible to land snail *Mcantiana* than the sugarbeet cultivar recorded by **Shalaby *et al.*⁶** and its soil texture was clay and our soil is sand. It is also possible to restore these changes to locations, meteorological parameters or other parameters.

Table 4: EIL & ETL determinations using 1WRB for RWL, RYL and SYL

Infest techniques	RWL/RYL		SYL	
	1 st season	2 nd season	1 st season	2 nd season
EIL				
SnP	5	6.6	5.9	6.6
SnM	35.1	46.5	41.4	46.5
ILnP	15	18.3	16.7	18.3
ILnp%	53.6	53.1	55.7	53.1
ETL				
	A	B	A	B
SnP	3.8	4.0	5.0	5.3
SnM	26.3	28.1	34.9	37.2
ILnP	11.3	12.0	13.7	14.6
ILnp%	40.2	42.9	39.8	42.5

A= Pedigo,²² (75% of EIL)

B= Ismayilzade *et al*²³ (80% of EIL)

From previous findings RWL, RYL or SYL, EIL or ETL was lower in the first season than in the second season except ILnP% infested technique (Table 4).

RW/YL's range of EIL values was 5.0-6.6 SnP, 35.1-46.5 SnM, 15-18.3 ILnP and 53.1-53.6 ILnP%. Regarding SYL, the previous infestation sequences were 5.9-6.6 SnP, 41.4-46.5 SnM, 16.7-18.3 ILnP and 53.1-55.7 ILnP%, respectively.

On the other hand, the range of ETL values for the RW / YL ranged from 3.8 to 5.3 SnP, 26.3 to 37.2 SnM, 11.3 to 14.7 ILnP and 39.8 to 42.9 ILnP% in both measured seasons. For SYL, the ETL values were 4.4 to 5.3 for SnP, 31.1 to 37.2 for SnM, 12.5 to 14.7 for ILnP and 39.8 to 44.6 for ILnP%.

2) Chi-Square Test

Only root weight and root weight losses were applied for chi-square tests because there were significant differences between those results. Conversely, there were no significant differences in the data for RYL and SYL (Table 5), so it could not evaluate EIL or DTL.

In 1st season EIL values for root weight were higher than 2nd one. Nevertheless for root weight losses in the 1st season, EIL values for SnP, SnM, ILnP and were lower than the second vice versa for ILnP%. The EIL range values for root weight were 6.2-6.9, 43.3-48.0, 14.7-19 and 46.3-59.3 for SnP, SnM, ILnP and ILnP%, respectively. However, for previous root weight loss techniques, the respective values were 4.3-6.2, 29.8-43.3, 10.7-11 and 38.1 -43.3.

Table 5: EIL and ETL Determination for all infested techniques with snails *M. cantiana* on sugarbeet the root weights and their losses using Chi-square during two consecutive seasons 2014/15 and 2015/16.

Infest techniques	Root weight				Root weight Losses			
	1 st season		2 nd season		1 st season		2 nd season	
EIL								
SnP	6.9		6.2		4.3		6.2	
SnM	48.0		43.3		29.8		43.3	
ILnP	19.0		14.7		10.7		11.0	
ILnp%	59.3		46.3		43.3		38.1	
ETL								
	A	B	A	B	A	B	A	B
SnP	5.2	5.5	4.6	5.0	3.2	3.4	4.6	5.0
SnM	36.0	38.4	32.5	34.6	22.4	23.9	32.5	34.6
ILnP	14.3	15.2	11.0	11.7	8.0	8.5	11.0	11.7
ILnp%	44.5	47.5	34.7	37.0	32.5	34.6	34.7	37.0

A= Pedigo,²² (75% of EIL)

B= Ismayilzade *et al*²³ (80% of EIL)

B) Economist definition:

1) Pedigo *et al.* ¹ Equation.

The EIL values for RWL and SYL were higher in the 2nd season as well as for RYL at SnP and SnM (Table 6), according to the **Pedigo *et al.*¹** equation and the **Goebel** adjustment (1999). On the other hand, the EIL values for RWL ranged from 6.0-6.4, 40.7-48.4, 16.3-18.0 and 54.5-55.0 at SnP, SnM, ILnP and ILnP%, respectively. Of previous infested techniques, the corresponding values for RYL were 5.8-6.4, 39.1-44.7, 14.9-15.7 and 48.4-53.4. As for SYL, the EIT values for the above strategies ranged from 6.4-8.7, 48.4-58.7, 18.0-26.7 and 55.0-73.1, respectively.

The range ETL values for RWL were 4.5-5.1, 30.5-38.7, 12.2-14.4 and 40.8-44.0 at SnP, SnM, ILnP and ILnP%, respectively. Nevertheless, the respective values for previous techniques to RYL were 4.4-5.1, 22.4-35.8, 8-11.9 and 32.5-38.7. On the other hand, the corresponding values of aforementioned treatments to SYL were 4.0-7.0, 26.8-46.9, 10.3-21.4 and 37.0-58.5, respectively.

The least values of EIT or ETL were recorded for RYL and the highest one was observed for SYL. Furthermore, the range between the least and the highest values of EIT/ETL was higher for SYL than SWL or RYL.

Table 6: EIL and ETL determination for all infested techniques with snails *M. cantiana* using Pedigo *et al.*¹ equation during two successive seasons 2014/15 and 2015/16 .

Infest techniques	RWL		RYL		SYL	
	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season
EIL						
SnP	6.0	6.4	5.8	6.4	6.4	8.7
SnM	40.7	48.4	39.1	44.7	48.4	58.7
ILnP	16.3	18.0	15.7	14.9	18.0	26.7
ILnP%	54.5	55.0	53.4	48.4	55.0	73.1
ETL						
	A	B	A	B	A	B
SnP	4.5	4.8	4.8	5.1	4.4	4.7
SnM	30.5	32.5	36.3	38.7	22.4	23.9
ILnP	12.2	13.1	13.5	14.4	8.0	8.5
ILnP%	40.8	43.6	41.2	44.0	32.5	34.6

A= Pedigo,²² (75% of EIL)

B= Ismaylzade *et al.*²³ (80% of EIL)

Collected EIL and ETL results

From Table (7), it could be mentioned that EIL for the effect on RWL and RYL were ranged between 5.0 to 6.4 SnP, 35.1 to 44.7 SnM, 14.9 to 18.3 ILnP and 48.4 to 55.0 % ILnP. However, for the effects on SYL, the relative their EIL were ranged from 5.9 to 8.7 SnP, 41.4 to 58.7 SnM, 16.7 to 26.7 ILnP and 53.1 to 73.1 % ILnP. In line with the results provided in Table (7), Ibraheem *et al.*⁷ reported that land snail *M. cartusiana* (Mullar) has the relatively highest economic threshold rates. was 3,12 snail / lettuce, 3,58 snail/100 pea, 3,19 clover snail / m2 and 3,224 wheat snails.

Table 7: Collected results of EIT and ETL for both 1WRB and Pedigo *et al.*¹

Infest techniques	1WRB	Pedigo <i>et al.</i> ¹		Collected results	1WRB	Pedigo <i>et al.</i> ¹	Collected results
	RWL/ RYL	RWL	RYL	RWL/RYL	SYL		
EIL							
SnP	5.0-6.6	6.0-6.4	5.8-6.4	5.0-6.4	5.9-6.6	6.4-8.7	5.9-8.7
SnM	35.1-46.5	40.7-48.4	39.1-44.7	35.1-44.7	41.4-46.5	48.4-58.7	41.4-58.7
ILnP	15.0-18.3	16.3-18.0	14.9-15.7	14.9-18.3	16.7-18.3	18.0-26.7	16.7-26.7
ILnp%	53.1-53.6	54.5-55.0	48.4-53.4	48.4-55.0	53.1-55.7	55.0-73.1	53.1-73.1
ETL							
SnP	3.8-5.3	4.5-5.1	4.4-5.1	3.8-5.3	4.4-5.3	4.0-7.0	4.0-7.0
SnM	26.3-37.2	30.5-38.7	22.4-35.8	22.4-38.7	31.1-37.2	26.8-46.9	26.8-46.9
ILnP	11.3-14.6	12.2-14.4	8.0-11.9	8.0-14.6	12.5-14.7	10.3-21.4	10.3-21.4
ILnp%	39.8-42.9	40.8-44.0	32.5-38.7	32.5-44.0	39.8-44.6	37.0-58.5	37.0-58.0

With respect to ETL, the effect on RWL / RYL ranged from 3.8 to 5.3 SnP, 22.4 to 38.4 SnM, 8 to 14.6 ILnP and 32.5 to 44.0 ILnP%. ETL values ranged from 4.0 to 7.0 SnP, 26.8 to 46.9 SnM, 10.3 to 21.4 ILnP and 37.0 to 58.0 ILnP% for the effects on SYL.

Results revealed a discrepancy between the ranges of the techniques tested for infestation. The ranges in SnP expression were very closely followed by ILnP for RWL RYL, ILnP% techniques and the highest ranges were recorded for SnM.

The same sequence was recorded for SYL. The ranges of EIL or ETL for RWL/RYL lower than for SYL.

Conclusion

The joint results of the testes of EIL lead to the conclusion that Chi-square tested was not valid in this study because this test gained significantly differences for only RWL, also it gave insignificantly differences for RYL and SYL. In addition, these results were varied and lower than other previous methods. Therefore, their results were neglected. 1WRB and **Pedigo *et al.*¹** equation could be used for determination EIL or ETL.

According to the present investigations, assessment of EIL on the basis of SnP is an appropriate idea than the rest of tested techniques.

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