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The Indentification of Indicators in Tolerance of Biotic Stres Durability Determination in Maize Plant

Ali Beyhan Uçak[1], M. Cüneyt Bağdatlı[2]

[1]*Siirt University, Agriculture faculty, Department of Biosystem Engineering, Turkey*
[2]*Nevsehir Hacı Bektas Veli University, Engineering and Architecture Faculty, Department of Biosystem Engineering, Turkey*

***Abstract*— This study was conducted to determine the stress tolerance markers in the corn genotypes (31D24, ADASA16, P1429) with biotic strase (*S. nonagrioides Lef*.) Resistance determined. The study was carried out in open field conditions in Siirt Province in Southeast of Turkey trial sites in three replications in 2015 and 2016 years with randomized blocks divided plot design. The average number of holes per year (2 years) / 100 internodi (number of years) was determined in the 31D24 genotype and the lowest P1429 genotype. However, the longest tunnel length (cm) was detected at the P1429 genotype, the lowest 31D24 genotype. It was determined that the tunnels were opened and fed from the varieties having high number of holes / 100 internods (31D24), but they did not show feeding behavior and the tunnels with long tunnel length (P1429) had long tunnels in the body. The highest yield (1039.83 kg da^{-1}) for two years was determined at 31D24 with low live larvae + pupa and low tunnel length. The lowest yield (1008.16 kg da^{-1}) was determined in the P1429 genotype with high tunnel length and high viable larvae + pupa. As a result of the research, it can be suggested that the number of holes of genotypes / 100 internodi in biotic strase (*S.nonagrioides Lef*.) Endurance lines in corn genotype lines, the tunel length and the number of live larvae are used as biotic stress tolerance indicator.**

***Keywords*— Full irrigation, Corncob worm (S.nonagrioides Lef.), Maize (Z. mays L.) Population, Tolerance, Turkey**

I. INTRODUCTION

Maize, (*Zea mays L.)* The mother of the maize is the American continent and spread to the world after the discovery of this continent. It is known that a corn plant in Turkey in the Maize in 1600s which plays an important role in human and animal nutrition, is the third after wheat and paddy in the world cereal plant and the second after wheat in production [1].

Maize is an important raw material used in the construction of industrial starch, syrup, sugar, beer and alcohol [2]. Maize growing areas in Turkey, 500-550 thousand hectares and production is 3850000-4500 thousand tons, while the average yield 741-1650 kg da^{-1} between [3]. In Turkey, as in the world as there are many types of the harmful insect species that adversely affect the maize farming.

Among these, Corncob worm *(Ostrinia nubilalis Hübner.)* and Maize Corncob worm (S.nonagrioides Lefebvre) are the two most important insects are common in many countries, European, including the United States and Turkey [4]. Corncob worn was is a common harmful especially in countries bordering the Mediterranean in Spain, France, Italy, Greece and Turkey [4, 5]. Because of this feature, it is also mentioned in the literature as "'Mediterran Com Borer" [6]. Different methods have been applied in assessing durability in resistant cultivar development work, in which corn raisins and corn cobs worm have been established. For example; Turkey in [7] were Corncob worm (Ostrinia nubilalis Hübner.) and Maize was your husband (P. nonagrioides Lefler.) Is resistant cultivar development in artificial inoculation study conducted to determine the plant growth stage will be held in Antalya in a year 2-3 offspring that In the second crop of Ostrinia nubilalis, artificial grafting cycle (6-8) was determined as pre-blooming period before the weekly tussle, indicating that they preferred the plants for a maximum of 7 weeks to lay eggs.

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Sesamia spp., Which gives 3 to 4 reproductive years in one year, is in the second crop planting stage, during the pre-bloom period (10 to 12 leaves), which is a 6-9 week plant growth cycle which is preferred by the adults for egg-) artificial vaccination can be done. Indirect evaluation techniques on plants by giving criteria for assessing resistance to insects in corn according to their resistance mechanisms and their use in natural artificial vaccination conditions; the amount of damage to the plant, the size of the lesions and cavities, the number of holes the larva has opened for exit, and so on [8].

Evaluating handle resistance to insects in corn plant; larva outlet holes, number of tunnels and length, number of holes in 100 internodes and number of larvae. Awadallah (1983) evaluated the dependence on O. nubilalis according to the number of "holes / 100 internodes" and the number of larvae, loss index; Durability: Between 20 and 35 holes, Medium durability: Between 35 and 50 holes, Sensitive: Between 51 and 74 holes, Very sensitive: Between 75 and 100 holes, Extremely precise : The number of holes is rated as over 100 denier [9,10,11,12]

In corporeal plant insect resistance studies; using the number of tunnels by proportioning the tunnel length in the handle to the plant length or by accepting 1 tunnel with a length of 2.5 cm [13].

It compared the methods of evaluating the endurance used in the world and revealed the advantages and disadvantages of the methods used in rehabilitation [12].

These methods are;

1. Hole number method; The number of holes / 100 internodes and the number of holes / plant were used in 2 different ways. This method is easier to work than tunnel length method, but the result is not as accurate as the tunnel length method.

2. Tunnel Length Method; Tunnel length / plant, tunnel length / plant height and number of tunnels / plant were used in three different ways, the result of this method is definite and clear but requires an intensive field study.

3. Larvae + Pupae / Plant Method: In studies conducted under artificial vaccination conditions where there is no natural population, or if the study is carried out only under natural populations, the corn plant may be more easily applied when a single fertilization is effective in the growing season.

If the pests of the natural population are applied in environments with more than one fertilization, it is necessary to repeat the plant cutting and counting process in a certain period. This requires more plant growth. When working with a large number of lines or hybrids, it is necessary to produce more plants and produce more seeds than the line or hybrid used to grow them.

To obtain seeds in large quantities, it is necessary to do self-mutation and hybridization in excess amount. He stated that he wanted to labor much more to repeat cutting and counting at certain intervals.

4. Plant Remaining Number Method: It is easy to apply in the field but it is only used by experienced researchers and only for pre-screening.

5. 1-9 Scale: It is easy to apply in the field but it is only used by experienced researchers and only for pre-screening.

Different methods have been applied to evaluating the quantitative regions (endurance) of maize seedlings that provide endurance to the corn borer [14, 15, 16].

However, the use has been made available to breeders agronomists or an adequate study to determine the tolerance index is easier and more precise determination of the resistance to biotic stress in the corn plants in Turkey. There is not enough literature about this research made in the literature survey and sufficient literature has not been given.

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Therefore, it was necessary to make this study which will fill an important gap in the literature and the output of many scientists will be used. In short, the aim of this study is to determine biotic stress screening parameters that are easy to apply and more accurate in different corn varieties (31D24, ADASA16, P1429)

On the other hand, it thought that making transgenic maize cultivation in Turkey, Egypt, which was detrimental to the development of corn and corn koçankurd resistant varieties is important. However, biotic stress screening parameters to be used as tolerance indicators have not been adequately demonstrated. Therefore, the main purpose of this study is to determine biotic stress screening parameters or indicators.

II. MATERIAL AND METHOD

Experiments were carried out over the experimental fields of Siirt Province during the maize growing seasons of 2015 and 2016. The research site has an altitude of 894 m and is located on 37˚ 58' N and 41˚ 50' E. Linoleic P64LE119, PR63F73, P64LL62 maize genotypes were used as the plant material of the study.

The climate of Siirt province of Turkey is hot and dry, winters are cold and rainy. The north and east of the province are colder in winter and cooler in summer. The average annual precipitation is 757 mm. The location and location of the study is shown in Figure 1.

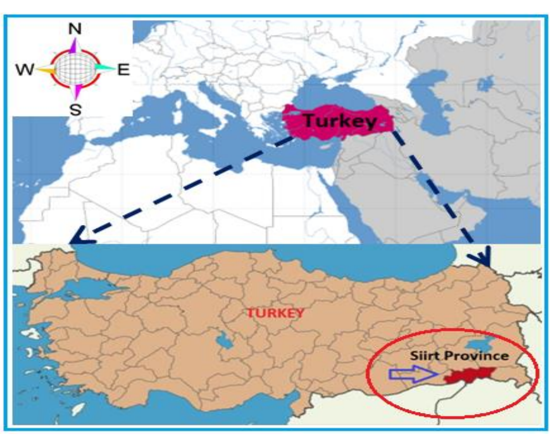

Figure 1. Location of the research area

Soil samples were taken for before sowing from 0-90 cm soil profile (from three depth segments as 0-30, 30-60 and 60-90 cm). Soil moisture content at field capacity (33 kPa) was determined in accordance with Klute (1986) and bulk density with [17] .

Disturbed samples were subjected to organic matter, texture and permanent wilting point analyses. Water holding capacity at permanent wilting point (1500 kPa) was determined in accordance [18].

Experimental soils were classified as brown forest soil with low electrical conductivity and salinity, low phosphor content, high potassium content and medium level organic matter content and lime levels were not posing any problems for plant growth.

Irrigation water quality parameters were determined in accordance with the method specified by [20]. Irrigation water quality class was C2S1 with an average EC value of 0.34 dS m-1 and a pH value of 7.21. Experiments were conducted in Random blocks try experimental design with 3 replications with genotypes (P64 LE119, PR63 F73 and P64 LL62). Irrigation program was scheduled as to have irrigations once a week. Treatments were selected as full irrigation (I100) in which 100% of depleted moisture was supplied. Therefore, one full irrigation treatments were created.

Drip irrigation was used to perform irrigations. A lateral line (20 mm and 4 atm operational pressure, 0.33 m apart 4 L h-1 drippers) was placed along each plant row. Soil infiltration rate was measured as 7 mm h-1. Deep percolation and surface runoff were not considered. Each plot has a size of 6 x 2.8 m (16.8 m2) with 4 plant rows with 70 cm row spacing and 30 cm on-row plant spacing. A buffer zone of 2 m placed between the experimental plots as to prevent interactions. Gravimetric moisture content of each layer (0-30, 30-60 and 60-90) was converted into depth with Equation 1.

$$d=(Pw-PwAW)xAsxD/100 \quad (1)$$

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Where; d, soil moisture content in depth (mm); Pw, field capacity (%); PwAW, moisture content of each layer (%); As, soil unit weight (g cm-3); D, layer depth (mm). Volume of water to be applied was calculated by using the following Equation 2.

$$dT_0\text{-}90=d(0\text{-}30)+d(30\text{-}60)+d(60\text{-}90) \quad (2)$$

Where; dT 0-90, Soil moisture at 0-90 cm soil profile (mm); d(0-30), Soil moisture at 0-30 cm soil profile (mm); d(30-60), Soil moisture at 30-60 cm soil profile (mm); d(60-90) : Soil moisture at 60-90 cm soil profile (mm).

Water budget method was used to calculate monthly and seasonal evapotranspiration values Water use efficiency (WUE) values were calculated by using Equation 3 [19].

$$WUE=Y/ETa \quad (3)$$

Where; WUE, water use efficiency (kg da mm-1); Y, yield; ETa, evapotranspiration (mm).

Plant water consumptions were calculated by using Equation 4 (Sahin et al 2007).

$$ETa=P+I-Rf-Dp\pm\Delta S \quad (4)$$

Where; ETa, evapotranspiration (mm); P, precipitation (mm); I, amount of irrigation water (mm); Rf, surface flow (mm); Dp, deep percolation (mm); ∆S, the change in soil moisture (mm).

Number of Live Larvae + Pupae: Determination of the effects of different irrigation levels on live larvae + pupae; 25 larvae and pups counted from the center of the lake, which were cut from the middle (Anonymous, 2012).

Number of Live Larvae + Pupae: The number of larvae and pupae were determined and the number of living larvae + pupae per plant were determined and genotypes were compared with each other.

Number of holes / 100 internodi: Number of holes of different irrigation levels / Determination of the effects on 100 internods; twenty-five plants were cut from each of the two rows of each genotype 20 days before the harvest and the leaves of the interrupted plants were torn off together with their sheaths, the number of internodes of the plant and the exit holes of the pests were separately determined [9,10,12].Number of holes / 100 internodi method:Plant cowl undercarriage: Number of holes / 100 internodi = B / A x 100 (The total number of holes under the cob is obtained by dividing by the total number of internods under the cob and multiplying by 100). B: Total number of holes under the cocoon, A: Number of total internodes under the cocoon.

Plant spade: Number of holes / 100 internodi = E / D x 100 (Total number of holes in the top of the cocoon, divided by the total number of internodes on the cocoon and multiplied by 100). E: Total number of holes above the cog, D: Total number of internodes above the cog.

Total plant: Number of holes / 100 internodi = B + E / A + D x 100 (Total number of holes under and above the cob is obtained by dividing by the total number of internods under the cob and multiplied by 100).

Tunnel (gallery) Length / Plant: Determination of the effects of different irrigation levels on the Tunnel (gallery) Length / Plant; 25 tunnels counted as the number of holes were determined by measuring on the scale with the scale of the bottom of the stump and the top of the stump where the damage was formed by splitting from the center [10,11,12].

Tunnel Length / Plant: Tunnel length / genotypes assessed by plant, damage index; tunnel length is 3 cm or less, it is very durable, 3-7 cm is durable, 7-10 cm is medium durable, 10 cm denier is sensitive. Tunnels under 2,5 cm nin were not considered to be tunnels, but they were considered to have entered the harmful plant and returned and were not fed in the plant.

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The study did not find statistical analysis for the analysis because the population of corn (ostrinia nubilalis hübner) population, which is one of the two most important pests of corn plant, is very low.

Analysis of variance (ANOVA) was performed in accordance with Random blocks try experimental design. Significant treatments were then subjected to LSD (Least Significant Difference) multiple comparison tests. Analyses were carried out with JUMP 5.0.1a statistical software.

III. RESULTS AND DISCUSSION

In the 1st and 2nd year of the study, effective soil depth (0-90 cm) for irrigation applications was reduced to 50%, soil fertilization started at 01.07.2015-2016 and the physiological phase was terminated at 11.09.2015 and 19.09.2016.

Irrigation water was applied to all irrigation areas seven times during the research years. The average amount of irrigation water applied to the genotypes in the first year of the study (686.33 and 666.32 mm) and in the second year (698.13 and 679.33 mm) varied. The seasonal plant water consumption values determined in the first year of labor (734.66 and 712.66 mm) and in the second year (749.56 and 724.46 mm, respectively). The highest grain yield value in the first year (2015) of the study was obtained in 31D24 genotype (1044.33 kg / da) while the lowest grain yield value was obtained in P1429 genotype (1013.33 kg / da). While 31D24 was present in the genotype group, P1429 genotype appeared in the C group. In the first year of the study, the highest number of holes / 100 internodes were obtained in the 31D24 genotype (11.50) while the lowest value was obtained in the P1429 genotype (8.98). While 31D24 was present in the genotype group, P1429 genotype appeared in the C group.

The lowest Tunnel length / plant value was obtained in the 31D24 genotype (8.96 cm / plant) and the highest value was obtained in the P1429 genotype (25.79 cm / plant) in the first year of the study. While the 31D24 genotype appeared in group C, it appeared in the P1429 genotype group. In the 1st year of the study, the lowest number of alive larvae + pupa in the plant value was obtained in the 31D24 genotype (2.82 pcs / body) while the highest value was obtained in P1429 genotype (4.32 pcs / body). While the 31D24 genotype appeared in group C, it appeared in the P1429 genotype group. The highest grain yield value in the second year (2016) of the study was 31D24 genotype (1035.33 kg / da) while the lowest grain yield value was obtained in P1429 genotype (1003.00 kg / da). While 31D24 was present in the genotype group, P1429 genotype appeared in the C group.

In the second year of the study, the highest number of holes / 100 internodes was obtained in 31D24 genotype (12.70) and the lowest value was obtained in P1429 genotype (10.10). While 31D24 was present in the genotype group, P1429 genotype appeared in the C group. In the second year of the study, the lowest Tunnel length / plant value was obtained in the 31D24 genotype (9.92 cm), while the highest value was obtained in P1429 genotype (26.83 cm). The 31D24 genotype was found in the C group and the P1429 genotype group.

In the second year of the study, the lowest number of alive larvae + pupa in the plant value was obtained in the 31D24 genotype (3.87 pcs / body) while the highest value was obtained in P1429 genotype (5.33 pcs / body). While the 31D24 genotype was present in group C, it appeared in the P1429 genotype group (Table 1).

Table 1. Changes in yield and entomological properties of corn genotypes

Treatments	Yield (kg da $^{-1}$) **	NOH/100 (piece) **	TL/P (cm) **	TNOAL+PP (piece/body) **	Irrigation water (mm)	ETa (mm)
2015 year						
I_{100} x 31D24	1044,33 a	11,50 a	8,96 c	2,82 c	686,33	734,66
I_{100} x ADASA16	1024,66 b	9,30 b	13,15 b	3,43 b	673,33	719.00
I_{100} x P1429	1013,33 c	8,98 c	25,79 a	4,32 a	666,32	712,61
LSD (0.05)	9.33	0.17	0.58	0.30		
2016 year						
I_{100}x31D24	1035,33 a	12.70 a	9,92 c	3,87 c	698.13	749,56
I_{100}xADASA16	1015,66 b	10.50 b	14,16 b	4,46 b	685.21	730.00
I_{100}xP1429	1003,00 c	10.10 c	26,83 a	5,33 a	679,33	724,46
LSD (0.05)	7.98	0.017	0.67	0.26		

* and **, significant at P≤0.05 and P≤ 0.01 level, respectively; ns, not significant; means in the same column with similar letter are not significantly different from each other;
NOH/100, Number of holes /100 internodes; TL/P, Tunnel length/plant;
TNOAL+PP, The number of alive larva+pupa in the plant; ETa, Plant water consumptions

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As a result, it was determined that the genotypes with the highest number of holes gave the highest yield whereas the longest tunal length and genotypes with live larvae yielded low yields. It has been found that the genotypes identified with the highest number of holes have no harmful inputs and no feeding behavior. However, in the genotypes with the longest length of the tunnels, it was determined that they stayed in the body of the plant for a long time and showed feeding behavior.

On the other hand, it has been determined that the use of the tunel length (cm) and the number of living larvae (number) as stress tolerance indicators in the biotic stress tolerance studies of corn plants is more accurate than all the other methods mentioned above (the number of holes / 100 internodi largely).

Briefly, it is suggested that the use of stress-screening indicators as a stress tolerance indicator can be suggested because the stress-screening indicators mentioned in the corn-stalk resistance studies in maize plants are quick, easy to apply and give more accurate results. Almost everywhere in the world, there is a chemical struggle 2-3 times in general with corn kochankurdu.

But when the spraying is not done in time, the larvae enter the plant and therefore the chemical struggle is impossible. Therefore, a large number of pesticides in this way cause environmental pollution as well as economic losses, directly affect human health, disrupt natural balance, and pose a risk for sustainable agriculture. As a result, agronomic and breeding studies to develop durable corn variety are considered to be beneficial for a cleaner environment in the coming years.

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