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The Resistant Tomato Genotype Cln2264g-La 4286 and Genetic Control to Late Blight Disease

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Abstract:*Late blight is destructive disease in tomato plants in Egypt. The purpose of this research was to study the performance of the genotypeCLN2264G-LA 4286 with the resistance gene Ph-3 and its F_1 hybrids which obtained byNCEBR-6, Peto-82, UCT5 and Super Strain B. Plants were evaluated under the greenhouse and in the fieldconditions. Resultsindicated that the genotype LA 4286 was the highest resistance value to late blight disease followed by F_1 hybrids Peto82 × LA 4286 and NCEBR-6 × LA 4286 based on symptoms severity. Most of varieties (parents) located in moderate to susceptible range of susceptibility to Phytophthorainfestans. The F_1 hybrid NCEBR-6 × LA 4286 was the highest value (2998.02g/plant).This cross had mean value (42.50 fruit/plant) associated with the partial dominance of potence ratio(PR=.85) for fruit number per plant and exhibited high amount of positive heterosis values in the better parent heterosis (35.34%, 29.34% and 24.66%) for fruit weight, yield, fruit set. Genetic variation coefficient GVC% values were ranged from 35. 11%, 34.34%, 19.87%, 18.21% and 14.36% for resistance degree and fruit number, fruit weight, fruit set, and total yield respectively under greenhouse. Plants of different tomato genotypesunder field conditions exhibited GVC% values ranged from 12.3% to 59.63% for different characteristics. Heritability BSH in the resistance assessment was the highest estimated value 0 .95 followed by fruit number and fruit set characteristics (0.93 and 0.92). In addition, in the field BSH ranged from 0.981 to 0. 789. Characteristics such as resistance, fruit number, fruit set and fruit weight recorded high genetic heritability and less influence by environmental in this trait this due to be used as a tool for accurate selection*

Keywords:*Tomato, late blight disease, Resistance, Heterosis, Heritability, GCV, PCV, coefficient of variability.*

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I. Instruction

Tomato (*Solanumesculentum*Mill) is very an important crop in Egypt and all over the world. Late blight is a very severe disease of potatoes and tomatoes caused by *Phytophthorainfestans*. The pathogen directly affects fruit and vegetative organs of plants. Disease progresses quickly under humid conditions, which are favorable for the pathogen, associated with cool temperatures, rain, heavy dew, or fog in field and especially in greenhouses. With favorable weather conditions late blight disease can cause total destruction of all plants **[1].**
Selection of resistant varieties is the best strategy for managing late blight. Resistant plants are effective way more than chemical material methods (e.g. fungicides) that can make the symptoms disappear. With resistant varieties, the management practice is in place before late blight starts to develop. **[2]**Reported that knowledge about the genetics of resistance in a variety and the pathogen genotypes (strains) occurring enables an accurate prediction of the level of control achievable with specific varieties. Major-gene resistance is the most common type of resistance available for many diseases, including late blight. The development of crops that possess durable genetic resistance provides the best prospect for efficient, economical and environmentally safe control of late blight **[3 and 4].** Major-gene resistance is easier to breed for than minor-gene resistance, and the degree of pathogen suppression is usually higher. Ability of the pathogen to overcome major-gene resistance is often with a simple genetic change. The tomato resistance genes are *Ph-1*, *Ph-2*, *Ph-3*, and Ph-5and the genetic analysis supported the hypothesis of two recessive genes controlling the resistance. Late blight control is increasingly difficult due to high variability in *P. infestans* the introduction of new pathogen isolates, and increased resistance of the pathogen to fungicides **[5].** Variety main effect with resistant plants gave horizontal resistance for the varieties against late blight disease in the experimental. Tomato varieties carrying the resistance genes *Ph-1* or *Ph-2* provide inadequate control against the local population of the pathogen **[6].** The genetic analysis supported the hypothesis of two recessive genes controlling the resistance **[7 and 8]** suggested that small number of genes and high heritability due to the presence of simple genetic system controlling LB resistance.

The aimed of this research is evaluation the performance of resistant genotype CLN2264G- LA 4286 and gene *Ph-3*, to late blight disease in Egypt. In addition, the performance of the sensitive different tomato genotypes searching for improvement and obtaining promises hybrids to the destructive pathogens of late blight disease. The other objective of this study is identifying genetic parameters to understand the gene action of resistance and susceptibility of different tomato genotypes to late blight disease. In addition to increase productivity and quality associated to resistance with desirable characteristics.

II. Materials and Methods

The present study was conducted at two growing seasons from winter to spring of 2010/2011 – 2011/2012 to screen five different genotypes of tomato namely, Peto-82, UCT5, Super Strain B and CLN2264G - LA 4286 with their crosses against natural infection of late blight disease that caused by *Phytophthorainfestans*. . Plants of all tomato genotypes were selfed for two generation before crossing. Seedlings of all different populations parents and F1 hybrids were sown at 1st of November in greenhouses and in the field in2010-2011 and repeated in (2011- 2012) in the winter to spring with day/night temperature ranged from 19.96/14.34 to 24.06/18.68 degree Celsius (°C) during growing season with activation period of pathogens caused late blight in average 21.19/ 15.69 (°C)and relative humidity(RH) 77.38%. The experiments were conducted of the experimental farm of Maryout Research Station, Desert Research Center, and Alexandria Governorate. Seeds of *Lycopersiconesculentum*cv.CLN2264G, LA 4286 as a resistant genotype to late blight were kindly provided by Dr. John I. Yoder, and Dr.R.Chetelat Professors of tomato breeding at the vegetable crops department, California University, Davis, USA.

The inbred line LA 4286 is no determinate growth habit, red fruits, was derived through breeding program in tomato genetic resource, Davis University from *Lycopersiconesculentum*cv.. CLN2264G has resistant gene *Ph3* against late blight disease and other pathogen resistance. The crosses which were obtained from the resistant genotype CLN2264G by susceptible varieties were evaluated under natural infection with *Phytophthorainfestans*under plastic greenhouse and in the field to study the performance and get genetic background in this study.

Crosses under greenhouse conditions:

1- NCEBR-6 × CLN2264G - LA 4286
2- Peto-82 × CLN2264G - LA 4286
3- CLN2264G-LA 4286 × NCEBR-6

Crosses in the field conditions:

1- CLN2264G-LA 4286 × NCEBR-6
2- UCT5 × CLN2264G - LA 4286
3- Super Strain B × CLN2264G - LA 4286

Disease assessment: The individual plants of different tomato genotypes and F_1 hybrids were kept under close observations to determine their resistance and reaction to late blight disease and their performancesto Late blight resistance was evaluated based on lesion size on leaf area and infected fruits in the plant. Disease eventually was rated 1:5 scale as 5 highly resistant to 1 highly susceptible.

Whereas, scale as 5 most resistant a few minute lesions to about 0-10% of the total leaf area leaf area with infection. 4=moderately resistant with a few lesions to about 10-20% of the total leaf area is blighted, no fruit infected.3=20-50%, moderately susceptibleseveral expanded lesions, on leaves and fruits.2=susceptible several expanding lesions, about 50-75% of the total leaf area is blighted and fruits.1=highly susceptible, full extensive Lesions on leaves and fruits are infected about 75-100% with late blight disease. Late blight symptoms were evaluated at 7 and 21 days by using the modified rating scheme of **[9].**

Measurements for fruits and yield characteristics

Measurements were recorded on ten randomly individual plantsfor each plot, on 9o day – old tomato plants grown under greenhouse and in the field.

Fruit weight g/fruit, fruit number, fruit set, fruit diameter/cm, fruit length/cm, yield per plant g, fruit flesh thickness, locules and the total soluble solids

Genetic and statistical analysis

Statistical analysisThe experimental designed was in randomized complete block design with four replications, correlation and calculations of the mean and its standard error on individual plant basis for the different characters were performed according to the methods described by **[10 and 11].**

The dominance was calculated according to the potence ratio of gene set (P) using the following equation that was given and described by **[12].**

Board sense heritability (BSH) was estimated by the method described by **[13].**
The data was subjected for analysis of variance **[14].** The genotypic and phenotypic correlations were calculated by **[15]** technique.

III. Results and Discussion

Data presented in Table 1and Fig.1 showed the performance of gene *Ph3* and different tomato genotypes in screening for late blight disease resistance under greenhouse conditions. There was natural infection caused by *P. infestans* infected tomato in legions on leaf, stem and fruits, these symptoms identified as *P. infestans* based on the morphological characteristics of different isolates **by [9].** Based on symptoms severity by blight disease ranged from 5 (most resistant) to 1(most susceptible). The resistant parent LA 4286 was the highest degree of resistant value 4.75> 90% to late blight disease followed by the value (4.5) in F_1 hybrids Peto82 × LA 4286 and NCEBR-6 × LA 4286. The lowest value of degree resistance was (2)about75% susceptibility was recorded in Super Strain B cv. followed by the genotypeNCEBR-6 value (2.62)about 50% which is identified as a source of early blight disease **[16 and 17]**.The performance of different tomato genotypes in the resistance assessment, the resistant parent lineLA 4286 and its hybrids located in (4.75 - 4.5) range, it is about 90% of resistance. These results agreed with **[18]** reported that tomato genotypes containing *Ph-2* and *Ph-3* had significantly lower disease severity compared with Super Strain B as a susceptible genotype. Most of cultivars (parents)located in moderate to susceptible range (2-2.75) 60-70% of susceptibility. Results in Table 1 indicated that significant differences between parents and their F_1 hybrids in fruit set percentage, the highest value 84.5% recorded by the cross NCEBR-6 × LA 4286. The parent LA 4286 recorded high value (68%) for fruit set when it was as female. On the contrary, F_1 hybrid Peto82 × LA 4286 was the lowest value of fruit set 48.5% followed by the cross LA 4286 × NCEBR-6 as a reciprocal hybrid.

The results presented in Table 1 showed high significant difference in mean values among tomato genotypes concerning fruit number per plant. The genotype CLN2264G (LA 4286) has gene controlling fruit number under infection of late blight and had the highest number of fruits/plant (44.25) followed by its F_1 hybrids which has the same gene expression, values (42.50, 31.0 and 28.25) fruits/plant for NCEBR-6 × LA 4286, Peto82 × LA 4286 and LA 4286 × NCEBR-6. Data presented in Table 1 revealed that parents were affected by late blight disease where UCT5 was recorded the lowest fruit number/plant (17.0) followed by Super Strain B cv. and genotype NCEBR-6, whereas values were 19.5 and 20.75 fruit number/plant.

Concerning means values of total yield per plant, Table 1 and Fig.2 showed that the F_1 hybrid NCEBR-6 × LA 4286 was the highest value (2998.02g/plant) followed by the resistant parent LA 4286 value (2317.9 g/plant). While reciprocal hybrid LA 4286 × NCEBR-6 appeared moderate resistance with value of total yield per plant (1818.45 g/plant) followed by the hybrid Peto82 × LA 4286 values (1427.07 g/ plant and 1244.95 g/plant) under natural infection of late blight under greenhouse conditions.

Table 1: Mean performance of different tomato genotypes for resistance, yield and yield components in the greenhouse to late blight disease.

Genotypes	Degree of resistance	Fruit set %	Fruit number	Fruit weight (g)	Yield g/plant	Fruit diameter (cm)	Fruit length (cm)	Flesh thickens (mm)	Locales	T.S.S %
LA 4286	4.75	68.00	44.25	52.40	2317.97	4.43	5.33	6.00	2.25	6.00
S. Strain B	2,00	52.00	19.50	51.83	1025.25	4.57	5.03	6.00	3.25	5.20
UCT5	2.75	67.75	17.00	69.50	1150.50	5.57	3.57	5.25	6.25	9.20
NCEBR-6	2.25	63.5O	20.75	41.05	830.20	3.92	5.65	6.25	2.50	5.98
LA 44286 × NCEBR-6	4,13	51.39	28.75	64.78	1818.45	4.82	4.92	6.50	3.00	4.55
NCEBR-6 × LA 4286	4.50	84.78	42.50	70.93	2998.02	5.25	4.52	6.75	3.00	4.85
Peto82 × LA 4286	4.50	48.50	31.00	40.75	1244.94	3.63	4.45	5.50	2.50	6.05
Peto82	2.62	63.88	26.25	55.10	1427.07	3.48	4.75	7.50	2.75	6.35
L.S.D. at 0.05	0.374	4.691	3.75	5.57	161.89	0.351	0.430	0.61	0.41	0.17

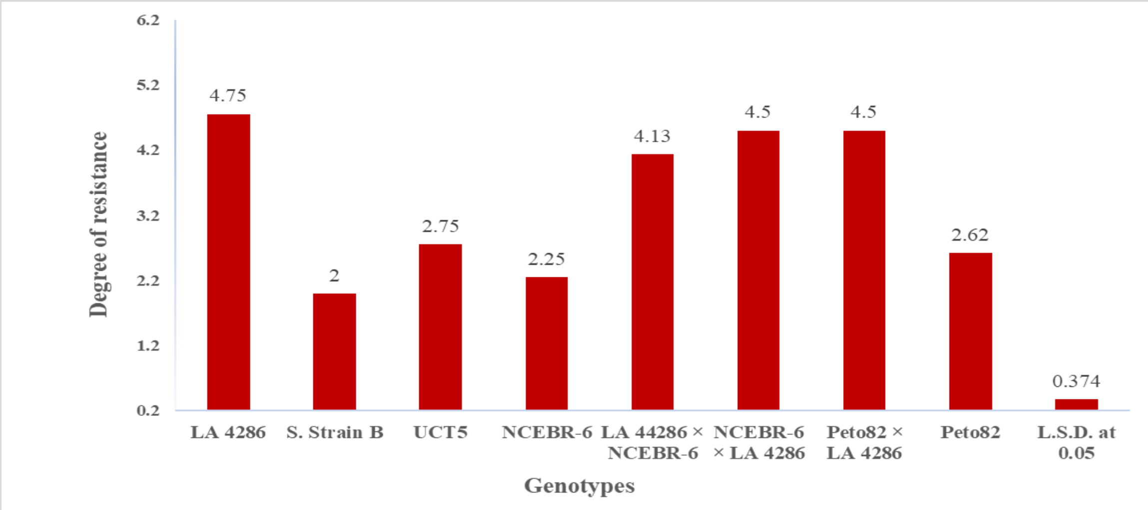

Fig.1: The performance of different tomato genotype for resistance to late blight.

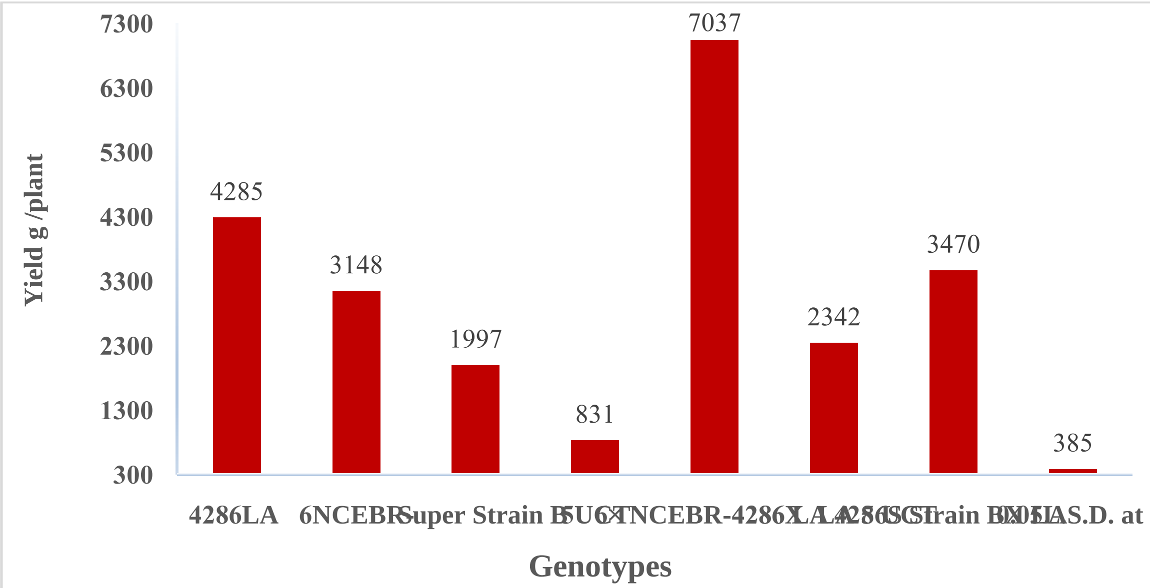

Fig.2: The performance of different tomato genotype for yield in the greenhouse

Data presented in Table 1 showed improvement of fruit weight and quality characteristics for the F_1 hybrids NCEBR-6 × LA 4286 and LA 4286 × NCEBR-6. The obtained crosses values were (70.90 and 64.77 g/fruit) while the moderate susceptible parentNCEBR-6 was the lowest value 41.05g/fruit by the screening for late blight disease in the greenhouse. The previously mentioned results identified the resistance the genotype LA 4286 and its hybrids to late blight disease caused by *P. infestans* due to line LA 4286 which has *Ph-3* and a group of resistance genes. This result was similar with **[19]**who reported an examination of the qualitative characters in the F_1 hybrids indicated improved fruit weight and quality to late blight disease in greenhouse.

Results in Table 1 indicated significant differences in fruit diameter, fruit length and fruit flashness, in addition total soluble solids TSS among different genotypes and F_1 hybrids expressed fruit quality and fruit shape. In spite of these characteristics, there was no trend to the resistance orsusceptibility observed through screening under late blight disease conditions.

Table2: Mean performance of different tomato genotypes for resistance, yield and yield

Genotypes	Degree of resistance	Fruit set %	Fruit No. plant	Yield g/plant	Fruit weight (g)	Fruit diam. (cm)	Fruit length (cm)	Flesh thickness (mm)	Locales	T.S.S%
LA 4286	5.00	84.75	77.50	4285.25	56.10	4.57	4.55	7.25	3.50	7.25
NCEBR-6	3.50	92.50	90.00	3148.65	35.93	3.73	4.63	6.25	2.50	8.50
Super Strain B	2.50	44.25	48.25	1997.50	42.47	4.23	4.32	6.25	3.50	6.25
UCT5	2.50	71.00	15.00	831.47	55.53	4.57	3.82	5.75	4.50	9.30
LA 4286 × NCEBR-6	4.62	85.75	127.25	7037.82	55.75	4.75	4.97	5.75	3.50	4.90
UCT5 X LA 4286	4.37	85.03	71.75	2342.05	33.95	3.60	4.15	600	2.75	9.00
SStrain BXLA 4286	4.87	93.13	62.70	3470.35	56.30	4.59	4.85	7.00	3.00	4.95
L.S.D. at 0.05	0.25	5.95	9.298	385.09	6,62	0.347	0.17	0.81	0.10	0.305

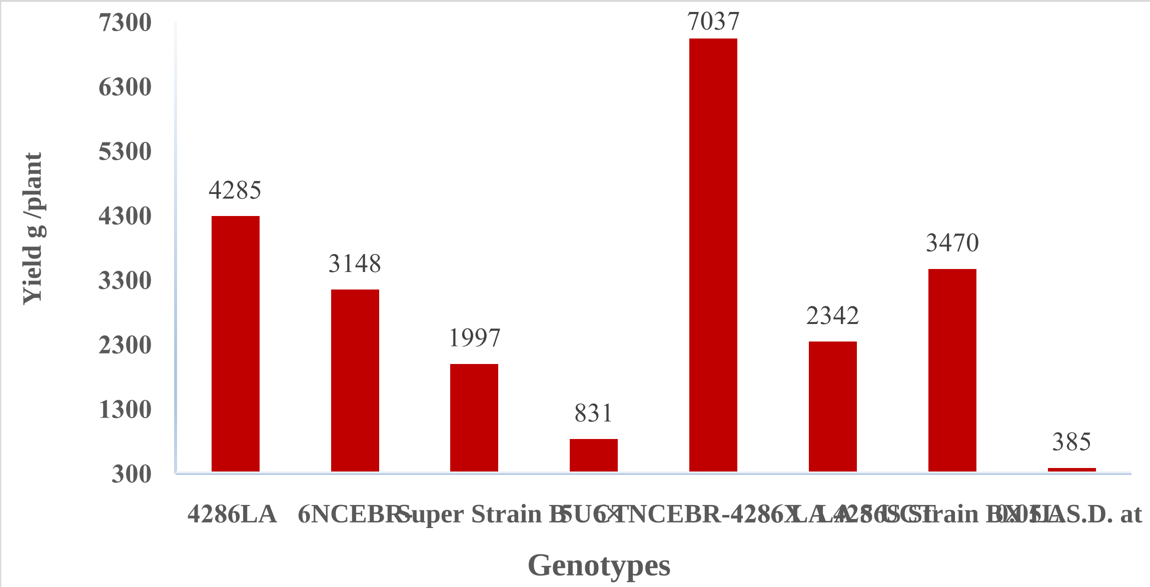

Fig. 3: The performance of different tomato genotypes for resistance to late blight disease in the field conditions.

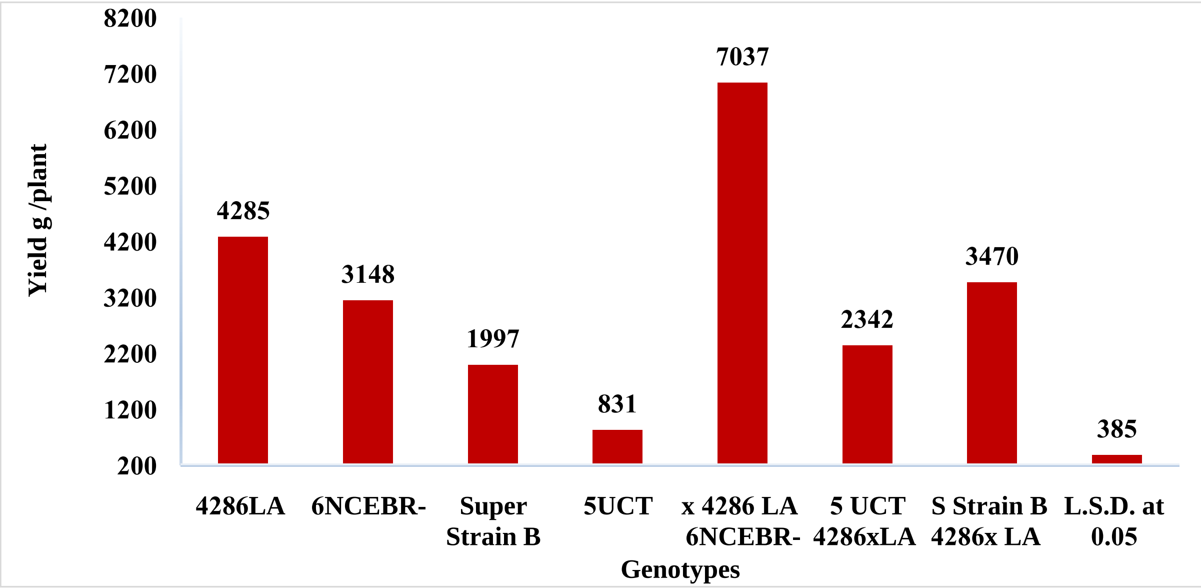

Fig. 4: The performance of different tomato genotypes for yield against late blight disease.

Data in Table 2 and Fig.3 andFig.4 showed performance of screening in individual plant assay for resistance,yield components and fruit quality indicated significant differences between different tomato genotypes under natural infection caused by *P. infestans* in the open field during growing season.

The highest value of resistance (5) was associated with LA 4286, F_1 hybrids Super Strain B × LA 4286(4.87), LA 4286 × NCEBR-6(4.62) and UCT5 × LA 4286(4.37). The lowest value of resistance assay was associated with UCT5, Super Strain B and NCEBR-6 (2.5, 2.62 and 3.6) respectively. These genotypes located in intermediate susceptible, may be due to in field could not keep the pathogen be controlledand were not severity to infect plants enough when it compares with infection under controlled greenhouse for oomycete*P. infestans* caused late blight disease with different strains.

Results in Table 2 indicate that the highest value in fruit set percentage was associated with the hybrid F_1 hybrid Super Strain B × LA 4286(93.12%), followed by NCEBR-6 mean value (92%). Results showed that F_1 hybridsLA 4286 × NCEBR-6and UCT5 × LA 4286 had high fruit setting values(85.75%and 85.02%). Data presented in Table 2 indicated significant differences among tomato genotypes concerning fruit number, the cross LA 4286 × NCEBR-6 was thehighest fruit number mean value 127.25 fruits/plant also, it had the highest value in total yield per plant (7037.82 g /plant). This cross exceeded its parents and indicated the potentiality of these important characters to be improved through hybridization. Comparing LA 4286 × NCEBR-6 under greenhouse and in the field, this F_1hybrid performed well in the field more than greenhouse and exhibited high resistanceagainst pathogen of *P. infestans*. This may be due to pathogen infectiondiffered from location and other, under greenhouse it was severity infection and epidemic because ofhigh relative humidity, low temperature for different strains of *P. infestans*.

Results presented in Table 2 and Fig. 3indicated that F_1 hybrids increased in their values for fruit weight, F_1 hybrid Super Strain B × LA 4286 was the highest value (56.3g/fruit) followed by the parent genotype LA 4286 where plants exhibitedhigh resistance and fruit weight recorded (55.10g/fruit).The highest yield was associated with the F_1 hybridLA 4286 × NCEBR-6 value(7037.82g/plant) followed by the parental genotypeLA 4286 (4285.25g/plant) The resistant parent exhibited gene controlling for yield under late blight disease conditions. Significant differencesamong tomato genotypes indicated the presence of enough genetic variability for the improvement of blight resistance, yield and yieldtraits**[9].**The results indicated significant difference among tomato genotype in Total Soluble Solids and fruit shape and quality. The genotype UCT5 was the highest mean value in TSS (9.30 brix) and followed by the cross UCT5 × LA 4286 and NCEBR-6 (9 and8.5 brix).There was no relationship between the resistance and TSS but this desirable character is important to accompanied to the resistant genotypes against the oomycete*P. infestans*.

Table 3: The potence ratio (PR) and better parent heterosis for resistance, yield and yield components in tomato hybridsto late blight disease in the greenhouse.

Crosses	Levelof resistance	Fruit number	Fruit weight (g)	Yield g/plant
NCEBR-6×LA 4286 (PR)	0.80	0.85	4.26	1.91
Better Parent Heterosis%	-5.26	-3.95	35.34	29.34
LA 4286 × NCEBR-6 (PR)	0.50	-0.319	3.18	0.328
Better Parent Heterosis%	-13.15	-35.02	23.60	-21.54
Peto-82 × LA 4286 (PR)	-0.77	-0.47	09.62	-1.40
Better Parent Heterosis%	-5.26	-29.94	-22.23	-46.29

Heterosis

The obtained data in Table 3 mentioned that high partial dominance of potence ratio (PR) for resistance degree value under the greenhouse against late blight disease in the F_1 hybrids NCEBR-6 × LA 4286, Peto82 × LA 4286and LA 4286 × NCEBR-6 (PR=0.80, 0.77 and 0.5).A dominant resistance gene, *Ph-3* was reported by **[20].**There are high partial dominance for fruit number associated with the cross NCEBR-6 × LA 4286,where (PR=0.85) mentioned that these cross exceeded than the susceptible parents in these characteristics. The crossesPeto82 × LA 4286 and LA 4286 × NCEBR-6 had exhibited moderate negative partial dominance towards susceptible parent in resistance assessment. The highest value (PR=.85) of potance ratio was recorded in the cross NCEBR-6 × LA 4286 for fruit number. Results showed over dominance of gene set for total yield in the cross NCEBR-6 × LA 4286 (PR=1.91) with value of better parent heterosis(BP=29.34%) the resistant genotype LA 4286, while the reciprocal cross had slightly partial dominance (PR=0.33).On the hand, there was negative over dominance value (-1.40) in trend to susceptible parent in F_1 hybrid Peto82 × LA 4286 in greenhouse to *P. infestans* caused late blight disease. The F_1 hybrid NCEBR-6 × LA 4286 recorded high amount of positive heterotic values in the better parent heterosis (35.34%, 29.34% and 24.66%) for fruit weight, yield, fruit set and negative heterosis values (-5.26% - and -3.95) for resistance assay and fruit number. Crosses LA 4286 × NCEBR-6 and Peto82 × LA 4286 exhibited negative heterosis in relative to the resistant parent ranged from -5.26 to 46.29%. These results agreed with some findings **[21]**four crosses exhibited desirable negative heterosis (-5.825% to -37.71%) in relative to resistant parent. Results revealed that most of F_1 hybrids did not super pass the resistant parent under greenhouse against late blight (LB) but these hybrids are promising in yield and fruit quality associated with high resistance. **[22]**who reported that the commercial cultivars have greater content of dominant genes than inbred lines with incomplete dominance in both cases.

Table 4: The potence ratio (PR) and better parent heterosis for resistance, yield and yield components in tomato hybrids under nature infection of late blight disease in the field.

Crosses	Level of resistance	Fruit number	Fruit weight (g)	Yield g/plant
UCT5 × LA 4286 (PR)	0.49	0.814	-75.72	-0.125
Better Parent Heterosis%	-12.6	-7.74	-39.48	-45.34
Super Strain B × NCEBR-6 (PR)	0.817	-0.11	1.03	0.287
Better Parent Heterosis%	-2.6	-19.10	0.35	-19.01
LA 4286 × LA 4286 (PR)	0.49	2.785	0.96	5.785
Better Parent Heterosis%	-76	41.38	-6.23	64.23

Results presented in Table 4 showed the potence ratio of the crosses in field. Indicatedthat high partial dominancein F_1 hybrid Super Strain B× LA 4286 (PR=0.817) and intermediate for resistance degree in both crosses UCT5 × LA 4286 and NCEBR-6 × LA 4286 were (PR=0.49). The LA 4286 × NCEBR-6 had genescontrolledfruit number and yield in the field conditions with LB disease and exhibited over dominance of potence ratio (PR=2.78 and 5.83). So, this hybrid super passed with value (63.66% and64.22%) fold the resistant parent as the Better Parent heterosis in the twocharacteristics.

Table 5 Mean square values for analysis of variance in different tomato for resistance and come characteristics to late blight disease in the greenhouse.

Source of Variance	d. f.	Resistance	F. set	F. No	F. weight	yield	TSS
Parent	4	5.20**	169.37**	483.92**	446.51**	1358370.8**	9.50**
Hybrids	2	0.188	1625.75	228.58	1017.04	3195714.40	2.52
All population	7	5.94**	563.52**	446.27**	553.65**	2170632.3**	8.26**
Replication	3	0.43	71.25	7.87	165.59	12827.02	0.28
Error	21	0.278	45.68	28.26	62.06	52418.38	0.06
F. Value		17.35	7.91	52.60	3.92	172.54	29.29
L.S.D. at 0.05		0.549	7.03	5.53	8.19	238.06	0.125

*, ** significant and highly significant at 5% and 1% levels of probability, respectively

Table 6: Mean square values for analysis of variance in tomato for resistanceand some characteristics to late blight disease in the field

Source of Variance	d. f.	Resistance	F. set	F. No	F. weight	*yield*	*TSS*
Parent	3	5.58**	658.42**	5028.25**	396.78**	8733428.2**	7.25**
Hybrids	2	0.250	80.35	4905.58**	650.04**	24033494.1**	22.41**
All population	6	4.66	466.68	5000.56	416.62	15771950.9	13.78**
Replication	3	0.177	55.46	33.429	12.89	8104.06	0.002
Error	18	0.169	50.54	153.73	87.74	292711.27	0.185
F. Value		26.57	8.39	147.86	31.66	1786	74.5
L.S.D. at 0.05		0.461	7.98	13.92	10.52	607.57	0.483

Table 7: Estimates of variance components in tomato for resistance and some characteristicsto late blight diseaseunder greenhouse conditions**.**

Sources	Resistance	Fruit set	Fruit N,	Yield	Fruit weight	TSS
Variance	5.94	563.52	416.27	2170632.32	553.65	8.264
Means	3.37	622.47	28.68	1601.55	55.79	6.02
Error	0.278	45.67	28.25	52418.33	62.056	0.058
Vg	1.45	129.46	97.01	529553.48	122.898	2.05
GVC %	35.12	18.21	34.34	14.36	19.87	23.78
VP	1.469	140.87	104.062	1542658.06	138.442	2.064
PVC %	35.96	18.99	35.56	45.99	21.089	23.86
H2	O,95	0.919	0.932	0.975	0.887	0.99

Table 8: Estimates of variance components in tomato for resistance,TSS,yield, and yield components to late blight disease in the field conditions

Sources	Resistance	Fruit set	Fruit N.	Yield	Fruit weight	TSS
Means	3.91	82.91	71.57	3298.65	47.00	7.17
Error	0.169	50.54	153.73	292711.27	87.74	0.185
Vg	1.12	104.04	1211.70	3869809.9	82.22	3.39
GVC %	27.06	12.30	48.63	59.63	18.89	25.68
VP	1.16	116.66	1250.13	42987.72	104.155	3.436
PVC %	27.54	13.11	49.40	60.19	21.26	25.86
H2	0.965	0.891	0.969	0.981	0.789	0.98

Genetic Analysis

The analysis of variance, degree of freedom, and expected mean squares to estimate variance components for all population parents, crosses under greenhouse were given in Table 5 and 6. Parents exhibitedhigh magnitude as a source of variation for gene controlling LB resistance in tomato, in addition, fruit number, yield and yield components.Population and most of this variation refers to the parent in resistance, yield, fruit number, fruit setting and TSS characteristics. Hybrids exhibited a high amount of variation in fruit number, fruit weight,and yield and TSS traits. So, these results mentioned that hybrids are promising and successful crosses. Data presented in Table 7 indicated thatthe range of genotypic, phenotypic variance and GVC% and PVC%. Genetic variation coefficientGVC% values wereranged from 35. 11%, 34.34%, 19.87%, 18.21% and 14.36%for resistance degree and fruit number, fruit weight, fruit set, and total yield respectively. These results indicated high magnitude of genetic variation for resistance and fruit number, this due to vigorous selection to improve these characteristics. Phenotypic variation coefficient PVC%was ranged from 45.99 to 21.089. The highest value wasfor total yield character45.99 % followed by 35.96 and 35.56 for resistance degree and fruit number. Inaddition, fruit weight and fruit set (21.089% and 18.99% respectively).A high PCV and GCV for the characters studied indicated that environment influences on the gene expression were minor. This variation is very important in tomato breeding program, and selection is effective when magnitude of variability in breeding population is enough.

Plants of different population exhibited GVC% values ranged from 12.3% to 59.63% for different characteristics under field conditions (Table 8). PVC% ranged from 13.11% to 60.19%, total yield per plant and fruit number had the highest values of GVC% andPVC% populations expressed moderate value for TSS, resistance assessment and lower GVC% and PVC% for fruit set and fruit weight. These result mentioned there was influence environment effects which controlled and suitable for oomycete*P. infestans* caused late blight disease in severity case under greenhouse more than field.

Results indicated broad sense heritability BSHfortheresistance to *P. infestans* caused late blight disease was the highest estimated value 0 .95 followed by fruit number and fruit set characteristics (0.93 and 0.92)this result agreed with**[23]**reported that the heritability in broad (Hb.s%) and narrow sense heritability were 73.28 and 26.86% for severity range to (BL).Results were similar with **[21 and24]**who reported similar values of heritability more than 90% for resistant plants to late blight disease. These results agreed, also with **[8]** who reported estimates heritability for LB resistance ranged from(0.56-0.86). The different population exhibited less heritability for yield 0.77 and fruit weight per plant 0.88.These two characters are influenced by environment, variation is due to the genetic and environmentaleffect, yield had the highest variation as mentioned previously associated with high environment affect. Similar values were recorded for broad sense heritability for different population against late blight disease under field conditions and values ranged from 0.981 to 0. 789. These results agreed **[9]** who concluded thatadditive type of genetic control was recorded for LB resistance, number of fruits and yield per plant. Characters such as resistance, fruit number, fruit set and fruit weight recorded high genetic heritability and less influence by environmental can be used as a tool for accurate selection when it combined with genetic advance as expected mean. The results ofthis study suggested that CLN2264G-LA 4286 with *Ph-3* is effective as a source of resistance to late blight disease in tomato breeding program. It has commercial quality and has desirable characteristics beside economic total yield and there are some of its hybrids with the commercial cultivars are promising hybrids. There is a need to get more genetic information through advanced breeding program to fromdifferent genotypes capable to face different strains of *oomycete P. infestans*and perform well against late blight disease.

Conclusion

The greenhouse and field experiments indicated that CLN2264G-LA 4286 with *Ph-3* is effective as a source of resistance to late blight disease in tomato breeding program. It has commercial quality and has desirable characteristics beside economic total yield and there are some of its hybrids by the commercial cultivars are promising hybrids. There is a need to get more genetic information through advanced breeding program for different genotypes to get accurate selection,and stability of resistance by resistant genesto be capable to face different strains of oomycete*P. infestans* and perform well against late blight disease.

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References

[1]G.N. Agrios , Plant pathology. Academic Press. New Approach, (3rd ed., pp. 400-428), (New York: McGraw Hill Book Co. Inc. 1998).

[2] M.T. McGrath, Late Blight Management in Tomato with Resistant Varieties. *Plant Pathology and Microbe Biology*, (Cornell University.Organic Agriculture November 30, (2015).

[3] E.S.G. Mizubuti, Custo da requeima. Cultivar - *Hortaliças e Frutas* 32:23-26. 2005.

[4] J. Bonnet, S. Danan, C. Boudet, L.P. Barchi, B. Caromel, A. Palloix and V. Lefebvre, Aref,The polygenic architectures of resistance to *Phytophthoracapsici* and *P. parasitica* independent in pepper, *Theoretical and Applied Genetics* 115, 2007,253-264.

[5] M. Kato, E.S. Mizubuti, S.B. Goodwin and W.E. Fry, Sensitivity to protectant fugicidies and pathogenic fitness of clonal lineages of *ofPhytopthorainfestans in the United States. Phytopathology 87, 1997, 973-978.*

[6] Y. Cohen, Populations of *Phytophthorainfestans* in Israel underwent three major genetic changes during 1983 to 2000.. *Phytopathology* 87, 1997, 973-978.

[7] A.Y. Elsayed, D.J. H. SilvaII, P. C.S. Carneiro, and E.G. Mizubuti, The Inheritance of late blight resistance derived from *Solanumhabrochaites*, Crop Breed. Appl. Biotechnol, 12 (3), 2012.

[8] T.S. Mathew, and M.R. Foolad, Genetic characterization of late blight resistance in *Solanumpimpinefolium*. Advanced Study in *Biology*, 10(1), 2018, 13-32.

[9] M.Y. Saleem, K.P. Akhtar, M. Asghar, R.Q. Iqbal and A.R. Khan, Genetic control of late blight, yield and some yield related, Pakistan *Journal of Botany*, 43(5), 2011, 2601-2605.

[10] K.A. Gomez, and A.A. Gomez, Statistical procedures for agricultural research. (John Wily & Sons.Inc. New York, USA, 1984).

[11] N.F. Briggs, and P.F. Knowles, Introduction to Plant Breeding, (*Reinhold Publishing Corporation*, USA, 1977).

[12] H.H. Smith, Fixing transgressive vigor in Nicotianarustica In Heterosis, (*Iowa State College Press Ames. Iowa, USA, 1952*).

[13] R.W. Allard, and A.D. Bradshaw, Implications of genetic environmental interactions in applied plant breeding. *Crop Science*, 4, 1964, 503-508.

[14] R.G.D. Steel, J.H. Torrie, and D.A. Dicky, Principles and procedures of Statistics. (*A Biometrical Approach (3rd ed., pp. 400-428*). *New York: McGraw Hill Book Co. Inc, 1997*).

[15] S.H. Kwon, and J.H. Torrie, Heritability and interrelationship of two soybean (Glycine max L.) Populations.*Crop Science*, 4, 1964, 196-198.

[16] R.G. Gardner and D.R.Panthee, NC 1 CELBR and NC 2 CELBR: early blight and late blight resistant fresh market tomato breeding lines. *Horticultural Science*, 45, 2010a, 975-976.

[17] Z.I. EL-Saka and K.I. Zaki, Tomato Breeding for Early Blight Disease Resistance.*IOSR. Journal of Agriculture and Veterinary Science*, 8(3), 2015, 88-94.

[18] R.A. Arafa, O.M. Moussa, N.E. Soliman, K. Shirasawa, S.M. Kamel, and M.T. Rakha, Resistance to Phytophthorainfestans in tomato wild relatives. *African journal of agricultural research*, 12(26), 2017, 2188–96.

[19] D.H.Y. Park, Y. Zhang, and B. S. Kim, Improvement of resistance to late blight in hybrid tomato,*Hort. Environ. Biotechnol*. 55(2), 2014, 120–124 |

[20] L.L. Black, T.C. Wang, P.M. Hanson, and J.T. Chen, (1996). Late blight resistance in four wild tomato accession: Effectiveness in diverse locations and inheritance of resistance. *Phytopathology* 86, 1996, 24.

[21] A.Y. Elsayed, E.M. Elsaid and E.A. Elsherbiny, The performance of late blight gene *ph-3* in tomato under the effect of local populations from *phytophthorainfestans. Journal Plant Production, Mansoura Univeristy*, 7(3), 2016, 361- 371.

[21] M. Heun, Combining ability and heterosis for quantitative powdery mildew resistance in barley. Plant Breeding, 99, 1987, 234-38.

[23] R.A. Arafa, O.M. Moussa, N.K. Soliman, K.W.A. Ramadan and S.M. Kamel, Inheritance of resistance against *Phytophthorainfestans* in *Lycopersiconpimpenellifolium* l3708 Ramadan, *Journal Plant Production, Mansoura Univeristy*, 5(12), 2014, 2023-2034.

[24] E.W. Ohlson, M.R. Foolad, Heritability of late blight resistance in tomato conferred by *Solanumpimpinellifolium* accession PI 224710. *Plant Breeding*, 134, 2015, 461–467.