 

The effect of simulating hail and late spring frost on certain parental forms of registered maize hybrids in the North West of Transylvania

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Introduction

- Maize is one of the most important crops worldwide and yield is affected by several risks with greater occurrence in the past years, as shown by Bălaş-Baconschi et al (2015).
- An analysis of these risks and testing the reaction of certain genotypes in case of simulating **early spring frost** and **hail** have a great importance, for both breeders and hybrid seed multiplier.
- Research on these risk factors were made for hail (Egharevba et al., 1976; Dwyer et al., 1994; Coulter et al., 2011, Klein et al., 2011; Robertson et al., 2011; Bălaş-Baconschi et al., 2015) and for frost by Cristea et al. (2004; 2013).
- In temperate and northern zones, maize crop success is closely related to physiological and biochemical properties of hybrids resistant to cold. In such conditions, the growing of the plant either completely ceases, or is growing slowly. For the genotypes not resistant to cold, the growing of the emerged plants is slowed down beginning with 14°C. Determination of cellular sap on vegetation phases show that in the early stages, the cellular sap concentration is lower. As the growing season progresses phases, cellular juice concentration increased. It is almost in all cases higher in cold-resistant forms, as shown by Cristea (2004).

Introduction

- The value of maize populations in terms of resistance to cold is important for choosing the initial breeding works, to create maize varieties or hybrids resistant to low temperatures, especially in the first part of the plant life according to Cristea (2013).

- Defoliation within 30 days after silking significantly reduced total accumulated dry matter. Complete defoliation was more detrimental (6.4 to 82% yield loss) than partial defoliation (1.5 to 32.7% yield loss). The effect of removing all leaves above the ear was not significantly different from that obtained by removing all leaves below the ear. Yield component affected most by leaf loss, for the overall treatment period, was kernel weight (12.7 to 53% decrease). However, number of kernels was greatly reduced (62.3%) when all leaves were removed 10 days after silking. Complete leaf removal thereafter and partial leaf removal affected number of kernels considerably less (approximate decline, 20%), as shown by Egharevba (1976).

- Damage to maize from hail is complex and hail-induced stand reduction is often accompanied with other forms of damage to the remaining plants. The level of yield compensation provided by the undamaged remaining plants may be overrepresented when compared to that following actual hail-induced stand reduction. Future research should evaluate the effect of maize stand reduction in conjunction with other types of damage to the remaining plants, such as defoliation, stalk breakage, stalk bruising, and whorl damage according to Coulter et al. (2011).

Objectives

The objectives of the study are:

1. Testing the reaction of late spring frost in different phenophases on some hybrids and inbred lines used as parental genotypes for Turda Star, Turda 201 and Turda 200 hybrids.

2. Testing the reaction of certain genotypes (hybrids and inbred lines) regarding the effect of hail in different phenological phases

Loss Frecvency by month and risk type in 2013, 2014 si 2015 (according to Groupama Asigurari)

Anul	Risk produced	May	June	July	August	September	October	Total
2013	Hail	1	35	15	8	3	1	63
	Storm	3	18	7	3	2	4	37
	Torrential rain	1	4	5	2	3	1	16
	Total	5	57	27	13	8	6	116
2014	Hail	9	14	57	3			83
	Storm		9	3			1	13
	Torrential rain	5	9	5	1	1		21
	Total	14	32	65	4	1	1	117
2015	Other risks	3		1	4			8
	Hail	10	20	4	2			36
	Storm	1	6	1	1	1		10
	Torrential rain	1	7	1	3		2	14
	Total	15	33	7	10	1	2	68

MATERIALS AND METHOD

- **Period**. The research was conducted for two years (2014 and 2015)
- **Location**: Agricultural Research and Development Station Turda (ARDS Turda), Cluj County, Romania.
- **Soil characteristics** The soil is a chernozem with poor drainage. The pH - 6.4, humus 3.69%, total N at 0.259% and mobile K at 459 ppm.
- **Ploughing** has been performed in autumn. In spring, the land has been processed with a cultivator.
- **Fertilization:** “Complex fertilizer NPK 27:13.5:0” (Azomures, Romania) with 400 kg/ha in 2014 and 2015.
- **Seed treatment:** Maxim XL for diseases control and with Sedoprid 600 FS for pests control.
- **Sowing** took place on May 12th, 2014, and on April 28th, 2015.
- **Weed management** preemergent herbicides, (Guardian with 2.0 l/ha in 2014 and Tender with 1.5 l/ha in 2015). The preemergent herbicide has been incorporated with tillage equipment at 3 cm depth. In both years, a postemergent herbicide treatment was been applied (Laudis 66 OD with 2.0 l/ha).
- **Maintenance during vegetation** - one mechanical hoeing and one manual hoeing in 2014. In 2015 two mechanical and one manual hoeing has been applied.
- **The biological material** used was represented by the simple hybrids used as maternal and paternal forms for the three-line hybrids Turda 201 and Turda Star, the maternal and paternal simple hybrids of the double hybrid Turda 200 and inbred lines used as parental forms of Turda 248, Turda 332, Turda 201 and Turda Star hybrids.

MATERIALS AND METHOD

The effect of **low temperatures** was studied with two graduations:

- Factor A – simple hybrids and inbred lines
- Factor B – natural phenomena: 1: Control; 2: simulated frost in the stage of 5-6 leaves; 3: simulated frost in the stage of 7-8 leaves. The frost was simulated by cutting the plants at the soil level.

The effect of **hail** was studied with five graduations:

- Factor A – simple hybrids and inbred lines
- Factor B – natural phenomena: 1: Control; 2: soft hail in the stage of 8-10 leaves; 3: hail of average intensity after pollination; 4: defoliation of 50% from the leaves after pollination; 5: defoliation of 80-90% from the leaves after pollination.

The results are presented for the yield (kg), the percent of erect plants (break resistance) (%), and hectoliter mass (the bulk density of cereals) (kg/hectoliter).

The experiments were set up in randomized blocks with three replications.

Breaking resistance has been counted by pushing the plants in order to test the resistance to medium winds. plants has been pushed gently from the cobs level till the plant reach the next plant in the same row. The plants that have fallen down were considered broken plants. By reporting the number of erect plants to total number of plants, we obtained the percent of erect plants. The harvest has been performed manually on October 8th, 2014, and on September 22nd, 2015.

Weather characteristics during the two experimental years (Turda Weather Station; longitude: 23° 47'; latitudine 46°35'; altitude 427 m)

	April	May	June	July	August	September	October
Temperature (°C)							
55 years mean	**9.8**	**14.7**	**17.7**	**19.6**	**19.2**	**14.9**	**9.6**
2014 deviation	+1.6	+0.4	+0.8	+0.8	+0.7	+1.7	+1.2
2015 deviation	-0.2	+1.1	+1.7	+2.7	+2.7	+2.4	+0.1
Rainfall (mm)							
	April	**May**	**June**	**July**	**August**	**September**	**October**
55 years mean	**44.7**	**67.7**	**84.5**	**76.7**	**55.9**	**40.3**	**32.0**
2014 deviation	+27.3	-1.5	-36.1	67.7	+27.9	+8.1	+35.4
2015 deviation	-12.5	-1.7	+31.2	-24.5	+16.3	+132.3	+13.4

In both years, the mean temperature was higher than the long-term mean temperature with higher values in 2015 than in 2014. We see that in 2015, temperature deviation is higher compared to 2014. At the same time, 2015 was drought during pollination because of the lack of rainfall from July.

Analysis of variance to determine the influence of late spring frost on yield, percentage of erect plants and hectoliter mass for hybrids – parental forms (Turda, 2014-2015)

Cause variation	DOF	Yield of grains (kg/ha)		Erect plants (%)		Hectoliter mass (kg/hl)	
		s^2	F test	s^2	F test	s^2	F test
TOTAL	53						
Years (Y)	1	451613800	241.61**	1277.51	36.35 *	514.71	200.95 **
Error Y	2	1869185		35.14		2.56	
Genotype (G)	2	23879660	16.81**	1635.08	34.68 **	87.62	73.82 **
Y x G	2	1675707	1.18 -	455.84	9.67 **	3.46	2.92 -
Error G	8	1421322		47.14		1.19	
Phenomena (P)	2	175239500	87.49**	131.54	1.98 -	63.31	25.66 **
Y x P	2	13958880	6.97**	24.95	0.38 -	2.66	1.08 -
G x P	4	2556860	1.28 -	97.75	1.47 -	4.83	1.96 -
Y x G x P	4	4553774	2.27 -	101.40	1.53 -	1.51	0.61 -
Error P	24	2003028		66.45		2.47	

Very significant differences between analyzed Genotypes from yield, percent of erect plants and hectoliter mass have been stressed out. Both the studied phenomena and the genotype along with the interaction of the experimental year significantly influenced the yield and hectoliter mass. The year and the genotype as well as the interaction between them are elements with a very significant influence.

Analysis of variance to determine the influence of late spring frost on yield, percentage of erect plants and hectoliter mass for inbreed lines – parental forms(Turda, 2014-2015)

Cause variation	DOF	Yield of grains (kg/ha)		Erect plants (%)		Hectoliter mass (kg/hl)	
		s^2	F test	s^2	F test	s^2	F test
TOTAL	53						
Years (Y)	1	142410000	462.19**	2856.92	7.23 -	1596.53	31.68 *
Error Y	2	308118		394.89		50.39	
Genotype (G)	2	9053226	6.95**	367.32	4.96 *	538.04	12.19 *
Y x G	2	3852826	2.96 -	498.40	6.73 *	78.33	1.77 -
Error G	8	1303164		74.04		44.15	
Phenomena (P)	2	51483520	219.52**	23.07	0.62 -	394.94	5.90 **
Y x P	2	16648660	70.99**	58.63	1.57 -	117.24	1.75 -
G x P	4	1331242	5.676**	31.17	0.83 -	155.41	2.32 -
Y x G x P	4	401697	1.713-	14.85	0.40 -	45.45	0.68 -
Error P	24	234527		37.42		66.98	

We can see very significant differences between the analyzed genotypes from the 3 parameters studied. In the same time, the studied phenomena as well as the genotype along with the interaction of the experimental years, significantly influenced the yield and hectoliter mass for inbreed lines too, and the percent of erect plants was also influenced but for the genotype and interaction between year and genotype.

Analysis of variance to determine the influence of hail on yield, percentage of erect plants and hectoliter mass for hybrids – parental forms (Turda, 2014-2015)

Cause variation	DOF	Yield of grains (kg/ha)		Erect plants (%)		Hectoliter mass (kg/hl)	
		s^2	F test	s^2	F test	s^2	F test
TOTAL	53						
Years (Y)	1	472876300	231.10 **	10411	689.80 **	157.85	68.11*
Error Y	2	2046159		15.09		2.32	
Genotype (G)	2	9106292	13.10 **	20.54	1.05 -	94.07	78.92 **
Y x G	2	1876858	2.70 -	174.48	8.92 **	1.21	1.01
Error G	8	695247		19.56		1.19	
Phenomena (P)	4	141013600	257.27 **	1589.17	41.37 **	121.29	75.43 **
Y x P	4	19842490	36.20 **	1077.34	28.04 **	34.01	21.15 **
G x P	8	1261994	2.30 *	152.26	3.96 **	12.06	7.50 **
Y x G x P	8	878697	1.60 -	55.89	1.45 -	3.32	2.07 -
Error P	48	548107		38.42		1.61	

the analysis of variance for yield, the percent of erect plants and hectoliter mass, shows very significant differences between the analyzed genotype in the expression of these parameters. In the same time, the studied phenomena and the genotype along with the interaction with the experimental years, significantly influenced the yield and hectoliter mass. Also, the double interaction between year and genotype and year and phenomena had very significant results for all the 3 studied characters.

Analysis of variance to determine the influence of hail on yield, percentage of erect plants and hectoliter mass for inbreed lines– parental forms (Turda, 2014-2015)

Cause variation	DOF	Yield of grains (kg/ha)		Erect plants (%)		Hectoliter mass (kg/hl)	
		s^2	F test	s^2	F test	s^2	F test
TOTAL	53						
Years (Y)	1	184677900	617.28 **	6406.64	192.99**	197.28	11.20-
Error Y	2	299182.60		33.20		17.62	
Genotype (G)	2	33917790	123.87**	108.30	6.00*	208.31	26.63**
Y x G	2	2027052	7.40	204.55	11.33**	137.91	17.63**
Error G	8	273818.80		18.06		7.82	
Phenomena (P)	4	39211030	149.72**	1174.45	34.40**	149.17	27.39**
Y x P	4	11103080	42.40**	1121.28	32.84**	51.23	9.41**
G x P	8	1503094	5.74**	76.93	2.25*	14.24	2.62*
Y x G x P	8	1736484	6.63**	95.22	2.79*	2.81	0.52 -
Error P	48	261893.50		34.14		5.45	

Significant differences between the genotypes (inbreed lines) in expression of these characters, both from the point of view of the year of the genotype and of the phenomena for all the analyzed characters. The interaction between the year and the phenomena is also significant for all the analyzed elements. In the same time, the studied phenomena and the genotype along with the interaction with the experimental years significantly influenced the yield and hectoliter mass. For yield there is a significant difference between the triple interaction of year, genotype and phenomena. The hail in case of inbreed lines are more influenced by the interaction between year and phenomena, the interaction between genotype and phenomena and also the triple interaction between year, phenomena and genotype compared to the hybrids..

Interaction between simulated late spring frost and hybrids for yield, erected plants and hectoliter mass (Turda, 2014-2015)

Hybrids		2014-2015					
phenomena	The hybrid	Yield of grains (kg/ha)		Erect plants (%)		Hectoliter mass (kg/hl)	
		Mean	± control	Mean	± control	Mean	± control
1	**HSM Turda 201**	**10650,0**	**Control**	69.16	**Control**	63.76	**Control**
2		9418,0	-1232,0 $^{-}$	74.85	5.69^{-}	62.76	-1.00 $^{-}$
3		5560,0	-5089,9 ^{000}	74.32	5.17^{-}	58.45	-5.30 ^{000}
1	**HS Turda Star**	**11296,8**	**Control**	79.43	**Control**	58.79	**Control**
2		9015,5	-2281,3^{0}	76.03	-3.39^{-}	57.63	-1.16 $^{-}$
3		5418,8	-5878,0 ^{000}	78.83	-0.6^{-}	55.51	-3.28 ^{00}
1	**Turda 200T**	**10095,8**	**Control**	58.15	**Control**	60.77	**Control**
2		7007,9	-3087,8 ^{000}	53.99	-4.17^{-}	60.91	0.14 $^{-}$
3		2591,6	-7504,1 ^{000}	66.61	8.45^{-}	58.76	-2.01 ^{0}
		LSD (p5%)	1683.2	LSD (p5%)	9.7	LSD (p5%)	1.87
		LSD (p1%)	2287.9	LSD p1%)	13.18	LSD (p1%)	2.54
		LSD (p0.1%)	3064.1	LSD(p0.1%)	17.65	LSD (p0.1%)	3.4

the interaction of the late spring frost with the hybrids in the case of the yield, the percent of erect plants and hectoliter mass showed significant differences between the genotypes (hybrids) in expression of these characteristics. Late spring frost produces the biggest losses, having a significantly negative influence on the yield, and the hectoliter mass. The resistance to break is insignificantly affected in the case of late spring frost. From the analyzed genotypes, Turda 201 hybrid proved its big resistance to frost. In the same time, the Turda 200T hybrid proved the lowest capacity of resistance, and appears to be more sensitive to the analyzed characteristics.

Interaction between simulated late spring frost and inbreed lines for yield, erected plants and hectoliter mass (Turda 2014-2015)

Inbreed lines		2014-2015					
phenomena	The inbreed line	Yield of grains (kg/ha)		Erect plants (%)		Hectoliter mass (kg/hl)	
		Mean	± control	Mean	± control	Mean	± control
1	**LC 660**	**4907.1**	**Control**	73.3	**Control**	61.95	**Control**
2		2711.7	-2195.3 ^{000}	75.54	2.25 $^{-}$	53.44	-8.51 $^{-}$
3		538.2	-4368.8^{000}	76.88	3.58 $^{-}$	41.37	-20.58 ^{000}
1	**LC 733**	**3809.9**	**Control**	74.70	**Control**	63.27	**Control**
2		2802.4	-1007.4^{00}	77.16	2.46 $^{-}$	62.67	-0.60 $^{-}$
3		1247.4	-2562.4^{000}	80.42	5.71 $^{-}$	59.04	-4.23 $^{-}$
1	**LC 761 cmsC**	**5376.7**	**Control**	84.79	**Control**	64.39	**Control**
2		4123.1	-1253.5^{000}	84.97	0.18 $^{-}$	59.89	-4.5 $^{-}$
3		2184.8	-3191.8^{000}	82.02	-2.77 $^{-}$	61.09	-3.29 $^{-}$
		LSD (p5%)	575.9	LSD (p5%)	7.28	LSD (p5%)	9.73
		LSD (p1%)	782.8	LSD p1%)	9.89	LSD (p1%)	13.23
		LSD (p0.1%)	1048.5	LSD(p0.1%)	13.24	LSD (p0.1%)	17.72

Regarding the interaction of late spring frost with the analyzed genotypes (inbreed lines) for the yield, percent of erect plants and hectoliter mass, very significant differences are stressed out between the inbreed lines both in the early phenophase and also in the late one (Table 7). Frost has a significantly negative influence of the yield and insignificant on the break resistance (percent of erect plants). The line LC 761 cms C proved its big resistance to late spring frost, while line LC 660 is the most sensitive among the analyzed genotypes.

Interaction between simulated hail and hybrids for yield, erected plants and hectoliter mass (Turda 2014-2015)

Hybrids		2014-2015					
phenomena	The hybrid	Yield of grains (kg/ha)		Erect plants (%)		Hectoliter mass (kg/hl)	
		Mean	± control	Mean	± control	Mean	± control
1	**HS M cmsC Turda201**	**9754.1**	**Control**	67.33	**Control**	63.66	**Control**
2		9522.5	-231.6^{-}	72.4	5.08^{-}	64.42	0.75^{-}
3		9059.2	-694.8^{-}	66.48	-0.85^{-}	64.82	1.16^{-}
4		6940.5	-2813.6^{000}	70.71	3.39^{-}	65.28	1.61^{*}
5		3052.9	-6701.2^{000}	48.28	-19.05^{000}	55.47	-8.20^{000}
1	**HS Turda Star**	**10504.9**	**Control**	76.41	**Control**	60.50	**Control**
2		10491.2	-13.6^{-}	73.73	-2.67^{-}	59.70	-0.81^{-}
3		9705.8	-799.1^{-}	71.72	-4.69^{-}	60.55	0.05^{-}
4		7668.3	-2836.5^{000}	66.32	-10.08^{00}	61.97	1.47^{-}
5		2859.1	-7645.8^{000}	42.13	-34.28^{000}	56.39	-4.11^{000}
1	**HST Turda 200McmsT**	**8570.1**	**Control**	67.16	**Control**	64.29	**Control**
2		9041.5	471.3^{-}	65.93	-1.23^{-}	63.63	-0.66^{-}
3		8140.7	-429.4^{-}	69.15	1.99^{-}	63.08	-1.21^{-}
4		6796.1	-1774.0^{000}	64.67	-2.49^{-}	64.13	-0.16^{-}
5		3174.0	-5396.1^{000}	55.21	-11.94^{00}	60.02	-4.27^{000}
		LSD (p5%)	859.1	LSD (p5%)	7.19	LSD (p5%)	1.47
		LSD (p1%)	1147.2	LSD (p1%)	9.60	LSD (p1%)	1.97
		LSD (p0.1%)	1496.8	LSD(p0.1%)	12.53	LSD (p0.1%)	2.56

There are significantly negative differences between the hybrids in expression of these characteristics, especially for the hail with 80-90% defoliation (phenomena 5). At the opposite, the soft hail in phenophase of 8-10 leaves (phenomena 2) has an insignificantly influence for all the analyze characteristics. Among the analyzed hybrids, Turda 200 M cms T appears to be the less resistant to hail, and at the opposite, the hybrid Turda Star which is the most sensitive to hail.

Interaction between simulated hail and inbreed lines for yield, erected plants and hectoliter mass (Turda 2014-2015)

Inbreed lines		2014-2015					
phenomena	The inbreed line	Yield of grains (kg/ha)		Erect plants (%)		Hectoliter mass (kg/hl)	
		Mean	± control	Mean	± control	Mean	± control
1	**LC A Turda 248**	4456.57	**Control**	86.45	**Control**	63.87	**Control**
2		4671.79	215.22 $^{-}$	82.58	-3.87 $^{-}$	63.73	-0.14 $^{-}$
3		4453.17	-3.41 $^{-}$	83.29	-3.16 $^{-}$	65.06	1.19 $^{-}$
4		3434.06	-1022.52 ^{00}	76.75	-9.70 ^{00}	65.19	1.32 $^{-}$
5		1862.84	-2593.73 ^{000}	69.67	-16.78 ^{000}	60.22	-3.64 ^{00}
1	**LC"A"Turda332**	7209.81	**Control**	83.66	**Control**	63.56	**Control**
2		7095.41	-114.40 $^{-}$	85.32	1.65 $^{-}$	64.71	1.15 $^{-}$
3		6384.06	-825.75 ^{00}	82.12	-1.54 $^{-}$	64.05	0.49 $^{-}$
4		6113.81	-1096.00 ^{000}	87.17	3.51 $^{-}$	65.90	2.34 $^{-}$
5		2355.23	-4854.58 ^{000}	66.90	-16.77 ^{000}	54.56	-8.99 ^{000}
1	**LC 761 cms C**	5047.67	**Control**	84.81	**Control**	59.54	**Control**
2		5151.17	103.50 $^{-}$	84.21	-0.60 $^{-}$	59.54	0.00 $^{-}$
3		5069.85	22.19 $^{-}$	78.26	-6.56 $^{-}$	60.05	0.52 $^{-}$
4		4288.78	-758.89 ^{0}	80.12	-4.69 $^{-}$	59.23	-0.31 $^{-}$
5		2107.73	-2939.93 ^{000}	59.07	-25.75 ^{000}	54.71	-4.83 ^{000}
		LSD (p5%)	5941	LSD (p5%)	6.78	LSD (p5%)	2.71
		LSD (p1%)	793.2	LSD (p1%)	9.05	LSD (p1%)	3.62
		LSD (p0.1%)	1034.8	LSD(p0.1%)	11.81	LSD(p0.1%)	4.72

Medium to strong hail significantly negative influenced the analyzed characteristics of inbreds, especially with the strongest hail with 80-90% defoliation (phenomena 5). Soft hail in the 8-10 leaves (phenomena 2) had an insignificant influence for all the analyzed characteristics. LC A Turda 332 proves the best resistance to the studied phenomena while LC A 248 was the most sensitive the hail.

Results

	Grain yield (kg/ha)					
	Hybrids			Inbreed lines		
Phenomena[1]	Genotype	2014	2015	Genotype	2014	2015
1	**HSM Turda 201**	**12903**	**8770**	**LC 660**	**6861**	**2953**
2		13518	5053		5080	343
3		8511	2810		857	200
1	**HS Turda Star**	**13823**	**8398**	**LC 733**	**5095**	**2525**
2		12979	5319		4733	872
3		8,028	2609		1645	850
1	**Turda 200T**	**13456**	**6735**	**LC 761 cms C**	**7455**	**3298**
2		10490	3526		7332	914
3		3375	1809		3258	1111
LSD (p<5%)		1683			576	
LSD (p<1%)		2288			783	
LSD (p<0.1%)		3064			1049	

In 2014, the effect of late spring frost had no effect in the case of simulated frost in the first phenophase, when yield losses were up to 8% in hybrids and up to 12% in inbred lines compared to the control (means over genotypes). However in 2015, the same phenomena produced a decrease of 42% for hybrids and 76% for inbreed lines compared to the control (means over genotypes). In the case of simulated frost in the stage of 8-9 leaves , late spring frost caused 71% loss in hybrids and 76% in inbred lines compared to the control (means over genotypes).

Results

	Grain yield (kg/ha)					
	Hybrids			Inbreed lines		
Phenomena[1]	Genotype	2014	2015	Genotype	2014	2015
1	**HS M cms C**	**12791**	**6718**	**LC A Turda**	**5794**	**3119**
2	**Turda 201**	12005	7040	**248**	5886	3457
3		11347	6771		**5623**	**3284**
4		9098	4783		4695	2173
5		3760	2346		2619	1106
1	**HS Turda**	**13956**	**7054**	**LC "A"**	**9672**	**4747**
2	**Star**	13854	7129	**Turda 332**	9425	4766
3		13183	6228		8341	4427
4		9764	5572		8219	4009
5		3375	2343		1788	2922
1	**HST Turda**	**11549**	**5590**	**LC 761 cms**	**7080**	**3015**
2	**200 M cms T**	12186	5897	**C**	7151	3152
3		10175	6107		7044	3095
4		9040	4553		5796	2782
5		3582	2766		2054	2161
LSD (p<5%)		859			594	
LSD (p<1%)		1147			793	
LSD (p<0.1%)		1497			1035	

Simulated hail before pollination (stage 2) did not cause any yield decreased compared the control in both years. Whereas defoliation of 80-90% from the leaves after pollination by simulated hail caused yield losses of 71% in hybrids and 70% in inbred lines in 2014 and 61% in hybrids and 45% for inbreed lines in 2015 compared to control (means for genotypes).

Conclusions

The influence of frost and hail combined with drought can affect seriously the yield of maize parental genotypes.

If the phenomena are occurring in advanced phenophases, both hybrids and inbred lines respond with a lower yield and a lower hectoliter mass.

If the simulated phenomena are combined with drought, the cumulated losses for these risk factors are much higher. For inbred lines, frost has a stronger effect compared to the damage caused by hail.

If the late spring frost occurs, another period of drought can reduce drastically the yield.

The percentage of erect plants after testing the breaking resistance before harvest was lower in a the year with more favorable growing conditions (2014) than in the year with drought during pollination (2015) as the yield was much higher in 2014 causing a higher amount of broken plants after testing.

Late spring frost and hail in early stages produced small losses, but when these risks appear later during crop growth with higher intensity, the yield decreases significantly. Within this study, maize showed a remarkable ecological plasticity in early stages, being able to adapt to stressful weather condition.

 

Hybrids after simulating late spring frost in 2014 and 2015

Inbreed lines after simulating late spring frost in 2014 and 2015

Inbreed lines after simulating hail in 2014 and 2015


Thank you for your attention