THE INFLUENCE OF AGROMETEOROLOGICAL CHARACTERISTICS OF THE AGRICULTURAL YEAR 2019-2020 ON WHEAT CROP IN THE NORTH-EAST PART OF MOLDOVA

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Abstract

The study based on the aforementioned theme puts to distinguish specifics agrometeorological characteristics of the agricultural year 2019-2020 in the North-East part of Moldova, and its influence on growth and yield in winter wheat crop. It's presented the average values of precipitations and air temperature for the last decade and the values of precipitations and air temperature recorded between September 2019 and July 2020 and its influence in winter wheat crop. The climatic conditions encountered during the agricultural year 2019-2020 and, especially in the first half of 2020 made this year a very special one, being characterized by the presence of a severe drought, with strong negative influences on growth of cultivated plants and especially of winter wheat.

Key words: agricultural year 2019-2020, wheat, yield, precipitation, temperature

Wheat is unquestionable the most important food crop in the world, and is counted among the 'big three' cereal crops, together with rice and corn (Shewry P.R., 2009; Morris C.F. *et al*, 1996). World wheat production currently stands at about 550 million metric tons, harvested from a surface of 220 million nectars, with a yield average around 2.4 t/ha^{-1}.

In Romania wheat and corn are the main crops, being cultivated on a surface around of 2.2 million hectares, each. Romanian national wheat production stands at about 6 million tons with an average yield around 4.5 t/ha^{-1}.

Stability of crop production is an important challenge for researchers. Although much has been done recently in this regard (yields stability), there are years in which crop production, including wheat yields, is decimated due to adverse weather conditions, of which drought is the phenomenon with the most serious implications (Săulescu N.N. *et al*, 2006; Pochișcanu S.F. *et al*, 2011).

Although, in Romania, wheat yields have increased gradually in recent years, reaching in 2017 the threshold of 4 t/ha^{-1}, there are years when the yield decreases by half, or even more, than that recorded in the previous years. Such years, when wheat yield was very low, were the agricultural years 1996, 2003, 2007, 2009, 2012 when during the vegetation period of wheat crop the atmospheric precipitations were completely absent (Gafencu A.M., 2019).

MATERIAL AND METHOD

The experience was placed in the experimental field of the Iasi Didactic Station, the "Ezăreni" farm of the "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine of Iasi, in the agricultural year 2019-2020, on a cambic chernozem with loam-clay texture and medium-good fertility.

The experiment was bifactorial, AxB type, where A was represented by the winter wheat cultivars, and B was represented by the seed-treatment applied.

The design of the experiment was done according to the "randomized block method" in four replications.

First factor (A) was represented by the winter wheat cultivars, with five graduations. The winter wheat cultivars studied were represented by the Romanian winter wheat genotypes Glosa, Miranda and Izvor, but also by the foreign winter wheat genotypes Apache and Mulan. The Glosa genotype is the most cultivate cultivar in Romania, and Miranda and Izvor genotypes are on the following positions. Regarding the foreign genotypes, Apache cultivar is the most cultivated foreign winter wheat variety in Romania, and Mulan is a winter wheat cultivar that which is cultivated on higher and higher areas from one year to another, due to the properties it is endowed with.

Second factor (B) was represented by the plant protection products (PPPs) present on the Romania market and used for the treatment of

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winter wheat seed. The pesticides used to treat winter wheat seeds were: Systiva 333 FS (fluxapiroxad 333 g/l), Premis (triticonazole 25 g/l), Biosild Top (methyl thiophanate 350 g/l + tetraconazole 20 g/l), Difend Extra (difenoconazole 25 g/l + fludioxanil 25 g/l), Redigo Pro 170 FS (protioconazole 15 g/l + tebuconazole 20 g/l), Bariton Super 97.5 (protioconazole 15 g/l + tebuconazole 20 g/l + fludioxonil 37.5 g/l), Bariton Super 97.5 + Peridiam (protioconazole 15 g/l + tebuconazole 20 g/l + fludioxonil 37.5 g/l + Adjuvant), Celest Super (ciproconazole 6.3 g/l + fludioxonil 18.8 g/l), Sponsor 6 FS (tebuconazole 6%), Royal Flo 42S (thiouram 490 g/l), Admiral Proffy 6 FS (tebuconazole 60 g/l), Austral Plus + AG40R (tefluthrin 40 g/l + fludioxonil 10 g/l + Adjuvant), Difend Extra + Wuxal Terios Mn + (difenoconazole 25 g/l + fludioxanil 25 g/l + Adjuvant).

The control variant of the experience was represented by an untreated variant (*figure 1*).

Figure 1 **The experience designed in the field (original)**

Winter wheat crop technology was represented by classical technology. Wheat crop was sown after *Lupinus* sp. and was fertilized with moderate doses of fertilizer: 120 kg N/ha^{-1} and 45 kg P_2O_5/ha^{-1}.

It should be noted that no phytosanitary treatments were carried out during the growing season.

The sowing took place on October 22, 2019 and was done with the help of the Wintersteiger seed drill, and the harvesting took place on June 20, 2020 and was carried out with the Wintersteiger combine harvester.

Data on atmospheric conditions were obtained from the weather station located within the farm.

Statistical analysis was performed using the SPSS program (IBM SPSS Statistics 20).

RESULTS AND DISCUSSIONS

Agriculture in Romania, as well as in the world, is strongly influenced by climate change. Given that in our country the most extensive crops are corn and wheat, it is clear that the highest production losses, due to climatically conditions, will be reported in their case.

From year to year, the presence of unfavorable meteorological phenomena is observed, which can upset, in a very short time, a good agricultural year. The worst weather events are drought, hail, storms or floods.

The influence of extreme weather events was materialized by the negative effects on agricultural production. In 2020, the main crops that suffered as a result of the extreme drought were autumn crops, especially wheat.

Weather data during growth period of wheat in 2020 are presented in table 1 and table 2. Climate data recorded in 2020 are compared to some periods of reverence, e.g. last century, last decade, and last four years.

Rainfall quantity recorded between August 2019 and July 2020 was with 63.4 mm lower than multiannual average sum, and with 73.9 mm lower than last decade. Of the last five agricultural years studied, 2020 was the driest.

Although in autumn, at the time of sowing, the wheat crop had enough water available for emergence, in spring the lack of precipitation during the most important phenophases caused the plants to shorten their vegetation period and dry prematurely.

The lack of atmospheric precipitation, together with the air temperatures, which were higher this year than the periods taken as a reference, led to a dramatic reduction of winter wheat yields.

Table 1

Rainfall quantity and monthly distribution (mm) during wheat growing season at Ezareni Farm

Month		VIII	IX	X	XI	XII	I	II	III	IV	V	VI	VII	Quantity
Phenophases		Uncultivated land	Sowing - Emergency			Winter reserve				Increased growth-flowering		Ripening	Uncultivated land	
1990-2000		56.0	54.3	32.5	37	29.7	29.7	26.9	28.4	43.9	55.9	82.6	69.3	**537.2**
2005-2014		45.4	36.8	40.1	27.5	39.1	32.6	28.9	29.7	54	69.8	77.8	66.1	**547.7**
2015/16		**40.8**	**19.8**	**66.4**	**104.2**	**10.2**	**80**	**28.8**	**33.8**	**76.2**	**70.4**	**142.4**	**24**	**697**
Deviation	Multi annual average	-15.2	-34.5	33.9	67.2	-19.5	50.3	1.9	5.4	32.3	14.5	59.8	-45.3	**159.8**
	Last decade	-4.6	-17	26.3	76.7	-28.9	47.4	-0.1	4.1	22.2	0.6	64.6	-42.1	**149.3**
2016/17		**53.4**	**10.2**	**212**	**69.8**	**20.6**	**323.6**	**13.8**	**107**	**140.4**	**72.8**	**71.6**	**84.4**	**1179.6**
Deviation	Multi annual average	-2.6	-44.1	179.5	32.8	-9.1	293.9	-13.1	78.6	96.5	16.9	-11	15.1	**642.4**
	Last decade	8	-26.6	171.9	42.3	-18.5	291	-15.1	77.3	86.4	3	-6.2	18.3	**631.9**
2017/18		**61.8**	**23.2**	**69.8**	**20.6**	**48.2**	**18.8**	**24.8**	**56.8**	**18**	**16.8**	**216**	**136.6**	**717.6**
Deviation	Multi annual average	5.8	-31.1	37.3	-16.4	18.5	-10.9	-2.1	28.4	-25.9	-39.1	133.4	67.3	**180.4**
	Last decade	16.4	-13.6	29.7	-6.9	9.1	-13.8	-4.1	27.1	-36	-53	138.2	70.5	**169.9**
2018/19		**1.2**	**21**	**3.4**	**32.8**	**41**	**16.8**	**48**	**40.4**	**62.6**	**125.2**	**113.8**	**24.2**	**530.4**
Deviation	Multi annual average	-54.8	-33.3	-29.1	-4.2	11.3	-12.9	21.1	12	18.7	69.3	31.2	-45.1	**-6.8**
	Last decade	45.4	36.8	40.1	27.5	39.1	32.6	28.9	29.7	54	69.8	77.8	66.1	**-17.3**
2019/20		**51.4**	**60**	**35**	**10.4**	**14.6**	**5.4**	**66**	**22.2**	**4**	**84**	**84**	**36.8**	**473.8**
Deviation	Multi annual average	-4.6	5.7	2.5	-26.6	-15.1	-24.3	39.1	-6.2	-39.9	28.1	1.4	-32.5	**-63.4**
	Last decade	6	23.2	-5.1	-17.1	-24.5	-27.2	37.1	-7.5	-50	14.2	6.2	-29.3	**-73.9**

Table 2

Monthly air average temperatures (^{0}C) during wheat growing season at Ezareni Farm

Month		VIII	IX	X	XI	XII	I	II	III	IV	V	VI	VII	Average
Phenophases		Uncultivated land	Sowing - Emergency			Winter reserve				Increased growth-flowering		Ripening	Uncultivated land	
1990-2000		20.50	15.90	10.00	4.10	-0.80	-3.50	-1.80	3.10	10.20	16.00	19.50	21.20	**9.53**
2005-2014		21.93	16.57	10.36	5.76	-0.02	-2.15	-1.47	4.63	11.34	17.15	20.8	22.91	**10.65**
2015/16		**23.04**	**19.23**	**9.37**	**6.37**	**2.04**	**-2.54**	**5.26**	**6.52**	**13.33**	**15.32**	**20.86**	**22.64**	**11.79**
Deviation	Multi annual average	2.54	3.33	-0.63	2.27	2.84	0.96	7.06	3.42	3.13	-0.69	1.36	1.44	**2.26**
	Last decade	1.11	2.66	-0.99	0.61	2.06	-0.39	6.73	1.89	1.99	-1.84	0.06	-0.27	**1.14**
2016/17		**21.38**	**18.27**	**8.15**	**4.03**	**0.35**	**-4.89**	**-0.81**	**8.00**	**10.05**	**16.07**	**21.11**	**21.64**	**10.28**
Deviation	Multi annual average	0.88	2.37	-1.85	-0.07	1.15	-1.39	0.99	4.90	0.15	0.07	1.61	0.44	**0.75**
	Last decade	-0.55	1.70	-2.21	-1.73	0.37	-2.74	0.66	3.37	-1.29	-1.08	0.31	-1.27	**-0.37**
2017/18		**21.95**	**17.18**	**10.96**	**5.85**	**3.00**	**-0.84**	**-1.75**	**1.18**	**15.43**	**18.67**	**20.78**	**21.3**	**11.14**
Deviation	Multi annual average	1.45	1.28	0.96	1.75	3.80	2.66	0.05	-1.92	5.23	2.67	1.28	0.10	**1.61**
	Last decade	0.02	0.61	0.60	0.09	3.02	1.31	-0.28	-3.45	4.09	1.52	-0.02	-1.61	**0.49**
2018/19		**22.64**	**16.85**	**12.29**	**3.01**	**-0.90**	**-2.60**	**2.16**	**7.35**	**10.58**	**16.05**	**21.90**	**21.15**	**10.87**
Deviation	Multi annual average	2.14	0.95	2.29	-1.09	-0.10	0.90	3.96	4.25	0.38	0.05	2.40	-0.05	**1.34**
	Last decade	0.71	0.28	1.93	-2.75	-0.88	-0.45	3.63	2.72	-0.76	-1.10	1.10	-1.76	**0.22**
2019/20		**21.93**	**16.99**	**11.68**	**8.76**	**2.68**	**0.60**	**4.42**	**7.35**	**11.01**	**14.29**	**20.97**	**22.42**	**11.93**
Deviation	Multi annual average	1.43	1.09	1.68	4.66	3.48	4.10	6.22	4.25	0.81	-1.71	1.47	1.22	**2.40**
	Last decade	0.00	0.42	1.32	3.00	2.70	2.75	5.89	2.72	-0.33	-2.86	0.17	-0.49	**1.28**

Yields obtained in 2020 were much lower than those normally obtained in this area. If the Glosa variety consistently obtained a production between 5 and 6 t/ha^{-1} (Gafencu A.M. *et al*, 2019), this year yields were at least 50-60% lower (table 3 A]).

Table 3

Yields recorded by winter wheat cultivars in 2019/2020

A] Yield recorded by Glosa variety

Variety	Seed treatment	Yield (kg/ha^{-1} 14% U)			Meaning
		Average (kg/ha^{-1})	Difference from control		
			(kg/ha^{-1})	%	
Glosa	Systiva 333 FS	2021.7±143.0	340.8	120.3	NS
	Premis	1382.2±104.7	-298.8	82.2	NS
	Biosild Top	1854.2±352.3	173.3	110.3	NS
	Difend Extra	2212.3±147.7	531.4	131.6	NS
	Redigo Pro 170 Fs	2279.0±307.8	598.1	135.6	NS
	Bariton Super 97,5	1691.2±95.1	10.2	100.6	NS
	Bariton Super 97,5 + Peridiam	1821.9±200.9	141.0	108.4	NS
	Celest Super	2809.9±375.1	1129.0	167.2	**
	Sponsor 6 FS	3067.4±484.7	1386.5	182.5	***
	Royal Flo 42S	1713.8±212.8	32.9	102.0	NS
	Amiral Proffy 6 FS	1905.5±216.0	224.6	113.4	NS
	Amiral Proffy 6 FS +AG40R	2137.1±89.4	456.2	127.1	NS
	Difend Extra + Wuxal Terios Mn+	2011.0±94.3	330.1	119.6	NS
	Control (untreated)	**1680.9±86.6**	**-**	**100.0**	**Cv**

B] Yield recorded by Izvor variety

Variety	Seed treatment	Yield (kg/ha^{-1} 14% U)			Meaning
		Average (kg/ha^{-1})	Difference from control		
			(kg/ha^{-1})	%	
Izvor	Systiva 333 FS	1285.7±349.4	77.7	106.4	Ns
	Premis	1473.9±153.3	265.9	122.0	Ns
	Biosild Top	590.3±83.3	-617.8	48.9	Ns
	Difend Extra	1078.5±239.5	-129.6	89.3	Ns
	Redigo Pro 170 Fs	664.2±92.7	-543.8	55.0	Ns
	Bariton Super 97,5	1455.6±346.9	247.6	120.5	Ns
	Bariton Super 97,5 + Peridiam	1465.1±364.5	257.1	121.3	Ns
	Celest Super	1373.4±109.8	165.4	113.7	Ns
	Sponsor 6 FS	1516.1±138.6	308.1	125.5	Ns
	Royal Flo 42S	1327.4±149.9	119.4	109.9	Ns
	Amiral Proffy 6 FS	1309.2±68.0	101.2	108.4	Ns
	Amiral Proffy 6 FS +AG40R	1632.1±260.2	424.1	135.1	Ns
	Difend Extra + Wuxal Terios Mn+	1455.7±444.5	247.7	120.5	Ns
	Control (untreated)	**1208.0±86.6**	**-**	**100.0**	**Cv**

C] Yield recorded by Miranda variety

Variety	Seed treatment	Yield (kg/ha^{-1} 14% U)			Meaning
		Average (kg/ha^{-1})	Difference from control		
			(kg/ha^{-1})	%	
Miranda	Systiva 333 FS	2063.5±233.5	626.4	143.6	*
	Premis	1406.1±62.1	-31.1	97.8	Ns
	Biosild Top	2391.8±370.9	604.7	142.1	**
	Difend Extra	1846.0±95.2	408.9	128.5	Ns
	Redigo Pro 170 Fs	1325.7±178.8	-111.5	92.2	Ns
	Bariton Super 97,5	1983.1±232.6	546.0	138.0	Ns
	Bariton Super 97,5 + Peridiam	1951.9±200.4	514.8	135.8	Ns
	Celest Super	1714.5±245.9	277.4	119.3	Ns
	Sponsor 6 FS	2414.7±109.6	977.6	168.0	**
	Royal Flo 42S	1782.1±348.0	345.0	124.0	Ns
	Amiral Proffy 6 FS	1135.0±99.0	-302.2	79.0	Ns
	Amiral Proffy 6 FS +AG40R	1681.9±102.9	244.8	117.0	Ns
	Difend Extra + Wuxal Terios Mn+	2370.2±241.7	933.1	164.9	**
	Control (untreated)	**1437.1±132.6**	**-**	**100.0**	**Cv**

Table 3 – contination

D] Yield recorded by Apache variety

Variety	Seed treatment	Yield (kg/ha^{-1} 14% U)			Meaning
		Average (kg/ha^{-1})	Difference from control		
			(kg/ha^{-1})	%	
Apache	Systiva 333 FS	1004.4±200.0	220.5	128.1	Ns
	Premis	868.6±63.7	84.7	110.8	Ns
	Biosild Top	910.2±144.7	126.3	116.1	Ns
	Difend Extra	1085.0±67.7	301.1	138.4	Ns
	Redigo Pro 170 Fs	872.3±87.1	88.4	111.3	Ns
	Bariton Super 97,5	790.1±151.3	6.2	100.8	Ns
	Bariton Super 97,5 + Peridiam	657.0±140.8	-126.9	83.8	Ns
	Celest Super	628.4±119.5	-155.5	80.2	Ns
	Sponsor 6 FS	1027.8±115.0	243.9	131.1	Ns
	Royal Flo 42S	1303.8±260.3	519.9	166.3	*
	Amiral Proffy 6 FS	767.0±153.1	-16.9	97.8	Ns
	Amiral Proffy 6 FS +AG40R	939.6±189.3	155.7	119.9	Ns
	Difend Extra + Wuxal Terios Mn+	829.5±105.1	45.6	105.8	Ns
	Control (untreated)	**783.9±147.6**	**-**	**100.0**	**Cv**

E] Yield recorded by Mulan variety

Variety	Seed treatment	Yield (kg/ha^{-1} 14% U)			Meaning
		Average (kg/ha^{-1})	Difference from control		
			(kg/ha^{-1})	%	
Mulan	Systiva 333 FS	1311.2±82.2	-98.5	93.0	Ns
	Premis	1238.5±217.1	-171.3	87.9	Ns
	Biosild Top	2009.5±266.9	599.8	142.5	*
	Difend Extra	1327.9±113.3	-81.9	94.2	Ns
	Redigo Pro 170 Fs	1408.1±332.0	-1.7	99.9	Ns
	Bariton Super 97,5	1142.0±151.8	-267.7	81.0	Ns
	Bariton Super 97,5 + Peridiam	1367.7±195.1	-42.0	97.0	Ns
	Celest Super	1465.6±207.6	55.9	104.0	Ns
	Sponsor 6 FS	1057.5±76.4	-352.2	75.0	Ns
	Royal Flo 42S	1362.2±186.4	-46.5	96.7	Ns
	Amiral Proffy 6 FS	2048.4±375.4	638.7	145.3	*
	Amiral Proffy 6 FS +AG40R	1407.5±146.6	-2.2	99.8	Ns
	Difend Extra + Wuxal Terios Mn+	1600.9±211.5	191.2	113.6	Ns
	Control (untreated)	**1409.7±123.4**	**-**	**100.0**	**Cv**

Ns – not significant (P>0.05)
* – significant (P > 0.01)
** – distinctly significant (P > 0.001)
*** – very significant (P < 0.001)

The same situation was observed in the case of the other four wheat crops studied.

In the agricultural year 2020, wheat yields were reduced by at least 50%, but crop losses of up to 70% were observed, as in the case of the Apache variety where the yields obtained were at most 1 t/ha^{-1} (table 3 D]). These results show us that foreign wheat varieties, in critical situations, such as those in 2020, do not rise to the level of local Romanian cultivars in terms of production.

The same situation was observed in the case of the Mulan variety. Although it registered higher yields than the Apache variety, the value of the yields did not approach those registered in the case of the Romanian varieties: Glosa, Miranda and Izvor.

Regarding pesticide products used for seed treatment, it was observed that there are differences in terms of production obtained, but these differences were in few cases statistically assured.

In the case of the Izvor variety, the differences compared to the control variant were not ensured in any of the cases from a statistical point of view.

In the case of the Apache variety, only one variant, represented by the one treated with Royal Flo 42S, was statistically assured, being significant.

Two situations each, where the yield difference was statistically assured, they were identified in the case of Glosa and Mulan cultivars.

In the case of the Mulan variety, both differences were significant, being recorded by the seed treatment do with Biosild Top and Admiral Proffy 6FS.

In the case of the Glosa variety, the differences from the control variant were distinctly significant when the seed treatment was done with Celest Super, respectively very significant, when the seed treatment was done with Sponsor 6FS.

Most statistically assured differences were observed in the case of the Miranda variety. Four situations were observed. In three of them the difference was distinctly significant, and in one situation the differences were significant.

It should be noted that in all cases where the difference in production was statistically assured, the production yield was superior to the control variant.

CONCLUSIONS

Climate elements, such as temperature and atmospheric precipitation, are driving factors in plant development and vary widely between years. Weather factors play a decisive role in achieving higher yields.

The influence of extreme situations caused by extreme weather conditions was strongly observed in 2020.

Due to the lack of atmospheric precipitation, cultivated plants were subjected to severe water stress, which is why the yields were about 50-60% lower than the normal years.

The results obtained in this study show that the Romanian varieties behaved better in these extreme situations, recorded superior yield values compared to foreign varieties. This shows us that in crisis situations, local varieties can lead to satisfactory yields.

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