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Improvement of Physico-chemical Properties of Macaroni Produced from Durum Wheat Cultivars

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ABSTRACT

Due to the interaction between the genotype and the growth environment, the yields of crops cultivars and lines are not the same in different environments. To obtain cultivars adaptable to different areas which have an optimal quality, 36 advanced genotypes were analyzed in two different experiments, including two control cultivars of Karkheh durum wheat and Hamoon bread wheat, in the form of Randomized Complete Block Design (RCBD) in three iterations in the city of Iranshahr as a region to conduct the study in.
Notes were taken from different phases such as growth and development, some morphological traits, the number of days from germination to the emergence of clusters to ripening, plant height, percentage of lodging, and after harvesting, some traits such as the kernel's color, 1000 kernel weight, yellow berry amount, etc. were determined and recorded. One kilogram of each cultivar kernel is sent to the Laboratory of Cereal Chemistry to determine the qualitative traits.
The performance and yield of the cultivars in both experiments were analyzed by variance, and then the results were ranked compared to the average yield of other stations by the Rank Method. Eighteen cultivars were selected from two experiments of ADYT-W and picked up for the final analysis of the adaptability of universal elite lines to the warm and dry climate of the South (ERDYT-W) for the next cropping season.

Keywords: *Yield comparison, advanced genotypes of durum wheat, hot and dry climate.*

INTRODUCTION

The plant breeders have long praised and considered the capability of some durum wheat cultivars that can grow and develop in different environmental conditions. Determining the interactions between the genotype and environment is greatly important for the breeder to prepare and introduce the adaptable and optimal cultivars (4).
Different cultivars do not have the same state in different regions. The amount of interaction between the genotype and environment is little for those genotypes that have multiple combinations of different parents or have survived for many years in different environmental conditions, i.e., the chance to obtain a cultivar that has a lower genotype-environment interaction is higher in the heterogeneous communities. Any cultivar that can neutralize environmental effects has an individual buffering and can show good adaptability to different environments (5).
The genotype-environment interaction has been considered by breeders for many years, and different methods have been developed to determine the state of a variety in different environmental conditions. Wilkinson & Finally, and Russel & Eberhart have suggested some methods for calculating the stability parameters based on the cultivars' regression value (1).

In the method proposed by Eberhart & Russel, the regression coefficient is calculated for each variety or line. The best variety in terms of adaptability is the one with a regression coefficient near one and has a high yield with a low deviation in regression. Another method to calculate the stability parameters based on the SS interaction was proposed by Wrick in the variance analysis Table (3).

In the adaptability investigation studies in terms of grains and the ANOVA and the F-test of the genotype-environment interaction, the simple Rank Method has been used to determine the stability rate of genotypes in different environments. The variety with the lowest average rank and standard deviation and the highest average yield is the most adaptable variety with the highest yield stability.

In the warm climate of the southern regions of the country, some regions do not show the full capacity of bread wheat cultivars production due to environmental stresses, and the modified irrigated durum wheat cultivars have a better yield. In these environments, the durum wheat has better adaptability than the bread wheat and tolerates environmental stresses better (1).

The durum wheat kernel is used to produce macaroni (spaghetti). To meet their raw material (semolina), the macaroni production industries of the country need more than 1 million tons of durum wheat. Optimal-quality products can conquer the markets of northern and southern neighboring countries. The value-added of these products can bring great benefits to the farmers, macaroni manufacturers, and exporters in currency.

In the four climates of the country, the drought and the living and non-living stresses are now common phenomena. Therefore, it is necessary to identify the regions with some stresses in all four climates and develop the durum wheat adaptable to these regions instead of bread wheat (Baluchestan is one of the very dry regions in the country) so that, in addition to the increase in country's wheat production, the value-added of this product can also be exploited in semolina and macaroni products exportation.

Using the experience of countries with environmental stresses such as Spain, Italy (Sicily with Mediterranean climate), Ethiopia, Tunisia, and other North African countries with hot and dry nature and Russia with cold and dry climate can be a good facilitator for our country's farmers (4).

Different breed studies on obtaining high yielding and compatible cultivars of irrigated and dry durum wheat have been carried out in international research centers and various stations in the country for the past years. The denominated cultivars such as Aria, Karkheh, Dena, and the D-79-15 are the results of the investigations during the past fifteen years in Iran (the Simareh and Kuhdasht have also been introduced by the Dry Farming Institution of the Country) (2).

Objective and Significance of the Study:

Durum wheat is the most suitable wheat for semolina production due to its hardness and glassiness, which should be considered for macaroni production. So far, comprehensive studies to recognize durum wheat potentials and state and investigate their qualitative traits for macaroni production have not been conducted in Iran. Currently, first, because the food products such as meat and rice are getting more and more expensive, the use of macaroni as the main food worldwide and especially in Iran is gradually increased, and second, due to the import of different kinds of macaroni products from other countries

which lead to the loss of a great deal of currency. Third, due to the role of diversity in proceeding with the breeding plans, research about the strategic product of durum wheat and its important macaroni product is necessary.

Generally, the total problems of macaroni in Iran are primarily related to flour (raw material). Regarding the necessity of durum wheat cultivation in the country to supply the raw material of the factories and macaroni industries and to prevent the outflow of significant amounts of currency that can lead to the development of the country elsewhere, a complete and comprehensive plan should be prepared for it.

The current study was conducted based on the requirements mentioned above and the objectives the following:

1- Investigation of the electrophoresis and recognition of the studied durum wheat genotypes
2- Investigation of the qualitative traits (physical and chemical) of the studied durum wheat species
3- Investigation of the effects of gluten and gliadin subunits on the qualitative traits of the studied durum wheat species and the macaroni produced by them
4- Determination of the subunits effective in the improvement of qualitative traits of the studied durum species and the macaroni produced by them
5- Determination of the subunits effective in the improvement of qualitative traits of the studied durum species and the macaroni produced by them

Methods and Materials:

In the 2008-2009 farming year, 36 advanced genotypes of durum wheat were selected from among 138 genotypes in the experiments on comparison of the uniform primary yield in the hot and dry climate of the southern regions of the country in the farming year 2007-2008 farming year, were divided into two 18-genotype groups in an experiment with a control group containing Karkheh durum wheat cultivar and a control group containing Hamoon bread wheat. A total of 20 cultivars were investigated in the form of Randomized Complete Block Design (RCBD) in three iterations in the city of Iranshahr, like the research stations in the hot and dry climate of the southern region the country.

Each row consisted of 6 lines of 6 meters at a distance of 20 cm, with crops being planted on two ridges. At harvest time, half a meter from the beginning and end of each row was removed as a margin, and the rest (6 square meters) was harvested, and its grain yield was weighed. Land preparation operations were usual, including plowing, disc, leveling (by leveler), and furrowing. The amounts of required nutrients, including N2, P2O5, and K2O, were 135, 90, and 46 kg, respectively, in which all fertilizers except nitrogen fertilizer are applied to the soil at the time of soil preparation and nitrogen fertilizer in the development stages of stemming, the emergence of the cluster, and granulation in the form of topdressing, spread evenly on the farm. To control broadleaf and narrow-leaf weeds, a mixture of Topic and Granstar herbicides were used at the rate of 1.5 liters and 20 grams per hectare and manual weeding, respectively. The number of seeds per unit area was calculated as 450 seeds per square meter, and the leakage method did sowing and irrigation.

During the growing period, different stages of development (Germination - sprout-tillering - the emergence of stems and cluster), the number of days from cultivation to

the emergence of cluster and ripening, the plant height, cluster length, and lodging rate were recorded. After harvesting, some traits such as the kernel's color, 1000 kernel weight, yellow berry amount, etc., were determined and recorded. Half a kilogram from each genotype of sample grain was sent to the Cereal Chemistry Laboratory to determine their qualitative traits. After the analysis, the samples were categorized in terms of the qualitative traits for semolina production.

After harvesting the weighing the grain yield, the yield of the cultivars was recorded, and the obtained results were separately analyzed by variance. Also, the average amount of cultivars was compared to the results obtained from other stations using the Rank Method. Among 36 genotypes studied, 18 more adaptable genotypes and higher yields than other control cultivars and species were selected to be tested in the nest year ERDYT-W experiments for two years, based on the farm's records the qualitative results from the Cereal Chemistry Laboratory.

Results and Discussion:

The records about the days required for the emergence of cluster and physical ripening, plant height, kernel color, and 1000 kernel weight were evaluated. The use of the LSD Method compared the mean values, and the cultivar yield percentage was compared to that of the control group of durum wheat. The results of these experiments are presented in tables 1 and 4.

The results of the ADYT-W1 experiment can be seen in Table 1. Among the studied cultivars in grain yield, this cultivar had a significant superiority with a probability rate of 1%, compared to the Karkheh control cultivar. The cultivar No.6 was placed in Class A with a 20% yield increase (near 1400Kg per hectare). The cultivars Nos. 2 and 11 showed a 17% yield increase with 7.987 and 8.021 tons per hectare and were ranked in Class B, compared to the Karkheh cultivar. Lines Nos. 8, 9, and 14 were placed in Class D, with a 16, 18, and 17% yield decrease compared to the Karkheh cultivar. Other cultivars were ranked in Class Control, even with an 11% increase and 13% decrease in yield. The lowest and highest yields belonged to cultivars No. 9 and No.6, respectively (5.576 and 8.215 t/ha).

Table 2 indicates the results obtained from the ADYT-W2 experiment in Iranshahr. It is seen that there is a 5% significance level among the genotypes in terms of grain yield among the cultivars studied compared to the control cultivar. The cultivar No.8 has shown a yield decrease with a 95% probability compared to the Karkheh control cultivar. However, cultivars Nos. 3, 2, 4, 9, 10, 11, and 13 have had a yield increase by 14, 7, 11, 5, 6, 4, and 5%, respectively. It should be noted that cultivar No.4 ha had the highest yield with 7.271 t/ha, and cultivar No.8 had the lowest yield with 5.049 t/ha. Other cultivars' yields did not significantly differ from the control cultivar, and all of them were placed in Class C.

The data obtained from the experiment ADYT-W1 ranking are shown in Table 3. Based on the qualitative analyses in the Cereal Chemistry Laboratory and the farm records, and most important of all, the YIR column percentage, it can be seen that cultivars Nos. 2, 3, 4, 7, 6, 11, 9, 8, 12, 15, and 18 all showed a yield increase compared to the population's mean yield, and were selected for EDYT-w(D-88) experiment for the investigation of adaptability of next year's promising lines. As seen in the table, among the regions

studied, the mean yields of the experiment cultivars have been higher in Iranshar, only after Zabol.

The data obtained from the ADYT-W2 experiment ranking can be seen in Table 4. Based on the qualitative analysis results in the Cereal Chemistry Laboratory and the farm records, the YIR column percentage, only eight cultivars showed a better yield than the population means to yield. Cultivars Nos. 2, 7,8, 9, 12, 11, 17, and 1 all showed a yield increase compared to the population mean yield and were selected for the EDYT-W(D-88) experiment for the investigation of adaptability of next year's promising lines. As seen in the experiment's cultivars' mean yield (except for cultivar No. 8), Iranshahr's mean yields were higher than all regions studied.

Based on this project's tables and the results obtained from other regions, it seems that due to the non-living environmental stresses, the cultivation of durum wheat in Sistan and Baluchesatn would be more successful and end in better yields than the bread wheat.

Table 1:

Station: Iranshahr Year : 1387-88 (2008-09) Plot size:6 m2 Test:ADYTW-1

Plot no.	Pedigree	Diseases				DHE	DMA	PLH	Lodg	K.C.	TKW	YLD	%Ch.	Class
		YR	LR	BYDV	PM			(cm)	(%)		(gr)	(t/ha)		
1	Karkhe(Check1)	O	O	O	O	93	95	85	O	Am	48	6.626	100	C
2	Bread wheat (check 2)chamran	O	O	O	O	97	95	100	O	W	40	7.986	117	B
3	RCOL/THKNEE_2	O	O	O	O	96	95	85	O	Am	52	7.486	110	C
4	STOT//ALTAR 84/ALD/3/GREEN_18/FO..	O	O	O	O	92	95	85	O	Am	48	6.632	97	C
5	CAMAYO/LLARETA INIA//CADO/BO..	O	O	O	O	93	95	95	O	Am	40	6.583	96	C
6	GUAYACAN INIA/GUANAY/3/BOOMER ...	O	O	O	O	91	95	90	O	Am	48	8.215	120	A
7	AINZEN_1/6/CMH82A.1062/3/GGO/Z394/..	O	O	O	O	91	95	90	O	Am	52	6.250	92	C
8	AINZEN_1/3/MINIMUS_6/PLATA_16...	O	O	O	O	89	95	80	O	Am	56	5.736	84	D
9	BCR/GUERO/U_1//PLATA_6/GREEN_17	O	O	O	O	85	95	95	O	Am	56	5.576	82	D
10	CF4-JS 40/3/STOT//ALTAR 84/ALD	O	O	O	O	97	95	85	O	Am	44	6.583	96	C
11	ALTAR 84/STINT//SILVER_45/3/LLA...	O	O	O	O	93	95	105	O	Am	44	8.021	117	B
12	AINZEN_1/3/SN TURK MI83-84 503/LO...	O	O	O	O	89	95	95	O	Am	56	6.785	99	C
13	ALTAR 84/BINTEPE 85/3/AJAIA_12...	O	O	O	O	90	95	90	O	Am	52	6.972	102	C
14	ALTAR 84/STINT//SILVER_45/3/POHO...	O	O	O	O	90	95	80	O	Am	52	5.639	83	D
15	GUAYACAN INIA//YUAN_1/GREEN_18/...	O	O	O	O	88	95	90	O	Am	56	7.556	111	C
16	ANADE_1/GREEN_2//GAUNT_10	O	O	O	O	89	95	90	O	Am	52	6.722	98	C
17	GAUNT_10/SNITAN	O	O	O	O	91	95	90	O	Am	44	6.813	100	C
18	LLARETA INIA/YEBAS_6/3/MINIMUS...	O	O	O	O	91	95	85	O	Am	36	6.951	102	C
19	SRN_3/AJAIA_15//DUKEM_1/3/DION_2/4...	O	O	O	O	92	95	90	O	Am	40	6.313	92	C
20	STOT//ALTAR 84/ALD	O	O	O	O	91	95	85	O	Am	44	5.938	87	C

LSD 5%= 0.995t/ha LSD 1%= 1.333 t/ha C.V.=8.88 %

Table 2:

Station: Iranshahr **Year : 1387-88 (2008-09)** **Plot size:6 m^2** **Test:ADYTW-2**

Plot no.	Pedigree	Diseases				DHE	DMA	PLH	Lodg	K.C.	TKW	YLD	%Ch.	Class
		YR	LR	BYDV	PM			(cm)	(%)		(gr)	(t/ha)		
1	Karkhe(Check1)	O	O	O	O	90	118	100	O	Am	52	6.576	100	C
2	Bread wheat (check 2)chamran	O	O	O	O	93	119	100	O	W	44	7.521	114	C
3	ALTAR 84/STINT//SILVER_45/4/SKES..	O	O	O	O	87	115	90	O	Am	56	7.056	107	C
4	SNITAN/3/STOT//ALTAR 84/ALD	O	O	O	O	91	117	100	O	Am	44	7.271	111	C
5	GUAYACAN INIA/GUANAY//CRAKE...	O	O	O	O	91	117	95	O	Am	48	6.243	95	C
6	CBC 509 CHILE/SOMAT_3.1//WODUCK...	O	O	O	O	90	115	85	O	Am	44	6.000	91	C
7	CBC 509 CHILE/4/SKEST//HUI/TUB/3/S...	O	O	O	O	90	117	80	O	Am	48	6.368	97	C
8	GUAYACAN INIA/YEBAS_8/3/TOPDY_..	O	O	O	O	90	117	100	O	Am	56	5.049	77	D
9	AINZEN_1//HYDRANASSA30/SILVER..	O	O	O	O	91	117	100	O	Am	56	6.931	105	C
10	ALTAR 84/STINT//SILVER_45/3/CAMA..	O	O	O	O	91	117	90	O	Am	56	7.000	106	C
11	LLARETA INIA/SOMAT_4//SNITAN	O	O	O	O	90	118	90	O	Am	48	6.633	104	C
12	DUIKEM_1//PATKA_7/YAZI_1/3/PA...	O	O	O	O	90	118	85	O	Am	44	6.479	99	C
13	USDA595/3/D67.3/RABI/CRA/4/ALO/5/HUI/YAV...	O	O	O	O	93	120	95	O	Am	44	6.924	105	C
14	ADAMAR_15//ALBIA_1/ALTAR 84/3/..	O	O	O	O	93	120	80	O	Am	48	5.606	88	C
15	PLATA_7//FILLO_9//PLATA_21/3/GREEN..	O	O	O	O	89	117	90	O	Am	48	5.889	90	C
16	STOT//ALTAR 84/ALD/3/SNITAN	O	O	O	O	91	115	95	O	Am	48	6.000	91	C
17	SOMO/CROC_4//LOTUS_1/3/KITTI/4/..	O	O	O	O	91	117	95	O	Am	52	6.083	93	C
18	CMH92A.1062/3/GGO/VZ394//SIBA81/PLC/4/AAZ_...	O	O	O	O	91	117	90	O	Am	44	6.438	98	C
19	STOT//ALTAR 84/ALD	O	O	O	O	91	118	90	O	Am	44	5.861	89	C
20	BD2338/3/AUK/GUIL//GREEN/4/STOT//..	O	O	O	O	93	120	100	O	Am	42	6.688	102	C

LSD 5%=1.220 t/ha **LSD 1%= 1.634t/ha** **C.V.=11.44 %**

Table 3:

Örgütsel Davranış Araştırmaları Dergisi
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Summary of results for ADYTW-1, 1387-88(2008-09)

Ent.no.	Pedigree	Yield (t/ha)						MeanYLD (t/ha)	Mean R	SDR	YIR (%)
		Khorramabad	Dezful	Ahvaz	Darab	Zabol	Iranshahr				
1	Karkhe(Check1)	5.297	5.900	3.335	6.056	6.803	6.826	5.703	14.3	4.320	94
2	Bread wheat (check 2)	6.644	6.414	3.998	5.787	8.920	7.986	6.625	7.3	6.713	109
3	RCOL/THKNEE_2	6.097	6.544	4.918	7.590	8.418	7.486	6.842	4.3	3.670	113
4	STOT//ALTAR 84/ALD/3/GREEN_18/FO..	6.328	6.678	4.249	5.929	8.047	6.632	6.311	8.2	4.665	104
5	CAMAYO/LLARETA INIA//CADO/BO..	6.075	5.266	4.368	6.157	6.822	6.583	5.885	12.4	4.055	97
6	GUAYACAN INIA/GUANAY/3/BOOMER_...	6.206	5.133	4.376	7.003	8.053	8.215	6.498	6.8	6.113	107
7	AINZEN_1/6/CMH82A.1062/3/GGOVZ394/..	5.033	5.308	4.917	6.477	7.023	6.250	5.835	11.7	6.976	96
8	AINZEN_1/3/MINIMUS_6/PLATA_16...	6.242	6.586	4.194	6.186	7.762	5.736	6.118	8.8	4.896	101
9	BCR/GUEROU_1//PLATA_6/GREEN_17	4.517	4.544	4.187	6.272	7.068	5.576	5.361	14.5	6.442	88
10	CF4-JS 40/3/STOT//ALTAR 84/ALD	6.619	6.175	3.063	6.241	7.515	6.583	6.033	10.9	5.535	99
11	ALTAR 84/STINT//SILVER_45/3/LLA...	6.769	5.111	3.985	4.696	8.323	8.021	6.151	10.0	8.649	101
12	AINZEN_1/3/SN TURK MI83-84 503/LO...	6.114	6.319	5.799	5.900	7.535	6.785	6.409	9.0	4.899	105
13	ALTAR 84/BINTEPE 85/3/AJAIA_12...	5.986	5.536	3.864	5.668	6.965	6.972	5.832	13.8	4.355	96
14	ALTAR 84/STINT//SILVER_45/3/POHO...	5.350	6.289	3.911	5.812	7.010	5.639	5.669	15.0	3.847	93
15	GUAYACAN INIA//YUAN_1/GREEN_18/...	6.922	5.433	4.392	6.302	7.703	7.556	6.385	6.0	4.517	105
16	ANADE_1/GREEN_2//GAUNT_10	6.194	5.403	3.441	6.163	6.192	6.722	5.686	13.5	4.550	94
17	GAUNT_10/SNITAN	5.672	7.169	3.999	6.156	6.677	6.813	6.081	11.2	5.981	100
18	LLARETA INIA/YEBAS_8/3/MINIMUS...	5.783	6.586	4.601	6.256	8.257	6.951	6.406	6.6	4.341	105
19	SRN_3/AJAIA_15//DUKEM_1/3/DION_2/4...	6.519	5.917	4.118	6.027	6.675	6.313	5.928	12.3	4.676	97
20	STOT//ALTAR 84/ALD	6.058	6.250	3.435	5.984	7.604	5.938	5.878	13.3	3.830	97

Grand mean =6.081 t/ha

Table 4:

Summary of results for ADYT W-2, 1387-88(2008-09)

Ent.no.	Pedigree	Yield (t/ha)						MeanYLD (t/ha)	Mean R	SDR	YIR (%)
		khorramabad	Dezful	Ahvaz	Darab	Zabol	Iranshshr				
1	Karkhe(Check1)	5.719	6.483	4.320	5.898	5.305	6.576	5.717	13.3	3.615	96
2	Bread wheat (check 2)	7.703	6.836	4.186	5.297	7.440	7.521	6.497	7.2	8.305	109
3	ALTAR 84/STINT//SILVER_45/4/SKES..	5.869	5.764	4.703	6.760	4.093	7.056	5.708	10.8	6.882	96
4	SNITAN/3/STOT//ALTAR 84/ALD	5.844	5.225	3.694	6.261	5.730	7.271	5.671	13.5	7.036	95
5	GUAYACAN INIA/GUANAY//CRAKE…	5.636	5.203	4.392	5.897	6.750	6.243	5.687	13.0	6.066	96
6	CBC 509 CHILE/SOMAT_3.1//WODUCK…	6.089	6.572	4.153	5.809	6.097	6.000	5.787	13.1	3.105	97
7	CBC 509 CHILE/4/SKEST//HUI/TUB/3/S…	6.492	7.022	5.275	6.221	6.310	6.368	6.281	6.7	3.777	105
8	GUAYACAN INIA/YEBAS_8/3/TOPDY_..	5.919	7.350	5.042	6.918	6.002	5.049	6.047	9.2	7.333	102
9	AINZEN_1//HYDRANASSA30/SILVER..	6.397	6.189	4.777	5.830	5.817	6.931	5.990	10.0	4.561	101
10	ALTAR 84/STINT//SILVER_45/3/CAMA..	5.331	6.147	4.085	6.553	6.252	7.000	5.895	11.2	6.494	99
11	LLARETA INIA/SOMAT_4//SNITAN	6.528	5.708	4.963	6.148	7.312	6.833	6.249	8.0	5.550	105
12	DUKEM_1//PATKA_7/YAZI_1/3/PA…	6.344	6.631	5.246	5.771	6.198	6.479	6.112	8.7	4.761	103
13	USDA595/3/D67.3/RABI//CRA/4/ALO/5/HUI/YAV_1/6/A..	7.600	7.406	4.189	6.778	6.082	6.924	6.497	6.5	5.683	109
14	ADAMAR_15//ALBIA_1/ALTAR 84/3/..	6.106	7.097	4.324	6.458	6.087	5.806	5.980	10.5	5.394	100
15	PLATA_7/FILLO_9//PLATA_21/3/GREEN..	5.914	6.597	5.319	5.597	5.182	5.889	5.750	12.5	7.148	97
16	STOT//ALTAR 84/ALD/3/SNITAN	6.303	6.589	3.767	7.084	5.337	6.000	5.847	11.4	6.888	98
17	SOMO/CROC_4//LOTUS_1/3/KITTI/4/..	6.667	6.219	4.463	6.222	6.638	6.083	6.049	8.3	4.179	102
18	CMH82A.1062/3/GGOVZ394//SBA81/PLC/4/AAZ_1/CRE..	5.036	5.881	5.172	5.472	6.120	6.438	5.687	13.0	6.000	96
19	STOT//ALTAR 84/ALD	6.281	5.803	4.104	6.534	6.427	5.861	5.835	11.7	5.715	98
20	BD2338/3/AUK/GUIL//GREEN/4/STOT//..	5.864	5.442	4.339	6.172	6.330	6.688	5.806	11.5	4.416	98

Grand mean =5.954 t/ha

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