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ADAPTIVE POTENTIAL OF MAIZE HYBRIDS OF FAO GROUPS 190-500 IN THE SOUTHERN OF UKRAINE

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Introduction. Corn on the potential catch exceeds all crops. In addition, it is highly resistant to drought and provided basic optimization techniques in agriculture, are capable of forming stable operation even without irrigation. When growing corn on irrigated land and without irrigation main factors affecting the increasing yield is nutrients and hybrids [1–3].

The study of eight new hybrids of maize held with irrigation and without irrigation because of the need to improve technological methods of growing corn hybrids adaptability and determination of patterns in soil and environmental and technological conditions of cultivation in southern Ukraine. Scheme experiment included the introduction of fertilizers in irrigated conditions. It is known that the humidity mode optimization increases crop productivity by 2-5 times. [4−8].

The aim of the work was to determine optimal doses of mineral fertilizers taking into consideration biological specificities of new maize hybrids of different FAO groups in irrigation conditions of the southern Ukraine and to trace their impact on the formation of grain productivity of plants.

Materials and Methods. The field method was used to study the interaction of the investigated object and both experimental and environmental factors using the registration of the yield volume and biometric measurements; the laboratory method was used to determine soil humidity, humidity content in grain and quality indices of grain; the statistical method was used to estimate the reliability of the results obtained; and the computational method was used in economic and energetic estimation of the employed cultivation techniques.

Results and Discussion. The studies were carried out in 2011–2013 on the experimental field of the Institute of Irrigated Agriculture NAAS of Ukraine, located in the south of Ukraine in the zone of the Ingulets irrigated area. The soil of the experimental plot was dark-chestnut, medium loam, weakly alkaline, the water table was deep.

The following factors were used in the experiments: A − maize hybrids, differing by FAO groups – Tendra, Kvitnevyy 187 MV, Syvash, Orzhytsia 237 MV, Azov, Krasyliv 357 MV, Sokolov 407 MV, Bystrytsia 400 MV; B − irrigation and no irrigation; C – fertilizers and no fertilizers (recommended dose of mineral fertilizers for the zone of experiments − $N_{150}P_{90}$ and the estimated dose − $N_{240}P_0$). The experiments were repeated four times with the location of variants by the method of randomized split plots. The area of the plot for sowing − 84.0 sq.m., the area for registration – 51.2 sq.m..

The agrotechnology of cultivating maize, used in the experiments, was common for the southern zone of Ukraine. The predecessor plant was soybean. The watering was carried out according to the scheme of the experiment by the raining method.

The mineral fertilizers (factor C) were introduced as follows: ammonia nitrate (N – 34 %) – during presowing harrowing; granular superphosphate (P – 20 %) – during autumn plowing, performed at the depth of 27–30 cm. The estimated dose of fertilizers $N_{240}P_0K_0$ was determined by the optimum parameters method as the difference between the yield carry-over and the actual content of nutritive elements in the soil [9].

Maize hybrids were sown in the first decade of May when the soil temperature at the depth of sowing the seeds was 12−14 °C.

The sowing, carrying out of the experiments, selection of soil and plant samples, their preparation for the analysis were conducted according to methodological instructions and DSTU.

Maize belongs to drought-resistant crops (mesophytes). However, the deficiency of moisture in the soil is a serious factor, limiting the yield of maize grain. The extreme weather conditions, frequently observed in the southern steppe of Ukraine (dry hot winds, high temperature, deficiency of productive moisture) have negative impact on the growth and development of these plants and decrease the efficiency of the fertilizers introduced.

In our experiments the plantings of maize were irrigated by vegetative watering, keeping the humidity at the level of 75 % from the least moisture-retention capacity in the soil layer of 0–70 cm.

Noteworthy is the index of the recoupment of the irrigation water by additionally obtained yield of grain due to irrigation (Table 1).

During three years of studies of all the hybrids with vegetative watering without fertilizers, on average this index was 2.65 kg/m^3; on the background of using the recommended dose of the mineral fertilizer − $N_{150}P_{90}$ – it increased up to 4.37 kg/m^3, and using the estimated dose – $N_{240}P_0$ − up to 4.83 kg of grain per 1 m^3 of water. The abovementioned testifies to the reasonability of introducing mineral fertilizers while cultivating crops, maize in particular, on irrigated lands.

The results of the registration demonstrated that on condition of irrigation the mineral fertilizers induced the productivity of the investigated hybrids on average from 40.3 to 74.3 % during 2011–2013 (Table 2). This increase was in direct proportion to the dose of the introduced nitrogen fertilizers.

The data of Table 2 confirm the tendency of grain yield surplus in all the groups of hybrid ripening depending on the irrigation and mineral dose of fertilizers (both recommended and estimated doses).

The maximal yield of maize grain was observed on the background of irrigation and introduction of the estimated dose of mineral fertilizers – on average during the years of studies of all the hybrids it is 12.71 t/ha, and in 2013 the yield of grain was 12.78 t/ha. In case of introducing the recommended dose of fertilizer $N_{150}P_{90}$ the yield was somewhat lower, amounting to 11.72 and 11.85 t/ha, respectively, which is 8.4 and 7.9 % less. The irrigation with no fertilizers had different effect on the yield level of maize grain – the surplus for hybrids of early-ripening group was rather considerable, during three years of studies it amounted to 210 % on average.

Table 1. – The recoupment of the irrigation water due to the grain yield surplus, kg/m^3 (average for 2011–2013 yy.).

Hybrid	FAO	Recoupment of irrigation water		
		Due to irrigation	Due to irrigation and recommended dose of fertilizers $N_{150}P_{90}$	Due to irrigation and estimated dose of fertilizers $N_{240}P_0$
Tendra	190	1.91	3.54	3.80
Kvitnevyy 187 MV	190	1.66	3.32	3.54
Syvash	250	1.99	3.10	4.11
Orzhytsia 237 MV	280	2.39	3.80	4.31
Azov	350	3.57	4.47	4.89
Krasyliv 357 MV	352	2.46	5.24	5.65
Sokolov 407 MV	420	2.91	5.05	5.67
Bystrytsia 400 MV	420	3.31	5.08	5.63

Generally, the yield surplus of maize grain after the irrigation increased from 38.2 % in favorable 2011 to 600.7 % in dry 2012. The highest index was demonstrated while cultivating mid-ripening hybrid Azov, the productivity of which due to irrigation for three years was on average 3.3 times higher than the absolute control with no irrigation.

The protein content in maize grain changes under the impact of fertilizers, irrigation and biological specificities of hybrids (Fig. 1). Compared to the cultivation with neither fertilizers nor irrigation, the protein content is somewhat decreased under the impact of irrigation, fluctuating in the range of 7.63–8.19 and 7.80–8.47 %. During three years of cultivation the amount of protein in grain for all the hybrids (with neither fertilizers nor irrigation) was 8.06 % on average, and with irrigation – 7.89 %.

In case of irrigation the mineral fertilizers increased the protein content in the maize grain considerably. While during the years of studies the protein content in grain was 7.89 % on average when cultivating maize hybrids with no fertilizers, in case of introducing the recommended dose of fertilizers its concentration was 8.77 %, and with the estimated dose – 8.92 %.

The determination of conditional yield of protein, starch and oil from the unit of area revealed its changes depending on the ripening groups of maize hybrids (Fig. 2) and its considerable increase under the influence of mineral nutrition.

Table 2. – Grain yield of maize hybrids depending on doses of mineral fertilizers and irrigation, t/ha

Hybrid (B)	No irrigation (A)				Irrigation (A)											
	No fertilizers (C)				No fertilizers (C)				$N_{150}P_{90}$ (C)				Calculated dose (C)			
	2011	2012	2013	Average	2011	2012	2013	Average	2011	2012	2013	Average	2011	2012	2013	Average
Early-ripening																
Tendra	5.42	1.42	2.96	3.27	6.39	7.83	7.03	7.08	9.48	11.02	10.52	10.34	10.14	11.51	10.96	10.87
Kvitnevyy 187 MV	5.39	1.38	2.83	3.20	6.02	6.91	6.62	6.52	9.13	10.57	10.09	9.93	9.46	10.93	10.41	10.27
Mid-ripening																
Syvash	4.05	1.47	3.94	3.15	6.47	7.67	7.23	7.12	8.48	10.08	9.50	9.35	10.34	12.16	11.58	11.36
Orzhytsia 237 MV	5.12	1.4	3.64	3.39	7.54	8.70	8.26	8.17	10.18	11.60	11.16	10.98	11.34	12.64	12.04	12.01
Mid-ripening																
Azov	5.43	1.87	2.08	3.13	9.83	10.72	10.26	10.27	10.87	12.96	12.39	12.07	11.98	13.84	12.90	12.91
Krasyliv 357 MV	6.21	1.98	2.83	3.67	7.88	9.20	8.68	8.59	13.50	14.76	14.16	14.14	14.53	15.42	14.97	14.97
Middle-late																
Sokolov	6.87	1.23	2.35	3.48	8.85	9.75	9.29	9.3	12.92	14.23	13.57	13.57	14.01	15.53	14.93	14.82
Bystrytsia 400 MV	6.56	1.11	2.02	3.23	9.26	10.34	9.91	9.84	12.73	14.06	13.39	13.39	13.84	15.16	14.44	14.48

Note**.** HIP_{05}, t/ha A – 0.72; AB – 0.77; ABC – 0.85; B – 0.38; AC – 0.81; C − 0.54; BC – 0.49.

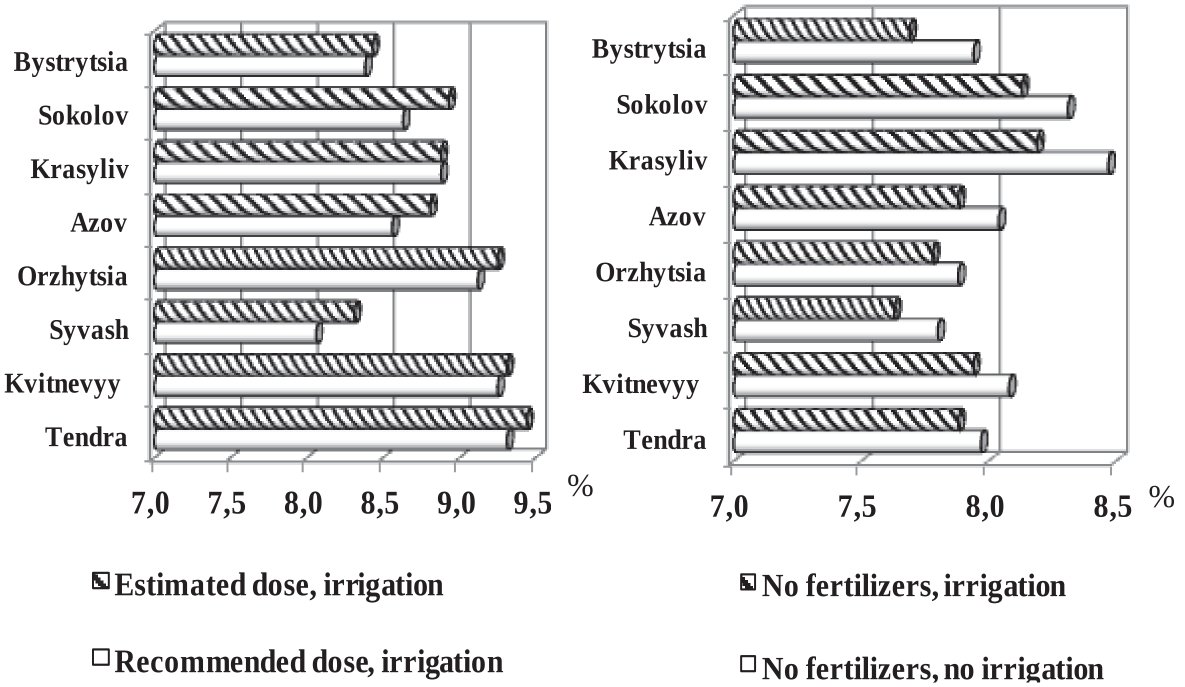

Fig. 1. The impact of investigated factors on the protein content (%) in the maize grain of hybrids of different ripening groups (average for 2011–2013)

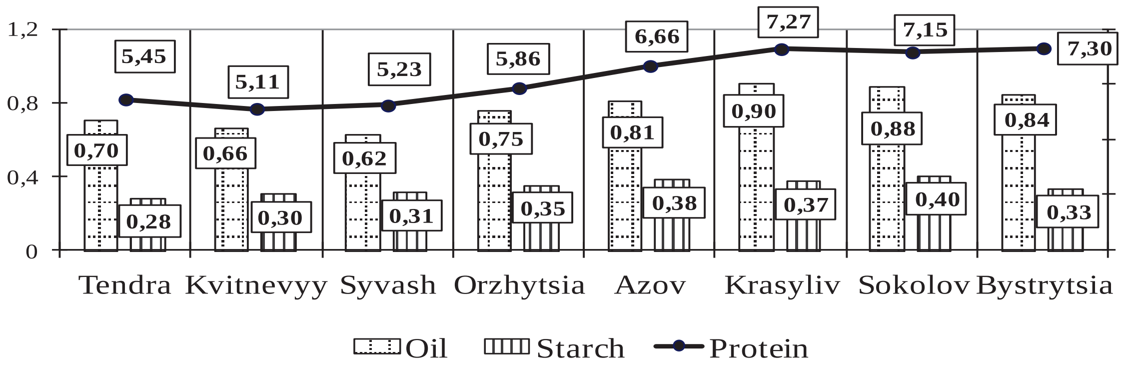

Fig. 2. The conditional yield (t/ha) of protein, oil and starch from the unit of area (average values for the investigated maize hybrids for 2011–2013).

The economic efficiency of the applied technology elements was determined with the purpose of objective grounding of the most rational combination of measures in agriculture. The general norms of performance, prices for manual and automated labor were accepted pursuant to the recommended production standards.

Grain was used in the calculations as the main kind of products while determining the cost of gross production from 1 ha. It was determined that the cost of the products obtained while cultivating maize changes with the regularity, observed for the culture productivity (Table 3).

The estimation of economic efficiency revealed that in case of cultivating the investigated hybrids with neither irrigation nor fertilizers the production costs were 2.0–2.8 times less compared to the ones, incurred with the introduction of the mentioned factors to technological ways of maize cultivation. The maximal expenses (12,528–12,972 UAH/ha) were incurred in case of irrigation and introduction of the recommended dose of the mineral fertilizer. With the introduction of the estimated dose the expenses were reduced, which is related to the reduction in expenses for phosphoric fertilizers.

The highest net profit in the experiment regardless of irrigation was demonstrated by mid-ripening hybrid Krasyliv 357 MV. It had the maximal values among all the hybrids in case of the estimated dose of fertilizers. Compared to the variants with neither fertilizers nor irrigation, the vegetative watering induced 1.7-fold increase in the net profit for hybrids on average. On the background of irrigation, due to fertilizers it increased by 52.5 % with the recommended dose of fertilizers, and by 88.9 % – with the estimated dose.

In 2013 due to the low purchase value of maize grain the net profit index for all the variants of the experiment was lower than the average indices for many years.

For instance, the highest profit – 6,859.2 UAH/ha – was obtained from Krasyliv hybrid 357 MV and the introduction of the estimated dose of fertilizers which was 2.2 times lower than the average value for three years. High profit was also obtained from hybrids Bystrytsia 400 MV and Sokolov 407 MV.

Quite a different situation was observed while determining the profitability level of cultivating maize hybrids. On average for the years of studies with neither fertilizers nor irrigation it was 132.1 % for all the hybrids, and in 2013 – 39.2 %. With vegetative watering this index decreased to 69.0 and 24.5 % respectively, which is related to the cost of the irrigation water and expenses for vegetative watering. In case of using the recommended dose of fertilizer $N_{150}P_{90}$ the profitability level increased up to 69.7 % compared to the plots with no fertilizers, and in case of introducing the estimated dose of the mineral fertilizer – up to 88.8 %.

Table 3. – Economic efficiency of cultivating maize hybrids of different ripening groups depending on the conditions of irrigation and the nutritious background in 2011-2013 yy.

Factor A	Factor B	Factor C	Yield, tons/ha	Cost of products, UAH/ha	Net profit, UAH/ha	Profit-ability, %
Tendra	No irrigation	No fertilizers	2.96	38480	1201	45.4
Kvitnevyy			2.83	36790	1036	39.2
Syvash			3.94	5122	2488	94.5
Orzhytsia			3.64	4732	2082	78.6
Azov			2.08	2704	77	2.9
Krasyliv			2.83	3679	1016	38.1
Sokolov			2.35	3055	410	15.5
Bystrytsia			2.02	2626	-3	-0.1
Tendra	Irrigation	No fertilizers	7.03	9139	141	1.6
		$N_{150}P_{90}$	10.52	13676	1010	8.0
		$N_{240}P_0$	10.96	14248	1973	16.1
Kvitnevyy 187 MV		No fertilizers	6.62	8606	-299	-3.4
		$N_{150}P_{90}$	10.09	13117	544	4.3
		$N_{240}P_0$	10.41	13533	1298	10.6
Syvash		No fertilizers	7.23	9399	403	4.5
		$N_{150}P_{90}$	9.50	12350	-179	-1.4
		$N_{240}P_0$	11.58	15054	2688	21.7
Orzhytsia 237 MV		No fertilizers	8.26	10738	1623	17.8
		$N_{150}P_{90}$	11.16	14508	1871	14.8
		$N_{240}P_0$	12.04	15652	3243	26.1
Azov		No fertilizers	10.26	13338	3957	42.2
		$N_{150}P_{90}$	12.39	16107	3273	25.5
		$N_{240}P_0$	12.90	16770	4306	34.5
Krasyliv 357 MV		No fertilizers	8.68	11284	2146	23.5
		$N_{150}P_{90}$	14.16	18408	5436	41.9
		$N_{240}P_0$	14.97	19461	6859	54.4
Sokolov 407 MV		No fertilizers	9.29	12077	2831	30.6
		$N_{150}P_{90}$	13.57	17641	4712	36.4
		$N_{240}P_0$	14.93	19409	6823	54.2
Bystrytsia 400 MV		No fertilizers	9.91	12883	3601	38.8
		$N_{150}P_{90}$	13.39	17407	4490	34.8
		$N_{240}P_0$	14.44	18772	6208	49.4

It is noteworthy that while cultivating maize hybrids with longer vegetation period the profitability was at a considerably higher level, and the cost of production per one production unit was reduced.

Conclusions. To obtain maize grain yield at the level of 11–14 t/ha with the irrigation of dark-chestnut soil of the southern Ukraine, it is reasonable to introduce the estimated dose of the mineral fertilizer, which is defined by the difference between the required amount of nutritious elements for the formation of productivity of the desired level and their content in the soil of a particular plot. It is also reasonable to use maize hybrids of mid-ripening and middle-late groups – Azov, Krasyliv 357 MV, Sokolov 407 MV, Bystrytsia 400 MV.

The hybrids of early-ripening and mid-ripening groups – Tendra, Kvitnevyy 187 MV, Syvash, Orzhytsia 237 MV, capable of better utilization of the moisture of soil resources and forming higher yield, – should be used when cultivating maize with no irrigation.

REFERENCES:

1. Стратегічні напрями розвитку сільського господарства України на період до 2020 року / за ред. Ю.О. Лупенка, В.Я. Месель-Веселяка. – К.: ННЦ "ІАЕ", 2012. – 182 с.
2. Troyer A.F. Background of U.S. hybrid corn: II. Breeding, climate, and food / A.F. Troyer // Crop Science. – 2004. – Vol. 44, №2. – P. 370-380.
3. Писаренко В.А. Науково-практичні аспекти формування режимів зрошення гібридів кукурудзи різних груп стиглості в умовах півдня України / [Писаренко В.А., Лавриненко Ю.О., Коковіхін С.В., Писаренко П.В.] // Зрошуване землеробство: Зб. наук. праць. – Херсон: Айлант, 2008. – Вип. 50. – С. 23-31.
4. Saracoglu, K. Saracoglu, B. Aylu and V. Fidan, "Influence of Integrated Nutrients on Growth, Yield and Quality of Maize (Zea mays L.)," American Journal of Plant Sciences, Vol. 2 No. 1, 2011, pp. 63-69.
5. M. Rasheed, H. Ali and T. Mahmood, "Impact of Nitrogen and Sulfur Application on Growth and Yield of Maize (L.Zea mays) Crop," Journal Research of Science, Vol. 15, No. 2, 2004, pp. 153-157.

6. M.J. Malakouti, “The Effect of Micronutrients in Ensuring Efficient Use of Macronutrients,” Turkish Journal of Agriculture, Vol.32, No.3, 2008, pp. 215-220.
7. Calvino P.A., Andradeb F.A., Sadrasb V.O. Maize Yield as Affected by Water Availability, Soil Depth, and Crop Management // Agronomy Journal. – 2003. – Vol. 95. No 2. – P. 275-281.
8. P. Barlog and K. Frckowiak-Pawlak, “Effect of Mineral Fertilization on Yield of Maize Cultivars Differing in Maturity Scale,” Acta Sci. Pol. Agricultura, Vol. 7, No. 5, 2008, pp. 5-17.
9. Гамаюнова В.В. Определение доз удобрений под сельскохозяйственные культуры в условиях орошения / В , И.Д. Филипьев // Вісник аграрної науки. Вип. 5. - 1997. - С.15-19.

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ЕКОЛОГО-ГЕОГРАФІЧНІ ВІДМІННОСТІ СОРТІВ ЯЧМЕНЮ ОЗИМОГО ЗА АДАПТИВНІСТЮ ТА КОМПЛЕКСОМ ОЗНАК

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Постановка проблеми. Селекційно-генетичний інститут входить до складу установ Системи генетичних ресурсів рослин України і має лабораторію генетичних ресурсів, головним завданням якої є постійне збагачення генофонду зернових культур за рахунок інтродукційних надходжень, оцінки та виділення потенційно цінних зразків, пошуку джерел та донорів господарсько-цінних ознак з метою їх оптимального поєднання в нових сортах [1]. Поповнення колекції лабораторії проводиться при тісній співпраці з науково-дослідними установами, що ведуть селекцію зернових культур - як з України, так і з країн близького та далекого зарубіжжя. Інтродуковані з-за кордону зразки проходять карантинну перевірку і первинне вивчення в карантинному розсаднику СГІ - НЦНС.

Стан вивчення проблеми. На півдні та заході України серед посівів зернових культур значне місце займає ячмінь озимий. Він характеризується скоростиглістю, високою продуктивністю, поживною якістю зерна. За врожайністю ячмінь озимий перевищує ярий, проте серйозною перешкодою в одержанні стабільних врожаїв зерна і розширення площ посіву є його недостатня зимостійкість. Численні спостереження показують, що зрідження посівів цієї культури найчастіше відбувається через вимерзання. За твердженням академіка А.А. Лінчевського [2], втрати врожаю ячменю озимого від вимерзання більш суттєві, ніж від захворювань, шкідників та бур'янів, разом взятих.

Генетичний пул ячменю озимого за морозостійкістю дуже обмежений [3] і тому головне завдання селекціонерів, генетиків, фізіологів в селекції ячменю озимого - добирати стійкі генотипи.

В умовах інтенсивного землеробства ще однією важливою проблемою злаків взагалі, а ячменю озимого – в особливій мірі є створення сортів, стійких до вилягання [4].

Завдання і методика досліджень. Метою дослідження був пошук у колекціях ячменю озимого потенційних донорів важливих господарсько-цінних ознак для використання в селекційних програмах.

Польові досліди з ячменем проведені у 2013 та 2014 рр., відповідно. Вони є частиною проведеного нашою лабораторією екологічного сортовипробування зразків озимого ячменю різного географічного походження із загальною кількістю 425 сортів у 2013р. і 358 – у 2014р. У даній роботі викладено результати одного із основних дослідів, у якому у 2013 р. було залучено 133 зразки, що походять із 13 країн, а у 2014 р. – 91 зразок із 12 країн. Визначали ознаки: перезимівля (пошкодження, 1-9 балів), довжина вегетаційного періоду, дата колосіння, вилягання (1-9 балів), висота рослин. Ступінь перезимівлі визначали згідно методичних рекомендацій щодо оцінки озимих на терморезистентність [6]. Оскільки цей показник первинно оцінювали за "старою" 5-бальною шкалою, дані перед аналізом трансформували до стандартної 9-бальної шкали за рівнянням емпіричної прямолінійної регресії. При цьому з метою максимального збереження інформації остаточний результат представлено з точністю до десятих.

Основні види статистичної обробки виконували у програмах:

Пакет *AGROBASE 99* компанії *Agronomix Software, Inc.,* Canada, www.agronomix.mb.ca. (загальна статистика). Ліцензія: AGX-98-118;

Пакет інструментів аналізу даних у програмі *EXCEL* із *Microsoft Office 2010*, *ver. 14.0.7128.5000*, Microsoft Corporation, USA, www.microsoft.com. (регресії, графіка). № продукту: 01631-551-4295762-27539

Кластерний аналіз та частину аналізу регресій виконували у програмі *SimFit, ver.7.0.5 Academic 32-bit,* автор: W.G. Bardsley, University of Manchester, UK, www.simfit.org.uk. Ліцензія: не потрібна. При цьому для вирівнювання пріоритетів ознак із дуже різними шкалами дані попередньо переводили у 9-бальну шкалу за емпіричними регресіями.

Результати досліджень.

У табл.1 представлені результати досліджень 133 зразків озимого ячменю у 2013 році. Ці зразки перекривали широкий діапазон ознак і властивостей: вегетаційний період – від 223 до 246 днів, висота рослин – від 70 до 130 см; перезимівля – від 5 до 8 балів, вилягання – від 3 до 8 балів.