Organization of seed breeding activities for leguminous crops and introduction of new varieties in conditions of piedmont and mountainous zones of Armenia

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Abstract. The article presents the results of breeding new leguminous crop varieties at the Scientific Center of Agriculture of the Republic of Armenia and the study results related to their testing and introduction in the piedmont and mountainous zones of the republic. Upon the findings of field experiments and laboratory research conducted throughout 2020-2022, it has been disclosed that the piedmont and mountainous zones of the republic are quite favorable for the growth and development of new varieties of chickpea (Stella), lentil (Erebuni), pea (Kangun) and groundnut (Arina), which were bred at the scientific center with further subjection to state varietal testing. Meanwhile, through the study results, it has been proved, that all mentioned varieties have ensured higher yield capacity and protein content as compared to other regionalized crops in those zones, and thus, it has been recommended to introduce them in a wide range of farm households for further cultivation.

1 Introduction

The increase in the number of people on the planet always implies finding ways to increase the production of agricultural crops, which is one of the most important conditions for ensuring food security of the population. Upon the long-term research results it has been justified that the problems solution is possible only through the integrated approach of different factors, among which the increase of vegetable protein production is, the insufficient quantity of which can cause physiological and functional modifications in human organism [1,6]. It is known that the daily protein intake can be supplemented in human organism at the expense of vegetable protein as well, which can be done through the expansion of legume croplands in the Republic of Armenia due to breeding and introduction of high-yielding varieties [8,10,17,].

The high value of leguminous crops is also related to the fact that they are endowed with significant biological and economic properties, since the nodule bacteria belonging to the genus Rizobium developed on their roots are able to bind/fix the free atmospheric nitrogen

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in the soil and to enrich the soils during the vegetation period with averagely 40-100 kg/ha biological nitrogen, at the same time improving the soil microflora and promoting the increase of soil fertility [2,3,7]:

Taking into account the most relevant biological, agrotechnical and nutritional properties of legume crops, as well as their role in the production of vegetable protein, an objective has been set up to get high yielding, global climate change resilient, drought resistant early ripening new varieties of chickpea, lentil, pea and groundnut crops, which can be cultivated in different climatic conditions of the republic.

As a result of research studies carried out in the scientific center of Agriculture of the Republic of Armenia, new varieties of chickpea, lentils, peas and groundnuts were obtained, which were tested in conditions of the piedmont and mountainous zone of the republic, which will contribute to the expansion of the sown areas for such important legume crops in the republic [9,13,14].

2 Materials and methods

In the scientific center, new varieties were obtained from the global collection of leguminous crops by the method of individual selection under the conditions of Ararat valley. Throughout the research 45 spring cultivars of the global/world chickpea collection has been studied. As a result, one chickpea variety ILC-3278 has been selected, which is currently undergoing state variety testing under the name "Stella" [4,5,15,18].

Twenty nine cultivars has been studied from the global lentil collection, as a result of which one variety has been selected and is undergoing state variety testing under the name of "Erebuni" [16].

Groundnut has a long vegetation period and was previously cultivated only in conditions of the Ararat valley of the republic. The goal of the research group was to get super early ripening groundnit varieties via expanding the sown areas of the mentioned crop. In the result high-yielding early-season variety “Lia” has been obtained and regionalized which together with “Arina” variety, currently under state variety testing, has been subjected to ecological testing in conditions of piedmont zone of the republic [11,19].

3 Results and discussions

The new spring chickpea variety “Stella” and the regionalized “Anush” variety have undergone ecological trial in the piedmont and mountainous zones. The “Anush” variety bred in the scientific center has served as a control variant for the new variety. The results of ecological trials of the mentioned varieties have shown, that in both climatic conditions the mentioned varieties have ensured high yielding capacity (Ghukasyan A., et al., 2022) [12].

The data of Table 1 testify that “Stella” variety has demonstrated higher results in the yield structural elements and yield capacity than that of “Anush” variety. It is noteworthy that the new variety has provided the highest yield indicators in conditions of mountainous zone, where the yield surplus has made 0.15 t ha-1.

Table 1. The structural yield elements, yield capacity and qualitative indicators of chickpea crop (average for 2020-2022)

Climatic zone	Variety	Per 1 plant		Weight of 1000 grains, g	Yield, t ha^{-1}	Yield surplus, t ha^{-1}	N, %	Crude protein, %
		Grain number, n	Grain weight, g					
Ararat valley	Anush	115.0	73.8	644.0	3.32	-	5.10	31.9
	Stella	125.0	76.6	648.7	3.52	0.2	5.17	32.3
Piedmont zone	Anush	107.0	65.1	634.1	3.27	-	4.88	30.5
	Stella	116.0	67.5	640.4	3.46	0.19	4.78	29.9
Mountainous zone	Anush	11	77.5	650.2	3.39	-	5.10	31.6
	Stella	129.0	78.0	659.1	3.50	0.22	5.12	32.0
Sx, % LSD_{05}, t						1.5 0.1		

According to the three-year average data of recent investigations, the lentil variety "Erebuni" bred through individual selection from the global collection, has provided high efficiency in the piedmont and mountainous zones of the republic as compared to the regionalized local variety "Talin-6".

The data of Table 2 show that the indices of yield structural element and yield capacity of the new lentil variety "Erebuni" exceed the same indices of "Talin-6" local variety both in the Ararat valley and in conditions of piedmont and mountainous zones of the republic. The average yield in the new "Erebuni" variety fluctuated within 2.52- 2.59 t ha-1 per climatic conditions, whereas in the local variety it was 2.37-2.42 t ha-1.

Table 2. The structural elements, yield capacity and qualitative indicators of lentil yield (average for 2020-2022)

Climatic zone	Variety	Per 1 plant		Weight of 1000 grains, g	Yield, t ha^{-1}	Yield surplus, t ha^{-1}	N, %	Crude protein, %
		Grain number, n	Grain weight, g					
Ararat valley	Talin-6	115	5.1	38.2	2.37	-	5.12	32.0
	Erebuni	159	6.2	46.7	2.52	0.15	5.26	32.9
Piedmont zone	Talin-6	119	4.9	42.6	2.40	-	4.99	31.2
	Erebuni	161	6.0	47.5	2.55	0.15	5.10	31.9
Mountainous zone	Talin-6	123	5.4	43.0	2.42	-	5.17	32.3
	Erebuni	179	6.5	49.0	2.59	0.17	5.23	32.7
Sx, % LSD_{05}, t						0,02% 0.13		

In order to expand and enroot the groundnut sown areas studies were carried out with the aim of breeding new early-ripening and high yielding groundnut varieties. In the result of the mentioned investigations an early-season "Lia" variety has been already regionalized for the conditions of Ararat valley and the "Arina" variety selected from the global groundnut collection is currently being subjected to state trial/testing. In the result of investigations, it has been found out that in order to expand the groundnut cultivation area it can be also grown in the piedmont zones of the republic.

Table 3. Structural elements, yield capacity and qualitative indicators of groundnut yield (average for 2020-2022)

Climatic zone	Variety	Per a plant			Weight of 1000 grains, g	Yield, t ha^{-1}	Yield surplus, t ha^{-1}	Crude protein, %	Fat content, %
		Pods number, n	Number of grains per pod, n	Grains weight, g					
Ararat valley	Lia	76.2	191.6	99.4	519.2	2.72	-	27.65	47.65
	Arina	78.5	195.9	103.6	522.5	2.93	0.21	28.21	48.04
Piedmont zone	Lia	75.8	189.7	98.9	517.1	2.70	-	27.39	47.79
	Arina	77.9	194.0	100.9	520.3	2.89	0.19	27.85	47.98
Sx, %						1.8			
LSD_{05}, t						0.13			

The research results show that the "Arina" variety cultivated in the piedmont zone is almost equal with that of regionalized in the Ararat valley in yield capacity indicator. The indicators presented in Table 4 indicate that the varieties of "Lia" and "Arina" cultivated in both climatic conditions have provided almost the same results in the pod number per plant, in the grain numbers and weight per pod, as well as in the weight of 1000 grains. As a result, the yield surplus in case of "Arina" variety grown in the Ararat valley has made 0.21 t ha-1, while that of cultivated in piedmont zone made 0.19 t ha-1.

The pea variety "Lili-5" regionalized for the climatic conditions of piedmont zones has served as a control variant for the ecological testing of regionalized "Kangun" pea variety bred in the scientific center.

Upon the results of ecological testing it has been disclosed that in the relatively temperate climatic conditions the pea variety "Kangun" develops the best indexes of yield structural elements and hence the best indexes for yield amount, as a result of which in the piedmont and mountainous zones high yield amount has been obtained (2.7-2.88 t ha-1) as compared to that of recorded in the Ararat valley. The data presented in Table 4 indicate that in piedmont and mountainous climatic conditions the number of pods per a plant is higher (101 and 104 n) than that of observed in conditions of Ararat valley, where the pods number makes 85. The same pattern has been recorded in case of grain number and weight per a pod.

At the same time the studies have shown that the yield surplus in the "Kangun" variety compared to the control variant has made 1.3, 1.8 and 0.2 t ha-1 per the climatic conditions (Table 4).

Table 4. The yield structural elements, yield capacity and qualitative indicators of the pea variety (average for 2020-2022)

Climatic zone	Variety	Per 1 plant			Weight of 1000 grains, g	Yield, t ha^{-1}	Yield surplus, t ha^{-1}	N, %	Crude protein, %
		Number of pods, n	Number of grains per a pod, g	Weight of grains, g					
Ararat valley	Lili-5	15.9	79.5	18.6	210.8	2.32	-	4.24	26.5
	Kangun	17.0	85.0	19.2	215.1	2.49	0.17	4.48	28.0
	Lili-5	18.4	92.0	20.8	219.1	2.59	-	4.29	26.8

Piedmont zone	Kangun	20.1	101	21.4	220.5	2.81	0.22	4.40	27.5
Mountainous zone	Lili-5	19.3	95.0	21.3	220.2	2.62	-	4.27	26.6
	Kangun	20.9	104	23.4	225.0	2.86	0.24	4.45	27.8
Sx, % LSD_{05}, t						3.1% 0.17			

The efficiency of agricultural crops, including the leguminous ones, is assessed not only per their yield capacity index but also per their qualitative indicators. The best qualitative indicators are resulted not only from the varietal, nitrogen-fixing efficiency, but also from agrotechnical and soil and climatic conditions .

The research results disclose that the protein content in the grains of chickpea, lentil, groundnut and pea varieties is higher in the seed varieties tested in the Ararat valley and in the rainfed conditions of mountainous zone. Thus, in the spring chickpea varieties of "Anush" and "Stella" in both climatic conditions (lowland and mountainous) the protein content has made 31.9, 31.6 and 32.3, 32 % respectively, while in conditions of piedmont zone it makes 30.5 and 29.9 % (Tables 1,2,3,4). The same pattern for the protein content has been observed in the lentil, pea and groundnut varieties.

4 Conclusion

Conditions of the three agroclimatic zones of the Republic of Armenia (lowlands, piedmont and mountainous) are quite favorable for the cultivation of leguminous crops (chickpea, lentil, groundnut and pea), whereas the three-year results of ecological testing conducted with the aim of introducing new varieties enable to expand the latter's cultivation area, which will surely promote the solution of a number of problems in agricultural sector, among which the following ones can be distinguished:

- Solving problems related to nitrogen deficiency in the soil,
- Increasing the production of vegetable protein,
- Mitigating the adverse effects (decline in the soil fertility, soil erosion, weediness of the croplands) caused due to the cultivation without crop rotation system,
- Providing fresh protein containing food to the population,
- Providing high quality seeds to the local productions.

5 Acknowledgements

The paper presents experimental findings obtained through the research programme "The organization of selection and seed breeding activities of legumes and introduction of effective technologies in the different agricultural zones of RA" implemented by the Science Committee Ministry of Education, Science, Culture and Sports Republic of Armenia.

The work was supported by the Science Committee of RA, in the frames of the research project № 21T-4B046.

References

1. F. Ahmad, P. M. Gaur, J. Croser, Grain Legumes **1,** 187–217 (2005)
2. N.A. Bhosale, A.A. Pisal, N.V Gawade, Int. J. Chem, Studies **5(3),** 110–112 (2017)

3. H. Kanouni, A. Taleei, M. Okhovat, International Journal of Plant Breeding and Genetics **5,** 1–22 (2010)
4. C. Toker, Genetic Resources and Crop Evolution **52,** 1–5 (2005) http://dx.doi.org/10.1007/s10722-005-1743-5
5. S.M. Udupa, L.D. Robertson, F. Weigand, M. Baum, G. Kahl, Molecular Genetics and Genomics **26,** 354–63 (1999)
6. A.A. Kutuzova, E.E. Provornaya, N.S. Tsybenko, Feed production **5,** 7–11 (2018)
7. H. Khazaei, et.al, Front. Plant Sci. **7,** 1093-1099 (2016)
8. L. Matevosyan, A. Barbaryan, N. Alichanyan, H. Nersisyan, A. Gevorgyan, Sciences of Europe (Praha, Czech Republic) **95**, 3-5 (2022) https://doi.org/10.5281/zenodo.6724296
9. R.H. Ghazaryan, A.A. Barbaryan, J.V. Yepremyan, Agroscience **9-10,** 479-481 (2014)
10. M. Galstyan, L. Matevosyan, Agrosciense **5-6,** 245-249 (2014)
11. M. Galstyan, L. Matevosyan, Bulletin of National University of Armenia **1,** 5-9 (2016)
12. A. Ghukasyan, M. Galstyan, L. Matevosyan, Annali d'Italia **35**, 3-5 (2022)
13. A. Ghukasyan, A. Barbaryan, R.H. Ghazaryan, N. Alichanyan, H. Nersisyan, Annali d'Italia **36,** 3-5 (2022) https://doi.org/10.5281/zenodo.7244019
14. R. Ghazaryan, L. Matevosyan, Bulletin of NAUA **2,** 9-12 (2017)
15. R.H. Ghazaryan, R.R. Sadoyan, L.S. Zagaryan, Agriscience **2,** 22-25 (2014)
16. A.A. Barbaryan, L.G. Matevosyan, Biological Journal of Armenia **3(72),** 6-9 (2020)
17. L.G. Matevosyan, A.A. Barbaryan, S.G. Avetisyan, Agriscience and Technology **3/71,** 56-59 (2020)
18. A. Barbaryan, L.G. Matevosyan, G. Shaboyan, R.G. Ghazaryan, N. Alikhanyan, Eurasian Union of Scientists (EUS) **8(77),** 55-57 (2020)
19. L.G. Matevosyan, Bulletin ANAU **1,** 33-35 (2013)