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YIELD COMPONENTS EVALUATION IN CHICKPEAGERMPLASM COLLECTION,GROWN IN AKMOLA REGION, KAZAKHSTAN

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Abstract

Germplasm collection of chickpea (*Cicer arietinum* L.) originated from various countriies andecology was evaluated in field trial conditions of Akmola region. The analysis of yield components among germplasm accessionswas carried out according to local standard indicators of productivity. The following genotypes are recommended for yield breeding in Kazakhstanbased on the current research: ICC-8515 (Greece); ICC-12947, ICC-1431, ICC-456, ICC-1205, and ICC-5337 (India); ICC-3776, ICC-1083, ICC-13283, ICC-13764, and ICC-13187 (Iran); ICC-15697 (Syria);and ICC-7272 (Algeria). The recommended germplasm accessions were identified asthe most adapted for cultivation in environment of Akmola region and, therefore, they can be used as ainitial genetic resourse for breeding of chickpea varieties with 'Northern-ecotype'. Hybrid populations were produced in the crossings between International and domestic chickpea germplasms. The offspring segregations in chickpea hybrid populations represent perspective and important genetic resorses for selection of superious genotypes with high yield and tolerance to drought. Finally, the best selected breeding lines are expected to be introduced into domestic chickpeabreeding programs in Kazakhstan.

Key words: Chickpea, drought, evaluation, genetic resource, germplasm collection, hybrid, yield, legume crops.

Introduction

Legumes are recognized as important part of 'healthy nutrition food'due to their high nutritional value.Seeds of legume crops have a huge bioresource potential and occupy a leading place in the development of 'third-generation' food technologies. These modern technologies provide more complete and 'in-depth' processing of natural seeds as raw material,better regulating the chemical composition in foods fortheir nutritional and biological value. It is now very clear that human nutrition will be improved in the nearest future due to the wider use of foods with rich in plant protein [1]. However, drought is a major threat with a huge

impact on plant growth and development. About a third part of agricultural land is known as drought-affected with a lack of water, although it can be potentially suitable for crop growing. In the rest of world, especially in arid and semi-arid regions, cropseven more suffer in dry environment [2]. Drought also inhibits plant growth, leads to chlorophyll destruction and hydrogen peroxide accumulation, which causes lipid peroxidation and, therefore, resulting in damagesofplant cell membranes [3-5].

The expanding ofchickpea areas is verydifficult task with a focus togrowing crops, high yield of seeds and their quality, tolerance to harsh adverse environment as well as diseases and pests. Plant tolerance to drought and heat stress is particular important for the sustanblecrop production [6]. Compared to other legumes, chickpea in North-Eastern Kazakhstanhas more advantageswith its biological characteristics, where moisture is the main limitation in plant life.Chickpea plants are known to be thermophilic and, at the same time, cold-tolerant, well-adapted to the agrometeorological environment of steppe zone, since they are less suffering from drought with higher and more stable yield of seeds.

The aim of the current research is the study of plant growth and adaptation of chickpea germplasm accessions withfurtheropportunities for expanding of chickpea production in Kazakhstan. The analysis of chickpea germplasm collection with various origin and economically valuable traits will make it possible to identify the most promising of them for further use as thegenetic resourcefor chickpea breeding programs.

Materials and methodsof research

The experiments were carried out in the field trial ofS.Seifullin Kazakh Agrotechnical University, located in agricultural farm‘Niva’, Akmola region.The type of soil in the experimental field site was dark chestnut, and according to its mechanical composition itwas classified as heavy-loamy

The chickpea germplasm collectionfor the research included 256 chickpea accessionsreserved in the International Genebank collection ICRISAT, India.Seeds were sow manually in the arranged area of the field trial with doubled repeats, whereeach accession was grown in a separate plot,with 1,5 m^2area each (Figure 1). Plant growth and yield components in chickpeagermplasm collection wereevaluation according to the Methodological guidelines prescribed by the Vavilov Research Institute of Plant Industry (VIR), St.-Petersburg, Russia [7-9].

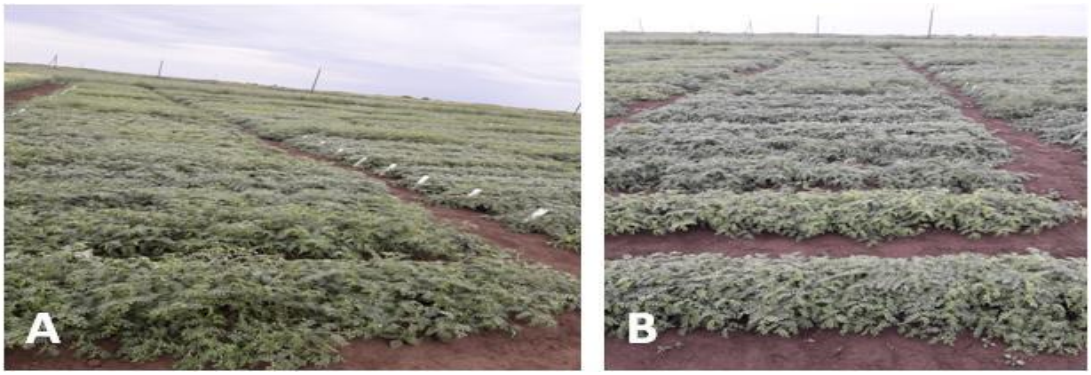

Figure 1 - General overview of chickpeaexperimental field trials: A – Germplasm collection;B –Hybrid progenies nursery

This research was carried out with chickpea germplasms originated from various ecological environment and from different countries, including: Afghanistan, Ethiopia, former USSR, India, Iran, Italy, Mexico, Morocco, Syria, Turkey, Pakistan, etc.(Figure 2).

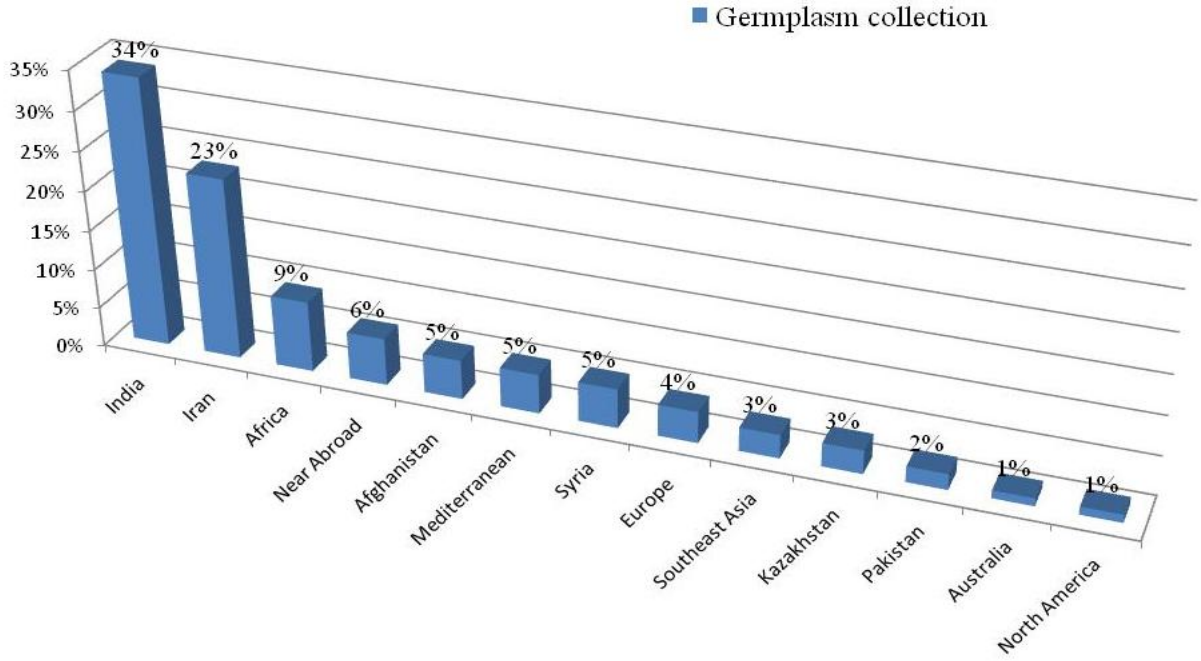

Figure 2 - Distribution of chickpea germplasm collection based on their country of origin

During the growing season of chickpea, phenological observations were carried out, including: dates of main phase onsert (shootoccurrence, time to start flowering andseed development, and full ripening). The chickpea plants were harvested manually when beans completely ripened. Before harvesting of chickpea plants in the field trial,plant number in each plot was counted and recorded.

For post-harvested analysis, 10 plants were selected from the middle rows in each plot. This post-harvested analysis of chickpea plants was carried out according to the following standard set of traits: plant height; distance on stem, where lowestbean attached; beansnumber per plant;

seedsnumber per plant; seeds weight per plant; and weight of 1000 seeds. Data analysis was carried out usingSnedecorsoftware in the conjunction with Microsoft Office Excel 2010 computer program.

The controlled hybridization was carried out according to the methods of S.Kalve and M.Tadege [10]. The process of manual emasculation included accurate cutting of petalsinflower keel of the maternalparental plantand remove the anthers with immature pollen. The exposed stigma surface of pistilswas quickly pollinated by pollen collected from flowers of paternal parent at the time of their initial flowering. This method showed about 75% efficiency of the hybridization result, which is much higher than the previouslyused methods (Figure 3).

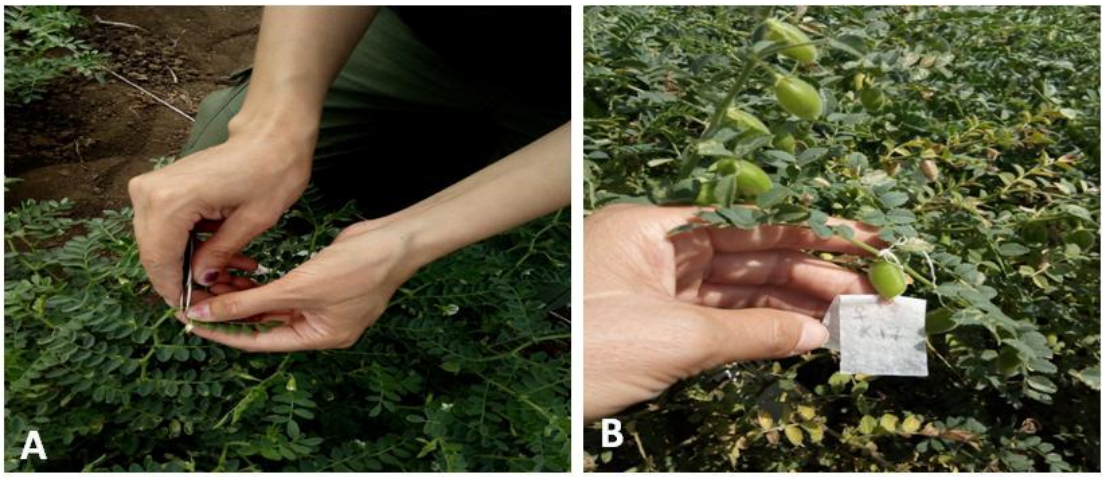

Figure 3 –Mannual hybridization: A - Pollination process; B –Pollinated flower of chickpea with paper-label after the pollination

Results

The production of new high-yieldingchickpea varieties and more tolerant to weather conditions is one of the most important areas of the crop breeding. Analysis of yield componentshelped to identify chickpea genotypes and germplasm accessionswith better yield during growing season in Akmola region of Kazakhstan. Highly productive varieties of chickpea can beidentifiedasgenotypes with better plantgrowth and yield components, such as 1000 seeds weightand seeds weightper plant.

In regards to increased demand in the current foreign market, commercial production of chickpea has been more interested inbigger seeds size. In our study, one group of the most promising chickpea accessions weregenotypes with dark largeseeds and pink flowers.The following chickpea germplasms were identified as highest1000 seedsweight: ICC-15762 (Syria); ICC-11903 (Germany); ICC-15294, and ICC-15248 (Iran); and ICC-14595 (India). The second perspective chickpea group included genotypes with light-colour seeds and white flowers, as follow: ICC-10755, and ICC-11879 (Turkey); ICC-7255 (India); ICC-15435, ICC-15406, and

ICC-15518 (Morocco); ICC-14199 (Mexico); ICC-7272 (Algeria);ICC-15697 (Syria);and ICC-13187 (Iran).Chickpea plants from both groups had weight of 1000 seeds in the range from 238,1 g to 339,1 g. The most productive plants with highest seed yield were identified in chickpea accessions, including: ICC-8515 (Greece); ICC-12947, ICC-1431, ICC-456, ICC-1205, and ICC-5337 (India); ICC-3776, ICC-1083, ICC-13283, ICC-13764, and ICC-13187 (Iran); ICC-15697 (Syria);and ICC-7272 (Algeria).

In the nursery of hybrid progenies, 12 crossingcombinations between domestic varieties and best selected International accessions were analysed (Table 1). During hybridization, the maternal forms wereselected fromelite local varieties, while the paternal formswere used from the identified best chickpea accessions in the International germplasm collection.

Table 1 - Results of chickpeacrossingcombinations, produced in the field trial, agricultural farm ‘Niva’, Akmola region.

№	Combination	Maternal parent	Paternal parent	Number of emasculated flowers	Number of pollinated flowers
1	2×22	Yubileiny	ICC-7272	195	87
2	4×72	Таccай	ICC-13523	144	52
3	5×77	TN-45/0-01	ICC-4841	151	28
4	276×222	Yubileiny	ICC-5510	137	26
5	268×420	Camilla	ICC-1915	149	31
6	271×422	Lin- C87	ICC-1915	151	29
7	270×437	ICARDA-1	ICC-15294	144	30
8	285×412	K-3179	ICC-2990	155	34
9	349×405	28-B	ICC-9590	140	23
10	335×407	Yubileiny	ICC-14778	138	31
11	319×414	Duet Azii	ICC-2990	158	43
12	316×420	Louch	ICC-1915	137	20

Discussion of the results and conclusion

Based on the presented study, the following genotypes can be recommended as the most promising and prospective accessions for chickpea breeding programs with high yield production as follow: ICC-8515 (Greece); ICC-12947, ICC-1431, ICC-456, ICC-1205, and ICC-5337 (India); ICC-3776, ICC-1083, ICC-13283, ICC-13764, and ICC-13187 (Iran); ICC-15697 (Syria);and ICC-7272 (Algeria). Manual hybridization was successfully carried outamong selected chickpea genotypes.Seeds in 12 hybrid combinations were attempted, where 463 flowers were emasculated and pollinated. In total, there were 48 hybrids produced with

10,3% of success. All obtained hybrid seeds from crossing combinations represent very poromising and interesting genetic material for furtherproduction ol new chickpea varieties with high-yield and tolerance to drought for chickpea breeding programs in Kazakhstan.

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chickpea, adapted to the climatic conditions of Northern and Central Kazakhstan'.We would like to express our deep gratitude to researchers, postgraduate and undergraduatestudents for their help in carrying out this study.

ОЦЕНКА ПРОДУКТИВНОСТИ КОЛЛЕКЦИОННОГО МАТЕРИАЛА НУТА В УСЛОВИЯХ СУХОСТЕПНОЙ ЗОНЫ АКМОЛИНСКОЙ ОБЛАСТИ

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Аннотация

В работе представлены результаты изучения коллекционных образцов нута (*CicerarietinumL.*) различного эколого-географического происхождения в условиях Акмолинской области. Проведен анализ сортообразцов по показателям продуктивности. На основании проведенных исследований для селекции на продуктивность рекомендуются следующие генотипы, ICC 8515 (Греция), ICC 12947, ICC 1431, ICC 456, ICC1205, ICC 5337 (Индия), ICC 3776, ICC 1083, ICC 13283, ICC 13764, ICC 13187 (Иран), ICC 15697 (Сирия), ICC 7272 (Алжир). Данные образцы более адаптированы для возделывания в условиях Акмолинской области и их можно использовать в качестве исходного материала для создания сортов нута северного экотипа. В результате скрещиваний получены гибридные семена, которые представляют собой ценный генетический материал для создания устойчивых генотипов и в дальнейшем найдут свое применение в отечественной селекции нута.

Ключевые слова: Коллекция, нут, гибридизация, исходный материал, продуктивность, оценка, засуха, зернобобовые культуры.

АҚМОЛА ОБЛЫСЫНЫҢ ҚҰРҒАҚ ДАЛАЛЫ АЙМАҒЫ ЖАҒДАЙЫНДА НОҚАТТЫҢ КОЛЛЕКЦИЯЛЫҚ МАТЕРИАЛЫНЫҢ ӨНІМДІЛІГІН БАҒАЛАУ

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Түйін

Жұмыста Ақмола облысы жағдайында әртүрлі экологиялық-географиялық шығу тегі бар ноқаттың (*CicerarietinumL.*) коллекциялық үлгілерін зерттеу нәтижелері ұсынылған. Өнімділік көрсеткіштері бойынша сұрыптық үлгілерге талдау жүргізілді. Жүргізілген зерттеулер негізінде өнімділігі бойынша іріктеу жұмыстарына келесі генотиптер ұсынылады:ICC

8515 (Греция), ICC 12947, ICC 1431, ICC 456, ICC 1205, ICC 5337 (Индия), ICC 3776, ICC 1083, ICC 13283, ICC 13764, ICC 13187 (Иран), ICC 15697 (Сирия), ICC 7272 (Алжир). Келтірілген ноқат үлгілері Ақмола облысы жағдайында өсіруге жақсы бейімделген және оларды солтүстік экотипіне сәйкес сұрыптарды алу үшін бастапқы материал ретінде пайдалануға болады. Будандастыру нәтижесінде будандық тұқымдар алынды, олардан тұрақты генотиптерді алу үшін құнды генетикалық материал болып табылады және болашақта отандық ноқат өсіруде өз қолданысын табады.

Кілт сөздер: коллекция, ноқат, будандастыру, бастапқы материал, өнімділік, бағалау, қуаңшылық, дәндібұршақ дақылдары.