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Original Research Article

A NEWLY APPROVED KABULI CHICKPEA VARIETY "ROHI-CHANA-21": A BOOST UP IN THE EXISTING YIELD POTENTIAL OF CHICKPEA

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Abstract: Rohi Chana-21' is the newly released kabuli chickpea variety with good yield potential and drought tolerance. It was approved in 2021 by Punjab Seed Council for general cultivation in irrigated and rain-fed areas of Southern Punjab. The variety was evolved through a local selection and exploited the pure-line selection method for subsequent stages of variety development at the Regional Agricultural Research Institute, Bahawalpur, Pakistan. The variety owes a good average yield potential (>2000 kg ha-1). It takes 80-100 days to 50% flowering and 135-147 days to 90% pod maturity. The seed size is bold, while seeds pod-1 ranged from 01 to 02. It has 100-seed weight of 28-35 g, no of pods plant-1 ranges from 60 to 70, plant height (65-85cm) and grain color is off–white. *As for as the quality is concerned, the protein percentage is high enough (23%) with desirable ash (*3.73%*) and crude fat contents* (3.42%). It expresses good yield potential when planted during October by keeping a seed rate of 25-30 kg acre-1 and a fertilizer dose of 90-100-00 NPK kg ha-1. *Rohi-Chana-21 was also tested under rainfed and irrigated conditions, which gave encouraging results, exhibiting itself as a drought-tolerant variety. This variety's inclusion will boost chickpea (kabuli) yield potential in farmer's field in Southern Punjab*.

Keywords: chickpea, cultivar, kabuli, Rohi-chana-21, drought tolerant

Introduction

Legumes, ecologically as well as economically significant plants, are of vital consideration for global food security, especially under predicted climatic conditions (Considine et al., 2017). Chickpea (*Cicer arientinum* L.), or gram, is an important domesticated crop of arid and semi-arid countries worldwide (Mushtaq et al., 2013,Varshney et al., 2019). It belongs to fabaceae family with diploid chromosome number 2n = 16. It exists as self-pollinated crop in nature. It is a good source of plant protein (20%) along with important amino acids just as leucine, isoleucine, valine and phenylalanine (Karim and Fattah, 2006), which is highly digestible (70-90%) (Williams and Singh, 1987). Also, it contains 60% carbohydrates and1.6% fats (Ali and Ahsan, 2012, Shah et al., 2015; Megersa et al., 2017; Iqbal et al., 2018; Rubiales et al., 2018, Mohammdi, 2019). That's why it is called the meat of poor man. In Pakistan, irrespective of the fact that the crop ranks second (after India) in terms of area (hectare), which is 1.094 million hectares, it has an average production of 444 kg ha^{-1} as compared to the average world production of 969 kg ha^{-1} (Nadeem et al., 2018, FAOSTAT, 2019). It contributes about 76% share in the total pulses production of Pakistan, occupying > 5%of the area under rabi crops. This chickpea production gap is due to a certain abiotic and biotic stresses. Among abiotic components, moisture stress is edthe most vital factor for low chickpea yield production, as it can affect up to 15-60% (Pandey et al., 2017). In Pakistan, Thal (Bhakkar, Layyah, Chakwal, Khushab, Mianwali, Faisalabad, and Jhang) contributes about 80 percent area for chickpea crop where it is cultivated on marginal land and dunes by facing terminal drought as reported by Mahmood et al., (2018). Whereas, drought severity generally depends upon the uneven occurrence and sometimes inadequate rainfalls during the crop season (Ali et al., 2014; Ali et al., 2016; Ali and Ahsan, 2012; Khan *et al*., 2017). Therefore, the current scenario demands that researchers explore and evaluate the best suited drought-tolerant germplasm for thal area (Merga and Haji, 2019; Nadeem et al., 2018; Varshney et al., 2019). As it is clear from research studies that various crop species, through tolerance mechanisms can adapt to severe drought stress conditions (Yadev et al., 2001). Fusarium wilt is also the most fatal fungal disease and has become a major threat to chickpea

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productivity after drought stress. The yield losses from this disease can range from 10- 90% depending upon the severity of the fungal attack (Bhardwaj et al., 2010; Megersa et al., 2017; Khan et al., 2017).There is a dire need to evolve high-yielding varieties capable for better performance under biotic and abiotic stresses to fill this yield gap (Rubiales et al., 2018).

Diversity among parental material ensures maximum chances to researchers to devise desirable breeding strategies (Aaujo et al., 2015; Babar et al., 2015; Nawaz et al., 2017a; Wang et al., 2017, Annicchiarico et al., 2018; Boukar et al., 2018; Ojiewo et al., 2018). In a crop enhancement scheme, the cultivars must be adapted to diversified environments, which is the critical objective of plant researchers. A crop variety is more adaptive if it shows a low degree of variation in yielding potential in diverse climatic conditions (Qureshi, 2001). Traditional chickpea varieties have a narrow genetic base, are less adaptable to a wide range of environments and are vulnerable to various abiotic and biotic stresses. Therefore, continuous breeding efforts are required to evolve new, improved and better-performing varieties (Atta et al., 2008; Gupta et al., 2011; Islam et al., 2017; Talebi and Rokhzadi, 2013). Therefore, the evolution and release of chickpea varieties with limited moisture requirements and capable of better performance under moisture stress conditions will serve as a driving force for uplifting this region's production. Therefore, consideration of the various constraints, constant release of chickpea varieties devouring the better yield potential, tolerance to drought, resistance against diseases and wider adaptability is a dreadful need. In the above current scenario, Rohi-chana-21, a newly released kabuli chickpea variety with high yielding and drought tolerance, is a result of well-focused and enthusiastic efforts of the researchers' team of Regional Agricultural Research Institute, Bahawalpur. It is suitable for cultivation in rainfed areas of Thal and irrigated areas of Bahawalpur. In short, the approved variety possesses high yield potential and resistance to biotic and abiotic factors existing in the region.

Materials and Methods

Pure line selection method

Rohi-Chana-21 was developed through the method of pure line selection attempted at Regional Agricultural Research Institute (RARI), Bahawalpur during 2010-11. All the progenies of the individual plant selections and yield trials were evaluated at RARI, Bahawalpur. 100- superior appearing chickpea plants were selected from a genetically variable population during 2010-11. Individual selected plants were sown in a single row of 2m in length with single row hand drill in the next year. Bulked the seeds of each selected row separately, considering the desirable traits. Selections of superior progenies were made during two successive years while plot size of four rows, each of 5m length was maintained. During 5th consecutive years, a prominent family was harvested as bulk on attaining maximum homozygosity. The selected family was coded as BRC-408 and put in yield assessment trials.

Yield assessment

The candidate strain BRC-408 was studied in replicated preliminary (A-trials), regular (B-trials) and adaptive trials on various locations and micro yield trials (CMYT) from 2015-16 to 2018-19. The layout for preliminary, regular, adaptive and micro yield trials was Randomized Complete Block Design (RCBD). Each trial was replicated thrice, having the plot size of 1.2m × 4m by maintaining 30cm apart rows. Single Row Hand Drill (SRHD) was used for sowing purposes. For comparison, one commercial cultivar was added in every experiment as a check. Eventually, the candidate line was tested in Chickpea National Uniform Yield Trials (CNUYT). These trials were independently managed by the National Coordinator (Food Legume), Pakistan Agriculture Research Council, Islamabad, at 08 sites in 2017-18 and 13 sites during the rabi season of 2019-20 throughout the country. These experiments were carried out in RCBD having 03 replications with plot size of 1.2m × 4m = 4.8m^2. While, 30cm row-to-row distance was maintained. Whereas, sowing time and crop management practices, soil and climatic conditions varied at all the experimental sites of Pakistan. The experimental data of each location was collected in averaged and then converted to kg ha^{-1} for evaluation. Furthermore, the statistical analyses were carried out for comparison. All necessary steps, from single plant selection to final approval of Rohi-Chana-21 are summarized in Table 1.

Table 1. Brief description of various steps year-wise in the evolution of Rohi-Chana-21

Year	Trials	Description
2010-11	Selection	Superior Plant Selection from genetically variable population
2011-14	Pure-line Selection	Selection of desirable families from progenies.
2014-16	A & B trials	On-station replicated yield trials at RARI, Bahawalpur
2016-17	CRYT	Multi-locations yield comparison in southern Punjab through the Director RARI, Bahawalpur
2017-18	CMYT	Multi-locations yield comparison on Punjab level through the Director Pulses Research Institute, Faisalabad

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2017-18 & 2019-20	CNUYT	Multi-locations yield comparison on Pakistan level through the National Coordinator Pulses, Pakistan Agriculture Research Council, Islamabad
2017-19	Agronomic studies	These studies were carried out at Agronomic Research Station Bahawalpur and RARI-Bahawalpur
2017-18	Pathological studies	These studies were carried out by pathological department of Regional Agricultural Research Institute, Bahawalpur
2017-18	Entomological studies	These studies were carried out by a team of entomologist at Regional Agricultural Research Institute, Bahawalpur
2017-18	Physio-chemical studies	Physio-chemical analysis was studied at physio-chemical Lab, Ayub Agricultural Research Institute, Faisalabad

Development of package of production technology

To develop the most appropriate fertilizer dose and the best combination of pre and post-emergence weedicide, a succession of replicated yield trials under different treatments were kept under observations for three consecutive years from 2013-14 through 2015-16. While, local commercial varieties were kept in the trials for yield comparison.

Pathological and entomological studies

To find out the specific disease reaction of the candidate strain, separate pathological experiments from the regular breeding experiments were carried out with the collaboration of pathological scientists of the institute for three years. During these experiments, yield contributing parameters of the candidate strain were also studied. The strain was also tested for tolerance against insect pests, especially pod borer in replicated yield trials and check variety Noor-2013.

Quality evaluation and Statistical Analysis

The experiments regarding physio-chemical properties of the grain of Rohi-Chana-21 were conducted at Bio-Chemistry Lab. at Ayub Agricultural Research Institute, Faisalabad. The crude protein content, ash (%) and crude fats (%) of candidate line were estimated and compared with commercial check variety. The yield means were used for statistical analysis through Statistix 8.1 software (Steel *et al*., 1997).

Results and discussions

On-station yield trials

The selected progenies of BRC-408 after passing through pure-line selection method, were subjected to replicated preliminary (A) and regular (B) yield trials at RARI, Bahawalpur during 2014-16. The grain yield data in preliminary trials showed that the variety gave 2368 kg ha-1 and out-yielded the check, Noor-2013 with a grain yield of 2035 kg ha^{-1}. Whereas, 16.4% increase in comparative yield of the test variety was observed. While in B trials, the variety gave grain yield of 2291 kg ha^{-1} compared to 1978 kg ha-1 grain yield produced by Noor-2013, resulting in a 15.8% increase in comparative yield of the candidate variety (Table 2). We found significant differences as compared to check variety in both trials.

Table 2. On-station yield trials at RARI, Bahawalpur, 2015-17

Year	Trial	Grain Yield (Kg ha^{-1})		%age increase over check
		BRC-408	Noor-2013	
2015-16	A Trial	2368	2035	16.4
2016-17	B Trial	2291	1978	15.8

Multi-location yield trials

To evaluate the stability and adaptability of the candidate variety to diverse environments, systematic multi-location yield trials were carried out through districts, provincial and national levels. Therefore, regional chickpea yield trials were performed at 05 locations (Khanaewal, Bhawalnagar, Layyah, Kalurkot and Bahawalpur) in Southern Punjab zone under the direction of Director, Regional Agricultural Research Institute, Bahawalpur during 2016-17. Results confirmed that Rohi-Chana-21 yielded more than the commercial check variety Noor-2013 at all 05 locations. Moreover, the grain yield of the tested strain ranged from 1950-2370 kg ha^{-1} whereas, the range of grain yield for commercial variety Noor-2013 was observed as 1600-2050 kg ha^{-1}. Furthermore, averaging yield of all the localities confirmed that the candidate chickpea variety exhibited a significant increase (15.8%) over Noor-2013 (Table 3).

Table 3. Regional yield trials at multi-locations, 2016-17

Sr.No	Location	Grain Yield (Kg ha^{-1})		% increase over check
		BRC-408	Noor-2013	
1	Adaptive Research Station, Khanaewal	2250	2035	16.4
2	Rice Research Station, Bhawalnagar	2290	1978	15.8
3	Adaptive Research Station, Karor, Layyah	2100	1800	16.6
4	Gram Research Sub- Station, Kalurkot	1950	1600	17.9

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5	Regional Agricultural Research Institute, Bahawalpur	2370	2050	13.5
	Mean	**2192**	**1892**	**15.8**

After successful district-level trials, the candidate variety was tested at Punjab level through Chickpea Micro Yield Trials (CMYT). These trials were studied under the supervision of Director, Pulses Research Institute, Faisalabad during 2017-18 at 10 different locations in Punjab. Average grain yield per hectare from the 10 sites/locations in Punjab showed that Rohi-Chana-21 showed 6.0% increased yield as compared to Noor-2013 (Table 4). Furthermore, the candidate chickpea variety was also evaluated in Chickpea National Uniform Yield Trials (CNUYT) for two years (2017-18 and 2019-20) across the country. The results of grain yield of target variety and check variety Noor-2013 is given in Table 5 & 6. It is noticeable that the average of 08 locations all over Pakistan in variable ecological climates, the targeted variety gave 15.4% increase over Noor-2013 during 2017-18 (Table 5). While, during the year 2019-20, Rohi-Chana-21 was tested at 10 sites on a whole Pakistan basis, average yield of candidate variety on 10 locations revealed a highly significant increase over the check Noor-2013 (10.4%). In addition to its higher yield potential, the yield trials (CRYT, CMYT and CNUYT) confirmed its better adaptability and stability in response to diverse agro-climatic conditions, which is of most significant for its long-term adaptation over a major growing area (Ahmad et al., 2012; Naveed et al., 2012; Waseem et al., 2014; Javed et al., 2016). Several other researchers like Saleem et al. (2002), Ahmad et al. (2002), Ahmad et al. (2005), Sarwar and Ahmad (2003), Bakhsh et al. (2005) also reported such kind of results in other pulses, oilseed and legume crops than the checks.

Table 4. Chickpea Micro Yield Trials 2017-2018

Sr. No	Location	Grain Yield (Kg ha^{-1}) BRC-408	Noor-2013	% increase over check
1	Pulses Research Institute, Faisalabad (Irrigated)	1365	1165	17.2
2	Pulses Research Institute, Faisalabad (Rainfed)	1098	1161	-5.5
3	Nuclear Institute for Agriculture and Biology, Faisalabad	1826	1753	4.1
4	Gram Breeding Research Sub Station, KalorKot (Rainfed)	627	197	218.3
5	Gram Breeding Research Sub Station, KalorKot (Irrigated)	854	542	57.6
6	Arid Zone Research Institute, Bhakar	1260	889	41.7
7	Adaptive Research Station, Karor, Layyah	2111	2896	-27.2
8	Regional Agricultural Research Institute, Bahawalpur	1944	1632	19.1
9	Barani Agricultural Research Institute, Chakwal	1065	1241	-16.5
10	Barani Agricultural Research Station, Fateh Jang	941	877	7.3
	Mean	**1309**	**1235**	**6.0**

Table 5. Chickpea National Uniform Yield Trial 2017-18.

Sr. No	Location	Grain Yield (Kg ha^{-1}) BRC-408	Noor-2013	% increase over check
1	Ayub Agricultural Research Institute, Faisalabad	1424	1264	12.6
2	Gram Research Sub Station, KalorKot	799	278	187.4
3	Arid Zone Research Institute, Bhakar	1274	573	122.3
4	Barani Agricultural Research Station, Fateh Jang	1316	1670	-21.1
5	National Agricultural Research Center, Islamabad	1232	700	76
6	Nuclear Institute for Agriculture and Biology, Faisalabad	1535	1433	7.1
7	Qaid-e-Awam Agrcultural Research Institute, Larkana	2576	2604	-1
8	Arid Zone Research Institute, Dera Ismail Khan	906	1064	-14.8
	Mean	**1383**	**1198**	**15.4**

Table 6. Chickpea National Uniform Yield Trial 2019-20.

Sr. No	Location	Grain Yield (Kg ha^{-1}) BRC-408	Noor-2013	% increase over check
1	Pulses Research Institute, Faisalabad	976	674	44.8
2	Adaptive Research Station, Karak	1283	1398	-8.2
3	Arid Zone Research Institute, Bhakar	1090	840	-29.7
4	Arid Zone Research Institute, Dera Ismail Khan	250	522	-52.1
5	Barani Agricultural Research Station, Fateh Jang	760	726	4.7
6	Gram Research Sub Station, KalorKot	1656	927	78.6
7	National Agricultural Research Center, Islamabad	1989	1874	6.1

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8	Nuclear Institute for Agriculture and Biology, Faisalabad	852	931	-8.5
9	Qaid-e-Awam Agrcultural Research Institute, Larkana	2438	2729	-10.6
10	Regional Agricultural Research Institute, Bahawalpur	2049	1458	40.5
	Mean	**1334**	**1208**	**10.43**

Agronomic Studies

Average data of candidate variety regarding fertilizer (NPK) doses for two years (2017-19) are presented in Table 7a. It is obvious from the results that Rohi-chana-21 gave the highest yield (1730.4 kg ha^{-1}) when fertilized with **90-100-0** kg NPK ha^{-1}, respectively. So, it is clear from the experiment that the candidate strain is responsive to fertilizers. Weedicide studies showed that the maximum yield of 1970 kg ha^{-1} was obtained where Dual Gold was applied as post-emergence to control all types of weeds in BRC-408 while pendimethalin proved to be the best as pre-emergence herbicide (Table 7b).

Table 7(a). Fertilizer studies

Treatments	Description (N-P-K)	Grain Yield (kg ha^{-1})
T_1	0-0-0	1452.9
T_2	30-60-0	1609.2
T_3	60-80-0	1725.6
T_4	**90-100-0**	**1730.4**
T_5	60-80-60	1727.2

Table 7(b). **Weedicide (2 years) trials**

	Pendi (pre-emergence)	Dual –Gold (pre-emergence)	Pendi (post-emergence)	Dual-Gold (post-emergence)	Forward	Control	Hand weeding
BRC-408	**Yield (kg ha^{-1})**						
	1805	1435	1111	1970	1759	803	1605

Resistance against diseases and insect pests

The response of kabuli chickpea candidate variety to Fusarium wilt and Ascochyta blight diseases remained under regular study during 2019-20 at Regional Agricultural Research Institute, Bahawalpur. The disease score of Rohi-Chana-21 was recorded throughout the period as presented in Table 8. It showed an immune response towards gram blight. While in the case of wilting, it showed resistant (R) and moderately resistant (MR) response. The variety showed reaction of 5MR for fusarium wilt as compared to 15MRMS to 10MSS of the check varieties Noor-2013 and CM-2008, respectively, under agro-climatic conditions of Bahawalpur. While Ascochyta blight was not observed under Bahawalpur climatic conditions. Entomological studies revealed that the candidate variety was less attractive to pod borer than Noor-2013 and CM-2008 (Table 9). Average pod damage caused by pod borer under normal planting remained 7% - 8% as compared to checks i.e Noor-2013 and CM-2008 which were (8% - 9%) and (12% - 13%), respectively. The research trials were conducted at RARI, Bahawalpur from 2018-19 and 2019-20.

Table 8. Pathological studies

Genotypes	Fusarium Wilt	Ascochyta Blight
BRC-408	5MR	-
Noor-2013(Check)	15MRMS	-
CM-2008(Check)	10MSS	-

*MR= Moderately Resistant *MS= Moderately Susceptible *MSS= Moderately Susceptible
*MRMS= Moderately Resistant Moderately Susceptible

Table 9. Entomolgical studies

Varieties	Pod Damage (%)	
	2018-19	2019-20
BRC-408	8	7
Noor-13	9	8
CM-2008	12	13

Quality traits

Seed quality traits are important parameters that determine the likeness and unlikeness of a commodity among users (Bhatty, 1988). The quality parameters showed that the grain of Rohi-Chana-21 contains protein up to 22.06% and ash up to 3.73% while crude fat was 3.42% whereas the check variety Noor-2013 also possessed the same qualities (Table 10). The quality traits revealed that the new variety is almost the same as the existing check regarding quality traits

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(Ali et al., 2010ab; Ali et al., 2011ab; Ali et al., 2012; Ali et al., 2013).

Table 10. Evaluation of physio-chemical traits

Variety/Strain	Ash (%)	Crude Protein (%)	Crude Fat (%)
BRC-408	3.73	22.06	3.42
Noor-2013 (Check)	3.46	25.83	3.40

Conclusion

Rohi-Chana-21 is a high-yielding chickpea cultivar possessing good quality traits. It is tolerant to drought, a serious emerging threat to chickpea crop in South Asia. It has an excellent potential to cover maximum area due to its adaptability and yield. Punjab Seed Council unanimously approved this variety during its 54th meeting held on 15th July, 2020 in Agriculture House Lahore under the Chairmanship of Minister for Agriculture, Government of Punjab, under the name of "Rohi-Chana-21" for general cultivation in the whole Punjab, especially for drought-prone areas of the province.

Conflict of interest

The authors declared the absence of a conflict of interest.

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