

## NOOR-2019: A High-yielding and Marvelous Chickpea Kabuli Variety Developed in Punjab, Pakistan

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### Abstract

The advancement of the latest crop varieties with advantageous characteristics is an ongoing process. Over time, a cultivated variety becomes vulnerable to several factors of biotic and abiotic plant stresses. This article discusses creating a novel and inventive chickpea Kabuli variety known as "Noor-2019." This variety was developed using conventional plant breeding techniques to enhance yield capacity, seed form, coloration, and resistance against various diseases. During Rabi 2002-03 period, two local genotypes, namely K-90399 and K-52582 were interbred to induce heredity diversity. After a selection of six generations, a remarkably consistent lineage of Chickpea Kabuli PCK-09012, later denoted as Noor-2019, with pedigree noted as C.15/15/15/105/98/80/12, originated from the F6 generation in 2008-09. Concurrently, this line of Chickpea Kabuli was evaluated for yield potential, disease reaction, and other agronomic studies from 2009 to 2019 at eight different Chickpea growing areas of Punjab. On an average scale, Noor-2019 surpassed the corresponding control groups with a notable margin, displaying a 102.74% increase in PYT and 53.72% improvement in AYT. This specific candidate line exhibited slightly elevated yields, with 0.8% more in MYT and 2.84% increase in CYT. Throughout the national testing phase, this particular variety exhibited its superiority, achieving a 33.26% higher yield during 2014-15 season and 3.61% increase in the subsequent year, compared to the benchmark variety Noor-2013. This remarkable performance culminated in the candidate variant "Noor-19" achieving an impressive yield potential of 1963 kg/ha in the (NUYT) during 2014-15 period at the Gram Breeding Research Sub Station, Kallurkot. Noor-19 contains 23.19% crude protein and 4.06% crude fat content. Significantly, it achieves higher seed yields and possesses in-built resistance against Fusarium wilt, accompanied by moderate resistance to Ascochyta blight. Furthermore, it shows a commendable tolerance towards insect pests. Notably, the cultivation of this novel variety doesn't necessitate specialized production techniques; instead, it harmonizes seamlessly with existing agronomic methods. Its adaptability extends to irrigated and rain-fed chickpea-growing regions within the province of Punjab.

**Keywords:** Chickpea Kabuli, yield potential, Noor-2019 and Punjab.

### Article History

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### Introduction

The chickpea crop is classified as a cool-season legume. It is a self-pollinating crop with a chromosomal count of  $2n=2x=16$ . Belonging to the *Cicer* genus, this crop encompasses one growing and 43 wild species. It is cultivated in more than 50 world countries, with a predominant presence in arid to semi-arid tropical regions. This crop holds a distinctive position among worldwide food legumes. Rich in essential minerals, vitamins, amino acids, and

quality protein, chickpea grains offer a valuable nutritional source. Notably, it possesses a natural capability to enhance soil condition and structure through a nodulation system, reducing the crop's nitrogen requirements by facilitating the processing of atmospheric nitrogen. Its compatibility with sustainable agricultural production systems is well-established in existing research [14, 23, 24]. Categorized based on seed characteristics, the chickpea crop is commonly divided into two variants: chickpea Desi and chickpea Kabuli. The restricted allotment of *Cicer reticulatum*, identified as a wild ancestor, the dropping of genetic diversity, and the exchange of locally adapted landraces by genetically homogeneous varieties collectively contribute to the confined genetic foundation of chickpeas. This situation has rendered the crop susceptible to several biotic and abiotic stresses. Consequently, breeding efforts are necessary for growing and using genetically diverse germplasm [1, 24].

In the 2020-21 timeframe, chickpea cultivation covered an area of 2322.8 thousand acres within Pakistan, culminating in a yield of 545 thousand tons. This particular year saw a substantial uptick of 21.9 percent in gram output on account of higher yield due to favorable weather conditions during the sowing period. Chickpea desi accounted for an overwhelming 85% of the share, predominantly grown in the "Thal region." This variety relies on soil moisture coming from pre-seasonal rains. In contrast, chickpea Kabuli is cultivated in rainfed areas of the "Pothowar" region, and it is also found cultivated in irrigated patches of "Bahawalnagar and Thal," constituting approximately 15% of the area [11]. Notably, Pakistan secures the second position globally regarding chickpea acreage; however, the total production of chickpeas within the country falls dismally short, failing to meet domestic demands. Consequently, Pakistan has to import substantial quantities annually from foreign countries such as the Middle East, Australia, and Canada to fulfill the local chickpea demand-supply gap.

In Pakistan, various biotic factors like (*Fusarium* wilt) and (*Ascochyta* blight) alongside abiotic factors such as (drought, heat, cold, etc.) have adverse impacts on chickpea production [21, 22]. The studies showed that wilt alone could show yield losses of 12 million rupees annually [31].

Similarly, chickpea blight has the potential to cause substantial yield reductions ranging from 50% to 70% [18, 24]. This affliction tends to spread in epidemic proportions in regions characterized by higher rainfall at various stages of crop development, potentially resulting in complete crop failure during severe infestations [7].

The growth of disease-resistant and stress-tolerant varieties is a highly effective and least expensive method of dealing with various yield loss challenges [8, 16, 21, 23, 24, 25, 38, 30]. The development of the latest crop varieties is an ongoing and evolutionary process and is a primary purpose of any crop-breeding program [25]. Developing a new crop variety is a long process, typically extending over a decade or more. The specific duration depends on pollination methods, breeding techniques, selection criteria, and associated protocols. This encompassing process involves several stages, including the identification of promising parent plants, experimentation with various crosses, single plant selection in successive generations, assessment of plant responses to diverse biotic and abiotic stresses, rigorous agronomic investigations to evaluate different parameters, establishment of standards for yield and its components, conduction of distinct uniformity stability (DUS) studies, presentation of advanced lines for thorough evaluation, approval from a committee of experts, registration of the new variety, and ultimately, the authorization for widespread cultivation by the Provincial Seed Council (PSC). It is necessary to identify alternatives by creating varieties with enhanced productivity potential and genetic resilience against various stresses.

Chickpea plant breeders within the local community have exerted significant efforts to introduce various crop varieties characterized by enhanced yield capabilities and diverse disease resistance levels [3, 4, 5, 24, 29, 30].

The breeding program conducted at the Pulses Research Institute in Faisalabad specifically focuses on the enhancement of chickpea varieties. These varieties are being developed to exhibit elevated yield levels and increased tolerance to blight and wilt diseases, making them well-suited for rain-fed and irrigated agricultural regions. The newly developed variety displays notable potential for achieving high yields and exhibits resilience

against soil and airborne pathogens, outperforming the currently approved commercial varieties. This genotype will serve as a source of genetic diversity, invaluable for addressing potential climatic challenges. This advanced line is expected to be a popular variety because of its yield potential and resistance against major chickpea diseases. This new advanced line, as represented by PCK-09012 showcases significant attributes such as a protein content of 23.19%, a fat content of 4.06%, and a mineral content of 3.42%, in contrast to the reference variety Noor 2013 which possesses 19.69% protein, 3.78% fat, and 3.37% mineral content.

### **MATERIALS AND METHODS**

The breeding program focuses on characteristics such as yield potential, seed size, and disease resistance. To achieve this, two specific varieties (K-90399 & K-52582) of the Kabuli type of Chickpea were chosen to serve as parent plants for the hybridization process. These two parent varieties exhibit distinct differences, including the growth habits of the plants, grain size, yield potential, and response to diseases. In particular, the K-52582 genotype naturally displays a spreading growth pattern and possesses bold seeds, making it an ideal male parent for chickpea breeding due to its resistance to wilt. On the other hand, the K-90399 genotype has an upright growth habit and demonstrates superior yield potential, used as a female parent for chickpea kabuli.

Hybridization (F0) for the development of new variety: To introduce genetic variability, several crosses were initiated in 2002-2003 at the research area of Pulses Research Institute Faisalabad. To execute the hybridization process, male and female parent plants were cultivated adjacently, with equal row lengths and maintaining distances of 15cm plant to plant and 60cm row to row. Starting from the middle of February and extending to the middle of March, immature and unopened flowers from the female chickpea plants underwent manual emasculation using forceps, a technique described in previous research [33]. Subsequently, pollen collected from the male parent plants was immediately sprinkled on female chickpea parent plants. This pollination procedure was conducted during the early morning hours, specifically from 8:00 a.m. to 11:00 a.m., to prevent self-pollination.

Once the flowers that had been cross-tagged advanced successfully into pods and reached physiological maturity, these pods were harvested and threshed to procure the F0 generation seeds. Over the subsequent years, the progress report of the latest approved Kabuli variety of chickpeas is showcased in Table 1.

Development and enhancement of filial generations (F1 to F6): In the 2003-04 cropping season, F0 chickpea seeds were sown in rows to promote the growth of F1 hybrid chickpea plants. These F0 seeds were planted in parental lines of 4 meters each. In the field, a precise spacing of 15cm between plants in a row (P-P) and 30cm between rows (R-R) was maintained using a dibbler. The harvested F1 seeds from each plant were combined to create a bulk, which was then used to advance the F2 chickpea population in the following growing season. Single Plant Selection began from the F2 generation, where chickpea plants exhibiting desired traits were visually identified and chosen in the field. This selection process continued through subsequent generations, extending to the F5 population in a designated field area for pulse experiments. Throughout this breeding phase of the chickpea variety, a combination of the bulk and pedigree methods was employed for plant selection. By the time the F6 generation was reached, only uniform and genuinely representative pure lines of Chickpea were retained. The seeds from these selected lines were grouped for further evaluation and testing in various yield trials, including station, adaptation, national, and research-supporting trials.

General details of Experiments. The soil preparation phase involved incorporating a single bag of DAP (Di-ammonium phosphate) fertilizer per acre. Except for entomological tests, all agricultural and cultural protocols for the experimental genotypes were the same. The research followed a Randomized Complete Block Design (RCBD) with three replications for both yield assessments and field-oriented entomological and bacteriological investigations. Standard spacing distances for R-R and P-P were maintained. A planting scheme of two seeds per hole was implemented throughout the research trials to sustain the chickpea plant population.

**Table 1. Chronological stages of Noor-2019.**

Year	Filial Generation/Trial	Operation
2002-03	Hybridization	F <sub>0</sub> seed harvested
2003-04	F <sub>1</sub>	F <sub>1</sub> seed harvested
2004-05	F <sub>2</sub>	Single plants selection
2005-06	F <sub>3</sub>	Plant-to-row progenies
2006-07	F <sub>4</sub>	Plant-to-row progenies
2007-08	F <sub>5</sub>	Plant-to-row progenies
2008-09	F <sub>6</sub>	The uniform line selected and bulked
2009-10	Preliminary Yield Trial	Yield data were recorded
2010-11	Advanced Yield Trial	Yield data were recorded
2011-12	Micro Yield Trial	Yield data were recorded
2012-13	Cooperative Yield Trial	Yield data were recorded
2013-14	Agronomic Studies	Response to different irrigation levels
2013-14	Pathological Studies	Reaction to Fusarium wilt & Ascochyta blight diseases
2013-14	Entomological Studies	Infestation of gram pod borer pest
2013-14	Bacteriological Studies	Response to rhizobial inoculation
2014-15	National Uniform Yield Trial	Response to rhizobial inoculation
2014-15	DUS Studies	Response to uniformity
2015-16	National Uniform Yield Trial	Response to uniformity
2016-17	DUS Studies	Response to uniformity
2017-18	Spot examination	Response in the field by different experts
2018-19	Seed Production (BNS)	Maintenance and supply of breeder nuclear seed to seed companies and the farming community

**Parameters recorded in yield trials:** A consistent plot size of 4×1.2 m<sup>2</sup> was maintained across all types of yield trials, including preliminary, advanced, micro, and cooperative trials. The plot dimensions were adjusted to 4×1.8 m<sup>2</sup> in the National Uniform Yield Trial. Each chickpea yield trial incorporated at least one to two control entries, facilitating the assessment and examination of the performance of the test materials. Recorded measurements encompassed parameters such as plant stand percentage, days to reach 50% flowering (D.T.F.), days to achieve

90% maturity (D.T.M.), count of pods per plant, weight of 100 grains (in grams), and plot-based yield (in grams).

**Pathological studies on chickpea Kabuli:** To conduct disease-checking experiments related to Fusarium wilt and Ascochyta blight, all chickpea genotypes were planted twice using a plot area of 0.3 m<sup>2</sup> on the sick plot method [28]. Experiments aimed at assessing the reaction of advanced test lines to Fusarium wilt were carried out using a naturally infested design where pathogen inoculum was consistently generated to maintain

appropriate pathotypes. Test advanced lines were grown in pairs, along with a susceptible chickpea check variety "AUG-424," to amplify the inoculum pressure. Among all susceptible lines, wilt disease was observed, indicating the highest level of field wilt infestation. Initial data collection regarding wilt frequency was initiated 30 days after planting and continued at 10-day intervals until the crop reached maturity. The susceptibility or resistance of each advanced line to *Fusarium* wilt was determined using the disease rating scale (DRS) [13].

For *Ascochyta* blight, an artificial plastic tunnel equipped with a sprinkler system generated an artificial mist exceeding 90%. The plastic tunnel is conducive to the advancement of *Ascochyta* disease. To monitor the disease's intensity and severity, chickpea variety Punjab-1, acting as a spreader or check variety, was interplanted every two test-advanced lines. Within the tunnel, plant inoculation occurred through spraying at the 8-10 leaf stage, typically within the initial days of February. Subsequent assessment took place approximately fourteen days post-inoculation, with a scoring system that ranged from 0 to 9 on the Disease Rating Scale (DRS) established by [32].

### Entomological studies on chickpea Kabuli:

#### Specific details of Insect Pest

*Helicoverpa armigera* [Hubner] is the most devastating chickpea pest responsible for substantial yield loss. Productivity losses by gram pod borer range from 20 to 90 percent, depending upon the severity of insect attack. *Helicoverpa armigera* is considered a widespread and cosmopolitan insect responsible for the drastic decline in chickpea productivity worldwide. Management of *H. armigera* is of prime importance to achieve sustainable chickpea yields. Its life cycle passes through egg, larvae, pupae, and adult stages in about 4-5 weeks. From 1<sup>st</sup> to 3<sup>rd</sup> instar larvae generally feed on leaves, twigs and flowers. In later stages, larger larvae (4<sup>th</sup> to 6<sup>th</sup> instar caterpillars) shift to developing pods by making holes/bores and consuming entire developing seeds. Pod borers can cause yield losses of up to 90 percent, depending upon the insect density. Due to its polyphagous nature being a voracious feeder, it may be called a pod borer in chickpeas & or a fruit borer in tomatoes depending

upon its host crop. One larva per meter per row/ 3 Larvae/ 25 Plants.

For conducting insect pest screening under natural field conditions experiments for Chickpea regarding pod borer, all the advanced lines of Chickpea (Kabuli) were laid out in RCBD having three replications including check-in each repeat following planting geometry of Inter/ Intra row spacing= 30/15 cm with plot size of 4x1.2 m.

Pod infestation (%) was assessed by calculating the total number of damaged pods from 10 randomly selected plants from each treatment. Percentage pod infestation was calculated by the formula *i.e.*,

$$\text{Pod infestation (\%)} = \frac{\text{No. of Damaged Pods} \times 100}{\text{Total No. Of Pods}}$$

Its ETL is 5 Larvae/ Sq.m [17].

#### Bacteriological studies on chickpea Kabuli:

Field experiments were carried out to estimate the performance of the potential variety in comparison with established chickpea varieties, using two different conditions: Control and inoculation with rhizobial bacteria. With a plot size of 4 x 1.2 meters, all the advanced lines of Chickpea (Kabuli) were planted in RCBD with three replications, each including a check. The planting geometry used was inter/intra row spacing of 30/15 cm. Data regarding the number of nodules of each plant and the yield of grains of each plant for chickpeas was recorded.

#### STATISTICAL ANALYSIS

The measured characteristics were put through variance analysis to identify the genetic distinctions among the parameters throughout the research duration [34]. Almost all of the morphological attributes linked to yield and yield-related factors exhibited noteworthy variations.

#### RESULTS AND DISCUSSION

The advancements achieved in agriculture, especially in plant breeding, focused on creating new crop varieties with desirable attributes, are truly remarkable. The expertise in identifying unique and favorable traits and incorporating them into new and advantageous, genotypes remains a fundamental aspect of classic plant breeding institutions [19]. This practice, with its roots tracing back to the dawn of human civilization, has significantly contributed to enhancing agricultural production systems [15, 26]. Numerous varieties of chickpeas such as

NIFA-88, Noor-91, Thl-2006, Punjab-2008, CM-2008, Punjab-Noor, Bittal-98, CM-98, CM-2000, Punjab-2000, Bhakkar-2011, and Noor-2013 in Pakistan and India (JGK-1 and PBG-2) have been developed utilizing this methodology [2, 3, 9, 12, 10, 11, 24, 29, 30, 5]. The yield potential of Noor-2019 was assessed through a chain of trials carried out at various locations and spanning multiple years. In these experiments, the performance of the Noor-2019 was outstanding. The yield outcomes of Noor-2019 were compared with control varieties and

are outlined in Table 2. In station-based trials, encompassing both preliminary and advanced stages, Noor-2019 exhibited grain yields ranging from 924 to 2449.5 kg/ha. This far exceeded the yield performance of the control varieties, namely Noor-91 (382 to 529 kg/ha) and Noor-2009 (1209 to 1979 kg ha<sup>-1</sup>). Notably, the average yield of Noor-2019 across station trials was 1686.5 kg ha<sup>-1</sup>, significantly surpassing the average of both control types (Noor-91 and Noor-2009) at 1024.5 kg/ha.

**Table- 2 Yield performance of the variety Noor-2019 in various yield experiments.**

Year	Name of trial	Check(s)	Yield (kg/ha)		+/- Over checks (%)
				PCK-09012	
<b>Preliminary yield trial</b>					
2009-10	AARI, Faisalabad	Noor-91	382	701	83.51
	GBRSS, Kallurkot		529	1146	116.64
		<b>Average</b>	455.5	924	102.74
<b>Advanced yield trial</b>					
2010-11	AARI, Faisalabad	Noor-2009	1208	2017	66.97
	GBRSS Kallurkot		1979	2882	45.63
		<b>Average</b>	1593.5	2449.5	53.72
<b>Micro yield trial</b>					
2011-12	AARI, Faisalabad	Noor-2009	2675	2428	-9.23
	GBRSS Kallurkot		1875	2118	12.96
		<b>Average</b>	2275	2273	0.89
<b>Cooperative yield trial</b>					
2012-13	Cooperative yield trial	Noor-2009	1550	1594	2.84

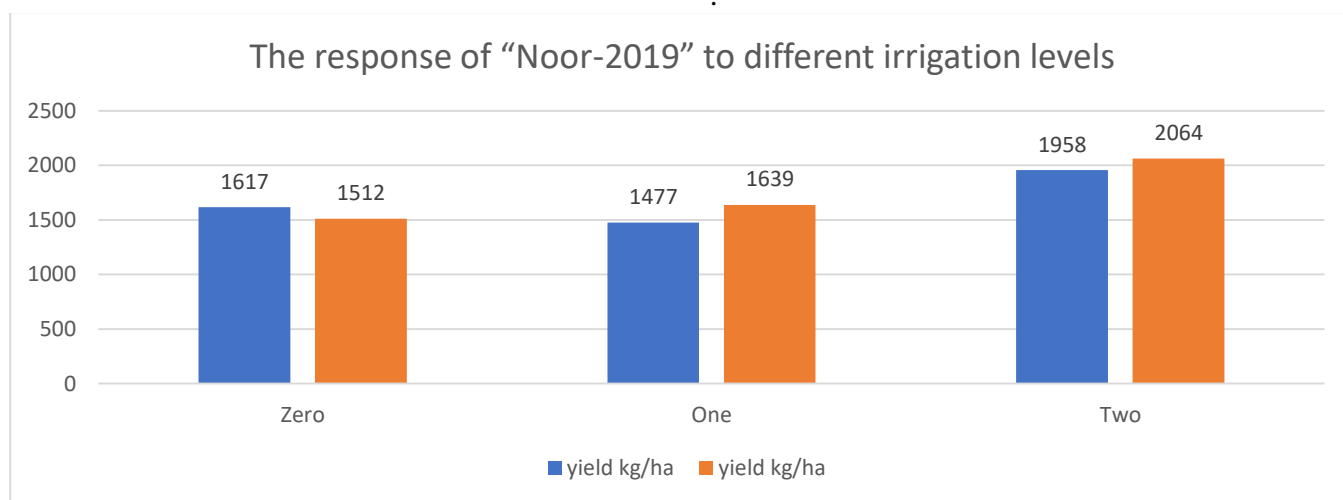
**Table-3. Performance of PCK-09012 as Noor-2019 in National Uniform Yield Trials (NUYT).**

Year	Locations	Check(s)	Yield (kg/ha)		+/- Over Checks (%)
				PCK-09012	
2014-15	NIAB, Faisalabad	Noor-2013	544	517	-4.96324
	AARI, Faisalabad		319	838	162.6959
	GBRSS, Kallurkot		778	1255	61.31105
	BARS, Fatehjang		373	356	-4.55764
	AZRI, Bhakkar		558	638	14.33692
	QAARI, Larkana		227	454	100
	RARI, Bahawalpur		1366	1644	20.35139
	AZRI, DIK		1017	911	-1 0.4228
<b>Average +/- Over checks (%)</b>					42.34395
2014-15 Coefficient of variation= 28.08% Genotypes(G), Location(L) & GxL interaction are highly					

significant (P <0.01)					
2015-16	BARS, Fatehjang	Noor-2013	1508	1379	-8.55438
	GBRSS, Kallurkot		1824	1963	7.620614
	AARI, Faisalabad		1627	1814	11.49355
	NIAB, Faisalabad		397	507	27.70781
	QAARI, Larkana		1051	930	-1 1.5128
	ARS, Karak		1799	1897	5.447471
	AZRI, Bhakkar		1760	1824	3.636364
	BARI, Chakwal		1028	951	-7.49027
	NARC, Islamabad		179	401	124.0223
	AZRC, D.I. Khan		1895	1900	0.263852
<b>Average +/- Over checks (%)</b>					15.26345
2015-16 Coefficient of variation= 20.01% Genotypes(G), Location(L) & GxL interaction are highly significant (P < 0.01)					
<b>The overall average in NUYT</b>			1013.889	1121.056	28.8037

In the Micro trial, Noor-2019 achieved grain yields ranging from 2118 kg/ha to 2428 kg/ha, showcasing superior performance over Noor-2009 (1875 to 2675 kg/ha). Moreover, the performance of Noor-2019 in NUYT (National Uniform Yield Trials) outperformed Noor-2013 and other reference varieties. Specifically, during the 2014-15 NUYT, Noor-2019 demonstrated a yield potential of 1963 kg/ha at GBRSS Kallurkot, Bhakkar, Punjab, Pakistan. The two-year average yield of NUYT amounted to 1092 kg/ha, in contrast to Noor-2013's average yield of 977.5 kg/ha. The new Kabuli chickpea variety, Noor-2019, developed using traditional techniques, demonstrated exceptional performance. It consistently out-yielded the comparison varieties throughout its assessment and testing phase. On average, Noor-2019 achieved a 102.74% higher yield in PYT and a 53.72% higher yield in AYT compared to the respective control groups. In multi-location yield trials that evaluated adaptability, the candidate variety displayed an 8% increase in MYT yield and a 2.84% increase in CYT yield. Across the two years of national testing, Noor-2019 exhibited a 33.26% higher yield in 2014-15 and a 3.61% increase in 2015-16 compared to the controls, showcasing its ability to thrive and yield effectively in diverse environmental conditions in Punjab, Pakistan [36]. Therefore, a candidate variety must consistently outperform existing checks and cultivated varieties

to gain approval from the relevant authorities. Notably, the Noor-2019 variety has surpassed earlier approved chickpea genotypes [5, 24, 29]. The key genetic enhancements in this variety, distinct from previously endorsed chickpea cultivars, encompass its high yield potential, inherent resistance to fusarium wilt, and moderate resistance (MR) to Ascochyta blight. The distinctive bold-seeded characteristic holds significant importance both in crop production and in satisfying end-user preferences [2, 12, 20, 35, 30, 23, 24]. Noor-2019 has demonstrated successful adaptation across Punjab, Pakistan, yielding 1963 kg per hectare in terms of potential yield and an average of 1406 kg ha<sup>-1</sup>. The outcomes of Noor-2019 and the control varieties under varying irrigation levels are shown in Fig.1. For the three irrigation levels (0, 1, and 2), consistent agronomic and cultural practices were kept, including plant-to-plant and row-to-row distances, as well as fertilizer applications. Under rain-fed or non-irrigated conditions, Noor-2019 yielded 1512 kg/ha, whereas the check variety Noor-2013 yielded 1617 kg/ha. Notably, Noor-2019 demonstrated a favorable response to the second irrigation level, resulting in a yield of 1639 kg ha<sup>-1</sup>, in contrast to Noor-2013's yield of 1477 kg ha<sup>-1</sup>. The overall average yield across all three irrigation levels indicated a yield of 1738.33 kg/ha for PCK-09012 (Noor-2019) compared to Noor-2013's standard variety yield of 1684 kg/ha.



**Fig 1. The reaction of Noor-2019 to different irrigation levels.**

The response of Noor-2019 to *Ascochyta* blight and *Fusarium* wilt is outlined in Table 4. These investigations were carried out in the Rabi season of 2013-14. About chickpea blight, both Noor-2019 and the standard variety received a rating of 5 on the scale, indicative of a moderately resistant (MR) disease reaction. Similarly, when assessed against chickpea wilt, the Kabuli chickpea line Noor-2019

obtained a rating of 3, representing a resistant (R) reaction. At the same time, the reference variety Noor 2013 received a rating of 5, indicating moderate resistance (MR). The insights into disease responses and performance in yield trials have established the potential for cultivating and promoting Noor-2019 across various environments conducive to various disease developments.

**Table-4. The response of PCK-09012 as Noor-2019 to *Fusarium* wilt and *Ascochyta* blight.**

S. No.	Diseases	PCK-09012	Punjab Noor (Check)
1	<i>Fusarium</i> wilt	Resistant	Moderately Resistant
2	<i>Ascochyta</i> blight	Moderately Resistant	Moderately Resistant

Entomological studies related to the infestation of pod borers, a Gram pest, on both Noor-2019 and the standard variety, are detailed in Table 5. The information about pest attacks and the percentage of pod infestation indicated a lower incidence of infestation on Noor-2019 when compared to the Noor-2013 control. However, the variations in infestation percentages did not demonstrate statistical significance.

The behavior of Noor-2019 and the comparison varieties in the presence of rhizobial inoculation (RI) are outlined in Table 6. The collected data unveiled an increase in the number of nodules and seed yield when subjected to inoculation as opposed to conditions without inoculation. In the context of

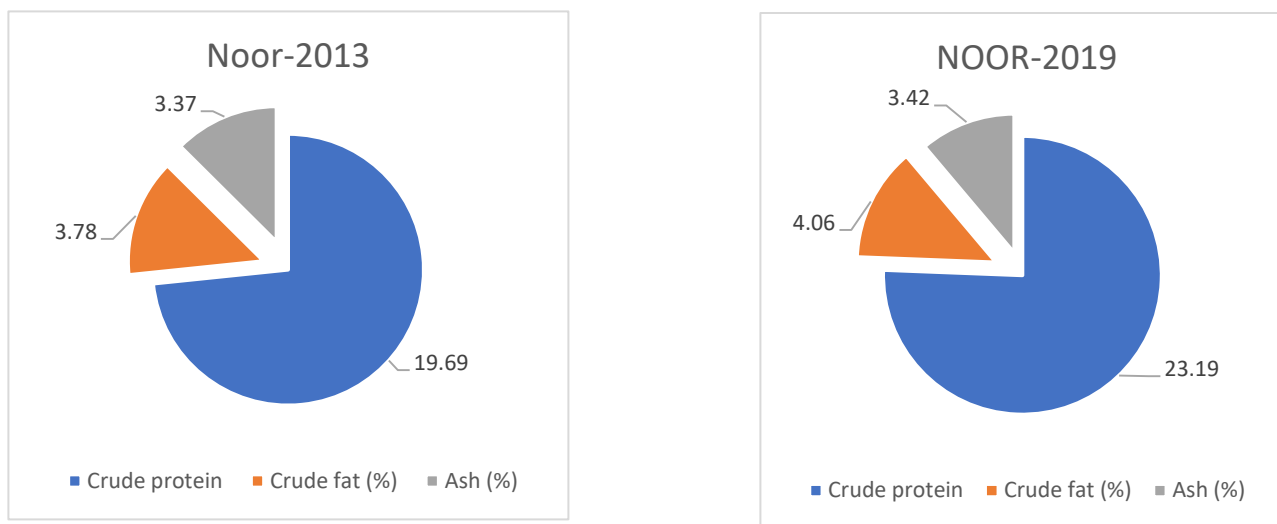
inoculation, Noor-2019 exhibited a range of 10 to 16 nodules of each plant and yielded between 1109 kg ha<sup>-1</sup> to 1412 kg ha<sup>-1</sup>. In parallel, Noor 2013 demonstrated a production range of 9 to 16 nodules per plant and yielded between 1374 kg/ha to 1463 kg/ha. Notably, the reaction of Noor-2019 under uninoculated conditions was superior to that of the reference variety Noor 2013. In this scenario, Noor-2019 displayed a produced range of 10 to 11 nodules of each plant and yielded between 1109 kg ha<sup>-1</sup> to 1490 kg ha<sup>-1</sup>, whereas Noor 2013 exhibited a produced range of 9 to 10 nodules of each plant and yielded between 1090 kg ha<sup>-1</sup> to 1374 kg ha<sup>-1</sup>. Several qualitative and quantitative characteristics of PCK-09012 in contrast to Noor 2013 are shown in Table 7.

**Table-5. The infestation of gram pod borer in Noor-2019**

Entries	No. of pods studied	Infested pods	%age infested	Yield (kg/ha)
PCK-09012	82	6	7.1a	1208a
Noor-2013	84	6	7.3a	1042b

**Table-6. The reaction of Noor-2019 to Rhizobial inoculation.**

Description		2013-1 4		2014-1 5		Average
Treatment	Trait	Noor 2013(c)	PCK-09012	Noor 2013(c)	PCK-09012	Average
Un-inoculation	No. of Nodules Yield (kg/ha)	9	11	10	10	20
Inoculation		16	18	14	16	16
Un-inoculation		1244	1490	1090	1109	1233.25
Inoculation		1463	1769	1374	1432	1509.5



**Fig -2. The comparison of quality analysis between Noor-2013 and Noor-2019**

**Table 7. Agronomic, morphological, and qualitative plant characteristics of PCK- 09012 as 'Noor-2019,' compared with the control variety 'Noor-2013.'**

	Traits	Noor-2019 (PCK-09012)	Noor 2013(c)
<b>A: Stem</b>			
1	Plant height (cm)	60-65	65-70
2	Growth habit	Semi erect	Semi-erect to semi-spread
3	Canopy spread	Medium	Wide
4	Stem color	Light green	Light green
5	Primary branches	2-4	4-5
6	Secondary branches	3-7	7-1 0
<b>B: Leaf</b>			
1	Leaf color	Green	Green
2	Leaflets per leaf	15-1 7	15
3	Leaflets size	Medium	Large

4	Leaf hairiness	Medium	Medium
5	Days to 50% flowering	115-1 20	110-1 15
<b>C: Pods</b>			
1	Pod size	Medium	Large
2	Shattering	Absent	Absent
3	Pods per plant	70-80	60-70
4	Seeds per pod	1-2	1-3
5	Days to 90% maturity	150-1 55	140-1 50
<b>D: Seeds</b>			
1	Seed shape	Ram-head	Ram-head
2	Seed color	Light brown	Brown
3	100 seed weight(g)	25	32-34
<b>E</b>	<b>Yield (kg/ha)</b>		
1	Yield potential (NUYT)	1963 (GBRSS K.kot)	3063
2	Average yield (NUYT)	1092	648
	<b>Adaptive areas</b>	All Punjab	All Punjab

**Botanical Description:** The growth habit of the chickpea plants ranged from semi-erect to semi-spread, accompanied by prominent pods and seed sizes. Contrasts were observed between the candidate line and the control variety, Noor 2013, regarding stem characteristics like plant height, growth pattern, canopy extension, and the count of primary and secondary branches on each plant. Other attributes also documented notable variations, encompassing leaf features such as color, the number of leaflets per leaf, and leaf hairiness. Similarly, the reproductive traits displayed dissimilarities, including phenological aspects like the duration to attain flowering and maturity, attributes of pods such as size and quantity, characteristics of seeds like color and weight per 100 seeds, potential yield, and disease response.

**Flower characteristics:** Noor-2019 displays a range of agro-morphological characteristics. Its plant height varies from 60 to 65cm, and it features a stem with a light green hue a semi-erect growth pattern. The canopy is of medium density, adorned with 2-4 primary branches and 3-7 secondary branches. The leaves comprise medium-sized leaflets, typically containing 14-17 greenish leaflets per leaf, and they possess a moderate amount of pubescence. The flowering process takes about 115-120 days to reach 50% bloom, while physiological maturity is achieved within 150-155

days.

**Pod and Seed characteristics:** The plant exhibits an average of 70-80 pods, each containing 1-2 seeds. Noor-2019 is characterized by larger pods that do not experience pod shattering. Seeds of Noor-2019 possess a ram's head shape and are light brown, with a 100-seed weight measuring 25 g.

**Conclusions:** The authorized variety Noor-2019 stands out as a high-yielding chickpea variant with bold seeds, exhibiting resilience against prevalent chickpea diseases such as Fusarium wilt and Ascochyta blight. Noor-19 contains 23.19% crude protein and 4.06% crude fat content. Seeds of this fresh variety display a light brown color, are ram-headed, and weigh 25 grams per 100 grains. The plant has a moderately expansive canopy with a semi-erect growth pattern, while the seeds range from medium to bold. It has showcased its significance through notable performances in station yield, adaptation yield, and National yield trials, surpassing the performance of comparator varieties by a considerable margin. The distinctive traits of Noor-2019 are anticipated to garner recognition within the agricultural community. Its adoption, encompassing processes like seed multiplication, refinement, and on-farm promotion, will contribute to stabilizing chickpea production. Moreover, this variety is poised to alleviate the escalating import expenses related to chickpeas (Pulses) in Pakistan. Notably, PCK-09012 emerged

as a top contender in national yield trials during 2015-15 and secured the second position in the 2014-15 trials. The well-suited attributes of Noor-2019 make it suitable for cultivation across diverse regions, including rain-fed and irrigated areas. Its compatibility with mechanical harvesting further enhances its appeal. The Punjab Seed Council (PSC), Lahore, has led to the approval of this novel variety, designated as Noor-2019, for widespread commercial cultivation throughout Punjab, Pakistan. This development is poised to be a significant advantage for Kabuli chickpea cultivators in Punjab, Pakistan.

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