Official publication of Pakistan Phytopathological Society
Pakistan Journal of Phytopathology
ISSN: 1019-763X (Print), 2305-0284 (Online)
http://www.pakps.com

PUNJAB MASOOR-2020: A NEW LENTIL VARIETY WITH HIGH SEED YIELD AND RESISTANCE TO POTENTIAL FUNGAL DISEASES

[a]Sadia Kaukab, [b]Muhammad E. Khan, [a]Muhammad A. Amin, [a]Muhammad Akhter, [c]Aziz U. Rehman, [d]Muhammad Shahid, [d]Muhammad J. Asghar, [d]Muhammad Rizwan

[a] *Pulses Research Institute, AARI, Faisalabad, Punjab, Pakistan.*
[b] *Sugarcane Research and Development Board, Punjab, Pakistan.*
[c] *Wheat Research Institute, AARI, Faisalabad, Punjab, Pakistan.*
[d] *Nuclear Institute of Agriculture and Biology (NIAB), Faisalabad, Punjab, Pakistan.*

A B S T R A C T

Lentil is a rich source of dietary proteins used worldwide and especially in Asian countries. The objective of the study was to develop and identify high-yielding, disease resistant and drought tolerant genotypes from available germplasm and international nurseries of lentil. The hybridization of (01503 × NL-2002) charted by the bulked pedigree method of selection. The newly developed line LPP 12161 was tested in a series of trials on multi-locations carried out in central Punjab at the farm area of Pulses Research Institute, Faisalabad, and NIAB. During Screening Nurseries Trials, this line produced 41.13% and 63.41% higher yields than the standard checks. Similarly, in yield trials, this line achieved 2925 kg ha^{-1} yield. This line was characterized by maximum yield potential along with better morphological characteristics that led to the adoption of this genotype with the other commercial cultivars. It is moderately resistant to rust, botrytis grey mold and resistant to collar rot and fusarium wilt diseases. It possesses excellent agronomic characteristics; better adoption and disease resistance attributes make it suitable for production throughout Pakistan. It stood the second position in National Uniform Yield Trials (NUYT) at a country level and secured the first position at Punjab in yield-related trials. Therefore, this line was approved as a variety and named Punjab Masoor-2020 used for commercial cultivation all over Punjab.

Keywords: *Lens culinaris* L., high yield, performance, breeding, disease resistance.

INTRODUCTION

To meet the protein requirements of common man in Pakistan, pulses play a major contribution as it contains 25 to 32% protein. In Pulses, Lentil (*Lens culinaris* Medik.), is a rabi pulse crop after chickpea and plays an important role in cereal-based diet (Ramdath *et al.,* 2020) The demand of lentil is increasing every year due to increase in population yet its area and production in the country is decreasing drastically (Erskine *et al.,* 2011). During last five years, a considerable decrease in overall area and production has been observed. In 2019-20, the area of lentil was 9.5 thousand hectares while in 2020-21 the area was decreased to 6.5 thousand hectares. It shows that area decreased by 30.5%. During 2020-21, lentil production remained same as in previous year 2019-20 because average yield of the cultivars were increased (Anonymous, 2020-21). In Pakistan, average yield of crop is considerably low while the potential yield of lentil varieties ranges between 1500 and 2000 kg ha^{-1} (Aktar *et al.,* 2016).

In Pakistan, a number of diseases caused by fungi, bacteria, viruses, nematodes and phanerogamic plant parasites were reported in lentil (Sarwar *et al.,* 2014, Akhtar *et al.,* 2016). Fusarium Wilt (FW), Rust (R), Botrytis Grey Mould (BGM) and Collar Rot (CR) are common diseases of lentil (Garkoti *et al.,* 2013 and Kant *et al.,* 2017). Fusarium wilt of lentil is an important disease reported in every continent where lentil is

Submitted: July 08, 2022
Revised: October 19, 2022
Accepted for Publication: Noverber 29, 2022
* Corresponding Author:
Email: ehsankhanuaf@gmail.com

grown. Normally wilt causes 5-10% yield losses but in severe destruction complete failure of the crop occurs (Stoilova and Chavdarov, 2006). Depending upon the crop stage at which it attack and severity of the pathogen (Chaudhary and Kaur, 2002). Lentil collar rot caused by *Sclerotium rolfsii* is major fungal disease of lentil. Yield losses up to 50% at farmer field. At seedling stage, when temperature and soil moisture high the disease spread in almost every region where lentil is grown. This disease causes huge losses in Pakistan, Bangladesh, Ethiopia and India (Chen *et al.,* 2011). In severe condition, rotting of whole plant and in some cases death of seedlings at ground level in small patched also observed (Agrwal *et al.,* 1979).

Rust of lentil is a widely occurring disease causing heavy losses to the crop in certain areas. It may assume an epidemic form if favorable weather conditions exist as much as 100%. Epiphytotic of lentil rust are common in many countries including Pakistan. Lentil rust caused by *U. fabae* is wide spread in South Asia and is characterized by abrasions on the stems and leaves, leaves drop and premature plant death. Losses from the disease have been estimated up to 70% (Beniwal *et al.,* 1993, Erskine and Saxena, 1993). Botrytis grey mould (BGM) of lentil, caused by the fungal pathogens *Botrytis fabae* and *B. cinerea*, is a serious, but sporadic disease. In Australia, the disease has also been reported in 1983 the wet year and since then it has caused extensive destruction to profitable lentil crops grown throughout Victoria and South Australia. Botrytis grey mould has also been reported as being a serious problem throughout the sub-continent including Bangladesh and Pakistan. It is a wide spread problem damaging 30% of the plants to total disaster in particular fields depending on the soil conditions and crop environment (Bayaa *et al.,* 1997). Development of genetic resistant varieties is the only viable control measure for these diseases otherwise it is very difficult to control through the use of chemicals or cultural practices (Younis *et al.,* 2008). To increase production it is essential to increase cropping area of lentil and this is only possible if we evolve better genotypes that can replace poor yield potential and less resistant varieties. It is very clear that among the many reasons of low production in the country, one is non-availability of pure seed of high yield potential varieties having inbuilt resistance against fungal diseases. Therefore, keeping in view the above situation, a new lentil variety was developed to enhance lentil productivity in Pakistan.

Variety Punjab Masoor-2020 was developed by NIAB and AARI Faisalabad. It is the first lentil variety with high yield and resistance against multiple fungal diseases, almost after 10 years of Punjab Masoor-2009 (check variety). The purpose for write-up this research was to highlight the breeding, agronomic and morphological characteristics of variety Punjab Masoor-2020.

Breeding Methods: The new variety Punjab Masoor-2020 is an outcome of hybridization of 01503 × NL-2002 followed by bulk-pedigree method of selection. Complete breeding history of this variety is presented in Table 1.

Parental lines (male and female) i.e. source populations were planted in the month of November 2004-05 keeping 30 cm row to row and 10 cm plant to plant distances. Parental lines were crossed in the morning between 7:00 to 10:00 AM at research farm of Pulses Research Institute, Faisalabad. Before pollen shedding, hand emasculation of female flower was done early in the morning and emasculated flowers were immediately pollinated. Harvested the seeds of F_0 from female parent and then space planting was done to advance F_1 population in 2005-06.

Sowing of F_1 hybrid seed was done in single row of 4 m length along with parental lines. The seeds of F_1 were planted by dibble method 4 cm p × p and 30 cm r × r distances and developed F_2, F_3 populations bulked in 2006-07 and 2007-08, respectively. Phenotypic selection of desirable plant was done in these generations (Gupta *et al.,* 2012). In F_4 generation, selection of single plants were made for desirable plants and continued up to F_5 generation during the year 2009-10. In F_6 generation, pure line was selected which was tested for yield in yield nursery trials (Preliminary Yield trials / Advance yield trials and Micro yield trials) during subsequent years 2010-2017.

Pure line LPP 12161 was first tested in yield and disease screening nursery in 2012-13 to 2013-14. It is previously tested for three years in station yield trials, two years agronomic trials, two years in national uniform yield trial (NUYT) during 2016-18 and two years in distinguished, uniformity and stability (DUS) 2018-19 studies. In all the yield related trial sowing was done usually in last week of October. In these

yield related trials experiments was laid out in Randomized Complete Block Design (RCBD) with three replications except NUYT which is conducted as per instructions of National Pulses Coordinator. The r × r distance was 30 cm while p × p distance was 10 cm in each yield related trial. Single row drill was used for planting in four rows of 4 m length. At seedling stage, plant population was maintained by thinning. One to two standard checks were included in every experiment for comparison. Disease reaction for the collar rot, fusarium wilt was recorded under artificially inoculated conditions. Screening against lentil rust and botrytis grey mold was done in hot spot area Kot Nainan, Sialkot Pakistan.

Table 1. Different stages of development of variety Punjab Masoor-2020

Years	Filial Generation/Trial	Operations
2004-05	Cross was attempted	F_0 harvested
2005-06	F_1	F_1harvested
2006-07	F_2	Bulked
2007-08	F_3	Bulked
2008-09	F_4	Selection of superior single plants
2009-10	F_5	Selection of superior single plants
2010-11	F_6	Pure line selection
2011-12	Yield Screening Nursery and Seed Multiplication	Yield data were recorded
2012-13	Yield & Disease Screening Nursery	Yield and disease response were recorded
2013-14	Yield & Disease Screening Nursery	Yield and disease response were recorded
2014-15	Preliminary Yield Trial	Yield data were recorded
2015-16	Advanced Yield Trial	Yield data were recorded
2016-17	Micro Yield Trial	Yield data were recorded
2016-17	National Uniform Yield Trial	Yield performance results received from National Coordinator Pulses
2017-18	National Uniform Yield Trial	Yield performance results received from National Coordinator Pulses
2017-18	Distinguished Uniformity Stability	DUS study performed by Federal Seed Certification and Registration Department
2018-19	Distinguished Uniformity Stability	DUS study performed by Federal Seed Certification and Registration Department
2018-19	Spot Examination	Spot Examination Committee visited and evaluated the performance of candidate line at farmer field. Recommended the candidate line for approval from Expert Sub Committee.

PERFORMANCE CHARACTERISTICS

Varietal descriptors: Punjab Masoor-2020 is a medium seeded (as people in Pakistan preferred desi type of masoor), high yielder and multiple disease resistant variety as compared to standard variety Punjab Masoor-2009. The variety performs equally better both in irrigated and rainfed conditions and has vigorous growth habit. Semi-erect plant type with 44-50 cm plant height as compared to Punjab Masoor-2009. Number of branches varies from 33-36 as compared to check variety i.e. 27-30 reliant to abiotic and biotic stresses. Leaf color is light green with 13 numbers of leaflets. The plant has erect leaf angle with rudimentary tendril length. Its flowers are small in size, whitish purple in color. After sowing, plant required 90-100 days for 50 percent flowering while flowering duration is 35-40 days. As compared to Punjab Masoor-2009 this variety has larger pod size of 1.0 cm length, 5.0mm width and 0.50 cm thickness. The number of pods varies from 350-400 with 1-2 seeds per pod while pod shattering is absent. Seed color is brown, dot less with ram head shape. Seed is grey in color and medium in size and larger than check variety having 3.76- 4.25 mm diameter and 2.0-2.28 mm thickness with 25 g/1000-seed weight.

Yield evaluation: In our study, it is observed that yield of Punjab Masoor-2020 was higher in both Screening nurseries (Figure-1). In screening nursery-I the yield of Punjab Masoor-2020 was 41.13% (1098 kg ha^{-1} to 778 kg ha^{-1}) higher from Punjab Masoor-2009. Similarly, in screening nursery-II yield of Punjab Masoor-2020 was 63.41% (1407 kg ha^{-1} to 861 kg ha^{-1}) higher than Punjab Masoor-2009. In Station trials, preliminary yield trial

(PYT), the yield of Punjab Masoor-2020 was 1.35% higher (2925 kg ha^{-1} while yield of Punjab Masoor-2009 was 2886 kg ha^{-1}) during 204-15, in advance yield trial (AYT) the yield of Punjab Masoor-2020 was 14.45% higher (847 kg ha^{-1} while yield of Punjab Masoor-2009 was 740 kg ha^{-1}) during 2015-16 and in micro yield trials the yield of Punjab Masoor-2020 was 15.71% higher (1097 kg ha^{-1} while yield of Punjab Masoor-2009 was 948 kg ha^{-1}) during the year 2016-17. On an average new variety Punjab Masoor-2020 gave more yield of kg ha^{-1} as compared to checks in station and micro yield trials (Figure 1).

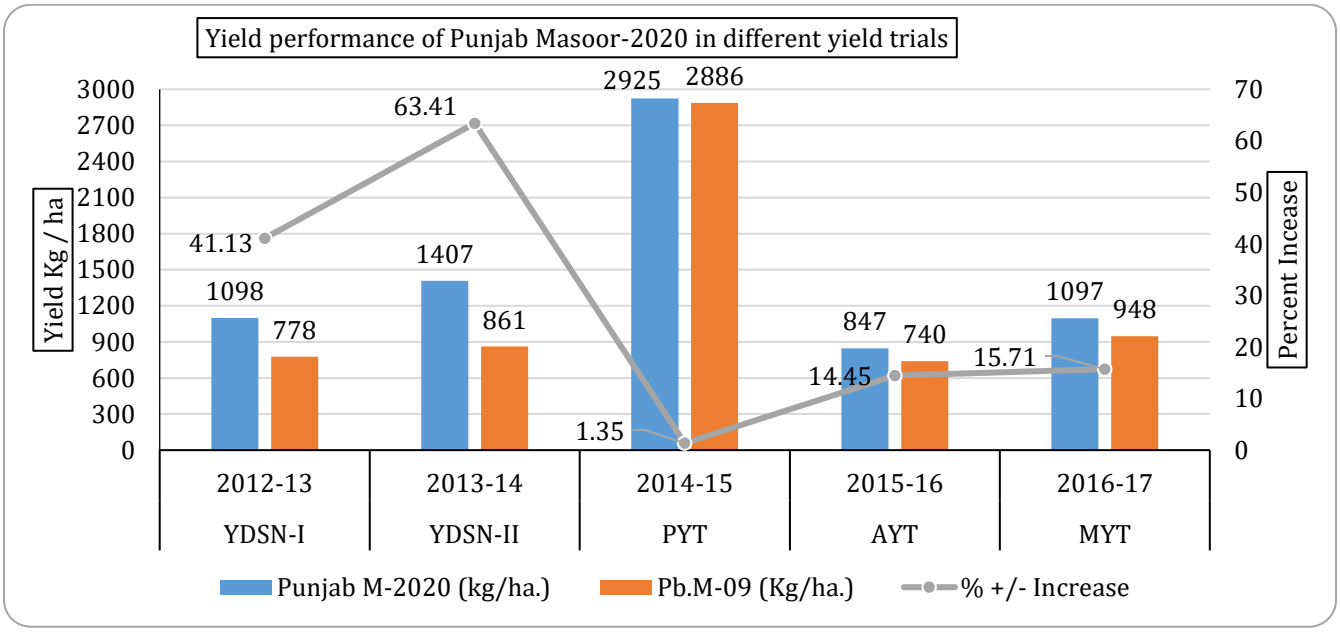

Figure 1. Yield performance of Punjab Masoor-2020 in different yield trials.

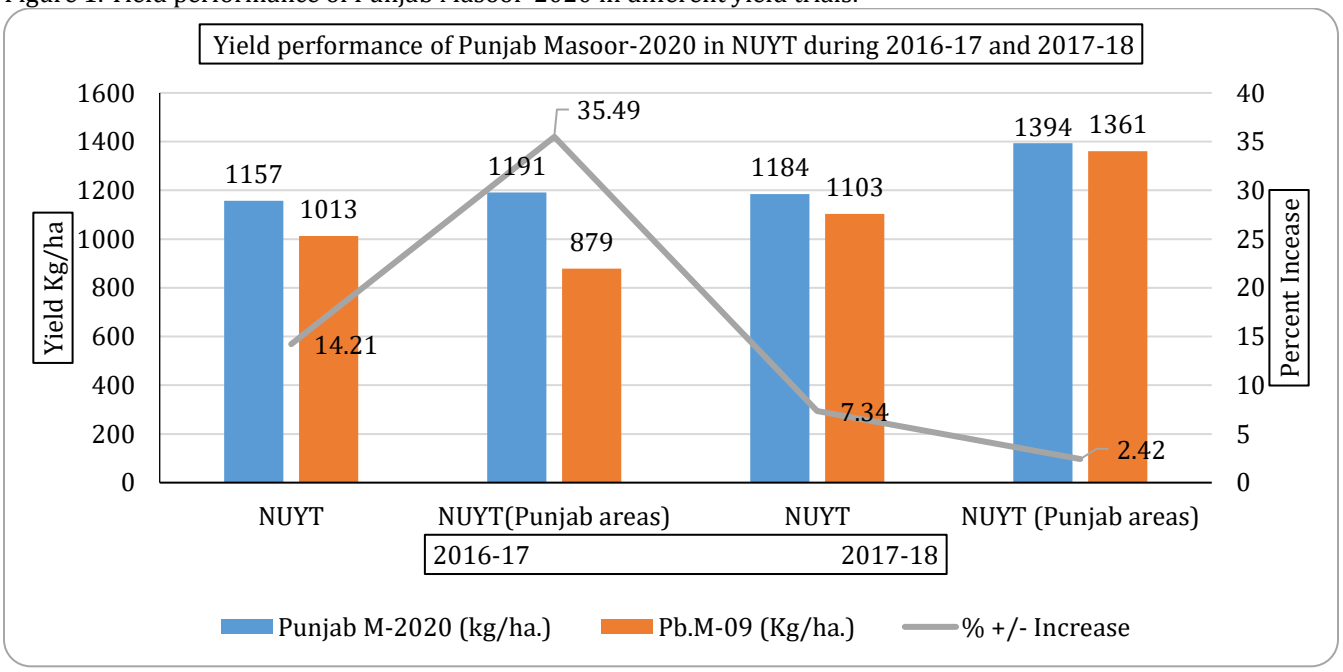

Figure 2. Yield performance of Punjab Masoor-2020 in National Uniform Yield Trials.

National Uniform Yield Trial (NUYT) was conducted consecutively for two years (2016-17 to 2017-2018) across the country. The data in Figure 2 showed that average grain yield of variety Punjab Masoor-2020 was 1191 kg ha^{-1} as compared to standard variety (879 kg ha^{-1}) means 35.49% higher yield in NUYT (Punjab areas) during 2016-17. The variety stood second position at country level in NUYT during the years 2016-17 with

yield of 1157 kg ha^{-1} while standard variety (1013 kg ha^{-1}) means 14.21% higher yield in NUYT and secured first position at Punjab level with a yield of 1394 kg ha^{-1} as compared to standard variety yield 1361 means 2.42% higher yield in NUYT (Punjab areas) during 2017-18. The potential yield of Punjab Masoor-2020 was 2150 kg ha^{-1} achieved in 2016-17 at Arid Zone Research Centre, Dera Ismail Khan.

Table 2. Yield (Kg ha^{-1}) response of Punjab Masoor-2020 in comparison with check variety under different sowing dates

Sowing Date	Punjab Masoor-2020		Punjab Masoor-09		Percentage increase	
Year	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
10 October	2194	2092	1962	1803	10.57	13.81
25th October	2529	2429	2420	2230	4.31	8.19
10 November	1015	1210	934	1104	7.98	8.76
25th November	1008	1108	919	1059	8.83	4.42
Average	1687	1710	1559	1549		

CV for reps × sowing = 10.67
CV for reps × sowing × entries = 13.55
LSD (0.05) varieties = 67 kg ha^{-1}
LSD (0.05) sowing dates = 51 kg ha^{-1}
CV for reps × sowing = 13.67
CV for reps × sowing × entries = 15.09
LSD (0.05) varieties = 74 kg ha^{-1}
LSD (0.05) sowing dates = 89 kg ha^{-1}.

Table 3. Disease reaction of newly evolved variety Punjab Masoor-2020 in comparison with check variety

Genotypes	Collar Rot	Fusarium Wilt	Lentil Rust	Botrytis Grey Mold
Punjab Masoor-2020	R	R	MR	MR
Punjab Masoor-2009 (Check variety)	S	S	S	MS

HR= Highly Resistant (Less than 1% of Plants infected), R = resistant (1-10%), MR = Moderately Resistant (11-20%), S= Susceptible (21-50%), HS= Highly Susceptible (>50%).

Agronomic studies: Planting date studies were conducted at Pulses Research Institute, Faisalabad during 2016-2017 and 2017-18 to fix specific agronomic requirements of the candidate variety Punjab Masoor-2020. Table-2 indicated that Punjab Masoor-2020 sown on 25th October, 2016 gave maximum yield of 2529 kg ha^{-1} as compared to other sowing dates and also 4.31% higher yield than Punjab Masoor-2009. Similar results were found during the year 2017-18 and Punjab Masoor-2020 was 8.19% higher yield than Punjab Masoor-2009. From these results it was observed that the new strain adheres to the existing production technology and needed no special treatments.

Resistance to fungal diseases: The disease screening studies for collar rot and fusarium wilt were carried out at Pulses Research Institute AARI, Faisalabad. For Rust and botrytis grey mould, screening was done in hot spot area i.e. Kot Nainan, Sialkot (Pakistan). Punjab Masoor-2020 was found moderately resistant to lentil Rust and Botrytis Grey Mold & resistant to Collar Rot and Fusarium Wilt while Punjab Masoor-2009 was found moderately susceptible for Botrytis Grey Mold and susceptible for Collar Rot, Fusarium Wilt and Lentil Rust.

Quality characteristics: This new lentil variety Punjab Masoor-2020 is suitable for eatable purpose both as whole as well as split (Dhall). It contains protein i.e. (28.9 %) as compared to check variety Punjab Masoor-2009 (28.2 %.)

Spot Examination: The candidate line was evaluated by spot examination committee on 27-03-2019. The committee reported the crop as fairly green and in good condition with moderate resistance to Lentil Rust & Botrytis Grey Mold and resistant to Collar Rot and Fusarium Wilt and recommended the candidate line to be presented in Expert Sub Committee meeting for its approval.

Approval notification and seed production: Punjab Masoor-2020 is the first lentil variety released in Pakistan which is endowed with high yield and resistance against multiple fungal diseases. With these attributes, Punjab Masoor-2020 should be an excellent choice for producers who wish to grow lentil in different lentil growing areas of Pakistan. In view of the comparative productive, morphological and agronomic characteristics, it was recommended for general cultivation in Punjab, Pakistan by Punjab Seed Council in 52nd meeting held on 14th of October, 2019. Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad

and Pulses Research Institute (PRI), AARI, Faisalabad are the maintainer of this cultivar and the producer of the nucleus and breeder seeds.

ACKNOWLEDGEMENTS

We are grateful to Punjab Agricultural Research Board (PARB) for funding under PARB Project 212 "Improvement of lentil germplasm for high yield and disease resistance". The contribution of field assistants, research and other staff in the development of this variety is also gratefully acknowledged.

REFERENCES

Agarwal, S., M. Khare and A. Jain. 1979. Diseases of lentil and their control. Technical bulletin. Jawaharlal Nehru Krishi viswa Vidyalaya, Jabalpur, Madhya Pradesh, India.

Akhtar, K. P., M. Dickinson, M. J. Asghar, G. Abbas and N. Sarwar. 2016. Association of 16SrII-C phytoplasma with lentil phyllody disease in Pakistan. Tropical Plant Pathology, 41: 198-202.

Anonymous. 2020-21. Economic survey of Pakistan. Government of Pakistan, Ministry of Finance, Economic Advisor's Wing, Islamabad.

Bayaa, B., W. Erskine and M. Singh. 1997. Screening lentil for resistance to Fusarium wilt: methodology and sources of resistance. Euphytica, 98: 69-74.

Beniwal, S., B. Bayaa, S. Weigand, K. Makkouk and M. Saxena. 1993. Field guide to lentil diseases and insect pests. International Center for Agricultural Research in the Dry Areas, 107.

Chaudhary, R. and A. Kaur. 2002. Wilt disease as a cause of shift from lentil cultivation in Sangod Tehsil of Kota (Rajasthan). Indian Journal of Pulses Research, 15: 193-194.

Chen, W., H. C. Sharma and F. J. Muehlbauer. 2011. Compendium of chickpea and lentil diseases and pests. American Phytopathological Society, 166.

Erskine, W. and M. Saxena. 1993. Breeding lentil at ICARDA for Southern latitudes. Lentil in South Asia Proceedings of the seminar on lentils in South Asia, 11–15 March 1991. New Delhi, India, 207-215.

Erskine, W., A. Sarker and S. Kumar. 2011. Crops that feed the world 3. Investing in lentil improvement toward a food secure world. Food Security, 3: 127-139.

Garkoti, A., S. Kumar, M. Lal and V. Singh. 2013. Major diseases of lentil: epidemiology and disease management-a review. Agriways, 1: 62-64.

Gupta, R., S. Begum, M. Islam and M. Alam. 2012. Characterization of lentil (*Lens culinaris* M.) germplasm through phenotypic marker. Journal of the Bangladesh Agricultural University, 10: 197-204.

Kant, P., M. Materne, M. S. Rodda and A. T. Slater. 2017. Screening lentil germplasm for stemphylium blight resistance. Australasian Plant Pathology, 46: 129-136.

Ramdath, D. D., Z.H. Lu, P. L. Maharaj, J. Winberg, Y. Brummer and A. Hawke. 2020. Proximate analysis and nutritional evaluation of twenty Canadian lentils by principal component and cluster analyses. Foods, 9: 175-183.

Sarwar, G., M. J. Asghar, G. Abbas and K. P. Akhtar. 2014. Effect of Fusarium wilt disease on seed yield of advance lentil genotypes. Pakistan Journal of Agricultural Sciences, 51: 1-12.

Stoilova, T. and P. Chavdarov. 2006. Evaluation of lentil germplasm for disease resistance to Fusarium wilt (*Fusarium oxysporum* f. sp. *lentis*). Journal of Central European Agriculture, 7: 121-126.

Younis, N., M. Hanif, S. Sadiq, G. Abbas, M. J. Asghar and M. A. Haq. 2008. Estimates of genetic parameters and path analysis in lentil (*Lens culinaris* Medik). Pakistan Journal of Agricultural Sciences, 45: 44-48.

Contribution of Authors:

Sadia Kaukab	:	Data Collection and guide in the write of the paper
Muhammad E. Khan	:	Write up of paper graphic presentation of data
Muhammad A. Amin	:	Technically evaluated the data and paper
Muhammad Akhter	:	Reviewed the paper
Aziz U. Rehman	:	Planning and evaluation of the experiment
Muhammad Shahid	:	Data provided from Nuclear Institute of Agricultural and Biology
Muhammad J. Asghar	:	Help out in research experiments, data collection and review
Muhammad Rizwan	:	Helped in statistical analysis