PERFORMANCE, ADAPTABILITY AND YIELDING POTENTIAL OF LENTIL (*LENS CULINARIS* L.) CULTIVARS UNDER DROUGHT SITUATIONS AND CURRENT CLIMATE CHANGE SCENARIO OF QUETTA BALOCHISTAN

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ABSTRACT

Lentil (*Lens culinaris L.*) is mostly cultivated and is one of Pakistan's most significant grain legume crops. In Pakistan, lentil are a crucial food source throughout the winter, and their growth typically occurs in rainy places. The regular yield of lentil in Pakistan is near to the ground because of non-stop farming of little conventional yield, potential cultivars requiring extreme vegetative progress along with unfortunate reaction to contributions and enhanced agro-management performances. The demand for lentil around the globe is very high, and the increase in the importance of lentil is estimated to be constant as for the estimated demand of the globe and in improvement in the study of lentil as the growth of enhanced cultivars. The present study was based on lentil cultivars comparison for yield and growth components at the investigation at field under the Directorate of Pulses, Agriculture Research Institute, Sariab, Quetta (30°11′N 67°00′E), Balochistan, during Rabi season, 2019-20. The experiment was put up as an (RCBD) in a split plot arrangement with 3 replications. The plot size was 4 x 4 m sq;row length, row to row space was 30 cm and five lines for drilling of seeds. Treatments were: six cultivars, i.e. T_1. Local Dasht Masoor, T_2. 99503 Masoor, T_3. PbMasoor 2009, T_4. Sheraz 96 T_5. Niab2002, and T_6. NIA Nasoor 2005. The sowing

of lentil cultivars was completed by single coulter hand drill in lines as recommended seed rate of 25 kg acr^{-1} was utilised for lentil cultivars. Nitrogen and phosphorus fertilisers were utilised at 20:50:30 NPK kg ha^{-1}, correspondingly. The recorded parameters are times to flowering, days to 90% plant maturity, plant height (cm), Number of pods plant-1, seed index, seed $plant^{-1,}$and Seed yield (kg ha^{-1}).Days to 50% flowering days to 90% maturity, plant height, seed index, amount of pods $plant^{-1}$yield per plot area and yield of grain per hectare (in kilogrammes) ranged from 146-125, 174-155, 38.84-28.17, 65-49, 2.26-1.60, 240.90-83.67 and 720.67-406.33, respectively. Sheraz 96 lentil cultivars' production was declared successively higher than the other cultivars in response to entire growth, yield and yield enhancing characters excluding plant height and $plant^{-1}$number. The maximum heights of plant had been recorded in Local Dasht Masoor (38.84cm) variety though the higher quantity of pods $plant^{-1}$has been documented inNiab 2002 (65).

SINTRODUCTION

Lentil (*Lens culinaris L.*), the local name considered as "Masoor",is known as the vital Rabi season pulse crop. It comes from the sub-family Papilionaceae further down the family Leguminosae. The cultivation of this pulse crop is 13.6 thousand ha in Pakistan, and the total production of cultivation is 6.4 thousand tons. The most suitable seasons are the rainy season and irrigated areas for its growth. Lentil is second among Pakistan's main seed legumes and vital crops(Economic Adviser's Wing(EAW), 2018-19). It is an inexpensive basis of vegetable protein and owns a significant quantity of vitamins, including vitamins A and B, along with phosphorus, iron and calcium, providing nutrition of great calories and nutritious worth. The normal protein concentration in lentil seeds is 23.7 per cent (Sharar*et al*. 2003). Leading producers of lentil are located in South Asia and China (44.3%), the United States (41%), North America (6.7%), North Africa along Central and West Asia (6.7%), Sub-Saharan Africa (3.5%), and Australia (2.5%). While South Asia grows lentil on 1.8 million hectares (ha) and produces 1.1 million metric tonnes (mt) fully as a postrainy period crop on residual moisture, which includes Turkey, Syria, Iran, and Morocco as major producers, grows lentil on 0.59 million hectares (ha) and produces 0.48 million metric tonnes. Lentil's bioactive constituents including squalene, phytosterols, and tocopherols likely originate from the plant's unsaponifiable

lipids (Ryan et al., 2007). For example, The saponins (triterpene glycosides) and phenolic complexes found in lentil have been linked to a reduction in animal hypercholesterolemia, which have excellent anti-oxidant active component capabilities (Amarowicz & Pegg, 2008; Amarowicz et al., 2009, 2010). Apart from that, the following crop is one of the most valued (green) manure and is utilised as a feeding crop. Husks, de-moisturised leaves, and stems are also utilised as livestock feedstuffs (Anon., 2000). Lentil' symbiotic nitrogen fixation and other beneficial properties make them a good crop to grow commercially, and their profitability in agriculture is on par with that of cereals.

It is known as the oldest grain legume domesticated. Its involvement in the human diet is of active reputation in numerous parts of the world. Its seeds afford an outstanding basis for carbohydrates, dietary fibres, and a stable variety of minerals, protein and vitamins. Lentil have the capability for the resolution of nitrogen in the atmosphere in the supreme regular amount of 4.4 kg ha^{-1} day^{-l}. This capability to resolve nitrogen in the atmosphere aids in developing the lentil itself and the crops planted afterwards (Parveen & Bhuiya, 2010).

Lentil is ranked the second prime planted legume in the Rabi crop season in Pakistan after chickpea (Cicer arietinum L.) together in excellence and amount (Zia et al., 2011). One of the most lentil growing countries in south Asia is Pakistan. Lentil were planted on 43.4 thousand acres in 2006, yielding an average of 597 kg per hectare and a total output of 25.7 thousand tonnes. The most important pulses grown in Pakistan are gram, lentil, mung and mash, cultured on about 6% of the entire cropped region, and Balochistan provides 7% of the entire region. Pulses are known as the finest substitute to achieve the necessities of proteins for reduced commonalities that are incapable of managing to pay for the livestock created protein rich goods (milk and meat) (Ashiqet al.2012).

It conquers second place amongst the most important grain legume. Pulses are recognised for their dietary worth and are an imperative element of the feeding basket of together rich and the poor. Due to the high resident growth, the call for pulses is growing speedily (Economic Survey of Pakistan 2009-2010).

In Pakistan, the accessible germplasm productivity and features related to productivity of lentil have not been estimated, whereas unlimited hereditary changeability was stated in the literature; usually in India, lentil germplasm grownup is considered a minor seed, primary flowering and maturation, petiteperiod and little biotic yield (Nourinet al., 2019). The lentil yield improvement is possible with a time of sowing and appropriate space in a row. Researchers showed that the lentil seed yield planted with a thin row with3 0 cm spacing formed a concentrated yield of seed than the 70 cm broader row spacing. The recognition of improved methods with implanting period, spacing of rows and advanced yielding variations might increase the yield of seed manufacture in lentil. On the other side, the plants cannot utilise the reserve proficiently after growing up low and planted scattered, eventually forming little yield (*Singh et al.*, 2009).It was resolved that the varieties NIAMasoor-2005 and NIA Masoor-2016 demonstrate maximum potential yield below the 30 cm row to row distance; it has demonstrated the finest presentation as associated with other cultivars under 30 cm row (Faqeer et al. 2020).

In the opinion of the overhead truths, the current study WAS conducted to understand the enactment of promising lentil (*lens culinaris* L.) cultivars for growth and yield constituents with following objectives.

1. To assess the adaptability and yielding potential of Lentil cultivars in climatic conditions of Quetta.
2. To examine different lentil cultivars for growth, development and biological yield components per unit area.

MATERIALS AND METHODS

The present study was accomplished on the enactment of good Lentil (*Lens culinaris* L.) cultivars for growth and yield components at the investigational field of Directorate of Pulses, Agriculture Research Institute, Sariab, Quetta (30°11′N 67°00′E), Balochistan, during Rabi season, 2019-20. The experiment wasset up as (RCBD) in a split plot arrangement with 3 duplications. Plot size was 4 x 4 m sq, row length, row to row space is 30 cm and five lines for drilling of seeds. Treatments were six cultivars, i.e. T1. Local DashtMasoor, T2. 99503 Masoor, T3. PbMasoor 2009, T4.Sheraz 96, T5.Niab2002, and T6.NIA Masoor 2005. The sowing of lentil cultivars

was done by means of a single coulter hand drill in lines. The suggested seed rate of 25 kilogram acr^{-1}wasutilised for lentil cultivars. Nitrogen and phosphorus fertilisers were applied at 20:50:30 NPK kg ha^{-1}, respectively.

The treatment details are as under:

T_1 = Local DashtMasoor, T2= 99503 Masoor, T3= PbMasoor 2009, T4= Sheraz 96

T5= Niab 2002, T6= NIA Nasoor 2005

The study parameters for treatments were: Flowering Days, Days to 90% plant ripeness, Plant Height (cm), Number of pods $plant^{-1}$, Seed index (g), Yield $plot^{-1}$ (g), Yield kg ha^{-1}

Procedure for recording observations

Days to flowering.

The flowering days amongst the verified lentil flowers reached 110 to116 days, divided, and multiplied with samples.

Days to 90% plant maturity.

Days to 90% plant ripeness were recorded attaining the 90% mature pods, and the procedure was like the recording of flowering days.

Plant Height (cm)

The plant height was taken in (cm)at the maturity stage of the crop with the help of measuring tape from the basal part to the areal (tip) of the plant in marked plants to each treatment.

Pods per plant

At the time of harvesting, we counted how many pods there were per plant across all treatments.

Seed index (g)

The index of seed worth was noted based on 100 seeds in gram manually detached by including in each treatment. They were weighed to record 100 seeds weight in grams.

Yield per Plot(g)

The following formula was used to determine the Yield/plot (g):

$$\frac{\text{Yield}}{\text{Plot}}(\text{g}) = \frac{Yield\ per\ Plot\ (kg)}{Plot\ Area\ (m^2)}\ \text{X}\ 100$$

Yield (kg per ha)

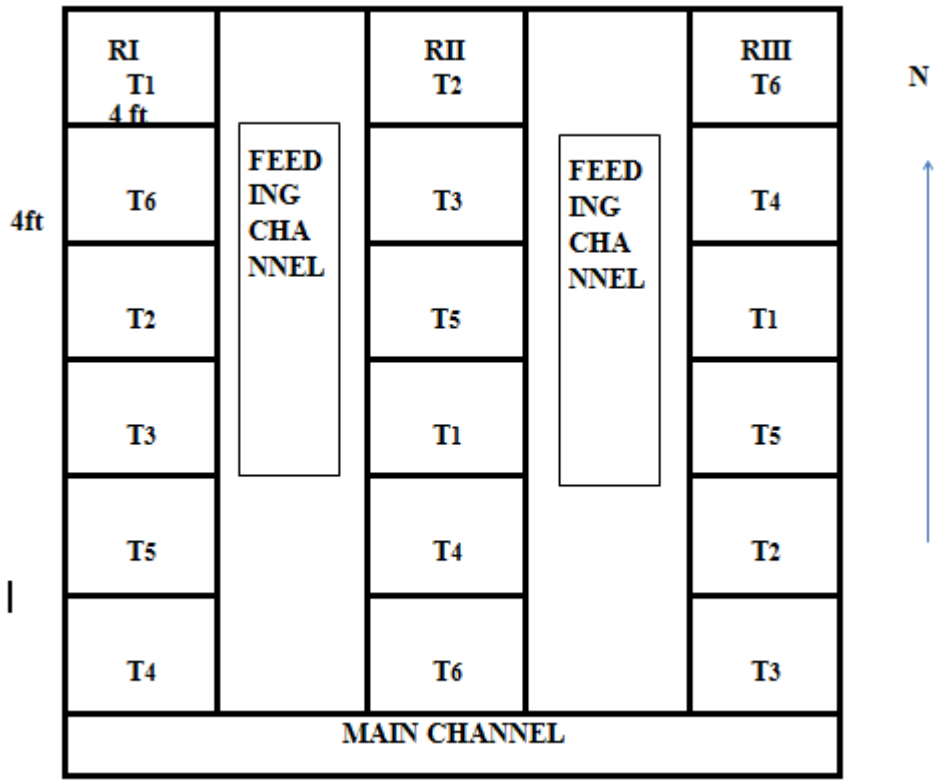
Calculation of yield (in kg per ha):

$$Yield\ (kg\ per\ ha) = \frac{Yield\ Plot^{-1}\ (kg)}{Plot\ area\ (m^2)}$$

Statistical analysis

The findingswere statistically analyzed to distinguish the supremacy of treatment means, utilizing the LSD (Least Significant Differences) test,using statistics 8.1 Computer Software.

LAYOUT PLAN OF EXPERIMENT



RESULTS AND DISCUSSION

The results for growth and yield parameters presented in tables 4.1 to 4.7 and interpreted as follows:

Days to flowering

The outcomes for phenological character ,days to flowering of different cultivars of lentil are presented in Table 4.1, whereas their examination of variance (ANOVA) is set in Appendix-I. The probability ($P<0.05$) estimations were high for days to flowering results, and the examination of variance exemplified that days to flowering were considerably ($P<0.05$) impacted under various varietal competition. Significantly minimum days to floweringof 125 were recorded with the treatment of Sheraz 96. However, there were non-significance differences betweenSheraz 96and Niab 2002. PbMasoor 2009 with 137 days and local DashtMasoor with 135 days

showed a difference, respectively. These cultivars had responded to efficient growth over production of early flowering between 125 to 146 days after sowing.

Consequently, on the other hand, the latest concerning days to flowering was 99503Masoor with 146 days. Furthermore, there was great competition between PbMasoor 2009 and Local DashtMasoor, positively obtaining 135 and 137 days to flowering, which was established as non-significant statistically each other. The early germination might have favoured rapid growth and enlargement of tissues resulting in higher flower initiation in lentil cultivars.

These outcomes closely conform with the result of Ali*et al.* (1999). They stated that they found Sheraz-96 colder tolerant than other lentil cultivars as they investigated in the upland of Balochistan. Due to This genetic potential of cold tolerance, Sheraz-96 performed better than other cultivars in respect of their contribution towards days to 50% flowering.

Days to flowering of different lentil cultivars.

Treatments	Cultivars	Mean
T_2	99503 Masoor	146 A
T_6	NIA Masoor 2005	142 AB
T_3	PbMasoor 2009	137B
T_1	Local DashtMasoor	135 B
T_5	Niab 2002	125 C
T_4	Sheraz 96	125 C

CV 3.12

Days to 90% Plant maturity

The results for phenological character days to 90% plant maturity of different lentil cultivars are presented in Table 4.2,although their examination of alteration (ANOVA) is specified in AppendixII. The data regarding the days to 90% plant maturity of lentilwas recorded as highly significant by six lentil cultivars.It is evident from the results that minimum days to 90% plant maturity (155) was recorded in treatment four

Sheraz 96 and Niab 2002,which were non-significant with each other. In comparison, the maximum days to 90% plant maturity (174) was achieved by 99503 Masoor and 169 days recorded in NIA Massor 2005. At the same time, results are statisticaly significantly different from each other except Local DashtMasoor and PbMasoor with the value of 164 days to 90% plant maturity. Due to high genetic potential and climatic adaptability, Sheraz 96 proved an early maturing variety regarding days to 90% maturity.

The lentil variety Shiraz 96 is exceptionally tolerant to cold (-18° C) and deficiency as it yields seed even at <100 mm rainfall,as reported by Asghar Ali *et al.* (1991).Therefore, due to this lentil variety, it performed better than other cultivars in respect of days to 90 % maturity.

The above stated para's have the most similarity to the actions of (Bicer and Sakar 2004), where they revealed that most early action of 90% plant maturity reached around 97 to 99 days. Furthermore, Awal*et al.* (2015) and Islam *et al*. (2015) investigated that the most statistically significantcultivars have taken 90 to 99 days regarding 90% plant maturity. While Conclusions of the current study are opposite to Wajid*et al.* (2013) reported that most cultivars have taken 148 days to 90% plant maturity interaction was significant for this character.

Table 4.2: Days to 90% plant maturity of different lentilcultivars.

Treatments	Cultivars	Mean
T_2	99503 Masoor	174 A
T_6	NIA Masoor 2005	169 AB
T_1	Local DashtMasoor	164 B
T_3	PbMasoor 2009	164 B
T_5	Niab 2002	155 C
T_4	Sheraz 96	155 C

CV 2.86

Plant height (cm)

The outcomesregardingthe height(cm)ofthe plant of different lentil cultivars are presented in Table 4.3,although their examination of alteration (ANOVA) is set in AppendixIII. The findings of the examination of alterationexemplified that various variety competition pointedly influenced the height (cm) of the plant.It was seen from the results that the highest (38.84 cm) plant height was observed under the Local DashtMasoor treatment with recommended fertiliser and cultural practices.In contrast, Niab 2002 was recorded at (27cm) in this study and considered the least value for plant height overall in this experiment. However, cultivar 99503 Masoor was observed (33.16) cm plant height, the second among all cultivars. The treatment (PbMasoor 2009) statistically with 31.83 in plant height and NIA Masoor 2005 with (30.96) cm, which is at par with 99503Masoor; the cultivarsSheraz 96 andNiab 2002 were close to each other and statisticaly similar to produce this growth parameter.

Our results contradict Faqeer et al.(2020), who reported maximum plant height in NIA masoor 2005.Consequently, these findings and measurements have similar results to Habib et al. (2013) examinationsregarding plant height.

Table 4.3:Plant height (cm) of different lentilcultivars.

Treatments	Cultivars	Mean
T_1	Local DashtMasoor	38.84 A
T_2	99503 Masoor	33.16 B
T_3	PbMasoor 2009	31.83 B
T_6	NIA Masoor 2005	30.96 B
T_4	Sheraz 96	28.17 C
T_5	Niab 2002	27.73 C

CV 4.39

Number of pods Plant^{-1}

The consequence of diversecultivars on the number of lentil podshas been examined, and the outcomes for this character are displayed in Table 4.4. The examination of alteration (AppendixIV) indicated that the impact of

growth and yield on the number of pods of lentil cultivars was significant.There were remarkable impact verities on the number of pod plant^{-1} in lentil, and crop performance for this parameter was superior under Niab 2002 and NIA Nasoor 2005.The lentilcultivarsNiab 2002 and NIA Nasoor 2005formedthe maximumamount of pods plant^{-1} (65). Cultivars Niab 2002, NIA Masoor 2005, and Sheraz 96 markedly reduced in PbMasoor 2009, while the lowermostamount of pod plant^{-1} of 49 was observed in 99503 Masoor,whichis at par with local DashtMasoor.

Almost alikeoutcomes were stated by Habib*et al.* (2013) and Hussain(2002); diverselentil cultivars also presented noteworthy variances in the amount of pods plant^{-1}. Lentil cultivar NIA Masoor-2005formed the maximum amount of pod against the lowest produced by Masoor-2009. The variance was because of inherited differences among the cultivars for this parameter. The number of pods plant^{-1} is sustainable evidence because of variation in their field.

Table 4.4: Number of pods plant^{-1}of different lentil cultivars.

Treatments	Cultivars	Mean
T_5	Niab 2002	65 A
T_6	NIA Nasoor 2005	65 A
T_4	Sheraz 96	64 A
T_3	PbMasoor 2009	58 B
T_1	Local DashtMasoor	51 C
T_2	99503 Masoor	49 C

CV 2.22

100 seed weight (g)

The seed test's weight is a significant feature in determining ultimate crop yield. The findings regarding 100 seed weight (g) as affected by diverse Lentil cultivars are presented in Table 4.5, whereas the examination of alteration is given in appendix V.

The outcomes of the alteration analysis elaborated that cultivars considerably influenced the 100 seed weight (g).Among other promising lentil cultivars, Sheraz 96 have significantly produced the highest seed weight, indicating that variation among these cultivars showedhigh yielding potential for growth.

A seed index value of 100 seed weight (g) was considerably supreme, 2.26 grams, in the situation of lentil variety Sheraz 96, followed by variety Niab 2002 and PbMasoor 2009with 100 seed weight (g) of 2.13 g.While thecultivar99503 Masoorand NIA Masoor 2005 produced seed weights of 1.86 g and 1.80 g, respectively. The last100 seed weight (g) value of 1.60 g was noted in the lentil variety Local DashtMasoor. These differences were due to inherited differences amongst the cultivars for this parameter.

Nearly few outcomes were stated by Sharar*et al.* (2003). Mahmood*et al.* (2010)supported their results in the cultivars regarding all characteristics, especially 100 seed weight. Their results further supported the rise in seed yield of diverse lentil cultivars due to the seed weight of different cultivars.

Asghar Ali *et al.* (1999) investigated and reported in favour of our findings; they reported that the seed size of Sheraz 96 is 3 times more than other cultivars; due to this character, Sheraz 96 produce 33% more seed than all other cultivars.

Table 4.5:Lentil' 100 seed weight (g)of different lentilcultivars.

Treatments	Cultivars	Mean
T_4	Sheraz 96	2.26 A
T_3	PbMasoor 2009	2.13 AB
T_5	Niab 2002	2.13 AB
T_2	99503 Masoor	1.86 BC
T_6	NIA Masoor 2005	1.80 C
T_1	Local DashtMasoor	1.60 C

CV 7.93

Yield plot^{-1} (g)

The results of the yield plot^{-1}as affected by different Lentil cultivarsare reported in Table 4.6,while the examination of alteration (ANOVA) is shown in Appendix-VI that elaboratedyield plot^{-1}(g) was pointedly (P<0.05) influenced by cultivars.

The observed range for different cultivars was 240.90yield plot^{-1}(g) for Sheraz 96 to 83.67yield plot^{-1}(g) for PbMasoor 2009. Yield plot^{-1}was a task of the collective impact of individual cultivars influenced by numerous genetic makeup. Thus, some difference between them is accountable for an alteration in seed yield. The maximum yield plot^{-1} 240.90 (g) of lentil was recorded for Sheraz 96 due to its adaptability in the Quetta environment.

The results of the two cultivars were non-significant with Sheraz 96; they were Local DashtMasoor and Niab 2002 with yield plot^{-1}of 204.15 g and 203.56 g, respectively. Variety NIA Masoor 2005 and 99503 Masoor also showed non-significant results with yield plot^{-1}of 188.13g and 151.63g, respectively. The lowest yield plot^{-1}was observed in PbMasoor 2009 with yield plot^{-1}of 83.67g.

The consequences are in agreement with those stated formerly (Wajid*et al.* (2013); the verities NIA Nasoor 2005, Punjab Masoor-2009, NIAB Masoor-2002 and NIAB Masoor-2006 were simulated exactly where Massor 85 exhibited the lowest one, the content of ash of lentil ranged in subsequent yield per plot. The consequences agree with the various content in lentil that numerous other workers have testified.

Table 4.6: Yield plot^{-1} (g) of different lentilcultivars.

Treatments	Cultivars	Mean
T4	Sheraz 96	240.90 A
T1	Local DashtMasoor	204.15 AB
T5	Niab 2002	203.56 AB
T6	NIA Masoor 2005	188.13 BC
T2	99503 Masoor	151.63 C
T3	PbMasoor 2009	83.67 D

CV 12.73

Yield kg ha^{-1}

The reaction of candidate variety and standards to different replications is presented in (Table4.7).Varieties of Lentil have a significant effect on yield (in kilos per hectare), while the variance analysis in appendix-VII explains that there was a significant increase in yield per hectare to influenced under implicatedcultivars.

These results revealed that the range for different cultivars was720.67 yield kg ha^{-1} for Sheraz 96 to 406.33 yield kg ha^{-1} for NIA masoor 2005. The final yield kg ha^{-1}combinedimpact of individual cultivars influenced by various genetic makeups.Thus, any distinction between them is accountable for altering seed yield.

The maximum yield kg ha^{-1} 720.67 was observed in Sheraz 96 because of its adaptability to the Quetta environment, whereas the least yield kg ha^{-1} 406.33 was recorded in NIA Masoor 2005. Regarding yield kg ha$^{-1,}$ results of three cultivars viz., Local dashtmasoor, 99503 masoor and Pbmasoor 2009 were non-significant with each other, with 538.67, 501 and 438.67 yield kg ha^{-1}, respectively.Cultivars 99503 Masoor, PbMasoor 2009, Niab 2002 and NIA Masoor 2005 showed non-significant results for yield kg ha^{-1}with values of 501.00, 438.67, 414.00 and 406.33, respectively.

Similar outcomes and results were found in the investigations of Habib*et al.* (2014). Furthermore, most of the obtained recordings of the current study also like Afeta et al. (2018) findings.

Table 4.7: Yield kg ha^{-1}of different lentil cultivars.

Treatments	Cultivars	Mean
T4	Sheraz 96	720.67 A
T1	Local DashtMasoor	538.67 B
T2	99503 Masoor	501.00 BC
T3	PbMasoor 2009	438.67 BC
T5	Niab 2002	414.00 C
T6	NIA Nasoor 2005	406.33 C

CV 12.89

CONCLUSIONS

In conclusion, it was declared that with the enhancement of the growth and yield, contributing traits of lentil slowly increased under these selected cultivars. However, the days to flowering did not increase significantly under 99503 Masoor and PbMasoor 2009 when compared with Sheraz 96, Niab 2002 and Local DashtMasoor, which indicates that Sheraz 96 was potentially a sound variety for obtaining higher growth and yield components.

RECOMMENDATION

The lentil cultivar Sheraz 96 is the best and recommended for cultivation by farmer sunder the climatic condition of Quetta Balochistan.

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