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Performance of Lentil (*Lens culinars* Medik. subsp. *culinaris*) varieties/Lines in Uplands of Tripura

U. Giri[1], A. Saha[2*], S. Biswas[3], R. Nath[4] and T.K. Maity[5]

[1 &2]Department of Agronomy, College of Agriculture, Tripura, Lembucherra, Tripura West-799210, India.
[3 &4]Department of Agronomy, BCKVV, Nadia, West Bengal-741252, India.
[5] Principal, College of Agriculture, Tripura, Lembucherra, Tripura West-799210 India.

(*Corresponding author: A. Saha**)
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ABSTRACT: Every year, Tripura has to incur lots of expenses in importing lentils from West Bengal, Bihar, UP as the productivity of lentil in Tripura is less due to non-availability of high-yielding varieties adopted in upland agro-climatic scenario. Lentil cultivators are losing interest in lentil production due to poor and uncertain yield achieved by locally available varieties. Keeping this in mind, a field experiment was conducted at Experimental farm of the College of Agriculture, Lembucherra, Tripura (W), India (23°56'N latitude and 91°10' E longitude, 160 m.s.l.) during 2019-20. The 11 cultivars along with a local check variety (total 12 varieties) were tested in complete randomized block design (CRBD) and replicated thrice. All the lentil varieties/lines took 41-50 days for flower initiation and 48-57 days for 50% flowering. $C_{23}E_{21}$ variety had highest germination percentage (86.97%) whereas Plant population at harvest was maximum (2, 57,143 ha^{-1}) for Bari Masoor-5 variety. Plant height was recorded maximum (34.37 cm) for IPL534 while maximum root length (9.27 cm) was noted for ILL10802. Among the yield attributes, the highest numbers of branches/plant was recorded in IPL220 (12.40). Maximum number of pods plant^{-1} (43.33) and seeds pod^{-1} (1.83) were recorded in L-4717 and IPL220 varieties, respectively.Test weight (weight of 1000 seeds) was recorded to be highest in L4717 (32.03 g) followed by L4727 (27.78 g). The highest seed yield was noted in L4717 variety (947.67 kgha^{-1}) followed by Bari Masoor-5 (892.89 kgha^{-1}) and L4727 (838.67 kgha^{-1}) varieties. Form the experimental findings, it can be concluded that Bari Masoor-5 lentil variety not only showed higher germination and plant stand at harvest in Tripura condition but also it recorded higher growth and yield attributes which significantly contributed towards its satisfactory seed yield in upland condition of Tripura.

Key words: Lentil, Varieties, Upland, Seed yield, Tripura.

INTRODUCTION

Legumes, and in particular pulses, are a source of protein for both human consumption and animal feed. They play an important role in sustainable and future-orientated food and feed systems (Vasconcelos *et al.,* 2019). They fix atmospheric nitrogen and give farmers independence from the need to purchase mineral nitrogen fertilizer. Legumes in total provide numerous beneficial effects to the ecosystem (Squire *et al.,* 2019). Among the many pulse species, lentils (*Lens culinars* Medik. subsp. *culinaris*) are used for human consumption throughout India. Lentils play a major role in the food and nutritional security of millions, particularly among low income Indian families, because of the high protein content of their seed. Lentil seed is a vital source of protein, with a mean of 28.3% ranging from 15.9 to 31.4% (Grusak 2009), especially for the poor, who cannot afford animal products. As in the case for many pulses, lentils play an important role as a rotation crop, enhancing soil fertility and providing other environmental services in production systems.Besides fixing atmospheric N and benefitting the succeeding crop with residual nitrogen in soil, lentil is also adapted to local climatic and soil fertility conditions (Srinivasarao *et al.,* 2012). Lentil crop is important export and cash crop that has highest price in domestic market compared to all other food legumes and cereals (Abraham, 2015).

Tripura being one of the seven sister state of the North Eastern India, is a land of beauty with a unique feature of land topography and cultural heritage. Tripura is 100% importer of pulses and so the state needs to emphasis on pulse production to attain self-sufficiency in pulses to meet the protein demand of the State. In Tripura, where a large part of the moisture deficit upland area remains fallow after *Kharif* rainfed crops, lentil has a very good potential for increasing farm income as well as cropping intensity (Das *et al.,* 2013). Lentil is the important pulse crop, mainly grown on residual soil moisture and prominent source of vegetable protein (Singh *et al.,* 2011).

Being a pulse crop, it also improves soil fertility and a very good option for crop rotation. Lentil cultivation in Tripura faces several constrains, such as water scarcity during post-monsoon season, lack of irrigation facilities, short time lag after rice harvest for seed sowing and flower dropping and poor pod setting in late sown crops. As a result, only mono cropping of rice is practiced and the farmers leave their land fallow. The low productivity in the region could be attributed to lack of adapted high yielding cultivars, susceptibility to disease, insect pests and inadequate agronomic management and lack of indigenous rhizobial symbionts of lentil in the soil as a result of continuous cereal mono-cropping system (Ghanem *et al.,* 2015) . The lack of interest in the cultivation of lentils among agricultural producers of Tripura is due to the imperfection of most of the existing varieties. According to Sarker *et al.,* 2004 lentil yields at the farm level are far below the genetic potential of its cultivars. Unavailability of the tested site-specific lentil cultivars and imbalanced use of fertilizers could be the contributing factors towards these lower yields. Among the main disadvantages is the low yield and manufacturability of existing varieties.

Currently, the status of Lentil production in Tripura is very poor though the demand is high. The main production constraints include the inherent low yielding genetic potential of the widely grown local cultivar and use of traditional agronomic practices. Therefore, this study was designed to evaluate twelve lentil varieties (Including check) for their yield and yield-related traits under upland areas of Tripura.

MATERIALS AND METHODS:

Experimental site. A field experiment was conducted at experimental farm of the College of Agriculture, Lembucherra, Tripura (W), India (23°56' N latitude and 91°10' E longitude, 160 m.s.l.) during 2019-20. Average rainfall of this area is 2100 mm per annum out of which around 80% is received during monsoon season. The soil (*Typic Kandihumults*) of the experimental field is sandy loam and the baseline soil sample had 6.4 g kg^{-1} SOC, 270.0 mg kg^{-1} available nitrogen (N), 8.5 mg kg^{-1} available phosphorus (P) and 265.5 mg kg^{-1} available potassium (K). The pH of soil was 5.2 i.e. acidic in nature. (Soil and water ratio of 1:2.6).

Experimental design and crop management. The experiment was performed receiving eleven varieties/lines of lentil collected from International Centre for Agricultural Research in the Dry Areas (ICARDA), Syria and Bidhan Chandra Krishi Viswa Vidyalaya (BCKV), Kalyani, West Bengal. Lentil was sown at 30 cm × 10 cm spacing (R-R × P-P). The 11 cultivars along with a local check variety (total 12 varieties/lines) were tested in complete randomized block design (CRBD) and replicated thrice. The gross plot size was 4 m × 3 m. Half of the recommended dose of 20 kg N and full dose 60 kg P_2O_5 and 40 kg K_2O ha^{-1} were applied in furrows before sowing of lentil seeds and covered the seed with soil to give a good seed-soil contact. The crop was raised as irrigated crop with three irrigations, provided at branching, pre-flowering and pod formation stages of crop for better growth. As the soil of experimental field is highly acidic, it has been observed that no nodule formation has been occurred. Therefore, to compensate the N requirement, the remaining half dose of N (10 kg N ha^{-1}) was applied at 21 days after sowing (DAS). Thereafter, foliar sprays of 2% urea at 28 DAS and 36 DAS were applied. Another foliar spray of 0.5% Borax and 0.1% Ammonium Molybdate was applied just after flowering at around 47 DAS.

Plant Sampling. Yield attributes (branches $plant^{-1}$, pods $plant^{-1}$, seeds pod^{-1} and 1000 seed weight) and seed yield of lentil were measured at harvest. For studying plant height and root length, five plants were selected randomly at harvest from the rows meant for sampling from each plot. Length of all the primary, secondary, and tertiary roots were measured and expressed as total root length. Final plant stand ha^{-1} was calculated by counting the nos. of plants of net plot area and then it was converted to plant population per hectare. Yield of lentil was estimated from weight of sun dried seeds obtained from each net plot after threshing and cleaning at 12% moisture content.

Statistical analysis. The experimental data pertaining to each parameter of study were subjected to statistical analysis by using the technique of analysis of variance and their significance was tested by "F" test (Gomez and Gomez, 1984). Standard error of means (SEm+) and critical difference (CD) at 5% probability (p=0.05) were worked out for each parameter studied to evaluate differences between treatment means.

RESULT AND DISCUSSION

Crop ontogeny. The lentil cultivars were sown on 14th November during 2019-20 and germinated within 4-5 DAS. All the lentil varieties/lines took 41-50 days for flower initiation and 48-57 days for 50% flowering (Table 1). Among the varieties/lines, Moitri, ILL 10961along with WBL77 took minimum number of days (41DAS) for flower initiation, whereas, Moitri, Bari Masoor-7 and WBL77 took least number of days(47-48 DAS) for 50% flowering (Yadav *et al*., 2015 and Layek *et al*., 2014). However, L4727 needed maximum days for flower initiation and 50% flowering (50 & 57 DAS respectively) followed by IPL534 variety (Layek *et al.,* 2014). In case of days to maturity, WBL77, L4717 and $C_{23}E_{21}$showed early maturity at 97, 98 and 99 DAS, however, Moitri and Bari Masoor-7 were the most late matured varieties (110 DAS to mature). This variation in crop ontogeny may be attributed due to the inherent genetic difference among the varieties of lentil and variability in phenological characteristics. Similarly, [Dugassa *et al.*, 2014] reported that high variability was observed among genotypes tested for days to flowering, maturity and grain filling period. All the tested varieties were matured in February during both the years, therefore, all the varieties were escaped from terminal drought.

Table 1: Germination %, Plant population/ha, Flowering and maturity time of different lentil varieties/lines

Treatment	Germination %	Flower initiation	Days to 50% flowering	Final Plant Stand per ha	Days to Maturity
Bari Masoor-5	84.24	44	50	257143	106
Bari Masoor-7	55.15	42	48	158095	110
Moitri	80.61	41	47	202857	110
$C_{23}E_{21}$	86.97	44	50	236667	99
ILL10802	76.52	46	52	235238	102
ILL10893	67.73	47	53	210000	108
IPL220	80.00	42	50	210476	105
IPL534	61.06	49	55	189048	109
L4717	81.67	48	53	227143	98
L4727	71.06	50	57	219048	108
ILL10961	78.03	41	50	219524	107
Local Check(WBL77)	79.24	41	48	201429	97
SEm(+)	**5.71**	**1.32**	**1.42**	**12945.36**	**1.62**
CD at 5%	**16.75**	**3.88**	**4.16**	**37967.43**	**4.74**

Germination Percentage and plant stand at harvest. Germination Percentage and plant stand at harvest, both attributes showed significant changes among the varieties/lines. $C_{23}E_{21}$ variety had highest germination percentage (86.97%) closely followed by Bari Masoor-5 (84.24%). Lowest germination of 55.15% was seen in Bari Masoor-7 variety. Plant population at harvest was maximum (2, 57,143 ha^{-1}) for Bari Masoor-5 followed by $C_{23}E_{21}$ variety (2,23,667 ha^{-1}), whereas, lowest Plant

population at harvest (1, 58,095 ha-$^{1)}$ was observed for Bari Masoor-7 variety. Similar results was obtained by Shukla *et al.* (2001), Singh and Gupta (2005).

Plant height and Root length. There was significant variation observed in plant height and root length in all the varieties/lines (Yadav *et al.*, 2015). Plant height was maximum (34.37 cm) for IPL534 closely followed by ILL-10961 and ILL-10802, whereas, lowest plant height (21.83 cm) was noted in $C_{23}E_{21}$ variety. ILL10802 was recorded maximum root length (9.27cm) followed by ILL-10893, Bari Masoor-7 and ILL-10961 while lowest root length (4.13 cm) was found in WBL-77 (Fig. 1 & 2). In accordance with this finding, variations on plant height due to genotypes were also reported by (Singh *et al*., 2006; Dugassa *et al*., 2014; Mekonnen *et al*., 2014; Yadav *et al.*, 2016).

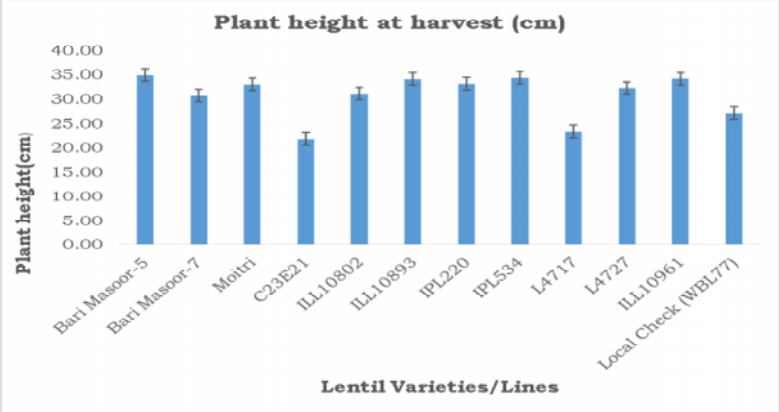

Fig. 1. Plant heights of different lentil varieties/lines.

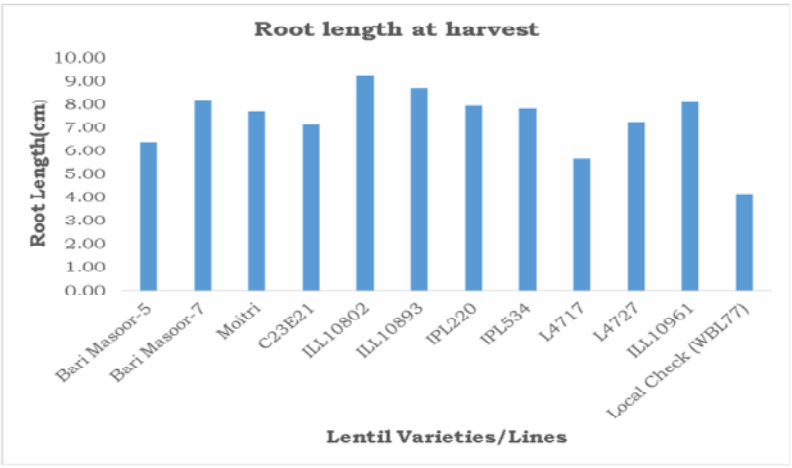

Fig. 2. Root lengths of different lentil varieties/lines.

Yield attributes. The highest numbers of branches plant^{-1} were recorded with IPL220 (12.40) followed by ILL10802 and Bari Masoor-5 (12.73 & 12.40, respectively) while the lowest number of branches plant^{-1} was recorded with WBL-77 (2.9) followed by Bari Masoor-7 (Yadav *et al.*, 2014). The maximum number of pods plant^{-1} was recorded with L-4717 (43.33) closely followed by L-4727 (42.73) and Moitri (41.53), whereas, the lowest number of pods plant^{-1} was recorded with WBL-77 (12.0). Number of seeds pod^{-1} was the highest in varieties of IPL220, ILL10893 and L4717 (1.83),however, the least nos. of seeds pod^{-1} (1.25) was found in ILL10961 variety (Table 2). The test weight (weight of 1000 seeds) was recorded to be highest in L4717 (32.03 g) followed by L4727 (27.78 g). The lowest test weight was recorded in ILL10961 (13.80g) followed by ILL10893 (15.10g).

Seed yield. The highest seed yield was noted in L4717 variety (947.67 kgha^{-1}) followed by Bari Masoor-5 (892.89 kgha^{-1}) and L4727 (838.67 kgha^{-1}) which was significantly higher over rest of the varieties/lines(Yadav *et al.*, 2015). This may be mainly due to better translocation of photsynthates to the sink and its positive influence on the yield parameters like no. of pods plant-^{1}, no. of seeds pod^{-1} than other varieties. Test weight (weight of 1000 seed) was also highest for L4717 followed by L4727 which is particularly genetical characteristics. Both these two varieties produced bold seeds which probably contributed mostly for their higher seed yield. But if smaller seeds are considered, which is mostly preferred by the consumers for dal preparation, then Bari Masoor-5 was the best variety in the varietal evaluation trial. Its seed yield was statistically at par with the L4717 variety. Bari Masoor-5 lentil variety not only showed higher germination and plant stand at harvest in Tripura condition but also it recorded higher growth and yield attributes, which significantly contributed towards its satisfactory seed yield in upland condition of Tripura. The results are in conformity with Islam *et al.* (2015). The difference in the seed yield per hectare in different lentil varieties may be due to genetic character and other factors such as soil, climate and environment. Similar yield variation (kg per hectare) also reported by Toklu *et al.*, (2015) who also found that biological yield is an important plant characteristic used in breeding programs for selection. Similar type of result was also recorded by Maurya and Rathi (2000) and Layek *et al.*, (2014). It becomes important that while selecting for high grain yield, due weightage is given to these characters (Tickoo *et al*., 2005).

In the correlation study between different growth and yield attributes with seed yield among the lentil varieties/lines, data clearly depicted that 1000 seed weight (Test weight) was highly correlated with seed yield of lentil varieties/lines having correlation of

70.64% followed by no. of pods plant^{-1} (Correlation coefficient value of 0.5492) [Table 3]. So, no. of pods plant^{-1} is an important yield attribute contributing towards the variation in seed yield of lentil varieties along with test weight of seeds. Very similar findings for days to maturity, plant height, filled pods/plant, seeds/pod and thousand grain weight with respect to grain yield has also reported by Aghili *et al.,* (2012).

Table 2: Yield attributes and yield of different lentil varieties/lines.

Treatment	No of primary & secondary branches /plant	No of pods/plant	No of seeds/pod	1000 seed weight (Test Wt) (g)	Seed yield (kg/ha)
Bari Masoor-5	12.40	41.30	1.67	20.51	892.89
Bari Masoor-7	6.30	34.67	1.67	18.63	430.33
Moitri	10.13	41.53	1.67	18.53	515.11
$C_{23}E_{21}$	9.32	33.17	1.50	17.32	547.00
ILL10802	12.73	32.67	1.58	18.24	487.56
ILL10893	10.98	41.00	1.83	15.10	437.33
IPL220	13.17	38.90	1.83	19.25	655.00
IPL534	11.75	39.17	1.67	26.09	773.33
L4717	9.23	43.33	1.83	32.03	947.67
L4727	7.05	42.73	1.75	27.78	838.67
ILL10961	8.33	40.23	1.25	13.80	711.67
Local Check (WBL77)	2.90	12.00	1.50	19.13	442.33
SEm(+)	**2.01**	**5.39**	**0.14**	**0.16**	**91.72**
CD at 5%	**5.88**	**15.80**	**NS (0.41)**	**0.46**	**269.01**

Table 3: Correlation between different growth and yield attributes with seed yield among the lentil varieties/lines.

Attributes	Seed yield (kg/ ha)
Plant height at harvest (cm)	0.0400
Rootlength at harvest(cm)	-0.2675
No of primary & secondary branches/ plant	0.2467
No of pods/ plant	0.5492
No of seeds/ pod	0.1909
1000 seed weight (Test Weight) (g)	0.7064

CONCLUSION AND FUTURE SCOPE

From the experimental study, it can be concluded that there is enough scope for cultivation of high yielding varieties of lentil in upland situation of Tripura. Varieties/lines like Bari Masoor-5, L4717, and L4727 are the most potential in terms of growth and productivity for Tripura. However, more varieties/lines from different institutes should be tested to identify short duration and high yielding verities suitable for the state. Varieties having smaller and bold seeds are preferred by the Tripura farmers for cultivation and so these varieties have to be developed and adopted in Tripura condition. Moreover, suitable lentil varieties for rice fallows are also to be popularised for area expansion under lentil.

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