

Evaluation of promising lines of Lai Patta (*Brassica juncea varrugosa L.*) suitable for cultivation in North Eastern India

ABSTRACT

Lai patta (*Brassica juncea varrugosa L.*), also known as Leafy mustard, is an important cruciferous leafy vegetable crop widely grown in Assam and North Eastern Region for consumption purpose. The green leaves can be eaten raw in salad form or cooked. They are enriched with a number of nutritional elements including vitamin A, B, C, E; also contains iron, calcium and protein in large quantities, In the North Eastern India, lot of germplasm are available, but proper studies on yield, its attributes and quality characters have not been done. Therefore, the present study was carried out with ten accessions of laipatta in Assam Agricultural University, Jorhat in order to identify suitable high yielding variety(s) with desirable quality characters. The accessions viz., JorMLG-1, JorMLP-2, MLG-3, MLP-4, MLG-5, MLP-6, ShLG-7, KjLP-8, ChL-9 (Check), and KL-10(Check)were collected from different locations of the state of Assam and North East. They were evaluated consecutively for three years in station trials in the Deptt. of Horticulture, AAU, Jorhat for plant yield and other quantitative and quality characters. The accessions were tested in Multilocation trialsin five research stations located in four different zones of the state viz., UBVZ (Upper Brahmaputra valley zone), NBPZ (North Bank Plains zone), LBVZ(Lower Brahmaputra valley zone)and HZ (Hill zone) also. In these trials. among all genotypes JorMLG-1 and JorMLP-2 were found to be the best for plant yield and other component characters. The On Farm trials conducted in 12 farmers' fields in Jorhat and Kokrajhar districts of the state exhibited average plant yield of 350.1 q/ha inJorMLG-1 and 318.2 q/ha in JorMLP-2 with 34 – 48% yield increase over the best check variety (ChL-9). JorMLG-1was a green leaf variety whereas JorMLP-2 was a greenish purple variety. The edible leaves could be harvested upto 60 days in JorMLG-1 and 55 days inJorMLP-2 after transplanting till the initiation of bolters. However, the best check variety ChL-9 showed bolting at 25 days after transplanting. Estimation of quality characters revealed 147.6 mg ascorbic acid, 186 mg calcium and 11.21 mg iron per 100g in JorMLG-1 whereas 145.2 mg ascorbic acid, 176 mg calcium and 10.61 mg iron per 100g in JorMLP-2. They have been recommended in the Zonal Research Committee MeetingandAnnual Technical Committee Meetingheld at Assam Agricultural University, Jorhatduring 2019-20 for release in the state of Assam. In view of yield performance, consumer preferenceand taste, the varieties are spreading very fast and getting popularity throughout entire NE states. However, more study is required on quality traits, genetic parameters and molecular aspects.

Key Words:Lai patta, *Brassica juncea var rugosa*, JorMLG-1, JorMLP-2, plant yield, NE States

1. INTRODUCTION

Lai patta (*Brassica juncea var. rugosa*), also known as leafy mustard, belongs tofamily*Brassicaceae* and is a succulent, fast-growing leafy vegetable[1]. The crop is having lust

green foliage varying from light green to deep purple in color [2]. The crop was originated in central and Eastern Asia and is consumed as a green leafy vegetable around the world. Asian countries including India, China and Japan are the top growers and suppliers of Lai patta. In India, it is cultivated in home backyard, cultivated land and hilly areas of Uttarakhand and some of the North Eastern states including Assam, Arunachal Pradesh, Nagaland, Meghalaya, Mizoram and Manipur. Peppery, crispy leafy crop has broad and soft leaves with high moisture content and thick tender stem. It can conveniently be used for saag preparation [3]. The green leaves can be eaten raw in salad form or cooked. They are enriched with a number of phyto-nutrients including vitamin A, B, C, E; also contains iron, calcium and protein in large quantities, and have health promotional and disease preventive properties [4]. Regular consumption of leafy mustard as vegetable in diet helps to protect the consumers from calcium and iron deficiency, osteoporosis and various cardiovascular diseases [5]. Lai patta or leafy mustard is also consumed in the form of a fermented pickle product locally known as ‘Gundruk’, which is a very famous and nationally popular Nepali dish [6]. India particularly North Eastern Region is enriched with germplasm of Lai patta and the cultivation as well as consumption is also very high. In spite of having lot of germplasm, systematic study and research work conducted in this crop for its improvement is limited in the country as a whole. Therefore, present investigation was undertaken at Assam Agricultural University, Jorhat with the objective of identifying suitable variety (s) of Lai patta with high yield, desirable attributes and important quality characters.

2. MATERIAL AND METHODS

All total ten (10) germplasm accessions of Lai patta as presented in Table 1 were JorMLG-1, JorMLP-2, MLG-3 (GGL), MLP-4, MLG-5, MLP-6, ShLG-7, KjLP-8, ChL-9 (Check), and KL-

10 (Check). These accessions were collected from different locations of the state of Assam and North Eastern region. With these materials including ChL-9 and KL-10 as two check varieties, the field experiment was conducted as Station Trials at the Horticultural farm of the Assam Agricultural University, Jorhat during Rabi seasons of 2016-17 to 2018-19. The seeds were sown on the nursery beds in the month of October, every year. At 30 days after sowing the seedlings were transplanted in the main field following a spacing of 45 cm between rows and 30 cm between plants in the rows. The experiment was laid out in a randomized block design with 3 replications. The size of the plot was 3.0 m x 2.0 m accommodating 40 plants per plot. The FYM and NPK were applied as per package of practices recommended for spinach beet grown in Assam. The observations were recorded on days to first bolting from transplanting, leaf yield per plant (kg), Leaf number per plant, leaf length (cm), petiole length (cm), leaf lamina length (cm), leaf lamina breadth (cm), leaf sheath length (cm), leaf sheath breadth (cm), plant height (cm), root length (cm) and seed yield per plant (g). The quality characters were judged based on leaf colour, consumption quality and organoleptic taste. The nutritional elements viz., iron, calcium, and ascorbic acid were estimated through laboratory analysis. Standard procedure [7] was followed for statistical analysis of yield, component and quality characters. The promising varieties were tested in Multilocation Trial (MLT)s conducted in AICRP (VC), Jorhat centre and 4 research stations located in Lower Brahmaputra Valley Zone (LBVZ), North Bank Plain Zone (NBPZ), Central Brahmaputra Valley Zone (CBVZ) and Hill Zone (HZ). The On Farm Trial (OFT)s were conducted in Farmers' Fields (12) located in two different districts covering two zones viz., UBVZ and LBVZ.

3. RESULTS

3.1 Green plant Yield, Crop duration and quality characters in Station Trials

The statistically analysed mean data for plant yield (kg/plant) of the genotypes in the three years' station trials are presented in Table 2. The pooled data for crop duration, quality characters such as ascorbic acid, calcium and iron content in mg/100 g per sample are also presented. From the mean green plant yield data the better performing genotypes among 10 were found to be JorMLG-1 and JorMLP-2 with mean green plant yield of 225 and 215 q/ha respectively. The mean plant yield in the best check variety 'ChL-9' was 175 q/ha. In these trials there was yield increase of 28.6% in JorMLG-1 and 22.8% in JorMLP-2 over the best check variety 'ChL-9'. The crop duration was 60 days in JorMLG-1 and 55 days in JorMLP-2 whereas it was 25-35 days only in the check varieties from transplanting to initiation of bolters. The content of ascorbic acid, calcium and iron was 147.6, 186 and 11.21 mg/100 g in JorMLG-1 and 145.2, 176 and 10.61 mg/100g respectively in JorMLP-2.

3.2. Plant yield performance in Multilocation Trials

The results of MLTs (Table 3) conducted in 5 locations revealed average plant yield of 190.32 q/ha in JorMLG-1 and 199.86 q/ha in JorMLP-2 (q/ha) which was 18.95% and 24.91% higher respectively than the check variety ChL-9 (160 q/ha). Among different locations, 3 locations viz., AICRP(VC), Jorhat; RARS, Gossaigaon and HRS, Kahikuchi have shown better performance of the varieties than other two locations. Highest yield performance of 302.22 q/ha in JorMLG-1 and 398.89 q/ha in JorMLP-2 was observed in AICRP(VC), Jorhat location. The percentage increase in yield over the best check variety ChL-9 was 18.95 in JorMLG-1 and 24.91 in JorMLP-2.

3.3. Plant yield performance in On Farm Trial (OFT)s

Table 4 shows the results of the OFTs conducted in 12 fields of 6 villages covering 2 districts of 2 zones such as UBVZ and LBVZ. Among the different fields, plant yield performance of 390 q/ha in JorMLG-1 and of 360 q/ha in JorMLP-2 was the highest in Na Ali, Jorhat. The mean yield was 350.1 q/ha in JorMLG-1, 318.2 q/ha in JorMLP-2 and 236.9 q/ha in the check entry ChL-9. The percentage increase in yield was 47.8 in JorMLG-1 and 34.3 in JorMLP-2 over the check variety.

3.4. Morphological and Quantitative characteristics

Table 5 shows the morphological and quantitative characteristics of the two varieties in comparison to the best check variety ChL-9. JorMLG-1 was having green leaf pigmentation whereas JorMLP-2 having greenish purple pigmentation. The per plant yield (kg), number of leaves, leaf length(cm), petiole length(cm), lamina length(cm), lamina breadth(cm), leaf sheath length(cm), leaf sheath breadth(cm), plant height(cm), root length(cm) and amount of seeds (q/ha) were 1.3, 30, 35, 12, 23, 18, 22,4,17,42 and 17.67 respectively in JorMLG-1 and 1.0, 20, 28, 8, 20, 15, 20, 1.5, 13, 35 and 13.83 respectively in JorMLP-2. The leaf colour was dark green in JorMLG-1 and greenish purple in JorMLP-2. The consumer preference was high and taste was good in these varieties. However, the check entry ChL- 9 was low in consumer preference and sour in taste. The accession number of JorMLG-1 was IC 586672 and of JorMLP-2 was IC 586673 by which these genotypes have been conserved at NBPGR, New Delhi.

4. DISCUSSION

4.1 Green plant Yield, Crop duration and quality characters in Station Trials

The analysis of variance for mean plant yield of the genotypes in the three years' station trials revealed significant differences among the genotypes (Table 2). Perusal of mean green plant yield data indicated better performing genotypes among 10 to be JorMLG-1 and JorMLP-2. The

mean green plant yield (q/ha) in JorMLG-1 and JorMLP-2 was 22 to 29% higher than the best check variety 'ChL-9' in the station trial. The earlier study [5] revealed a significant variation among 59 accessions of leafy mustard (Pahari Rai) in both qualitative and quantitative agromorphological traits. In our study, both the varieties took longer duration for bolting from transplanting i.e. 55 to 60 days for both the varieties as compared to Check ChL-9 where bolting took place at 25 days itself. It indicates that harvesting for edible leaves/plant could be continued in these two tested varieties for quite a longer duration of time as compared to the check variety. These genotypes have been reported to be promising in earlier findings also [8,9,10].

For women and growing children, iron is vital, and mustard green or Lai patta is the greatest solution to provide them with their daily needs. *Brassica juncea* var. *rugosa* accessions possessed iron ranging from 11.81–20.23 mg/100g [11]. They further reported high amount of essential minerals including calcium in some germplasm accessions of Pahari Rai (*Brassica juncea* var *rugosa*). Calcium functions as a secondary messenger in numerous physiological and developmental processes, as well as its involvement in the formation of cell walls and bones, stability of cell membranes, and how it responds to biotic stress by concentrating when necessary [12]. In our study the content of ascorbic acid, calcium and iron was 147.6, 186 and 11.21 mg/100 g in JorMLG-1 and 145.2, 176 and 10.61 mg/100g respectively in JorMLP-2. The ascorbic acid was lower and calcium content was higher in these two varieties in comparison to the check. However, both the varieties showed slightly lower or equal amount of iron as compared to the check entries. Similar reports have been made in earlier studies also in leafy vegetable crops[14].

4.2. Plant yield performance in Multilocation Trials

The results of MLTs conducted in 5 locations revealed that the average plant yield in JorMLG-1 (190.32 q/ha) and JorMLP-2 (199.86 q/ha) was 18.95% and 24.91% higher respectively than the check variety ChL-9 (160 q/ha). However, there was a considerable variation in yield performance of the varieties in different locations. Three locations have reported higher yield performance than other two locations. This variation might be due to variations in soil and agro-climatic conditions. The study carried out earlier [3] on broad leaf mustard (*Brassica juncea* var. *rugosa*) genotypes reported significant variation in growth and yield of leafy mustard genotypes under integrated nutrient management system.

4.3. Plant yield performance in On Farm Trials

The results of the OFTs conducted in different farmers' fields covering 2 districts of 2 zones such as UBZ and LBZ showed higher mean yield performance in the tested varieties than the check 'ChL-9'. The percentage increase in yield was 47.8 in JorMLG-1 and 34.3 in JorMLP-2 over the check variety. These results established that the two tested varieties were considerably superior to the check varieties and were the best among all 10 entries.

4.4. Morphological and Quantitative characteristics

The morphological and quantitative characteristics of the two varieties along with the best check variety ChL-9 are described in Table 5. JorMLG-1 was having green leaf pigmentation whereas JorMLP-2 having greenish purple pigmentation. Both the varieties were characterized by increase in per plant yield, number of leaves, leaf length, petiole length, lamina length, lamina breadth, leaf sheath length, leaf sheath breadth, plant height, root length having good amount of seeds produced. The leaf colour was dark green to greenish purple, consumer preference was high and taste was good in the tested entries. However, the check entry ChL- 9 was low in consumer preference and was sour in taste. It was also reported in earlier studies [3,11] that the

leaves of well grown *rugosa* were 40–50 cm long and 20–25 cm wide having flat petioles, smooth to crumpled margins which were fleshy and non-hairy.

5. CONCLUSION

Based on the results mentioned above, the varieties JorMLG-1 and JorMLP-2 have been found to be very good, high yielding with most of the desirable quantitative and quality characters. These have been recommended in the ZREAC and ATCM meeting held at AAU in the year 2019 and 2020 respectively for release in the state of Assam [13] and North Eastern India. In the national level, the varieties have been conserved at NBPGR, New Delhi (Accession Nos. IC 586672 and IC 586673). Preliminary reports have been published in different literatures [1,8,9,10] at different times about these varieties. In view of the consumer preference and taste, the varieties are spreading very fast and getting popularity throughout the entire NE states. However, the varieties warrant more studies particularly on quality characteristics, medicinal properties and on various genetic parameters including more genotypes for further improvement. Gene profiling may also been done through molecular studies.

REFERENCES

1. Bora GC. Leafy vegetable research in AAU, Jorhat. In “Leafy vegetable research in India” - a compendium on ‘Brainstorming Session on Leafy Vegetables’ held on 12 th Feb., 2009 at Coimbatore organized by TNAU, Coimbatore and IIVR, Varanasi.2009:129 - 132.
2. Pant U, Bhajan R, Singh A, Kulshrestha K, Singh AK and Punetha H. Green leafy mustard: a healthy alternative. Electronic J. Plant Breed. 2020;11(1):267 - 270.
3. Rauniyar K, Bhattarai BP. Growth, yield and soil nutrient status of broad leaf mustard *Brassica juncea* var. *rugosa*) under integrated nutrient management. Nepalese J Agric. Sci. 2017;15:98 - 106.
4. Adhikari A. and Punetha H. Comprehensive Assessment of *Brassica juncea* variety *rugosa* (Pahari Rai) Accessions from the Sub-Himalayan Region: Phytochemical, Antioxidant, Enzymatic, Mineral, and Fatty Acid Profiling. Research Square.2024; DOI: <https://doi.org/10.21203/rs.3.rs-4340286/v1>.

5. Sharma D, Nanjundan J, Singh L, Singh S P, Parmar N, Sujith Kumar M S, Singh K H, Mishra A K, Singh R, Verma K S and Thakur A K. Genetic diversity in leafy mustard (*Brassica juncea* var. *rugosa*) as revealed by agro-morphological traits and SSR markers. *Physiol Mol Biol Plants*. 2020, Oct; 26(10): 2005 - 2018.
6. Bhattarai BP, Singh MP, Shakya SM, Khatri-Chhetri GB, Khadka YG. Effect of organic and conventional nutrient management on post-harvest status of broad leaf mustard (*Brassica juncea* var *rugosa*). *Int J Hort Agric*. 2018; 3(2):1 - 4.
7. Panse V G and Sukhatme P V. *Statistical methods for Agricultural workers*, ICAR, New Delhi; 1978.
8. Bora G C, Kalita B, Deori B B and Paul S K. JORMLG-1: A Promising Laipatta (*Brassica rugosa* L.) Selection from AAU. In *Souvenir cum abstracts of National Seminar on Harnessing Science For Societal Development, 60th Annual Session*, Assam Science Society held at AAU, Jorhat, Assam, India; 2015.
9. Bora G C and Paul S K. Varietal improvement research in vegetable crops in AAU – A review. In *Proceedings of Leadpapers and abstracts of Fourth National Symposium on Transforming Indian Agriculture Towards Food and Nutritional Security*, organized by SAP, Kanpur and held at ICAR-IGFRI, Jhansi (UP) on 20 – 21 February, 2016; 1.3.69(P): 44.
10. Bora G C, Kalita U C, Gogoi S, Das R T, Baruah M, Rajkhowa D and Kharghoria P P. Glimpses of Vegetable Improvement Research in Assam Agricultural University, India. *Int. Journal of Agricultural Sciences*. 2023; 15(9):12619-12622.
11. Adhikari A, Punetha H, and Pant U. Genetic diversity analysis using agro-morphological traits of *Brassica juncea* subspecies *rugosa* (Pahari Rai) from North-Eastern Himalayan region. *Electronic J of Plant Breeding*. 2022; 13(3):1-10.
12. Thor K. Calcium - Nutrient, and messenger. *Frontiers in Plant Sci*. 2019; 10:440.
13. Anonymous, AAU News letter; 2021.
14. Gopalan C, Rama Shastri B V and Balasubramaniam S C. *Nutritive value of Indian foods*. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India; 1982.



Plate (a)



Plate (b)

Plate a,b : Two Promising Varieties of Lai Patta (*Brassica juncea* var *rugosa*)

Table 1. List of genotypes included in the experiment

Sl. No.	Genotypes	Sl. No.	Genotypes
---------	-----------	---------	-----------

1	JorMLG-1	6	MLP-6
2	JorMLP-2	7	ShLG-7
3	MLG-3 (GGL)	8	KjLP-8
4	MLP-4	9	ChL -9 (Check)
5	MLG-5	10	KL-10 (Check)

Table 2. Plant yield performance of Lai patta genotypes in AAU trials

Entries/ Trials	Jor MLG-1	Jor MLP-2	ChL-9 (C-1)	KL-10 (C-2)	CD (5%)	CV (%)
Station Trial (ST)s	Plant / Leaf Yield (q/ha)					
IVT	215	211	164	156	25.1	17.2
AVT-I	235	220	185	168	23.4	14.6
AVT-II	236	214	176	162	27.6	18.3
Mean over STs	225	215	175	162	-	-
PC increase over best check	28.6	22.8	-	-	-	-
Crop duration						
Days from transplanting to initiation of bolters	60	55	25	35	5.2	3.5
Quality characters						
Ascorbic acid (mg/100 g)	147.6	145.2	197.4	175.4	15.3	8.6
Calcium (mg/100 g)	186	176	160	165	NS	-
Iron (mg/100 g)	11.21	10.61	11.29	10.87	NS	-

Table 3. Plant yield performance (q/ha) of Lai patta genotypes in Multilocation trial (MLT)s

Location of MLTs	Genotypes		
	JorMLG-1	JorMLP-2	ChL-9 (Check)
AICRP(VC), AAU, Jorhat	302.22	398.89	270
RARS, Gossaingaon	320	350	250
HRS, Kahikuchi	151.0	91.0	135
RARS, North Lakhimpur	98.0	83.2	70
RARS, Diphu	80.4	76.2	75
Mean over MLTs	190.32	199.86	160.00
PC increase over best check	18.95	24.91	-

Table 4. Plant yield performance (q/ha) of Lai patta genotypes in On farm trial (OFT)s

Sl. No.	Farmers' Fields	JorMLG-1	JorMLP-2	ChL-9 (Check)
---------	-----------------	----------	----------	---------------

1	Khangia, Jorhat (2)*	365	325	245
2	Dhekiajuli, Jorhat (1)	380	340	220
3	Sahpuria, Jorhat (1)	370	350	240
4	Na Ali, Jorhat (1)	390	360	260
5	Cherfunguri, Gossaigaon (1)	355	315	280
6	Hazari Gaon, Jorhat (6)	240.5	219.3	176.4
	Average (q/ha)	350.1	318.2	236.9
	(%) increase over the check	47.8	34.3	-

*Value in parenthesis indicates number of fields.

Table 5. Descriptor for 3 Lai patta genotypes

Sl. No.	Characteristics	Genotypes		
		JorMLG-1	JorMLP-2	ChL-9 (Check)
1	Per plant leaf yield (kg)	1.30	1.00	0.70
2	Number of leaves per plant	30	20	12
3	Leaf length (cm)	35	28	21
4	Petiole length (cm)	12	8	5
5	Leaf lamina length (cm)	23	20	16
6	Leaf lamina breadth (cm)	18	15	11
7	Leaf sheath length (cm)	22	20	17
8	Leaf sheath breadth (cm)	4.0	1.5	1.3
9	Root length (cm)	17	13	9
10	Plant height (cm)	42	35	25
11	Seed yield per plant (q/ha)	17.67	13.83	-
12	Leaf colour	Dark green	Greenish purple	Light green
13	Consumer preference	High	High	Low
14	Organoleptic Taste	Very tasty	Very tasty	Sour in taste
15	NBPGR Accession no.	IC 586672	IC 586673	-