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Phenological and Agro-Morphological Traits of Selected Broad-Leaf Mustard Varieties of Nepal

Damodar Poudyal[1]*, Prakriti Poudyal[2], Prakash Acharya[3], Gopal Prasad Shrestha[4]

[1]SEAN Seed Service Centre Ltd., Kathmandu
[2]Institute of Agriculture and Animal Science, Lamjung Campus, Lamjung
[3]Seed Quality Control Centre, Hariharbhawan, Lalitpur
[4]Narephant, Kathmandu

*Corresponding author: damodarpoudyal@gmail.com | **ORCID:** 0000-0001-7758-3564

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A B S T R A C T

An action research study was conducted in 2016 to characterize some of the major winter vegetables commonly cultivated in Nepal, focusing on three widely grown broad-leaf mustard (*Brassica juncea var. rugosa)* varieties: Khumal Rato Paat, Manakamana, and Khumal Chauda Paat. The objective was to document key phenological features and agronomic traits of these varieties under field conditions at Thankot, Kathmandu. The study recorded varietal differences in seedling traits, vegetative growth, floral attributes, and seed characteristics. Significant morphological and agronomic variations were observed among the varieties. Khumal Rato Paat featured dark green glossy leaves with deep serration and purple veins and was comparatively late to bolt. Manakamana matured early and produced the highest fresh leaf yield. Khumal Chauda Paat was intermediate in most traits but exhibited highly blistered leaves. These findings highlight distinct varietal traits that can support variety identification, seed quality control, and future breeding efforts in leafy mustard crops.

Introduction

Broad leaf mustard (*Brassica juncea var. rugosa L.) is one of the most widely grown leafy vegetables in Nepal. Its popularity is attributed to its adaptability to diverse agro-climatic* conditions, rapid growth cycle, and nutritional value. Commonly consumed as a green vegetable, it holds significant importance in both household consumption and local markets. Several landraces and improved varieties of broad leaf mustard are cultivated across Nepal. There are 12 varieties of broad leaf mustard registered for commercial seed use in Nepal (SQCC 2025). Among the listed varieties at the National Seed Board, Khumal Chauda Paat was registered in 2046 BS. Similarly, Khumal Rato Paat was registered in 2051 BS and Manakamana Rayo in 2077. However, there exists limited systematic documentation and characterization of these varieties based on standardized descriptors (AVRDC 2008).

Comprehensive research aimed at compiling and documenting distinguishable traits of vegetable varieties in Nepal is notably lacking. During the study time, there was no suitable reference document or official variety catalog for vegetables, including broad-leaf mustard. Field technicians often relied on verbal sources and traditional knowledge for varietal identification. Even the National Seed Board provided limited information on registered broad-leaf mustard varieties typically only the registration date and recommendation domain without detailed morphological or agronomic descriptors. This gap underscored the urgent need for a well-structured variety catalog to support variety identification, selection, source seed maintenance, and seed quality control. The absence of a comprehensive catalog presented challenges for researchers, seed producers, students, and policymakers in maintaining varietal purity, recommending suitable varieties, and planning effective breeding strategies. Although some initiatives had been undertaken to document local vegetable varieties, a thorough and comparative characterization of broad-leaf mustard varieties cultivated in Nepal remained unavailable (CEAPRED 2014).

In this background, the present study was undertaken to characterize three prominent broad leaf mustard varieties namely Khumal Rato Paat, Manakamana, and Khumal Chauda Paat under field conditions in the Kathmandu valley. The primary objective was to document their seedling, vegetative, floral, and seed traits to support varietal identification, seed quality maintenance, and future crop improvement programs.

Materials and Methods

The study was conducted at the experimental plots of SEAN Seed Service Centre Ltd., located in Chandragiri-7, Thankot, Kathmandu, from September 1, 2016, to April 31, 2017. Seeds of the selected broad-leaf mustard (*Brassica juncea* var. *rugosa*) varieties were sourced from the National Gene Bank of Nepal. Seeds were initially sown in nursery plots, and seedlings at the four-leaf stage were transplanted into larger field plots arranged in a randomized complete block design with three replications. Each replication consisted of 20 seedlings per genotype, managed under standard horticultural practices. Randomly chosen five plants were tagged for consecutive measurements during the study. Trait values were obtained by averaging measurements recorded from five individual plants and were subsequently used for further analysis.

Observations were made on seedling, vegetative, floral, and seed traits using established crop descriptor guidelines developed by the International Board for Plant Genetic Resources (IBPGR 1990). Data collection focused on morphological characteristics such as leaf shape, margin, size, glossiness, flowering time, silique morphology, and seed traits. Measurement methods for traits such as leaves, flowers, and seeds followed the IBPGR crop descriptor protocols.

Detailed records were maintained for each variety's unique features and agronomic performance under field conditions. Collected data were compiled and analyzed using Microsoft Excel to calculate average values. The preliminary findings were presented at a stakeholder interaction meeting organized by the Seed Quality Control Centre (Secretariat of the National Seed Board) in Hariharbhawan, Lalitpur, Nepal, on March 20, 2017 (2073 Chaitra 07, B.S.). During the meeting, the key varietal traits were reviewed, discussed, and officially validated by a panel of horticulturists and scientists. Before the presentation, a peer review process was carried out with experts and horticulturists to incorporate their insights and recommendations.

Results and Discussion

Three broad leaf mustard varieties were characterized in this study. The observed phenotype and agronomical traits (leaf shape, size, weight, seed characters, etc.) are presented variety-wise in the following paragraphs.

Khumal Rato Paat

Seedling characteristics

The hypocotyl color is purple. The leaves are purplish green. Dentate type of seedling leaf margin and pubescence absent (Figure 1).

Figure 1. Seedlings of Khumal Rato Paat

Vegetative characteristics

Shortened non-branching stem supporting leafy rosette. Plants were uniform in morphology. The average plant height is 19.9 cm (14.7 - 26 cm) with a diameter of 88.9 cm (80 - 100 cm) when measuring at the extremity of the plant. Low lodging recorded. Per plant 12 – 18 leaves before bolting and without season harvest, an average of 15 leaves. Leaf length is 52.2 cm (46 - 60 cm), average leaf blade width is 20.8 cm (12 - 30 cm) at the widest point of the largest leaf. The leaf angle (angle of petiole with horizontal axis) is prostrate (<30°). The leaf shape is obovate with dentate margin and sinuate type of leaf division. The leaf apex is broadly rounded (Figure 2).

Figure 2. Plant at vegetative stage (left), purple leaf veins (middle), and leaves showing deeply serrated lamina near the petiolar end

Leaf blade thickness average 0.8 mm (thick), intermediate blistering, leaf tip attitude straight, leaf lamina attitude drooping, leaf color dark green with purple veins, leaf pubescence, and leaf bloom absent. Leaf glossiness is high. Petiole or mid-vein are intermediately enlarged (flat) with an average of 27.88 mm (26 - 29.5 mm) span, average petiole length is 1.8 cm (1.3 - 2.2 cm). The cross-section of the petiole is semi-round (cup-shaped). The petiole color is white and intermediately overlapped, the petiole and main vein axis is a little wavy. The leaf lamina at the petiolar end is deeply serrated (Figure 2).

Physiologically matures (ready for fresh leaf harvest) within 30 - 40 days after transplanting. A Late season variety, average leaf weight 50 - 60 g, fresh leaf production 25 - 30 t/ha.

Flower and seed characteristics

Figure 3. Pre-floral branches (left), flowering branches (middle left), green pods (middle right) and seeds

Loosely branched floral apex branch with small terminal heads. It's an annual plant, with no need for vernalization to flower, days to 50% flowering from sowing takes 120 - 125 days. Flower stalks are green in color and on an average 105.3 cm long (97 - 118 cm), with intermediate flowering stalk internode length and also intermediate in branching habit. Petals are yellow in color and flower stalk bloom is intermediate. Comparatively late bolter than Khumal Chauda Paat in Thankot, Kathmandu condition (Figure 3).

The number of days from sowing to when 90% of plants are ready for seed harvest is 185 - 190 days (160 - 165 days after transplanting), average silique length of 2.8 cm (2.5 - 3 cm) and 3.64 mm (3 - 4 mm) diameter. Beak length about 0.77 cm (0.7 - 0.9 cm). Silique is green before drying, erect in attitude, silique surface outline is constricted between seeds, no hairs present on silique, intermediate in shattering. The number of seeds per silique is 13 (12 - 15), primary seed coat color is black. Thousand seed weight at 5.7% moisture level is 1.5 - 1.7 g.

Manakamana

Seedling characteristics

Hypocotyl color is pale green, the margin of the seedling leaf is serrate type, the seedling leaf color purple green, and pubescence is absent (Figure 4)

Figure 4: Seedling of Manakamana

Vegetative characteristics

Plant growth habit is shortened non-branching stem supporting leafy rosette, uniform plant morphotype, suitable for autumn planting with 45 cm × 30 cm crop geometry, average plant height (measure extremity of the plant, before flowering stalk initiation) is 64 cm (51 - 69 cm) and width is 41 cm (24 - 50 cm), low lodging, leaf per plant with an average of 37 leaves (ranging from 17 - 40 leaves), leaf length (largest leaf including petiole) 42 cm (35 - 45 cm) and leaf blade width (widest point of the largest leaf) is 18 cm (15 - 20 cm), leaf angle (angle of petiole with horizontal) is open type (~67°), leaf shape outline obovate, leaf margin serrate, with the sinuate type of leaf division. Leaf glossiness is low (not smooth and shiny as Khumal Rato Paat and Khumal Chauda Paat). It is difficult to detach the leaf while harvesting fresh leaf (Figure 5).

Figure 5. Leaves showing purple leaf veins (left), plants ready to fresh leaf harvest (middle), and leaves showing serrated leaf margin

The leaf apex is intermediate in shape with a thin leaf blade, and low leaf blade blistering. Straight leaf tip attitude, leaf lamina attitude is convex and curving upward, green leaf with purple leaf veins, intermediate leaf pubescence, and leaf bloom absent, intermediate in leaf pigmentation (Figure 5).

Petiole/mid-vein enlargement is intermediate, average petiole length 1 cm (0.5 - 2.5 cm) and 15 mm (11.3 - 17.4 mm) wide, with semi-round petiole cross-section, light green and intermediately overlapped each other, no tillering characterized, it is early in maturity, fresh leaf ready in 25 - 30 days for harvesting after transplanting, fresh leaf production 30 - 35 t/ha.

Flower and seed characteristics

Its floral apex branching is loosely branched with terminally raceme inflorescence. Annual flowering, takes 85 - 95 days from sowing to 50% of the plant's first flower, flowering stalk color is yellow-green, and the average length of flower stalk length is 33.7 cm (20 - 45 cm). Intermediate in flowering stalk internode length and branching habit, yellow petal color, and low bloom (wax) in flower stalk.

Figure 6: Pre-floral branching (left), flowering plant (middle left), green pods and seeds

Days to maturity (number of days from sowing to when 90% of plants are ready for seed harvest) is 175 - 180 days. The average length of silique is 3.46 cm (3 - 4 cm) and the width (diameter) is 4.18 mm (3.8 - 4.8 mm) with 0.78 cm (ranges between 0.6 cm and 0.9 cm) beak length, silique color before drying is green, erect is silique attitude, silique surface outline is constricted between seeds, no hairs, no or very low shattering (Figure 6).

The primary seed coat color is red-brown, the average number of seeds per silique is 19 seeds (17 - 22 seeds) and the thousand seed weight is 1.4 - 1.5 g at 6% moisture.

Khumal Chauda Paat

Seedling characteristics

Pale green hypocotyl color, green seedlings, crenate type of seedling leaf margin, glabrous seedling, no pigmentation on leaves (Figure 7).

Figure 7. Seedlings of Khumal Chauda Paat

Vegetative characteristics

Shortened non-branching stem supporting leafy rosette, uniform plant morphotype, plant height is an average 36.12 cm (27.8 - 47.5 cm), with 55.6 cm (49 - 63 cm) diameter measured at the extremity of the plant. Low lodging, average 30 leaves (ranging from 25 - 35 leaves), average leaf length 49.22 cm (43 - 52 cm) (largest leaf including petiole), and width (widest point of the largest leaf) 24.98 cm (23 - 27 cm). Leaf glossiness is moderately high (Figure 8).

Figure 8: Plants at the vegetative stage (left and middle) and leaf showing crenate type of leaf margin

Semi-prostrate (~45°) leaf angle, leaf shape (outline) is obovate with crenate leaf margin, leaf division is sinuate, leaf apex shape is broadly rounded. Intermediate in leaf thickness and high in leaf blade blistering. Leaf tip attitude is drooping, leaf lamina attitude is concave drooping, leaves are green in color, leaf pubescence and bloom are both absent, and no pigmentation on leaves is observed (Figure 8).

Leaf petioles are intermediately enlarged with average petiolar length 2.62 cm (2 - 3.6 cm), 25.44 mm (23.8 - 28 mm) wide with semi-round petiole cross-section, petiole color is white and is intermediately overlapped. No tillering, variety is intermediate in maturity, can harvest first fresh leaf in 30 - 35 days after transplanting, able to produce 30 - 40 t fresh leaves per hectare.

Flower and seed characteristics

The floral apex is loosely branched with small terminal heads. Annual flowering behavior (without vernalization), the number of days from sowing to 50% of the plant's first flower is 110 - 115 days (Figure 9).

Figure 9. Pre-floral branching (left), flowering plants (middle left), green pods and seeds (right)

The flowering stalk is green in color, average length of 89.7 cm (80 - 94 cm), flowering stalk internodes are intermediately long, the branching habit is intermediate, yellow petals and low flower stalk bloom, number of days from sowing to when 90% plants are ready for seed harvest is 180 - 200 days.

Silique length av. 3.65 cm (3.2 - 4.1 cm), width 3.55 mm (3.3 - 3.9 mm), beak length av. 0.79 (0.5 - 1.0 cm), green silique before drying, erect in silique attitude, silique surface outline is constricted between seeds, hairs on silique absent, intermediate in shattering, primary seed coat color is dark gray, average No. of seed per silique is 11 (10 - 15). Thousand seed weight at 5.3% moisture level is 1.6 - 1.7 g (Figure 9).

A summary of the typical traits of the varieties is presented in Table 1 for comparative analysis. The table highlights key distinguishing traits with a focus on economically important parameters.

Table 1. Morphological and agronomic characteristics of broad-leaf mustard varieties

Traits	Khumal Chauda Paat	Khumal Rato Paat	Manakamana
Seedling hypocotyl color	Pale green	Purple	Pale green
Leaf margin (seedling)	Crenate	Dentate	Serrate
Plant morphology	Non-branching leafy rosette	Non-branching leafy rosette	Non-branching leafy rosette
Plant height, before flowering stalk initiation (cm)	27.8-47.5	14.7-26	51-69
Plant spread (cm)	49-63	80-100	24-50
Leaf number (avg.)	30 (range 25-35)	15 (range 12-18)	37 (range 17–40)
Leaf length (cm)	43-52	46-60	35-45
Leaf width (cm)	23-27	12-30	15-20
Leaf color & veins	Green, glossy, blistered	Dark green, purple veins, glossy	Green with purple veins, low glossiness
Leaf shape & margin	Obovate with crenate leaf margin, sinuate type of leaf division	Obovate with dentate margin, sinuate type of leaf division	Obovate with serrate margin, sinuate type of leaf division
Petiole cross-section	Semi-round	Cup-shaped, slightly wavy	Semi-round
Fresh leaf harvest time	30–35 days post-transplanting	30–40 days post-transplanting	25–30 days post-transplanting
Fresh leaf yield (t/ha)	30–40	25–30	30–35
Days to 50% of plants flowering	110–115 from sowing	120–125 from sowing	85–95 from sowing
Maturity for seed (days after sowing)	180–200	185–190	175–180
Silique length (cm)	3.2-4.1	2.5-3	3-4
Seeds per silique	10-15	12-15	17-22
Seed color	Dark gray	Black	Red-brown
1000-seed weight (g)	1.6–1.7 at 5.3% moisture	1.5–1.7 at 5.7% moisture	1.4–1.5 at 6% moisture

Conclusion

The morphological and agronomic characterization of three broad-leaf mustard varieties Khumal Rato Paat, Manakamana, and Khumal Chauda Paat revealed notable differences in seedling traits, vegetative morphology, maturity, flowering behavior, and seed characteristics. Khumal Rato Paat was characterized by glossy, purple-veined, deeply serrated leaves and late bolting, making it suitable for extended harvest. Manakamana matured early and produced higher fresh leaf yields, favoring commercial cultivation. Khumal Chauda Paat exhibited intermediate traits with prominently blistered leaves. These findings underscore the value of systematic varietal documentation to support informed decisions in variety selection, seed production, and breeding, contributing to improved identity and quality assurance in Nepal's leafy vegetable seed sector.

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Author contributions

All authors have equally contributed to the manuscript.

Conflict of interest declaration

None to declare.

Data availability statement

The data will be available upon reasonable request.

Declaration on the use of generative AI tools

Generative AI tools were used solely to improve the grammar of the manuscript.

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