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Morpho-Agronomic Grain Trait Diversity Analysis of Traditional Rice Varieties of West Bengal, India

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Abstract

Grain morpho-agronomic characterization and Scanning Electron Microscopy (SEM) analysis were conducted on five traditional rice varieties from South Bengal. Among the studied varieties, Badamsaru, Bahurupi, and Barani variety exhibited medium grain size while Ashinlaya and Bachi were short grained. Ashinlaya possessed red Karnel, while the rest of four varieties had white kernel. Grains of all varieties have tubercles arranged in parallel and longitudinal rows from base to apex. All of them have distally pointed trichomes, generally covered the whole surface of the grains but more concentrated near the apex. Sterile lemma of five rice lines is also different among them Badamsaru and Barani have rough sterile lemma whereas rest of three have smooth sterile lemma surface. Scanning electron micrograph study of grain of traditional rice varieties helps to identify the different rice varieties and its helps to remove the misconception between the different name of the same variety.

Keywords: Rice landraces, grain, SEM, West Bengal, agronomic characters.

Introduction

Rice (*Oryza sativa L.*) belongs to the family Poaceae provides staple food to more than half of the world's population. Highest number of Asians consumed Rice in their daily diet in comparison to the other cereals and every layer of rice has variable amount of different nutrition's[1]. India has extensive genetic diversity of rice. India possesses 88,681 different rice varieties, out of which 55,615 are landraces, 1,171 are wild races and 32,895 are other Varieties[2].

West Bengal in India is known as 'Bowl of Rice' for highest area of rice cultivation[3]. Before Green revolution all the rice fields of Bengal were occupied by more than 5000 traditional rice lines as recorded by a number of survey[4]. But now most of such traditional rice lines were replaced by so called high yielding semi dwarf rice lines which are highly water and nitrogen responsive and increase the gene erosion of traditional and wild rice varieties.

The very few existing traditional rice lines are still grown by limited marginal farmers. Traditional rice varieties contain medicinal, nutritional, aromatic features along with antioxidant properties. They also contain high amount of vitamin E, Vitamin B complexes, micronutrients like Zn, Fe, certain alkaloids than any high yielding varieties[5,6].

They have good number of additional advantages like abiotic and biotic stress tolerance and could grow in both deep waters and inland fields[7].

Morphological and qualitative characterization like grain characters, of traditional rice varieties provide an opportunity to investigate phenotypic and genotypic relationship among them[8].

For conservation of biodiversity the traditional rice lines are important as they are reservoir of significant gene pool and can serve as potential genetic resources for improving crop yield. On the other hand, production and identification of quality rice is very important according to the consumer concern. Good quality of rice depends on various grain characters like size, shape and textures of a grain.

Grains are classified into long slender, slender, long bold, short slender, short bold according to their respective grain characters and most of the cases examination of grain characters done by manually through human observation. But there is always a possibility of making a mistake when doing it by human observation, and the process is time consuming also.

Currently various machine learning methods for detecting grain quality using several computer-based applications are gaining increasing popularity. Computer based image processing application like Phyton, OpenCV, NumPy, Matplotib, Seikit-learn, are used to identify damaged chalky and discoloured rice grains[9].

To minimize the mistake and save time Digital Image Processing technology is a very effective and competent computer application to analyse the shape and texture of various rice grains[10].

Characterization of traditional rice varieties predominant in West Bengal according to the ultrastructure of rice grain surface is not so common. The main objective of this work is to characterize five landraces of rice of West Bengal using different grain agro-morphological characters and study of Electron micrograph structure of grains to provide helpful information for diversity analysis and future breeding program.

Materials and Methods

Seeds of five traditional rice varieties have been collected from the ARSWS Community seed bank, situated at Vill-Ranbahal, PO-Amarkanan, Dist-Bankura, West Bengal. Traditional rice varieties selected for this study are- Ashinlaya, Bachi, Badamsaru, Bahurupi, & Barani. Grain morphological characterization conducted as per DUS (Distinctiveness, Uniformity and Stability) guidelines of rice (*Oryza sativa* L.)[11]. In this study grain morphological characters observed of traditional rice varieties include, Lemma and palea colour, Presence or absence of awn, 1000 Grain weight, Grain length, Grain width, Decorticated grain length, Decorticated grain width, Decorticated grain shape, Decorticated grain colour etc.SEM study of the grain (lemma and palea) has been conducted by Gemini SEM450-8216010130 (ZEISS).

Results and Discussion

Finding and Analysis: Diversity observed on Grain morpho-agronomic characterization and SEM analysis of studied five traditional rice lines are given in the Table-1.

Table-1: Agro-morphological characterization of 5 traditional rice varieties.

Name of the varieties	Ashinlaya	Bachi	Badamsaru	Bahurupi	Barani
Lemma & Palea: colour	Straw	Purple furrow on straw	Straw	Brown spots on straw	Reddish to light purple
Grain length (mm	8.2	8.2	9.3	9.2	9.4
Grain width (mm)	3	3.8	2.1	3	3
1000 grain weight (gm)	24.7	23.6	19.4	25.5	24.9
Karnel colour	Red	White	White	White	White
Karnel length (mm)	5.8	5.6	6.6	6.4	6.7
Karnel width (mm)	2	3	2	2.7	2.3
Karnel shape	Medium slender	Short bold	Long slender	Long bold	Long bold
SEM trait analysis					
Mean length of trichomes of apex (µm)	464.951	406.431	357.052	525.85	555.759
SD of apex of trichomes	39.604	49.037	35.676	30.112	108.157
Mean length of trichomes of base (µm)	222.359	191.70	159.327	257.838	206.235
SD of base of trichomes	16.279	30.758	17.096	9.717	29.634
Rachila area(µm)	170335.1	280942.8	96266.65	195573.8	139409
Rachila length(µm)	423.895	608.059	366.942	519.901	426.932
Rachila width(µm)	559.987	714.429	429.116	556.073	502.666
S.L length of lemma side (µm)	2372.866	2808.835	2222.56	2290.677	2531.398
S.L length of palea side (µm)	2511.054	2886.33	2086.212	2333.501	2921.7
Mean tubercles distance (µm)	103.474	90.905	92.568	89.845	84.572

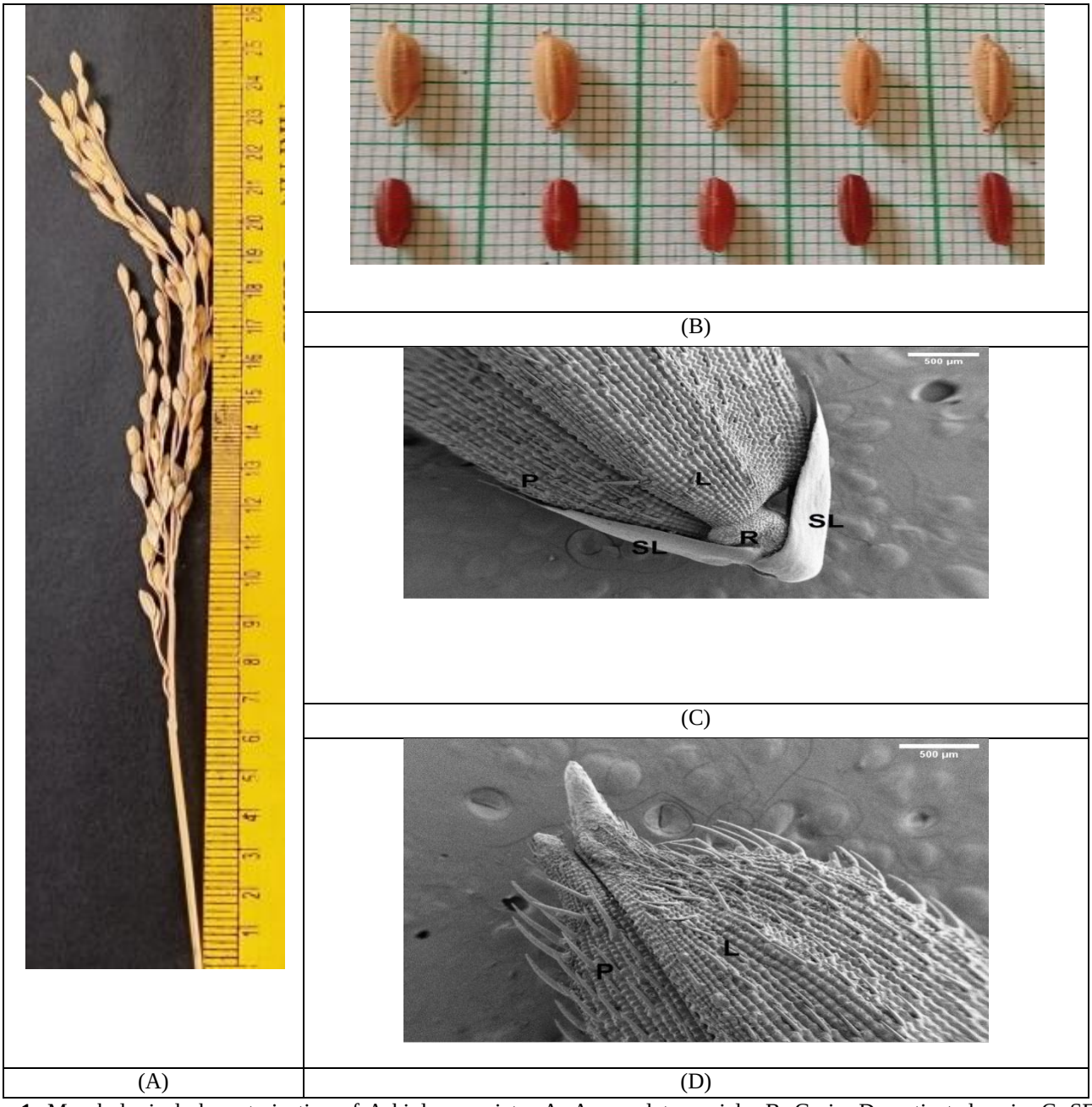

Figure-1: Morphological characterization of Ashinlaya variety. A. A complete panicle, B. Grain, Decorticated grain, C. SEM of Basal part of grain, D. SEM of Apex of grain (P-Palea, L-Lemma, SL-Sterile lemma, R-Rachila).

Ashinlaya variety (Figure-1) have straw coloured Lemma and palea, average grain length is 8.2mm and grain width is 3mm, 1000 grain weight is 24.7gm, average Karnel length is 5.8mm and Karnel width is 2mm. Shape of Karnel is medium slender and colour of Karnel is red.On SEM analysis we observed that, mean length of trichomes in apex area of grain is 464.9µm and in basal area is 222.35. Rachila length is 423.89µm and width is 559.98µm. Length of Sterile lemma of lemma region is 2372.86µm and in palea side is 2511.05µm. The area of the rachila is 170885.1µm. The mean distance of each tubercle of the lemma and palea is observed 103.47µm.

Bachi variety (Figure-2) showed purple furrows on straw on lemma and palea, average grain length is 8.2mm and grain width is 3.8mm, 1000 grain weight is 23.6gm, average Karnel length and width is 5.6mm & 3mm respectively. Karnel is short bold shaped and white in colour. The mean length of trichomes in apex area is 406.431µm and in basal area is 191.709 µm. Rachila length is 608.059µm and width is 714.429 µm. Length of Sterile lemma of lemma region is 2808.835µm and in palea side is 2886.33 µm. The area of the rachila is 280942.8µm. The mean distance of each tubercl of the lemma and palea is observed 90.905µm.

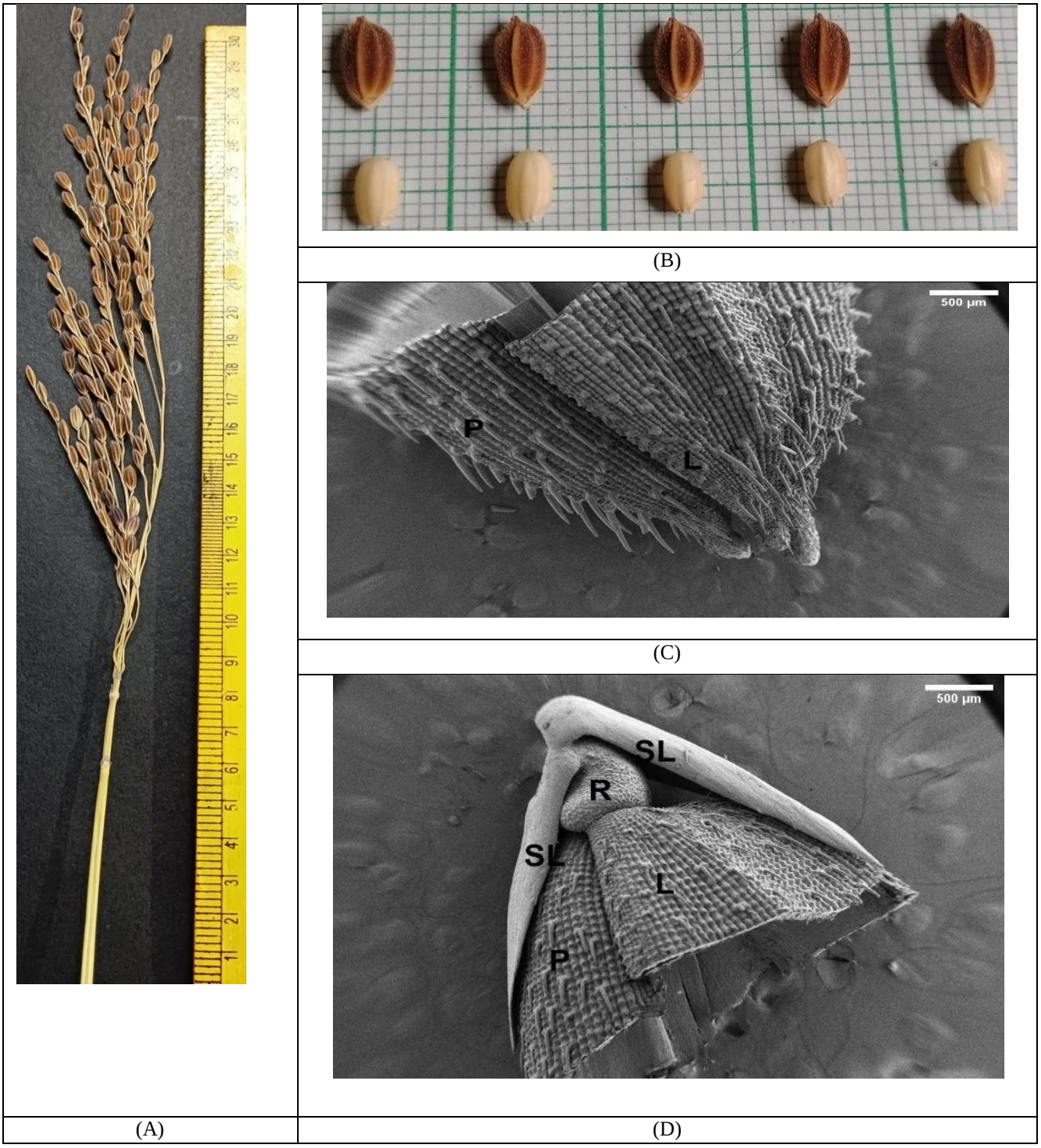

Figure-2: Morphological characterization of Bachi variety. A. A complete panicle, B. Grain, Decorticated grain, C. SEM of Basal part of grain, D. SEM of Apex of grain (P-Palea, L-Lemma, SL-Sterile lemma, R-Rachila).

Badamsaru variety (Figure-3) has straw colour lemma and palea, average grain length is 9.3mm and grain width is 2.1mm, 1000 grain weight is 19.4gm, average Karnel length and width is 6.6mm & mm respectively. Karnel is long slender shaped and white in colour. Mean length of trichomes in apex area is 357.052µm and in basal area is 159.327µm. Rachila length is 366.942µm and width is 429.116µm. Length of Sterile lemma of lemma region is 2222.56µm and in palea side is 2086.212µm. The area of the rachila is 96266.65µm. The mean distance of each tubercle of the lemma and palea is observed 92.568µm.

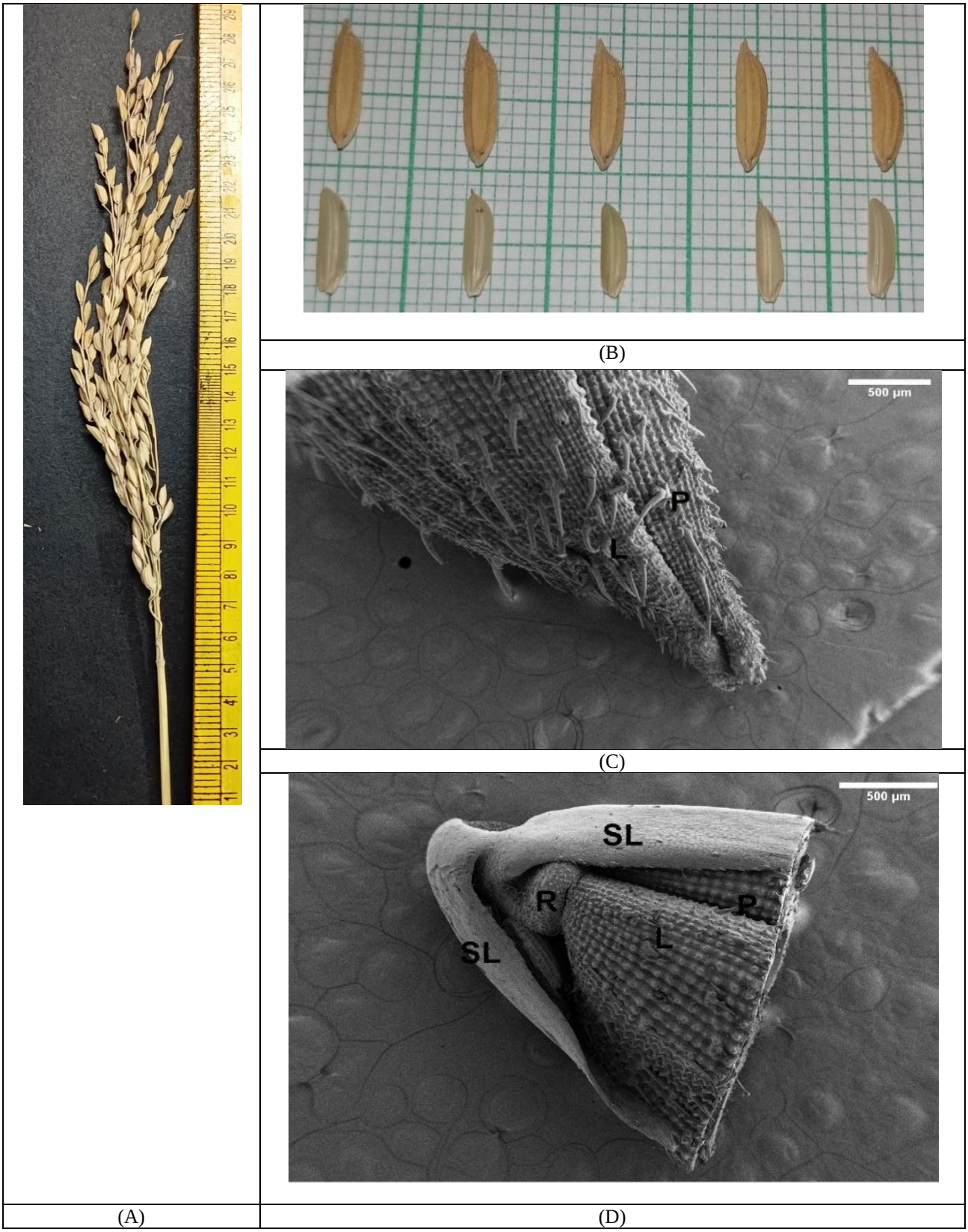

Figure-3: Morphological characterization of Badamsaru variety. A. A complete panicle, B. Grain, Decorticated grain, C. SEM of Basal part of grain, D. SEM of Apex of grain (P-Palea, L-Lemma, SL-Sterile lemma, R-Rachila).

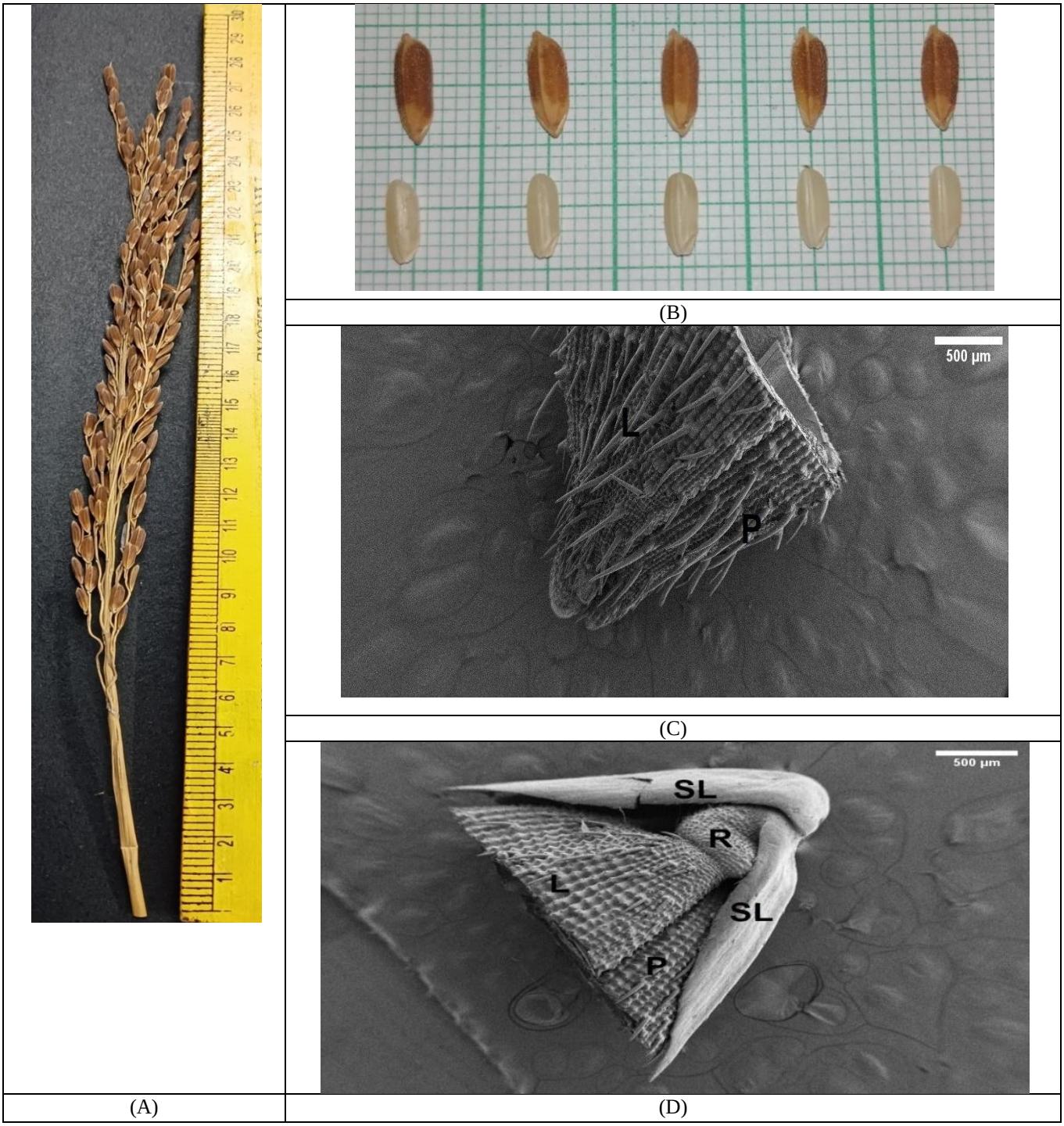

Figure-4: Morphological characterization of Bahurupi variety. A. A complete panicle, B. Grain, Decorticated grain, C. SEM of Basal part of grain, D. SEM of Apex of grain (P-Palea, L-Lemma, SL-Sterile lemma, R-Rachila).

Bahurupi variety (Figure-4) have brown spots on straw coloured Lemma and palea, average grain length is 9.2mm and grain width is 3mm, 1000 grain weight is 25.5gm, average Karnel length is 6.4mm and Karnel width is 2.7mm. Shape of Karnel is long bold and colour of Kalnel is white. On SEM analysis we observed that, mean length of trichomes in apex area is 525.85µm and in basal area is 257.838µm. Rachila length is 519.901 µm and width is 556.073µm. Length of Sterile lemma of lemma region is 2290.677µm and in palea side is 2333.501µm. The area of the rachila is 195573.8µm. The mean distance of each tubercle of the lemma and palea is observed 89.845 µm.

Barani variety (Figure-5) have reddish to light purple coloured Lemma and palea, average grain length is 9.4mm and grain width is 3mm, 1000 grain weight is 24.9gm, average Karnel length is 6.7mm and Karnel width is 2.3mm. Shape of Karnel is long bold and colour of Kalnel is white. On SEM analysis we observed that, mean length of trichomes in apex area is 555.759µm and in basal area is 206.235µm. Rachila length is 426.932µm and width is 502.666µm. Length of Sterile lemma of lemma region is 2531.398µm and in palea side is 2921.7µm. The area of the rachila is 139409µm. The mean distance of each tubercle of the lemma and palea is observed 84.572µm.

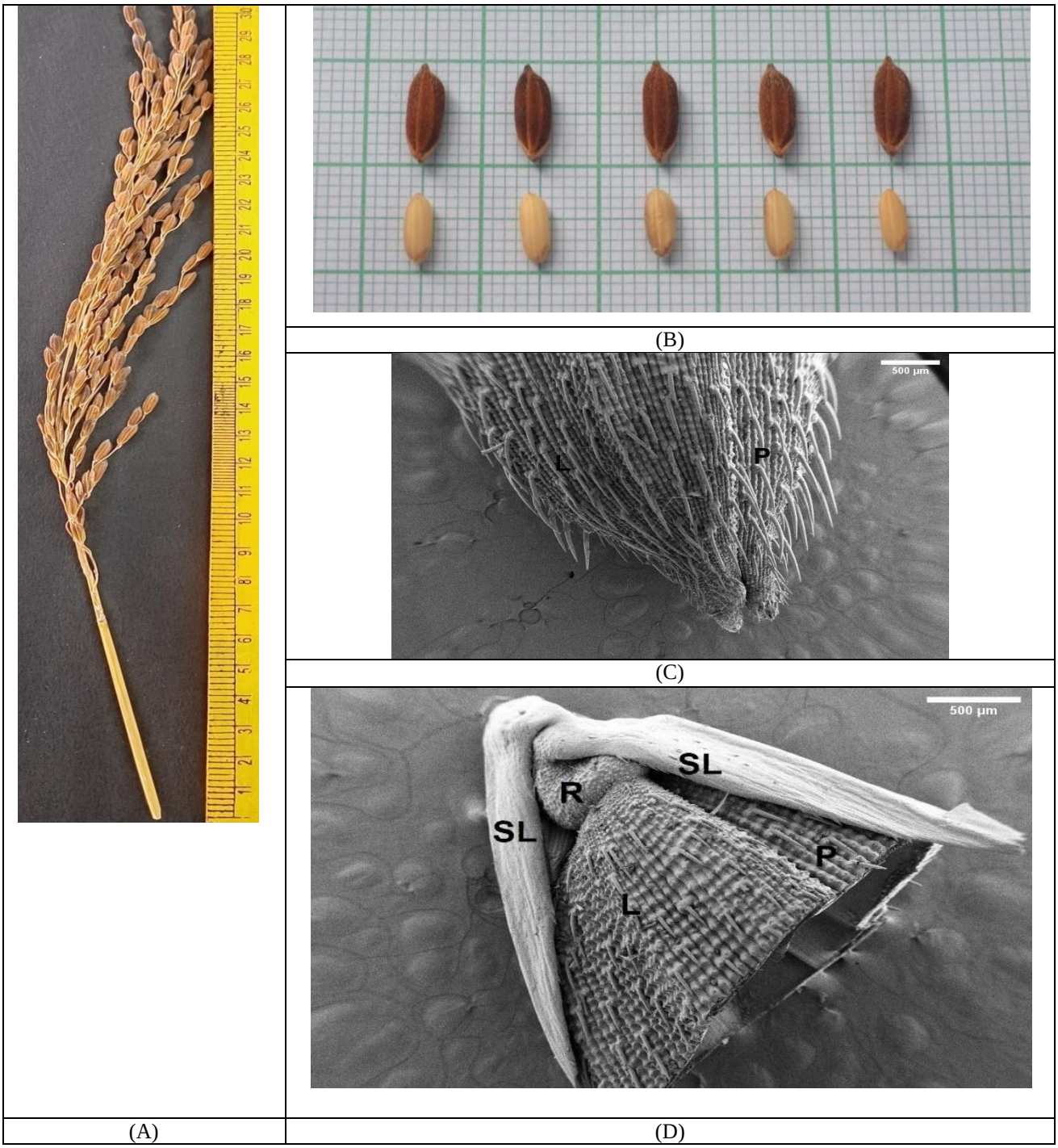

Figure-5: Morphological characterization of Barani variety. A. A complete panicle, B. Grain, Decorticated grain, C. SEM of Basal part of grain, D. SEM of Apex of grain (P-Palea, L-Lemma, SL-Sterile lemma, R-Rachila).

Conclusion

Scanning electron micrograph has been used to study the surface structure of a number of crop seeds. The SEM has both greater focus and resolution that make an image which gives a clearer, three-dimensional concept at high degree of magnification. That's why the SEM has been used in many taxonomic studies including identification of seeds[12].

Maeda[13] examined unhulled seed surface of the rice variety with the help of SEM. Hoagland and Paul[14] also study surface structure of seeds of different rice varieties. Murthy and Sanjappa[15] had studied seed surface morphology of 51 species of *Indigofera* using SEM and broadly classified seeds into 5 groups (Spherical, Boat-shaped, Discoid, Bilateral and cylindrical type).

de Queiroz & Lewis[16] studied various macromorphological and micromorphological characters of 13 species of *Tephrosia* Pers. using Electron Scanning Microscopy and find considerable variation in seed colour, form and size, testa pattern, reticulum anticlinal wall, hilum form etc.

In this work SEM analysis of five investigated traditional rice varieties may provide the basis for further investigations among other commercial rice varieties. Study of plant surfaces with the SEM yield a better understanding of morphological and taxonomic relationships between other plant varieties.

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