MORPHOLOGICAL AND PHYSIOLOGICAL CHARACTERISTICS OF RICE (ORYZA SATIVA)

R. Khanal¹
P.R. Neupane²
A.J. Ghimire³

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Pakhrubes Agricultural Centre,
c/o STCC, P O BOX 106,
Kathmandu, Nepal.

¹. Senior Seed Technologist.
². Seed Technologist.
³. Assistant Seed Technologist.
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SUMMARY

Rice is the most widely grown cultivated cereal crop of Nepal. Seed certification is necessary to ensure that an adequate supply of high quality seed is maintained. Availability of high quality seed to the public is only possible when the technicians involved in seed certification have a sound knowledge of the cultivars' characteristics. This study on the rice varieties Khumal-4, Khumal-3, Pokhreli masino and N.R. 10041 was conducted during 1988/89 and 1989/90 at the PAC rented farm in Hattikharka (900 masl).
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INTRODUCTION

1.1 A new variety is the end product of years of research and breeding work by many agricultural scientists and workers. However, a new variety with all its superior plant characters will not maintain itself automatically. It may get mixed with seeds of other crops or other varieties of the same crop and lose its own identity. In order to achieve the maximum benefit from plant breeding programmes it is essential to have a seed certification programme to safeguard the purity of individual varieties. The purpose of a seed certification programme is to maintain and make available to the public propagating materials of superior crop plant varieties to ensure genetic identity and purity, and to protect them from unscrupulous seed merchants. Acceptance of varieties for seed certification is based on the morphological characteristics (e.g. colour, height, uniformity, leaf head or flower characteristics), and physiological characteristics such as seed emergence. This information is of value to field inspectors.

MATERIALS AND METHODS

2.1 Rice cultivars Khumal-3, Khumal-4, Pokhreli masino and N.R. 10041 were planted at the PAC rented farm in Hattikharka (900 masl) during 1988/89. Rice seedlings were raised in a wet nursery bed. Seeds were sown in a nursery bed in mid June. One month old seedlings were transplanted in a 10 sq. m. area on sandy loam soil. One seedling in each hill was transplanted at a spacing of 25 x 25 cm. Chemical fertilizer was applied at 100:50:50 kg NPK/ha respectively. Observations and a meteorological summary are given in Appendix 1.

PHYSIOLOGICAL CHARACTERISTICS

Seed emergence

3.1 Physiological characters such as emergence of seedlings in the seed bed are an important aspect of cultivar character studies. It was observed that 50% emergence was found 2-3 days after seed sowing in all the rice cultivars tested.

Seed dormancy and germination per cent of fresh seed after dormancy breaking:

3.2 Seed dormancy in rice differs from variety to variety, for example N.R. 10041 has no dormancy while Pokhreli masino and Khumal-4 have seed dormancy. The intensity of seed dormancy also differs from variety to variety. The general procedure prescribed to break dormancy by ISTA (1985) is to pre-heat seed at 50° C in an oven for seven days before conducting the germination test.
4. MORPHOLOGICAL CHARACTERS OF THE RICE PLANT

4.1 The rice plant is an annual grass with round, hollow, jointed culms, rather flat leaves, and a terminal panicle. It is adapted to growing in flooded soils, but it also grows well in non-flooded soil (Rice Production Manual, 1970). Different parts of the rice plants are given in Figure 6.

Vegetative parts

4.2 The vegetative phase begins with seed germination, which is signified by the emergence of the coleoptile and radicle in the germination embryo.

a. Roots

The roots are fibrous and consist of rootlets and root hairs. The embryonic roots or those which grow out of the seed (grain) when it germinates, have few branches. They live only for a short time after germination when secondary adventitious roots, which are freely branched and produced from the underground nodes of the young culm, replace the embryonic roots.

b. Culm

The culm or stem is made up of a series of nodes and internodes in alternate order. The node bears a leaf and a bud which may grow into a tiller or shoot. The main internode is hollow and finely grooved. Its outer surface is hairless (Figure 1).

c. Leaves

Leaves are borne at an angle on the culm or stem in two ranks, one at each node. The blade or the expanded part of the leaf is attached to the node by the leaf sheath.

Reproductive organs

4.3 This phase begins with flowering to seed formation (maturity).

a. Floral organs

The panicle (Figure 2) is a group of spikelets borne on the uppermost node of the culm. The node between the uppermost internode of the culm and the main axis of the panicle is the panicle base.

b. Spikelet

The individual spikelet (Figure 3) consists of two very small "outer glumes" (sterile lemmas) with all other floral parts lying between or above them. It is borne on the pedical which connects with the panicle branch.
c. The grain

The rice grain (Figure 4) is composed of the ripened ovary, the lemma and palea, rachilla, sterile lemmas and awn whenever present. The embryo is fused with the endosperm. The lemma and palea and their associated structures constitute the hull or husk and can be removed by applying a rolling pressure.

5. SEEDLING MORPHOLOGY

5.1 When exposed to warm moist conditions, the grains of non-dormant varieties can germinate immediately upon ripening. In dormant varieties, a period of time (depending upon the variety) must elapse before germination is possible. Special procedures such as heat treatment (50°C for 4 to 5 days) or mechanical dehulling can be used to break the dormancy of freshly harvested samples if the seeds are needed for immediate sowing. Many of the tropical varieties have a degree of dormancy which could be considered beneficial as it prevents the grain in the panicles from sprouting when rainy weather occurs at harvest time. However, if seed dormancy does not allow the farmer to use his seed for the subsequent crop, then it might be considered disadvantageous.

5.2 When the grain germinates in an aerated environment, such as a well-drained soil, the sheath (coleorhiza) enveloping the primary root in the embryo protrudes (Figure 5) before the radicle.

5.3 If it germinates in water, the cylinder-like structure (coleoptile) emerges ahead of the coleorhiza.

5.4 The primary embryonic root (radicle) then breaks through the coleorhiza shortly after the latter appears. This is followed by two or more secondary embryonic roots, all of which develop lateral roots. The embryonic roots later die and are replaced by secondary adventitious roots (Rice Production Manual 1970).

6. AGRONOMICAL CHARACTERISTICS

Plant height

6.1 This was measured in average cm. The shortest plant height 57 cm was found in NR 10041 and 80 cm in Khumal-3. Similarly, 110 cm and 111 cm plant heights were observed in Khumal-4 and Pokhrell masino respectively. The varieties with varying plant height are given in Appendix 1.

Days to 50% flowering

6.2 This was recorded by the number of days from the effective sowing date until 50% of plants in an accession had begun to flower. The variation in flowering is presented in Appendix 1 and Figure 7.
Days to maturity

6.3 This was calculated from the day of transplanting to harvesting. The shortest duration, 86-88 days, was found in Khumal-3 and the longest in Pokhreli masino (140-142 days). Details are given in Appendix 1 and Figure 8.

7. CONCLUSION

7.1 Variations in plant heights were observed. The varieties Khumal-3 and NR 10041 were found shorter when compared to Khumal-4 and Pokhreli masino in plant height. The variety Khumal-3 had a shorter maturity period than Pokhreli masino. All the rice cultivars tested were non-glutinous types except Khumal-3. Purple colour at the base of the stem above the ground level in the case of Khumal-3 and changes in seed colour (dark brown) in the Phenol test have been found in Pokhreli masino and Khumal-4. In all the tested cultivars, except NR 10041, seed dormancy was found.

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APPENDIX 1

CULTIVAR CHARACTERS OF PADDY/RICE

Cultivar: Pokhrell masino

1. Days to 50% emergence in seed bed: 2 - 3.
2. Tillering capacity: 11 - 12.
5. Leaf length (cm) (leaf just below the flag leaf at 5-6 growth stage): 30.0-30.5 cm.
6. Leaf width (cm) (leaf just below the flag leaf at 5-6 growth stage): 2.07-2.09.
7. Leaf blade pubescence (at 4-6 growth stage): Intermediate.
8. Leaf blade colour (at 3-5 growth stage): Green.
10. Leaf angle (at 3-4 growth stage): Erect.
11. Flag leaf angle (at 3-4 growth stage): Erect.
13. Ligule colour (at 3-4 growth stage): White.
14. Ligule shape (at 3-4 growth stage): Truncated.
15. Collar colour (at 3-4 growth stage): White.
17. Culm number/plant (at 3-4 growth stage): 11 - 12.
18. Culm length (cm) (at 7-9 growth stage): 113-114.
22. Lemma and palea colour (at growth stage 9): Golden yellow.
23. Lemma and palea pubescence (at growth stage 7-9): Medium hairs on lemma and palea.
26. Days to harvesting after transplanting: 140-142.
30. 1000 grain weight (gm) at 13% moisture content (before dehulling): 25.0-25.5.
31. 1000 grain weight (gm) (after dehulling): 21.5-22.5.
32. Endosperm type (at growth stage 9): Non glutinous.
33. Chalkiness of endosperm: None.
34. Seed coat (bran) colour: Brownish white.
35. Scent (at growth stage 6-9): Lightly scented.
36. Phenol test reaction: No colour change.
37. Seed dormancy of fresh seed: Dormancy.
38. Seed germination percentage of fresh seed after dormancy breaking: 90 percent.
### Cultivar: Khumal 3

1. Days to 50% emergence in seed bed: 2 - 3.
2. Tillering capacity: 11 - 12.
3. Plant height (cm) (at 9 growth stage): 80 - 81.
4. Leaf length (cm) (leaf just below the flag leaf at 5-6 growth stage): 19.5 - 20.5 cm.
5. Leaf width (cm) (leaf just below the flag leaf at 5-6 growth stage): 1.25 - 1.75.
6. Leaf blade pubescence (at 4-6 growth stage): Intermediate.
7. Leaf blade colour (at 3-5 growth stage): Green.
9. Leaf angle (at 3-4 growth stage): Erect.
10. Flag leaf angle (at 3-4 growth stage): Erect.
11. Ligule length (cm) (at 3-4 growth stage): 16 - 17.
12. Ligule colour (at 3-4 growth stage): White.
13. Ligule shape (at 3-4 growth stage): Truncate.
15. Auricle colour (at 3-4 growth stage): Whitish red.
17. Culm length (cm) (at 7-9 growth stage): 85.5 - 86.5.
19. Days to first flowering after transplanting: 40 - 42.
20. Days to 50% flowering after transplanting: 47 - 49.
21. Lemma and palea colour (at growth stage 9): Dark white yellow (golden).
22. Lemma and palea pubescence (at growth stage 7-9): Medium hairs, slightly more hairs at upper portion.
23. Sterile lemma colour (at growth stage 7-9): Straw to gold.
24. Sterile lemma length (mm) (at growth stage 7-9): 7.5 - 8.3.
27. Brown rice length (mm) (after dehulling): 6 - 6.4.
29. 1000 grain weight (gm) at 12% moisture content (before dehulling): 24.600 gm.
30. 1000 grain weight (mm) (after dehulling): 22.5 - 23.5.
32. Chalkiness of endosperm: Chalkiness toward the centre.
33. Seed coat (bran) colour: White.
34. Scent (at growth stage 6-9): Lightly scented.
35. Phenol test reaction: Dark brown.
36. Seed dormancy of fresh seed: Dormancy.
37. Seed germination percentage of fresh seed after dormancy breaking: 90 percent.
Cultivar: Khumal-4 (NR-10078-76-14)

1. Days to 50% emergence in seed bed: 2 - 3.
2. Tillering capacity: 11 - 12.
4. Variety group: Indica
5. Leaf length (cm) (leaf just below the flag leaf at 5-6 growth stage): 26 - 28.6 cm.
6. Leaf width (cm) (leaf just below the flag leaf at 5-6 growth stage): 2.0 - 2.18.
7. Leaf blade pubescence (at 4-6 growth stage): Intermediate.
8. Leaf blade colour (at 3-4 growth stage): Green.
10. Leaf angle (at 3-4 growth stage): Erect.
11. Flag leaf angle (at 3-4 growth stage): Erect.
12. Ligule length (cm) (at 3-4 growth stage): 20.5 - 21.4.
13. Ligule colour (at 3-4 growth stage): White.
15. Auricle colour (at 3-4 growth stage): White.
17. Culm length (cm) (at 7-9 growth stage): 103 - 104.
18. Culm angle (at 7-9 growth stage): Open.
20. Days to 50% flowering after transplanting: 86 - 87.
22. Lemma and palea pubescence (at growth stage 7-9): Medium hairs, glabrous (more hairs).
23. Sterile lemma colour (at growth stage 7-9): Straw.
24. Sterile lemma length (mm) (at growth stage 7-9): 7.91.
25. Days to harvesting after transplanting: 130 - 141.
26. Grain length (mm) (before dehulling): 7.5 - 8.3.
29. 1000 grain weight (mm) (before dehulling): 21 - 21.8.
30. 1000 grain weight (gm) (after dehulling): 18 - 19.
31. Endosperm type: Non glutinous.
32. Chalkiness of endosperm: None.
33. Seed coat (bran) colour: Light brown.
34. Scent (at growth stage 6-9): Non scented.
35. Phenol test reaction: No colour change.
36. Seed dormancy of fresh seed: Dormancy.
37. Seed germination percentage of fresh seed after dormancy breaking: 90 percent.
Cultivar: NR 10041

1. Days to 50% emergence of seedling in nursery bed: 3.
2. Tilling capacity: 16.
5. Leaf length (cm) (leaf just below the flag leaf at 5-6 growth stage): 35.9.
6. Leaf width (cm) (leaf just below the flag leaf at 5-6 growth stage): 0.99.
7. Leaf blade pubescence (Glabrous, intermediate or pubescent at 4-6 growth stage): Intermediate.
8. Leaf blade colour (at 2-4 growth stage): Dark green.
10. Leaf angle (erect, horizontal or drooping at 3-4 growth stage): Erect.
11. Flag leaf angle (erect, horizontal, intermediate or descending at 3-4 growth stage): Erect.
12. Ligule length (at 3-4 growth stage): 1.2 cm.
13. Ligule colour (at 3-4 growth stage): Slightly white.
15. Auricle colour (at 3-4 growth stage): Brown.
16. Culm number per plant: 16
17. Culm length (cm) from soil surface to penicle base (at 7-9 growth stage): 52.02.
18. Culm angle (Erect, intermediate, open, spreading or procurement at 7-9 growth stage): Intermediate.
19. Days to 50% flowering after transplanting: 62.
21. Lemma and palea pubescence (Glabrous, Hairs on lemma keel, Hairs on upper portion, short hairs or long hairs at growth stage 7-9): Glabrous hairs.
23. Sterile lemma length (mm) (at growth stage 9): 7.92.
24. Days to harvesting after transplanting: 104.
25. Grain length (mm) (before dehulling): 8.7 mm/9.48.
27. Brown rice shape (length - width): Length- 7.2 mm, Width- 1.806 mm.
28. 1000 grain weight (gm) (before dehulling): 25.18.
29. 1000 grain weight (gm) (after dehulling): 20.81.
30. Endosperm type (Non-glutinous, glutinous or intermediate): Non-glutinous.
32. Seed coat (bran) colour: Light brown.
33. Scent (Non-scented, lightly scented or scented): Non-scented.
34. Phenol test reaction: Blackish tip.
35. Seed dormancy of fresh seed: No dormancy.
36. Seed germination percentage of fresh seed after dormancy breaking: 94.
Fig. 1. Parts of a primary tiller and its secondary tiller.

Fig. 2. Component parts of a panicle (partly shown)
Fig. 3. Parts of a spikelet

Fig. 4. Structure of a grain

Fig. 5. Parts of germinating seedling

Figure 6.

A. Base of plant
B. Portion of stem with sheath node
C. Base of Lemma with ligule and auricles
D. Emerging inflorescence
E. Portion of inflorescence
F. Open spikelet
G. Caryopsis

Figure 7: The differences in 50% flowering
8: Differences in days to maturity of rice varieties
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PAKHRIBAS AGRICULTURAL CENTRE

Pakhribas Agricultural Centre (PAC) is located in Dhankuta district in the Koshi Hills of eastern Nepal. It is an agricultural, livestock and forestry research institution principally funded by the Overseas Development Administration of the British Government. Established in 1972, the Centre undertakes an intensive programme of interdisciplinary research and training aimed at improving the quality of life in the eastern hill region. The Centre introduces and develops technologies suitable for the local environment and helps farmers raise their standard of living through increased, sustainable productivity. Besides conducting on-farm and outreach research in collaboration with various JMG/N departments and institutions, the Centre also provides support services to the Koshi Hill Development Programme, SNV Mechi and other donor funded projects working in the region.

PAC is now integrated into the national research system. The research command area of the project includes the eleven hill districts of Sagarmatha, Koshi and Mechi zones of eastern Nepal. This area covers over 21,000 sq km with approximately 300,000 farm families representing a population of more than 1.5 million.

PAC’s work integrates key aspects of crop science, forestry, animal husbandry and health. Its facilities include an 80 hectare research station, training centre and comprehensive laboratories. The Centre has a range of specialist sections: Agronomy, Extension Research, Forestry, Horticulture, Livestock, Seed Technology, Socio-economics, Training, Information, Outreach and Veterinary Investigation and Analytical Services. These sections combine their expertise to form inter-disciplinary working groups to address priority problem areas such as women’s development, low-input alternative technologies, farming systems, and fodder production in the dry season.

PAC transmits and applies the results of its research through a broad range of programmes which include field demonstrations, the distribution of minikits to farmers, seed multiplication, establishment of nucleus breeding units, plant analysis and animal health clinics, extension information and educational leaflets and training.