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# Lodging in rice

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Rice plants that lean excessively or fall over are said to be lodged (Figure 1). Lodged crops are difficult and expensive to harvest. If lodging occurs before the crop is mature it interferes with ripening, resulting in reduced grain yield and poor grain quality.

High summer temperatures during stem elongation have been shown to increase lodging, so lodging is worse in some seasons.

Excess nitrogen (N) is a major cause of lodging. However, adequate N is essential for optimal yield. A N rate and timing balance is required for each variety to achieve a high grain yield with minimal lodging.

Some factors that influence lodging susceptibility can be managed. These include variety selection, sowing method, N rate and timing, plant density, water depth and draining time.

Figure 1. Extensive lodging in an aerial sown rice crop.

## Variety

Rice varieties vary in structural characteristics, directly influencing their lodging potential (Figure 2). Plant characteristics, including plant height, stem strength and sturdiness of the lower part of the plant, influence its ability to stand up at maturity, even with high grain yields.

Figure 2. High nitrogen variety experiment shows the differences in variety lodging potential.

Varieties that are more prone to lodging are generally taller and have thinner stems, as shown by decreased stem weight per cm (Table 1). Varieties such as Doongara, Topaz$^{\phi}$, Reiziq$^{\phi}$ and V071$^{\phi}$ are relatively tolerant of lodging, while Koshihikari and YRK5$^{\phi}$ are highly susceptible (Table 1).

Table 1. Average lodging score (1=standing, 10=fully lodged), plant height (cm) and stem weight (g/cm) for current rice varieties collected from research experiments located in commercial fields.

| Variety | Lodging score (1=less lodging) | Plant height (cm) | Stem weight (g/cm) |
|---|---|---|---|
| Doongara | 1.0 | 75 | 0.028 |
| Topaz$^{\phi}$ | 1.0 | 81 | 0.022 |
| Reiziq$^{\phi}$ | 1.1 | 80 | 0.024 |
| V071$^{\phi}$ | 1.1 | 78 | 0.023 |
| Sherpa$^{\phi}$ | 1.2 | 83 | 0.022 |
| Opus$^{\phi}$ | 2.0 | 81 | 0.022 |
| Langi | 2.1 | 86 | 0.022 |
| Viand$^{\phi}$ | 2.6 | 85 | 0.019 |
| YRK5$^{\phi}$ | 5.6 | 93 | 0.018 |
| Koshihikari | 6.1 | 91 | 0.018 |

Varieties that are prone to lodging require specific agronomic management to reduce their lodging potential.

## Sowing method

Aerial sown crops are more prone to lodging than drill sown crops, with delayed permanent water (DPW) crops the most tolerant to lodging. Lodging resistance in drill sown crops is due to better root anchorage in the soil and resistance against stem bending and breaking (Terashima et al. 1992).

Water management also affects lodging resistance as crops that are fully flooded from germination grow taller and have thinner stems than rice crops grown with intermittent irrigation during establishment and tillering.

Varieties sensitive to lodging (Koshihikari, YRK5$^{\Phi}$ and Viand$^{\Phi}$) should not be aerially sown.

## Nitrogen rate and timing

Nitrogen is vital for achieving high grain yields, but excessive N rates applied before pre-permanent water increase lodging, especially for lodging-susceptible varieties. Straw-breaking strength and bending stress are reduced due to lower stem cellulose and lignin content at higher N rates (Zhang et al. 2017).

High N rates also increase lodging susceptibility in rice by increasing tiller numbers, the length of lower internodes and plant height (Zhang et al. 2016).

Reducing the N rate applied before pre-permanent water is important for varieties that are very susceptible to lodging (e.g. Koshihikari). Apply only 50% of the normal application rate for a Reiziq$^{\Phi}$ crop grown in the same field. At panicle initiation (PI), measure the crop's N uptake and then top-dress with N if required.

When applying N to crops, growers need to be aware of not only the N rate applied but also the evenness of fertiliser spreading patterns. Areas that receive heavier application rates often lodge, sometimes bringing down surrounding crop areas.

## Plant density

Although research has shown rice grain yield potential to be the same between plant densities of 40 plants/m² and 400 plants/m², higher plant densities can lead to increased lodging. Research using Viand$^{\Phi}$ showed that higher plant densities tend to produce plants more prone to lodging than those grown with lower plant densities.

To reduce lodging potential, it is important not to use higher than recommended sowing rates, especially for the small grain varieties, which have many more seeds per kilogram.

Recommended sowing rates for rice varieties based on seed size and average varietal establishment percentages from field experiments are presented in Table 2.

Table 2. Sowing rates (kg/ha) required to meet plant population recommendations based on seed size and average varietal establishment percentages.

| Variety | Sowing rate (kg/ha) |
|---|---|
| Reiziq$^{\Phi}$ and Topaz$^{\Phi}$ | 140 |
| V071$^{\Phi}$, Sherpa$^{\Phi}$, Langi Doongara and Viand$^{\Phi}$ | 130 |
| Opus$^{\Phi}$ | 110 |
| Koshihikari | 100 |

## Water depth during establishment

The need for seedlings to emerge from the water and intercept sunlight for photosynthesis, combined with the buoyancy provided by the water, results in taller weaker plants in deeper water. It is important to keep water depth shallow during establishment and through mid-tillering so plant height is not increased, which will increase crop lodging potential.

## Draining

When to drain the water from a rice crop for harvest is a very important and difficult decision. If the field is drained too early, not providing sufficient soil moisture to take the plants to physiological maturity, the crop will 'hay off'. Haying off weakens the stem, resulting in considerable lodging, reducing grain yield and whole grain millout.

## Weather

A high-yielding crop is often finely balanced as it nears maturity, so anything that upsets the balance, such as heavy rain or strong winds, can cause it to lodge. Harvesting as soon as the crop is mature helps to reduce the chance of lodging due to weather and ensures good grain quality.

## References

Terashima K, Akita S and Sakai N. 1992. Eco-physiological characteristics related with lodging tolerance of rice in direct sowing cultivation: I. comparison of the root lodging tolerance among cultivars by the measurement of pushing resistance. *Japanese Journal of Crop Science*, 61: 380–387.

Zhang W, Wu L, Ding Y, Yao X, Wu X, Weng F, Li G, Liu Z, Tang S, Ding C and Wang S. 2017. Nitrogen fertiliser application affects lodging resistance by altering secondary cell wall synthesis in japonica rice. *Journal of Plant Research*, 130: 859–871. https://pubmed.ncbi.nlm.nih.gov/28451936/

Zhang W, Wu L, Wu X, Ding Y, Li G, Li J, Weng F, Liu Z, Tang S, Ding C and Wang S. 2016. Lodging resistance of Japonica rice (*Oryza sativa* L.): morphological and anatomical traits due to top-dressing nitrogen application rates. *Rice*, 9: 31. https://thericejournal.springeropen.com/articles/10.1186/s12284-016-0103-8

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