

Application of Plant Growth Regulators in Seed Treatment

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Why the first week decides the crop

Every crop is won or lost in its first few days. Seeds that germinate slowly or unevenly leave gaps, produce weak seedlings and force farmers into costly re-sowing. Hard-coated, dormant or old seeds, and seeds sown in cold, salty or dry soils, are the usual culprits. Seed treatment is the practice of applying a protective or stimulating material to the seed before sowing. Fungicides and insecticides protect the seed, while biological treatments add helpful microbes. PGR treatment belongs to a third group, often called seed priming or "hormonal priming", which prepares the seed's own physiology for rapid germination (Paparella et al., 2015; Rhaman et al., 2021).

What are plant growth regulators?

PGRs are natural or synthetic chemicals that, in very small amounts, change how a plant grows. They are not fertilisers and supply no nutrients. Instead they act as signals. Rademacher (2015) describes how such compounds are used across crop production to modify rooting, shoot growth, flowering and stress response.

The main groups relevant to seeds are:

- **Gibberellins (GA3):** wake the seed up and push germination.
- **Auxins (IAA, IBA, NAA):** stimulate root initiation and early root growth.
- **Cytokinins (kinetin, 6-BA):** promote cell division and can overcome heat-induced dormancy.
- **Salicylic acid and brassinosteroids:** mainly improve tolerance to stress.
- **Abscisic acid (ABA):** the natural "brake" that keeps seeds dormant; it is rarely applied to seeds, but its balance with gibberellins is central to the story.

How a hormone soak wakes up a seed

A dry seed is a living but sleeping embryo with stored starch, protein and oil. Germination begins when water enters the seed and the embryo switches on enzymes to release that stored food. The balance between gibberellins, which promote germination, and ABA, which restrains it, largely decides whether a seed sprouts or stays dormant (Bewley et al., 2013; Nonogaki, 2014).

PGR soaking tips the hormone balance toward germination

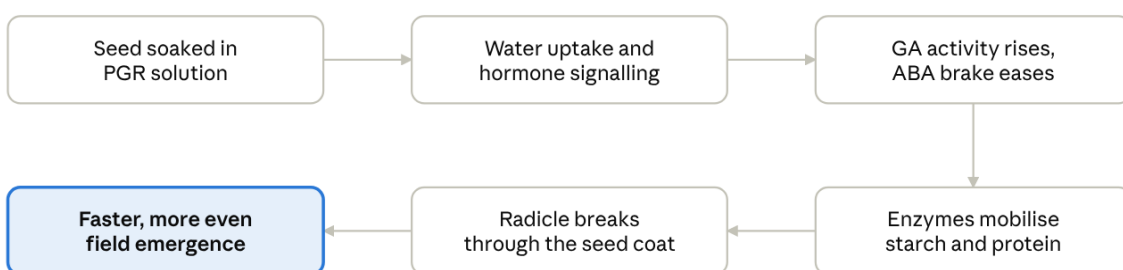


Figure 1. From PGR soak to field emergence

In cereals, gibberellin from the embryo signals the surrounding aleurone layer to make α -amylase, an enzyme that breaks starch into sugars the seedling can burn for energy (Taiz et al., 2015). Supplying GA3 from outside can therefore speed up this chain, especially in seeds whose own hormone production is low. Miransari and Smith (2014) review how auxins, cytokinins and ethylene also interact with this core GA-ABA balance, which is why different PGRs produce different effects on the same seed.

Which PGRs are used, and how much?

Table 1 gives commonly reported ranges from the general literature. Treat them as starting points for trials, not recommendations: the right dose depends on the crop, variety, seed age and seed coat.

Table 1. Plant growth regulators commonly used in seed treatment

PGR	Indicative range (mg/L, ppm)	Usual soaking time (h)	Main purpose	Typical use
Gibberellic acid (GA3)	50–500	6–24	Break dormancy, speed up germination	Hard-to-germinate vegetable, fruit and ornamental seeds
IAA / IBA / NAA (auxins)	10–100	4–12	Early root growth, seedling vigour	Cereals, pulses, vegetables
Kinetin / 6-BA (cytokinins)	10–50	6–12	Overcome heat-induced dormancy, early growth	Lettuce-type and other small-seeded crops
Salicylic acid	50–100	6–12	Tolerance to salt, drought and cold	Cereals, vegetables under stress
Brassinosteroids	0.01–0.1	4–12	Stress tolerance, uniform emergence	Cereals and vegetables under stress

(Indicative ranges compiled from Rademacher, 2015; Jisha et al., 2013; Rhaman et al., 2021).

Benefits seen in practice

Faster and more uniform emergence. Seeds treated at the right dose germinate earlier and closer together, which gives a more even stand and easier crop management (Paparella et al., 2015).

Breaking dormancy. GA3 is the best-known tool for seeds that refuse to germinate even when moisture and temperature are right (Miransari and Smith, 2014).

Better performance under stress. Hormone-primed seeds often cope better with salinity, drought and temperature extremes. Ibrahim (2016) and Jisha et al. (2013) review how priming helps seeds under salt and other stresses, and Rhaman et al. (2021) focus on hormone priming specifically.

Low cost and low input. A few grams of PGR can treat many kilograms of seed, and a bucket is the only equipment needed.

A simple soaking method

1. **Choose good seed.** Use clean, graded seed with good initial viability; PGRs improve a seed's start but cannot revive dead seed.
2. **Prepare the stock.** GA3 dissolves poorly in cold water, so first dissolve the powder in a few millilitres of ethanol, then make up the volume with clean water to the required concentration.
3. **Soak the seed.** Immerse seed in enough solution to cover it, using a seed-to-solution ratio of roughly 1:2 to 1:5 by volume, for the time suited to the crop. Keep it shaded and cool.
4. **Rinse and dry back.** Drain, rinse lightly and dry the seed in shade to near its original moisture so it flows through the planter.
5. **Sow promptly.** Primed seed often stores less well than untreated seed, so sow soon after treatment (Halmer, 2004).

Cautions: more is not better

PGRs follow a bell-shaped response. Too little does nothing, the right dose helps and too much harms. Excess GA3 can give tall, thin, weak seedlings, and Shuai et al. (2017) showed that high auxin levels can suppress soybean germination by tilting the gibberellin–ABA balance the wrong way. A few rules keep treatment safe and effective:

- Always run a small germination test with 3–4 doses before treating a full seed lot.
- Weigh PGRs accurately; milligram errors matter at these concentrations.
- Use clean water, and make fresh solution for each batch.
- Wear gloves, and check that any PGR you use is permitted for the crop in your region.
- Check compatibility before mixing a PGR with a fungicide or biological treatment.

Looking ahead

Hormone priming is moving from the laboratory into seed enterprises, and combinations of PGRs with protectants and beneficial microbes are being tested to give seedlings protection and stimulation in one step. Because responses vary so much between crops and seed lots, careful, small-scale trials remain the best investment before any large treatment.

Conclusion

Plant growth regulators work by adjusting the hormone balance inside the seed, so germination is faster and more even. With the right PGR, the right dose and a short soaking time, growers can improve emergence and early vigour at very low cost. The key is to treat PGRs as precise tools: test, measure and sow promptly.

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