Plant Stand Yield Analysis — A Practical Summary

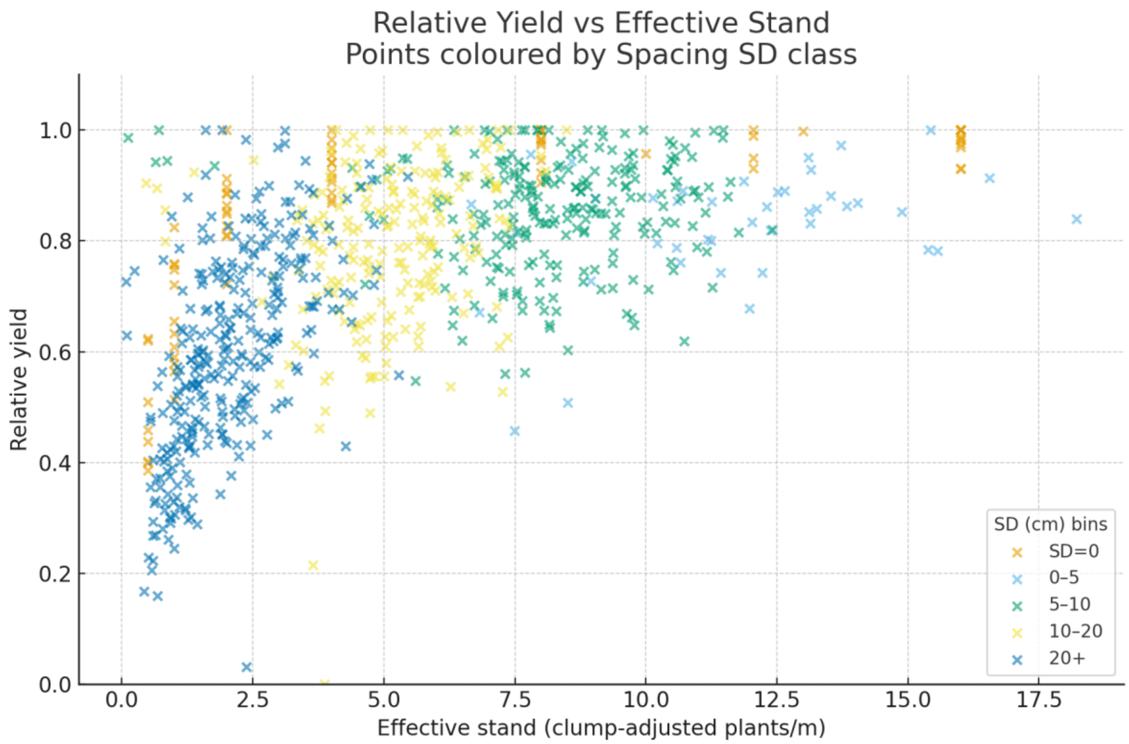
Getting establishment right is still one of the key ingredients in producing cotton yield. What these series of trials confirm is that plant stand isn't just about "how many plants we've got." It's also about how those plants are arranged, whether they're evenly spaced, and whether they're competing in tight clumps. Across seasons, regions, and a wide range of stand outcomes, the same pattern keeps showing up: effective plant stand sets yield potential, and variability decides how much of that potential you capture.

Relative yield let us compare years fairly. Because across many seasons and sites have different the trials have differing yield ceilings, this work used relative yield. For every trial, the best treatment was set to a relative yield of 1.0, and all other treatments were expressed as a fraction of that. This means the conclusions are about stand effects, not just good or bad seasons. In practical terms, it lets growers use the results no matter the season.

A big step forward in this analysis was shifting from raw plants per metre to effective plant stand. In the field we often see doubles and clusters where two or more plants emerge within a couple of centimetres of each other. Raw counts treat those plants as extra stand, but in reality they behave like one productive unit. They compete for light, water and nutrients, limit branching, and reduce fruiting sites. So even though raw plants/m may look "high," yield doesn't follow because much of that stand is tied up in clumps. To fix that, plants closer than a small threshold were treated as one effective plant. This corrected measure aligns much better with yield across all sites and years and gives a truer answer to the question growers care about: how many productive plants does my crop actually have?

When CSD plotted effective stand against relative yield, the response was not a straight line. Relative yield climbed sharply from very low plant stands, then began to flatten, and eventually reached a ceiling where extra plants didn't add much yield at all. This is exactly the kind of biological curve captured by a Michaelis–Menten model. That model is well-suited for cotton plant stand analysis' because it reflects what growers see: strong yield gains as a crop moves from "too thin" into "adequate," followed by diminishing returns once stands are solid. The uniform-spacing trials (where plants were hand-thinned and spacing was perfectly even) provided a clean benchmark for the best-case pathway. Those uniform plots define the upper line of what the crop can achieve with ideal stand arrangement. In practice, this curve becomes the standard for judging real paddocks.

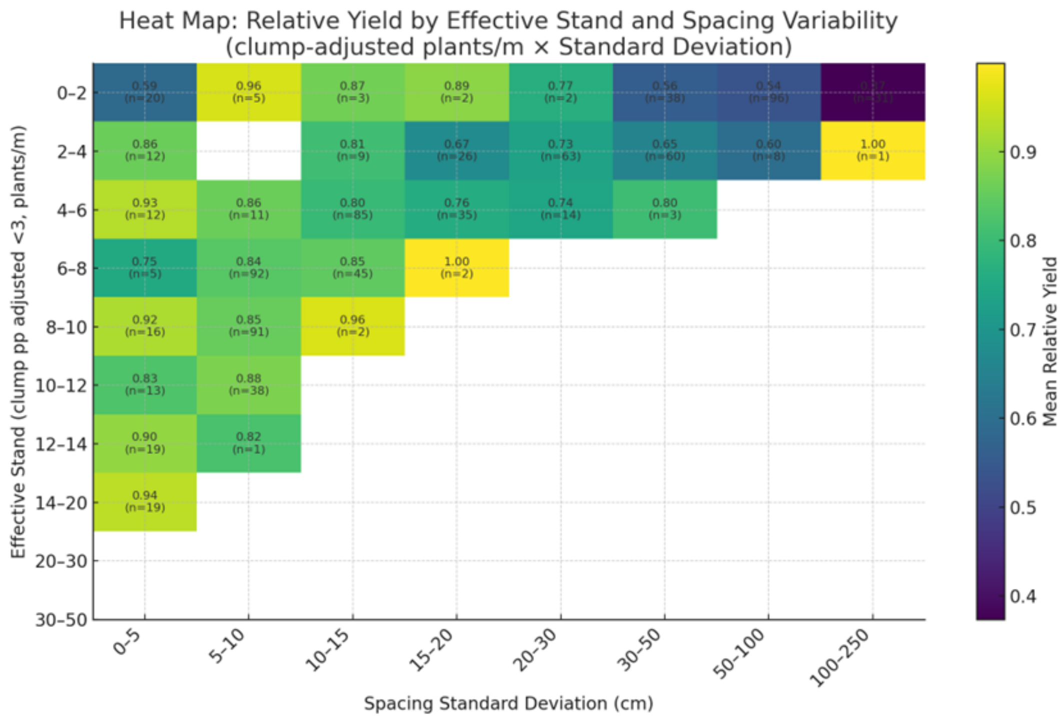
Figure 1: Relative yield plotted against effective stand with differentiation for in field variability highlighted with differing colour scale.



Once population was sorted out, the second big lever was plant stand evenness. Spacing variability (measured as standard deviation of the gaps between plants) showed a clear negative relationship with yield. Two paddocks with the same effective stand can yield very differently if one is even (uniform) and the other is patchy (variable). The penalty from variability is biggest when stands are low. At low effective populations, every gap and clump matters more because the crop has fewer productive plants to compensate. But variability still matters even in good stands. Once you're in the main "high yield zone," unevenness becomes a reason crop fall short of their potential. This supports a simple extension message: once you've got enough plants, evenness pays more than extra seed

Heat maps of relative yield across effective stand and variability classes were a useful way to simplify the story. They show a clear sweet spot where yield is most reliable: adequate effective stand combined with low–moderate variability. They also flag a danger zone: low effective stand plus high variability, where yield penalties are consistently large. A second heat map looked at yield loss versus the uniform benchmark curve, which isolates variability effects from population effects. That map puts a number on the "uniformity penalty." It shows how much yield is being lost to patchiness and clumping compared with what the crop should be able to do at the same effective stand if spacing was ideal. For growers, this is an easy way to understand "yield at risk from stand expression."

Figure 2: Relative yield and effective stand displayed as a heat map.



To test climate-linked plant stand theory, the trials dataset was split into Southern Valleys (cooler systems) and Central Valleys (warmer systems). When all real paddock data were analysed, the Southern Valleys curve did rise more slowly and plateau later. In plain terms, Southern crops tended to keep benefiting from additional effective plants/m for longer before the yield ceiling was reached. Central Valleys generally hit their plateau earlier. However, when we looked only at perfectly even uniform plots by region, the difference was small. That's important because it suggests the regional effect is not about cotton biology under perfect establishment. Instead, the regional difference shows up because real stands in cooler valleys express differently — variability, establishment stress, and uneven emergence drive a higher stand requirement in practice.

It boils down to this. In Southern Valleys, aim toward the top end of the effective stand sweet spot and protect emergence consistency. Central and other warmer valleys plateau earlier, so once effective stands are solid, returns from pushing population higher are smaller unless uniformity is poor.

To make the results usable in-season, a decision support tool was built. Users measure a run of sequential plant gaps (distance between two plants) down a representative row, enter those spacings, and the tool automatically calculates effective plants/m (adjusting for clumps), variability (SD), expected relative yield based on the Michaelis–Menten stand response and a variability penalty, and yield loss versus both the theoretical maximum and the uniform planting benchmark. The embedded chart shows the paddock position against the ideal line, making it easy to see whether yield risk is mainly coming from too few effective plants, too much variability, or both. For extension work, this gives growers a consistent language for stands beyond "looks good" or "looks average."

Across all trials, the stand rules are clear: count effective stand, not raw plants/m; protect adequate effective stands early; once stands are adequate, focus on uniformity; use the uniform benchmark as your ideal; adjust targets by valley; and use objective measurements rather than relying on a quick glance. These trials reinforce a simple truth: Effective stand determines what's possible, and stand evenness determines what you actually get. If growers aim for a strong effective stand and manage the planting system so plants emerge uniformly, they lock in the cheapest yield gains available.