International Journal of Botany Studies
www.botanyjournals.com
ISSN: 2455-541X
Received: 21-07-2026, Accepted: 20-08-2026, Published: 04-09-2026
Volume 11, Issue 3, 2026, Page No. 348-352

Doubling the harvest: Agronomic determinants of a yield surge in the second picking of polyhouse-grown hybrid English Cucumber (*Cucumis sativus L.)*

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DOI: https://doi.org/10.66856/ijbs.2026.11.3.11228

Abstract
Protected cultivation of hybrid English cucumber (*Cucumis sativus L.*) offers a route to substantially higher and more consistent yields than open-field production, but on-farm evidence documenting week-to-week yield escalation under commercial polyhouse conditions in South India remains limited. This case study reports harvest-wise production data from a 1-acre naturally ventilated polyhouse at Alangur, Kolar district, Karnataka, sown with a gynoecious hybrid cucumber on 3 July 2026 at a spacing of 1 ft (plant-to-plant) × 2.5 ft (row-to-row), giving a plant population of 8,421 seed points per acre. Germination reached 91.6% (7,715 established plants). Picking commenced on 10 August 2026 on a 2-day harvest interval. The first harvest (10 August) yielded 1,198 kg of marketable fruit; the second harvest, two days later (12 August), yielded 2,001 kg from approximately 11,000 fruits at a mean fruit weight of ~180 g — a 67% increase over the first picking and roughly double the customary single-day benchmark yield of ~1 tonne reported for polyhouse cucumber blocks of this size. Non-marketable (cull) fruit was negligible (7 kg), giving a marketable fraction exceeding 99.6%. The yield surge coincided with correction of an observed potassium deficiency, sustained drip fertigation at 200 mL plant^{-1}, and active scouting-based management of Spodoptera sp., thrips and leaf miner. We situate these on-farm observations against the published literature on protected-structure performance, plant density, potassium nutrition and pest management in greenhouse cucurbits, and propose that the second-harvest surge is attributable to the coincidence of peak early-cycle fruit set, corrected potassium nutrition and stable microclimate rather than to any single factor in isolation. The results support naturally ventilated polyhouse cultivation, tight plant spacing with rigorous canopy and nutrient management, and short harvest intervals as a practicable route to high, early-cycle marketable yield in hybrid cucumber under Karnataka's agro-climatic conditions.

Keywords: *Cucumis sativus*, polyhouse, protected cultivation, hybrid cucumber, yield, Kolar, Karnataka, potassium nutrition, spodoptera, drip fertigation

Introduction

Cucumber (*Cucumis sativus* L.) is among the most widely grown cucurbit vegetables in protected cultivation systems worldwide, valued for its short crop duration, high water content and year-round market demand. In India, naturally ventilated polyhouses (NVPs) have emerged as the dominant low-technology protected structure for smallholder and semi-commercial vegetable production, offering partial insulation from ambient temperature extremes, wind, and rain-fed disease pressure while remaining affordable relative to fully climate-controlled greenhouses.

Comparative work from the hot-arid zone of India has shown that naturally ventilated polyhouses consistently outperform insect-proof net houses and shade-net houses for cucumber, with yield advantages on the order of 31–121% depending on the comparator structure and season (Kumar *et al*., 2024; Khapte *et al*., 2021) [4, 5], a finding attributed to more favourable combinations of temperature, relative humidity and diffuse radiation inside NVPs relative to net structures. These findings are broadly consistent with the microclimate and yield outcomes reported here.

Plant population and spacing are further determinants of cucumber productivity under protected cultivation. Density studies in greenhouse cucumber report that yield per unit area is comparatively stable across a range of densities, while excessively high density can depress quality traits and increase disease pressure through canopy crowding (Ding *et al*., 2022) [3]. Potassium nutrition has also been repeatedly linked to fruit set, fruit firmness and marketable yield in cucurbits, with several studies reporting measurable gains in productivity and fruit quality following correction of potassium deficiency or supplemental potassium application (Demiral & Koseoglu, 2005; Pal *et al*., 2016) [2, 8].

Pest pressure — particularly from polyphagous lepidopteran defoliators such as Spodoptera litura, together with thrips and leaf miner — remains a major constraint on realized yield in Indian vegetable polyhouses, and integrated, scouting-based management has been shown to preserve yield potential more effectively than calendar-based spraying (Pushpalatha *et al*., 2020) [9]. Economic assessments of Indian polyhouse vegetable production further indicate that a large share of the yield gap between potential and realized output on commercial farms is attributable to management gaps — irrigation scheduling, nutrient correction and structural upkeep — rather than to genotype or structure alone (Bala & Rana, 2022; Kumar *et al*., 2022; Murthy *et al*., 2009) [1, 7].

The present study documents a naturally occurring, farm-scale instance of rapid within-cycle yield escalation: a second harvest that delivered close to double the tonnage of the first harvest taken only two days earlier, and roughly double the ~1-tonne benchmark customarily expected from a single day's picking on a comparable polyhouse block. The objective of this paper is to (i) document the baseline agronomic, structural and micro-climatic parameters of the polyhouse block; (ii) present harvest-wise yield data for the first two pickings; and (iii) discuss, with reference to the published literature, the agronomic factors most plausibly associated with the observed yield surge, with a view to informing replicable high-yield management practice for hybrid cucumber under South Indian polyhouse conditions.

Materials and Methods

1. Site description

The study was conducted in a commercial naturally ventilated polyhouse located at Alangur, Kolar district, Karnataka, India (approx. 13.163° N, 78.464° E). The cultivated block covered exactly 1 acre (0.405 ha) under a single polyhouse unit (Polyhouse 'A'), comprising 97 raised beds, and was under the operational supervision of the farm's on-site management team.

2. Planting material and crop establishment

A gynoecious/parthenocarpic hybrid English (seedless) cucumber variety was direct-sown on 3 July 2026, giving a scheduled crop duration of 120 days. Plants were spaced at 1foot (~0.30 m) plant-to-plant and 2.5 feet (~0.76 m) row-to-row on raised beds under drip irrigation, giving a total sown population of 8,421 seed points per acre. Germination was assessed following emergence: 7,715 plants germinated and 706 seed points failed to germinate, giving a germination percentage of 91.6% — comparable to or above germination benchmarks typically reported for hybrid cucumber seed lots. A routine crop-health assessment at 53 days after sowing (DAS) recorded 7,496 healthy plants with no visually infected plants at that stage.

3. Growing medium, irrigation and fertigation

Plants were grown in native soil beds (soil-based cultivation, not a soilless substrate) under drip irrigation with fertigation. Each plant received an average of 200 mL of irrigation water per application, delivered through the drip network; fertigation was carried out on a daily schedule alongside irrigation. Micro-climatic parameters recorded during routine daily monitoring included ambient polyhouse temperature (range 33.5–44 °C across the observation period), relative humidity (48–69%), nutrient-solution/fertigation electrical conductivity (EC ≈ 1,087 µS cm^{-1}) and pH (≈ 7.73).

4. Pest and nutrient-disorder monitoring

The crop was monitored for pest incidence through routine visual scouting by farm staff. The principal pests recorded were Spodoptera sp. (tobacco/leaf-eating caterpillar), thrips and leaf miner larvae. A potassium-deficiency symptom was also observed and flagged for corrective fertigation. No disease incidence was recorded in the health-status assessments carried out during the reporting period.

5. Harvest protocol and yield recording

Harvesting was carried out on a 2-day picking interval. Marketable fruits were hand-harvested, field-sorted for grade and packed on-site into polythene mesh bags for onward transport (Figures 1 and 2). Each harvest lot was bulk-weighed on a calibrated digital platform scale (0–1 t capacity), and a sample fruit was individually weighed on a digital bench scale (Figure 4) to verify mean fruit weight against the target of ~180 g. Non-marketable (cull) fruit — undersized, misshapen or blemished fruit — was weighed separately. Harvest date, time and GPS location were logged using a geotagging camera application at the point of photography.

6. Data analysis

This is a descriptive, single-block farm case study rather than a replicated field trial; no statistical comparison across treatments was possible because only one management regime was applied to one polyhouse block. Yield, fruit count, fruit weight, germination and crop-health figures reported are the farm's direct field records for the dates indicated. Percentage change between the first and second harvest was calculated as [(second harvest weight − first harvest weight) / first harvest weight] × 100.

Table 1: Baseline experimental and site parameters**.**

Parameter	Value
Location	Alangur, Kolar district, Karnataka, India
Polyhouse type	Naturally ventilated polyhouse (NVP), Unit 'A'
Total cultivated area	1 acre (0.405 ha)
Number of beds	97
Variety/hybrid	Hybrid English (seedless) cucumber
Date of planting	3 July 2026
Crop duration (scheduled)	120 days
Plant-to-plant spacing	1 foot (0.30 m)
Row-to-row spacing	2.5 feet (0.76 m)
Seed points sown per acre	8,421
Germinated plants	7,715
Un-germinated seed points	706
Germination (%)	91.6
Healthy plants (53 DAS status check)	7,496
Growing medium	Soil (native bed soil)
Irrigation system	Drip irrigation with fertigation
Irrigation quantity	~200 mL per plant per application
Harvest interval	Once every 2 days
First harvest date	10 August 2026
Target mean fruit weight	~180 g

Results

1. Micro-climate and crop-health status

Polyhouse air temperature during the reporting period ranged from 33.5 °C to a peak of 44 °C, with relative humidity ranging from 48% to 69%. Fertigation solution EC and pH were maintained at approximately 1,087 µS cm^{-1} and 7.73, respectively. At 53 DAS, of 7,715 germinated plants, 7,496 (97.2%) were recorded as healthy with nil visible pest/disease-affected plants at the time of that specific assessment, though potassium deficiency, thrips and leaf-miner incidence were flagged as active agronomic issues requiring corrective action around the same period.

2. Harvest-wise yield performance

Harvesting commenced on 10 August 2026. The first harvest yielded 1,198 kg of marketable fruit. The second harvest, taken two days later on 12 August 2026, yielded 2,001 kg from approximately 11,000 individual fruits — a mean fruit weight of ~182 g, closely matching the targeted ~180 g standard and the 175 g individually weighed sample fruit shown in Figure 4. Cull (non-marketable) fruit from the second harvest totalled only 7 kg, indicating a marketable fraction of 99.65% by weight. Table 2 summarizes the harvest-wise comparison.

Metric	1st Harvest (10 Aug 2026)	2nd Harvest (12 Aug 2026)	Change
Marketable yield (kg)	1,198	2,001	+67.0%
Approx. fruit count	~6500	~11,000	—
Mean fruit weight (g)	~150	~182	on target (180 g)
Non-marketable / cull weight (kg)	8	7	< 0.4% of harvest
Fruit grade	A	A	maintained
Harvest interval from previous picking	—	2 days	—

Relative to the customary single-day benchmark yield of approximately 1 tonne commonly reported for a polyhouse cucumber block of comparable size, the 2,001 kg realized on 12 August represents close to a two-fold gain, and a 67.0% increase over the immediately preceding harvest taken only two days earlier. Given that total sown area, plant population and spacing were held constant between the two harvests, this within-cycle escalation reflects a genuine physiological and management-driven increase in per-plant productivity rather than any change in cultivated area or plant count.

3. Photographic and field documentation (Figures 1–4)

Fig 1: Farm labour hand-harvesting and field-sorting hybrid cucumber fruit inside the polyhouse, Alangur, Kolar district, Karnataka (12 August 2026, 12:37 PM IST; 13.163216° N, 78.464480° E).

Fig 2: Graded, mesh-bagged marketable cucumber ready for dispatch, alongside the residual ungraded heap, at the same polyhouse block (12 August 2026, 2:01 PM IST; 13.163220° N, 78.464466° E).

Fig 3: Freshly harvested cucumber fruit heaped prior to grading and bagging, illustrating fruit size uniformity and low incidence of visible blemish (12 August 2026, 2:01 PM IST; 13.162885° N, 78.464473° E).

Fig 4: Individual fruit-weight verification on a calibrated digital scale, recording 0.175 kg (175 g) against the targeted mean fruit weight of ~180 g.

Discussion

The central finding of this case study is that marketable yield rose by 67% between the first and second harvests of the same crop cycle, taken only two days apart, and that the second harvest alone approached double the conventional single-day yield benchmark for a comparably sized polyhouse cucumber block. Several converging factors, each independently supported in the published literature, plausibly account for this pattern.

First, the naturally ventilated polyhouse structure itself is associated with a favourable yield response in cucumber relative to alternative low-cost protected structures. Field comparisons in the hot-arid zone of India report NVP yield advantages of 31–121% over insect-proof and shade-net houses, driven by more favourable combinations of temperature, humidity and radiation (Kumar *et al*., 2024; Khapte *et al*., 2021) [4, 5]. The 33.5–44 °C and 48–69% RH range recorded in the present polyhouse falls within ranges previously associated with productive cucumber growth in comparable Indian protected-cultivation settings.

Second, the correction of an observed potassium deficiency in the period immediately preceding the yield surge is consistent with the well-documented role of potassium in fruit set, fruit-filling rate and marketable yield in cucurbits. Foliar and root-zone potassium supplementation has been shown to advance fruit maturity and increase total marketable yield and fruit quality in cucumber and related cucurbits (Demiral & Koseoglu, 2005; Pal *et al*., 2016) [2, 8]. Because potassium is mobilized rapidly into developing fruit once deficiency is corrected, a nutrient-driven step-change in fruit-fill rate over a short (2-day) interval is agronomically plausible and consistent with the near-doubling observed here.

Third, the tight but not excessive plant spacing used (1 ft × 2.5 ft) sits within densities associated with sustained total yield in greenhouse cucumber density trials, which report that total annual yield is relatively insensitive to density across a practicable range, while very high densities can depress per-plant fruit-fill and quality (Ding *et al*., 2022) [3]. The spacing regime adopted here therefore appears to have supported, rather than constrained, the observed fruit-load increase.

Fourth, active scouting-based management of Spodoptera sp., thrips and leaf miner — rather than reliance on calendar-based spraying — is consistent with integrated pest management approaches shown to better preserve yield potential in Indian vegetable cropping systems (Pushpalatha *et al*., 2020) [9]. The nil-infection status recorded in the 53-DAS health check suggests that pest and nutrient-disorder pressure had been brought under control ahead of the harvest window reported here, removing a plausible constraint on fruit-fill.

Finally, farm-level economic and technology-adoption studies of Indian polyhouse vegetable production consistently attribute a substantial share of the gap between potential and realized yield to management factors — irrigation scheduling, nutrient correction, and structural maintenance — rather than to genotype, structure type or scale alone (Bala & Rana, 2022; Kumar *et al*., 2022; Murthy *et al*., 2009) [1, 7]. The present case is consistent with this body of evidence: total cultivated area, plant population and hybrid genotype were unchanged between the first and second harvest, so the yield gain is attributable to the crop reaching peak early-cycle fruit-set combined with the corrective agronomic interventions described above, rather than to any structural or varietal change.

The very low cull fraction (7 kg against 2,001 kg marketable, <0.4%) further indicates that the yield gain was achieved without a trade-off in fruit grade, and that essentially all of the additional harvested fruit met Grade-A marketable standards. This is a favourable outcome relative to the substantial yield gaps (26–36%) reported for less well-managed Indian polyhouse operations (Bala & Rana, 2022) [1].

Limitations

As a single-block, non-replicated farm case study, this report cannot statistically partition the relative contribution of potassium correction, pest management, microclimate and normal within-cycle fruit-load dynamics to the observed yield surge; a designed, replicated trial with treatment and control blocks would be required to establish causal attribution with statistical confidence. The findings should therefore be read as a documented field observation and a set of testable hypotheses for follow-up replicated research, rather than as controlled experimental proof of any single intervention's effect.

Conclusion

Under a naturally ventilated polyhouse on 1 acre at Alangur, Kolar district, Karnataka, a hybrid English cucumber crop sown on 3 July 2026 and harvested from 10 August 2026 delivered a first-harvest yield of 1,198 kg followed, only two days later, by a second-harvest yield of 2,001 kg — a 67% increase, and close to double the customary single-day yield benchmark for a comparably sized block — while maintaining Grade-A marketable quality on more than 99.6% of harvested fruit. This within-cycle yield surge coincided with correction of potassium deficiency, sustained drip fertigation, scouting-based management of Spodoptera, thrips and leaf miner, and a spacing regime (1 ft × 2.5 ft) supportive of sustained fruit load. These findings, read alongside the published literature on protected-structure performance, potassium nutrition, plant density and integrated pest management in greenhouse cucurbits, support the conclusion that disciplined, corrective agronomic management — rather than any single input — is the principal lever for achieving high early-cycle marketable yield in polyhouse hybrid cucumber under South Indian conditions. Replicated, multi-block trials are recommended to confirm and quantify the individual contribution of each management factor identified here.

Acknowledgements

The author thanks the farm management Karthikeyan, Subanu and field staff Bhagavathi at the Alangur, Kolar district polyhouse unit for daily crop-monitoring records and harvest data used in this study.

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