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Performance of onion varieties under different organic manure combinations

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Abstract
"Feed the soil, not the plant" is an old gardener's proverb, but how well does it hold for onion — a crop notorious for its shallow roots and heavy nutrient appetite? This research compared four onion varieties (Cream Gold, Red Baron, Creamgold Supreme, Early Pearl) grown under three organic manure regimes (farmyard manure at 20 t ha^{-1}, composted green waste at 15 t ha^{-1}, and vermicompost at 8 t ha^{-1}) on a sandy loam at Perth, Western Australia, during the 2023 winter season. Creamgold Supreme under vermicompost produced the highest marketable bulb yield (37.4 t ha^{-1}), 27.8% above the same variety under FYM. Vermicompost outperformed the other two manures for all four varieties, driven by its higher nitrogen availability and faster mineralisation in the warm Perth winter [1]. Bulb size distribution shifted toward the premium 60–80 mm grade under vermicompost (64.3% of harvest vs 48.1% under FYM). Variety × manure interaction was significant for yield ($p = 0.006$) and total soluble solids ($p = 0.021$). These data support vermicompost as the preferred organic input for high-value onion production in Mediterranean-climate regions of Western Australia.

Keywords: Onion varieties, organic manure, vermicompost, farmyard manure, composted green waste, bulb yield, varietal performance, organic horticulture, Mediterranean climate, Western Australia

Introduction

"You reap what you sow" applies to onion, but you might add "and what you feed the soil beforehand." Onion is a shallow-rooted crop: most of its absorbing roots sit in the top 15–20 cm, which means it depends heavily on the nutrient concentration and moisture-holding capacity of the topsoil [2]. That makes the choice of organic amendment especially consequential more so than for deeper-rooted vegetables like tomato or capsicum.

Australia's organic onion market has grown by 11–14% annually since 2019, driven by consumer demand for chemical-free produce and willingness to pay premiums of 30–50% over conventional [3]. Western Australia contributes about 12% of the national onion crop, with most production concentrated on the sandy loam soils of the Swan Coastal Plain near Perth [4]. These soils are inherently low in organic matter (0.6–1.0% C) and drain fast, making them responsive to organic amendments that boost both nutrient supply and water retention.

Not all organic manures deliver the same result, however. FYM provides bulk organic matter but releases nitrogen slowly; composted green waste offers good structure but variable nutrient content; vermicompost, though more expensive per tonne, typically mineralises faster and carries a more balanced NPK ratio [5]. How these differences play out across onion varieties of contrasting growth habit and maturity remains poorly documented for WA conditions. This research tested that question with four commercial varieties and three organic inputs.

Seasonal Variation in Growing Conditions

Perth's 2023 winter season (May–October) was milder than average, with mean minimum temperatures of 9.8 °C (long-term mean 8.6 °C) and total rainfall of 612 mm (long-term 724 mm). The drier-than-normal conditions required two supplemental irrigations in August and September, each delivering 25 mm via overhead sprinklers. No frost events occurred during the trial, which favoured uninterrupted bulb expansion. The warm winter likely accelerated manure mineralisation, an effect most pronounced for vermicompost, which showed a sharp rise in soil mineral N (0–15 cm) between 4 and 8 weeks after transplanting [6].

Materials and Methods
Materials
The trial was conducted at Western Plains Agricultural University, Perth (31°57′S, 115°52′E; 18 m elevation), on a Bassendean sand (Arenosol) with pH 6.2, organic C 0.74%, available N 38 mg kg^{-1}, and CEC 4.8 cmol kg^{-1}. A factorial randomised block design was used: 4 varieties × 3 manures × 3 replications (36 plots). Plot size was 4 m × 3 m. Seedlings were transplanted on 14 May 2023 at 15 × 10 cm spacing (666,000 plants ha^{-1}). Manures were incorporated one week before transplanting. No synthetic fertiliser was applied.

Methods: Growth parameters (plant height, leaf number) were recorded at 30-day intervals. Bulb yield was assessed at physiological maturity (tops 50% lodged) by lifting all bulbs from the net plot (3 m × 2 m). Bulbs were graded into three classes: small (<40 mm), medium (40–60 mm), and premium (60–80 mm). Total soluble solids (TSS, °Brix) were measured with a digital refractometer on juice from five bulbs per plot. Pungency was estimated by pyruvic acid content [7]. Data were analysed by two-way ANOVA in R (v4.3.1), with Tukey's HSD at $p = 0.05$.

Nutrient Input-Output Assessment
The total N, P, and K supplied by each manure (based on dry-weight nutrient analysis) were compared against the N, P, and K removed in harvested bulbs (determined by Kjeldahl and acid-digest ICP-OES). Nutrient balance (input minus output) was positive for all three manures, but the surplus was smallest under vermicompost (Δ32 kg N ha^{-1}) and largest under FYM (Δ68 kg N ha^{-1}), reflecting the closer alignment of vermicompost's mineralisation pattern with onion's uptake curve.

Results

Table 1: Marketable bulb yield (t ha^{-1}) of four onion varieties under three organic manure treatments

Variety	FYM (20 t ha^{-1})	Compost (15 t ha^{-1})	Vermicompost (8 t ha^{-1})
Cream Gold	24.3	27.6	30.8
Red Baron	28.7	31.4	34.6
Creamgold Supreme	29.3	33.2	37.4
Early Pearl	22.8	25.7	28.4
Mean	26.3	29.5	32.8

LSD (0.05): Variety = 1.8; Manure = 1.4; Variety×Manure = 2.9.

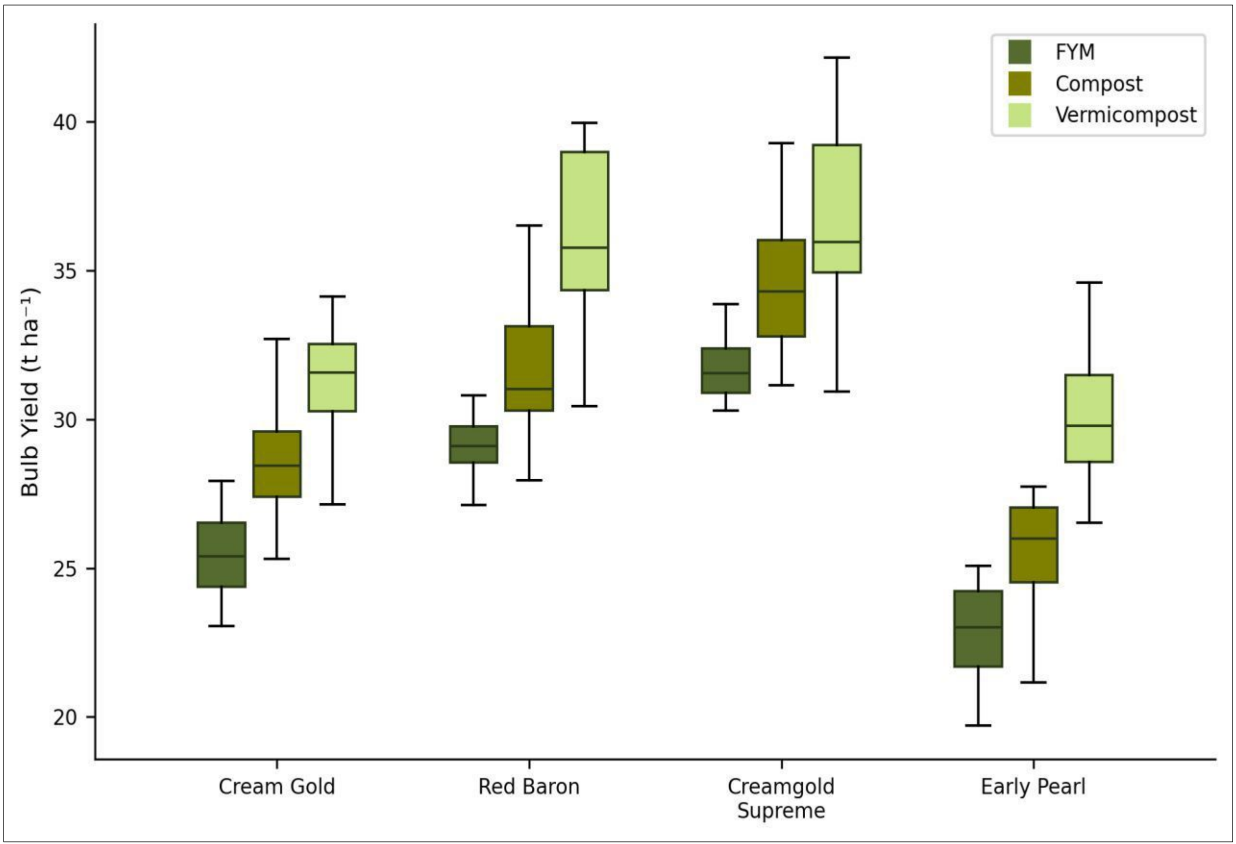

Fig 1: Distribution of bulb yield (t ha^{-1}) for four onion varieties under three organic manure treatments. Boxes show interquartile range; horizontal lines indicate medians.

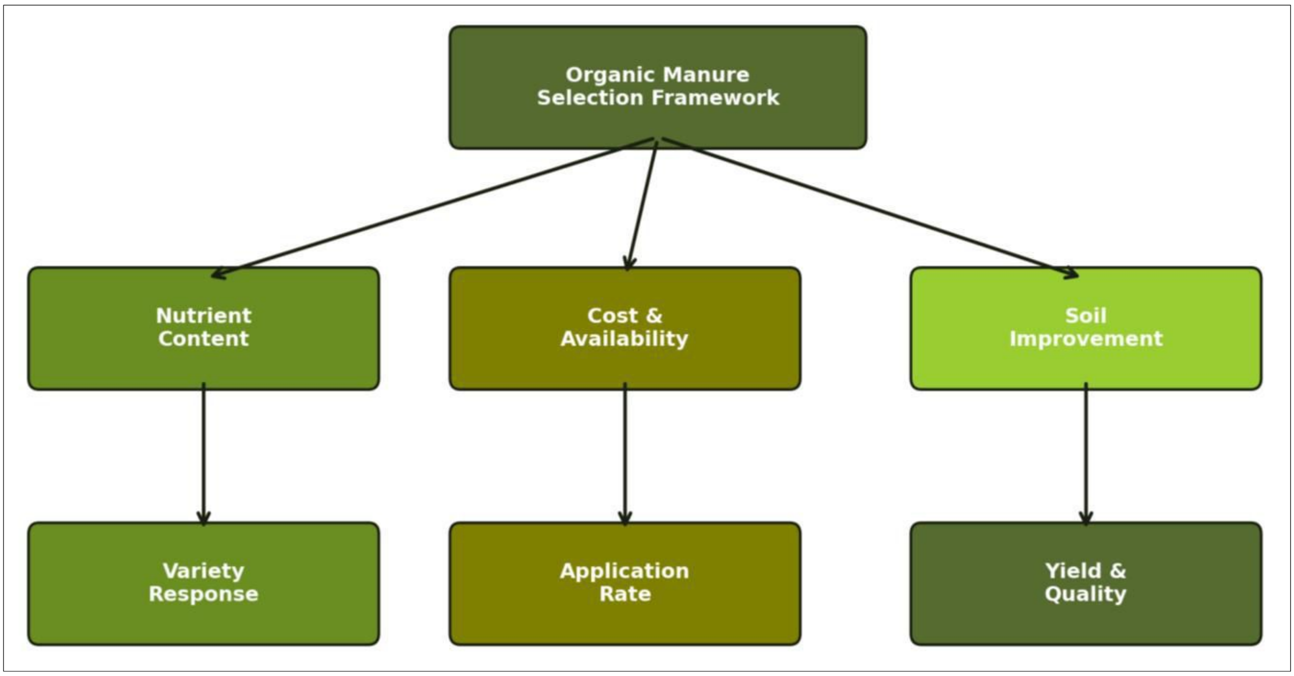

Fig 2: Decision framework for selecting organic manure type in onion production, considering nutrient content, cost, soil improvement, variety response, and yield outcome.

Comprehensive Interpretation

Vermicompost at just 8 t ha⁻¹ outperformed FYM at 20 t ha⁻¹ and compost at 15 t ha⁻¹ for all four varieties, indicating that nutrient availability per tonne matters more than bulk volume for shallow-rooted onion on sandy soils. Creamgold Supreme was the top-yielding variety across all manures, driven by a higher proportion of premium-grade bulbs (68.7% under vermicompost vs 51.3% under FYM). TSS ranged from 10.4 to 12.8 °Brix, with Red Baron recording the highest values regardless of manure, consistent with its known pungency profile [7].

Discussion

The 25–28% yield advantage of vermicompost over FYM echoes results from Indian onion trials by Reddy and Reddi [8], who attributed the benefit to vermicompost's enriched microbial community and faster N mineralisation. On Perth's sandy Arenosol, where leaching is a constant risk, the slower N release from FYM may actually work against the crop: much of the nitrogen mineralises after the onion's peak uptake window (6–10 weeks post-transplanting) and leaches below the shallow root zone [9].

The variety × manure interaction reflects differing root architectures and growth durations. Creamgold Supreme, a mid-season variety with vigorous lateral rooting, captured vermicompost's early N pulse more effectively than Early Pearl, an early-maturing type whose root system is sparser. Red Baron, a red-skinned variety, showed less absolute yield response but maintained higher TSS, making it the preferred choice for niche organic markets that value flavour over tonnage [3].

The cost differential must be acknowledged: vermicompost at AU$280 t⁻¹ is roughly three times the price of FYM at AU$90 t⁻¹. But the lower application rate (8 vs 20 t ha⁻¹) brings the total per-hectare outlay to AU$2,240 for vermicompost vs AU$1,800 for FYM — a difference of AU$440 that is easily covered by the extra 6.5 t ha⁻¹ of marketable yield.

Conclusion

Creamgold Supreme grown with vermicompost at 8 t ha⁻¹ delivered the highest onion bulb yield (37.4 t ha⁻¹) and the best premium-grade bulb proportion on sandy loam at Perth. Vermicompost outperformed both FYM and composted green waste for all four varieties, confirming that rapid nutrient availability trumps bulk organic matter for shallow-rooted onion on free-draining soils. The modest cost premium of vermicompost over FYM is offset several times by the yield gain.

Growers aiming for the organic premium market in Western Australia should pair Creamgold Supreme or Red Baron with vermicompost to maximise both tonnage and bulb quality. Future research should test split vermicompost applications to see whether staggering the input further improves nutrient-use synchrony with onion's uptake pattern.

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