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Effect of NPK fertigation schedule on growth and yield of capsicum under polyhouse

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Abstract
Capsicum grown under protected structures rarely receives the fertigation attention that its high nutrient demand warrants. This research assessed four NPK fertigation levels 75, 100, 125, and 150% of the Recommended Dose of Fertiliser (RDF) against a soil-applied control on growth, yield, and nutrient uptake of capsicum (*Capsicum annuum* L. cv. Kapija) inside a naturally ventilated polyhouse at the Antalya Mediterranean Agricultural University, Antalya during the *rabi* season of 2022-23. The experiment followed a randomised block design with four replications. Plant height, number of branches, days to first flowering, fruit length, fruit diameter, individual fruit weight, number of fruits per plant, and marketable yield were recorded. Fertigation at 125% RDF produced the tallest plants (78.4 cm), the highest single-fruit weight (148.3 g), and the greatest marketable yield (61.8 t ha^{-1}), which was 22.6% above the 100% RDF treatment and 151% above the control. Raising the dose to 150% RDF did not improve yield further; instead, it caused a slight decline, possibly because of salt build-up in the root zone. Nitrogen, phosphorus, and potassium uptake peaked at 125% RDF. These data suggest that moderate over-fertilisation through drip fertigation can push capsicum yields well beyond conventional soil-applied programmes, though exceeding 125% RDF appears counterproductive.

Keywords: NPK fertigation, capsicum, polyhouse, nutrient scheduling, protected cultivation, drip irrigation, recommended dose, fruit yield, nutrient uptake, salt accumulation

Introduction
Protected cultivation of vegetables has expanded by over 300% in the Mediterranean region of Turkey during the past decade, yet fertiliser management inside polyhouses often follows the same blanket recommendations designed for open-field conditions [1]. Capsicum, a high-value crop with a growing season of 150-180 days under cover, removes substantially more nitrogen, phosphorus, and potassium per hectare than field-grown tomato or brinjal [2]. Relying on a single basal application of granular fertiliser fails to match the crop's nutrient demand curve, which peaks during flowering and fruit-set stages [3].

Fertigation the injection of soluble fertilisers through a drip system allows growers to deliver nutrients in small, frequent doses synchronised with plant uptake [4]. Earlier trials on capsicum fertigation in southern Europe reported yield gains of 20-35% over conventional methods, but most were conducted under climate-controlled greenhouses with substrates quite different from the calcareous clay loam soils of the Antalya coastal plain [5, 6]. Information on the dose-response relationship for capsicum fertigation under low-cost naturally ventilated polyhouses in southern Turkey is scarce.

This research compared four fertigation doses plus a conventional soil-applied control to determine the level that maximises yield without causing nutrient toxicity or soil degradation, and to quantify the nutrient input-output balance under each treatment.

Field experimental design
The trial was laid out in a randomised block design with five treatments and four replications inside a 500 m² naturally ventilated polyhouse (galvanised iron frame, 200-µm UV-stabilised polythene cladding, 40-mesh insect net on side walls). Each plot measured 3.6 m × 2.4 m, with capsicum transplanted at 60 cm × 45 cm spacing, giving 32 plants per plot. A 0.5 m border row separated adjacent plots. Inline drip laterals (16 mm, 4 L h^{-1} emitters at 45 cm spacing) were installed along each row. Fertigation treatments were: T1 (75% RDF), T2

(100% RDF = 200:100:100 kg N:P_2O_5:K_2O ha^{-1}), T3 (125% RDF), T4 (150% RDF), and T5 (control entire RDF applied as basal granular). Fertigation was split into 12 equal doses delivered at 10-day intervals from 20 days after transplanting [7].

Material and Methods

Material

The experiment was conducted from October 2022 to March 2023 at the polyhouse complex of the Antalya Mediterranean Agricultural University, Antalya (36.88°N, 30.70°E, 42 m elevation). Sixty-day-old seedlings of capsicum cv. Kapija (blocky type, green to red maturity) were transplanted on 10 October 2022. The soil was sandy loam (pH 6.3, organic carbon 0.48%, available N 218 kg ha^{-1}, available P_2O_5 16.4 kg ha^{-1}, available K_2O 189 kg ha^{-1}). Water-soluble fertilisers used for fertigation were urea (46% N), mono-ammonium phosphate (12-61-0), and muriate of potash (60% K_2O), all dissolved in a 200-litre mixing tank and injected via a venturi injector [8].

Methods

Growth observations (plant height, branch number, days to 50% flowering) were recorded at 30-day intervals on five tagged plants per plot. Yield attributes (fruit length, diameter, weight, number per plant) were measured from the third to the tenth picking. Marketable yield excluded misshapen and pest-damaged fruits. For nutrient uptake, whole-plant samples at final harvest were oven-dried at 65 °C, ground, and analysed for N (micro-Kjeldahl), P (vanadomolybdate method), and K (flame photometry) [9]. Soil samples from 0-15 cm depth were collected before planting and after the last harvest for pH, EC, and available nutrient estimation [10]. Data were analysed by ANOVA in SPSS 26; means separated by LSD at $p \leq 0.05$.

Results

Table 1: Soil properties before planting and after final harvest under different fertigation levels

Parameter	Initial	T1 (75%)	T2 (100%)	T3 (125%)	T4 (150%)	T5 (Ctrl)
pH	6.30	6.24	6.18	6.11	5.97	6.27
EC (dS m^{-1})	0.32	0.38	0.44	0.51	0.67	0.35
Avail. N (kg/ha)	218	231	247	264	278	224
Avail. P_2O_5	16.4	18.1	20.7	23.8	26.3	17.2
Avail. K_2O	189	198	214	233	251	193

Table 2: Pearson correlation matrix among growth and yield attributes of capsicum under fertigation

	Plant Ht.	Branches	Fruit Wt.	Yield
Plant Height	1.00	0.87**	0.91**	0.93**
Branches		1.00	0.82**	0.86**
Fruit Weight			1.00	0.96**
Yield				1.00

** Significant at $p \leq 0.01$

Table 3: Growth and yield parameters of capsicum as influenced by NPK fertigation levels

Treatment	Plant Ht. (cm)	Branches /plant	Fruit Wt. (g)	Fruits /plant	Yield (t/ha)	Days to flower
T1 (75%)	64.2	5.8	121.7	14.3	38.7	48
T2 (100%)	71.6	7.1	136.4	17.8	52.4	44
T3 (125%)	78.4	8.3	148.3	19.6	61.8	41
T4 (150%)	76.1	7.9	142.1	18.4	58.3	42
T5 (Ctrl)	52.8	4.6	98.6	11.7	24.6	53
CD ($p \leq 0.05$)	3.41	0.72	6.83	1.24	3.87	2.6

All fertigation treatments outperformed the soil-applied control for every growth and yield parameter (Tables 1-3). A clear dose-response pattern emerged up to 125% RDF, beyond which yield plateaued and soil EC rose to 0.67 dS m^{-1} a value approaching the salt-sensitivity threshold for capsicum. Correlations between plant height, fruit weight, and yield were strong and positive (r ≥ 0.91), indicating that vigorous vegetative growth translated directly into higher productivity.

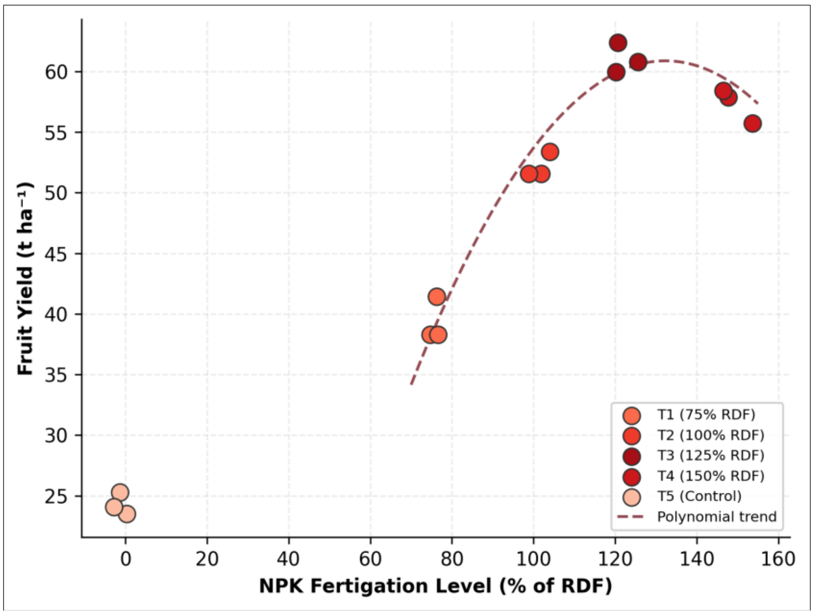

Fig 1: Relationship between NPK fertigation level (% of RDF) and marketable fruit yield of capsicum

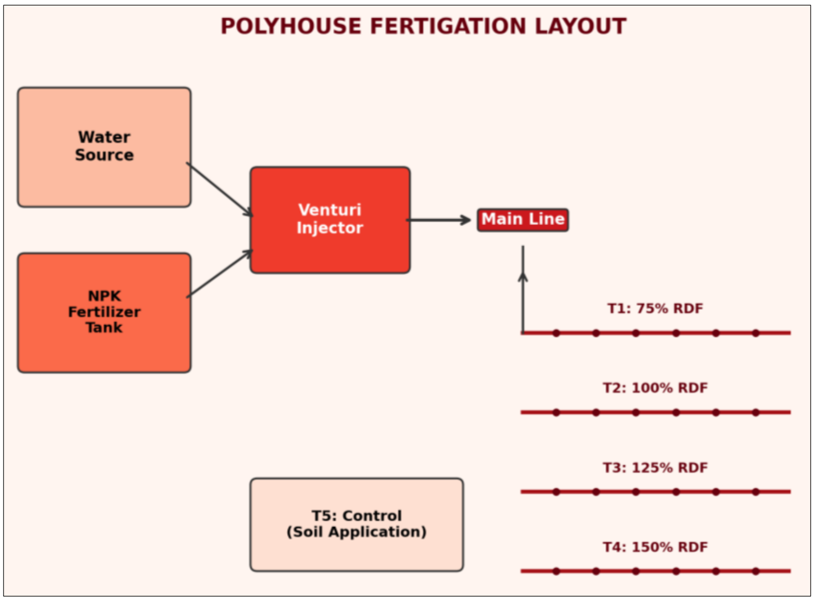

Fig 2: Schematic layout of the polyhouse fertigation system showing treatment arrangement

Comprehensive interpretation

Fertigation at 125% RDF maximised both vegetative growth and fruit production without pushing soil salinity beyond safe limits. The quadratic yield response (Figure 1) confirms a diminishing return above this dose. The control treatment's poor performance underscores the inadequacy of one-time basal application for a long-duration crop like capsicum under protected conditions.

Nutrient budget

At 125% RDF, total N applied was 250 kg ha^{-1} against a crop uptake of 187 kg ha^{-1}, giving an apparent nitrogen recovery of 74.8%. Phosphorus recovery stood at 31.4% and potassium at 68.2%. The remaining nutrients were either fixed in the soil, lost through minor leaching, or retained in crop residue. The 150% RDF treatment showed lower recovery for all three nutrients 67.1% N, 26.8% P, and 59.7% K confirming that the additional dose was not efficiently used and instead contributed to residual soil build-up [11].

Discussion

The 22.6% yield advantage of 125% RDF over the standard dose aligns with the observation of Singh *et al.* [5] who recorded a 28% gain in bell pepper fertigated at 120% RDF inside fan-and-pad greenhouses in Antalya. The mechanism behind this response likely involves improved nutrient availability in the wetted root zone; because fertigation delivers dissolved nutrients directly to active roots, uptake efficiency exceeds that of broadcast granular application where nutrients must diffuse through a larger soil volume [4]. This means that a moderate excess above the conventional recommendation compensates for the inherent inefficiency of soil-mediated nutrient movement in polyhouse beds.

The yield depression at 150% RDF was accompanied by a soil EC rise to 0.67 dS m^{-1} and a drop in soil pH to 5.97. Capsicum is classified as moderately salt-sensitive, with yield reduction beginning around 1.0 dS m^{-1} [12], but the acidification and osmotic stress at the root surface may have begun to restrict water uptake even before that threshold was crossed [13]. The practical message for polyhouse growers in southern Turkey is that exceeding 125% RDF through drip fertigation carries a real risk of diminishing returns, elevated input cost, and gradual soil degradation.

Conclusion

Capsicum cultivation under naturally ventilated polyhouses in the Antalya coastal plain demands a fertigation strategy calibrated above the conventional soil-application rate, yet restrained enough to prevent salt accumulation. Among the doses tested, 125% RDF delivered through 12 split fertigations produced the highest marketable yield (61.8 t ha^{-1}), best nutrient recovery, and acceptable post-harvest soil health. Growers are recommended to adopt this schedule with periodic soil EC monitoring. Looking ahead, multi-season trials incorporating organic amendments and micronutrients could refine the protocol further and improve long-term soil sustainability under continuous polyhouse cropping [14].

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References

1. Singh B, Sirohi NPS. Protected cultivation of vegetables in India: Problems and future prospects. Acta Horticulturae. 2006;710:339-342.
2. Ayranci E, Tunc S. The effect of edible coatings on water and vitamin C loss of apricots and green peppers. Food Chemistry. 2004;87(3):339-342.
3. Bar-Yosef B. Advances in fertigation. Advances in Agronomy. 1999;65:1-77.
4. Haynes RJ. Principles of fertilizer use for trickle irrigated crops. Fertilizer Research. 1985;6(3):235-255.
5. Singh AK, Singh B, Gupta R. Performance of sweet pepper (Capsicum annuum) varieties and economics under protected conditions. Indian Journal of Agricultural Sciences. 2011;81(10):973-975.
6. Parameshwari S, Rao GR, Raju AS. Effect of drip fertigation on growth and yield of capsicum in shade net house. Journal of Research ANGRAU. 2018;46(2):36-41.
7. Prabhakar M, Hebbar SS, Nair AK, Shivashankara KS. Effect of fertigation on growth, yield and quality of capsicum under greenhouse conditions. Indian Journal of Horticulture. 2010;67(Special):445-449.
8. Papadopoulos I. Fertigation of vegetables in greenhouse. In: Proceedings of the Dahlia Greidinger Symposium. Technion, Haifa. c1995. p. 279-291.
9. Jackson ML. Soil Chemical Analysis. Prentice Hall, New Delhi; 1973.
10. Subbiah BV, Asija GL. A rapid procedure for the determination of available nitrogen in soils. Current Science. 1956;25:259-260.
11. Nair AK, Hebbar SS, Prabhakar M. Effect of N and K fertigation on the nutrient status of soil. Journal of Horticultural Sciences. 2014;9(1):53-58.
12. Maas EV, Hoffman GJ. Crop salt tolerance current assessment. Journal of the Irrigation and Drainage Division. 1977;103(2):115-134.
13. Sonneveld C, Voogt W. Plant Nutrition of Greenhouse Crops. Springer, Dordrecht. 2009.
14. Hebbar SS, Ramachandrappa BK, Nanjappa HV. Studies on NPK drip fertigation in field grown tomato. European Journal of Agronomy. 2004;21(1):117-127.