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Drip Fertigation Techniques in Citrus Production

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Citrus crops like sweet orange, mandarin, and lemon are heavy feeders but have shallow, sensitive root systems. Conventional broadcasting of fertilizers leads to 40-60% nutrient loss through leaching and volatilization. Drip fertigation delivers water-soluble nutrients directly to the root zone through drip emitters, improving fertilizer use efficiency to 85-95%. This article discusses drip system design, fertigation scheduling, nutrient management, and economics for citrus orchards under Indian conditions, with focus on water-scarce regions like Rajasthan.

Introduction

Citrus is a perennial crop with year-round nutrient demand for vegetative growth, flowering, fruit set, and fruit development. Soil application is inefficient due to uneven distribution and fixation of P, K, Ca, Mg. Fertigation, the application of fertilizers through drip irrigation, matches nutrient supply with crop demand stages. In Rajasthan and Udaipur region, where water is limited and soil pH is alkaline, fertigation reduces water use by 30-50% and increases citrus yield and fruit quality significantly.

Importance of Fertigation in Citrus

1. Precision : Nutrients applied directly to active root zone 30-60cm from trunk, matching citrus feeder roots.
2. Efficiency : Uptake efficiency of N, P, K increases from 30-40% to 80-90%.
3. Water saving : Drip uses 4-6 L/plant/day vs 15-20 L in flood irrigation.
4. Reduced leaching : Critical in sandy loam soils of Rajasthan where nitrate leaching is high.
5. Quality improvement : Uniform nutrient supply improves TSS, acidity ratio, and reduces fruit drop.

Drip System Components for Citrus

Emitter design : Inline drippers 4 LPH at 60-75cm spacing, or 2-4 pressure-compensating emitters per tree. For mature trees, place emitters in circular pattern 50-75cm from trunk.
Laterals : 16-20mm LDPE laterals, one lateral per row for single-line system. Double-line for >6-year-old orchards.
Filtration : Sand + screen + disc filter mandatory. Citrus is sensitive to emitter clogging.
Fertigation tank/venturi : 200-500L tank with injector pump for acid + fertilizer injection. Acid for pH correction in alkaline soils.

Fertigation Schedule & Nutrient Requirements

Citrus requires NPK + Ca, Mg, S, Zn, Fe, Mn, B, Cu. Total annual dose for 5-year-old sweet orange: N 600g, P_2O_5 300g, K_2O 500g per tree.
Stage-wise split:
1. Vegetative flush Feb-Mar : N 40%, K 20% of annual dose. Promotes new growth.
2. Flowering & fruit set Apr-May : K 30%, Mg 50%, B 100%. Reduces flower drop.

3. Fruit development Jun-Sep : N 40%, K 40%, Ca 60%. Improves fruit size and rind quality.
4. Post-harvest Oct-Jan : N 20%, P 100%, K 10%, Zn 100%. Rebuilds tree reserves.

Micronutrients : Fe, Zn, Mn as chelates 0.2% foliar + 0.1% through fertigation monthly.

Techniques of Drip Fertigation

Pulse fertigation : Split daily dose into 2-3 pulses of 20-30 min each. Prevents nutrient leaching in light soils.

Acid injection : Inject phosphoric/nitric acid weekly to keep pH 6.0-6.5 at root zone. Critical for Fe, Zn availability in alkaline Rajasthan soils.

Placement : Keep emitters 30-60cm from trunk in young trees, 75-100cm in bearing trees. Move emitters outward as canopy grows.

Duration : Irrigate 1-2 hours to wet 40-50cm soil depth. Fertigation done in last 20 min of irrigation cycle to avoid leaching.

Flush schedule : Flush system with acid every 15 days to prevent $CaCO_3$ precipitation in emitters.

Advantages of Fertigation

1. 30-50% water saving compared to basin irrigation.
2. 40-50% fertilizer saving with higher yield. Yield increase 25-35% in mandarin and sweet orange.
3. Labor saving: No manual fertilizer application needed.
4. Salinity management: Frequent light irrigation keeps root zone EC low.
5. Improved fruit quality: Higher TSS, better peel color, less granulation in citrus.

Challenges & Precautions

- Clogging : Use only 100% water-soluble fertilizers like urea, SOP, MAP. Avoid SSP, MOP granules.
- Salt accumulation : At emitter point. Periodically apply heavy irrigation to leach salts beyond root zone.
- pH issue : Alkaline water + soil fixes Fe, Zn. Regular acid injection needed.
- Root proliferation : Roots concentrate near emitters. Maintain wetting pattern to cover 60% of canopy area.
- Initial cost : ₹60,000-80,000/acre for drip + fertigation setup. Subsidy 50-55% available under PMKSY/MIDH.

Economics

Cost : Drip + fertigation ₹1.2-1.6 lakh/ha. Subsidy reduces farmer cost to ₹60,000-80,000/ha.

Returns : Conventional yield 15-18 ton/ha. With fertigation: 22-28 ton/ha in Nagpur mandarin. @ ₹25/kg, extra income ₹1.5-2.5 lakh/ha/year.

B:C ratio : 2.5-3.2 over 3 years. Payback period 1.5-2 years.

Conclusion

Drip fertigation is not just water saving technology for citrus, it's precision nutrition management. By delivering right nutrient, right dose, right time, right place, it solves major problems of citrus cultivation: nutrient inefficiency, water scarcity, and poor fruit quality. For citrus growers in Udaipur and semi-arid regions, adopting stage-wise fertigation with acid injection can make orchards more profitable and sustainable. Training + soil/water testing is key before starting fertigation.