

Advanced Course
INTEGRATED NUTRIENT MANAGEMENT:
PRESENT CHALLENGES AND FUTURE OPPORTUNITIES
Zaragoza (Spain), 15-20 February 2027

Programme

- 1. Official opening. Course presentation, objectives, participants & working approach (1 h)**
- 2. Conceptual frameworks and indicators (5 h)**
 - 2.1. Definitions and scope of INM in relation to soil fertility management, plant nutrition and sustainable agriculture.
 - 2.2. Nutrient cycles (N, P, K and micronutrients) at plot, farm and territory scales. Nutrient balances.
 - 2.3. Performance indicators: NUE, PUE, KUE, partial factor productivity and surplus indicators.
 - 2.4. Guided debate & case study: Are indicators operational in Mediterranean systems?
- 3. Soil, organic matter and microbiology (7 h)**
 - 3.1. Soil health implications in the Mediterranean region linked to INM.
 - 3.2. Physical, chemical and biological properties of Mediterranean soils: determination and relevance to nutrient dynamics (texture, density, CEC, pH, salinity, carbonates).
 - 3.3. Role of organic matter in retention, buffering, aggregation and water holding capacity.
 - 3.4. Microbial communities as drivers of mineralisation, solubilisation, immobilisation and stabilisation; functional groups.
 - 3.5. Guided debate and group work: Biology or chemistry as the limiting factor in each context?
- 4. Plant nutrition and plant-microbe interactions (6 h)**
 - 4.1. Nutrient pathways from soil to plant.
 - 4.2. Transport, assimilation and remobilisation of nutrients within the plant; primary and secondary metabolic pathways.
 - 4.3. Relationships between mineral nutrition, enzyme activity, carbon and nitrogen allocation under Mediterranean stress.
 - 4.4. Plant-microbe interactions: rhizosphere, root exudates, beneficial symbioses and metabolic plasticity.
 - 4.5. Guided debate: biostimulants, stress tolerance and efficiency gains through biotic interactions.
- 5. Water–nutrient–climate interactions (5 h)**
 - 5.1. Coupling between irrigation, soil water status, nutrient mobility and crop uptake (rainfed and irrigated systems).
 - 5.2. Leaching, volatilisation, denitrification and runoff under variable rainfall, fire and extreme events.
 - 5.3. Fertigation, deficit irrigation and precision water-nutrient tools and management; climate change impacts and implications for INM.
 - 5.4. Guided debate and case study: water-nutrient management strategies under Mediterranean conditions.
- 6. Organic resources, circularity, methods and case studies (6 h)**
 - 6.1. Organic resources: types, quality and nutrient content (manure, compost, green manures, biosolids, digestate). Contributions to soil.

- 6.2. Circular nutrient management: logistics, variability, contaminants, sanitary risks and territorial strategies. Energy and circularity.
- 6.3. Methods and tools in INM research: long-term trials, tracers and isotopes, omics, modelling and decision-support tools.
- 6.4. Final debate: Mediterranean case studies, final synthesis, political perspective (future and challenges), evaluation and course closure.

SATURDAY 20 TECHNICAL VISIT

Fertinagro (Utrillas, Teruel)