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Nanotechnology in Weed Management

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Brief Introduction / History:

- The first ever concept was presented in 1959 by the famous professor Dr.Richard Feynman in the lecture of "There are plenty of rooms at the bottom" and The Nobel prize was awarded in 1965.
- The term "Nano Technology" had been coined by Prof.Norio Taniguchi in 1974.
- Dr. Eric Drexlergives the idea of "Molecular Machinery Manufacturing and Computation" in 1980's.

Nanotechnology: Meaning

a) the word "Nano" is developed from the Greek word meaning "dwarf".
b) In more technical terms, the word "nano" means 10^{-9}, or one billionth of something.
c) Nanotechnology exploits the properties , processes and phenomena of matter at the nanometer (1 to~100 nm) scale.
d) To realize their practical application, nanoparticles with different sizes, shapes and composition need to be synthesized.
e) Thus, by controlling nano-scale composition, size and shape we can create new materials with new properties.
f) For the synthesis of nanoparticles, researchers routinely practice either 'top-down' or 'bottom-up' approaches.

Approach of Nanotechnology

a. Top-down method : Big molecules to small atoms
b. Bottom-up method: Small atoms to big molecules

Properties:

a) Surface to Volume ratio of nanoparticle increases.
b) Quantum physics apply instead of Newton's law.
c) Enhance the efficiency and performance of nanobased systems.
d) Improves catalytic properties of nanomaterials.

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e) Size dependent Melting temperature of Nanomaterials.

f) Exhibits Optical properties of nanomaterials (Metallic and semiconducting).

g) Electrical properties of nanomaterials.

h) Magnetic properties of nanomaterials.

i) Bulk behaviour of nanostructured materials,

j) Mechanical behaviour: Structural nanostructured materials, Elastic properties, Hardness and Strength , Ductility and Toughness.

Types of Nanoparticles:

Inorganic Nanoparticles			**Organic Nanoparticles**
Metal	**Metal oxides**	**Carbon Materials**	
1. Gold 2. Silver 3. Platinum 4. Copper 5. Palladium 6. Ruthenium 7. Iron 8. Nickel	1. Iron Oxide 2. Copper Oxide 3. Titanium Oxide 4. Manganese Oxide 5. Magnesium Oxide 6. Zinc Oxide 7. Silicon Oxide 8. Nickel Oxide 9. Aluminium Oxide	1. Diamond 2. Fullerene 3. Carbon nanotube 4. Graphite 5. Graphene 6. Graphene Oxide 7. Carbon dot	1. Liposomes 2. Poly-e-lysine 3. Micelles 4. Ferritin 5. Dendrimers 6. Chitosan 7. Cationic quaternarypolyelectrolytes

Current Status of weed Management

• **Issues**	• **Challenges**
❖ Labour shortage	❖ Enlarging Weed Seed Bank
❖ Labour cost	❖ Herbicide Residue
❖ Introduction of GM Crops	❖ Herbicide Resistant Weeds
❖ Organic agriculture	

Nano doesn't mean the scale. It actually means……

❖ More Precise

❖ Highly Accurate

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- ❖ Exact

Issues being addressed with Nanotechnology

1. Exhausting Weed Seed Bank
2. Degrading germination inhibitor
3. Exhausting food reserve
4. Absorption (root/shoot)
5. Translocation
6. Smart release-rainfed
7. Slow release-season long weed control
8. Rapid degradation of Herbicide residue

Issues can be addressed with Nanotechnology

- Weed Identification tool kit
- Weed based specific formulation
- In situ low-cost HR estimation

Nano-Herbicide for effective weed control:

- ➢ Encapsulated herbicide in a MnO_2 core shell.
- ➢ Smart delivery mechanism(SDS).
- ➢ Herbicides inside nano-particles are developed that can be timed-release or have release linked to an environmental trigger.
- ➢ Less herbicide is required to achieve the reduction weed reduction effects.
- ➢ If the a.i., is combined with a SDS, herbicide will be applied only when necessary according to the conditions present in the field.

Advantages:

- Nano-encapsulated agrochemicals designed in such a way that they possess all indispensable properties such as
  a) Effective concentration with high solubility, stability and effectiveness,
  b) Time controlled release in response in to certain stimuli,
  c) Enhanced targeted activity,
  d) Less Eco toxicity with nature,
  e) Effortless mode of delivery thus avoiding repetitive application.

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Disadvantage:

1) **Health issues**
   a) Nanoparticles could be inhaled, swallowed, absorbed through skin, Carbon Nanotubes could cause infection of lungs.
   b) They trigger inflammation and weaken the immune system and interfere with regulatory mechanisms of enzymes and proteins.
2) **Environmental issues**
   a) Nanoparticles could accumulate in soil, Water, and plants.
3) **Other issues**
   a) Loss of jobs (in manufacturing, farming, etc).
   b) Atomic weapons could be more accessible and destructive.
4) **New risk assessment methods are needed**
   a) National and international agencies are beginning tp study the risk.
   b) Results will lead to new regulations.

Conclusion

- From the ongoing topic, it can be concluded that the Nanotechnology is capable of being used in agriculture for weed management, monitor plant growth and environmentally safe.
- Scientists are still seeking new applications of nanotechnology in agriculture specially in weed management aspects.
- The agricultural sector will indeed see tremendous changes for the better in the coming years.
- Apart from detection, nanotechnology also has solutions for degrading persistent chemicals into harmless and sometimes useful components.
- Agricultural technology should take advantage of the powerful tools of nanotechnology for the removal of contaminants from soil by detection for benefit of mankind.
- Among all the methods of encapsulation (Direct, Indirect, solvent evaporation, Nano spray methods) solvent evaporation method is the best method because of higher releasing efficiency.

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- The phenols which were released in large quantities under abiotic stress in *Cyperus rotundus* have a capacity to prevent germination and undergo dormancy, this nature of weeds can be successfully removed by iron nanoparticles (INP'S).
- Nanotechnology (nanoparticles) have capacity to change molecular structure of commercial herbicides and makes it non-toxic.

References

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