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Nano Fertilizer, Benefits and Effects on Fruit Trees

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The agricultural growth around the world has shown that applying fertiliser is the most effective way to increase crop yield, security in food supply and sustainable production growth. Fertilization increase crop yields by 30% to 50% worldwide. When fertilisers are used then about 40% and 70% of the nitrogen and 80% to 90% of the phosphorus either escape into the environment or stop being useful to crops. It not only results in significant economic and resource losses but also seriously contaminates the environment. Many industrial methods have been used to overcome the problem of fertilizer use and increase economic use.

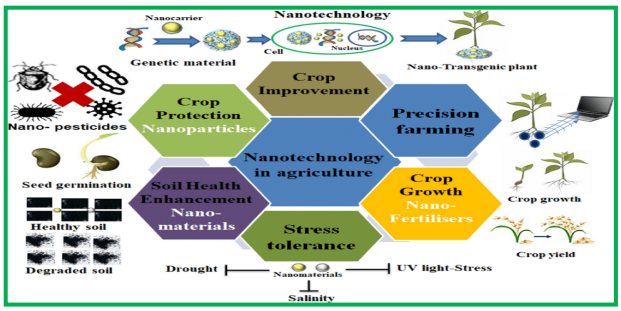
Nanotechnology is one of the new areas of research and has become the subject of modern science and the focus of its attention and has become at the forefront of the most important fields in physics, chemistry, agriculture and others. It is a group of emerging technologies in which the structure of the matter is controlled at the nanometer scale to produce materials having unique properties.

Defination

The word 'nanotechnology' is coined from the Greek word "nano", meaning 'dwarf'. The emergence of nanotechnology is deeply connected to a historic statement by the Nobel Prize winner Richard Phillips Feynman "There is plenty of room at the bottom". The science, engineering, and technology at the nanoscale (about 1 to 100 nanometers) is called nanotechnology . Nanotechnology is the design, characterization, production, and application of structures, devices, and systems by controlling the shape and size at the nanometer scale. New nanomaterials have a great deal of potential for creating new crop kinds in agriculture through the use of innovative, highly effective agrochemicals for agricultural plant nutrition and protection, hybrid crop types, and genetic engineering.The principle of this technique is to capture, control and move nanoparticles from their original positions to other positions and then merge them with atoms of other materials to form a crystal line in order to obtain high-performance.

Application of Nanotechnology in Advancements of Horticultural Science

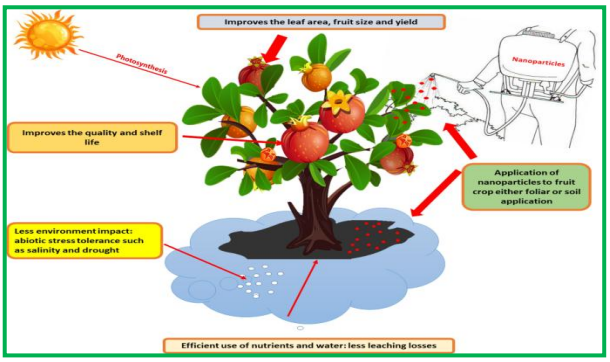
It was necessary to use alternative methods such as nanotechnology and its most significant applications are Nano fertilisers which have been used on a commercial scale in recent years in order to improve the production of food on a full scale to improve the productive efficiency of the cultivated area and increase the return.



Horticultural products waste is estimated around 20-30% in developing countries, so even if we manage to reduce this amount for 5-10% huge saves will be obtained. Now, employing cutting-edge sciences like biotechnology and nanotechnology in products can increase production efficiency and reduce post-harvest waste which might be considered the best answer to this issue. Nanotechnologies have a lot of exciting potential to improve people's health, prosperity and quality of life while having less of an adverse effect on the environment.

Nanotechnologies in the production, processing, storage, packaging and transportation of agricultural products research and studies have shown that this technology is promising in improving the agricultural field and is known as Agro-Nanotechnology. Smart fertilisers or nano fertilisers have become more popular in recent years as an alternative to conventional fertilizers.

Nano-fertilizer



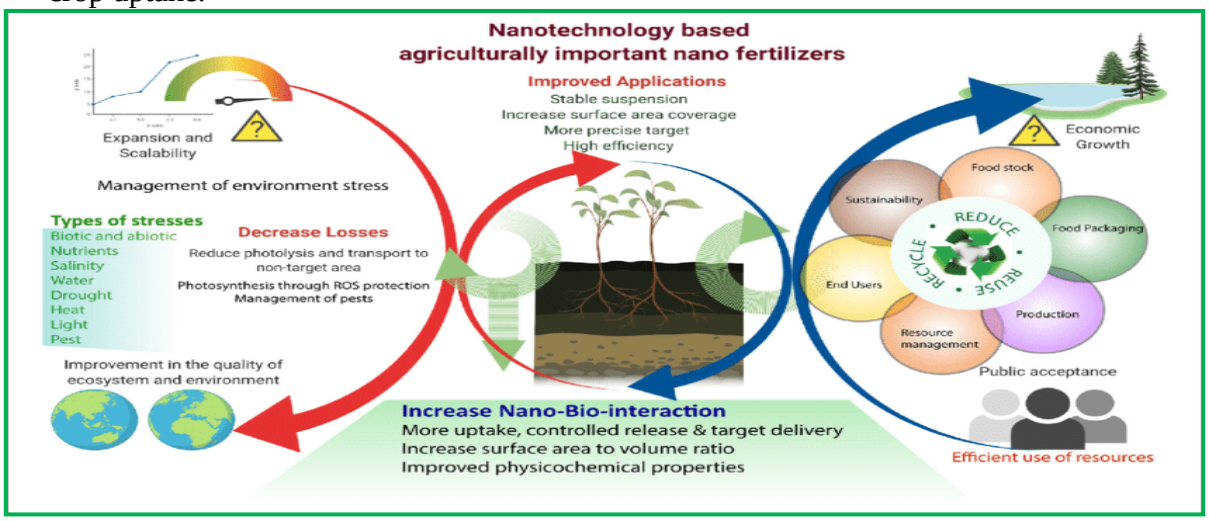
Nanofertilizers are nutrient carriers developed using substrates with 1-100 nm nano dimensions of that can supply single nutrient or in combination to enhance plant growth, performance and yield. Any product created using nanoparticles or nanotechnology and enriched with nutrients to the adsorbents to increase plant nutrition and optimise nutrient performance is referred to as a nanofertilizer. Nanoparticles large surface areas enable them to retain nutrients in large quantities and release nutrients on purpose to fulfil crop needs without producing any unfavourable effects.

According to environmental factors such soil moisture percentage, temperature changes, and soil acidity level, the rate of nutrient release in nanofertilizers can be successfully managed. Nano-fertilizers are designed to purposefully and consistently release nutrients for more than 35 days. By increasing the effectiveness of applied fertilisers and reducing leaching loss of nutrients this may help in reducing negative effects on soil, plants and the environment.

Types of Nano-fertilizers

- **Chitosan based nanofertilizer:** Chitosan is a linear polysaccharide, which occurs naturally and can also be produced commercially. It is cheap and biodegradable. The delivery potential of chitosan in plants and its effect on growth enhancement, antimicrobial and agrochemical (micronutrient and pesticide) is being studied widely in horticulture. Chitosans can be utilized as a substitute for synthetic fungicide for fruits. Chitosan is overcoated on post-harvested mangoes to prevent the edible portion from spoiling, boost vitamin C levels, keep the fruit fresher longer and extend shelf life and also provide protection from microbial attacks, upregulation of anthocyanin activities, prevention of colour changes, and water content retention on pomegranate and sweet cherry fruits.
- **Macronutrient nanofertilizers:** Macronutrient nanofertilizer include nitrogen, phosphorus, potash, calcium, magnesium and sulphur. They are required by plants in comparatively huge amount. Development or creation of nano macronutrient with high efficiency i.e. low leaching rate, low immobililization rate by soil and high plant uptake rate and low environmental risk i.e. low eutrophication potential and low nitrogen leaching rate is required.

❖ **Micronutrient nanofertilizers:** Micronutrient fertilizers include iron, manganese, zinc, copper, molybdenum and other nutrients. They are required by plants in relatively smaller amounts. Though only a trace amount is required they are required for proper crop growth. Macronutrient fertilisers like nitrogen, phosphorous, and potash are frequently supplemented with micronutrients as soluble salts at low rates i.e., 5 mg/L, to increase crop uptake.



Effect of normal and nano boron on growth, leaf boron concentration and yield of mango cv. keitt

TREATMENTS	SHOOT LENGTH	LEAF AREA	YIELD (Kg/tree)
Control	41.9	70.9	15.5
Normal B 50 ppm	43.0	72.6	19.5
Normal B 100 ppm	44.7	74.3	23.4
Normal B 200 ppm	45.0	74.4	23.9
Nano B 5 ppm	46.3	76.9	28.6
Nano B 10 ppm	48.0	78.6	32.1
Nano B 20 ppm	48.3	78.7	32.6

Effect of nano zinc on growth and leaf zinc concentration of grapes cv. Flame seedless.

TREATMENTS	SHOOT LENGTH (cm)	LEAF AREA (cm^2)	Leaf Zn (ppm)
Control	26.66	129.36	22.56
ZnSO4 565 ppm	43.33	169.60	55.93
Zn EDTA 140 ppm	42.66	174.23	56.26
Nano Zn 0.4 ppm	52.00	195.83	66.00
Nano Zn 0.8 ppm	54.66	176.30	69.30
Nano Zn 1.2 ppm	48.66	175.46	69.30

Effect of nano selenium (N-Se) and (Se) foliar spray on quality parameters of pomegranate cv. Malase savehz

TREATMENTS	TSS (%)	ACIDITY (%)	TSS:ACIDITY RATIO
Control	16.43	2.11	7.79
N-Se 1µM	16.53	2.04	8.12
N-Se 2µM	18.20	2.16	8.52
Se 1µM	17.70	2.06	8.61
Se 2µM	16.83	1.85	9.08

Effect of nano calcium chloride ($CaCl_2$) treatment on starch, total sugar, total soluble solids (TSS) and acidity of 'red delicious' apples

TREATMENTS	STARCH (g/100 g DW)	TOTAL SUGARS (g/100 g DW)	TSS (%)	ACIDITY (%)
Control	27.20	16.15	15.70	0.29
$CaCl_2$	34.19	14.23	14.60	0.37
$CaCl_2$	38.76	13.06	14.10	0.42
N Ca (1.5%)	43.19	11.71	13.60	0.46
N Ca (2%)	47.11	10.30	13.10	0.49

Application of nanofertilizer in fruit crops

- Foliar spray of nanofertilizers, nano-Zn and nano-B on pomegranate (cultivar Ardestani) led to increase in pomegranate fruit yield, fruit quality, including T.S.S., maturity index, juice and deceases in total acidity.
- Spraying mango trees with nano-zinc at 1 mg/L before flowering improved yield and fruit quality as well as raised resistance of malformation.
- Maximum proliferation was observed in 100 mg/L of enriched nano chelated iron wherein the growth of shoots, leaves and nodes increased showing that it can be used for increasing plant growth.
- Ca nano based fertilizers increased foliage development and chlorophyll content in vines.
- Apple cultivars Red Delicious, Golden Delicious and Starking Delicious potted plants were given nano biofertilizer at 1 g/pot and dosage had greater impact on growth of apple plants.
- Treatment of Bitter almond seeds with nanofertilizers improved seed germination by 50 % at younger stages compared to chemical fertilizer treatment.
- It was observed that best yield, improved berry colouration and highest quality fruits were obtained when the vine was treated with amino mineral nanofertilizer at 0.1 %.
- Application of nutrients and injection of nano NPK fertilizers improved vegetative growth and increased yield of date palm.

Conclusion

In the developing countries, agriculture sector is very important sector in the economy. So, the use of nanofertilizers causes an increase in nutrients use efficiency, reduces soil toxicity, minimizes the potential negative effects associated with over dosage and reduces the frequency of the application. Hence, nanotechnology has a high potential for achieving sustainable agriculture especially in developing countries.

Nanotechnology use in agriculture and the industry of food can renovate the sector with new tools for the recognition of diseases, directed treatment, improving the capacity of plants to take up nutrients, fight diseases and withstand environmental pressures and powerful frameworks for preparing, storage and packaging. Nanotechnology has also established its capacity to change the hereditary association of crop plants, thus helping to advancing improve crop plants.