The Impact of Chemical Fertilizers on our Environment and Ecosystem

Chapter · February 2019

CITATIONS
13

READS
55,289

4 authors, including:

Randeep Kumar
Indian Agricultural Research Institute
12 PUBLICATIONS **14** CITATIONS
SEE PROFILE

Ravendra Kumar
G. B. Pant University of Agriculture and Technolog…
48 PUBLICATIONS **137** CITATIONS
SEE PROFILE

Om Prakash
G.B. Pant University of Agriculture and Technolog…
109 PUBLICATIONS **881** CITATIONS
SEE PROFILE

Chapter - 5
The Impact of Chemical Fertilizers on Our Environment and Ecosystem

Authors

Chandini
M.Sc. (Ag) Agronomy, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Randeep Kumar
M.Sc. (Ag) Agricultural chemicals, G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, India

Ravendra Kumar
Asst. Prof., Dept. of Chemistry, G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, India

Om Prakash
Prof., Dept. of Chemistry, G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, India

Chapter - 5

The Impact of Chemical Fertilizers on our Environment and Ecosystem

Chandini, Randeep kumar, Ravendra kumar and Om Prakash

Abstract

Though the chemical fertilizer increases the plant growth and vigour, hence meets the food security of the world, but the plants grown in this way does not develop good plant characters such as, good root system, shoot system, nutritional characters and also will not get time to grow and mature properly. Chemically produced plant will accumulate in the human body, toxic chemicals, which are very dangerous. The deleterious effect of the chemical fertilizers will itself start from the manufacturing of these chemicals, whose products and byproducts are some toxic chemicals or gases like NH_4, CO_2, CH_4 etc. which will cause air pollution. And when the wastes from the industries are disposed off untreated into nearby water bodies it will cause water pollution. It also includes the most devastating effect of chemical waste accumulation in the water bodies i.e., the water eutrophication. And when added in soil, its continuous use degrades the soil health and quality hence causing the soil pollution. Therefore, this is high time to realize that this crop production input is depleting our environment and ecosystem. Hence its continuous use without taking any remedial measure to reduce or judicious use will deplete all the natural resources one day and will threaten all the life from the earth. The adverse effect of these synthetic chemicals on human health and environment can only be reduced or eliminated by adopting new agricultural technological practices such as shifting from chemical intensive agriculture which includes the use of organic inputs such as manure, biofertilizers, biopesticides, slow release fertilizer and nanofertilizers etc. which would improve the application efficiency as well as use efficiency of the fertilizers. Opting organic farming will create a healthy natural environment and ecosystem for the present as well as future generation.

Keywords: Chemical fertilizers, environment and ecosystem, plant growth and maturity, organic agriculture

1. Introduction

The industrial revolution followed by the green revolution which fulfilled the food demands of the growing population caused an increase in yield per unit area in crop production, but they also increased the use of synthetic fertilizers in agriculture. Less soil fertility is one of the most vital constraints in improving the agricultural production [1]. But the intensive use of inorganic fertilizer in agriculture worldwide for ensuring the world food security caused so many health problems and unrecoverable environmental pollution.

Total world consumption of nitrogen (N), phosphorus (P), and potassium (K) in 1998/1999 was 81, 14, and 18 Tg/yr, respectively [2]. Fifty-five per cent of the nutrients were used for cereal production, 12% for oilseed crops, 11% for grassland, 11% for commodities (e.g., cotton, sugar, and coffee), 6% for root cropps, and only 5% for fruit and vegetable production. In 1950, fertilizers comprised only a small percentage of the nutrients needed for grain production, most of the supply being provided by the "natural fertility" of the soil and added manure [3]. By 2020, more than 70% of the grain yield will have to depend on fertilizers. The demand for plant nutrients is expected to increase continuously with population growth [4]. According to Keeney (1997), world population is expected to increase by about 2.3 billion by 2020 and double by the year 2050. If meat and food consumption in developed countries are matched by the rest of the world by the mid-21st century, then grain and nutrient demand are expected to triple [5]. Keeping in mind that the amount of land used for food production changed very slightly over the past few decades [3], and may even have decreased in parts of the world due to urbanization [5], the nutrient load per unit area is steadily increasing. All this implies that food production will have to be much more intensive and efficient than ever before.

Thus, to reduce and eliminate the adverse effects of Synthetic fertilizers on human health and environment, nowadays a new agricultural practice has been developed called as organic agriculture, sustainable agriculture or ecological agriculture [6]. Organic fertilizers are primarily cost-effective, easily available from locality products than chemical fertilizers [7]. Organic matter is the basis of soil fertility [8]. Microbial fertilizers are distinctly environment-friendly, non-bulky, cost-effective which plays a significant role in plant nutrition [9]. On the other hand, inorganic fertilizers are known for their high cost and their negative environmental effects if managed poorly [10]. All these give rise to reduced crop yields as a result of soil degradation and nutrients imbalance [11]. Some other technologies and

management practices such as integrated nutrient management (INM), using slow release fertilizer or Nano-fertilizers, conservation tillage, cover cropping etc. can be adapted to supply balanced nutrients to plants. Fertilizers are very important for the crop growth, yield, quality parameters, even for soil health only when applied in optimum recommended dose or when used judiciously. Fertilizer improves the nutrient status and quality of soil by enriching it with nutrients which it lacks. Crop plants require nitrogen, phosphorous and potassium to maintain the normal physiological function of the cell. In a similar way according to [12] lack of nitrogen results in poor growth and slow growth, but the excess use of nitrogen results in delayed maturity and low quality of leaf [13]. However intensive fertilizer application causes serious environmental problems, (for e.g. eutrophication of waters, loss of biodiversity, global warming and stratospheric ozone depletion), soil and plant health problems as some fertilizers also contains heavy metals, excess use of which leads fertilizer to enter the food chain via absorption from soil. Thus, fertilization leads to water, soil and air pollution.

2. Fertilizer Basics

A fertilizer is any material of natural or synthetic origin (other than liming materials) that is applied to soils or to plant tissues to supply one or more plant nutrients essential to the growth of plants or to overcome the plant nutrient deficiency. Many sources of fertilizer exist, both natural and industrially produced. Any natural or manufactured material that contains at least 5% of one or more of the three primary nutrients – nitrogen (N), phosphorous (P), or potassium (K) – can be considered a fertilizer. Industrially manufactured fertilizers are sometimes referred to as "mineral" fertilizers. Fertilizers contain varying proportions of plant essential major (N, P, K, etc.) and minor (Zn, Mn, Fe, etc.) elements, as well as impurities and other non-essential elements. This definition includes both inorganic (mineral) and organic fertilizers and also soil conditioners, such as lime and gypsum, which may promote plant growth by increasing the availability of nutrients that are already in the soil or by changing the soil's physical structure.

Fertilizers typically provide following nutrients in varying proportions:

Three Main/Primary Macronutrients

- Nitrogen (N), is a major constituent of several of the most important plant substances like chlorophyll hence causes leaf growth.
- Phosphorus (P), is involved in many vital plant processes like energy transfer, Development of roots, flowers, seeds, fruit.

- Potassium (K): serves as an activator of enzymes used in photosynthesis and respiration, strong stem growth, movement of water in plants, promotion of flowering and fruiting.

Three Secondary Macronutrients

- Calcium (Ca), regulates the transport of other nutrients into the plant and is also involved in the activation of certain plant enzymes, is also involved in photosynthesis and plant structure.
- Magnesium (Mg), in plant nutrition, is as a constituent of the chlorophyll molecule. As a carrier, it is also involved in numerous enzyme reactions as an effective activator.
- Sulphur (S), is a structural component of some amino acids and vitamins, and is essential for chloroplast growth and function; it is found in the iron-sulfur complexes of the electron transport chains in photosynthesis. It is needed for N_2 fixation by legumes, and the conversion of nitrate into amino acids and then into protein.

And Micronutrients

- Copper (Cu), is important for photosynthesis, involved in the manufacture of lignin (cell walls) and involved in grain production.
- Iron (Fe), is necessary for photosynthesis and is present as an enzyme cofactor in plants.
- Manganese (Mn), is necessary for photosynthesis, including the building of chloroplasts.
- Molybdenum (Mo), is a cofactor to enzymes important in building amino acids and is involved in nitrogen metabolism.
- Zinc (Zn), is required in a large number of enzymes and plays an essential role in DNA transcription.
- Boron (B), has many functions within a plant: it affects flowering and fruiting, pollen germination, cell division, and active salt absorption.
- Silicon (Si), strengthen cell walls, improve plant strength, health, and productivity.
- Cobalt (Co), essential for nitrogen fixation by the nitrogen-fixing bacteria associated with legumes and other plants.
- Vanadium (V), may be required by some plants, but at very low concentrations. It may also be substituting for molybdenum.

3. Fertilizers Classification

The term fertilizer is defined in the Act. No. 156/1998 Coll., as amendment. So fertilizers are required and thus applied to replenish nutrients taken away from the soil by crop harvest and so they are applied to supplement more nutrients to boost crop yield [14]. Plant nutrients are essential for the production of healthy crops for the world's increasing population. Plant nutrients are therefore a vital component of sustainable agriculture. Increased crop production largely depends on the type of fertilizers used for supplementing the essential plant nutrients [15]. The nature and the function of nutrient released from inorganic, organic and biofertilizers are different, also each type of fertilizer has its own advantages and limitations with regard to crop growth and soil fertility. Thus a sound fertilizer management must be done to ensure both an enhanced and safeguarded environment; therefore, a balanced fertilization strategy that combines the use of chemical, organic or biofertilizers must be developed and evaluated [32]. Fertilizers can be classified in numerous ways, like for eg; on the basis of a number of nutrient elements present, on the basis of the type of essential nutrient present, etc. [17].

I. On the Basis of Its Nature

Types	Examples
Inorganic fertilizer	These include industrially synthesized fertilizers. e.g., CO $(NH_2)_2$ (Urea) 45-46% nitrogen, chile saltpetre with 15% nitrogen.
Organic fertilizer	Fertilizers derived from living or formerly living materials. e.g., animal wastes, plant wastes from agriculture, compost, and treated sewage sludge. Beyond manures, animal sources can include products from the slaughter of animals-blood meal and bone meal.
Biofertilizers	Fuentes-Ramirez and Caballero-Mellado (2005) defined a biofertilizer as "a product that contains living microorganisms, which exert direct or indirect beneficial effect on plant growth and crop yield through different mechanisms". E.g., AM fungi, N-fixer, P solubilizer and K solubilizer.

II. On the Basis of Form of the Fertilizer

Types	Examples
Solid	1. Powder (single superphosphate) 2. Crystals (ammonium sulphate) 3. Prills (urea, diammonium phosphate, superphosphate) 4. Granules (Holland granules) 5. Supergranules (urea supergranules) 6. Briquettes (urea briquettes)
Liquid	1. Liquid fertilizers are applied with irrigation water or for direct application.

	2. Ease of handling, less labor requirement and possibility of mixing with herbicides have made the liquid fertilizers more acceptable to farmers

III. On the Basis of Complexity of Fertilizers

Types	Examples
Single nutrient or straight fertilizer	Supplies only one primary plant nutrient, namely nitrogen or phosphorus or potassium. E.g. Urea, ammonium sulfate, potassium chloride and potassium sulfate.
Multinutrient or complex fertilizer 1. Binary 2. NPK	Supplies two or three primary plant nutrients of which two primary nutrients are in chemical combination. These fertilizers are usually produced in granular form. E.g. DAP, nitro-phosphates and ammonium phosphate.
Mixed fertilizers	physical mixtures of straight fertilizers, contain two or three primary plant nutrients

IV. On the Basis of the Type of Nutrient Present

Types	Examples
Macronutrient fertilizer	Contains either one or two essential macronutrient.
Micronutrient fertilizer	Contains either one or two micronutrient.

V. On the Basis of Application of Fertilizer

Types	Examples
Foliar fertilizer	Water soluble straight nitrogen fertilizer is applied directly to the leaves or fruits of high value crops.
Controlled & Slow released fertilizer	Slow and controlled-release fertilizers are fertilizers containing a plant nutrient in a form which either a) Delays its availability for plant uptake and use after application, or b) which is available to the plant significantly longer than a reference 'rapidly available nutrient fertilizer' such as ammonium nitrate or urea, ammonium phosphate or potassium chloride (AAPFCO, 1995), the microbially decomposed N products, such as UFs (Urea-Formaldehydes), are commonly referred to in the trade as slow-release fertilizers and coated or encapsulated products as controlled-release fertilizers.
Nitrogen based fertilizer with certain chemicals that enhance their efficiency	Nitrification inhibitor suppresses the conversion of ammonia to nitrate that is more prone to leaching. Eg, 1-carbamoyl-3-methylpyrazole (CMP), nitrapyrin (2-chloro-6-trichloromethylpyridine) and 3, 4-Dimethylpyrazole phosphate (DMPP). Urease inhibitor slows the hydrolytic convertion of urea into ammonia, which is prone to evaporation as well as nitrification. Eg, urea ammoniums nitrate (UAN).

4. Impact of Chemical Fertilizers on Natural Resources

The World agricultural systems is using a large number of chemicals

such a fertilizers, pesticides, herbicides to achieve more production per unit area but using more doses than optimum or recommended of these chemicals and fertilizers leads to several problems like environment pollution (soil, water, air pollution), reduced input efficiency, decreased food quality, resistance development in different weeds, diseases, insects, soil degradation, micronutrient deficiency in soil, toxicity to different beneficial living organism present above and below the soil surface, less income from the production, etc. Despite these many problems, there is also a challenge to meet the food demands of the world's growing population. Therefore, there is a need to produce nutrition rich and chemicals free agricultural produce for the human and animal consumption without deteriorating are natural resources that is why emphasis should be laid on the production of food rich in quality as well as quantity.

Fertilizer use is no doubt beneficial to plant in providing deficient nutrients; also they have several other conveniences such as the cheaper source of nutrient, higher nutrient content and its solubility hence immediate availability, then it's required in less amount, which makes it more acceptable than organic fertilizer. There is abundance of evidence that inorganic fertilizers can improve the yield of crop significantly [18]. Fertilizers raise soil fertility so that the yield of crops is independent and no longer be limited by the deficient amounts of plant nutrients [19]. Despite these benefits, fertilizer has several negative effects on the environment because of its growing consumption and lowering nutrient use efficiency. Therefore, the major challenge in intensive agricultural production systems is to combine intensive cultivation with high nutrient use efficiency.

4.1 Deleterious Effects of Chemical Fertilizers

Soil nutrient level gets decreased over time when crop plants get harvested, and these nutrients get replenished either through natural decomposition process or by adding fertilizers. Hence fertilizer is an essential component of modern agriculture.

But though chemical fertilizers are the major cause of sufficient crop production for the world population, their overuse is bringing serious challenges to the present and future generations like polluted air, water, and soil, the degraded lands, depleted soils and increased emissions of greenhouse gases. These synthetic fertilizers are not only becoming hazardous for our environment but also to humans, animals and to the microbial life forms too. It's high time that everyone understands the ill effects of using excess chemical fertilizers and take initiatives for reducing

the use of chemical fertilizer and pesticides substituting it with other organic amendments like organic manures which not only provides essential nutrients to the plants but also maintains the soil health for the subsequent crops. There are so many other technologies developing like slow or controlled released fertilizers, prilled or granulated fertilizer, nitrification inhibitors, Nano-fertilizer etc., all these are the promising options we can use to overcome these serious challenges and can save our environment as well as the ecosystem. Let us now learn about the different hazards occurring due to excessive use of chemical fertilizers used for enhancing the crop production.

4.1.1 Effects of Chemical Fertilizers on Water Pollution

As the nutrient use efficiency of the chemical fertilizer is very less hence these are applied in quantities much more actually required and when these are applied in unfavorable environmental condition then these get lost in the environment by different ways. These can be leaching, drainage or surface flow, for example, in most cultivated upland soils, mineral N is likely to be oxidized to nitrate due to microbial activity. As a result, relatively high fractions of the applied N may potentially be leached or removed from the root zone into the surface and groundwater [20]. Even when these chemicals are applied in ideal conditions, plants use only up to 50% of the N fertilizer applied, 2-20% gets volatilized, 15-25% reacts with organic compounds in the clay soil and the remaining 2-10% interfere surface and groundwater [21]. One of the most important parameters of the pollution of water is nitrate which is the basic component of fertilizer. Nitrate is the most common form of dissolved nitrogen present in groundwater or other water bodies. When nitrate concentration exceeds 50 mg NO_3^-/L in drinking water or high nitrate accumulation can lead to (i) 'blue baby syndrome' (acquired methemoglobinemia in infants) and in ruminants; (ii) gastric cancer, for which a possible link with nitrite or nitrosoamines has been suggested; (iii) other diseases such as goiter, birth defects, and heart disease; and (iv) eutrophication of surface water [21].

Major deleterious effect of the intensive use of fertilizers (mainly nitrogen and phosphorus) is water eutrophication. The primary factor responsible for eutrophication is phosphate. Surface waters should contain ≤ 50 μg/liter phosphorus. Nitrogen can also become a factor for eutrophication when increased biomass growth takes place [17]. Eutrophication result in increased growth of aquatic plants and algae in the water body covering the whole water body leading to the loss of other aquatic living species like fishes due to the reduced oxygen supply. Hence eutrophication can lead to

the killing of aquatic life, the proliferation of unwanted species, and loss of recreation due to bad odour, polluted water etc.

4.1.2 Effects of Chemical Fertilizers on Air Pollution

High application rates of chemical fertilizer for enhancing crop production is generating numerous harmful greenhouse gases, depleting the protective ozone layer hence exposing the humans to harmful ultraviolet rays [22]. Agriculture accounts for 60% of anthropogenic N_2O emissions, and agricultural soils are the dominant source [23]. The greenhouse gases like CO_2, CH_4 and N_2O are produced during the manufacture of nitrogenous fertilizer. The effects can be combined into an equivalent amount of CO_2. Nitrogen fertilizer can be converted by soil bacteria into nitrous oxide, a greenhouse gas. Nitrogen fertilizer whose excess use results in an emission of nitrogen oxides (NO, N_2O, NO_2) is responsible for severe air pollution [24]. Other gases also responsible for the ozone depletion are water vapour, carbon dioxide, methane, hydrogen sulfide and chloro-fluoro hydrocarbons [14]. Nitrous oxide (N_2O) has become the third most important greenhouse gas after carbon dioxide and methane. Its global warming potential is 310 times more than that of carbon dioxide. The main concern regarding the emission of nitrous oxides has to do with the effect of global warming and the role of nitrous oxides in ozone destruction that consequently leads to atmospheric "holes," thus exposing humans and animals to excessive ultraviolet radiation [25]. Ammonia volatilized or emitted from fertilized lands, gets deposited in atmosphere and oxidized to become nitric acid, sulfuric acids, creating acid rain after the chemical transformations. Acid rain can damage vegetation, buildings; also can damage organisms that live in both lakes and reservoirs [14]. Methane emissions from transplanted paddy fields are also a serious concern, as methane is a potent greenhouse gas and its concentration is increased by the application of ammonium-based fertilizers. All these emissions contribute to global climate change [16].

4.1.3 Effect of Chemical Fertilizer on Soil Pollution

The Soil is the natural body and a medium for plant growth. The Soil is a habitat of soil organisms, is a nutrient recycling system, and provides many other ecosystem services. The over-use of chemical fertilizers can lead to soil acidification and soil crust thereby reducing organic matter content, humus content, beneficial organisms, stunting plant growth, can change the soil pH, increase pests, and even contribute to the release of greenhouse gases. The soil acidity diminishes phosphate intake by crops, increases the toxic ion concentration in the soil, and inhibits crop growth [20]. The

depletion of humus in the soil reduces its ability to store nutrients. Greenhouse gases derived from excess nitrogen fertilizer harm the climate. Nitrogen applied to fields in large amounts destroys the balance between the three macronutrients, N, P and K over time which would result in lack of micronutrients; it also damages topsoil, resulting in reduced crop yields. Sandy soils are much more prone to soil acidification than are clay soils. Clay soils have an ability to buffer the effects of excess chemical fertilization. Repeated applications of chemical fertilizer may result in a toxic buildup of heavy metals such as arsenic, cadmium, and uranium in the soil. These toxic heavy metals not only pollute the soil but also get accumulated in food grains, fruits and vegetables. For example, Fertilizers like Triple superphosphate has trace elements like cadmium and arsenic that accumulate in plant and through food chains reach to human that may cause health problems. The effects of chemical fertilizers on soil are great and irreversible [26].

Fertilizer application without the using soil testing recommendation can lead to implications such as soil degradation, nutrient imbalance, destruction of soil structure, increasing bulk density [27]. Fertilizers, more than the recommended amounts causes formation, accumulation and concentration of mineral salts of fertilizers which leads to compaction layer and soil degradation in the long-term.

4.1.4 Other Deleterious Effects of Chemical Fertilizers

1. Excessive use of chemical fertilizer, especially N, can contribute to crop tip browning, lower leaf yellowing, wilting and crop lodging. When fertilizer scorches roots, the root may blacken and go limp. All these symptoms occur due to salt accumulation in the soil which would cause difficulty in water absorption by plants.
2. Using higher doses of N fertilizers in malt barley may cause undesirable effect on quality of the beer.
3. Over-application of chemical fertilizer to plants may cause the leaves to turn yellow or brown, damaging the plant and reducing the crop yield.
4. The excessive accumulation of nitrate or nitrite in plant parts consumed by humans or animals is likely to cause the same detrimental effects associated with nitrate contamination of water sources [28].
5. Over-fertilization effects reduce the biodiversity resulting from ammonia deposition in forests and waters [29].

6. They reduce the mycorrhizal root colonization and inhibit symbiotic N fixation by rhizobia due to high N fertilization.
7. Nutrients are easily lost from soils through fixation, leaching or gas emission and can lead to reduced fertilizer efficiency [32].

5. Other Alternatives Besides Using the Chemical Fertilizers

Excessive use of the chemical fertilizer for a long time on the same soil may lead to soil degradation, loss of beneficial soil microorganisms, and many other losses as discussed above [30]. Therefore, to ensure both the enhanced and sustainable agricultural production and to safeguard the environment integrated use of different types of nutrient suppliant such as chemical fertilizer, organic manures, biofertilizers and other slow released or controlled released fertilizers should opt [31]. The use of organic fertilizers together with chemical fertilizers, compared to the addition of organic fertilizers alone, had a higher positive effect on microbial biomass and hence soil health [15].

a) Biofertilizer: It is defined as a substance which contains living micro-organisms and is known to help with the expansion of the root system and better seed germination. A healthy plant usually has a healthy rhizosphere which should be dominated by beneficial microbes.

Biofertilizers differ from chemical and organic fertilizers in the sense that they do not directly supply any nutrients to crops and are cultures of special bacteria and fungi. The production technology for biofertilizers is relatively simple and installation cost is very low compared to chemical fertilizer plants [32].

b) Slow-Release Fertilizers: It involves the release of the nutrient in a slower manner than common fertilizers. However, the rate, pattern, and duration of release are not well controlled. But the rate, pattern, and duration of release are well known in controlled release fertilizers [35]. Different types of slow or controlled release fertilizers are:

1. Organic-N Low-Solubility Compounds for e.g. Urea-formaldehyde (UF) and Isobutyledene-diurea (IBDU).

2. Fertilizers in Which a Physical Barrier Controls the Release for e.g., the coated fertilizers coated with organic polymer coatings that are either thermoplastic or resins and fertilizers coated with inorganic materials such as sulfur- or mineral-based coatings etc.

3. **Inorganic Low-Solubility Compounds:** Fertilizers such as metal ammonium phosphates and partially acidulated phosphates rock (PAPR).

c) Nanofertilizers: "Nanofertilizers are synthesized or modified form of traditional fertilizers, fertilizers bulk materials or extracted from different vegetative or reproductive parts of the plant by different chemical, physical, mechanical or biological methods with the help of nanotechnology used to improve soil fertility, productivity and quality of agricultural produce. Nanoparticles can be made from fully bulk materials. For example, nano-TiO_2 treated seed produced plant recorded more dry weight, higher photosynthetic rate, chlorophyll-a formation compared to the control [34].

d) Application Efficiency: Application of any fertilizer should be done at an economic rate other than optimum rate. Also application from right source, rate, placement & time will reduce the adverse effect on both the crop and the environment.

Various techniques that maintain and enrich the soil fertility & the soil humus content should be used like using compost, manure, agro-forestry, green manure, mulch manure etc.

Conclusion

Fertilizers application is very vital for today's agricultural crop production system as it restores the soil nutrient and promotes crop growth & yield [14]. But, to reduce the different kinds of hazards taking place due to excessive use of fertilizers, judicious and sustainable use of fertilizers should be made for that firstly soil testing and analysis should be done properly and then, fertilizer should be given to soil. Therefore, to ensure both the enhanced and sustainable agricultural production and to safeguard the environment, integrated use of different types of nutrient suppliant such as chemical fertilizer, organic manures, biofertilizers and other slow released or controlled released fertilizers should be adopted. To eliminate the pollution hazards due to chemical fertilizers, improved nutrient use efficient fertilizers particularly nitrogen should be adopted by using organic manures, controlled-release or slow-release fertilizers. Using different Nano-fertilizers which have the greater role in enhancing crop production this will reduce the cost of fertilizer for crop production and also minimize the pollution hazard. Current resources should be overhauled in favour of the sustainable use of resources, also boosting the production simultaneously.

References

1. Ayoub AT. Fertilizers and the Environment. Nutrient Cycling in Agro-ecosystems. 1999; 55:117-121.
2. IFA. World Fetilizer Consumption Statistics, Annual, 1999.
3. Kaarstad Ola. Fertilizer's significance for cereal production and cereal yield from, 1950, 1997.
4. Keeney D. What goes around comes around-The nitrogen issues cycle. In Third Int. Dahlia, 1990.
5. Greidinger. Sym. on Fertilization and the Environment. (J.J. Mortwedt and A. Shaviv, Eds.). Technion, Haifa, Israel, 1997.
6. Keeney DR, Follett RF. Managing nitrogen for ground water quality and farm profitability: Overview and introduction. In Managing Nitrogen for Ground Water Quality and Farm Profitability (R.F. Follet *et al.*, Eds.), 1991, 1-7.
7. Aksoy U. Ecological Farming. II. Ecological Farming Symposium in Turkey. 14-16 December. Antalya, 2001.
8. Solomon WGO, Ndana RW, Abdulrahim Y. The Comparative study of the effect of organic manure cow dung and inorganic fertilizer NPK on the growth rate of maize (*Zea mays* L.). International Research Journal of Agricultural Science and Soil Science. 2012; 2:516-519.
9. Aboudrare A, Agronomie Durable. Principes ET Pratiques. Rapport de Formation Continue. FAO, 2009, 49.
10. Mahajan Gupta RD, Sharma R. Bio-fertilizers-A way to sustainable agriculture. Agrobios Newsletter. 2008; 6:36-37.
11. Hijbeek R, Ten Berge HFM, Whitmore AP, Barkusky D, Schroder JJ, Van Ittersum MK. Nitrogen fertilizer replacement values for organic amendments appear to increase with N application rates. Nutrient Cycling in Agroecosystems. 2018; 110(1):105-115.
12. Omidire Niyi S, Raymon Shange, Victor Khan, Russell Bean, Jewel Bean. Assessing the impacts of inorganic and organic fertilizer on crop performance under a microirrigation-plastic mulch regime. Professional Agricultural Workers Journal, 2015; 3(1):1-9.
13. Mani J. Early events in environmental stresses in plants: Induction mechanisms of oxidative stress. In: D. Inzè and M.V. Montague (eds.) Oxidative stress in plants. Taylor and Francis, New York, 2002, 217-246.

14. Sharma A, Chetani R. A Review on the Effect of Organic and Chemical Fertilizers on Plants. International Journal for Research in Applied Science & Engineering Technology (IJRASET), 2017, 677.
15. Usman M, VU Madu, Alkali G. The combined use of organic and inorganic fertilizers for improving maize crop productivity in Nigeria. International Journal of Scientific and Research Publication. 2015; 5:1-7
16. Chen, Jen-Hshuan. The combined use of chemical and organic fertilizers and/or biofertilizer for crop growth and soil fertility. In International workshop on sustained management of the soil-rhizosphere system for efficient crop production and fertilizer use. 2006; 16:20.
17. Neue, Heinz-Ulrich. Methane emission from rice fields. Bioscience. 1993; 43(7):466-474.
18. Scherer Heinrich W, Konrad Mengel, Heinrich Dittmar, Manfred Drach, Ralf Vosskamp, Martin Trenkel E *et al*. Fertilizers. Ullmann's Encyclopedia of Industrial Chemistry, 2005.
19. Ojeniyi SO. Effect of Goat Manure on Soil Nutrients and Okra Yield in the Rain Forest Area of Nigeria. Applied Tropical Agriculture. 2000; 5:20-23.
20. Cooke GW. Fertilizing for maximum yield. Third Edition English Language Book society/Collins, 1982, 457.
21. Feigin A, Halevy J. Irrigation-fertilization-cropping management for maximum economic return and minimum pollution of ground water. Research report, Inst. Soil Water, ARO, The Volcani Center, Bet Dagan, 1989.
22. Savci Serpil. An agricultural pollutant: chemical fertilizer. International Journal of Environmental Science and Development. 2012; 3(1):73.
23. Shoji S, Delgado J, Mosier A, Miura Y. Use of controlled release fertilizers and nitrification inhibitors to increase nitrogen use efficiency and to conserve air and water quality. Communications in Soil Science and Plant Analysis. 2001; 32(7-8):1051-1070.
24. Cooper Julia, Eleanor Reed Y, Stefan Hörtenhuber, Thomas Lindenthal, Anne-Kristin Løes, Paul Mäder *et al*. Phosphorus availability on many organically managed farms in Europe. Nutrient Cycling in Agroecosystems, 2017, 1-13.
25. Rütting T, Aronsson H, Delin S. Efficient use of nitrogen in agriculture. Nutrient Cycling in Agroecosystems. 2018; 110:1-5.
26. Sonmez Kaplan M, Sonmez S. An investigation of seasonal changes in

nitrate contents of soils and irrigation waters in greenhouses located in Antalya-Demre region. Asian Journal of Chemistry. 2007; 19(7):5639.

27. TC Çevre Ve Orman Bakanlığı Türkiye Çevre Atlası CED Planlama Genel Müdürlüğü Çevre Envanteri Dairesi Başkanlığı, Ankara, 2004.
28. Bhattacharyya Ranjan, Birendra Nath Ghosh, Pradeep Dogra, Prasanta Kumar Mishra, Priyabrata Santra, Suresh Kumar *et al*. Soil conservation issues in India. Sustainability. 2016; 8(6):565.
29. Nelson DW. Effect of nitrogen excess on quality of food and fiber. Nitrogen in Crop Production (R.D. Hauck, Ed.), 1984, 643-661.
30. Vitousek PM, Aber JD, Howarth RW, Likens GE, Matson PA, Schindkerm DW *et al*. Human Alterations of the Global Nitrogen Cycle: Sources and Consequences: Ecological Applications, 1997.
31. Pandiselvi T, Jeyajothiand R, Kandeshwari M. Organic nutrient management a way to improve soil fertility and Sustainable Agriculture-A review. International Journal of Advanced Life Sciences. 2017; 10(2):175-181.
32. Trenkel Martin E. Controlled-release and stabilized fertilizers in agriculture. Paris: International fertilizer industry association, 11, 1997.
33. Chen, Jen-Hshuan. The combined use of chemical and organic fertilizers and/or biofertilizer for crop growth and soil fertility. In International workshop on sustained management of the soil-rhizosphere system for efficient crop production and fertilizer use. 2006; 16:20.
34. Singh MD, Chirag G, Prakash PO, Mohan MH, Prakasha Vishawajith G. Nano-Fertilizers is a New Way to Increase Nutrients Use Efficiency in Crop Production. International Journal of Agriculture Sciences. 2017; 9(7):3831-3833.
35. Shaviv A. Advances In Controlled Release Fertilizers. Advances in Agronomy. 2000; 71:1-49.