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Dr. Ranjeet K Singh
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Analytical Techniques for Pesticides Detection in Food Commodities

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Abstract:

Pesticides are those substances that prevent, destroy or control a harmful organism (pest), or disease and protect the plant, crops during the production. The use of pesticides are increasing worldwide due to large population and their needs. Small quantity of the pesticides is used to kill or control the pest whereas, left pesticides remain in environment or absorbed by the food material, water is harming the health of humans, and aquatic life. Thus, the screening of these pesticides is important to ensure legally acceptable quantity 'MRLs' of pesticides that should be used in controlling the pests or disease. Different techniques such as Gas Chromatography-Mass Spectrometry (GC-MS), High Performance Liquid Chromatography (HPLC), Liquid Chromatography-Mass Spectrometry (LC-MS), Enzyme Linked Immunosorbent Assay (ELISA) and so on have been developed to detect the pesticides. These techniques have high sensitivity, high accuracy, reliability and less time consumption capability but some techniques have drawbacks i.e., HPLC has a low sensitivity for pesticides in food. This review paper studies different analytical techniques for the detection of pesticides in food.

Keywords: *Pesticides, MRLs, Chromatography*

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Introduction

Chemical substances are those substances which are used in agricultural field to increase the production with high quality by controlling the pests is known as pesticides. These pesticides include insecticides, herbicides, fungicides, disinfectants and various other substances. The mechanism of pesticide is that it attacks on the targeting system or enzymes in the pests. This mechanism is also followed in the case of humans because of the identical or very similar system or enzymes in humans. The pollution in air, soil and water is increasing by the greater use of pesticides. The health of humans are at very high risk, not only by misuse or accidental ingestion but also by the traces of chemicals left into the environment that is affecting the health. Pesticides not particularly target pests, it also affect the non-target plants and animals. According to the researchers, only 0.1% pesticides reach to the targets while left pesticides contaminate the surrounding environment (Elhag *et al.*, 2017).

Generally, all creatures, human and environment are facing the problems related to the pesticides but the high risk of exposures is seen in cases of agriculture worker and family members of pesticides applicators. There are different reason of pesticides exposure with the humans which are as follows:

- Spillage from the packaging
- Applying too much pesticides product
- Accidentally, exposure the chemicals during aerial treatment or from spray drift.
- Incorrect use of equipments.
- Failure to follow the label instructions
- Storage of pesticide in unsecured places (Darcin and Darcin, 2016)

Classification of Pesticides

Pesticides are classified on the basis of their use such as insecticides, miticides, herbicides, nematicides, fungicides, molluscicides and rodenticides due to large amount of chemicals and pesticides combination of compounds. Another classifications of pesticides were given by World Health Organization (WHO) based on their health risk. Most important and useful classification is based on the chemical structure which can be divided into four main groups.

Organochlorine: These are stable compounds that persists in the environment and have a tendency to accumulate in fatty tissues. It is used in the destruction of disease vectors such as dengue and malaria. For the preservation of grapes, lettuce, tomato, alfalfa, corn, rice, sorghum, cotton and wood Organochlorine is used during cultivation. These pesticides or their metabolites directly act on Central Nervous System (CNS) of human that alter the electrophysiological properties and enzymatic neuronal membranes due to which change in the kinetics of the flow of sodium and potassium through the membrane of the nerve cell causing symptoms such as seizures and respiratory arrest.

Organophosphates: These are the esters of phosphoric acid. The mechanism of these compounds are as they act on the Central Nervous System (CNS) and inhibits the acetyl cholinesterase enzyme due to which amount and level of neurotransmitter acetylcholine is modulated and nerve impulse is disrupted by serine phosphorylation of hydroxyl group in the active site of enzyme. This mechanism creates many symptoms such as loss of reflexes, headache, dizziness, nausea, convulsion, coma and even death. Organophosphorous compounds are used in agricultural field such as vegetable crops, fruit trees, grains, cotton, sugarcane, and others.

Carbamates: These esters are derived from the acids or dimethyl N-methyl carbamic acid. Carbamates are used in the form of insecticides, herbicides, fungicides and nematicides. They have less value in comparison to organophosphates and Organochlorine but have the same effect as the organophosphate act on acetyl cholinesterase. But the action in Carbamates is very fast, the carbamylation of the enzyme is done through the kinetics of blocking by the covalent attachment of electrophilic groups steric carbamoyl sites of the enzyme.

Pyrethroids: These pesticides is originated from the natural insecticides which are derived from pyrethrum extract from chrysanthemum flowers (pyrethrins**).** They also act on the Central Nervous System (CNS) and make changes in the nerve cell by altering the dynamics of the sodium channels that cause the increment in the opening time of nerve cell due to which sodium current flows for a long time across the membrane in both insects and vertebrates (Garcia *et al.*, 2012).

Pesticide Residues

The deposits of pesticide active ingredient, metabolites, breakdown products of pesticides are present in the components such as food grains, fruits and vegetables, soil and water are known as pesticide residues. This residue analysis gives an idea about the nature and level of any chemical contamination in the environment. Extensive efficiency, environmental and toxicological testing of the pesticides should be registered by Governments for legal use in specified applications. Regulatory bodies set the types and amount of residues should be present legally in the food articles is called Maximum Residue Levels (MRLs). These MRLs are called as ‘tolerances’ in the United States (Dasika, Tangirala and Naishadham, 2011).

Analytical Techniques

In determination of pesticides from analytical techniques, sample preparation is the main step in which extraction of analytes from matrix bulk is performed and then the clean-up the contents from any co-extractives presence in the matrix. There are different methods for the extraction of Pesticides form the matrix such as Liquid-liquid extraction (LLE), Solid-phase extraction (SPE), Matrix solid-phase dispersion (MSPD), quick easy cheap effective rugged and safe (QuEChERS), Solid-phase microextraction (SPME) and so on. After the extraction and clean-up of the sample from the matrix, next step is the detection of targeted pesticides. For the modern multi-residue target pesticide analysis, the most common techniques are Gas Chromatography, Liquid Chromatography coupled to Mass Spectrometry (GC-MS, LC-MS) and Tandem Mass Spectrometry (GC-MS/MS, LC-MS/MS) with triple quadrupole mass analyzers and High Performance Liquid Chromatography (HPLC). Other advanced techniques are electrochemical sensors, optical sensor, and immunosensors and enzymatic biosensor for the analysis of pesticides (Samsidar, Siddiquee and Shaarani, 2018).

Review of Literature

Dasika, Tangirala and Naishadham (2012) proposed a combination of Liquid Chromatography Tandem Mass Spectrometry (LCMS/MS) in their paper for the analysis of pesticides in fruits and vegetables and gave a conclusion that fast and easy qualitative screening of target pesticides within 45 min of LCMS/MS.

Bresin *et al.* (2015) discussed about the analytical technique ‘Gas chromatography-mass spectrometry’ with the extraction method QuEChERS for caffeine removal from the extract. GC-MS have a high sensitivity and less time consuming for the detection of pesticides. Same benefits are with the liquid chromatography tandem mass spectrometry (LC-MS/MS).

Rani and Dhiraj (2015) studied on water to detect the pesticide ‘organ phosphorous’ by High Performance Liquid Chromatography. This method showed accuracy, linearity, precision and robustness. And this method can be used without sample preparation (separation of pesticides from the aqueous phase).

Stachniuk and Fornal (2016) concluded that the combination of liquid chromatography with selective mass spectrometry is a change in the analytical field. From this technique, detection of many compound with trace amount has been easy. He also discussed about the high performance liquid chromatography coupled with QQQ tandem mass spectrometer that have the short duration of analysis by determination of number of compounds in a single analytical cycle. But this HPLC/MS has a limitation of sensitivity to the accompanying matrix components.

Tette *et al.* (2016), In their paper find out the quantity of pesticides in honey using modified QuEChERS for sample preparation and the Ultra high performance liquid chromatography mass spectrometry (UHPLC-MS/MS) for the detection and concluded that this method is fast efficient and reliable.

According to Rimawi (2016), High performance liquid chromatography is a simple, accurate, precise and selective method for the determination of pesticides in water. In this study, the detection and quantification of pesticides in water was possible at low concentration. This method is suitable for real water samples such as groundwater, surface water, and waste water**.**

Chang, Hsieh and Chiu (2016), after the analysis of pesticides in environmental sample by Capillary Electrophoresis Mass Spectrometry, they concluded that Capillary Electrophoresis has high versatility, high efficiency and selectivity due to which it has become more powerful technique for the screening of pesticides.

Djue Tea, Sabarudin and Sulistyarti (2017) analyzed the pesticides Diazinon and Chlorantranilipole in soil sample from High performance liquid chromatography with ultra violet detector in their study and concluded that both pesticides were detected in real sample above 85%. And in the suspected sample there was not diazinon as well as chlorantranilipole.

Elhag *et al.* (2017) in their paper, they detected the Organophosphorous pesticides in the vegetables by Gas chromatography-mass spectrometry and gave a conclusion that It is a powerful technique to determine the pesticides at low levels. And gave a suggestion of periodic monitoring programs to reduce exposure, accumulation and toxicity of pesticides.

Nazir, Rafique and Ahad (2017) analyzed a pesticides in honey sample by microextraction technique with Gas chromatography-Electron coupled plasma. GC-µECD is a best technique for the pesticides analysis. GC and LC with mass spectrometry are also suitable technique for the detection of accaricides and neonicotinoid pesticides in honey.

Samsidar, Siddiquee and Shaarani (2018) discussed several analytical techniques such as GC and HPLC with selective detectors NPD, ECD, MS DAD AND fluoresces detectors for the detection of pesticides in the matrix because of the high sensitivity. But these techniques are time consuming and expensive. To overcome from this limitation, new advanced techniques enzymatic biosensor has been developed to detect the pesticide residues. This device is ecofriendly and have low cost compare to other analytical devices.

Conclusion

Pesticides that are used to kill or control the pests, also have an adverse effect on the humans, aquatic life and plants. These pesticides produce the different types of diseases such as cancer, endocrine disease, asthma, learning disability etc. Different types of technique are used to detect the pesticides in matrix such as GC-MS, LC-MS/MS, HPLC, ELISA etc. This review concludes that the analytical technique 'Liquid Chromatography Tandem Mass Spectrometry (LC-MS/MS)' is a best technique for the detection of pesticides in matrix (grains, fruit, vegetable, water and soil) as it is reliable, have high sensitivity, and consumes less time.

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Control on Plant Virus Disease

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Abstract:

Throughout the world, plant viruses and its diseases are one of the important limitations for food production. From 100 years ago, studies about the plant viruses and virus diseases given much attention to their control. According to IXth International Committee on Taxonomy of Viruses (ICTV) classification of 2012, "there are 91 genera 1005 virus and viroid species infecting plants which are classified largely based on differences in host reaction, serology, genome sequence identity and phylogenic analysis of the virus". Controlling of plant has been difficult to achieve because lack of any effective means of curing virus-infected plants. Chemotherapy, thermotherapy and meristem-tip culture can be successful but still it cannot be used at large scale. Subsequently, the main aim is prevent or delay virus infection or to improve its effects. According to objectives, used to achieve including phytosanitation (involving quarantine measures, crop hygiene, use of virus-free planting material and eradication), changes in cropping practices, and use of pesticides to control vectors, mild strain protection and the deployment of resistant or tolerant varieties. In this review paper, we will discuss about the controlling of plant viral diseases through some techniques such as Control measures, Host Plant Resistance, Chemical Method, Phytosanitation etc.

Keywords: *Plant Virus Disease, Phytosanitation, Cropping, Pesticides Chemotherapy, Thermotherapy, Meristem-tip*

Authors:

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Introduction

Plants are infected naturally by different viruses worldwide and number of viruses continually developed. Higher plants provide the habitat for a wide range of pathogens, of which viruses are some of the most widespread. Plant affect different crop species including that contain the great importance in agriculture. Sometimes effects of viruses are not harmful but their crop growth and yield usually decreases and may cause serious losses. It have long been recognized and provided the inducement studies of viruses of crop plants. It main aim controls the developed effective viruses which could be used on large scale to increase crop productivity and make effective use of the land, labour and other resources under utilisation.

This paper considers the limitation to adoption and the scope for developing and utilizing integrated control measures.

Control Measures: Eliminated some viruses from infected plants without killing or removing but by heat or meristem-tip therapy or by the use of chemicals. By using these method, developed virus-free plants of vegetatively-propagated crops for further propagation and release to growers. Therapy cannot be used on large scale and lack of any possible means of curing infected plants is an important limitation of control. Subsequently, other methods have been accepted. These are to:

- Prevent plants from becoming infected.
- Delay infection to such a late stage of crop growth that yields are not seriously impaired.
- Decrease the effects of infection.

Phytosanitation: According to this term, various approaches are applied that control achieved by decreasing the number of foci of infection from which further virus spread can occur. It contain five main ways for doing this that is as follows:

- Quarantine measures to avoid introducing viruses and their vectors to areas free of them
- Sanitation including the removal of all surviving plants, debris and self-sown ‘volunteer’ seedlings of previous crops.
- Removal from within and around crops of any weed or wild plants known to be alternative hosts.
- Use of virus-free stocks of seed or vegetative propagules for all new plantings.
- Removal (‘roguing’) of diseased plants from within plantings, especially those found during the early most vulnerable stages of crop growth.

Quarantine: Information available on the geographical distribution of viruses and their organism is inadequate because of lack of facilities and trained personnel to demeanor surveys and virus identifications. Viruses and vectors are restricted to certain regions which is apparent but in some areas, it shows absence.

It contains obvious advantages in adopting quarantine and measures to maintain the current situation and to avoid introducing virus and vectors areas where they are established and cause problem. There are also particular problems in controlling the movement across land borders and by natural disasters, insecurity and civil unrest, difficulties are associated with the disruptions. Quarantine controls are of limited value that are suggested by these problems because pests and pathogens will eventually become established in all areas where agro-ecological conditions are suitable.

For virus detection, importance maintaining and improving quarantine procedures and need to develop new techniques to overcome currently intractable problems.

Crop Sanitation: It creates the problem that is by growth of ‘self-sown’ seedling ‘volunteers’ of crops such as cereals, rice and groundnut. This facilitates the survival and perennation of viruses and their vectors, and can provide a ‘green bridge’ between successive growing seasons.

It contain advantages that are gained by approving agriculture practices which decrease the amount of crop debris and obstruct survival. According to Sudan Gezira Irrigation Scheme, it was appreciated at an early stage in studies on cotton leafcurl disease. Special implements were devised to facilitate the removal and destruction of the cotton stumps remaining after harvest that would otherwise survive and regenerate to become foci of infection in subsequent plantings. In this Sanitation, measures are accepting to avoid the carryover of inoculum in sugarcane, tobacco and other commercial crops and it contain the law to help the removal of all crops residues before new planting begins.

Removal of weed or wild hosts: Many viruses have weed or wild hosts that act as foci of infection from which there is spread into or within crops. Remove the sources of virus infection or vector hosts by standard phytosanitary control measure that are not part of crop so as to minimize the initial virus infection source and number of vectors. For example, patches of the perennial grass weed is the symptoms of maize dwarf mosaic disease and Sorghum halepense that occur commonly within and around crop stands. It contain advantages that to be gained are also apparent from experience with Cacao swollen shoot virus in the Western Region of Ghana, where many outbreaks in cocoa are associated with under-storey forest tree Cola chlamydantha.

Virus-free Propagules: For all new plantings, use of virus-free propagules that is a basic approach to control which is beneficial for several reasons:

- Virus-free material establishes more readily and is more productive than infected.
- If virus-free material is adopted there are no initial foci of infection within crops from the outset, during the early most vulnerable stages of crop growth. This delays and curtails the period over which any subsequent spread can occur.
- Plants not infected until a late stage of crop growth are affected less severely than those infected early.
- Infected propagules are particularly dangerous sources of inoculum because they tend to be distributed randomly within crops. This facilitates virus spread from infected to neighboring healthy plants, whether this is by contact or by vectors.

Much attention has been given in technologically to advance countries by these reasons that producing the virus-free stocks of seed and tubers, cuttings or other propagules of crops that are propagated vegetatively. There are no major problem for obtaining stocks that are free from infection by careful selection or by using some form of therapy. To maintain and designate the health status of stock by using the official inspection and certification procedures.

Roguing: Removal of symptomatic plants, known as roguing, is a phytosanitary control measure that is widely used to remove sources of virus infection from within crops. Roguing is widely applicable and used to control infected diseases of diverse crops in both tropical and temperature regions. The approaches is most effective against viruses that is not spread quickly in any considerable amount. It is popular with farmers, who are seldom prepared to allocate the time and effort required to inspect crops with thoroughness and required frequency to identify and remove diseases plants When symptoms are conspicuous and when the symptomatic plants are removed early, before vectors have visited them in case of effective of roguing and when vector number are low and when a virus is being transmitted persistently by insect vector in case of non-effective.

Host Plant Resistance: Crop species contain a feature that is some degree of genetic diversity and it is used by agriculturalists and horticulturalists to increase crop productivity and remove the most damaging effects of pest and pathogens. By selecting and adopting genotypes, it is achieved that yield satisfactorily and avoid or withstand biotic and abiotic limitations.

Host plant resistance is virus diseases which is helpful to distinguish between 'positive' and 'negative' selection. *Negative selection* is recognized as being several diseased and they do not grow or yield satisfactorily due to which particularly vulnerable crop genotypes are discarded by farmers or researchers. *Positive selection* is recognized by to identify particularly resistant genotypes when heterogeneous populations are exposed to infection. Positive selection is requires substantial scientific input and expertise, while negative selection is practiced within even the most primitive cropping systems. Both selection has been used widely and intentionally or unintentionally host plant resistance that play a big contribution to control the virus diseases by decreasing incidence.

There are widely used in agriculture and horticulture and could make a greater contribution to control the diseases but for several constraints:

- Effective resistance breeding programmes are developed by considerable research as these must also take explanation of other biotic and abiotic constraints and requirements of farmers, consumers and processors. For a sufficiently long period, necessary funds, personnel and resources are not always available.
- There have been occurrences of resistant varieties being released without adequate on-farm testing to ensure that the varieties are suitable for adoption and that they meet the often severe requirements of farmers and consumers.
- In case of resistant varieties are developed, they may not available because of the lack of an effective seed multiplication and distribution system, and farmers are unaware of benefits that are gained from adoption.
- The resistance may be associated with undesirable traits as resistant varieties may lack some of the desirable attributes of the susceptible varieties being grown.

- The need to adopt resistant varieties is not necessarily compelling, especially if the disease occurs occasionally and attracts less attention than other factors decreasing yield.
- Resistance may be overcome due to the emergence or increased prevalence of virus strains that damage previously unaffected varieties. Moreover, varieties that are resistant in some areas may be susceptible in others. Thus, it may be difficult to develop and exploit broad-based resistance that is also durable.

Chemical Control: To decrease the spread of legume viruses vectored by insects that is the application of insecticides. It is frequently ineffective because success with it depends on factors such as mode of action of pesticide and mechanism of transmission of virus. Insecticides should always be applied carefully as they become ineffective when vectors develop resistance to them and overuse results in unwanted side effects with environmental and economic consequences, such as buildup of toxic residues, loss of beneficial natural enemies of vectors, and unanticipated growth of other pests or pathogens. By using chemical control of vectors, success in decreasing virus that is greater with persistently than with non-persistently transmitted viruses.

Non-persistent Viruses: Most common types of insecticides are infected at controlling non-persistently aphid-borne viruses. It is the newer generation of synthetic pyrethroids because of their rapid knockdown and greater antifeedant activity. This newer generation viruses contain applications that did not control the virus sufficiently well to provide reproducible yield increases.

Persistently Viruses: Success was obtained with chemical control of luteoviruses, such as BLRV and related viruses, in cool-season grain legumes. In growing season, treatment could prove useful in areas where infection with FBNYV is likely to occur because chemicals are used in low temperature (100-200g/ha) that is more acceptable environmentally than many of the older generation of systemic insecticides normally applied as foliar sprays. However, due to the environmental impact, chemical control should still only be considered when other control approaches are insufficient to achieve economic yields in infected crops.

Review of Literature

Thresh (2003), improved technology would only be attained by developing more effective methods of controlling pests or pathogens diseases. Crucial challenge for researchers, extensionists and farmers to developed the effective and sustainable methods to control the plant viral disease and also not harmful effects on human health and environment.

Jones (2006), concluded that challenge to achieving satisfactory yield and quality of produce to virus epidemics in cultivated plant. An increasingly sophisticated and diverse range of host resistance, cultural (phytosanitary and agronomic), chemical, biological and legislative control measures are becoming available to meet this challenge. There is an increasing knowledge base and sophistication technology to control the plant virus diseases. In this review paper, control measure also need to be ecologically and socially sustainable, robust, affordable and compatible with standard agriculture practices.

Bosch, Jeger and Giligan (2006), dictated that from the previous crop as planting material, transmission of virus through the use of infected cuttings and transmission through an herbivorous insect vector map onto vertical and horizontal disease transmission modes. The effect of transmission mode on virulence which is depend on mechanisms responsible for transmission in combination with the trade-offs operating in system under consideration.

Loebenstein and Katis (2014), to control the virus disease in legume crops is through Integrated Plant Disease Management (IDM) that is, by crop management or ecosystem management. In this review paper applying the chemical methods to controlled the virus-infected crop.

Islam (2017), stated that knowledge and perceptive criticize the farmer's literacy about the plant diseases, their symptoms recognition and proper management practices. The farmers are not confused with virus diseases but they are pile up to their loss through wrong usage of pesticides. The long lasting solution against these diseases can only be through incorporation of host plant resistance due to the lack of knowledge of farmers about virus diseases. More than hundreds of research institutes, laboratories and universities about the plant virus diseases are failed and in generating the virus resistance crop verities against most of the plant viruses. Only few success stories relating to virus resistance cultivars but 0.1% is un-justifying.

Conclusion

In this review paper, many approaches are applied due to which controlling plant virus diseases and it also contain little doubt that many of the diseases now causing serious losses and diseases could be controlled through the application of existing knowledge in tropics areas. There are also likely to be important contributions from new technologies and approaches to control the viral diseases by biotechnologists. This information is utilized by researchers and extensionists in developing and stimulating suitable large scale control measures that are not effective but appropriate for use by farmers. Avoiding the harmful effects on human health or environment by using control measures and should complement and be fully compatible with those being used against pests and pathogens. If these studies should be done on large scale and over a sufficiently long period to provide a reliable indication is cost-effectiveness of the control measures. Improved methods of virus control plays an important role in enhancing productivity and utilized the experience gained already in developed countries and introducing the new biotechnologies.

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Nitrogen Fertilizer's Role in Plant Growth

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Abstract:

Nitrogen (N) is an essential element for plant growth and development that is utilized by all plants in the form of NO_3 and NH_4; it accumulates in edible parts of these leaf vegetable due to the environmental pollution and high nitrate concentrations, mostly if excessive part of nitrogen fertilizer has been applied then, it would be dangerous to individual health. Approximately, 78-79% Nitrogen is available in the atmosphere in inert structure that is not useful for plants and not take-up directly. It is available from industries, atmospheric and biological as well as organic fixation. To conduct the randomized experiment to determine the effect of different concentration of nitrogen on growth, biochemical, quality and yield attributes of plant. Plant were supplied with five levels of basal nitrogen which is 0 (control), 40, 80, 120 and 160 kg N/ha (Hectare). Nitrogen fertilizer have no significant effect on plant height and number of outer leaves. In this review paper, going to discuss about the evaluation of different rate of nitrogen fertilizer on growth of plants, crop etc.

Keywords: *Nitrogen, Fertilizer, Biochemical, Organic Fixation*

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Introduction

For satisfactory crop growth and production, there is a need of proper nutrition to the crop as there are 16 elements that are essential for the growth of plant. These 16 elements are derived from the soil, present in the form of inorganic salts. 94-95% of plant material contains carbon, hydrogen and oxygen. Other 6% contain other nutrients such as calcium, phosphorous, nitrogen etc.

Any compound which contains one or more chemical elements that may be present in organic or inorganic form is known as fertilizers. These fertilizers may be natural or synthetic. In agricultural activities, Fertilization are used to increase the efficiency and better quality of product recovery.

Role of Nitrogen in Plant

For the successful growth of plant, nitrogen element plays a vital role because of the protein and chlorophyll are the essential constituents of the plants. Less than 5% of inorganic nitrogen (NH_4, NO_2, and NO_3) in soil that are absorbed by most of the plants. To maintain the nutritional condition of different cropping systems, Inorganic and organic fertilizers are applied to the crops. In an organic agricultural system, the quantity of nitrogen, phosphorous, calcium, magnesium and potassium are increased by the continuous application of manure. After applying the organic fertilizers to the soil, Inorganic nitrogen is released and absorbed by the plants during the beginning of mineralization. Therefore, mineralization rate is controlled by several factors such as agricultural management, microorganism, soil properties, temperature water content and type of organic fertilizer.

Once, agricultural system is treated by the nitrogen fertilizer that is directly absorbed by the plants. This absorbed fertilizer converts into various different forms by the oxidation process. Through the leaching, volatilization and denitrification, excess nitrogen is lost in ionic or gaseous form. Nitrogen fertilizer is carried away by runoff or leaches into the soil with water, if it is not absorbed by the plants. As the large quantity of the nitrogen fertilizer is applied due to which the phytoavailability of nitrogen pool increases and cause the potential threat to the surrounding environment. It shows the close relationship between the excessive nitrogen fertilizers and environmental problems i.e., eutrophication, greenhouse effect, and acid rain (Liu *et al.*, 2014).

A significant role is played by the soil and climate condition in uptake and utilization of Nitrogen. Hence, before conducting any experiment to know the response of nitrogen on the growth and productivity of diverse crop species, the condition of soil and climate of any particular region must be considered. There are some advantages of nitrogen as follows:

- Nitrogen give the dark green color to the plants,
- Promote leaves stem, and other vegetables part’s growth and development.
- Stimulate Root growth
- Improve fruit quality
- Enhance the growth of leafy vegetables
- Increase the protein content of fodder crops (Leghari *et al.*, 2016).

Nitrogen Fertilizers

Inorganic Nitrogen (N) Fertilizers: It includes ammonium, nitrate forms and urea.

Ammonium Sulphate: It is a soluble fertilizer that contains nitrogen and sulfur. It is present in two forms; dry form with 21% Nitrogen and 24% sulfur while liquid form. Ammonium sulphate has a lower nitrogen volatilization risk than urea. So, it is compatible for the topdressing application. Ammonium sulfate is a good source of sulphur. Hence, where sulphur is needed, ammonium sulphate is used.

Anhydrous Ammonia: This compound has highest composition of nitrogen (82%) compare to other compounds and it is the cheapest nitrogen source. It is a high pressure liquid that is injected 6-8 inches deep into soil to prevent the ammonia loss. The high pressure, specially designed and well maintained equipment is required for storing the anhydrous ammonia for safety reasons. Personal protective equipment should be used during the application of it.

Ammonium Nitrate: It is the oldest salt that contains only 33 to 34% nitrogen. It can be used by applying on the surface or by incorporating into the soil. It has a low risk of volatilization as compared to urea because of the presence of ammonium and nitrate. The soil has the low pH as it contain ammonium.

Potassium Nitrate: It is also known as saltpeter or nitric acid, used as a fertilizer. It is found in the form of white colored powder or colorless transparent crystal that contains 14% nitrogen and 46% potassium. The soil does not have low pH in the presence of potassium nitrate.

Chilean Nitrate: It contains 16% of plant available form of nitrate-N and sodium used in organic cropping systems as well as conventional systems. It is available in two forms; dry and flowable prill form.

Urea: It is a highly soluble dry material. Urea's nitrogen is available after the conversion into ammonium and then in nitrate. It can be used as starter and top dressing application. It has an advantage: 45 to 46% nitrogen with the low cost per pound (lb) of nitrogen. Nitrogen losses to the air and approaches 40% of the applied nitrogen, if it is applied to the surface, not incorporated. Hydrogen ion is formed after the conversion of ammonium into nitrate due to which soil pH is reduced with the repeated use of urea fertilizer.

Urea Ammonium Nitrate: It is readily soluble that contains 28 to 32% nitrogen. It is made by mixing of ammonium nitrate and urea. It is non-pressurized liquid fertilizers used for the side dressing of the crops. Urea ammonium nitrate has the low volatilization compare to urea because of the lower percentage of nitrogen in urea and ammonium form. This product has the benefits such as uniformity, ease of storage, handling and application. Urea ammonium nitrate has the lower soil pH because of the conversion of ammonium to nitrate and release of Hydrogen ion. (http://nmsp.cals.cornell.edu).

Review of Literature

Hirel et.al, (2011), studies about the last two decades to identify by means of agronomic, physiological and genetic studies. Nitrogen use efficiency (NUE) has become the second priority after drought both in private and public sector for abiotic stress improvement in crops. To use many tools for crops and cereals for decipher the genetic and physiological basis of NUE. In this paper, improvement in yield for most crops over the last 50 years, approximately 40%, due to improvement in cultural practice and 60% due to genetic grains which is indicating the breeding for improved NUE.

Singh, Khan and Naeem (2014), stated that the application of 120 kg N/ha proved optimum for enhancing crop productivity, nutrient content of leaf and rhizome as well as biochemical and quality attributes of plants.

Liu *et al.* (2014), stated that nitrogen fertilizers help in plant growth and development but it accumulate in the edible parts and harms when organic and liquid fertilizers are used and liquid fertilizers with inorganic fertilizers increase the conductivity of the soil due to which growing lettuce crops are affected negatively. They provided the useful information to farmers and policy makers.

Farnia and Ghorbani (2014), proposed by the studying the effect of potassium and nitrogen in the form of bio fertilizers on red bean that these both fertilizers are effective on the component of red bean and says that chemical fertilizers should be removed by these fertilizers.

Selassie (2015), concluded that nitrogen fertilizers have a positive effect on the crop 'Maize' by height, lodging percentage, and grain yield etc. 60 kg nitrogen per hectare gives profit from unit investment.

Woldesenbet and Haileyesus (2016), studied about the mazia crop and the effect of nitrogen on the crop. They concluded that as the nitrogen level is increased, the quality and quantity of yield start to decrease. They suggest that chemical composition of soil should be identified that can have positive and negative effects on the level of fertilization.

Abera, Debele and Wegary (2017), concluded that nitrogen fertilizer application has been increased the production of maize. Problem related to soil fertility is alleviated using crop management practices. They concluded that nitrogen fertilizer is better for the sustainable maize production.

Yeshiwas (2017), studied the effect of nitrogen fertilizer on the growth of cabbage and concluded that Nitrogen rate has a significant effect on the leaf length of cabbage and suggest that 150 kg of nitrogen per hectare should be used by the stakeholder due to crops and its components will become cost-effective.

Walsh, Shafian and Christiaens (2018), by using nitrogen application with timely and efficiency, improve wheat Grain Yield (GY) and quality. Increasing the grain yield (GY), protein content in grain (GP) and Nitrogen use (NUP) values for Nitrogen fertilizer in the 90 kg N/ha but increasing the rate to 135 kg N/ha did not further enhance wheat production. It indicate the 90 kg N/ha rate was adequate to optimize spring wheat GY and GP.

Megaladevi *et al.*, (2018), concluded that notice the increase in root yield with increasing the nitrogen levels of aphid incidence that indicate the radish crop can yield more at high nitrogen with high aphid incidence but decrease the cost of root quality. Highest population was observed on plants receiving more Nitrogen (450.00 mg N/plant) and minimum population on plants receiving no Nitrogen. Effect of nitrogen on plant height was significant.

Conclusion

The fertilizers play an important role for the production of crop with high quality in the field of agriculture. In these, nitrogen fertilizer that helps in the growth and development of the plant and give color to the plant, leave and stem. But the excess of the nitrogen level can damage the quantity and quality of the crops and the less amount of nitrogen in plant also gives an adverse effect on plant (yellow leave- less chlorophyll). From this review, it can be concluded that the use of nitrogen fertilizers should be in required amount only for the high quality production.

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Plastic Waste Management Technologies

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Abstract:

Plastics use is considered as the crucial part of our daily life and used in large number of applications in worldwide. It is mostly used in Indian cities and villages, for the purpose of buying vegetable, drinking water bottle, plastic furniture in home, plastics objects in kitchen, plastic drum in packing, storage of different chemicals for industrial use and its utensils are used in home and in many more due to their natural properties such as inertness and low bulk densities and make them suitable mover material and contamination less. It will be a part of waste garbage, after the usage of plastic, due to which it creates pollution by the presence of toxic chemicals and it will contributes in spreading diseases. By plastic waste management policy, packaging revolt has not been backed but in a lot of countries in India, left littered part of plastic waste creates horrible visual troubles and other community health problems. In most development countries, increasing environmental awareness and decrease in available landfill capacity have encouraged plastic recycling programmes. Now a days, plastic waste is recycled only 5 to 25% and it contain limited methodologies for utilization of plastic waste again. This review paper, discusses about the existing methodologies of plastic waste management schemes.

Keywords: *Plastic waste management, Landfill, Recycle, Packaging Revolt*

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Introduction

In our everyday life, plastic items plays a significant contribution for greenhouse, coating and wiring, packaging, films, and covers, bags and containers. In medical products, plastics like disposable syringes, blister packing of tablets and capsules, joint replacement prostheses, inter venous (IV) fluid bottles, blood bags, catheters, heart valves, etc., that have significantly helped supporting the human life. It contains the lightweight (energy saving), low cost, exhibit unique and versatile properties. One of the most important application of plastics is packaging in which 40% plastic materials are used for packaging. Thermoplastic are used of the total plastic consumption roughly 80% and used for packaging that is application of plastics but non-plastic applications such as plastic fiber and coating.

Packaging has been possible due to following attributes of plastic materials:

- Safe and hygienic – inert and chemical resistance
- Light weight and non-breakability
- Excellent barrier properties - enhancing shelf-life
- Superior impact resistance
- Sterilizable and resistance to bacterial and other microbial growth
- Transparency as well as opacity
- Lower fuel consumption and product loss during transportation

Health, safety and environmental problems are created by the use of plastics. As the plastics and non-biodegradable, so this property cause waste management problem and choke the drain urban cities.

Effective mass awareness campaign is very important because solid waste management contain the solution that lies in segregation of dry and wet solid waste at the source. To increase the concept of resource management by occurring plastics can be recycled to produce articles. With the recycle of plastics, many useful products have been developed and in small, micro and informal sectors, large number of people is employed in these activities. The unwanted and discarded plastic waste does not remain in road side not it is carried to landfill that is providing through the recycling. By conventional process, many types of plastic waste like multilayer laminates, EPS etc. are not easily recyclable.

The total environmental impact of a product or activity on the earth is analysed by Life Cycle Impact Analysis (LCIA) that is an important and modern scientific tool. Life Cycle Analysis (LCA) proved that plastics have much less adverse impacts on the environment pollution as compared to their alternative that is conducted by credible academic institutions and independent professional organisations of reputation.

Plastic is produced from fossil oil which is distilled to fractions containing a mixture of hydrocarbon chains and subsequently cracked into repeating molecular units, 'monomers'. The monomers are synthesized into polymers forming the base material, e.g. granulate or powder, that can be manufactured to different shapes and products by several mechanical means, as for example, extruding and molding.

Plastic can be divided into two main groups that is based on their thermal processing behavior: thermoplastics, which account for by far the largest amount of plastic produced (around 80%), and thermosets.

Type of plastics with their major applications are as follows:

Thermoplastics:

Thermoplastics have a structure with long chains of polymers and increase temperature and pressure in which doing the mechanically work. It can be stable at large temperature range that make them attractive for use and also for recycling.

- This type of plastic become soft
- When it is heated, they can be moulded or shaped with pressure
- When it is cooled, they are solidify and retain the shape or mould

Some common thermoplastics with their uses and properties which is as follows:

Table 1: Types of Thermoplastic and their Properties

Plastic type	Abbreviation	Thermosetting	Properties
Polyethylene terephthalate	PET	Bakelite	• Tough and clear, good strength and stiffness, chemical and heat resistance • Used in packaging, soft-drink and mineral water bottles, fibers for clothing, films, food containers, transport, building and appliance industry (as it is fire resistant), etc.
High density polyethylene	HDPE	Alkyd	• Good process ability • Excellent balance of rigidity and impact strength, • Excellent chemical resistance, crystalline, melting point (130-1350C), • Excellent water vapour barrier properties • Used for making blow moulded products (various types of containers, water bottles), pipes, injection moulded products (storage bins, caps, buckets, mugs), films (carrier bags), etc.
Polyvinyl chloride	PVC	Polyester	• Versatility and energy saving, • Adaptability to changing time and environment, • Durability and fire resistance • It is used in industries such as building and construction, packaging, medical, agriculture, transport. • Also used for making wires and cables, furniture, footwear, domestic appliances, films and sheets, bottles, etc.
Low density polyethylene	LDPE	Urea - Formaldehyde	• Versatility and energy saving • Adaptability to changing time and environment • Durability and fire resistance • It is used in industries such as building and construction, packaging, medical, agriculture, transport. • Also used for making wires and cables, furniture, footwear, domestic appliances, films and sheets, bottles, etc.

Polypropylene	PP	Epoxy	• Low density and excellent chemical resistance, • Environmental stress resistance and high melting point • Good process ability, dielectric properties and low cost, creep resistance • Used for making bottles, medical containers, pipes, sheets, straws, films, furniture, house wares, luggage, toys, hair dryer, fan, etc.
Polystyrene	PS	Polyurethane	• Glassy surface, clear to opaque, rigid, hard and high clarity • Affected by fats and solvents • Used for making electrical and communication equipment's such as plugs, sockets, switch plates, coil forms, circuit boards, spacers and housing • Also used for making containers, toys, wall tiles, baskets, cutlery, dishes, cups, tumblers, dairy containers, etc.
Polyvinyl Acetate	PVA	Melamine	• It is amorphous polymer, not a crystalline one. • It is good adhesion to most surfaces. • Used in engineering sector.

Source: (Siddiqui and Pandey, 2013; Gawande *et al.*, 2012)

Some common technologies for Plastic Waste Management that is as follows:

Recycling: It is carried out in such a manner that reduces the pollution level throughout the process and results in increasing the efficiency of the process and conserve the energy. This type of recycling have been divided into four types:

Primary: It is included in plant process of recycling of waste scrap into a material with features similar to the original product.

Secondary: In this recycling, the process of waste plastics into products with the characteristics dissimilar to the original plastics products.

Tertiary: In this recycling, plastics scrap is produce the basic chemicals and fuels that is as part of municipal waste stream or as a segregated waste.

Quaternary: By burning or incineration, reclaims the energy content of the scrap plastics and it is not use in India.

Landfilling: This process is purely temporary and to manage the plastic waste and buried the waste materials in specific area. It give result that harm to environment and create risk of contamination of soils and underground water by breakdown of water. This may result in:

- Affecting water recharge
- Reducing soil microbial activity
- Clogging the drainage
- Water line clogging

Such clogging may result in production of gases like methane that affects Green House effect.

Incineration: It can be used with recovery of some of energy part in plastic and vary energy that is depending on whether which is used for electricity generation, heat and power. It is carried out about 700°C and incineration of polymers like PE, PP, PS that produces gases like CO, CO_2 etc. and these gases cause global warming, air pollution, monsoon failure etc. but in case of PVC mixed with waste that produces of HCl, Cl_2 and dioxin, poisonous gas.

Co-processing of Plastic waste in Cement Kiln: Municipal Solid Waste (MSW) contains the part in which plastic waste generated from different cities and towns. Disposal of plastic waste is causing many problem such as leaching impact on land and ground water, choking of drains, making land infertile, indiscriminate burning causing environmental hazards etc. It is generated approximately 15,342 tonnes per day (TPD) in country. It is most effective methods of recycling of plastics waste for recovery of energy that is used as an alternative fuel in cement kilns. With the aim of plastic into new energy sources that is apart from recycling of plastic for making new products and saving energy. Plastic is made up from crude oil that is the same raw material from which fuel is made. It contain the goal that waste plastic back to crude oil which is reused for powering engines that is made by scientists. The high temperature used in the cement kilns gives a scope to some type of plastic waste contaminated with toxic chemicals such as pesticides and some other hazardous materials without creating any increase in amounts of emissions in the air or water.

Co-processing of plastic waste as an Alternative Fuel and Raw Material (AFR): Co-processing is referred to as the utilization of waste materials in industry process such as cement, production of lime or steel and power stations or any other large combustion plants. By waste recovery industry and material from waste, co-processing shows replacement of primary fuel and raw material. In this, plastic waste are used for co-processing that are referred to as alternative fuels and raw materials (AFR). It advises the advantages for cement industry as well as for the Municipal Authorities responsible for waste management. Fossil fuel and raw material consumption are saved by cement producers and contributing the more eco-efficient production.

Pyrolysis Technology: Till the waste plastic material decompose into gases and oils, when plastic materials are heated in the absence of oxygen. Plastic polymers are broken down into small molecules during pyrolysis. At high temperature (greater than 600°C), produces the small gases molecules but at low temperature (less than 400°C), produces more viscous liquids during pyrolysis. This process is viable route for recycling of waste plastics and convert into gases and fuels and also solve the environmental problem because most of the plastic contains toxic and halogen flame retardants. For pyrolysis, fluidized reactor is a better equipment which contain advantages are obtaining more oil products, better temperature control mechanism. Pyrolysis or thermal cracking is a suitable technique and is used in process of petrochemicals. Pyrolysis helpful in conversion of post-consumer waste plastic for the production of valuable hydrocarbons and also unique approach for catalytic recycling of plastic waste.

Advantages of Pyrolysis process

- It reduces CO_2 emissions
- It reduces landfilling
- It helps to faster commercialization of products
- It helps to product could be used to produce electricity and heat

Review of Literature

Salem, Lettieri and Baeyens (2009), for plastic waste management recycling, treatment and recovery, have various technologies which contributed greatly to eco-image of waste management. Certain benefit of current situation is re-using and decreasing single-life polymeric materials. Plastic solid waste (PSW) is derived from oil and has recoverable energy that are comparable to the other energy sources. One or two stage combustion technologies occur direct incineration that reduce the volume of PSW as well as dependence on fossil fuels, which lead to result with better conservation of natural resources and integrated waste management schemes. Incineration is most important to consider recycling and energy recovery methodologies in plastic manufacturing and converting facilities.

Gawande (2012), in this review paper, find out the effective ways to reutilize of hard plastic waste particle. Use of recycled waste plastic in pavement asphalt represents a valuable outlet for such materials. The use of waste plastics in manufacturing of roads and laminated roofing also help to consume large quantity of waste plastics.

Sasane *et al.* (2015), dictated that increase of waste plastic in bitumen, increases the properties of aggregate and bitumen. Their shows good result when use of waste plastic in flexible pavements and compared with conventional flexible roadways. It is an eco-friendly technique which has more value in minimizing the disposal of plastic waste.

Sharma (2015), day by day, increasing the generation of waste plastics and have polymers such as polyethylene, polypropylene, polystyrene that is show adhesion property in their molten state. One of the best method is use of waste plastics for pavement, for easy disposal of waste plastics. It has increase the technologies for prevention of harmful from waste plastic products.

Joshi and Ahmed (2016), stated that Muncipal Solid Waste Management system are fail from many reason such as lack of awareness, inappropriate technical knowledge, inadequate funding, unaccountability, implementation of legislation and policies. In this review paper, enhanced capacity, improved procedures and training can decrease the issues such as proper site selection, adequate financial support, and improper human resource management. The development and adoption of appropriate technologies and lack of trained manpower will require at realistic time frame for solution of the problems. It is not only central government bodies but also state government have taken various actions for strengthening Muncipal Solid Waste Management in country.

Singh and Sharma (2016), concluded that reduce the pollution and waste is viable through the industries due to which produces the harmful effects. In this, reduce packing materials for products and make products that last longer and easier recycle, reuse and repair.

Conclusion

In present day, Plastic Waste Management has presumed great significance. In India, plastic waste management contains the various schemes that are implemented to mitigate the impacts of plastic waste. Recycling is one of most useful technique to manage the plastic solid waste. It increases the rate of recovery and recycling of plastic wastes in current trend and rising sense environmentally as well as economically. This trends are expected to continue but some significant challenges still exist from both technological factors and from economic or social behaviour issues relating to the collection of recyclable wastes, and substitution for exploited material. In this review paper, discuss about the technology for improving the environmental performance of polymer industry of recycling of waste plastics.

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Study on the Adverse Effects of Agriculture on Environment

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Abstract:

It is well known that maximum part of the earth is used in the agricultural field for the production of food. This agricultural field is mostly affected by the environment as it depends upon the natural resources (soil, water, air etc.). In the same way, the agricultural activities also affect the environment because of the need of more production of food (large population). To overcome this problem, farmers use new technologies in which most of the technique give an adverse effect on the environment as the different factors such as chemical fertilizers, use of pesticides, and more irrigation create the problems of land degradation, soil erosion, production of harmful gases, water pollution etc. These problems harms the health of organisms. So, there is a need to reduce the impact of agriculture on the environment by reducing these problems. This review paper gives an idea about how to reduce the impact of agricultural activities on the environment. Government started a scheme of sustainable agriculture through which the impact on the environment can be reduced.

Keywords: *Chemical Fertilizers, Erosion, Agricultural Activities.*

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Introduction

Nature is the beneficial source for humans from the existence as they were dealing with the agricultural events. They have applied various agricultural techniques without any disturbance in the nature for a long time. Various activities, methods and results of the science and technology had a nature disruption attributes. From these results (damage in nature), human being were unaware for a certain period of time. The humans are harming the environment which is not considered because of the renewability features of environment. With the time, the detriments on environment is being increased due to which the renewable capability of the environment is not working.

Nowadays, the growth of the population is increasing continuously due to which the demand of agricultural land for food fiber and fuel is also growing. The disagreeable facts (using of plastic bags) which are followed by the every nation for the development without knowing the environmental impact of degradation and pollution of agricultural lands due to which global environment is changing and has become a challenge to living systems. In reducing the environmental and agricultural land pollutions, both the business sector and the individual consumers plays an important role. The environmental and agricultural land pollution such as waste water and solid waste discharges and energy use are strictly reduced by business sectors over these years along with consumer have increased environmental and agricultural land pollution. The concern of the global community and caring media around the world have been raised due to the negative environmental impacts and agriculture land pollution.

Agriculture and Environment

The intensification of agriculture impact on the environment that indicates the use of unsustainable resources and modern inputs such as chemicals and machinery. The common domains for agriculture are water, soil, air and biodiversity. Due to any detrimental effect on these domains creates an impact on the environment. The change in the climate is the global threat that harms the agriculture, natural eco-system, water supply, health, soil and atmosphere are the component that maintain the sustainability of the life on earth. Many factors such as temperature, rainfall, and extreme weather events related with the climate change affects the crops.

Impact of Agriculture on Environment

Agriculture activities are affected by the environmental condition. Agriculture is a major cause of many types of environmental degradation such as 25 to 33% greenhouses gases are emitted from the agricultural activities, 40% land of earth surface for agriculture, more than 70% freshwater withdrawals for the agricultural field, deforestation and habitat fragmentation, loss of biodiversity and agrochemicals make aquatic water acidic. So, there is a need to understand the relation between diets, agricultural production practices and environmental degradation. Agriculture system has both negative and positive impacts on the environment.

1. **Negative Effects of Agricultural Application**: The place where human, animals and plant live together is known as an environment. The environment is divided into two parts; man-made and natural environment. The environment is polluted day by day because of the rapid industry, urbanization, organic and inorganic wastes are left in the environment. Unintended usage of agricultural lands and wrong agricultural application like chemical fertilizers, also damage the environment. There are different factors through which environment is affected:

   a. **Degradation of Land:** Irrigation is the main factor for the degradation of land. The importance of irrigation is very high in agricultural field. Environmental issues are basically due to wrong irrigation. During the irrigation of water, rising of ground water, salinity, fertilizers and chemical additives residues are gone deeper into the ground. Trace elements are mixed with the water sources due to which soil erosion, water make disease harms the living organism. It can be said that land use and amount of soil erosion are affected by the agricultural policies.

   b. **Biodiversity:** A wide variety of agro-climatic condition is found in India that works as a shelter for animals and plants. But now, number of plant and animal species are endangered; some species have been extinct due to the fact of more and more commercialization of agricultural industry.

   c. **Pesticides Usage:** Pesticides are used to kill or control the harmful pests like insect, microorganism etc. they are mixed with the soil during the cultivation due to which they absorbed by the water, food and environment and harm human and animals. It also contaminates the surface water. According to World Health Organization (WHO)'s classification very dangerous pesticides are

33, quite dangerous are only 48, and moderately dangerous are 118 pesticides while 239 pesticides are less dangerous. Developed countries use the pesticides at the rate of 75%.

d. **Disposal of industrial and Agriculture Wastes:** The increment in the harmful gases such as carbon dioxide and carbon monoxide is due to the burning of By-products such as paddy straw, and rice husk. These gases produce the respiratory problems for the animals and human beings.

Industries and domestic uses create the many products such as affluent water, smoke and un-degradable solid waste which are responsible for the toxicity in plant, aquatic life and animals. It also unbalanced the soil nutrients.

e. **Chemical Fertilizer Usage**: The excessive use or wrong use of chemical fertilizers can cause to the environmental pollution such as soil washing, contamination to ground water, drinking water, stream and sea are because of the high amount of nitrogen fertilizers. So, many countries make a limit to the usage of the fertilizers. Excess of micronutrient elements in soil are harmless to the domestic plants. Hence, they have more importance than nitrogen and phosphorous fertilizers.

2. **Positive Effect of Agricultural Application:** Various positive environmental effects are seen because of the agricultural applications as in the fertilization field, photosynthesis consists oxygen, increased in the atmosphere. 12 ton oxygen in per 1 ha area constitute by the cereal production. Agriculture area produces the more oxygen in comparison of forests and empty areas. Another is food that become more affordable to the consumer as the costs of production is less.

Review of Literature

Önder, Ceyhan and Kahraman (2011) analyzed that different types of chemicals are used to produce a high quality food but this chemicals also affects the non-target organisms that result to ecological imbalance. A new agriculture technique ‘sustainable agriculture’ is an environmental friendly as this is good agriculture practice, organic agriculture and precision agriculture.

Parris (2011) studied the impact of agriculture on water pollution In OECD (Organization for Economic Co-operation and Development) countries and gave a conclusion that agriculture actives pollute the surface water, groundwater, marine water and drinking water that harms the ecosystem. They give a suggestion that sustainable management of water quality in agriculture can reduce the water pollution.

Vats (2012), in this paper, he studied about the effect of burn crop on environment and concluded that a large amount of smoke in short duration is produced by agriculture burning. Permission is required to burn the agriculture that can reduce the impacts. By taking permission, type and amount of agriculture materials can be restricted.

Adomako and Ampadu (2015) studied that some agriculture activities effects such as deforestation, land clearing, slash burn agriculture, irrigation etc. can give an adverse effects on the target ‘environment’. Hence, for reversing the environmental degradation trend and enhance the conservation of the basic resources of the environment, the respective roles should be played by the stakeholder. The positive impact on agriculture-environment-health synergies is seen because of the sustainable agricultural technologies.

Ali (2016) proposed that different types of alternative inputs should be used by farmers instead of those input that give adverse effect on environment and damage the biological diversity. Various methods such as polycultures in term of fallow rotation, use of residues, bio- manuring, alley cropping, contour planning should be applied to promote sustainable agriculture.

Chatterjee, Lamba and Zaveri (2017) gave a conclusion on their research that the ground water level is decreasing due to the high cultivation of wheat. The reason behind the decline in the ground water level is Subsidy Induce Shift from pulse cultivation to wheat cultivation.

Rohila *et al.* (2017) studied the ‘Impact of Agricultural Practices on Environment’ and concluded that for improving the agriculture infrastructure, strengthening research, new policies are needed. By new laws and regulation, new technologies and their enhancement would be possible in the field of agriculture which are in the favor of environment.

According to Almaraz *et al.* (2018), oxides of nitrogen is mostly produce by agriculture (major source). These oxides emission affects the quality of air and human health. The knowledge of the sources, and their distribution and then the impact of biologically produced oxides of nitrogen should be improved which will enhance the ability to mitigate emissions in the future.

Conclusion

Environment and agriculture are correlated to each other as both are affected by the activities of each other. In this manner, agriculture has some positive as well as some negative effects on the environment. Due to the negative effect caused by chemical fertilizers, use of pesticides and others, the environment and ecosystem are being disturbed in a large quantity by harming the health of organisms. So, there is a need to reduce these effects by emerging new technologies in the field of agriculture. After reviewing the conclusions of many researcher, this review paper concludes that the sustainable agriculture system can help in reducing the impacts of agriculture on the environment by using the favorable farming techniques that protects the environment, and organism's health.

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Precipitation, Fertilization, and Crop Rotation Effects on Organic Carbon Changes

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Abstract:

It is well known the effect of fertilizer applications in Haplic Luvisols after crop production, but long term changes in precipitation and soil organic carbon are not well documented. The present study aimed to determine the effect of precipitation and fertilization (NPKCaMg) on the changes in soil organic carbon (SOC) in a long-term field experiment set up in Nyírlugos (Nyírség region, Hungary: N: 47º 41' 60'' and E: 22º 2' 80'') on a Haplic Luvisol with popular rotation crops. Over the 40 year period, from 1962 to 2002, SOC pool values ranged between 2.32 and 3.36 mg kg-1. On the untreated control plots the values remained nearly constant (3.31 mg kg-1: ±0.29 mg kg-1 and 0.52 mg kg-1). In the 1st 20-year period, (1963–1982) there was a significant (P<0.001) decrease (16%) on all experimental plots, which may be due to the winter half year (WHY) precipitation (228 mm), summer half year (SHY) precipitation (288 mm), the NPKCaMg fertilizer application rate (64 kg ha-1), and the potato–rye–wheat–lupin–sunflower crop sequence. In the 2nd 20-year period (1983–2002) SOC pool values varied betweem 3.13 and 4.47 mg kg-1. The 16.9% significant (P<0.001) increase 16.9% could be attributed to the lower WHY (204 mm) precipitation, higher SHY (320 mm) precipitation, higher NPKCaMg fertilizer rate (213 kg ha-1), and the sunflower–grass–barley–tobacco–wheat–triticale cropping system. NPKCaMg fertilization resulted in a significant (P<0.001) decline (16.6%) in SOC in comparison to the control plots in the 1st 20-year interval, while in the 2nd 20-year period a significant (P<0.001) rise (up to 31.9%) was registered. During the 40 experimental years the seasonal correlations (R^2) among SOC (mg•kg-1), WHY and SHY precipitation (mm) ranged from 0.3343 to 0.9078 (on the P<0.001 significance level). The correlations (R^2) on the influence of NPKCaMg fertilization on SOC (mg•kg-1) and precipitation (mm) were significant (P<0.001): the means for WHY, SHY and over the 40 years were 0.4691, 0.6171 and 0.6582, respectively. Organic carbon reserves (mg kg-1) in soils decreased linearly as precipitation increased (from 3.22 to 7.27 mm yr-1). In case this trend – increasing precipitation caused by climate change reduces SOC in arable soils – will continue, and is aggravated by warming temperatures and a more altering climate (as predicted by climate change forecasts), the livelihoods of many Hungarian and European farmers may be substantially altered. Thus, farmers must take into consideration the climate (WHY and SHY precipitation), fertilization (NPKCaMg), and cropping (tuber–seed–tobacco–protein–oil–forage) changeability to optimize their SOC pool, soil carbon sequestration, soil sustainability and crop management in the nearest future.

Keywords: *Organic Carbon, Precipitation, Fertilization, Crop Rotation*

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Introduction

Organic carbon in arable soils (SOC) has a favourable effect on soil fertility, soil tilth, crop production (Burke *et al.* 1989; Jolánkai 2005), and overall soil sustainability, as soil biological activity, biodiversity and soil biological productivity (Houghton *et al.* 1983; Lal 1995; Lal *et al.* 1995; Lal *et al.* 1998; Kirschbaum *et al.* 2001). SOC regulates, partitions soil water and solute transports, and filters, buffers, degrades, immobilizes, detoxifies organic and inorganic materials, including industrial and municipal by-products and atmospheric deposition (Patron *et al.* 1987; Burke *et al.* 1989; Bajtes and Sombroek 1997; Lal 2002; Várallyay 1992, 1994, 2005). SOC stores and cycles nutrients (Voss *et al.* 1970; Walter 1973; Kádár 1992; Kádár and Szemes 1994; Várallay 1994; Horst 1995) and other elements in the biosphere. With a renewed interest in climate change (CC), soil quality and long-term sustainability interrelations, research on soil organic carbon (SOC) status has taken on new significance, nowadays (Várallyay 2005). This can be explained by the fact that SOC correlates quite well with climate (precipitation) and a number of important soil physical, chemical and microbiological changes as a consequence of fertilization (Adams *et al.* 1995; Marschner 1995; David *et al.* 1998; Németh *et al.* 1998; Barrow *et al.* 2000; Bryant *et al.* 2000; Kirschbaum *et al.* 2001; Rosenzweig and Iglesias 2003; Várallyay 2005; Lásztity 2006). The optimisation of agricultural management for SOC accumulation benefits the sequestration of atmospheric CO_2, thereby partially mitigates the current increase in atmospheric CO_2 (Houghton *et al.* 1983; Schlesinger and Andrews 2000; Lal 2001, 2002). In addition to the environmental benefits of soil carbon sequestration (SCS), consideration has also been given to the implementation of a carbon (C) credit trading system, which may provide economic incentives for C sequestration initiatives (Parton *et al.* 1987; Smith *et al.* 1997; Metting *et al.* 2001; Post *et al.* 2001).

Recently, there is a concern that increased precipitation caused by climate change (CC) may reduce SOC in arable soils (Le Houérou 1995; Graef and Haigis 2001; Lal 2002; Wang *et al.* 2005; Márton 2005, 2007), because of the increased rate of SOC decomposition, and SOC leaching from the upper soil layer to the lower (Trierweiler and Lindsay 1969; Várallyay 2005; Russel and Jennifer 1991). Furthermore, fertilizer input limits (e.g., nitrogen, phosphorus, potassium, etc.) for crops have been introduced in Europe to reduce pollution originating from agriculture (Von Blottnitz 2006). In some countries (Germany, Portugal and Spain), where fertilizer limits are applied, crop yields and residue returns are expected to decline, and hence in agricultural systems there may be a reduction in the potential SOC equilibrum (Kádár 1992; Ardö and Olsson 2003; Von Blottnitz 2006). Long-term experiments are ideal for evaluating the complex influences of climate change (CC) (as precipitation) and agricultural practices (as crop fertilization) on changes in soil organic carbon (SOC). As at the moment, little is known about the net-interrelations of the quantity and distribution of precipitation, and NPKCaMg fertilization on altering SOC in soil, the present study aimed to investigate this problem in a long-term field experiment in Hungary.

Materials and Methods

The interrelations among the quantity and distribution of precipitation, mineral fertilization (N, P_2O_5, K_2O, CaO, MgO) and the changes in SOC were studied in a long-term field experiment set up at the Experimental Station of the Research Institute for Soil Science and Agricultural Chemistry of the Hungarian Academy of Sciences in Nyírlugos (Hungary) in 1962 (Láng, 1973) on a Haplic Luvisol (sandy, acidic lessivated brown forest soil) with different indicator crops [rye (*Secale cereale* L.), potato (*Solanum tuberosum* L.), winter wheat (*Triticum aestivum* L.), lupin (*Lupinus albus* L.), sunflower (*Helianthus annuus* L.), grass, barley (*Hordeum vulgare* L.), tobacco (*Nicotiana tabacum* L.), triticale (*X Triticosecale* W.)] for a 40-year period (1962–2002).

The experimental station is located in the Debrecen and Nyíregyháza region, found in the East Northern–Eastern part of the country. The area – 160 m above sea level – is a typical lowland field with very poor mineral resources in the soil (Marosi and Szilárd 1967). There are no major differences in elevation within the region, but the climate is rather variable. The local climate is somewhat drier in the summer and a bit warmer in the winter than that of the surrounding Hungarian Great Plain. The total number of sunny hours is 1900–2000 per year. The min/max temperatures are about -25 ºC and +35 ºC. The annual mean temperature is 10–12 ºC. The area is very windy (SW and NE). It is one of the driest parts of Hungary (Márton 2005) with an annual precipitation of only 520–550 mm (Kádár and Szemes 1994). The distribution of precipitation is uneven and unpredictable. The site is extremely drought sensitive. This is one of the major constraints explaining why plant production is less successful. The groundwater table level is found at a depth of 2–3 m.

The initial soil properties at the beginning of the long-term experiment (in 1962) were as follows (Láng 1973): particle-size distribution in the 0–25 cm layer: sand (> 0.05 mm) 70–85%, loam (0.05-0.002 mm) 8–20%, clay (< 0.002 mm) 3–6%; clay in colloid accumulation layers: 10–18%; saturation percentage: 25–30; pH(H_2O) 5.4; pH(KCl) 4.3; organic matter 0.5–0.8%; CEC 3–5 meq·100 g^{-1}. The main chemical characteristics of the plowed (0–25 cm) soil layer in the untreated plots in 1962, 1983, 1988, 1998 and 2002 are presented in Table 1. From 1962 to 1980 the trial included 2 (crops)×2 (plough)×16 (fertilization)×8 (replications) = 512 plots and from 1980 to 2001 32 (fertilization)×4 (replications) = 128 plots in random block design. The treatments and their combinations are shown in Table 2. The gross plot size was 10×5 = 50 m². The fertilizers were applied in the form of Ca-ammonium nitrate (N: 25%), superphosphate (P_2O_5: 18%), muriate of potash (K_2O: 40%), powdered limestone ($CaCO_3$: 96%) and dolomite (MgO: 14%).

The production technology was based on rainfall condition. Additional irrigation had not been used. The crop sequence was potato (tuber)–rye (seed)–wheat (seed)–lupin (protein)–sunflower (oil) in the 1st 20-year period (1963–1983), and sunflower (oil)–grass (forage)–barley (seed)–tobacco (tobacco)–wheat (seed)–triticale (seed) in the 2nd 20-year interval (1983–2002). The 1st and 2nd 20-year crop yield average was 3.37 and 2.47 t ha^{-1}, respectively (mean 2.9 t ha^{-1}).

Table 1. Chemical soil properties in the plowed (0–30 cm) layer of the untreated control plots of the long-term fertilization experiment on sandy, acidic lessivated brown forest soil (Nyírlugos) in 1963, 1983, 1988, 1998 and 2002

Year	pH		Hydro-lytic acidity	hy_1	Humus	Total Nitrogen	AL-soluble	
	H_2O	KCl					P_2O_5	K_2O
					%	mg kg-1		
1963	5.9	4.7	8.4	0.3	0,7	34	43	60
1983		4.16			0.35		67	57
1988		4.40			0.54		59	90
1998		3.41			0.55		65	27
2002		4.1			0,56		54	72.8

Table 2. Fertilizer treatments in the long-term fertilization experiment on sandy, acidic lessivated brown forest soil (Nyírlugos) between 1962 and 2002

From 1962 to 1980, kg ha^{-1} yr^{-1}

<table>
<tr><td colspan="3">Control</td></tr>
<tr><td>N_1 = 30
N_2 = 60
N_3 = 90</td><td colspan="2">P = 48 (P_2O_5)
K = 80 (K_2O)
Mg = 15 (MgO)</td></tr>
<tr><td colspan="3">N, P, K, Mg combinations</td></tr>
<tr><td colspan="3">Control</td></tr>
<tr><td>N_1
N_1P
N_1K
N_1PK
N_1PKMg</td><td>N_2
N_2P
N_2K
N_2PK
N_2PKMg</td><td>N_3
N_3P
N_3K
N_3PK
N_3PKMg</td></tr>
</table>

From 1980, k ha^{-1} yr^{-1}

Level	N	P_2O_5	K_2O	$CaCO_3$	$MgCO_3$
Control	0	0	0	0	0
1	50	60	60	250	140
2	100	120	120	500	280
3	150	180	180	1000	0

Precipitation was collected in a BES-01 collector (collecting precipitation on a standard 200 cm² surface) at the Meteorological Station in Napkor. The average precipitation (mm) in the 1st 20-year period for the winter half year (WHY) (October–March), the summer half year (SHY) (April–September), and the total year (YT) (October–September) was 228, 288 and 516 mm, while in the 2nd 20-year interval these values were 204, 320 and 523 mm, respectively.

Composite soil samples (consisting of 20 cores drawn from the 0–30 cm layer; Ap horizon) were collected randomly from each plot in 1963, 1973, 1983, 1988, 1998 and 2002. After thorough manual root separation the soil samples of all plots were air-dried at 40 ºC, sieved through a 2 mm mesh and ground. For measuring pH (KCl) the suspension was made 1 M L^{-1} with respect to KCl and stirred. The chemical analysis were carried out on the basis of standard procedures: pH (KCl) (MSZ 08-0206-2, Baranyai *et al.* 1987); hydrolytic acidity (HA) and exchangeable acidity (hy_1) (MSZ-080206-1-78, Baranyai *et al.* 1987); total N (Bremner and Keeney 1966); phosphorus and potassium (Egnér *et al.* 1960). Phosphorus was determined by photometry, and potassium by Atomic Emission Spectrophotometry (AES). Soil organic matter (SOM), and soil organic carbon (SOC) contents were determined by the Tyurin method (Baranyai *et al.* 1987; MSZ-080210-77 protocol).

All of the experimental data matrixes were estimated by ANOVA and MANOVA (One and Multivariate Analysis of Variance) by SPSS test (SPSS Inc., 2000). Results are shown on the averaged level of the main effects (N, P, K, Ca, Mg, NP, NK, NPK, NPKCa, NPKMg, NPKCaMg) to enable the summing up of the principal experimental results from the 40-year database.

Results and Discussion

The dynamics, seasonal changes and mechanisms of SOC in arable soils are essential in understanding and mitigating global climate change in interrelation with crop nutrition. Thus, with a renewed interest in soil quality and long-term sustainability, research on soil organic carbon (SOC) status has taken on new significance. This can be explained by the fact that SOC correlates quite well with climate (as precipitation), and the changes in a number of important soil chemical properties as a consequence of fertilization. The effects of NPKCaMg fertilization on the soil organic carbon (SOC) pool (in mg· kg^{-1} and in M ha^{-1}) between 1963 and 2002 are presented in Table 3.

In the 1st 20-year period, from 1963 to 1982 SOC yields ranged from 2.32 mg kg^{-1} (1.05 Mg ha^{-1}) to 3.48 mg kg^{-1} (1.58 Mg ha^{-1}) over all treatments. On the control plots SOC changed between 3.02 mg kg^{-1} (1.37 Mg ha^{-1}) and 3.36 mg kg^{-1} (1.52 Mg ha^{-1}), and stabilized at 3.21 mg kg^{-1} (1.45 Mg ha^{-1}). In case of untreated plots and those receiving unfavorable N, NP and NK rates, there was a 10.1%, 31.0%, 11.9% and 13.7% decline in SOC, respectively. In the NPK, NPKCa, NPKMg and NPKCaMg treated plots SOC decreased by 11.9%, 13.7%, 22.3% and 13.7% ($P<0.001$ level of significance). In comparison to the control plots there was a 5.0%, 1.3%, 2.5%, 2.5%, 7.3%, 3.7% decrease in the values in the N, NP, NK, NPKCa, NPKMg and NPKCaMg treatments and a 1.6% increase in the NPK-treated plots. In the various treatments the mean SOC mass production was as follows: control: 3.21 mg kg^{-1} (1.45 Mg·ha^{-1}), N: 3.05 mg kg^{-1} (1.38 Mg ha^{-1}), NP: 3.17 mg kg^{-1} (1.45 Mg ha^{-1}), NK: 3.13 mg kg^{-1} (1.42 Mg ha^{-1}), NPK: 3.27 mg kg^{-1} (1.48 Mg ha^{-1}), NPKCa: 3.13 mg kg^{-1} (1.42 Mg ha^{-1}), NPKMg: 2.98 mg kg^{-1} (1.35 Mg ha^{-1}), NPKCaMg: 3.09 mg kg^{-1} (1.40 Mg ha^{-1}). It can be stated that in the 1st 20-year period of the trial SOC concentration decreased from 3.36 mg kg^{-1} to 2.82 mg kg^{-1}, and SOC yield from 1.52 Mg ha^{-1} to 1.28 Mg ha^{-1}, in general. The depression in SOC may be due to the higher WHY.

Table 3. The effects of fertilization on the soil organic carbon (SOC) pool (mg kg^{-1} and Mg ha^{-1}, soil bulk density: 0.15 Mg ha^{3-1}) between 1963 and 2002

(Long-term fertilization experiment on sandy, acidic lessivated brown forest soil, Nyírlugos)

Treatment	Sampling year						Average
	1963	1973	1983	1988	1998	2002	
SOC, mg kg^{-1}							
Control	3.36	3.25	3.02	3.13	3.83	3.25	3.31
N	3.36	3.48	2.32	3.54	3.83	3.94	3.41
NP	3.36	3.19	2.96	4.18	4.35	4.06	3.68
NK	3.36	3.13	2.90	3.65	4.18	4.00	3.54
NPK	3.36	3.48	2.96	4.47	4.23	4.12	3.77
NPKCa	3.36	3.13	2.90	3.83	4.12	3.77	3.52
NPKMg	3.36	2.96	2.61	4.06	3.89	4.23	3.52
NPKCaMg	3.36	3.02	2.90	4.00	3.83	3.77	3.48
$LSD_{5\%}$	0.0	0.29	0.87	1.51	0.93	0.58	0.70
Average	3.36	3.21	2.82	3.86	4.03	3.89	3.53

SOC, Mg ha^{-1}							
Control	1.52	1.47	1.37	1.42	1.73	1.47	1.50
N	1.52	1.58	1.05	1.60	1.73	1.99	1.58
NP	1.52	1.45	1.34	1.89	1.97	1.84	1.67
NK	1.52	1.42	1.31	1.66	1.89	1.81	1.60
NPK	1.52	1.58	1.34	2.02	1.92	1.87	1.71
NPKCa	1.52	1.42	1.31	1.73	1.87	1.71	1.59
NPKMg	1.52	1.34	1.18	1.84	1.76	1.92	1.59
NPKCaMg	1.52	1.37	1.31	1.81	1.73	1.71	1.58
$LSD_{5\%}$	0.0	0.13	0.39	0.68	0.42	0.26	0.31
Average	1.52	1.45	1.28	1.75	1.83	1.79	1.60

(228 mm) precipitation, lower SHY (288 mm) precipitation, lower NPKCaMg fertilizer application rate (64 kg·ha^{-1}), and the potato–rye–wheat–lupin–sunflower crop sequence, respectively.

In the 2nd 20-year period (1983–2002) of the trial SOC sets changed from 3.13 mg kg^{-1} (1.42 Mg ha^{-1}) to 4.47 mg kg^{-1} (2.02 Mg ha^{-1}) in all treatments. In the untreated plots the SOC yields ranged between 3.13 mg kg^{-1} (1.42 Mg ha^{-1}) and 3.83 mg kg^{-1} (1.73 Mg ha^{-1}), and stabilized at 3.40 mg kg^{-1} (1.54 Mg ha^{-1}). Comparing the 1963 mean SOC pool with the 2nd 20-year period's SOC pool of the control, N, NP and NK treated plots, it can be seen that the SOC yield was expanded by 1.3%, 12.2%, 24.9% and 17.4%, respectively. In the NPK, NPKCa, NPKMg and NPKCaMg treated soils the SOC stocks significantly (P<0.001) increased by 27.2%, 16.3%, 20.8% and 15.1%. Parallelly, yields increased by 10.8%, 23.3%, 15.9%, 25.6%, 14.8%, 19.3% and 13.6% in the case of the control, N, NP, NK, NPK, NPKCa, NPKMg and NPKCaMg treatments. Results of the 2nd 20-year experimental term show that SOC concentration grew from 2.82 mg kg^{-1} to 3.89 mg kg^{-1}, and SOC yield from 1.28 Mg ha^{-1} to 1.79 Mg ha^{-1}. The increase in SOC could be attributed to the lower WHY (204 mm) precipitation, higher SHY (320 mm) precipitation, higher NPKCaMg fertilization rate (213 kg ha^{-1}), and the sunflower–grass–barley–tobacco–wheat–triticale cropping system.

Over the 40-year period, the minimum and maximum SOC mean yields were 3.31 mg kg^{-1} (1.50 Mg ha^{-1}) and 3.77 mg kg^{-1} (1.71 Mg ha^{-1}). Without mineral fertilization the SOC pool stabilized at the level of 3.31 mg kg^{-1} (1.50 Mg ha^{-1}). As compared to the untreated plots, the N, NP, NK and NPK treatments led to a significant (P<0.001) yield rise of 3.02%, 11.2%, 6.9% and 13.9%, respectively, while the NPKCa, NPKMg or NPKCaMg combinations resulted in an increase of 6.3%, 6.3% and 5.1%.

Table 4. Correlations (R^2) between precipitation (mm) of winter half years (WHY), summer half years (SHY), years total (YT), and soil organic carbon (SOC) stock (mg kg^{-1}) between 1963 and 2002

(Long-term fertilization experiment, sandy, acidic lessivated brown forest soil, Nyírlugos)

	Winter Half Year (October–March)	Summer Half Year (April–September)	Year Total (October–September)

	Precipitation, mm		
Minimum	111.5	301.7	353.0
Maximum	320.6	372.6	781.0
Average	216.1	337.2	567.0
	Soil Organic Carbon (SOC), mg kg^{-1}		
Minimum	-	-	2.32
Maximum	-	-	4.47
Average	-	-	3.40
	Precipitation and SOC Model		
Function	$Y'=-1205.5-7.7x+0.02x^2$	$Y'=1069.8+11.2x-0.02x^2$	$Y'=-4790.8-16.8x+0.02x^2$
n	160	160	160
R^2	0.7049 ($P<0.001$)	0.9204 ($P<0.001$)	0.6582 ($P<0.001$)

The correlations (R^2) between precipitation (mm) of the winter half years (WHY), summer half years (SHY), total years (TY) and soil organic carbon (SOC) stocks (mg kg^{-1}) between 1963 and 2002 are shown in Table 4. The main relationships are characterized mainly by polynominal correlations (winter-half year: $R^2 = 0.7049$ at $P<0.001$, summer-half year: $R^2 = 0.9204$ at $P<0.001$, year total: $R^2 = 0.6582$ at $P<0.001$). The total coefficients (R^2) among precipitation and SOC sink fluctuated from 0.65 to 0.92 at $P<0.001$ depending on the different precipitation (mm yr^{-1}), and the fertilization (kg ha^{-1} yr^{-1}) rates. The correlations (R^2) for the winter half years and years total were negative, while they were positive for the summer half years. SOC reserves in soils decreased linearly with increasing rainfall, from 322 to 727 mm yr^{-1}.

Summary and Conclusions

Summing up our findings, it can be stated that in the 1st 20-year period (from 1962 to 1983) of the trial SOC concentration decreased strongly (16%). The depression in SOC may be due to the higher WHY (228 mm) precipitation, lower SHY (288 mm) precipitation, lower NPKCaMg fertilization level (64 kg ha^{-1}), and the tuber–seed–seed–protein–oil crop sequence, respectively. This is particularly true ,when we are talking about Luvisols. The less than 15 cm “A” horizon and low organic matter content support eluviations processes. The eluviations of clay in organic and inorganic forms is the dominant process, where the leaching of carbonates is prerequisite before clay can translocate. When clay particles are dispersed in aqueous suspension, as effect of the seasonal precipitation, they are translocated from the “A” and “E” horizon under the influence of percolating water. The influence of organic matter as electron donor for reduction and solubilisation iron oxides causes the leaching of iron. The presence of organic acids destabilizes the soil micro-aggregates and produces dispersible leaching clays. Results of the 2nd 20-year experimental term (from 1983 to 2002) show that there was a 38% rise in SOC concentration, which can be attributed to the lower WHY (204 mm) precipitation, higher SHY (320 mm) precipitation, higher NPKCaMg fertilizer rate (213 kg ha^{-1}), and the oil–forage–seed–tobacco–seed–seed cropping system. The unpredictable moisture regime (because the variable precipitation) favors the declination of SOC, because the wetahering and translocation processes are supported by percolation water and the precipitation of translocated material by the erratic moisture regime.

Since the 1950s, there has been a significant expansion in the variability experienced by European and Hungarian farmers in term of soil organic carbon (SOC), seasonal precipitation, NPKCaMg fertilization, and cropping changeability has also increased over the same period. The dynamics, seasonal changes and mechanisms of SOC in arable soils are essential in understanding and mitigating global climate change in interrelation with crop nutrition. There is a concern that increasing precipitation as a result of climate change, and reduced fertilizer input may reduce SOC in arable soils, as stated by Le Houérou (1995), Wigley (1999), Graef and Haigis (2001), Lal (2002), Wang *et al.* (2005) and Márton (2007). If this trend continues, and is aggravated by warming temperatures and a more altering climate, as predicted by climate change forecasts, the livelihoods of many Hungarian and European farmers may be substantially altered. Thus, it should be emphasized that farmers must take into consideration the changeability of climate (WHY and SHY precipitation), fertilization (NPKCaMg), and cropping pattern (tuber–seed–tobacco–protein–oil–forage) to optimize their SOC pool, soil carbon sequestration, soil sustainability and crop management in the nearest future. Especially important fact the increased calcium content by fertilization, because it increases the exchangeable calcium content in the soil, which flocculates clay particles. The created particles are too large to be transported in suspension. The calcium-humate aggregate's komplex is not soluble and water resistent (it expands but not leaching).

The changes in the crop rotation also has a stabilizing effect on SOC. Crops like grass increase SOC in two ways. First, they contribute with additional organic matter into SOM. Second, illuviated materials are deposited (or block illuviaton) along the root channels instead on the surfaces of argillans from the deeper soil horizon.

However, the presented study demonstrated that the properly calibrated and tested long-term experiment-based models are capable of detecting SOC yield responses to climatic (at first winter half year, summer half year and year total precipitation) variations (closely corresponding with the findings of Jolánkai 2005 and Márton *et al.* 2007) in interaction with several nitrogen, phosphorus, potassium, calcium and magnesium fertilization systems for Hungary and on the European level under the changeable climate conditions.

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