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Effect of integrated nutrient management in wheat (*Triticum aestivum* L.)

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Abstract

Wheat (*Triticum aestivum* L.) is one of the most important and staple food crop of the India as well as other countries. Being rich in vitamins, minerals, protein and carbohydrates it provides a balanced nutrition to people each and every day. In India the area under wheat cultivation is 9.85 million hectares. Mostly in India north-eastern states are leading contributors of wheat production and UP is the leading state in production of wheat in India. It requires a cool and humid climate for optimum cultivation. Wheat requires ideal temperature of 10-15 degree Celsius during winters and 21-26 degree Celsius during summers and sowing is done in September-October and harvesting done in April. As farmers using synthetic fertilizers and chemicals in excessive amounts to increase production but they don't even realize the harmful effects of these chemicals on soil as well as on environment. So, concept of Integrated nutrient management was brought earlier by scientists to enhance the productivity and quality of grains but also to conserve the physical and chemical health of soil as well as environment. With the integration of Integrated nutrient management approach in wheat crop several researchers conducted experiments to determine the beneficial effects of INM and proudly they reported that due to imbalanced used of synthetic fertilizers and chemical INM approach reduce the drastic effects or hazard of these synthetic chemicals makes the environment friendly. This review paper will summarize about the effect of integrated nutrient management on crop growth, yield and nutrient uptake and various sources of integrated nutrient management which has to be supplemented individually or in combination.

Keywords: Integrated, nutrient, management, wheat, *Triticum aestivum* L.

Introduction

Wheat is known as one of the major staple food crop of India. Wheat contributes to around 35% of food basket of country. Due to such tremendous achievement in production of wheat India holds the 2nd position in wheat production worldwide with an area of 103.6 million metric tons. Wheat belongs to family Poaceae or Gramineae. It is used for bakery products like bread, flour, pasta, biscuit, cake, porridge, halwa, sweet meal and most commonly used for Chapatti making. Wheat is having more protein than other cereals. The main protein of wheat is known as "gluten" which is very important source for bakers. That's why it is called "king of cereals". It is the second most important crop after rice. Besides, staple food for human being wheat straw is the major source for animal feed. The challenging factor is to increase the wheat grain yield while maintaining its protein content. The era of green revolution made a drastic increment in the area and production of wheat which makes the country self-sufficient and at present India is having surplus amount of food grains to meet the requirement of ever-increasing population. The area of wheat in India is around 30 million hectares (14% of global area), with production of around 69.5 million tonnes and productivity is 2607 kg/ha. Uttar Pradesh is the leading state in wheat production with a share of 31.35%.

Around 55% of world's population directly or indirectly depends on wheat for about 20% of their Calories intake. Due to the adverse climatic conditions in India and depends on the demands of populations the three basic type of wheat (bread wheat, durum and dicoccum) are mostly cultivated. 95% area is under bread wheat cultivation, 4% for durum and nearly 1% area is under dicoccum wheat. Nitrogen, phosphorus, potassium are the major nutrients, Sulphur, calcium, magnesium are secondary nutrients and zinc, boron are micronutrients which is having a major role is yield and quality wheat production.

To meet the demands of the population farmers using inorganic synthetic fertilizers and chemicals day by day at an excessive rate. Several health problems arise in humans as well as in animals. The continuous use of such inorganic sources of nutrients the health and fertility of soil was also disturbed and at some places there is occurrence of barren soil noted.

Thus, scientists brought the concept of Integrated nutrient management to provide adequate amount of nutrients to the crop individually or in combination with inorganic sources but the aim is to conserve the soil and environment to maximum extent. Integrated nutrient management refers to the combination of organic as well as inorganic sources or biological sources of nutrients from all possible sources in a judicious way to obtain economically feasible, environment friendly and ecologically sound farming system (Jat *et al.* 2015) [18]. Due to Spiraling prices of chemicals, the use of organic sources of plant nutrients as renewable sources is assuming importance. Continuous use of organic sources of nutrients for several years stabilizes the soil structure, enhance cation exchange capacity, improves soil water holding capacity, increase fertility and productivity, increase organic matter content, providing substrate for microorganisms and increase the nutrients in soil nutrient pool (Bohme and Bohme 2006). Nutrient use efficiency and water use efficiency is also increased in INM approach. The production of wheat crop, grain yield and straw yield also enhanced while adopting INM technology because it is environment friendly approach. To achieve the main aim of increased production but also conserving the soil health and environment the use of chemicals and organic sources together gives more results. Some other terminologies such as IPNS (integrated plant nutrient supply), INSAM (integrated nutrient supply and management) are also synonyms of INM. Research shows that application of Green Manure crop, Poultry Manure, Farm yard manure, Press- mud and sewage sludge in combination gives maximum productive tillers, no. of grains per spike and 1000 grain weight as a result this combination gave highest wheat grain yield.

Keywords- INM, Synthetic fertilizers, Organic sources, Inorganic sources, Farm yard manure

Components of Integrated Nutrient Management

1. Fertilizers
2. Manures
3. Compost
4. Green manures
5. Crop residue
6. Biofertilizers

- **Fertilizers:** Fertilizer is defined as any material which is of natural or synthetic origin when applied to soil gives one or more plant nutrients. Based on their composition the fertilizers are of three types: straight fertilizer, complex fertilizer, mixed fertilizer. Straight fertilizer is that which supplies only one primary plant nutrient namely nitrogen, phosphorus or potassium. Example urea, single super phosphate, potassium sulphate, double super phosphate etc. Complex fertilizers are those which are able to provide two or three primary plant nutrients. Example DAP, nitro-phosphates, ammonium-phosphate. Mixed fertilizers are kind of fertilizers which are made by mechanically mixing straight fertilizers.
- **Manures:** Organic manures is regarded as the product obtained after the biological decomposition of organic matter. It is of two types: bulky organic manures (FYM, compost, green manure), concentrated organic manure (oilseed cakes). Major sources from where we get organic manures are cattle shed waste, crop residues, slaughter house waste, poultry litter, green manure crops, human

waste. Nutrient content of various manures given below:

Table 1: Show bulky organic manure Nitrogen Phosphorus, Potassium

Bulky organic manure	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Farm yard manure	0.5	0.3	0.5
Compost	0.5	0.15	0.5
Sheep and goat manure	3.0	1.0	2.0
Poultry manure	1.5	1.2	0.5
Sewage and sludge	2.5	0.6	0.5
Press mud	0.35	2.0	-

- **Compost:** This is the organic manure produced from decomposition of farm or town waste but cattle excreta is not used, known as compost. The major material used for making compost is farm waste, town waste, rural waste, urban waste, super digested waste. The compost has been prepared by collecting the waste material and making a heap of that material.
- **Vermicompost:** This is the kind of manure which has been prepared by using the earthworm as a decomposing agent. The earthworm feeds on the waste material and the end product obtained is known as vermicompost. Earthworms in coordination with soil microbes plays a role in degrading organic material and maintains the nutrient pool of soil. Earthworm physically known as aerator, crusher, mixer and chemically degrader and pest controller.
- **Green manures:** Undecomposed green matter used as manures is known as green manure and crops grown for this purpose is known as green manure crops. Mostly the green manure crops belong to leguminosae family. The major green manure crops are *Crotolaria juncea*, *sesbania aculeata*, *sesbania rostrata*, *vigna unguiculata*. Green manuring is of two types:
 1. Green manuring in-situ= It means that the field where green manure crop is grown has to be incorporated in same field itself.
 2. Green leaf manuring= It refers to the collection of green leaves, twigs, branches from somewhere else and Incorporated at some another place.
- **Crop residues:** The leftover material after the harvesting of crop is known as crop residues. It is also a source of several primary, secondary and micronutrients. When the leftover straw or residues incorporated in the field itself it helps to increase the soil fertility, productivity, increase nutrient status of soil and also enhances the water holding capacity of soil.
- **Biofertilizers:** These are the kind of fertilizers which is prepared from living cells or latent cells of strains of microorganisms. They enhance the ability of plants to absorb more nutrients from soil and also increase the immunity of plants to deal with diseases and pests. They liberate the growth promoting products and helps to maintain soil fertility. Nitrogen fixing biofertilizers are Blue green algae, Azolla, Azotobacter, Azospirillum.

Effect of Integrated Nutrient Management on Nutrient uptake

The success of any crop and the yield of that crop depends upon the optimum nutrient uptake by the crop. If the nutrients

are available at adequate quantities but the crop is unable to absorb that nutrient then there is no role of presence of that nutrients. The nutrient absorbing ability of any crop is increased by adopting the Integrated Nutrient Management approach because it improves the soil properties as well as environment health and plant withstand. Several researches had been conducted and results significantly reveals that INM approach is most promising approach in enhancing growth, yield and productivity of crop as well as increasing the soil fertility. It has been found that application of Phosphorus solubilizing bacteria (PSB) and vermicompost together increased the nutrient uptake more efficiently as when applied individually (Datt *et al.* 2003). The uptake of nutrients is more when sulphur, boron, farm yard manure and 75% NPK applied in combination (Reena *et al.* 2017). As nutrient uptake is calculated by the product of concentration of nutrients and yield of crop. Highest nutrient uptake is seen with the application of Organic manures. This is due to solubilization of nutrients from different places and complex organic molecules produced by decomposition of organic matter and accumulation in different parts of plants. Similarly, the farm yard manure decomposition leads to solubilization of organic molecules which enhances the native phosphorus release, micro-organisms growth and increases root growth of plant which causes enhancement in phosphorus uptake by plant. A phosphorus solubilizing bacteria and farm yard manure when applied un combination with inorganic phosphorus, it enables to makes soil phosphorus more readily available to plants. When organic manures start decomposing they secrets organic acid which consists of potassium, then they makes potassium more available to plants. As when different levels of nutrients applied to wheat the uptake ability of sulphur decreased. When the seeds of wheat was diluted with azotobacter or PSB before sowing enables to absorb more sulphur as compared to untreated seeds. We can say very easily that the nutrient uptake ability of crop plants has increased by many folds with the application of organic sources of nutrients in Integrated Nutrient Management system. Although, it has been considered that combination of organic and inorganic fertilizers supplies the adequate quantities of nutrients to the current crop. As in INM approach there is slow release of nutrients it can also be beneficial for subsequent crops to meet the nutrient requirements.

Effect of Integrated Nutrient Management on growth parameters

There is a significant result revealed in increase of growth parameters of wheat crop when supplemented with organic and inorganic sources of fertilizers. 90 DAS there is increase in maximum number of plant height, number of tillers when wheat was treated with N, P, K, Farm yard manure and zinc (Sangam *et al.* 2017). When crop was applied with farm yard manure and other organic sources higher production of photosynthates achieved and more availability of nutrients is there which leads to increase in productive tillers per plant and higher plant yield. At harvest when 75% NPK, vermicompost 2.5 ton/hac and azotobacter was applied higher the plant height and more yield is obtained (Kaur *et al.* 2018). By the application of farm yard manure and crop residues in combination more grain yield, grain per year, thousand grain weight increased by many folds (Kler *et al.* 2017). Likewise, combination of organic sources of fertilizers gives more

positive results as when applied individually. When farm yard manure, vermicompost, crop residues applied it will increase the microbial biomass in soil and enhance their activity which leads to increase in plant growth and growth promoting substances. To get the bumper wheat crop the key element for this is Nitrogen. Studies showed that application of more nitrogen leads to conversion of carbohydrates into protein, which leads to formation of protoplasm (Brady and Weil, 2002). Nitrogen is a necessary key component because it involves in all plant growth processes and functions. The yield of wheat was achieved maximum when NPK was applied in combination with azolla or NPK with cowdung (Bharati *et al.* 2017). It is quite normal when levels of Nitrogen application increased in wheat this leads to increase in yield of crop due to release of yield enhancing attributes. The most appropriate source of Nitrogen is thereby from organic sources. Improved crop growing practices having much more influence on growth and yield of crop. Integrated nutrient management is having an important role in imparting the nutrient as per requirement of crop and make them easily available to plants as the uptake by plant is more easy.

Effect of Integrated Nutrient Management on Soil productivity

Integrated nutrient management is basically the application of Organic as well as inorganic fertilizers in combination with organic manure in conjugation and input through biological processes. As we know when organic sources applied to soil it will leads to increase in organic matter content of soil so makes the soil more productive and healthier. It increases the nutrient suppling ability of soils, water holding capacity of soil, improves soil structure, improves bulk density, porosity, cation exchange capacity, organic carbon content, NPK status and soil water storage. Due to slow releasing nature of Organic fertilizers it will also imparts nutrients to the succeeding crop and to the current crop. The Integrated Nutrient Management involves the combined application of farm yard manure, compost, vermicompost, biofertilizers, chemical fertilizers which leads to increase in infiltration rate of soil, moisture storage capacity, aggregate stability also. The use of Integrated nutrient management approach year after year makes the soil more productive as it increases the microbial flora of soil and also reduce the adverse effects of the chemicals which has been used earlier in excessive amounts. The more we bring the organic sources for crop cultivation the more we get the profits as well as returns because the organic fertilizers, manures are cost effective also. The soils which remain barren from several years due to cultivation of green manures or application of farm yard manure, compost, vermicompost having ability to make the soils again productive and fertile. Some soils are universally deficient in important macro and micro nutrients. The combined use of organic fertilizers and chemical fertilizers also increase the nutrient content which is deficient in soils. Use of farm yard manure, inorganic fertilizer and biofertilizers are becoming environmentally sound approaches for more yield and sustainable crop production. The success of INM relies on 4R's: Right form, Right combination, Right dose and Right time.

Role of Integrated Nutrient Management in Organic carbon status and Disease controlling

When Integrated Nutrient Management practices are followed

or different organic amendments are used for crop production it leads to increase in organic matter of soil which plays a very important role in crop production. Soil organic matter content increase means the availability of nutrients or fertility of soil is also increased. The carbon content is found to be higher when NPK+ Compost, NPK+ Azolla compost, NPK+ Green manure has been applied (Bharati *et al.* 2016). The essential component of integrated nutrient management is increased soil fertility and good crop husbandry. As when nutrients present in adequate amounts then crop plants are able to eradicate the harmful effects of insect-pests and diseases. Organic amendments make plants more resistant to diseases which are prevalent in particular areas because the metabolic activities of plants lead to increase. The application of adequate amount of Nitrogen from organic sources results in decreasing the incidence of stripe rust disease. The application of Zinc reduces the severity of Khaira disease in rice. Application of optimum dose of potassium decrease the leaf rust and leaf blight disease. Applying copper reduces the incident of ergot disease in bajra. Application of boron reduces the severity of Powdery mildew disease. All these nutrients should be supplied in adequate quantities thorough organic + inorganic sources.

Advantages of Integrated Nutrient Management

- Sustain and maintain the physical and chemical properties of soil.
- INM system improves the soil nutrient pool and increase the solubility and availability of fertilizers which has been used.
- Balanced nutrition to crop thus enhancing growth and yield attributes.
- Decreases the nutrient losses and soil, water degradation by enhancing organic matter and organic carbon content.
- Being cost effective the cost incurred in crop production by farmer also reduced
- It improves the resistance of crops against biotic and abiotic stresses of various kinds.
- It increases the quality of food products, ensure healthy food and meets the nutritional demand of population.
- Encourages well developed plant root system and allows to absorb nutrients and water from larger volume of soil thus ensures better plant stand.
- Creating awareness among farmers regarding climate change which having greater ecological impact in order to produce safer food than attaining higher profits.

Conclusion

This review paper tells us about the effect and role of Integrated Nutrient Management in Wheat (*Triticum aestivum* L.) through various experiments conducted in Indian sub-continent. Achieving higher yields per unit area and more crop per drop to meet the demand of increasing population are the main challenges for specialists. So, the excessive use of chemical fertilizers and lower response of crop to these recommended doses are the main constraints in quality, yield production. Integrated Nutrient Management is an cost-effective and ecologically sound approach to gain more yields but also maintaining environmental and soil health too. The overall results indicates that the INM treatment over Inorganic alone, Organic alone and controlled treatments gives positive results on grain yield of wheat. The Net returns obtained through Integrated Nutrient Management were increased by

127% in wheat and 121% in rice. Management of soil fertility is very essential step for optimal wheat production to meet the demand of such population. In order to preserve environment and soil or further increase in wheat production globally must be with proper management of fertilization. Integrated use of organic and chemical fertilizers improves crop yield, soil pH, Organic carbon, Yield and quality components and available NPK content in soil. To reduce effect of chemical fertilizer it is necessary to recycle organic wastes such as compost, green manure, farm yard manure, poultry manure etc.

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