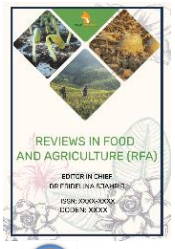
ZIBELINE INTERNATIONAL PUBLISHING

ISSN: 2735-0312 (Online)
CODEN: RFAEAW

Reviews In Food And Agriculture (RFNA)

DOI: http://doi.org/10.26480/rfna.01.2020.30.35



REVIEW ARTICLE

A REVIEW ON INTEGRATED NUTRIENT MANAGEMENT ON WHEAT (*TRITICUM AESTIVUM L.*)

Swastika Sharma, Nisha Kandel, Pooja Chaudhary, Priyanka Rai

Institute of Agriculture and Animal Science, Pakhlihawa, Nepal.
****Corresponding Author Email: sharmaswastika664@gmail.com***

ARTICLE DETAILS

Article History:

Received 05 September 2020
Accepted 07 October 2020
Available online 23 October 2020

ABSTRACT

Wheat is one of the staple foods of the Nepalese diet which is grown in the winter season in most of the areas of our country. This short review article analyses the previous works and studies to investigate the role of various micro and macronutrients in wheat crops. Long-time research which was conducted in several locations has shown that in addition to natural resource deterioration and biotic-abiotic stress, deficiency of multiple nutrients is also an essential factor that influences yield reduction, productivity declination, and shrinkage in net profit. Therefore, Integrated Nutrient Management in terms of using chemical fertilizers in conjugation with organic manures as well as biological inputs is needed to improve the nutrient status of the soil. INM increases the nutrient uptake rate of the plant and influences the nutrient supply in the soil system. As soil is the primary source of nutrients, any degradation in the quality of soil can create a reduction in crop yield. Hence the adoption of suitable measures is highly necessary for sustaining the environment and enhancing productivity.

KEYWORDS

Wheat, Organic fertilizer, Inorganic fertilizer.

1. INTRODUCTION

Wheat *(*Triticum aestivum *L.)* is a major agronomic crop belonging to the family Poaceae which is well known for flour, pasta, pastry, semolina, crumpets, flake, chapatti, cookies, etc. It is a chief staple food which supplies approximately 35% of total food as consumed by the global population (Mohammadi Joo et al., 2015). The total production of wheat estimated in 2019-2020 was 765.41million metric tons (Shahbandeh et al., 2020). In the year 2016/2017, the wheat production in Nepal was 187919 metric tons (Statistical information on Nepalese agriculture) Production of wheat needs to be increased to meet the demand of the increasing population. The industrial revolution followed by the green revolution increased the use of synthetic fertilizers to increase the yield per unit area of agricultural production (Chandini et al., 2019).

The world consumption of potassium(K), phosphorus(p), and nitrogen(N) in 1988/1999 was 18, 14, and 81 Tg/yr, respectively (IFA,1999). Due to the continuous population growth demand for plant nutrients is expected to increase continuously (Keeney et al., 1990). Health problems and unrecoverable environmental pollution are seen due to the intensive use of inorganic fertilizer in agriculture (Chandini et al., 2019). The concept of Integrated Nutrient Management should be followed to prevent severe health hazards and to protect the environment. Integrated nutrient management refers to the combination of all possible sources of nutrients like organic sources inorganic sources and biological sources or components in a judicious way for obtaining an ecologically sound environment and economically optimal farming system (Jat et al., 2015). Integrated use of organic and inorganic nutrient sources helps in gaining sustainable yield and improved soil quality for enhanced production (Kumara et al., 2013) (Brar et al.,2015). Continuous application of organic manures year after year improves physical and chemical conditions by providing a favorable soil structure, enhance soil cation exchange capacity, increase the quantity and availability of plant nutrients, increase humus content, and providing the substrate for microbial activities (Bohme and Bohme, 2006). By using organic manure alone lower yield in wheat was observed which shows organic manure alone cannot satisfy the nutrients demands of wheat (Sheoran et al., 2017). Increased productivity of the pearl-millet wheat cropping system was seen by the combined application of FYM and recommended dose of fertilizers compared to the application of a recommended dose of fertilizers alone (Narwal et al., 2005; Brar et al., 2015).

The accessibility of the crop to the soil determines the fertilizer requirement of wheat (Krentos and Orphanos, 1979). Nutrient use efficiency and water use efficiency are found higher in INM (Jat et al., 2015). Production of wheat grain and straw increased by 9 percent with the treatment of INM with municipal solid waste manure in the cotton wheat system (Akram et al., 2007). For sustainable crop production the integrated use of chemical and organic fertilizer has been highly beneficial (Yasin et al., 2015). The main objective of this study was to know about the effect of Integrated Nutrient Management on yield and yield attributing character, total organic carbon, and total organic matter content, nutrient

Quick Response Code	Access this article online	
	Website: www.rfna.com.my	**DOI:** 10.26480/rfna.01.2020.30.35

Cite The Article: Swastika Sharma, Nisha Kandel, Pooja Chaudhary, Priyanka Rai (2020). A Review On Integrated Nutrient Management On Wheat (*Triticum Aestivum* L.). *Reviews In Food And Agriculture, 1(1): 30-35*.

uptake, soil productivity, growth parameter, and the role of INM in reducing environmental impact and controlling the disease.

2. Effect of Integrated Nutrient Management on Nutrient Uptake

The uptake of nutrients is found to be increased by the application of PSB and vermicompost with fertilizers than using the fertilizers alone or vermicompost alone (Datt et al., 2003). The uptake of NPK was maximum from 75 % RDF+ Vermicompost @ 1tn/ha + PSB. (Datt et al., 2003). Total nutrient uptake was increased by the combined use of boron, sulfur, and farmyard manure with 75 % NPK (N-150, P-60, K-60) (Reena et al., 2017; Rathar and Sharma, 2010). Nutrients uptake is the product of the concentration of nutrients and yield (Natan and Anurag., 2011). High nutrient uptake is seen with organic manures, this might be due to the solubilization of native nutrients and complex intermediate organic molecules that are produced during organic matter decomposition, their mobilization and accumulation in a different part of plant crops (Mitra et al., 2010). Likewise, the decomposition of farmyard manure helps in the solubilization of organic acids which helps to increase the release of native phosphorous, microbial growth stimulation, and favor growth of root system which leads to increase phosphorous uptake by the plant.

Application of FYM and PSB in conjugation with inorganic phosphorous helps to make soil phosphorous more available to plant a crop. The available phosphorous increases by adding phosphorous through manure over of removal of the plant (Singh et al., 2008). The increased availability of potassium is related to the release of potassium from potassium bearing mineral from organic acids produced by organic manure decomposition (Swarkar et al., 2013). The uptake of sulfur by wheat decreased with different levels of nutrient application. However, the availability of sulfur further decreased when the nutrient application rate was reduced to 50 % when the seed was inoculated with azotobactor and or PSB, there was a significant increase in an update of Sulphur (Sharma et al., 2013). The nutrient use efficiency can be improved by the enriching the organic resources with zinc (Meena et al., 2006).

3. Effect of INM on Growth Parameters

The significant role of inorganic and organic sources was seen in growth parameters (Joy et al., 2018). At 90 days after showing, the maximum number of plant height (86.43cm) and many tillers per plant (7.33) was observed when wheat was treated with nitrogen-120, phosphorous-60, potassium-40, farmyard manure-10, and zinc 25 kg /ha (Sangam et al.,2017). By the treatment of 100 % NPK and FYM, 10 ton/ha growth parameter was significantly affected (Arvind et al., 2006; Singh et al., 2008). Due to higher production of photosynthates and nutrient availability, higher yield and biomass production is seen which is reflected by higher effective tillers per plant and higher yield per plant (Kanchroo and Razdan., 2006; Ahmad et a., 2007; Khan and Singh., 2011; Singh et al., 2018; Kaur et al., 2018). At 30 days after sowing, plant height is maximum by the application of 100% recommended dose of fertilizer and at harvest stage by the application of 75% NPK, vermicompost @ 2.5ton/hec, and azotobactor (Kaur et al, 2018). Using nitrogen can result in more productive tillers and 1000 grain weight which increases the yield (Singh et al., 2011). By the application of ten-ton FYM per hectare with crop residues, the recommended dose of fertilizer and 80 % of mineral fertilizer dose; grain yield, grain per year, and thousand-grain weight was significantly high (Kler et al., 2007). For improvement in growth and yield attribute of wheat, the combination of FYM and rice residue was better than FYM alone (Davari et al., 2012). The organic manures in addition to nutrients contain microbial load and growth-promoting substances which helps in improving the metabolic activity and plant growth. Biofertilizers are minute organisms that are beneficial to plant growth.

4. Effect of Integrated Nutrient Management on Yield and Yield Attributing Characters

Nitrogen is the principal raw material that is required for plant growth and yield increment of the crop. The study revealed that the application of organic matter with chemical fertilizers increases the yield of biomass and grain yield of crops (Khan et al., 2007). The application of a proper amount of nitrogen is considered a key element to obtain several bumper crops of wheat. A study stated supply of high N favors the conversion of carbohydrates into proteins, which in turn promotes the formation of protoplasm (Brady and Weil., 2002). Since it is a necessary component of all proteins, N is involved in all plant growth processes. The Yield of wheat was increase maximum with NPK+ Azolla compost (27.015%) followed by NPK+ cow dung (24.42%) (Bharati et al., 2017). While comparing different treatments, the treatment where a recommended dose of fertilizer (RDF) applied in combination with FYM, biofertilizers, and zinc produced the maximum grain yield of 50.39 and 52.73 Quintal per hectare during 2007-2008and 2008_ 2009 respectively and 49.28 Quintal /hector yield was obtained by the application of RDF +FYM+BF in the year 2007-08 and 51.22q/ha in the year 2008 _2009.

It is quite normal that increasing levels of applied N increased grain yield of wheat (Jena et al., 1998). Increasing N levels increased grain yield by increasing the magnitude of yield attributes. The increase in grain yield was due to an increase in the yield attribute as the level of nitrogen was increased. A study stated that the increase in yield attributing characters, however, was the result of better nutrition or N uptake, leading to greater dry matter production and its translocation to the sink (Dalal and Dixit., 1987). Increased productivity of wheat can be achieved by adopting improved agronomic practices and varieties (Sadat et al., 2008). Increasing nitrogen rates had a significant effect on the grain yield with maximum grain yield was obtained in the case of 150 kg N ha-1 (3.91 t ha-1) while nitrogen application beyond the level of 100 kg N ha-1 did not increase the grain yield ha-1 to a significant extent (Maqsood et al., 2000). Ayoub also reported that grain yield increased significantly with the application of nitrogen fertilizer (Ayoub, 1994). Yield attributing parameters like dry matter accumulation, no effective tillers, grain per spike, and the test weight increased with the integrated use of inorganic fertilizer and organic fertilizer (Mary et al., 2018).

5. Effect of INM on Soil Productivity

Integrated Nutrient Management involves the use of chemical fertilizers combined with organic manure in conjugation with input through the biological process (Jaga and Upadhya., 2013). Organic matter has increased the supply of nutrients, increased water holding capacity of the soil, providing a favorable soil environment to plant. Soil organic matter imparts a desirable physical environment to the soil by improving soil porosity, bulk density, soil water storage (Benbi and nieder., 2003). It is also reported that an increase in nutrient uptake by the plant, improve in organic carbon content in the soil, and also NPK status in soil (Khan et al., 2007). Application of manure in a certain year not only favorably influenced the current season but also the further season. Field experiment shows that nitrogen availability was 40 percent for manure and 15% for compost in the first year and was 18 percent for manure and 8 percent for compost in the second year after application and enhancing the biomass and grain yield of crops (Sarwar et al., 2007).

The result obtained through the integrated application of chemical fertilizers, farmyard manure, organic manure, and biofertilizers showed the improved soil organic matter content, aggregate stability, moisture retention capacity, increased infiltration rate of the soil while reducing bulk density (Saha et al., 2010). Through the continuous application of farmyard manure over the year, the organic matter in the soil is recorded to be increased from 28.6 to 35.7% over control and continuous use of organic fertilizers increases the effectiveness of chemical fertilizers in the soil through favorable soil microbial activity and augmentation of organic soil colloids that posses large nutrient retaining surface area (Manna et al., 2005). We can mitigate the deficiency of many secondary and micronutrients in the field that continuously received only chemical fertilizers through the combined use of chemical and organic fertilizers (Chand et al., 2006). Their addition to soil has created a soil environment conducive for the formation of humic acid, stimulated the activity of soil microorganism an increase in the organic carbon content of soil (Bajpai et al., 2006).

6. Effect of Integrated Nutrient Management on Total Organic Carbon and Total Organic Matter Content

Soil organic carbon (SOC) is believed to play a crucial role in many soil functions and ecosystem services. Application of different organic amendments over control NPK results in increased soil organic carbon pool in the soil as there is an efficient supply of beneficial macro and micronutrients to the soil which results in higher yield (Biswas and Beni et al., 1997). Concentration of carbon content is found higher on NPK +CD which is 39.36% followed by NPK + GM (38.37%), NPK +RHD (36.05%), NPK +AC (14.14%) over NPK alone (Bharati et al., 2016). By offering fossil fuel emission and improving water quality, organic carbon sequestration (SOC) can mitigate global warming (Khan et al., 2007). For soil having < 90 % sand needs a minimum of approx. 0.9 % soil organic carbon and while for sandy soil in the long term; organic carbon i.e. 1 to 1.5 % is agroecological suitable (Araki et al., 1993). Higher organic matter in the soil helps in sustaining soy productivity and helps in increasing soil microbial activities that promote soil aggregation and nutrient buffering capacity (Snapp et al., 1988). Organic matter content is higher in an organic source of fertilizer like FYM, biofertilizer crop residues, etc. The application of an organic source of fertilizer enhances soil health and productivity as it contains a high amount of organic matter than an inorganic source. So, the application of both organic and inorganic sources of fertilizer is best to meet nutrient level to plant and to improve soil health.

7. Effect of Integrated Nutrient Management in Reducing Environmental Impact

As the concept of sustainability as a goal has become widely accepted; researchers advocate and develop INM approach based on more than 20 years of studies that can lead to significantly improved nutrient use efficiency (NUE), Water use efficiency (WUE) and soil health condition while increasing yield and reducing environmental risk (Zhang et al., 2012). Nutrient management has been concerned for optimizing the economic return but today keeping economic requirements of nutrient management aside, we must consider the potential impact of these nutrients on environmental quality. As sustainable agricultural production is the theme of INM, it focuses to integrate all possible sources of nutrients that sustain soil productivity and improve soil health (Jovaria et al, 2010). By the application of manure in the rice-wheat cropping system higher carbon sequestration with greater capacity of sequester carbon was observed (Gosh et al., 2012; Kukal et al., 2009; Bharali et al., 2017).

The increasing demand for cereal crops for a growing human population leads to excessive use of inorganic fertilizer to obtain higher crop yield (Wu and M.A., 2015). Till the date, most of the farmer is unknown about the organic source of fertilizer and INM approach strategy. The Integrated Nutrient Management approach leads to high crop productivity and less environmental impact. Integrated Nutrient Management improves plant performance, resource use efficiency, increases water use efficiency and enables environmental protection (Wu and M.A., 2015). Associative use of inorganic fertilizer (NPK) along with organic source increases crop yield by (8 to 150%) and increase the economic return to farmers (Wu and M.A, 2015). As soil is the primary source of nutrients, any degradation in the quality of soil can create a reduction in crop yield as well as undesirable environmental changes (Yadav et al., 2018). Integrated Nutrient Management improves soil health as high carbon sequestration availability of organic sources reduces greenhouse gas emission. As sustainable agricultural production is the theme of INM, it focuses to integrate all possible source of nutrients that sustains soil productivity and improve soil health (Jovaria and Khan., 2010). The use of organic sources can minimize the application of inorganic source which in turn improves soil health conditions. So, applications of organic sources reduce the impact of using an inorganic source of fertilizes on soil and the environment by reducing the emission of GHG and makes the environment sound and clean.

8. Role of Integrated Nutrient Management In Controlling Disease

8.1 Nutrient supply

The essential part of integrated crop management is better soil fertility and good crop husbandry (Subedi et al., 2009). The influence of mineral nutrients on disease is based on three facts:

a) Effect of fertilizers on the incidence or severity of the disease.
b) The effect of mineral concentration in diseased or susceptible tissues compared with healthy or resistant tissues
c) Conditions that affect the availability of a specific nutrient with disease

Table 1: The application of essential nutrients influence disease resistance

Nutrient	Plant disease	Casual organism	Presence of nutrient	Reference
Nitrogen	Stripe rust	Puccinia striiformis f. sp. tritici	The Severity of infection decreases with nutrient supply	Devdas et a., 2014
Potassium	Leaf blight Leaf rust	Pyrenophora tritici-repentis Puccinia triticina	Resistance increases with potassium	Sharma et al., 2005 Sweeney et al., 2000
Phosphorous	Root disease	Rhizoctonia	Resistance increases with phosphorous	Kirkegaard et al., 1999
Boron	Powdery mildew	Blumeria graminis	Decrease with applied boron	Marschner et al., 1995
Zinc	Root rot	Fusarium solani	Application of zinc increases tolerance	Khoshgoftarmanesh et al., 2010
Copper	Ergot	Claviceps sp.	Reduction with copper application	Evans et al., (2007)
Chlorine	Stripe rust Leaf rust	Puccinia striiformis f. sp. tritici Puccinia recondite	Control in presence of chlorine Suppression with chlorine fertilizer application	Graham and Webb., 1991 Elmer et al., 2007

8.2 Soil organic matter/amendments

Soil-borne pathogens and their ability to infect the crop can be affected by the application of organic matters like green manures, crop residues, etc (Gupta et al., 2017). The application of sphagnum peat is found to inhibit the disease produced by Pythium species (Hu et al., 1997). The waste substance from crop residues and animal substances to various solid wastes and urban composts come under organic amendments (Gupta et al., 2017). Due to the presence of easily assimilable carbon substrates, the organic wastes/residues provide soil microorganism with high energy and these can contain microbes that show the antagonistic property to the soil pathogens (Janvier et al., 2007).

Further recent studies show that the suppression of soil-borne disease can be better influenced by anaerobic soil disinfestation (ASD) about organic

amendments. ASD encompasses with the application of organic residues or other liable sources of carbon combined with irrigation, it is then followed by mulching the soil surface with polythene mulch, which helps to create microbial mediated anaerobic soil environment and the soil-borne pathogen can be suppressed (Momma et al., 2013).

9. Control of Disease in Sustainable Nutrient Management

Any management practices which influence soil environment like ph modification through liming or gypsum application moisture control through manure etc can affect the development of disease (Gupta et al., 2017). Plant disease under field condition can be affected by fertilizer application directly by improving the nutritional status of crop and indirectly affecting the conditions which produce disease development like dense stands, change in light interceptions humidity within the crop plant (Dordas et al., 2008). Liming of soil to near neutral ph can increase the susceptibility of wheat to root infection (Halvin et al., 2009). The root rot disease can be controlled effectively by the nutrition of the host plant (Graham and Webb, 1991; Thompson and Huber., 2007). The spring wheat without nitrogen fertilization was more susceptible to disease which further increased by the application of ammonium in the autumn (Huber et al., 1989). In contrast, the same quantity of ammonium nitrogen when sprayed in spring increased resistance of infections, and high yield was obtained (Manjhi et al., 2014). The application of ammonium fertilizer timely is, therefore a practical approach to suppress disease incidence (Christensen et al., 1987). The demand for chemical disease control in some case can be reduced by fertilizer application but in some case, it might increase the demand (Huber et al., 2012).

Table 2: Take-all (*Gaeumannomyces graminis*) root infection and grain yield of winter wheat at different times and rates of ammonium N fertilizer application

Time of application	Rate of application (kg N per hectare)	Take all infection (%)	Grain yield (Kg per hectare)
0	0	1.9	2610
Autumn	83	2.8	1740
Spring	83	2.8	5290
Autumn + Spring	83+28	1.9	2350

Adopted from (Hober et al., 1989)

10. Conclusion

In conclusion, the review paper emphasizes the management strategies of organic and inorganic nutrients, sources role, and the significances of Integrated Nutrient Management in wheat. With the increasing global food insecurity, the haphazard use of chemical fertilizer is leading to soil deterioration, soil acidification, and environmental pollution. The INM is the alternative approach for sustainable, eco-friendly, and cost-effective management for improving soil fertility, soil productivity, quality, and reducing the impact of inorganic fertilizers on the environment. Combined application of inorganic and organic sources resulted in good growth parameters of wheat, yield attributes, significantly higher yield, and controlling disease in wheat. The Integrated Nutrient Management system also significantly increases the availability of nutrient status in the soil as well as microbial activity in the soil. Continuous cropping with combined application of organic manure along with chemical fertilizer was found to be effective not only for increasing the grain yield of crops but also for higher nutrient uptake, and maintenance of soil fertility status. Based on the foregoing discussion, it is concluded that the integrated use of fertilizers and organic sources enhances the productivity of wheat while maintaining soil health through enhanced carbon and other available nutrients in the soil. Finally, the findings suggested that Integrated Nutrient Management may be one of the viable nutrient management options in Nepal for wheat.

References

Ahmad, N.I., Shahid, M., Singh, B., Anaytullah, 2007. Studies on conjunctive use of organic manures and inorganic fertilizers on growth and yield of wheat (*Triticum aestivum L.*). Agricultural Science Digest, 27 (4), Pp. 276-278.

Akram, M., Quaz, N.A., Ahamad, N., 2007. INM for wheat by municipal solid waste manure in rice, wheat and cotton –wheat cropping system. Polish Journal of environmental studies, 16 (4).

Araki, S., 1993. The effect of burning ash fertilization and soil organic matter on productivity of the chitemene shifting cultivation in northern Zambia. Soil organic matter dynamics and sustainability of tropical agriculture, Pp. 367-375.

Arvind, V., Nepalia, V., Kanthaliya, P.C., 2006. Effect of integrated nutrient supply on growth, yield and nutrient uptake by Maize (*Zea-may L.*) - wheat (*Triticumaestivum L.*) cropping system. 2006. Indian Journal of Agronomy, 51 (1), Pp. 3-6.

Ayoub, M., Guertin, S., Lussier, S., Smith, D.L., 1994. Timing and level of nitrogen fertility effects on spring wheat yield in eastern Canada. Crop Science, 34 (3), Pp. 748-756.

Bajpai, R.K., Chittale, Upadhya, S., Urkhurkar J.S., 2006. Long term studies on soil physic-chemical properties and productivity of the rice-wheat system as influenced by integrated nutrient management in Inseptisol of Chattisgarh. Journal of the Indian society of soil science, 54 (1), Pp. 24-29.

Benbi, D.K., Nieder, R., 2003. Handbook of process and modeling in the soil-plant system. Haworth press, Pp. 752.

Bharali, A., Brauah, K.K., Bhattacharyya, P., Gorh, D., 2017. Integrated Nutrient Management in wheat grown in northeast India soil: Impacts on soil organic carbon functions in relation to grain yield. Elsevier, 168, Pp. 81-91.

Bharati, A., Baruah, K., Bhattacharya, P., Groh, D., 2017. Integrated nutrient management in wheat grown in northeast India soil: Impacts on soil organic carbon fractions in relation to grain yield, 168, Pp. 81-91.

Bharati, B., Kumar, S., Lee, H. N., Kumar, R., 2016. Formation of oxygen vacancies and Ti 3+ state in TiO 2 thin film and enhanced optical properties by air plasma treatment. Scientific reports, 6, Pp. 32355.

Biswas, C.R., Benbi, D.K., 1997. Sustainable yield trends of irrigated maize and wheat in a long-term experiment on a loamy sand in semi-arid India. Nutrient cycle agroecosystem, 46, Pp. 225-234.

Bohme and Bohme., 2006. Soil microbiological and biochemical properties affected by plant growth and different long-term fertilization. European J. Soil Biol., 42, Pp. 1-12.

Brady, N.C., Weil, R.R., 2002. The Nature and Properties of Soils (13th ed). Pearson Education Ltd., USA. Pp. 960.

Brar, B.S., Singh, J., Singh, G., Kaur, G., 2015. Effect of long-term application of inorganic and organic fertilizers on soil organic carbon and physical properties in maize wheat rotation. Agron., 5, Pp. 220-238.

Chand, S., Anwar, M. and Patra, D.D., 2006. Influence of long-term application of organic and inorganic fertilizer to build up soil fertility and nutrient update in mint-mustard cropping sequence. Communication in soil science and plant analysis, 37, Pp. 63-76.

Chandini., Kumar, R., Kumar, R., Prakash, O.M., 2019. The impact of chemical fertilizers on our environment and ecosystem. Research trends in environmental sciences, Pp. 69-86.

Christensen, N.W., Powelson, R.L., Brett, M., 1987. Epidemiology of wheat take-all as influenced by soil ph and temporal changes in inorganic soil N. plant soil., 98, Pp. 221-230.

Dalal, P.K., Dixit, L., 1987. Response of medium duration rice varieties to levels of nitrogen. Indian Journal of Agronomy, 32 (3), Pp. 286-287.

Dardas, C., 2008. Role of nutrients in controlling plant disease in sustainable agriculture a review. Agron Sustain Dev., 28, Pp. 33-46.

Datt, N., Sharma, R.P., Sharma, G.D., 2003. Effect of supplementary use of farmyard manure long with chemical fertilizers on productivity and nutrient uptake of vegetable pea and nutrient built up to soil fertility in the Lahual valley of Himanchal Pradesh. Indian journal of agriculture

science, 7 (3), Pp. 266-68.

Davari, M.R., Sharma, S.N., Mirzakhani, M., 2012. Effect of Combination of Organic materials and biofertilizers on productivity, Grain quality, Nutrient uptake and economics in organic farming of wheat. Journal of Organic Systems, 7 (2).

Devdas, R., Simpfendorfer, S., Backhouse, D., Lamb, D.W., 2014. Effect of stripe rust on the yield response of wheat to nitrogen. Crop J., 2, Pp. 201-206.

Elmer, W.H., 2007. Chlorine and plant disease. In: Datnoff, L.E., Elmer, W.H., Huber, D.M(ed). Mineral nutrition and plant disease. APS Press. st, Paul. Pp. 189-202.

Evans, I., Solberg, E., Huber, D.M., 2007. Copper and plant disease. In: Platnoff L.E., Elmer, W.H., Huber, D.M(ed). Mineral Nutrition and plant disease. APS Press, st Paul, Pp. 177-188.

Ghosh, S., Wilson, B., Ghoshal, S., Senapati, N., Mandal, B., 2012. Organic amendments influence soil quality and carbon sequestration in the Indo- Gangetic plains of India. Agric. Ecosyst. Environ., 156, Pp. 134–141.

Graham, D.R., Webb, M.J., 1991. Micronutrients and disease resistance and tolerance in plants. In: Mortvedt, J.J., Cox, F.R., Shuman, L.M., Welch, R.M (eds). Micronutrients in agriculture, 2nd edition. Soil science society of America, Madison, Wisconsin, Pp. 329-370.

Gupta, N., Debnath, S., Sharma, S., Sharma, P., 2017. Agriculturally Important Microbes for Sustainable Agriculture. Springer Nature Singapore Pte. Ltd., Pp. 218-251.

Halvin, J.l., Beaton, J.D., Tisdale, S.L., Nelson, W.L., 2009. Soil fertility and fertilizers- an introduction to nutrient management. PHI Learning Pvt. LTD, New Delhi.

Hu, S., van Bruggen, A.H.C., Wakeman, R.J., Grunwald, N.J., 1997. Microbial suppression of in vitro growth of Pythium ultimum and disease incidence in relation to soil C and N availability. Plant Soil, 195, Pp. 43–52.

Huber, D.M., 1989. The role of nutrition in the take-all disease of wheat and other small grains. In: Engetharad, A.W(ed). Soil-borne plant pathogens: Management of Disease with macro and micronutrients, APS press, Am phyopathol society, st Paul. Pp. 46-75.

Huber, D.M., Romheld, V., Weinmann, M., 2012. Relationship between nutrition, plant, diseases, and pests. In: Marsehner (ed). Marscheners mineral nutrition of higher plants. Academic Press, Sydney, Pp. 283-299.

IFA., 1999. World fertilizer consumption statistics. Annual.

Jaga, P.K., Upadhya, V.B., 2013. Effect of Integrated Nutrient management on wheat – A review. Innovane journal of agricultural science, 5 (13).

Jat, K., Singh, Y.V., Meena, S.K., Meena, S.K., Parihar, M., Jatav, H.S., Meena, R.K., Meena, V.S., 2015. Does INM enhance agricultural productivity? Journal of pure and applied microbiology, 9 (2), Pp. 1211-1221.

Jena, S.N., Behera, A.K., 1998. Effect of row spacing, seed rate and fertilizer levels on weeds and yield of wheat (Triticum aestivum). India Agriculturist, 42 (2), Pp. 139-142.

Jonvier, C., Villeneuve, F., Alabouvette, C., Edele-Harman, V., Mateille, T., Steinberg, C. 2007. Soil health through soil disease suppression: which strategy from descriptions to indicators? Soil Biol Biochem., 39, Pp. 1-23.

Jovaria, S., Khan, M.Q., 2010. Impact of INM on tomato yield quality and soil environment. Journal of Plant Nutrition, 34 (1).

Jovaria, S., Khan, M.Q., 2010. Impact of INM on tomato yield quality and soil environment. Journal of plant nutrition, 34 (1).

Joy, J.M.M., Ravinder, J., Rakesh, S., Somasakhe, G., 2018. A review on INM on wheat crop. International Journal of Chemical Studies, 6 (4), Pp. 697-700.

Kachroo, D., Razdan, R., 2006. Growth, nutrient uptake and yield of wheat (Triticum aestivum L.) as influenced by biofertilizers and nitrogen. Indian Journal of Agronomy, 51 (1), Pp. 37-39.

Kaur, R., Kumar, S., Kaur, R. and Kaur, J., 2018. Effect of Integrated Nutrient Management on growth and yield of wheat (*Triticum aestivum L.*) under irrigated condition. International Journal of Chemical Studies, 6 (4), Pp. 1800-1803.

Keeney, D., 1990. What goes around comes around- The nitrogen issues cycle. In Third Int. Dahila.

Khan, K., Singh, B., 2011. Response of wheat crop to nitrogen and azotobacter inoculation in alluvial soils of U.P. Trends in Biosciences, 4 (1), Pp. 109-111.

Khan, M.U., Qasim, M., Khan, I.U., 2007. Effect of INM on crop yield in rice, wheat cropping system. Sarhad Journal of agriculture, 1019, 23 (4).

Khoshgoftarmanesh, A., Kabiri, S., Shariatmadari, H.B., Sharifnabi B., Sachulin, R., 2010. Zinc nutrition effect on the tolerance of wheat genotypes to fusarium root rot disease in a solution culture experiment. Soil Science Plant Nutrition, 56, Pp. 234-243.

Kler, F., Sharma, C.R., Sharma, J., 2007. Effect of rock phosphate enriched FYM on wheat (Triticum aestivum L.) -rice (Oryza sativa L.) cropping sequence in acid alfisol. Himachal Journal of Agriculture Research, 25 (1/2), Pp. 13-18.

Krentos, V.D., Orphanos, P.I., 1979. Nitrogen and phosphorous fertilizer for wheat and barley in a semi-arid region. The journal of agricultural science, 93 (3), Pp. 711-717.

Krikegaard, J.A., Munns, R., James, R.A., Neate, S.M., 1999. Does water and phosphorous uptake limit leaf growth of Rhizoctonia- infected wheat seedlings plant soil, 209, Pp. 157-166.

Kukal, S.S., Rasool, R. and Benbi, D.K., 2009. Soil organic carbon sequestration in relation to organic and inorganic fertilization in rice, wheat and maize–wheat systems. Soil Tillage Res., 102, Pp. 87–92.

Kumar, B.H., Antil, R.S., Devi, R., 2013. Long term effects of nutrient management on soil health and crop productivity under pearl millet-wheat cropping system. Indian J. Fert., 9, Pp. 86-97.

Mana, M.C., Swarup, A., Wanjari, R.H., Ravankar, N.H., Mishra, B., Sahah, M.N., Singh, Y.V., Shahi, D.K., Swarup, P.A., 2005. Long term effect of fertilizer and manure application on soil organic carbon storage soil quality and yield sustainability under sub-humid and sub arid tropical India. Field crop research, 93, Pp. 264-280.

Manjhi, R.P., Yadav, M.S., Thakur, R., 2014. Effect of INM in crop productivity and changes in soil fertility in maize – wheat cropping sequence). Indian Journal of Agronomy, 59 (3), Pp. 371-376.

Maqsood, M., Akbar, M., Mahmood, M.T., Wajid, A., 2000. Yield and quality response of wheat to different nitrogen doses in rice-wheat cropping system. Int. J. Agri. Biol., 2 (1-2).

Marschner, H., 1995. Mineral nutrition of higher plants. Academic Press, London pp?.

Mary, J.M.J., Ravinder, J., Rakesh, S., Somashekar, G., 2018. A review article on INM in wheat crop. International journal of chemical studies, 6 (4), Pp. 697-709.

Meena, M.C., Patel, K.P., Rathod, D.D., 2006. Effect of zinc and iron-enriched FYM on mustard yield and micronutrient availability in loamy sand soil (Typic Haplusteps) of Anands. Journal of the Indian society of soil science, 54, Pp. 50-55.

Mitra, S., Roy, A., Saha, R., Maitra, D.N., Sinha, M.K., Mahapatra, B.S., Shah, S., 2010. Effect of Integrated Nutrient management in yield, uptake, and soil fertility in jute (Corchorus olitorius). Indian journal of agricultural science, 80 (9), Pp. 801-804.

Mohammadi-joo, S., Mishra, A., Saediabueshaghi, R., Amiri, M., 2015. Evaluation of bread wheat (Triticum aestivum L.) based on resistance indices under field conditions. Intl I Boisci 6 (2), Pp. 331-337.

Momma, N., Kobara, Y., Uematsu, S., Kita, N., Shinmura, A., 2013. Development of biological soil disinfestations in Japan. Appl Microbial Biotechnol., 97, Pp. 3801-3809.

Narwal, R.P., and Antil, R.S., 2015. INM in pearl millet wheat cropping system. In: Kapoor, K.K., Sharma, k.k., Dudeja, S.S., Kundu, B.S (eds), National symp. On management of organic Sheoran, S., Raj, D., Antil, R.S.,

Mor, V.S., Dahiya, D.S. 2017. Productivity, Seed quality, and Nutrients use efficiency of wheat (Triticum aestivumL.) under organic, inorganic waste for crop production. Department of Microbiology, CCS. Haryana agricultural university. Hisar, India. Pp. 205-213.

Natan, U.P., Anurag, C.R., 2011. Residual effect of organic and inorganic fertilizer nutrients on sulfur content and uptake in wheat crop under rice-wheat cropping system. Journal of Soil and crop, 21 (10), Pp. 82-88.

Rather, S.A., Sharma, N.L., 2019. Effect of integrated nutrient management (INM) on productivity and nutrient in wheat and soil fertility. Asian Journal of Soil Science, 4 (2), Pp. 208-210.

Reena., Pandey, S.B., Tiwari, D.D., Nigam, R.C., Singh, A.K., Kumar, S., 2017. Effect of INM on yield and nutrient uptake of wheat and soil health. International Archive of applied sciences and technology, 8 (3), Pp. 25 - 28.

Sadat, H.A., Nematzadeh, G.A., Jelodar, N.B., Chapi, O.G., 2010. Genetic evaluation of yield and yield components at advanced generations in rapeseed (*Brassica napus L.*). African Journal of Agricultural Research, 5 (15), Pp. 1958-1964.

Saha, R., Mishra, V.K., Majumdar, B., Laxminarayan, K. and Ghosh, P.K., 2010. Effect of integrated nutrient management on soil physical properties and crop productivity under a maize-mustard cropping system in hilly ecosystem of Northern India. Communications in soil science and plant analysis, 41 (18), Pp. 2187-2200.

Sangma, B., David, A.A., Thomas, T., 2017. Response of Integrated Nutrient on Soil Health (Physico-Chemical Properties) and Yield of Wheat (*Triticumaestivum L.*). International Journal for Scientific Research & Development, 5 (3), Pp. 865-870.

Sarwar, G., Hussain, N., Schimeisky, M., Muhammad, S., 2007. Use of compost an environment-friendly technology for enhancing rice-wheat production in Pakistan. Pak J Bot., 395, Pp. 1553-1558.

Shabandeh, M., 2020. Global wheat production from 2011/2012 to 2019/2020 (in metric tons). Statista.

Sharma, G.D., Thakur, R., Som Raj, Kauraw, D.L., Kulhane, P.S., 2013. Impact of INM on yield, nutrient uptake, the protein content of wheat (T aestivum), and soil fertility in a typic Haplustest. The Bioscan., 8 (4), Pp. 1159-1164.

Sharma, S., Duveiller, E., Basnet, R., Karki, C.B., Sharma, R.C., 2005. Effect of potash fertilization on helminthosporium leaf blight severity in wheat and associated increases in grain yield and kernel weight. Field Crop Res., 93, Pp. 142-150.

Sheoran, S., Raj, D., Antil, R.S., Mor, V.S. and Dahiya, D.S., 2017. Productivity, seed quality, and nutrient use efficiency of wheat (Triticum aestivum L.) under organic, inorganic, and INM practices after 20 years of fertilization. Cereal Research Communications, 45 (2), Pp. 315-325.

Singh, C.M., Sharma, P.K., Kishor, P., Mishra, P. K., Singh, A.P., Verma, R., Raha, P., 2011. Impact of Integrated Nutrient Management on Growth, Yield and Nutrient Uptake by Wheat (Triticum aestivum L.). Asian Journal of Agricultural Research, 5, Pp. 76-82.

Singh, Fateh, Kumar, Ravindra, and Pal, S., 2008. Integrated Nutrient Management in rice-wheat cropping system for sustainable productivity. Journal of Indian society of soil science, 56 (2), Pp. 205 - 208.

Singh, G., Kumar, S., Sidhu, G.S., Kaur, R., 2018. Effect of integrated nutrient management on yield of wheat (Triticum aestivum L.) under irrigated conditions. Inetrnational Journal of Chemical Science, 6 (2), Pp. 904-907.

Singh, R., Singh, B., Patidar, M., 2008. Effect of preceding crops and nutrient management on productivity of wheat (*Triticumaestivum L.*) based cropping system in arid region. Indian Journal of Agronomy, 53 (4), Pp. 267-272.

Snap, S.S., Mafongoya, P.L., Wadington, S., 1998. Organic matter technologies for integrated nutrient management in smallholder cropping system of South Africa. Elsevier., 71, Pp. 185 -200.

Statistical information on Nepalese Agriculture. 2006/2007. Government of Nepal, Ministry of agriculture and cooperatives, Agribusiness promotion, and statistics division.

Subedi, S., Kandel, Y.R., Burlakoti, R.R., Rosyara, U.R. and Shrestha, S.M., 2009. Management of Helminthosporium leaf blight (spot blotchand tan spot) complexin wheat In: Shrestha SM, Rosyara UR (eds.) Advances in Helminthosporium leaf blight (spot blotch and tan spot) research, Tribhuvan University, Institute of Agriculture and Animal Science, Rampur, Chitwan, Nepal.

Swarkar, S.D., Khamparia, N.K., Thakur, R., Dewda, M.S, and Singh, Maheshwari, 2013. Effect of long-term application of inorganic fertilizers and organic manure on yield, potassium uptake, and profile distribution of potassium fraction in vertical under soybean-wheat cropping system. Journal of Indian society of soil science, 6 (2), Pp. 94-98.

Sweeney, D.W., Granadae, G.V., Eversmeyer, M.G., Whiteny, D.A., 2000. Phosphorous, Potassium, Chloride and Fungicide effect on wheat yield and leaf rust severity. J. plant nutrition, 23, Pp. 1267-1281.

Thompson, I.A., Huber, D.M., 2007. Mineral nutrition and plant disease. APS Press, st Paul. Pp. 139-154.

Wu, W., Baulo, M.A., 2015. Integrated Nutrient Management for sustaining crop productivity and reducing environmental impacts: A review. Elsevier, Vol. 512, Pp. 415 -427.

Yadav, R.K., Sain, P.K., Grish, G., 2018. Integrated Nutrient Management in wheat crop. International Journal of Multidisciplinary Research and Development, 5 (9).

Yasin, G.C., 2015. Effect of Integrated Nutrient Management on wheat. A review journal of Biology, agriculture, and health care, 5 (13).

Zhang, F., Cui, Z., Chen, X., Ju, X., Shen, J., Chen, Q., Liu, X., Zhang, W., Mi, G., Fan, M. and Jiang, R., 2012. Integrated nutrient management for food security and environmental quality in China. Science Direct (Elsevier), 116, Pp. 1-40.