Journal of Advances in Science and Technology
Vol. 17, Issue No. 1, March-2020, ISSN 2230-9659

Integrated Nutrient Management Long Term Impact on Dynamics of Nutrients in Rice-Wheat System

Shiva Pastor[1]*, Dr. Narendra Singh Gurjar[2]

[1] Research Scholar, Shri Krishna University, Chhatarpur M.P.

[2] Assistant Professor, Shri Krishna University, Chhatarpur M.P.

Abstract - About 85% of India's agricultural land is devoted to the rice (Oryza sativa L.)-wheat (Triticum aestivum L. emend Fiori and Paol) cropping sequence (RWCS), making it the greatest agricultural production system in the world (IGPs). The RWCS have revealed signs of soil nutrient depletion and imbalances, poor fertiliser use efficiency, a general decline in soil organic matter, and stagnant yields as a consequence of decades of continuous cropping under conventional techniques.

Keywords - Integrated nutrient management, impact, long term, rice-wheat system, dynamics

---------------------------------X---------------------------------

INTRODUCTION

Farming is still a soil-based sector and there are no yield gains for key crops that can be obtained unless plants have an appropriate and balanced supply of nutrients (Antil and Singh, 2007 and Kumar, 2016). In order to achieve high yields in the short and long term, a suitable environment must exist in which nutrients are accessible to a specific crop in the proper form, in the correct absolute and relative quantities, and at the appropriate time (Chandrashekara et al., 2000 and Casado-Vela et al., 2007). Some affluent nations and a few locations in developing countries are now experiencing the environmental consequences of high fertiliser usage (Casado-Vela et al., 2007 and Kumar, 2015). Maintaining yields and minimising pollution may be achieved by using fertilisers in an appropriate and responsible manner (Jat et al., 2013 and Kumar, 2015). In contrast, most developing nations utilise fertiliser at such low quantities that its application is unlikely to cause severe environmental concerns. Indeed, more organic and inorganic fertiliser use in these places might improve the ecosystem and enhance harvests (Kumar and Chopra, 2016).

Maintaining and perhaps improving soil fertility for long-term crop yield and reducing inorganic (fertiliser) input costs are still the primary goals of an integrated nutrient management system (INMS) (Kumar and Chopra, 2010 and Kalhapure et al., 2013). For this reason, integrated nutrients supply/management (INM) is focused on ensuring that agricultural production is maintained or adjusted to an optimal level by maximising the benefits of all potential sources of plant nutrients in an integrated way (Kannan et al., 2013 and Jat et al., 2015).

Plants benefit greatly from the nutrients included in manure. Approximately 70-80% of the nitrogen, 60-85% of the phosphate, and 80-90% of the potassium in feeds is expelled in the dung. Farm animals' faeces and urine are combined with their litter to produce FYM, a bulky organic manure that decomposes quickly (bedding material). It comprises 0.5 to 1.0 percent N, 0.15 to 2% P2O5 and 0.5 to 0.6 percent K20 on average, decaying FYM. In FYM, a C:N ratio of no more than 15-20 is ideal (Bhattacharyya and Tandon, 2002). By improving the soil's physical qualities as well as giving nutrients, FYM is more important for long-term sustainability.

Vermicomposting is a low-cost, environmentally-friendly method of removing organic waste from the environment. Peat-like vermicompost has a high level of porosity, aeration, drainage and water-holding capacity, making it ideal for growing plants. There is a lot of surface area in vermicompost, which means that nutrients are easily absorbed and retained (Sinha et al., 2013). Earthworms inoculated with a broad variety of organic wastes increased the nutritional content and decreased the C:N ratio to a desired level, according to a number of trials. Microbial diversity in vermicompost helps break down nutrients already present in the soil into plant-available form. In addition to enhancing the physical structure of the soil, it also encourages the presence of deep-burrowing earthworms, which improves root development and structural integrity. Approximately 1.5 to 2.2 percent of vermicompost is made up of N, P, and K. There is a wide range of organic carbon, from 9.15 to 17.98 percent, including secondary and micronutrients (Adhikary, 2012).

Farmers must manage soil fertility and nutrients in an integrated manner in the 21st century if they are to fulfil the increasing food needs of a growing population. A balanced supply of nutrients is essential for the necessary improvements in yields of main crops. INM is a technique that aims to both boost agricultural productivity and protect the environment for future generations by integrating nutrient management. Using both organic and inorganic plant nutrients, it is possible to increase crop yields, protect soil from deterioration, and satisfy future food supply requirements.

EFFECT OF FERTILITY LEVELS

Effect on growth attributes

Rice

Anbumani et al. (2000) conducted a field experiment on rice cv. ADT 38 from August 1995 to January 1996 in the Department of Agronomy, Annamalai University, Chidambaram Tamil Nadu, India, to explore the impact of planting/sowing procedures and NPK levels. Increasing the NPK level resulted in enhanced growth parameters such as the number of tillers m-2, LA!, and DMP, according to the data.

Wheat

To evaluate the influence of varying doses of fertiliser on growth, yield and quality of four cultivars of late-sown wheat, Gwal et al. (1999) at Sehore, Madhya Pradesh, and applied 0-0-0, 60-30-30, 120-60-60 or 180-90-90 kg N-P20S-K20 ha-I. Averaged throughout the cultivars, plant height rose with NPK rates.

Effect on yield attributes and yield

Rice

It was in the wet seasons of 1999 and 2000 that Singh and Namdeo (2004) tested the effects of fertility levels and herbicides on rice growth, yield, and nutrient absorption at Lawaharlal Nehru Krishi Vishwa Vidyalaya, Rewa, Madhya Pradesh (Oryza sativa L.). For yield-attributing characteristics and grain yield, 45 kg N + 40 kg P + 30 kg K + 25 kg ZnS04 + foliar spray of micronutrient combination (thrice) proven to be the best, yielding 6.34 q ha-1 more grain and Rs 6,968 ha-1 more net return above no fertility level.

During the growing season of 2002-03, Manivannan et al. (2005) tested the performance of two rice hybrids, KRH 2 and DRRH 1, in the Veeranam ayacut region of Tamil Nadu with three levels of nitrogen (0, 40, and 80 kg ha-1), and three levels of potassium (0, 40, and 80 kg ha-1). Using the various amounts of N and K in hybrid KRH 2, the findings clearly showed its better performance. Using 150, 60, and 80 kg NPK ha-1 gave a maximum of 4.97 t ha-1 in grain production.

Wheat

At Rahuri, Maharashtra, Auti et al. (1999) found that increasing rates of fertiliser application, from the lowest to highest, enhanced grain and straw yields in wheat cv. HD 2189 with four fertility levels of 30,15,15, 60,30,30, 90,45,45 and 120,60,60 kg NPK ha-1. Similarly, Gwal et al. (1999) found that increasing NPK levels up to the maximum level (180, 90, 90 kg N, P20S, K20 ha-1) significantly incorporated yield contributing parameters such as tiller/plant number, spike length, grain yield, and straw yield in late-sown wheat at Sehore, Madhya Pradesh.

Effect on quality attributes

Rice

It was shown that grain protein content rose with increasing N application amounts and postponing N dressing dates in rice by Liu et al. (2005) in their investigation of the correlations between N fertiliser application at the mid-growing stage and grain protein content and starch viscosity. The diverse N rates applied at the mid-growth stage had a substantial impact on grain starch viscosity, whereas the different N dressing dates had no such effect. From 0 to 270 kg ha-1 of N dressing, the viscosity of grain starch fell dramatically in terms of its peak viscosity, hot viscosity, and breakdown end viscosity.

Wheat

It was found that the chemical composition of the wheat cultivars V-94091, V-94105 and Inqulab 91 was affected by NPK concentrations of 50, 50, 0, 75, 100, and 175: 125: 50 in a field experiment performed in Faisalabad, Pakistan, in 1999-2000. NPK fertiliser rates were shown to enhance moisture, ash, and protein content. The fat and fibre content of the experimental wheat cultivars was unaffected by the NPK fertilisers.

Effect on nutrient content and uptake

Rice

At the blooming and harvest phases of a field experiment in Killikulam, Tamil Nadu, Gobi et al. (2008) showed that five N splits (S3) and four K splits (S4) had greater Nand K absorption. A greater P absorption was seen when N was applied as five splits and K was applied as four splits (S3), compared to four splits of N (S2) and three splits of K. Crop establishment technique and split application of N, P, and K absorption had a substantial impact on crop growth.

Wheat

Researchers in Rahuri, Maharashtra (Auti et al., 1999) studied the effects of four fertility levels on wheat cv. HD 2189 (NPK rate: 30, 15, 15; 60,30,30; 90, 45-45 or 120, 60-60 kg NPK ha-1) and found that the absorption of N, P, and K improved with increasing fertiliser rate up to a higher level.

Surface-seeded wheat (Triticum aestivum L. emend. Fiori & Paol.) in the lowland rice environment of north Bihar was researched by Pandey et al. for its growth and yield in fertiliser levels and seed rates (2004). To their knowledge, they found that the crop's NPK absorption was much greater when fertiliser was applied at 150, 75 and 50 kg N, P and K ha-1.

Effect on soil health

Physical properties

According to an experiment conducted by Choudhary and colleagues in Palampur (Himachal Pradesh, India), the bulk density of a silty clay loam soil decreased when NPK levels were increased from 50 to 150 percent of optimum NPK provided to wheat. Increases in fertiliser levels were shown to enhance soil moisture content at harvest for both wheat and rice, including soil water retention at various suction values and PA WC.

Chemical properties

Kocmit et al., (1997) were experimenting with spring wheat cultivar Cv. A spring triticale cv. called Hera Forage barley cv, Migo Cv. of a lot of oats. High NPK fertiliser rates mixed with irrigation boosted the soil nutrient content, which in turn enhanced plant physiological processes and subsequently exchangeable absorption processes, according to Boryna Activated H+ cation enters soil sorption complex and replaces other ions that are more easily available to plants and also more mobile in the soil. Treatments altered N03 and NH4 concentration, soil pH, and sorption characteristics, and it was claimed that management intended to increase plant output might damage the ecosystem.

Biological properties

According to Mahajan et al. (2007), who examined the long-term effects of mineral fertilisers and amendments on the microbial dynamics of an alfisol in the Western Himalayas, the populations of bacteria, fungi, actinomycetes, and Azotobacter were at their highest in plots treated with mineral fertilisers and FYM (100 per cent) As the concentration of NPK grew (from 50% to 150%), the bacterial population fell and the fungal population increased.

Rice variety IR-64 was subjected to a field experiment by Nakhro and Dkhar (2010) that examined the microbial populations and carbon content of the microbial biomass. An rise in the NPK level in the soil may be explained by the application rates of inorganic fertilisers. However, the soil had a low organic carbon content and microbial counts, as well as microbial biomass carbon.

EFFECT OF INTEGRATED NUTRIENT MANAGEMENT

Effect on growth attributes

Rice

To determine the impact of crop residue management and integrated nutrition management on the development of rice transplanted from the field. On the sandy clay loam soil Pant Nagar, Uttaranchal, Mukherjee and Singh (2001) performed field experiments. Plant height at 50 and 70 DAP and harvest was significantly influenced by green manuring with Sesbania, but plant heights in all residue management treatments were statistically indistinguishable at all stages. Summer green manuring of Sebania before to rice transplanting resulted in considerably more tillers at 30 and 50 days after transplantation than residue included, residue burned, or residue removed treatments. Rice dry matter accumulation was substantially greater in green manured plots than in non-green manured plots.

Wheat

On the sandy-loam soil of Hisar, Haryana, India, Nehra et al. (2001) performed a wheat field experiment in the winter of 1997-98 and 1998-99 to examine the impact of integrated nutrient management on wheat (Triticum aestivum) development and production. There were six organic manure treatments (no manure, farmyard manure at IS tonnes, vermicompost at 10 and IS tonnes, pressmud at 2.S and S tonnes ha-1, and recommended doses of 120 kg N+60 kg P20S+60 kg K20 ha-1) and six chemical fertiliser treatments (no fertiliser, 60 and 120 kilogrammes per hectare, N at 90 kilogrammes per hectare, N at 90 kilogrammes per hectare, and the recommended dose of 120 kilogrammes per hectare). When organic manure was applied to wheat both years, it had a considerable influence on grain and straw yields as well as photosynthesis. Vermicompost had the highest IS tonnes ha-1 values of all the qualities, greatly outperforming the other organic manure treatments. Wheat's performance was increased by increasing the rate of N. The prescribed dosage of NPK produced the highest readings. It was shown, however, that N at 120 and 90 kg ha-1+Azotobacter were statistically comparable to the recommended dosage ofNPK in terms of efficacy.

Effect on yield attributes and yield

Rice

Yaduvanshi (2003) working on integrated nutrient management in rice-wheat system at the Central Soil Salinity Research Institute, Kamal, Haryana involving the use of NPK fertilizers alone and in combination with green manure *(Sesbania bispinosa)* or FYM reported that application of NPK in combination with green manuring and FYM increased the rice yield significantly. It was furthered that green manure or lOt FYM ha-1 in combination with 50% recommended NPK the mean rice yield (5.8 t ha-1) was similar to the yield (5.5 t ha-1) obtained from the 100% recommended NPK treatment.

Wheat

Song *et al.* (2001) conducting a 9-year (1991-99) field experiment with winter wheat cv. 8693 grown in cinnamon soil in a field plot, at Changping, Beijing, China, reported that the application of fertilizer NPK alone or fertilizer NPK combined with OM increased (P<O.Ol) the wheat's spike length, grains/spike, and plant height compared with the control treatment, thus enhancing biomass and grain yield of wheat. The application of fertilizer NPK combined with OM had a better yield- increase effect than the application of fertilizer NPK alone, especially combined with farmyard manure at a higher dose. It was concluded that the application of fertilizer NPK combined with OM might not only make good use of resources, but also enhance wheat yield.

Effect on quality attributes

Rice

Using green manure, N, P20S, and K20 at the recommended levels, plus gypsum at 500 kg ha-1 in Tamil Nadu, Subbiah and Kumaraswamy (2000) found that quality parameters like crude protein content, bran oil content, total amylose content, hot water insoluble amylose, percentage of milling recovery, and grain hardness improved.

Wheat

Xiong et al. (2005) at Sichuan University, Sichuan Chengdu, China, evaluated the effects of fertiliser application on winter wheat root development, grain production, and quality. Wheat grain protein content, total amino acid content, and total essential amino acid content may be increased by applying organic manure or artificial N, P, or K fertiliser. Wheat grain quality might be improved even more by using organic fertiliser in conjunction with artificial N, P, and K fertiliser.

Effect on nutrient content and uptake

Rice

NPK was used in a field experiment by Bhat et al. (2005) with rice cv. Pusa Basmati-l, farmyard manure (FYM), and biofertilizer (blue green algae (BGA) at 10 kg ha-1) in three concentrations (control, 50%, and 100% of 120: 60: 60 kg ha). The combined application ofNPK, FYM, and BGA resulted in a considerable increase in grain N, P, and K absorption.

Wheat

Patel et al. (2014) examined the influence of organic and inorganic fertiliser on the macronutrient composition and absorption of wheat crops in Raipur, Chattishgarh, India. Organic sources of N, P, K and organic sources FYM at lOt ha-1, green manure (sunhemp in situ), blue green algae @ 10 kg ha-1, and ZnS04 @ 10 kg ha-1 were administered solely in the kharif season. Treatments containing 100 percent NPK + FYM + 150 percent NPK fertilisers were found to have the maximum overall absorption of both nitrogen and phosphorus, whereas potassium and sulphur were found to have the lowest uptake.

Effect on soil health

Physical properties

Rasool et al. (2007) evaluated the long-term impacts of FYM and inorganic fertiliser treatment in a rice-wheat system at Punjab Agricultural University (PAU), Ludhiana, Punjab. In many cases, the importance of physical fertility is neglected. Rice and wheat are being experimented on to see what effect long-term application of farm yard manure (FYM) and inorganic fertilisers has on soil physics. Rice and wheat crops received I farm yard manure @ 20 t ha-l (FYM), nitrogen @ 120 kg ha-l (N120), nitrogen, phosphorus and potassium @ 120, 30, 30 kg ha-l (N120 P30 K30), and a control treatment (i.e. no fertiliser or FYM addition) as well as (ii) nitrogen @ 120 kg ha-l (N120) during rice crops. On a sandy loam soil, each treatment was replicated four times (typic Ustipsament, non-saline, slightly alkaline). Investigations were carried out at depths ranging from 0 to 60 cm on the stability, bulk density, and water holding capacity of soil aggregates. The average mean weight diameter (MWD) of FYM plots was found to be greater than that of N120 P30 K30 plots and N120 P30 K30 plots (0.237 mm) (0.249 mm). Soil depth had a less impact on FYM's capacity to expand the width of the mean weight (MWD). Adding FYM and N 120P30 K30 increased rice's organic carbon content by 44 and 37 percent, respectively. In compared to the control plots, soil porosity was improved in both FYM and N120 P30 K30 treatments. Overall, the 0-15 em soil layer's porosity increased by 25% when FYM was applied, compared to the control plots.

Chemical properties

Hemalatha et al. (2000) studied the impact of organic manures, dhaincha (Sesbania cannabina), sunn hemp (Crotalaria juncea), and farmyard manure (FYM), on rice yield, quality, and soil fertility in Tamilnadu, India. When dhaincha was added to organic manures, it had an even greater impact on soil fertility by increasing the amount of organic carbon and the amount of accessible N, P, and K in the soil after harvest. Organic manures, as shown by Subbiah and Kumaraswamy (2000), also have a positive effect on soil qualities such as organic carbon content and nutrient lability.

Biological activity

In Johrat, Assam, Baruah and Talukdar (1999) investigated the long-term and persistent effects of FYM and fertiliser on soil nutrient status and microbial population. The treatment using both organic and inorganic sources resulted in a considerable increase in the amount of readily accessible NPK. The growth of microbes was not significantly influenced by the use of balanced fertiliser. However, expanding the microbial population was considerably easier with organic matter input and appropriate fertiliser dosages.

ECONOMICS CONSIDERATION / APPRAISED UNDER RICE - WHEAT SYSTEM

Thakur *et al.* (1999) studied the effect of organic manure, fertilizer level and seed rate on the yield and quality of late-sown wheat in Bihar. Application of lOt organic manure harecorded higher values of net return and net return per rupee invested than treatment with no organic manure. Application of 150% of the recommended rate of fertilizers (100, 50, 25 kg N, P, K ha-^{1}) recorded significantly higher grain yield and harvest index than the lower levels of fertilizers. However, the net return and net return per rupee invested with 125 or 150% of the recommended rates of fertilizers were at par with the recommended rate of fertilizers (100%).

SYI UNDER LONG TERM INTEGRATED NUTRIENT MANAGEMENT

Sustainability yield index (SYI) values were highest with 50 percent NPK + 50 percent N via green manuring with sunnhemp to rice, followed by 100 percent NPK to wheat, as reported by Gupta et al. (2006) in Jabalpur, M.P.

At Raipur, Chattisgarh, Urkurkar et al. (2010) investigated the impact of a long-term field experiment of integrated nutrition management in a rice-wheat system on the permanent plot. When rice and wheat were treated with 100% of the fertiliser recommended dose, and 50% of the fertiliser recommended dose plus 50% of N (green manure), the sustainable yield index was 0.78, 0.44, 0.84, and 0.45, respectively, compared to 0.30, 0.19, 0.64, and 0.33 in the control treatments.

CONCLUSION

High productivity rice-wheat cropping systems cannot be sustained without compensating for the reduction in soil fertility produced by these crops. Increasing energy costs, limited input availability, and high fertiliser prices prohibit farmers from using chemical fertilisers to the extent necessary. Consequently, the alternative is to use an integrated nutrition management plan that makes use of organics in order to lessen reliance on synthetic chemicals.

REFERENCES

1. Basha, S.J., Basavarajappa, R. and Babalad, H.B. (2016) Influence of organic and inorganic nutrient management practices on yield, economics and quality parameters of aerobic rice. *Research on Crops*, 17(2): 178-187.

2. Kumagai, K. (2016) Changes in the pH, EC, available P, SOC and TN stocks in a single rice paddy after long-term application of inorganic fertilizers and organic matters in a cold temperate region of Japan. *Journal of Soils and Sediments,* 1-9. doi:10.1007/s11368-016-1544-9

3. Bhatt, R., Kukal, S.S., Busari, M.A., Arora, S. and Yadav, M. (2016) Sustainability issues on rice–wheat cropping system. *International Soil and Water Conservation Research*, 4(1): 64-74.

4. Sharma, K.L., Ramachandrappa, B.K., Suma Chandrika, D., Sathish, A., Dhanpal, G.N., Rao, C.S., Shankar, M.A., Grace, J.K., Maruthi Sankar, G.R., Ravindra Chary, G., Munnalal, Kumar, T.S., Rani, K.U. and Venkateswarlu, B. (2016) Effect of organic manure and crop residue based long-term nutrient management systems on soil quality changes under sole finger millet (*Eleusine Coracana* (L.) *Gaertn*.) and Groundnut (*Arachis hypogaea* L.)- finger millet rotation in rainfed *Alfisol*. *Communications in Soil Science and Plant Analysis,* 47(7): 899-914.

5. Wang, F., Wang, Z., Kou, C., Ma, Z. and Zhao, D. (2016) Responses of wheat yield, macro-and micro-nutrients, and heavy metals in soil and wheat following the application of manure compost on the North China plain. *PloS one*, 11(1): e0146453.

6. Zhao, J., Ni, T., Li, J., Lu, Q., Fang, Z., Huang, Q., Zhang, R., Li, R., Shen, B. and Shen, Q. (2016) Effects of organic–inorganic compound fertilizer with reduced chemical fertilizer application on crop yields, soil biological activity and bacterial community structure in a rice–wheat cropping system. *Applied Soil Ecology,* 99: 1-12.

7. Sohel, M.H., Sarker, A., Razzak, M.A. and Hashem, M.A. (2016) Integrated use of organic and inorganic fertilizers on the growth and yield of Boro rice (*cv.* BRRI dhan 29). *Journal of Bioscience and Agriculture Research*, 10(01): 857-865.

8. Dhaliwal, M.K., Dhaliwal, S.S., Thind, H.S. and Gupta, R.K. (2015) Effect of integrated nutrient management on physico-chemical parameters of soil in rice-wheat system. *Agricultural Research Journal,* 52(2): 130-137.

9. Dubey, L., Dwivedi, A.K. and Dubey, M. (2015) Long term application of fertilizer and manures on physico-chemical properties and N, P and K uptake in soybean-wheat cropping system. *Plant Archives*, 15(1):143-147.

10. Pandey, S.K. and Chandra, K.K. (2013) Impact of integrated nutrient management on tomato yield under farmers field conditions. *Journal of Environmental Biology*, 34(6): 1047-1051.

11. Vidyavathi, V., Dasog, G., Babalad, H., Hebsur, N.S., Gali, S. K., Patil, S.G. and Alagawadi, A.R. (2012) Nutrient status of soil under different nutrient and crop management practices. *Karnataka Journal of Agricultural Sciences*, 25(2): 193- 198.

12. Radulov, I., Berbecea, A., Sala, F., Crista, F. and Lato, A. (2011) Mineral fertilization influence on soil pH, cationic exchange capacity and nutrient content. *Research Journal of Agricultural Science*, 43(3): 160-165.

13. Fageria, N.K., De Morais, O.P. and Dos Santos, A.B. (2010) Nitrogen use efficiency in upland rice genotypes. *Journal of plant nutrition*, 33(11): 1696-1711.

14. Virdia, H.M. and Mehta, H.D. (2010) Integrated nutrient management in transplanted rice (*Oryza sativa* L.). *International Journal of Agricultural Sciences*, 6(1): 295-299.

Corresponding Author

Shiva Pastor*

Research Scholar, Shri Krishna University, Chhatarpur M.P.