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The Influence of INM on Yield and Growth under Indian Climatic conditions of Winter Wheat (*Triticum aestivum* L. *emend. Flori & Paol*)

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ABSTRACT: Wheat, a crop that is produced in many regions of the nation throughout the winter, is the backbone of Indian cuisine. A long-term research in a number of locations has found that since soil is another supplier of nourishment, it should be safeguarded against a variety of exterior elements, including excessive fertilizer usage. Aside from natural resource deterioration and biotic-abiotic stress, nutrient scarcity is a key factor in yield loss, productivity decrease, and net profit reduction. This brief review article examines previous research and studies on the role of various micro and macronutrients in wheat crops, and offers a concise analysis of the effects of INM (Integrated Nutrient Management) on several wheat crop development and production characteristics, as well as their nutritional absorption rate, by affecting the soil system's nutrient status. According to the research, INM, which comprises it's use synthetic chemicals through collaboration using pure natural fertilizers & biological inputs, is essential to improve the soil's nutritional quality. INM increases the plant's nutrient absorption rate, which impacts the nitrogen supply in the structure of soils. Because The soil is primary resource for nutrition's, any degradation in soil quality may lead to a reduction in crop yield. As a consequence, in order to enhance output while simultaneously conserving the environment, it is necessary to take suitable and realistic methods to decrease its influence in wheat cultivation.

Keywords: Wheat, Yield, Organic Manures, Growth, chemical Fertilizers, Integrated Nutrient Management (INM) are all words that come to mind when thinking about wheat.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is an important staple food crop that is also known as the "King of Cereals" or "Staff of Life." Wheat originated in Turkey, in South Western Asia. The genus *Triticum* belongs to the Poaceae or Gramineae family, and it is a major agronomic crop. Flour, pasta, pastry, semolina, crumpets, flake, chapati, biscuits, and a range of other foods are made from wheat. It is the most essential staple food on the planet, accounting for around 35% of all food eaten by the global population (Mohammadi Joo *et al.*, 2015). It is the world's top cereal in terms of area and production, & it's provides the sufficient amount of caloric and protein in the diet of humans than any other cereal. Wheat has a protein content of 12-13 percent. Gluten makes up 75-85% of the protein in wheat, which is important to backers. The fat content of wheat is 1.5 percent (Book Essentials of Agriculture, 1st Edition, 2018).

Natural resources values are steadily growing as a result of current technical advancements & worldwide population growth. As a result, there will come a day when those nations possessing abandoned agricultural goods, as well as optimal usage of these resources, will be the richest countries in this world (Saleem *et. al.*, 2021). The world produces wheat in at least 43 countries. India, Indonesia, China, Thailand, and the United States of America are the primary top wheat-growing nations, producing 647 million tons of wheat on 218 million hectare and a output of 2960 kilograms per hectare (FAO, 2012). With a total output of 93.50 million tonnes, India has the greatest wheat-growing acreage (30.23 mha), followed by China. In India, the average wheat yield per hectare is just 3.3 tonnes per hectare. Around 12% of the world's wheat is produced in India (Book Essentials of Agriculture, 1st Edition, 2018). The primary wheat-growing states in India are UP, PB, MP, HR, RJ, BR, GJ, MH, UK, and HP. Despite having the largest wheat acreage and production, Punjab has the highest average yield per hectare (5090 kg/ha), followed by Haryana (4412 kg/ha), with India's entire wheat output of 99.70 million tonnes on 29.58 million hectares yielding 3371 kg/ha. (Agristatglance, 2018). The data on Wheat: Area, Production, and Yield in Major Producing States in 2016-17 and 2017-18, as well as coverage under irrigation is shown in Table 1.

Table 1: Wheat: Area, Production, and Yield in Major Producing States in 2016-17 and 2017-18, as well as coverage under Irrigation.

States	2017-18			2016-17		
	Area	Production	Productivity	Area	Production	Productivity
UP	9.75	31.88	3269	9.66	30.06	3113
PB	3.51	17.85	5090	3.50	16.44	4704
MP	5.32	15.91	2993	6.03	17.94	2976
HR	2.53	11.16	4412	2.56	11.55	4514
RJ	2.81	9.19	3270	2,83	8.99	3175
BR	2.04	5.74	2816	2.11	5.11	2427
GJ	1.06	3.10	2932	1.00	2.74	2751
MH	0.92	1.62	1761	1.27	1.88	1474
UK	0.33	0.91	2727	0.34	0.88	2587
HP	0.34	0.59	1734	0.35	0.70	2033
Others	0.97	1.75	@	1.16	2.23	@
All-India	29.58	99.70	3371	30.79	98.51	3200

Area- mha, Production- mt, Productivity- kg/ha
Source: Department of Agriculture and Farmer Welfare
https://agricoop.gov.in/sites/default/files/agristatglance2018.pdf
@ - production is low

India's wheat consumption is predicted to rise to 105 million to 109 million tonnes by 2020, up from 72 million tonnes currently produced (Jince). Joy, Mary *et al.*, 2018). *Triticum aestivum* (common bread wheat, 2n=42), *Triticum durum* (macaroni or durum wheat, 2n=28), and *Triticum dicoccum* (emmer wheat, 2n=28) are the only economically significant wheat species in India. Wheat is planted at the beginning of the Rabi cycle and harvested at the start of the Kharif cycle. Climate changes may affect the timing of planting, growth, and harvesting. Based on agro - climatic conditions, India is classified into 6 (six) wheat-cultivating regions or zones. Southern Hill Zone, Peninsular Zone, North-Western Plains Zone, Central Zone, Northern Hill Zone, and North-Eastern Plains Zone are the different types of zones. The North-Western Plains Zone produces the most wheat, accounting for around 45 percent of total wheat acreage in India (Vimlesh, 2010). The data regarding to Wheat agro-climatic zone in India is as shown in Table 2. Because each agro-climatic zone has different growing seasons, the vegetative and reproductive phases change, resulting in differences in potential yield. Wheat consumption is predicted to climb in the next decades, especially in emerging nations to feed a growing population, and wheat will continue to account for a large amount of human energy needs in 2050 as a preferred diet (EIAR).

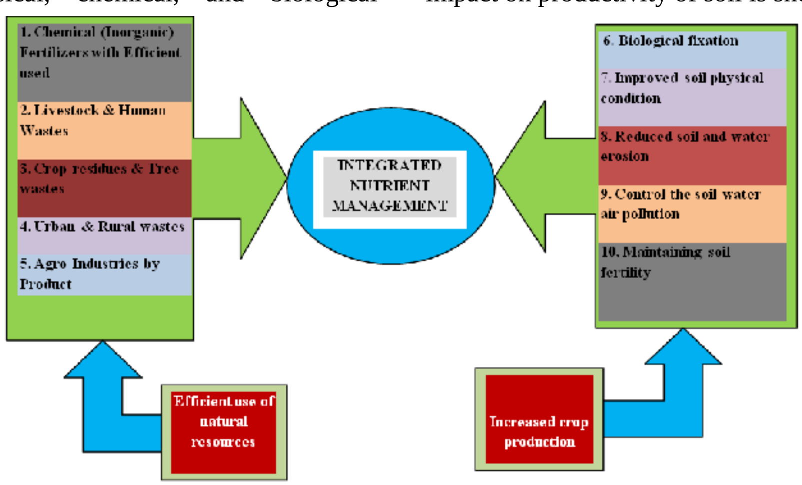
Table 2: Wheat agro-climatic zone in India. Vimlesh, (2010).

Agro-climatic Zone	States Under Zone	Production	Area	Wheat Species
North-Western Plains Zone	Western Uttar Pradesh, Parts of Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Delhi, and Rajasthan are included.	45%	37%	*Triticum aestivum*
North- Eastern Plains Zone	Arunachal Pradesh, Orissa, West Bengal, Uttar Pradesh, Bihar, Assam, Sikkim, and other Eastern States	24%	27%	—
Central Zone	Central highlands (North)India	13%	17%	*Triticum durum*
Peninsular Zone	Western Ghats, Central highlands (South) India, Karnataka	2.5%	6%	*T. aestivum, T. durum, T. dicoccum*
Northern Hill Zone	J&K, HP, Uttaranchal, Sikkim, Arunachal Pradesh	3%	4%	
Southern Hill Zone	Tamil Nadu, Kerala	minor	minor	*T.dicoccum*

Source:-http://agropedia.iitk.ac.in/content/agroclimatic-zone-wheat-india#:~:text=The%20zone%20comprises%20eastern%20Uttar,relatively%20short%20in%20this%20zone

INM (Integrated Nutrient Management: The use of a mix of natural organic manures, inorganic synthetic fertilizers, and chemicals helps to maintain the environment while enhancing soil output (Nambiar and Abrol, 1992). Individual or combination chemical fertilizer use, as well as optimum and reasonable organic fertilizer use, provide and solve the issue of growing chemical fertilizer costs and loss of soil productivity and fertility. Proper management, a wider range of yields, the right planting time, water (irrigation), and fertilizer control may all assist to boost production and productivity. Crop productivity and nutritional security can only be raised vertically by increasing and enhancing the use of both organic and inorganic sources (Kale and Bano, 1986; Srivastava, 1994). Fertilizers are a crucial component of improvement of crop's yields and productivity of the soil. When it comes to enhancing crop yields, using the right quantity of fertilizer is crucial (Manpreet, 2018). Implementing an advanced agricultural plan will fulfill the needs of a rising population, but it will need a lot of energy, which will raise input prices and pose environmental dangers. The rising usage of inorganic sources to boost productivity has long been recognized. Uncontrolled fertilizer usage, on the other hand, may have negative consequences for soil health, ecology, and other natural resources; also, the expensive cost of manure prevents its widespread application. In INM, organic fertilizers are utilized to help address soil nutritional deficiencies. Adding organic nutrients to soil improves its physical, chemical, and biological characteristics while also providing a conducive environment for seed germination. Chemical fertilizers are expensive and depend on nonrenewable resources that are limited. Combining the use of inorganic fertilizers with indigenous sources such as farmyard manure should be encouraged in order to improve Physicochemical & psychological elements from the soils fertility & productivity (Ezekiel, 2010). With all crops, soil contains free-living microorganisms capable of nitrogen fixation. The positive impact of Azotobacter on plants is responsible for the formation of complex chemicals such as vitamin B3 (nicotinic acid), vitamin B6 (pyridoxine), vitamin H or B7 (biotin), and vitamin B1 (thiamine), Gibberellins, indole acetic acid, and other growth-promoting hormones increase seed germination and create optimal environmental conditions for plant development. Many bacteria occur in soil that increase the amount of phosphorus [PO_4(3-)] available to plants by mineralizing inorganic P_2O_5 (phosphorus) and converting it to organic forms that are readily accessible to plants (Manpreet, 2018). Nitrogen is an important component of agricultural production. It is involved in the metabolism of nucleotides, enzymes, vitamins, and hormones. The absorption of potassium, phosphorus, and other minerals is aided by nitrogen. Phosphorus is required for seedling establishment as well as early development and growth. Sulphur encourages root growth, seed formation, and chlorophyll production in plants (Manpreet, 2018).

An illustration of INM resources and their impact on productivity of soil is shown in Fig. 1.



(**Source:**https://www.slideshare.net/vkskumar49/1-integrated-nutrient-management-in-various-agroecosystems-in-tropics).

Fig. 1. An illustration of INM resources and their impact on productivity of soil.

The Impact of Integrated Nutrient Management On Uptake of nutrients: The uptake of nutrients is greater when PSB and vermicompost are coupled with fertilizers than when fertilizers or vermicompost are applied alone (Datt *et al.*, 2003). When 75 percent RDF+ Vermicompost @ 1tn/ha + PSB was applied, NPK absorption was highest (Datt *et al.*, 2003). The Bulk density (BD) (0 to 15 cm) ranged between 1.29 - 1.38 Mg m^{-3} according to the combined results from multiple treatments of combinations (Jyoti Bangre *et al.*, 2021). The crop's Nitrogen (N), Phosphorous (P), and Potasium (K) absorption was substantially greater when worm-manure (VC) and P-solubilizing biofertilizer (PSB) were coupled to the fertilizer dose than when fertilizers were used alone or when vermicompost was used alone. The crop absorbed the most NPK with 75 percent NPK + vermi-compost @ 1t ha^{-1} + Phosphate solubilizing bacteria (PSB) and 100 percent NPK + vermi-compost @ 1ton/ha + Phosphate solubilizing bacteria (PSB). Increased food supply and a An extensive root system resulted In improved Nutrients absorption and water uptake, resulting in improved nutritional uptake (Devi *et al*., 2011). The solubilization of native micro-macronutrients and other intermediate organic compounds created by the breakdown of biological waste, as well as their mobilization and accumulation in various areas of plant crops, may be linked to the high nutrient absorption rate of organic manures (Mitra *et al.*, 2010). When S+B+FYM and 75 percent NPK are applied together, the higher absorption might be ascribed to the additional natural nutrient release out of the ground & transportation through the plants bodies. Similarly, across both years, utilizing S (sulphur), B (boron) or Farm yard manure (FYM) with 100 percent RDF (150:60:60 kg/ha NPK) improved overall nutrient absorption (Reena *et al*., 2017). The solubilization of organic acids in farmyard manure assists in the release of P_2O_5 (phosphorus), bacterial growth stimulation, and plant root system development, all of which lead to greater phosphorus absorption by plants. When used in combination with inorganic phosphorus, FYM and PSB assist to improve phosphorus availability in the soil for crop planting. The available phosphorus increases by giving phosphorus via manure rather than eliminating the plant (Singh *et al.*, 2008). This could be due to yield characteristics, as wheat yield increased when S, B, and FYM were used alone with 150:60:60 kg/ha NPK and combined with 75 percent RDF, and grain and straw nutrient content increased when S, B, and FYM were used with chemical fertilizers or alone conjugation of75 percent NPK. Nutrients absorption is influenced by nutrient concentration and production. The results of Natan and Anurag support this view (2011). Organic acids produced by the decomposition of organic manure liberate potassium from potassium-bearing minerals, resulting in increased potassium availability (Swarkar *et al.*, 2013). The addition of zinc to organic resources may improve nutrient consumption efficiency (Meena *et al*., 2006). Wheat's sulphur absorption decreased when fertilizer supply levels varied. The availability of sulphur declined even more when the nutrient supply rate was reduced to 50% and the seed was infected with azotobacter and/or PSB (Sharma *et al.*, 2013). Data on the impact of INM on nutrient absorption in a nutshell is display in Table 3.

Table 3: Data on the impact of INM on nutrient absorption in a nutshell.

Nutrient Dose (INM)	Reference
75 % RDF+ Vermicompost @ 1tn/ha + PSB	Datt *et al*. (2003)
Zinc+ organic manure	Meena *et al*. (2006)
FYM+PSB	Singh *et al.* (2008)
5 percent NPK + 1 t/ha vermi-compost + PSB; 100 percent NPK + 1 t/ha vermi-compost + PSB	Devi *et al*. (2011)
S+B+FYM +75% NPK	Natan and Anurag (2011)
Potassium + organic manure	Swarkar *et al.* (2013)
Azotobacter + PSB+ Sulphur	Sharma *et al*. (2013)
S+B+FYM+100 % NPK	Reena *et al*. (2017)

Integrated Nutrient Management's Impact on Growth Parameters: Reproductive traits are influenced by both inorganic and natural biological resources (Joy *et al*., 2018). 90 days after showing, wheat treated with nitrogen-120, phosphorous-60, potassium-40, farmyard manure-10, and zinc 25 kg/ha generated the largest plant height (86.43cm) and the most tillers per plant (7.33) (Sangam *et al*., 2017). The application of 100 percent NPK and FYM changed the 10 ton/ha growth parameter considerably (Arvind *et al.*, 2006; Singh *et al.*, 2008). Increased photosynthate synthesis and nutrient availability result in better yield and biomass production, as indicated by more effective tillers per plant and higher output per plant (Kaur *et al.*, 2018; Khan and Singh, 2011; Kanchroo and Razdan, 2006; Singh *et al.*, 2018; Ahmad *et al*., 2007). Plant height is maximized 30 days after planting by administering 100% of the needed fertilizer dosage, and at harvest stage by adding 75% NPK, vermicompost @ 2.5ton/hector, and azotobacter (Kaur *et al.*, 2018). Nitrogen may lead to more productive tillers and a grain weight of 1000 grains, resulting in increased output (Singh *et al.*, 2011). Applying ten tons of FYM per hectare with crop residues, the proper fertilizer dosage, and 80 percent of mineral fertilizer dose considerably boosted grain yield, grain per year, and thousand-grain weight (Kler *et al*., 2007). More than FYM alone, the combination of FYM with rice residue enhanced wheat development and yield parameters (Davari *et al.*, 2012). In addition to nutrients, organic manures include a microbial population and growth-promoting chemicals that aid in the increase of enzymatic activities and crop expansion or growth. Biofertilizers are tiny organisms that help plants grow.

The Influence of INM on Yield and Yield Attributing Characteristics: Nitrogen is the most important essential component for crop development and output enhancement. The data show that mixing organic matter with chemical fertilizers increases crop biomass and grain yields (Khan *et al*., 2007). When VC and P-solubilizing biofertilizer were administered combined, DMA, no. of effective tillers, grains spike-1, and Test wt. increased. Vermicompost with or without Phosphate solubilizing bacteria (PSB) biofertilizer, in conjunction with various dosages of fertilizers, yielded considerably better grain and biological yields than fertilizer treatment alone. The maximum grain yield and biological yield (4.89 ton/ha) were obtained with 100 percent NPK + vc @ 1ton/ha + Biofertilizer and 75 percent NPK + vc @ 1ton/ha + Biofertilizer. 100 percent Recommended Dose of Fertilizer + vc @ 1ton/ha + PSB, 75 percent RDF + vermicompost @ 1t/ha + PSB, 75 percent RDF + vermicompost @ 1t/ha + PSB, 75 percent NPK + vc @ 1ton/ha + P-Solubilizing Biofertilizer, 75 percent NPK + vc @ 1ton/hectare + PSB, 75 percent NPK+ vc @ 1ton/hectare + PSB (Devi *et al*., 2011). The proper application of nitrogen is recognized as a crucial component in achieving several bumper wheat harvests. According to studies, a high nitrogen supply promotes the conversion of carbohydrates to proteins, which boosts protoplasm formation (Brady and Weil, 2002). Because N is an essential component of all proteins, it is involved in all phases of plant growth. The combination of NPK and Azolla compost boosted wheat yield the greatest (27.015%), followed by NPK and cow dung (24.42%) (Bharati *et al.,* 2017). The number of tillers m^{-2} rose dramatically when PSB was combined with natural manures or other compositions. These results are similar to those of (Kumar *et al.*, 1999), who discovered that inoculating with *Azotobacter chrococcum* greatly enhanced the number of plants per metre row (Afzal *et al.,* 2005). When weighing the pros and cons of various therapies, The prescribed dosage of fertilizers (RDF) combined with Farmyard Mannure, biofertilizer, & Zn generated maximum yields of 50.39 and 52.73 qt/hectare in 2007-2008 and 2008-2009 respectively, whereas RDF + FYM + BF yielded 49.28 qt/ha in 2007-08 and 51.22 qt/ha in 2008-09. It's unsurprising that increasing the quantity of nitrogen sprayed increased wheat grain yield (Jena *et al.,* 1998). Increasing N levels boosted grain output by enhancing the amplitude of yield characteristics. Grain yields increased when the amount of N was increased and the yield characteristic was elevated. According to one research, the increase in yield contributing characteristics was attributed to higher nutrition or nitrogen intake, which led in greater dry material creation and transport to the abyss (Dalal and Dixit, 1987). Wheat tillers and the test weight was found to be affected significantly by the Integrated Nutrient Management (INM). The treatment (75 percent RDF + 10 t FYM ha^{-1}) had the greatest crop height (78 centimeters), active tiller number (82.77), and average weight (test weight) (33.30 gram 1000 per seeds) of all the treatments. INM treatments that contribute N, as well as another nutrients and development-stimulating chemicals, may explain the rise in production contributing characteristics generated by organic manure (FYM 10 tonnes per hectare) (TejAlben *et al*., 2017). Using sophisticated agricultural practices and cultivars, wheat yield may be boosted (Sadat et al., 2010). Increased N (nitrogen) doses had a discernible impact on crop yield, with the greatest crop-grain output (yield) (3.91 ton/ha) at 150 Nitrogen kilogram per hectare (3.91 tonne per hacter), however N (nitrogen) doses over 100 kg N ha^{-1} had little effect on grain yield ha^{-1} (Maqsood *et al*., 2000). Ayoub went on to say that nitrogen fertilizer greatly increased grain output (Ayoub *et al.*, 1994). When compared to the control Nitrogen-120 kilogram per hectare, Phosphorous-60 kilogram per hectare (RDF) *i.e.* T1 [grain and straw yields were 3209 kg per ha and 4223 kg per ha], the implementation of N-150 kg/ha, P-75 kg/ha + Farm yard manure @ 5 tonne per hacter + Azotobacter Biofertilizer + Phosphate Solubilizing Bacteria (Recommended Dose Of Fertilizer). It could also be largely a result of natural fertilizer (farmyard manure), BF, & syntheticfertilizer containing S in sufficient amounts, which plays a critical role in the degradation and incredibly simple release of various nutrient content as well as their accumulation through the plant, Thus, dry matter production is increased & also its absorption of various parts of the crop, their yield and crop growth attributes, and that in turn contrives (Desai *et al.,* 2015). Dry matter accumulation, test weights, ineffective tillers, grain/spike, and grain /spike all rose with the combined application of inorganic and organic fertilizers (Mary *et al*., 2018).

Integrated Nutrient Management's Impact on Soil Productivity: In Integrated Nutrient Management, chemical fertilizers are combined with organic manure and input via the biological process (Jaga and Upadhya 2013). Organic matter has improved nutrient availability and soil water storage capacity, resulting in a more favorable soil environment for plants. Soil organic matter enhances soil porosity, apparent density, and water holding capacity, creating a favorable physical environment for the soil (Benbi and Nieder, 2003). By mixing vermicompost + PSB with fertilizer levels, the levels of Nitrogen, Phosphorous, and Potassium in the soil were considerably enhanced. Harvesting of wheat, available NPK levels were found to be highest when 100 percent NPK (RDF) + vermi-compost @ 1 tonne per hectare + Phosphate Solubilizing Bacteria and 75 percent NPK (RDF) + vermi-compost @ 1 tonne per hectare + Phosphate Solubilizing Bacteria were used, and lowest when controls were used (Devi *et al*., 2011). Increased plant nutrient absorption, increased OC content in the soil, and enhanced Nitrogen, Phosphorus, Potassium status in the soil have all been observed (Khan *et al.,* 2007). Manure application in a particular year benefits not only the current season but also the next season. In a field experiment, nitrogen accessibility was 40% from manures & 15% from composts in the 1st year of treatment, & 18% from manure and 8% from composting in the second year of treatment, improving crop bio-mass and grain yield (Sarwar *et al*., 2007). Chemical fertilizers, farmyard manure, organic manure, and biofertilizers were used in combination to increase soil organic matter content, infiltration rate, moisture retention capacity, and aggregate stability of soil (Saha *et al*., 2010). Continuous use of organic fertilizers increases the effectiveness of chemical fertilizers in the soil by increasing soil microbial activity and adding organic soil colloids with a high nutrient retention surface area, which increased organic matter in the soil from 28.6 percent to 35.7 percent over a year of continuous application of farmyard manure (Manna *et al.,* 2005). By combining chemical and organic fertilizers, it may be feasible to compensate for a lack of certain main (secondary) and minor nutrients in areas that have previously solely received synthetic fertilizers (Chand *et al*., 2006). Their addition to soil has created a soil environment that promotes humic acid production, enhanced soil microbial activity, and increased soil organic carbon content (Bajpai *et al.,* 2006). Adding natural fertilizer (10 tonne Farm yard manure) to fertilizer concentrations dramatically boosted nutrient absorption by wheat crops and raised OC (organic carbon), Nitrogen, Phosphate, and Potassium levels as compared to chemical fertilizer alone. The application of worm compost and Biofertilizer, which increase the life of soil microorganisms, has improved the soil's Nitrogen, Phosphorus, and Potassium levels (Pandey *et al*., 2009).

CONCLUSION

Finally, the review research emphasizes the relevance of wheat Integrated Nutrient Management, as well as organic and inorganic nutrient management strategies, and the role of sources. Due to widespread nutrient deficit or toxicity, soil health is rapidly deteriorating. As a consequence of poor nutrient use, cereal crops have low yield and profitability. Inorganic fertilizer used in conjunction with widely accessible natural sources has a transformational effect on soil health, improving soil fertility, productivity, and quality while reducing inorganic fertilizer's environmental impact. INM are the tools that provide great alternatives and cost effective ways to provide crops to sufficient quantities among most major nutrients and minor nutrients while also reducing the use of synthetic fertilizers, creating beneficial soil physio-chemical environments as well as a good environment, removing constraint, ensuring long-term balanced soil nutrient, generating an optimal amount for sustaining intended agricultural yields, and finally finding a secured method. Wheat yield qualities, considerably greater yield, growth metrics, and disease management were all improved with the use ofa mix of chemical as well as natural source. Thus, using Integrated nutrient management methods such as macro nutrients, secondary nutrients, and minor nutrients, organic fertilizers, biofertilizers, and soil-amendments into wheat crop cultivation improves fertility of the soil and accelerates nutrient absorption, consequently increasing crop development and production qualities as well as food quality. India is the world's second-largest nation by population, behind China. So we won't be able to feed our Indian people by organic farming. The use of pure organic manures in farms is good, but it is a lengthy procedure that yields modest yields after roughly 4-5 years. Furthermore, organic manures are heavy and need professional labor. Instead of organic manures, pure chemical or inorganic fertilizers provide better results with higher yields in less time, but they have a negative influence on the soil's physical and biological state. Finally, the data indicated that Integrated Nutrition Management (INM) might be one of the feasible wheat nutrition management options in India. Pure chemical or inorganic fertilizers, instead of organic manures, produce higher yields in less time, but they have a negative influence on the soil's physiological and biologic health. Finally, the data indicated that one of the most successful wheat nutrition management systems in India is Integrated Nutrition Management (INM). Agriculture experts and farmers should concentrate on a simple INM (integrated nutrient management) technique that is a viable option, as well as a cost-effective approach that farmers can easily implement, and an environmentally friendly methodology that reduces fertilizer use and can produce higher yields with better quality traits while maintaining a profitable profit margin.

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REFERENCES

Afzal A, Ashraf M., Saeed A. A., and Farooq, M. (2005). Effect of phosphate solubilizing microorganisms on phosphorus uptake, yield and yield traits of wheat (*Triticum aestivum* L.) in rainfed area. *International Journal of Agriculture and Biology*, (7): 207-09.

Ahmad, N. I., Shahid, M., Singh, B., and 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): 276-278.

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

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

Bajpai, R. K., Chittale, Upadhya, S., and 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): 24-29.

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

Bharati, A., Baruah, K., Bhattacharya, P., and 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*: 81-91.

Book Essentials of Agriculture by Narayan A. Nagre, 1st Edition, (2018).

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

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*: 63-76.

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

Datt, N., Sharma, R. P., and 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): 266-68.

Davari, M. R., Sharma, S. N., and 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): 12-19

Desai, H. A., Dodia, I. N., Desai, C. K., Patel, M. D., and Patel, H. K. (2015). Integrated Nutrient Management in Wheat (*Triticum aestivum* L.) *Trends in Biosciences, 8*(2): 472-475.

Devi, K. N., Singh, M. S., Singh, N. G., and Athokpam, H. S. (2011). Effect of integrated nutrient management on growth and yield of wheat (*Triticum aestivum* L.) *Journal of Crop and Weed, 7*(2): 23-27.

Ethiopian Institute of Agricultural Research (EIAR) (2019). Kulumsa Agricultural Research Center, Ethiopia, P.O. Box 489, *J Plant Sci Res*., (1): 183.

Ezekiel, Thomas and Nyangani (2010) Effect of combined application of organic manure and chemical fertilizer on soil properties and crop yields *Nigerian journal of science 3*: 31-32

Food and Agriculture Organization, (2012).

Husnain Saleem, Tehseen Ali Jilani , Muhammad Saleem Jilani , Kashif Waseem, Imran Khan, Israr Ullah Khan, Muhammad Niamatullah Babar, Muhammad Naveed, Anjum, Umar Khitab Saddozai, Hafiz Waheed ud din, Javeria Sherani, Abdul Manan and Sami Ullah, (2021). Selection of Suitable Wheat Variety in Rainfed Areas using BEST WORST Method, DEX Method and Expert System Technology: An Integrated Approach. *International Journal on Emerging Technologies, 12*(2): 231-244.

IFA (1999). World fertilizer consumption statistics. Annual.

Jaga, P. K., Upadhya, and V. B. (2013). Effect of Integrated Nutrient management on wheat – A review. *Innovane journal of agricultural science, 5* (13):32-37.

Jena, S. N., and 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):139-142.

Jyoti Bangre, A. K. Dwivedi , M. Mohanty , Subhash, Shish Ram Jakhar and Nishant K. Sinha (2021). Impact of Continuous Application of Fertilizer and Organic Manure on Soil Physical Properties of a Vertisol in Central India. *Biological Forum – An International Journal 13*(2): 646-650.

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

Kachroo, D., and 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): 37-39.

Kale, R.D. and Bano, K. (1986) Field Trials with Vermicompost (Vee Comp. E.83 UAS) an Organic Fertilizer. In: Dash, M.C., Senapati, B.K. and Mishra, P.C., Eds., Procedings of the National Seminar on Organic Waste Utilization, Vermicompost, Part B: Verms and Vermicomposting, Five Star Printing Press, Burla, 151-157.

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): 1800-1803.

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): 109-111.

Khan, M. U., Qasim, M., and Khan, I. U. (2007). Effect of INM on crop yield in rice, wheat cropping system. *Sarhad Journal of agriculture, 23 (*4):10-12.

, F., Sharma, C. R., and 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):13-18.

Kumar, V., Punia, S.S., Lakshminarayan, K., and Narula, N. (1999). Effect of phosphate solubilizing analogue resistant mutants of *Azotobacter chroococcum* on sorghum. *Indian Journal of Agricultural Sciences, 69*: 198-200.

Manpreet, K. (2018). Effect of Integrated Nutrient Management on Growth and Yield of Wheat. Lovely Professional University Punjab (India) 144411.

Manna, M. C., Swarup, A., Wanjari, R. H., Ravankar, N. H., Mishra, B., Sahah, M. N., Singh, Y. V., Shahi, D. K., and 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.

Maqsood, M., Akbar, M., Mahmood, M. T., and 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).

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., and 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*: 50-55.

Mitra, S., Roy, A., Saha, R., Maitra, D. N., Sinha, M. K., Mahapatra, B. S., and 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): 801-804.

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

Nambiar, K. K. M. and Abrol. I. P. (1992). Long term fertilizer experiments in India. *An overview. Fertilizer News, 34*(4): 11-16.

Natan, U. P., and 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): 82-88.

Natan, U. P., and Anurag, C. R. (2011). Residual effect of organic and inorganic fertilizer nutrients on sulphur content and uptake in wheat crop under rice-wheat cropping system. *Journal of Soils and Crops, 21*(10): 82-85.

Pandey, I. B., Dwivedi, D. K., and Pandey, R. K. (2009). Integrated nutrient management for sustaining wheat (*Triticum aestivum* L.) production under late sown condition. *Indian Journal of Agronomy, 54*(3): 306-309.

Reena, P., S. B., Tiwari, D. D., Nigam, R. C., Singh, A. K., and 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): 25-28.

Sadat, H. A., Nematzadeh, G. A., Jelodar, N. B., and 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): 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): 2187-2200.

Saleem,H., Jilani, T.A., Jilani, S.M., Waseem,K. , Khan,I., Khan,I.U., Babar,M.N., Muhammad Naveed, Anjum , Umar Khitab Saddozai , Hafiz Waheed ud din, Javeria Sherani, Abdul Manan and Sami Ullah, 2021. Selection of Suitable Wheat Variety in Rainfed Areas using BEST WORST Method, DEX Method and Expert System Technology: An Integrated Approach**.** *International Journal on Emerging Technologies 12*(2): 231-244.

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

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

Sharma, G. D., Thakur, R., Som Raj, Kauraw, D. L., and 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): 1159-1164.

Sharma, S., Duveiller, E., Basnet, R., Karki, C. B., and 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*: 142-150.

Singh, C.M., Sharma, P.K., Kishor, P., Mishra, P. K., Singh, A.P., Verma, R., and 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:* 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): 205-208.

Singh, G., Kumar, S., Sidhu, G. S., and 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): 904-907.

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

Source: https://agricoop.gov.in/sites/default/files/agristatglance,(2018).pdf.

Source**:** https://www.slideshare.net/vkskumar49/1 - integrated-nutrient-management-in-various agroecosystems-in-tropics.

Srivastava, P., Parkash, B., Sehgal, J. L., and Kumar, S. (1994). Role of neotectonics and climate in development of the Holocene geomorphologyand soils of the Gangetic Plains between the Ramganga and Rapti rivers. *Sedimentary Geology*, *94*, 119–151.

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): 94- 98.

Tejalben, P. G., Patel, K. C., and Vimal, P. N. (2017). Effect of integrated nutrient management on yield attributes and yield of wheat (*Triticum aestivum* L.) *International Journal of Chemical Studies, 5*(4): 1366-1369.

Vimlesh (2010). Agroclimatic zone of wheat in India. Source:-http://agropedia.iitk.ac.in/content/agroclimatic-zone-wheat-india#:~:text=The%20zone%20comprises%20eastern%20Uttar,relatively%20short%20in%20this%20zone

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