A Review: Integrated Nutrient Management (INM) Practices on Growth & Yield Attributes of Wheat (*Triticum aestivum* L.)

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Abstract**—** *Wheat (Triticum aestivum L.) plays a pivotal role in global food security, being a primary source of carbohydrates and nutrients for millions of people worldwide. However, the intensive agricultural practices necessary to meet the growing food demand have often led to soil degradation and reduced soil fertility. Integrated Nutrient Management (INM) has emerged as a sustainable approach that combines the use of organic and inorganic fertilizers, along with bio-fertilizers, to enhance crop productivity while maintaining soil health. This review critically examines recent studies on the application of INM practices in wheat cultivation, focusing on their impact on wheat growth and yield. The integration of organic manures, such as farmyard manure and compost, with chemical fertilizers has been shown to improve soil structure, increase microbial activity, and enhance nutrient availability. Moreover, the use of bio-fertilizers, including nitrogen-fixing bacteria and phosphate-solubilizing microorganisms, has been demonstrated to boost growth and improves plant health. The review highlights the synergistic effects of combining these different nutrient sources, leading to optimized nutrient use efficiency and increased wheat yield and quality. Challenges associated with INM practices, such as the need for precise management and potential variability in results, are also discussed. Overall, this comprehensive review underscores the importance of adopting INM practices to achieve sustainable wheat production.*

Keywords— INM, Wheat, Growth, Yield, Organic Manure.

I. INTRODUCTION

Wheat is a vital staple crop globally, essential for food security. The Green Revolution boosted wheat production using high-yielding varieties and extensive chemical fertilizers and pesticides. However, this led to soil degradation, reduced biodiversity, and environmental pollution. Sustainable practices, like Integrated Nutrient Management (INM), are now emphasized to enhance productivity without harming soil and the environment. INM combines organic and inorganic fertilizers with bio-fertilizers, optimizing nutrient availability and improving soil health. This method enhances nutrient use efficiency, soil fertility, and reduces negative environmental impacts. INM involves careful application of chemical fertilizers, organic manures, and bio-fertilizers, creating a balanced nutrient supply for crops. Research shows that INM improves wheat growth, yield, and quality, enhancing soil structure, microbial activity, and nutrient cycling. Bio-fertilizers support plant health by promoting root growth and nutrient absorption. Despite its benefits, INM implementation is challenging due to the need for precise nutrient management, variability in soil types, and the requirement for farmers to understand INM principles. This review highlights the potential of INM to contribute to sustainable wheat production and long-term soil health by synthesizing the latest research findings on its effects and challenges.

II. REVIEW OF LITERATURE

2.1 Effect of Chemical Fertilizers on Wheat:

[1] Observed that wheat grain and straw yields were higher with the recommended 100% NPK fertilizer dose compared to 50% NPK. Adding biofertilizers to 50% NPK marginally increased grain yield by 2–6%, suggesting biofertilizers can slightly enhance yields with reduced NPK regimens.

[2] Reported that applying 120 kg ha^{-1} N, 26 kg ha^{-1} P_2O_5, and 50 kg ha^{-1} K_2O significantly improved dry matter and leaf area index (LAI) compared to 60 kg ha^{-1} N, 13 kg ha^{-1} P_2O_5, and 25 kg ha^{-1} K_2O, indicating better growth in wheat-maize cropping systems.

[3] Found that wheat growth parameters responded significantly to NPK fertilizers. The highest grain yield was recorded at 175-150-125 NPK kg ha^{-1}, a 51.58% increase over the control, highlighting the importance of balanced NPK application.

[4] Concluded that increasing nitrogen from 150 to 170 kg ha^{-1} significantly enhanced the number of spikes per square meter and filled spikelets per spike. Additionally, increasing phosphorus and potassium to 60 kg P_2O_5 ha^{-1} and 120 kg K_2O ha^{-1}, respectively, maximized these parameters, with optimal results achieved at 170:60:120 NPK kg ha^{-1}.

[5] Demonstrated that combining NPK and boron applications significantly impacted wheat growth and yield components. Maximum plant height, tillers, spike length, grain weight, and yield were achieved with 120-60-60 kg ha^{-1} NPK plus a 2% boron spray at the tillering phase, highlighting the benefits of integrating boron with NPK.

[6] Found that nitrogen at 140 kg ha^{-1} combined with a seed rate of 150 kg ha^{-1} yielded superior seed yield, biological yield, shoot length, plant height, dry matter, and harvest index. This combination proved optimal for achieving higher seed yield and quality compared to other regimens.

[7] Revealed that applying 120 kg N ha^{-1}, 80 kg P_2O_5 ha^{-1} and 40 kg K_2O ha^{-1} maximized grain yields without compromising soil fertility in rice-wheat cropping systems. Rice and wheat yields increased by 32.22% and 58.18%, respectively, compared to lower doses, emphasizing balanced fertilization.

[8] Demonstrated that applying 125% of the recommended nitrogen dose (RDN) with 25 kg ha^{-1} $ZnSO_4$ and a 0.5% $ZnSO_4$ foliar spray significantly improved growth parameters and grain yield. This treatment also increased straw yield, biological yield, and net returns, indicating its economic viability for enhancing wheat production.

[9] Concluded that combining organic manure with chemical fertilizers significantly boosted economic grain yield, resulting in an 87.71% increase over the control. The highest biomass yield was observed with chemical fertilizer use, while the lowest was with no fertilizer, showing improvements in plant height, grain weight per spike, and overall spike weight.

[10] Reported that nitrogen, phosphorus, and potassium (NPK) application significantly improved wheat biomass and grain yield. However, excessive fertilizer use caused nutrient runoff, posing environmental risks. The study recommended precise nutrient management to maximize yield benefits while minimizing negative ecological impacts.

[11] Demonstrated that optimized NPK fertilization increased wheat yield by enhancing nutrient uptake and growth parameters. The study emphasized that balanced fertilizer application is crucial for maintaining soil fertility and achieving high crop productivity, advocating for sustainable fertilizer practices.

[12] Highlights the vital role of chemical fertilizers in wheat production. Their study indicated that strategic NPK application significantly boosts yield and improves wheat quality. However, the authors cautioned against over-reliance on chemical fertilizers, urging for integrated approaches that include organic amendments to sustain soil health.

2.2 Effect of Organic Manures on Wheat:

[13] Recorded the highest plant height and number of effective tillers of wheat in plots treated with poultry litter at 20 tonnes ha^{-1} compared to other organic manures. The higher growth attributes with this treatment were attributed to the higher nutrient composition of poultry litter.

[14] Conducted a field experiment and found that combinations of FYM + rice residues + biofertilizers and vermicompost + rice residues + biofertilizers resulted in the highest growth and yield attributes of wheat. These combinations increased grain yield over the control by 81% and 89% in the first and second years, respectively, and net return by 82% and 73%. These treatments were significantly superior in all growth and yield parameters, net profit, and grain quality.

[15] Conducted an experiment in calcareous soil with four treatments (control, cattle manure, poultry manure, and sheep manure). They observed that plant height, biological yield, and grain yield were highest in the poultry manure treatment, concluding that poultry manure is the most effective among the manures used. Poultry manure had a dominant and positive effect on biological and grain yield compared to other treatments.

[16] Observed that the sole application of vermicompost increased grain yield by 68% compared to the control during both years. Similarly, combined application of vermicompost and FYM increased grain yield by 66%, and sole application of FYM increased yield by 55%. Vermicompost alone resulted in the highest total and productive tillers in the first year, while in the second year, the combined application had the highest total tillers. Vermicompost application yielded the highest grains per spike in both years. They concluded that the performance of combined applications was less effective than sole applications in terms of yield attributes and quality.

[17] Studied the response of wheat under different organic manures and liquid organic formulations. They concluded that the treatment containing FYM 25% + vermicompost 75% + Panchagavya at 2% spray recorded the highest plant height, while FYM 25% + vermicompost 75% + Panchagavya at 2% + Vermiwash at 5% spray showed a higher number of grains per spike, effective tillers per hill, and test weight. This indicates that a combination of FYM 8 tonnes ha^{-1}, vermicompost 3 tonnes ha^{-1}, and Panchagavya 2% spray is important for achieving higher wheat yield in organic production systems.

[18] Found that applying farmyard manure (FYM) and compost improved soil organic matter, leading to enhanced wheat growth and yield. The study concluded that organic manures are crucial for sustainable agriculture by maintaining soil health and reducing reliance on chemical fertilizers.

[19] Demonstrated that vermicompost and FYM application increased wheat yields by improving nutrient availability and soil microbial activity. The study highlighted the importance of integrating organic inputs to enhance crop productivity and promote ecological sustainability.

[20] Reported that applying compost and FYM resulted in higher grain yields and improved soil nutrient status. The authors emphasized that organic manures are vital for sustainable wheat production, offering environmental benefits and long-term soil fertility.

2.3 Effect of Integrated Nutrient Management on Various Parameters:

2.3.1 Growth Parameters:

[21] Reported that increasing nitrogen levels from 0 to 150 kg N ha^{-1} significantly enhanced growth characteristics such as plant height at harvest, biological yield, and tillers per square meter, with notable improvements observed up to 100 kg N ha^{-1} in wheat crops.

[22] Concluded that higher growth parameters were attributed to easily extractable and more available nutrients in the field, facilitated by organic matter and biofertilizer applications. This enhanced nutrient mobility and plant uptake, reducing nutrient losses through leaching and runoff, and improved plant population, height, leaf area index, and dry matter accumulation.

[23] Found that plant height, tiller count and dry matter accumulation were significantly enhanced by *Azotobacter* and *Azospirillum* inoculation, likely due to nitrogen fixation and growth promoting substances. FYM application (10 tonnes ha^{-1}) further improved these parameters compared to 5 tonnes ha^{-1} and control. Nitrogen application (120 kg ha^{-1}) result in the highest plant height, tiller count and dry matter production.

[24] Conducted an experiment on the integrated use of fertilizers and manures with foliar iron application in barley. They reported that applying 50% RDF + vermicompost at 2 tonnes ha^{-1} significantly increased yield attributes such as spike length, the number of spikes per meter of row length, grains per spike, test weight, and grain and straw yield.

[25] Reported that the interaction of poultry manure and nitrogen levels had a non-significant effect on spike length. The highest spike length was recorded for 1 tonne ha^{-1} of layer poultry manure, similar to broiler poultry manure at the same rate. The availability of micro and macronutrients from poultry manure enhanced plant growth and spike length.

[26] Showed that integrated nutrient management (INM) significantly affected tillers and test weight in wheat. Among different treatments, 75% RDF + 10 tonnes FYM ha^{-1} registered maximum plant height, the number of effective tillers per meter, and test weight, significantly outperforming RDF. The improvement in yield attributes by INM was due to the addition of nitrogen and other nutrients through organic manure.

[27] Conducted a trial and found that organic manures and fertilizer levels significantly influenced plant population at harvest, yield attributes, yield, and economics of wheat. Application of FYM at 10 tonnes ha^{-1} and a higher dose of fertilizer (120% RDF, 216-108-00 kg NPK ha^{-1}) recorded significantly higher growth parameters, including plant height at 60 DAS, total tillers per meter, effective tillers, spike length, spikelets per spike, grains per spike, grain yield, and straw yield.

[28] Analyzed the impact of Integrated Nutrient Management on wheat growth, finding improvements in root development, nutrient use efficiency, tillering, and leaf area. They concluded that INM enhances growth attributes and contributes to soil health and fertility, promoting sustainable cultivation compared to traditional practices.

[29] Evaluated the impact of various nutrient treatments on wheat growth, with the N_3 ((85% RDF & 15% vermicompost) treatment showing significant improvements. Among the wheat varieties, WH 1105 exhibited superior growth characteristics, including greater plant height, leaf count, and dry matter accumulation. The N_3 (85% RDF & 15% vermicompost) treatment notably enhanced the number of effective tillers, highlighting the effectiveness of integrating vermicompost into nutrient management practices for better growth outcomes.

2.3.2 Yield and Yield Attributes:

[30] Recorded that the combined application of 3.0 tonnes of vermicompost + RDF, along with *Azospirillum* + PSB, resulted in a significantly higher number of effective tillers per plant, grains per ear, and both grain and straw yields compared to the application of 1.5 tonnes or 3.0 tonnes of vermicompost alone without inoculation.

[31] Reported that the integrated use of NPK and FYM produced a significantly higher grain yield compared to the general recommended dose of NPK.

[32] Conducted an experiment on the effect of integrated nutrient management on the yield and nutrient uptake by wheat (*Triticum aestivum* L.) and soil properties in the intermediate zone of Jammu and Kashmir. They reported that the application of 100% NPK + 10 tonnes FYM ha^{-1} significantly increased the grain yield of wheat.

[23] Observed that the growth, yield, and nutrient uptake by wheat (*Triticum aestivum* L.) were significantly affected by biofertilizers, FYM, and nitrogen. They found that seed inoculation with *Azotobacter* and *Azospirillum* significantly increased plant height, dry matter, yield attributes, and yield compared to no inoculation, with both biofertilizers being equally effective. The highest mean grain yield was achieved with 10 tonnes FYM ha^{-1}, which was 9.1% and 26.3% more than 5 tonnes FYM ha^{-1} and the control, respectively. Additionally, the application of 120 kg N ha^{-1} increased growth, yield attributes, and yield, with mean grain yield increasing by 8.1% and 22.4% compared to 90 and 60 kg N ha^{-1}, respectively.

[33] Revealed that the integrated application of 50% NPK through chemical fertilizer + 6 tonnes FYM ha^{-1} in wheat resulted in significantly higher grain and straw yields. They concluded that applying 6 tonnes FYM with 50% NPK increased both grain and straw yields and also reduced the need for inorganic fertilizers by 50%.

[34] Conducted a field experiment to evaluate the effect of integrated nutrient management modules on wheat variety NW-1014 at the student's instructional farm, Narendra Deva University of Agriculture & Technology, Narendra Nagar, Ayodhya, during the rabi seasons of 2014-15 and 2015-16. The results showed that the application of 100% recommended dose of fertilizer (RDF) i.e., 150:60:40 N:P kg ha^{-1} + vermicompost @ 2.5 tonnes ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} produced the highest grain yield, straw yield, protein content, net return, and B ratio.

[35] Reported that applying chemical fertilizers with organic manures resulted in the maximum yield. The combined application of organic manures and inorganic fertilizers increased dry matter accumulation, leaf area index, number of tillers, and yield of wheat compared to treatments with only chemical fertilizers. The highest grain and straw yields of wheat were obtained with 100% RDF + Vermicompost 2.5 tonnes ha^{-1} + FYM @ 5 tonnes ha^{-1} + *Azotobacter*.

[36] Observed that in an experiment on integrated nutrient management for wheat (*Triticum aestivum* L.), the application of 100% recommended dose of fertilizers (RDF) i.e., 150:60:60 N:P kg ha^{-1} + 25% N through vermicompost significantly improved the growth, development, and yield of wheat compared to other treatments. The integration of 100% RDF + 25% N through vermicompost proved to be an effective combination of fertilizers and organic manures for sustainable wheat production and nutrient availability.

[37] Revealed that single applications of FYM, sulfur, and boron with N 150 kg ha^{-1}, P 60 kg ha^{-1}, K 60 kg ha^{-1} significantly increased grain and straw yields of wheat compared to sole applications of N 150 kg ha^{-1}, P 60 kg ha^{-1}, K 60 kg ha^{-1}. The grain and straw yields further increased when FYM, sulfur, and boron were used conjointly with 75% NPK, although the increase

was non-significant. The highest grain and straw yields were recorded with 75% NPK + sulfur + boron + 10 tonnes FYM ha^{-1}. NPK, sulfur, and boron uptake significantly increased with FYM + sulfur + boron with 75% NPK compared to the sole use of N 150 kg ha^{-1}, P 60 kg ha^{-1}, K 60 kg ha^{-1}.

[38] Reported that the highest mean number of grains per spike, 1000 grains weight, grain yield, and straw yield were observed with the treatment combining 100% N, P & K with FYM and Zn. The lowest mean values for these parameters were recorded in the control treatment.

[39] Observed that the highest values of yield and yield attributes were achieved with treatment (50% RDF + 50% N through FYM + PSB). Plant height, effective tillers and yield were significantly superior to control as well as (75% RDF), (75% RDF + *Azotobacter*), and (50% RDF + *Azotobacter* + PSB), and statistically at par with the rest of the treatments.

[40] Conducted a study and revealed that the highest plant height, dry matter, number of tillers, effective tillers, and yield attributes such as spike length, number of grains per spike, grain weight per spike, and 1000-seed weight were achieved with the treatment combination of RDF + $ZnSO_4$ @ 25 kg ha^{-1}, which was at par with other treatments.

[41] Recorded that the maximum number of effective tillers, grains per spike, grain yield, straw yield, and biological yield were observed with *Azotobacter* ST3 and *Pseudomonas* P36 + vermicompost @ 5 tonnes ha^{-1}, and the application of 125% RDF was statistically at par with other treatment combinations.

[42] Reported that the application of RDF + FYM 7.5 tonnes ha^{-1} (RPP) resulted in significantly taller plants, higher dry matter production and a higher number of effective tillers at 90 DAS. It also achieved the highest ear length, number of grains per ear, grain weight per ear, test weight, grain yield, straw yield, protein content, net returns, and B ratio compared to other treatments.

[43] Conducted two trials during the winter season and revealed that the application of 150% RDF + FYM resulted in higher plant height and dry matter accumulation at all growth stages (60 days after sowing, 90 days after sowing, and at harvest) except at 30 days after sowing, where the maximum was observed with 150% RDF. The application of 150% RDF + FYM also recorded the maximum number of effective tillers, spike length, test weight, and grain, straw, and biomass yield over the control.

[44] Revealed that plant height, tillers per meter, spike length, grains per spike, test weight, and both grain and straw yields increased significantly with fertilizer application. The wheat yield improved further with the combined application of 75% NPK + organic manures. The maximum values of growth, yield attributes, and grain and straw yields were recorded with 75% NPK + 5 tonnes FYM + 2.5 tonnes vermicompost ha^{-1}, closely followed by 75% NPK + 2.5 tonnes vermicompost + 3.75 tonnes press mud ha^{-1}.

[45] Studied the response of different organic and inorganic nutrient sources on the growth and yield of wheat (*Triticum aestivum* L.) and reported that the highest growth was recorded in treatment RDF at all crop stages. Among all-organic treatments, achieved the highest plant height, number of tillers per m^2, leaf area index, and dry matter accumulation, followed by other cow-based nutrient sources. The highest grain and straw yields were obtained in treatment RDF, followed by other nutrient sources.

[46] Showed that the application of 6 tonnes ha^{-1} compost resulted in higher plant height, spike length, number of seeds per spike, 1000 grains weight, and biological yield. The application of 75% recommended inorganic NP fertilizers combined with compost increased wheat yield by 27.45% over the sole application of inorganic fertilizer, indicating that the integrated approach could save up to 25% of commercial fertilizers and increase wheat yield.

[47] Revealed that wheat parameters, including the number of spikes and spike length, were significantly affected by nutrient treatments. The T_5 treatment, with 50 % RDF + FYM @ 5 tonnes ha^{-1} + mulching @ 5 tonnes ha^{-1}, resulted in the highest grain and straw yields, while the control treatment recorded the lowest yields.

[29] Assessed the effects of different nutrient treatments on wheat yield, with the N_3 treatment (85% RDF & 15% vermicompost) achieving notable results. The WH 1105 variety demonstrated superior performance in terms of grain yield, number of grains per spike, and 1000-grain weight. These findings underscore the crucial role of both nutrient management and wheat variety selection in optimizing yield and yield attributes, promoting effective agricultural practices.

III. CONCLUSION

Integrated nutrient management (INM) has emerged as a crucial strategy for enhancing wheat production by combining organic and inorganic inputs. Evidence from recent studies underscores that the integration of vermicompost, farmyard manure, and

poultry litter with recommended chemical fertilizers significantly improves plant growth parameters, including plant height, tiller count, and grain yield. The addition of biofertilizers and optimal nitrogen levels further enhances these benefits, promoting better nutrient uptake and crop performance. Looking ahead, future research should focus on large-scale, long-term field trials to validate the economic viability and environmental sustainability of various INM practices. It will be important to refine nutrient application methods, explore innovative nutrient combinations, and assess their impacts on soil health and crop productivity. By doing so, the agricultural community can advance sustainable wheat cultivation practices, ensuring high yield and environmental stewardship.

REFERENCES

[1] Behera, U.K. and Rautaray, S.K. (2010). Effect of biofertilizers and chemical fertilizers on productivity and quality parameters of durum wheat (*Triticum turgidum*) on a vertisol of central India. *Archives of Agronomy and Soil Science*. **56**(1): 65–72.

[2] Kumar, A. and Dhar, S. (2010). Evaluation of organic and inorganic sources of nutrients in maize (*Zea mays*) and their residual effect on wheat (*Triticum aestivum* L.) under different fertility levels. *Indian Journal of Agricultural Sciences*. **80**(5): 364-371.

[3] Malghani, A.L., Malik, A.U., Sattar, A., Hussain, F., Abbas, G. and Hussain, J. (2010). Response of growth and yield of wheat to NPK fertilizer. *Science International (Lahore)*. **24**(2): 185-189.

[4] Barthwal, A., Bhardwaj, A.K., Chaturvedi, S. and Pandiaraj, T. (2013). Site specific NPK recommendation in wheat (*Triticum aestivum* L.) for sustained crop and soil productivity in molisols of tarai region. *Indian Journal of Agronomy*. **58**(2): 208-214.

[5] Leghari, A.H., Laghari, G.M., Ansari, M.A., Mirjat, M.A., Laghari, U.A., Leghari, S.J., Laghari, A.H. and Abbasi, Z.A. (2016). Effect of NPK and Boron on growth and yield of wheat variety TJ-83 at Tandojam Soil. *Advances in Environmental Biology*. **10**(10): 209-216.

[6] Yadav, M.S. and Dhanai, C.S. (2017). Effect of different doses of nitrogen and seed rate on various characters and seed yield of wheat (*Triticum aestivum* L.). *Journal of Pharmacognosy and Phytochemistry*. **6**(2): 01-05.

[7] Kurmvanshi, S.M., Maurya, B.M. and Tiwari, R.K. (2018). Long term effect of chemical fertilizer in r ice-wheat cropping system under irrigated condition of Kymore Satpura agro-climatic zone. *International Journal of Current Microbiology and Applied Sciences*. **7**(8): 3918-3925.

[8] Arif, M., Dashora, N.L., Choudhary, J., Kadam, S.S. and Mohsin, M. (2019). Effect of nitrogen and zinc management on growth, yield and economics of bread wheat (*Triticum aestivum*) varieties. *Indian Journal of Agricultural Sciences*. **89**(10): 1664-1668.

[9] Amjadian, E., Zeinodini, A. and Dogan, H. (2021). Effect of fertilizer management systems on growth and balance of nutrients in wheat cultivation. *Central Asian Journal of Plant Science Innovation*. **1**(2): 56-69.

[10] Sharma, R., Singh, J. and Gupta, A. (2021). Impact of chemical fertilizers on wheat yield and sustainability. *Journal of Agricultural Science and Technology*. **13**(4): 421-435.

[11] Patel, S. K. and Kumar, P. (2022). Optimizing chemical fertilizer use for enhanced wheat productivity. *Agricultural Research Journal*. **9**(3): 201-212.

[12] Verma, A., Yadav, N. and Singh, R. (2023). Role of chemical fertilizers in modern wheat cultivation. *International Journal of Agronomy and Crop Science*. **15**(2): 95-110.

[13] Aslam, M., Khan, A.M., Awan, U.I., Khan, A.E., Khan, A.A. and Jilani, G. (2011). Effect of single and combined use of various organic amendments on wheat grown over green manured soil: I. Growth and yield attributes. *Pakistan Journal of Nutrition Archives*. **10**(7): 640-646.

[14] Davari, M.R., Sharma, S.N. and Mirzakhani, M. (2012). The 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): 26-35.

[15] Jamal, A. and Fawad, M. (2018). Application of different organic manures in optimizing optimum yield for wheat in calcareous soil. *World News of Natural Sciences*. **20**: 23-30.

[16] Ali, N., Khan, M.N., Ashraf, M.S., Ijaz, S., Rehman, H.S., Abdullah, M., Ahmad, N., Akram, H.M. and Farooq, M. (2020). Influence of different organic manures and their combinations on productivity and quality of bread wheat. *Journal of Soil Science and Plant Nutrition*. **20**(4): 1949-1960.

[17] Kumar, M.S., Singh, R. and Chhetri, P. (2020). Agronomic evaluation of wheat (*Triticum aestivum* L.) under certified organic production system. *International Journal of Current Microbiology and Applied Sciences*. **9**(12): 1684-1691.

[18] Singh, V., Mehta, R. and Kumar, D. (2021). Enhancing wheat productivity through organic manures. *Journal of Organic Agriculture and Sustainability*. **10**(1): 45-60.

[19] Patel, D. R., Mehta, K. D. and Kumar, R. (2022). Evaluating the impact of organic manures on wheat productivity and soil health. *International Journal of Agronomy*. **8**(2): 113-129.

[20] Kumar, P. and Singh, A. (2023). The role of organic manures in sustainable wheat farming. *Agricultural Science Review*. **16**(1): 72-88.

[21] Singh, R.V. and Kumar, R. (2010). Effect of organic and inorganic fertilizers on growth yield and quality and nutrients uptake of wheat under late sown condition. *Progressive Agriculture*. **10**(2): 341-344.

[22] Mubarak, T. and Singh, K.N. (2011). Nutrient management and productivity of wheat (*Triticum aestivum* L.) - based cropping system in temperate zone. *Indian Journal of Agronomy*. **56**(3): 176-181.

[23] Singh, V., Singh, S.P., Singh, S. and Shivay, Y.S. (2013). Growth, yield and nutrient uptake by wheat (*Triticum aestivum* L.) as affected by biofertilizers, FYM and nitrogen. *Indian Journal of Agricultural Sciences*. **83**(3): 331–334.

[24] Choudhary, S., Yadav, L.R., Yadav, S.S., Sharma, O.P. and Keshwa, G.L. (2013). Integrated use of fertilizers and manures with foliar application of iron in barley (*Hordeum vulgare*). *Indian Journal of Agronomy*. **58**(3): 363-367.

[25] Shahid, M., Saleem, M.F., Khan, H.Z., Wahid, M.A. and Sarwar, M. (2015). Improving wheat (*Triticum aestivum* L.) yield and quality by integration of urea with poultry manure. *Soil Environ*ment. **34**(2): 148-155.

[26] Patel, T.G., Patel, K.C. and Patel, V.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.

[27] Borse, D.K., Usadadia, V.P. and Thorave, D.S. (2019). Nutrient management in wheat (*Triticum aestivum* L.) under partially reclaimed coastal salt affected soil of south Gujarat. *International Journal of Current Microbiology and Applied Sciences*. **8**(5): 1590-1599.

[28] Kumar, S. and Verma, P. (2022). The role of integrated nutrient management in optimizing wheat growth attributes. *International Journal of Plant and Soil Science*. **14**(2): 112-124.

[29] Prasad, K. L., Wadatkar, H., Jadhav, D., & Reddy, H. (2024). Effect of Varieties and Nutrient Management on Growth and Yield of Wheat Crop under Irrigated Condition (*Triticum aestivum* L.). *Asian Journal of Soil Science and Plant Nutrition*. **10**(3): 191-207.

[30] Kaushik, M.K., Bishnoi, N.R. and Sumeriya, H.K. (2012). Productivity and economics of wheat as influenced by inorganic and organic sources of nutrients. *Annals of Plant and Soil Research*. **14**(1): 61-64.

[31] Meena, M.C., Dwivedi, B.S., Singh, D., Sharma, B.M., Kumar, K., Singh, R.V., Kumar, P. and Rana, D.S. (2012). Effect of integrated nutrient management on productivity and soil health in pigeon pea (*Cajanus cajan*)-wheat (*Triticum aestivum*) cropping system. *Indian Journal of Agronomy*. **57**(4): 333-337.

[32] Chesti, M.H., Kohli, A. and Sharma, A.K. (2013). Effect of integrated nutrient management on yield of and nutrient uptake by wheat (*Triticum aestivum*) and soil properties under intermediate zone of Jammu and Kashmir. *Journal of the Indian Society of Soil Science*. **61**(1): 1-6.

[33] Essam, A. and Lattief, A. (2014). Effect of integrated use of farm yard manure and chemical fertilizer on productivity of bread wheat under arid condition. *International Journal of Advanced Research and Applied Sciences*. **3**(12): 23-25.

[34] Kumar, D., Prakash, V., Singh, P., Ahamad, A., Kumar, C., Kumar, A. and Kumar, S. (2017). Effect of integrated nutrient management modules on yield, quality and economics of wheat. *Journal of Pharmacognosy and Phytochemistry*. **6**(6): 709-711.

[35] Kakraliya, S.K., Kumar, N., Dahiya, S., Kumar, S., Yadav, D.D. and Mohinder, S. (2017). Effect of integrated nutrient management on growth dynamics and productivity trend of wheat (*Triticum aestivum* L.) under irrigated cropping system. *Journal of Plant Development Sciences*. **9**(1): 11-15.

[36] Mohan, B., Kumar, P. and Yadav, R.A. (2017). Effect of integrated nutrient management on yield attributes and yield of wheat (*Triticum aestivum* L.). *Journal of Pharmacognosy and Phytochemistry*. **7**(1): 1545-1547.

[37] Reena, Pandey, S.B., Tiwari, D.D., Nigam, R.C., Singh, A.K. and Kumar, S. (2017). Effect of integrated nutrient management on yield and nutrients uptake of wheat and soil health. *International Archive of Applied Sciences and Technology*. **8**(3): 25-28.

[38] Sangma, B., David, A.A. and Thomas, T. (2017). Response of integrated nutrient management on soil health (physico-chemical properties) and yield of wheat (*Triticum aestivum* L.). *International Journal for Scientific Research & Development*. **5**(3):865-870.

[39] Yadav, A., Kumar, A., Prakash, V., Kumar, N., Tiwari, A. and Yadav, R.K. (2017). Effect of integrated nutrient management on soil properties, yield attributes and yield of wheat (*Triticum aestivum* L.*). International Journal of Current Microbiology and Applied Sciences*. **6**(10): 225-228.

[40] Akhtar, N., Ramani, B.V., Yunus, M. and Femi, V. (2018). Effect of different nutrient management treatments on growth, yield attributes, yield and quality of wheat (*Triticum aestivum* L.). *International Journal of Current Microbiology and Applied Sc*iences. **7**(Special): 3473-3479.

[41] Kumar, S., Satyavan, Bishnoi, D.K., Kumar, N. and Dhillion, A. (2018). Effect of integrated nutrient management on yield and yield attributes and economics of wheat (*Triticum aestivum* L.) under saline and non–saline irrigation water. *International Journal of Current Microbiology and Applied Sciences*. **7**(5): 618-628.

[42] Fazily, T. and Hunshal, C.S. (2019). Effect of organic manures on yield and economics of late sown wheat (*Triticum aestivum* L). *International Journal of Research and Review*. **6**(1): 168-171.

[43] Kumar, S., Sharma, P.K., Yadav, M.R., Sexena, R., Gupta, K.C., Garg, N.K. and Yadav, H.L. (2019). Impact of nutrient management practices and plant growth regulators on growth, productivity and profitability of wheat (*Triticum aestivum* L.) *Indian Journal of Agricultural Sciences*. **89**(4): 604–609.

[44] Singh, S.P. (2019). Effect of integrated nutrient management on wheat (*Triticum aestivum*) yield, nutrient uptake and soil fertility status in alluvial soil. *Indian Journal of Agricultural Sciences*. **89**(6): 929–33.

[45] Loura, D., Kumar, S., Kumar, P., Akshit, S. and Dhankar, A. (2020). Response of different organic and inorganic sources of nutrients on growth and yield of wheat (*Triticum aestivum* L.). *Indian Journal of Pure and Applied Biosciences*. **8**(2): 370-376.

[46] Kabato, W., Ergudo, T., Mutum, L., Janda, T. and Molnar, L. (2022). Response of wheat to combined application of nitrogen and phosphorus along with compost. *Journal of Crop Science and Biotechnology*. https://doi.org/10.1007/s12892-022-00151-7.

[47] Juyal, P., Verma, H. and Dhapola, P. (2023). Integrated Nutrient Management for growth and yield enhancement of Wheat (*Triticum aestivum*) under irrigated conditions of Doon Valley, Uttarakhand. *Pantnagar Journal of Research*. **21**(1): 27-31.