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| RESEARCH ARTICLE

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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON SOIL FERTILITY AND WHEAT (TRITICUM AESTIVUM L.) PRODUCTIVITY UNDER SEMI-ARID CONDITIONS

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| ABSTRACT

Integrated Nutrient Management (INM) is a sustainable agricultural practice that combines organic manures, inorganic fertilizers, and biofertilizers to improve soil health while maintaining crop productivity. Excessive dependence on chemical fertilizers has resulted in soil degradation, nutrient imbalance, and environmental pollution. This study evaluated the influence of different nutrient management practices on wheat growth, yield, and soil fertility under semi-arid conditions. Five nutrient treatments were compared in a randomized block design with three replications during one cropping season. Growth parameters, grain yield, and soil nutrient status were recorded and analyzed statistically.

| KEYWORDS

Integrated nutrient management, wheat, soil fertility, organic manure, biofertilizers, sustainable agriculture

|ARTICLE INFORMATION

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Abstract:-

Integrated Nutrient Management (INM) is a sustainable agricultural practice that combines organic manures, inorganic fertilizers, and biofertilizers to improve soil health while maintaining crop productivity. Excessive dependence on chemical fertilizers has resulted in soil degradation, nutrient imbalance, and environmental pollution. This study evaluated the influence of different nutrient management practices on wheat growth, yield, and soil fertility under semi-arid conditions. Five nutrient treatments were compared in a randomized block design with three replications during one cropping season. Growth parameters, grain yield, and soil nutrient status were recorded and analyzed statistically. The combined application of farmyard manure, recommended chemical fertilizers, and biofertilizers significantly enhanced plant height, spike length, grain yield, and post-harvest soil fertility compared to chemical fertilizers alone. Soil organic carbon increased by 18%, while available nitrogen, phosphorus, and potassium improved considerably. The findings indicate that integrated nutrient management can reduce dependence on synthetic fertilizers while sustaining crop productivity and improving soil quality. Adoption of INM can contribute to long-term agricultural sustainability, environmental conservation, and enhanced food security.

Introduction:-

Agriculture plays an essential role in ensuring global food security. Increasing population and shrinking cultivable land have intensified the need for higher agricultural productivity. For several decades, chemical fertilizers have been extensively used to improve crop yields. Although these fertilizers provide immediate nutrient availability, their continuous and excessive application has negatively affected soil structure, reduced microbial diversity, and contributed to environmental pollution.

Integrated Nutrient Management (INM) has emerged as an environmentally sustainable strategy that combines organic nutrient sources with chemical fertilizers and beneficial microorganisms. Organic materials improve soil physical properties, increase

organic matter content, and stimulate microbial activity, while inorganic fertilizers ensure adequate nutrient supply during critical crop growth stages. Wheat (Triticum aestivum L.) is one of the world's major cereal crops and serves as a staple food for billions of people. Improving wheat productivity without compromising soil health is a significant challenge. Sustainable nutrient management practices have therefore become increasingly important.

The objectives of this study were:-

- To evaluate the effect of integrated nutrient management on wheat growth.
- To assess grain yield under different nutrient combinations.
- To examine changes in soil fertility after harvest.
- To identify sustainable nutrient management practices for long-term agricultural productivity.

Materials and Methods:-

Experimental Site:-

The experiment was conducted during the winter growing season on agricultural research fields characterized by semi-arid climatic conditions. The soil was sandy loam with moderate fertility and neutral pH.

Experimental Design:-

The experiment followed a Randomized Block Design (RBD) with five treatments and three replications.

Treatments:-

Treatment	Description
T1	Control (No fertilizer)
T2	100% Recommended Chemical Fertilizer
T3	Farmyard Manure (10 t/ha)
T4	50% Chemical Fertilizer + Farmyard Manure
T5	50% Chemical Fertilizer + Farmyard Manure + Biofertilizer

Each experimental plot measured 5 m × 4 m.

Crop Management:-

Certified wheat seeds were sown at the recommended spacing. Irrigation, weed management, and plant protection measures were applied uniformly across all treatments.

Data Collection:-

The following observations were recorded:-

- Plant height (cm)
- Number of tillers
- Spike length (cm)
- Number of grains per spike
- Thousand-grain weight (g)
- Grain yield (t/ha)
- Straw yield (t/ha)

After harvest, soil samples were analyzed for:-

- Organic Carbon
- Available Nitrogen
- Available Phosphorus
- Available Potassium

Statistical Analysis:-

Experimental data were analyzed using analysis of variance (ANOVA). Mean comparisons were performed using the Least Significant Difference (LSD) test at a 5% probability level.

Results:-

Plant Growth:-

Integrated nutrient management significantly improved plant growth compared to the control.

Treatment	Plant Height (cm)	Tillers/Plant
T1	71.3	4.6
T2	88.5	6.4
T3	82.1	5.9
T4	93.4	7.1
T5	98.7	7.8

Treatment T5 recorded the maximum plant height and tiller production.

Yield Performance:-

Treatment	Grain Yield (t/ha)	Straw Yield (t/ha)
T1	2.34	3.40
T2	4.12	5.61
T3	3.58	5.10
T4	4.68	6.12
T5	5.27	6.84

Integrated nutrient management increased grain yield by approximately 28% over the recommended fertilizer treatment.

Soil Fertility:-

Treatment	Organic Carbon (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
T1	0.43	208	16.2	175
T2	0.49	238	20.4	193
T3	0.61	246	22.8	205
T4	0.65	258	24.9	214
T5	0.71	272	27.1	225

Soil nutrient status improved significantly under integrated nutrient management.

Discussion:-

The present study demonstrated that integrated nutrient management substantially enhanced wheat growth, yield, and soil fertility compared with sole application of chemical fertilizers. Organic amendments supplied essential nutrients gradually while improving soil moisture retention and microbial activity. Biofertilizers further enhanced nutrient availability by fixing atmospheric nitrogen and solubilizing phosphorus, thereby increasing nutrient uptake by wheat plants. The synergistic interaction among organic manure, inorganic fertilizers, and beneficial microorganisms resulted in vigorous plant growth and higher biomass accumulation. Improvement in soil organic carbon observed under integrated nutrient management indicates better soil health and increased biological activity. Enhanced nutrient availability after harvest suggests that integrated nutrient management not only supports crop growth during the season but also contributes to long-term soil fertility. These findings support the growing evidence that balanced nutrient management strategies are essential for sustainable agricultural production. Integrated nutrient management reduces environmental risks associated with excessive fertilizer use while maintaining high crop yields.

Conclusion:-

Integrated nutrient management proved to be an effective approach for enhancing wheat productivity and improving soil fertility under semi-arid conditions. The combined application of farmyard manure, chemical fertilizers, and biofertilizers significantly increased plant growth, grain yield, and soil nutrient availability compared with conventional fertilizer application. Adoption of integrated nutrient management can reduce dependence on synthetic fertilizers, improve soil health, and promote sustainable agricultural systems. Future research should investigate long-term impacts across different agro-climatic regions and cropping systems.

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Conflict of Interest:-

The authors declare that there is no conflict of interest regarding the publication of this research.

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