The Journal of Rural and Agricultural Research Volume 26, No. 1, 31-37 (2026)
Received May 2026; Acceptance June 2026
RNI UP BILL/2001/7990 ISSN 2348-6643 (Online) ISSN 0972-4370 (Print)

Agronomic Evaluation of Super Nano Urea for Enhancing Growth, Yield, and Productivity of Summer Maize in Varanasi, Uttar Pradesh

RAMAWATAR MEENA*
Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221 005, and Uttar Pradesh, India.
**Corresponding author:* ramawatar.meena@bhu.ac.in

Abstract

At the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University (BHU), Varanasi, Uttar Pradesh, a field experiment was carried out in the summer of 2023 to assess the effectiveness of Super Nano Urea (SNU) on the growth and productivity of summer maize (Zea mays L.) hybrid SUJATA. 11 treatments and 3 replications made up the Randomized Block Design used in the investigation. Results showed that the recommended dose of fertilizers (RDF; 100% NPK) recorded the highest growth and yield parameters. However, plant height (168.67 cm), grain yield (24.67 q ha{ ^{1}), and straw yield (37.00 q ha{ ^{1}) were statistically comparable to RDF in treatment T (50% required nitrogen dose + two foliar sprays of SNU @ 1.0%). When compared to the control, Super Nano Urea greatly enhanced cob attributes, grain number, and harvest index. According to the results, foliar application of SNU at 1.0% can efficiently replace 50% of baseline nitrogen fertilizer while preserving maize yield. This enhances nitrogen usage efficiency and promotes sustainable nutrient management.

Keywords: Super Nano Urea, maize, nitrogen use efficiency, foliar application, grain yield, sustainable nutrient management

Introduction

Food grain self-sufficiency has resulted from high input agriculture, but it has also created a number of new difficulties. There is currently much discussion about converting modern agriculture to organic farming. According to Rawat et al. (2024) and Maignan et al. (2020), modern chemical-intensive agriculture has led to land degradation due to low crop yields and poor produce quality due to the cultivation of high-yielding varieties with indiscriminate fertilizer use, poor water management practices, and ineffective plant-protection measures.

Zea mays L., or maize, is a member of the Poaceae family and is native to Mexico. Maize, one of the world's most important cereal crops, contributes to food security in several poor countries. In India, maize is considered one of the three most essential crops, after wheat and rice. The fact that maize is used not just for human nutrition but also for animal feed and the food processing industries accounts for its widespread appeal. As a result, it is known as the "Queen of Cereals" (Tripathi et al., 2025; Yadav et al., 2019; Singh, R. K., 2022). The grain of maize has 11.1% protein, 66.3% carbs, 3.6% fat, 2.7% fiber, and 1.5% minerals.

It is the only cereal crop that can be grown in a range of habitats, temperatures, and ecosystems. Regular yellow/white grain, sweet corn, baby corn, popcorn, waxy corn, high amylase corn, high oil corn, and quality protein maize are only a few of the many types of maize. In addition to being a staple food for humans and premium animal feed, maize is a basic raw material used in thousands of industrial products, such as starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, textile, gum, package, and paper industries (Singh et al., 2023; Shukla et al., 2016; Pal et al., 2015).

Nitrogen, which is essential for plant growth, is lacking in India's soils. The main causes of this nutrient loss are volatilization, denitrification, and leaching. To stop these losses from occurring, we can apply fertilizers and nutrients to the soil by foliar application (Vasanth et al., 2024; Meena et al., 2014; Mitra and Mandal, 2012). Applying fertilizer directly onto a plant's leaves is known as foliar application. Plants can absorb nutrients through their foliage. Field crops usually receive most of the nutrients from the soil through their roots, even if above-ground plant structures, especially leaves, can only absorb trace amounts of some elements. This technology is easy to use and reasonably priced (Sharma et al., 2022).

Materials and Methods

A field experiment was conducted during the summer season of 2023 at the Agricultural Research Farm, Institute of Agricultural Sciences (IAS), Banaras Hindu University (BHU), Varanasi, Uttar Pradesh, India, along with a farmer's field, to evaluate the efficacy of Super Nano Urea (SNU) on the growth and productivity of summer maize using hybrid maize variety SUJATA (Pahuja Seeds Pvt. Ltd.), a widely cultivated hybrid suitable for summer cultivation. The subtropical climate at the testing site exhibits discernible seasonal variations. With average temperatures ranging from 39°C to 43°C, May and June are the hottest months. Winters are quite cold, with January having the lowest temperatures of 9 to 10 degrees Celsius. The weekly mean maximum and lowest temperatures during crop growth range from 38.1°C to 16.1°C and from 4.8°C to 20.1°C, respectively. This area's sandy clay loam soil has a consistent nutrient distribution and texture.

The experiment a Randomized Block Design (RBD) with eleven treatments and three replications, comprising a total of 33 experimental plots. Each plot measured 5 m × 4 m (20 m²). The treatments included: T –Absolute control; T‚ –Recommended Dose of Fertilizers (RDF; 100% NPK as per BHU recommendation); Tƒ –50% recommended nitrogen dose (RDN) with 100% recommended phosphorus and potassium (PK); T„ –50% RDN + two sprays of SNU @ 0.25%; T… –50% RDN + two sprays of SNU @ 0.5%; T† –50% RDN + two sprays of SNU @ 1.0%; T‡ –50% RDN + two sprays of conventional urea @ 1.0%; Tˆ –50% RDN + one spray of SNU @ 1.0%; T‰ –50% RDN + two sprays of SNU @ 0.5%; T € –25% RDN + three sprays of SNU @ 0.5%; and T –25% RDN + three sprays of conventional urea @ 1.0%. Advanced/Super Nano Urea was applied as a foliar spray at three concentrations: 0.25% (2.5 mL L{ ¹ water), 0.5% (5.0 mL L{ ¹ water), and 1.0% (10.0 mL L{ ¹ water). Depending on the treatment, one, two, or three foliar sprays were administered at the knee-high, pre-flowering, and grain-filling (milking) stages of crop growth. At 30, 45, and 60 days after sowing (DAS), measurements of the plant's height

Fig. 1: Plant height measurement at 45 DAS and silking stage of the summer maize

and leaf count were made. Following normal agronomic techniques, yield variables such as cob length, cob weight, grain rows per cob, number of grains per cob, grain yield, straw yield, biological yield, and harvest index were recorded during harvest. Analysis of variance (ANOVA) suitable for the Randomized Block Design was applied to the experimental data, and treatment means were compared at the 5% significant level.

Results and Discussion

Plant Height

Plant height (Table 1) was measured at 30, 45 and 60 days after sowing. At 30 DAS, the maximum plant height was observed in treatment T_2 (80.33 cm) followed by treatment T_6 (80.00 cm) which was 28.21 and 27.91 % higher over control T_1 (57.67 cm). The plant height of T_6 (50% RDN + 2 Sprays of SNU @ 1.0 %) was observed at par with treatment T_2 (RDF (100% NPK University Recommendation - 100% Urea, DAP, MOP). At 45 DAS, the maximum plant height was observed in treatment T_2 (149.52 cm) followed by treatment T_6 (147.33 cm) which was 24.04 and 22.91 % higher over control T_1 (113.58 cm). The plant height of T_6 (50% RDN + 2 Sprays of SNU @ 1.0 %) was found at par with treatment T_2 (RDF (100% NPK University Recommendation - 100% Urea, DAP, MOP). At 60 DAS, the maximum plant height was observed in treatment T_2 (171.00 cm) followed by treatment T_6 (168.67 cm) which was 18.48 and 16.86 % higher over control T_1 (144.33 cm). The plant height of T_6 (50% RDN + 2 Sprays of SNU @ 1.0 %) was observed at par with treatment T_2 (RDF (100% NPK University Recommendation - 100% Urea, DAP, MOP). Rapid absorption of nano-sized nitrogen particles through leaf stomata, increased nitrogen use efficiency, improved chlorophyll synthesis, and increased photosynthetic activity—all of which ultimately encourage cell division and stem elongation—may be responsible for the increase in plant height (Razauddin et al., 2025).

Number of Leaves

Maximum number of leaves at 30 days after sowing was observed in treatment T_2(RDF (100% NPK University Recommendation) and T_4 (50% RDN + 2 Sprays of SNU @ 0.25 %) both at 10.67

Table 1: Effect of Super Nano Urea application on plant height and number of leaves at 30, 60 and 90days after sowing of maize crop

Treatments	Plant Height cm 30 DAS	Plant Height (cm) 45 DAS	Plant Height (cm) 60 DAS	No. of Leaves 30 DAS	No. of Leaves 45 DAS	No. of Leaves 60 DAS
T1	57.67	113.58	144.33	8.33	12.33	11.67
T2	80.33	149.52	171.00	10.67	13.67	14.11
T3	61.00	114.00	145.00	9.67	12.78	12.00
T4	61.67	116.67	146.33	10.67	12.56	13.28
T5	73.33	130.67	154.00	9.33	13.56	13.00
T6	80.00	147.33	168.67	9.67	13.56	14.09
T7	75.67	133.61	157.33	10.33	12.56	12.56
T8	62.00	122.00	147.00	9.67	12.89	12.89
T9	70.67	128.00	153.67	10.33	13.00	14.00
T10	66.67	122.67	149.67	10.33	12.22	11.81
T11	69.00	124.33	151.33	10.33	12.89	12.00
SEM	1.80	2.41	2.06	0.48	0.29	0.32
CD	5.19	6.95	5.95	1.37	0.84	0.91

T_1- Control (Absolute), T_2- RDF (100% NPK University Recommendation)(100% Urea, DAP, MOP), T3- 50% RDN (100% PK), T_4-50% RDN + 2 Sprays of SNU @ 0.25 %, T_5 - 50% RDN + 2 Sprays of SNU @ 0.5 %, T_6- 50% RDN + 2 Sprays of SNU @ 1.0 %, T_7 - 50% RDN + 2 Sprays of Conventional urea @ 1.0 %,T_8 - 50% RDN + 1 Spray of SNU @ 1.0 %, T_9- 50% RDN + 2 Sprays of SNU @ 0.5 %, T_{10} -25% RDN + 3 Sprays of SNU @ 0.5 %, T_{11} -25 % RDN + 3 Spraysof Conventional urea @ 1.0 %

followed by treatmentT_7 (50% RDN + 2 Sprays of Conventional urea @ 1.0 %), T_9 (50% RDN + 2 Sprays of SNU @ 0.5 %), T_{10} (25% RDN + 3 Sprays of SNU @ 0.5 %), T_{11} (25 % RDN + 3 Sprays of Conventional urea @ 1.0 %) all being at (10.33) which was 21.93 and 19.36 % higher over control (8.33). At 45 DAS, Maximum number of leaves were found in treatment T_2(RDF (100% NPK University Recommendation - 100% Urea, DAP, MOP) at 13.67 followed by treatment T_5(50% RDN + 2 Sprays of SNU @ 0.5 %) and T_6(50% RDN + 2 Sprays of SNU @ 1.0 %) both being at (13.56) which was 9.8 and 9.01 % higher respectively over control (12.33). At 60 DAS, Maximum number of leaves were found in treatment T_2(RDF (100% NPK University Recommendation - 100% Urea, DAP, MOP) at 14.11 followed by treatmentT_6(50% RDN + 2 Sprays of SNU @ 1.0 %) being at 14.09 which were17.29 and 17.18 % higher respectively over control (11.67). This result statistically supports that the use of super nano urea is having similar effect with the use of RDF where 100% NPK treatment has been used. According to Meena et al. (2012) and Singh et al. (2025), increased leaf initiation, expansion, and improved canopy development may result from sustained nitrogen availability during active vegetative growth, which is linked to higher leaf production under SNU treatments.

Cob Length

Cob length was measured with scale and found maximum 14.67 cm in treatment T_2(RDF (100% NPK University Recommendation - 100% Urea, DAP, MOP) followed by T_6(50% RDN + 2 Sprays of SNU @ 1.0 %)14.40 cm which were 11.38 and 9.72 % higher than control (10.17 cm). T5 (50% RDN + 2 Sprays of SNU @ 0.5 %)13.00 cm and T6 were found at par with T2 (RDF (100% NPK University Recommendation - 100% Urea, DAP, MOP).

Cob Weight

The critical perusal of data contained in Table 2 showed that cob weight increased significantly over control with application of 100% RDF. The maximum cob weight was recorded in treatment T_2(RDF (100% NPK University Recommendation - 100% Urea, DAP, MOP) 119.00 g followed byT_6(50% RDN + 2 Sprays of SNU @ 1.0 %) 115.67 g which were 24.09, 21.91 % respectively higher over control (90.33 g). The minimum cob weight was recorded in control (90.33) while T_6 was found at par with 100 % RDF (T_2).

Grain Lines per cob

The number of grain lines per cob was found to be highest in the treatment number T_2(RDF (100% NPK University Recommendation - 100% Urea, DAP, MOP) (17.67) followed by treatment number T_6(50% RDN + 2 Sprays of SNU @ 1.0 %) (17.33) which were 32.09 and 30.76 % higher respectively over the control (12.00). Treatment T_6(50% RDN + 2 Sprays of SNU @ 1.0 %) was found at par with T_2(100% NPK University Recommendation - 100% Urea, DAP, MOP).

Number of Grains per Cob

The number of grains per cob was found maximum in the treatment numberT_2(RDF (100% NPK University Recommendation - 100% Urea, DAP, MOP) (421) followed by treatment scheme T_6 (411) which were 29.22 and 27.49 % higher than the control (298) followed by Treatment T_7 (50% RDN + 2 Sprays of Conventional urea @ 1.0 %) (385) and T_5 (50% RDN + 2 Sprays of SNU @ 0.5 %,) (380).

Grain Yield

The maximum grain yield (26.50 q ha^{-1}) was obtained from treatment T_2(RDF (100% NPK University Recommendation - 100% Urea, DAP, MOP). The lowest grain yield (12.33q ha^{-1}) registered in control (T_1). The grain yield of T_6 (50% RDN + 2 Sprays of SNU @ 1.0 %) was at par with the T_2, with the grain yield of 24.67 q ha^{-1}. Statistically, the result suggests the use of RDF dosage and the use of foliar application of super nano urea along with half basal dose of urea have similar kind of effect in terms of grain yield of maize crop.

Straw Yield

The straw yield (Table 2) of ranged from 24.67 to 38.00 q ha^{-1}. The lowest straw yield (24.67 q ha^{-1}) was recorded with control (T_1) and the maximum (38.00 q ha^{-1}) was recorded with T_2 which had shown about 35.08percent increase over control (24.67). But the yield data of T_6 plot where the use of 1 % Super NanoUrea in form of foliar spray along with half basal dose of urea also accounted the yield

Table 2: Effect of Super Nano Urea application on cob length, cob weight, grain lines per cob, number of grains per cob, grain yield, straw yield, biological yield and harvest index of Maize crop

Treatments	Cob Length (cm)	Cob Weight (g)	Grain Lines/ cob	No. of Grains/ cob	Grain Yield (q/ha)	Straw Yield (qt/ha)	Biological yield(q/ha)	Harvest Index(%)
T1	10.17	90.33	12.00	298	12.33	24.67	37.00	33.32
T2	14.67	119.00	17.67	421	26.50	38.00	64.50	41.09
T3	11.33	92.00	14.00	314	16.67	25.33	42.00	39.69
T4	11.54	92.67	14.33	320	18.67	27.33	46.00	40.59
T5	13.70	110.33	16.67	380	22.33	34.00	56.33	39.64
T6	14.40	115.67	17.33	411	24.67	37.00	61.67	40.00
T7	13.73	111.67	16.67	385	22.33	33.33	55.66	40.12
T8	12.03	97.33	14.67	325	18.00	29.67	47.67	37.76
T9	13.17	106.00	16.00	369	19.00	32.33	51.33	37.02
T10	12.67	102.33	14.67	343	17.00	32.33	49.33	34.46
T11	12.87	104.33	15.33	349	19.00	31.67	50.67	37.50
SEm±	0.62	1.72	0.64	2.05	0.85	1.70	7.68	1.39
CD at 5%	1.79	4.95	1.84	5.89	2.46	4.90	22.11	3.99

T_1- Control (Absolute), T_2- RDF (100% NPK University Recommendation)(100% Urea, DAP, MOP), T3- 50% RDN (100% PK), T_4-50% RDN + 2 Sprays of SNU @ 0.25 %, T_5- 50% RDN + 2 Sprays of SNU @ 0.5 %, T_6- 50% RDN + 2 Sprays of SNU @ 1.0 %, T_7 - 50% RDN + 2 Sprays of Conventional urea @ 1.0 %,T_8 - 50% RDN + 1 Spray of SNU @ 1.0 %, T_9- 50% RDN + 2 Sprays of SNU @ 0.5 %, T_{10} -25% RDN + 3 Sprays of SNU @ 0.5 %, T_{11} -25 % RDN + 3 Sprays of Conventional urea @ 1.0 %

of 37.00 q ha^{-1}which was statistically at par with the data of T_2 plot where RDF recommended dose was used. This suggests the positive effect of super NanoUrea in the straw yield of maize crop.

Biological Yield

Biological yield is the calculated value of grain and straw, therefore calculated value is having similar trend of yield and matching with the grain and straw yield.

Harvest index

The data pertaining to harvest index (Table-2) showed the maximum (41.09%) harvest index value which was observed in the treatment of T_2 (RDF (100% NPK University Recommendation) (100% Urea, DAP, MOP) which is at par with T_7 50% RDN + 2 Sprays of Conventional urea @ 1.0 % (40.12%) and T_6 (50% RDN + 2 Sprays of SNU @ 1.0 %) (40.00%) respectively.

These yield parameters (Cob Length, Cob Weight, Grain Lines per cob, Number of Grains per Cob

Grain Yield, Straw Yield, Biological Yield and Harvest index) show that Super Nano Urea successfully improved grain filling, assimilate translocation, and reproductive growth, leading to improved cob development and kernel formation (Meena et al., 2017; Chudasama et al., 2024). Since biological yield is the sum of grain and straw yields, it likewise followed the same pattern. According to Kumar et al. (2025), Meena et al. (2013), and Maurya et al. (2015), the harvest index was highest in T2 (41.09%), followed by T7 (40.12%) and T6 (40.00%), showing effective dry matter partitioning towards economic yield under these treatments (Table 2).

Super Nano Urea's enhanced nitrogen use efficiency, regulated nutrient release, and quick foliar absorption reduce nitrogen losses from volatilization, leaching, and denitrification. During crucial crop growth phases, nano-sized nitrogen particles offer a steady supply of nutrients, improving photosynthesis, biomass accumulation, and grain development. Super Nano Urea foliar application has the ability to cut conventional nitrogen fertilizer requirements by up to 50% without significantly reducing yield, according to the comparable performance of T6 with RDF. These reported by Kumar et al. (2025), Sharma et al. (2022), Meena et al. (2023), and Singh et al. (2024).

Conclusion

Super Nano Urea (SNU) foliar spraying significantly improved the growth, yield characteristics, and productivity of summer maize. Although the recommended fertilizer dose (100% RDF) recorded the highest values for most parameters, the treatment consisting of 50% recommended nitrogen dose (RDN) + two foliar sprays of SNU @ 1.0% produced statistically comparable results for plant height, cob characteristics, grain yield, straw yield, and harvest index. These findings demonstrate that Super Nano Urea can effectively lower the dose of base nitrogen fertilizer by 50% without compromising crop productivity. By using this nutrient management strategy, nitrogen losses to the environment can be reduced, fertilizer use efficiency can be increased, and the need for conventional urea can be reduced. Therefore, combining 50% RDN with two foliar sprays of 1.0% Super Nano Urea is a sustainable and economically viable way to cultivate summer maize.

Acknowledgement

The authors gratefully acknowledge the financial support provided by the Indian Farmers Fertiliser Cooperative Limited (IFFCO) for carrying out this research. The authors also express their sincere gratitude to the Head, Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, BHU, Varanasi for providing the necessary laboratory facilities, infrastructure, and continuous support to successfully conduct the research work. Their valuable assistance and encouragement are sincerely appreciated.

References

Rawat, S., Singh, R. K., Singh, P., Upadhyay, P. K., Shekhawat, K., Sangwan, S. and Shukla, R. (2024). Studies on comparison of nano-urea and pilled urea for enhancing maize (Zea mays) growth and productivity. Ind J Agric Sci, 94(3), 325-328.

NAGAR, S. (2022). Effect of Foliar Application of Nano Urea on Growth, Development and Yield of Maize (Zea mays L.) (Doctoral dissertation, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya).

Tripathi, S. C., Kumar, N. and Venkatesh, K. (2025). Nano urea's environmental edge and economic efficacy in boosting wheat grain yield across diverse Indian agro-climates. Scientific Reports, 15(1), 3598.

Singh, R. K. (2022). Effect of Nitrogen rates and foliar application of nano-urea on growth, yield and grain protein density in wheat (Triticum aestivum L.) (Doctoral dissertation, Banaras Hindu University Varanasi).

Singh, P. P., Priyam, A., Singh, J. and Gupta, N. (2023). Biologically synthesized urea-based nanomaterial shows enhanced agronomic benefits in maize and rice crops during Kharif season. Scientia Horticulture, 315, 111988.

Vasanth, P., Sivakumar, K., Jeyajothi, R. and Chandrasekaran, P. (2024). Foliar spray of urea and nano-urea on the growth and yield of maize (Zea mays L.). International Journal of Research in Agronomy, 7, 428-431.

Sharma, S. K., Sharma, P. K., Mandeewal, R. L., Sharma, V., Chaudhary, R., Pandey, R. and Gupta, S. (2022). Effect of foliar application of nano-urea under different nitrogen levels on growth and nutrient content of pearl millet (Pennisetum glaucum L.). International Journal of Plant & Soil Science, 34(20), 149-155.

Razauddin, Maji, S., Kumar, S., Meena, M. L., Mayaram, Meena, R. C. and Shukla, U. (2025). Use of nano fertilizers to reduce chemical fertilizer load for okra production.

Singh, A., Singh, S. K., Thakur, R., Kaur, H., Sejwal, A., Kaur, S. and Kaur, R. (2025). Enhancing Growth and Quality of Red Okra (Abelmoschus esculentus cv. Kashi Lalima) Using Nano Urea and Bioenhancers. International Journal of Plant and Environment, 11(01), 213-218.

Chudasama, S. D., Usadadia, V. P., Kaswala, A. R., Patel, K. K., Chaudhary, B. J. and Shiyal, V. N. (2024). Influence of Liquid Nano Urea Fertilizer on growth and yield of summer rice (Oryza sativa L.) under South Gujarat conditions. International Journal of Environment and Climate Change, 14(6), 355-364.

Kumar, M., Velu, G., Subramanian, M., Pandian, K., Arunachalam, L., Golla, G. and Mustaffa, M. R. A. F. (2025). 15N-isotope tracing reveals enhanced nitrogen uptake, assimilation and physiological response from Nano urea in maize. NanoImpact, 40, 100592.

Sharma, S. K., Sharma, P. K., Mandeewal, R. L., Sharma, V., Chaudhary, R., Pandey, R. and Gupta, S. (2022). Effect of foliar application of nano-urea under different nitrogen levels on growth and nutrient content of pearl millet (Pennisetum glaucum L.). International Journal of Plant & Soil Science, 34(20), 149-155.

Maurya, S. K., Meena, R., Meena, R. N., Meena, R. K., Ram, B., Verma, M. K. and Rai, A. (2015). Effect of mulching and organic sources on growth parameters and yield of pearl millet (Pennisetum glaucum L.) crop under rainfed area of Vindhyan region, India. Journal of Pure and Applied Microbiology, 9(Spl. Edn. 2), 351-355.

Meena, R. S., Ramawatar, K., Meena, V. S. and Ram, K. (2013). Effect of organic and inorganic source of nutrients on yield, nutrient uptake and nutrient status of soil after harvest of greengram. Asian Journal of Soil Science8(1):80–83.

Meena, R. and Singh, Y. V. (2011). Effect of nitrogen and poultry manure on yield, quality and nutrient uptake by wheat crop (Triticum aestivum L.). The Journal of Rural and Agricultural Research11(2): 50–52.

Meena, R., R. B. Singh and Y. V. Singh (2012). Effect of integrated nutrient management on barley (Hordeum vulgare L.) under alluvial soil of western Uttar Pradesh, The Journal of Rural and Agricultural Research12, 36–38.

Meena, R., R. N. Meena, R. K. Singh, Y. V. Singh and R. K. Meena (2017). Effect of integrated nutrient management on growth, yield, soil fertility and economics of barley (Hordeum vulgare L.), Environment & Ecology35, 2361–2366. https://environmentandecology.com/wp-content/uploads/2025/03/MS29-1-10.pdf

Meena, R., Singh, S. P. P., Singh, D. R. K., Verma, A. K. and Tiwari, D. K. (2014). Response of wheat (Triticum aestivum L.) to integrated nutrient management on growth, yield, content and soil fertility status after harvest of the crop. Ecology, Environment and Conservation 20 (4):1737–1740.

Meena, R., Singh, S. P. P., Singh, D. R. K., Verma, A. K. and Tiwari, D. K. (2014). Response of wheat (Triticum aestivum L.) to integrated nutrient management on growth, yield, content and soil fertility status after harvest of the crop. Ecology, Environment and Conservation 20 (4):1737–1740.

Mitra, B. and Mandal, B. K. (2012). Influence of Bio zyme on growth and yield performance of rice in rice-rice cropping sequence. ORYZA-An International Journal on Rice,49(3): 189-194. https://agris.fao.org/search/en/providers/122535/records/65de4d9b0f3e94b9e5cd2eda

Pal, A., Dwivedi, S. K., Maurya, P. K. and Kanwar, P. (2015). Effect of seaweed saps on growth, yield, nutrient uptake and economic improvement of maize (sweetcorn). Journal of Applied and Natural Science, 7(2): 970-975. https://doi.org/10.31018/jans.v7i2.716

Shukla, S., Meena, R. N., Meena, R., Verma, V. K., Ghilotia, Y. K. and Gaurav, G. (2016). Effects of different organic sources of nutrition on nutrient uptake, yield attributes and economics of Oryza sativa L. Bangladesh Journal of Botany, 45(2), 445–449.

Yadav, S., R. Meena, S. Seema, S. Kumar and D. K. Sharma, (2019). Effect of nitrogen and poultry manure on yield and nutrient uptake by maize (Zea mays), Indian Journal of Agricultural Sciences 89, 1979–1981. https://epubs.icar.org.in/index.php/IJAgS/article/view/95357

Maignan, V., Bernay, B., Géliot, P. and Avice, J. C. (2020). Bio stimulant effects of glutathione and its derived formulations mixed with N fertilizer on post-heading N uptake and remobilization, seed yield, and grain quality in winter wheat. Frontiers in Plant Science, 11, 607615.