International Journal of Plant & Soil Science

Volume 35, Issue 22, Page 801-808, 2023; Article no.IJPSS.110230
ISSN: 2320-7035

Effect of Tillage and Precision Nitrogen Management Practices on N Uptake and Nutrient Use Efficiency (NUE) in Wheat in Western Uttar Pradesh, India

Aditya Shukla [a*], Mukesh Kumar [a], Sandeep Kumar Verma [a] and Akanksha Shukla [b]

[a] Department of Agronomy, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India.
[b] Department of Plant Pathology, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i224191

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/110230

Original Research Article

Received: 01/10/2023
Accepted: 06/12/2023
Published: 08/12/2023

ABSTRACT

At the Crop Research Center of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, (U.P.), during the rabi seasons of 2021–22 and 2022–23, an investigation titled " Effect of tillage and precision nitrogen management practices on N uptake and Nutrient Use Efficiency (NUE) in wheat in western UP " was conducted. The experiment was carried out using a split plot design with three replications. The treatments included four precise nitrogen treatments (N1- Control, N2-State recommendations, N3- Leaf Colour Chart (LCC) based nitrogen Application, and N4- Soil Plant Anaylsis Development (SPAD) meter based treatments) as sub plot treatments, and three conservation tillage treatments (C1- Conventional tillage, C2- Reduced tillage, and C3-

**Corresponding author: E-mail: adishuklabhaiu@gmail.com;*

Furrow irrigated raised bed (FIRB)} as main plots. The soil of the experimental site was sandy loam having low organic matter (0.43%), low in available nitrogen, low in available phosphorus and high in available potassium. The maximum N uptake and NUE was recorded under furrow irrigated raised beds plots during both the years. The maximum total N uptake and NUE was recorded under SPAD and was at par with LCC treatments.

Keywords: Tillage; nitrogen management practices; N uptake; nutrient use efficiency; wheat.

1. INTRODUCTION

The world's most significant food crop is wheat. Grown over 217 million hectares of land in 122 countries worldwide, it produced 781.7 million tons of wheat in 2021–2022. The yearly global consumption of wheat is estimated to be 777 million tons, and it is anticipated to rise over the next several years [1].

India is the world's leading producer of wheat. It is currently producing more wheat than the United States of America and ranks second only to China. In India, 31.6 million hectares of wheat were planted in 2021–2022, yielding 109.52 million tons of grain and 3464 kg ha–1 of productivity [2]. Even though rice is the most popular staple meal in India, wheat is more popular in the food market due to its superior nutritional qualities when compared to rice, which is consumed by a larger population. During the crop growing period, the soil moisture regime and the current weather patterns have a significant impact on wheat genotype productivity.

According to Anonymous [3]. six states in India—Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, and Bihar—produce 91% of the country's wheat. As the nation's leading producer of wheat, Uttar Pradesh has the potential to significantly contribute to the growth of the nation's wheat output.

The most significant limiting factor affecting wheat output is nitrogen. Because nitrogen is a component of protein, chlorophyll, alkaloids, vitamins, hormones, protoplasm, and chlorophyll, healthy crop production requires an adequate amount of nitrogen. In the end, nitrogen produces more dry matter and higher yields. Application of nitrogen to wheat crops is beneficial, while too much nitrogen cannot be tolerated. On the other hand, excessive nitrogen application to wheat increases the risk of NO_3 pollution of ground water and reduces nitrogen recovery efficiency. The crop's production may suffer if nitrogen stress persists during the "critical growth stage" of the crop.

The precise nutrient management method makes use of comprehensive site-specific data to manage the nutrients that crops require. With the use of precise techniques and equipment, producers can enhance the efficiency and effectiveness of nutrients, maintain or boost yields, reduce nutrient losses from fields, and safeguard surface and ground water supplies by implementing a precision nutrient management plan. The 4 R's (Right rate, Right source, Right application method, and Right application time) guarantee that the crop receives the right amount of nutrients where they are needed thanks to precision nutrition management approaches.

The majority of Indian farmers apply nitrogen fertilizer in split applications; nevertheless, there are significant variations in the number of splits, amount of nitrogen applied each split, and application time. LCC improves fertilizer use efficiency by managing nitrogen over a vast region. Using the LCC method resulted in an average nitrogen savings of 25 kg ha^{-1} without compromising production [4].

Conventional tillage methods in agricultural production systems raise labor and energy expenses, which reduces economic returns [5]. Additionally, by speeding up the oxidation and breakdown of organic matter, vigorous plowing causes a decrease in soil organic matter and degrades the characteristics of the soil [6]. Conventional or traditional agriculture practices come with a host of additional restrictions.

The timely planting of crops is seriously threatened by the scarcity of labor and the rising expense of it [7]. Numerous researchers have attested to the fact that excessive residue burning and various types of soil degradation are causing the land quality in this area to deteriorate [8].

Based on CA principles, farmer-led agricultural production system transformation is already taking place globally (157 mha) and is gaining traction as a new paradigm for the twenty-first century, according to empirical data collected globally [9]. It is anticipated that the alterations in the physical and biological characteristics of the soil brought about by CA practices will change the kinetics and direction of chemical and biochemical reactions, changing the dynamics of nutrients in the soil [10]. However, each CA principle calls for a series of actions tailored to the specifics of the area, which has an impact on nutrient dynamics and soil processes [11]. These field operations have an impact on crop productivity because they modify the chemical and physical properties of the soil and conserve water [12].

Wheat yield and soil physical qualities are influenced by significant factors such as manure application and soil tillage. Among all agricultural production factors, tillage accounts for up to 20% of the total [13]. Soil is frequently harmed by the use of intensive and pointless traditional tillage techniques. When wheat is planted after puddled rice as opposed to non-puddled rice, a yield reduction of 8–9% has been noted [14]. In a similar vein, traditional wheat farming requires extensive land preparation that includes multiple passes with discs, tine harrows, and planking to produce a friable seedbed. If wheat is not sown by mid-November, there will be a yield loss of 15–60 kg $ha^{-1}day^{-1}$ due to intensive tillage [15]. As a result, the move to reduced and zero-tillage is currently receiving a lot of attention and focus in an effort to increase crop productivity and water usage efficiency [16].

2. MATERIALS AND METHODS

Split plot design was used for the experiment, with three replications. The treatments included four precise nitrogen treatments (N1-Control, N2-State recommendations, N3- LCC based nitrogen application, and N4- SPAD based treatments) as sub plot treatments, and three conservation tillage treatments (C1-Conventional tillage, C2-Reduced tillage, and C3- Furrow irrigated raised bed (FIRB)) as main plots. Row spacing was maintained at 20 cm, with a gross plot size of 5 x 4.8 and a net plot size of 4 x 4. A seed rate of 100 kg ha^{-1} was employed, and 150:75:60 kg ha^{-1} of NPK was advised. The variety used was DBW-222. LCC measurements beginning at 15 DAS. Random selections were made from each plot so that five plants could be measured for LCC. From the highest, fully extended, and healthy leaf of each of the five plants, observations were made by correlating the color shade of the LCC with the average score. By comparing the leaf's center with the LCC's color strips, readings were acquired. You shouldn't break off a leaf. Daily readings were obtained between 8:00 and 10:00 a.m. There won't be direct sunshine on the LCC when readings are taken. The same person will conduct each LCC reading from the first to the last. In the event that the average measurement is less than the critical LCC value, N was given in accordance with the treatments. When LCC readings were obtained again after 7 days, the same 5 plants were discovered.

When the color of the leaves was less than the strip's threshold color (4), 20 kg N ha^{-1} was given. At 15 DAS, SPAD readings started. A random selection of five plants per plot were used to get SPAD readings. Every one of the five tagged plants had its top three healthy, fully grown leaves observed. The sample to be examined was placed into the sample slot on the measuring head once the device had been calibrated. It was very carefully made sure the sample completely covered the reception window. It was not attempted to measure very thick portions, like leaf veins. For leaves with lots of tiny veins, several measurements were taken and averaged for best results. Breaking off a leaf was not allowed. Every day between 8 and 10 AM, readings were taken. If the average SPAD value dropped below the crucial value, N was applied to the fields at a rate of 20 kg ha^{-1} if the SPAD readings were less than 45. Nitrogen was obtained by precision nitrogen treatments at a rate of 135 kg ha^{-1} as opposed to 150 kg ha^{-1} for the SR treatment.

2.1 Field Preparation

Crop will be grown following the recommended package of practices, crop production measures shall be applied on need basis and crop will be established using following tillage systems.

1. Reduced- tillage (RW): In this approach, there is still some tillage *per se*, but there are far fewer preliminary tillage operations. Using a zero-till drill and an inclined planting plate, seeds are sown in rows 20 cm apart.

2. Furrow irrigated raised bed (FIRB): Using a tractor drawn multi-crop raised bed planter with inclined plate metering for planting wheat, the soil is tilled by two harrowing, followed by one field levelling (using a wooden board). The furrows separating the beds, which have a top width of 140 cm and a height of 12 cm, are each 30 cm broad. Each bed contains seven rows of wheat, spaced 20 cm apart.

3. Conventional tillage (CTW): This system uses two harrowing, two ploughing (using a cultivator), and one planking (using a wooden plank) after the harvest of the rice to achieve good tilth. Wheat is then seeded in rows 20 cm apart using a seed drill with a dry fertiliser attachment.

3. RESULTS

3.1 Nutrient Content and Uptake in Wheat

3.1.1 Nitrogen content in grain and straw (%)

Treatment FIRB (C_3) recorded significantly maximum nitrogen content in grain and straw of wheat as compared to all other treatments. Reduced tillage plots recorded significantly lowest nitrogen content in grain and straw than rest of the tillage technique treatments during both the year of study.

Among the different precise nitrogen management treatments, the highest nitrogen content in grain and straw was obtained with SPAD (N_4) based nitrogen application followed by LCC (N_3) based nitrogen application treatment during both the years. Significantly lowest nitrogen content in grain and straw was obtained in the control treatment during both the years.

3.1.2 Nitrogen uptake in grain and straw (kg ha^{-1})

The highest nitrogen uptake by grains and straw of wheat was obtained due to moisture retention along with FIRB (C_3) practice, which was significantly higher than rest of the treatment during both the year of experimentation. The lowest nitrogen uptake by grains and straw of wheat was observed in reduced tillage (C_2) than rest of tillage techniques during both the year of study.

Among the different precise nitrogen management treatments, the highest nitrogen content in grain and straw was obtained with SPAD (N_4) based nitrogen application which was at par with LCC (N_3) based nitrogen application treatments but significantly higher than rest of the treatments during both the years. Significantly lowest nitrogen content in grain and straw was obtained in the control treatment during both the years.

3.1.3 Total nitrogen uptake (kg ha^{-1})

The highest total nitrogen uptake by wheat crop was obtained due to moisture retention along with furrow irrigated raised beds practice, which was significantly higher than rest of the treatment during both the year of experimentation. The lowest total nitrogen uptake by wheat crop was observed in reduced tillage (C_2) than rest of tillage techniques during both the year of study.

The data on precise N management had significant variation in total nitrogen uptake during both the year of study. The maximum total nitrogen uptake was recorded with the SPAD (N_4) which remained statistically at par with LCC (N_3) based nitrogen application treatments but significantly high than rest of the treatments during both the years. Lowest total nitrogen uptake was obtained in control plot during both the years.

Table 1. Effect of conservation tillage and precise nitrogen management techniques on N content and uptake by wheat

Treatments	N content (%)				N uptake (kg ha^{-1})				Total N uptake (kg ha^{-1})	
	Grains		Straw		Grains		Straw			
	21-22	22-23	21-22	22-23	21-22	22-23	21-22	22-23	21-22	22-23
Conservation tillage (Main plot)										
C_1	1.51	1.47	0.44	0.43	76.5	73.5	29.3	28.9	105	101
C_2	1.41	1.40	0.42	0.40	62.6	61.4	26.1	24.4	88.7	85.8
C_3	1.61	1.59	0.50	0.49	88.2	86.0	34.5	31.8	122	117
SEm±	0.03	0.04	0.007	0.008	1.9	2.1	1.2	1.0	1.5	1.7
C D	0.11	0.14	0.02	0.03	5.8	6.3	3.9	3.4	4.9	5.3
Precise nitrogen management (Sub plot)										
N_1	1.23	1.26	0.39	0.40	43.1	45.3	19.2	18.7	62.3	64.0
N_2	1.50	1.46	0.44	0.43	76.5	73.4	29.8	27.8	106	101
N_3	1.63	1.61	0.49	0.47	88.1	85.6	34.8	33.8	121	117
N_4	1.70	1.67	0.52	0.51	93.6	91.6	36.6	35.4	130	127
SEm±	0.05	0.04	0.009	0.01	2.7	3.0	0.68	0.74	2.9	3.8
C D	0.17	0.13	0.03	0.05	8.2	9.0	2.01	2.22	9.4	11.6

Table 2. Effect of conservation tillage and precise nitrogen management techniques on PFP of N, P and K in wheat

Treatments	PFP (kg grain/kg of nutrient applied)					
	Nitrogen		Phosphorus		Potassium	
	21-22	22-23	21-22	22-23	21-22	22-23
Conservation tillage (Main plot)						
CT	29.49	29.37	67.64	67.02	84.55	83.78
RT	26.17	25.91	59.24	58.57	74.05	73.22
FIRB	30.63	31.68	71.30	72.96	89.13	90.19
SEm±	0.61	0.71	2.05	0.64	0.62	1.22
C D (P=0.05)	2.35	2.81	8.12	2.51	2.43	4.78
Precise nitrogen management (Sub plot)						
Control	-	-	-	-	-	-
SR @ 150:75:60	33.92	34.01	67.84	68.03	84.80	85.04
LCC Based N	39.46	40.09	71.03	72.16	88.79	90.20
SPAD Based N	40.68	40.84	73.22	73.51	91.52	91.88
SEm±	0.51	0.65	1.01	0.97	0.95	1.22
C D (P=0.05)	1.53	1.95	3.07	2.90	2.91	3.75

3.2 Nutrient Use Efficiencies

3.2.1 Partial Factor Productivity (PFP)

Significantly higher values of partial factor productivity of nitrogen fertilizer was obtained with FIRB plots (C_3) during both the years of experimentation. The values of partial factor productivity of nitrogen fertilizer were remained statistically at par in FIRB and CT treatments during both the years. The significantly lowest value of partial factor productivity of nitrogen fertilizer was observed in reduced tillage (C_2). Among precise nitrogen management practices, significantly higher partial factor productivity of nitrogen fertilizer was obtained in SPAD (N_4) based nutrient management plots which was at par with LCC (N_3) treatments but significantly higher than rest of the treatments during both the years of experimentation. Lowest value of partial factor productivity of nitrogen fertilizer was obtained for control treatments during both the years of experimentation.

3.2.2 Agronomic Nutrient Use Efficiency (ANUE)

Significantly higher values of ANUE of nitrogen fertilizer was obtained with FIRB plots (C_3) during both the years of experimentation. The values of ANUE of nitrogen fertilizer were remained statistically at par in FIRB and CT treatments during both the years. The significantly lowest value of ANUE of nitrogen fertilizer was observed in reduced tillage (C_2). Among precise nitrogen management practices, significantly higher ANUE of nitrogen fertilizer was obtained in SPAD (N_4) based nutrient management plots which was at par with LCC (N_3) treatments but significantly higher than rest of the treatments during both the years of experimentation. Lowest value of ANUE of nitrogen fertilizer was obtained for control treatments during both the years of experimentation.

3.2.3 Apparent nutrient recovery (ANR)

Significantly higher values of ANR of nitrogen fertilizer was obtained with FIRB plots (C_3) during both the years of experimentation. The values of ANR of nitrogen fertilizer were remained statistically at par in FIRB and CT treatments during both the years. The significantly lowest value of ANR of nitrogen fertilizer was observed in reduced tillage (C_2). Among precise nitrogen management practices, significantly higher ANR of nitrogen fertilizer was obtained in SPAD (N_4) based nutrient management plots which was at par with LCC (N_3) treatments but significantly higher than rest of the treatments during both the years of experimentation. Lowest value of ANR of nitrogen fertilizer was obtained for control treatments during both the years of experimentation.

4. DISCUSSION

The tillage crop establishment practices increased the N uptake by the crop with increase in moisture availability during the year of study. The nitrogen uptake was more through the grain (67 % of total N). The higher N uptake in grain is because of its chemical composition due to higher amino acid and protein content in grain require more N. The higher N uptake was mainly because of higher grain and straw yield in FIRB followed by CT. Similar trend has been observed by Ingle *et al.,* [17].

Table 3. Effect of conservation tillage and precise nitrogen management techniques on ANUE of N, P and K in wheat

Treatments	ANUE (kg grain/kg of nutrient applied over control)					
	Nitrogen		Phosphorus		Potassium	
	21-22	22-23	21-22	22-23	21-22	22-23
Conservation tillage (Main plot)						
CT	8.27	8.72	14.55	16.12	19.71	21.45
RT	6.90	8.37	12.37	12.91	16.92	15.24
FIRB	9.45	9.80	17.78	19.85	22.44	24.63
SEm±	0.35	0.06	0.58	0.40	0.74	0.52
C D (P=0.05)	1.31	0.22	2.06	1.32	2.62	2.10
Precise nitrogen management (Sub plot)						
Control	-	-	-	-	-	-
SR	7.84	8.50	15.68	16.99	19.60	21.24
LCC	10.49	11.74	18.88	21.12	23.59	26.41
SPAD	11.70	12.48	21.06	22.47	26.33	28.09
SEm±	0.28	0.52	0.53	0.97	0.66	1.22
C D (P=0.05)	0.84	1.54	1.57	2.90	1.96	3.63

Table 4. Effect of conservation tillage and precise nitrogen management techniques on ANR of N, P and K in wheat

Treatments	ANR (%)					
	Nitrogen		Phosphorus		Potassium	
	21-22	22-23	21-22	22-23	21-22	22-23
Conservation tillage (Main plot)						
CT	46.3	39.8	9.9	16.2	13.4	13.2
RT	41.4	40.4	15.4	13.2	9.9	10.6
FIRB	47.6	45.4	17.7	16.3	12.7	13.6
SEm±	1.4	1.1	0.5	0.6	0.4	0.4
C D (P=0.05)	5.1	4.2	1.9	2.3	1.5	1.6
Precise nitrogen management (Sub plot)						
Control	-	-	-	-	-	-
SR @	20.0	16.6	11.0	11.8	11.0	14.4
LCC	31.8	28.4	16.8	14.7	16.8	18.8
SPAD	35.4	31.0	17.7	16.0	17.7	20.9
SEm±	1.7	1.1	1.1	1.2	0.8	0.9
C D (P=0.05)	5.2	3.3	3.5	3.6	2.5	2.9

The higher uptake and content of N, P and K in grain and straw under precision nitrogen treatments (LCC and SPAD) was because of more availability of these nutrients, which encouraged the crop growth and finally higher grain and biomass yield. The precision N management based nutrient prescriptions are more balanced as per the crop requirement and soil fertility status. Thus, precision nitrogen treatments might have contributed for higher N, P and K uptake as more splits of N application in LCC and SPAD treatments must have decreased N losses due to denitrification, ammonia volatilization and leaching which in turn increased N uptake and N uptake facilitates P and K uptake in crops. Similar findings were reported by Godebo *et al.,* [18] and Sharma *et al.,* [19].

Nitrogen, phosphorus and potassium partial factor productivity (PFP) obtained was significantly higher with precision N management. Among precision N management practices, SPAD produced significantly higher nitrogen, phosphorus and potassium PFP, respectively. Significantly higher N, P and K agronomic nutrient use efficiency (ANUE) and apparent nutrient recovery (ANR) was obtained with precision N management. PFP, ANUE and ANR of N, P and K of LCC treatments was at par with that of SPAD treatments while above stated nutrient use efficiencies was significantly lower for SR treatments. Split application in case of precision nitrogen management techniques would have decreased nitrogen loss through nitrification and volatilization and increased its uptake and use by wheat crop. The precision N management based nutrient prescriptions are more balanced as per the crop requirement and soil fertility status. Thus, balanced nutrient recommendation might have contributed for higher nutrient use efficiency. A more balanced N, P and K nutrition practiced in the precision N management-based practices might also have contributed to increase. Similar result was also observed by Mahajan [20] and Gawdiya [21].

5. CONCLUSION

Use of different tillage practices gave significant result in respect to N content in grain and straw during both the year of study. Different tillage practices have significant variation in total N uptake during both the year of study. The maximum total N uptake and NUE was recorded under furrow irrigated raised beds plots during both the years. Total N uptake and NUE, *i.e.,* Partial Factor Productivity, Agronomic Nutrient Use Efficiency and Apparent Nutrient Recovery all these indices showed that SPAD and LCC performed best during both the years of treatment. Yield and nutrient content was highest in SPAD and LCC treatments and application of fertilizer was less (~ 32kg urea) which resulted in better NUE.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Anonymous Cereal Supply and Demand: Crop Prospects and Food Situation, Food and Agricultural Organisation, Geneva, Switzerland; 2022.
2. Anonymous Third Advance Estimates of Principal Crops for 2020-21, Ministry of Agriculture and Farmers Welfare, Govt of India; 2021.
3. Anonymous. Ag. Stat. at a glance, Directorate of Economics & Statistics, DAC&FW, Ministry of Agriculture & Farmers welfare, Govt. of India; 2019.
4. Balasubramanian V, AC. Morales R. Torres G. Gines W. Collado, Redona E, Response of rice hybrid and an inbred variety to urea briquette deep placement in the Philippines. Journal of Agricultural Research Manage .2012;1:50-60.
5. Kumar Dinesh SP, Patil BN, Hiremath SM, Koti RV, Angadi VV, Basa B. Nitrogen management through leaf colour chart (LCC) on growth, yield and yield attributes of emmer wheat [Triticum dicoccum] under irrigated condition in Karnataka. The Journal of Agricultural Science .2013; 26(3):350-355.
6. Naresh RK, Vivek Kumar Sunil DK, Purushattom, Tiwari, Richa and Tomar SS. Minimal soil disturbance and increased residue retention on aggregates carbon storage potential and energy relations in Typic Ustochrept soil of Uttar Pradesh: A review. Journal of Pharmacognosy and Phytochemistry .2012;7(5):1429-1447.
7. Jat ML, Bijay-Singh and Gerard B. Nutrient management and use efficiency in wheat systems of South Asia. Advances in Agronomy .2014;125:171–259.
8. Das TK, Bhattacharyya R, Sharma AR, Das S, Saad AA, Pathak H. Impacts of conservation agriculture on total soil organic carbon retention potential under an irrigated agro-ecosystem of the western Indo Gangetic Plains. European Journal of Agronomy. 2013;51:34–42.
9. Kassam A, Friedrich T, Derpsch R, Kienzle1 J. Overview of the worldwide spread of conservation agriculture. Field Actions Science Reports. 2015;8:2015.
10. Sapkota TB, Majumdar K, Khurana R, Jat RK, Stirling CM, Jat ML. Precise nutrient management under conservation agriculture based cereal systems in South Asia. Chapter. 2016;7:132–161.
11. Lal R. A system approach to conservation agriculture. Journal of Soil and Water Conservation. 2015;70(4):82A–88A.
12. Bonfil DJ, Mufradi I, Klitman S, S. Asido S. Wheat grain yield and soil profile water distribution in a no till arid environment. Agronomy Journal .2009;91:368-373.
13. Ahmad M, Ghafoor A, Asif M, Farid HU. Effect of irrigation techniques on wheat production and water saving in soils. Soil Environment .2016;29(1):69-72.
14. Kumar V, Ladha JK. Direct seeding of rice: recent developments and future research needs. Advances in Agronomy .2011;111:297–313.
15. Pathak H, Ladha JK, Aggarwal PK, Peng S, Das S, Singh Y, Singh B, Kamra SK, Mishra B, Sastri ASRAS, Aggarwal HP, Das DK, Gupta RK. Trends of climatic potential and on-farm yields of rice and wheat in the Indo-Gangetic Plains. Field Crops Research .2013;80:223–234.
16. Dawelbeit MI, Babiker EA. Effect of tillage and sowing method on growth and yield of

wheat. Soil and Tillage Research .1997;42:127–132.
17. Ingle AV, Shelke DK, Aghav VD. Karad ML. Effect of irrigation schedules and nutrient management on WUE and nutrient uptake of wheat on vertisol. Journal of Soils and Crops. 2007; 17(1):188-190.
18. Godebo T, Laekemariam F, Loha G. Nutrient uptake, use efficiency and productivity of bread wheat (*Triticum aestivum* L.) as affected by nitrogen and potassium fertilizer in Keddida Gamela Woreda, Southern Ethiopia. Environ Syst Res. 2021;10:12. Available:https://doi.org/10.1186/s40068-020-00210-4.
19. Sharma RK, PS, Bajpai and Kumar, Vinod. Use of LCC and SPAD for precision nutrient management in wheat in trans Gangetic planes. Journal of Pharmacognosy and Phytochemistry. 2019;15(3):123-139.
20. Mahajan NC. Improving wheat (*Triticum aestivum* L.) and soil productivity through precision nitrogen management practices and efficient planting system. M.Sc. Thesis. SVPUAT, Meerut; 2018.
21. Gawdiya, Sandeep. Precision nutrient management in conservation agriculture-based wheat production, nutrient use efficiency, soil health and profitability in western Uttar Pradesh. MSc Thesis. SVPUAT, Meerut; 2020.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/110230