The Pharma Innovation Journal 2022; 11(12): 2990-2994

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 2990-2994

www.thepharmajournal.com
Received: 08-10-2022
Accepted: 15-11-2022

Sanjay Kumar Dhaker
Research Scholar, Agronomy, College of Agriculture, AU Kota, Rajasthan, India

KM Sharma
Associate Professor, Agronomy, Agriculture Research Station, AU Kota, Rajasthan, India

BS Meena
Associate Professor, Agronomy, Agriculture Research Station, AU Kota, Rajasthan, India

MK Sharma
Associate Professor, Soil Science and Agricultural chemistry, Agriculture Research Station, AU Kota, Rajasthan, India

LK Meena
Assistant Professor, Agricultural Economics, College of Agriculture, AU Kota, Rajasthan, India

Corresponding Author:
Sanjay Kumar Dhaker
Research Scholar, Agronomy, College of Agriculture, AU Kota, Rajasthan, India

Effect of nutrient management on growth and productivity of wheat (*Triticum aestivum* L.) grown under rice-wheat based cropping system in South-eastern Rajasthan

Sanjay Kumar Dhaker, KM Sharma, BS Meena, MK Sharma and LK Meena

Abstract
A field experiment was conducted at Agricultural Research Station, Kota, Rajasthan, during *rabi* season of 2021-2022 to assess the effect of nutrient management on growth and productivity of wheat (*Triticum aestivum* L.) under rice-based cropping system. The treatment consisted of eight nutrient levels and combinations *viz*., 100% RDF, RDF + FYM, 125% RDF, 150% RDF, RDF + Zn, RDF + S, RDF + Zn + S and RDF + Foliar sprays of NPK. Application of 150% RDF registered the maximum growth parameters *viz*., number of tillers/mrl, DMA, CGR & plant height at different growth stages and grain, straw & biological yields, however, 125% RDF, RDF+FYM and RDF + Zn + S treatments found at par with it. Further, applications of RDF + Zn + S, RDF + Zn and RDF+S as well as RDF + foliar sprays of NPK 19:19:19 also enhanced the growth and productivity of wheat as compared to 100% RDF. Maximum net return was obtained under 150% RDF (₹ 106464/ha), however, 125% RDF (₹ 103460/ha) and RDF+FYM (₹ 99907/ha) as well as RDF + Zn + S (₹ 99155/ha) were found at par with 150% RDF. Application of 125% RDF provided maximum B: C ratio (3.27), which was found significantly superior over the application 100% RDF, RDF+FYM, RDF+S, RDF + Zn + S and RDF + foliar sprays of NPK.

Keywords: Crop growth rate, dry matter accumulation, grain yield, nutrient management, wheat, yield attributes

Introduction
Wheat is the most important staple food in the world and is the second important cereal crop after rice in India. It is cultivated in 31.61 million ha area with an annual production of about 109.52 million tonnes and an average productivity of 3464 kg/ha (GOI, 2021) [5]. In Rajasthan, it occupies an area of 30.93 lakh ha with an annual production of 120.21 lakh tonnes and average productivity of 3885 kg/ha (GOR, 2021) [6]. The agriculture sector in India is facing a serious challenge to produce more food from shrinking amounts of cultivated land. The target for wheat production in India is projected around 140 million tonnes by 2050 considering its growing demand for consumption and trade due to burgeoning population (Anonymous, 2015) [1]. Rice-wheat cropping system is one of the most dominant cropping systems in India as well as South-eastern Rajasthan. This particular cropping system covers about one-third of the total rice cultivation and two-fifths of the total wheat cultivation in the Indian sub-continent (Sharma *et al*. 2019) [18]. The nutrient management of plants is one of the most important factors determining ultimate crop productivity. Long-term studies reveal that crop productivity is declining even after applying recommended dose of NPK fertilizers (Yadav and Kumar, 2009) [26]. The field crops exhibit substantial economic response on high fertility levels. The productivity may be further enhanced by increase in nutrient doses of NPK fertilizers (Singh, 2016) [23]. Integrated use of organic and inorganic sources of nutrient may support enhanced yield of wheat (Kumar *et al*. 2013) [7]. FYM is a good source of nutrients and contributed towards build-up of organic matter in soil (Das *et al*. 2008) [3] and it is not only supply macro and micronutrients but also improve the soil physical, chemical and biological properties of the soil. The importance of micronutrients applications in increasing crop productivity has been recognized in India. Zinc deficiency is a common phenomenon in cereals (Singh, 2017) [22]. Zn is considered to play important role in synthesis of various enzymes, N metabolism and several oxidation-reduction reactions. Sulphur is now recognized as the fourth major plant nutrient after NPK. Currently, the addition of S and Zn is regarded a vital component of

balanced fertilization in order to increase the effectiveness of applied nutrients and increase wheat yield. Foliar spray of one or more nutrients to supplement soil application of fertilizers has gaining more attention in recent years to overcome the problem of low fertilizer nutrient supply from soil to plant (Reena *et al*. 2018) [14]. Foliar fertilizers (NPK) can provide the plant nutrient at critical stages of plant growth where the nutrient requirement of plant exceeds the normal uptake for certain nutrients (Fageria *et al*. 2009) [4]. Keeping in view the above facts, present experiment was carried out to study the effect of nutrient management on growth and productivity of wheat (*Triticum aestivum* L.) grown under rice based cropping system in South-eastern Rajasthan" at Agricultural Research Station, Ummedganj Farm, Kota during *Rabi* 2021-22

Material and Methods

The experiment was undertaken on Research farm of Agricultural Research Station, Ummedganj, Kota during rabi season of 2021-2022 on wheat (var. Raj 4079) grown after rice. The soil of experimental field was clay in texture. The soil was low in available nitrogen, medium in phosphorus and high in potassium, while sulphur and zinc content found to be slightly lower than critical level. The experiment was carried out in randomized block design with four replications and eight nutrient management treatments *viz*., 100% RDF (NPK @ 120-40-30 kg/ha), RDF+FYM @ 10 t/ha, 125% RDF, 150% RDF, RDF + Zn @ 5.5 kg/ha, RDF+S @ 40 kg/ha, RDF + Zn + S and foliar sprays of NPK 19:19:19 @ 0.5% at tillering and ear initiation stages. Half doses of nitrogen and total quantity of phosphorus & potassium were applied at sowing time as per randomly allotted treatment by drilling in furrows. Remaining half doses of nitrogen was top dressed at the time of first irrigation (CRI stage). Full doses of zinc and sulphur were applied before sowing as basal doses. Foliar spray of NPK 19:19:19 were applied at maximum tillering (45 DAS) and ear initiation (65 DAS) stages, using spray volume of 500 lit/ha. The annual rainfall received during growing seasons was 99.0 mm in 2021–22. Four irrigations were applied in experimental wheat crop.

The data on periodical dry matter accumulation (DMA) in wheat plants were recorded by collecting whole plant samples from randomly selected two rows of 0.5 m length at 45 DAS, 90 DAS and harvest stages. Observations on number of tillers per m row length at 45 DAS and plant stands in one-meter row length at 30 DAS and at harvest stage were counted from randomly selected rows in each plot. The efficiency parameter namely crop growth rate (CGR) between 45 DAS to 90 DAS and 90 DAS to harvest stage were computed on the basis of dry matter accumulation, by using formula given by Redford (1967) [13]. For plant height, three plants selected at randomly and height was measured in centimetres from ground level to the base of the top or ear head. The above ground portion of plants after harvest were sun dried for one week and then weighed to work out biomass yield. After threshing and winnowing, grain yields from each plot were weighed separately. The harvest index was computed as suggested by Donald and Hamblin (1976) [27]. Net return was calculated by deducting total cost of cultivation from gross return each treatment and the benefit: cost (B: C) ratio was estimated by dividing the net return with total cost of cultivation. All the data were subjected to statistical analysis by adopting appropriate method of analysis of variance for testing the significance of variation in experimental results (Panse and Sukhatme 1985) [12].

Result and Discussion

Growth parameters

It is evident from results (Table 1) that different nutrient management treatments exhibited significant effect on growth parameters *viz*., plant height, number of tillers, DMA at 45, 90 DAS and harvest stages and CGR between 45 to 90 DAS and 90 DAS to harvest stages. While, number of plants per meter row length at 30 DAS and harvest stages did not vary significantly due to different nutrient management treatments, indicating that plant stand was almost uniform in all the treatment plots.

Results of the experiment revealed that plant growth parameters *viz*., number of tillers, plant height, DMA at 45, 90 DAS and harvest stage and CGR between 45 to 90 DAS and 90 DAS to harvest stages of wheat crop increased significantly with increasing NPK fertilizer doses from 100% to 150% RDF and maximum values for growth parameters were recorded with 150% RDF, however, 125% RDF and RDF+FYM treatments were found at par with 150% RDF.

Data (Table 4.1) shows that maximum plant height at 45 & 90 DAS and at harvest stage were recorded under the application of 150% RDF, however, it was statistically at par with RDF+FYM, 125% RDF and RDF + Zn + S treatments. Data indicates that the maximum number of tillers (146.0/mrl) at 45 DAS was recorded under the application of 150% RDF which was significantly higher over RDF + foliar sprays of NPK, 100% RDF and RDF + Zn, however, it was found statistically at par with the application of RDF + FYM, 125% RDF, RDF + Zn + S and RDF + S.

Maximum dry matter accumulation at 45 DAS was recorded under the application of 150% RDF, which proved significantly superior over RDF + foliar sprays of NPK, 100% RDF and RDF + Zn, however, 125% RDF, RDF + Zn + S, RDF+S and RDF+FYM were found statistically at par with 150% RDF. At 90 DAS, maximum DMA was observed with the application of 150% RDF followed by 125% RDF and RDF+FYM. However, these nutrient management treatments remained at par with each other. Application of 150% RDF also recorded maximum DMA at harvest stage, which was significantly superior over all the other treatments except 125% RDF and RDF+FYM which remained at par among thems. Further, application of RDF + Zn + S, RDF + S, RDF + foliar sprays of NPK and RDF + Zn also accumulated significantly higher DM over 100% RDF, however, all these treatments found at par among them.

Results clearly indicates that all the nutrient management treatments significantly improved the CGR between 45 to 90 DAS and 90 DAS to harvest stages over 100% RDF. Maximum CGR between 45 to 90 DAS was observed with the application of 150% RDF, which was significantly superior over RDF + Zn + S, RDF + S, RDF + Zn and 100% RDF, however, 125% RDF, RDF+FYM and RDF + foliar sprays of NPK treatments were found at par with it. The maximum CGR between 90 DAS to harvest stages was also recorded under the application of 150% RDF followed by RDF+ FYM, 125% RDF, RDF + Zn + S, RDF + foliar sprays of NPK and RDF+S which were found at par among them and significantly superior over 100% RDF. Positive influence of increasing level of NPK nutrients on growth parameters seems to be on account of increasing availability of NPK

maintaining congenial nutritional environment in soil and plant system. Similar findings were also reported by Kumar *et al.* (2019) [9]; Mohanta *et al.* (2020) [10] and Kumar and Pareek (2022) [8].

Application of RDF+FYM @ 10 t/ha also improved growth parameters *viz*. number of tillers, plant height, DMA at 45, 90 DAS and harvest stage and CGR between 45 to 90 DAS and 90 DAS to harvest stage of wheat crop as compared to sole 100% RDF and it was found at par with 125% RDF, 150% RDF, RDF + Zn + S, RDF + Zn and RDF + S treatments. The optimum availability of nutrients under integrated use of FYM and NPK might led to improve photosynthetic area of plants, meristematic activity, nutrient uptake and its further reflectance into the increased growth parameters. The results of study are in close agreement with the results of Borse *et al.* (2019) [2] & Kumar and Pareek (2022) [8].

Further evaluations of data reflect that the number of tillers/mrl, plant height, DMA and CGR also improved significantly with the application of Zn + S along with RDF as compared to 100% RDF alone. Tiwari *et al*. (2021) [24] opined that application of Zn and S with RDF increased in plant height and number of tillers may be attributed to increased availability of macro nutrients (N, P, K and S) as well as micro nutrients (Zn) to plants and also enhanced meristematic activity, thereby increased division, enlargement and elongation of cells resulting in higher plant height and number of tillers. Sharma and Jain (2014) [19] also reported the same findings.

Foliar sprays of NPK (19:19:19) showed significant improvement in plant height and DMA at 90 DAS and harvest stage as well as CGR between 45-60 DAS and 90 DAS to harvest stage as compared to RDF only. This may be due to the quick absorption of nitrogen, phosphorus and potash and helped in expansion of leaf area owing to increased meristematic activity and provided greater photosynthetic surface to intercept more radiant energy and improved the capacity of the plants to utilize more available nutrients and net photosynthesis (Nitharwal *et al.* 2022) [11].

Yield and Yield attributes

The results indicated that nutrient management treatments had significant positive influence on yield attributes *viz*., effective tillers, grains/ear and test weight, however, significant impact on ear length were not observed (Table 2).

In present investigation, maximum number of effective tillers/m row was recorded with 150% RDF, while maximum grain number per ear and test weight were observed with RDF + FYM. However, application of 150% RDF, 125% RDF, RDF + FYM, RDF + S + Zn, and RDF + NPK 19:19:19 treatments were found at par among them with regards to these yield attributing characters. All these treatments as well as RDF+ Zn and RDF+S significantly improved these yield attributes as compared to RDF which ultimately bring significant increments in grain productivity.

The increase in yield attributes with higher fertility levels could be ascribed to overall improvement in crop growth as indicated from higher CGR and manifested in terms of dry matter accumulation. Significant improvement in yield attributes *viz*., grains/ear and test weight of wheat due to higher level of NPK were also reported by Mohanta *et al*. (2020) [10] and Vishwakarma *et al*. (2020) [25].

Maximum grain yield was recorded with the application of 150% RDF (54.32 q/ha), however, it did not differ significantly over RDF+FYM, 125% RDF, RDF + Zn + S. RDF + Zn and RDF + foliar spray of NPK 19:19:19 treatments. All these treatments as well as RDF + S recorded significantly higher grain yield over 100% RDF and were found at par among them. Application of 150% RDF, RDF+FYM, 125% RDF and RDF + Zn + S produced additional grain yield of 8.52, 7.35, 7.12 and 6.49 q/ha, representing 18.60, 16.05, 15.55, and 14.17 per cent increment; respectively over 100% RDF (45.80 q/ha). Further, applications of RDF + foliar sprays of NPK and RDF + Zn also significantly enhanced the grain yield to the extent of 10.94 and 10.57 per cent; respectively as compared to 100% RDF alone. This increment might be due to improvement in yield attributes and cumulative interaction between vegetative and reproductive growth of the crop plants.

The highest biological yield (128.84 q/ha) was recorded under 150% RDF, however, 125% RDF, RDF+ FYM and RDF + Zn + S treatments were found to be statistically at par with it. Application of RDF + Zn, RDF+S and RDF + foliar sprays of NPK also significantly increased the biological yield as compared to 100% RDF. Straw and biological yields of wheat were enhanced due to application of 150% RDF, 125% RDF and RDF+FYM and RDF + foliar sprays of NPK by 17.82, 12.68 and 12.21 per cent and 18.15, 13.88 and 13.81 per cent; respectively over 100% RDF (63.25 and 109.05 q/ha). While RDF + Zn + S treatments increased straw & biological yield by11.40 and 12.56 per cent; respectively over 100% RDF. The nutrient management treatments did not bring significant variation in harvest index during present experimentation.

Significant improvement in yield attributes *viz*., grains/ear and test weight of wheat due to higher level of NPK were also reported by Mohanta *et al*. (2020) [10] and Vishwakarma *et al*. (2020) [25]. Application of RDF + FYM produced significantly higher grain and straw as well as biological yield over 100% RDF. This could be due to higher availability of nutrients and modifying soil environment for better retention of nutrients and water during critical growth stages of crop due to addition of organic manures and ultimately increases the yield attributes and directly effect on grain yield of wheat. Borse *et al*. (2019) [2], Sharma *et al*. (2021) [16] and Verma *et al*. (2021) [28] also reported enhancement in grain, straw and biological yield of wheat due to application of FYM along with RDF. The higher yield in RDF + Zn + S treatment might be ascribed to better yield attributes due to greater availability of nutrients and metabolites for growth and development of reproductive structures (sink) under balanced fertilization which ultimately led to realization of higher productivity of individual plant. Sharma *et al*. (2011) [15] and Pandey (2018) [21] also reported similar results. Foliar application of NPK along with RDF increased the yield and yield attributes. This might be due to increased growth rate and photosynthesis process, high dry matter production and its partition in fruiting parts which in turns give significantly high yield (Nitharwal *et al*. 2022) [11]. Enhancement in yield attributes and yield due to foliar NPK were also reported by Sharma (2016) [23].

Economics

Economic evaluation reveals (Table 2) that maximum net return was obtained with the application of 150% RDF treatment (₹ 106464/ha) due to greater yield advantage, however, it was not significantly superior over 125% RDF, RDF+FYM and RDF + Zn + S (₹103460, 99907 and 99155/ha) treatments during present experimentation.

Conversely, maximum B: C ratio was fetched with application of 125% RDF (3.27) which was significantly higher over RDF+FYM, 100% RDF, RDF + Zn + S, RDF + S and foliar sprays of NPK 19:19:19 treatment. Further, application of RDF+FYM @ 10t/ha RDF + S, RDF + Zn + S and foliar sprays of NPK 19:19:19 also fetched significantly higher net returns as compared to RDF, however, these treatments did not improved B:C ratio. Moreover, RDF+FYM slightly reduced B: C ratio as compared to RDF on account of higher cost of FYM.

Table 1: Effect of nutrient management on different growth parameters at successive stages of wheat

Treatments	Plant population per m row length		Plant height (cm)			No. of tillers per m row length	DMA/m row length (g)			CGR (g/m/day)	
	30 DAS	At harvest	45 DAS	45 DAS	90 DAS	At harvest	45 DAS	90 DAS	At harvest	45-90 DAS	90 DAS to Harvest
100% RDF	38.3	32.6	43.2	37.32	226.84	269.37	37.32	226.84	269.37	4.21	1.25
RDF + FYM	37.0	34.1	45.9	41.23	247.95	296.48	41.23	247.95	296.48	4.59	1.43
125% RDF	38.3	33.8	47.2	43.38	251.12	298.83	43.38	251.12	298.83	4.62	1.40
150% RDF	36.8	33.3	47.6	44.32	256.50	305.23	44.32	256.50	305.23	4.72	1.43
RDF + Zn	39.3	32.5	44.8	39.67	239.55	285.37	39.67	239.55	285.37	4.44	1.35
RDF + S	39.4	33.0	45.2	41.44	242.05	288.27	41.44	242.05	288.27	4.46	1.36
RDF + Zn + S	38.8	33.5	45.4	41.56	245.38	292.55	41.56	245.38	292.55	4.53	1.39
RDF + foliar sprays of NPK (19:19:19)	38.1	32.7	43.4	36.88	241.28	287.80	36.88	241.28	287.80	4.54	1.37
SEm±	0.96	0.87	0.8	1.35	3.73	3.84	1.35	3.73	3.84	0.06	0.03
CD (p = 0.05)	NS	NS	2.2	2.8	2.7	10.19	3.98	10.98	11.29	0.19	0.10
C.V.	5.01	5.26	3.31	2.20	2.06	5.06	6.65	3.06	2.64	2.85	4.78

Table 2: Effect of nutrient management on yield attributes, yield and economics of wheat

Treatments	No. of effective tillers/m row length	Number of grains/ear	Ear length (cm)	Test weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest index (%)	Net return (₹/ha)	B: C ratio
100% RDF	84.83	41.23	9.09	42.84	45.80	63.25	109.05	42.02	87015	2.85
RDF + FYM	90.00	45.43	9.50	44.21	53.15	70.97	124.12	42.84	99907	2.81
125% RDF	92.33	45.05	9.43	44.00	52.92	71.27	124.19	42.68	103460	3.27
150% RDF	94.08	44.48	9.50	43.85	54.32	74.52	128.84	42.21	106464	3.25
RDF + Zn	89.75	44.10	9.34	43.62	50.64	67.58	118.22	42.86	96898	3.01
RDF + S	90.17	43.58	9.25	43.07	49.89	68.88	118.77	42.03	95277	2.91
RDF + Zn + S	92.50	44.51	9.42	43.88	52.29	70.46	122.75	42.53	99155	2.88
RDF + foliar sprays of NPK (19:19: 19)	90.25	44.78	9.42	44.10	50.81	68.02	118.83	42.77	96113	2.87
SEm±	1.58	0.81	0.20	0.30	1.32	1.96	2.69	0.74	3004.6	0.09
CD (p = 0.05)	4.63	2.37	NS	0.87	3.88	5.77	7.91	NS	8837	0.27
C.V.	3.48	3.65	4.37	1.35	5.16	5.65	4.46	3.49	6.13	6.08

Conclusion

Based on the results of one year experimentation, it may be concluded that recommended doses of NPK need to increase in wheat crop grown after rice, as the application of 125% RDF (NPK @ 150-50-37.5 kg/ha) significantly enhanced the grain yield and fetched higher net return (₹ 103460/ha) with maximum B: C ratio (3.27), however, wheat crop responded up to 150% RDF which was at par with 125% RDF and 100% RDF+FYM 10t/ha. Further, soil application of Zn @ 5.25 kg/ha and sulphur @ 40 kg/ha along with 100% RDF also found yield remunerative and cost-effective treatments as compared to 100% RDF only (NPK @ 120-40-30 kg/ha), which indicates that addition of S and Zn is required in order to increase the effectiveness of applied nutrients and increase wheat yield. Foliar sprays of NPK 19:19:19 @ 0.5% at 45 DAS and 65 DAS along with recommended doses of NPK also significantly improved the grain yield and net returns.

References

1. Anonymous. Vision 2050. ICAR-Indian Institute of Wheat and Barley Research, Karnal; c2015. p. 34.
2. Borse DK, Usadadia VP, Thorave DS. 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. 2019;8(5):1590-1599.
3. Das A, Shivay Y, Prasad M. Production potential and economic evaluation of cotton wheat cropping system as influenced by prilled urea, Azotobacter and farmyard manure under Indo-Gangetic plains. Journal of Sustainable Agriculture. 2008;32(1):37-50.
4. Fageria NK, Filho MB, Moreira A, Guimarães CM. Foliar fertilization of crop plants. Journal of plant nutrition. 2009;32(6):1044-1064.
5. GOI. Agricultural Statistics at a glance 2020 -21. Government of India, Ministry of Agriculture and Farmers Welfare Department of Agriculture. Cooperation and Farmers Welfare Directorate of Economics and Statistics, New Delhi; c2021.
6. GOR. Agricultural Statistics at a glance 2020-21. Government of Rajasthan, Department of Agriculture. Commissione rate of Agriculture, Jaipur, Rajasthan; c2021.
7. Kumar M, Bauddh K, Kumar S, Sainger M, Sainger PA, Singh RP. Increase in growth, productivity and nutritional status of wheat and enrichment in soil fertility applied with organic matrix entrapped urea. Journal of Environmental Biology. 2013;34(1):1.
8. Kumar R, Pareek BL. Effect of organic manure, *Azospirillum* and inorganic fertilizer on growth and

yield of wheat (*Triticum aestivum* L.). The Pharma Innovation Journal. 2022;11(2):2179-2183.
9. Kumar S, Sharma PK, Yadav MR, Sexena R, Gupta KC, Garg NK, Yadav HL. Impact of nutrient management practices and plant growth regulators on growth, productivity and profitability of wheat (*Triticum aestivum* L.). Indian Journal of Agricultural Sciences. 2019;89(4): 604-609.
10. Mohanta S, Banerjee M, Shankar T. Influence of nutrient management on the growth, yield and nutrient uptake of wheat (*Triticum aestivum* L.) in lateritic belt of West Bengal. International Journal of Current Microbiology and Applied Science. 2020;9(6):1389-1396.
11. Nitharwal PK, Chauhan PS, Mandeewal RL, Shivran H, Sharma AS, Ramniwas, *et al*. Influence of different levels and methods of NPK fertilizer application on the growth and production of wheat (*Triticum aestivum* L.) in arid region of Rajasthan. International Journal of Plant and Soil Science. 2022;34(16):107-114.
12. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. ICAR publication, New Delhi; c1985.
13. Redford RJ. Growth analysis formula-there use and abuse. Crop Science. 1967;7:171-175.
14. Reena Verma O, Shikha Datta D. Response of field crops to foliar nutrition: A Review. Chemical Science Review and Letters. 2018;7(26):402-40
15. Sharma KM, Sharma D, Tomar SS, Chauhan GS, Tanwar SPS. Balanced fertilization and bio regulators: sEnhancing productivity and profitability of wheat (*Triticum aestivum*). Archives of Agronomy and Soil Science. 2011;1:1-11.
16. Sharma N, Sankhyan NK, Sharma RP, Chakkal AS, Thakur A, Kumar P. Effect of Long-Term Application of Fertilizers and Amendments on Wheat Productivity and Available Nutrient Status in an Acid Alfisol. Himachal Journal of Agricultural Research. 2021;47(2):244-250.
17. Sharma NK. Effect of foliar fertilization of NPK on wheat grain yield at farmers field. Indian Journal of Extension Education and Rural Development. 2016;24:193-196.
18. Sharma S, Padbhushan R, Kumar U. Integrated nutrient management in rice–wheat cropping system: an evidence on sustainability in the Indian subcontinent through meta-analysis. Agronomy. 2019;9(2):71.
19. Sharma SK, Jain, NK. Nutrient management in wheat (*Triticum aestivum*)-based cropping systems in sub-humid southern zone of Rajasthan. Indian Journal of Agronomy. 2014;59(1):26-33.
20. Singh S, Singh V. Maximizing wheat (*Triticum aestivum*) productivity and profitability using site specific nutrient management strategy. Annals of Plant and Soil Research. 2018b;20(1):103-106.
21. Singh V, Pandey M. Direct effect of sulphur and zinc on productivity, quality and nutrient uptake by pearl millet (*Pennisetum glaucum*) and their residual effect on succeeding wheat (*Triticum aestivum*) in pearl millet – wheat crop sequence. Annals of Plant and Soil Research. 2018;20(3):233-238.
22. Singh V. Effect of balanced use of nutrients on productivity and economics of wheat (*Triticum aestivum*). Annals of Plant and soil Research. 2017;19(1):105-109.
23. Singh M. Impact of nutrient management and changing climate on productivity and carbon sequestration: A case study from long term- fertilizer experiment. Journal of Indian Society of Soil Science. 2016;64:67-76.
24. Tiwari H, Kumar N, Anshuman K, Yadav S, Singh N, Srivastava A. Effect of Customized fertilizer on yield and economics of wheat (*Triticum aestivum* L.). The Pharma Innovation Journal. 2021;10(4):592-595.
25. Vishwakarma M, Kulhare PS, Tagore GS, Sahu RK. Effect of different sources of nutrient and NPK levels on growth, yield attributes and productivity of wheat (*Triticum aestivum*) in a Vertisol. International Journal of Current Microbiology and Applied Sciences. 2020;9(10): 2625-2632.
26. Yadav DS, Kumar A. Long-term effect of nutrient management on soil health and productivity of rice (*Oryza sativa*)-wheat (*Triticum aestivum*) system. Indian Journal of Agronomy. 2009;54(1):15-23.
27. Donald CM, Hamblin J. The biological yield and harvest index of cereals as agronomic and plant breeding criteria. Advances in agronomy. 1976 Jan 1;28:361-405.
28. Verma AK, Lavine KJ, Lin CY. Myocarditis after Covid-19 mRNA vaccination. New England Journal of Medicine. 2021 Sep 30;385(14):1332-4.