Effect of integrated nutrient management on growth parameters, yield components and yield of wheat (*Triticum aestivum* L.) under the central plain zone of Uttar Pradesh

Abstract

Field experiments were conducted to ~~studies~~ studythe effect ofintegrated nutrient management on growth parameters, yield components, and yield of wheat during the rabi season of 2020-21 and 2021-22 at ~~students~~ students'instructional farm, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur. The experiment consisted of 10 treatment~~s~~ combinationsin a randomized complete block design with three replications consisting~~ed~~ of different combinations of inorganic fertilizer, organic manure, and biofertilizer. Wheat variety HD-2967 was grown with the recommended agronomic practices.On the basis of results ~~emanated~~ emanatingfrom the investigation, it can be concluded that among the growth parameters,the maximum plant height at maturity ~~is~~ was109.25 cm and 110.12 cm, the maximum number of effective tillers~~is~~ was352.67 and355.72andthe maximum spike length~~is~~ was13.55cm and 13.79 cm are associated with the treatment T_{10} [100%NPK+FYM+S_{30}+Zn_5+*Azotobacter*+ PSB] during ~~the~~ both years of experimentation. Similarly, among the yield components and productivity parameters,the maximum values in relation to the number of spikelet ear^{-1}, grain ear^{-1}, 1000 grain wt. (gm), grain yield (q ha^{-1}), andstraw yield (q ha^{-1}) were found in the treatment T_{10} [100%NPK+FYM+S_{30}+Zn_5+*Azotobacter*+ PSB].

Keywords ~~Words~~:*Azotobacter*,FYM, Phosphorous, PSB, Wheat and Yield.

Introduction

Wheat being an energy-rich winter cereal contributes around 35% to the food grain basket of the country. Globally, wheat (*Triticum aestivum* L.) is grown in 124 countries and occupied an area of about 215 million hectares with a production of 734.50 ~~mt.~~MTs. of grain during 2019-20 **(Anonymous, 2020).** In India, the area under wheat increased since the start of the green revolution in 1967and ~~the~~ production and productivity also increased. The area under wheat increased from 12.8 mha. In 1966-67 to 31.45 mha. in 2019-20. In this period production has also increased from 11.4 to 107.59 ~~mt.~~MT and the productivity was increased from 887 to 3421 kg ha^{-1}**(Anonymous, 2020).** Wheat ~~(*Triticum aestivum L.*)~~ is one of the major cereal crops with a unique protein, which is consumed by humans and is grown around the world in different

Comment [H1]: You must write in a way that this would link the previous paragraph.

Comment [H2]: Write in full at first appearance if not a widely known abbreviation.

Comment [H3]: Same as before.

Comment [H4]: Recast!

Comment [H5]: Avoid abbreviations in keywords.

Comment [H6]: Write in full or replace with something else!

Comment [H7]: Do you mean million ha?

Comment [H8]: Same!

environments **(Abedi *et al.*,2010**). ~~Wheat~~ It is foremost among cereals as ~~a~~ the main source of carbohydrates and protein for both human beings and animals; it contains starch (60-90%), protein (11-16.5%), fat (1.5-2%), inorganic ions(1.2-2%) and vitamins (B complex and vitamin E) **(Rueda-Ayala *et al.*, 2011)**.

There are many reasons ~~of~~ forthe low productivity of wheat out of which imbalance and excess fertilizer application is a major one and changes in the ~~physico-chemical~~physicochemical composition of the soil, a depletion and diminution in bioavailability of soil nutrients, a scarcity of good groundwater, the buildup of pests and attack of various diseases of wheat greatly affected its yield and quality (**Timsina and Connor, 2001**). Injudicious application of chemical fertilizers not only harms the biological power of soil but also decreases ~~the~~ soil fertility and crop productivity **(Chand 2008, Parewa *et al.* 2014)**. Thus, integrated nutrient management advocates balanced and conjoint use of inorganic fertilizer, organic manure, and bio-inoculants in order to maintain~~enance~~ or adjust~~mentof~~ soil fertility and plant nutrient supply to an optimum level for sustaining desired crop productivity (**Rakshit *et al.* 2008**; ~~,~~ **Parewa *et al.* 2014**).

Nitrogen (N) is a major factor ~~for~~ in theyield of wheat. The efficiency of wheat cultivars to N use has become increasingly important to allow a reduction in N fertilizer use without decreasing yield.Wheat is an important cereal crop and requires a good supply of nutrients especially nitrogen for its growth **(Mandal *et al.*, 1992)** and yield (**Krylov and Pavlov, 1989**). Nitrogen rate, type of nitrogen, and timing of its application are important factors to increase wheat yield **(Garrido-Lestache *et al.*, 2005).** Some studies showed that N fertilization increases the total quantity of flour proteins, resulting in an increase in both gliadins and glutenin (**Dupont and Altenbach, 2003).**

Phosphorus is essential for enhancing seed maturity and seed development (**Ziadi *et al.* 2008**). Phosphorus plays a significant role in several vital functions such as ~~as~~photosynthesis, the transformation of sugar to starch, protein information, nucleic acid production, nitrogen fixation, and the formation of oil. It is also, ~~the~~ part of all biochemical cycles in plants (**Mehrvarz and Chaichi, 2008**).

Potassium (K^+) is of unusual significance because of its live role in the biochemical functions of the plant like activating various enzymes, improvement of protein, carbohydrates, and fat concentration, and developing tolerance against drought and resistance to frost, lodging, pests, and disease attack. Therefore, potassium is known as "quality element" and it was considered~~as~~ a

Comment [H9]: Not listed!

Comment [H10]: Not listed!

key factor in crop production (**Moussa, 2000**).

Zinc is also reported as an important micronutrient for wheat production because it is required in a large number of enzymes and plays an essential role in DNA transcription.~~.~~ It is reported that high amount of zinc is contained in pollen and mostly zincisinverted to seed only during seed formation and an application of zinc improves grain formation **(Choudhary *et al*., 2007).**

Generally, crops need~~s~~ less sulphur like cereals, still start suffering more and more from sulphur deficiency even there are some crops which need more sulphur as well **(McGrath *et al*, 1996).** The baking properties of wheat and the biological value of proteins can also be improved by increasing sulphur fertilization which has been reported many times **(Jarvan *et al*., 2006).**

Judicious use of FYM with chemical fertilizers improves ~~soil~~ soil'sphysical, chemical, and biological properties and improves ~~the~~ crop productivity **(Sharma *et al*., 2007).** Application of organic manures may also improve availability of native nutrients in soil as well as the efficiency of applied fertilizers **(Sawrup,2010).**

The need of the hour is to evolve an integrated plant nutrient supply system, comprising balanced useofchemicalfertilizer, organicmanures and bio-fertilizers. An improvement in crop performance might be attributed to the N_2-fixing and phosphate solubilising capacity of *Azotobacter* as well as the ability of these microorganisms to produce growth promoting substances (**Salantur *et al*., 2006**). *Azotobacter* and graded doses of nitrogen increase phosphorus and potassium uptake by plants significantly **(Agrawal *et al*., 2004).** Wheat poses problem for the establishment of*Azotobacter* in its rhizosphere. The inoculation of crop plants with bacterial preparation is recommended because a selective and compatible strain is supposed to accelerate plant growth **(Apte and Shende 1981**). Phosphate solubilizing bacteria (PSB) as bio-fertilizers have been found effective in solubilizing the fixed soil P and applied phosphates resulting in higher crop yields (**Panhwar *et al*., 2020).**

~~Resources~~ Materials and Methods

Experimental s~~S~~ite

The experiment was conducted during *rabi* season of 2020-21 and 2021-22 at S~~s~~tudents'~~s~~ Instructional F~~f~~arm, C.S.A., University of Agriculture and Technology, Kanpur Nagar (U.P.).

Comment [H11]: There should be a link between these and the previous paragraph. This part is disjointed.

Formatted: Font: Not Bold

Comment [H12]: Recast!

Comment [H13]: Write in full at first mention!

Comment [H14]: Not listed! Swarup?

Formatted: Font: Not Bold, Font color: Auto

Comment [H15]: Meaning?

The field was well leveled and irrigated by tube well. The farm is situated at main campus of the university, in the west northern part of Kanpur city under sub-tropical zone in vth ~~agroclimatic~~agro climatic zone (central plain zone).

Edaphic c~~C~~ondition

The soil was moist, well-drained with uniform plane topography. The soil of the experimental field was alluvial in origin, sandy loam in texture and slightly alkaline in reaction having pH 8.14 and 8.13 (1:2.5 soil: water suspension method given by **Jackson, 1973**), electrical conductivity 0.45 and 0.44 dSm^{-1} (1:2.5 soil: water suspension method given by **Jackson, 1973**), Organic carbon percentage in soil is 0.42 and 0.43 percent (Walkley and Black's rapid titration method given by **Walkley and Black, 1934**), with available nitrogen 193.0 and 195.0 kg ha^{-1} (Alkaline permanganate method given by **Subbiah and Asija, 1956**), available phosphorus as sodium bicarbonate-extractable P was 12.84 and 12.86 kg ha^{-1} (Olsen's calorimetrically method**, Olsen *et al.*, 1954**) available potassium was 146.76 and 148.52 kg ha^{-1} (Flame photometer method given by **Hanwey and Heidel, 1952**), available sulphur was8.5 and 8.6 kg ha^{-1}**(**Turbidimetric method given **by Chensin and Yien, 1951) and** available zinc was0.53 and 0.54 ppm**(**DTPA extraction method given by (**Lindsay and Norvell, 1978).**

Detail of treatments and design

The 10 treatments combination of nutrient management practices of inorganic fertilizer (Urea, DAP, and MOP), Organic manure (FYM), and Biofertilizer (*Azotobacter* and PSB). The ~~Experiment~~experiment was laid out in a randomized complete block design with three replications.

Table -1.~~:detail~~Detail of the treatment combinations~~:~~

S/~~.~~No.	Symbols	Treatment combinations
1.	**T_1**	CONTROL
2.	**T_2**	50%NPK OF R.D.F.
3.	**T_3**	75%NPK OF R.D.F.
4.	**T_4**	100% NPK OF R.D.F.
5.	**T_5**	125% NPK OF R.D.F.

Comment [H16]: In full at first mention.

Comment [H17]: Same here.

Formatted: Font: (Default) Times New Roman, Not Bold

Formatted: Font: Not Bold

Comment [H18]: R.D.F? These abbreviations should be written in full as legend to this table.

6~~.~~	**T_6**	100%NPK+FYM
7~~.~~	**T_7**	100%NPK+FYM+S_{30}
8~~.~~	**T_8**	100%NPK+FYM+S_{30}+Zn_5
9~~.~~	**T_9**	100%NPK+FYM+S_{30}+Zn_5+*Azotobacter*
10~~.~~	**T_{10}**	100%NPK+FYM+S_{30}+Zn_5+*Azotobacter*+ PSB

Crop h~~H~~usbandry

A pre-sowing irrigation (Paleva) was done in the experimental field with an object to get optimum moisture conditions for attaining good germination. At proper tilth, one ploughing with ~~tractor drawn~~tractor-drawn mould bold plough was done followed by two ploughings by the cultivator. Half a dose of nitrogen ~~Nitrogen~~ together with a full dose of phosphorus ~~Phosphorus~~, and p~~P~~otash were ~~applied as~~ applied as basal at the time of sowing in the form of u~~U~~rea, DAP, and MOP respectively. The r~~R~~emaining half dose of nitrogen was top-dressed into two split doses at 30 and 55 days after sowing (DAS). The sowing of seeds of wheat cv. HD-2967 was done by line sowing by hand at a 2-3 cm depth of soil and with line to line spacing of 22.5 cm to maintain uniform plant population. Application of FYM and ~~Soil~~ treatment with *Azotobacter* and PSB was done.

Harvesting and threshing: T~~t~~he crop was harvested at maturity and was allowed to dry in sun. Separate bundles were made for each plot and weighted. The after drying harvest was threshed manually.

Data c~~C~~ollection

Grain yield

After threshing the grain yield from each plot was separately weighed and recorded after converting into quintals per hectare.

Straw yield

After subtracting the grain yield per plot from the total biological yield. After converting the yields into quintals per hectare, yields were recorded.

Statistical analysis: The growth parameters and yields were recorded and analyzed as per Gomez and Gomez (1984) the tested at 5% level of significance to interpret the significant differences.

Comment [H19]: ??

Comment [H20]: Recast!

Comment [H21]: Are DAP and MOP treatments? Does DAP mean days after planting, and MOP month of planting? You may have to recast for clarity.

Comment [H22]: What are the growth parameters measured?

Comment [H23]: Recast!

Comment [H24]: What are the specific analysis done?

Result and Discussion

Growth pParameters

A critical perusal of the data given in Table-2 clearly shows that among the growth parameters of wheat such as plant height (cm) at maturity, the maximum number of effective tiller [1] and spike length significantly increase due to the application of nitrogen,zZinc, sSulphur, FYM,*Azotobacter*, and PSB. Growth parameters also increased with the lapse of time. Plant height at maturity varied from 91.19-109.68 cm. Themaximum number of effective tillersvaried from 284.61-354.10and spike length varied from 9.52-13.67 cm on a pooled basis. The mMaximum plant height (110.12cm) at maturity, the maximum number of effective tillers(355.72) and the maximum spike length (13.79 cm)was were associated with the etreatment T_{10} [100%NPK + FYM + S_{30}+ Zn_5 +*Azotobacter* + PSB]during the second year (2021-22) of experimentation. The mMinimum plant height (91.12 cm) at maturity, the minimum number of effective tillers[1](283.58), and spike length (9.40 cm) was were associated with the treatment T_1 [control] during the first year (2020-21) of experimentation. The growth parameters of wheat might be increased due to Nitrogen (N) is beinga major factor for inthe yield of wheat. The efficiency of wheat cultivars to N use has become increasingly important to allow reduction in N fertilizer use without decreasing yield. It is reported that high amount of zincis contained in the pollen and mostly,zinc is invertedtoseed onlyduring seed formation and an application of zinc improves grain formation.,The baking properties of wheat and the biological value of proteins can also be improved by increasing sulphur fertilization which has reported many timesapplication of organic manures may also improve availability of native nutrients in soil as well as the efficiency of applied fertilizers.. Organic materials, such as FYM and their continuous use have a strong influence on soil productivity and N dynamics in the soil–plant system. *Azotobacter* and graded doses of nitrogen increase phosphorus and potassium uptake by plants significantly**.** Wheat poses problem for the establishment of*Azotobacter* in its rhizosphere. Phosphate solubilizing bacteria (PSB) as bio-fertilizers have been found effective in solubilizing the fixed soil P and applied phosphates resulting in higher crop yields**.** The consequences of the current investigation are additionally in concurrence with the investigation of**Agrawal *et al*., (2004),Jarvan *et al*., (2006), Choudhary *et al*., (2007), Sawrup,(2010), Panhwar *et al*., (2020) and Choudhary*et al.* (2022)**

Table-2.:Effect of different treatment combination on growth parameters of wheat

Comment [H25]: Not cognizance of punctuations. Recast!

Comment [H26]: References?

Comment [H27]: Rephrase!

Comment [H28]: Not listed

Formatted: Font: Not Bold

Treatments	Plant Height (cm) at Maturity			Number of effective tillers			Spike length (cm)		
	2020-21	**2021-22**	**Pooled**	**2020-21**	**2021-22**	**Pooled**	**2020-21**	**2021-22**	**Pooled**
T_1	91.12	91.25	91.19	283.58	285.63	284.61	9.40	9.65	9.52
T_2	93.46	93.57	93.52	288.65	291.47	290.06	10.25	10.56	10.41
T_3	95.52	95.64	95.58	292.71	295.56	294.14	10.65	10.92	10.79
T_4	97.87	97.98	97.93	298.62	301.24	299.93	11.12	11.32	11.22
T_5	99.74	99.86	99.80	315.26	318.69	316.98	11.96	12.10	12.03
T_6	98.42	98.55	98.49	305.39	307.42	306.41	11.52	11.98	11.75
T_7	101.45	101.52	101.49	322.48	325.54	324.01	12.13	12.56	12.35
T_8	103.76	103.84	103.80	335.47	337.67	336.57	12.68	12.92	12.80
T_9	106.48	106.62	106.55	343.19	346.96	345.08	13.16	13.62	13.39
T_{10}	109.25	110.12	109.68	352.67	355.72	354.10	13.55	13.79	13.67
SE(m) ±	1.31	0.73	0.86	3.02	4.82	5.80	0.21	0.21	0.21
C.D. at 5 %	3.93	2.17	2.57	9.04	14.43	17.38	0.64	0.64	0.62

Yield c~~C~~omponents

At a glance over the data given in the Table~~-~~3 clearly shows that among the yield attributing characters of wheat such as s~~S~~pikelet ear^{-1}, g~~G~~rain ear^{-1}, and 100 grain weight (g~~m~~) significantly increase due to the application of n~~N~~itrogen,~~,~~z~~Z~~inc, s~~S~~ulphur, FYM, *Azotobacter*,andPSB. Significant~~ly~~ response on yield components was recorded with T_{10} [100%NPK + FYM + S_{30}+ Zn_5 +*Azotobacter* + PSB]over other treatments. The s~~S~~pikelet ear^{-1}, g~~G~~rain ear^{-1}, and 100 grain weight (g~~m~~) increased to the magnitude of 36.97 to 45.56, 4.36 to 6.6, and 59.4 to 67.65 respectively, on a pooled basis. The m~~M~~aximum number of spikelet ear^{-1}(22.93), number of grains ear^{-1} (3.32), and 100 grain weight (33.91g~~m~~) was associated with the treatment T_{10} [100%NPK + FYM + S_{30}+ Zn_5 +*Azotobacter* + PSB]during the second year (2021-22) of experimentation. The m~~M~~inimum number ofs~~S~~pikelet ear^{-1} (18.34), number of grain ear^{-1} (2.17), and 100 grain weight (29.51g~~m~~) was associated with the treatmentT_1 [Control] during the first year (2020-21)of experimentation. The results of the present investigation are also in agreement with the findings of **Shaharoona *et al.* (2006), Prasad *et al.* (2010), Mahato and Kafle**

(2013),Yadav *et al.* (2017),Rathwa *et al.* (2018),Maurya *et al.* (2019), and Kumar *et al.* (2022).

Table-3.: Effect of different treatment combinations on yield components of wheat

Treatments	Spikelet ear^{-1}			Grain ear^{-1}			100 Grain Weight (gm)		
	2020-21	**2021-22**	**Pooled**	**2020-21**	**2021-22**	**Pooled**	**2020-21**	**2021-22**	**Pooled**
T_1	18.34	18.63	36.97	2.17	2.19	4.36	29.51	29.89	59.4
T_2	18.62	18.86	37.48	2.38	2.40	4.78	30.12	30.45	60.57
T_3	18.91	19.11	38.02	2.73	2.76	5.49	30.65	30.89	61.54
T_4	19.19	19.63	38.82	2.89	2.92	5.81	31.10	31.35	62.45
T_5	19.56	19.89	39.45	2.95	2.98	5.93	31.64	31.93	63.57
T_6	19.82	20.16	39.98	2.98	3.07	6.05	32.15	32.42	64.57
T_7	20.19	20.56	40.75	3.05	3.09	6.14	32.68	32.80	65.48
T_8	20.52	20.75	41.27	3.14	3.18	6.32	32.00	33.12	65.12
T_9	21.11	21.63	42.74	3.22	3.26	6.48	33.45	33.65	67.1
T_{10}	22.63	22.93	45.56	3.28	3.32	6.6	33.74	33.91	67.65
SE(m) ±	0.21	0.37	0.37	0.39	0.40	0.22	0.46	0.51	0.48
C.D. at 5 %	0.63	1.10	1.11	1.17	1.19	0.67	1.39	1.51	1.44

Productivity pParameters

It is visualized from the data given in Table-4 clearly indicates that among the productivity parameters viz. grain yield (q ha^{-1}) and straw yield (q ha^{-1}) significantly increased due to the application of nNitrogen, ,zZinc, sSulphur, FYM, *Azotobacter*,and PSB. Grain yield varied from 30.31 to 54.21 q ha^{-1}, and straw yield varied from 45.51to 76.86q ha^{-1}. The maximum grain yield (50.94 q ha^{-1}),and straw yield (76.86q ha^{-1})was were associated with the treatment T_{10} [100%NPK + FYM + S_{30}+ Zn_5 +*Azotobacter* + PSB] during the second year (2021-22) of experimentation. The minimum grain yield (30.31q ha^{-1}), and straw yield (45.51q ha^{-1}) was werefound observedunder the treatment T_1 [control] during the first year (2020-21) of experimentation during the second year (2021-22) of experimentation. The surge in seed and

Comment [H29]: Specific Kumar et al., 2022 should be indicated; a or b.

Formatted: Font: Not Bold

Comment [H30]: Recast!

Comment [H31]: Do you mean during the first and the second year of experimentation? Recast for clarity.

straw yields under adequate nutrients supply might be attributed to mainly to the collective effect of a greater number of spikelet ear^{-1}, grains ear^{-1}, and higher test weight, which was the result of improved translocation of photosynthates from source to sink ultimately yield is increased. The increase in grain yield under adequate nutrients supply mainly due to more yield attributes ultimately resultedin more grain yield. Grain and straw yields of wheat significantly increased due to nitrogen 270 (kg ha^{-1}) and FYM(10t ha^{-1}) over their controls. Inoculation of Azotobacter and PSB further increased grain & straw yield of wheat significantly over without inoculation.It may due to treatment of soil with bio-inoculant which fix atmospheric nitrogen and increased the supply of other nutrients to plants and ultimately increased grain and strawyield of wheat. These results also confirms the findings of **Kumar *et al.* (2017)**, **Yadav *et al.* (2017), Yadav *et al.* (2018),Kumar *et al.* (2022),and Sirohiya*et al.* (2022)**

Comment [H32]: Not clear!

Comment [H33]: Recast for clarity.

Comment [H34]: Recast also!

Comment [H35]: Not listed!

Table-4.: Effect of different treatment combinations on productivity parameters of wheat

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold, Font color: Black

Treatments	**Grain Yield (q ha^{-1})**			**Straw Yield (q ha^{-1})**		
	2020-21	**2021-22**	**Pooled**	**2020-21**	**2021-22**	**Pooled**
T_1	30.31	31.15	30.73	45.51	46.45	45.98
T_2	33.23	33.79	33.51	50.21	51.65	50.93
T_3	36.12	36.95	36.15	53.13	54.19	53.66
T_4	40.32	40.51	36.54	55.18	56.91	56.05
T_5	42.15	42.46	40.42	59.23	60.25	59.74
T_6	46.20	46.66	42.31	62.52	63.96	63.24
T_7	47.82	48.21	46.43	65.25	66.56	65.91
T_8	48.33	48.85	48.02	72.52	73.21	72.87
T_9	50.13	50.94	48.59	75.85	76.86	76.36
T_{10}	53.79	54.21	50.54	80.76	81.35	81.06
SE(m) ±	0.57	0.63	0.67	0.61	1.02	1.05
C.D. at 5 %	1.71	1.87	2.01	1.83	3.05	3.15

Conclusion

The current study demonstrate the benefit of nitrogen,zZinc,sSulphur, FYM, *Azotobacter*, and PSBalone with recommended N, K for achieving higher growth parameters and productivity by wheat crop. Application of nitrogen, zZinc, sSulphur, FYM, *Azotobacter*, and PSB increased yield attributes and yield of wheat crop. Finally it can be concluded that the treatment T_{10} [100%NPK+FYM+S_{30}+Zn_5+*Azotobacter*+ PSB] is a thebest option for improving productivity of wheat crop.

Comment [H36]: Recast!

References

Abedi T, Alemzadeh A, Kazemeini SA. (2010). Effect of organic and inorganic fertilizers on grain yield and protein banding pattern of wheat *Australian J. of Crop Sci., AJCS* 4(6):384-389.

Agrawal, N.,Singh,H.P and Savita,U.S.(2004). Effect of *Azotobacter* inoculation and graded doses of nitrogen on the content, uptake and yield of wheat in a Mollisol. *Indian J. Agric. Res*., **38**: 288- 292

Anonymous. (2020). Agricultural Statistics at a Glance 2020. Directorate of Economics & Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Govt. of India, New Delhi, p. 63.

Apte, R., & Shende, S. T. (1981). Studies on Azotobacter chroococcum: IV. Seed Bacterization with Strains of Azotobacter chroococcum and Their Effect on Crop Yield. *Zentralblatt für Bakteriologie, Parasitenkunde, Infektionskrankheiten und Hygiene. Zweite Naturwissenschaftliche Abteilung: Mikrobiologie der Landwirtschaft, der Technologie und des Umweltschutzes*, *136*(8), 637-640.

Chand, T.K. (2008). Analysis of fertilizer use by crops. Indian Journal of Fertilizers 4: 11-16.

Chaudhary, S.K., Thakur, S.K., Pandey, A.K. (2007). Response of wetland rice to nitrogen and zinc. *Oryza;* **44**(1):31-34.

Chensin, L. and Yien, C. H. (1951). Turbidimetric determination of available sulphates. *Soil Science Society of America Proceedings.* 15: 149-151

Choudhary, L., Singh, K. N., Gangwar, K., & Sachan, R. (2022). Effect of FYM and Inorganic fertilizers on growth performance, yield components and yield of wheat (*Triticum aestivum* L.) under indo-gangetic plain of Uttar Pradesh. *The Pharma Innovation Journal* 2022; 11(4): 1476-1479

Dupont, F.M., Altenbach, S.B. (2003).Molecular and biochemical impacts of environmental factors on wheat grain development and protein synthesis. *J Cereal Sci.*,**38**: 133–146.

Garrido-Lestache, E.L., L´opez-Bellido, R.J., L´opez-Bellido, L. (2005). Durum wheat quality under Mediterranean conditions as affected by N rate, timing and splitting, N form and S fertilization. *Europ J Agron*., **23**: 265–278.

Hanway, J.J; and Heidel, H. (1952). Soil analysis methods as used in Iowa State College, Soil Testing Laboratory. *Iowa Agriculture* **54**: 1-31.

Jackson, M.L. (1973). Soil chemical analysis. Prentice Hall of India Pvt. Ltd, New Delhi.

Järvan, M. L., Lukme and Akk,A., (2006). The effect of sulphur on biological quality of protein and baking properties of winter wheat. *Transactions of ERIA* 71, 123-128.

Kirrilov, Y. A. I., & Pavlov, V. D. (1989). Effect of fertilizer on yield and protein contents in wheat grain. *Agrochimiya, 1*, 49-51.

Kumar, P., Dubey, S. D., Sachan, R., Rawat, C. L., & Kumar, V. (2022). Effect of Organic Manure, Inorganic Fertilizers and Biofertilizers on Nutrient Content of Maize (Zea mays L.) and Their Residual Effect on Succeeding Wheat (*Triticum aestivum* L.) Crop. *International Journal of Plant & Soil Science* 34(20): 817-827, 2022; Article no.IJPSS.89229 ISSN: 2320-7035

Kumar, A., Dimree, S., Sachan, R., Shekhar, C., Gangwar, K., & Kumar, M. (2022). Effect of FYM and zinc on growth, yield attributes and productivity parameters of wheat(*Triticum Aestivum* L.). *Asian Jr. of Microbiol. Biotech. Env. Sc.* Vol. 24, No. (4): 2022: 20-23 © Global Science Publications ISSN-0972-3005

Kumar, V., Nikhil, R., and R. A. Singh (2017). Effect of different combination of FYM and urea on growth and yield of wheat (*Triticum aestivum* L.). *Journal of Bulletin of Environment, Pharmacology and Life Sciences*, 6(2): 395-398

Lindsay, W. L., & Norvell, W. (1978). Development of a DTPA soil test for zinc, iron, manganese, and copper. *Soil science society of America journal*, *42*(3), 421-428.

Mandal, N.N., P.P. Chaudhry and Sinha, D. (1992). Nitrogen, nitrogen and potash uptake of wheat (var.Sonalika). *Environ. Econ*., **10**: 297-297.

Formatted: Font color: Red

Comment [H37]: Not cited!

Formatted: Font color: Red

Formatted: Font: Font color: Red, English (United States)

Comment [H38]: Not cited! You can separate with a and b in text.

Formatted: Font color: Red

Mahato, S. and Kafle, A. (2013). Comparative study of Azotobacter with or without other fertilizers on growth and yield of wheat inWestern hills of Nepal. *Annals of Agrarian Science.* 16: 250-256.

Maurya RN, Singh U.P., Kumar S., Yadav A.C., and Yadav R.A. (2019). Effect of integrated nutrient management on growth and yield of wheat (Triticum aestivum L.). *International Journal of Chemical Studies.* 7(1): 770-773

McGrath, S.P., Zhao,F.J., and Withers,P.J. (1996). Development of sulphur deficiency in crops and its treatment Proceedings of the Fertilizer Society No 379, pp.87-92. *Peterborough,* UK.

Mehrvarz, S. and M.R. Chaichi., (2008). Effect of phosphate solubilizing microorganisms and phosphorus chemical fertilizer on forage and grain quality of barely (*Hordeum vulgare*, L.). *Am-Euras. J. Agric. & Environ. Sci.*, 3 (6): 855- 860.

Moussa, B.I.M. (2000). Response of wheat plants growth in sandy soils to K and some micronutrients fertilization. *Egypt J. Soil Sci.*, 40 (4):481-493

Olsen, S.R, Cole, C.V., Watanable, F. S. and Dean, L. A. (1954). Estimation of available phosphorous in soil by extraction with sodium bicarbonate. *USDA, Cric.* **930**:19- 23

Parewa H P, Yadav J. and Rakshit A. (2014). Effect of Fertilizer Levels, FYM and Bioinoculants on Soil Properties in Inceptisol of Varanasi, Uttar Pradesh, India. *Int. J. Agri. Environ. Biotechn.* 7(3): 517-525.

Rueda-Ayala VP, Rasmussen J, Gerhards R, Fournaise NE. (2011). The influence of post-emergence weed harrowing on selectivity, crop recovery and crop yield in different growth stages of winter wheat. Weed Res. 51:478-488.

Panhwar, Q. A., Ali, A., Depar, N., & Shah, J. A. (2020). Screening of plant growth promoting rhizobacteria for sustainable wheat (*Triticum aestivum* L.) crop production. *Pak. J. Bot*, *52*(1), 1-20.

Prasad, J., Karmakar, S., Kumar, R. and Mishra, B. (2010) Influence of integrated nutrient management on yield and soil properties in maize-wheat cropping system in an Alfisol of Jharkhand. Journal of the Indian Society of Soil Science 58, 200-204

Rakshit A, Sarkar NC and Sen D (2008). Influence of organic manures on productivity of two varieties of rice. J. Central Euro. Agri. 9(4):629-634.

Rathwa, P. G., Mevada, K. D., Ombase, K. C., Dodiya, C. J., Bhadu, V., Purabiya, V. S., and Saiyad, M. M. (2018). Integrated nitrogen management through different sources on growth and yield of wheat (*Triticum aestivum* L.). *Journal of Pure and Applied Microbiology*, 12(2): 905-911.

Salantur, A., Ozturk, A., & Akten, S. (2006). Growth and yield response of spring wheat (*Triticum aestivum* L.) to inoculation with rhizobacteria. *Plant Soil and Environment*, *52*(3), 111.

Shaharoona, B., Arshad, M., Zahir, Z. A., & Khalid, A. (2006). Performance of Pseudomonas spp. containing ACC-deaminase for improving growth and yield of maize (*Zea mays* L.) in the presence of nitrogenous fertilizer. *Soil Biology and Biochemistry*, *38*(9), 2971-2975.

Sharma, A., Singh, H. and Nanwal, R. K. (2007). Effect of nutrient management on productivity of wheat (*Triticum aestivum*) under limited and adequate irrigation supply.*Indian J. Agron*., **52**: 120-123.

Sirohiya, A., Kumar, A., Pathak, R. K., Sachan, R., Tiwari, A., Nema, S., & Singh, A. K. (2022). Effect on Organic Manure and Inorganic Fertilizers on Productivity Parameters and Quality Traits of Wheat (*Triticum aestivum* L.) under Central Plain Zone of Uttar Pradesh. *International Journal of Environment and Climate Change 12(11): 1197-1202, 2022; Article no.IJECC.90083 ISSN: 2581-8627*

Subbiah, B.V. and Asija, C.L. (1956). A rapid procedure for the estimation of available N in Soil. *Curr. Sci.* **25**:259-260.

Swarup A. (2010). Integrated plant nutrient supply and management strategies for enhancing soil quality, input use efficiency and crop productivity. *Journal of the Indian Society of Soil Science*. **58**: 25-31.

Walkley, A. and Black, C. S.A. (1934). Old piper, S.S. soil and plant analysis. Soil Sci. 37:29-38.

Formatted: Font color: Red

Comment [H39]: Not cited!

Formatted: Font color: Red

Formatted: Font color: Red

Yadav, K. K., Raju, N., Kumar, P. N. S., and Kumar, S. (2017). Effect of Integrated Nutrient Management on Yield and Availability of Micronutrients in Soil. *Bulletin of Environment, Pharmacology and Life Sciences*, 6: 25-30.

Yadav, K.K., S.P. Singh., Nishant and Vineet Kumar (2018). Effect of integrated nutrient management on soil fertility and productivity of wheat crop. *International Journal of Experimental Agriculture*, 24 (2): 1-9

Ziadi, N., G. Bélanger, A.N. Cambouris, N. Tremblay, M.C. Nolin and A. Claessens. (2008). Relationship between phosphorus and nitrogen concentrations in spring wheat. *Agron. J.* 100 (1): 80- 86