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Influence of Chemical Fertilizers and Micronutrients on Nutrient Uptake and Quality Parameter under Maize-Wheat Cropping System

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ABSTRACT

A field experiment entitled Influence of chemical fertilizers and micronutrients on nutrient uptake and quality parameter under maize-wheat cropping system was conducted at Pot house of the Department of Soil Science and Agricultural Chemistry, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur for two consecutive year of 2016-17 in *kharif* season and 2017-18 in *rabi* seasons in micro plots. The experiment consisted of 9 treatments viz. Control, $N_{(150)}$, $N_{(150)} + P_{(75)}$, $N_{(150)} + P_{(75)} + K_{(75)}$, $N_{(150)} + P_{(75)} + K_{(75)} + S_{(60)}$, $N_{(150)} + P_{(75)} + K_{(75)} + Zn_{(5)}$, $N_{(150)} + P_{(75)} + K_{(75)} + S_{(60)} + Zn_{(5)}$, $N_{(150)} + P_{(75)} + K_{(75)} + S_{(60)} + Zn_{(5)} + Fe_{(10)}$ and $N_{(150)} + P_{(75)} + K_{(75)} + S_{(60)} + Zn_{(5)} + Fe_{(10)} + Az$ which were replicated four times in randomised block design (RBD). Maize (*cv*-Azad Kamal) and wheat (*cv*. PBW-343) were taken as trail basis on maize-wheat cropping system. The results revealed that the significant improvement in the physical properties (Bulk density, Hydraulic conductivity and Water stable aggregates) and chemical properties like cation exchange capacity and total organic carbon content of the soil were recorded by silty clay loam in texture, acidic in reaction (pH 7.8), medium in organic carbon (4.0 g kg^{-1}) with 180, 10.11 and 170.0 kg ha^{-1} of available N, P and K, respectively. Nine treatment combinations were replicated four times in RBD. Surface (0-15 cm) and subsurface (15-30 cm) soil samples taken after the harvest of wheat (*rabi*, 2017-18) were analysed for pH, organic carbon, available N, P and K using standard analytical methods. Besides, different fractions of N, P, K, S, Zn and Fe were also determined in the soil samples taken after the wheat harvest (2017-18) and the composite soil samples drawn from adjacent fallow plots. The results revealed that the nutrient uptake in grain and stalk/stover of wheat and maize were analysed highest with the application of $N_{(150)} + P_{(75)} + K_{(75)} + S_{(60)} + Zn_{(5)} + Fe_{(10)} + Az$ while lowest were found in control treatment. All the application with or without S, Zn and Fe along with NPK were also recorded higher nutrients uptake over control treatment during both of the year. Quality parameter (protein) in maize and wheat was recorded significantly highest with the application of $N_{(150)} + P_{(75)} + K_{(75)} + S_{(60)} + Zn_{(5)} + Fe_{(10)} + Az$. while lowest were found in control treatment. All the application with or without S, Zn and Fe along with NPK were also recorded higher nutrients uptake over control treatment during both of the year.

Keywords

Wheat, Maize,
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Phosphorus,
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Introduction

The overall strategy for increasing crop yield and sustaining them at a high level must include an integrated approach to the management of soil nutrients along with other complementary measures. Integrated approach recognizes that soils are the store house of most of the plant nutrients essential for plant growth and that the way in which nutrients are managed will have a major impact on plant growth, soil fertility and agricultural sustainability. Farmers, researchers and government all have an important role to play in sustaining agricultural productivity. Indian agriculture is operating as a net negative balance of plant nutrients at the rate of 8-10 million tonnes/annum. This continuous nutrient imbalance can become staggering when we consider a future need of food production. India would have to produce around 300 million tonnes of food grains by 2025 A.D. to nourish over 1.4 billion populations against the current estimated production of about 203 million tonnes. To achieve the target of 300 million tonnes India will need at least 45 million tonnes of plant nutrients. Demand of chemical fertilizer would be 35 m.t. consisting from 5.6 - 8.8 million tonnes P_2O_5 , 2.3 to 4.7 million tonnes K_2O and the rest nitrogenous fertilizers. At least 10 million tonnes nutrients should come from organic manure, crop residues and biofertilizers. Thus, food security is very much linked with fertilizer input (Somani, 2001).

India is endowed with enormous potential for plant nutrients locked up in the biological wastes. A total quality of around 875 million tonnes of these so-called biodegradable waste materials is available in the country, which is equivalent to 18.45 million tonnes of nutrients annually. This organic waste needs to be composted properly to recycle its nutrient reserve to bridge the gap between fertilizer manufacturer and crop demand for balance

nutrients. As maize-wheat cropping system is the most prevalent in Central Plain Zone of Uttar Pradesh, therefore, fertilization as well as integrated use of nutrient sources in maize-wheat cropping system needs to be examined for their effect on soil physico-chemical properties, nutrient uptakes by the crops and also crop yields. Maize-wheat is the third most important cropping system after rice-wheat and rice-rice in India, and is grown on about 1.80 million ha each year (Jat *et al.*, 2011).

It is also prevalent cropping system adopted in uplands of Uttar Pradesh. Increasing crop productivity, reducing production costs and improving environmental quality are the three inter linked components determining the sustainability of cropping system.

Materials and Methods

Geographically, the district Kanpur situated in the Central part of Uttar Pradesh, where annual rainfall is about 830mm. Most of the rains are received from the last week of June to the mid of September. April, May and June are the driest months, while, August and September are the wettest months. The district Kanpur is situated in sub-tropical and semi-arid zone falling between the parallels $25^{\circ}26'$ to $26^{\circ}58'$ north latitude and $79^{\circ}31'$ to $80^{\circ}34'$ east longitude, and is located at an elevated belt of Gangetic plains of Central Uttar Pradesh. The climate is sub-tropical semi-arid with hot dry summers and severe cold winters. Average annual precipitation is about 700-800 mm, the most of which generally is received in the last week of June to first week of October. A field experiment was conducted at Pot house of the Department of Soil Science and Agricultural Chemistry, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur for two consecutive year of 2016-17 in *kharif season* and 2017-18 in *rabi* seasons in micro plots. The investigation

consisted of 8 treatments viz. Control, N₍₁₅₀₎, N₍₁₅₀₎ + P₍₇₅₎, N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎, N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎, N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+Zn₍₅₎, N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+ Zn₍₅₎, N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₎+Fe₍₁₀₎ and N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₎+Fe₍₁₀₎+Az which were replicated four times in randomised block design (RBD). Maize (*cv*-Azad Kamal) and wheat (*cv*. PBW-343) were taken as test crops. The soil of experimental farm was silty clay loam in texture, acidic in reaction (pH 7.8), medium in organic carbon (4.0 g kg⁻¹) with 180, 10.11 and 170.0 kg ha⁻¹ of available N, P and K, respectively. Nine treatment combinations were replicated four times in RBD. Different fractions of N, P, K, S, Zn and Fe were also determined in the soil samples taken after the wheat harvest (2017-18) and the composite soil samples drawn from adjacent fallow plots.

Results and Discussion

Maize

Nutrient uptake

In the present study, we used the different levels of NPK alone and also in combination with S, Zn and Fe. These treatments have demonstrated spectacular increase in evidently sufficient removal of the nutrients is affected during crop growth, Thus it becomes necessary to see the dynamics of the nutrients from soil to plant and also their distribution in vegetative and economic parts. In this objective the soil and plants were analysed their concentration and quantitative uptake by plant.

Nitrogen

Results given in Table 1 and 2 revealed that nitrogen uptake varied from 20.17 to 58.56 kg ha⁻¹ in grain and from 14.68 to 50.89 kg ha⁻¹ in straw on the basis of mean of two years. The

highest values were obtained in treatment N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₎+Fe₍₁₀₎+Az. This increase was 66% higher in case of grain and 71% higher in case of straw over control, indicating that the nitrogen absorption was increased appreciably under different treatments.

Results in this study similar buildup in this fraction under same set of agro climatic conditions has been reported by Karkiet *al.*, (2005), and Singh *et al.*, (2008).

Phosphorus

The Table 1 and 2 indicated that significant effect of different treatments marked on phosphorus uptake varied from 4.26 to 11.81 kg ha⁻¹ in gain and from 4.67 to 12.64 kg ha⁻¹ in straw on the basis of mean of two years.

The highest values were obtained in treatment increase was 63% higher in case of grain and 60% higher in case of straw over control indicating that the phosphorus absorption was increased was increased appreciably under different treatments. Results in this study are agreement with those of following workers Yaduvanshi (2001) and Karki *et al.*, (2005).

Potassium

The data presented in Table 1 and 2 showed that potassium uptake varied from 43.11 to 122.44 kg ha⁻¹ in gain and from 71.21 to 216.72 kg ha⁻¹ in straw on the basis of mean of two years.

The highest values were obtained in treatment increase was 64.79% higher in case of grain and 67.14% higher in case of straw over control indicating that the potassium absorption was increased appreciably under different treatments. Results in this study are agreement with those of following workers Yaduvanshi (2001) and Karki *et al.*, (2005).

Sulphur

The table 1 and 2 indicated that Sulphur uptake data varied from 5.36 to 15.82 kg ha⁻¹ in gain and from 8.25 to 21.25 kg ha⁻¹ in straw on the basis of mean of two years. The highest values were obtained in treatment increase was 66.11% higher in case of grain and 61.17% higher in case of straw over control indicating that the sulphur absorption was increased was increased appreciably under different treatments. Results in this study are agreement with those of following workers Yaduvanshi (2001) and Karki *et al.*, (2005).

Zinc

The results given in Table 1 and 2 clearly showed that zinc uptake varied from 37.39 to 126.07 kg ha⁻¹ in gain and from 129.72 to 390.81 kg ha⁻¹ in straw on the basis of mean of two years.

The highest values were obtained in treatment increase was 70.34% higher in case of grain and 66.81% higher in case of straw over control indicating that the zinc absorption was increased was increased appreciably under different treatments. Results in this study are agreement with those of following workers Yaduvanshi (2001) and Karki *et al.*, (2005).

Iron

The Table 1 and 2 indicated that iron uptake varied from 200.55 to 427.45 kg ha⁻¹ in gain and from 198.84 to 454.38 kg ha⁻¹ in straw on the basis of mean of two years.

The highest values were obtained in treatment increase was 53.08% higher in case of grain and 56.23% higher in case of straw over control indicating that the iron absorption was increased was increased appreciably under different treatments. Results in this study are

agreement with those of following workers Yaduvanshi (2001) and Karki *et al.*, (2005).

Protein

The results (Table 1) showed that the protein content was varied from 7.93 to 11.31% and 8.31 to 11.50% with average mean value 8.12 to 11.40. The lowest and the highest value were obtained in control and N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎ +S₍₆₀₎+Zn₍₅₀₎+Fe₍₁₀₎+Az, respectively. The highest protein yield was obtained in N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎ +S₍₆₀₎+Zn₍₅₀₎+Fe₍₁₀₎+Az followed by N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₎+Fe₍₁₀₎ (varying from 11.40 to 11.02 kg ha⁻¹). The data clearly indicated that addition of sulphur; zinc and iron enhance the protein content significantly during first and second years respectively. These findings of present investigation are supported by those of Kachroo and Razdan (2006), Majumdar *et al.*, (2012) and Crista *et al.*, (2012).

Wheat

Table 3 and 4 showed that the concentration and uptake NPK S, Zn and Fe were estimated in grain and straw after the harvest of the crop. It was revealed that the concentration of nutrients and the biomass were increase with increasing doses of NPK from control to 150:75:75 NPK. The results indicated that at each level of NPK the concentrations of NPK S, Zn and Fe were increased at significant level. This was the region that uptake (nutrient concentration x biomass yield) increase significantly.

Nitrogen

The results (Table 3 and 4) clearly determined that the nitrogen uptake varied from 20.17 to 58.56 kg ha⁻¹ in grain and from 14.68 to 50.89 kg ha⁻¹ in straw on the basis of mean of two years.

Table.1 Effect of different treatment on nutrients uptake and protein content (%) of grain in maize crop during both of the year

Treatments combination	N uptake		P uptake		K uptake		S uptake		Zn uptake		Fe uptake		Protein content (%)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Control	19.35	20.96	4.15	4.37	42.29	43.93	5.18	5.55	36.57	38.22	196.95	204.16	7.93	8.31
N₍₁₅₀₎	28.52	32.15	5.56	6.13	59.78	65.74	7.15	7.81	49.98	53.85	262.91	278.46	9.00	9.50
N₍₁₅₀₎ + P₍₇₅₎	36.49	39.37	7.07	7.36	80.91	85.90	9.26	10.00	65.80	71.04	328.53	348.81	9.37	9.56
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎	38.42	40.93	7.30	7.78	85.76	90.22	10.10	10.98	72.35	76.49	338.47	356.73	9.62	9.81
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎	40.73	43.50	8.41	9.03	92.51	98.25	12.15	13.03	78.84	83.43	357.77	377.45	9.68	9.87
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+Zn₍₅₎	41.21	43.97	8.24	8.85	92.97	97.78	10.99	11.80	89.47	94.48	349.96	368.60	10.06	10.25
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+ Zn₍₅₎	44.70	47.59	8.97	9.76	100.51	105.79	12.80	13.85	98.68	107.66	377.35	396.90	10.18	10.37
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₎+Fe₍₁₀₎	52.31	56.13	10.10	10.99	112.32	119.22	14.37	15.34	113.74	121.78	414.19	440.72	10.93	11.12
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₀₎+Fe₍₁₀₎+Az	56.49	61.23	11.24	12.38	118.29	126.60	15.06	16.62	121.72	130.43	437.36	468.33	11.31	11.50
SE(m)	2.06	1.09	0.38	0.37	3.74	3.03	0.37	0.34	3.29	3.30	4.98	5.68	0.44	0.47
C.D. (P=0.05)	6.32	3.36	1.16	1.15	11.50	9.30	1.13	1.03	10.11	10.14	15.30	17.45	1.35	1.45

Table.2 Effect of different treatment on nutrients uptake and protein content (%) of straw in maize crop during both of the year

Treatments combination	N uptake		P uptake		K uptake		S uptake		Zn uptake		Fe uptake	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Control	14.28	15.09	4.69	4.66	70.51	71.91	7.79	8.71	127.82	131.62	196.84	200.84
N₍₁₅₀₎	23.06	24.41	6.30	6.69	99.67	103.89	11.53	12.97	183.96	192.42	278.07	284.00
N₍₁₅₀₎ + P₍₇₅₎	29.76	30.91	9.32	9.09	126.09	128.26	14.06	15.70	237.10	246.24	334.27	341.57
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎	31.39	32.30	9.04	9.25	131.13	141.33	15.12	16.15	253.09	264.16	338.43	350.03
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎	37.87	40.02	9.83	10.32	151.50	157.55	16.44	17.39	280.44	287.95	371.04	378.30
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+Zn₍₅₎	37.96	40.11	9.84	9.62	157.11	160.42	16.52	17.83	293.82	301.25	370.81	379.37
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+ Zn₍₅₎	40.78	42.56	9.83	10.27	183.51	185.08	17.11	17.98	309.46	311.78	395.54	402.05
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₎+Fe₍₁₀₎	47.50	49.59	12.08	12.19	205.50	207.91	18.92	19.92	348.20	361.71	450.13	458.64
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₎+Fe₍₁₀₎+Az	50.47	51.31	12.15	13.14	215.05	218.39	20.60	21.90	374.87	406.75	465.14	478.87
SE(m)	1.69	1.65	0.44	0.40	6.61	3.90	0.60	0.61	8.80	9.62	9.14	9.02
C.D. (P=0.05)	5.19	5.07	1.35	1.23	20.31	11.99	1.83	1.87	27.09	29.58	28.08	27.72

Table.3 Effect of different treatment on nutrients uptake and protein content (%) of grain of wheat crop during both of the year

Treatments combination	N uptake		P uptake		K uptake		S uptake		Zn uptake		Fe uptake		Protein content (%)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Control	45.65	45.73	7.15	7.31	4.89	5.07	2.74	2.95	43.64	45.06	123.98	125.03	12.00	12.12
N₍₁₅₀₎	53.20	55.74	8.51	8.88	6.16	6.56	3.53	4.02	59.47	60.94	157.72	169.15	12.00	12.37
N₍₁₅₀₎ + P₍₇₅₎	81.12	81.87	12.60	12.91	9.06	9.06	5.61	5.91	92.21	96.19	236.27	244.37	12.87	13.00
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎	90.43	92.28	13.94	14.40	10.89	11.13	6.86	7.53	114.92	116.58	270.21	279.22	13.00	13.25
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎	106.30	108.59	16.85	16.62	12.92	13.45	9.25	9.51	143.97	150.70	329.42	345.05	13.12	13.37
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+Zn₍₅₎	116.70	118.90	18.18	18.82	14.52	15.00	10.99	11.32	165.23	168.23	374.50	392.70	13.43	13.62
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+ Zn₍₅₎	118.18	120.14	18.92	18.93	15.08	15.77	11.79	12.34	174.67	177.15	411.31	433.41	13.50	13.68
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₎+Fe₍₁₀₎	119.87	122.82	19.38	19.50	16.33	16.99	13.43	13.79	179.82	183.18	431.90	462.29	13.56	13.81
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎ +S₍₆₀₎+Zn₍₅₀₎+Fe₍₁₀₎+Az	127.80	133.86	20.86	21.96	18.95	19.72	15.28	15.24	194.48	200.31	481.80	501.98	13.62	14.00
SE(m)	2.74	2.48	0.56	0.56	0.53	0.56	0.41	0.45	4.23	3.47	8.019	9.312	0.37	0.38
C.D. (P=0.05)	8.43	7.63	1.73	1.71	1.63	1.73	1.25	1.37	13.00	10.66	24.649	28.624	1.11	1.17

Table.4 Effect of different treatment on nutrients uptake and protein content (%) of straw of wheat crop during both of the year

Treatments combination	N uptake		P uptake		K uptake		S uptake		Zn uptake		Fe uptake	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Control	11.08	11.81	3.25	3.26	50.96	51.55	3.62	3.94	73.02	75.01	286.53	296.62
N₍₁₅₀₎	18.43	18.61	4.83	4.85	77.14	78.07	5.54	5.46	105.81	107.56	398.76	408.53
N₍₁₅₀₎ + P₍₇₅₎	24.32	25.00	6.44	6.94	100.88	103.01	6.96	7.07	138.95	143.55	535.66	555.08
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎	26.57	27.26	7.09	7.43	108.47	110.26	7.90	8.12	164.36	167.77	626.87	644.21
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎	31.28	31.90	8.02	9.00	128.57	132.00	10.69	10.89	195.48	198.40	741.84	757.91
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+Zn₍₅₎	36.04	36.94	9.53	10.10	145.01	147.57	12.13	13.07	235.15	239.58	852.40	874.25
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₎	36.81	37.63	10.52	11.25	151.11	152.81	12.97	13.72	239.10	242.10	883.47	893.32
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₎+Fe₍₁₀₎	38.83	40.81	11.61	12.57	157.49	159.79	14.52	15.30	261.59	264.86	929.04	946.93
N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₀₎+Fe₍₁₀₎+Az	41.12	42.52	12.72	13.49	161.51	163.59	15.67	16.08	268.00	271.06	958.68	983.40
SE(m)	1.29	1.20	0.39	0.43	3.30	3.35	0.46	0.39	6.99	9.27	19.926	17.907
C.D. (P=0.05)	3.97	3.69	1.19	1.32	10.13	10.31	1.40	1.20	21.49	28.51	61.249	55.043

The highest values were obtained in treatment N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₀₎+Fe₍₁₀₎+Az this increase was 66% higher in case of grain and 71% higher in case of straw over control, indicating that the nitrogen absorption was increased appreciably under different treatments.

Similar buildup in this fraction under same set of agro climatic conditions has been reported by Karki *et al.*, (2005) and Singh *et al.*, (2008).

Phosphorus

Table 3 and 4 showed that phosphorus uptake varied from 7.23 to 21.41 kg ha⁻¹ in gain and from 3.25 to 13.10 kg ha⁻¹ in straw on the basis of mean of two years. The highest values were obtained in treatment N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₀₎+Fe₍₁₀₎+Az increase was 66% higher in case of grain and 75% higher in case of straw over control indicating that the phosphorus absorption was increased appreciably under different treatments. Results in this study are agreement with those of following workers Yaduvanshi (2001), Karki *et al.*, (2005) and Tyagi and Mahapatra (2012).

Potassium

The data presented in Table 3 and 4 showed that potassium uptake varied from 4.98 to 19.13 kg ha⁻¹ in gain and from 51.25 to 162.55 kg ha⁻¹ in straw on the basis of mean of two years. The highest values were obtained in treatment increase was 74% higher in case of grain and 68% higher in case of straw over control. When NPK combined with S, Zn and Fe indicating that the potassium absorption was increased was increased appreciably. Results in this study are agreement with those of following workers Karki *et al.*, (2005), Majumdar *et al.*, (2012) and Kumar *et al.*, (2017).

Sulphur

Table 3 and 4 showed that sulphur uptake varied from 2.84 to 15.26 kg ha⁻¹ in gain and from 3.78 to 15.87 kg ha⁻¹ in straw on the basis of mean of two years. The highest values were obtained in

treatment (N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₀₎+Fe₍₁₀₎+Az) increase was 81% higher in case of grain and 76% higher in case of straw over control indicating that the sulphur absorption was increased was increased appreciably under different treatments. Results in this study are agreement with those of following workers Yaduvanshi (2001), Karki *et al.*, (2005) and Barbara *et al.*, (2008).

Zinc

Table 3 and 4 showed that zinc uptake varied 44.35 to 197.39% kg ha⁻¹ in gain and from 74.01 to 269.53% kg ha⁻¹ in straw on the basis of mean of two years. The highest values were obtained in treatment N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₀₎+Fe₍₁₀₎+Az increase was 20.32% % higher in case of grain and 16.95% higher in case of straw over 150:75:75 NPK alone indicating that the zinc absorption was increased was increased appreciably under this treatments. Results in this study are agreement with those of following workers Yaduvanshi (2001), Karki *et al.*, (2005) and Upadhayay *et al.*, (2011).

Iron

The results of iron uptake (Table 3 and 4) varied from 124.50 to 491.89 kg ha⁻¹ in gain and from 291.57 to 971.04 kg ha⁻¹ in straw on the basis of mean of two years. The highest values were obtained in treatment N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn₍₅₀₎+Fe₍₁₀₎+Az increase was 44.15% higher in case of grain and 34.55% higher in case of straw over NPK alone indicating that the iron absorption was increased was increased appreciably under this treatment. Results in this study are agreement with those of following workers Yaduvanshi (2001) and Karki *et al.*, (2005).

Protein

Table 3 showed that the protein content was varied from 12.00 to 13.62% and 12.12 to 14.00% with average mean value 12.06 to 13.81. The lowest and the highest value were obtained in control and N₍₁₅₀₎+P₍₇₅₎+K₍₇₅₎+S₍₆₀₎+Zn

⁽⁵⁰⁾+Fe ⁽¹⁰⁾+Az. The highest protein yield was obtained in N ⁽¹⁵⁰⁾+P ⁽⁷⁵⁾+K⁽⁷⁵⁾ +S ⁽⁶⁰⁾+Zn ⁽⁵⁰⁾+Fe ⁽¹⁰⁾+Az followed by N ⁽¹⁵⁰⁾+P ⁽⁷⁵⁾+K ⁽⁷⁵⁾+S ⁽⁶⁰⁾+Zn ⁽⁵⁾+Fe ⁽¹⁰⁾ (varying from 13.81 to 13.68 kg ha⁻¹). The data clearly indicated that addition of sulphur, zinc and iron enhance the protein content significantly during first and second years respectively. These findings of present investigation are supported by those of Kachroo and Razdan (2006), Madan *et al.*, (2009) and Crista *et al.*, (2012).

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