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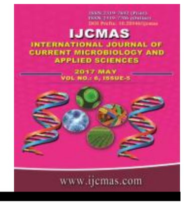

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Study of Missing Nutrient Technique on the Yield and Nutrient Uptake of Wheat

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Balanced fertilization is necessary for betterment of crop and soil health. To assess the effect of different nutrient on yield uptake and soil fertility experiment was conducted in pot culture in Department of Soil Science and Agricultural Chemistry, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur in 2012-13. Results revealed that the omission of all studied nutrient (NPKSZnB) from complete treatment (NPKSZnB) drastically decreased yield than continuously fertilized complete treatment. The amount of yield increase obtained upon a missing element fertilization nearly equivalent to yield loss when that particular nutrient was absent as compared to complete fertilization. When nitrogen @120kg, phosphorus @ 40 kg, potassium @ 40 kg, zinc @ 10 kg, sulphur@ 30 kg and boron @ 1.0 kg then results found not only highest grain and straw yield of wheat but also better uptake of nutrient and render the soil in healthy and fertile condition as compare to control or when any nutrient were missing.

Introduction

Wheat (*Triticum aestivum* L.) is the first important and strategic cereal crop for the majority of world's populations. It contributes nearly one third of the total food grain production. Wheat is cultivated worldwide and most important staple food of about two billion people (36% of world population). In 2008-09 world production of wheat was 645 million tonnes (DWR 2010); making it the third most produced cereal after maize (784 million tonnes) and rice (651 million tonnes). Wheat area has risen from 12.8 million hectare in 1966-67 to 29.8 million hectare in 2013-14. Wheat production in 2013-14 was 87 million tonnes (USDA, 2013-14) while the production of wheat crop in Uttar Pradesh was 30.3million tonnes from 9.74 million hectare area in 2012-13 (Ministry of Agriculture 2013). The area of wheat crop in Uttar Pradesh was increased up to 9.94 million hectare in 2013-14 (Economic Times 2014). The productivity of wheat in India in 2012-13 was 3119 Kgha^{-1} and in Uttar Pradesh 3113 kgha^{-1}(Ministry of Agriculture 2013). India is facing with an explosive population, hence a massive food production programme, specially for wheat is needed. India being the second largest in population, it is also the second largest in wheat consumption after China.

Soil is a biologically active layer of material resulting from complex transformations which in turn involve rock and mineral weathering, nutrient cycling, as well as biomass production and decomposition. It is thus the primary medium for plant growth (Novais *et al*., 2007). A way of maintaining nutrient levels and soil stability is to use fertilization. However, suitable management of fertilization involves defining not only the correct dosages and sources of nutrients but also the best seasons and methods to apply liming and fertilizers to the soil (Oliveira *et al*., 1991).The learning process of soil-plant relationships calls for experiments with which to identify nutrient deficiencies in the target species (Oliveira *et al*., 1991). The most widely used method in experiments on nutrient deficiency is the missing element technique, based on Liebig's law of the minimum (1840)

To increase the production of wheat in our country as well as state and to sustain the productivity of land proper management practices must be followed. To complete their life cycle plants need certain elements; which are known as essential nutrients and without them Plants are unable to complete their life cycle. These elements are carbon, oxygen, hydrogen, nitrogen, phosphorus, calcium, magnesium, sulphur, iron, manganese, zinc, copper, boron, molybdenum and chlorine. Out of these, carbon, oxygen and hydrogen are needed in highest amount and their source is atmosphere. In current study the N, P, K, S, Zn and B have been taken under missing nutrient technique on wheat crop.

Materials and Methods

The treatments details were as follows: $\mathbf{T_{1;}}$Control,$\mathbf{T_{2;}}$120 kg N, $\mathbf{T_{3;}}$120 kg N + 40 kg P,$\mathbf{T_{4;}}$ 120 kg N + 40 kg P + 40 kg K, $\mathbf{T_{5;}}$ 120 kg N + 40 kg P + 40 kg K + 10 kg Zn$\mathbf{T_{6;}}$ 120kg N + 40 kg P + 40 kg K + 30 kg S, $\mathbf{T_{7;}}$ 120kg N + 40 kg P + 40 kg K + 10 kg Zn + 30 kg S,$\mathbf{T_{8;}}$ 120kg N + 40 kg P + 40 kg K + 10 kg Zn + 30 kg S + 1.0 kg B.

The experimental soils sandy loam in texture having pH (8.15), EC (2.60 ds m^{-1}), organic carbon (0.44 g kg^{-1}), available N (252kg ha^{-1}), available P_2O_5 (14.40 kg ha^{-1}) available K (138 kg ha^{-1}), available S (9.80 kg ha^{-1}), DTPA- extractable Zn (0.52 mg kg^{-1}), Fe (3.92 mg kg^{-1}), Mn (4.62 mg kg^{-1}) and Cu (0.85 mg kg^{-1}) and available B (0.47 mg kg^{-1}).

The post harvest soil samples were drawn from all the fields, and analyzed for pH, electrical conductivity (Jackson, 1973), organic carbon (Walkley and Black, 1934). Soil samples were also analyzed for available nitrogen (Subbiah and Asija, 1956), available phosphorus (Olsen *et al*., 1954), available potassium (Hanway and Heidal, 1952) and $CaCl_2$ extractable-S (Williams and Steinbergs, 1959). The available micronutrients (Zn, Fe, Cu and Mn) in soil were extracted by DTPA (Lindsay and Norvell, 1978) and determined on atomic absorption spectrophotometer. Hot water extractable boron was determined by colorimeter methods (Berger and Truog, 1939). The economics of various treatments was computed on the basis of prevailing market price of inputs and produces**.**

The experiment was conducted on cemented pots of 10 kg soil capacity in 'pot culture house' of the Department of Soil Science and Agricultural Chemistry, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during Rabi season 2012-13. It is located between latitude of $25^0 28'$ to $26^0 58'$ north and $79^0 31'$ to $80^0 34'$ east with an elevation of 125.9m from the sea level. The pots 10 kg capacity having 30 cm diameter at the top and 26 cm depth were selected for the experiment. Each pot was filled with 10 kg well pulverized homogenous soil.

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The formula expressed below was used for the computation of uptake of the nitrogen, phosphorus, potassium, sulphur, zinc and boron at harvest in both grains as well as straw.

$$\text{Uptake of nutrient (kgha}^{-1}\text{)} = \frac{\text{Nutrient content (\%) X Yield (kgha}^{-1}\text{)}}{100}$$

The initial soil fertility status of soil use for filling the pots are shown in Table 1

The experiment was laid out in a complete randomized design with 8 treatments replicated with 4 times. The details of treatments given below:

The Seeds were sown on 26 Nov 2012 @ of 100 kg ha^{-1}. The half dose of the nitrogen and full dose of the phosphorus, potassium, sulphur, zinc and boron were applied before sowing i.e. basal dressing. The remaining amount of nitrogen was applied through top dressing after 22 to 25 days of date of sowing. The crop was harvested at maturity on 07 Apr 2013 and bundles of each pot were tagged and kept separately. Harvested material of each pot were threshed and stored separately. Calculate the yield in q ha^{-1}. The data were subjected to statistical analysis by the method described by Chandel (1991).

Results and Discussion

The experimental results of grain and straw yield of wheat are presented in table 3. The grain yield varied from 31.00 qha^{-1} to 48.20 qha^{-1}. The treatment T_8 (N_{120} + P_{40} + K_{40} + Zn_{10} + S_{30} + $B_{1.0}$) gave the highest grain yield in present investigation. The experimental data clearly shows that all the treatments gave significantly higher grain yield in comparison to control. The grain yield of wheat increased by increasing the nutrient doses. The straw yield for different treatments ranged from 40.20 to 62.20 qha^{-1}. Highest straw yield (62.20 qha^{-1}) achieved from T_8 (N_{120} + P_{40} + K_{40} + Zn_{10} + S_{30} + $B_{1.0}$). All the treatments gave significantly higher yield in comparison to control.Shah *et al.*, (2008) also reported that the long-term missing of major nutrient individually from the complete treatment (NPKSZn) significantly decreased yield and still significantly higher than absolute control treatment. This may be due to Liebig's law of the minimum (1840) according to them, nutrient present in minimum amount, decide the growth of plants so until all the nutrient would not be present in optimum yield will also be sub optimum.

The data of table 3 shows the percent contribution of sequential addition of different nutrients under present study. The contribution of N over control was about 22.58 and 20.65% in grain and straw, respectively. Addition of P resulted in a positive interaction with N and magnitude of increase in yield over control reached up to30.64 and 24.38% respectively in grain and straw. Addition of K and NP resulted in 43.87 and 37.31% Yield increase and addition of S to NPK gave almost similar increase in yield but when added Zn to NPKS, the magnitude of yield increase was 54.19 and 50% in grain and straw, respectively over control. Addition of boron to NPKS and Zn resulted highest increase in yield (55.48 and 55%) in grain and straw respectively. The increased in grain yield of wheat from T_1 to $T_8$is might be due to the increased availability of essential nutrients from the enhanced level of nutrients applied to the crop. These findings are in close conformity with the earlier findings of Parasuraman (2006) in maize. In this missing nutrient technique sufficient justification is exhibited in yield maximization through sequential missing nutrients. It was further observed that there have been responses of all the missing nutrients in varying degree.

The data pertaining to nutrient uptake are presented in table 4 and 5. Nutrient uptake was affected significantly due to various treatments. The uptake of N, P, K, S, Zn and B by plants increased significantly with successive increase in nutrient level, which led to maximum N, P, K, S, Zn and B uptake. The data pertaining to nitrogen uptake are presented in table 4. The nitrogen uptake in wheat grain ranged from 55.80 to 99.78 kgha^{-1}. The treatment combination T_8 (N_{120} + P_{40} +K_{40} + Zn_{10} + S_{30} + $B_{1.0}$ kgha^{-1}) gave the highest value of nitrogen uptake. The nitrogen uptake values in wheat straw ranged from 16.48 to 31.72 kgha^{-1}. Similar trends of variation were observed in this case. Total uptake was more or less similar to grain and straw uptake. The result of present investigation indicated that the increase in fertilizer dose gave the increasing values of all types of uptake. The phosphorus uptake varied from 9.61 to 18.80 kgha^{-1} in wheat grain and 4.02 to 8.71 kgha^{-1} in wheat straw. All the treatment combinations gave the higher uptake value in comparison to control. The total uptake values varied between 13.63 and 27.51 kgha^{-1}. All types of uptake values gave similar kind of variation. The uptake of potassium by the grain of wheat crop ranged from 6.20 to 12.05 kg ha^{-1} and for the straw of wheat values varied from 70.35 to 130.62 kg ha^{-1}.

The highest uptake of potassium for both grain and straw of wheat 12.05 kg ha^{-1} and 130.62 kg ha^{-1} were obtained from treatment combination T_8 (N_{120} + P_{40} +K_{40} + Zn_{10} + S_{30} + $B_{1.0}$ kgha^{-1}). The total uptake of potassium varied from 76.55 to 142.67 kg ha^{-1}. The pattern of variation is more are less similar in all types of uptake values. The findings of Rana and Choudhary (2006) confirmed these results.

Table.1 Physic-chemical properties of pots soil before sowing and fertilization

S.No.	Particulars	Values
1.	Sand (%)	56.50
2.	Silt (*%*)	23.55
3.	Clay (*%*)	19.95
4.	Textural Class	Loam
5.	pH (*1:2.5*)	8.15
6.	EC (*1:2.5*) (*dSm^{-1} at 25^{0}C*)	2.60
7.	Organic Carbon (*%*)	0.44
8.	Available Nitrogen (*kg ha^{-1}*)	252.0
9.	Available Phosphorus (*kg ha^{-1}*)	14.40
10.	Available Potassium (*kg ha^{-1}*)	138.0
11.	Available Sulphur (*kg ha^{-1}*)	9.80
12.	Available Zinc (*ppm*)	0.52
13.	Available Boron (*ppm*)	0.47
14.	Particle Density (*mg m^{-3}*)	2.52
15.	Bulk Density (*mg m^{-3}*)	1.34
16.	Pore Space *(%)*	45.0

Table.2 Treatment Details

S.No.	Treatment	Nutrient dose (kg ha^{-1})
1.	T_1	Control
2.	T_2	120 kg N
3.	T_3	120 kg N + 40 kg P
4.	T_4	120 kg N + 40 kg P + 40 kg K
5.	T_5	120 kg N + 40 kg P + 40 kg K + 10 kg Zn
6.	T_6	120kg N + 40 kg P + 40 kg K + 30 kg S
7.	T_7	120kg N + 40 kg P + 40 kg K + 10 kg Zn + 30 kg S
8.	T_8	120kg N + 40 kg P + 40 kg K + 10 kg Zn + 30 kg S + 1.0 kg B

Table.3 Effect of different treatments on grain and straw yields of wheat crop (qha-1)

Treatment no.	Treatments details	Average yield (qha^{-1})		Percent increase over control	
		Grain	Straw	Grain	Straw
T_1	Control	31.00	40.20	-	-
T_2	N_{120}	38.00	48.50	22.58	20.65
T_3	N_{120} + P_{40}	40.50	50.00	30.64	24.38
T_4	N_{120} + P_{40} +K_{40}	44.60	55.20	43.87	37.31
T_5	N_{120} + P_{40} +K_{40} + Zn_{10}	45.80	56.10	47.74	39.55
T_6	N_{120} + P_{40} +K_{40} + S_{30}	46.70	58.00	50.64	44.28
T_7	N_{120} + P_{40} +K_{40} + Zn_{10} + S_{30}	47.80	60.00	54.19	49.25
T_8	N_{120} + P_{40} +K_{40} + Zn_{10} + S_{30} + $B_{1.0}$	48.20	62.20	55.48	54.73
	S.E. $\pm$	0.4636	0.5304		
	C.D. (at 5%)	1.3533	1.5481		

Table.4 Effect of different treatments on the uptake of Nitrogen, Phosphorus and potassium on wheat crop (kgha-1)

Treatment	Nutrient uptake Kg ha^{-1}								
	N			P			K		
	Grain	Straw	Total	Grain	Straw	Total)	Grain	Straw	Total
T_1	55.80	16.48	72.28	9.61	4.02	13.63	6.20	70.35	76.55
T_2	71.44	20.86	92.29	12.16	5.34	17.50	7.98	89.73	97.71
T_3	79.38	22.50	101.88	13.77	6.00	19.77	8.91	93.50	102.41
T_4	86.53	25.39	111.92	15.61	7.18	22.79	10.26	104.88	115.14
T_5	90.23	26.36	116..59	16.49	6.73	23.22	10.08	107.71	117.79
T_6	92.47	27.84	120.31	17.28	7.54	24.82	10.74	112.52	123.26
T_7	95.60	29.40	125.00	18.16	7.80	25.96	11.47	117.60	129.08
T_8	99.78	31.72	131.49	18.80	8.71	27.51	12.05	130.62	142.67
S.E. $\pm$	2.2421	1.6031		1.2096	0.3758		0.4467	0.5025	-
CD at 5%	6.5443	4.6789	-	3.5306	1.0969	-	1.3039	1.4667	-

Table.5 Effect of different treatments on the uptake of sulphur,zinc and boron on wheat crop (kgha-1)

Treatment	Nutrient uptake Kg ha^{-1}								
	S			Zn			B		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
T_1	3.41	4.42	7.83	46.50	44.22	90.72	62.00	52.26	114.26
T_2	4.94	5.82	10.76	60.80	63.05	123.85	83.60	72.75	156.35
T_3	5.67	6.50	12.17	72.90	70.00	142.90	93.15	80.00	173.15
T_4	6.69	7.72	14.41	89.20	81.69	170..89	115.96	94.94	210.90
T_5	7.33	7.85	15.18	100.76	85.27	186.03	128.24	103.22	231.46
T_6	8.41	8.70	17.11	107.41	90.48	199.89	126.09	101.50	227.59
T_7	9.08	9.60	18.68	114.72	100.80	215.52	138.62	114.00	252.62
T_8	9.64	10.58	20.21	119.54	119.96	231.49	149.42	130.62	280.04
S.E. $\pm$	0.3550	0.2993		0.8058	0.5556		0.6072	0.6675	
CD at 5%	1.0362	0.8736		2.3518	1.6218		1.7724	1.9484	

Table.6 Effect of different treatments on the nutrients content in soil after harvest of wheat crop

Treatment No.	O.C. (%)	N (Kgha^{-1})	P (kgha^{-1})	K (kgha^{-1})	S (kgha^{-1})	Zn (ppm)	B (ppm)
T_1	0.46	252	13.7	139.4	9.60	0.52	0.42
T_2	0.47	257	13.9	139.6	9.61	0.53	0.43
T_3	0.47	258	14.1	139.5	9.62	0.54	0.44
T_4	0.48	260	14.2	140.0	9.63	0.55	0.47
T_5	0.48	262	14.3	140.2	9.64	0.57	0.47
T_6	0.48	262	14.4	140.3	9.74	0.56	0.46
T_7	0.48	263	14.5	140.5	9.80	0.60	0.47
T_8	0.48	264	14.6	140.9	9.80	0.60	0.50

The result of present investigation related to uptake of sulphur, zinc and boron are presented in table 5. The uptake values of sulphur in grain ranged from 3.41 to 9.64 kg ha^{-1}. The uptake values in straw ranged from 4.42 to 10.58 kg ha^{-1} while the total uptake values varied from 7.83 to 20.21 kg ha^{-1}. The treatment combination T_8 (N_{120} + P_{40} +K_{40} + Zn_{10} + S_{30} + $B_{1.0}$ kgha^{-1}) gave the highest values of grain, straw and total uptake in this case also. The sulphur uptake values increased when supply of fertilizers increased. The zinc and boron uptake values in grain and straw also follow similar trend. Uptake of zinc in grain and straw varied from 46.50 to 119.54 g ha^{-1} and 44.22 to 119.96 g ha^{-1} respectively. The total uptake values varied from 90.72 to 231.49 g ha^{-1}. The values are more or less similar to other nutrient content. The treatment T_8 (N_{120} + P_{40} +K_{40} + Zn_{10} + S_{30} + $B_{1.0}$ kg ha^{-1}) once again was found best combination of fertilizers. It is in accordance with the finding of Kedar Prasad *et al.*, (2005) which told that due to the balanced supply of all nutrients to plants at all stages of crop growth. The grain and straw uptake values of boron in wheat crop varied from 62.00 to 149.42 g ha^{-1} and 52.26 to 130.62 g ha^{-1} respectively. The total uptake value varied from 114.26 to 280.04 g ha^{-1}. The result is more or less similar to other nutrient content. The treatment T_8 (N_{120} + P_{40} +K_{40} + Zn_{10} + S_{30} + $B_{1.0}$ kg ha^{-1}) once again was found superior over other treatments. It is also important that nutrient minus treatments gave the lower nutrient uptake in comparison to nutrient containing combinations. Similar result found by paramasivan *et al.*, (2012) showed that the lower uptake of N, P, K and Zn was in treatments omitted with N, P or K and in absolute control.

Effect of different treatments on soil fertility status is revealed in table 7. Data are showing that after harvesting organic carbon, available N, P, K, S, Zn and B content are found highest in soil having treatment T_8 while minimum in T_1 or control. The better build up of soil fertility in treatment T_8 is due to balanced fertilization. Balanced fertilization not only increase yield and uptake of particular nutrient but also render the soil in healthy and well fertile condition which make the basis for sustainable crop management. These results are in agreement with the findings of Brar *et al*., (2006).

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