The Pharma Innovation Journal 2021; 10(4): 614-617

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(4): 614-617

www.thepharmajournal.com
Received: 15-02-2021
Accepted: 18-03-2021

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Effect of effect of customized fertilizer on soil fertility and nutrient uptake by wheat

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Abstract
A field experiment was conducted to study the scope of customized fertilizer for increasing the productivity of wheat system in U.P. during *Rabi* season of the year 2016-17 at Farmer field in the village of Pero Saraiya (Dehli Bazar) in the District of Sultanpur. The results revealed that maximum uptake of N (108.12 $kgha^{-1}$), P (29.02 $kgha^{-1}$), K (116.24 $kgha^{-1}$), S (70.10$kgha^{-1}$), Zn (207.10gha^{-1}) and B (58.15gha^{-1}) observed in treatment having Soil test based recommendation (T_3) followed by T_4 -Indo-Gulf Customized Fertilizer, similarly the maximum availability of P (17.10 $kgha^{-1}$), S (11.80 $kgha^{-1}$), Zn (0.51 ppm) and B (0.45 ppm) and maximum decline in soil pH (7.57), EC (0.26 dSm^{-1}) with maximum buildup of organic carbon (0.34gkg^{-1}) content in soil recorded in treatment T_3 -Soil test based recommendation, while the maximum available N (176.28 $kgha^{-1}$) and K (250.10$kgha^{-1}$) were observed under treatment T_2 (RDF). The minimum uptake and availability of N, P, K, S, Zn, B and minimum decline in soil pH and EC were recorded in the treatment T_1 (control).

Keywords: customized fertilizer, wheat, NPK and Zn uptake

Introduction
Wheat (*Triticum aestivum* L.) is a staple food of the world and belong to family (Gramineae). It is a C_3 plant primarily grown in temperate regions and also at higher altitude under tropical climatic areas in winter season. It has been described as the “King of cereals” because of the acreage and high productivity which also occupies a prominent position in the international food grain trade. As for as India is concerned, about 91% of the total wheat production is contributed by six northern states *viz*., Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, and Bihar. Among them, Uttar Pradesh ranks first with respect to area (9.85 million hectare) and production (25.22 million metric tonnes) but the productivity is much lower (2561kg ha^{-1}) than Punjab (4474 kg ha^{-1}) and Haryana (4574 kg ha^{-1}) (Agricultural Statistics at a Glance 2015) [2]. The continuous mining of nutrients from soils coupled with in adequate and imbalanced fertilizer use has resulted in emergence of multi-nutrient deficiency. The deficiency of at least seven nutrients (N, P, K, S, Zn, B, and Fe) is quite common in soils of U.P. An annual depletion of 36 million tons of nutrients (N, P, K,) from soil, has been estimated while the replacement through fertilizer is only 28 million tonnes leaving a net annual deficit of 8 million tonnes which keeps accumulating year after year depleting the soil fertility (Tewatia *et al.* 2012) [24]. Rice-Wheat system is highly exhaustive for nutrient removal from the soil. Rice-Wheat system producing a grain yield of 6.95 tonnes per hectare rice and 3.86 tonnes per hectare wheat it removes as much as 316 kg N, 28 kg P, and 342 kg per hectare apart from significant amount of different secondary and micro nutrient. (Hegde and Pandey, 1989) [11]. The balance nutrient supply to the crops resulted minimal deleterious effect on environment as well as soil (Hegde *et al*., 2007) [12]. The ‘Customized Fertilizer’ made up of mixing Nitrogen, Phosphorus, Potassium, Sulphur and Zinc has been tested for enhancing wheat yield. Customized fertilizers are unique and ready to use granulated fertilizers, formulated on sound scientific plant nutrition principles integrated with soil information, extensive laboratory studies and evaluated through field research (Rakshit *et al*., 2012) [18]. The Central Fertilizer Committee has included customized fertilizers in the Fertilizer (Control) Order (FCO) 1985, as a new category of fertilizers that are area, soil and crop specific. Depending on the soil test results, climate, water requirement and crop chosen, a particular type of grade of fertilizer (Customized fertilizer) is prescribed to get the best yield and maintain soil health. Maintenance of proper soil fertility in wheat system is formidable challenge. Therefore present study was proposed to study the effect of customized fertilizer on

soil fertility and nutrient uptake by wheat.

Materials and methods

A field experiment was conducted to study the scope of customized fertilizer for increasing the productivity of wheat system in U.P. during *Rabi* season of the year 2016-17 at Farmer field in the village of Pero Saraiya (Dehli Bazar) in the District of Sultanpur. The experimental soil having silty loam in texture pH (1:2.5) 7.8, electrical conductivity (EC) 0.30 dS m^{-1}, organic carbon 0.31 %, available N 132.40 $kgha^{-1}$, P 13.08 $kgha^{-1}$, K 238.20 kg ha^{-1}., S 9.10 $kgha^{-1}$, Zn 0.50 (ppm), B (0.48 ppm) All six treatments were randomly allocated and replicated four times in a randomized block design was adopted for the experimentation. The wheat variety PBW 502 was sown in first fortnight of December. To assess the various treatment effects, soil sample were collected after harvest of the crop from each plots. Soil pH and EC were determined by following Chopra and Kanwar (1991). Soil organic carbon was determined by Walkley and Black (1934) rapid titration procedure. Soil available N was determined following Subbiah and Asija (1956). Available P was determined by Olsen *et al.* (1954) method. Available K was determined by following Jackson (1973). 0.15% CaCl2 extractable S by developing turbidity using $BaSO_4$ (Chesnin and Yien, 1950) and DTPA extractable Zn (Lindsay and Norwell, 1978) by atomic absorption spectrophotometer following the procedure outlined in Sparks (1996). Available B by Hot Water Soluble method. The chemical analysis of the plant sample was carried out by wet digesting with HNO_3:$HClO_4$ (4:1) di-acid mixture as per the procedure outlined by Jackson (1973) and to determine concentrations of N, P, K, S and Zn at harvest using procedure described by Jackson, (1973). From the chemical analytical data, uptake of the each nutrient was calculated as shown below:

$$\text{Nutrient uptake (kg ha}^{-1}) = \frac{\textit{Nutrient content } (\%) \times \textit{dry weight in per kg ha}}{100}$$

The data recorded on various parameters were subjected to statistical analysis following analysis of variance technique and were tested at 5% level of significance to interpret the significant differences.

Result and discussion

Uptake of N, P and K

The nitrogen is mainly responsible for vegetative growth of plants. In all the three macro nutrients the uptake of potassium was maximum by crop because it involve in translocation process and in a plant its maximum amount was found in wheat straw than seed. Phosphorus is essential for root growth and seed filling process so its maximum amount was found in wheat seed than straw (Table -1). The maximum uptake of N (108.12 $kgha^{-1}$), P (29.02 $kgha^{-1}$) and K (116.24 $kgha^{-1}$) were observed under treatment T_3 (Soil test based recommendation). While minimum uptake of N (46.55 $kgha^{-1}$), P (12.76 $kgha^{-1}$) and K (49.90 $kgha^{-1}$), were observed under T_1 (Control).The uptake of potassium is more in wheat straw than seed. The phosphorus uptake by crop is less in comparison to other macro nutrients due to its low availability in soil. The higher nutrient uptake was mainly due to higher biological (straw + grain) yield. Pandey *et al.* (2007) [17] also reported similar findings. Application of customized fertilizer helps to provide essential nutrient to get the targeted yield. This shows that N, P, K, S and Zn combination is useful for wheat growth and yield. Chaplot (2014) [6] and Chaudhary *et al.* (2003) [7] also reported similar findings for N, P, K, S and Zn.

Uptake of S, Zn and B

The maximum uptake S (70.10$kgha^{-1}$), Zn (207.10gha^{-1}) and B (58.15gha^{-1}), were observed (Table-1) under treatment T_3 (Soil test based recommendation). While, minimum uptake of S (29.71$kgha^{-1}$), Zn (89.60gha^{-1}) and B (40.17gha^{-1}), were observed under T_1 (Control). The higher nutrient uptake was mainly due to higher biological yield (straw + grain). Nutrients uptake by wheat crop is mainly a function of crop yield and nutrient concentration in grain and straw. The concentration of nutrients also increase due to balanced application (NPK, S and Zn) through soil test based recommendation because of improved nutrition environment in rhizosphere and consequently in plant system (Dewal and Pareek, 2014) [9]. Choudhary *et al.* (2003) [7] was also concluded that application of S and Zn improve the yield and quality traits of crop. Similar results were obtained by Milapchand (1969) [15]. Similar results were also found in research of De *et al.* (2003) [8] and Kaushik and Sharma (1997) [13].

Residual fertility Status

Soil pH, EC and organic carbon

Physico-chemical properties of experimental field after harvesting of wheat crop where analyzed in laboratory as prescribed methods (Table-2). The soil pH and EC was not significantly affected by various treatments while decreasing trends were found through application of nutrients by various treatments; however organic carbon were significantly affected by application of fertilizers through various. Maximum reduction in soil pH is observed in treatment T_3 - Soil test based recommendation (7.57) similarly maximum reduction in EC was found in same treatment (0.26 dSm^{-1}). While, minimum reduction in soil pH (7.62) and EC (0.30) is found in treatment T_1 (control). Similar result was found in the research Sharma *et al.* (2012) [22], Azaz *et al.* (2016) [4] and Oram and Ok (2012) [16].

The maximum organic carbon content in soil was found in treatment T_3 -Soil test based recommendation (0.34gkg^{-1}) followed by T_4 -Indo-Gulf Customized Fertilizer (0.33gkg^{-1}) and T_5 -TCL Customized Fertilizer (0.33 gkg^{-1}). Slightly increase in organic carbon might be due to improvement in root and shoot growth and thus higher production biomass, which in turn, increased the organic carbon content in soil after decay. Manna *et al.* (2016) [14] reported that over the course of time the application of nalon decreased total organic carbon by 20.4%, whereas addition of balanced NPK doses either maintain or enhanced as compared to initial value. Similar result was found in research of Rather *et al.* (2009) [20], Dhaka *et al.* (2013) [10] and Samimi *et al.* (2016) [21].

Available N, P and K

The maximum available N (176.28 $kgha^{-1}$) was observed in treatment T_2 (RDF), P (17.10 $kgha^{-1}$) in T_3 (Soil test based recommendation) and K (250.10$kgha^{-1}$) in T_2 (RDF) were observed under treatment T_3 (Soil test based recommendation) as given in the Table-3. While minimum available amount of N (133.34 $kgha^{-1}$), P (13.80 $kgha^{-1}$), K (227.10 $kgha^{-1}$) were observed under treatment T_1 (Control). The improvement in the status of available N, P, and K in soil after harvest of the crop were due to addition of these nutrients through the application of chemical and customized fertilizers. Related to above results some other findings were found in some other research that is Rather *et al.* (2009) [20], Rakshit *et al.* (2015) [19] and Srivastava and Kanungo (2014) [23].

Available S, Zn and B

The maximum S (11.80 kgha^{-1}), Zn (0.51 ppm) and B (0.45 ppm) content in soil were observed under treatment T_3 (Soil test based recommendation) as given in the Table-3. While minimum content of S (8.10kgha^{-1}), Zn (0.41 ppm) and B (31 ppm) in soil were recorded under treatment T_1 (Control). The availability of S depends on the solubilization and mineralization process. When the availability of Zn and B increases the efficiency of primary and secondary nutrients (N, P, K, and S) were also enhanced. In soil test based recommendation the S, Zn and B containing fertilizers were also applied separately, so its availability in this treatments were increased. Available S and Zn status of the soil reduced in the soil from their initial status in S and Zn free treatments (Barthwal *et al.* 2013) [5]. Similar result was also reported by Ahmed *et al.* (2014).

Conclusion

From the above it can be clearly concluded that by use of soil test based recommendation or customized fertilizers showed better in terms of improving uptake of nutrients and soil properties *viz.* soil pH, EC, organic carbon as well as increasing the availability of nutrients, thus this treatments may be opted for sustaining soil fertility, and improved soil health.

Table 1: Nutrient uptake affected by various treatments after harvest of wheat crop

Treatments		Uptake of nutrients (grain +straw)					
		Nitrogen (kgha^{-1})	Phosphorus (kgha^{-1})	Potassium (kgha^{-1})	Sulphur (kg ha^{-1})	Zinc (gha^{-1})	Boron (gha^{-1})
T_1	Control (No fertilizer)	46.55	12.76	49.90	29.71	89.60	40.17
T_2	Recommended dose of Fertilizer	91.30	24.04	97.88	58.27	176.33	47.25
T_3	Soil test based recommendation (NPKSZnB)	108.12	29.02	116.24	70.10	207.10	58.15
T_4	Indo Gulf Customized Fertilizer- Vardan	105.47	28.92	113.07	67.32	203.18	55.90
T_5	TCL-Customized Fertilizer-Paras	102.74	27.05	109.74	65.42	198.74	53.85
T_6	Farmer`s Practice	76.29	20.92	81.79	48.70	147.35	44.10
SEm±		2.19	0.71	2.46	1.97	3.14	1.60
C.D. (P=0.05)		6.59	2.13	7.43	5.94	9.46	4.83

Table 2: Soil pH, EC and organic carbon affected by various treatments after harvest of wheat crop

Treatments		Soil pH	EC (dSm^{-1})	Organic carbon (%)
T_1	Control (No fertilizer)	7.62	0.30	0.30
T_2	Recommended dose of Fertilizer	7.58	0.28	0.31
T_3	Soil test based recommendation (NPKSZnB)	7.57	0.26	0.33
T_4	Indo Gulf–Customized Fertilizer- Vardan	7.58	0.27	0.32
T_5	TCL-Customized Fertilizer-Paras	7.59	0.28	0.31
T_6	Farmer`s Practice	7.61	0.29	0.30
SEm±		0.07	0.01	0.01
C.D. (P=0.05)		NS	NS	NS

Table 3: Nutrients availability affected by various treatments after harvest of wheat crop

Treatments		Nitrogen (kgha^{-1})	Phosphorus (kgha^{-1})	Potassium (kgha^{-1})	Sulphur (kgha^{-1})	Zinc (ppm)	Boron (ppm)
T_1	Control (No fertilizer)	133.34	13.80	227.10	8.10	0.41	0.31
T_2	Recommended dose of Fertilizer	176.28	16.55	250.10	9.05	0.41	0.38
T_3	Soil test based recommendation (NPKSZnB)	161.18	17.10	244.16	11.80	0.51	0.45
T_4	Indo Gulf–Customized Fertilizer- Vardan	172.16	16.20	242.36	11.10	0.48	0.40
T_5	TCL-Customized Fertilizer-Paras	169.51	15.90	241.12	10.60	0.49	0.41
T_6	Farmer`s Practice	146.23	14.58	233.10	8.40	0.42	0.35
SEm±		2.26	0.48	3.28	0.38	0.01	0.01
C.D. (P=0.05)		6.81	1.46	9.90	1.16	0.04	0.04

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