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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(4): 592-595

www.thepharmajournal.com
Received: 12-02-2021
Accepted: 15-03-2021

Hariom Tiwari
Department of Soil Science & Agril. Chemistry, ANDUAT, Ayodhya, Utter Pradesh, India

Neeraj Kumar
Department of Soil Science & Agril. Chemistry, ANDUAT, Ayodhya, Utter Pradesh, India

Kumar Anshuman
Department of Soil Science & Agril. Chemistry, ANDUAT, Ayodhya, Utter Pradesh, India

Sandeep Yadav
Department of Soil Science & Agril. Chemistry, ANDUAT, Ayodhya, Utter Pradesh, India

Nandan Singh
Department of Soil Science & Agril. Chemistry, ANDUAT, Ayodhya, Utter Pradesh, India

Anurag Srivastava
Department of Soil Science & Agril. Chemistry, ANDUAT, Ayodhya, Utter Pradesh, India

Corresponding Author:
Hariom Tiwari
Department of Soil Science & Agril. Chemistry, ANDUAT, Ayodhya, Utter Pradesh, India

Effect of Customized fertilizer on yield and economics of wheat (*Triticum aestivum* L.)

Hariom Tiwari, Neeraj Kumar, Kumar Anshuman, Sandeep Yadav, Nandan Singh and Anurag Srivastava

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 experiment was comprised with six treatments *viz*. T_1-Control (No fertilizer), T_2-Recommended dose of Fertilizer (N:P:K 150:60:60) kgha^{-1}, T_3- Soil test based recommendation (N,P,K,S,Zn,B) (120:60:30:30:5:2 Kgha^{-1}) T_4 - Indo Gulf–Customized Fertilizer- Vardan @250 kgha^{-1} (N-12%, P_2O_5- 26%, K_2O-18%, S-5%, Zn-0.5%)+Urea @250 kgha^{-1} as split doses T_5-TCL-Customized Fertilizer-Paras @250 kgha^{-1} (N-10%, P2O5- 18%, K_2O-18%, B-0.3%, Zn-1%)+ Urea @250 kgha^{-1} as a split doses. T_6-Farmer's Practice (N: P: K 100:40:0 Kgha^{-1}). The results revealed use of Soil test based recommendation (T_3) registered maximum Plant height, No. of tillers per meter row, No. of effective tillers, Spike length, No. of grains per spike, 1000-grain test weight, grain and straw yield, benefit cost ratio, net returns followed by application of T_4-Indo Gulf Customized Fertilizer.

Keywords: customized fertilizer, yield, net return, benefit cost ratio

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. Wheat provided nearly 55% of the carbohydrate and 20 % of food calories which is consumed by two billion people (36% of world population) as staple food. It is said that as a food, wheat is more nutritive as compared to the other cereals. In India it's grown in an area (30.22 million hectare) and production (87 million metric tonnes) with productivity of 2.88 million tonnes per hectare, and the present year in India with respect area about 30.79 million hectare and production 98.51 million metric tonnes with productivity 3.20 metric tonnes per hectare. (FAS/USDA-May-2018) [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, 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) [14]. The decrease in productivity was observed to be associated with the new emerging problems of deficiency of micronutrients such as zinc (Zn) and of secondary nutrients such as sulphur (S). The balance nutrient supply to the crops resulted minimal deleterious effect on environment as well as soil (Hegde *et al*., 2007) [3]. 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) [10]. The productivity of wheat in eastern U.P. after reaching a plateau has starting showing declining trend. Customized fertilizers which are crop, soil and area specific show a good promise to maintained soil health by ensuring appropriate fertilization. Customized fertilizers facilitate the application of the complete range of plant nutrients in the right proportion and to suit the specific requirement of a crop at different stage of growth and are more relevant under site specific nutrient management practices. Therefore, keeping these points in view, the present study was propose to study the scope of customized fertilizer for increasing the productivity of wheat system in U.P.

Materials & 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). The experiment was comprised with six treatments *viz*. T_1-Control (No fertilizer), T_2-Recommended dose of Fertilizer (N:P:K 150:60:60) $kgha^{-1}$, T_3- Soil test based recommendation (N,P,K,S,Zn,B) (120:60:30:30:5:2 $Kgha^{-1}$) T_4 - Indo Gulf–Customized Fertilizer- Vardan @250 $kgha^{-1}$ (N-12%, P2O5- 26%, K2O-18%, S-5%, Zn-0.5%)+Urea @250 $kgha^{-1}$ as split doses T_5-TCL-Customized Fertilizer-Paras @250 $kgha^{-1}$ (N-10%, P_2O_5- 18%, K_2O-18%, B-0.3%, Zn-1%)+ Urea @250 $kgha^{-1}$ as a split doses. T_6-Farmer's Practice (N:P:K 100:40:0 $Kgha^{-1}$). 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. All recommended agronomic practices were followed to raise the crop. Below normal temperatures prevalent during April 2017 delayed the maturity considerably at experimental site. Straw and grain yield parameters were recorded at maturity. Other observations included number of effective tillers per plant or per meter row, plant height at maturity, spike length, number of grains per spike, grain test weight, etc. For plant height, plants selected at random were tagged and height was measured in centimeters from ground level to the base of the ear head. Effective tillers in one meter row length were counted from randomly selected rows in each plot. Grains per spike were assessed by randomly selecting ten ear heads from each plot. The economics of various treatments was calculated by converting the total yield into money value. The cost of cultivation was computed on the prevailing market of expenditure. Net income was calculated by with the following formulae: Net income (Rs ha^{-1}) = Gross income (Rs ha^{-1})- cost of cultivation. Benefit cost ratio was calculated by dividing net return to the cost of cultivation of the individual treatment combination.

$$\text{BCR} = \frac{\text{Net return (Rs.)}}{\text{Cost of cultivation (Rs.)}}$$

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

Plant height

Plant height is not a yield component especially in grain crops but it indicates the influence of various nutrients on plant metabolism. The maximum plant height was recorded with treatment T_3-STR at (60, 90, DAS and at harvest) stages (Table 1). The plant height attained in T_3 (Soil test based recommendation) was at par with T_4 (Indo-Gulf Customized Fertilizer) and T_5 (TCL Customized Fertilizer) and significantly higher than the T_1 (control), T_2 (RDF) and T_6 (Farmer's Practice) at all growth stages. While minimum plant heights were recorded with control at all growth stage. The increase in plant height in response to application of nutrients through soil test based recommendation and customized fertilizers are might be due to enhanced availability of macro nutrients (N, P, K and S) as well as micro nutrients (Zn and B). This result is supported by the finding of Malghani *et al.* (2010) [8], Kale *et al.* (2015) [4] and Kumar *et al.* (2012) [6].

Number of tillers $meter^{-2}$

The numbers of tillers per $meter^{-2}$ at all growth stages were influenced significantly by different treatments (Table 1). Significantly higher number of tillers $meter^{-2}$ were recorded under T_3 (Soil test based recommendation) treatment which was significantly higher than T_1 (Control), T_6 (Farmer's Practices) and T_2 (RDF) while at par with T_4 (Indo-Gulf Customized Fertilizer) and T_5 (TCL Customized Fertilizer) at all growth stages. The minimum number of tillers $meter^{-2}$ was recorded under T_1 (Control). The number of tillers are closely related to yield of wheat, more number of tillers especially effective tillers, the more will be the yield. Singh *et al.* (2011) reported that increase in number of tillers in wheat crop due to influence of different fertilizer combinations. The higher number of tillers associated with soil test based recommendation and customized fertilizers. At later stages of growth the number of tillers $meter^{-2}$ were increased due to enhanced cell expansion and various metabolic processes in the presence of abundant supply of nutrients (Laghari *et al.* 2010) [7]. Similar results were also reported by Khan *et al.* (2008) [5] and Yadav *et al.* (2005) [15].

Number of grains $spike^{-1}$and test weight

Yield contributing characters are the resultant of vegetative growth which determines the yield. The number of grains $spike^{-1}$ and test weight are the major contributing characters which govern the yield. Their relative contribution in the manifestation of yield is necessary to assess with respect to treatment effect (Table-2).

The number of grains $spike^{-1}$and test weight significantly increased with different treatments. The increase in above characters was found probably due to optimum availability of phosphorus, potassium, sulphur and micro nutrients, which might increase the utilization of other nutrients also. The applied nutrients increased the source capacity such as number and size of leaves, photosynthesis efficiency and translocation of photosynthates from source to sink, its utilization towards yield contributing characters. The maximum number of grains $spike^{-1}$ were found under the treatment T_3-Soil test based recommendation (48.69) which was at par with T_4 -Indo-Gulf Customized Fertilizer (47.06) and T_5 -TCL Customized Fertilizer (46.06). While minimum number of grains $spike^{-1}$ was found with treatment T_1 – Control (33.94).

The examination of data manifests that maximum test weight was obtained under STR which was significantly better than T_1 (control), T_6 (Farmer's Practice) and T_2 (RDF) while at par with T_4 (Indo-Gulf customized fertilizer) and T_5 (TCL customized fertilizer).

The more number of grains per spike was found with the application of NPK with combination of micro nutrients under soil test based recommendation and application of customized fertilizers. The effect of boron and zinc in soil test based recommendation and customized fertilizers are clearly seen. The results were partially agreed with the results of Khan *et al.* (2008) [5], Samimi and Thomas (2016) [11], and Zagonal *et al.* (2002) [16].

Grain and straw yield of wheat

Yield is the result of cumulative response of yield contributing characters which are determine from the growth and development traits. A short discussion is made below about grain and straw yield affected by different treatments (Table-2).

The maximum grain yield of wheat (41.97qha^{-1}) was obtained under T_3 (Soil test based recommendation) treatment which was significantly superior over T_1-control (18.10qha^{-1})**,** T_6 - farmer's Practices (29.18qha^{-1}) and T_2-RDF (35.40qha^{-1}) while, at par with T_4-Indo-Gulf Customized Fertilizer (40.48qha^{-1}) and T_5-TCL Customized Fertilizer (39.51qha^{-1}). The minimum grain yield (18.10qha^{-1}) of wheat was found in treatment T_1-control. Similarly, maximum straw yield of wheat (56.24qha^{-1}) was found with T_3 (Soil test based recommendation) and minimum under T_1-control (23.53qha^{-1})**.** The higher grain yield may be owing to the application of sufficient nutrients in combination which resulted to greater availability of essential nutrients to plants, improvement of soil environment which facilitate in better root proliferation leading to higher absorption of water and nutrients and ultimately resulting in higher yield. The extent of increase in grain and straw yield may be dependent on the effect of soil test based recommendation and use of customized fertilizers. Shekhon *et al.* (2012) [12] also reported that application of higher dose of customized fertilizer produced additional grain and straw yields. Similar, results were also reported by Dwivedi *et al.* (2014) [1] and Khan *et al.* (2008) [5].

Harvest index

Harvest index is a function of economic yield to biological yield. Application of soil test based recommendation and customized fertilizers failed to bring remarkable difference in the harvest index.

Economics

The maximum cost of cultivation incurred under the treatments T_5 –TCL Customized Fertilizer (Rs. 40200 ha^{-1}).While minimum cost of cultivation was calculated under treatment T_1 – Control (Rs. 31700 ha^{-1}).

The maximum gross income was recorded with treatment T_3-soil test based recommendation (Rs. 89648 ha^{-1}) followed by T_4-Indo Gulf Customized Fertilizer (Rs. 86304 ha^{-1}) and T_5-TCL Customized Fertilizer (Rs. 84016 ha^{-1}) and the lowest gross return was recorded with treatment T_1-control (Rs. 38372 ha^{-1}). The maximum gross return with T_3 -soil test based recommendation was due to the higher increment in yield value as compared to value of input required to apply nutrients in crop (Table-3).

The highest net return was recorded with treatment T_3-Soil test based recommendation (Rs.51089 ha^{-1}) followed by T_4-Indo Gulf Customized Fertilizer (Rs. 46604 ha^{-1}) and T_5 -TCL Customized Fertilizer (Rs. 43816 ha^{-1}) and the lowest net return was recorded with treatment T_1 -control (Rs.6672 ha^{-1}).

The highest benefit: cost ratio (1.32) was obtained under T_3-Soil test based recommendation and next best treatments were T_4-Indo-Gulf CF (1.17) and T_5-TCL Customized Fertilizer (1.09). The lowest benefit: cost ratio (0.21) was obtained under treatment T_1 (control).Similar findings were found in results of Shekhon *et al.* (2012) [12], Singh and Uttam (1994) [13].

Conclusion

It can be concluded that use of T_3-Soil test based recommendation or customized fertilizers recorded taller plants height, maximum no. of tillers, higher effective tillers, grain weight per panicle panicle no., test wt. grain yield, straw yield, harvest index considered to be most effective for sustainable wheat production and profitability over other treatments and may be opted for getting higher benefit: cost ratio.

Table 1: Effect of various treatments on growth attributes

Treatments		Plant height (cm)				No. of tillers			
		30 DAS	60 DAS	90 DAS	At harvest stage	30 DAS	60 DAS	90 DAS	At harvest stage
T_1	Control (No fertilizer)	18.15	40.10	79.15	78.10	187.90	272.25	274.90	265.85
T_2	Recommended dose of Fertilizer	19.10	49.85	89.18	88.26	208.25	333.10	338.45	334.45
T_3	Soil test based recommendation (NPKSZnB)	19.95	58.45	99.25	98.33	224.36	372.14	376.80	372.25
T_4	Indo Gulf–Customized Fertilizer- Vardan	19.70	57.15	97.15	95.93	219.60	368.29	371.15	367.55
T_5	TCL-Customized Fertilizer-Paras	19.60	56.80	96.80	95.10	218.10	365.45	368.10	362.85
T_6	Farmer's Practice	18.80	46.25	87.12	86.12	195.24	322.18	324.10	318.65
SEm±		0.12	1.37	1.61	1.37	2.84	3.17	3.43	3.72
C.D. (P=0.05)		0.37	4.12	4.85	4.14	8.56	9.54	10.34	11.20

Table 2: Effect of various treatments on yield and yield attributes

Treatments	Grains spike^{-1}	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index
T_1 –Control (No fertilizer)	33.94	38.82	18.10	23.53	43.47
T_2-Recommended dose of Fertilizer	42.08	39.04	35.40	46.25	43.35
T_3-Soil test based recommendation (NPKSZnB)	48.69	39.87	41.97	56.24	42.73
T_4- Indo Gulf–Customized Fertilizer- Vardan	47.06	39.36	40.48	53.84	42.91
T_5-TCL-Customized Fertilizer-Paras	46.06	39.31	39.51	52.15	43.40
T_6 –Farmer's Practice	37.67	38.94	29.18	39.05	42.80
SEm±	1.83	0.67	1.13	1.80	-
CD at 5%	5.50	NS	3.41	5.42	-

Table 3: Economics of wheat affected by various treatments

Treatments		Cost of cultivation (Rs/ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio
T_1	Control (No fertilizer)	31700	38372	6672	0.21
T_2	Recommended dose of Fertilizer	37570	75140	37570	1.00
T_3	Soil test based recommendation (N,P,K,S,Zn,B)	38559	89648	51089	1.32
T_4	Indo Gulf–Customized Fertilizer- Vardan	39700	86304	46604	1.17
T_5	TCL-Customized Fertilizer-Paras	40200	84016	43816	1.09
T_6	Farmer's Practice	34969	62268	27299	0.78

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