International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 11, Issue 17, 2019, pp.- 9007-9010.
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

RESPONSE OF INTEGRATED PLANT NUTRIENT SUPPLY UNDER SOIL TEST CROP RESPONSE BASED FERTILIZER RECOMMENDATION ON TARGETED YIELD AND ECONOMICS OF WHEAT (*TRITICUM AESTIVUM*) IN INCEPTISOLS OF CHHATTISGARH PLAINS

SINGH S.P.*, PATEL C.R. AND PAIKRA K.K.
ICAR-Krishi Vigyan Kendra, Raigarh, 496001, Indira Gandhi Krishi Viswavidyalaya, Raipur, 492012, Chhattisgarh, India
*Corresponding Author: Email - spsinghsahab@gmail.com

Received: August 30, 2019; Revised: September 12, 2019; Accepted: September 13, 2019; Published: September 15, 2019

Abstract: Field experiments were carried out on wheat (*Triticum aestivum*) during *rabi* 2017-18 to investigate the response of integrated plant nutrient supply undersoil test crop response-based fertilizer recommendation by following Ramamoorthy's inductive approach of fertility gradients in Inceptisols of Raigarh district of Chhattisgarh plains. The fertilizer adjustment equations are derived by the All India Coordinated Research Project (AICRP), College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, C.G. The results revealed that targeted yield of wheat (30and 45 q ha^{-1}) have been achieved by using the plant nutrients on the basis of targeted yield concept (soil test crop response). The N, P and K fertilizers were contributed in increase yield 31.60 and 42.75 q ha^{-1} in first location, 33.10 and 44.50 q ha^{-1} in second location, 32.40 and 43.75 q ha^{-1} in third location and 34.25 and 46.25 q ha^{-1} in fourth location as compared to farmers practice which were 22.75, 24.66, 21.85 and 23.45 q ha^{-1}, respectively. The maximum net returns of wheat first location (Rs.16009.30 and Rs.34669.75), second location (Rs.15102.50 and Rs.34341.50), third location (Rs.13938.50 and Rs.33807.45) and fourth location (Rs.16033.00 and Rs.36212.75) were obtained in treatment where plant nutrients applied as per soil test value (STCR treatment).Soil test based fertilizer adjustment equations for targeted yield of wheat crop 2.02, 0.56 and 2.12 kg N, P_2O_5 and K_2O nutrients (NR) were required to produce one quintal of wheat grain yield. The percent contribution from soil (CS) was recorded as 10.00, 48.29 and 8.28 % N, P_2O_5 and K_2O nutrients in case of wheat crop. The percent contribution of organic source (CFYM) for N, P_2O_5 and K_2O nutrients were recorded 3.47, 5.45 and 2.13 for wheat. The results clearly indicate that soil test-based fertilizers adjustment equations were evolved for wheat crop to achieve a definite yield target.

Keywords: *Wheat, Target yield, STCR, FYM, Fertilizer recommendations, Ready reckoner*

Citation: Singh S.P., *et al*., (2019) Response of Integrated Plant Nutrient Supply Under Soil Test Crop Response Based Fertilizer Recommendation on Targeted Yield and Economics of Wheat (*Triticum aestivum*) in Inceptisols of Chhattisgarh Plains. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 11, Issue 17, pp.- 9007-9010.

Introduction

Efficient fertilizer use ensures increased production, productivity, high profit and environmentally friendly. The most appropriate balanced and economic doses of fertilizers can be evolved on the basis of soil test crop response studies. At present, about 10 million tonnes gap between nutrients removal by the crops and nutrients addition through various sources has been estimated in the country. The organic resources available (organic manure, crop residues and bio-fertilizers) presently could meet this gap but at present only one third of these resources are used in agricultural production. Fertilizers are generally applied to crops on the basis of generalized state level fertilizer recommendations which lead imbalance use of fertilizers and economic losses because the fertilizer requirement of a crop is not a static one and it may vary from field to field for same crop on the same soil. Therefore, it is essential to protect the soil health by adopting balanced fertilization through soil testing and organic source as an integrated nutrient management (INM) approach [1,2]. Considering the soil fertility status, crop requirement of nutrients, efficiency of fertilizer, soil and organic source and the economic condition of the cultivator, it has now been possible to formulate a yield target-oriented fertilizer schedule based on the principle of balanced nutrition of crops. In India, Ramamoorthy[3] established the theoretical basis and experimental proof for the fact that Liebig's law of minimum operates equally well for N, P and K [4,5]. Wheat is one of the most important staple foodcrop. In addition to being a major source of carbohydrates and also provides substantial amounts of a number of components which are essential or beneficial for health, notably protein, vitamins (notably B vitamins), dietary fibre, phyto-chemicals and reduced risk of cardio-vascular disease, type 2 diabetes, and forms of cancer (notably colo-rectal cancer). Keeping these aspects in view, the present study was undertaken to develop balanced fertilizer recommendation based on soil test values for desired yield targets of wheat in Inceptisolsof Chhattisgarh.

Materials and Method

The on farm testing trials (OFTs) were conducted in Kharsia block of Raigarh district during *rabi* 2017-18to investigate the response of integrated plant nutrient supply under soil test crop response based fertilizer recommendation on targeted yield and economics of wheat (*Triticum aestivum*) in Inceptisols. The initial surface (0-15 cm) soil samples were collected, dried and passed through 2 mm sieve and analyzed for physico- chemical characteristics as described by [6]. Available nitrogen, by the alkaline permanganate method [7]; available phosphorus, by [8] and available potassium, by the ammonium acetate method [9] as described by [6]. Five fertilizers treatments viz., control, farmers practice (FP), general recommendation dose (GRD) of fertilizer, Soil test crop response (STCR) for 30and 45 q ha^{-1} in wheat (GW-366) targeted yield were taken. Pre sowing soil samples were analyzed according to the standard procedures. Soil resource inventory of the study area is given in the [Table-1]. Quantities of nitrogen, phosphorus and potassium were calculated with the help of fertilize adjustment equations as follow.

Table-1 *Physico-chemical characteristics of experimental soils*

Location of trials	Physico-chemical characteristics			Available nutrient status		
	pH	EC (dSm^{-1})	Organic carbon (%)	Nitrogen ($kgha^{-1}$)	Phosphorus($kgha^{-1}$)	Potassium ($kgha^{-1}$)
Location-I	5.62	0.45	0.47	148.57	6.58	260.58
Location-II	6.05	0.55	0.45	204.52	7.50	295.87
Location-III	5.35	0.63	0.49	185.65	6.56	287.55
Location-IV	6.30	0.57	0.49	203.47	6.51	319.52

Table-2 *Grain yield and economics of wheatcrop*

Treatments	Nutrients applied (kg ha^{-1}) and FYM(t ha^{-1})	Average Grain yield (q ha^{-1})	Additional grain yield (q ha^{-1})	Nutrients cost (Rs.ha^{-1})	Gross Return (Rs.ha^{-1})	Net Return (Rs.ha^{-1})	B:C ratio
Location - I							
T_1-Control	0:0:0	15.60	-	-	-	-	-
T_2-FP	80:50:30	22.75	7.15	7833.75	12405.25	4571.50	1.58
T_3-GRD	120:60:40	26.50	10.90	10500.25	18911.50	8411.25	1.80
T_4-30 q ha^{-1}	100:40:30:10	31.60	16.00	11750.70	27760.00	16009.30	2.36
T_5-45 q ha^{-1}	125:60:30:10	42.75	27.15	12435.50	47105.25	34669.75	3.78
Location - II							
T_1-Control	0:0:0	17.30	-	-	-	-	-
T_2-FP	90:60:30	24.60	7.30	8275.00	12665.50	4390.50	1.53
T_3-GRD	120:60:40	26.75	9.45	10150.25	16395.75	6245.50	1.61
T_4-30 q ha^{-1}	110:50:30:10	33.10	15.80	12310.50	27413.00	15102.50	2.22
T_5-45 qha^{-1}	120:50:30:10	44.50	27.20	12850.50	47192.00	34341.50	3.67
Location - III							
T_1-Control	0:0:0	16.80	-	-	-	-	-
T_2-FP	80:45:30	21.85	5.05	7250.00	8761.75	1511.75	1.20
T_3-GRD	120:60:40	25.90	9.10	10500.50	15788.50	5288.00	1.50
T_4-30 q ha^{-1}	100:60:40:10	32.40	15.40	12780.50	26719.00	13938.50	2.09
T_5-45 q ha^{-1}	110:60:40:10	43.75	26.95	12950.80	46758.25	33807.45	3.61
Location - IV							
T_1-Control	0:0:0	18.15	-	-	-	-	-
T_2-FP	90:50:20	23.45	5.30	6850.25	9195.50	2345.25	1.34
T_3-GRD	120:60:40	27.80	9.65	10450.00	16742.75	6292.75	1.60
T_4-30 q ha^{-1}	110:60:30:10	34.25	16.10	11900.50	27933.50	16033.00	2.34
T_5-45 q ha^{-1}	125:60:40:10	46.25	28.10	12540.75	48753.50	36212.75	3.88

Note: Wheat @Rs.1735.00 q^{-1}, N@Rs.17.80 kg^{-1}, P_2O_5@Rs.56.75 kg^{-1}, K_2O@Rs.27.25 kg^{-1},FYM.@ Rs.300.00 q^{-1}

FN = 6.96 Y - 0.34 SN - 0.12 FYM
FP = 2.96 Y – 2.57 SP - 0.29 FYM
FK = 2.83 Y - 0.11 SK - 0.03 FYM
Where,
Y = Yield target (t ha^{-1})
FN = Fertilizer N (kg ha^{-1})
FP = Fertilizer P (kg ha^{-1})
FK = Fertilizer K (kg ha^{-1})
SN = Soil available nitrogen (kg ha^{-1})
SP = Soil available phosphorus (kg ha^{-1})
SK = Soil available potassium (kg ha^{-1})

The wheat crop was raised up to maturity by following standard agronomic practices in same field. The crop received one third N and full dose of P_2O_5 and K_2O as basal application and remaining two third dose of N was applied in two splits. The N, P and K were applied through urea, single superphosphate (SSP) and muriate of potash (MOP), respectively. Grain and straw yields of the crop was recorded and plant samples were analyzed for N, P and K contents to work out their uptake. The data on grain yield, uptake of N, P and K, available N, P and K and fertilizer and FYM nutrient doses for N, P_2O_5 and K_2O were used to compute the basic parameters viz, nutrient requirement (NR) contribution of nutrients from soil (CS), fertilizers (CF) and FYM (CFYM) were computed following the equations given by [3]. These basic data were transformed into simple workable fertilizer adjustment equations for calculating N, P and K fertilizers doses for yield targets based on initial soil test values under integrated plant nutrient supply (IPNS).

Results and Discussion

Soil physico-chemical characteristics

The experimental soils were Inceptisols in slightly acidic reaction with pH varied from 5.35 to 6.30. The organic carbon content varied from 0.45 to 0.49 percent. The available nitrogen varied from 148.57 to 204.52 kg ha^{-1}, available phosphorus varied from 6.51 to 7.50 kg ha^{-1} and available potassium from 260.58 to 319.52 kg ha^{-1} of initial soils, respectively. Though these soils are considered to be most fertile, they are deficient in nitrogen and organic content but moderately supplied with phosphorus and potassium. Such variation in nutrient status of experimental sites is ideal for conducting soil test crop response experiments.

Table-3 *Soil test-based fertilizer adjustment equations for targeted yield of wheat crop*

Parameters	Wheat		
	N	P_2O_5	K_2O
NR (kg q^{-1})	2.02	0.56	2.12
CF (%)	29.03	18.79	74.74
CS (%)	10.00	48.29	8.28
CFYM (%)	3.47	5.45	2.13
Fertilizer adjustment equations	FN = 6.96 Y - 0.34 SN - 0.12 FYM FP = 2.96 Y – 2.57 SP - 0.29 FYM FK = 2.83 Y - 0.11 SK - 0.03 FYM		

Grain yield

The grain yields and economics of experimental sites is presented in [Table-2]. Data revealed that average grain yield of experimental field's was quite higher as compared to farmer's practice. The results revealed that targeted yield of wheat (30 and 45 q ha^{-1}) have been achieved by using the plant nutrients on the basis of targeted yield concept (soil test crop response). The N, P and K fertilizers were contributed in increase yield 31.60 and 42.75 q ha^{-1} in first location, 33.10 and 44.50 q ha^{-1} in second location, 32.40 and 43.75 q ha^{-1} in third location and 34.25 and 46.25 q ha^{-1} in fourth location as compared to farmers practice which were 22.75, 24.66, 21.85 and 23.45 q ha^{-1}, respectively. The nutrient requirement (NR), contribution of nutrients from soil (CS), fertilizer (CF) and farm yard manure

Soil test-based fertilizer adjustment equations for targeted yield of wheat crop 2.02, 0.56 and 2.12 kg N, P_2O_5 and K_2O nutrients (NR) were required to produce one quintal grain yield of wheat. The percent contribution from soil (CS) was recorded as 10.00, 48.29 and 8.28 % N, P_2O_5 and K_2O nutrients in case of wheat crop. These results indicated that there was remarkable contribution of soil nutrients. Similar results have been reported by [10, 11]. The percent contribution of organic source (CFYM) for N, P_2O_5 and K_2O nutrients were recorded 3.47, 5.45 and 2.13 for wheat. The results clearly indicate that soil test-based fertilizers adjustment equations were evolved for wheat crop to achieve a definite yield target. It was noted that contribution of potassium from fertilizer for wheat was higher in comparison to soil. This high value of potassium could be to the interaction effect of higher doses of N, P coupled with priming effect of starter K doses in the treated plots, which might have caused the release of soil potassium form, resulting in the higher uptake from the native soil sources by the crop [4]. Similar type of higher efficiency of potassic fertilizer was also reported for wheat by [5]. In alluvial soils. This is probably due to the higher N use efficiency as well as increased N recovery by crop under increased K application [12]. These results accorded with the findings of [13]. Between the two targets tried, targeting for 45 q ha^{-1} recorded relatively higher response ratio than with 50 q ha^{-1} though it has also recorded higher yields. This might be due to the better use efficiency of applied NPK fertilizers at low yield target levels [14-16]. Ready reckoners' chart for fertilizer N, P_2O_5 and K_2O application based on the soil test values for specific yield targets of wheat were also prepared which are useful for the soil testing laboratories. Therefore, obtaining maximum gain, sustain soil fertility, health status and application of plant nutrients as per soil test value (STCR) is essential. The maximum net returns of wheat first location were obtained in treatment where plant nutrients applied as per soil test value (STCR treatment).

Table-4 *Ready reckoner of soil test-based fertilizer recommendations for wheat (GW-366) in Inceptisols with 5 tons of FYM*

Wheat											
Soil Test values (kg ha^{-1})			Yield Target (q ha^{-1})								
			20			30			45		
N	P	K	FN	FP	FK	FN	FP	FK	FN	FP	FK
150	4	200	88	47	34	122	62	49	157	77	63
175	6	225	79	42	32	114	57	46	149	72	60
200	8	250	71	37	29	105	52	43	140	67	57
225	10	275	62	32	26	97	47	40	132	62	55
250	12	300	54	27	23	88	42	38	123	57	52
275	14	325	45	22	21	80	37	35	115	51	49
300	16	350	37	17	18	71	31	32	106	46	46
325	18	375	28	11	15	63	26	29	98	41	44
350	20	400	20	6	12	54	21	27	89	36	41
375	22	425	11	6	10	46	16	24	81	31	38
400	24	450	3	6	7	37	11	21	72	26	35
425	26	475	3	6	4	29	6	18	64	21	33
450	28	500	3	6	4	20	6	16	55	15	30

Economics analysis

The Economic analysis of on farm testing trials revealed that maximum net returns in first (Rs.16009.30 and Rs.34669.75), second location (Rs.15102.50 and Rs.34341.50), third location (Rs.13938.50 and Rs.33807.45) and fourth location (Rs.16033.00 and Rs.36212.75), gross return in first location (Rs.27760.00 and Rs.47105.25), second location (Rs.27413.00 and Rs.47192.00), third location (Rs.26719.00 and Rs.46758.25) and fourth location (Rs.27933.50 and Rs.48753.50) and B:C ratio in first location (2.36 and 3.78), second location (2.22 and 3.67), third location (2.09 and 3.61) and fourth location (2.34 and 3.88) were recorded in targeted yield of wheat (30and 45 qha^{-1}) have been achieved by using the plant nutrients on the basis of targeted yield concept (soil test crop response). This might be due to higher yield obtained in this technology compared to farmers practice in all locations. It was economically observed that lowest net returns (Rs. 4571.50, 4390.50, 1511.17 and 2345.25 ha^{-1}) and B:C ratio (1.58, 1.53, 1.20 and 1.34) were recorded under farmers practice in all locations due to lower yields of wheat. The present study was concluded that soil test-based fertilizer adjustment equations for targeted yield of wheat crop proved beneficial in respect of yield and economics of wheat grown in Inceptions of Raigarh District in Chhattisgarh Plains.

Conclusion

From these results, it may be concluded that the soil test-based fertilizer N, P_2O_5 and K_2O adjustment equations for target yield of rice and wheat under IPNS would result in balanced fertilization to achieve a pre-desided yield targets. The STCR based fertilizer recommendations may be popularized for higher production of rice and wheat as well as higher efficiency use of nutrients so as to improvement of farmer's economy. The fertilizers may be calculated for lower/higher yields targets depending upon the availability of inputs. The ready reckoner may be used by soil testing laboratories for fertilizer recommendations in Chhattisgarh state.

Application of research: The STCR based fertilizer recommendations may be popularized for higher production of wheat as well as higher efficiency use of nutrients so as to improvement of farmer's economy.

Research Category: STCR on wheat.

Abbreviations: STCR: Soil test crop response, MOP: Muriate of potash
IPNS: Integrated plant nutrient supply, SSP: Single superphosphate

Acknowledgement / Funding: Authors are thankful to ICAR-Agricultural Technology Application Research Institute, Zone-IX, Jabalpur, M.P. and Indira Gandhi Krishi Vishwavidyalaya, Raipur, 492012, Chhattisgarh for providing necessary financial support.

***Research Guide or Chairperson of research: Dr S. P. Singh**
University: Indira Gandhi Krishi Vishwavidyalaya, Raipur, 492012, Chhattisgarh
Research project name or number: Nil

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Kharsia block, Raigarh district

Cultivar / Variety / Breed name: Wheat (*Triticum aestivum*)

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

References

[1] Singh V. (2017) *Annals of Plant and Soil Research*, 19 (1), 105-109.
[2] Singh S. and Singh V. (2018) *Annals of Plant and Soil Research*, 20(1), 103-106.
[3] Ramamoorthy B., Narasimham R.L. and Dinesh R.S. (1967) *Indian Farming*, 17, 43-45.
[4] Ray P.K., Jana A.K., Maitra D.N., Saha M.N., Chaudhury J., Saha S. and Saha A.R. (2000) *Journal of Indian Society of Soil Science*, 48, 79-84.
[5] Ahmed S., Raizuddin, M. and Krishna Reddy, P.V. (2002) *Agropedology*, 12, 133-40.
[6] Jackson M.L. (1973) *Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd, New Delhi.*
[7] Subbiah, B.V. and Asija, G.I. (1956) *Current Science*, 31, 196-98.
[8] Olsen S.R., Cole C.V., Watanbe F.S. and Dean L.A. (1954) *U.S.A. Circ. 939. (c.f.methods of soil analysis, part 2. Ed. C. A. Black. American Society of Agronomy, Madison, Wisconsin).*

[9] Hanway, J.J. and Heidal, H. (1952) *Lowa State College of Agriculture Bulletin*, 57, 1-31.

[10] Sahu V., Srivastava L.K., Mishra V.N., Banwasi R. and Jatav G.K. (2017) *Annals of Plant and Soil Research*, 19(4), 413-17.
[11] Singh S.P., Paikra K.K. and Patel C.R. (2018) *International Journal of Agriculture Sciences*, 10(9), 5958-61.
[12] Marschner H. (1995) *Mineral nutrition of higher plants. 2nd edition, Academic Press. San Diego*, 889.
[13] Avtari S., Singh S. and Kumar S. (2010) *Pantnagar Journal of Research* 8, 2-6.
[14] Sharma V.K. and Singhal S.K. (2014) *Annals of Plant and Soil Research*, 16 (4), 367-71.
[15] Singh M., Goyal V., Panwar B.S. and Sangwan P.S. (2017) *Journal of the Indian Society of Soil Science*, 65, 80-85.
[16] Singh S.P., Patel P.K., Patel, C.R., Paikra K.K. and Sharma Y.K. (2018) *Annals of Plant and Soil Research*, 20(2), 153–58.
[17] Singh Y.V., Singh, S.K. Sharma, P.K. and Singh, Priyanka (2014) *Journal of the Indian Society of Soil Science*, 62, 255-58.
[18] Singh S.P., Paikra K.K. and Patel C.R. (2018) *Annals of Agriculture Research*, 39(2), 147-52.