Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.5171

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (5):** 1070-1074 (2017)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Site-Specific Nutrient Management with Rice-Wheat Crop Manager in South Bihar Alluvial Plain Zone of India

Sanjeev Kumar Gupta[1], Mainak Ghosh[1*], Anshuman Kohli[2], Sheetal Sharma[3], Y. K. Singh[2], Sunil Kumar[2], Uday Kumar[4] and Koneru Lakshman[5]

[1]Department of Agronomy, Bihar Agricultural College,

[2]Department of Soil Science and Agricultural Chemistry, Bihar Agricultural College,

[3]International Rice Research Institute (IRRI), NASC Complex, Pusa, New Delhi

[4]Department of Agronomy, V. K. S. College of Agriculture, Dumraon,

[5]Jute Research Station, Katihar, Bihar Agricultural University, Sabour 813210, Bhagalpur, Bihar

*Corresponding Author E-mail: mainakghosh999@gmail.com

Received: 10.07.2017 | Revised: 26.08.2017 | Accepted: 4.09.2017

ABSTRACT

The SSNM approach provides algorithms that can be used to determine field-specific fertilizer requirements matching the needs and conditions of individual fields. Field experimentswere conducted on farmers' fields in different villages of Bhagalpur district in Bihar under Bihar Agricultural University, Sabour, Bhagalpur, India, during 2013-14 to study the effect various fertilizer recommendation regimes on productivity of wheat crop vis-a-vis farmer's practice. There are two sets of experiment conducted,each in randomized block design with eight locations and the locations were taken as replications. The first experiment involved four treatments namely farmer's fertilizer practice (FFP), state fertilizer recommendation (SFR), soil test based recommendation (STR) and rice-wheat crop manager (RWCM) based recommendation. In order to determine the nutrient limited yield the second experiment on nutrient omission was conducted with five treatments namely full dose of P, K and Zn (N omission) (T1), full dose of N, K and Zn (P omission) (T2), full dose of N, P and Zn (K omission) (T3), full dose of N, P and K (Zn omission) (T4) and full dose of N, P, K and Zn (T5). The amount of N and K_2O applied in RWCM varied from 85-90 and 25-30 kg ha^{-1} respectively.However, in farmers' field there was large variation in nutrient application. The statistically similar performance in first experiment appears due to the large variation in thevarious farmers' fields.From the study it was observed that N is the most essential nutrient and devoid of N reduced the grain yield by 33%. After one year of field experiment it was noted that farmers are applied about 60 to 80kg more N per hectare over that of RWCM with 50% less K in FFP than RWCM.

Key words: *Site-specific nutrient management, Omission plot, Crop manager, Wheat.*

INTRODUCTION

Achieving food security under sustainable systems without deteriorating natural resources is highly critical for reducing poverty. Despite modern technologiessuch as, improved cultivars, cultivation practices and pest management, nutrientsare still a key factor determining agricultural productivity.

Cite this article: Gupta, S.K., Ghosh, M., Kohli, A., Sharma, S., Singh, Y.K., Kumar, S., Kumar, U. and Lakshman, K., Site-Specific Nutrient Management with Rice-Wheat Crop Manager in South Bihar Alluvial Plain Zone of India, *Int. J. Pure App. Biosci.* **5(5):** 1070-1074 (2017). doi: http://dx.doi.org/10.18782/2320-7051.5171

The site specific nutrient management (SSNM) approach provides scientific principles for determining field-specific fertilizer nitrogen (N), phosphorus (P), and potassium (K) requirements for crops. The SSNM approach provides algorithms that can be used to determine field-specific fertilizer requirements matching the needs and conditions of individual farmers. Recent advances in information and communication technology (ICT) offerample opportunities to use mobile phones to provide farmers with field-specific nutrient management recommendations calculated by decision-making tools using algorithms based on SSNM. Use of SSNM based fertilizer recommendations were shown to increase yields, net income of farmers, and provide positive impacts on the environment when compared with existing fertilizer practices[4]. Wheat (*Triticum aestivum* L.) is one of the most important cereals in the human diet and its cultivation is largely dependent on extensive use of fertilizers. The large variation in soil fertility status and improper adoption of general fertiliser recommendations by the farmers leads to over application of fertilizers. The blanket recommendations may serve well for large tracts to produce optimum grain yields, but failed to increase the partial factor productivity[6]. The reasons behind poor nutrient use efficiency and less partial factor productivity are application of fertilizer in excess of crop demand. From a sustainability point of view, nutrient management needs to be refined for improving nutrient use efficiency and crop productivity while minimizing the fertilizer loss to the environment. Recent advances in information and communication technologies provide emerging opportunities to farmers with field-specific nutrient recommendations. International Rice Research Institute (IRRI) has developed a crop management decision-making tool, which calculates field-specific nutrient recommendations[1] for rice based systems. Keeping the above idea in view and realizing the importance of sustainability in changing climate, an attempt has been made in this study for location specific nutrient management in south Bihar alluvial plain zone of India.

MATERIAL AND METHODS

Experimental sites

Field experiments were conducted ateight farmers' fields in different villages of Bhagalpur district in Bihar during 2013-14 to study the effect various fertilizer recommendation regimes on crop productivity vis-a-vis farmer's practice. The geographical coordinates of the experimental fields along with their physico-chemical properties is presented in table-1. The climate of the region is characterized by hot and humid summers (April and May), humid rainy seasonduring June to September, moderately hot and dry autumn (October and November)and cool and dry winters (December and January) and moderate in spring (February and March). The area receivesan average annual rainfall of about 1200 mm of which 70-75% occurs in the monsoon months (June to October). The average temperature varies from 19°C in December/January to 29.6°C in May/June. The eight locations selected were spread over Goradih, Shahkund, Sanhola, Kahelgaon, Jagadishpurand Rangrablocks of Bhagalpur, Bihar, India. However, Goradi and Sanhola blocks contain two sets of location and the remaining block has one location for field experiments.

Experimental details and treatments

Two sets of experiment were conducted at each location of farmers' field. The first set of experiment involved four treatments namely farmer's fertilizer practice (FFP), state fertilizer recommendation (SFR), soil test based recommendation (STR) and rice-wheat crop manager (RWCM) based recommendation. In order to determine the nutrient limited yield (for each omitted nutrient) from the indigenous nutrient supply, another set of experiment on nutrient omission was conducted at a location contiguous with the location of the first experiment, at each site. This nutrient omission experiment involved five treatments namely full dose of P, K and Zn (N omission) (T1), full dose of N, K and Zn (P omission) (T2), full dose of N, P and Zn (K omission) (T3), full dose of N, P and K (Zn omission) (T4) and full dose of N, P, K and Zn (T5).

Wheat variety HD-2967was used and sown at a row spacing of 20 cm in each plot with the seed rate of 100 kg ha^{-1}. The recommended SFR dose used for wheat was 120-60-40 kg/ha in terms of N-P_2O_5-K_2O. In STR the nutrient dose was generalized as 150-45-70-30 kg/ha in terms of N-P_2O_5-K_2O-Zn and in RWCM it was 80-50-60 kg/ha asN-P_2O_5-K_2O. The nutrient dose of FFP in the first experiment varied location wise and is presented in table 2. Nutrient omission plots had the recommended dose of 150-80-100-8 kg/ha N- P_2O_5- K_2O and Zn respectively for all the locations. The sources of fertilizers were urea for N, single super phosphate for P, muriate of potash for K and Zinc sulphate heptahydrate ($ZnSO_4$. $7H_2O$-22% zinc) for Zn. In SFR, wheat crop received a uniform dose of 60 kg P_2O_5 and 40 kg K_2O ha^{-1} at the time of sowing which was broadcast and mixed into the soil. Half dose of N was applied as basal and remaining half was top dressed in two equal splits at the time of first and second irrigation. Nitrogen was applied in different plots as per the treatments. The crop was harvested from 10 m^2 area for yield estimation in each plot. The soil samples were collected at from a depth of 0-15cm from each location after the harvest of crop.

Statistical analysis

The eight locations for the two sets of experiment were considered as replications and the data analyzed for one way analysis of variance using F-test. The data were analysed statistically by applying "Analysis of Variance" (ANOVA) technique (Cochran and Cox, 1985). The significance of different sources of variations was tested by error mean square of Fisher Snedecor's 'F' test at probability level 0.05. Critical difference (CD) at 5% level of significance were worked out for each character to compare the difference between the treatment means.

RESULTS AND DISCUSSION

The grain yield, straw yield and harvest index did not vary significantly among the treatments in the first experiment (Table 3). However, in farmers' field there was a large variation in nutrient application among the locations and in couple of locations the farmers applied almost double dose of N fertilizer while maintaining similar yield with RWCM. The statistically similar performance of various treatments appears to have resulted due to the large variation in the yields between various farmers' fields, which have been considered as replications. The similar grain yield in FFP despite having high N application may be due to relatively lower number of ear-bearing tillers, grains ear-$head^{-1}$ and lower test weight as compared to those of RWCM[7,5,8]. The nutrient omission technique showed significant effects on grain and straw yields (Table 4). Maximum grain and straw yields were noted with the application of full dose of N, P, K and Zn (T_5) and were significantly higher over other omission treatments (T_1, T_2 and T_3) except Zn omission (T_4) which produced crop yield comparable to that of T_5. N omission (T_1) recorded significantly lower grain and straw yields than those of other treatments. This justifies N as the key input in cereal production as it contributes to carbohydrate accumulation in culms and leaf sheaths during the pre-heading stage and in the grain during the ripening stage. Higher grain yield in T_4 and T_5 may be due to higher biomass yield[3]. The lowest grain yield in T_1 was associated with lowest biomass in N omission treatment[8]. The harvest index was found non-significant among the treatments in both the experiment. Soil pH, EC, organic carbon and zinc were not varied significantly among the treatment in both the experiments (Table 5 and 6). In the first experiment available N was also not varied significantly but remained low in all the treatments. The STFR and FFP recorded the maximum soil available P_2O_5 and K_2O which were significantly superior to RWCM and SFR. However, in nutrient omission trial the available N, P_2O_5 and K_2O were also differed significantly among the treatments (Table 4). The lowest P_2O_5 was found in phosphorus omitted treatment and potassium omitted treatment also was recorded the lowest available K_2O. From the study it was observed that N is the most essential nutrient and devoid of N reduced the grain yield by 33% and for lacking of P and K the grain yield can be reduced by 16%. It can be concluded that crop manager though not significantly improve the crop yield, however yield increment can be done with adequate amount of fertilizer application. Further research in this area will be required for better understanding and clarification.

Table 1: Geographical coordinates and physico-chemical status of experimental fields

Location	Latitude	Longitude	Soil condition	Soil color*
Goradi 1	25° 09.112' N	87° 05.311' E	Slightly Alkaline	Olive Brown
Goradi 2	25° 09.386' N	87° 05.902' E	Acidic	Olive Brown
Shahkund	25° 06.275' N	86° 54.768' E	Slightly Alkaline	Dark Yellowish Brown
Sanhola 1	25° 07.958' N	87° 09.896' E	Acidic	Very Dark Grayish Brown
Sanhola 2	25° 08.122' N	87°10.225' E	Neutral	Olive Brown
Kahalgaon	-	-	Slightly Alkaline	Dark Yellowish Brown
Jagdishpur	-	-	Neutral	Olive Brown
Rangra	-	-	Slightly Alkaline	Olive Gray

*From Munsell Soil color chart

Table 2: Disparity of nutrient dose under FFP at farmers' field

Location	$N-P_2O_5-K_2O$ (kg ha^{-1})
Goradi 1	135-45-60
Goradi 2	155-45-60
Shahkund	50-35-25
Sanhola 1	200-60-30
Sanhola 2	175-55-25
Kahalgaon	150-45-20
Jagdishpur	90-45-30
Rangra	190-70-50

Table 3: Wheat productivityunder different nutrient management practices (averaged over 8 farmers' fields)

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index
FFP	35.68	43.61	0.45
SFR	35.88	43.71	0.45
STR	38.15	44.10	0.46
RWCM	37.31	45.31	0.45
CD at 5%	NS	NS	NS

Table 4: Wheat productivityunder different nutrient omission technology (averaged over 8 farmers' fields)

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index
T1 (PKZn)	26.23	31.50	0.45
T2 (NKZn)	32.48	38.53	0.46
T3 (NPZn)	32.56	39.21	0.45
T4 (NPK)	36.96	43.99	0.46
T5 (NPKZn)	38.93	45.73	0.46
CD at 5%	2.77	3.28	NS

Table 5: Effect of different nutrient management practices on soil chemical properties at 0-15cm depth (averaged over 8 farmers' fields)

Treatments	pH	EC	OC (%)	Ava. N (kg ha^{-1})	Ava. P_2O_5 (kg ha^{-1})	Ava. K_2O (kg ha^{-1})	Ava. Zn (ppm)
STFR	6.89	0.926	0.55	161	30.75	211	1.32
SFR	6.90	0.904	0.49	151	26.00	197	1.06
FFP	6.91	0.850	0.55	157	29.00	208	1.20
RWCM	6.91	0.836	0.49	148	25.12	190	0.97
CD at 5%	NS	NS	NS	NS	2.62	7.7	NS

Table 6: Effect of different nutrient omission technology on soil chemical properties at 0-15cm depth (averaged over 8 farmers' fields)

Treatments	pH	EC	OC (%)	Ava. N (kg ha^{-1})	Ava. P_2O_5 (kg ha^{-1})	Ava. K_2O (kg ha^{-1})	Ava. Zn (ppm)
NPKZn (P)	6.88	0.771	0.54	154	31.00	203	1.18
PKZn (P)	6.93	0.856	0.46	138	32.37	209	1.23
NKZn (P)	6.91	0.843	0.47	149	24.25	200	1.15
NPZn (P)	6.90	0.831	0.47	144	26.50	186	1.12
NPK (P)	6.88	0.797	0.49	135	25.87	196	1.06
CD at 5%	NS	NS	NS	12	2.41	8.5	NS

REFERENCES

1. Buresh, R.J., Castillo, R., van den Berg, M. and Gabinete, G. Nutrient management decision tool for small-scale rice and maize farmers. Food and Fertilizer ecology center, Taipei, Taiwan. http://www.fftc.agnet.org/library.php?func=view&style=type&id=20140305111316 (2014).
2. Cochran, W.G. and Cox, G.M., Experimental Designs, Second Edition, Asia publishing House, Bombay, India. pp. 576 (1985).
3. Cui, Z., Zhang, F., Chen, X., Miao, Y., Li, J., Shi, L., Xu, J., Ye, Y., Liu, C., Yang, Z., Zhang, Q., Huang, S. and Bao, D. On-farm evaluation of an in-season nitrogen management strategy based on soil N min test. *Field Crops Research,* **105:** 48-55 (2008).
4. Pampolino, M.F., Manguiat, I.J.S., Ramanathan, H.C., Gines, P.S., Tan, T.T.N., Chi, R.R. and Buresh, R.J. Environmental impact and economic benefits of site-specific nutrient management (SSNM) in irrigated rice systems. *Agricul. Syst*., **93:** 1-24 (2007).
5. Peng, L.L., Ying, L.Y., Guo, L.S. and Long, P.X. Effects of nitrogen management on the yield of winter wheat in cold area of northeastern China. *J. Integrative Agric.* **11(6):** 1020-1025 (2012).
6. Singh, B., Singh, V., Singh, Y., Thind, H.S., Kumar, A., Gupta, R.K., Kaul, A. and Vashistha, M. Fixed-time adjustable dose site-specific fertilizer nitrogen management in transplanted irrigated rice (*Oryzasativa* L.) in South Asia. *Field Crops Research,* **126:** 63-69. (2012).
7. Singh, V., Singh, B., Singh, Y., Thind, H.S. and Gupta, R.K. Need based nitrogen management using the chlorophyll meter and leaf colour chart in rice and wheat in South Asia: a review. *Nutr. Cycl. Agroecos.*, **88:** 361–380 (2010).
8. Walsh, O.S., Klatt, A.R., Solie, J.B., Godsey, C.B. and Raun, W.R. Use of soil moisture data for refined Green Seeker sensor based nitrogen recommendations in winter wheat (*Triticum aestivum* L.). *Precision Agriculture,* **14:** 343–356 (2013).