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Wheat productivity and its profitability as influenced by targeted yield approach versus nutrient management practices

KAPIL A. CHOBHE [1*], V.K. SHARMA[2], SARVENDRA KUMAR[3], INDU CHOPRA[4] AND ANKITA TRIVEDI[5]

ICAR-Indian Agricultural Research Institute, New Delhi-110 012 India

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ABSTRACT

Field experiments were conducted on wheat cv. HD-2967 at farmer's field during 2015-16 and 2016-17 to evaluate fertilizer management practices vis-a-vis farmer's practice on wheat productivity and its profitability in Rajpura village of Aligarh, (U.P.) wherein three trials for each site were studied. Results indicated that, maximum average yield of wheat was 4.58 and 4.60 t ha^{-1} at site I and II, respectively under targeted yield approach for 5.5 tonne ($TY_{5.5t}$) which were higher by 39.5% at site-I and 41.8% at site-II over farmer's practice (FP). The application of nutrients under soil test based targeted yield approach; nearly 39-42% wheat yield could be increased over FP. Moreover, the higher net profit was recorded as Rs. 32,110 ha^{-1} and 28,400 ha^{-1} at site-I and II, respectively with targeted yield approach fertilizer management. The improvement in available nitrogen, phosphorus and potassium was noticed at both sites (I and II) under targeted yield based fertilizer management approach in post-harvest soil after two years of trials.

Key words: Wheat, nutrient management practices, net profit, soil fertility, targeted yield

INTRODUCTION

Wheat (Triticum aestivum L) is most important crop grown under irrigated condition in arid and semi arid tropical climate of India requiring higher amounts of nutrients due to high yielding varieties besides producing higher yield. The share of wheat to the total food grain production in India is around 37% and occupies about 24% of the total area under food grains. Wheat is grown in India over an area of about 29 million hectares. Nearly 82-85% of the wheat grown in India is under irrigated conditions while the rest is grown under rainfed ecology. At present, nutrient mining is a major threat for agricultural soil as there is wide gap between nutrient addition and nutrient removal, one of the reasons for lower production is imbalanced use of fertilizer by the farmers without knowing soil fertility status and nutrient requirement of crop which causes adverse effect on soil and crop both in terms of nutrient toxicity and deficiency. In India, farmers are using excess chemical fertilizer to get higher yield but the decision on fertilizers requirement by crop needs the knowledge for expected crop yield vis-a-vis response to the nutrient application. This farmers' fertilizer practice not only deteriorates the soil health but also led to economical loss to farmers. There is an enormous scope to increase the productivity of wheat based on soil test and targeted yield approach. In this approach, the fertilizer doses are recommended based on fertility status using fertilizer adjustment equations which are developed after establishing significant relationship between soil test values and the amount of added fertilizers (Sharma et al., 2016). Due to intensive cultivation, most of the Indian soils have become deficient in the macronutrients considerably which decrease the crop productivity. In long-term experiments, after the harvest of wheat, a negative balance of nutrients has been commonly observed (Bhatt et al., 2016). In view of the above mentioned facts, the present investigation was undertaken to achieve attainable yield and profits from wheat crop grown using improved fertilizer management option. Therefore, targeted yield and soil test based fertilizer management practice is urgently required to enhance the productivity of wheat for achieving food security of Indian population.

MATERIALS AND METHODS

Field experiments using wheat crop (cv. HD-2967) at farmer's field at Rajpura village of Aligarh district of Uttar Pradesh were conducted at two different sites having three trials each with four treatments *i.e.* control, farmer's practice

Corrosponding Author and [1]Scientist (E-mail: chobhekapil27@gmail.com); [2]Principal Scientist (vksharma.iari@gmail.com); [3]Scientist (E-mail: sarv.grandee@gmail.com); [4]Scientist (tinaindu@gmail.com); [5]Scientist (ankita_trivedi@outlook.com); ICAR-Indian Agricultural Research Institute, New Delhi, India

(FP), recommended dose of fertilizers (RDF) and soil test based targeted yield fertilizer application ($TY_{5.5t}$).The experimental soils analyzed before starting the experiment were sandy loam in texture with varying range of pH (7.82 - 8.72), EC (0.11 - 0.28 dSm^{-1}), organic carbon (3.0 - 5.0 g kg^{-1}), available N (198 - 260 kg ha^{-1}), available P_2O_5 (24.8 - 31.0 kg ha^{-1}) and available K (192 - 280 kg ha^{-1}). The urea, diammonium phosphate (DAP) and muriate of potash (MOP) were applied as per treatments as a source of NPK nutrients. Nutrient doses for different treatments applied to wheat were 80 N + 58 P_2O_5 kg ha^{-1} for Farmer's practices (FP), 120 N + 60 P_2O_5 + 40 K_2O kg ha^{-1} for recommended dose of fertilizers (RDF) and 180 N + 37.2 P_2O_5 + 72.2 K_2O kg ha^{-1} at site-I and 169 N + 32.7 P_2O_5 + 80.6 K_2O kg ha^{-1} at site-II during 2015-16 whereas 156 N + 60.7 P_2O_5 + 76.8 K_2O kg ha^{-1} at site-I and 167 N + 26.0 P_2O_5 + 73.8 K_2O kg ha^{-1} at site-II during 2016-17 for soil test based targeted yield fertilizer application ($TY_{5.5t}$) (average of three trials at each site). The amount of fertilizer/nutrients for targeted 5.5 t ha^{-1} yield of wheat were calculated by using equations of fertilizer prescription developed by Division of Soil Science and Agricultural Chemistry, ICAR-IARI, New Delhi. As per treatments, full dose of P and K was applied as basal and N was applied in three splits during crop growth period. The wheat was harvested at maturity in second week of April in the both the years and grain yield was recorded. The post-harvest soil samples were collected from experimental trials (treated plots) 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) and available potassium (Hanway and Heidal, 1952). The economics of various treatments was computed on the basis of prevailing market inputs (fertilizers) and produces (wheat grain). Also, the fertilizer response rate was calculated as grain production per kg of applied nutrients.

RESULTS AND DISCUSSION

Yield

Data (Table 1) revealed that, the grain yield of wheat ranged from 1.68 to 3.95 t ha^{-1} at site-I and from 1.63 to 4.05 t ha^{-1} at site-II during 2015-16. Also, it ranged from 2.04 to 5.36 t ha^{-1} and 2.24 to 5.39 t ha^{-1} at site I and II respectively, during 2016-17.

Table 1: Effect of different fertilizer management practices on wheat yield and fertilizer response (2 years data)

Treatment		Yield (t ha^{-1})					Yield response over control (t ha^{-1})	Increase over control (%)	Increase over FP (%)	Fertilizers response rate
		2015-16		2016-17		Pooled				
		Range	Mean	Range	Mean					
Site I	Control	1.68-1.81	1.75	2.04-2.15	2.09	1.92	0	0	0	0
	FP	2.47-2.65	2.56	3.94-4.05	4.00	3.28	1.36	70.8	0	9.8
	RDF	2.81-3.12	2.95	4.56-4.83	4.70	3.83	1.91	99.2	16.6	8.6
	$TY_{5.5t}$	3.74-3.95	3.85	5.24-5.36	5.30	4.58	2.66	138.3	39.5	9.2
Site II	Control	1.63-1.89	1.76	2.24-2.31	2.27	2.02	0	0.0	0.00	0
	FP	2.52-2.78	2.62	3.72-3.98	3.86	3.24	1.22	60.4	0.00	8.9
	RDF	2.84-3.21	2.99	4.57-4.81	4.71	3.85	1.83	90.6	18.8	8.3
	$TY_{5.5t}$	3.81-4.05	3.90	5.19-5.39	5.29	4.60	2.58	127.5	41.8	9.5

FP = Farmer's practices, RDF= Recommended fertilizer dose and $TY_{5.5t}$ = Soil test based targeted yield fertilizer application

In both the sites, lowest average wheat yield was recorded under control as 1.75 and from 2.09 t ha^{-1} at site-I and 1.76 and 2.27 t ha^{-1} at site-II during 2015-16 and 2016-17, respectively. Farmers are generally producing wheat yield with a range from 2.56 to 4.00 t ha^{-1} during both the cropping season at studied sites, where they generally used only urea and DAP neglecting MOP application in wheat. Among the treatments, maximum pooled yield of wheat under targeted yield approach ($TY_{5.5t}$) was 4.58 and 4.60 t ha^{-1} at site I and II, respectively and it was increased by 138% and 127% over control and it was higher by 39% at site-I and 42% at site-II over farmers practice (FP). Increased yield of wheat under $TY_{5.5t}$ may be attributed to the soil test based targeted yield approach where NPK fertilizers were used judiciously. Maximum response of fertilizer was recorded 2.66 and 2.58 t ha^{-1} at site-I and site-II, respectively over control, while it was minimum (1.36 t ha^{-1} at site-I and 1.22 t ha^{-1} at site-II with farmer practices (FP). However, recommended dose of fertilizer (RDF) increased wheat yield by 0.55 and 0.61 t

ha^{-1} at site I and II, respectively over farmer practices (FP). The RDF gave similar response in terms of yield (3.83 and 3.85 t ha^{-1} at site-I and II, respectively). The results indicated that, around 39-42% wheat yield could be increased with the application of soil test based targeted yield approach. Moreover, highest fertilizer response rate in wheat was recorded in farmer practices (FP) treatments (9.8 kg grain kg^{-1} nutrients) at site-I (Table 1), this may be due to the lower application of nitrogen and phosphatic fertilizers as per requirement of crop as well as lower available N and P status of soil. Under $TY_{5.5t}$ treatment, the fertilizer response rate was highest (9.5 kg grain kg^{-1} nutrient) at site-II. This might be due to balanced use of fertilizers based on soil test results. These results were in line with the findings of Sharma *et al.* (2014), Sharma and Singhal (2016) and Kumar *et al.* (2020).

Economics

Results (Table 2) showed that highest gross returns of Rs. 32,099 ha^{-1} was obtained at site-I which was similar to site-II (Rs. 32,114 ha^{-1}) with soil test based fertilizer application for targeted yield ($TY_{5.5t}$) treatment. On the other hand, minimum gross return was obtained as Rs. 27,840 ha^{-1} and Rs. 29,218 ha^{-1} at site-I and site-II under control respectively. Highest net profit from wheat crop at both the sites were recorded as Rs. 32,099 and Rs. 32,144 ha^{-1} with soil test based fertilizer application for targeted yield ($TY_{5.5t}$) followed by recommended dose of fertilizers (RDF) as Rs. 22,235 ha^{-1} (site-I) and Rs. 21,243 ha^{-1} (site-II), while farmers practices (FP) recorded minimum net return in the range of Rs.11,117 ha^{-1} (site-II) to Rs.16,026 ha^{-1} (site-I). Sharma and Singhal (2014) and Sharma *et al.*

Table 2: Economics of different fertilizer management practices (means of two year)

	Treatment	Average grain yield (t ha^{-1})	Gross income (Rs. ha^{-1})	Extra income over control (Rs. ha^{-1})	Cost of fertilizers (Rs. ha^{-1})	Net profit over control (Rs. ha^{-1})
Site I	Control	1.92	27840	--	--	--
	FP	3.28	47560	19720	3694	16026
	RDF	3.83	55463	27623	5388	22235
	$TY_{5.5t}$	4.58	66338	38498	6399	32099
Site II	Control	2.02	29218	--	--	--
	FP	3.24	46980	17762	3694	14117
	RDF	3.85	55825	26607	5388	21243
	$TY_{5.5t}$	4.60	66628	37410	5344	32114

(2016) also recorded higher grain yield of wheat using soil test based targeted yield approach fertilizer application. This might be attributed to the unbalanced use of fertilizers, which gave low yield besides poor productivity of soil. The net income of farmers in wheat growing area under study would be about 2 times higher if farmers adopt the improved fertilizer recommendation based on soil testing as well as targeted yield approach.

Fertility status

There was no marked difference in soil pH due to various nutrient management practices and it was in the range of 8.4-8.7 at site-I and 8.2-8.6 at site-II. No significant change was observed in soluble salt content (EC) in the soil which ranged from 0.17 to 0.20 dS m^{-1} at site-I and 0.18 to 0.23 dS m^{-1} at site-II. Use of different nutrient management practices showed remarkable changes in the soil organic carbon (SOC) content at both the sites. The organic carbon content at site-I as well as site-II was significantly improved under soil test based targeted yield approach over farmer's practice. It can be inferred that soil chemical properties do not get deteriorated if proper nutrient management practices were followed (Table 3). In case of available nitrogen content, there were no marked differences at both the sites of wheat crop under various nutrient management options. Moreover, the available nitrogen content ranged from 222 (Control) to 243 ($TY_{5.5t}$) $kgha^{-1}$ at site-I and 216 (Control) to 242 ($TY_{5.5t}$) $kgha^{-1}$ at site-II. However, significant available P content in post-harvest soil was recorded under soil test based targeted yield approach (28.3 kg ha^{-1}) over farmer's practice (24.3 kg ha^{-1}) at site-II only (Table 3). The lowest available P content of 24.3 kg ha^{-1} was observed under control at site-I and it was 20.3 kg ha^{-1} at site-II. Whereas, application of soil test based targeted yield approach ($TY_{5.5t}$) showed significant buildup of available potassium content (312 kg ha^{-1}) in post-harvest soil over farmer's practice (275 kg ha^{-1}) at site-I while at site-II the available K ranged from 258 to 298 kg ha^{-1}.

Table 3: Fertility status of post-harvest soil of wheat under different fertilizer practices (after two year)

	Treatment	pH (1:2)	EC (dS m^{-1})	O.C. (g kg^{-1})	Available macronutrients (kg ha^{-1})		
					N	P	K
Site 1	Control	8.5	0.18	3.3	222	24.3	268
	FP	8.7	0.17	3.4	225	25.4	275
	RDF	8.4	0.19	3.6	236	28.2	298
	$TY_{5.5t}$	8.6	0.2	3.9	243	27.3	312
	LSD (5%)	NS	NS	0.4	NS	NS	17.6
Site II	Control	8.2	0.18	3.1	216	20.3	258
	FP	8.3	0.22	3.2	221	22.4	265
	RDF	8.5	0.23	3.4	229	25.2	278
	$TY_{5.5t}$	8.6	0.19	3.6	242	28.3	298
	LSD (5%)	NS	NS	0.3	NS	4.32	NS

The studies conducted by Sharma *et al.* (2014 and 2016) also recorded that the application of fertilizer based on targeted yield improved the soil fertility status over the other nutrient management practices.

From the study, it may be concluded that application of fertilizer based on targeted wheat yield enhanced the grain yield as well as net profits as compared to the recommended dose of fertilizer. The fertility status of post-harvest soil after two year of experiments also improved with the adoption of targeted yield approach in wheat. Higher yield, net profit of wheat with targeted yield based fertilizer application over other fertilizer management practices clearly indicated that the balanced fertilizer application is required to not only increase the profitability but also to increase productivity besides maintaining soil fertility.

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