Universal Journal of Agricultural Research 7(1): 20-24, 2019 http://www.hrpub.org
DOI: 10.13189/ujar.2019.070103

Response of Phosphorus Application on Productivity of Wheat at Farmer Field

B. S. Dwivedi[1,*], Abhishek Sharma[1], A. K. Dwivedi[1], R. K. Thakur[2]

[1]Department of Soil Science and Agricultural Chemistry, Jawaharlal Nehru Krishi Vishwa Vidyalaya, India
[2]College of Agriculture, Waraseoni (Balaghat) Jawaharlal Nehru Krishi Vishwa Vidyalaya, India

Abstract Wheat (*Triticum aestivum L.*) is one of most important *rabi* cereal crop of northern Madhya Pradesh in India. The availability of phosphorus in the soil for plant utilization is known to be affected not only by the inherent soil characteristics but also by the fertilizer use and management practices followed for crop production. Therefore, a study on the response of phosphorus on farmer field for improving wheat productivity was performed at Jabalpur, India. In between the technology intervention HRD components were also included to excel the farmers understanding and skill about the demonstrated technology on nutrient management aspects. The front line demonstration conducted at six farmer's field of village's viz. Luhari, Gathora, Ghatera, Kanthi and Gurda pipariya on wheat (variety GW-366) during Rabi 2015-16. The soil contained pH 6.5 to 7.2, EC 0.16 to 0.21 dSm^{-1}, organic carbon 0.49 to 0.69%, available nitrogen 204 to 254 Kg ha^{-1}, phosphorus 7.1 to 16.2 Kg ha^{-1} and potassium 411 to 470 Kg ha^{-1}.The experiment included 5 treatments viz., T_1 - 100% NPK + 5 t FYM ha^{-1}, T_2 - 100% NPK, T_3 - 100% NK+ 50% K, T_4 - 100% NPK – (S) and T_5 – farmer's practice. The result indicated that the treatment T_1-100% NPK+FYM produced the highest average yield of wheat. The lowest yield was recorded in T_5-farmer's practice. The highest increase in yield (26%) was observed with 100% NPK + FYM over farmer's practice, followed by 13% increase in yield (100% NPK) of wheat over farmer's practice.

Keywords Wheat, Phosphorus, Manure, Yields

1. Introduction

Wheat (*Triticum aestivum L.*) is one of most important *rabi* cereal crops of northern Madhya Pradesh, India. Approximately 95 percent of wheat grown in the world is hexaploid bread wheat (*Triticum aestivum, L.*), used for a wide range of baked goods, including bread, cookies, cakes and biscuit, with most of the remaining about 5 percent being tetraploid durum wheat (*Triticum durum, Desf.*) commonly used for pasta and noodles *etc*. Protein content and composition is a critical quality factor in the production of these products [10]. It is cultivated in an area of 30.72 mha in India with an annual production of 97.44 mt and average productivity of 3172 kg ha^{-1}. Whereas in Madhya Pradesh it is being cultivated in 5.94 mha of land with its annual production 17.78 mt and average productivity of 2993 kg ha^{-1} [2]. The availability of phosphorus in the soil for plant utilization is known to be affected not only by the inherent soil characteristics but also by the fertilizer use and cropping practices followed [11]. It has been observed in black soil that a major part of the applied phosphorus gets fixed (80-85%) and only a small part (15-20%) of it becomes available to the crop plants [12]. Keeping in view the above facts, the present investigation was undertaken.

2. Materials and Methods

The present study is a part of the ongoing All India Coordinated Research Project on Long Term Fertilizer Experiment at Madhya Pradesh, India. The location of investigation was Jabalpur district of Madhya Pradesh, India. The study area has a semi-arid and sub-tropical climate with a characteristic feature of dry summer and cold winter. In winter season i.e. from November to February months, the temperature ranges from 4 to 33°C and the relative humidity varies from 70 to 90%. Dry and warm weather usually prevails during the months of March to June. The temperature in the month of May rise as high as 46°C. Monsoon season extends from mid-June to mid-September. The temperature during this period ranges from 25to 35°C and the relative humidity ranges between 70 to 80%. The total annual rainfall varies from 1400 to 1500 mm with the mean value of around 1400 mm.

Participatory rural appraisal (PRA), group discussion and transect walk were followed to explore the detail

information of study area. In between the technology intervention HRD components (Trainings/ soil health camp/ field day etc.) were also included to excel the farmers understanding and skill about the demonstrated technology on nutrient management. The front line demonstration conducted at six farmer's field of adopted villages viz. Luhari, Gathora, Ghatera, Kanthi and Gurda pipariya on wheat (varietyGW-366) during Rabi 2015-16. Information on soil condition of the fields used in this experiment was as follows; pH 6.5 to 7.2, EC 0.16 to 0.21 dSm^{-1}, organic carbon 0.49 to 0.69%, available nitrogen 204 to 254 kg ha^{-1}, phosphorus 7.1 to 16.2 $ha^{-1}$and potassium 411 to 470 kg ha^{-1}.The experiment included 5 treatments viz., T_1 - 100% NPK + 5 t FYM ha^{-1}, T_2 - 100% NPK, T_3 - 100% NK+ 50% K, T_4 - 100% NPK – (S) and T_5 – farmer's practice (table 1). Extension and technological gaps were also calculated.

Table 1. Information regarding experiment

Parameters	Details
Problems diagnose	Low yield of soybean due to imbalance nutrition
Technology selected for assessment	
T_1:100% NPK + 5 t FYM ha^{-1} T_2:100% NPK T_3:100% NK + 50% P T_4:100% NPK – S T_5:Farmer's Practice	
Production system	Soybean- wheat
Thematic area	Nutrient management
Micro farming situation	Irrigated
Constants identified and feedback for research work	Facilities for soil testing are not available in block level
Process for farmers participation and their reaction	Training, soil health camp, demonstration, field day and popular article
Number of trails/ farmers	Six
Crop	Wheat
Variety	GW-366

The recommended N, P and K dose, based on initial soil test, was 120 kg N, 80 kg P_2O_5 and 40 kg K_2O ha^{-1} for wheat. The sources of N, P and K used were urea, single super phosphate and muriate of potash. During Rabi season, all the nutrients, viz. half dose of N + full dose of P and K were applied at the time of sowing. Whereas, remaining half dose of nitrogen in two split doses were applied as top dressing. Wheat (variety GW-366) was sown in the second week of November to first week of December during *Rabi*. Insects and diseases were kept under check following suitable control measures. Wheat was harvested at maturity and yield data were recorded after threshing. The soil samples were collected after harvest of crop from 0-15 cm depth were analyzed for different parameters by standard laboratory procedures.

3. Results and Discussion

Yield analysis

The data presented in Table-2 indicated that the treatment T_1-100% NPK+FYM produced the highest average yield (4058 kg ha^{-1}) followed by T_2-100% NPK which gave 3642 kg ha^{-1} yield. The data clearly indicated that addition of integrated application of fertilizer with FYM was found to be beneficial for improving the productivity potential of wheat [8]. The lowest yield of wheat (3210 kg ha^{-1}) was recorded in T_5-farmer's practice. Maximum increase in yield (26%) was observed with 100% NPK + FYM over farmer's practice, followed by 13% increase in yield (100% NPK) of wheat over farmer's practice. The data further showed that even the 50% P application with 100% NK was found to be increased the yield for about 11% in wheat over farmer's practice. These results established the importance of P application and found to be a major fertility constraint in controlling productivity of crops grown especially in black soil [13].

Extension gap

Extension gap was calculated by subtracting farmer's practice yield from recommended practice. The difference of this gap is denoted that there is a sufficient chance to increase in wheat yield by adopting recommended technology. The data presented in table 3, indicated that the treatment T_1-100% NPK+FYM had the highest average extension gap (848 kg ha^{-1}) followed by T_2-100% NPK (432 kg ha^{-1}) and T_3-100% NK + 50% P (365 kg ha^{-1}). The lowest average extension gap (195 kg ha^{-1}) was recorded in T_4-100% NPK – S. The results are in close conformity with results of [1] and they were reported that 36.66 per cent of the farmers had low and medium adopted use of recommended dose of fertilizers. These results are also in agreement with the findings of [7and 6].

Table 2. Grain Yield (kg ha^{-1}) of wheat

S. No.	Name of farmers	Village	T_1	T_2	T_3	T_4	T_5
1	Shri Ramesh Patel	Luhari	4250	3750	3700	3550	3350
2	Smt Jayanti Patel	Luhari	4050	3500	3550	3350	3220
3	Shri Hari Lal Patel	Gathora	4200	3800	3700	3550	3370
4	Shri Santosh Yadav	Dhatera	3800	3450	3350	3180	3020
5	Shri Pramod Jain	Kanthi	3950	3600	3500	3350	3050
6	Shri Kamal Patel	Amkhera	4100	3750	3650	3450	3250
Average yield (kg ha^{-1})			4058	3642	3575	3405	3210
% Increase over farmers practices			26	13	11	6	-

Table 3. Extension Gap

Name of farmers	Village	T_1	T_2	T_3	T_4
Shri Ramesh Patel	Luhari	900	400	350	200
Smt Jayanti Patel	Luhari	830	280	330	130
Shri Hari Lal Patel	Gathora	830	430	330	180
Shri Santosh Yadav	Dhatera	780	430	330	160
Shri Pramod Jain	Kanthi	900	550	450	300
Shri Kamal Patel	Gurda pipariya	850	500	400	200
Average		848	432	365	195

Technology gap

Technological gap was calculated by subtracting recommended technological yield from yield capacity of particularly variety. This gap is express that there is need to guide and educate for adopting recommended technology. The data presented in table 4, indicated that the treatment T_5-Farmer's Practices had the highest average technology gap (2490 kg ha^{-1}) followed by $T_4$100% NPK-S (2295 kg ha^{-1}),T_3-100% NK + 50% P (2125 kg ha^{-1}) and T_2-100% NPK (2058 kg ha^{-1}). The lowest average technology gap 1642 kg $ha^{-1}$was recorded in T_1-100% NPK+FYM. The similar results were also supported by the scientists [3and 6].

Table 4. Technology Gap

Name of farmers	Village	T_1	T_2	T_3	T_4	T_5
Shri Ramesh Patel	Luhari	1450	1950	2000	2150	2350
Smt Jayanti Patel	Luhari	1650	2200	2150	2350	2480
Shri Hari Lal Patel	Gathora	1500	1900	2000	2150	2330
Shri Santosh Yadav	Dhatera	1900	2250	2350	2520	2680
Shri Pramod Jain	Kanthi	1750	2100	2200	2350	2650
Shri Kamal Patel	Gurda pipariya	1600	1950	2050	2250	2450
Average		1642	2058	2125	2295	2490

Soil test values

The result revealed that the soil pH recorded before sowing ranged between 6.5 -7.2, while pH value was found to be unchanged even at harvest of crop which ranged between 6.1 to 7.7.The EC values of the soil ranged between 0.16 to 0.21 dSm^{-1} in soil before sowing. While**,** EC values were found to be unchanged at harvest of crops which ranged between 0.14 to 0.23dSm^{-1}, indicate that imposition of different treatments had altered not change in soil EC. The application of fertilizer could not exhibit any adverse effect on the soil physico-chemical properties due to its inherent high buffering capacity. Similar finding have also been reported by [5]. The data also indicated (Table-5) that organic carbon content in soil found to increase with increasing levels of fertilizer addition application thereby, lower content was found in farmer's practice as compared to 100% NPK+FYM application followed by treatment receiving imbalanced fertilizer doses. The organic carbon content in soil indicated that the contribution of organic carbon

content appeared due to decomposition of plant and root residues [9 and 4]. Similarly, the available N, P and K content in soil was found to be higher with 100% NPK + FYM treatment, however, lowest content was noted in farmer's practice.

Table 5. Soil test values of various farmers field

Treatment	pH	EC (dSm^{-1})	OC ($g\ kg^{-1}$)	Available Nutrients ($kg\ ha^{-1}$)		
				N	P	K
Shri Ramesh Patel						
100% NPK + 5 t FYM ha^{-1}	6.7	0.17	6.9	280	19.4	429
100% NPK	6.6	0.16	6.8	275	17.9	425
100% NK + 50% P	6.5	0.14	6.7	270	18.5	426
100% NPK - S	6.4	0.15	6.7	265	18.2	424
Farmer's Practice	6.5	0.17	6.6	255	16.1	412
Smt Jayanti Patel						
100% NPK + 5 t FYM ha^{-1}	6.8	0.20	5.8	220	18.2	460
100% NPK	6.4	0.19	5.7	218	17.9	455
100% NK + 50% P	6.6	0.18	5.6	216	18.1	456
100% NPK - S	6.5	0.19	5.5	214	17.9	440
Farmer's Practice	6.2	0.16	5.4	217	16.4	421
Shri Hari Lal Patel						
100% NPK + 5 t FYM ha^{-1}	6.6	0.19	5.4	210	18.2	540
100% NPK	6.3	0.19	5.3	205	17.8	535
100% NK + 50% P	6.3	0.18	5.2	207	18.1	530
100% NPK - S	6.4	0.21	5.1	203	16.7	529
Farmer's Practice	6.1	0.22	4.9	201	15.5	505
Shri Santosh Yadav						
100% NPK + 5 t FYM ha^{-1}	7.7	0.21	6.1	240	9.0	505
100% NPK	7.3	0.19	6.0	235	8.8	501
100% NK + 50% P	7.1	0.22	6.1	230	8.5	498
100% NPK - S	7.5	0.21	6.2	228	8.7	504
Farmer's Practice	7.0	0.20	5.8	218	7.8	482
Shri Pramod Jain						
100% NPK + 5 t FYM ha^{-1}	7.5	0.22	7.6	274	15.8	457
100% NPK	7.3	0.23	7.1	278	14.9	452
100% NK + 50% P	7.1	0.19	7.3	265	15.3	439
100% NPK - S	7.4	0.22	7.2	270	15.1	431
Farmer's Practice	7.1	0.19	6.9	255	14.1	423
Shri Kamal Patel						
100% NPK + 5 t FYM ha^{-1}	7.6	0.20	6.8	260	12.4	675
100% NPK	7.3	0.18	6.5	258	12.1	670
100% NK + 50% P	7.2	0.19	6.3	256	12.3	673
100% NPK - S	7.3	0.18	6.6	250	12.0	657
Farmer's Practice	7.0	0.15	6.1	240	11.6	645

HRD components

Table 6. Human Resource Development Components

HRD Components	Frequency	Beneficiaries
Training	03	72
Soil health camp	1	36
Field day	2	38
Popular articles	3	Mass
Training hand out	3	105
Kisan Mela	1	Mass

During the study period, Human Resources Development Components i.e. training, soil health camp, field day, popular articles, training handout and Kisan Mela were also taken to increase the farmers understanding and skill about the recommended practice on soil test crop response (Table 6). The similar results were also supported by the scientists [1 and 3]. They concluded that farmers are required HRD components to make aware about the associated activities.

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