Response of Phosphorus Application on Productivity of Wheat at Farmer Field

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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., T1 - 100% NPK + 5 t FYM ha⁻¹, T2 - 100% NPK, T3 - 100% NK+ 50% K, T4 - 100% NPK – (S) and T5 – farmer’s practice. The result indicated that the treatment T1-100% NPK+FYM produced the highest average yield of wheat. The lowest yield was recorded in T5-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 pipriya on wheat (variety GW-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 kg ha⁻¹ and potassium 411 to 470 kg ha⁻¹. The experiment included 5 treatments viz., T1-100% NPK + 5 t FYM ha⁻¹, T2-100% NPK, T3-100% NK + 50% P, T4-100% NPK – (S) and T5- 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|                                                   |
| T1: 100% NPK + 5 t FYM ha⁻¹      |                                                   |
| T2: 100% NPK                      |                                                   |
| T3: 100% NK + 50% P              |                                                   |
| T4: 100% NPK – (S)               |                                                   |
| T5: 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 P₂O₅ and 40 kg K₂O 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 T1-100% NPK+FYM produced the highest average yield (4058 kg ha⁻¹) followed by T2-100% 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 T5-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 T1-100% NPK+FYM had the highest average extension gap (848 kg ha⁻¹) followed by T2-100% NPK (432 kg ha⁻¹) and T3-100% NK + 50% P (365 kg ha⁻¹). The lowest average extension gap (195 kg ha⁻¹) was recorded in T4-100% 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 | T₁  | T₂  | T₃  | T₄  | T₅  |
|--------|-----------------------|---------|-----|-----|-----|-----|-----|
| 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       | T₁  | T₂  | T₃  | T₄  |
|-----------------|---------------|-----|-----|-----|-----|
| 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 | Gurdapiariya | 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 T₅-Farmer’s Practices had the highest average technology gap (2490 kg ha⁻¹) followed by T₄-100% NPK-S (2295 kg ha⁻¹), T₃-100% NK + 50% P (2125 kg ha⁻¹) and T₂-100% NPK (2058 kg ha⁻¹). The lowest average technology gap 1642 kg ha⁻¹ was recorded in T₁-100% NPK+FYM. The similar results were also supported by the scientists [3and 6].

Table 4. Technology Gap

| Name of farmers | Village       | T₁  | T₂  | T₃  | T₄  | T₅  |
|-----------------|---------------|-----|-----|-----|-----|-----|
| 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 | Gurdapiariya | 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 0.23 dSm⁻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   |
| 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  | 15.5 | 505 |
| 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 handout | 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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