**Original Research Article**

**Effect of levels of Phosphorus and P Solubilization by Spent Wash from Rock Phosphate on Protein, Total Sugar and Total Starch Contain in Grain and Straw of Wheat in an Inceptisol**

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**A B S T R A C T**

Phosphorus is the most important nutrient element for growth and development of wheat. In this field experiment, the effects of Solubilization of rock phosphate by spent wash on protein, total sugar and total starch content in grain and straw was studied. application of 100% N&K + 75% P through SSP recorded significantly highest protein content in grain and straw found significantly superior to their lower levels. Results further indicate that solubilization of rock phosphate remained at par with RP:SW@1:40 but recorded significantly protein, total sugar and total starch content in grain and straw as compared to remaining levels of rock phosphate and control. The application of RP:SW@1:40 significantly increased the protein, total sugar and total starch content in grain and straw and total uptake. These improvement manifested in highest values of crop productivity in terms of protein, total sugar and total starch content in grain, straw under this treatment. The RP:SW@1:40 recorded the highest protein, total sugar and total starch content in wheat crop.

**Keywords**
Rock Phosphate, Spent Wash, Protein, Total sugar and Total starch, Wheat

**Introduction**

Wheat is second most important crop after rice. It is grown under diverse agro climatic conditions. The world production of wheat figures over 670 million tons annually. The largest producer of wheat in the world is the European Union followed by China, India and United States of America. India occupies area (28.46 million hectares) and production (80.8 million tonnes) of wheat. Uttar Pradesh has highest production (35.03%) of nation and also large area. In Uttar Pradesh has wheat production is 24.5 million tonnes, productivity of 2.7 tonnes/ha and area is 9.2 million ha. The total wheat production of the world is slightly concentrated and is clear from the fact that these four producers contribute to around 60% of the total production. The consumption of wheat in the world is 667 million tons but is kept satisfied with an equally high production figures. Consumption has been constantly increasing during the last 15 years with the increase in population and is prepared to shoot up further to 780 million tonnes in 2020. It has been
estimated that India will need at least 109 million tonnes of wheat by 2020 as against present area of 305.97 lac ha and production of 98.38 million tonnes (Agricultural Statistics at a Glance, 2015-16). Since very little scope exists for horizontal growth, the alternative is to achieve vertical growth through increasing productivity.

Fertilizer is the single most important input in modern agriculture to raise the crop productivity. Phosphorus plays vital role in enhancing maturity and development of seed. Application of phosphorus and potassium fertilizers reduce lodging tendency and support tillering in wheat, improves photosynthesis resulting high grains (Zhang et al., 2010) reported that adequate P application increase of 20% grain yield. Increased P applications resulted in Nitrogen uptake, Chaturvedi (2006) reported that 28.5 kg P ha\(^{-1}\) as optimum dose for growth, plant height, grains spike\(^{-1}\), tillers, 1000 grain weight, grain and straw yields. Jiang et al., (2006) observed 108 kg P ha\(^{-1}\) for higher tillers, leaf area index, ear bearing tillers and dry matter accumulation. Khalid et al., (2004) reported that obtained maximum productive tillers, grain yield and biological yield on application of 45 kg P ha\(^{-1}\) in wheat.

Materials and Methods

Field Experiment conducted at Agriculture Research farm Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, followed by laboratory analysis of the plant and grain samples in the Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. Experiment located between 25°18’ North latitude and 80°36’ East longitude. Climate condition was semi-arid to sub humid climate with moisture deficit index between 20-40. The annual rainfall of this region is about 1100 mm. Generally, the maximum and minimum temperature ranged between 20 - 42°C and 9 - 28°C, respectively. The total protein was estimated in this supernatent by folin reagent by the method Lowry et al., (1951). Estimation of starch and total sugar content by anthrone reagent in the plant samples was measured by following the method as proposed by Hedge and Hofreiter (1962). Experiment data was statistical analysis by following the Split Plot Design (SPD) to draw the valid differences among the treatments using SPSS software.

Results and Discussion

Protein content

Levels of phosphorus

A critical scrutiny of the data (Table 1) pertaining to protein content in grain and straw indicate that protein content increased significantly with increasing level of phosphorus in A\(_3\) (100% RD of N & K +75% P through SSP) during both the years as well as in pooled analysis. Application of A\(_3\) increased the protein content in grain to the extent of 7.96 and 2.93, 7.58 and 3.45, 7.67 and 3.23 per cent and in straw, the increase was 8.18 and 3.56, 11.28 and 4.96, 10.11 and 4.26 per cent over A\(_1\) and A\(_2\), respectively. While, the level A\(_4\) and A\(_5\) found at par with each other.

Solubilization of rock phosphate

It is evident from the data presented in Table 1 that the increasing level of applied rock phosphate significantly increased the protein content in grain and straw during both the years as well as in pooled analysis. Application of B\(_3\) increased the protein content in grain by 32.49 and 16.26, 34.33 and 13.90, 33.46 and 15.10 per cent over B\(_1\) and B\(_2\), respectively. The corresponding
increase in case of straw was 30.34 and 3.74, 29.41 and 4.41, 30.08 and 4.07 per cent over B\textsubscript{1} and B\textsubscript{2}, respectively during both the years and in pooled analysis. However, it was statistically remained at par with B\textsubscript{4}.

**Total sugar content**

**Levels of phosphorus**

The critical examination of data (Table 2) revealed that application of phosphorus the total sugar content of grain and straw was not affected significantly due to application of phosphorus levels under both the years as well as in pooled analysis.

**Solubilization of rock phosphate**

It is evident from the data presented in Table 2 that the increasing level of applied rock phosphate significantly increased the total sugar content in grain and straw during both the years as well as in pooled analysis. Application of B\textsubscript{3} increased the total sugar content in grain by 57.83 and 20.19, 58.99 and 20.29, 58.41 and 20.24 per cent over B\textsubscript{1} and B\textsubscript{2}, respectively. The corresponding increase in case of straw was 98.79 and 29.13, 87.78 and 26.12, 94.19 and 27.48 per cent over B\textsubscript{1} and B\textsubscript{2}, respectively during both the years and in pooled analysis. However, it was statistically remained at par with B\textsubscript{4}.

### Table 1 Effect of levels of Phosphorus and P solubilization by Spent Wash from Rock Phosphate on Protein content of wheat

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Protein content</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grain</td>
<td>Straw</td>
</tr>
<tr>
<td><strong>Main plot</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A\textsubscript{1} Control (Absolute)</td>
<td>11.72</td>
<td>12.00</td>
</tr>
<tr>
<td>A\textsubscript{2} 100% RD of N &amp; K +50% P through SSP</td>
<td>12.27</td>
<td>12.48</td>
</tr>
<tr>
<td>A\textsubscript{3} 100% RD of N &amp; K +75% P through SSP</td>
<td>12.63</td>
<td>12.91</td>
</tr>
<tr>
<td>A\textsubscript{4} 100% RD of N &amp; K +75% P through RP</td>
<td>12.44</td>
<td>12.79</td>
</tr>
<tr>
<td>A\textsubscript{5} 100% RD of N &amp; K +100% P through RP</td>
<td>12.54</td>
<td>12.84</td>
</tr>
<tr>
<td>SE\textsubscript{m}</td>
<td>0.07</td>
<td>0.08</td>
</tr>
<tr>
<td>CD (p=0.05)</td>
<td>0.24</td>
<td>0.27</td>
</tr>
<tr>
<td>CV (%)</td>
<td>2.05</td>
<td>2.32</td>
</tr>
<tr>
<td><strong>Sub plot</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B\textsubscript{1} No SW</td>
<td>10.31</td>
<td>10.37</td>
</tr>
<tr>
<td>B\textsubscript{2} RP:SW @ 1:10</td>
<td>11.75</td>
<td>12.23</td>
</tr>
<tr>
<td>B\textsubscript{3} RP:SW @ 1:40</td>
<td>13.66</td>
<td>13.93</td>
</tr>
<tr>
<td>B\textsubscript{4} RP:SW@ 1:80</td>
<td>13.56</td>
<td>13.88</td>
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<tr>
<td>SE\textsubscript{m}</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>CD (p=0.05)</td>
<td>0.17</td>
<td>0.18</td>
</tr>
<tr>
<td>CV (%)</td>
<td>1.87</td>
<td>2.16</td>
</tr>
</tbody>
</table>
### Table 2 Effect of levels of Phosphorus and P solubilization by Spent Wash from Rock Phosphate on Total Sugar of wheat

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total sugar content</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Main plot</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$A_1$ Control (Absolute)</td>
<td></td>
<td>4.16</td>
<td>4.20</td>
<td>4.18</td>
<td>1.29</td>
<td>1.33</td>
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<tr>
<td>$A_2$ 100% RD of N &amp; K +50% P through SSP</td>
<td></td>
<td>4.25</td>
<td>4.33</td>
<td>4.29</td>
<td>1.30</td>
<td>1.38</td>
</tr>
<tr>
<td>$A_3$ 100% RD of N &amp; K +75% P through SSP</td>
<td></td>
<td>4.31</td>
<td>4.40</td>
<td>4.36</td>
<td>1.40</td>
<td>1.44</td>
</tr>
<tr>
<td>$A_4$ 100% RD of N &amp; K +75% P through RP</td>
<td></td>
<td>4.25</td>
<td>4.35</td>
<td>4.30</td>
<td>1.34</td>
<td>1.41</td>
</tr>
<tr>
<td>$A_5$ 100% RD of N &amp; K +100% P through RP</td>
<td></td>
<td>4.29</td>
<td>4.39</td>
<td>4.34</td>
<td>1.36</td>
<td>1.42</td>
</tr>
<tr>
<td>SEm+</td>
<td></td>
<td>0.09</td>
<td>0.10</td>
<td>0.07</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>CD (p=0.05)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CV (%)</td>
<td></td>
<td>7.72</td>
<td>8.28</td>
<td>8.01</td>
<td>8.63</td>
<td>7.69</td>
</tr>
<tr>
<td>Sub plot</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$B_1$ No SW</td>
<td></td>
<td>3.13</td>
<td>3.17</td>
<td>3.15</td>
<td>0.82</td>
<td>0.90</td>
</tr>
<tr>
<td>$B_2$ RP:SW @ 1:10</td>
<td></td>
<td>4.11</td>
<td>4.19</td>
<td>4.15</td>
<td>1.27</td>
<td>1.34</td>
</tr>
<tr>
<td>$B_3$ RP:SW @ 1:40</td>
<td></td>
<td>4.94</td>
<td>5.04</td>
<td>4.99</td>
<td>1.64</td>
<td>1.69</td>
</tr>
<tr>
<td>$B_4$ RP:SW @ 1:80</td>
<td></td>
<td>4.82</td>
<td>4.95</td>
<td>4.89</td>
<td>1.61</td>
<td>1.65</td>
</tr>
<tr>
<td>SEm+</td>
<td></td>
<td>0.06</td>
<td>0.06</td>
<td>0.05</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>CD (p=0.05)</td>
<td></td>
<td>0.17</td>
<td>0.17</td>
<td>0.14</td>
<td>0.05</td>
<td>0.06</td>
</tr>
<tr>
<td>CV (%)</td>
<td></td>
<td>5.40</td>
<td>5.93</td>
<td>7.02</td>
<td>5.27</td>
<td>6.17</td>
</tr>
</tbody>
</table>

### Table 3 Effect of levels of Phosphorus and P solubilization by Spent Wash from Rock Phosphate on Total Starch of wheat

| Treatments                                      | Total starch content |          |          |          |          |          |          |
|------------------------------------------------|----------------------|----------|----------|----------|----------|----------|
| Main plot                                      |                      |          |          |          |          |          |          |
| $A_1$ Control (Absolute)                        |                      | 68.75    | 69.09    | 68.92    | 1.44     | 1.51     | 1.47     |
| $A_2$ 100% RD of N & K +50% P through SSP       |                      | 69.27    | 70.02    | 69.64    | 1.46     | 1.54     | 1.50     |
| $A_3$ 100% RD of N & K +75% P through SSP       |                      | 69.68    | 70.42    | 70.05    | 1.54     | 1.61     | 1.58     |
| $A_4$ 100% RD of N & K +75% P through RP        |                      | 69.34    | 69.95    | 69.64    | 1.50     | 1.55     | 1.52     |
| $A_5$ 100% RD of N & K +100% P through RP       |                      | 69.64    | 70.32    | 69.98    | 1.52     | 1.58     | 1.55     |
| SEm+                                           |                      | 1.42     | 1.64     | 1.08     | 0.03     | 0.04     | 0.02     |
| CD (p=0.05)                                    |                      |          |          |          |          |          |          |
| CV (%)                                         |                      | 7.07     | 8.13     | 7.62     | 7.98     | 7.91     | 7.94     |
| Sub plot                                       |                      |          |          |          |          |          |          |
| $B_1$ No SW                                    |                      | 65.11    | 65.94    | 65.53    | 0.87     | 0.95     | 0.91     |
| $B_2$ RP:SW @ 1:10                             |                      | 68.78    | 69.34    | 69.06    | 1.41     | 1.46     | 1.44     |
| $B_3$ RP:SW @ 1:40                             |                      | 72.30    | 72.46    | 72.38    | 1.86     | 1.92     | 1.89     |
| $B_4$ RP:SW @ 1:80                             |                      | 71.14    | 72.09    | 71.62    | 1.83     | 1.90     | 1.87     |
| SEm+                                           |                      | 1.15     | 1.04     | 0.87     | 0.02     | 0.02     | 0.02     |
| CD (p=0.05)                                    |                      | 3.31     | 2.98     | 2.43     | 0.05     | 0.05     | 0.05     |
| CV (%)                                         |                      | 6.40     | 6.29     | 7.47     | 4.92     | 4.95     | 6.42     |
**Fig. 1** Effect of levels of Phosphorus and P solubilization by Spent Wash from Rock Phosphate on protein content in grain and straw of wheat (Pooled mean)

**Fig. 2** Effect of levels of Phosphorus and P solubilization by Spent Wash from Rock Phosphate on total sugar content in grain and straw of wheat (Pooled mean)
The critical examination of data (Table 3) revealed that application of phosphorus the total starch content in grain and straw was not affected significantly due to application of phosphorus levels under both the years as well as in pooled analysis.

**Solubilization of rock phosphate**

It is evident from the data presented in Table 3 that the increasing level of applied rock phosphate significantly increased the total starch content in grain and straw during both the years as well as in pooled analysis. Application of $B_3$ increased the total starch content in grain by 11.04 and 5.12, 9.89 and 4.50, 10.45 and 4.81 per cent over $B_1$ and $B_2$, respectively. The corresponding increase in case of straw was 113.79 and 31.91, 102.11 and 31.51, 107.69 and 31.25 per cent over $B_1$ and $B_2$, respectively during both the years and in pooled analysis. However, it was statistically remained at par with $B_4$.

**Acknowledgment**

The authors are thankful to the head Department of Soil Science & Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi for providing necessary facilities to conduct this research work.

**References**

Agricultural Statistics at a Glance, 2015-16

Yong, p. 420.


How to cite this article: