Effect of sowing methods and nutrient resources on growth, yield attributes, grain yield and soil health of wheat (*Triticum aestivum* L.)

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**Abstract**

A field experiment conducted during 2014-15 and 2015-16 at Agricultural research farm Department of Agronomy, SHUATS, Prayagraj; to effect of sowing methods and nutrient resources on growth, yield attributes, grain yield and soil health of wheat. Data revealed that sowing methods; system of wheat intensification (SWI) found significantly higher tillers/hill, leaf area index, plant dry matter accumulations (g/hill), crop growth rate (g/hill/day), spike length, spikes/hill, grain yield, biological yield, gross return, net return and soil health of wheat over to FRIBS and conventional method of sowing. Application of nutrient sources viz. 75% inorganic fertilizers and 25% vermicompost was recorded maximum tillers/hill, leaf area index, plant dry matter accumulations (g/hill), crop growth rate (g/hill/day), spike length, spikes/hill, grain yield, biological yield, gross return, net return and soil health over to 100% inorganic fertilizers, 50% inorganic fertilizers and 50% vermicompost, 25% inorganic fertilizers and 75% vermicompost and 100% vermicompost.

**Keywords:** Crop growth rate, grain yield, net return, soil health, sowing methods, spike length

**Introduction**

Wheat is the dominant cereal crop of world commerce and second after rice in India. It is occupying a significant part of the daily diet of millions of people. In India, increasing the productivity of wheat becomes a must to overcome the unusual increase in population. Methods of sowing plays a significant role in providing for the proper space required by the plant for efficient utilization of air, water, solar energy, and nutrients; therefore, the crop yield and quality of the product may be improved to a great extent (Raghuvanshi et al. 2021) [8]. India, being blessed and enriched with a diverse agro ecological condition, ensuring food and nutrition security to a majority of the Indian population through production and steady supply particularly in the recent past, is the second largest producer of wheat worldwide (Sharma and Sendhil, 2015) [15], (Sharma and Sendhil, 2016) [16] and (Sharma et al. 2015) [13]. The crop has been under cultivation in about 30 million hectares (14% of global area) to produce the all-time highest output of 99.70 million tonnes of wheat (13.64% of world production) with a record average productivity of 3371 kg/ha (Anonymous, 2018) [2]. Having a significant share in consumption of food basket with a 36% share in the total food grains produced from India and ensuring not only food security but also nutrition security, wheat is extensively procured by the government and distributed to a majority of the population; it ensures not only food security but also nutrition security. The cereal is one of the cheapest sources of energy, provides a major share of protein (20%) and calorie intake (19%) from consumption. Wheat is accessible across the country and consumed as various processed forms from prehistoric times (Sharma et al. 2014) [14].

The extrapolated methodology of System of Wheat Intensification (SWI) warrants investigation to see to what extent the reports of its advantages – agronomic, economic, social, and environmental - can be validated under experimental conditions. The experience of farmers in Bihar and some other states of India who have undertaken SWI crop management suggests that it over opportunities for higher production per unit of inputs, such as seeds, water, fertilizer, land, labor, and capital and (Abraham et al., 2014) [1]. But there has been no systematic scientific evaluation of SWI with appropriate controls and replications. The principles of SRI, which include early and healthy plant establishment with either direct seeding or transplanting, reducing competition among crop plants through wider spacing,
careful application of water to maintain moist aerobic soil conditions, increasing soil organic matter, and active soil aeration to promote the growth of roots and beneficial soil organisms, have been shown to increase the productivity of a number of crops (Dhar et al. 2016) [5]. Production strategies for SRI when applied to wheat (SWI) have often been considered as labor-intensive for widespread adoption. But resource-poor farmers who can achieve more yields from their small landholdings find that the additional effort and care in crop management with these alternative agronomic systems is compensated for by higher net returns and improvements in food security. Moreover, the concepts and principles of SRI and SWI are amenable to a considerable degree of mechanization, as demonstrated in Pakistan Punjab (Sharif et al. 2014) [12]. SWI plants are reported by farmers to be more robust, more resistant to pests and diseases, and more tolerant of adverse climatic conditions like drought and hail storm, which are increasingly important considerations. But thus far, there has been no rigorous evaluation of SWI methods applied to wheat, a crop of worldwide importance and great significance in India. This prompted a 2-year, on-station experiment using standard methods of agronomic evaluation conducted at the Indian Agricultural Research Institute (IARI) in New Delhi. This study compared the performance of standard recommended practices (SRP) currently recommended by Indian wheat scientists with the methods of SWI management for growing a widely planted improved variety of wheat. Because SWI is an innovation of recent origin, the literature that can be cited on it is unfortunately sparse. However, this made a proper empirical evaluation all the more important to conduct and report, since if there would be positive results, these should encourage further research and the build-up of a substantial literature on SWI. Present investigation of research main objective on the sowing methods and nutrient resources influenced of growth, yield attributes, grain yield and soil health of wheat.

Materials and Methods
A field experiment was conducted during Rabi seasons of the 2014-15 and 2015-16 at the research farm of Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) located at 25° 24' 42" N latitude and 81° 50' 56" E longitude, and 98 m above mean sea level (MSL). The experimental site was generally sandy loam in texture (61.5% sand, 17.8% silt, and 20.7% clay), slightly alkaline in reaction (pH 7.60), with a water penetration impedance was responsible for better root development there by producing higher yield attributes. Similar beneficial effect of bed planting on yield attributes of wheat has been reported by Jani et al., (2008) [6].

Application of nutrient sources viz. 75% inorganic fertilizers and 25% vermicompost was recorded maximum growth viz. tillers/hill, leaf area index at 60 DAS, plant dry matter accumulations (g/hill) and crop growth rate (g/hill/day) at 80 DAS of wheat (table 1) over to FRIBS and conventional method of sowing during both the year of experimentation. Relative growth rate (g/g/day) at 80 DAS and days to maturity of wheat crop (table 1) non-significant effect of sowing methods during crop growth period of both the years. Effect of sowing methods (table 2) viz., system of wheat intensification (SWI) found significantly maximum spike length and spikes/hill of wheat over to FRIBS and conventional method of planting during both the year of experimentation. The higher yield attributes of SWI planting may be ascribed to higher dry matter production and translocation and the conversion of photosynthates in to reproductive parts. Fine tilth and better aeration causing less penetration impedance was responsible for better root development there by producing higher yield attributes. Application of nutrient sources viz. 75% inorganic fertilizers and 25% vermicompost was recorded maximum growth viz. tillers/hill, leaf area index at 60 DAS, plant dry matter accumulations (g/hill) and crop growth rate (g/hill/day) at 80 DAS (table 1) over to 100% inorganic fertilizers, 50% inorganic fertilizers and 50% vermicompost, 25% inorganic fertilizers and 75% vermicompost and 100% vermicompost during both the year of experimentation. Relative growth rate (g/g/day) at 80 DAS and days to maturity of wheat crop (table 1) non-significant effect of nutrient sources during crop growth period of both the years. Application of nutrient sources viz. 75% inorganic fertilizers and 25% vermicompost was recorded taller spike length and higher spikes/hill over to 100% inorganic fertilizers, 50% inorganic fertilizers and 50% vermicompost, 25% inorganic fertilizers and 75% vermicompost and 100% vermicompost during both the years. It thus indicated that combined use of organic manure (vermicompost) and fertilizer was more useful than chemical fertilizers alone, particularly with respect to tillers/m² in
Grain and biological yield (kg/ha)

Effect of sowing methods viz., system of wheat intensification (table 2) found significantly grain yield (4.7 and 5.1 t/ha) of wheat over to FRRIBS (4.6 and 4.9 t/ha) and conventional method (4.3 and 4.5 t/ha) of planting during both the year of experimentation. Biological yield of wheat was found significantly sowing methods viz. system of wheat intensification (SWI) over to FRRIBS and conventional method of planting during both the year of experimentation. Abraham et al., (2014) [1] reported an increase of 18-67% grain and 9-27% straw yield of wheat at farmer field in SWI as compare to broadcast method. The results of experiments represent that SWI methods are superior than conventional line sowing of wheat with improved recommended practices and far superior to usual farmers practice. The total amount of irrigation water used in conventional line sowing of wheat was 60mm more than SWI method. It was due to higher irrigation depth. Summarized the results from wheat sown under SWI in farmers field reported that a 30% water saving is observed in SWI in comparison with conventional method of sowing. The increase in grain yield of wheat under SWI could be attributed to higher yield attributes whereas; the increase in biological yield was due to higher plant height, dry matter accumulation. Similar results were also reported by Sagar and Naresh (2019) [9].

Application of nutrient sources viz. 75% inorganic fertilizers and 25% vermicompost (table 2) was recorded maximum grain yield (5.3 and 5.5 t/ha) over to 100% inorganic fertilizers (5.2 and 5.5 t/ha), 50% inorganic fertilizers and 50% vermicompost (4.6 and 4.6 t/ha.), 25% inorganic fertilizers and 75% vermicompost (4.0 and 4.5 t/ha) and 100% vermicompost (3.7 and 3.9 t/ha) during both the years of experiment. Application of nutrient sources viz. 75% inorganic fertilizers and 25% vermicompost was recorded maximum biological yield over to 100% inorganic fertilizers, 50% inorganic fertilizers and 50% vermicompost, 25% inorganic fertilizers and 75% vermicompost and 100% vermicompost during both the year of experimentation. Overall, combined application of RDN and organic manure like vermicompost helped wheat crop better in enhancing the grain yield and harvest index over sole application of chemical fertilizers (RDN). Shah and Ahmad (2006) [11] and Singh et al., (2012) [17].

Economics

Data showed on table 2 effect of sowing methods viz., system of wheat intensification (SWI) found significantly gross and net return of wheat over to FRRIBS method and conventional method of planting during both the year of experimentation. Effect of nutrient sources viz. 75% inorganic fertilizers and 25% vermicompost was recorded maximum gross and net return over to 100% inorganic fertilizers, 50% inorganic fertilizers and 50% vermicompost, 25% inorganic fertilizers and 75% vermicompost and 100% vermicompost during both the years. Even application of organic manure (vermicompost) with RDN proved much better over RDN alone, particularly with respect to the gross income and net income. Yadav and Kumar (2009) [19] and Devi et al. (2011) [4] also reported similar results.

Soil health

Effect of sowing methods viz., system of wheat intensification (SWI) found significantly higher organic carbon, available soil nitrogen, phosphorus and potassium of wheat over to FRRIBS method and conventional method of planting during both the year of experimentation. Effect of nutrient sources viz. 75% inorganic fertilizers and 25% vermicompost was recorded maximum organic carbon, available soil nitrogen, phosphorus and potassium over to 100% inorganic fertilizers, 50% inorganic fertilizers and 50% vermicompost, 25% inorganic fertilizers and 75% vermicompost and 100% vermicompost during both the years (Pandey et al., 2009) [7].

Table 1: Effect of sowing methods and nutrient resources on growth and physiological character of wheat

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Tillers/hill at 60 DAS</th>
<th>Leaf area index at 60 DAS</th>
<th>Plant dry matter accumulation (g/hill) at 80 DAS</th>
<th>Crop growth rate (g/hill/day) at 80 DAS</th>
<th>Relative growth rate (g/g/day) at 80 DAS</th>
<th>Days to maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>System of Wheat Intensification</td>
<td>13.1</td>
<td>3.3</td>
<td>3.4</td>
<td>57.4</td>
<td>60.3</td>
<td>0.7179</td>
</tr>
<tr>
<td>Furrow Irrigation Raised Bed System</td>
<td>11.2</td>
<td>12.4</td>
<td>2.9</td>
<td>3.2</td>
<td>55.8</td>
<td>58.7</td>
</tr>
<tr>
<td>Conventional Method</td>
<td>7.2</td>
<td>7.9</td>
<td>2.6</td>
<td>2.8</td>
<td>52.3</td>
<td>54.9</td>
</tr>
<tr>
<td>S.Em±</td>
<td>0.23</td>
<td>0.27</td>
<td>0.10</td>
<td>0.11</td>
<td>0.73</td>
<td>0.76</td>
</tr>
<tr>
<td>C.D.(P = 0.05)</td>
<td>0.92</td>
<td>1.06</td>
<td>0.38</td>
<td>0.43</td>
<td>2.86</td>
<td>3.00</td>
</tr>
</tbody>
</table>

Sowing methods

Nutrient sources

100% RDN through inorganic fertilizer | 11.7 | 12.9 | 3.6 | 3.7 | 61.9 | 65.0 | 0.7742 | 0.7834 | 0.04840 | 0.0469 | 122 | 125 |
75% RDN + 25% RDN through VC | 12.5 | 13.8 | 3.6 | 3.8 | 62.6 | 65.7 | 0.7828 | 0.7918 | 0.04846 | 0.0465 | 122 | 125 |
50% RDN + 50% RDN through VC | 9.6 | 10.6 | 2.8 | 3.02 | 55.5 | 58.2 | 0.6933 | 0.7037 | 0.04842 | 0.0462 | 121 | 125 |
25% RDN +75% RDN through VC | 8.8 | 9.7 | 2.5 | 2.7 | 49.8 | 52.4 | 0.6233 | 0.6327 | 0.04839 | 0.0459 | 121 | 124 |
100% RDN through VC | 8.0 | 8.9 | 2.2 | 2.4 | 46.1 | 48.4 | 0.5763 | 0.5850 | 0.04835 | 0.0460 | 120 | 123 |
S.Em± | 0.29 | 0.33 | 0.10 | 0.10 | 0.72 | 0.76 | 0.0090 | 0.0091 | 0.000002 | 0.000001 | 0.70 | 0.75 |
C.D.(P = 0.05) | 0.85 | 0.96 | 0.28 | 0.30 | 2.11 | 2.21 | 0.0263 | 0.0267 | NS | NS | NS | NS |
Acknowledgement

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Reference
9. Rathor SA, Sharma NL. Effect of integrated nutrient

Table 2: Effect of sowing methods and nutrient resources of yield attributes and yield attributes of wheat

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Spike length (cm)</th>
<th>Spikes/hill</th>
<th>Grain yield (t/ha)</th>
<th>Biological yield (t/ha)</th>
<th>Gross return (INR 103/ha)</th>
<th>Net return (INR 103/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>System of Wheat Intensification</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Furrow Irrigation Raised Bed System</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Conventional Method</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. Em-</td>
<td>0.07</td>
<td>0.10</td>
<td>0.09</td>
<td>0.15</td>
<td>0.32</td>
<td>0.34</td>
</tr>
<tr>
<td>C.D. (P = 0.05)</td>
<td>0.29</td>
<td>0.40</td>
<td>0.36</td>
<td>0.57</td>
<td>1.25</td>
<td>1.33</td>
</tr>
</tbody>
</table>

Table 3: Effect of sowing methods and nutrient resources on organic carbon and available nutrients in soil

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Organic carbon (%)</th>
<th>Available nutrients in soil (kg ha-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>System of Wheat Intensification</td>
<td>0.372</td>
<td>0.395</td>
</tr>
<tr>
<td>Furrow Irrigation Raised Bed System</td>
<td>0.365</td>
<td>0.388</td>
</tr>
<tr>
<td>Conventional Method</td>
<td>0.324</td>
<td>0.345</td>
</tr>
<tr>
<td>S. Em-</td>
<td>0.006</td>
<td>0.008</td>
</tr>
<tr>
<td>C.D. (P = 0.05)</td>
<td>0.023</td>
<td>0.032</td>
</tr>
</tbody>
</table>

Nutrient sources

1. 100% RDN through inorganic fertilizer
2. 75% RDN + 25% RDN through Vermicompost
3. 50% RDN + 50% RDN through Vermicompost
4. 25% RDN + 75% RDN through Vermicompost
5. 100% RDN through Vermicompost

C.D. = 0.05

Conclusion

It can be thus concluded that, the system of wheat intensification (SWI) with combined application of 75% inorganic fertilizers and 25% vermicompost application of 75% RDN + 25% RDN vermicompost was observed higher growth, yield attributes, grain yield and soil health with proved more productive, remunerative and the best option for wheat cultivation.

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