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# Effect of integrated nutrient management on growth and yield of wheat *(Triticum aestivum)*

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## ABSTRACT

A field experiment was conducted during winter season of 1997–98 and 1998–99 on sandy-loam soil of Hisar, Haryana. The experiment consisting of 6 organic manures in main plots and 5 fertilizer levels in subplots was laid out in split-plot design with 3 replications. Application of organic manures irrespective of source and rate increased the dry-matter accumulation, leaf-area index, effective tiller number, grains/ear, grain and straw yields, photosynthetic pigments (chlorophyll 'a', 'b' and carotenoids) and photosynthesis of wheat *(Triticum aestivum* L. emend. Frori & Paol.) significantly over no organic manure during both years. Maximum values of all the attributes were observed with vermicompost at 15 tonnes/ha which was significantly superior to the rest of the organic manure treatments. Increasing dose of nitrogen improved all the above-mentioned parameters of wheat. Maximum values were recorded with the recommended dose of 120 kg N + 60 kg $P_2O_5$ + 60 kg $K_2O$/ha. However, nitrogen at 120 and 90 kg/ha + *Azotobacter* were statistically at par with recommended dose of NPK. Inoculation of wheat seeds with *Azotobacter chroococcum* strain HT-56 also improved growth, yield, photosynthetic pigments and photosynthesis of wheat during both the years.

***Key words :*** Integrated nutrient management, Wheat, Vermicompost, Inoculation, *Azotobacter*, Photosynthesis

In India, during the past 3 decades, intensive agriculture involving exhaustive high-yielding varieties of rice and wheat has led to heavy withdrawal of nutrients from the soil. Furthermore, imbalanced use of chemical fertilizers by farmers has deteriorated soil health and declines soil organic carbon content. The widely practiced rice–wheat system in northern India is one such instance, where sustainability is under threat. However, it is also the most productive and profitable system. So, it is time to look for measures to stimulate sustainability in production of cereals on a long-term basis. To curb this trend of declining yield, there is a need to adopt the concept of integrated nutrient management. Organic manures such as

vermicompost (Ranwa and Singh, 1999), pressmud (Sharma, 1997) and farmyard manure (Patra *et al.*, 1998) are important components of a integrated nutrient management and may help to recover soil health in the rice–wheat system (Nehra, 2000). Besides, organic manures also supply the traces of micronutrients which are not supplied by chemical fertilizers. Therefore, it is needed to compare various organic manures with chemical fertilizers to find out the most effective combinations. Keeping this in view, an experiment was conducted to study the effect of integrated nutrient management on growth and yield of wheat.

## MATERIALS AND METHODS

The field experiment was conducted during winter season of 1997–98 and 1998–99 at Agronomy Research area, CCS Haryana Agricultural University, Hisar. The soil was sandy loam, low in available nitrogen (145 kg/ha), medium in available phosphorus (8 kg/ha) and high in available potash (307 kg/ha) with 0.5% in organic carbon content. The soil was alkaline in reaction (pH 7.8). The experiment was conducted in split-plot design with 6 treatments of organic manures (no organic manure, farmyard manure at 15 tonnes, vermicompost at 10 and 15 tonnes, pressmud at 2.5 and 5 tonnes/ha) in main plots and 5 treatments of chemical fertilizer (no fertilizer, nitrogen at 60 and 120 kg/ha, nitrogen at 90 kg/ha + *Azotobacter* and recommended dose of 120 kg N + 60 kg $P_2O_5$ + 60 kg $K_2O$/ha) in subplots. The treatments were replicated thrice. The farmyard manure contained 0.63% N, 0.22% $P_2O_5$ and 0.79% $K_2O$; vermicompost 1.21% N, 0.55% $P_2O_5$ and 0.81% $K_2O$; and pressmud 2.0% N, 1.57% $P_2O_5$ and 7.5% $K_2O$ on dry-weight basis. Organic manures were incorporated in the soil about 3 weeks before sowing of the crop during both the years. Half dose of nitrogen in the form of urea and full dose phosphorus as single superphosphate and full dose of potash as muriate of potash as per treatments were applied at sowing and remaining N was top-dressed after the first irrigation. Wheat var. 'WH 283' was sown on 5 December during both the years and the crop was harvested on 8 and 10 April during 1997–98 and 1998–99 respectively. All other operations were performed as per the recommendations for the crop.

## RESULTS AND DISCUSSION

### *Organic manures*

Application of organic manures at all levels improved the growth and yield of wheat significantly over no organic manure. Dry-matter accumulation/m, leaf-area index (LAI) at 90 days after sowing (DAS), effective tillers/m, grains/ear and grain and straw yields (Table 1), photosynthetic pigments (chlorophyll 'a', 'b' and carotenoids) and photosynthesis (Table 2) were the maximum with vermicompost at 15 tonnes/ha and the treatment was significantly superior to rest of organic manure treatments. Farmyard manure at 15 tonnes, vermicompost at 10 tonnes and pressmud at 5 tonnes/ha being statistically at par with each other, resulted in significantly higher dry matter, LAI, effective tiller, grain number, grain and straw yields, photosynthetic pigments and

**Table 1.** Effect of integrated use of organic manures and fertilizers on growth and yield of wheat

| Treatment | Dry weight (g/m) | | Leaf-area index at 90 DAS | | Effective tillers/m | | Grains/ ear | | Grain yield (q/ha) | | Straw yield (q/ha) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1997–98 | 1998–99 | 1997–98 | 1998–99 | 1997–98 | 1998–99 | 1997–98 | 1998–99 | 1997–98 | 1998–99 | 1997–98 | 1998–99 |
| No organic manure | 289.70 | 293.00 | 4.55 | 4.59 | 74.47 | 79.27 | 36.09 | 37.78 | 33.57 | 34.55 | 50.94 | 54.02 |
| FYM at 15 tonnes/ha | 332.37 | 337.07 | 5.31 | 5.58 | 94.79 | 102.00 | 45.96 | 48.21 | 42.81 | 41.72 | 64.65 | 64.20 |
| Vermicompost at 10 tonnes/ha | 334.74 | 339.68 | 5.37 | 5.60 | 95.47 | 102.33 | 46.46 | 49.07 | 43.12 | 42.58 | 65.25 | 64.98 |
| Vermicompost at 15 tonnes/ha | 350.03 | 348.00 | 5.78 | 6.26 | 105.07 | 112.20 | 50.38 | 52.99 | 49.26 | 48.67 | 71.24 | 70.27 |
| Pressmud at 2.5 tonnes/ha | 327.88 | 324.33 | 4.82 | 5.01 | 84.06 | 91.30 | 40.92 | 45.42 | 38.15 | 38.65 | 59.12 | 60.39 |
| Pressmud at 5.0 tonnes/ha | 332.99 | 333.00 | 5.30 | 5.57 | 93.86 | 101.40 | 45.57 | 48.61 | 42.72 | 41.46 | 64.45 | 65.60 |
| CD (P=0.05) | 4.99 | 8.60 | 0.08 | 0.10 | 1.87 | 3.06 | 1.79 | 2.14 | 0.67 | 1.54 | 1.50 | 2.46 |
| No fertilizer | 280.49 | 284.78 | 4.80 | 4.94 | 72.23 | 76.39 | 38.56 | 41.70 | 33.36 | 26.84 | 39.37 | 37.03 |
| Nitrogen at 60 kg/ha | 320.40 | 325.67 | 5.07 | 5.26 | 86.79 | 88.72 | 42.55 | 46.53 | 39.26 | 41.98 | 57.68 | 58.56 |
| Nitrogen at 120 kg/ha | 345.71 | 345.79 | 5.32 | 5.64 | 97.76 | 107.06 | 46.52 | 49.13 | 44.76 | 45.86 | 70.97 | 72.85 |
| Nitrogen at 90 kg/ha + *Azotobacter* | 344.44 | 341.28 | 5.33 | 5.64 | 97.33 | 107.50 | 46.57 | 47.69 | 44.95 | 45.25 | 71.94 | 73.65 |
| Recommended dose of N, $P_2O_5$, $K_2O$ (120,60,60 kg/ha) | 348.04 | 346.02 | 5.40 | 5.69 | 99.32 | 111.28 | 46.96 | 50.02 | 45.70 | 46.45 | 73.07 | 74.12 |
| CD (P = 0.05) | 7.28 | 5.17 | 0.08 | 0.08 | 3.43 | 3.78 | 1.47 | 1.55 | 2.02 | 1.49 | 2.24 | 1.65 |

**Table 2**. Chlorophyll 'a', Ab', carotenoids and photosynthesis in wheat as influenced by organic manures and fertilizer levels

| Treatment | Chlorophyll 'a' (mg/g fresh of flag leaf) | | Chlorophyll 'b' (mg/g fresh of flag leaf) | | Carotenoids (mg/g fresh weight of flag leaf) | | Photosynthesis (m mol $CO_2/m^2/sec^2$) | |
|---|---|---|---|---|---|---|---|---|
| | 1997–98 | 1998–99 | 1997–98 | 1998–99 | 1997–98 | 1998–99 | 1997–98 | 1998–99 |
| No organic manure | 1.84 | 1.88 | 0.65 | 0.64 | 2.59 | 2.63 | 13.98 | 14.81 |
| FYM at 15 tonnes/ha | 2.15 | 2.20 | 0.75 | 0.75 | 3.20 | 2.20 | 16.10 | 16.42 |
| Vermicompost at 10 tonnes/ha | 2.16 | 2.22 | 0.75 | 0.74 | 3.03 | 3.19 | 16.19 | 16.44 |
| Vermicompost at 15 tonnes/ha | 2.31 | 2.31 | 0.77 | 0.77 | 3.19 | 3.36 | 17.45 | 17.61 |
| Pressmud at 2.5 tonnes/ha | 2.01 | 2.05 | 0.70 | 0.71 | 2.83 | 2.93 | 14.93 | 15.92 |
| Pressmud at 5 tonnes/ha | 2.13 | 2.20 | 0.74 | 0.74 | 3.02 | 3.19 | 16.13 | 16.42 |
| CD (P=0.05) | 0.05 | 0.03 | 0.013 | 0.04 | 0.11 | 0.19 | 0.30 | 0.02 |
| No fertilizer | 1.94 | 2.00 | 0.67 | 0.666 | 2.46 | 2.49 | 13.62 | 14.13 |
| Nitrogen at 60 kg/ha | 2.07 | 2.10 | 0.71 | 0.704 | 2.85 | 2.99 | 14.94 | 15.96 |
| Nitrogen at 120 kg/ha | 2.17 | 2.21 | 0.75 | 0.76 | 3.12 | 3.27 | 16.82 | 17.06 |
| Nitrogen at 90 kg/ha + *Azotobacter* | 2.15 | 2.20 | 0.74 | 0.75 | 3.13 | 3.31 | 16.74 | 17.13 |
| Recommended dose of N, $P_2O_5$, $K_2O$ (120, 60, 60 kg/ha) | 2.18 | 2.22 | 0.75 | 0.75 | 3.16 | 3.35 | 17.00 | 17.18 |
| CD (P = 0.05) | 0.07 | 0.03 | 0.022 | 0.03 | 0.100 | 0.084 | 0.34 | 0.16 |

photosynthesis over pressmud at 2.5 tonnes/ha. Application of FYM at 15 tonnes/ha, vermicompost at 10 and 15 tonnes and pressmud at 2.5 and 5 tonnes/ha increased grain yield by 27.5, 28.5, 46.7, 13.6 and 27.3% during 1997–98, and by 20.8, 23.2, 40.9, 11.9 and 19.1% during 1998–99, respectively, over no organic manure.

The beneficial effect of organic manures on yield and attributes of wheat could be attributed to the fact that after proper decomposition and mineralization, the manures supplied available nutrients directly to the plant and also had solubilizing effect on fixed forms of nutrients in soil (Sinha *et al.*, 1981). The organic manures also increased the adsorptive power of soil for cations and anions, particularly phosphates and nitrates, and these were released slowly for the benefit of crop during entire crop-growth period leading to higher yield (Singh *et al.*, 1981). Better mineral status of the soil owing to the application of organic manures was responsible for maintaining higher levels of chlorophylls and carotenoids in leaves and thereby more photosynthesis.

Among all the organic manures, vermicompost showed better results because of higher nutrient content. The use of vermicompost also resulted in introduction of earthworms in the field and these could have tilled the soil and made it more porous and loose, thus increased the aeration of roots which resulted in better root ramification. Vermicompost also contains more number of nitrogen-fixing, phosphate-solubilizing and other beneficial microbes, antibiotics, vitamins, hormones, enzymes, etc. which have better effects on growth and yield of plants (Bhawalkar, 1992). Kale *et al.* (1987) reported improvement in enzymatic and microbial activities and thus increase in soil fertility owing to earthworm.

### *Fertilizer*

Application of increasing levels of nitrogen through fertilizer improved the dry-matter accumulation, leaf-area index, effective tiller number, grains/ear, grain and straw yields (Table 1), photosynthetic pigments and photosynthesis (Table 2) significantly over no fertilizer treatment. The highest values were recorded under recommended dose of NPK. It was however, at par with application of nitrogen at 120 kg/ha and 90 kg/ha + *Azotobacter*. The effect of these treatments was found significantly more over nitrogen at 60 kg/ha.

An increase in level of nutrients increased the leaf-area index and the photosynthetic pigment in leaves, resulting in more photosynthesis and dry-matter accumulation. This might be the reason for higher yield components under fertilizer treatments. These findings support results of Patra *et al.* (1998) and Azad *et al.* (1998).

## REFERENCES

Azad, B.S., Gupta, S.C. and Peer, A.C.1998. Influence of organic and inorganic fertilizers in maximising wheat yield under irrigated conditions. *Environment and Ecology* **16** (1) : 71–73.

Bhawalkar, U.S. 1992. Chemical farming to natu-

ral farming–A quick changeover without loss of yield. *(In) Proceedings of National Seminar on Natural Farming* Somani, L.L., Totawat, K.L. and Baser B.L. (Eds). Rajasthan College of Agriculture, Udaipur, pp. 79–88.

Kale, R.D., Bano, K. and Gajaman, G.N. 1987. *Journal of Soil Biology and Ecology* 7(2) : 98–104.

Nehra, Ajit S. 2000. 'Integrated nutrient management for sustainable productivity in wheat'. Ph.D. Thesis, CCS Haryana Agricultural University, Hisar, India, p. 178.

Patra, A.P., Panda, D., Patra, B.C. and Karmakar, A.J. 1998. Effect of FYM, zinc and NPK fertilizers on yield components and yield of wheat after winter rice in West Bengal. *Journal of Intracademicia* 2(1/2) : 1–6.

Ranwa, R.S. and Singh, K.P. 1999. Effect of integrated nutrient management with vermicompost on productivity of wheat. *Indian Journal of Agronomy* : **44** (3) : 554–559.

Sharma, R.D. 1997. Effect of organic and inorganic amendments on rice and wheat yields in a Typic Natrustalf. *Advances in Agricultural Research in India* **8** : 129–134.

Singh, B.P., Chahal, R.S. and Singh, Mahendra. 1981. Fertility management through organic and inorganic fertilisers in bajra–wheat crop sequence. *Fertiliser News* **26** (8) : 16–19.

Sinha, N.P., Prasad, B. and Ghosh, A.B. 1981. Effect of continuous use of fertilisers on yield and nutrient uptake in wheat in wheat–soyabean–potato cropping system. *Journal of Indian Society of Soil Science* **29** : 537–542.