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# Effect of integrated nutrient management on growth and yield of cabbage (*Brassica oleracea* var. capitata) and soil fertility

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**Abstract**
An experiment was conducted during winter season of 2016-17 at the Institute of Agriculture Science, Bundelkhand University, Jhansi (U.P.). Among the INM treatments, 50% NPK ($N_{75}P_{50}K_{20}$) recorded maximum plant height (21.42 cm), girth of head (54.81 cm), folded leaves (22.60 /head), fresh weight of head (1646 g), dry weight of head (65.81 q) and cabbage yield (609.5 q/ha). However the equally second best treatment was 100% NPK ($N_{150}P_{100}K_{40}$) which yield 604.3 q/ha, closely followed by 10t PM/ha (450.3 q/ha) and 50% NPK+15t FYM/ha (457.4 q/ha). Application of 50t PM/ha with dual biofertilizers (*Azotobacter* +PSB) further enhanced the cabbage yield upto 729.3g/ha. Only 100% NPK enhanced the available P and K in the post harvest soil over control.

**Keywords:** Integrated nutrient management, cabbage, nutrient status, post harvest soil

## Introduction
The long-term use of chemical fertilizers is known to degrade physico-chemical and biological properties of soil. The multi-nutrient requirement of crops cannot be met through NPK fertilizers alone. The organic sources of nutrients viz. FYM, poultry manure, neem cake etc., are gaining importance in sustainable crop production and are required to be integrated with chemical fertilizers. Organic manures also supply the traces amount of micronutrients in addition to improving the physico-chemical and biological properties of soil. This is eco-friendly system where living organisms are mutually benefited and food for better health is obtained.

Application of bio-fertilizers like *Azotobacter* as nitrogen fixer and PSM as the phosphate-solubilizer have gained much importance as these have been shown encouraging response on many crops. However, authentic information's are meager which necessitate the detailed investigation, particularly in conjunction with organic manure. Cabbage is well known for its large demand of nutrients and optimum nutrients level vary with yield goal, weather conditions and management factors. Sustainable production of the improved variety of cabbage viz. "Golden Acre" may be obtained under the integrated nutrient management. The relevant information was lacking for the agro-climatic conditions of Jhansi, hence the present research was taken up.

## Materials and Methods
The experiment was conducted during winter season of 2016-17 at the Institute of Agriculture Science, Bundelkhand University, Jhansi (U.P.). The soil of the experimental field was clay-loam having pH 7.2, organic carbon 0.35%, available N,$P_2O_5$ and $K_2O$ available N in the initial soil is missing in the thesis. The same should be added, 50 and 197.5 kg/ha, respectively. The treatments consisted of eight integrated nutrient management (control $T_0$, 100% NPK ($T_1$), 30 t FYM/ha ($T_2$), 10 t PM/ha ($T_3$), 5 t NC/ha ($T_4$), 50% NPK + 15 t FYM/ha ($T_5$), 50% NPK + 5 t PM/ha ($T_6$), and 50% NPK + 2.5 t NC/ha ($T_7$) as the main-plot treatments and two bio-fertilizer treatments bio-fertilizer ($B_0$) and dipping of seedling in *Azotobacter* + soil application of PSM ($B_1$) as sub-plot treatments sixteen treatment combinations were laid out in a split-plot design with three replications. The cabbage cv. *Golden Acre* was sown in the nursery and thirty five days-old seedlings were transplanted on 30 October, 2016 under 60 cm x 45 cm planting geometry. The crop was grown as per recommended package of practices. The crop was harvested between 2016 to 2017.

## Results and Discussion

### Growth and yield-attributes

The data in Table 1 reveals that the best INM treatment was $T_6$ (50 % NPK + 5 t PM/ha) which resulted in significantly higher plant height, folded and unfolded leaves/plant, head girth, fresh and dry weight of herd as composed to most of the other treatments. However, this was almost equally followed by $T_1$ ($N_{150}P_{100}K_{40}$), $T_3$ (10 t PM/ha) and $T_5$ (50% NPK + 15 t FYM/ha). The control treatment recorded almost significantly lowest all these growth and yield-attributes of cabbage. The significant variation in growth and yield-attributes of cabbage out of applied INM treatments from different sources depends on the variation in their nutrient contents, decomposition of organic residues, C: N ratio, nutrient release pattern, climate and soil characteristics (Dhama, 2003 and Sanwal *et al*., 2007) [1, 3].

The higher growth and yield-attributes from $T_1$, $T_3$, $T_5$ and $T_6$ may be ascribed to increased chlorophyll contents in leaves as a result of increased supply of all the essential plant nutrients as well as increased physico-chemical and biological properties of the soil. All these favourable situations might have resulted in greater accumulation of carbohydrates, protein and their translocation towards the reproductive organs (yield-attributes). These results are in close agreement with those of Supe and Marbhal (2008) [5], Wani *et al*. (2010) [8], Verma *et al*. (2013) [7].

Dual inoculation of bio-fertilizers did not deviated most of parameters due to supply of N and P nutrients only in insufficient amount for plant growth and development.

**Table 1:** Growth and yield-attributes of cabbage as influenced by Integrated Nutrient Management.

| Treatments | Plant Height (cm) 60DAT | Unfolded leaves /Plant 30DAT | Head girth (cm) 75DAT | Number of head formed/plot at 35DAT | Number of folded leaves/head at harvest | Fresh weight of head per plant (g) | Dry weight of head per plant (g) | Cabbage yield (q/ha) |
|---|---|---|---|---|---|---|---|---|
| **Integrated Nutrient Management** | | | | | | | | |
| $T_0$ Control | 16.50 | 12.50 | 38.35 | 18.17 | 18.53 | 633 | 30.64 | 240.8 |
| $T_1$ $N_{150}P_{100}K_{40}$ | 19.43 | 13.23 | 49.48 | 31.50 | 21.50 | 1632 | 75.22 | 604.3 |
| $T_2$ 30 t FYM/ha | 17.56 | 12.37 | 38.88 | 26.83 | 20.37 | 673 | 32.94 | 249.3 |
| $T_3$ 10 t PM/ha | 19.28 | 13.20 | 49.32 | 28.83 | 20.87 | 1216 | 48.03 | 450.3 |
| $T_4$ 5 t NC/ha | 17.34 | 11.97 | 42.88 | 22.83 | 20.83 | 915 | 32.89 | 338.8 |
| $T_5$ 50% NPK + 15 t FYM/ha | 19.59 | 13.23 | 48.67 | 33.00 | 22.40 | 1236 | 51.56 | 457.5 |
| $T_6$ 50% NPK + 5 t PM/ha | 21.42 | 13.30 | 54.81 | 31.50 | 22.60 | 1646 | 65.81 | 609.5 |
| $T_7$ 50% NPK + 2.5 t NC/ha | 19.96 | 13.70 | 44.65 | 29.50 | 21.60 | 1149 | 47.75 | 425.4 |
| C.D. at 5% | 03.07 | 01.56 | 02.73 | 09.22 | 01.18 | 477 | 19.55 | 175.7 |
| **Biofertilizers** | | | | | | | | |
| $B_0$ Uninoculated | 18.94 | 13.24 | 44.66 | 25.54 | 21.17 | 1075 | 48.59 | 399.2 |
| $B_1$ Inoculated (*Azotobacter* + PSB) | 18.83 | 12.63 | 47.10 | 30.00 | 21.01 | 1200 | 47.62 | 444.7 |
| C.D. at 5% | NS | 00.55 | 01.62 | 02.41 | NS | NS | NS | NS |

### Productivity

The highest cabbage yield (609.5 q/ha) was obtained from $T_6$ (50% NPK + 5 t PM/ha), closely followed by $T_1$ ($N_{150}P_{100}K_{40}$), $T_3$ (10 t PM/ha) and $T_5$ (50% NPK + 15 t FYM/ha) yielding 450.3 to 604.3 q/ha. On the other hand, control treatment gave yield only 240.8 q/ha. The productivity of cabbage under different INM treatments was exactly in accordance with the growth and yield-attributing parameters. The results corroborate with those of Pandey *et al*. (2007) [6], Choudhary *et al*. (2012) [4], Verma *et al*. (2013) [7] and Amit Kumar and Khare (2015) [3].

Bio-fertilizers inoculation resulted in almost significantly higher cabbage yield (444.7 q/ha) over no inoculation (399.2 q/ha). When bio-fertilizers were applied along with 50% NPK + t PM/ha ($T_6$) the cabbage yield further encouraged synergistically (729.3 q/ha) as revealed from Table 2.

**Table 2:** Cabbage yield 9q/ha) as influenced by Integrated Nutrient Management.

| Integrated Nutrient Management | Bio-fertilizers | |
|---|---|---|
| | Uninoculated | Inoculated |
| Control | 197.8 | 283.8 |
| $N_{150}P_{100}K_{40}$ | 674.3 | 534.3 |
| 30 t FYM/ha | 190.3 | 308.2 |
| 10 t PM/ha | 395.5 | 505.0 |
| 5 t NC/ha | 389.2 | 288.4 |
| 50% NPK + 15 t FYM/ha | 422.8 | 492.1 |
| 50% NPK + 5 t PM/ha | 489.7 | 729.3 |
| 50% NPK + 2.5 t NC/ha | 434.3 | 416.5 |
| C.D. at 5% Comparison of means of bio-fertilizers under the same level of nutrient management | 132.65 | |
| Comparison of means of nutrient management under the same level of bio-fertilizers | 199.24 | |

**Table 3:** Nutrient status of the post-harvest soil as influenced by integrated nutrient management.

| Treatments | Nitrogen (kg/ha) | Phosphorus (kg/ha) | Potassium (kg/ha) |
|---|---|---|---|
| **Integrated Nutrient Management** | | | |
| $T_0$ Control | 234.3 | 30.6 | 245.2 |
| $T_1$ $N_{150}P_{100}K_{40}$ | 240.9 | 35.7 | 263.2 |
| $T_2$ 30 t FYM/ha | 237.3 | 33.0 | 253.5 |
| $T_3$ 10 t PM/ha | 238.4 | 33.0 | 253.9 |
| $T_4$ 5 t NC/ha | 236.4 | 33.5 | 250.1 |
| $T_5$ 50% NPK + 15 t FYM/ha | 238.1 | 35.6 | 252.7 |
| $T_6$ 50% NPK + 5 t PM/ha | 240.5 | 33.1 | 254.1 |
| $T_7$ 50% NPK + 2.5 t NC/ha | 240.8 | 33.3 | 250.6 |
| C.D. at 5% | NS | 3.55 | 8.53 |
| **Biofertilizers** | | | |
| $B_0$ Uninoculated | 238.2 | 33.2 | 252.8 |
| $B_1$ Inoculated (*Azotobacter* + PSB) | 238.5 | 33.7 | 253.0 |
| C.D. at 5% | NS | NS | NS |

**Nutrient status of the soil**

The nitrogen status of the post harvest soil did not change than its initial status under all the INM treatments. But phosphorus status of the soil significantly increased due to $T_5$ (50% NPK + 15 t FYM/ha) and $T_1$ 100% NPK over control. The K content in soil was found to be significantly higher (263.2 kg/ha) as compared to all the remaining INM treatments. Bacterial inoculation had non-significant effect on the nutrient status of soil as compared to un-inoculated treatment. Such variation in the nutrient status of the post-harvest soil was on account of the differences in the nutrient supplying power of the different applied INM treatments and the nutrients taken up by the crop.

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