**Impact of Integrated nutrient management on growth and yield of cucumber (*Cucumis sativus* L.) under Balaghat (MP) region**

**ABSTRACT**

 The present investigation was carried out with objectives to study the effect of various treatment on growth yield and quality of Cucumber and to work out the economics and Impact of Integrated nutrient management on growth and yield of cucumber cultivation. The experimental material consisted 08 treatments of variety Pusa Uday. The experiment was conducted at Research farm of School of Agriculture Science, Technology and Research, Sardar Patel University, Balaghat(M. P.). The sowing of experimental material was done on 4th week of July, 2023 arranged in Randomized Block Design (RBD) which was replicated thrice. The data for 08 characters were recorded on five randomly selected plants. The data on all the characters were subjected to statistical analysis using statistical software. The overall results obtained from this investigation clearly revealed that the application of T7 (50% RDF + 25%Azosprillum +25% vermicompost) showed the better performance for vegetative growth & flowering (vine length, number of branches per plant, days to first male flowering, number of fruits per vine, average fruit weight, fruit length and fruit yield (t/ha) would be useful to enhance the productivity of cucumber. Cucumber sown in the field under the treatment with 50% RDF + 25% Azospirillum + 25% Vermicompost (T7) recorded the maximum monetary advantage with the benefit cost ratio of 4.24, during the year of experimentation.

**Keyword: -** *Azospirillum, Cucumber, Vermicompost, INM and Yield.*

**Introduction**

Botanically Cucumber is known as *Cucumis Sativus* L. belongs to family Cucurbitaceae*.* It is a diploid cross-pollinated species with chromosome number 2n=2x=14 **(Mckay, 1930).** Cucumber probably originated from Indo-Burma region of Hindustan center **(Vavilov, 1935).** It is mainly cultivated in China, India, Turkey, Iran and other parts of south-east Asia. Progenitor of cucumber is “*Cucumis hardwickii”.* Economic sex ratio is 15:1. The area under Cucumber production in India accounts to 94 million ha with production of 1608.29 million tons in year 2020-21 **(*Source: NHB,* Ministry of Agriculture & Farmers Welfare, Government of India, 2021-22).** West Bengal ranks first in area and production of Cucumber in year 2021-22 followed by Madhya Pradesh and Haryana. The cucumber is used as salad, pickles, and as cooked vegetable. It has many uses in ayurvedic medicines. According to ‘Unani medicines’, the oil from its seed is God for the brain and the body. Cucumber has 96.3 g water, magnesium 11 mg, sodium 10.2 mg, Vitamin C 7 mg, 2.5g Carbohydrates, Oxalic acid 15 mg, Calcium 10 mg, Sulphur 17 mg, Potassium 50 mg and many other nutrients out of 100 g of edible portion **(Choudhary, 2013).** It is considered as quality dietary food due to its excellent digestibility and rich water content (96.3 g/100 g). Cucumber is a dependable laxative for those who suffer constipation. The juice of cucumber is a valuable food in the treatment of hyper acidity, gastric and duodenal ulcers (**Ernestina, 2001).** Cucumber is well adapted crop for warm season. The crop performs well in temperature range between 18°C - 24°C and soil having pH ranging between 5.5-6.7 irrespective of its kind from sandy to heavy clay soil. It is grown as sole crop in India in *Zaid* and *Kharif* season*.* It is well suited to hot and warm climate with annual rainfall of 60-75 cm. However, cucumber cannot withstand water lodging.

 Cucumbers are often eaten as a vegetable but they are scientifically considered a fruit as they contain enclosed seeds and develop from a flower. Cucumbers are extremely beneficial for overall health, especially during the summer since they are mostly made of water and important nutrients that are essential for the human body. The flesh of cucumbers is rich in vitamin A, vitamin C and folic acid while the hard skin of cucumbers is rich in fiber and a range of minerals include magnesium, molybdenum and potassium. Additionally, cucumber contains silica, a trace mineral that contributes greatly to strengthening our connective tissues.

Integrated nutrient management (INM) is one important technology to be followed by the farmers to get high yield with less detrimental effect on soil health. Integrated nutrient management (INM) system refers to the balanced use of chemical fertilizers in combination with organic manures, crop residues, bio fertilizers and other biological sources **(Thriveni *et al*. 2015)**. The continuous use of high level of chemical fertilizers leads to decrease the nutrient uptake efficiency of plants, resulting in either stagnation or decrease in yield and also causing environmental pollution **(Singh and Kalloo, 2000).** The integration of different nutrient sources enhances growth, yield and quality attributing characters in vegetables as compared with sole application of recommended dose of chemical fertilizers (Kumar *et al*. 2018). In recent times the concept of Integrated Nutrient Management system has been receiving increasing attention worldwide obviously for reasons of economization of fertilizer usage, safeguarding and ensuring scientific management of soil health for optimum growth, yield and quality of crops in an integrated manner in a specific agroecological situations, through balanced use of organic and inorganic plant nutrients; so that one can harvest good yield without deteriorating soil health.

**Material and Methods: -**

The experiment was laid out in Randomized Block Design (RBD) with 08 treatments and three replications. For this purpose, 24 plots were made in Horticulture Research Farm, School of Agriculture Science, Technology and Research, Sardar Patel University, Balaghat (M.P.) during fourth week of July in the year of 2023. Balaghat District is located the south-eastern portion of the Satpura Range and the upper valley of the Wainganga River. The district extends from 21°19’ to 22°24’ north latitude and 79°31’ to 81°30’ east longitude. The treatment comprises of T1 (Control), T2 (100% RDF Recommended Dose of Fertilizer), T3 (75% RDF + 25% Azospirillum), T4 (50% RDF + 50% FYM), T5 (50% RDF + 50% Vermicompost), T6 50% RDF + 25% Azospirillum + 25% FYM, T7 (50% RDF + 25% Azospirillum + 25% Vermicompost) and T8 (50% RDF + 25% FYM + 25% Vermicompost)

Vine length was measured from ground level to the last tip of main stem of the plant of five randomly selected plants at the time of maturity. Vine length was taken at harvesting stage. Number of branches per vine was counted and recorded in individual plants from each replication and hybrid sown. The numbers of days taken from the date of sowing to the date at which first male flower appeared in plants or date at which male flower in plants start flowering in whole plot were recorded as days to first male flowering. The numbers of days taken from the date of sowing to the date at which first female flower appeared in plants or date at which female flower in plants start flowering in whole plot were recorded as days to first female flowering. Number of male flowers that appeared were counted and recorded in each replication for each hybrids sown. Number of female flowers that appeared were counted and recorded in each replication for each hybrids sown. Ratio was calculated to for male female flower in each replication and hybrids sown. The number of fruits per vine of five randomly selected vines were counted, averaged, and subjected to statistical analysis. Average fruit weight was taken from randomly five fruits from randomly selected plants by using physical balance, averaged, and subjected to statistical analysis. Average fruit length was taken from randomly five fruits from randomly selected plants by using measuring tape and scale, averaged, and subjected to statistical analysis. The fruit weight of the tagged plants was recorded at every harvest. The fruit weight is then averaged and analyzed. The yield was calculated by weighing the marketable fruits. The readings for all the two plants/plot were recorded. The average yield/plant was calculated by dividing the total yield of the treatments with the total number of plants in plot using unitary method converted to per hectare yield. A BCR less than 1. indicates that the costs exceed the benefits, indicating a less favorable financial outlook. The data recorded during experimental investigation were subjected to statistical analysis of “Analysis of variance” technique **(Fisher and Yates, 1967).**

**RESULTS AND DISCUSSION**

**A. Growth and yield parameter of cucumber**

**1. Vine length (cm)**

The maximum vine length (cm) i.e. 191.01 cm were noted by the application of T7- (50%RDF +25% Azospirillum +25% Vermicompost) closely followed by T8- 50% RDF+ 25% FYM + 25% vermicompost i.e. 185.03 cm and T6 –50% RDF + 25% Azospirillum +25% FYM i.e. 159.21 cm and this improvement was significantly highest then rest of the treatment. However, minimum values i.e. 117.73 cm were in control (T1) where plots were deprived off by the use of any organic, inorganic fertilizers and biofertilizers in the years (Table 1 & Fig 1). This may be due to improved nutrient uptake by plants in this treatment, resulting improved vegetative growth. The organic manure applied in the form of FYM and vermicompost might have improved the physical and chemical properties of the soil and leading to the adequate supply of nutrients to the plants with sufficient water holding capacity and might have accelerate the vine length, number of leaves plant-1 and number of primary branches plant-1. The combined application of FYM, vermicompost and inorganic fertilizers increased the absorption of nutrients especially nitrogen which enhanced the cell division, cell elongation and increased the plant growth Similar result were also reported that the **Kanaujia, S. P., & Daniel, M. L. (2016)**, **Singh *et al*., (2018)**

**2. Number of branches per vine**

The maximum number of branches per vine i.e. 4.60 were noted by the application of T7- (50% RDF +25% Azospirillum +25% Vermicompost) closely followed by T8- 50% RDF+ 25% FYM + 25% vermicompost i.e. 3.80 and T5 –50% RDF + 50% vermicompost i.e. 3.73 and this improvement was significantly highest then rest of the treatment, however, minimum values i.e. 3.40 were in control (T1) This may be due to improved nutrient uptake by plants in this treatment, resulting improved vegetative growth (Table 1 & Fig 1). The organic manure applied in the form of FYM and vermicompost might have improved the physical and chemical properties of the soil and leading to the adequate supply of nutrients to the plants with sufficient water holding capacity and might have accelerate the vine length, number of leaves plant-1 and number of primary branches plant-1. The combined application of FYM, vermicompost and inorganic fertilizers increased the absorption of nutrients especially nitrogen which enhanced the cell division, cell elongation and increased the plant growth. **Kanaujia, S. P., & Daniel, M. L. (2016)**, **Singh *et al*., (2018)**

**3. Days to male flowering**

The maximum days to male flowering i.e. 43.00 days were noted by the application of T1 (control), closely followed by T2- 100 % RDF i.e. 42.33 days and T4 –50% RDF + 50% FYM i.e. 40.47 days and this improvement was significantly highest then rest of the treatment, however, minimum values i.e. 33.47 days were in T7- (50%RDF +25% Azospirillum +25% Vermicompost) (Table 1 & Fig 1). The earliness of flowering might be due to the better translocation of nutrients to the aerial parts of the plant and enhancement in reproductive phase due to the treatment of relevant combinations of organic and inorganic source of nutrients. Likewise, phosphorus plays an important role for reproductive organs and initiation of flowering. **Singh *et al*., (2018)**, **Anjanappa *et al.* (2012) and Singh *et al.* (2017)** in cucumber .

**4. Number of fruits per vine**

The maximum number of fruits per vine i.e. 7.87 were noted by the application of T7- (50%RDF +25% Azospirillum +25% Vermicompost), closely followed by T8- 50% RDF+ 25% FYM + 25% vermicompost i.e. 7.20 and T6 –50% RDF + 25% Azospirillum + 25% FYM i.e. 7.00 and this improvement was significantly highest then rest of the treatment. However, Minimum values T1- control i.e. plots were deprived off by the use of any organic, inorganic fertilizers and biofertilizers in the years (Table 1 & Fig 1). It might be due to balanced nutrition, better uptake of nutrients by the plants which helped for better fruit set and fruit yield. More number of fruits plant-1 and fruit weight plant-1 ultimately resulted in highest fruit yield ha-1. Maximum yield of cucumber in present study could be due to the influence of organic manures (FYM and vermi-compost) in combination with NPK enhanced the synthesis of photosynthesis by increasing the growth hormones and amino acids. **Kanaujia, S. P., & Daniel, M. L. (2016)** , **Pradhan *et al,* (2018), Singh *et al*.,(2018)** , **Singh *et al,* (2020).**

**5. Average fruit weight (g)**

The maximum Average fruit weight (g) i.e. 166.85gm was noted by the application of T7- (50 % RDF +25% Azospirillum +25% Vermicompost), closely followed by T5- 50% RDF+ 50% vermicompost i.e. 160.85 gm and T4 –50% RDF + 50% FYM i.e. 159.46gm and this improvement was significantly highest then rest of the treatment. However, minimum values were observed in T1- control i.e.137.24 gm which was deprived off by the use of any organic, inorganic fertilizers and biofertilizers. It might be due to balanced nutrition, better uptake of nutrients by the plants which helped for better fruit set and fruit yield (Table 1 & Fig 1). More number of fruits plant-1 and fruit weight plant-1 ultimately resulted in highest fruit yield ha-1. Maximum yield of cucumber in present study could be due to the influence of organic manures (FYM and vermi-compost) in combination with NPK enhanced the synthesis of photosynthesis by increasing the growth hormones and amino acids.  **Kanaujia, S. P., & Daniel, M. L. (2016)** , **Pradhan *et al,* (2018) , Singh *et al*.,(2018)** , **Singh *et al,* (2020)**

**6. Fruit length (cm)**

The maximum fruit length (cm) i.e. 14.48 cm, were noted by the application of T7- (50%RDF +25% Azospirillum +25% Vermicompost), closely followed by T8- 50% RDF+ 25% FYM + 25% vermicompost i.e. 14.43 cm and T6 –50% RDF + 25% Azospirillum + 25% FYM i.e. 13.84 cm. This improvement was significantly highest then rest of the treatment; however, Minimum values was found in T1- control i.e. 12.35cm. were deprived off by the use of any organic, inorganic fertilizers and biofertilizers in the years (Table 1 & Fig 1). It might be due to balanced nutrition, better uptake of nutrients by the plants which helped for better fruit set and fruit yield. More number of fruits plant-1 and fruit weight plant-1 ultimately resulted in highest fruit yield ha-1. Maximum yield of cucumber in present study could be due to the influence of organic manures (FYM and vermicompost) in combination with NPK enhanced the synthesis of photosynthesis by increasing the growth hormones and amino acids. **Kanaujia, S. P., & Daniel, M. L. (2016)**, **Pradhan *et al,* (2018) Singh *et al*.,(2018)** and **Singh *et al.,* (2020).**

**7. Fruit yield per ha. (t/ha.)**

The maximum fruit yield per ha. (t/ha) i.e. (15.02 t/ha) were noted by the application of T7- (50%RDF +25% Azospirillum +25% Vermicompost), closely followed by T8- 50% RDF+ 25% FYM + 25% vermicompost i.e. (13.17 t/ha) and T6 –50% RDF + 25% Azospirillum + 25% FYM i.e. (12.31 t/ha). This improvement was significantly highest then rest of the treatment. However, minimum values T1- control i.e. (8.70 t/ha) were deprived off by the use of any organic, inorganic fertilizers and biofertilizers in the years (Table 1 & Fig 1). It might be due to balanced nutrition, better uptake of nutrients by the plants which helped for better fruit set and fruit yield. More number of fruits plant-1 and fruit weight plant-1 ultimately resulted in highest fruit yield ha-1. Maximum yield of cucumber in present study could be due to the influence of organic manures (FYM and vermicompost) in combination with NPK enhanced the synthesis of photosynthesis by increasing the growth hormones and amino acids. **Kanaujia, S. P., & Daniel, M. L. (2016)** , **Pradhan *et al,* (2018) Singh *et al*.,(2018)** and **Singh *et al.,* (2020).**

**8. Economic:**

Cucumber sown in the field under the treatment with 50% RDF + 25% Azospirillum + 25% Vermicompost (T7) recorded the maximum monetary advantage with the benefit cost ratio of 3.23 and minimum was found to be 1.87 T1- control, during the year of experimentation was mainly due to higher yield, while enhanced net return and benefit: cost ratios was because the cost of cultivation involved in the production was minimum under this treatment combination **Shree *et al.*, (2018)** . The result of this study is in agreements with the finding of  **Moakala *et al.,* (2015), Karuppaiah and Balasankari (2008) Kanaujia, S. P., & Daniel, M. L. (2016)**, **Singh *et al*., (2018)** and **Singh *et al,* (2020).**

**Conclusion**

The overall results obtained from the present investigation clearly revealed that the application of T7 (50% RDF + 25%Azosprillum +25% vermicompost) showed the better performance for vegetative growth & flowering (vine length, number of branches per plant, days to first male flowering, number of fruits per vine, average fruit weight, fruit length and fruit yield (t/ha) would be useful to enhance the productivity of cucumber. Cucumber sown in the field under the treatment with 50% RDF + 25% Azospirillum + 25% Vermicompost (T7) recorded the maximum monetary advantage with the benefit cost ratio of 4.24, during the year of experimentation.

**Disclaimer (Artificial intelligence)**

I hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of this manuscript.

**Competing Interests**

Authors have declared that no competing interests exist.

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**Table 1: Impact of Integrated nutrient management on growth and yield of cucumber**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Variety Symbols** | **Treatment****Detail** | **Vine Length (cm)**  | **Number of Branches Per Vine**  | **Days To Male Flowering** | **Number of Fruit Per Vine** | **Average Fruit Weight (g)** | **Fruit Length (cm)** | **Fruit Yield Per hac. (t/ha.)** | **B:C** **Ratio**  |
| T1 | Control | 117.73 | 3.40 | 43.00 | 6.20 | 137.24 | 12.35 | 8.70 | 1.87 |
| T2 | 100% RDF(Recommended Dose of Fertilizer) | 153.12 | 3.71 | 42.33 | 6.27 | 151.54 | 13.42 | 11.83 | 2.54 |
| T3 | 75% RDF + 25% Azospirillum | 157.93 | 3.72 | 34.27 | 6.20 | 150.59 | 13.72 | 11.10 | 2.39 |
| T4 | 50% RDF + 50% FYM | 142.79 | 3.67 | 40.47 | 6.27 | 159.46 | 13.52 | 10.34 | 2.22 |
| T5 | 50% RDF + 50% Vermicompost | 151.97 | 3.73 | 38.01 | 6.33 | 160.85 | 13.21 | 11.86 | 2.55 |
| T6 | 50% RDF + 25% Azospirillum + 25% FYM | 159.21 | 3.60 | 39.74 | 7.00 | 151.93 | 13.84 | 12.31 | 2.65 |
| T7 | 50% RDF + 25% Azospirillum + 25% Vermicompost | 191.01 | 4.60 | 33.47 | 7.87 | 166.85 | 14.48 | 15.02 | 3.23 |
| T8 | 50% RDF + 25% FYM + 25% Vermicompost | 185.03 | 3.80 | 37.33 | 7.20 | 157.26 | 14.43 | 13.17 | 2.83 |
|  | **CD 0.05** | **15.10** | **1.69** | **2.80** | **0.46** | **1.37** | **1.51** | **1.26** |  |
|  | SE. m (±) | **5.39** | **0.25** | **0.95** | **0.16** | **4.30** | **0.39** | **0.43** |  |

**Fig1: Impact of Integrated nutrient management on growth and yield of cucumber**

**T1-** Control, **T2-** 100% RDF (Recommended Dose of Fertilizer), **T3** – 75% RDF + 25 % Azospirillum**, T4-** 50% RDF + 50% FYM, **T5-** 50% RDF + 50% Vermicompost, **T6-** 50% RDF + 25% Azospirillum + 25% FYM, **T7-** 50% RDF + 25% Azospirillum + 25% Vermicompost **T7-** 50% RDF + 25% FYM + 25% Vermicompost.