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EFFECT OF DIFFERENT LEVELS OF NITROGEN, PHOSPHORUS AND POTASSIUM ON THE GROWTH AND YIELD OF CUCUMBER (*Cucumis sativus* L.) IN THE COASTAL REGION OF BANGLADESH

Md. Sabuj Ali[2,1]*, Dipta Majumder[2,1], Rakib Hasan[1], Tawseef Al Aff[2], Nur Mohammad[1], and Kawsar Hossen[3,1]

[1]Department of Agriculture, Faculty of Science, Noakhali Science and Technology University, Noakhali-3814, Bangladesh; [2]Department of Plant Pathology, Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh; [3]The United Graduate School of Agricultural Sciences, Ehime University, Matsuyama 790-8566, Japan.

***Corresponding author:** Md. Sabuj Ali; E-mail: ishobuj66@gmail.com

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ABSTRACT

The experiment was carried out at Agricultural Research Field, Noakhali Science and Technology University, Noakhali, Bangladesh during the period of March to June 2021, to evaluate the growth and yield of cucumber (*Cucumis sativus* L. CV: MOHABIR) as influenced by different levels of NPK fertilizer. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The treatments were T_0 (no NPK), T_1 (N 69 kg ha^{-1}, P_2O_5 48 kg ha^{-1} and K_2O 75 kg ha^{-1}), T_2 (N 69 kg ha^{-1}, P_2O_5 60 kg ha^{-1} and K_2O 90 kg ha^{-1}), T_3 (N 92 kg ha^{-1}, P_2O_5 72 kg ha^{-1} and K_2O 105 kg ha^{-1}), respectively. Data were recorded from different stages of plant growth on the number of leaves per plant, number of fruits per plant, fruit length, fruit diameter, individual fruit weight, yield per plant and yield per plot. All the recorded parameters were statistically significant ($p<0.01$). The maximum number of leaves per plant (37.83) was recorded from T_3 (N 92 kg ha^{-1}, P_2O_5 72 kg ha^{-1} and K_2O 105 kg ha^{-1}) whereas the minimum number of leaves per plant (27.92) was obtained from the control T_0 (no NPK). Highest number of fruits per plant (11.92), fruit length (16.00 cm), fruit diameter ((4.10 cm), individual fruit weight (167.17 g), weight of fruits per plant (2.00 kg), and yield per hectare (68.35 t/ha) was found in treatment T_3 (N 92 kg ha^{-1}, P_2O_5 72 kg ha^{-1} and K_2O 105 kg ha^{-1}) whereas lowest data recorded from control T_0 (no NPK). Observing the results, it can be stated that application of NPK fertilizer @ N 92 kg ha^{-1}, P_2O_5 72 kg ha^{-1} and K_2O 105 kg ha^{-1} for cucumber cultivation gave better growth and yield in the coastal region of Bangladesh.

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INTRODUCTION

Cucumber (*Cucumis sativus* L.) is a popular vegetable belongs to the family cucurbitaceae. Cucumber is native to the tropics and is one of the oldest cultivated vegetable crops (Yawalkar, 1985). Cucumber is one of the important fresh fruit vegetables grown commonly throughout the world. In Bangladesh, it is available in all the year round. Its production is gradually rising in fields and greenhouses due to its excellent nutritional benefits (Zarei *et al*., 2019). High nutrient treatment during the past part of the century has significantly improved crop yields (Salim and Raza, 2020). Cucumber requires large amounts of both macro and micro nutrients for economic yields of cucumber. Nitrogen, phosphorus and potassium are important nutrients for cultivation of cucumber. Cucumber plants should be fertilized with adequate dose of nitrogen, phosphorus and potassium which are the main elements and they have significant effect on growth of plants. Nitrogen (N) is perceived as one of the principal macronutrients which is necessary for plants (Ali *et al.,* 2017). However, improper nitrogenous fertilizer use led to major problems with both environmental and human health (Ahmed *et al*., 2017; Nieder *et al*., 2018). Nitrogen is a component of chlorophyll, the green pigment of plants that stimulates photosynthesis.

Deficiency of nitrogen significantly reduces growth and yield of cucumber. The element phosphorus (P) is a must for photosynthesis. High level of available phosphorus throughout the root zone is essential for root development and good utilization of water and other nutrients by the plants (Schachtman *et al*., 1998). Potassium is absorbed in greater amounts by plants than any other mineral element with the exception of nitrogen and, in some cases, calcium as well. Potassium helps in some essential functions in plants like protein building, photosynthesis, maintaining fruit quality and diseases reduction (Ramezani *et al*., 2017).

Cucumber plants need potassium in a much greater amount than any other nutrient element. It has been observed that potassium has the capability to improve the quality of cucumber fruits. Potassium is supplied to plants by various means like soil minerals, organic materials and fertilizer as well. The osmatic potential of cells and tissues in glycophytic plant species is significantly increased by K^+ and its accompanying anions (Marshaner, 1995). Various biotic and abiotic stress factors have a significant impact on cucumber production. One of the reasons that affects cucumber productivity and the spread of its cultivation in many parts of the world is soil salinity. Soil Salinity has a negative impact on crop quality, yield, and growth (Razzouk and Whittington, 1991; Dong, 2008). Cucumber is very sensitive to soil salinity (Maas, 1977), particularly in the growth stages. High salt contents reduce the growth and production of cucumber by affecting physiological processes, including modification of ion balance, water movements, stomata behavior and chlorophyll content. The suitable cucumber growing conditions are decreasing due to the salinity in many coastal areas of Bangladesh. In coastal region of Bangladesh, most of the farmers lacking knowledge about the appropriate levels of nitrogen, phosphorus and potassium fertilizer for cucumber cultivation. These facts suggest that there is a large scope of increasing cucumber production with the appropriate use of nitrogen, phosphorus and potassium fertilizers. The present experiment was conducted with the aim to investigate the effects of nitrogen, phosphorus and potassium on the growth and yield quality of cucumber in coastal regions of Bangladesh.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at Agricultural Research Field, Noakhali Science and Technology University, Noakhali, Bangladesh, during the period of March to June, 2021 in the agro-ecological zone Young Meghna Estuarine Floodplain (AEZ 18). The proportions of the particle size of the soil of that site is Sand: Silt: Clay = 40%: 40%: 20%. The soil type is loamy with organic matter (0.68%), with total nitrogen of 0.04 g/kg, available P in the soil 27.79 µg/g, and available K in the soil 0.18 meq/100 g soil with soil is pH value 7.5 and the soils become saline in dry season.

Experimental Methodology

Cucumber cultivar MOHABIR was used as test variety. The experiment was laid out in a Randomized Complete Block Design (RCBD) comprising four treatments with three replications. The treatments were T_0 (no NPK), T_1 (N 69 kg ha^{-1}, P_2O_5 48 kg ha^{-1} and K_2O 75 kg ha^{-1}), T_2 (N69 kg ha^{-1}, P_2O_5 60 kg ha^{-1} and K_2O 90 kg ha^{-1}), T_3 (N 92 kg ha^{-1}, P_2O_5 72 kg ha^{-1} and K_2O 105 kg ha^{-1}). The unit plot size was 1.6 m × 1.1 m. The land properly loosened with spade and big clods were broken into small clods and properly prepared for seedling transplantation. Seeds of cucumber obtained from local market, sown in Poly bag and at two-leaf stage, seedlings were transplanted in the main field. In field, 6 seedlings were

planted in each plot having 50 cm plant-to-plant distance and 70 cm row-to-row distance. A uniform basal dose of 5 tons per hectare well rotten farm yard manure was applied per plot before transplantation of seedlings. Nitrogen was applied in the form of urea. Application of urea was done in three uniform splits, i.e. first dose was applied at transplanting stage, second after transplanting (one month later) and third at fruiting stage. Phosphorus and potassium were applied in the form of triple super phosphate and muriate of potash, respectively at the time of transplantation of seedlings (Okoli and Nweke, 2015). Irrigations were given by hand sprayer when needed. Weeding was done two times in plots to keep plots free from weeds. Imidacloprid and mancozeb was applied at 2 times for the control of insect and fungi.

Data Collection

Data on number of leaves, fruit per plant, fruit length, fruit diameter, fruit weight, yield per plant and yield per hectare of cucumber were recorded from six plants being randomly selected from each plot.

Statistical Analysis

The mean values for all the parameters were calculated and the analysis of variances for the characters was accomplished by F variance test. The significance of difference between pair of means was tested by the least significant difference (LSD) test at 1% levels of probability (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Leaf number

Application of different levels of NPK fertilizer showed statistically significant ($p<0.01$) variation on the number of leaves per plant (Figure 1). The maximum number of leaves per plant (37.83) was recorded in treatment T_3 (N 92 kg ha^{-1}, P_2O_5 72 kg ha^{-1} and K_2O 105 kg ha^{-1}) followed by treatment T_2 (35.42), T_1 (32.17) and T_0 (27.92), respectively. Generally, the more number of leaves per plant, the more is the yield in cucumber. Diaz *et al*. (1973), Kmiecik (1976), Yuasa (1981), El- Badawi (1994), Lawal (2000) and Agba and Enya (2005) had also reported increase in growth and yield components of cucumber to applied chemical fertilizer.

Number of fruit per plant

Application of different doses of NPK fertilizer showed statistically significant ($p<0.01$) variation on the number of fruit per of cucumber (Figure 2). The maximum number of fruits per plant (11.92) was recorded in T_3 (N 92 kg ha^{-1}, P_2O_5 72 kg ha^{-1} and K_2O 105 kg ha^{-1}) followed by T_2 (N 69 kg ha^{-1}, P_2O_5 60 kg ha^{-1} and K_2O 90 kg ha^{-1}) which was (9.83). While the minimum number of fruits per plant was recorded in T_0 (no fertilizer), which was (4.92). This result shows that the rate of N 92 kg ha^{-1}, P_2O_5 72 kg ha^{-1} and K_2O 105 kg ha^{-1} through the application of chemical fertilizer has the highest mean number of fruit per plant. Similar results have been reported by Choudhari and More (2002) and Jilani *et al*. (2009). Ravikumar *et al*. (2003) recorded highest number of fruits per plant of cucumber with the application of NPK 120:80:50 kg ha^{-1}.

Fruit length

Statistically significant ($p<0.01$) variation was recorded on fruit diameter of cucumber for different levels of NPK fertilizer management practices (Figure 3). The longest fruit (16.00 cm) of cucumber was measured in T_3 (N 92 kg ha^{-1}, P_2O_5 72 kg ha^{-1} and K_2O 105 kg ha^{-1}), and the lowest fruit (12.20 cm) was recorded in the treatment T_0 (no fertilizer) followed by the treatment T_1 (14.07 cm), and T_2 (15.10 cm), respectively. Jilani *et al*. (2009) observed highest fruit length with NPK at 100-50-50 kg ha^{-1}.

Fruit diameter

Fruit diameter**s of the plants were** recorded from all the treatments. Fruit diameter of cucumber was significantly ($p<0.01$) influenced by the application of different levels of NPK fertilizer (Figure 4). The highest fruit diameter of cucumber (4.10 cm) was recorded in treatment T_3 (N 92 kg ha^{-1}, P_2O_5 72 kg ha^{-1} and K_2O 105 kg ha^{-1}) followed by treatment T_2 (3.90 cm), T_1 (3.67 cm) and T_0 (3.03 cm), respectively. Zahid *et al*. (2021) observed similar average fruit diameter of cucumber with application of N at 55 kg ha^{-1}.

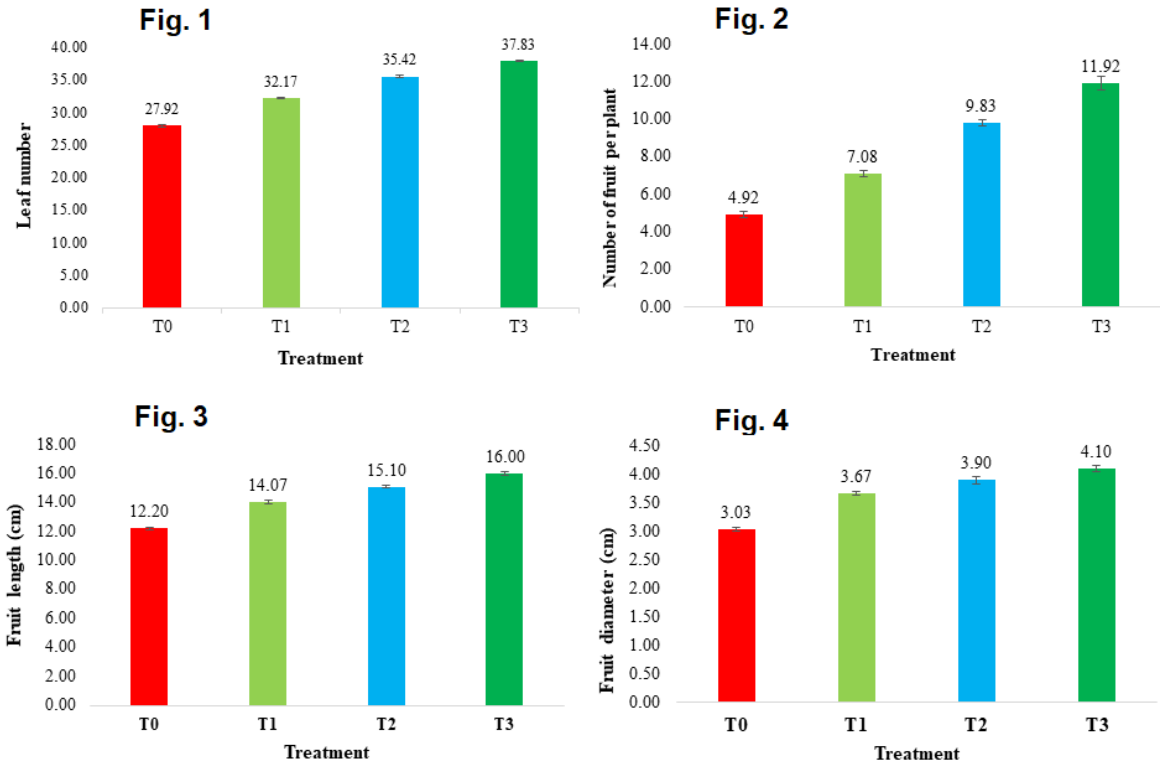


Figure 1. Effects of NPK fertilizer on leaf number of cucumber; **Figure 2.** Effects of NPK fertilizer on number of fruits per plant of cucumber; **Figure 3.** Effects of NPK fertilizer on fruit length of cucumber; **Figure 4.** Effects of NPK fertilizer on fruit diameter of cucumber

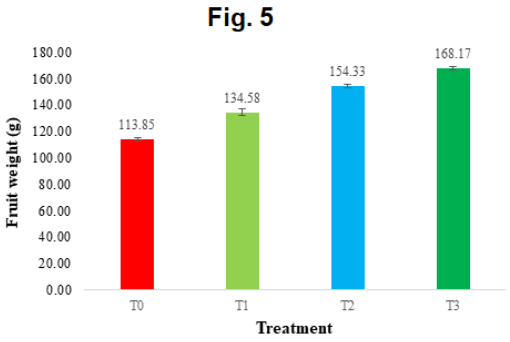
Legends: T_0 = (no fertilizer), T_1 = (N 69 kg ha^{-1}, P 48 kg ha^{-1} and K 75 kg ha^{-1}), T_2 = (N 69 kg ha^{-1}, P 60 kg ha^{-1} and K 90 kg ha^{-1}), T_3 = (N 92 kg ha^{-1}, P 72 kg ha^{-1} and K 105 kg ha^{-1}).

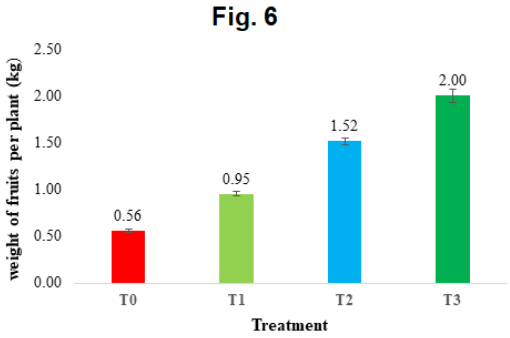
Fruit weight

Weight of individual fruit of cucumber was significantly ($p<0.01$) varied by the application of different levels of NPK fertilizer (Figure 1). The maximum weight of fruit (168.17 g) was observed in treatment T_3 (N 92 kg ha^{-1}, P_2O_5 72 kg ha^{-1} and K_2O 105 kg ha^{-1}) followed by treatment T_2 (154.33 g), T_1 (134.58 g) where the lowest weight of individual fruit (113.85 g) was obtained from the treatment T_0 (no fertilizer). Similar results have also been reported by Choudhari and More (2002) and Jilani *et al.* (2009). Mohammed *et al*. (2021) observed similar average fruit weight of cucumber with application of NPK at 150:120:120 NPK kg ha^{-1}.

Weight of fruits per plant

Application of different levels of NPK fertilizer showed a statistically significant ($p<0.01$) variation on the weight of fruits per plant (Figure 6). The highest weight of fruits per plant (2.00 kg) was observed in treatment T_3 (N 92 kg ha^{-1}, P_2O_5 72 kg ha^{-1} and K_2O 105 kg ha^{-1}) followed by treatment T_2 (1.52 kg), T_1 (0.95 kg) where the lowest weight of fruits per plant (0.56 kg) was obtained from the treatment T_0 (no fertilizer). The significant response of parameters evaluated (number of leaves, number of fruits per plant, weight of fruits per plant, fruit length and fruit diameter and yield) to applied NPK fertilizer may be an indication that the nutrients taken up by the plant was well utilized in cell multiplication, amino acid synthesis and energy formation hence increase in photosynthesis. The products of photosynthesis were then translocated to the sinks. El-Badawi (1994) and Lawal (2000) who reported significant response of cucumber fruit weight per plant and total yield to applied chemical fertilizer.





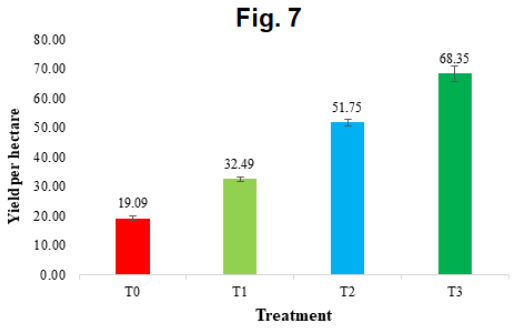


Figure 5. Effects of NPK fertilizer on fruit weight of cucumber; **Figure 6.** Effects of NPK fertilizer on weight of fruits per plant of cucumber; **Figure 7.** Effects of NPK fertilizer on yield of cucumber

Legends: T_0 = (no fertilizer), T_1 = (N 69 kg ha^{-1}, P 48 kg ha^{-1} and K 75 kg ha^{-1}), T_2 = (N 69 kg ha^{-1}, P 60 kg ha^{-1} and K 90 kg ha^{-1}), T_3 = (N 92 kg ha^{-1}, P 72 kg ha^{-1} and K 105 kg ha^{-1})

Yield per hectare

Application of different levels of NPK fertilizer showed a statistically significant ($p<0.01$) variation on the yield per hectare (Figure 7). The maximum yield per hectare (68.35 ton) was observed in treatment T_3 (N 92 kg ha^{-1}, P_2O_5 72 kg ha^{-1} and K_2O 105 kg ha^{-1}) followed by treatment T_2 (51.75 ton), T_1 (32.49 ton) where the lowest yield per plant (19.09 ton) was obtained from the treatment T_0 (no fertilizer). Mohammed *et al*. (2021) observed average 56.76 t ha^{-1} yield of cucumber with application of NPK at 150:120:120 kg ha^{-1}. Jassal *et al*. (1970) has been reported that increase in the yield of muskmelon due to higher levels of NPK application. Arora and Siyag (1988) reported that in both the season N and P gave maximum fruit yield per hectare.

CONCLUSION

The results indicated that nitrogen, phosphorus and potassium fertilizer doses had a positive impact on the growth and yield parameters of cucumber like leaf number, fruit per plant, fruit length, fruit diameter, individual fruit weight, weight of fruits per plant and yield per hectare. Comparative results of various parameters studied in the present investigation suggested that T_3 was the best treatment because weight of fruits per plant was highest (2.0 kg) in treatment T_3 and also the highest yield (68.35 t/ha) was found in treatment T_3 (N 92 kg ha^{-1}, P_2O_5 72 kg ha^{-1} and K_2O 105 kg ha^{-1}). Therefore, recommendation of treatment T_3 (N 92 kg ha^{-1}, P_2O_5 72 kg ha^{-1} and K_2O 105 kg ha^{-1}) as fertilizer dose necessitates both regional and multi-location trials.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper.

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