# INFLUENCE OF SOWING TIME AND PHOSPHORUS ON THE GROWTH AND YIELD PERFORMANCE OF CUCUMBER

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# INFLUENCE OF SOWING TIME AND PHOSPHORUS ON THE GROWTH AND YIELD PERFORMANCE OF CUCUMBER

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## *CERTIFICATE*

*This is to certify that the thesis entitled **'Influence of Sowing Time and Phosphorus on the Growth and Yield Performance of Cucumber (Cucumis sativus L)'** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of **Master of Science (MS)** in* **Horticulture***, embodies the result of a piece of bonafide research work carried out by* **Sufia Akter***, Registration number: **08-02793** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

*I further certify that any help or source of information, received during the course of this investigation has duly been acknowledged.*

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*TheAuthoress*

**INFLUENCE OF SOWING TIME AND PHOSPHORUS ON THE GROWTH AND YIELD PERFORMANCE OF CUCUMBER (*Cucumis sativus* L.)**

**BY**

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## ABSTRACT

The study was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from March to July, 2013. The experiment consisted with two factors. Factor A: Sowing time (4 levels), $T_1$: Sowing on 20 March, $T_2$: 5 April, $T_3$: 20 April, $T_4$: 5 May and also Factor B: Phosphorus (4 levels)-$P_0$: 0 kg $P_2O_5$/ha (control), $P_1$: 30 kg $P_2O_5$/ha, $P_2$: 60 kg $P_2O_5$/ha and $P_3$: 90 kg $P_2O_5$/ha. The present study was laid out in a Randomized Complete Block Design (RCBD) with three replications. Sowing time and levels of phosphorus showed significant variations on most of the parameters. The maximum number of fruits per plant (22.75), individual fruit weight (180.74 g) and fruit yield(48.49 t/ha) was recorded from $T_2$ treatment, whereas the lowest was recorded from $T_4$ treatment. On the other hand, the maximum number of fruits per plant (23.86), individual fruit weight (192.58 g) and fruit yield (51.14 t/ha) was recorded from $P_2$ treatment, while the lowest was recorded from $P_0$ (control) treatment. In the treatment combination, maximum number of fruits per plant (25.89), individual fruit weight (203.09 g) and fruit yield (58.42 t/ha) was recorded from $T_2P_2$, while the lowest were (16.0, 140.8 g, 25.05 t/ha) recorded from $T_4P_0$ treatment combination, respectively. The highest benefit cost ratio (2.49) was noted from $T_2P_2$ and the lowest (1.08) from $T_4P_0$ treatment combination. In the present study, combination of $T_2P_2$ showed more profitable than rest of the combinations in cucumber cultivation.

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# LIST OF ABBREVIATED TERMS

| ABBREVIATIONS | FULL WORD |
|---|---|
| Agric. | Agriculture |
| Agril. | Agricultural |
| AEZ | Agro Ecological Zone |
| ANOVA | Analysis of Variance |
| *et al.* | And others |
| AVRDC | Asian Vegetable Research and Development centre |
| @ | At the rate |
| BARI | Bangladesh Agricultural Research Institute |
| cv. | Cultivar (s) |
| df | Degrees of Freedom |
| DMRT | Duncan's Multiple Range Test |
| etc. | Etcetera |
| LSD | Least significant difference |
| Max. | Maximum |
| ml/L | Mililitre per litre |
| viz. | Namely |
| ppm | Parts Per Million |
| % | Percent |
| CV% | Percentage of Coefficient of Variation |
| R.H | Relative Humidity |
| $m^2$ | Square meter |

# CHAPTER I

# INTRODUCTION

Cucumber (*Cucumis sativus* L.) belongs to the family of Cucurbitaceae is a major vegetables crop worldwide and develops rapidly, with a shorter time from planting to harvest (Wehner and Guner, 2004). The crop is the second most important vegetable crop after tomato in Western Europe and is the fourth most cultivated vegetable in the world after tomatoes, brassicas and onions (Wehner, 2007). In tropical Africa, the crop has not been ranked because of limited use. Cucumber is grown widely in different parts of the world. It is an all year round out door vegetable in the tropics and an important greenhouse vegetable especially in Northern Europe and North America (Mingbao, 1991).

Vegetable production in Bangladesh is far below of actual requirements. In 2013-2014, total vegetable (summer and winter season) production area was 7.56 lac hectares of land with total production of 13.8 million tons (BBS, 2014). Our daily requirement of vegetables is 235 gm/day/person for adult which are recommended by Bangladesh Council of Nutrition. Cucumber can meet up the shortage of vegetable consumption in our country. It is a great source of vitamins and minerals of people (AVRDC, 1999). It contains 0.6g protein, 2.6g carbohydrate (CHO), 12 calorie energy, 18 mg calcium (Ca), 0.2 mg Fe, 0.02 mg thiamin, 0.02g riboflavin, 0.01 mg niacin and vitamin per 100g of edible portion (Rashid, 1999).

Cucumber is cultivated during summer but it can be grown round the year except the acute cold months of winter in Bangladesh. For its growth and development optimum temperature is required within 20-30$^0$C. It can be grown in well drained any type of soil. The total production of cucumber in Bangladesh was about 136,000 metric ton in 8,600 hectare of land with an average yield 15.80 ton/ha (BBS, 2012). This figure indicates the low yield of this crop and the low yield in Bangladesh however, is not an indication of low yielding potentiality of this crop, but may be attributed to a number of reasons, viz. unavailability of quality seeds of high yielding varieties in appropriate time, fertilizer management, disease and insect infestation, improper or limited irrigation facilities and other appropriate agronomic practices including sowing of seeds. Among the factors sowing time and appropriate dose of phosphorus fertilizer with high yield potentiality is an important factor (Liang and Shang, 2013).

Cucumber is a kharif season vegetable but needs cool temperature for flowering. Its growth and development are greatly influenced by growing environment. The production of a crop depends on many factors such as quality of seed, proper management practices including time of sowing, plant spacing, soil fertility management, intercultural operations etc. Sowing time is an important factor for yield of crop. Sowing time of cucumber beyond or before optimum period causes reduction in yield. The time of sowing determines the flowering time and also has great influence on dry matter accumulation, fruit setting, and average yield (Benzioni *et al*., 1991). So it is important to study the effect of time of sowing for achieving optimum growth and yield of cucumber.

Fertilizer management is one of the important factors that contribute in the production and yield of any crop. Deficiency of soil nutrient is now considered as one of the major constraints to successful upland crop production in Bangladesh (Islam and Noor, 1982). The cultivation of vegetable crops requires proper supply of plant nutrient. Cucumber responds greatly to major essential elements like N, P and K for its growth and yield (Thompson and Kelly, 1988). Phosphorus is one of the important essential macro elements for the normal growth and development of plant. The phosphorus requirements vary depending upon the nutrient content of the soil (Bose and Som, 1986). Phosphorus shortage restricts the plant growth and influence maturity of plant (Hossain, 1990). Cucumber is a short duration crop (few months to finish) for that easily soluble fertilizer like as phosphorus should be applied in the field. On the other hand nutrient availability in a soil depends on some factors, among them balance fertilizer is the important one. The optimum proportion of fertilizer enhances the growth and development of a crop as well as ensures the availability of other essential nutrients for the plant. Again secondary mechanism of interference was the absorption of phosphorus from the soil through luxury consumption, increasing the tissue content without enhancing smooth biomass accumulation (Santos *et al*., 2004). Since, the land is limited in Bangladesh, it is important to increase the per hectare yield of any crop in this country through different possible efforts. An early and rapid vegetative growth of plant is necessary for quality soft and succulent cucumber, which is believed to be influenced by the application of phosphorus fertilizer to the soil.

Information on the definite sowing time and optimum level of phosphorus fertilizer to optimize the cucumber production within the farmer's limited resources is inadequate in Bangladesh. So from the above mentioned constraints for cucumber cultivation in Bangladesh, the present research study was undertaken with the following objectives-

a. To determine the optimum sowing time for maximizing the vegetative growth and yield of cucumber;

b. To find out the optimum dose of phosphorus for better growth and yield of cucumber; and

c. To optimize the better combination of sowing time and phosphorus of cucumber for ensuring better growth and higher yield with maximum economic return.

# CHAPTER II

# REVIEW OF LITERATURE

One of the major reasons of yield reduction of cucumber is not to follow the optimum sowing time or growing period and also unawareness of the farmers in the judicious application of fertilizer especially phosphorous for different agro-climatic condition. So, sowing time and subsequently application of phosphorous fertilizer are the most important factors needed to be considered in cucumber cultivation. A few research works related to growth, yield and development of cucumber have been carried out in our country. But research works related to sowing time as a management practices and phosphorous fertilizer in cucumber are limited. However, some of the important and informative works and research findings related to the sowing time and application of phosphorous fertilizer on cucumber so far been done at home and abroad have been reviewed with other related crops in this chapter under the following headings-

## 2.1 Effect of sowing time

Sanjay Kumar *et al*. (2015) was conducted a research work at the research farm and laboratory of Department of Vegetable Science, CCS Haryana Agricultural University, Hisar on early season cultivation of bottle gourd. For studying the experiment was laid out with five different date of sowing as main plot treatments and three different growing conditions as sub-plot treatments, thus making a total of fifteen treatment combination. From the various parameters recorded percent establishment of seedlings at 30 days of sowing, vine length (cm) at 30, 45, 60 & 75 days after sowing and at final harvest, primary branches per plant, fruit length (cm), fruit diameter (cm) & fruit weight (g) were maximum with 15th December date of sowing ($D_1$) and direct seed sowing under poly-tunnel ($M_2$) growing condition i.e. $D_1M_2$. While, number of days taken to first harvest was minimum with 15th February date of sowing ($D_5$) and direct seed sowing under poly-tunnel ($M_2$) growing condition i.e. $D_5M_2$. So, it was concluded that to get good crop establishment & growth, quality fruit production and to get earliest season yield to capture the high market value in offseason, the crop should be sown on 15th December ($D_1$) with direct seed sowing under poly-tunnel ($M_2$) planting methods i.e. $D_1M_2$.

Oloyede and Adebooye (2013) conducted an experiment with aimed at determining the effects of planting date on the yield and proximate composition of pumpkin fruits. The experiment was a randomized complete block design. In the study was used four planting dates (1- 1st of April; 2- 15th of April; 3- 1st of May; 4- 15th of May). The yields of the crops planted on the 1$^{st}$ and 15th of April were not significantly different but significantly out-yielded (53.56 and 49.93 tons ha-1 respectively) every other crop planted subsequently. The 1st planting date produced significantly highest protein (17.98 g $100g^{-1}$), crude fibre (1.90 g $100g^{-1}$) and ash (3.9 g $100g^{-1}$), compared to other planting dates. Lesser rainfall, moderately higher temperature and higher sunshine hour were observed to be responsible for the results. In conclusion, early planting (April) or planting at the onset of rainfall will bring about optimal yield and food value of pumpkin at the location where this experiment was conducted (rainforest tropical region).

Latifi *et al*. (2012) carried out a field experiment to study the effects of sowing date and plant population on seed yield of *Cucurbita pepo* L. were investigated by with plant population at three levels (0.6, 1.3 and 2.2 plant $m^{-2}$) as the main plot and sowing date at three levels (April 18, 29 and May 9) as the sub-plot. Seed yield per unit area, the number of seeds per fruit, fruits per plant, flowers per plant and auxiliary branches per plant were recorded. The highest seed yield was recorded in plots having 2.2 plant $m^{-2}$ sown on April 18. Thus, present results revealed that suitable plant density cannot improve yield and yield components of pumpkin if sowing date was delayed.

Susila *et al*. (2012) conducted a field experiment at Herbal garden, Rajendranagar, Hyderabad, India to study the influence of different sowing dates and spraying of brassinosteroid (BR) on yield and fruit quality of watermelon. The study consists of four sowing dates (October 4 week, November 2 week, November 4 week and December 2 week) and two levels of and untreated control. Crop sown on December 2 week was significantly superior over remaining other sowing dates and recorded highest yield. Spraying of BR 0.1 ppm at 2 and 4 leaf stage was highly effective in increasing the yield of watermelon. The maximum number of fruits per plant was recorded in December 2 week sowing and sprayed with BR @ 0.1 ppm.

Eifediyi and Samson (2009) was conducted a field experiment during the wet season of 2006 at the Teaching and Research Farm of the Ambrose Alli University, Ekpoma and 460 meters above sea level to evaluate five varieties of cucumber (Marketmore 76, Ashley, Palmetto, Marketer and Beith Alpha) and determine the appropriate time during the wet season for planting. Planting was done in the month of April, May and June. The results of the study revealed significant differences ($P < 0.05$) among the varieties in terms of vine length, number of branches, leaf area, number of fruit, per plant and total fruit weight per hectare. The highest fruit, yield per hectare was obtained in the April planting and the Ashley variety consistently had higher yields than the other varieties.

Harrelson *et al*. (2008)evaluated the yield response of no-till pumpkin to planting date and nitrogen (N) fertilization. Experiments were conducted at the Mountain (MRS), Upper Mountain (UMRS), and the Mountain Horticultural Crops Research Stations (MHCRS) in summer using no-till cultural practices. Three planting dates were established at 2-week intervals and 0, 40, 80, and 120 kg $ha^{-1}$ N treatments were applied at each planting date in a randomized complete block design. The 80 and 120 kg $ha^{-1}$ N fertilization rates produced greater yields and larger fruit size than the 0 and 40 kg $ha^{-1}$ N rates. Pumpkins planted earliest produced the greatest marketable and total yields for all N rates at all three locations. The latest planting date (9 July) and highest N rate yielded more cull fruit compared with marketable pumpkins with the earlier planting date at the Upper Mountain Research Station. This location has a shorter growing season and cooler summer temperatures than the two other locations. Although the third planting date was late for pumpkin planting, higher N rate treatments at that timing produced marketable yields comparable to earlier planting dates at the two warmer summer locations (MRS and MHCRS). In these experiments, the highest rate applied (120 kg $ha^{-1}$ N) maximized pumpkin yield. This observation would indicate that higher yields might be possible with even greater N rates.

Benzioni *et al*. (1991) conducted an experiment to asses growth, flowering, and yields of *Cucumis metuliferus* Mey in several seasons and conditions in the northern Negev, Israel. They reported that plants sown in mid-March set fruit in mid-May and gave a higher yield of export-quality fruits than plants sown in mid-April, which set fruit normally but produced a large proportion of small (<200 g) fruits. Plants sown in June did not flower until October. *C. metuliferus* sown in a greenhouse on three dates in October and November developed very slowly during the cold months and leaves were chlorotic; however, fast growth and development resumed in the spring and high yields were eventually achieved.

Bacha *et al.* (2005) conducted an experiment on the Effect of Phosphorus rate ( 0, 30, 40, 50 or 60 kg/ha as $P_2O_5$) and sowing date(15 May, 30 May, 20 June and 5 July) on the growth and yield of bitter gourd (*Momordica Charantia* cv. Land Race) were studied in Mingora, Pakistan. The increase in the rate of $P_2O_5$ resulted in early germination, flowering and harvesting, but had no effect on growth and yield. The lowest number of days to first picking was obtained with the application of 60 kg, p/ha and sowing on 20 june (51.7). Phosphorus at 0 kg/ha and sowing on 30 May gave the highest number of fruits per plant (40.0)

Singh *et al.* (2002) conducted a field experiment during 1998-99 to determine the suitable sowing date (30 November, 10 December and 20 December) for early production of cucurbitaceous vegetables cucumber, watermelon, longmelon (*Cucumis utilissimus*) and ridge gourd (*Luffa acutangula*) for availability in the beginning of the summer season in Chotanagpur, Bihar, India. The highest yield (159.78 q/ha) was obtained from watermelon sown on 30 November compared to sowing on 10 and 20 December. The lowest yield (89.81 q/ha) was obtained from ridge gourd sown on 20 December.

### 2.2 Effect of phosphorous

Mia *et al*. (2014) reported that growth regulator and NPK fertilization effects are important tools for flower stimulation and yield improvement in cucurbits. This investigation demonstrates the comparative male-female flower induction and fruit yield of small sized bitter gourd treated with NPK fertilizers and plant growth regulators. Namely, two experiments were with NPK fertilization and plant growth regulators-$GA_3$, NAA and Ethophon application on small sized bitter gourd-genotype $BG_5$ at the research field of the Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU). In experiment 1, different doses of NPK fertilizers comprised of 10 treatments and in that of experiment 2, different levels of plant growth regulators indicated 10 treatments. The results indicated that application of different doses of NPK fertilizer and plant growth regulators significantly influenced over the flower initiation and fruit setting. The application of $N_{90}$; $P_{45}$; $K_{60}$ fertilizers along with Ethophon spraying resulted in the better yield of small sized bitter gourd.

Constan-Aguilar *et al*.(2014) carried out an experiment with aim to determine how different phosphite and phosphate rates applied together affect the growth and morphology parameters in cucumber plants as well as to characterize the nutritional and physiological state of phosphorus (P). Different foliar application rates of phosphite were applied to analyze subsequent biomass production, the relative growth rate, morphological parameters, P bioindicators, P forms, and P-use efficiency. The data suggest that the application of phosphite as a P fertilizer at a rate of > =0.5 mM would be an appropriate and effective strategy under suboptimal conditions of phosphate in the growth medium, represented by 0.5 mM in our work, as it improved the growth parameters, number of flowers, leaf area, nutritional state of P, incorporation of P in structural organs, and P-use efficiency by the plant. The results indicate that the validity of the foliar use of phosphite as a P fertilizer in cucumber plants was subject to phosphate availability in the culture medium.

Oloyede *et al.* (2013) carried out an experiment to observed the purpose of evaluating the influence of NPK fertilizer on fruit yield and fruit yield parameters of pumpkin at the Teaching and Research Farm, Obafemi Awolowo University, Nigeria. NPK 15:15:15 compound fertilizer was applied as ring/side dressing at the rates of (0, 50, 100, 150, 200, 250 kg/ha). The fresh fruit yield was 21 t/ha and 7 t//ha for early and late seasons, respectively. Fruits number/ha significantly increased from 7000 in control to over 10,000/ha at fertilizer rates between 100 and 250 kg NPK/ha. Fruit weight also increased from 9 to 17 t/ha between control and higher fertilizer rates. Seed yield from the application at 100 to 250 kg/ha were similar and significantly better than control and 50 kg/ha NPK application. Mean seed yield between 100-250 kg NPK was 460 kg/ha. The value was 37% higher than at 50 kg NPK and 57% higher than in control. Increasing fertilizer above 100 kg NPK/ha did not significantly increase the fruit yield nor the seed yield.

Liang and Shang (2013) conducted a greenhouse experiment to study the effects of excess and deficient phosphorus on growth and development of cucumber (*Cucumis sativus* L. 'Zhongnong 203') and tomato plug seedling. Different phosphorus levels (3.88, 31, 288 mg/L) were used for the test. The plant height, stem diameter, root dry weight, shoot dry weight, chlorophyll content and mineral content were investigated. The results showed that the height of seedling decreased 12.7% and 17.3% for cucumber, after 13 days of excess or deficient phosphorus treatment. The root/shoot ratio of tomato and cucumber were increased when excess or deficient phosphorus were supplied. Fifteen days after phosphorus deficiency, chlorophyll content of cucumber plug seedling increased by 14.4%. Fifteen days after excess supply of phosphorus, cucumber plug seedling chlorophyll content increased by 21.6%. In addition, phosphorus deficiency can promote the uptake of potassium and magnesium; excess phosphorus has the opposite effects. Our results show that phosphorus can regulate the growth and development of tomato and cucumber plug seedling.

Sabo *et al*. (2013)conducted an experiment at Kaltungo Local Government Area demonstration farm in Gombe state during the 2011 rainy season, to evaluate the effect of NPK fertilizer and spacing levels on growth and yield of Watermelon (*Citrillus lanatus* L). Three different spacings and four levels of NPK fertilizer (0, 100, 150 and 200 kg/ha) were used. All the treatments were set in a Randomized Complete Block Design (RCBD) with three replications. Plant height, number of leaves, number of male and female flowers at 50% flowering, number of fruits per plant and weight of fruits at harvest were observed. The result of the experiment shows a significant difference in plant height and number of leaves. Similarly, the result shows significant difference in number of flowers, number of fruits, weight of fruits (2.96 kg) and yield per hectare (63.6 t) as compared to the control. The interaction between the treatments indicate that 150 kg/ha of NPK and a spacing of 1 × 1.5 m gave the highest number of fruit and yield per hectare. Therefore, based on the result of this findings, it is hereby recommended that the use of 150 kg NPK/ha at a spacing of 1 × 1.5 m should be adopted by the farmers for profitable watermelon production in the study area.

Oloyede (2012) carried out an experiment to provide information on the influence of NPK fertilizer on the agronomic performance and antioxidant concentration of pumpkin leafy vegetable for the purpose of enhancing its cultivation and popularizing its utilization. Compound fertilizer, NPK /15:15:15/ was used and added as ring dressing in four levels; 0, 90, 180, 270 kg/ha. Data were recorded for several growth and leaf yield parameters. The significant highest estimates for vine length, leaves number, stem diameter, number of branches and number of tendrils per plant and total young leaf yield were resulted from plants treated with 180 and 270 kg/ha. It is concluded that 180 kg/ha of NPK fertilizer is required for optimal yield and antioxidant composition of pumpkin leafy vegetable.

Oloyede *et al*. (2011)carried out an investigation to find out the proximate composition and antioxidant profile of pumpkin seeds obtained from different levels of NPK 15:15:15 compound fertilizer application at the Obafemi Awolowo University, Nigeria. Pumpkin seeds were grown following fertilizer rates were applied: 0, 50, 100, 150, 200, and 250 kg/ha. The highest concentrations of the proximate and antioxidants were found from the seeds of control and those treated with lower NPK rates. The mean protein, ash, crude fibre, and carbohydrate values of pumpkin seeds at zero to 100 kg NPK/ha were 27%, 1.56%, 0.56%, and 11.7% , respectively.

Eifediyi and Samson (2010a) conducted field experiments for three years during the rainy seasons of 2006 to 2008 at the Teaching and Research Farm of Ambrose Alli University, Ekpoma. Compound fertilizer (N.P.K.20:10:10) was applied at 0, 100, 200, 300 and 400 kg/ha to two varieties (Ashley and Palmetto) using a 2 × 5 factorial scheme replicated three times. Data were collected on vegetative traits, yield and yield components of cucumber and statistically analyzed. Results revealed significant differences ($P<0.05$) among the varieties in terms of vine length, number of branches and leaf area, The growth and yield attributes of cucumber including the vine length, number of leaves per plant, number of branches, leaf area, number of fruits per plant, fruit length, fruit girth, fruit weight per plant, fruit number per plant and total yield per hectare increased significantly ($P < 0.05$) with increase in inorganic fertilizer application up to the highest level.

Eifediyi and Samson (2010b) evaluated the growth and yield of Ashley variety of cucumber in response to the effect of farmyard manure and inorganic fertilizer NPK 20:10:10 was evaluated by at the Teaching and Research Farm of the Ambrose Alli University, Ekpoma, Nigeria. The farmyard manure was applied at the rates of 0, 5 and 10 t/ha and the inorganic fertilizer at 0, 100, 200, 300 and 400 kg/ha. The combined rates of farmyard manure at 10 t/ha × 400 kg/ha fertilizer increased the growth characters such as the vine length and the number of leaves. At 8 weeks after planting (WAP), the application of 10 t/ha of farmyard manure × 400 kg/ha of fertilizer gave the longest vine length of 276.93 cm and the highest number of leaves. The fruit length, fruit girth, fruit weight per plant and fruit weight per hectare were significantly influenced by the application of farmyard manure × fertilizer. The highest weight of 2.43 kg per plant and yield per hectare of 43,259 kg/ha were obtained with 10 t/ha farmyard manure and 400 kg/ha of fertilizer which were 166.42% higher than the control.

Jilani *et al.* (2009) found that effect of different levels of P on the growth and yield of hybrid cucumber the best performance in almost all the parameters studied, as it took least days to flowering (39.33), fruit setting (11.55), maturity (7.88), maximum fruit per plant (35.5), maximum fruit length (18.36 cm), maximum fruit weight (136.03 g) and yield per hectare (60.02) tons.

Al-Jaloud *et al*. (2006) conducted a green house experiment to determine the effect of different levels of N, P, and K applied through irrigation water on cucumber yield. Three experiments were set up to study each nutrient element separately. In each experiment one nutrient was applied in 4 different levels while the other 2 were held at high levels so that they would not be limiting plant growth and yield. For the N experiment, the rates were 125, 150, 175 and 200 ppm N with basic fertigation of 70 ppm $P_2O_5$ and 200 ppm $K_2O$. For the P experiment, the rates were 40, 50, 60 and 70 ppm $P_2O_5$ with 200 ppm N and 200 ppm $K_2O$. For the K experiment, the rates were 140, 160, 180 and 200 ppm $K_2O$ with 200 ppm N and 70 ppm $P_2O_5$. The design for each experiment was a complete randomized design with four replicates. In the N experiment, the highest yield (49.5 t/ha) was obtained at 150 ppm N with 70 ppm $P_2O_5$ and 200 ppm $K_2O$. In the P experiment, 60 ppm $P_2O_5$ with 200 ppm N and 200 ppm $K_2O$ gave the best yield (42.0 t/ha). In the K experiment, the highest yield (33.2 t/ha) was obtained when $K_2O$ was applied at 200 ppm with 200 ppm N and 70 ppm $P_2O_5$. Potassium levels increased yield linearly indicating higher K levels may still increase yield, whereas N and P showed a typical nutrient response curve and interaction.

Umamaheswarappa *et al*. (2005) carried out an experiment to find out the effect of varying levels of nitrogen, phosphorus and potassium on flowering, fruit set and sex ratio of cucumber and reported that Phosphorus levels also showed positive effect on number of male and female flowers per vine, fruit set per cent and sex ratio.

Abdrabbo *et al*. (2005) were grown cucumber (*Cucumis sativus* L., cv. Delta Star $F_1$) plants in 34 litre white plastic containers filled with sand at different levels of nitrogen, phosphorus and potassium under a typical plastic-covered greenhouse. The experiment was carried out in the Protected Cultivation Experimental Site at Dokki, Giza during two successive seasons of 2002/2003 and 2003/2004. Twenty seven combinations of nitrogen; phosphorus [15 ($P_1$), 35 ($P_2$) and 70 ($P_3$) mg/l] and potassium [120 ($K_1$), 240 ($K_2$) and 360 ($K_3$) mg/l] were applied. The results showed that plant height, leaves area, stem diameter and chlorophyll content were increased with increasing nitrogen concentration in the nutrient solution accompanied with ($P_2K_2$), ($P_2K_3$), ($P_3K_2$) or ($P_3K_3$). The lowest early and total yields were obtained in $N_1$ accompanied with different combinations of P and K. Meanwhile, $N_2$ gave the highest early yield under different combinations with P and K; $N_3$ gave significantly the highest total yield followed by $N_2$ accompanied with ($P_2K_2$), ($P_2K_3$), ($P_3K_2$) and ($P_3K_3$) in comparison with both $N_2$ and $N_3$ treatments with either $P_1$, $K_1$ or both of them. Plant analysis revealed that low concentrations of N, P or K in the $4^{th}$ leaf were proportional to low vegetative growth parameters and total yields.

Sahar *et al*. (2005) investigated the effect of seedling age and different levels of phosphorus fertilizer on cucumber performance in the experimental area, Department of Horticulture, University of Arid Agriculture, Rawalpindi, Pakistan. Cucumber plants were transplanted at three different seedling ages i.e. 21 days, 28 days and 35 days after germination along with phosphorus application of 45, 90 and 135 kg $ha^{-1}$. Results indicated that highest survival percentage (100.00%), position of first female reproductive node (3.00), female to male flower percentage (48.10%), number of fruits per plant (14.33), fruit yield per plant (1.72

kg) and fruit yield per hectare (67,270 kg) were obtained with 28 days seedling age + 90 kg $P_2O_5$/ha. The maximum number of leaves per plant (35.00) and individual fruit weight (138.67 g) were recorded with 21 days seedling age + 90 kg $P_2O_5$ /ha.

# CHAPTER III

# MATERIALS AND METHODS

The experiment was conducted to find out the influence of sowing time and phosphorus on growth and yield performance of cucumber (*Cucumis sativus* L.). This chapter includes materials and methods i.e. experimental period, description of experimental site, climate condition and soil of the experimental plot, materials used, design of the experiment, data collection procedure and procedure of data analysis that were used in conducting the experiment are presented below under the following headings:

## 3.1 Description of the experimental site

### 3.1.1 Experimental period

The experiment was conducted during the period from March to July, 2013.

### 3.1.2 Description of experimental site

The experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh. The experimental site is situated between $23^0 74^/$N latitude and $90^0 35^/$E longitude and at an elevation of 8.4 m from sea level (Anon., 1989).

### 3.1.3 Climatic condition

The climate of experimental site is subtropical, characterized by three distinct seasons, the monsoon from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October.The monthly average temperature, humidity and rainfall during the crop growing period were collected from Weather Yard, Bangladesh Meteorological Department, and presented in Appendix I. During the experimental period the maximum temperature ($35.4^0$C), minimum temperature ($22.5^0$C), highest relative humidity (80%) and highest rainfall (227 mm) was recorded in the month of June 2014, whereas the lowest relative humidity (67%) and lowest rainfall (78 mm) was recorded in the month of April, 2013.

### 3.1.4 Characteristics of soil

The soil of the experimental field belongs to the Tejgaon series under the Agroecological Zone, Madhupur Tract (AEZ- 28) and the general soil type is Shallow Red Brown Terrace soil. A composite sample was made by collecting soil from several spots of the field at a depth of 0-15 cm before the initiation of the experiment. The collected soil was air-dried, grind and passed through 2 mm sieve and analyzed at Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka for some important physical and chemical properties. The soil was having a texture of silty clay with pH and organic matter 6.2 and 1.16, respectively. The results showed that the soil composed of 28% sand, 42% silt and 30% clay, which have been presented in Appendix II.

## 3.2 Experimental details

### 3.2.1 Treatments of the experiment

The experiment comprised of two factors

Factor A: Sowing time (4 levels)

i) $T_1$- 20 March

ii) $T_2$ - 5 April

iii) $T_3$- 20 April

iv) $T_4$ -5 May

Factors B: Phosphorus (4 levels)

i) $P_0$ - 0 kg $P_2O_5$/ha (control)

ii) $P_1$ - 30 kg $P_2O_5$/ha

iii) $P_2$ - 60 kg $P_2O_5$/ha

iv) $P_3$- 90 kg $P_2O_5$/ha

There were in total 16 (4×4) treatment combinations such as $T_1P_0$, $T_1P_1$, $T_1P_2$, $T_1P_3$, $T_2P_0$, $T_2P_1$, $T_2P_2$, $T_2P_3$, $T_3P_0$, $T_3P_1$, $T_3P_2$, $T_3P_3$, $T_4P_0$, $T_4P_1$, $T_4P_2$, $T_4P_3$.

### 3.2.2 Planting material

Seeds of cucumber cultivar (Alavy) was used as the test crops and the seeds were collected from Lal Teer Seed Company, Siddique Bazar, Gulistan, Dhaka. It was imported by Lal Teer Seed Company Bangladesh.

### 3.2.3 Land preparation

The land was first opened at 7th March 2013 with the power tiller. Ploughed soil was brought into desirable fine tilth by ploughing and cross-ploughing, harrowing and laddering. The stubble and weeds were removed. The first ploughing and the final land preparation were done on $15^{th}$ and $20^{th}$ March, 2013, respectively. Experimental land was divided into unit plots following the experimental design.

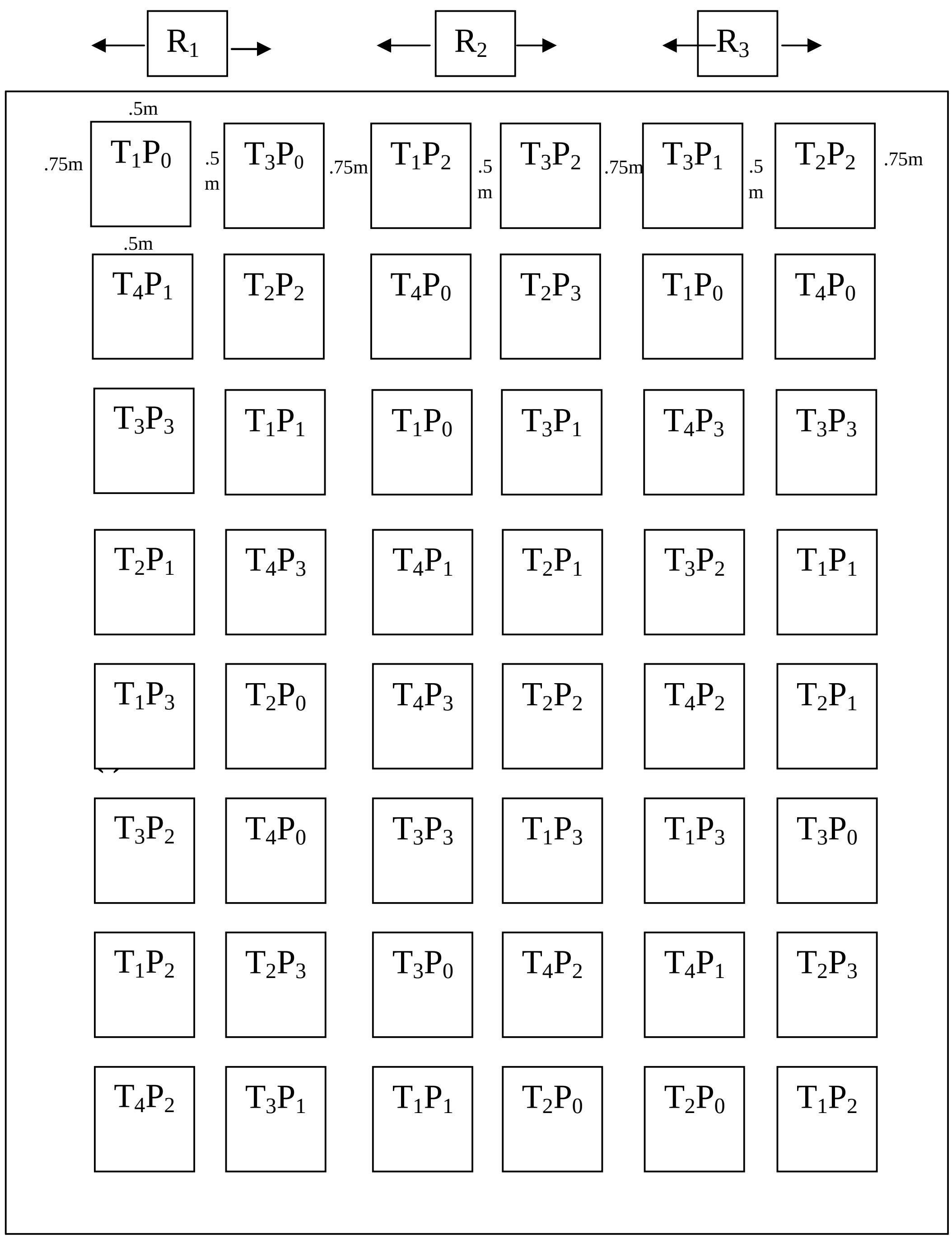
### 3.2.4 Fertilizer application

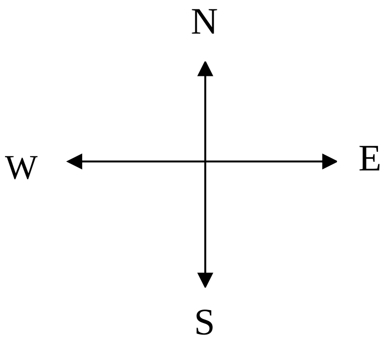
Urea, triple super phosphate (TSP), muriate of potash (MP), gypsum, zinc sulphate, boric acid and molybdenum were used as a source of nitrogen, phosphorous, potassium, gypsum, sulphur, zinc, boron and molybdenum, respectively. Urea, muriate of potash (MP), gypsum, zinc sulphate, boric acid, and molybdenum were applied at the rate of 150, 100, 40, 10, 2.0 and 1.0 kg/ha, respectively following the BARI recommendation but phosphorous were applied as per treatment. All of the fertilizers except urea and ½ MP (50 kg/ha) were applied during final land preparation. Urea and ½ MP (50 kg/ha) was applied in two equal installments at 25 and 45 days after seed sowing.

### 3.2.5 Experimental design and layout

The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. An area of 28.5 m × 15.3 m was divided into three blocks. The size of the each unit plot was 3 m × 1.8 m. There were 6 pits in each unit plot. The space between two blocks and two plots were 75 cm and 50 cm, respectively. The layout of the experiment is shown in Figure 1.

## DESIGN AND LAYOUT OF THE EXPERIMENT:




**Legend**
Plot Size = 3 m × 1.8 m
Plant spacing = 60×60 cm
Block-Block dist. = 75 cm
Plot- Plot Dist= 50 cm
Plot length= 28.5 m
Plot Breadth = 15.3 m
Area: = 436.05 $m^2$
Total number of plot= 48

Here,

| **i) Factor A:** Sowing time | **Factors B:** Phosphorus |
|---|---|
| $T_1$ = 20 March | $P_1$ = 0 kg $P_2O_5$/ha |
| $T_2$ = 5 April | $P_2$ =30 kg $P_2O_5$/ha |
| $T_3$ = 20 April | $P_3$ = 60 kg $P_2O_5$ /ha |
| $T_4$ = 5 May | $P_4$ = 90 kg $P_2O_5$ /ha |

Fig. 1: Field layout of the experimental plot

### 3.3 Growing of crops

#### 3.3.1 Sowing of seeds in the field

Cucumber seeds were sown on 20 March to 5 May, 2013 at 15 days interval as per sowing time. Seeds were sown in pit (30 cm×30 cm) having a depth of 2-3 cm with maintaining distance at 60 cm between the rows and 60 cm between the plant in a row, respectively.

#### 3.3.2 Intercultural operations

##### 3.3.2.1 Thinning

Seeds germination was seen at 4 DAS (Days After Sowing). Thinning was done two times; first thinning was done at 15 DAS and second was done at 30 DAS to maintain optimum plant population in each plot.

##### 3.3.2.2 Irrigation and weeding

Irrigation was provided at 10, 20, 30 and 40 DAS for optimizing the vegetative growth of cucumber for the all experimental plots equally. Weeding was done in the crop field as per necessary.

##### 3.3.2.3 Earthing up

Earthing up was done at 25 and 45 days after sowing  followed by the application of fertilizers on both sides of rows by taking the soil from the space between the rows by a small spade.

##### 3.3.2.4 Stacking

When the plants were well established, staking was given to each plant to keep them straight.

##### 3.3.2.5 Protection against insect and pest

At early stage of growth few worms (*Agrotis ipsilon*) infested the young plants and at later stage of growth pod borer (*Maruca testulalis*) attacked the plant. Ripcord 10 EC was sprayed with 1 litre water for two times at 15 days interval after seedlings germination to control the insects.

### 3.4 Harvesting

The plant bears flowers within 27-33 days after sowing of seeds and the fruit goes to edible stage 10-15 days after fruit setting. The fruit should be harvested before hardening of seeds in the fruit. The tender fruits are harvested, which is helpful for increasing the number of flower. Picking of fruit at the right edible maturity stage but it dependent upon individual kinds and varieties. In salad as slicing cucumber, dark green color  not turn into brownish-yellow or russeting and white spine color will also be useful indication for edible maturity. Optimum length of the fruit will be around 12-15 cm at edible maturity stage, depending upon the cultivar in case of slicing cucumber.

### 3.5 Crop sampling and data collection

Three plants from each treatment were randomly selected and marked with sample card. Plant height, number of leaves per plant and number of branches per plant were recorded from selected plants at an interval of 10 days started from 20 DAS to 60 DAS.

### 3.6 Procedure of data collection

#### 3.6.1 Plant height

The plant height was measured at 20, 30, 40, 50 and 60 DAS and with a meter scale from the ground level to the top of the plants and the mean height was expressed in cm.

#### 3.6.2 Number of leaves per plant

The total number of leaves per plant was counted from each selected plant. Data were recorded as the average of 3 plants selected at random of each plot at 10 days interval starting from 20 days after sowing (DAS) and continued upto 60 DAS.

### 3.6.3 Number of branches per plant

The total number of branches per plant was counted from each selected plant. Data were recorded as the average of 3 plants selected at random of each plot at 10 days interval starting from 20 days after sowing (DAS) and continued upto 60 DAS. Only side branches that arisen from main vine were counted.

### 3.6.4 Days required for sowing to 1$^{st}$ flowering

Difference between the dates of sowing to the date of 1$^{st}$ flowering in a plot was counted as days required to 1$^{st}$ flowering. Days required from sowing to 1$^{st}$ flowering were counted when plants of a plot produced in maximum 1$^{st}$ flower.

### 3.6.5 Days required for sowing to 1$^{st}$ harvest

Difference between the dates of sowing to the date of 1$^{st}$ fruit harvest in a plot was counted as days required to 1$^{st}$ harvest. Days required from sowing to 1$^{st}$harvest were counted when fruits were harvested as 1$^{st}$ harvest.

### 3.6.6 Number of male flowers per plant

The number of male flowers per plant was counted from each plot after flowering and recorded per plant basis. Male flower selected based on the absence of initial oval shape fruit like structure at the base of flower.

### 3.6.7 Number of female flowers per plant

The number of female flowers per plant was counted from each plot after flowering and recorded per plant basis. Female flower selected based on the presence of initial oval shape fruit like structure at the base of flower.

### 3.6.8 Ratio of male and female flower

The ratio of male and female flower was calculated by dividing male flowers to female flowers recorded from at least 3 selected plants.

### 3.6.9 Number of fruits per plant

The number of fruits per plant was counted after harvesting of fruits and recorded per plant basis.

### 3.6.10 Length of fruit

The length of individual fruit was measured in one side to another side of fruit from five selected fruits with a meter scale and average of individual fruit length recorded and expressed in centimeter (cm).

### 3.6.11 Diameter of fruit

The diameter of individual fruit was measured in several directions with meter scale and the average of all directions was finally recorded and expressed in centimeter (cm).

### 3.6.12 Fruit weight

The weight of individual fruit was recorded in gram (g) by a digital weighting machine from all fruits of selected three plants and converted individually.

### 3.6.13 Fruit yield/plant

Fruit yield per plant was recorded in kilogram (kg) by multiplying individual fruit weight and number of fruits/plant.

### 3.6.14 Fruit yield/plot

Fruit yield of cucumber per plot was recorded as the whole fruit per plot and was expressed in kilogram.

### 3.7.15 Fruit yield/hectare

Fruit yield per hectare of cucumber was calculated by converting the weight of plot yield into hectare and was expressed in ton.

## 3.8 Statistical analysis

The data obtained for different characters on effect of sowing time and phosphorous fertilizer on the growth and yield contributing characters of cucumber were statistically analyzed to find out the significance of the difference. The mean values of all the recorded characters were evaluated and analysis of variance was performed by the ‘F’ test. The significance of the difference among the treatment combinations of means was estimated by Duncan’s Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

### 3.9 Economic analysis

The cost of production was analyzed in order to find out the most economic treatment of sowing time and level of phosphorous. All input costs were considered in computing the cost of production. The market price of cucumber was considered for estimating the return. Analyses were done according to the procedure of Alam *et al*. (1989). The benefit cost ratio (BCR) was calculated as follows:

$$\text{Benefit cost ratio} = \frac{\text{Gross return per hectare (Tk.)}}{\text{Total cost of production per hectare (Tk.)}}$$

# CHAPTER IV

# RESULTS AND DISCUSSION

The experiment was carried out to find out the influence of sowing time and phosphorus on the growth and yield performance of cucumber (*Cucumis sativus* L). The analysis of variance (ANOVA) of the data on different growth and yield parameter are presented in Appendix III-VII. The results have been presented and discussed, and possible interpretations were given under the following headings:

## 4.1 Plant height

Plant height of cucumber showed statistically significant differences due to different sowing time at 20, 30, 40, 50 and 60 DAS (Appendix III). At 60 DAS, the tallest plant (203.99 cm) was found from $T_2$ (sowing on 5 April) treatment, which was statistically similar (202.08 cm) to $T_1$ (sowing on 20 March) treatment. Whereas the shortest plant (194.83 cm) was recorded from $T_4$ (sowing on 5 May) treatment which was statistically similar (195.50 cm) to $T_3$ (sowing on 20 April) treatment at the same DAS (Fig. 2). Data revealed that the sowing at 5 April produced the longest plant followed by 20 April sowing and delayed planting produced the shortest plant. Cucumber grown in Bangladesh needs to suitable temperature for its optimum growth and development and the plant growth of cucumber are greatly influenced by growing environment which was governed by time of sowing. The optimum sowing time ensures plant to grow properly through efficient utilization of moisture, temperature, light etc. Benzioni *et al*. (1991) also reported similar findings from their earlier experiment.

Phosphorus level varied significantly in terms of plant height of cucumber at 20, 30, 40, 50 and 60 DAS (Appendix III). At 60 DAS, the tallest plant (208.24 cm) was found from $P_2$ (60 kg $P_2O_5$/ha) treatment which was statistically similar (206.43 cm) to $P_3$ (90 kg $P_2O_5$/ha) treatment and followed (197.69 cm) by $P_1$ (30 kg $P_2O_5$/ha) treatment, while the shortest plant (189.54 cm) was found from $P_0$ (0 kg $P_2O_5$/ ha i.e. control condition) for the same DAS (Fig. 3). Sabo *et al.* (2013) also found the similar findings in their experiment.

Combined effect of different sowing time and levels of phosphorus showed statistically significant variation in terms of plant height of cucumber 20, 30, 40, 50 and 60 DAS (Appendix III). At 60 DAS, the tallest plant (214.98 cm) was observed in $T_2P_2$ (sowing on 5 April and 60 kg $P_2O_5$/ha) treatment combination and the shortest plant (183.78 cm) was recorded from $T_4P_0$ (sowing on 5 May and 0 kg $P_2O_5$/ha) treatment combination at the same DAS (Table 1).

**4.2 Number of leaves per plant**

Statistically significant variation was recorded due to different sowing time in terms of number of leaves per plant of cucumber at 20, 30, 40, 50 and 60 DAS (Appendix IV). At 60 DAS, the maximum number of leaves per plant (64.28) was found from $T_2$ treatment which was statistically similar (63.89) to $T_1$ treatment, Whereas the minimum number of leaves per plant (59.39) was recorded from $T_4$ treatment which was statistically similar ( 62.19 ) to $T_3$ treatment at the same DAS (Fig. 4). Benzioni *et al.* (1991) also reported similar findings from their earlier experiment which showed that early planting increased number of leaves per plant.

**Table 1. Combined effect of sowing time and phosphorus on plant height at different days after sowing of cucumber**

| Treatment | Plant height (cm) at | | | | |
|---|---|---|---|---|---|
| | **20 DAS** | **30 DAS** | **40 DAS** | **50 DAS** | **60 DAS** |
| $T_1P_0$ | 16.06 cd | 70.11 b-d | 136.96 c | 179.58 bc | 197.90 b-e |
| $T_1P_1$ | 16.42 cd | 69.29 b-d | 145.32 a-c | 187.87 a-c | 199.82 b-d |
| $T_1P_2$ | 18.51 a-c | 70.90 a-d | 147.25 a-c | 190.41 a-c | 209.84 ab |
| $T_1P_3$ | 17.20 b-d | 69.86 b-d | 146.40 a-c | 188.70 a-c | 200.76 a-d |
| $T_2P_0$ | 12.61 e | 60.76 ef | 123.17 d | 163.10 d | 184.45 e |
| $T_2P_1$ | 17.17 b-d | 72.04 a-d | 148.17 a-c | 189.12 a-c | 205.26 a-c |
| $T_2P_2$ | 20.33 a | 77.77 a | 156.82 a | 201.49 a | 214.98 a |
| $T_2P_3$ | 19.08 ab | 75.46 ab | 153.07 ab | 195.14 ab | 211.28 ab |
| $T_3P_0$ | 15.36 d | 64.64 d-f | 142.65 bc | 177.90 b-d | 192.04 c-e |
| $T_3P_1$ | 15.50 d | 67.89 cd | 139.67 c | 176.89 cd | 196.83 b-e |
| $T_3P_2$ | 17.87 a-d | 69.99 b-d | 146.32 a-c | 189.04 a-c | 205.05 a-c |
| $T_3P_3$ | 17.90 a-d | 73.59 a-c | 146.59 a-c | 186.48 a-c | 200.07 ab |
| $T_4P_0$ | 12.24 e | 60.11 f | 122.00 d | 162.91 d | 183.78 e |
| $T_4P_1$ | 15.98 cd | 67.24 c-e | 137.40 c | 179.08 b-d | 188.86 de |
| $T_4P_2$ | 17.35 b-d | 70.21 b-d | 145.98 a-c | 184.80 a-c | 203.08 a-d |
| $T_4P_3$ | 16.82 b-d | 68.88 b-d | 142.70 bc | 180.87 bc | 203.61 a-c |
| $LSD_{(0.05)}$ | 2.277 | 6.418 | 11.25 | 14.85 | 12.78 |
| CV(%) | 8.20 | 5.55 | 4.73 | 4.61 | 3.33 |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

Here,

$T_1$: 20 March — $P_0$: 0 kg $P_2O_5$/ha

$T_2$: 5 April — $P_1$: 30 kg $P_2O_5$/ha

$T_3$: 20 April — $P_2$: 60 kg $P_2O_5$/ha

$T_4$: 5 May — $P_3$: 90 kg $P_2O_5$/ha

Number of leaves per plant of cucumber varied significantly in terms of levels of phosphorus at 20, 30, 40, 50 and 60 DAS (Appendix IV). At 60 DAS, the maximum number of leaves per plant (66.14) was found from $P_2$ treatment which was statistically similar (7.33) to $P_3$ treatment while the minimum number of leaves per plant (56.69) was found from $P_0$ treatment for the same DAS (Fig. 5).Sabo *et al*. (2013) also reported the similar findings in their experiment.

Combined effect of different sowing time and levels of phosphorus showed statistically significant variation in terms of number of leaves per plant of cucumber 20, 30, 40, 50 and 60 DAS (Appendix IV). At 60 DAS, the maximum number of leaves per plant (70.56) was observed from $T_2P_2$ treatment combination and the minimum number of leaves per plant (52.33) was recorded from $T_4P_0$ treatment combination at the same DAS (Table 2).

**4.3 Number of branches per plant**

Number of branches per plant of cucumber showed statistically significant differences due to different sowing time at 20, 30, 40, 50 and 60 DAS (Appendix V). At 60 DAS, the maximum number of branches per plant (11.14) was found from $T_2$ treatment, which was statistically similar (11.08) to $T_1$ treatment, whereas the minimum number of branches per plant (9.83) was recorded from $T_4$ treatment which was statistically similar (10.67) to $T_3$ treatment at the same DAS (Fig. 6). Benzioni *et al*. (1991) also reported similar findings from their earlier experiment.

Number of branches per plant of cucumber varied significantly in terms of Phosphorus level at 20, 30, 40, 50 and 60 DAS (Appendix V). At 60 DAS, the maximum number of branches per plant (11.22) was found from $P_2$ treatment which was statistically similar (10.94) to $P_3$ treatment and followed (10.78) by $P_1$ treatment, while the minimum number of branches per plant (9.92) was found from $P_0$ treatment for the same DAS (Fig. 7). Singh (1976) also found similar trend of results in his study. Eifediyi and Samson (2010a) also found the similar response of cucumber to phosphorus fertilizer in their field experiment.

Combined effect of different sowing time and levels of phosphorus showed statistically significant variation in terms of number of branches per plant of cucumber 20, 30, 40, 50 and 60 DAS (Appendix V). At 60 DAS, the maximum number of branches per plant (11.67) was observed from $T_2P_2$ treatment combination and the minimum number of branches per plant (9.45) was recorded from $T_4P_0$ treatment combination at the same DAS (Table 3).

## 4.4 Days required to 1$^{st}$ flowering

Days required for 1$^{st}$ flowering of cucumber varied significantly in terms of different sowing time (Appendix VI). The highest days required for sowing to 1$^{st}$ flowering (30.58) was recorded from $T_4$ treatment which was statistically similar (30.42) to $T_3$ treatment whereas the lowest days required for sowing to 1$^{st}$ flowering (28.92) was found from $T_2$ treatment which was statistically similar (29.17) to $T_1$ treatment (Table 4). Early sowing took more time for flower initiation for attaining optimum vegetative growth whereas delay plant produced early flower due to shortest vegetative growth period.

Days required to 1$^{st}$ flowering levels of phosphorus varied significantly in cucumber (Appendix VI). The highest days required for sowing to 1$^{st}$ flowering (31.83) was found from $P_0$ treatment which was statistically similar (30.67) to $P_1$ treatment, while the lowest days (28.17) was found from $P_2$ treatment, which was statistically similar (29.08) to $P_3$ treatment (Table 4).

**Table 2. Combined effect of sowing time and phosphorus on number of leaves per plant at different days after sowing of cucumber**

| Treatment | Number of leaves per plant at | | | | |
|---|---|---|---|---|---|
| | 20 DAS | 30 DAS | 40 DAS | 50 DAS | 60 DAS |
| $T_1P_0$ | 6.78 c | 26.67 cd | 42.22 fg | 54.22 c-e | 61.67 bc |
| $T_1P_1$ | 6.89 c | 28.67 bc | 48.33 b-d | 55.11 b-e | 62.78 bc |
| $T_1P_2$ | 7.11 bc | 29.33 bc | 50.00 a-c | 59.67 a-c | 64.00 a-c |
| $T_1P_3$ | 7.45 a-c | 29.33 bc | 50.55 a-c | 55.56 b-e | 67.11 a-c |
| $T_2P_0$ | 5.67 d | 22.78 ef | 39.67 g | 47.56 fg | 52.55 d |
| $T_2P_1$ | 7.44 a-c | 31.00 ab | 48.44 b-d | 56.78 a-d | 65.78 a-c |
| $T_2P_2$ | 8.11 a | 32.67 a | 52.78 a | 61.89 a | 70.56 a |
| $T_2P_3$ | 7.89 ab | 31.78 ab | 51.44 ab | 60.67 ab | 68.22 ab |
| $T_3P_0$ | 6.67 c | 25.11 de | 44.00 ef | 50.89 d-g | 60.22 c |
| $T_3P_1$ | 7.00 bc | 28.67 bc | 45.45 d-f | 53.00 d-f | 62.89 bc |
| $T_3P_2$ | 7.33 a-c | 30.00 ab | 49.89 a-c | 56.78 a-d | 65.78 a-c |
| $T_3P_3$ | 7.11 bc | 29.22 bc | 47.89 b-d | 59.11 a-c | 63.89 a-c |
| $T_4P_0$ | 5.44 d | 22.00 f | 39.00 g | 46.11 g | 52.33 d |
| $T_4P_1$ | 6.78 c | 29.00 bc | 47.11 c-e | 50.56 e-g | 60.33 c |
| $T_4P_2$ | 7.33 a-c | 29.67 a-c | 48.00 b-d | 54.00 c-e | 64.22 a-c |
| $T_4P_3$ | 6.89 c | 28.67 bc | 46.78 c-e | 51.22 d-g | 60.67 c |
| $LSD_{(0.05)}$ | 0.839 | 2.840 | 3.314 | 5.161 | 5.988 |
| CV (%) | 7.19 | 5.99 | 4.23 | 5.67 | 5.73 |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

Here,

$T_1$: 20 March
$T_2$: 5 April
$T_3$: 20 April
$T_4$: 5 May

$P_0$: 0 kg $P_2O_5$/ha
$P_1$: 30 kg $P_2O_5$/ha
$P_2$: 60 kg $P_2O_5$/ha
$P_3$: 90 kg $P_2O_5$/ha

Combined effect of different sowing time and levels of phosphorus showed statistically significant variation in terms of days required for sowing to 1st flowering of cucumber (Appendix VI). The highest days required for sowing to 1st flowering (33.00) was observed from $T_4P_0$ treatment combination which was statistically similar to $T_1P_0$, $T_1P_1$, $T_2P_3$, $T_3P_0$, $T_3P_1$ and $T_4P_2$ treatment combination and the lowest days required for sowing to 1st flowering (27.00) was recorded from $T_2P_2$ treatment combination which was statistically similar to $T_1P_2$, $T_2P_0$, $T_2P_1$, $T_3P_2$, $T_3P_2$, $T_4P_2$, $T_4P_3$ treatment combination (Table 5).

### 4.5 Days required to 1st harvest

Statistically significant variation was recorded in terms of days required to 1st harvest of cucumber due to different sowing time (Appendix VI). The highest days required for sowing to 1st harvest (44.08) was recorded from $T_4$ treatment which was statistically similar (43.92) to $T_3$ treatment, whereas the lowest days required for sowing to 1st harvest (41.83) was found from $T_2$ treatment which was statistically similar (42.25) to $T_1$ treatment (Table 4).

Levels of phosphorus varied significantly in terms of days required for sowing to 1st harvest of cucumber (Appendix VI). The highest days required for sowing to 1st harvest (44.50) was found from $P_0$ treatment which was statistically similar (44.33) to $P_1$ treatment, while the lowest days required for sowing to 1st harvest (41.42) was found from $P_2$ treatment which was statistically similar (42.58) to $P_3$ treatment (Table 4).

Different sowing time and levels of phosphorus combined effect showed statistically significant variation in terms of days required for sowing to 1st harvest (Appendix VI). The highest days required for sowing to 1st harvest (45.67) was observed from $T_4P_0$ treatment combination which was statistically identical to $T_3P_0$, $T_3P_1$, $T_1P_2$ treatment combination and similar to $T_1P_0$, $T_1P_1$, $T_1P_2$, $T_1P_3$, $T_2P_0$, $T_2P_1$, $T_2P_3$, $T_4P_1$, $T_4P_2$ and $T_4P_3$ and the lowest days required for sowing to 1st harvest (39.33) was recorded from $T_2P_2$ treatment combination.

**Table 3. Combined effect of sowing time and phosphorus on number of Branches per plant at different days after sowing of cucumber**

| Treatment | Number of branches per plant at | | | | |
|---|---|---|---|---|---|
| | 20 DAS | 30 DAS | 40 DAS | 50 DAS | 60 DAS |
| $T_1P_0$ | 1.33 cd | 4.11 b | 4.78 d | 6.78 ef | 10.45 b-d |
| $T_1P_1$ | 1.33 cd | 4.11 b | 5.78 a-c | 7.44 b-e | 10.89 a-c |
| $T_1P_2$ | 1.56 a-c | 4.22 ab | 6.00 ab | 8.00 a-c | 11.67 a |
| $T_1P_3$ | 1.56 a-c | 4.56 ab | 5.78 a-c | 8.11 ab | 11.33 a |
| $T_2P_0$ | 1.22 de | 3.22 c | 4.44 d | 6.22 fg | 10.00 de |
| $T_2P_1$ | 1.33 cd | 4.67 ab | 5.89 a-c | 7.89 a-d | 11.33 a |
| $T_2P_2$ | 1.78 a | 4.89 a | 6.33 a | 8.22 a | 11.67 a |
| $T_2P_3$ | 1.67 ab | 4.56 ab | 6.22 a | 8.00 a-c | 11.56 a |
| $T_3P_0$ | 1.33 cd | 4.00 b | 5.33 c | 7.33 c-e | 9.78 de |
| $T_3P_1$ | 1.22 de | 4.11 b | 5.33 c | 7.22 de | 11.11 ab |
| $T_3P_2$ | 1.56 a-c | 4.44 ab | 5.78 a-c | 7.89 a-d | 11.33 a |
| $T_3P_3$ | 1.44 b-d | 4.33 ab | 5.78 a-c | 7.67 a-d | 11.00 a-c |
| $T_4P_0$ | 1.00 e | 3.22 c | 4.78 d | 5.78 g | 9.45 e |
| $T_4P_1$ | 1.33 cd | 4.11 b | 5.44 bc | 7.33 c-e | 9.78 de |
| $T_4P_2$ | 1.67 ab | 4.22 ab | 5.56 bc | 7.44 b-e | 10.22 c-e |
| $T_4P_3$ | 1.33 cd | 4.11 b | 5.44 bc | 7.22 de | 9.89 de |
| $LSD_{(0.05)}$ | 0.224 | 0.613 | 0.522 | 0.648 | 0.731 |
| CV(%) | 9.35 | 8.79 | 5.66 | 5.25 | 5.02 |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

Here,

$T_1$: 20 March
$T_2$: 5 April
$T_3$: 20 April
$T_4$: 5 May

$P_0$: 0 kg $P_2O_5$/ha
$P_1$: 30 kg $P_2O_5$/ha
$P_2$: 60 kg $P_2O_5$/ha
$P_3$: 90 kg $P_2O_5$/ha

**Table 4. Effect of sowing time and phosphorus on yield contributing characters and yield of cucumber**

| Treatment | Days required for sowing to 1st flowering | Days required for sowing to 1st harvest | Number of male flowers per plant | Number of female flowers per plant | Ratio of male and female flowers |
|---|---|---|---|---|---|
| **Sowing time** | | | | | |
| $T_1$ | 29.17 b | 42.25 b | 43.81 b | 27.56 b | 1.58 ab |
| $T_2$ | 28.92 b | 41.83 b | 48.25 a | 29.08 a | 1.66 a |
| $T_3$ | 30.42 a | 43.92 a | 44.64 b | 27.14 bc | 1.64 a |
| $T_4$ | 30.58 a | 44.08 a | 39.19 c | 25.78 c | 1.52 b |
| $LSD_{(0.05)}$ | 1.212 | 1.593 | 2.774 | 1.472 | 0.099 |
| **Levels of phosphorus** | | | | | |
| $P_0$ | 31.83 a | 44.50 a | 34.03 d | 22.64 c | 1.51 b |
| $P_1$ | 30.67 a | 44.33 a | 44.08 c | 27.03 b | 1.63 a |
| $P_2$ | 28.17 b | 41.42 b | 50.72 a | 30.61 a | 1.66 a |
| $P_3$ | 29.08 b | 42.58 b | 47.06 b | 29.28 a | 1.61 ab |
| $LSD_{(0.05)}$ | 1.212 | 1.593 | 2.774 | 1.472 | 0.099 |
| CV(%) | 4.85 | 4.42 | 7.57 | 6.45 | 7.45 |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

Here,

$T_1$: 20 March
$T_2$: 5 April
$T_3$: 20 April
$T_4$: 5 May

$P_0$: 0 kg $P_2O_5$/ha
$P_1$: 30 kg $P_2O_5$/ha
$P_2$: 60 kg $P_2O_5$/ha
$P_3$: 90 kg $P_2O_5$/ha

**Table 5. Combined effect of sowing time and phosphorus on yield contributing characters and yield of cucumber**

| Treatment | Days required to 1st flowering | Days required to 1st harvest | Number of male flowers per plant | Number of female flowers per plant | Ratio of male and female flowers |
|---|---|---|---|---|---|
| $T_1P_0$ | 32.00 a-c | 44.67 ab | 34.00 fg | 25.22 f | 1.36 d |
| $T_1P_1$ | 31.00 a-e | 44.67 ab | 42.11 de | 26.67 d-f | 1.57 a-d |
| $T_1P_2$ | 28.67 e-h | 43.00 a-d | 49.44 bc | 27.89 b-f | 1.78 a |
| $T_1P_3$ | 30.00 b-g | 43.33 a-c | 49.67 bc | 30.44 b | 1.63 a-c |
| $T_2P_0$ | 29.67 c-h | 42.33 a-d | 34.55 fg | 20.89 g | 1.66 a-c |
| $T_2P_1$ | 28.67 e-h | 42.33 a-d | 48.44 bc | 29.00 b-d | 1.67 a-c |
| $T_2P_2$ | 27.00 h | 39.33 d | 57.78 a | 36.22 a | 1.60 a-c |
| $T_2P_3$ | 30.33 a-f | 43.33 a-c | 52.22 b | 30.22 bc | 1.73 ab |
| $T_3P_0$ | 32.67 ab | 45.33 a | 38.22 ef | 24.67 f | 1.56 a-d |
| $T_3P_1$ | 31.33 a-e | 45.00 a | 44.00 c-e | 26.89 c-f | 1.64 a-c |
| $T_3P_2$ | 28.00 f-h | 40.67 cd | 51.44 b | 29.22 b-d | 1.77 a |
| $T_3P_3$ | 27.33 gh | 41.00 b-d | 44.89 cd | 27.78 b-f | 1.62 a-c |
| $T_4P_0$ | 33.00 a | 45.67 a | 29.33 g | 19.78 g | 1.49 cd |
| $T_4P_1$ | 31.67 a-d | 45.33 a | 41.78 de | 25.55 ef | 1.65 a-c |
| $T_4P_2$ | 29.00 d-h | 42.67 a-d | 44.22 c-e | 29.11 b-d | 1.52 b-d |
| $T_4P_3$ | 28.67 e-h | 42.67 a-d | 41.44 de | 28.67 b-e | 1.45 cd |
| $LSD_{(0.05)}$ | 2.424 | 3.186 | 5.547 | 2.944 | 0.197 |
| CV(%) | 4.85 | 4.42 | 7.57 | 6.45 | 7.45 |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

Here,

$T_1$: 20 March
$T_2$: 5 April
$T_3$: 20 April
$T_4$: 5 May

$P_0$: 0 kg $P_2O_5$/ha
$P_1$: 30 kg $P_2O_5$/ha
$P_2$: 60 kg $P_2O_5$/ha
$P_3$: 90 kg $P_2O_5$/ha

which was statistically similar to $T_1P_2$, $T_2P_0$, $T_2P_1$, $T_3P_2$, $T_3P_3$, $T_4P_2$ and $T_4P_3$ (Table 5).

**4.6 Number of male flowers per plant**

Number of male flowers per plant showed statistically significant variation due to different sowing time of cucumber (Appendix VI). The maximum number of male flowers per plant (48.25) was recorded from $T_2$ treatment, whereas the lowest number of male flowers per plant (39.19) was found from $T_4$ treatment (Table 4). Benzioni *et al*. (1991) also reported similar findings from their earlier experiment.

Number of male flowers per plant of cucumber varied significantly in terms of Phosphorus level (Appendix VI). The highest number of male flowers per plant (50.72) was found from $P_2$ treatment which was closely followed (47.06) by $P_3$ treatment while the lowest number of male flowers per plant (34.03) was found from $P_0$ treatment which was followed (44.08) by $P_1$ treatment (Table 4).Sabo *et al*. (2013) also observed the similar findings in their experiment.

Combined effect of different sowing time and levels of phosphorus showed statistically significant variation in terms of number of male flowers per plant of cucumber (Appendix VI). The maximum number of male flowers per plant (57.78) was observed from $T_2P_2$ treatment combination and the lowest number of male flowers per plant (29.33) was recorded from $T_4P_0$ treatment combination, which was statistically similar to $T_2P_0$ treatment combination (Table 5).

**4.7 Number of female flowers per plant**

Different sowing time varied significantly in terms of number of female flowers per plant of cucumber (Appendix VI). The highest number of female flowers per plant (29.08) was recorded from $T_2$ treatment whereas the lowest number of female flowers per plant (25.78) was found from $T_4$ treatment which was statistically similar (27.14) to $T_3$ treatment (Table 4). Benzioni *et al*. (1991) also recorded similar findings from their earlier experiment.

In terms of number of female flowers per plant, levels of phosphorus varied significantly in cucumber (Appendix VI). The highest number of female flowers per plant (30.61) was found from $P_2$ which was statistically identical (29.28) to $P_3$ treatment, while the lowest number of female flowers (22.64) was found from $P_0$ treatment (Table 4). Sabo *et al*. (2013) also found the highest number of female flowers per plant with higher levels of phosphorus in their experiment.

Combined effect of different sowing time and levels of phosphorus showed statistically significant variation in terms of number of female flowers per plant of cucumber (Appendix VI). The highest number of female flowers per plant (36.22) was observed from $T_2P_2$ and the lowest number of female flowers per plant (19.78) was recorded from $T_4P_{0,}$ which was statistically similar to $T_2P_0$ treatment combination (Table 5).

**4.8 Ratio of male and female flowers**

Statistically significant variation was recorded in terms of ratio of male and female flowers of cucumber due to different sowing time (Appendix VI). The highest ratio of male and female flowers (1.66) was recorded from $T_2$ treatment which was statistically similar (1.64 and 1.58) to $T_3$ treatment and $T_1$ treatment, whereas the lowest ratio of male and female flowers (1.52) was found from $T_4$ treatment (Table 4).

Ratio of male and female flowers of cucumber varied significantly in terms of levels of phosphorus (Appendix VI). The highest ratio of male and female flowers (1.66) was found from $P_2$ treatment which was statistically identical (1.63 and 1.61) to $P_1$ treatment and similar to $P_3$ treatment, while the lowest ratio of male and female flowers (1.51) was found from $P_0$ treatment (Table 4). Sabo *et al*. (2013) also found their experiment that phosphorus increases the ratio of male and female flowers.

Combined effect of different sowing time and levels of phosphorus showed statistically significant variation in terms of ratio of male and female flowers of cucumber (Appendix VI). The highest ratio of male and female flowers (1.78) was observed from $T_1P_2$ treatment combination and the lowest ratio of male and female flowers (1.36) was recorded from $T_1P_0$ treatment combination (Table 5).

**4.9 Number of fruits per plant**

Significant variation was recorded due to different sowing time in terms of number of fruits per plant of cucumber (Appendix VII). The highest number of fruits per plant (22.75) was recorded from $T_2$ treatment which was statistically similar (21.97 and 21.72) to $T_1$ treatment and $T_3$ treatment, whereas the lowest number of fruits per plant (21.03) was found from $T_4$ treatment (Fig. 8).

Phosphorus level varied significantly in terms of number of fruits per plant of cucumber (Appendix VII). The highest number of fruits per plant (23.86) was found from $P_2$ treatment which was statistically similar (23.44) to $P_3$ treatment while the lowest number of fruits per plant (18.39) was found from $P_0$ treatment (Fig. 9). Eifediyi and Samson (2010a) also found the similar response of cucumber to phosphorus fertilizer in their field experiment.

Combined effect of different sowing time and levels of phosphorus showed statistically significant variation in terms of number of fruits per plant of cucumber (Appendix VII). The highest number of fruits per plant (25.89) was observed from $T_2P_2$ treatment combination and the lowest number of fruits per plant (16.00) was recorded from $T_4P_0$ treatment combination (Fig. 10).

**4.10 Length of fruits**

Different sowing time showed statistically significant variation in terms of length of fruits of cucumber (Appendix VII). The longest fruit (15.02 cm) was recorded from $T_2$ treatment which was statistically similar (14.41 cm and 14.27 cm) to $T_1$ and $T_3$ treatment, whereas shortest fruits(13.76 cm) was found from $T_4$ treatment (Table 6).

In terms of length of fruits of cucumber levels of phosphorus varied significantly (Appendix VII). The longest fruit (15.13 cm) was found from $P_2$ treatment which was statistically similar (14.95 cm and 14.50 cm) to $P_3$ and $P_1$ treatment, while the shortest fruit (12.87 cm) was found from $P_0$ treatment (Table 6). Jilani *et al.*(2009) observed the same trend of result in their experiment.

Combined effect of different sowing time and levels of phosphorus showed significant variation in terms of length of fruits (Appendix VII). The highest length of fruits (16.27 cm) was observed from $T_2P_2$ treatment combination and the lowest length of fruits (12.18 cm) from $T_4P_0$ treatment combination (Table 7).

**4.11 Diameter of fruits**

Statistically significant variation was recorded in terms of diameter of fruits of cucumber due to different sowing time (Appendix VII). The highest diameter of fruits (3.23 cm) was recorded from $T_2$ treatment which was statistically identical (3.16 cm and 3.00) to $T_3$ and similar to $T_1$ treatment, whereas the lowest diameter of fruits (2.91 cm) was found from $T_4$ treatment (Table 6).

Diameter of fruits of cucumber varied significantly in terms of phosphorus level (Appendix VII). The highest diameter of fruits (3.54 cm) was found from $P_2$ treatment which was statistically identical (3.34 cm) to $P_3$ treatment, while the lowest diameter of fruits (2.46 cm) from $P_1$ treatment (Table 6). Eifediyi and Samson (2010a) also found the similar response of cucumber to phosphorus in their field experiment.

Combined effect of different sowing time and levels of phosphorus showed statistically significant variation in terms of diameter of fruits of cucumber (Appendix VII). The highest diameter of fruits (3.71 cm) was observed from $T_2P_2$ treatment combination and the lowest diameter of fruits (2.32 cm) was recorded from $T_4P_0$ treatment combination (Table 7).

**Table 6. Effect of sowing time and phosphorus on yield contributing characters and yield of cucumber**

| Treatment | Length of fruits (cm) | Diameter of fruit (cm) | Individual fruit weight (g) | Fruit yield per plant (kg) | Fruit yield per hectare (ton) |
|---|---|---|---|---|---|
| **Sowing time** | | | | | |
| $T_1$ | 14.41 ab | 3.00 ab | 176.73 ab | 3.90 ab | 43.33 b |
| $T_2$ | 15.02 a | 3.23 a | 180.74 a | 4.37 a | 48.49 a |
| $T_3$ | 14.27 ab | 3.16 a | 179.40 a | 3.16 bc | 35.02 c |
| $T_4$ | 13.76 b | 2.91 b | 170.85 b | 2.84 c | 31.55 c |
| $LSD_{(0.05)}$ | 0.787 | 0.227 | 7.409 | 0.346 | 3.842 |
| Level of significance | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| **Levels of phosphorus** | | | | | |
| $P_0$ | 12.87 b | 2.46 c | 152.38 c | 2.82 c | 31.37 c |
| $P_1$ | 14.50 a | 2.97 b | 176.89 b | 3.86 bc | 42.87 b |
| $P_2$ | 15.13 a | 3.54 a | 192.58 a | 4.60 a | 51.14 a |
| $P_3$ | 14.95 a | 3.34 a | 185.87 a | 4.37 ab | 48.50 a |
| $LSD_{(0.05)}$ | 0.787 | 0.227 | 7.409 | 0.346 | 3.842 |
| CV(%) | 6.57 | 8.81 | 5.02 | 10.60 | 10.60 |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

Here,

$T_1$: 20 March
$T_2$: 5 April
$T_3$: 20 April
$T_4$: 5 May

$P_0$: 0 kg $P_2O_5$/ha
$P_1$: 30 kg $P_2O_5$/ha
$P_2$: 60 kg $P_2O_5$/ha
$P_3$: 90 kg $P_2O_5$/ha

### 4.12 Individual fruit weight (g)

Statistically significant variation was recorded in individual fruit weight of cucumber due to different sowing time (Appendix VII). The highest individual fruit weight (180.74 g) was recorded from $T_2$ treatment which was statistically identical (179.40 g and 176.73 g) to $T_3$ treatment and similar to $T_1$ treatment, whereas the lowest individual fruit weight (170.85 g) was found from $T_4$ treatment (Table 6). The optimum sowing time ensures plant to grow properly through efficient utilization of moisture, temperature, light etc. that leads to produced highest individual fruit weight.

Individual fruit weight of cucumber varied significantly in terms of Phosphorus level (Appendix VII). The highest individual fruit weight (192.58 g) was found from $P_2$ treatment which was statistically similar (185.87 g) to $P_3$ treatment, while the lowest individual fruit weight (152.38 g) was found from $P_0$ treatment (Table 6).

Combined effect of different sowing time and levels of phosphorus showed statistically significant variation in terms of individual fruit weight of cucumber (Appendix VII). The highest weight of individual fruits (203.09 g) was observed from $T_2P_2$ treatment combination, which was statistically similar to $T_1P_2$, $T_1P_3$, $T_2P_3$, $T_3P_2$, $T_3P_3$ and $T_4P_2$ and the lowest individual fruit weight (140.89 g) was recorded from $T_4P_0$ treatment combination, which was statistically identical to $T_2P_0$ treatment combination (Table 7).

### 4.13 Fruit yield per plant

Different sowing time varied significantly in terms of fruit yield per plant of cucumber (Appendix VII). The highest fruit yield per plant (4.37 kg) was recorded from $T_2$ treatment which was statistically similar (3.90 kg) to $T_1$ treatment, whereas the lowest fruit yield per plant (2.84 kg) was found from $T_4$

**Table 7. Combined effect of sowing time and phosphorus on yield contributing characters and yield of cucumber**

| Treatment | Length of fruits (cm) | Diameter of fruit (cm) | Individual fruit weight (g) | Fruit yield per plant (kg) | Fruit yield per hectare (ton) |
|---|---|---|---|---|---|
| $T_1P_0$ | 14.34 b-d | 2.36 f | 167.94 d-f | 3.38 ef | 37.57 ef |
| $T_1P_1$ | 13.80 c-e | 2.63 d-f | 165.53 ef | 3.54 d-f | 39.28 d-f |
| $T_1P_2$ | 15.21 a-c | 3.49 ab | 186.29 a-c | 4.14 b-e | 46.00 b-e |
| $T_1P_3$ | 14.27 b-d | 3.54 ab | 187.17 a-c | 4.54 a-c | 50.45 a-c |
| $T_2P_0$ | 12.36 e | 2.69 d-f | 141.84 g | 2.52 gh | 28.04 gh |
| $T_2P_1$ | 15.47 a-c | 3.02 b-d | 183.86 b-d | 4.27 b-d | 47.44 b-d |
| $T_2P_2$ | 16.27 a | 3.71 a | 203.09 a | 5.26 a | 58.42 a |
| $T_2P_3$ | 15.98 ab | 3.51 ab | 194.17 ab | 4.68 ab | 52.04 ab |
| $T_3P_0$ | 12.62 de | 2.49 ef | 158.84 f | 3.13 fg | 34.81 fg |
| $T_3P_1$ | 14.66 a-c | 3.10 b-d | 178.41 b-e | 3.85 c-f | 42.73 c-f |
| $T_3P_2$ | 14.65 a-c | 3.65 a | 193.67 ab | 4.54 a-c | 50.42 a-c |
| $T_3P_3$ | 15.16 a-c | 3.40 a-c | 186.68 a-c | 4.15 b-e | 46.10 b-e |
| $T_4P_0$ | 12.18 e | 2.32 f | 140.89 g | 2.25 h | 25.05 h |
| $T_4P_1$ | 14.08 cd | 3.13 b-d | 179.75 b-e | 3.78 c-f | 42.02 c-f |
| $T_4P_2$ | 14.38 b-d | 3.30 a-c | 187.29 a-c | 4.48 bc | 49.73 bc |
| $T_4P_3$ | 14.41 bc | 2.90 c-e | 175.46 c-e | 4.09 b-e | 45.42 b-e |
| $LSD_{(0.05)}$ | 1.574 | 0.454 | 14.82 | 0.692 | 7.684 |
| CV(%) | 6.57 | 8.81 | 5.02 | 10.60 | 10.60 |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

Here,

| | |
|---|---|
| $T_1$: 20 March | $P_0$: 0 kg $P_2O_5$/ha |
| $T_2$: 5 April | $P_1$: 30 kg $P_2O_5$/ha |
| $T_3$: 20 April | $P_2$: 60 kg $P_2O_5$/ha |
| $T_4$: 5 May | $P_3$: 90 kg $P_2O_5$/ha |

treatment which was statistically similar (3.16 kg) to $T_3$ treatment (Table 6). Benzioni *et al*. (1991) also reported similar findings from their earlier experiment.

Levels of phosphorus varied significantly in terms of fruit yield per plant of cucumber (Appendix VII). The highest fruit yield per plant (4.60 kg) was found from $P_2$ treatment which was statistically similar (4.37 kg) to $P_3$ treatment, while the lowest fruit yield per plant (2.82 kg) was found from $P_0$ which was statistically similar (3.86 kg) to $P_1$ treatment (Table 6). Eifediyi and Samson (2010a) also found the similar response of cucumber to phosphorus fertilizer in their field experiment.

Combined effect of different sowing time and levels of phosphorus showed statistically significant variation in terms of fruit yield per plant of cucumber (Appendix VII). The highest fruit yield per plant (5.26 kg) was observed from $T_2P_2$ treatment combination which was statistically similar to $T_1P_3$, $T_2P_3$ and $T_3P_2$ treatment combination and the lowest fruit yield per plant (2.25 kg) was recorded from $T_4P_0$ treatment combination which was statistically similar to $T_2P_0$ treatment combination (Table 7).

**4.14 Fruit yield per plot**

Statistically significant variation was recorded in terms of fruit yield per plot of cucumber due to different sowing time (Appendix VII). The highest fruit yield per plot (26.21 kg) was recorded from $T_2$ treatment which was followed (23.40 kg) to $T_2$ treatment, whereas the lowest fruit yield per plot (17.05 kg) was found from $T_4$ treatment which was statistically similar (18.93 kg) to $T_3$ treatment (Fig. 11). The optimum sowing time ensures plant to grow properly through efficient utilization of moisture, temperature, light etc. which leads to highest yield.

In terms of fruit yield per plot of cucumber levels of phosphorus varied significantly (Appendix VII). The highest fruit yield per plot (27.62 kg) was found from $P_2$ treatment, which was statistically similar (26.19 kg) to $P_3$ treatment and followed (23.15 kg) by $P_1$ treatment, while the lowest fruit yield per plot (16.94 kg) was found from $P_0$ treatment (Fig. 12).

Combined effect of different sowing time and levels of phosphorus showed statistically significant variation in terms of fruit yield per plot of cucumber (Appendix VII). The highest fruit yield per plot (31.55 kg) was observed from $T_2P_2$ and the lowest fruit yield per plot (13.53 kg) was recorded from $T_4P_0$ treatment combination (Fig. 13).

**4.15 Fruit yield per hectare**

Different sowing time showed significant variation in terms of fruit yield per hectare of cucumber (Appendix VII). The highest fruit yield per hectare (48.49 ton) was recorded from $T_2$ treatment, whereas the lowest fruit yield per hectare (31.55 ton) from $T_4$ treatment which was statistically similar (35.02 ton) to $T_3$ treatment (Table 6). The yield of the crop, for obvious reason, depends on the environmental conditions prevailing during the growing season in a particular place.

Levels of phosphorus varied significantly in terms of fruit yield per hectare of cucumber (Appendix VII). The highest fruit yield per hectare (51.14 ton) was found from $P_2$ treatment which was statistically identical (48.50 ton) to $P_3$ treatment, while the lowest fruit yield per hectare (31.37 ton) was found from $P_0$ treatment (Table 6). Jilani *et al.* (2009) observed the same trend of result in their experiment.

Combined effect of different sowing time and levels of phosphorus showed statistically significant variation in terms of fruit yield per hectare of cucumber (Appendix VII). The highest fruit yield per hectare (58.42 ton) was observed from $T_2P_2$ treatment combination which was statistically significance to $T_1P_3$, $T_2P_3$ and $T_3P_2$ treatment combination and the lowest fruit yield per hectare (25.05 ton) from $T_4P_0$ treatment combination (Table 7).

### 4.16 Economic analysis

Input costs for land preparation, seed cost, fertilizers, irrigation and manpower required for all the operations from planting to harvesting of cucumber were recorded for unit plot and converted into cost per hectare. Price of cucumber was considered as per market rate. The economic analysis presented under the following headings-

#### 4.16.1 Gross return

The combination of sowing time and phosphorus showed different gross return. The highest gross return (7, 01,040 Tk/ha) was obtained from $T_2P_2$ treatment combination and the second highest gross return (6, 24,480 Tk.)/ha was found in $T_2P_3$. The lowest gross return (3, 00,600 Tk./ha) was obtained from $T_4P_0$ treatment combination (Table 8).

#### 4.16.2 Net return

In case of net return different treatment combination showed different net return. The highest net return (4, 19,558 Tk.) was found from $T_2P_2$ treatment combination and the second highest net return (3, 41,528 Tk./ha) was obtained from $T_2P_3$ treatment combination. The lowest (22,056 Tk/ha) net return was obtained $T_4P_0$ treatment combination (Table 8).

#### 4.16.3 Benefit cost ratio

In the combination of sowing time and phosphorus highest benefit cost ratio (2.49) was noted from $T_2P_2$ treatment combination and the second highest benefit cost ratio (2.21) was estimated from $T_2P_3$ treatment combination. The lowest benefit cost ratio (1.08) was obtained from $T_4P_0$ treatment combination (Table 8). From economic point of view, it was apparent from the above results that the combination of $T_2P_2$ treatment combination was more profitable than rest of the combination.

**Table 8. Cost and returns of cucumber cultivation as influenced by sowing time and phosphorus**

| Treatment | Cost of production (Tk./ha) | Yield of Cucumber (t/ha) | Gross return (Tk./ha) | Net return (Tk./ha) | Benefit cost ratio |
|---|---|---|---|---|---|
| $T_1P_0$ | 278544 | 37.57 | 450840 | 172296 | 1.62 |
| $T_1P_1$ | 280013 | 39.28 | 471360 | 191347 | 1.68 |
| $T_1P_2$ | 281482 | 46.00 | 552000 | 270518 | 1.96 |
| $T_1P_3$ | 282952 | 50.45 | 605400 | 322448 | 2.14 |
| $T_2P_0$ | 278544 | 28.04 | 336480 | 57936 | 1.21 |
| $T_2P_1$ | 280013 | 47.44 | 569280 | 289267 | 2.03 |
| $T_2P_2$ | 281482 | 58.42 | 701040 | 419558 | 2.49 |
| $T_2P_3$ | 282952 | 52.04 | 624480 | 341528 | 2.21 |
| $T_3P_0$ | 278544 | 34.81 | 417720 | 139176 | 1.50 |
| $T_3P_1$ | 280013 | 42.73 | 512760 | 232747 | 1.83 |
| $T_3P_2$ | 281482 | 50.42 | 605040 | 323558 | 2.15 |
| $T_3P_3$ | 282952 | 46.10 | 553200 | 270248 | 1.96 |
| $T_4P_0$ | 278544 | 25.05 | 300600 | 22056 | 1.08 |
| $T_4P_1$ | 280013 | 42.02 | 504240 | 224227 | 1.80 |
| $T_4P_2$ | 281482 | 49.73 | 596760 | 315278 | 2.12 |
| $T_4P_3$ | 282952 | 45.42 | 545040 | 262088 | 1.93 |

Here,

$T_1$: 20 March
$T_2$: 5 April
$T_3$: 20 April
$T_4$: 5 May

$P_0$: 0 kg $P_2O_5$/ha
$P_1$: 30 kg $P_2O_5$/ha
$P_2$: 60 kg $P_2O_5$/ha
$P_3$: 90 kg $P_2O_5$/ha

# CHAPTER V

## SUMMARY AND CONCLUSION

The experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh March to July, 2013 to find out the influence of sowing time and phosphorus on growth and yield performance of cucumber (*Cucumis sativus* L). Seeds of 'Alavy' cucumber cultivar were used as the test crop. The experiment comprised of two factors- Factor A: Sowing time (4 levels), $T_1$: Sowing on 20 March, 2013, $T_2$: Sowing on 5 April, 2013, $T_3$: Sowing on 20 April, 2013, $T_4$: Sowing on 5 May, 2013 and Factor B: Levels of phosphorus (4 levels)- $P_0$: 0 kg $P_2O_5$/ha (control), $P_1$: 30 kg $P_2O_5$/ha,$P_2$: 60 kg $P_2O_5$/ha and $P_3$: 90 kg $P_2O_5$/ha. The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications.

For sowing time, at 20, 30, 40, 50 and 60 DAS, the tallest plant (17.30, 71.35, 145.31, 187.21 and 203.99 cm, respectively) was found from $T_2$, whereas the shortest plant (15.60, 65.77, 135.02, 176.91 and 194.83 cm, respectively) was recorded from $T_4$. At 20, 30, 40, 50 and 60 DAS, the maximum number of leaves per plant (7.28, 29.56, 48.08, 56.72 and 64.28, respectively) was found from $T_2$, whereas the minimum number of leaves per plant (6.21, 27.33, 45.22, 50.47 and 59.39, respectively) was recorded from $T_{4.}$ At 20, 30, 40, 50 and 60 DAS, the maximum number of branches per plant (1.50, 4.33, 5.72, 7.58 and 11.14, respectively) was found from $T_{2.}$ Whereas the minimum number (1.23, 3.81, 5.20, 6.94 and 9.83, respectively) was recorded from $T_{4.}$ The highest days required for sowing to 1$^{st}$ flowering (30.58) was recorded from $T_4$, whereas the lowest (28.92) from $T_2$. The highest days required for sowing to 1$^{st}$ harvest (44.08) was recorded from $T_4$ whereas the lowest (41.83) from $T_2$. The highest number of male flowers per plant (48.25) was recorded from $T_{2,}$ whereas the lowest number (39.19) was found from $T_4$. The highest number of female flowers per plant (29.08) was recorded from $T_{2,}$ whereas the lowest number

(25.78) was found from $T_4$. The highest ratio of male and female flowers (1.66) was recorded from $T_{2,}$ whereas the lowest ratio (1.52) was found from $T_4$. The highest number of fruits per plant (22.75) was recorded from $T_{2,}$ whereas the lowest number (21.03) was found from $T_4$. The highest length of fruits (15.02 cm) was recorded from $T_{2,}$ whereas the lowest length of fruits (13.76 cm) from $T_4$. The highest diameter of fruits (3.23 cm) was recorded from $T_{2,}$ whereas the lowest (2.91 cm) from $T_{4.}$ The highest weight of individual fruits (180.74 g) was recorded from $T_{2,}$ whereas the lowest weight (170.85 g) was found from $T_4$. The highest fruit yield per plant (4.37 kg) was recorded from $T_{2,}$ whereas the lowest fruit yield per plant (2.84 kg) was found from $T_{4.}$ The highest fruit yield per plot (26.21 kg) was recorded from $T_{2,}$ whereas the lowest fruit yield per plot (17.05 kg) from $T_{4.}$ The highest fruit yield per hectare (48.49 ton) was recorded from $T_{2\ ,}$ whereas the lowest fruit yield per hectare (31.55 ton) from $T_{4.}$

In case of levels of phosphorus, at 20, 30, 40, 50 and 60 DAS, the tallest plant (18.52, 72.22, 149.09, 191.43 and 208.24 cm, respectively) was found from $P_2$, while the shortest plant (14.07, 63.91, 131.20, 170.88 and 189.54 cm, respectively) was found from $P_0$. At 20, 30, 40, 50 and 60 DAS, the maximum number of leaves per plant (7.47, 30.42, 50.17, 58.08 and 66.14, respectively) was found from $P_2$ while, the minimum number of leaves per plant (6.14, 24.14, 41.22, 49.69 and 56.69, respectively) was found from $P_{0.}$ At 20, 30, 40, 50 and 60 DAS, the maximum number of branches per plant (1.64, 4.44, 5.92, 7.89 and 11.22, respectively) was found from $P_{2,}$ while, the minimum number of branches per plant (1.22, 3.64, 4.83, 6.53 and 9.92 respectively) was found from $P_{0.}$ The highest days required for sowing to 1$^{st}$ flowering (31.83) was found from $P_0$ while the lowest days required for sowing to 1$^{st}$ flowering (28.17) was found from $P_2$. The highest days required for sowing to 1$^{st}$ harvest (44.50) was found from $P_0$ , while the lowest days required for sowing to 1$^{st}$ harvest (41.42) was found from $P_{2.}$ The highest number of male flowers per plant (50.72) was found from $P_{2,}$ while the lowest number of male flowers per plant (34.03) was found from $P_0$. The highest number of female flowers per plant (30.61) was found from $P_2$, and followed (27.03) by $P_1$, while the lowest number of female flowers (22.64) was found from $P_0$. The highest ratio of male and female flowers (1.66) was found from $P_2$, while the lowest ratio of male and female flowers (1.51) was found from $P_0$. The highest number of fruits per plant (23.86) was found from $P_2$, and followed (21.78) by $P_1$, while the lowest number of fruits per plant (18.39) was found from $P_0$. The highest length of fruits (15.13 cm) was found from $P_2$, while the lowest length of fruits (12.87 cm) was found from $P_0$. The highest diameter of fruits (3.54 cm) was found from $P_2$, while the lowest diameter of fruits (2.46 cm) was found from $P_1$. The highest weight of individual fruits (192.58 g) was found from $P_2$, while the lowest weight of individual fruits (152.38 g) was found from $P_0$. The highest fruit yield per plant (4.60 kg) was found from $P_2$, while the lowest fruit yield per plant (2.82 kg) was found from $P_0$. The highest fruit yield per plot (27.62 kg) was found from $P_2$, while the lowest fruit yield per plot (16.94 kg) was found from $P_0$. The highest fruit yield per hectare (51.14 ton) was found from $P_2$, while the lowest fruit yield per hectare (41.37 ton) was found from $P_0$.

Due to the combined effect of sowing time and levels of phosphorus, at 20, 30, 40, 50 and 60 DAS, the tallest plant (20.33, 77.77, 156.82, 201.49, 214.98 cm, respectively) was observed from $T_2P_2$ and the shortest plant (12.24, 60.76, 122.00, 162.91 and 183.78 cm, respectively) was recorded from $T_4P_0$. At 20, 30, 40, 50 and 60 DAS, the maximum number of leaves per plant (8.11, 32.67, 52.78, 61.89 and 70.56, respectively) was observed from $T_2P_2$ and the minimum number of leaves per plant (5.44, 22.00, 39.00, 46.11 and 52.33, respectively) was recorded from $T_4P_0$. At 20, 30, 40, 50 and 60 DAS, the maximum number of branches per plant (1.78, 4.89, 6.33, 8.22 and 11.67, respectively) was observed from $T_2P_2$ and the minimum number of branches per plant (1.00, 3.22, 4.78, 5.78 and 9.45, respectively) was recorded from $T_4P_0$. The highest days required for sowing to $1^{st}$ flowering (33.00) was observed from $T_4P_0$ and the lowest days required for sowing to $1^{st}$ flowering

(27.00) was recorded from $T_2P_2$. The highest days required for sowing to 1st harvest (45.67) was observed from $T_4P_0$ and the lowest days required for sowing to 1st harvest (39.33) was recorded from $T_2P_2$. The highest number of male flowers per plant (57.78) was observed from $T_2P_2$ and the lowest number of male flowers per plant (29.33) was recorded from $T_4P_0$. The highest number of female flowers per plant (36.22) was observed from $T_2P_2$ and the lowest number of female flowers per plant (19.78) was recorded from $T_4P_0$. The highest ratio of male and female flowers (1.77) was observed from $T_1P_2$ and the lowest ratio of male and female flowers (1.36) was recorded from $T_1P_0$. The highest number of fruits per plant (25.89) was observed from $T_2P_2$ and the lowest number of fruits per plant (16.00) was recorded from $T_4P_0$. The highest length of fruits (15.98 cm) was observed from $T_2P_2$ and the lowest length of fruits (12.18 cm) was recorded from $T_4P_0$. The highest diameter of fruits (3.71 cm) was observed from $T_2P_2$ and the lowest diameter of fruits (2.32 cm) was recorded from $T_4P_0$. The highest weight of individual fruits (203.09 g) was observed from $T_2P_2$ and the lowest weight of individual fruits (140.89 g) was recorded from $T_4P_0$. The highest fruit yield per plant (5.26 kg) was observed from $T_2P_2$ and the lowest fruit yield per plant (2.25 kg) was recorded from $T_4P_0$. The highest fruit yield per plot (31.55 kg) was observed from $T_2P_2$ and the lowest fruit yield per plot (13.53 kg) was recorded from $T_4P_0$. The highest fruit yield per hectare (58.42 ton) was observed from $T_2P_2$ and the lowest fruit yield per hectare (25.05 ton) was recorded from $T_4P_0$.

The combination of sowing time and phosphorus the highest gross return (Tk. 701,040) was obtained from $T_2P_2$ and the lowest gross return (Tk. 300,600) was obtained from $T_4P_0$. In case of net return the highest net return (Tk. 419,558) was found from $T_2P_2$ and the lowest (Tk. 22,056) net return was obtained $T_4P_0$. In the combination sowing time and phosphorus highest benefit cost ratio (2.49) was noted from $T_2P_2$ and the lowest benefit cost ratio (1.08) was obtained from $T_4P_0$.

## Conclusion

Considering the above results of this experiment, further studies in the following areas may be suggested:

- For obtaining the maximum fresh fruit yield of cucumber, sowing of seeds on 05 April was found the best among the sowing times because yield and yield attributes decreased gradually with the delay of sowing.
- The level of phosphorus dose was 60kg/ha gave higher fresh fruit yield of cucumber.
- On 05 April sowing time with phosphorus-60 kg/ha is found to be the best sowing time and phosphorus dose for cucumber cultivation.

Further research work needs to be conducted in different regions of the country considering only the promising combinations of sowing time and phosphorus for a wider acceptability of the findings.

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# APPENDICES

**Appendix I. Monthly average of air temperature, relative humidity and total rainfall of the experimental site during the period from March to July, 2013**

| Month (2013) | *Air temperature ($^oC$) | | *Relative humidity (%) | *Rainfall (mm) (total) |
|---|---|---|---|---|
| | Maximum | Minimum | | |
| March | 33.6 | 23.3 | 69 | 81 |
| April | 33.4 | 23.2 | 67 | 78 |
| May | 34.7 | 25.9 | 70 | 185 |
| June | 35.4 | 22.5 | 80 | 277 |
| July | 35.1 | 22.2 | 69 | 238 |

* Monthly average,

* Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka - 1212

**Appendix II. Characteristics of soil of experimental field**

**A. Morphological characteristics of the experimental field**

| Morphological features | Characteristics |
|---|---|
| Location | Horticulture Farm, SAU, Dhaka |
| AEZ | Madhupur Tract (28) |
| General soil type | Shallow red brown terrace soil |
| Land type | High land |
| Soil series | Tejgaon |
| Topography | Fairly leveled |

**B. Physical and chemical properties of the initial soil**

| Characteristics | Value |
|---|---|
| % Sand | 28 |
| % Silt | 42 |
| % clay | 30 |
| Textural class | Silty-clay |
| pH | 6.2 |
| Organic matter (%) | 1.16 |
| Total N (%) | 0.03 |
| Available P (ppm) | 20.00 |
| Exchangeable K (me/100 g soil) | 0.10 |
| Available S (ppm) | 23 |

**Source:** Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

**Appendix III. Analysis of variance of the data on plant height of cucumber as influenced by different sowing time and levels of phosphorus**

| Source of variation | Degrees of freedom | Mean square | | | | |
|---|---|---|---|---|---|---|
| | | Plant height (cm) at | | | | |
| | | 20 DAS | 30 DAS | 40 DAS | 50 DAS | 60 DAS |
| Replication | 2 | 0.567 | 0.165 | 1.570 | 30.826 | 48.756 |
| Sowing time (A) | 3 | 6.746* | 44.854* | 167.134* | 271.123* | 188.156* |
| Levels of phosphorus (B) | 3 | 46.016** | 178.617** | 773.195** | 963.040** | 892.025** |
| Interaction (A×B) | 9 | 4.616* | 34.186* | 118.830* | 227.143* | 194.235* |
| Error | 30 | 1.864 | 14.812 | 45.544 | 79.290 | 58.747 |

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

**Appendix IV. Analysis of variance of the data on number of leaves per plant of cucumber as influenced by different sowing time and levels of phosphorus**

| Source of variation | Degrees of freedom | Mean square | | | | |
|---|---|---|---|---|---|---|
| | | Number of leaves per plant at | | | | |
| | | 20 DAS | 30 DAS | 40 DAS | 50 DAS | 60 DAS |
| Replication | 2 | 0.038 | 0.071 | 0.709 | 4.711 | 5.006 |
| Sowing time (A) | 3 | 0.928* | 10.024* | 19.893** | 96.086** | 60.457** |
| Levels of phosphorus (B) | 3 | 4.312** | 99.674** | 192.803** | 163.613** | 212.555** |
| Interaction (A×B) | 9 | 0.623* | 6.740* | 9.362* | 17.739* | 30.158* |
| Error | 30 | 0.253 | 2.900 | 3.950 | 9.579 | 12.897 |

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

**Appendix V. Analysis of variance of the data on number of branches per plant of cucumber as influenced by different sowing time and levels of phosphorus**

| Source of variation | Degrees of freedom | Mean square | | | | |
|---|---|---|---|---|---|---|
| | | Number of branches per plant at | | | | |
| | | 20 DAS | 30 DAS | 40 DAS | 50 DAS | 60 DAS |
| Replication | 2 | 0.0001 | 0.016 | 0.082 | 0.030 | 0.010 |
| Sowing time (A) | 3 | 0.062* | 0.402* | 0.361* | 1.167** | 4.407** |
| Levels of phosphorus (B) | 3 | 0.436** | 1.649** | 2.866** | 4.511** | 3.794** |
| Interaction (A×B) | 9 | 0.039* | 0.324* | 0.297** | 0.421* | 2.424* |
| Error | 30 | 0.018 | 0.135 | 0.098 | 0.151 | 0.192 |

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

**Appendix VI. Analysis of variance of the data on yield contributing characters of cucumber as influenced by different sowing time and levels of phosphorus**

| Source of variation | Degrees of freedom | Mean square | | | | |
|---|---|---|---|---|---|---|
| | | Days required for sowing to 1st flowering | Days required for sowing to 1st harvest | Number of male flowers per plant | Number of female flowers per plant | Ratio of male and female flowers |
| Replication | 2 | 1.313 | 0.583 | 1.451 | 2.263 | 0.010 |
| Sowing time (A) | 3 | 6.799* | 12.806* | 166.350** | 22.242** | 0.048** |
| Levels of phosphorus (B) | 3 | 31.965** | 26.139** | 615.829** | 146.564** | 0.051** |
| Interaction (A×B) | 9 | 4.502* | 15.157* | 21.882* | 17.990** | 0.031** |
| Error | 30 | 2.113 | 3.650 | 11.067 | 3.117 | 0.014 |

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

**Appendix VII. Analysis of variance of the data on yield contributing characters and yield of cucumber as influenced by different sowing time and levels of phosphorus**

| Source of variation | Degrees of freedom | Mean square | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Number of fruits per plant | Length of fruits (cm) | Diameter of fruit (cm) | Weight of individual fruits (g) | Fruit yield per plant (kg) | Fruit yield per plot (kg) | Fruit yield per hectare (ton) |
| Replication | 2 | 0.953 | 0.410 | 0.005 | 0.648 | 0.001 | 0.043 | 0.148 |
| Sowing time (A) | 3 | 6.060* | 3.197* | 0.256** | 230.659* | 0.571* | 20.561* | 70.509* |
| Levels of phosphorus (B) | 3 | 74.288** | 12.700** | 2.674** | 3711.18** | 7.486** | 269.498** | 924.204** |
| Interaction (A×B) | 9 | 5.708* | 1.789* | 0.228* | 281.099* | 0.483** | 17.396** | 59.658** |
| Error | 30 | 2.087 | 0.891 | 0.074 | 78.969 | 0.172 | 6.192 | 21.233 |

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

## Appendix VIII. Per hectare production cost of cucumber

### A. Input cost

| Treatment combination | Labour cost | Ploughing cost | Seed cost | Water for plant establishment | Sticking cost | Manure and fertilizers | | | | Insecticide/ pesticides | Sub Total (A) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Cowdung | Urea | TSP | MoP | | |
| $T_1P_0$ | 40000.00 | 32000.00 | 4000.00 | 25000.00 | 30000.00 | 15000.00 | 4800.00 | 0.00 | 3750.00 | 10000.00 | 164550.00 |
| $T_1P_1$ | 40000.00 | 32000.00 | 4000.00 | 25000.00 | 30000.00 | 15000.00 | 4800.00 | 1320.00 | 3750.00 | 10000.00 | 165870.00 |
| $T_1P_2$ | 40000.00 | 32000.00 | 4000.00 | 25000.00 | 30000.00 | 15000.00 | 4800.00 | 2640.00 | 3750.00 | 10000.00 | 167190.00 |
| $T_1P_3$ | 40000.00 | 32000.00 | 4000.00 | 25000.00 | 30000.00 | 15000.00 | 4800.00 | 3960.00 | 3750.00 | 10000.00 | 168510.00 |
| $T_2P_0$ | 40000.00 | 32000.00 | 4000.00 | 25000.00 | 30000.00 | 15000.00 | 4800.00 | 0.00 | 3750.00 | 10000.00 | 164550.00 |
| $T_2P_1$ | 40000.00 | 32000.00 | 4000.00 | 25000.00 | 30000.00 | 15000.00 | 4800.00 | 1320.00 | 3750.00 | 10000.00 | 165870.00 |
| $T_2P_2$ | 40000.00 | 32000.00 | 4000.00 | 25000.00 | 30000.00 | 15000.00 | 4800.00 | 2640.00 | 3750.00 | 10000.00 | 167190.00 |
| $T_2P_3$ | 40000.00 | 32000.00 | 4000.00 | 25000.00 | 30000.00 | 15000.00 | 4800.00 | 3960.00 | 3750.00 | 10000.00 | 168510.00 |
| $T_3P_0$ | 40000.00 | 32000.00 | 4000.00 | 25000.00 | 30000.00 | 15000.00 | 4800.00 | 0.00 | 3750.00 | 10000.00 | 164550.00 |
| $T_3P_1$ | 40000.00 | 32000.00 | 4000.00 | 25000.00 | 30000.00 | 15000.00 | 4800.00 | 1320.00 | 3750.00 | 10000.00 | 165870.00 |
| $T_3P_2$ | 40000.00 | 32000.00 | 4000.00 | 25000.00 | 30000.00 | 15000.00 | 4800.00 | 2640.00 | 3750.00 | 10000.00 | 167190.00 |
| $T_3P_3$ | 40000.00 | 32000.00 | 4000.00 | 25000.00 | 30000.00 | 15000.00 | 4800.00 | 3960.00 | 3750.00 | 10000.00 | 168510.00 |
| $T_4P_0$ | 40000.00 | 32000.00 | 4000.00 | 25000.00 | 30000.00 | 15000.00 | 4800.00 | 0.00 | 3750.00 | 10000.00 | 164550.00 |
| $T_4P_1$ | 40000.00 | 32000.00 | 4000.00 | 25000.00 | 30000.00 | 15000.00 | 4800.00 | 1320.00 | 3750.00 | 10000.00 | 165870.00 |
| $T_4P_2$ | 40000.00 | 32000.00 | 4000.00 | 25000.00 | 30000.00 | 15000.00 | 4800.00 | 2640.00 | 3750.00 | 10000.00 | 167190.00 |
| $T_4P_3$ | 40000.00 | 32000.00 | 4000.00 | 25000.00 | 30000.00 | 15000.00 | 4800.00 | 3960.00 | 3750.00 | 10000.00 | 168510.00 |

$T_1$: Sowing on 20 March
$T_2$: Sowing on 5 April
$T_3$: Sowing on 20 April
$T_4$: Sowing on 5 May

$P_0$: 0 kg $P_2O_5$/ha
$P_1$: 30 kg $P_2O_5$/ha
$P_2$: 60 kg $P_2O_5$/ha
$P_3$: 90 kg $P_2O_5$/ha

**Appendix VIII. Contd**

**B. Overhead cost (Tk./ha).**

| Treatment combination | Cost of lease of land for 6 months (12% of value of land Tk. 15,00000/year | Miscellaneous cost (Tk. 5% of the input cost | Interest on running capital for 6 months (Tk. 12% of cost/year | Sub total (Tk) (B) | Total cost of production (Tk./ha) [Input cost (A)+ overhead cost (B)] |
|---|---|---|---|---|---|
| $T_1P_0$ | 90000 | 8228 | 15767 | 113994 | 278544 |
| $T_1P_1$ | 90000 | 8294 | 15850 | 114143 | 280013 |
| $T_1P_2$ | 90000 | 8360 | 15933 | 114292 | 281482 |
| $T_1P_3$ | 90000 | 8426 | 16016 | 114442 | 282952 |
| $T_2P_0$ | 90000 | 8228 | 15767 | 113994 | 278544 |
| $T_2P_1$ | 90000 | 8294 | 15850 | 114143 | 280013 |
| $T_2P_2$ | 90000 | 8360 | 15933 | 114292 | 281482 |
| $T_2P_3$ | 90000 | 8426 | 16016 | 114442 | 282952 |
| $T_3P_0$ | 90000 | 8228 | 15767 | 113994 | 278544 |
| $T_3P_1$ | 90000 | 8294 | 15850 | 114143 | 280013 |
| $T_3P_2$ | 90000 | 8360 | 15933 | 114292 | 281482 |
| $T_3P_3$ | 90000 | 8426 | 16016 | 114442 | 282952 |
| $T_4P_0$ | 90000 | 8228 | 15767 | 113994 | 278544 |
| $T_4P_1$ | 90000 | 8294 | 15850 | 114143 | 280013 |
| $T_4P_2$ | 90000 | 8360 | 15933 | 114292 | 281482 |
| $T_4P_3$ | 90000 | 8426 | 16016 | 114442 | 282952 |

$T_1$: Sowing on 20 March
$T_2$: Sowing on 5 April
$T_3$: Sowing on 20 April
$T_4$: Sowing on 5 May

$P_0$: 0 kg $P_2O_5$/ha
$P_1$: 30 kg $P_2O_5$/ha
$P_2$: 60 kg $P_2O_5$/ha
$P_3$: 90 kg $P_2O_5$/ha

Plate 1.  Land preparation

Plate 2.  Seed germination

Plate 3. Vegetative growth stage

Plate 4.  Flowering Stage

Plate 5.  Male Flower

Plate 6.  Female flower

Plate 7. Fruiting stage