

Effect of Seedling Age and Different Levels of Phosphorus on Growth and Yield of Cucumber (*Cucumis sativus* L).

SAHAR TANWEER, ISHFAQ AHMED HAFIZ, NADEEM AKHTAR ABBASI AND SAJJAD ZAHOR
Department of Horticulture, University of Arid Agriculture, Rawalpindi–Pakistan

ABSTRACT

Cucumber crop was evaluated for the effect of seedling age and different levels of phosphorus fertilizer, during the year 2003, in the experimental area, Department of Horticulture, University of Arid Agriculture, Rawalpindi. 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 (67270 kg) were obtained with 28 days seedling age + 90 kg P₂O₅ ha⁻¹. The maximum number of leaves per plant (35.00) and individual fruit weight (138.67g) were recorded with 21 days seedling age + 90 kg P₂O₅ ha⁻¹.

Key Words: Seedling age; Phosphorus; Cucumber

INTRODUCTION

In Pakistan, cucumber (*Cucumis sativus* L) is cultivated on an area of 887 hectares with annual production of 5618 tonnes (Government of Pakistan, 2003). Climatic factors, like temperature play an important role in cucumber production. Cucumber is easily injured by frosts, consequently, field planting be delayed until the danger of frost is over (Hussain *et al.*, 1989). Cucumber seeds can be successfully grown under plastic tunnels during cooler months and then seedlings can be transplanted at optimum seedling age. To encourage early plant growth and harvest, the technique of transplanting cucumber may be employed. Determination of optimum seedling age to encourage plant establishment and early harvest could improve the success and profitability of cucumber crop (Handley & Hutton, 2003).

Cucumber crop requires heavy manure and sufficient amount of fertilizers especially nitrogen and phosphorus, for heavy yield. In Pakistan, more than 90% of soils are deficient in phosphorus, resulting in low crop yield (Tandon & Kimno, 1998). Phosphorus enhances many aspects of plant physiology including the fundamental processes of photosynthesis, nitrogen fixation, flowering, fruiting and maturation. Root growth particularly development of lateral roots and fibrous rootlets are encouraged by phosphorus (Brady & Weil, 2002). Hence, the application of phosphorus fertilizer might be helpful in minimizing plant death, due to root injury at transplantation. Phosphorus helps in cell division and cell enlargement and the quality of certain fruits and vegetables is improved with application of phosphorus fertilizer (Memon, 2000).

By realizing the importance of seedling age and phosphorus fertilizer for early cucumber production, the present study was envisaged with specific objective to find out the effect of seedling age and different phosphorus levels on growth and yield of cucumber.

MATERIALS AND METHODS

The experiment was conducted on the experimental area of Department of Horticulture, University of Arid Agriculture, Rawalpindi. Seeds of hybrid, 'Bambino' were sown on 24th January, 2003 in plastic tubes in growing media of FYM, sand and soil in proportion of 1:1:1, respectively, and were germinated under plastic tunnels. A field block of 90 m² was prepared during mid February, 2003. Twenty seven beds of 1.5 m x 1m size, 60 cm apart were raised for all the treatments. Cucumber seedlings on both sides of the beds were transplanted keeping six seedlings in each plot at a distance of 45 cm between them. Potash was applied @ 60 kg ha⁻¹ while, urea @ 120 kg ha⁻¹ was applied in two split doses, one at the time of field preparation and second three weeks after transplantation.

Seedlings were transplanted at three different ages viz.; 21 days, 38 days and 35 days after germination. Seedlings were provided with three different rates of phosphorus viz., 45, 90 and 135 kg ha⁻¹. Transplanting for the combination of seedling age and phosphorus fertilizer was carried out with a week interval, starting from last week of February, 2003.

The experiment was laid out according to two factor, factorial Randomized Complete Block Design (RCBD) with three replications. Average data pertaining to seedling survival percentage, number of leaves per plant, position of first reproductive node, female to male flower percentage, number of fruits per plant, single fruit weight (g), fruit yield per plant (kg) and fruit yield (kg ha⁻¹) were recorded.

RESULTS AND DISCUSSION

Seedling survival percentage. Data relevant to seedling survival percentage in Table I, revealed that survival was significantly affected by seedling age. Maximum survival (88.97%) was recorded with 28 days seedling age and minimum (70.29%) with 35 days seedling age at transplantation. This might be due to excessive root growth

and damage at transplantation. Hence, there was poor survival of cucumber seedlings transplanted at older age (Handley & Hutton, 2003). The effects of phosphorus on seedling survival were non significant. This might be attributed to the fact that phosphorus is the least mobile nutrient among macro nutrients and might not be readily available to the newly transplanted seedlings (Choudhary *et al.*, 2003).

The maximum survival (100.00%) was obtained with 28 days seedling age + 90 kg P₂O₅ ha⁻¹ whereas, minimum (66.40%) with 35 days seedling age + 90 kg P₂O₅ ha⁻¹. This might be due to optimum phosphorus level applied at proper age. Even though, survival was not significantly affected by phosphorus treatments, yet 90 kg P₂O₅ ha⁻¹ gave a higher mean survival percentage because phosphorus has a positive effect on seedling survival as it helps in healing of injured root system (Tandon & Kimno, 1998).

Number of leaves per plant. It was observed that differences in number of leaves per plant were significant (Table I). Maximum number of leaves (34.00) was produced with 21 days seedling age at transplantation and minimum (31.44) with 35 days seedling age. This might be due to their susceptibility to transplantation shock (Vavrina,

1998). Application of 90 kg P₂O₅ ha⁻¹ resulted in maximum number of leaves per plant (33.11) while, 45 kg P₂O₅ ha⁻¹ produced minimum number of leaves (31.61). Phosphorus plays a vital role in photosynthesis (Memon, 2000) so, optimum phosphorus level might have led to higher photosynthetic activity through production of more number of leaves per plant.

Interaction of seedling age and phosphorus fertilizer revealed that maximum number of leaves per plant (35.00) were recorded with 21 days seedling age + 90 kg P₂O₅ ha⁻¹ while, minimum (31.00) with 28 days seedling age + 45 kg P₂O₅ ha⁻¹. Supply of phosphorus fertilizer at early stage of plant growth increase the photosynthetic efficiency (Tisdale & Nelson, 1984) thus, resulted in increase in number of leaves.

Position of first female reproductive node. Data regarding position of first female reproductive node are shown in Table II. The first female flower at latest node (7.44) was noted with 21 days seedling age and at earliest node (3.78) with 35 days seedling age. The lower node number to female flower is a desirable character showing the earliness of cucumber crop (Seshadri, 1993). It can be inferred that later transplants tend to reproduce earlier as compared to

Table I. Seedling survival percentage and number of leaves per plant as affected by seedling age and different levels of phosphorus fertilizer

Phosphorus fertilizer/ Seedling age	Seedling survival percentage			Mean for phosphorus	Phosphorus fertilizer/ Seedling age	Number of leaves per plant			Mean for phosphorus
	21 days	28 days	35 days			21 days	28 days	35 days	
45 kg P ₂ O ₅ ha ⁻¹	88.87 AB	77.87 BC	77.87BC	81.53A	45 kg P ₂ O ₅ ha ⁻¹	33.00C	31.00E	31.00E	31.67C
90 kg P ₂ O ₅ ha ⁻¹	88.87 AB	100.00 A	66.40C	85.06A	90 kg P ₂ O ₅ ha ⁻¹	35.00A	32.00D	32.33D	33.11A
135 kg P ₂ O ₅ ha ⁻¹	88.87 AB	88.87AB	66.60C	81.44A	135 kg P ₂ O ₅ ha ⁻¹	34.00B	32.00D	31.00E	32.33B
Mean for seedling age	88.87 A	88.91A	70.29B		Mean for seedling age	34.00A	31.67B	31.44B	

Note: All values sharing similar letters are statistically non significant at 0.05 probability level

Coefficient of Variation: 9.35%

Coefficient of Variation: 1.13%

LSD value for Seedling age = 7.726

LSD value for Seedling age = 0.365

LSD value for Phosphorus = 13.38

LSD value for Phosphorus = 0.365

LSD value for Interaction = 0.633

Table II. Effect of seedling age and different levels of phosphorus fertilizer on position of first female reproductive node and female to male flower percentage

Phosphorus fertilizer/ Seedling age	Position of first female reproductive node			Mean for phosphorus	Phosphorus fertilizer/ Seedling age	Female to male flower percentage			Mean for phosphorus
	21 days	28 days	35 days			21 days	28 days	35 days	
45 kg P ₂ O ₅ ha ⁻¹	8.00 A	5.00 B	4.00B	5.67A	45 kg P ₂ O ₅ ha ⁻¹	29.27DE	34.80C	37.93B	34.00B
90 kg P ₂ O ₅ ha ⁻¹	7.00 A	3.00 C	4.00B	4.67A	90 kg P ₂ O ₅ ha ⁻¹	28.15E	48.10A	39.49B	38.58A
135 kg P ₂ O ₅ ha ⁻¹	7.33 A	4.00B	3.33C	4.87A	135 kg P ₂ O ₅ ha ⁻¹	30.44D	38.50B	34.37C	34.44B
Mean for seedling age	7.44 A	4.00B	3.78B		Mean for seedling age	29.29C	40.47A	37.27C	

Note: All values sharing similar letters are statistically non significant at 0.05 probability level

Coefficient of Variation: 18.82%

Coefficient of Variation: 2.68%

LSD value for Seedling age= 0.954

LSD value for Seedling age= 0.956

LSD value for Phosphorus= 0.954

LSD value for Phosphorus= 0.956

LSD value for Interaction = 1.657

earlier transplants (Vavrina, 1998). The effects of phosphorus on position of first female reproductive node were non significant.

The interaction of seedling age and phosphorus fertilizer revealed that 21 days age + 45 kg P₂O₅ ha⁻¹ produced first female flower at latest node (8.00) while, earliest first female flower nide (3.00) was observed with 28 days age + 90 kg P₂O₅ ha⁻¹. The interaction indicated that provision of optimum phosphorus level at proper age might have caused an earliness in reproductive phase initiation (Tisdale & Nelson, 1984).

Female to male flower percentage. Maximum female to male flower percentage (40.47%) was recorded with 28 days seedling age and minimum (29.29%) with 21 days seedling age. Lorenz and Maynard (1988) reported that increased femaleness is observed with four weeks old cucumber transplants. 90 kg P₂O₅ ha⁻¹ showed the highest female to male flower percentage (38.58%) and 45 kg P₂O₅ ha⁻¹ showed the lowest (34.00%). The lowest phosphorus level might be deficient and the highest might be excessive. Shanmugavelu (1989) reported increased female to male flower percentage with highest phosphorus level of 100 kg ha⁻¹.

Interaction of seedling age and phosphorus fertilizer

treatments revealed that 28 days seedling age + 90 kg P₂O₅ ha⁻¹ proved to be the best combination producing highest female to male flower percentage (48.10%). This might be due to the fact that phosphorus fertilizer promoted femaleness in plants and its effects are more pronounced at seedling age of four weeks (Shanmugavelu, 1989).

Number of fruits per plant. Data pertaining to number of fruits per plant shown in Table III, revealed that number of fruits were significantly affected by seedling age. Maximum (12.47) and minimum fruits per plant (9.05) were noted with 28 days and 21 days of seedling age, respectively. The vigorous vegetative growth might be the contributing factor towards reduced number of fruits in 21 days old seedlings. NeSmith (1993) reported more number of fruits with 28 days old seedlings.

Phosphorus application @ 90 kg P₂O₅ ha⁻¹ produced maximum number of fruits per plant (11.58) while, 45 kg P₂O₅ ha⁻¹ resulted in minimum number of fruits per plant (9.66). Phosphorus directly enhances metabolic processes and fruit set (Memon, 2000). These results are in agreement with the findings of Choudhari *et al.* (2002). Interaction of seedling age and phosphorus fertilizer revealed that 28 days transplant age + 90 kg P₂O₅ ha⁻¹ resulted in maximum number of fruits per plant (14.33) while, 21 days transplant

Table III. Effect of different levels of phosphorus fertilizer and seedling age on number of fruits per plant and single fruit weight of cucumber

Phosphorus fertilizer/ Seedling age	Number of fruits per plant			Mean for phosphorus	for phosphorus	Single fruit weight			Mean for phosphorus
	21 days	28 days	35 days			21 days	28 days	35 days	
45 kg P ₂ O ₅ ha ⁻¹	8.50 D	11.25 B	9.25CD	9.66B	45 kg P ₂ O ₅ ha ⁻¹	136.33AB	127.67C	122.00DE	128.20C
90 kg P ₂ O ₅ ha ⁻¹	8.91 CD	14.33A	11.50B	11.58A	90 kg P ₂ O ₅ ha ⁻¹	138.67A	130.33BC	127.67C	132.20A
135 kg P ₂ O ₅ ha ⁻¹	9.75 C	11.83B	9.00CD	10.19B	135 kg P ₂ O ₅ ha ⁻¹	138.00A	128.00C	125.00CD	130.30B
Mean for seedling age	9.05 C	12.47A	9.91B		Mean for seedling age	137.7A	128.70B	124.90C	

Note: All values sharing similar letters are statistically non significant at 0.05 probability level

Coefficient of Variation: 5.52%

Coefficient of Variation: 1.43%

LSD value for Seedling age= 0.584

LSD value for Seedling age= 1.861

LSD value for Phosphorus= 0.584

LSD value for Phosphorus= 1.86

LSD value for Interaction= 1.012

LSD value for Interaction= 1.86

Table IV. Yield components of cucumber as affected by seedling age and different levels of phosphorus fertilizer

Phosphorus fertilizer/ Seedling age	Fruit yield per plant (kg)			Mean for phosphorus	for phosphorus	Fruit yield (kg ha ⁻¹)			Mean for phosphorus
	21 days	28 days	35 days			21 days	28 days	35 days	
45 kg P ₂ O ₅ ha ⁻¹	1.15 E	1.42 B	1.12E	1.23C	45 kg P ₂ O ₅ ha ⁻¹	38330E	42600D	33600F	38180C
90 kg P ₂ O ₅ ha ⁻¹	1.23 D	1.72A	1.46B	1.47A	90 kg P ₂ O ₅ ha ⁻¹	41000D	67270A	38930E	49070A
135 kg P ₂ O ₅ ha ⁻¹	1.35 C	1.43B	1.12E	1.30B	135 kg P ₂ O ₅ ha ⁻¹	45000C	47640B	29870G	40840B
Mean for seedling age	1.24 B	1.52A	1.23B		Mean for seedling age	41440B	52510A	34130C	

Note: All values sharing similar letters are statistically non significant at 0.05 probability level

Coefficient of Variation: 1.30%

Coefficient of Variation: 2.19%

LSD value for Seedling age= 0.0099

LSD value for Seedling age= 934.1

LSD value for Phosphorus= 0.0099

LSD value for Phosphorus= 934.1

LSD value for Interaction= 0.0173

LSD value for Interaction= 1618

age + 45 kg P₂O₅ ha⁻¹ resulted in minimum number of fruits per plant (8.50). It can be inferred that phosphorus nutrition availability at proper stage of plant growth promoted flowering (Brady & Weil, 2002).

Single fruit weight. It was revealed that maximum (137.70 g) and minimum fruit weight (124.9 g) was obtained with 21 days seedling age and 35 days seedling age, respectively. Grimstads and Frimanslund (2002) reported that cucumber seedlings transplanted at three weeks age produced the heaviest fruits. Phosphorus application @ 90 kg P₂O₅ ha⁻¹ produced heaviest fruits (132.2 g) while, 45 kg P₂O₅ ha⁻¹ showed the lowest fruit weight (128.20 g). This might be due to the fact that phosphorus hastens plant energy metabolism and increases cell division and enlargement (Taiz & Zeiger, 1991).

Interaction of seedling age and phosphorus fertilizer showed that 21 days seedling age + 90 kg P₂O₅ ha⁻¹ resulted in highest fruit weight (138.67 g) while, 35 days seedling age + 45 kg P₂O₅ ha⁻¹ resulted in lowest fruit weight (122.00 g). This might be due to active source to sink relationship.

Fruit yield per plant. It was revealed that maximum fruit yield per plant (1.52 kg) was obtained with 28 days seedling age while, lowest fruit yield per plant (1.232 kg) was obtained with 35 days seedling age at transplantation. The higher fruit yield per plant can be positively correlated with more number of fruits per plant. NeSmith (1993) reported higher fruit yield with four weeks old transplants of zucchini squash. Application of 90 kg P₂O₅ ha⁻¹ resulted in maximum fruit yield per plant (1.47 kg) while, 45 kg P₂O₅ ha⁻¹ produced minimum fruit yield per plant (1.23 kg). These results are in line with the findings of Choudhari *et al.* (2002).

Interaction of seedling age and phosphorus fertilizer showed that 28 days seedling age + 90 kg P₂O₅ ha⁻¹ resulted in maximum fruit yield per plant (1.72 kg) whereas, 35 days seedling age + 45 kg P₂O₅ ha⁻¹ produced lowest fruit yield per plant (1.23 kg). This might be due to improved phosphorus utilization as the effects of phosphorus are more pronounced at seedling age of four weeks (Shanmugavelu, 1989).

Fruit yield (kg ha⁻¹). Data regarding fruit yield (kg ha⁻¹) presented in Table IV, revealed a significant effect of seedling age. Maximum fruit yield (52510 kg ha⁻¹) was obtained with 28 days seedling age. While, minimum fruit yield (34130 kg ha⁻¹) was obtained with 35 days seedling age. This might be attributed to the fact that older transplants are susceptible to transplant shock and consume more energy and time to reestablish which resulted in yield reduction (Handley & Hutton, 2003). Phosphorus application @ 90 kg ha⁻¹ produced highest fruit yield (49070 kg ha⁻¹) and 45 kg P₂O₅ ha⁻¹ produced lowest fruit yield (38180 kg ha⁻¹). These results are in line with Choudhari *et al.* (2002).

Interaction of seedling age and phosphorus fertilizer revealed that 28 days seedling age + 90 kg P₂O₅ ha⁻¹ resulted in maximum fruit yield (67270 kg ha⁻¹) while, 35

days seedling age + 135 kg P₂O₅ ha⁻¹ produced the minimum fruit yield (29870 kg ha⁻¹). This might be due to more pronounced effects of phosphorus at four weeks age (Shanmugavelu, 1989). Furthermore, the increased seedling survival and increased fruit yield per plant might have contributed towards increased overall fruit yield.

It is evident from the results that seedling age of 28 days + 90 kg P₂O₅ ha⁻¹ proved to be the best combination for earlier production and increased fruit yield of cucumber transplants. Furthermore, it resulted in production of fruits with medium weight and is more acceptable from consumer point of view.

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