



# Studies on Graded Levels of NPK on Nutrient Status of Soil and Plant of Parthenocarpic Cucumber (*Cucumis sativus* L.) under Naturally Ventilated Polyhouse Condition

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

The present investigation entitled "Studies on graded levels of NPK on growth, yield and quality of parthenocarpic cucumber (*Cucumis sativus* L.) under naturally ventilated polyhouse condition" during Winter season of year, 2022 at A field experiment was conducted at College of Agriculture, Ambajogai. The experiment was layout in RBD with three replications and recommended variety of - Parthenocarpic cucumber as a test crop along with nine treatments. nutrient availability, nutrient

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uptake were significantly influenced by application of 125% NPK RDF of cucumber crop. Significantly higher uptake of N among the fertigation levels, significantly higher total nitrogen uptake was noticed in the cucumber plant for treatment T<sub>9</sub> (125% RDF at 7 days intervals upto 90 DAT). (47.21 %) at harvest and at par with T<sub>6</sub>, T<sub>7</sub> and T<sub>8</sub>. whereas the lowest total nitrogen uptake was observed in treatment T<sub>1</sub> (control) at harvest (10.11 %), P Among the fertigation levels, significantly higher total phosphorus uptake was noticed in the cucumber plant for treatment T<sub>9</sub> (125% RDF at 7 days intervals upto 90 DAT). (26.70 %) at harvest and observed at par with treatments T<sub>6</sub>, T<sub>7</sub> and T<sub>8</sub>. whereas the lowest total phosphorus uptake was observed in treatment T<sub>1</sub> (control), at harvest (12.78 %), K Among the fertigation levels, significantly higher total potassium uptake was noticed in the cucumber plant for treatment T<sub>9</sub> (125% RDF at 7 days intervals upto 90 DAT). 96.80 % at harvest respectively and at par with T<sub>6</sub>, T<sub>7</sub> and T<sub>8</sub>. The lowest total nitrogen uptake was observed in treatment T<sub>1</sub> (control). at harvest (63.19 %).and organic carbon was found in cucumber with treatment T<sub>9</sub> (application of 125% of RDF 7 days of interval upto 90 DAT). Available soil nutrient status in post soil samples after harvest were comparably found maximum than initial soil samples.

**Keywords:** Parthenocarpic cucumber;125% RDF; higher uptake of NPK.

## 1. INTRODUCTION

“Global vegetable production of 956 million tonnes has grown by 56 percent in the last decade. Asia cultivates by far the most vegetables in the world and has also shown the strongest growth over the last decade. The total area of protected cultivation in India is approx 30,000 ha. Contributes 0.23% of the total area under the horticulture crop cultivation in India at and of the 11th five-year plan” (Shweta et al., 2014). The total area of cucumber growing in India is 78,000 hectares with an annual production of 11.42 lakh MT (National Horticulture Board 2016-17). The cucumber (*Cucumis sativus* L.) is one of the most important greenhouse vegetable crops of the cucurbitaceous family and has a chromosome number,  $2n = 14$ . “As a vegetable crop parthenocarpic cucumber has great economic importance. The immature fruit of cucumber is used as salad and for making pickles, paharirayata and brined on a commercial scale. The root system consists of the main root which branches out into very fine secondary roots which are white in colour. the main stem is angular and thorny, with nodes at the point where thorns and leaves developed. The flowers are yellow in colour. The fruits of cucumbers possess various medicinal properties e.g. cooling effect, prevention of constipation, checks jaundice and indigestion. Cucumber is a very low-calorie vegetable, providing only 15 calories 100 per g, it contains a high content of water which makes cucumber an ideal food for hydration and cooling. This is a very good source of potassium, vitamin K and other special antioxidants that are essential for the human

body's brain, heart and urinary system” (Sikarwar, 2016).

Cucumber contains 0.6 g protein, 2.6 g carbohydrate, 12 cal energy, 18 mg Ca, 0.2 mg Fe, 0.02 mg thiamine, 0.02 mg riboflavin, 0.01 mg niacin and 10 mg vitamin C per 100 g of edible portion (Rashid 1999). “Parthenocarpic and gynocarpic cucumber cultivars increase the potential to yield high fruit load in controlled environments resulting in a high harvest index. The yield of cucumber is influenced by several factors including the optimum nutrition of the crop. Cucumber is the fourth most important sole vegetable crop after tomato, cabbage and onion in Asia. the second most important vegetable after tomato in western Europe Cucumber is a thermophilic and frost-susceptible crop, growing best at temperature above 20°C Growing of high-value vegetables like cucumber in the greenhouse has been reported to give high yield and good quality produce in developed countries. Hence there is a need to standardize the integrated nutrient management practices for cucumber growing under low-cost greenhouses to increase productivity under indian conditions” (Anjanappa et al. 2012).

## 2. MATERIALS AND METHODS

A field experiment entitled “Studies on graded levels of NPK on growth, yield and quality of parthenocarpic cucumber (*Cucumis sativus* L.) Under naturally ventilated polyhouse condition” was conducted in Research field of the College of Agriculture, Ambajogai. during 2021-2022. The details of the material used and the techniques employed in the experiment are given in this chapter.

The total geographical area of Beed district is 10.69 mha. Geographically Beed district comes under Maharashtra state which is located between 18.72° 05' to 18° 75' North. The soils of Beed district belong to order Vertisols, Inceptisol and Entisol derived from Deccan trap. RDF (100: 50: 50 kg NPK ha) was supplied through water soluble fertilizer as 0:52.34, and 13:00:45. The composite soil sample before sowing was taken for their initial values. The soil pH (7.23) and EC (1.04 dSm<sup>-1</sup>) were analyzed using soil:water suspension (1:2.5) and determined by potentiometric method and Conductivity meter method (Jakson, 1973), respectively,

The soil was also carried for organic carbon (0.30%) by Walkley & Black (1934) method, available N (198.2 kg ha<sup>-1</sup>) determined by alkaline KMnO<sub>4</sub> as described by Subbiah & Asija (1956), available P (16.23 kg ha<sup>-1</sup>) by Olsen's method as described by Jackson (1973), and available K (275.5 kg ha<sup>-1</sup>) by using Flame photometer as described by Piper (1966). The experiment was laid out in factorial randomized block design with two factors viz. At the time of bed preparation, 5 qt FYM was applied to experimental plots uniformly. Cucumber plants were fertigated on day of 2 days intervals and seven days intervals of treatments and one-hour were irrigation applied through drip irrigation. Water soluble fertilizers viz, 0:52.34, and 13:00:45 will be applied treatment-wise as soil application according to RDF of cucumber crop at 2 days and 7 days of intervals up to 90 DAT.

### 3. RESULTS AND DISCUSSION

#### 3.1 The Effect of Graded Levels of NPK on Nutrient Status of Soil in Cucumber under Naturally Ventilated Polyhouse Condition

##### 3.1.1 Available nutrients (macronutrients and micronutrients)

**Available nitrogen:** Data pertaining to the available nitrogen content of the soil at harvest is presented in the Table 1 and Fig. 1. The data revealed that there was an increase in the available nitrogen content over initial status (198.2 kg ha<sup>-1</sup>). The maximum nitrogen content (240.3 kg ha<sup>-1</sup>) at harvest was recorded in T<sub>9</sub> (125% RDF at 7 days intervals upto 90 DAT) treatment at harvest and at par with T<sub>6</sub> (234.2 kg ha<sup>-1</sup>), T<sub>7</sub>(236.4 kg ha<sup>-1</sup>) and T<sub>8</sub> (238.1 kg ha<sup>-1</sup>). Whereas the lowest nitrogen content was observed in T<sub>1</sub> (control) (197.4 kg ha<sup>-1</sup>).

A higher amount of available nitrogen was observed in soil with chemically treated plots as the application of different levels of fertilizer or organic manures, might be due to poor soil physical structure and lack of microbial activity thus resulting in poor utilization of nitrogen as such treatments left over higher residual of these nutrients. Similar findings were also reported by Kanaujia & Daniel, (2016) who reported high residues of nitrogen in application of 100 percent RDF in cucumber.

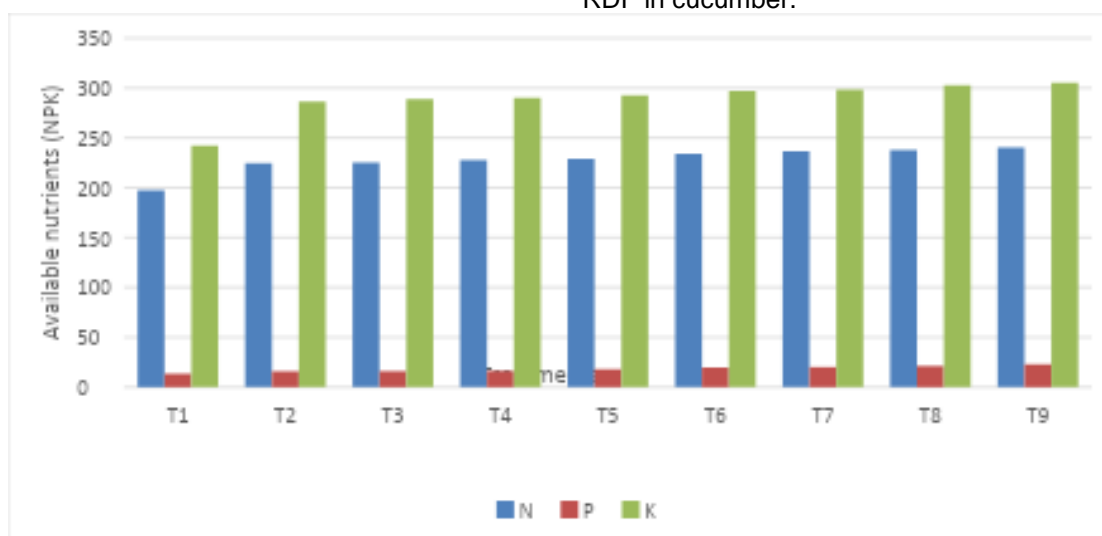


Fig. 1. Effect of graded level of NPK on available nutrients (NPK) of plant at harvest of parthenocarpic cucumber

**Table 1. Effect of graded level of NPK on availability of NPK in soil at harvest of parthenocarpic cucumber**

Treatments	Available NPK (kg/ha)		
	N	P	K
T1 Control	197.4	13.45	242.1
T2 50% RDF at 2 days interval upto 90 DAT	224.8	15.89	286.4
T3 50% RDF at 7 days interval upto 90 DAT	225.3	16.02	288.7
T4 75% RDF at 2 days interval upto 90 DAT	227.6	16.23	289.9
T5 75% RDF at 7 days interval upto 90 DAT	229.2	17.95	292.5
T6 100% RDF at 2 days interval upto 90 DAT	234.2	19.67	297.1
T7 100% RDF at 7 days interval upto 90 DAT	236.4	20.12	298.5
T8 125% RDF at 2 days interval upto 90 DAT	238.1	21.23	302.8
T9 125% RDF at 7 days interval upto 90 DAT	240.3	22.90	305.4
S. E $\pm$	<b>2.81</b>	<b>1.07</b>	<b>2.87</b>
C. D @ 5 %	<b>8.43</b>	<b>3.23</b>	<b>8.61</b>

**Available phosphorus:** Data pertaining to available phosphorus of the soil at harvest is presented in Table 1 and Fig. 1. The data revealed that there was an increase in the available phosphorus over initial status (16.23 kg ha<sup>-1</sup>). The maximum phosphorus (22.90 kg ha<sup>-1</sup>) was recorded with T<sub>9</sub> (125% RDF at 7 days intervals upto 90 DAT) treatment at harvest and at par with T<sub>6</sub> (19.67 kg ha<sup>-1</sup>), T<sub>7</sub> (20.12 kg ha<sup>-1</sup>) and T<sub>8</sub> (21.23 kg ha<sup>-1</sup>), whereas lowest phosphorus content was observed in T<sub>1</sub> (control) (13.45 kg ha<sup>-1</sup>). at harvest.

Higher application of phosphatic fertilizer leads to more availability of phosphorus. With the application of fertilizer at the rate of 300:225:375 NPK (kg ha<sup>-1</sup>) Similar results were obtained by Janeesa et al. (2022) who observed that a higher dose of phosphorus resulted in more availability of phosphorus content in soil at harvest in cucumber.

**Available potassium:** Data received for available potassium of the soil at harvest is presented in the Table 1 and Fig. 1. The data revealed that there was an increase in the available potassium content over initial status (275.5 kg ha<sup>-1</sup>). The maximum available potassium (305.4 kg ha<sup>-1</sup>) was recorded in T<sub>9</sub> (125% RDF at 7 days intervals upto 90 DAT) treatment at harvest and at par with T<sub>6</sub> (297.1 kg ha<sup>-1</sup>), T<sub>7</sub> (298.5 kg ha<sup>-1</sup>), and T<sub>8</sub> (302.8 kg ha<sup>-1</sup>), and lowest potassium content was observed in T<sub>1</sub> (control) (242.1 kg ha<sup>-1</sup>).

Potassium is an abundant source of nutrients in Indian soil so the availability of K is observed more in soil. Application of fertigation at the rate of 300:225:375 NPK (kg ha<sup>-1</sup>) registered maximum values of (429.33, 22.9) and (189.0 kg ha<sup>-1</sup>) for available potassium, which was

significantly superior reported with other levels. Similar results were obtained by Li et al. (2020), observed that a higher dose of potassium resulted more availability of potassium content in soil at harvest.

### 3.2 The Effect of Graded Levels of NPK on Nutrient Content and Uptake by Parthenocarpic Cucumber under Naturally Ventilated Polyhouse Condition

**Nitrogen content:** Data revealed that the nitrogen content of plants influenced by the application of different graded levels of fertigation at harvest are presented in the table no 2 and Fig no 2. Among the fertigation levels, significantly higher nitrogen content was noticed in the cucumber plant for treatment T<sub>9</sub> (125% RDF at 7 days intervals upto 90 DAT). (1.33%) at harvest and at par with T<sub>6</sub>, T<sub>7</sub> and T<sub>8</sub>, and Lowest nitrogen content was observed in treatment T<sub>1</sub> (control). at harvest (0.79 %) Maximum nutrient contents in cucumber crop along with the minimum nutrient residues in the soil after harvest. this might be due to the reason that the application of maximum application of NPK in the different graded levels of fertilizers was effectively utilized by the plants as these inputs were placed near the crop root zone area and also applied at the desired amount. Similar results were found by Padmaja et al. (2020) where significantly higher nitrogen content was noticed in cucumber fruit at 150% recommended dose of N followed by 125% RDF.

**Phosphorus content:** Data revealed that the phosphorus content of plants influenced by the application of different graded levels of fertigation at harvest are presented in the Table 2 and Fig. 2.

Among the fertigation levels, significantly higher phosphorus content was noticed in the cucumber plant at treatment T<sub>9</sub> (125% RDF at 7 days intervals upto 90 DAT). (0.74 %) at harvest and at par with T<sub>6</sub>, T<sub>7</sub> and T<sub>8</sub>. The lowest nitrogen content was observed in treatment T<sub>1</sub> (control), at harvest (0.36 %).

Maximum nutrient contents in cucumber crop along with the minimum nutrient residues in the soil after harvest was observed which might be due to the application of maximum NPK graded level of fertilizers which were effectively utilized by the plants and find significant nutrient content

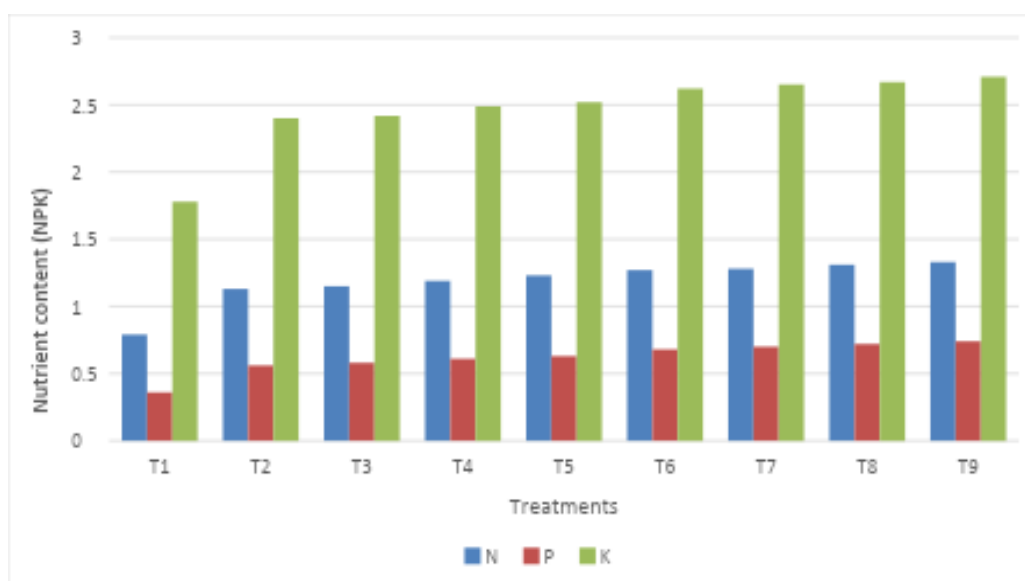
in plants as these inputs were placed near crop root zone area and also applied at the desired amount.

Similar result was found by Padmaja et al. (2020) where significantly higher nitrogen content was noticed in cucumber fruit at 150% recommended dose of N followed by 125% RDF.

**Potassium content:** Results obtained for the potassium content of plant influenced by the application of different graded levels of fertigation at harvest are presented in the Table 2 and Fig. 2.

**Table 2. Effect of graded level of NPK on nutrient content (NPK) of plant at harvest of parthenocarpic cucumber**

Treatments	NPK Content (%)		
	N	P	K
T1 Control	0.79	0.36	1.78
T2 50% RDF at 2 days interval upto 90 DAT	1.13	0.56	2.40
T3 50% RDF at 7 days interval upto 90 DAT	1.15	0.58	2.42
T4 75% RDF at 2 days interval upto 90 DAT	1.19	0.61	2.49
T5 75% RDF at 7 days interval upto 90 DAT	1.23	0.63	2.52
T6 100% RDF at 2 days interval upto 90 DAT	1.27	0.68	2.62
T7 100% RDF at 7 days interval upto 90 DAT	1.28	0.70	2.65
T8 125% RDF at 2 days interval upto 90 DAT	1.31	0.72	2.67
T9 125% RDF at 7 days interval upto 90 DAT	1.33	0.74	2.71
S. E ±	0.02	0.02	0.03
C. D @ 5 %	0.07	0.06	0.10



**Fig. 2. Effect of graded level of NPK on nutrient content (NPK) of plant at harvest of parthenocarpic cucumber**

The maximum potassium content observed at 125% RDF of potassium at harvest in T<sub>9</sub> Treatment (2.71 %) at par with T<sub>6</sub> (2.62 %), T<sub>7</sub> (2.65%), T<sub>8</sub> (2.67 %) and lowest shown in T<sub>1</sub> (control) (1.78%). Maximum nutrient contents in cucumber crops were observed along with the minimum nutrient residues in the soil after harvest, this might be due to the application of maximum NPK combination fertilizers that were effectively utilized by the plants and find significant nutrient content in plants as these inputs were placed near crop root zone area and also applied at desired amount.

Similar results were also recorded by Padmaja et al. (2020) where significantly higher potassium content was noticed in cucumber fruit at 150 % recommended dose of K followed by 125% RDF.

### 3.3 Nutrient Uptake (Plant)

**Nitrogen uptake:** Data regarding the total nitrogen uptake of plant influenced by the application of different graded levels of fertigation at harvest are presented in the Table 3 and Fig. 3. Among the fertigation levels, significantly higher total nitrogen uptake was noticed in the cucumber plant for treatment T<sub>9</sub> (125% RDF at 7 days intervals upto 90 DAT). (47.21 %) at harvest and at par with T<sub>6</sub>, T<sub>7</sub> and T<sub>8</sub>. whereas the lowest total nitrogen uptake was observed in treatment T<sub>1</sub> (control) at harvest (10.11 %).

Increased uptake of nitrogen might be due to higher levels of nitrogen application through fertigation, which could have accelerated physiological activity. This would have created a better pump in root hairs to further absorb nutrients and there by the total nutrient could have been increased. The increase in nutrient uptake may also be due to the better availability of nutrients in the root zone as a result of frequent fertilizer application through fertigation. Similar observations of increased nutrient uptake as a result of water-soluble fertilizers have resulted in lesser leaching of NO<sub>3</sub>-N and K to deeper layers of soil and NPK uptake was increased by water-soluble fertilizer (WSF) fertigation.

Similar result was found by Padmaja et al., (2020) where significantly higher nitrogen uptake was noticed in the cucumber plant at 150% recommended dose of N followed by 125%.

**Phosphorus uptake:** Data received for the total phosphorus uptake of plants influenced by the application of different graded levels of fertigation at harvest is presented in the Table 3 and Fig. 3.

Among the fertigation levels, significantly higher total phosphorus uptake was noticed in the cucumber plant for treatment T<sub>9</sub> (125% RDF at 7 days intervals upto 90 DAT). (26.70 %) at harvest and observed at par with treatments T<sub>6</sub>, T<sub>7</sub> and T<sub>8</sub>. whereas the lowest total phosphorus uptake was observed in treatment T<sub>1</sub> (control), at harvest (12.78 %). Fertigation was found to increase the uptake by vine and fruit compared to other treatments. The higher macronutrient uptake was also observed with the application of water-soluble fertilizers.

Maximum nutrient uptake in cucumber crops was observed along with the minimum nutrient residues in the soil after harvest. This might be due to the reason that application of maximum application of NPK in different graded level of fertilizers were effectively utilized by the plants and find significant nutrient content in plants as these inputs were placed near crop root zone area and also applied at the desired amount. Similar results were also found by Padmaja et al. (2020). Significantly higher phosphorus uptake was noticed in the cucumber plant at 150% recommended dose of P followed by 125%.

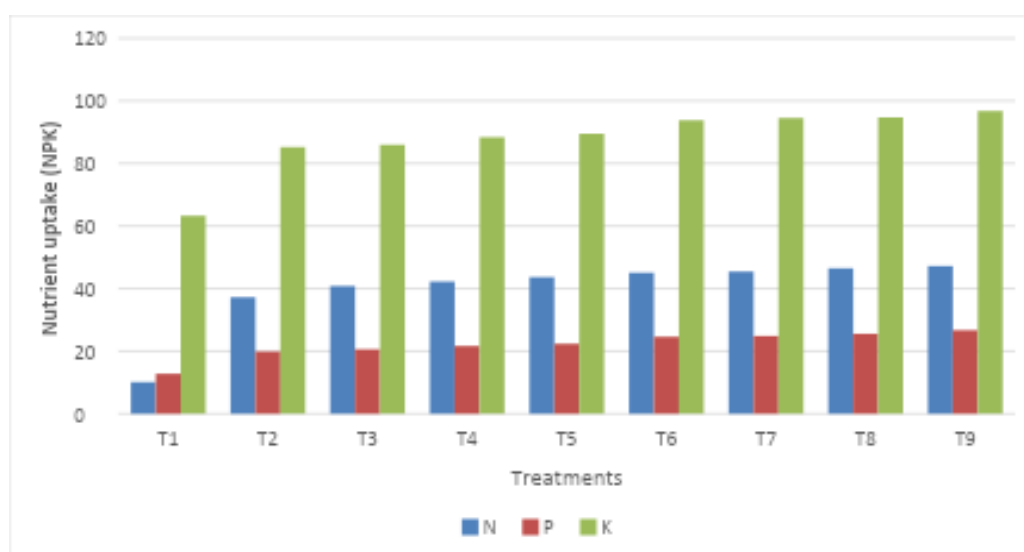
**Potassium uptake:** Data resulting in respect of the total potassium uptake of plant influenced by the application of different graded levels of fertigation at harvest are presented in the Table 3 and Fig. 3. Among the fertigation levels, significantly higher total potassium uptake was noticed in the cucumber plant for treatment T<sub>9</sub> (125% RDF at 7 days intervals upto 90 DAT). 96.80 % at harvest respectively and at par with T<sub>6</sub>, T<sub>7</sub> and T<sub>8</sub>. The lowest total nitrogen uptake was observed in treatment T<sub>1</sub> (control). at harvest (63.19 %).

Maximum nutrient uptake in cucumber crop along with the minimum nutrient residues in the soil observed after harvest. might be due to the maximum application of NPK in different graded levels of fertilizers. Those were effectively utilized by the plants and found significant nutrient content in plants as these inputs were placed near crop root zone area and also applied at the desired amount. The higher uptake of potassium might be due to the high availability of potassium in Indian soil, and the availability of potassium to translocate more in plants.

Similar result was found by Padmaja et al. (2020), where significantly higher potassium uptake was noticed in the cucumber plant at 150% recommended dose of K followed by 125%.

**Table 3. Effect of graded level of NPK on nutrient uptake (NPK) of plant at harvest of parthenocarpic cucumber**

Treatments	NPK uptake (kg ha <sup>-1</sup> ) (Plant and Fruit)		
	N	P	K
T1 Control	10.11	12.78	63.19
T2 50% RDF at 2 days interval upto 90 DAT	37.23	19.88	85.21
T3 50% RDF at 7 days interval upto 90 DAT	40.82	20.59	85.91
T4 75% RDF at 2 days interval upto 90 DAT	42.24	21.65	88.39
T5 75% RDF at 7 days interval upto 90 DAT	43.66	22.36	89.46
T6 100% RDF at 2 days interval upto 90 DAT	45.08	24.60	93.70
T7 100% RDF at 7 days interval upto 90 DAT	45.44	24.85	94.56
T8 125% RDF at 2 days interval upto 90 DAT	46.50	25.56	94.80
T9 125% RDF at 7 days interval upto 90 DAT	47.21	26.70	96.80
S. E ±	<b>2.07</b>	<b>1.86</b>	<b>2.39</b>
C. D @ 5 %	<b>2.63</b>	<b>2.53</b>	<b>3.45</b>



**Fig. 3. Effect of graded level of NPK on Nutrient uptake (NPK) of plant at harvest of parthenocarpic cucumber**

#### 4. CONCLUSION

Parthenocarpic cucumber crop fertilized with application of 125% of RDF 7 days of interval. Available soil nutrient status in post-harvest soil samples were comparably found maximum than initial soil samples. So it is significantly more uptake and availability of nutrients of parthenocarpic cucumber plant under naturally ventilated polyhouse conditions.

#### DISCLAIMER (ARTIFICIAL INTELLIGENCE)

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

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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