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# Influence of fertigation and training systems on yield and other horticultural traits in greenhouse cucumber

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## ABSTRACT

**Appropriation of major nutrients in proper ratio and systems of plant manipulation are important factors deciding the yield of greenhouse cucumber. So, a study involving 4 levels of fertilizers and 3 of training systems in factorial arrangements was conducted during 2013-2015 to optimize nutrient dose and training system in greenhouse cucumber. Greenhouse cucumber responded significantly to higher level of fertigation and displayed not only earliest flowering resultantly early picking but showed excellent vegetative growth as well. Greenhouse cucumber plants trained to single stem system also exhibited good performance in terms of plant height and leaf area. The higher level of fertigation also produced fruits with good amount of fibre content and had significant effect on various yield components like fruit length and diameter. The sensory scoring of such fruits on acceptability by heterogeneous panel of evaluators demonstrated its importance for prompt applicability under field. A significant effect on number of fruits per plant as governed interactively by fertigation and training system contributed to greenhouse cucumber yield. The plants administered with higher level of fertigation and trained to single stem system exhibited higher yield per unit area resulting in good net returns of Rs. 83724 within three months of crop duration. Furthermore, higher economic gain could be realized by availing 65% and 75% subsidy being offered by the government on the basis of socio-economic status of the farmers.**

**Key words:** *Cucumis sativus*, fertilizers, umbrella system, V system, economics.

## INTRODUCTION

Protected cultivation is an important agricultural sector showing constant growth and rapid expansion worldwide (Orgaz *et al*., 13). There is a great interest in reconciling maximum yields (Castilla *et al*., 2) with optimization of resource use efficiency through careful monitoring of environmental parameters and the improvement of cultivation techniques in this sector. Fertigation has emerged as an excellent method to improve the sustainability of greenhouse production by enabling better control over water and nutrient supply to the plants. So, drip irrigation under greenhouse cultivation is concentrated to supply irrigation water and fertilizers to rhizosphere through various phases of nutrient demand of a crop. (Mostafa *et al*., 12).

Cucumber (*Cucumis sativus* L.) is one of the potential greenhouse vegetables and truly a versatile crop because of wide range of uses from salads to pickles and digestive aids to beauty products. Greenhouse cucumbers have a high nutrient requirement and the correct quantity of fertilizers application not only increases the yield but also improve the quality. Application of major nutrients in proper ratio and required quantity can help growers to get the maximum out of these inputs (Kavitha *et al*., 11). Manipulation of plant architecture through training with appropriate spatial arrangements has also been revealed as a key management factor for getting maximum yield from greenhouse crops (Cebula, 3). Therefore, keeping in view all the perspectives of protected cultivation, fertigation and training system, the present investigation was framed to study the performance of greenhouse cucumber in varying levels of fertilizer and training systems.

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## MATERIALS AND METHODS

Dinamik, a greenhouse cucumber cultivar of Yuksel Tohumculuk Limited, Turkey was used in the experiment. The experiment was conducted at Regional Horticultural Research Station, Navsari Agricultural University, Navsari (Gujarat), India during 2013, 2014 and 2015, which is situated at latitude 20° 57`N and longitude 72° 54`E with an altitude of 12 m above the mean sea level. The location is characterized by humid climate with high annual rainfall of more than 1600 mm mostly concentrated during monsoon.

The growing media used for the experiment proportionally composed of 70% red soil: 20% FYM: 10% rice husk, which was subjected to sterilization with formaldehyde (1: 10) prior to planting. The physico-chemical analysis of growing media as well as water quality is given in Table 1.

**Table 1.** Physico-chemical properties of growing media and water.

| Parameter | Value | Parameter | Value | Parameter | Value | Parameter | Value |
|---|---|---|---|---|---|---|---|
| $EC_{soil}$ (dS/m) | 1.43 | $EC_{Water}$ (dS/m) | 0.70 | Organic Carbon (%) | 0.61 | Available P (kg) | 39.87 |
| $pH_{soil}$ | 6.40 | $pH_{Water}$ | 7.30 | Available N (kg) | 435.73 | Available K (kg) | 317.32 |

The whole experiment was arranged over 12 treatments consisting of 4 levels of fertilizers [$F_1$-60:50:50 kg/ha (RDF through conventional method), $F_2$-50% RDF (Fertigation), $F_3$-100% RDF (Fertigation), $F_4$-150% RDF (Fertigation)] and 3 training systems having system specific spacing as illustrated by Premalatha *et al*. (15) [$P_1$-'Umbrella' (60 × 60 cm), $P_2$-'V' (60 × 60 cm), $P_3$-'Single Stem' (60 × 45 cm)] and laid out in randomized block design under factorial arrangements. In case of conventional method of fertilizer application, full dose of phosphorous and potassium and half dose of nitrogen were applied before seed sowing and remaining half of N in two splits at 30 and 60 days after sowing (DAS). The remaining fertigation treatments were applied with the following distribution pattern as per ratio of nutrients (Table 2).

Vermicompost (4 t/ha), *Trichoderma viride* (5 kg/ha), *Pseudomonas fluorescens* (5 l/ha) and Grade-5 micro-nutrients (50 kg/ha) were applied commonly to all the treatments at the time of sowing.

**Methodology adopted in training systems:**

1. **Umbrella System ($P_1$):** Pinching of apical buds of plants at the height of approximately 180 cm near to the overhead wire (45 to 50 DAS).
2. **'V' System ($P_2$):** Pinching of apical buds of plants at the height of 45-60 cm (10 to 15 DAS) and retaining two strong suckers/ side shoots just below pinching point.
3. **Single stem system ($P_3$):** Training of main stem along the supporting string by pruning all the side shoots.

All the laterals arising from the axials of leaves commonly known as suckers were removed from the plants after attaining 8-10 cm of length in all the three systems.

The data on various parameters *viz.,* days to first flowering, days to first picking, plant height, leaf area, fruit length, fruit diameter, average fruit weight, number of fruits per plant, yield, shelf life and crude fibre were recorded and the mean values were subjected to statistical analysis as per Panse and Sukhatme (14). The data on sensory characters like fruit colour, texture and flavour were recorded on the basis of 9 point Hedonic scale and accordingly, the overall acceptability was worked out.

The produce of three seasons was marketed at *Shree* Navsari Jalalpore *Taluka* Horticulture Cooperative Society Ltd., Navsari, Gujarat and average selling rate was worked out accordingly. To work out and simplify calculations, the data generated through accounting method were subjected to analysis as suggested by Gittinger (8). The actual values on fixed investment were subjected to amortized accounting by adopting certain assumptions (Table 3).

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**Table 2.** Distribution pattern of nutrients applied through fertigation.

| Crop Duration | Distribution pattern / ratio of fertilizers | | | Remarks |
|---|---|---|---|---|
| | N | P | K | |
| First Growth Period (Up to 30 days) | 2 | 3 | 1 | – Fertigation should start at the appearance of 2nd true leaf stage.<br>– Fertigation should be carried out twice a week. |
| Second Growth Period (30-60 days) | 1 | 2 | 3 | |
| Third Growth Period (30-60 days) | 1 | 2 | 3 | |

**Table 3.** Assumptions for the calculation of fixed component of cost.

| S. No. | Particulars | Useful life (yrs) | Remarks |
|---|---|---|---|
| 1. | Polyhouse Structure | 10 | *Conditional life of red soil has been considered equivalent to that of structure's life assuming that sufficient organic matter will be incorporated into it over the period of time. |
| 2. | Red soil* | 10 | |
| 3. | Rice husk | 3 | |
| 4. | Plant support system | 5 | |

by imparting 50% subsidy to the farmers. Incentives in terms of subsidy to the tune of 65 and 75% are further disseminated by Government of Gujarat State (India) to encourage the farmers for adopting protected cultivation by adding its share of 15 and 25% in Union Government subsidy depending upon socio-economic status of the farmers.

Therefore an attempt has also been made to work out comparative trend of economic returns for cucumber cultivation under NVPH in each case (without subsidy (Actual), with 65 and 75% subsidy). The labour wages were established as per the notification of Assistant Labour Commission and Minimum Wages Act, Gandhinagar, Government of Gujarat State for respective years of experimentation (Anonymous, 1). As far as calculation of variable components is concerned, the prevailing market value at that point of time was accounted into analysis.

## RESULTS AND DISCUSSION

The data pertaining to pooled analysis of growth, reproductive and quality parameters are presented in Table 4 and it is clearly evident from the results that differences due to individual effect of fertilizers and training systems were significant for most of the parameters. However, interaction effect due to different levels of fertilizers and training systems was observed to non-significant. It is revealed from the study that $F_4$ took significantly minimum number of days to first flowering, which was also reflected for earliness in picking by the same level of fertilizer. The plants trained to $P_3$ training system were earliest in flowering taking 28.08 days, which was at par with $P_1$, while $P_1$ recorded early pickings with at par performance with $P_3$. A significant response of greenhouse cucumber to earliness in terms of flowering and picking under higher level of fertigation signifies higher requirement of nutrients at different phases of the crop growth for various metabolic activities. Fertigation not only stimulates photosynthesis but also various metabolic intermediates synthesis leading to earliness in reproductive activities (Goh and Haynes, 9).

Cucumber plants fertigated with $F_4$ level of fertilizers showed significant maximum plant height as well as leaf area at all the intervals of crop growth. In case of training systems, plants trained to $P_1$ system recorded significantly maximum plant height. However, progressive gain in plant height at 60 and 90 DAS was significantly highest in the plants trained to $P_3$ training system. P3 also expressed maximum leaf area at 30 as well as 60 DAS, which was at par with the plants trained to $P_1$ training system. This contributes to an improved availability of moisture, nutrients, and uniform distribution of fertigated nutrients in the crop root zone throughout the growth stages leading to better uptake of nutrients. The enhancing effects of NPK on vegetative growth might be attributed to their vital contribution in several metabolic process in plants related to growth. These results are in accordance with those obtained by Choudhari and More, 4; Jilani *et al*., 10; Mostafa *et al*., 12.

Plants administered with $F_4$ level of fertigation recorded significantly maximum fruit length (16.10 cm) and diameter (4.15 cm). However, average fruit weight remained unaffected by any of the level of fertilizers. Training systems didn't show any significant differences for these fruit characters.

**Table 4.** Effect of various levels of fertilizer and training system on growth, reproductive and quality parameters of greenhouse cucumber (Pooled mean).

| Treatment | Days to first flowering | Days to first picking | Plant height (cm) 30 DAS | Plant height (cm) 60 DAS | Plant height (cm) 90 DAS | Leaf area ($cm^2$) 30 DAS | Leaf area ($cm^2$) 60 DAS | Fruit length (cm) | Fruit diameter (cm) | Shelf life (days) | Crude fibre (g/100 g) | Overall acceptability (Fruit colour, texture, flavour) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $F_1$ | 28.85 | 39.30 | 119.94 | 202.13 | 277.10 | 263.52 | 407.23 | 14.69 | 3.86 | 5.41 | 1.21 | 6.04 |
| $F_2$ | 30.71 | 41.59 | 104.77 | 188.50 | 259.07 | 215.81 | 338.71 | 15.04 | 3.75 | 4.70 | 1.20 | 5.48 |
| $F_3$ | 28.26 | 39.22 | 131.01 | 210.23 | 294.89 | 274.11 | 435.78 | 15.39 | 3.91 | 6.03 | 1.51 | 6.94 |
| $F_4$ | 26.74 | 37.00 | 146.78 | 245.17 | 326.34 | 340.46 | 542.68 | 16.10 | 4.15 | 7.78 | 1.65 | 7.70 |
| C.D. $_{0.05}$ | 1.34 | 1.48 | 4.22 | 7.64 | 12.39 | 7.00 | 12.61 | 0.55 | 0.15 | 0.45 | 0.12 | 0.31 |
| $P_1$ | 28.11 | 38.64 | 132.17 | 208.64 | 263.47 | 278.58 | 439.72 | 15.14 | 3.92 | 5.81 | 1.42 | 6.51 |
| $P_2$ | 29.72 | 40.47 | 116.65 | 203.38 | 287.36 | 258.40 | 403.34 | 15.31 | 3.89 | 5.97 | 1.36 | 6.44 |
| $P_3$ | 28.08 | 38.72 | 128.06 | 222.51 | 317.23 | 283.44 | 450.24 | 15.47 | 3.95 | 6.17 | 1.40 | 6.67 |
| C.D. $_{0.05}$ | 1.16 | 1.30 | 3.74 | 6.67 | 11.12 | 6.70 | 11.08 | NS | NS | NS | 0.04 | NS |

Among various levels of fertilizers, $F_4$ excelled all other levels for shelf life (7.78 days), crude fibre (1.65%) and overall acceptability (7.70). The quality parameters like shelf life and overall acceptability remained unaffected by any of the training system. However, plants trained to $P^1$ system showed maximum content of crude fibre (1.42%), which was at par with $P_3$ system. The optimal presence of fibre content in cucumber reflects the digestibility and the fibre content of more than 1.5% is highly desirable. The presence of high score for various sensory aspects under higher level of fertigation was also supported by earlier researchers Thompson *et al*. (16) who have also demonstrated close relationship between results of instrumental measurements and sensory evaluation by human thereby showing equal importance of sensory evaluation for prompt applicability.

The data presented in Table 5 reveal significant differences due to individual as well as interaction effect of different levels of fertilizers and training systems. Treatment combination $F_4P_2$ recorded significantly maximum number of fruits per plant. Similarly significantly higher yield per plant was also recorded by $F_4P_2$ combination. However, plants administered to $F_4$ level of fertigation in combination with $P_3$ (Single Stem System) recorded higher yield per 1000 square meter, which was at par with treatment combination $F_4P_2$ attributable to more number of plants per unit area. The higher number of fruits per plant as shown by $F_4P_2$ could be reflected by the positive effect of fertilizer application (El Sanafawi *et al*., 6) and decapitation of apical bud at early stage of growth on yield of cucumber (Premalatha *et al*., 15). However, maximum fruit yield of 11.09 tonnes per 1000m$^2$ was recorded by the treatment combination $F_4P_3$ having statistically similar results with $F_4P_2$ because of accommodation of more number of plants in single stem system ($P_3$). It was obvious that increased yield potential was achieved at the expense of number of fruits per plant and number of plants per unit area, which was supported by Choudhari and More, 4; Jilani *et al*., 10. Eifediyi and Remison (5) also indicated a significant increase in number of fruits per plant and total yield per hectare with increased levels of NPK fertilizers.

The economic analysis presented in Table 6. shows that it was only the cost of structure, which made huge difference in economic gain for greenhouse cucumber as protected cultivation is highly capital intensive farming requiring substantial investment during the initial period of establishment. However, with the involvement of Government in boosting this technology financially, the initial capital investment came down to Rs. 8999 and 6428 only with 65 and 75% subsidy, respectively. The data revealed highest net profit of Rs. 83724.00 in greenhouse cucumber fertigated with $F_4$ level of fertilizer and trained to $P_3$ training system. Moreover, farmers availing 65% or 75% subsidy could realize more returns to the tune of Rs. 100437.00 or Rs. 103008.00, respectively. Engindeniz and Gul (7) were also of the view that that production as well as market risks affects profitability and economic feasibility of vegetables grown under protected structure. Therefore, it is undoubtedly evident that provisions made by the Government in this direction have truly lowered down the financial burden from the shoulders of farmers.

It is therefore concluded from the study that greenhouse cucumber growers could get higher yield and better net returns through fertigation

**Table 5.** Effect of various levels of fertilizer and training system on number of fruits and yield in greenhouse cucumber (Pooled mean).

| Treatment | Number of fruits per plant | | | | Yield per plant (kg) | | | | Yield per 1000 m$^2$ (t) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean |
| $F_1$ | 16.74 | 19.35 | 15.02 | 17.04 | 1.83 | 2.36 | 1.89 | 2.03 | 3.88 | 4.99 | 5.37 | 4.75 |
| $F_2$ | 14.42 | 15.94 | 12.58 | 14.31 | 1.68 | 1.93 | 1.5 | 1.70 | 3.57 | 4.13 | 4.22 | 3.97 |
| $F_3$ | 23.43 | 25.12 | 19.16 | 22.57 | 2.89 | 3.14 | 2.43 | 2.82 | 6.14 | 6.63 | 6.89 | 6.55 |
| $F_4$ | 29.19 | 40.24 | 30.13 | 33.19 | 3.60 | 5.10 | 3.93 | 4.21 | 7.60 | 10.80 | 11.09 | 9.83 |
| Mean | 20.95 | 25.16 | 19.23 | | 2.50 | 3.13 | 2.44 | | 5.30 | 6.64 | 6.89 | |
| | $CD_{0.05}$ | | | | $CD_{0.05}$ | | | | $CD_{0.05}$ | | | |
| F | 1.27 | | | | 0.15 | | | | 0.32 | | | |
| P | 1.14 | | | | 0.13 | | | | 0.29 | | | |
| F × P | 2.10 | | | | 0.25 | | | | 0.53 | | | |

[All other interactions (F × Y, P × Y and F × P × Y) were found to be non-significant]

**Table 6.** Economic analysis of various treatments for greenhouse cucumber cultivation under 1000 $m^2$ area of naturally ventilated polyhouse.

| S. No. | Components | Treatments | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $F_1P_1$ | $F_1P_2$ | $F_1P_3$ | $F_2P_1$ | $F_2P_2$ | $F_2P_3$ | $F_3P_1$ | $F_3P_2$ | $F_3P_3$ | $F_4P_1$ | $F_4P_2$ | $F_4P_3$ |
| A. AMORTIZED FIXED COST: | | | | | | | | | | | | | |
| | Polyhouse (Actual) | 25713 | 25713 | 25713 | 25713 | 25713 | 25713 | 25713 | 25713 | 25713 | 25713 | 25713 | 25713 |
| | Polyhouse (65% Subsidy) | 8999 | 8999 | 8999 | 8999 | 8999 | 8999 | 8999 | 8999 | 8999 | 8999 | 8999 | 8999 |
| | Polyhouse (75% subsidy) | 6428 | 6428 | 6428 | 6428 | 6428 | 6428 | 6428 | 6428 | 6428 | 6428 | 6428 | 6428 |
| | Red Soil | 1980 | 1980 | 1980 | 1980 | 1980 | 1980 | 1980 | 1980 | 1980 | 1980 | 1980 | 1980 |
| | Rice Husk | 367 | 367 | 367 | 367 | 367 | 367 | 367 | 367 | 367 | 367 | 367 | 367 |
| | Plant support system | 550 | 550 | 550 | 550 | 550 | 550 | 550 | 550 | 550 | 550 | 550 | 550 |
| Total (A) Actual | | 28609 | 28609 | 28609 | 28609 | 28609 | 28609 | 28609 | 28609 | 28609 | 28609 | 28609 | 28609 |
| Total (A) (65% Subsidy) | | 11896 | 11896 | 11896 | 11896 | 11896 | 11896 | 11896 | 11896 | 11896 | 11896 | 11896 | 11896 |
| Total (A) (75% Subsidy) | | 9325 | 9325 | 9325 | 9325 | 9325 | 9325 | 9325 | 9325 | 9325 | 9325 | 9325 | 9325 |
| B. VARIABLE COST: | | | | | | | | | | | | | |
| | Labour | 18750 | 22500 | 15000 | 18750 | 22500 | 15000 | 18750 | 22500 | 15000 | 18750 | 22500 | 15000 |
| | Pesticides | 867 | 867 | 867 | 867 | 867 | 867 | 867 | 867 | 867 | 867 | 867 | 867 |
| | Fertilizer | 1806 | 1806 | 1806 | 1524 | 1524 | 1524 | 3048 | 3048 | 3048 | 4571 | 4571 | 4571 |
| | Packing | 804 | 1034 | 1113 | 738 | 854 | 916 | 1267 | 1374 | 1424 | 1574 | 2236 | 2296 |
| | Seed cost | 10267 | 10267 | 13533 | 10267 | 10267 | 13533 | 10267 | 10267 | 13533 | 10267 | 10267 | 13533 |
| | Requirement of Formaldehyde | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 |
| | Application of formaldehye | 1400 | 1400 | 1400 | 1400 | 1400 | 1400 | 1400 | 1400 | 1400 | 1400 | 1400 | 1400 |
| | *Trichoderma viridi* | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| | *Pseudomonas inflorescens* | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| | Micro-nutrients | 908 | 908 | 908 | 908 | 908 | 908 | 908 | 908 | 908 | 908 | 908 | 908 |
| | Bed preparation | 1800 | 1800 | 1800 | 1800 | 1800 | 1800 | 1800 | 1800 | 1800 | 1800 | 1800 | 1800 |
| | Miscellaneous | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 |
| Total (B) | | 44602 | 48582 | 44427 | 44254 | 48120 | 43948 | 46306 | 50163 | 45980 | 48137 | 52549 | 48375 |
| Total cost (A+B) Actual | | 73211 | 77191 | 73036 | 72863 | 76729 | 72557 | 74915 | 78772 | 74589 | 76746 | 81159 | 76985 |
| Total cost (A+B) (65% Subsidy) | | 56498 | 60478 | 56323 | 56150 | 60016 | 55844 | 58202 | 62059 | 57876 | 60033 | 64445 | 60272 |
| Total cost (A+B) (75% Subsidy) | | 53927 | 57907 | 53752 | 53578 | 57444 | 53272 | 55631 | 59488 | 55305 | 57462 | 61874 | 57700 |
| Yield (t) | | 3.88 | 4.99 | 5.37 | 3.56 | 4.12 | 4.42 | 6.11 | 6.63 | 6.88 | 7.60 | 10.80 | 11.08 |
| Sale rate (Rs./kg) | | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |

| S. No. | Components | Treatments | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $F_1P_1$ | $F_1P_2$ | $F_1P_3$ | $F_2P_1$ | $F_2P_2$ | $F_2P_3$ | $F_3P_1$ | $F_3P_2$ | $F_3P_3$ | $F_4P_1$ | $F_4P_2$ | $F_4P_3$ |
| | Gross Realization (Rs.) | 56308 | 72371 | 77881 | 51668 | 59756 | 64090 | 88659 | 96151 | 99712 | 110232 | 156552 | 160708 |
| | Net Realization (Rs.) (Actual) | -16903 | -4820 | 4845 | -21194 | -16973 | -8467 | 13744 | 17379 | 25122 | 33486 | 75393 | 83724 |
| | Net Realization (Rs.) (65% Subsidy) | -190 | 11893 | 21558 | -4481 | -259 | 8246 | 30457 | 34092 | 41835 | 50199 | 92106 | 100437 |
| | Net Realization (Rs.) (75% Subsidy) | 2382 | 14464 | 24129 | -1910 | 2312 | 10818 | 33028 | 36663 | 44407 | 52770 | 94677 | 103008 |
| | Benefit-cost-ratio (Actual) | -0.23 | -0.06 | 0.07 | -0.29 | -0.22 | -0.12 | 0.18 | 0.22 | 0.34 | 0.44 | 0.93 | 1.09 |
| | Benefit-cost-ratio (65% Subsidy) | 0.00 | 0.20 | 0.38 | -0.08 | 0.00 | 0.15 | 0.52 | 0.55 | 0.72 | 0.84 | 1.43 | 1.67 |
| | Benefit-cost-ratio (75% Subsidy) | 0.04 | 0.25 | 0.45 | -0.04 | 0.04 | 0.20 | 0.59 | 0.62 | 0.80 | 0.92 | 1.53 | 1.79 |

@ 9.0: 7.5: 7.5 kg NPK per 1000 m2 (As per the Fertigation Schedule: Table 2) and training plants to single stem system along with application of vermicompost (0.4 t), *Trichoderma viride* (0.5 kg), *Pseudomonas fluorescens* (0.5 l), and micro-nutrients- Grade-5 (0.5 kg) at the time of sowing. Net returns from greenhouse cucumber could further be enhanced by the growers availing subsidies on fixed component of greenhouse house cultivation *i.e.* structure cost.

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