

**EFFECT OF DIFFERENT FERTIGATION LEVELS AND
SCHEDULES ON GROWTH, YIELD AND QUALITY OF CUCUMBER
UNDER POLYHOUSE CONDITION**

A thesis submitted to the
**MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI - 413 722, DIST. AHMEDNAGAR,
MAHARASHTRA, INDIA**

In partial fulfilment of the requirements for the degree

of

DOCTOR OF PHILOSOPHY (AGRICULTURE)

in

AGRONOMY

by

Mr. Tekale Chaitanya Devram

(Reg. No. 010/06)

DEPARTMENT OF AGRONOMY

**POST GRADUATE INSTITUTE
MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI-413 722, DIST. AHMEDNAGAR
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APPROVED BY

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MAHARASHTRA, INDIA**

2014

CANDIDATE'S DECLARATION

*I here by declare that
this thesis or part of this thesis
has not been submitted by me or
any other person to any other
University or Institution for
Degree or Diploma.*

Place: M.P.K.V. Rahuri.

Date: /12/2014

(Chaitanya D. Tekale)

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CERTIFICATE

This is to certify that the thesis entitled, "**EFFECT OF DIFFERENT FERTIGATION LEVELS AND SCHEDULES ON GROWTH, YIELD AND QUALITY OF CUCUMBER UNDER POLYHOUSE CONDITION**" submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (M.S.) for the award of the degree of **DOCTOR OF PHILOSOPHY (AGRICULTURE)** in **AGRONOMY**, embodies the results of a *bonafide* research carried out by **Mr. TEKALE CHAITANYA DEVRAM**, under my guidance and supervision and that no part of the thesis has been submitted for any other Degree or Diploma.

The assistance and help received during the course of this investigation have been acknowledged.

Place: **M.P.K.V. Rahuri**

(**A. D. Tumbare**)

Date: **/12/2014**

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Maharashtra, (India)

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Place: M.P.K.V. Rahuri

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Date: /12/2014

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Place: M.P.K.V. Rahuri

(Chaitanya D. Tekale)

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ABSTRACT

**“EFFECT OF DIFFERENT FERTIGATION LEVELS AND SCHEDULES
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Rahuri – 413 722

2014

Research Guide	:	Dr. A. D. Tumbare
Department	:	Agronomy

A field investigation on “Effect of different fertigation levels and schedules on growth, yield and quality of cucumber (*Cucumis sativus* L.) under polyhouse condition” was carried out at Instructional Farm of Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.) during the year 2011-12 and 2012-13 with a view to study the growth and yield potential of cucumber under polyhouse condition during off season (winter).

The soil of the experimental site was red sandy clay in texture with moderate in available nitrogen ($279.11 \text{ kg ha}^{-1}$), medium in available phosphorus (18.81 kg ha^{-1}) and very high in available potassium ($358.42 \text{ kg ha}^{-1}$). The experiment was laid out in Factorial Completely Randomized Design (FCRD) with three replications. The treatment consisted of three fertigation levels *viz.*, 75, 100 and 125 per cent of RDF and three fertigation schedules *viz.*, fertigation of recommended dose of N and K at every two (2) days interval up to 110 days in equal splits (52 splits); fertigation of recommended dose of N and K at every four (4) days interval up to 110 days in equal splits (26 splits) and fertigation of

recommended dose of N and K at every six (6) days interval up to 110 days in equal splits (18 splits).

The higher fertigation level (125 % RDF) along with fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days (52 splits) + P as a basal dose to cucumber exhibited significantly maximum vine length, number of branches vine⁻¹, number of functional leaves vine⁻¹, leaf area vine⁻¹, leaf area duration, relative leaf area growth rate, leaf area index, chlorophyll content, leaf water content and dry matter vine⁻¹ compared to rest of the fertigation levels and schedules under polyhouse condition.

Significantly higher number of fruits vine⁻¹ (25.50, 26.74 and 26.12), fruit length (15.48, 16.63 and 16.06 cm), average fruit weight (206.33, 214.54 and 210.44 g), fruit weight vine⁻¹ (5.16, 5.59 and 5.38 kg) was recorded with fertigation of 125 per cent of RDF and fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days (52 splits) + P as a basal dose to cucumber, respectively than rest of the treatment combinations during first year, second year and on pooled mean.

Fertigation of 125 per cent of RDF coupled with fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days (52 splits) + P as a basal dose to cucumber recorded significantly maximum fruit yield of cucumber (113.97, 125.33 and 119.65 t ha⁻¹) than rest of the treatment combinations during both the years and on pooled mean.

Cucumber fruit quality parameters *viz.*, fruit skin colour, fruit strip colour, fruit shape, fruit bitterness and presence of placental cavity were almost identical in all the fertigation levels and schedules. Whereas, fruit density (1.17 and 1.18 g cm⁻³), flesh thickness (1.40 and 1.41 cm) and total soluble solids (4.06 and 4.15 °brix) was influenced significantly due to different fertigation levels and registered schedules were not influenced significantly these quality

parameters except fruit density. Significantly higher fruit density (1.19 and 1.20 cm) was registered with fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days (52 splits) + P as a basal dose.

The physiological studies indicated that, fertigation level of 125 per cent of RDF and fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days (52 splits) + P as a basal dose to cucumber registered maximum photosynthetic rate, CO₂ concentrations, stomatal conductance, transpiration rate and minimum stomatal resistance and leaf temperature at all the stages of crop growth during both the years.

Significantly maximum uptake of nitrogen (185.95 and 206.22 kg ha⁻¹), phosphorus (40.37 and 49.89 kg ha⁻¹) and potassium (156.98 and 178.55 kg ha⁻¹) by cucumber was recorded under application of 125 per cent of RDF while fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose recorded significantly maximum uptake of nitrogen (187.07 and 208.20 kg ha⁻¹), phosphorus (41.24 and 51.07 kg ha⁻¹) and potassium (159.24 and 181.70 kg ha⁻¹) by cucumber during first and second year, respectively.

The growth and yield attributing characters of cucumber were positively correlated with photosynthetic rate, CO₂ concentrations, stomatal conductance and transpiration rate, whereas it was negatively correlated with stomatal resistance and leaf temperature during both the years.

Fertigation of 125 per cent of RDF coupled with fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days (52 splits) + P as a basal dose to cucumber obtained significantly maximum gross monetary returns (₹ 2,02,353 unit⁻¹ of polyhouse) and net monetary returns (₹ 1,38,183 unit⁻¹ of polyhouse).

1. INTRODUCTION

Cucurbit vegetables forms an important and a large group of extensively cultivated vegetables in India and other tropical and subtropical countries. This group consists of remarkable range of vegetables, either used as salad (cucumber) or for cooking (all gourds) or desert fruits (muskmelon and watermelon). They are of tremendous economic importance as food plants like edible vegetables, fruit or seed and medicinal plants and are extensively grown throughout the year. They are cultivated in mix cropping systems like river bed culture and river sand, diara; an unique, indigenous and improvised system of vegetable forcing which alone approximately covers 60 per cent of the total area under cucurbits in this country.

Cucumber (*Cucumis sativus* L.) belongs to the *cucurbitaceae* family and is a warm season crop originating from *Asia*. It is an important crop grown extensively throughout the country. It is mainly used as salad or slicer, also commercially processed as pickle (in brine) in Western countries. In some areas of India, cucumber is used as a cooked vegetable and in some regions, cucumber fruit is ripened and eaten. Cucumber seed is edible and used as additive in some confectionary products. It is rich in vitamin B and C and contains calcium, phosphorus, iron and potassium. The flavour in cucumber is traced to two compound 2,6- nonadienal and 2 - noneal and pleasant aroma is said to be derived mainly from 2,6 nonadienal, along with 2 hexanal, the more astringent taste being contributed by 2 - noneal. Cucumber and other cucurbitaceous vegetables are extensively used to reduce blood sugar levels also have purgative and antheoplastic and pharmacodynamic properties. Cucumber is cooling, nutritious, diuratic, ionic (bitter) vegetable (Sheshadri and More, 2009).

Among the various advanced techniques developed to achieve breakthrough in productivity of vegetable crops; cultivation of this crop in protected environment (glasshouse, greenhouse or plastic house) has proved, beyond doubt, the vast potential to increase yields in manifold. Yield of

cucumber in polyhouse can be obtained upto 137 tonnes ha⁻¹ (Kanuja *et al.*, 2006). This sophisticated way of vegetable cultivation is followed in more than 50 countries in the world. Prevailing low temperature and frost injury during winter season are limiting factors for successful cultivation of cucumber in Indian plains. It is difficult to grow them under open conditions during November - March because of adverse effects of low temperature on the fruit setting. To mitigate these problems, efforts were made to standardize agro-techniques and off-season techniques for vegetable under low cost polyhouse during winter season. Cucumber is highly thermo-sensitive in nature and its cultivation is hampered in India because of extreme temperatures.

Polyhouse technique is an effective tool to overcome adverse temperature problem. Cucumber can be grown under polyhouse by protecting them against frost, severe cold, rain, hail and other aberrant weather conditions. The increase in temperature inside polyhouse hastened germination and early bonus price from the market due to early produce. Polyhouse technique can be profitably used for cultivation of both warm as well as cool season vegetables. Vegetable production under polyhouse conditions needs special varieties and cultural practices as compared to outdoor cultivation. The fertilizer requirement of N, P and K under polyhouse is 2-3 times more than open conditions. Light irrigation for winter vegetables in polyhouse not only enhances growth but also improves low temperature tolerance of plants which ultimately results in higher yields.

Fertigation implies the application of fertilizers through pressurize system, thus forcing nutrient containing water in desired concentration as per the crop needs. It is controlled system to supply irrigated greenhouse vegetable crops with soluble plant nutrients at the root zone. Fertigation facilitates optimization of nutrient supply adjusted to the specific requirements of the crops at different stages of growth and development. The right combinations of water and fertilizers have key role in protected vegetable production for food quality and productivity. In most of the advanced countries

the fertigation has become standard practice of fertilizer application in greenhouses.

The use of correct fertigation schedule over two fold increase in yield is possible. Every plant fertigated received a regular flow of both water and nutrients directly in the root zone resulting in improved growth and increased the productivity. Fertigation helps in application of fertilizers at predetermined time according to the critical growth stages of the crop. Since nutrients directly reach to rhizosphere in liquid form, so there is no loss of nutrients. Fertigation gives better root absorption of nutrients and consequently higher yield and good quality.

Appropriate fertigation schedule offers an opportunity to correct the nutrient status of plant regularly and thus protecting plant from nutrient deficiencies. The most important factor to workout fertigation schedule, if plants get balanced nutrition at all stages of growth and get the best ratio in feeding programme, it will grow fast with higher yields. For the balanced nutrition therefore, it is essential to have knowledge regarding different growth stages of crop and their nutritional requirement. High levels of nitrogen is required during vegetative growth period.

The cucumbers have very high requirements of nutrients and grow very rapidly when supplied with sufficient nutrients in greenhouse. The maximum demand for nutrients is during the peak fruit production period. Nitrogen and potassium requirement is more, however a complete plant nutrition programme comprising all essential minor elements is needed. It is generally sensitive to nitrogen deficiency and grows slowly and produces less flowers and smaller fruits in low N regimes. Increase in cucumber production can be achieved either bringing more area under its cultivation, or by adopting improved varieties and better cultural practices. The second approach is more often preferred and among various cultural practices, fertilizer application is one of the quickest and easiest way of increasing the per unit area yield of cucumber. Higher levels of N, P and K fertigation improves number of fruits

per vine, fruit weight, yield plant⁻¹, yield ha⁻¹ and fruit quality of cucumber (Choudhari and More, 2002 and Ahmed *et al.*, 2007).

At present most of the farmers using different water soluble fertilizers through drip irrigation to various crops grown under protected condition or in open field condition. So far the fertigation schedule has been standardized based on various levels of recommended dose of fertilizers. It has proved that the fertigation saves about 25 to 30 per cent of fertilizers coupled with higher productivity and quality of fruits (Raman *et al.*, 2000). As fertilizer is the costly input, it is very essential to increase the fertilizer use efficiency by standardizing the fertigation schedule for various crops. Cucumber is one of the most important crops grown in protected condition for achieving higher productivity. However, there is no specific recommendation about scheduling of fertigation. Very meager research work has been carried out on apportioning or scheduling of fertilizers, hence there is scope to increase the productivity of cucumber by adopting suitable fertigation level and schedule. Hence, the present research work has been carried out to study the effect of fertigation levels and schedules on the growth, yield and quality of cucumber grown under polyhouse condition with the following objectives.

1. To study the growth, yield and quality of cucumber under different fertigation levels and schedules under polyhouse condition.
2. To find out the suitable fertigation level and schedule for cucumber under polyhouse condition.
3. To study the nutrient uptake by cucumber under different fertigation levels and schedules under polyhouse condition.
4. To study the economics of cucumber under different fertigation levels and schedules under polyhouse condition.

2. REVIEW OF LITERATURE

Cucumber (*Cucumis sativus* L.) belongs to the *cucurbitaceae* family, is one of the most widely used and popular vegetable in the World. The sizeable research has been carried out in respect of different fertigation levels on growth and yield of cucumber but very limited research were done by researchers on fertigation apportioning and scheduling. The available literature on these aspects has been reviewed in this chapter under following subheadings.

2.1. Effect of fertigation levels and schedules

2.1.1. Growth and yield

Papadopoulos (1986) conducted greenhouse experiment at Agricultural Research Institute, Nicosia (Cyprus) to study the response of cucumber to three nitrogen levels. Water containing 5.8, 11.8 and 17.8 m mol N l⁻¹ and uniformly supplied at 2-3 times daily with 2.0 and 3.9 m mol N l⁻¹ of phosphorus and potassium, respectively. The results of the experiment revealed that, the highest yield (9.42 kg plant⁻¹) was obtained with 11.8 m mol N l⁻¹ due to increased number of fruits plant⁻¹. The dry matter concentration of fruits was not affected by the different N levels.

Arora and Siyag (1989) carried out field experiment to study the effect of nitrogen and phosphorus on growth and flowering of sponge guard (*Luffa aegyptiaca* Mill.) at HAU, Haryana. They studied 4 levels of N viz., 0, 25, 50 and 75 kg N ha⁻¹ and 3 levels of P viz., 10, 20 and 40 kg P ha⁻¹. They found that, application of 75 kg N ha⁻¹ recorded significantly higher vine length (385 cm), days to first female flower appearance (56.4), while 50 kg N ha⁻¹ and 20 kg P ha⁻¹ recorded maximum number of secondary branches, leaves plant⁻¹ and node number at which first female flower appeared.

Rehman *et al.* (1995) studied the effect of different levels of NPK on the performance of three varieties of cucumber and observed that the application of higher fertilizers dose *i.e.* 140:60:150 NPK kg ha⁻¹ significantly delays the days to flowering, fruit setting and maturity. They also observed that NPK fertilizer (140:60:150 kg ha⁻¹) exhibited better results for highest germination

percentage, vine length, more fruits per vine, maximum fruit diameter, average fruit weight and total yield.

Mahapatra *et al.* (1996) conducted a field experiment to study the effect of nitrogen and frequency of its application on the performance of point guard (*Trichosanthes dioica* Roxb.) at OUA&T, Bhubaneswar (Orissa). Four levels of nitrogen application (60, 90, 120 and 150 kg ha⁻¹) and two frequencies (15 and 30 days interval) were studied. Results of the experiment showed that, application of 150 kg N ha⁻¹ recorded significantly maximum vine length, number of branches, leaf area, number of days to first female flower appearance, node number at which first female flower appeared, fruit length, diameter, number of fruits plant⁻¹, average fruit weight and yield. Fertigation applied at 15 and 30 days interval did not significantly affect the above said parameters.

Nerson *et al.* (1997) studied the effect of monopotassium phosphate as a P and K source for greenhouse winter grown cucumber at ARU, Newe Ya, ar Research centre, Israel. Five rates of P and K each were used 20 (control), 100, 200, 300 and 400 ppm and fertigation applied at 3 times per week. Findings of the experiment revealed that, cucumber yield significantly increases with increase in P and K application rates from 200 to 400 ppm. The P and K concentration between 100 to 400 ppm did not affect cucumber yield in the first two month of harvest but in the third month of harvest the yield was raised with increasing P and K concentration in the nutrient solution.

Premalakshmi *et al.* (1998) conducted a filed experiment to study the effect of N and K on growth, yield, flowering and quality of gherkin at TNAU, Coimbatore during 1995-96. They revealed that, application of 150 kg N and 100 kg K ha⁻¹ recorded the highest fruit yield (343.33 g) vine⁻¹ with a common dose of 75 kg P ha⁻¹. The growth and yield attributes like vine length, number of branches, number of fruits vine⁻¹ were favourably influenced due to application of N and K at 150:100 kg ha⁻¹.

Madane (1999) conducted an experiment on fertigation in tropical gynoecious hybrid cucumber at M.P.K.V., Rahuri (M.S.). The result indicated that, application of 150:90:90 N:P₂O₅:K₂O kg ha⁻¹ by fertigation was found to be optimum for better growth, yield and for better utilization of fertilizers.

Ruiz and Romero (1999) conducted an experiment at University of Granada (Spain) to study the cucumber yield and nitrogen metabolism in response to nitrogen supply rate. They studied four N rates in the form of KNO₃ viz., 5, 10, 20 and 40 g KNO₃ m⁻². Findings of the experiment revealed that, application of 10 g KNO₃ m⁻² registered significantly higher yield plant⁻¹ with higher N content in dry matter of plant. They stated that excess or limiting N application rate reduces fruit yield severely.

The study was carried out during autumn 1995 at Faculty of Agriculture, Ege University, Turkey. Nine different nutrient solutions containing 100, 200 and 300 ppm N and K in various combinations were tested on cucumber grown in glasshouse in perlite media. Nitrogen concentration significantly influenced the plant growth and quality. Average fruit weight and fruit yield ha⁻¹ appears to decrease with increasing N concentration but they also found that with increasing K concentration average fruit weight and yield ha⁻¹ increases. The use of 300 ppm N decreased plant growth and total yield while application of 200 ppm N along with 200 or 300 ppm K gives the higher yield. Further, they found that, nutrient concentration of N should not be more than 200 ppm and K concentration should be between 200-300 ppm for profitable production of cucumber. The interactions between N and K concentrations was found to be significant for yield. Yield decreased at high N concentrations combined with increasing K concentrations (Altunlu *et al.*, 1999).

Al-Jaloud *et al.* (1999) carried out an experiment on greenhouse cucumber with four drip fertigation frequencies, viz., once, twice and three times daily and two times every other day to study their corresponding effects on growth and production of greenhouse cucumber during winter season. Results of the experiments revealed that the maximum plant height (cm) and vine length (cm) was observed under treatment with three fertigation daily.

However, at fruiting stage growth component were not significantly influenced by fertigation frequencies. They also revealed that, crop yield during summer season in treatment which received one and three fertigation daily, significantly out yielded over the treatment fertigated every other day by more than 4 t ha⁻¹. But during the winter effect of various treatments on yield was non significant.

Raman *et al.* (2000) investigated the effect of fertigation on growth and yield of gherkin at ANGRAU, Andhra Pradesh (India) and concluded that, the application of 75 per cent of recommended dose of NPK with soluble fertilizers through drip irrigation system using urea, mono-ammonium phosphate (MAP) and potassium nitrate (Multi-K) gave higher yield resulting in 25 per cent saving of fertilizer, than band placement of conventional fertilizer in the soil.

Espinola *et al.* (2001) studied the dry matter accumulation and distribution of pickling cucumber plants under three mineral nutrient levels at Santa Maria, Brazil and dry matter of aerial organs was measured weekly. They revealed that, the nutrition level had a significant effect on dry matter accumulation in both experiments. In the first experiment, the highest fraction allocated to fruits was 0.64. The dry matter distribution was not constant due to interactions with environmental variables.

Papadopoulos (2001) conducted an experiment on computerized fertigation for cucumber production in soil and in soilless media at greenhouse and Processing Crops Research Centre, Ontario (Canada). He suggested that, the ideal optimal fertilizer application to a crop throughout the entire cropping season in accordance with the changing needs of the plants for nutrients has come close to reality in greenhouse vegetable production, due to a greatly improved understanding of plant nutrition and the availability of sophisticated fertilizer delivery systems. He suggested weekly fertigation schedule for greenhouse cucumber from sowing to last harvest of the crop.

Panagiotopoulos (2001) studied effect of nitrogen fertigation on growth, yield and quality of melon at Southern Greece. He reported that, nitrogen and

potassium levels did not alter significantly fruit yield produced from the first flush of fruit set in both the years of experimentation.

Surve *et al.* (2002) evaluated the efficacy of liquid fertilizer through drip irrigation on growth and yield of cucumber (*cv. Himangi*) at M.P.K.V., Rahuri (M.S.). They observed that, the length of vine (106.85 cm), number of branches plant⁻¹ (6.15) and number of leaves plant⁻¹ (74.50) were found to be maximum at harvest with application of 125 per cent of recommended dose, out of which 50 per cent through liquid fertilizer and 50 per cent through FYM and 125 per cent recommended dose of liquid fertilizer through drip irrigation over control. The application of 100 per cent recommended dose (50 per cent through liquid fertilizer and 50 per cent through FYM) recorded maximum number of fruits (6.8 vine⁻¹), fruit length (18.10 cm), diameter of fruit (13.30 cm), weight of fruit (305 g) and statistically superior yield (264.04 q ha⁻¹) over control (187.60 q ha⁻¹).

Choudhari and More (2002) carried out a fertigation experiment on gynoecious cucumber hybrid “*Phule Prachi*” at M.P.K.V., Rahuri (M.S.) with different NPK levels. Results of the experiment revealed that, maximum fruits vine⁻¹, maximum fruit weight, yield plant⁻¹ and yield (49.39 t ha⁻¹) were recorded when 150:90:90 kg NPK ha⁻¹ was applied through fertigation, which was 81.2 per cent higher than the control.

Guler and Ibrikci (2002) conducted an experiment at Black Sea Agricultural Research Institute, Turkey to study the response of greenhouse grown cucumber to nitrogen applied by fertigation and furrow irrigation. Crop was treated with nitrogen at 0, 100, 200 and 300 ppm, same levels applied through furrow irrigation with optimum doses of P and K. N solution applied twice a week. Results of the experiment revealed that, drip fertigated plant gave higher yield (78.0 t ha⁻¹) when compared to furrow irrigated plants (72.0 t ha⁻¹). The N applied at 200 ppm level through fertigation produced the highest yield (89.3 t ha⁻¹). Nitrogen levels had significant effects on both total fruit number and mean fruit weight (g) increased with increasing N levels, where as stem diameter was not affected by N levels.

Spizewski and Knaflewski (2004) investigated the effect of fertigation with nitrogen and potassium on yielding of pickling cucumbers at Poznan University of Life Sciences, Poznan in 2001 and 2002 and revealed that, in 2001, when fertigation was given for 4 weeks, the yield was significantly higher as compared to that obtained when fertigation was given for 8 weeks. There was no difference in yield when fertigation was done daily and once a week. Time, duration and frequency of fertigation did not significantly affect the dry matter and sugar content in cucumber fruits. In 2002, there was no significant effect of time, duration and frequency of fertigation on the yield and sugar content of fruits. However, dry matter content was significantly higher when fertigation was applied daily.

Suojala *et al.* (2005) observed that the relatively low nitrogen dose (120-140 kg ha⁻¹) was sufficient for good yield under warm growing conditions, a higher nitrogen dose increased yield, but only by 5 per cent. Addition of N and K by fertigation was sufficient when other nutrients were provided by pre-planting fertilization. Nutrient uptake per tonne of fruit was 1.2-1.4 kg N, 0.28-0.35 kg P and 2.2 kg K. Their results indicated that, high cucumber yield can be obtained by moderate fertilization when drip irrigation and fertigation are used.

Lee *et al.* (2005) carried out a greenhouse experiment at University of Seoul, Korea to study the effect of fertigation level and frequency on uptake of nutrients, growth and yield of cucumber. Findings of the experiment revealed that, plant height and leaf number of cucumber increased when the amount of fertigation solution per day increased from 0.5 to 2 L plant⁻¹. Plant height, stem diameter, leaf length, leaf width and dry weight plant⁻¹ were increased with increasing fertigation levels upto 2.0 L plant⁻¹. The average fruit weight, number of fruits plant⁻¹ and total fruit yield including marketable yield of cucumber increased when the amount of fertigation solution per day increased from 0.5 to 2 L plant⁻¹. The highest fruit yield was obtained at 1.5 and 2 L of fertigation level per day.

Sawant (2005) studied the response of cucumber to fertigation under drip irrigation system at M.P.K.V., Rahuri (M.S.) and showed that, drip irrigation with 100 per cent RDN through fertigation (8 split) increased significantly vegetative growth and yield of crop as compared to 100 per cent RDN through fertigation (6 splits).

Umamaheswarappa *et al.* (2005) studied effect of varied levels of nitrogen, phosphorus and potassium on flowering, fruit set and sex ratio of cucumber at University of Agricultural Sciences, Bangalore and reported that, nitrogen levels had a significant effect on number of days required for initiation of first male and female flowers, number of male and female flowers per vine, number of days required for first fruit set, fruit set per cent and sex ratio during 2001 and 2002. Phosphorus levels also showed positive effect on number of male and female flowers per vine, fruit set per cent and sex ratio. Whereas, application of varying levels of potassium had no significant effect on flowering, fruit set per cent and sex ratio of cucumber *cv. Poinsette* during both the years.

Cengiz *et al.* (2005) carried out field experiment at university of Harran, Turkey to study the influence of polyethylene mulch, irrigation regime and potassium rates on field grown cucumber yield and related traits. Three levels of K_2O viz., 20, 40 and 60 g m^{-2} were studied. Finding of the experiment revealed that, application of 60 g m^{-2} K_2O recorded significantly maximum plant dry weight, relative leaf water content, chlorophyll content and marketable fruit yield. Significantly higher N, P, K content in plant and fruit were observed under 60 g K_2O m^{-2} application rate.

Kolota and Slociak (2006) conducted an experiment to study the effect of nitrogen fertilization on yield and chemical composition of zucchini fruits (*Cucurbita pepo* L.). Nitrogen applied at 60 to 240 kg ha^{-1} at different times. They found that, application of N at 180 and 240 kg N ha^{-1} recorded significantly maximum fruit length while dry matter of plant was not influenced significantly by nitrogen fertilization.

Al-Wable *et al.* (2006) conducted a green house experiment at King Saud University, Riyadh (Saudi Arabia) to evaluate the effect of fertigation on cucumber yield. There were five treatments *viz.*, control (N_0), Soil N_5 (120 mg N l^{-1}) and three treatment labeled N^{15} (N_1 -60, N_2 -120, N_3 -180 $\text{mg N}^{15} \text{ l}^{-1}$). The highest yield (33.74 t ha^{-1}) was obtained from N_3 and lowest (7.73 t ha^{-1}) from the control treatment.

Greenhouse study conducted at Al-Muzahimiyah Research Station, Riyadh (Saudi Arabia) by Al-Jaloud *et al.* (2006) to determine the effect of different levels of N, P and K applied through fertigation on cucumber yield. In each experiment one nutrient was applied in four different levels, while the other two were held at high levels. 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 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 . In N experiment the highest yield (49.5 t ha^{-1}) was obtained with 150 ppm N along with 70 ppm P_2O_5 and 200 K_2O . In P experiment 60 ppm P_2O_5 with 200 ppm N and 200 ppm K_2O gave best yield (42.0 t ha^{-1}). In the K experiment the highest yield (33.2 t ha^{-1}) was obtained when K_2O was applied at 200 ppm with 200 ppm N and 70 ppm P_2O_5 .

Guler *et al.* (2006) investigated the effect of different nitrogen rates on yield and leaf nutrient contents of drip-fertigated and greenhouse-grown cucumber at Black Sea Agricultural Research Institute, Turkey. They showed that, in the study of different N concentrations, best result was obtained with the application of 200 mg N L^{-1} twice per week (86.6 t ha^{-1}), based on that, the application of 200 mg N L^{-1} at twice per week via irrigation together with $200 \text{ mg K} + 40 \text{ mg Mg L}^{-1} + 2.5 \text{ mg Fe L}^{-1}$ once a week was adequate in terms of yield and leaf nutrient contents. Also, the application of lower N concentrations at each irrigation did not produce greater yield when compared to the 200 mg N L^{-1} application at twice per week treatment.

Umamaheswarappa *et al.* (2006) conducted a field experiments to assess the effect of nitrogen, phosphorus and potassium levels on dry matter

accumulation in various plant parts and chlorophyll content in leaf of cucumber. Application of various levels of nitrogen had significant effect on dry matter accumulation in vine, leaf, fruit, root and total plant at harvest and chlorophyll a, b and total chlorophyll in leaf at 70 days after sowing during both the years. Phosphorus levels also had significant effect on dry matter accumulation in leaf, fruit, root and chlorophyll 'b' content in leaf during both the years and total dry matter accumulation in plant during first year. Application of varying levels of potassium had no significant effect on dry matter accumulation in various plant parts and chlorophyll content in leaf of cucumber cv. *Poinsette* during both years.

Satpute *et al.* (2008) carried out a field experiment at M. P.K.V., Rahuri (M.S.) to study the cost economics of cucumber influenced by fertigation. They observed that, the maximum yield (216.17 q ha^{-1}) was obtained with the fertigation level of 80 per cent RD. Though the individual effect of fertigation and irrigation levels was significant, their interaction effects were non-significant.

Waseem *et al.* (2008) reported that the 100 kg N ha^{-1} had significantly maximized fruit length (cm), fruit weight (g), vine length (cm) of cucumber which was indirectly related to the yield but 80 kg N ha^{-1} was most economical dose for minimizing the days to flowering, days to fruit setting, days to fruit maturity and getting higher number of fruits and ultimately higher yield (kg plant^{-1}).

Sumathi *et al.* (2008) studied the anatomical changes of cucumber leaves and roots influenced by shade and fertigation at T.N.A.U., Coimbatore (T.N.) and they concluded that, shade and fertigation showed positive influence on growth and yield parameters in cucumber hybrid. The highest root:shoot ratio, dry matter accumulation was observed with the application of 100 per cent water soluble fertilizer plus calcium chloride spray under shade net condition.

An experiment was carried out at Wageningen University, Netherlands to investigate the effects of two constant levels of nutrient concentration in the rhizosphere (3.2 and 7.0 dS m⁻¹) on growth, yield as well as water and nutrient uptake by cucumber (*cv. Activa*); the cultivation cycle lasted from July (transplanting) to October (93 days). Findings of the experiment revealed that, nutrient concentration had no effect on the dry matter production in cucumber plants or on its partitioning. The high nutrient treatment resulted in a significant decrease of leaf area and SLA. The fresh biomass, particularly the marketable yield was significantly reduced at high nutrient concentration *viz.*, 7.0 dS m⁻¹. This reduction was the result of a decline in fruit number and a larger incidence of unmarketable fruits. The dry matter percentage of high concentration fruits was always higher. The extra nutrient concentration in the root zone reduced about 11 per cent uptake of water. As regard nutrient, the uptake concentration of single ions was not influenced by ion content in the root zone at least at lower EC levels (Giuffrida and Heuvelink, 2008).

Carciu *et al.* (2008) conducted a field experiment at Banat's University of Agriculture Sciences, Banat, to study the impact of fertilization on yield of cucumbers. Four levels of nitrogen *viz.*, 0, 60, 90 and 120 kg N ha⁻¹ along with 45 kg P and K common to all treatment were studied. Findings of the experiment revealed that, application of 120 kg N ha⁻¹ recorded significantly maximum yield of cucumber (140.26 t ha⁻¹) over the rest of the treatments.

Babaik and Kowalczyk (2009) carried out a greenhouse experiment to determine the optimal nitrogen content in fertigation medium for the greenhouse cucumber at Research Institute of Vegetable Crops, Skierniewice (Poland). The different nitrogen levels *viz.*, 200, 250, 300 and 350 (mg dm⁻³) were studied. They found that, application of 250 N-NO₃ mg dm⁻³ gave significantly maximum fruit yield (32.6 kg m⁻²) which was at par with 250 and 300 N-NO₃ mg dm⁻³.

Eifediyi and Remison (2009) carried out field experiment at Ambrose Ali University, Nigeria for 3 years during 2006-2008 to study the effect of inorganic fertilizers on yield of two cucumber varieties (Ashley and Palmetto);

compound fertilization (20:10:10 NPK) was applied at 0, 100, 200, 300 and 400 kg ha⁻¹. Results of the experiment revealed that, the growth and yield attributes of cucumber including the vine length, number of fruits vine⁻¹, number of leaves plant⁻¹, number of branches plant⁻¹ and fruit weight plant⁻¹ and total fruit yield increased significantly with increase in inorganic fertilizer application upto highest levels (400 kg ha⁻¹). Fruit girth and length was not significantly influenced due to fertilizer application levels.

Sharma *et al.* (2009) conducted an experiment under low cost plastic greenhouse at Dr. Y. S. Parmar University of Horticulture and Forestry, Solan (H.P.) to study the effect of fertigation levels on cucumber production in hills. They studied three levels of N *viz.*, 100, 200 and 300 kg NPK ha⁻¹ along with different growing media. Findings of the experiment revealed that, application of 300 kg NPK ha⁻¹ registered significantly maximum vine length, number of fruits, average fruit weight, fruit length, girth, fruit yield plant⁻¹, flesh thickness and TSS than 100 and 200 kg N, P, K ha⁻¹. Application of 100 kg NPK ha⁻¹ registered maximum days to first female flower appearance and node to first female flower appeared.

Yang *et al.* (2009) studied the effect of three nitrate levels 14-CK, 56 (T₁) and 140 (T₂) mmol L⁻¹ on growth and photosynthetic capacity of cucumber seedlings at College of Horticulture Sciences and Technology, Shandong (China). The results showed that, at 12 days after treatment; plant height, leaf area, leaf number of cucumber seedling were significantly increased with application of 56 mmol l⁻¹ nitrate. Whereas, significantly inhibited by 140 mmol l⁻¹ nitrate compared with 14 CK.

An experiment was conducted by Jilani *et al.* (2009) at Faculty of Agriculture, Gomal University, Pakistan to study the effect of N, P and K on the growth and yield of hybrid cucumber. Application of NPK fertilizers (100:50:50 kg NPK ha⁻¹) showed the best performance almost all the parameters studied, as it took least days to flowering (39.33), fruit setting (11.55), maturity (7.88) and maximum vine length (3.85m) was recorded with application of 120:60:60 NPK kg ha⁻¹. Application of NPK fertilizers

(100:50:50 kg NPK ha⁻¹) showed the best performance in almost in all yield attribute parameters, *i.e.* fruits plant⁻¹ (35.50), maximum fruit length (18.3cm), maximum fruit weight (136.14) and yield ha⁻¹ (60.02 t ha⁻¹). Application of NPK fertilizers @ 120:60:60 kg ha⁻¹ also showed beneficial effect on some parameters including fruit weight (150.69 g).

Kamal *et al.* (2009) carried out an experiment at Minofia University, Egypt, to study the effect of deficit irrigation and fertilization on cucumber. They observed that, maximum leaf chlorophyll content, leaf area index and cucumber yield was obtained under adequate water with high N levels (314 kg N ha⁻¹).

Cabello *et al.* (2009) studied yield and quality of musk melon grown under different irrigation and nitrogen rates at Spain and concluded that, the best yield (41.3 Mg ha⁻¹) was obtained with 100 per cent ETc at 93 kg N ha⁻¹ as compared to 243 and 393 kg N ha⁻¹.

Eifediyi *et al.* (2011) studied the relationship between morphological characters, dry matter yield and fruit yield of cucumber at Ekpoma (Nigeria) and revealed that, applying fertilizer at various rates (0, 100, 200, 300 and 400 kg ha⁻¹) resulted in an increase in dry matter production over the control. The dry matter production as well as the yield attributes of cucumber were significantly enhanced by the application of 400 kg NPK ha⁻¹.

A field experiments was conducted by using different soilless media with two drip fertigation levels *i.e.* 80 and 100 per cent RDF (150:75:100 kg NPK ha⁻¹) at Tamil Nadu Agricultural University, Coimbatore (India) during spring – summer (November - May) seasons for 2 years to evaluate the economic feasibility of soilless media in combination with drip fertigation levels for a cucumber variety *Green Long*. The results of the experiment revealed that, application of 100 per cent RDF in conjunction with different growing media was found to have a positive influence on plant height, flower characters and yield ha⁻¹ in greenhouse. Significantly maximum plant height (cm), fruit length (cm), average fruit weight (g) and fruit yield (t ha⁻¹) was

registered with application of 100 per cent RDF while, 80 per cent RDF in conjunction with different growing media recorded significantly maximum days to first flowering, days to 50 per cent flowering and days to first harvest under naturally ventilated polyhouse. A yield increase of 18.45 per cent was observed with the cucumber grown in greenhouse under the application of 100 per cent RDF compared to 80 per cent RDF (Janapriya *et al.*, 2010).

Shinde *et al.* (2010) conducted a field experiment at Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.) during summer 2005 on clay loam soil with cucumber (*cv. Himangi*). Among the growth attributes, number of leaves, vine length, number of primary branches, dry matter accumulation plant⁻¹, days required for first flowering and internodes at which first flower appear were significantly influenced by different levels of nitrogen and number of splits. Significantly higher values of these parameters were recorded with 100 per cent recommended dose of nitrogen (100 kg N ha⁻¹) through fertigation with 8 splits. The length, girth and density of fruits increased with increase in fertilizer levels and number of splits, while fruit weight did not show any remarkable difference. Number of fruits plant⁻¹ (10.40), fruit yield (2.166 kg plant⁻¹) and yield (255.03 q ha⁻¹) were recorded significantly higher with 100 per cent RDN through drip irrigation with 8 splits.

Zhang *et al.* (2011) conducted a greenhouse experiment to study the yield and quality response of cucumber to nitrogen fertilization under subsurface drip irrigation in solar greenhouse at Shenyang (China) with three different nitrogen fertilization levels *i.e.* 300, 450 and 600 N kg ha⁻¹. The results of the experiment showed that, application of 600 kg N ha⁻¹ recorded maximum number of fruits, mean fruit weight and cucumber fruit yield. He stated that, the optimum nitrogen fertilizer application level (600 N kg ha⁻¹) was suitable for cucumber under subsurface drip irrigation in the solar greenhouse.

Jokinen *et al.* (2011) carried out experiment under open and semi closed plastic greenhouse to study the effect of split root fertigation on cucumber yield at MTT Agrifood Research Institute, Finland. They found that, split root

fertigation significantly increases number of leaves plant⁻¹, leaf fresh weight, number of fruits plant⁻¹, average fruit weight and marketable fruit yield under both open and semi closed greenhouse compared to traditional fertigation method.

Dai *et al.* (2011) conducted a field experiment to quantify the effect of nitrogen on fruit growth and yield of cucumber crop under greenhouse condition at Nanjing Agricultural University, Nanjing (China). They studied different N levels (17.5, 40, 80, 160 mg N L⁻¹). Findings of the experiment revealed that, application of 160 mg N L⁻¹ recorded significantly higher number of fruits plant⁻¹, fruit length and fruit yield of cucumber over the remaining N application rates.

Krup *et al.* (2011) carried out an experiment to study the response of cucumber to different levels of NPK fertilizers under soilless culture at Kuwait. They used NPK in the form of kristalone (18:18:18 % NPK) compound at different rates *i.e.* T₁- 2.5,5.0,7.5,10.0, T₂- 2.5,2.5,5.0,7.5, T₃- 2.5,5.0,12.5 and T₄- 5.0,7.5,10,12.5 g plant⁻¹ week⁻¹. Findings of the experiment revealed that, treatment T₂ registered significantly maximum vine length, number of leaves plant⁻¹, fruit volume, fruit girth, fruit length and fruit yield ha⁻¹ as compared to other treatments.

Heidari and Mohammad (2012) conducted a field experiment at University of Zabol (Iran) to evaluate the effect of rate and time of nitrogen application of fruit yield and accumulation of nutrient elements in *Memordica charantia*. They use three levels on N *viz.*, 75, 150 and 225 kg N ha⁻¹ and three time of application (T₁- ½ at 3-4 leaves and ½ before flowering, T₂- ½ at 3-4 leaves and ½ after fruit to start and T₃- 1/3 at 3-4 leaves, 1/3 before flowering and 1/3 after fruit to start). Findings of the experiment showed that application of 225 kg N ha⁻¹ registered significantly maximum fruit yield (1722.1 g m⁻²). Among the time of N application; treatment T₃ gave significantly maximum fruit yield (1334.7 g m⁻²). Significantly maximum accumulation of nutrients in plant and fruits was observed under application of 225 kg N ha⁻¹ and in treatment T₃.

Yang *et al.* (2013) carried out an experiment in Big Arch sheltered to study the effect of various nitrogen fertilizer and their levels on cucumber yield at Beijing University of Agriculture, Beijing. They revealed that, with increasing application rate of N kg ha⁻¹, yields were gradually increased (0, 350, 550, 750 kg N ha⁻¹).

Ng'etich *et al.* (2013) studied the effect of different rates of nitrogen fertigation on the growth and yield of zucchini (*Cucurbita pepo* Cv. *Diamamentt*) at Egerton University, Egerton (Kenya). Five N levels *viz.*, 0, 40, 80, 120 and 160 kg N ha⁻¹ were studied. The significantly maximum plant height, stem diameter, number of leaves, leaf area and leaf area index observed with application of nitrogen at 160 kg N ha⁻¹. Biomass yield was also found significantly higher with application of N at 120 and 160 kg N ha⁻¹. Maximum fruit yield was recorded with application of 120 kg N ha⁻¹ which was 86.0 % more than the control treatment.

Tiwari (2013) carried out greenhouse experiment at IGKVV, Raipur (C.G.) to study the impact of different fertigation levels on morpho-physiological traits and yield of cucumber. He studied five levels of RDF *viz.*, 60, 80, 100 and 120 per cent RDF along with control fertigation. Findings of the experiment revealed that, application of 120 per cent RDF exhibited significantly maximum vine length, days to first flowering and days to first fruiting while, application of 100 per cent RDF registered significantly maximum chlorophyll content, fruit length, average fruit weight and fruit yield ha⁻¹.

2.1.2 Physiological studies:

Premalakshmi *et al.* (1998) observed that the application of N and K at 150:100 kg ha⁻¹ recorded significantly maximum chlorophyll content in cucumber leaves.

Cengiz *et al.* (2005) studied the effect of three levels of K₂O (20, 40 and 60 g m⁻²) on cucumber crop and revealed that, application of 60 g m⁻² K₂O

recorded significantly maximum relative leaf water content and chlorophyll content.

Xiaoyu *et al.* (2009) conducted an experiment to study the changes in growth and photosynthetic capacity of cucumber seedlings in response to nitrate stress. They studied three treatments *viz.*, (CK) complete nutrient solution (control), (T₁) complete nutrient solution + Ca(NO₃)₂ 10.5 mmol L⁻¹ +KNO₃ 21 mmol L⁻¹ and (T₂) complete nutrient solution + Ca(NO₃)₂ 31.5 mmol L⁻¹+KNO₃ 63 mmol L⁻¹. They recorded maximum photosynthetic rate in treatment T₁. They found that, photosynthetic rate was substantially reduced with increasing nitrate levels. High nitrate concentration can impose both ionic and osmotic stresses on cucumbers. Stomatal closure, which increases the diffusive resistance to the entry of CO₂ into the leaf, is often a rapid initial response to salt stress and can result in reduction of photosynthetic rate.

Yang *et al.* (2009) studied the effect of three nitrate levels 14-CK, 56 (T₁) and 140 (T₂) mmol L⁻¹ on growth and photosynthetic capacity of cucumber seedlings at College of Horticulture Sciences and Technology, Shandong (China). The results showed that, at 12 days after treatment significantly maximum photosynthetic rate were found under 56 mmol L⁻¹ nitrate application followed by 14 CK. Application of 140 mmol L⁻¹ nitrate recorded significantly lowest rate of photosynthesis. This means that high levels of nitrate may reduce photosynthesis through its effect not only on stomatal conductance but also on the photosynthetic apparatus.

Hamid *et al.* (2009) studied the response of cucumber plant to NH₄ and NO₃ nutrition by using relative addition rate (RAR) technique at Vali-e-Asr University of Rafsanjan (Iran). The four RAR *viz.*, 0.15, 0.25, 0.35 and 0.45 day⁻¹ was studied. They found that, plant growth responded to increasing N supply upto RAR 0.35 day⁻¹. Significantly maximum relative growth rate was about 0.25 day⁻¹ with RAR 0.35 day⁻¹, which also registered maximum fresh plant weight.

Eifediyi and Remison (2009) revealed that the leaf area plant⁻¹ of cucumber increased significantly with increase in inorganic fertilizer application upto highest level (400 kg ha⁻¹).

Yang *et al.* (2010) revealed that, chlorophyll content of cucumber leaves increased with increasing K application rate. Significantly maximum chlorophyll content was recorded with application of 720 K₂O kg ha⁻¹.

Yinkun *et al.* (2010) studied the effect of water and nitrogen condition on photosynthesis and yield of cucumber in greenhouse. They revealed that, the relationship between photosynthetic rate and yield of cucumber showed a quadratic curve. With moderately reduced water and nitrogen application rate, the net photosynthetic rate of cucumber did not decrease significantly. In experiment, the highest yield was achieved with an irrigation quantity of 5190 m³·hm⁻² and nitrogen amount of 600 kg hm⁻². The general analysis showed that the optimization of water and nitrogen treatment resulted in a more rational management. This practice not only achieved a higher net photosynthetic rate and water use efficiency, but also a higher cucumber yield.

Li *et al.* (2010) studied the photosynthetic rate, transpiration rate and water use efficiency at different growth stages and yield of cucumber under different water and nitrogen levels in solar greenhouse to investigate the effect of water and nitrogen interaction on cucumber photosynthetic characteristics and production. The results showed that, photosynthetic rate and transpiration rate reach the highest in full fruit stage, while water use efficiency in primary fruit stages. Under conventional irrigation, photosynthetic rate and transpiration rate increase with increase in nitrogen rate and reach the highest under 7470 m³·hm⁻² irrigation quantity and 1200 kg·hm⁻² nitrogen rate (W₁N₁₂₀₀), but are not significantly different from those under W₂N₆₀₀ (irrigation quantity 5190 m³·hm⁻², and nitrogen rate 600 kg·hm⁻²).

Yang *et al.* (2010) conducted experiment in solar greenhouse to study the effect of potassium fertilization on photosynthetic rate of cucumber. There were five levels of K fertilizer K₂O (0, 240, 480, 720 and 960 kg ha⁻¹) tested.

The results of the experiment showed that, the higher net photosynthetic rate ($13.96 \text{ CO}_2 \text{ } \mu\text{mol m}^{-2}\text{s}^{-1}$) with application of K_2O at 720 kg ha^{-1} . With increasing K application rate photosynthesis of cucumber increased initially and then decreased.

Dai *et al.* (2011) studied the effect of different N levels (17.5, 40, 80, 160 mg N L^{-1}) on cucumber photosynthetic rate and observed that, application of 160 mg N L^{-1} recorded significantly higher photosynthetic rate ($23.2 \text{ } \mu\text{mol m}^{-2} \text{ s}^{-1}$) as compared to other N levels. They also revealed that, application of 160 mg N L^{-1} recorded significantly higher leaf area plant⁻¹ (m^{-2}) as compared to other N levels.

Zhang *et al.* (2011) observed that, the photosynthetic rate and transpiration increased with increasing N levels. Maximum photosynthetic rate ($28.23 \text{ } \mu\text{mol m}^{-2}\text{s}^{-1}$) and transpiration rate ($5.77 \text{ mmol m}^{-2}\text{s}^{-1}$) was recorded with application of 600 N kg ha^{-1} as compared to 300 and 400 N kg ha^{-1} .

2.1.3 Fruit Quality

Altunlu *et al.* (1999) found that the total soluble solids and titrable acidity increased with increasing N concentrations, while no change was noticed with respect to the different K concentrations.

Kaniszewski and Elkner (2002) studied quality of cucumber as affected by drip irrigation and fertigation and concluded that, the drip irrigation and N fertigation affected the quality of fresh and processed cucumbers. Increased nitrogen doses also increase fruit percentage with empty cavities while drip irrigation reduced the percentage of such fruits. The best quality indices were observed in fruits from treatments receiving 100 and 200 kg N ha^{-1} . Fruits from these treatments had olive-green colour and good consistency and flavour.

Sawant (2005) studied the response of cucumber fertigation under drip irrigation system and revealed that, among all fertigation fruit density increased with increase in fertilizer level and recorded maximum at 100 per cent RDN while, in same level of fertilizer, it was increased with increase in number of splits and recorded highest value with 8 splits.

Sharma *et al.* (2009) observed that the application 300 per cent RDF recorded significantly maximum flesh thickness (cm), total soluble solids ($^{\circ}$ brix) and total carbohydrates as compared to 100 and 200 per cent of RDF through fertigation.

Sumathi *et al.* (2011) carried out a field experiment at Horticulture College and Research Institute, TNAU, Coimbatore, to elucidate the effect of fertigation on quality of cucumber hybrid “NS-404”. The recommended dose of NPK at 150:75:75 kg ha⁻¹ was applied as fertigation of three doses *viz.*, 125, 100 and 75 % of RDF and compared with control (100 % soil application of normal fertilizers). Findings of the experiment revealed that, application of 100 per cent water soluble fertilizer registered significantly higher TSS (3.3⁰ brix), fruit firmness (3.42 kg cm⁻²), titrable acidity (0.25 %), ascorbic acid content (7.39 mg 100 g⁻¹) and moisture content (98.16 %) than 75 and 125 per cent fertigation and over the control.

2.1.4 Nutrient uptake

Papadopoulos (1986) conducted a greenhouse experiment to study the response of cucumber to three nitrogen levels, water containing 5.8, 11.8 and 17.8 m mol N L⁻¹ and uniformly supplied with 2.0 and 3.9 m mol N L⁻¹ of phosphorus and potassium, respectively, 2-3 times daily. The results of the experiment revealed that, total N and NO₃-N in laminae and petioles increased with increasing N levels whereas P and K content in general decreased.

Panagiotopoulos (2001) studied an effect of nitrogen fertigation on growth, yield and quality of melon in Southern Greece and showed that, the mineral nitrogen in the root zone increased significantly from 17 mg kg⁻¹ NO₃-N in the low N treatment to 50 NO₃-N mg kg⁻¹ in the highest N treatment, at fruit swelling. In both years, nitrogen concentration of the recently matured leaves at the initial fruit stage reached high level ranging between 5.0 and 5.3 per cent in 1991 and 4.8-4.9 per cent in 1992, while decreasing to 2.5-3.6 per cent at harvest time. The same trend was found for leaf P, K and Mg, but the opposite trend for Ca.

Guler and Ibrikci (2002) studied yield and elemental composition of cucumber as affected by drip and furrow irrigation at Adana (Turkey) and concluded that, irrigation treatments significantly affected leaf composition, resulting in higher leaf N, P and K contents in drip-fertigated plants, however soil K was affected by both treatments. Drip-fertigated plots had higher soil K compared to furrow-irrigated plots and increasing nitrogen level (200 ppm N) also increase in soil K.

Kotsiras *et al.* (2002) studied the effect of nitrogen concentrations on the distribution of ions within cucumber plant and fruits under greenhouse condition at Agricultural University of Athens (Greece). They studied three levels of N concentrations *viz.*, 100, 200 and 400 mg L⁻¹ in nutrient solution. They revealed that, plant and fruit N content increases with increasing levels *i.e.* maximum at 400 mg L⁻¹ but P and K content were significantly maximum in application of 100 mg N L⁻¹.

Dry matter accumulation in the plants during the crop growth period showed that there was linear increase in dry matter, nitrogen and phosphorus content with increase in fertilizer levels. Application of 150:90:90 kg NPK ha⁻¹ through fertigation also shows maximum uptake of N, P and K (kg ha⁻¹) (Choudhari and More, 2002)

Lee *et al.* (2005) conducted an experiment to study the effect of fertigation level and frequency on growth, yield and uptake of nutrients in cucumber at Seoul, Republic of Korea and showed that, N content in cucumber leaves was not significantly affected by fertigation frequency, whereas the content of the less mobile element such as P, K and Mg were significantly affected by fertigation frequency.

Suojala *et al.* (2005) carried out an experiment on nutrient demand and uptake by pickling cucumber under drip irrigation at Agrifood Research Station, Piikkio (Finland). They revealed that, fertilization with 120-140 kg ha⁻¹ of nitrogen is usually sufficient for producing high yield. A higher N level may give a small increase in fruit yield (5-10 %), but only under warmer growing

conditions and the N, P and K uptake in yield of 71-75 t ha⁻¹ was 88-106 kg ha⁻¹ of N, 21-25 kg ha⁻¹ of P and 157-163 kg ha⁻¹ of K, respectively.

Cengiz *et al.* (2005) revealed that, significantly higher N P K content in plant and fruit were observed under 60 g m⁻² K₂O application rate.

Kolota and Słociak (2006) revealed that, TSS, P, K, Ca, and Mg content in zucchini fruit were not influenced by nitrogen fertilization while N content in fruit significantly influenced by increasing N levels. Nitrate content in fruit was increased (3.39 to 4.19 %) with increasing N application rates.

Guler *et al.* (2006) recorded that, the application of 200 mg N l⁻¹ at twice per week via irrigation together with 200 mg K + 40 mg Mg + 2.5 mg Fe litre⁻¹ once a week was adequate in terms of leaf nutrient contents.

Al-Wable *et al.* (2006) revealed that, fertigation as a tool to improve nitrogen use efficiency and yield of cucumber at Almuzahemiah Research Station Riyadh (Saudi Arabia). There were five treatments, N₀ = control, soil Ns = 120 mg N L⁻¹ and three treatments labeled N¹⁵ (N₁ = 60, N₂ = 120 and N₃ = 180 mg N¹⁵ L⁻¹). The mean nitrogen use efficiency (NUE) based on fresh fruit yield was 72.7 kg kg⁻¹N for soil application, 129.53 kg kg⁻¹N for the N₁, 94.74 kg kg⁻¹ N for the N₂ and 102.82 kg kg⁻¹ N for the N₃ treatments. The NUE was significantly higher in the N₁ than all the other treatments. The mean concentration N¹⁵ varied *i.e.* ranged from 0.10 to 0.84 per cent (leaves), 0.05 to 0.85 per cent (shoot), 0.04 to 0.74 per cent (roots) and 0.07 to 0.82 per cent (fruits).

Meenakshi *et al.* (2008) carried out an experiment to study nutrient uptake and dry matter production as influenced by fertigation in bitter melon (*Momordica charantia* L.) at T.N.A.U., Tamil Nadu (India). The results revealed that, the application of 100 per cent macro and micronutrients in water soluble fertilizer form significantly increased the nutrient content and uptake of N, P, K and Fe and proved most superior over rest of the fertigation levels in case of content and uptake of N, P, K and Fe. Similarly, the same fertigation level *viz.*, application of 100 per cent macronutrient in combination with

micronutrient recorded the highest yield as compared to other fertigation levels and conventional method of fertilizer application.

Babaik and Kowalczyk (2009) revealed that cucumber plant nutrient content *viz.*, N, P and K influenced significantly due to different N levels. The highest N content was found in the plants fertilized with a fertigation medium containing the highest concentration of N-NO₃ at 350 mg dm⁻³.

2.1.5 Economics

Singh *et al.* (2002) studied the effect of fertilizer dose on fruit yield and economics of off season cucumber cultivation under low cost polyhouse. Different doses of NPK were used to grow cucumber under low cost polyhouse during 1998-1999 and 1999-2000, to ascertain the optimum dose of NPK so as to get the maximum yield of good quality fruits at PAU, Punjab. Results revealed that, an application of NPK @ 175:60:60 kg ha⁻¹ obtained maximum net returns (₹ 91.86 m⁻²) as compared to other fertilizer doses.

Singh and Kumar (2006) studied the techno-economic feasibility of naturally ventilated greenhouse for year round cucumber cultivation. They revealed that, growing of cucumber through out the year under greenhouse was economical with B:C ratio of 2.06 in the northern plains of India.

Greenhouse trials conducted at the Indo-Israel project of IARI, New Delhi under which an indigenously designed naturally ventilated greenhouse was evaluated for its techno-economic feasibility for year round cultivation of cucumber. Findings of the experiment showed the cost: benefit ratio of 1: 2.29 and concluded that, the low cost naturally ventilated greenhouses were more suitable and economical for year round cucumber cultivation (Singh *et al.*, 2007).

Satpute *et al.* (2008) observed that application of 80 per cent RDF to cucumber crop obtained significantly maximum net income (₹ 44,580 ha⁻¹) and maximum B:C ratio (1.94) as compared to rest of the treatments.

Janapriya *et al.* (2010) revealed that, application of 100 per cent RDF to cucumber crop along with different growing media was recorded maximum B:C ratio (3.43) as compared to application of 80 per cent RDF.

Shinde *et al.* (2010) conducted an experiment on response of cucumber to fertigation under drip irrigation system and observed that, in treatment 100 per cent RDN through fertigation with 8 number of splits obtained maximum net returns (₹ 71465.6 ha⁻¹) and benefit:cost ratio of 3.34.

2.1.6 Correlation studies

Christopher *et al.* (2000) carried out an experiment on correlation studies in cucumber at Las Cruces University (New Mexico). They revealed that, the number of branches per plant had a direct positive effect on yield and was correlated with the number of total fruit per plant. The number of nodes per branch, the percentage of pistillate nodes, and the percentage of fruit set were less correlated with total fruit number per plant than the number of branches per plant. Weak correlations between yield components and fruit yield often resulted from weak correlations among yield components. The correlations among fruit number traits were generally strong and positive.

Hanchinamani and Patil (2009) studied the correlation studies in cucumber at Karnataka (India). They revealed that, fruit yield had positive and highly significant association phenotypically and genotypically with vine length, internodal length, number of branches per vine, number of nodes per vine, fruit length, fruit diameter, flesh thickness, dry weight of fruit, average fruit weight, number of marketable fruits per vine, number of unmarketable fruits per vine and total number of fruits per vine.

Eifediyi *et al.* (2011) studied the relationship between morphological characters, dry matter yield and fruit yield of cucumber at Ekpoma (Nigeria). The analyses of the relationship between yield and yield components indicated a strong positive relationship between growth factors, dry matter accumulation, yield and yield components except fruit weight per plant that had a negative correlation. This indicates that leaf area, number of leaves, dry matter

accumulation are important factors in yield formation in crops. The positive correlation between total yields and the other growth factors, dry matter weights, yield and yield components except fruit weight per plant indicates that total yield and other yield components were dependent on growth factors and dry matter accumulation.

An experiment was carried out by Arunkumar *et al.* (2011) to study the association of yield and yield components of cucumber. Findings of the experiment revealed that, total fruit yield vine⁻¹ showed highly significant and positive correlation with total number of fruits vine⁻¹, average fruit weight, fruit length, fruit diameter, number branches vine⁻¹, number of nodes per vine and vine length. While, it was significantly and negatively correlated with days to first female flower initiation and days to first fruit harvest.

Veena *et al.* (2013) studied the character association for fruit yield and yield traits in cucumber at University of Agricultural Sciences, Bengaluru (Karnataka) and revealed that, numbers of fruits vine⁻¹, fruit length, average fruit weight, flesh thickness and seed cavity had significant positive correlation fruit yield vine⁻¹. They observed that seed cavity breadth, flesh thickness, average fruit weight, number of fruits vine⁻¹ had positive direct effects on fruit yield while days to first female flower opening, days to first fruit harvest and fruit breadth had negative effect on yield.

3. MATERIAL AND METHODS

The present experiment entitled “Effect of different fertigation levels and schedules on growth, yield and quality of cucumber (*Cucumis sativus* L.) under polyhouse condition” was carried out at Instructional Farm of Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri during *rabi* season of 2011-12 and 2012-13.

The details of material used and methods adopted during the course of investigation are as follows.

3.1 Details of experimental material

3.1.1 Experimental site

The experiment was carried out at Instructional Farm of Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra) during *rabi* season of 2011-12 and 2012-13.

3.1.2 Polyhouse

Open Ventilated Polyhouse (28 m x 28 m size) erected at Instructional Farm of Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri was used to conduct the experiment. GH-1 type and U.V. stabilized 200 μ m thickness polyhouse film was used as cladding material. The ventilators were kept on all four sides of polyhouse covered by anti insect nets. To cover ventilators manually operated moveable curtains were provided on sidewalls. For control of temperature and humidity misting system was provided.

3.1.3 Soil

The soil used for the experiment in polyhouse was red sandy clay and well drained. Representative and composite soil sample was collected from experimental site for assessing the initial soil fertility status of the soil. The soil sample was analyzed in laboratory for determination of physical and chemical properties by adopting standard analytical methods (Table 3.1).

Data presented in Table 3.1 revealed that, the soil physical properties viz., field capacity, permanent wilting point and bulk density were 22.18 %, 11.06 % and 1.40 g cm^{-3} , respectively. The soil chemical properties such as pH, EC and organic carbon content were 7.72, 0.25 dSm^{-1} at 25°C and 0.57 per cent, respectively. The soil was moderate in available nitrogen ($279.11 \text{ kg ha}^{-1}$), medium in available phosphorus (18.81 kg ha^{-1}) and very high in available potassium ($358.42 \text{ kg ha}^{-1}$) and moderate in Fe (12.62 mg kg^{-1} soil), Mn (19.46 mg kg^{-1} soil), Zn (0.56 mg kg^{-1} soil) and Cu (2.53 mg kg^{-1} soil).

Table 3.1 Physical and chemical composition of experimental site

Sr. No	Characteristics	Composition	Method used	Reference /s
I. Physical properties				
1.	Coarse sand (%)	44.37	International pipette method	Piper, (1966)
2.	Fine sand (%)	18.13		
3.	Silt (%)	20.09		
4.	Clay (%)	16.91		
5.	Textural class	Sandy clay		
II. Soil moisture constants				
1.	Field capacity (%)	22.18	Pressure plate apparatus	Richards, (1947)
2.	Permanent wilting point (%)	11.06	Pressure plate apparatus	Richards, (1947)
3.	Bulk density (g cm^{-3})	1.40	Core sampler	Dastane, (1972)
III. Chemical properties				
1.	Soil pH (1:2.5)	7.72	Potentiometry	Piper, (1966)
2.	EC (dSm^{-1})	0.25	Conductometry	Piper, (1966)
3.	Organic carbon (%)	0.57	Wet oxidation	Nelson and Sommer, (1982)
4.	Available Nitrogen (kg ha^{-1})	279.11	Modified alkaline permanganate	Saharawat and Burford, (1982)
5.	Available Phosphorus (kg ha^{-1})	18.81	Ascorbic acid reduced molybdophosphatic blue colour in sulphuric acid	Watnabe and Olsen, (1965)

6.	Available Potassium (kg ha ⁻¹)	358.42	Flame photometer	Knudsen <i>et al.</i> ,(1982)
7.	Available Fe (mg kg ⁻¹ soil)	12.62	Atomic absorption Spectrophotometer	Lindsay and Norvell, (1978)
8.	Available Mn (mg kg ⁻¹ soil)	19.46		
9.	Available Zn (mg kg ⁻¹ soil)	0.56		
10.	Available Cu (mg kg ⁻¹ soil)	2.53		
IV Plant analysis				
1.	N (%)	-	Micro-kjeldhal method	A. O. A. C., (2005)
2.	P (%)	-	Vandamolybdate yellow colour in nitric acid system	Jackson, (1973)
3.	K (%)	-	Flame photometer	A. O. A. C., (2005)

3.1.4 Climatic conditions

A. General

Geographically, the Central Campus of Mahatma Phule Krishi Vidyapeeth, Rahuri is situated between 19^o47' and 19^o57' N latitude and between 74^o19' and 74^o32' E longitude. The altitude varies from 495 to 555 m above the mean sea level.

The average annual rainfall is 520 mm; which is mostly concentrated during monsoon months from June to October from South-West monsoon which is nearly 80 per cent of the total rainfall. The distribution of rainfall is erratic with 15 to 45 rainy days. The tract is under the rain shadow area lying on Eastern sides of Western Ghats. Agroclimatically falls under Scarcity Zone of Maharashtra state.

B. Nature and season during experimental period

The meteorological data on important weather parameters during the crop growth period for the year 2011-12 and 2012-13 was obtained from Meteorological Observatory located at Water Management Project, Mahatma

Phule Krushi Vidyapeeth, Rahuri and presented in Table 3.2 and 3.3, respectively and graphically depicted in Fig. 3.1 and 3.2.

a. Season of 2011-12

There was no rainfall received during the experimental period of November, 2011 to May, 2012. The mean maximum and minimum temperature ranged from 26.4 °C to 38.8 °C and 7.0 °C to 22.0 °C, respectively. The maximum temperature (38.8 °C) was observed during 18th meteorological week, where as minimum temperature (7.0 °C) was noticed during 2nd meteorological week. The mean weekly morning relative humidity ranged from 36.0 to 82 per cent while, evening humidity ranged from 11 to 66 per cent. The maximum relative humidity (82 %) was observed during 1st meteorological week at morning hours, where as minimum relative humidity (11 %) was noticed during 12th meteorological week at evening hours. The maximum pan evaporation (9.7 mm) was observed during 15th meteorological week, while minimum (3.1 mm) during 52nd meteorological week. The mean wind velocity ranged between 1.2 to 3.3 km hr⁻¹. The bright sunshine hours during crop growth period ranged from 8.0 to 10.6 hrs. throughout the crop growth period.

b. Season of 2012-13

There was no rainfall received during the experimental period of November, 2012 to May, 2013. The mean maximum and minimum temperature ranged from 29.1 °C to 40.8 °C and 10.1 °C to 24.4 °C, respectively. The maximum temperature (40.8 °C) was observed during 18th meteorological week, where as minimum temperature (10.1 °C) was noticed during 2nd meteorological week. The mean weekly morning relative humidity ranged from 36.0 to 68 per cent while, evening humidity ranged from 14 to 54 per cent. The maximum relative humidity (68 %) was observed during 5th meteorological week at morning hours, where as minimum relative humidity (14 %) was noticed during 14th and 15th meteorological week at evening hours. The maximum pan evaporation (10.5 mm) was observed during 18th meteorological week, while minimum (3.8 mm) during 2nd and 5th meteorological week.

Table 3.2 Meteorological data recorded during the experimental period (2011 –12)

Met. week	Date	Temperature (°C)		Relative humidity (%)		Evapo-ration (mm)	Sun-shine (hrs.)	Wind speed (km hr. ⁻¹)
		Max.	Min.	Morn.	Even.			
November, 2011								
45	07-13	32.4	14.3	57	29	5.5	9.7	1.2
46	14-20	31.8	13.5	65	28	5.4	9.6	1.5
47	21-27	30.7	11.3	69	27	4.3	9.4	2.3
48	28-04	31.3	15.3	66	28	4.0	9.2	2.0
December, 2011								
49	05-11	31.7	13.2	72	36	4.1	9.3	1.3
50	12-18	30.1	11.6	65	29	3.7	8.8	1.2
51	19-25	29.8	10.2	69	29	3.5	9.0	1.0
52	26-01	30.2	11.8	75	28	3.1	9.2	1.2
January, 2012								
1	02-08	31.8	13.5	82	64	4.1	8.3	1.2
2	09-15	26.4	7.0	55	26	3.8	10.0	1.6
3	16-22	28.7	8.6	61	26	4.2	9.9	1.5
4	23-29	29.0	13.7	64	32	3.8	8.5	1.4
5	30-05	29.1	12.8	66	32	3.7	8.9	1.3
February, 2012								
6	06-12	29.8	9.6	66	54	3.4	9.5	1.7
7	13-19	31.9	11.9	72	54	5.3	9.4	1.4
8	20-26	34.3	13.7	70	48	6.0	9.7	1.7
9	27-04	31.2	12.2	73	66	6.6	9.4	2.0
March, 2012								
10	05-11	33.1	10.9	47	15	8.0	9.6	2.6
11	12-18	35.3	13.9	37	15	8.2	9.4	2.1
12	19-25	37.6	15.0	40	11	8.5	8.7	2.0
13	26-02	38.1	16.7	36	13	8.3	8.6	1.7
April, 2012								
14	03-09	38.4	19.5	45	15	9.6	8.8	3.3
15	10-16	38.6	20.7	44	17	9.7	9.0	2.7
16	17-23	37.1	22.0	51	24	8.0	8.0	2.8
17	24-30	37.6	19.7	40	16	9.3	10.1	3.3
18	31-06	38.8	19.3	42	15	8.7	10.6	2.9
May, 2012								
19	07-13	37.9	21.8	62	25	8.3	9.7	2.6
20	14-20	38.9	19.8	45	15	7.9	11.2	3.1

**Table 3.3 Meteorological data recorded during the experimental period
(2012 –13)**

Met. Week	Date	Temperature (°C)		Relative humidity (%)		Evapra- tion (mm)	Sun- shine (hrs.)	Wind speed (km hr. ⁻¹)
		Max.	Min.	Morn.	Even.			
November, 2012								
45	05-11	31.7	14.9	62	34	5.4	9.0	1.1
46	12-18	30.2	12.7	56	29	5.2	8.7	1.2
47	19-25	30.0	11.3	52	29	5.4	8.9	1.2
48	26-02	31.8	13.6	56	31	4.5	8.8	0.6
December, 2012								
49	03-09	31.3	12.6	52	30	4.0	8.7	1.2
50	10-16	31.4	12.4	60	27	4.6	9.4	0.9
51	17-23	29.9	11.2	55	28	4.2	9.1	1.2
52	24-30	32.4	20.5	62	54	4.3	7.2	1.5
January, 2013								
1	31-06	31.3	11.2	56	31	4.3	8.6	1.2
2	07-13	29.1	10.1	49	31	3.8	9.0	0.8
3	14-20	30.4	11.7	50	32	4.2	9.2	1.5
4	21-27	30.2	13.5	62	32	4.4	8.2	1.0
5	28-03	31.7	15.9	68	33	3.8	6.3	1.1
February, 2013								
6	5-11	30.9	15.2	59	35	4.4	7.8	1.8
7	12-18	31.9	14.5	59	31	5.6	8.4	2.0
8	19-25	33.4	12.5	53	20	6.3	9.9	1.9
9	26-4	33.8	13.6	40	26	6.6	10.2	2.2
March, 2013								
10	5-11	35.1	13.6	46	16	7.3	9.5	1.9
11	12-18	35.4	17.2	43	20	7.9	8.6	2.1
12	19-25	36.5	16.5	36	26	8.2	8.9	2.1
13	26-1	36.5	18.0	51	21	7.8	8.4	2.7
14	2-8	37.6	16.8	50	14	9.1	9.4	2.7
April, 2013								
15	9-15	39.0	20.2	49	14	9.0	9.3	2.5
16	16-22	37.0	16.1	55	20	9.4	10.1	4.1
17	23-29	38.9	21.7	51	18	10.0	10.4	3.6
18	30-6	40.8	22.7	42	15	10.5	10.6	4.3
May, 2013								
19	7-13	40.1	22.4	38	17	9.9	10.6	5.2
20	14-20	39.3	24.4	47	21	10.2	10.1	5.0

The mean wind velocity ranged between 0.6 to 5.2 km hr⁻¹. The bright sunshine hours during crop growth period ranged from 6.3 to 10.6 hrs. throughout the crop growth period. By and large, during both the seasons the weather condition was not suitable for crop growth under open field condition because of off season (winter season) but the favourable climatic situation was maintained in open ventilated polyhouse during the experimental period.

3.2. Cropping history of experimental plot (Polyhouse)

The cropping history of experimental plot (polyhouse) for previous two years are presented in Table 3.4.

Table 3.4 Cropping history of experimental plot (polyhouse)

Sr. No.	Year	Season		
		<i>Kharif</i>	<i>Rabi</i>	Summer
1.	2009-10	-	Capsicum	Capsicum
2.	2010-11	Capsicum	Capsicum	Capsicum
3.	2011-12	Capsicum	Cucumber*	Cucumber*

* Present investigation

3.3 Treatment details

The experiment consists of nine treatments combinations with three fertigation levels and three fertigation schedules. The treatments were replicated three times in Factorial Completely Randomized Design (FCRD). The plan of layout used for experimentation is depicted in Plate 3.1 The details of the treatments and symbol used are presented in Table 3.5.

Table 3.5 Details of treatments and symbols used

Sr.No.	Treatment	Symbol
A.	Fertigation level	
1.	75 % of RDF*	F ₁
2.	100 % of RDF	F ₂
3.	125 % of RDF	F ₃
B.	Fertigation schedule (up to 110 days)	
1.	Fertigation of recommended dose of N and K at every two days interval in equal splits (52 equal splits)	S ₁
2.	Fertigation of recommended dose of N and K at every four days interval in equal splits (26 equal splits)	S ₂
3.	Fertigation of recommended dose of N and K at every six days interval in equal splits (18 equal splits)	S ₃

RDF* = Recommended dose of fertilizer (100:50:50 kg N:P₂O₅:K₂O ha⁻¹)

Note:

- 100 per cent recommended dose of phosphorus was applied before sowing of crop through single super phosphate to all treatments as a basal dose.
- Fertigation was started at 6 days after sowing.

3.3.1 Other details of experiment

1. Crop : Cucumber
2. Variety : Gypsy (Hybrid)
3. Layout : Broad Bed Furrow (BBF)
4. Design : Factorial Completely Randomized Design (FCRD)
5. Replications : Three
6. Recommended dose of fertilizers : 100:50:50 kg N:P₂O₅:K₂O ha⁻¹
+ 20 t FYM ha⁻¹

7. Time of sowing : I- Season: 11th November, 2011
II- Season: 11th November, 2012
8. Spacing : 60 cm – 90 cm × 50 cm
9. Plot size : Gross : 8.0 m × 3.0 m
Net : 8.0 m × 3.0 m

3.4 Addition of farmyard manure and fumigation

The required quantity of farmyard manure (2.0 kg m⁻²) was applied 15 days before preparation of Broad Bed Furrows in polyhouse.

This homogenous mixture of soil and FYM within polyhouse was disinfected with 2 per cent Formalin (20 ml L⁻¹) by saturating the soil with application of diluted Formalin (meq L⁻¹) @ 4 liter of solution m⁻³, immediately after treating the soil, the entire area was covered with black polythene sheet for 7 days and thereafter irrigated twice to remove chemical residues of Formalin if any. Formalin treatment to polyhouse soil was done to sterilize the soil and added FYM and the overcome the soil borne diseases.

3.5 Preparation of bed

Raised beds of 45 cm height, 24 m length and 1.20 m width were prepared with drainage space of 30 cm between beds.

3.6 Seeds and sowing

The required quantity of seeds of cucumber procured from the Agriculture Service Centre, Rahuri, Dist. Ahmednagar (M.S.) for present investigation. The sowing was done on 11th November, 2011 during first season and 11th November, 2012 during second season in pair row system at a spacing of 60 cm - 90 cm × 50 cm.

**Table 3.6 Schedule of cultural operations carried out in the experimental site
(2011-12)**

Sr. No.	Field operation	Frequency	Date of operation
A.	Preparatory tillage		
1.	Addition of FYM	1	01-11-2011
2.	Fumigation	1	01-11-2011
3.	Preparation of bed	1	08-11-2011
4.	Installation of drip irrigation system	1	10-11-2011
B.	Sowing		
1.	Application of basal dose of phosphorus	1	11-11-2011
2.	Dibbling of cucumber seeds	1	11-11-2011
C.	Post sowing operations		
1.	Gap filling	1	18-11-2011
2.	Trailing	-	25-12-2011 to last picking at an interval of 6 days
3.	Weedings	5	15-12-2011, 09-01-2012, 27-01-2012, 05-03-2011, 13-04-2014
4.	Irrigation	-	At every alternate day
D.	Fertigation		
a.	Fertigation of recommended dose of N and K at every two (2) days interval up to 110 days	52	As per treatment
b.	Fertigation of recommended dose of N and K at every four (4) days interval up to 110	26	As per treatment
c.	Fertigation of recommended dose of N and K at every six (6) days interval up to 110 days	18	As per treatment
E.	Plant protection		
a.	Spraying		

1.	Trizophos 40 EC	1	04-12-2011
2.	Thiomethoxam 36 % WG + Mancozeb 64 % WP	1	29-12-2011
3.	Acetamiprid 20% sp + Penaconazole 23% EC	1	09-01-2012
4.	Imidacloprid 17.8 SL + Carbendazim 70% wp	1	23-01-2012
5.	Profenophos 50 EC	1	11-02-2012
6.	Fipronil 4.0 SC	1	27-02-2012
7.	Thiomethoxam 36 % WG + Pinaconazole 23 % EC+Pyromite	1	15-03-2012
8.	Dimethoate 30 EC	1	13-04-2012
b.	Drenching		
1.	Carbendazim 70% wp + Captan 70 % wp	1	16-12-2011
2.	Hexaconazole 5% EC	1	23-01-2012
3.	Copper oxychloride 50% WP	1	19-02-2012
F.	Harvesting	20	24.01.2012, 30.01.2012, 04.02.2012, 09.02.2012 14.02.2012, 21.02.2012, 25.02.2012, 28.02.2012, 04.03.2012, 10.03.2012, 16.03.2012, 22.03.2012, 25.03.2012, 30.03.2012, 06.04.2012, 13.04.2012, 13.04.2012, 21.04.2012, 28.04.2012, 03.05.2012

Table 3.7 Schedule of cultural operations carried out in the experimental site (2012-13)

Sr. No.	Field operation	Frequency	Date of operation
A.	Preparatory tillage		
1.	Addition of FYM	1	30-10-2012
2.	Fumigation	1	30-10-2012
3.	Preparation of bed	1	07-11-2012
4.	Installation of drip irrigation system	1	10-11-2011
B.	Sowing		
1.	Application of basal dose of phosphorus	1	11-11-2012
2.	Dibbling of cucumber seeds	1	11-11-2012
C.	Post sowing operations		
1.	Gap filling	1	17-11-2012
2.	Trailing	-	19-12-2012 to last picking at an interval of 6 days
3.	Weedings	4	29-11-2012, 28-01-2013, 14-03-2103, 18-04-2013
4.	Irrigation	-	at every alternate day
D.	Fertigation		
a.	Fertigation of recommended dose of N and K at every two (2) days interval up to 110 days	52	As per treatment
b.	Fertigation of recommended dose of N and K at every four (4) days interval up to 110	26	As per treatment
c.	Fertigation of recommended dose of N and K at every six (6) days interval up to 110 days	18	As per treatment
E.	Plant protection		
a.	Spraying		
1.	Spinosad 45 SC	1	28-11-2012

2.	Profenophos 50 EC + Mancozeb 64 % WP	1	19-12-2012
3.	Thiomethoxam 36 % WG	1	09-01-2013
4.	Imidacloprid 17.8 SL + Carbendazim 70% wp	1	21-01-2013
5.	Acetamiprid 20% sp + Pinaconazole 23 % EC	1	8-02-2013
6.	Carbosulphuran 30 % EC + Tubeconazole 25% EC + Pyromite	1	15-03-2013
b.	Drenching		
1.	Carbendazim 70% wp + Captan 70 % wp	1	10-12-2012
2.	Hexaconazole	1	09-01-2013
3.	Copper oxychloride 50% WP + Carbendazim 70% wp	1	28-02-2013
F.	Harvesting	19	28.01.2013, 01.02.2013, 04.02.2013, 11.02.2013, 15.02.2013, 21.02.2013, 25.02.2013, 28.02.2013, 05.03.2013, 12.03.2013, 16.03.2013, 22.03.2013, 27.03.2013, 03.04.2013, 09.04.2013, 15.04.2013, 22.04.2013, 27.04.2013, 01-05-2013

3.7 Fertigation

The recommended dose of phosphorous was applied before sowing of crop through single super phosphate (16 % P₂O₅) to all plots as per treatment as a basal dose. After the emergence of the seed (6 days after the sowing) the fertigation of recommended dose of nitrogen and potassium (100 kg N + 50 kg K₂O ha⁻¹) was started through Automatic Fertigation Unit as per the treatments. For treatment F₁, 52 splits were applied, for treatment F₂, 26 splits were applied whereas for treatment F₃, 18 splits were applied. The fertigation was done through using 13:00:45 (% N:P₂O₅:K₂O) grade of water soluble fertilizer and urea (46.6 % N). The details of fertigation schedule are presented in Table 3.8.

3.8 Cultural operations

Details of cultural operations carried out during the experimental period are presented in Table 3.6 and 3.7.

3.8.1 Gap filling

To maintain the optimum plant population, gap filling was carried out one week after sowing during both the years on 18.11.2011 and 18.11.2012, respectively.

3.8.2 Irrigation

Irrigation was applied at every alternate day starting from sowing to the last picking.

3.8.3 Weeding

To keep the experimental plot weed free throughout the growing season, five hand weedings during first year and four during second year were carried out as given in Table 3.6 and 3.7.

Table 3.8 Details of fertigation schedule for cucumber

Treatment	Number of splits	Sources of water soluble fertilizer	Quantity of WSF added split ⁻¹ (kg ha ⁻¹)	Nutrient added split ⁻¹ (kg ha ⁻¹)	
				N	K ₂ O
T ₁ : 75 % RDF	52 splits	13.00.45	1.60	0.17	0.69
		Urea	2.60	1.22	-
T ₂ : 75 % RDF	26 splits	13.00.45	3.20	0.35	1.39
		Urea	5.21	2.43	-
T ₃ : 75 % RDF	18 splits	13.00.45	4.63	0.52	2.08
		Urea	7.64	3.65	-
T ₄ : 100 % RDF	52 splits	13.00.45	2.14	0.35	1.04
		Urea	3.65	1.74	-
T ₅ : 100 % RDF	26 splits	13.00.45	4.27	0.52	1.91
		Urea	7.64	3.65	-
T ₆ : 100 % RDF	18 splits	13.00.45	6.17	0.87	2.78
		Urea	10.42	4.86	-
T ₇ : 125 % RDF	52 splits	13.00.45	2.67	0.35	1.22
		Urea	4.51	2.08	-
T ₈ : 125 % RDF	26 splits	13.00.45	5.34	0.69	2.43
		Urea	8.85	4.17	-
T ₉ : 125 % RDF	18 splits	13.00.45	7.72	1.04	3.47
		Urea	13.02	6.08	-

3.8.4 Plant protection

To avoid the incidence of pests *viz.*, leaf minor, spodoptera aphids, jassids, thrips, white fly and mites different sprayings of recommended insecticides were undertaken at time to time. Similarly, to avoid the incidence of diseases *viz.*, downy mildew, powdery mildew, and wilting, sprayings and drenching of fungicides was carried out as per the need as given in Table 3.6 and 3.7.

3.8.5 Polyhouse management

Open Ventilated Polyhouse assembled with side ventilation was managed for providing favourable environment for healthy growth of cucumber. Side ventilations were closed at evening with the rollable polyethylene sheet to protect the cucumber crop from prevailing low night temperatures. Again in the morning everyday side ventilators were opened to provide favourable temperature and aeration for healthy crop growth. Cucumber crop was also protected from prevailing high temperatures during summer months with the help of white colored shadenet and fogger system which was erected beneath the roof of polyhouse.

The vertical trailing was done in cucumber vines, for which iron rods are fitted at 5 and 10 feet height from the ground vertically at a distance of every 6 meter. The vines from all the treatments were trailed first up to 5 feet height during vegetative stage by using nylon threads and after flowering up to 10 feet height. The trailing of vine was continued till last picking,

3.9 Details of observation

3.3.1 Biometric observations

Details of biometric observations recorded during the growth period are presented in Table 3.9.

3.3.1.1 Sampling techniques

For recording various growth observations five plants were selected randomly from each net plot. The plastic coated labels were tied to each observational plant for easy identification. The biometric observations were

recorded periodically from these five plants. The detail schedule adopted for recording various growth observations are presented in Table 3.9.

3.3.1.2 Plant population

The initial and final plant population was recorded by counting the number of plants from each plot at 10 days after sowing and at last picking, respectively.

3.3.1.3 Vine length (cm)

The length for each observational vine was recorded in centimeter from base of vine to the longest vine tip with the help of measuring tape at 15, 30, 45, 60, 75, 90, 105, 120 and 135 DAS and at last picking.

3.3.1.4 Number of functional leaves vine⁻¹

Total number of leaves for each observational vine were counted at 15, 30, 45, 60, 75, 90, 105, 120 and 135 DAS and at last picking.

3.3.1.5 Number of branches vine⁻¹

Total number of primary branches for each tagged vine were counted at 30, 45, 60, 75, 90, 105, 120 and 135 DAS and at last picking.

3.3.1.6 Days to first female flower initiation

Number of days required to first female flower initiation was recorded for each treatment plot.

3.3.1.7 Node number at which first female flower appeared

The node number at which first female flower appeared was recorded for each treatment plot.

3.3.1.8 Internodal distance (cm)

The internodal distance was recorded for each treatment plot with the help of measurement scale and expressed in centimeters.

3.3.1.9 Dry matter (g vine⁻¹)

Five plants from each treatment were uprooted after completion of last picking and separated leaf, stem and branches. Then they were chopped into small pieces to enable sun drying and then dried in hot air oven at 65 °C temperature till

obtained constant weight. The oven dry weight of stem along with leaves and branches was used to work out dry matter plant⁻¹ and expressed in gram.

3.3.2 Physiological studies

3.3.2.1 Leaf area vine⁻¹ (dm²)

The functional leaf area were measured with the help of Automatic Leaf Area Meter (Model *Biovis* AM-100) at 30, 60, 90 and 120 DAS and at last picking. For this purpose three leaves (lower, middle and upper) from a plant in net plot were brought to laboratory and leaf area of each individual leaf was measured with the help of leaf area meter. Then leaf area plant⁻¹ was worked out by multiplying leaf area of each group with number of leaves of that group and summation of all three groups and expressed in decimeter square.

Table 3.9 Details of biometric and other observations recorded during experimentation

Sr. No.	Particulars	Frequency	Days after sowing	Sample size
A	Plant Count			
1	Initial	1	10 DAS	All plants
2	Final	1	at last picking	All plants
B	Growth observations			
1	Vine length (cm)	10	At 15, 30, 45, 60, 75, 90, 105 120 and 135 DAS and at last picking	5 plants
2	Number of functional leaves vine ⁻¹	10	At 15, 30, 45, 60, 75, 90, 105 120 and 135 DAS and at last picking	5 plants
3	Number of branches vine ⁻¹	9	At 30, 45, 60, 75, 90, 105 120 and 135 DAS and at last picking	5 plants
4	Days to first female flower initiation	1	-	All plants
5	Node number at which first female flower appears	1	-	
6	Internodal distance (cm)	1	at last picking	5 plants

7	Dry matter (g vine ⁻¹)	1	at last picking	5 plants
C	Physiological observations			
1	Leaf area vine ⁻¹ (dm ²)	5	At 30, 60, 90, and 120 DAS and at last picking	5 plants
2	Total chlorophyll content (%)	9	At 15, 30, 45, 60, 75, 90, 105 and 120 DAS and at last picking	5 plants
3	Leaf water potential (Ψ)	5	30, 60, 90, 120 DAS & at last picking	5 plants
4	Photosynthetic rate (μ mol m ⁻² s ⁻¹)	9	At 15, 30, 45, 60, 75, 90, 105, 120 and 135 DAS	5 plants
5	CO ₂ concentration (μ mol CO ₂ m ⁻² s ⁻¹)	9	At 15, 30, 45, 60, 75, 90, 105, 120 and 135 DAS	5 plants
6	Stomatal conductance (μ mol m ⁻² s ⁻¹)	9	At 15, 30, 45, 60, 75, 90, 105, 120 and 135 DAS	5 plants
7	Transpiration rate (m mol H ₂ O m ⁻² s ⁻¹)	9	At 15, 30, 45, 60, 75, 90, 105, 120 and 135 DAS	5 plants
8	Stomatal resistance (μ mol m ⁻² s ⁻¹)	9	At 15, 30, 45, 60, 75, 90, 105, 120 and 135 DAS	5 plants
9	Leaf temperature (°C)	9	At 15, 30, 45, 60, 75, 90, 105, 120 and 135 DAS	5 plants
D	Post harvest studies			
1	Days to first fruit harvest	1	At first picking	-
2	Number of fruits vine ⁻¹	-	At each picking	5 fruits
3	Fruit length (cm)	-	At each picking	5 fruits
4	Fruit girth (cm)	-	At each picking	5 fruits
5	Weight of fruit (g)	-	At each picking	5 fruits
6	Fruit weight vine ⁻¹ (kg)	-	At each picking	5 fruits
7	Days to last fruit harvest	-	At each picking	5 plants
8	Fruit yield plot ⁻¹ (kg)	-	At each picking	All plants
E	Fruit quality			
1	Fruit skin colour	-	At each picking	5 fruits

2	Fruit strip colour	-	At each picking	5 fruits
3	Fruit shape	-	At each picking	5 fruits
4	Density of fruit (g/cm ³)	-	At each picking	5 fruits
5	Fruit bitterness	-	At each picking	5 fruits
6	Presence of placental cavity	-	At each picking	5 fruits
7	Flesh thickness (cm)	-	At each picking	5 fruits
8	Total soluble solids (⁰ Brix)	-	At each picking	5 fruits

3.3.2.2 Total chlorophyll content

Chlorophyll content was recorded by using the Spadometer (SPAD 502) at 15, 30, 45, 60, 75, 90, 105, 120 and 135 DAS and expressed in per cent.

3.3.2.3 Leaf water potential (Ψ)

The leaf water potential in cucumber leaves was measured with the help of Plant Water Console instrument at 30, 60, 90, 120 and 135 DAS.

3.3.3.4 Physiological parameters.

The photosynthetic rate ($\mu \text{ mol m}^{-2} \text{ s}^{-1}$), CO₂ concentration ($\mu \text{ mol m}^{-2} \text{ s}^{-1}$), stomatal conductance ($\mu \text{ mol H}_2\text{O m}^{-2} \text{ s}^{-1}$), transpiration rate ($\text{m mol H}_2\text{O m}^{-2} \text{ s}^{-1}$), stomatal resistance ($\mu \text{ mol H}_2\text{O m}^{-2} \text{ s}^{-1}$), and leaf temperature ($^{\circ}\text{C}$) were measured using Portable Photosynthesis System LI-COR XT-6400 at an interval of 15 days after sowing to last picking. It is an open system, which means that measurement of photosynthesis is based on the differences in CO₂ and H₂O in an air stream that is flowing through the leaf cavette. The observations were recorded on the five tagged plants on the upper, middle and lower leaves and then averaged for per plant. The observations were recorded between 10-12 am at every observational day.

3.3.2.5 Leaf area duration ($\text{dm}^{-2} \text{ day}^{-1}$)

The leaf area duration was calculated by using following formula (Hunt, 1982),

$$\text{LAD} = \frac{L_1 + L_2 \times (t_2 - t_1)}{2} + \dots + \frac{L_{n-1} + L_n \times (t_n - t_{n-1})}{2}$$

where, LAD- leaf area duration, L_1 - leaf area at the time t_1 ; L_2 - leaf area at time t_2 ; L_n - leaf area at the time t_n ; and L_{n-1} - leaf area at the time t_{n-1} .

3.3.2.6 Relative leaf area growth rate ($\text{cm}^{-2}\text{cm}^{-2}\text{day}^{-1}$)

The relative leaf area growth rate was calculated by using following formula (Fisher 1921),

$$\text{RLAGR} = \frac{\log_e W_2 - \log_e W_1}{t_2 - t_1}$$

where RLAGR- Relative leaf area growth rate, W_1 and W_2 are the leaf area at times t_1 and t_2 .

3.3.3 Post harvest studies

3.3.3.1 Days to first fruit harvest

The number of days required to first fruit harvest was recorded for each treatment plot.

3.3.3.2 Days to last fruit harvest

The number of days required to last fruit harvest was recorded for each treatment plot.

3.3.3.3 Number of fruits vine⁻¹

The number of fruits per vine from each plot were recorded at the time of each picking.

3.3.3.4 Fruit length (cm)

At the time of each picking the length of five selected fruits from stalk end to style end was measured by scale in centimeter from observational vines from each treatment plot.

3.3.3.5 Fruit girth (cm)

The fruit girth was recorded with the same fruits which were used for recording the fruit length. The fruit girth was measured at middle portion with the help of vernier caliper.

3.3.3.6 Weight of fruit (g)

The average weight of fruit was recorded by using the same fruits which were used for recording the fruit length and girth.

3.3.3.7 Fruit weight vine⁻¹ (kg)

The treatment wise fruit weight per vine was computed by weighing total number of fruits at each picking from observational vines and calculate the fruit weight vine⁻¹ by summing the fruit weight of all pickings.

3.3.3.8 Fruit yield plot⁻¹

The treatment wise fruit yield per plot was computed by weighing total number of fruits at each picking from net plot including fruit weight of observational vines and calculate the per plot yield by summing the fruit weight of all treatments

3.3.3.9 Harvesting

Periodical pickings of cucumber fruits were done, when marketable size of fruits was achieved. The total 20 pickings during first season and 19 pickings during second season were carried out.

3.3.5 Quality studies

3.3.5.1 Fruit skin colour

Skin colour of five randomly selected fruits from the respective treatments was judged by using Methuen Handbook of Colour (Kornerup and Wanscher, 1998). Fruit skin colour was recorded at marketable stage of cucumber fruits at every picking.

3.3.5.2 Fruit strip colour

Fruit strip colour of five randomly selected cucumber fruits at marketable maturity stage of respective treatments was recorded by using following minimal descriptors of cucumber during each picking (Srivastava *et al.*, 2001).

Descriptors No.	0	1	2	3	99
Fruit strip colour	Absent	White	Green	Yellow	Others

3.3.5.3 Fruit shape

Fruit shape of five randomly selected cucumber fruits pertaining to different treatments was recorded with the help of following minimal descriptors of cucumber (Srivastava *et al.*, 2001) at marketable stage of cucumber fruits during each picking.

Descriptors No.	Fruit shape	Descriptors No.	Fruit shape
1	Elliptical elongate	2	Oblong ellipsoid
3	Globular (round)	4	Stem end tapered
5	Blossom end tapered	99	Others

3.3.5.4 Fruit bitterness

Fruit bitterness of five randomly selected cucumber fruits at marketable maturity stage from each treatment under study was recorded by using following minimal descriptors of cucumber (Srivastava *et al.*, 2001) at the time of each picking.

Descriptors No.	0	3	5	7	99
Fruit bitterness	Absent	Low	Intermediate	High	Others

3.3.5.5 Presence of placental cavity

Presence of placental cavity in five randomly selected cucumber fruits at marketable maturity stage was recorded by cutting fruit in two halves with the help of knife. The treatment wise presence of placental cavity was recorded at every picking by using following minimal descriptors of cucumber (Srivastava *et al.*, 2001).

Descriptors No.	0	1
Placental cavity	Absent	Present

3.3.5.6 Density of fruit (g cm^{-3})

At the time of each picking observational plants were harvested separately. From the bulk sample of fruits from observational plants, five fruits were selected for measurement of fruit density. These fruits were dipped in measuring cylinder with full of water one by one to measure the volume of each fruit separately. The volume of water displaced due to fruit was measured by measuring cylinder. The fruit density calculated by dividing fruit weight to volume of water displaced.

3.3.5.7 Flesh thickness (cm)

At the time of each picking five observational plants were harvested separately. From bulk sample of these fruits, five fruits were selected and cut into two halves at horizontal axis and the flesh thickness of cucumber fruit was recorded with the help of Vernier Caliper. The mean flesh thickness of fruit was computed and expressed in centimeters.

3.3.5.8 Total soluble solids ($^{\circ}$ brix)

The total soluble solids (TSS) of five randomly selected cucumber fruit pertaining to different treatments was measured with the help of hand refractometer at marketable stage during each picking. The cucumber fruit juice was extracted by squeezing the fruits. This extracted cucumber fruit juice was dropped on the lens of hand refractometer and measured the total soluble solids (TSS) in the range of 0 to 32 $^{\circ}$ brix.

3.4 Chemical analysis

3.4.1 Soil analysis

Before layout of the experiment soil samples were collected before application of the FYM from five randomly selected spots at a depth of 0-30 cm and made a composite sample for initial analysis.

After harvest of crop soil samples from 0 to 30 cm depth from each net plot were collected from each treatment plot. After air drying they were pounded in wooden mortar and pestle and passed through 2 mm sieve and were used for

chemical analysis *viz.*, pH, EC, organic carbon, available N,P,K, DTPA extractable Cu, Mn, Zn and Fe content in the soil by using standard methods as indicated in Table 3.1 during both the years of the experimentation.

3.4.2 Plant analysis

The observational vines and fruits of cucumber were collected after last picking for chemical analysis. These samples were sundried and then dried in Hot Air Oven at 65 °C till constant weight was obtained. These samples after grinding into fine powder, used for analysis of nitrogen, phosphorus and potassium content from vine and fruit separately. The standard methods were used for determination of nutrient content as indicated in Table 3.1.

The uptake of NPK were worked out by multiplying the nutrient concentration to dry matter of vine and fruits then calculated on hectare basis for each treatment.

3.5 Economic studies

3.5.1 Gross monetary returns

The gross monetary returns were obtained by multiplying prevailing market price with total yield of cucumber. The prevailing market prices of cucumber are given in Appendix-I were considered for calculation of treatment wise gross monetary returns in each year.

3.5.2 Cost of cultivation

The total cost of cultivation of cucumber crop was estimated by considering the cost required for all inputs and infrastructure facilities. The item wise cost per unit are given in Appendix- II were used for workout the treatment wise cost of cultivation each year.

3.5.3 Net monetary returns

The treatment wise net monetary returns were worked out by subtracting treatment wise cost of cultivation from the gross monetary returns during both the years.

3.5.4 Benefit: cost ratio (B:C ratio)

The treatment wise B:C ratio was worked out by dividing the gross monetary returns with the cost of cultivation of respective treatment in each year.

$$\text{B: C ratio} = \frac{\text{Gross monetary returns (₹ unit}^{-1}\text{)}}{\text{Cost of cultivation (₹ unit}^{-1}\text{)}}$$

3.6. Statistical analysis

The standard method of ‘Analysis of Variance’ was used for analyzing the data for Factorial Completely Randomized Design as suggested by Panse and Sukhatme, (1985). The ‘F’ test of significance was used for testing the null hypothesis and appropriate standard error of mean (S.Em.± mean) for each treatment effect, where the treatment effect were significant, the critical difference (C.D.) at 5 per cent probability level was worked out for testing the significance of treatment differences.

4. EXPERIMENTAL RESULTS

The present investigation on “Effect of different fertigation levels and schedules on growth, yield and quality of cucumber (*Cucumis sativus* L.) under polyhouse condition” was conducted during *rabi* seasons of 2011-12 and 2012-13 and data base prepared on there are statistically analyzed and presented in this chapter.

4.1 Growth studies

4.1.1 Plant count

The mean initial and final plant population as influenced by different treatments are presented in Table 4.1. The mean initial and final plant count was 2090 and 2058 plants unit⁻¹ of polyhouse for the year 2011-12, while it was 2090 and 2057 plants unit⁻¹ of polyhouse for the year 2012-13, respectively.

4.1.1.1 Fertigation levels

The initial and final plant population was not influenced significantly due to different fertigation levels during both the years of experimentation. The uniform plant population was observed in all the fertigation levels.

4.1.1.2 Fertigation schedules

The initial and final plant population was not influenced significantly due to different fertigation schedules during both the years of experimentation. This indicate that the uniform plant population was observed in all fertigation schedule treatments.

4.1.1.3 Interactions

The interaction effect between fertigation levels and schedules on the initial and final plant population was found non significant for both the years of investigation.

4.1.2 Vine length (cm)

The data pertaining to vine length of cucumber as influenced by different treatments are presented in Table 4.2 and 4.3. The mean vine length was 5.38, 60.10, 149.05, 220.18, 311.64, 410.76, 480.59, 502.74, 519.15 and 525.69 cm,

Table 4.1 Initial and final plant population of cucumber as influenced by different treatments

(2011-13)

Treatment	Plant Population (unit ⁻¹ of polyhouse*)							
	2011-12				2012-13			
	Initial	Per cent	Final	Per cent	Initial	Per cent	Final	Per cent
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)								
F ₁ - 75% RDF (75:37.5:37.5)	2090	100.00	2060	98.52	2090	100.00	2058	98.43
F ₂ - 100% RDF (100:50:50)	2090	100.00	2059	98.46	2090	100.00	2057	98.38
F ₃ - 125% RDF (125:62.5:62.5)	2090	100.00	2057	98.37	2090	100.00	2057	98.40
SEm±	2.15	-	1.01	-	1.21	-	1.08	-
C.D. at 5%	NS	-	NS	-	NS	-	NS	-
B. Fertigation schedule (up to 110 days)								
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	2090	100.00	2060	98.54	2090	100.00	2058	98.44
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	2090	100.00	2057	98.40	2090	100.00	2058	98.44
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	2090	100.00	2058	98.42	2090	100.00	2055	98.32
SEm±	2.15	-	1.01	-	1.21	-	1.08	-
C.D. at 5%	NS	-	NS	-	NS	-	NS	-
C. Interaction(AXB)								
CV (%)	0.17	100.00	0.15	99.44	0.17	100.00	0.16	99.39
General mean	2090	-	2058	-	2090	-	2057	-

*(Polyhouse unit area = 28 m x 28 m)

Table 4. 2 Periodical vine length of cucumber as influenced by different treatments

(2011-12)

Treatment	Vine length of cucumber (cm)									
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS	At last picking
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)										
F ₁ - 75% RDF (75:37.5:37.5)	5.22	56.52	142.69	198.75	290.23	390.11	464.04	484.97	495.88	499.95
F ₂ - 100% RDF (100:50:50)	5.37	60.61	150.52	228.18	320.04	415.48	482.46	506.63	524.05	531.23
F ₃ - 125% RDF (125:62.5:62.5)	5.54	63.17	153.94	233.61	324.64	426.70	495.26	516.63	537.53	545.90
SEM±	0.10	1.48	3.08	3.39	4.16	8.05	11.38	10.99	11.68	11.02
C.D. at 5%	NS	4.39	9.16	10.07	12.36	23.93	33.82	32.65	34.70	32.75
B. Fertigation schedule (up to 110 days)										
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	5.49	64.80	157.11	240.02	332.06	437.73	504.02	528.13	548.25	556.56
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	5.42	61.67	152.64	230.54	323.78	420.66	489.33	509.50	529.15	533.64
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	5.22	53.83	137.40	189.99	279.08	373.89	448.41	470.61	480.06	486.88
SEM±	0.10	1.48	3.08	3.39	4.16	8.05	11.38	10.99	11.68	11.02
C.D. at 5%	NS	4.39	9.16	10.07	12.36	23.93	33.82	32.65	34.70	32.75
C. Interaction(AXB)	NS	NS	NS	Sig.	Sig.	NS	NS	NS	NS	NS
CV (%)	5.68	7.37	6.21	4.62	4.00	5.88	7.11	6.56	6.75	6.29
General mean	5.38	60.10	149.05	220.18	311.64	410.76	480.59	502.74	519.15	525.69

Table 4.3 Periodical vine length of cucumber as influenced by different treatments

(2012-13)

Treatment	Vine length of cucumber (cm)									
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS	At last picking
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)										
F ₁ - 75% RDF (75:37.5:37.5)	5.35	59.45	146.94	236.00	305.42	409.54	450.44	503.90	520.51	523.86
F ₂ - 100% RDF (100:50:50)	5.50	63.54	156.25	250.50	341.52	438.21	503.49	533.97	548.14	565.64
F ₃ - 125% RDF (125:62.5:62.5)	5.71	65.64	159.88	255.42	348.30	449.86	516.60	547.18	561.93	568.41
SEm±	0.10	1.45	3.38	5.13	4.57	9.80	7.49	10.90	11.07	10.23
C.D. at 5%	NS	4.30	10.04	15.23	13.58	29.12	22.24	32.38	32.90	30.38
B. Fertigation schedule (up to 110 days)										
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	5.64	67.82	163.34	260.92	353.33	461.46	525.02	560.16	574.75	583.84
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	5.57	64.98	157.80	253.55	345.40	443.47	501.63	537.40	553.92	560.25
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	5.35	55.83	141.92	227.45	296.50	392.69	443.88	487.49	501.91	513.83
SEm±	0.10	1.45	3.38	5.13	4.57	9.80	7.49	10.90	11.07	10.23
C.D. at 5%	NS	4.30	10.04	15.23	13.58	29.12	22.24	32.38	32.90	30.38
C. Interaction(AXB)	NS	NS	NS	NS	Sig.	NS	Sig.	NS	NS	NS
CV (%)	5.66	6.90	6.57	6.22	4.13	6.80	4.58	6.19	6.11	5.56
General mean	5.52	62.88	154.36	247.31	331.75	432.54	490.18	528.35	543.53	552.64

at 15, 30, 45, 60, 75, 90, 105, 120, 135 days after sowing and at last picking , respectively for the year 2011-12, while it was 5.52, 62.88, 154.36, 247.31, 331.75, 432.54, 490.18, 528.35, 543.53 and 552.64 cm, respectively for the year 2012-13.

The mean vine length was increased progressively with the advancement of age of the plant due to indeterminate growth habit of cucumber crop. Initially, the growth rate of plant height was at lower magnitude up to 30 days and there after it was more vigorous between 30 to 105 days and then decreased there after during both the years.

4.1.2.1 Fertigation levels

The vine length of cucumber was influenced significantly due to different fertigation levels at all the crop growth stages. Fertigation of 125 per cent RDF recorded significantly maximum vine length of cucumber at all the stages of crop growth except at 15 DAS and it was at par with 100 per cent of RDF at all the stages during both the years of investigation. Significantly minimum vine length was observed with fertigation of 75 per cent RDF at all the crop growth stages during both years.

4.1.2.2 Fertigation schedules

The vine length of cucumber was influenced significantly due to different fertigation schedules at all the crop growth stages. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose exhibited significantly maximum vine length at all the crop growth stages except at 15 DAS during the year 2011-12 and 2012-13 and at par with fertigation at every 4 days interval at all the growth stages except at 105 DAS during second year. Significantly minimum vine length of cucumber was recorded with fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose during both the years.

4.1.2.3 Interaction

The interaction effect between fertigation levels and schedules were found significant at 60 and 75 DAS during first year (Table 4.2 a) and 75 and 105 DAS

during second year of experimentation (Table 4.3 a). At 60 DAS, fertigation of 125 per cent of RDF coupled with fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum vine length of cucumber and at par with 125 per cent RDF with 4 days fertigation interval and 100 per cent of RDF with every 2 and 4 days fertigation interval. Similar trend as that of 60 DAS was noticed at 75 DAS during first year.

During second year at 75 DAS application of 125 per cent of RDF and fertigation at every 2 days interval registered significantly maximum vine length and it was at par with fertigation at every 4 days interval under same fertigation level (125 % RDF) and 100 per cent RDF with fertigation at every 2 and 4 days interval. At 105 days almost similar trend was noticed as that of 75 DAS.

Table 4.2 a. Interaction effect between fertigation levels and schedules on vine length of cucumber at 60 and 75 DAS

(2011-12)

Treatment	Vine length (cm)					
	60 DAS			75 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	212.68	252.07	255.31	302.10	343.49	350.58
Fertigation of R. D. of N and K at every 4 days interval in equal splits	201.72	241.08	248.80	294.47	336.77	340.09
Fertigation of R.D. of N and K at every 6 days interval in equal splits	181.84	191.40	196.73	274.14	279.85	283.26
SEm±	5.87			7.21		
C.D. at 5%	17.44			21.42		

Table 4.3 a. Interaction effect between fertigation levels and schedules on vine length of cucumber at 75 and 105 DAS

(2012-13)

Treatment	Vine length (cm)					
	75 DAS			105 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	317.21	369.68	373.11	317.21	369.68	373.11
Fertigation of R. D. of N and K at every 4 days interval in equal splits	310.62	360.43	365.17	310.62	360.43	365.17
Fertigation of R.D. of N and K at every 6 days interval in equal splits	288.44	294.44	306.62	288.44	294.44	306.62
SEm±	7.92			12.97		
C.D. at 5%	23.52			38.53		

4.1.3 Number of branches vine⁻¹

Data regarding the number of branches vine⁻¹ of cucumber as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.4 and 4.5. The mean number of branches vine⁻¹ were 1.06, 1.70, 3.33, 5.27, 7.93, 10.68, 12.33, 13.07 and 13.27 at 30, 45, 60, 75, 90, 105, 120, 135 days after sowing and at last picking during first year while during second year these values were 1.08, 1.95, 3.55, 6.74, 8.92, 11.12, 13.09, 13.69 and 13.88, respectively.

4.1.3.1 Fertigation levels

The number of branches vine⁻¹ of cucumber were influenced significantly due to the different fertigation levels throughout crop growth period. Fertigation of 125 per cent of RDF recorded significantly maximum number of branches vine⁻¹ of cucumber at all the crop growth stages and at par with 100 per cent of RDF at all the crop growth stages during both the years. Significantly minimum

Table 4. 4 Periodical number of branches vine⁻¹ of cucumber as influenced by different treatments

(2011-12)

Treatment	Number of branches vine ⁻¹ of cucumber								
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS	At last picking
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)									
F ₁ - 75% RDF (75:37.5:37.5)	1.04	1.51	3.10	4.80	7.01	9.93	11.51	11.79	11.94
F ₂ - 100% RDF (100:50:50)	1.07	1.75	3.34	5.36	8.23	10.88	12.57	13.52	13.63
F ₃ - 125% RDF (125:62.5:62.5)	1.08	1.83	3.53	5.63	8.55	11.22	12.92	13.91	14.24
SEm±	0.03	0.04	0.10	0.14	0.12	0.28	0.33	0.22	0.29
C.D. at 5%	NS	0.13	0.29	0.42	0.37	0.84	0.97	0.64	0.85
B. Fertigation schedule (up to 110 days)									
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	1.12	1.94	3.67	5.83	8.73	11.58	13.35	14.22	14.33
S ₂ - Fertigation of R.D. of N and K at every 4 days interval in equal splits	1.02	1.85	3.49	5.48	8.38	11.08	12.72	13.75	14.08
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	1.04	1.31	2.81	4.48	6.68	9.37	10.93	11.26	11.41
SEm±	0.03	0.04	0.10	0.14	0.12	0.28	0.33	0.22	0.29
C.D. at 5%	NS	0.13	0.29	0.42	0.37	0.84	0.97	0.64	0.85
C. Interaction(AXB)	NS	NS	NS	NS	Sig.	NS	NS	NS	Sig.
CV (%)	9.58	7.64	8.77	8.09	4.71	7.92	7.97	4.95	6.50
General mean	1.06	1.70	3.33	5.27	7.93	10.68	12.33	13.07	13.27

Table 4.5 Periodical number of branches vine⁻¹ of cucumber as influenced by different treatments

(2012-13)

Treatment	Number of branches vine ⁻¹ of cucumber								
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS	At last picking
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)									
F ₁ - 75% RDF (75:37.5:37.5)	1.06	1.74	3.31	6.28	7.89	10.32	12.29	12.77	12.97
F ₂ - 100% RDF (100:50:50)	1.08	2.00	3.60	6.85	9.25	11.29	13.25	13.88	13.99
F ₃ - 125% RDF (125:62.5:62.5)	1.11	2.11	3.75	7.09	9.63	11.74	13.72	14.41	14.66
SEm±	0.03	0.05	0.11	0.18	0.15	0.32	0.38	0.35	0.29
C.D. at 5%	NS	0.16	0.32	0.54	0.43	0.94	1.14	1.05	0.87
B. Fertigation schedule (up to 110 days)									
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	1.13	2.21	3.90	7.30	9.83	12.18	14.15	14.91	15.13
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	1.10	2.12	3.69	7.03	9.32	11.50	13.48	14.18	14.30
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	1.01	1.53	3.07	5.89	7.61	9.68	11.63	11.98	12.20
SEm±	0.03	0.05	0.11	0.18	0.15	0.32	0.38	0.35	0.29
C.D. at 5%	NS	0.16	0.32	0.54	0.43	0.94	1.14	1.05	0.87
C. Interaction(AXB)	NS	NS	NS	NS	Sig.	NS	NS	NS	NS
CV (%)	9.42	8.09	9.08	8.13	4.89	8.52	8.76	7.76	6.33
General mean	1.08	1.95	3.55	6.74	8.92	11.12	13.09	13.69	13.88

number of branches vine⁻¹ of cucumber were observed with fertigation of 75 per cent of RDF at all the crop growth stages during both years.

4.1.3.2 Fertigation schedules

The number of branches vine⁻¹ of cucumber were influenced significantly due to different fertigation schedules at all the crop growth stages. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum number of branches vine⁻¹ at all crop growth stages during both the years. However, it was at par with fertigation of recommended dose of N and K at every 4 days interval in equal splits upto 110 days + P as a basal dose at all crop growth stages during both the years of investigation. Significantly minimum mean number of branches vine⁻¹ of cucumber were recorded with fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose during both the years.

4.1.3.3 Interaction

The interaction effect between fertigation levels and schedules was found significant at 90 DAS during both the years (Table 4.4a and 4.5a) and at last picking during first year (Table 4.4a). At 90 DAS, fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days interval in equal splits upto 110 days + P as basal dose registered significantly maximum number of branches vine⁻¹ of cucumber than rest of the treatment combinations except fertigation of 100 per cent of RDF coupled with every 2 days fertigation interval and 125 per cent RDF with every 4 days fertigation interval during first year.

Almost similar trend was noticed at 90 DAS during second year. At last picking during first year, fertigation of 125 per cent of RDF coupled with fertigation interval at every 2 days registered significantly maximum number of branches vine⁻¹ and at par with 125 per cent of RDF with every 4 days fertigation interval and 100 per cent RDF and every 2 and 4 days fertigation interval.

Table 4.4 a. Interaction effect between fertigation levels and schedules on number of branches vine⁻¹ of cucumber at 90 DAS and at last picking

(2011-12)

Treatment	Number of branches vine ⁻¹					
	90 DAS			Last picking		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	7.50	9.22	9.47	11.71	14.11	14.42
Fertigation of R. D. of N and K at every 4 days interval in equal splits	7.24	8.80	9.09	11.40	13.52	13.99
Fertigation of R.D. of N and K at every 6 days interval in equal splits	6.30	6.65	7.08	10.26	10.64	10.96
SEm±	0.22			0.35		
C.D. at 5%	0.64			1.04		

Table 4.5 a. Interaction effect between fertigation levels and schedules on number of branches vine⁻¹ of cucumber at 90 DAS

(2012-13)

Treatment	Number of branches vine ⁻¹		
	75% RDF	100% RDF	125% RDF
Fertigation level			
Fertigation schedule			
Fertigation of R.D. of N and K at every 2 days interval in equal splits	8.26	10.41	10.83
Fertigation of R. D. of N and K at every 4 days interval in equal splits	8.10	9.67	10.21
Fertigation of R.D. of N and K at every 6 days interval in equal splits	7.30	7.68	7.85
SEm±	0.25		
C.D. at 5%	0.74		

4.1.4 Number of functional leaves vine⁻¹

Data regarding the number of functional leaves vine⁻¹ of cucumber as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.6 and 4.7. The mean number of functional leaves vine⁻¹ of cucumber were 2.95, 10.19, 20.96, 60.70, 141.39, 253.19, 285.61, 266.96, 201.49 and 127.02 during 2011-12 and 3.05, 11.45, 24.17, 72.50, 177.42, 266.72, 328.97, 298.90, 219.11 and 154.11 during year 2012-13 at 15, 30, 45, 60, 75, 90, 105, 120, 135 days after sowing and at last picking, respectively.

4.1.4.1 Fertigation levels

The number of functional leaves vine⁻¹ of cucumber were influenced significantly due to the different fertigation levels at all the crop growth stages during both the years. Fertigation of 125 per cent of RDF recorded significantly maximum number of functional leaves vine⁻¹ at all the crop growth stages except at 15 DAS and at par with 100 per cent of RDF at all the crop growth stages during both the years of investigation. Significantly minimum number of functional leaves vine⁻¹ were observed under 75 per cent of RDF at all the crop growth stages during both the years.

4.1.4.2 Fertigation schedules

The number of functional leaves vine⁻¹ of cucumber were influenced significantly due to different fertigation schedules at all the crop growth stages. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose exhibited significantly maximum number of leaves vine⁻¹ and it was at par with fertigation of recommended dose of N and K at every 4 days interval in equal splits upto 110 days + P as a basal dose at all crop growth stages except at 15 DAS and at last picking during first year and at 60 DAS and at last picking during second year. Significantly minimum number of functional leaves vine⁻¹ of cucumber were recorded with fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose during both the years.

Table 4.6 Periodical number of functional leaves vine⁻¹ of cucumber as influenced by different treatments

(2011-12)

Treatment	Number of functional leaves vine ⁻¹ of cucumber									
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS	At last picking
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)										
F ₁ - 75% RDF (75:37.5:37.5)	2.85	9.27	19.64	54.39	132.35	238.25	253.69	247.09	185.49	105.84
F ₂ - 100% RDF (100:50:50)	2.94	10.47	21.36	62.70	143.77	257.02	297.13	272.23	206.41	134.35
F ₃ - 125% RDF (125:62.5:62.5)	3.05	10.83	21.89	65.01	148.04	264.30	306.00	281.57	212.58	140.87
SEm±	0.09	0.25	0.52	0.92	3.66	6.20	5.18	7.54	4.24	2.49
C.D. at 5%	NS	0.75	1.56	2.74	10.89	18.43	15.41	22.40	12.61	7.40
B. Fertigation schedule (up to 110 days)										
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	3.05	11.26	22.61	67.92	153.16	271.72	312.59	290.90	221.30	146.90
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	2.97	10.79	21.72	65.08	146.03	259.61	299.58	276.31	206.96	137.02
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	2.83	8.52	18.56	49.10	124.98	228.23	244.66	233.68	176.22	97.14
SEm±	0.09	0.25	0.52	0.92	3.66	6.20	5.18	7.54	4.24	2.49
C.D. at 5%	NS	0.75	1.56	2.74	10.89	18.43	15.41	22.40	12.61	7.40
C. Interaction(AXB)	NS	NS	NS	Sig.	NS	NS	Sig.	NS	NS	Sig.
CV (%)	5.99	7.43	7.50	4.55	7.78	7.35	5.45	8.47	6.32	5.88
General mean	2.95	10.19	20.96	60.70	141.39	253.19	285.61	266.96	201.49	127.02

Table 4.7 Periodical number of functional leaves vine⁻¹ of cucumber as influenced by different treatments

(2012-13)

Treatment	Number of functional leaves vine ⁻¹ of cucumber									
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS	At last picking
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)										
F ₁ - 75% RDF (75:37.5:37.5)	2.98	10.67	22.73	65.42	166.34	251.20	306.92	279.14	201.70	136.16
F ₂ - 100% RDF (100:50:50)	3.05	11.64	24.41	74.96	180.24	270.54	335.04	303.24	223.61	159.99
F ₃ - 125% RDF (125:62.5:62.5)	3.13	12.03	25.36	77.12	185.69	278.42	344.96	314.31	232.02	166.20
SEm±	0.09	0.28	0.64	0.99	4.42	6.73	8.34	8.84	5.29	2.31
C.D. at 5%	NS	0.83	1.90	2.93	13.12	19.99	24.78	26.27	15.72	6.87
B. Fertigation schedule (up to 110 days)										
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	3.18	12.48	26.18	79.10	190.42	287.51	356.58	324.15	237.90	174.01
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	3.09	11.90	24.67	75.98	181.38	274.59	341.85	307.00	224.95	165.91
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	2.90	9.96	21.65	62.43	160.48	238.06	288.49	265.54	194.48	122.42
SEm±	0.09	0.28	0.64	0.99	4.42	6.73	8.34	8.84	5.29	2.31
C.D. at 5%	NS	0.83	1.90	2.93	13.12	19.99	24.78	26.27	15.72	6.87
C. Interaction(AXB)	NS	NS	NS	Sig.	NS	NS	NS	NS	NS	Sig.
CV (%)	8.81	7.33	7.95	4.08	7.47	7.57	7.61	8.87	7.24	4.50
General mean	3.05	11.45	24.17	72.50	177.42	266.72	328.97	298.90	219.11	154.11

4.1.4.3 Interaction

The interaction effect between fertigation levels and schedules on number of functional leaves vine⁻¹ of cucumber were found significant at 60, 105 DAS and at last picking during first year (Table 4.6a, b) and at 60 DAS and at last picking during second year (Table 4.7a).

At 60 DAS, fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum number of functional leaves vine⁻¹ and at par with 100 per cent of RDF and fertigation at every 2 days interval and 125 per cent of RDF with fertigation at every 4 days interval during first year. Similar trend as that of 60 DAS was noticed at last picking during first and second year of experiment. At 105 DAS, during first year, the combination of 125 per cent of RDF and fertigation at every 2 days interval recorded significantly maximum number of functional leaves vine⁻¹ and it was at par with 100 per cent of RDF coupled with fertigation at every 2 days and 4 days interval and 125 per cent of RDF with fertigation at every 4 days interval. Almost similar trend was noticed at 60 DAS during second year of experimentation.

Table 4.6 a. Interaction effect between fertigation levels and schedules on number of functional leaves vine⁻¹ of cucumber at 60 and 105 DAS

(2011-12)

Treatment	Number of functional leaves vine ⁻¹					
	60 DAS			105 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	59.44	71.44	72.89	265.73	332.41	339.62
Fertigation of R. D. of N and K at every 4 days interval in equal splits	57.35	68.08	69.80	261.68	313.19	323.85
Fertigation of R.D. of N and K at every 6 days interval in equal splits	46.38	48.58	52.35	233.66	245.78	254.54
SEm±	1.60			8.98		
C.D. at 5%	4.74			26.68		

Table 4.6 b. Interaction effect between fertigation levels and schedules on number of functional leaves vine⁻¹ of cucumber at last picking

(2011-12)

Treatment	Number of functional leaves vine ⁻¹		
Fertigation level	75% RDF	100% RDF	125% RDF
Fertigation schedule			
Fertigation of R.D. of N and K at every 2 days interval in equal splits	119.72	157.41	163.58
Fertigation of R. D. of N and K at every 4 days interval in equal splits	109.08	148.33	153.67
Fertigation of R.D. of N and K at every 6 days interval in equal splits	88.72	97.32	105.38
SEm±	4.31		
C.D. at 5%	12.81		

Table 4.7 a. Interaction effect between fertigation levels and schedules on number of functional leaves vine⁻¹ of cucumber at 60 DAS and at last picking

(2012-13)

Treatment	Number of functional leaves vine ⁻¹					
Fertigation level	60 DAS			Last picking		
Fertigation schedule	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation of R.D. of N and K at every 2 days interval in equal splits	69.98	82.87	84.45	148.77	184.07	189.19
Fertigation of R. D. of N and K at every 4 days interval in equal splits	67.01	79.79	81.13	144.98	173.23	179.53
Fertigation of R.D. of N and K at every 6 days interval in equal splits	59.28	62.22	65.78	114.73	122.66	129.86
SEm±	1.71			4.00		
C.D. at 5%	5.08			11.90		

4.1.5 Leaf area vine⁻¹ (dm²)

Data regarding the leaf area vine⁻¹ of cucumber as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.8 and 4.9. The mean leaf area vine⁻¹ of cucumber was 14.68, 119.10, 629.73, 659.14 and 335.63 dm² at 30, 60, 90, 120 days after sowing and at last picking during first year and 17.28, 144.31, 680.76, 708.37 and 410.66 dm² during second year, respectively.

4.1.5.1 Fertigation levels

The leaf area vine⁻¹ of cucumber was influenced significantly due to different fertigation levels during both the years. Fertigation of 125 per cent of RDF recorded significantly maximum leaf area vine⁻¹ of cucumber at all the crop growth stages. However, it was at par with 100 per cent of RDF at 60 and 90 DAS during first year and at 120 DAS during second year. Significantly minimum leaf area vine⁻¹ of cucumber was observed under 75 per cent of RDF at all the crop growth stages during both the years of investigation.

4.1.5.2 Fertigation schedules

The leaf area vine⁻¹ of cucumber was influenced significantly due to different fertigation schedules at all the crop growth stages during both the years of experimentation. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose recorded significantly maximum leaf area vine⁻¹ at all the crop growth stages during both the years and it was at par with fertigation of recommended dose of N and K at every 4 days interval in equal splits upto 110 days + P as a basal dose at 90 and 120 DAS during both the years of experimentation.

4.1.5.3 Interaction

The interaction effect between fertigation levels and schedules on leaf area vine⁻¹ was found significant at 30, 90 DAS and at last picking during first year (Table 4.8a, b) and 30, 60, 90 DAS and at last picking during second year (Table 4.9a, b).

Table 4.8 Periodical leaf area vine⁻¹ of cucumber as influenced by different treatments

(2011-12)

Treatment	Leaf area vine ⁻¹ of cucumber (dm ²)				
	30 DAS	60 DAS	90 DAS	120 DAS	At last picking
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)					
F ₁ - 75% RDF (75:37.5:37.5)	13.65	105.03	558.42	632.31	261.96
F ₂ - 100% RDF (100:50:50)	14.31	122.06	651.82	665.01	349.83
F ₃ - 125% RDF (125:62.5:62.5)	16.08	130.20	678.94	680.11	395.09
SEm±	0.34	2.83	10.76	16.60	8.57
C.D. at 5%	1.00	8.41	31.97	49.31	25.45
B. Fertigation schedule (up to 110 days)					
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	17.15	140.56	685.30	697.48	435.51
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	14.65	126.58	664.53	669.34	370.53
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	12.25	90.15	539.35	610.61	200.83
SEm±	0.34	2.83	10.76	16.60	8.57
C.D. at 5%	1.00	8.41	31.97	49.31	25.45
C. Interaction(AXB)					
CV (%)	6.88	7.13	5.13	7.55	7.66
General mean	14.68	119.10	629.73	659.14	335.63

Table 4.9 Periodical leaf area vine⁻¹ of cucumber as influenced by different treatments

(2012-13)

Treatment	Leaf area vine ⁻¹ of cucumber (dm ²)				
	30 DAS	60 DAS	90 DAS	120 DAS	At last picking
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)					
F ₁ - 75% RDF (75:37.5:37.5)	15.88	124.98	621.50	670.96	329.44
F ₂ - 100% RDF (100:50:50)	17.03	148.37	692.38	716.98	428.36
F ₃ - 125% RDF (125:62.5:62.5)	18.92	159.59	728.39	737.19	474.18
SEm±	0.25	2.82	10.45	15.98	10.37
C.D. at 5%	0.75	8.37	31.05	47.49	30.81
B. Fertigation schedule (up to 110 days)					
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	19.23	167.39	754.83	757.05	520.30
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	17.80	153.13	725.67	722.22	438.73
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	14.80	112.42	561.77	645.86	272.96
SEm±	0.25	2.82	10.45	15.98	10.37
C.D. at 5%	0.75	8.37	31.05	47.49	30.81
C. Interaction(AXB)	Sig.	Sig.	Sig.	NS	Sig.
CV (%)	4.38	5.86	4.60	6.77	7.58
General mean	17.28	144.31	680.76	708.37	410.66

During first year at 30 DAS, fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum leaf area vine⁻¹ of cucumber than rest of the treatments combinations except 100 per cent RDF and fertigation at every 2 days interval. At 90 DAS, fertigation of 125 per cent of RDF coupled with fertigation at every 2 days interval registered maximum leaf area vine⁻¹ and at par with 100 per cent of RDF and every 2 days fertigation interval and 125 per cent RDF coupled with every 4 days fertigation interval.

During second year, at 30 and 60 DAS almost similar trend as that of 90 DAS during first year was noticed however, at 90 DAS in addition to that it was at par with 100 per cent RDF and fertigation at every 4 days interval. At last picking 125 per cent RDF and fertigation at every 2 days interval + P as a basal dose registered significantly maximum leaf area vine⁻¹ and at par with 100 per cent RDF and every 2 days fertigation interval.

Table 4.8a. Interaction effect between fertigation levels and schedules on leaf area vine⁻¹ of cucumber at 30 and 90 DAS

(2011-12)

Treatment	Leaf area vine ⁻¹ of cucumber (dm ²)					
	30 DAS			90 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	15.09	17.75	18.60	592.54	716.68	746.68
Fertigation of R. D. of N and K at every 4 days interval in equal splits	14.74	13.33	15.87	571.29	689.48	732.81
Fertigation of R.D. of N and K at every 6 days interval in equal splits	11.12	11.86	13.76	511.43	549.29	557.34
SEm±	0.58			18.64		
C.D. at 5%	1.73			55.38		

Table 4.8b. Interaction effect between fertigation levels and schedules on leaf area vine⁻¹ of cucumber at last picking

(2011-12)

Treatment	Leaf area vine ⁻¹ of cucumber (dm ²)			
	Fertigation level	75% RDF	100% RDF	125% RDF
Fertigation schedule				
Fertigation of R.D. of N and K at every 2 days interval in equal splits		326.95	463.57	516.03
Fertigation of R. D. of N and K at every 4 days interval in equal splits		294.58	384.48	432.53
Fertigation of R.D. of N and K at every 6 days interval in equal splits		164.35	201.45	236.71
SEM±		14.84		
C.D. at 5%		44.08		

Table 4.9a. Interaction effect between fertigation levels and schedules on leaf area vine⁻¹ of cucumber at 30 and 60 DAS

(2012-13)

Treatment	Leaf area vine ⁻¹ of cucumber (dm ²)					
	30 DAS			60 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	17.62	19.65	20.42	139.11	177.37	185.70
Fertigation of R. D. of N and K at every 4 days interval in equal splits	16.45	16.70	20.25	132.57	156.27	170.53
Fertigation of R.D. of N and K at every 6 days interval in equal splits	13.57	14.76	16.08	103.26	111.48	122.54
SEM±	0.44			4.88		
C.D. at 5%	1.30			14.50		

Table 4.9b. Interaction effect between fertigation levels and schedules on leaf area vine⁻¹ of cucumber at 90 DAS and at last picking**(2012-13)**

Treatment	Leaf area vine ⁻¹ of cucumber (dm ²)					
	90 DAS			Last picking		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	688.92	777.19	798.38	394.07	558.98	607.86
Fertigation of R. D. of N and K at every 4 days interval in equal splits	634.24	744.90	797.88	357.49	454.12	504.57
Fertigation of R.D. of N and K at every 6 days interval in equal splits	541.35	555.05	588.91	236.76	271.99	310.12
SEm±	18.10			17.96		
C.D. at 5%	53.78			53.37		

4.1.6 Leaf area duration (dm² day⁻¹)

Data regarding the leaf area duration of cucumber as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.10. The mean leaf area duration of cucumber was 0.67, 3.56 and 4.97 dm² day⁻¹ during first year and 0.81, 4.06 and 5.60 dm² day⁻¹ during the second year between 30-60, 60-90, 90-120 and 120-150 days after sowing, respectively.

4.1.6.1 Fertigation levels

The leaf area duration of cucumber was influenced significantly due to different fertigation levels at all the crop growth stages during both the years of investigation. Fertigation of 125 per cent of RDF recorded significantly maximum leaf area duration at all the stages of observation. However, it was at par with 100 per cent of RDF at all growth stages during first year and between 90-120 DAS during second year. Significantly minimum leaf area duration of cucumber was recorded with 75 per cent of RDF at all the crop growth stages during both the years of study.

Table 4.10 Periodical leaf area duration of cucumber as influenced by different treatments

(2011-13)

Treatment	Leaf area duration (dm ² day ⁻¹)					
	2011-12			2012-13		
	Between 30 - 60 DAS	Between 60 - 90 DAS	Between 90 - 120 DAS	Between 30 - 60 DAS	Between 60 - 90 DAS	Between 90 - 120 DAS
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)						
F ₁ - 75% RDF (75:37.5:37.5)	0.59	3.14	4.47	0.70	3.58	5.00
F ₂ - 100% RDF (100:50:50)	0.68	3.67	5.07	0.83	4.16	5.73
F ₃ - 125% RDF (125:62.5:62.5)	0.73	3.88	5.38	0.89	4.43	6.06
SEm±	0.02	0.09	0.12	0.02	0.09	0.13
C.D. at 5%	0.05	0.26	0.37	0.04	0.25	0.38
B. Fertigation schedule (up to 110 days)						
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	0.79	4.12	5.66	0.93	4.68	6.39
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	0.71	3.73	5.20	0.85	4.24	5.80
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	0.51	2.84	4.06	0.64	3.25	4.59
SEm±	0.02	0.09	0.12	0.02	0.09	0.13
C.D. at 5%	0.05	0.26	0.37	0.04	0.25	0.38
C. Interaction(AXB)						
CV (%)	6.99	7.31	7.45	5.59	6.32	6.78
General mean	0.67	3.56	4.97	0.81	4.06	5.60

4.1.6.2 Fertigation schedules

The leaf area duration of cucumber was influenced significantly due to different fertigation schedules. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum leaf area duration at all the stages of observations. While significantly minimum leaf area duration of cucumber was recorded with fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose during both the years of investigation.

4.1.6.3 Interaction

The interaction effect between fertigation levels and schedules on leaf area duration of cucumber was found non significant during both the years of study.

4.1.7 Relative leaf area growth rate ($\text{cm}^{-2}\text{cm}^{-2}\text{day}^{-1}$)

Data in respect of the relative leaf area growth rate of cucumber as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.11. The mean relative leaf area growth rate of cucumber was 0.49, 3.48 and 15.81 $\text{cm}^{-2}\text{cm}^{-2}\text{day}^{-1}$ during first year and 0.58, 4.23 and 17.42 $\text{cm}^{-2}\text{cm}^{-2}\text{day}^{-1}$ during the second year between 30-60, 60-90 and 90-120 days after sowing, respectively.

4.1.7.1 Fertigation levels

The relative leaf area growth rate of cucumber was influenced significantly due to different fertigation levels during both the years of experimentation. Fertigation of 125 per cent of RDF recorded significantly higher relative leaf area growth rate of cucumber at all the crop growth stages. However, it was at par with 100 per cent of RDF at all crop growth stages except between 30-60 DAS during first year and between 30-60 and 90-120 DAS during second year. Significantly lowest relative leaf area growth rate of cucumber was observed in 75 per cent of RDF at all the stages of observations during both the years.

Table 4.11 Periodical relative leaf area growth rate of cucumber as influenced by different treatments

(2011-13)

Treatment	Relative leaf area growth rate (cm ² cm ⁻² day ⁻¹)					
	2011-12			2012-13		
	Between 30 - 60 DAS	Between 60 - 90 DAS	Between 90 - 120 DAS	Between 30 - 60 DAS	Between 60 - 90 DAS	Between 90 - 120 DAS
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)						
F ₁ - 75% RDF (75:37.5:37.5)	0.45	3.05	13.93	0.53	3.64	15.56
F ₂ - 100% RDF (100:50:50)	0.48	3.59	16.30	0.57	4.38	17.82
F ₃ - 125% RDF (125:62.5:62.5)	0.54	3.80	17.20	0.63	4.69	18.89
SEm±	0.01	0.09	0.43	0.01	0.09	0.42
C.D. at 5%	0.03	0.25	1.29	0.03	0.26	1.23
B. Fertigation schedule (up to 110 days)						
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	0.57	4.11	18.09	0.64	4.94	20.01
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	0.49	3.73	16.40	0.59	4.51	18.09
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	0.41	2.60	12.94	0.49	3.25	14.15
SEm±	0.01	0.09	0.43	0.01	0.09	0.42
C.D. at 5%	0.03	0.25	1.29	0.03	0.26	1.23
C. Interaction(AXB)	Sig.	NS	NS	Sig.	Sig.	NS
CV (%)	6.88	7.34	8.22	4.38	6.21	7.15
General mean	0.49	3.48	15.81	0.58	4.23	17.42

4.1.7.2 Fertigation schedules

The relative leaf area growth rate of cucumber was influenced significantly due to different fertigation schedules. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly highest relative leaf area growth rate at all the crop growth stages. Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose recorded significantly lowest relative leaf area growth rate of cucumber at all the stages of observations during both the years.

4.1.7.3 Interaction

The interaction effect between fertigation levels and schedules on relative leaf area growth rate was found significant between 30-60 DAS during first year (Table 4.11a) and 30-60 and 60-90 DAS during second year (Table 4.11b). Fertigation of 125 per cent of RDF coupled with fertigation at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum relative leaf area growth rate between 30-60 DAS than rest of the treatment combinations and at par with 100 per cent RDF alongwith fertigation of N and K at every 2 days interval during first year. Whereas during second year, fertigation of 125 per cent of RDF coupled with fertigation at every 2 days interval registered significantly maximum relative leaf area growth rate between 30-60 DAS and it was at par with fertigation of N and K at every 4 days interval under same fertigation level and 100 per cent RDF with fertigation of N and K at every 2 days interval. Almost similar trend as that of 30 - 60 DAS during first year was noticed between 60 – 90 DAS during second year.

Table 4.11a. Interaction effect between fertigation levels and schedules on relative leaf area growth rate of cucumber between 30-60 DAS

(2011-12)

Treatment	Relative leaf area growth rate ($\text{cm}^{-2}\text{cm}^{-2}\text{day}^{-1}$)		
Fertigation level	75% RDF	100% RDF	125% RDF
	Fertigation schedule		
Fertigation of R.D. of N and K at every 2 days interval in equal splits	0.50	0.59	0.62
Fertigation of R. D. of N and K at every 4 days interval in equal splits	0.49	0.44	0.53
Fertigation of R.D. of N and K at every 6 days interval in equal splits	0.37	0.40	0.46
SEm±	0.02		
C.D. at 5%	0.06		

Table 4.11b. Interaction effect between fertigation levels and schedules on relative leaf area growth rate of cucumber between 30-60 and 60-90 DAS

(2012-13)

Treatment	Relative leaf area growth rate ($\text{cm}^{-2}\text{cm}^{-2}\text{day}^{-1}$)					
	30-60 DAS			60-90 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
	Fertigation schedule					
Fertigation of R.D. of N and K at every 2 days interval in equal splits	0.59	0.65	0.68	4.05	5.26	5.51
Fertigation of R. D. of N and K at every 4 days interval in equal splits	0.55	0.56	0.67	3.87	4.65	5.01
Fertigation of R.D. of N and K at every 6 days interval in equal splits	0.45	0.49	0.54	2.99	3.22	3.55
SEm±	0.02			0.15		
C.D. at 5%	0.04			0.45		

4.1.8 Leaf area index

Data regarding leaf area index of cucumber as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.12 and 4.13. The mean leaf area index of cucumber was 0.39, 3.13, 16.57, 17.35 and 8.83 during first year and 0.45, 3.80, 17.91, 18.64 and 10.81 during second year at 30, 60, 90, 120 days after sowing and at last picking, respectively.

4.1.8.1 Fertigation levels

The leaf area index of cucumber was influenced significantly due to the different fertigation levels at all the crop growth stages during both the years. Fertigation of 125 per cent of RDF recorded significantly maximum leaf area index at all the crop growth stages followed by 100 per cent of RDF during both the years. The significantly minimum leaf area index was observed under 75 per cent of RDF at all the growth stages during the period of experimentation.

4.1.8.2 Fertigation schedules

The leaf area index of cucumber was influenced significantly due to different fertigation schedules at all the crop growth stages. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose exhibited significantly maximum leaf area index at all the crop growth stages and it was at par with fertigation of recommended dose of N and K at every 4 days interval in equal splits upto 110 days + P as a basal dose at 90 and 120 DAS during both the years. Significantly minimum mean leaf area index of cucumber was recorded with fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose at all the stages of observations during both the years.

4.1.8.3 Interaction

The interaction effect between fertigation levels and schedules on leaf area index was found significant at 90 DAS and at last picking during first year (Table 4.12a) and at 60, 90 DAS, and at last picking during second year (Table 4.13a, b).

During first year at 90 DAS, fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days interval in equal splits upto 110 days +

Table 4.12 Periodical leaf area index of cucumber as influenced by different treatments

(2011-12)

Treatment	Leaf area index				
	30 DAS	60 DAS	90 DAS	120 DAS	At last picking
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)					
F ₁ - 75% RDF (75:37.5:37.5)	0.36	2.76	14.70	16.64	6.89
F ₂ - 100% RDF (100:50:50)	0.38	3.21	17.15	17.50	9.21
F ₃ - 125% RDF (125:62.5:62.5)	0.42	3.43	17.87	17.90	10.40
SEm±	0.01	0.07	0.28	0.44	0.23
C.D. at 5%	0.03	0.22	0.84	1.30	0.67
B. Fertigation schedule (up to 110 days)					
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	0.45	3.70	18.03	18.35	11.46
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	0.39	3.33	17.49	17.61	9.75
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	0.32	2.37	14.19	16.07	5.29
SEm±	0.01	0.07	0.28	0.44	0.23
C.D. at 5%	0.03	0.22	0.84	1.30	0.67
C. Interaction(AXB)	NS	NS	Sig.	NS	Sig.
CV (%)	6.88	7.13	5.13	7.55	7.66
General mean	0.39	3.13	16.57	17.35	8.83

Table 4.13 Periodical leaf area index of cucumber as influenced by different treatments

(2012-13)

Treatment	Leaf area index				
	30 DAS	60 DAS	90 DAS	120 DAS	At last picking
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)					
F ₁ - 75% RDF (75:37.5:37.5)	0.42	3.29	16.36	17.66	8.67
F ₂ - 100% RDF (100:50:50)	0.45	3.90	18.22	18.87	11.27
F ₃ - 125% RDF (125:62.5:62.5)	0.50	4.20	19.17	19.40	12.48
SEm±	0.01	0.07	0.28	0.42	0.27
C.D. at 5%	0.02	0.22	0.82	1.25	0.81
B. Fertigation schedule (up to 110 days)					
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	0.51	4.41	19.86	19.92	13.69
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	0.47	4.03	19.01	19.10	11.55
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	0.39	2.96	14.78	17.00	7.18
SEm±	0.01	0.07	0.28	0.42	0.27
C.D. at 5%	0.02	0.22	0.82	1.25	0.81
C. Interaction(AXB)					
CV (%)	4.38	5.86	4.60	6.77	7.58
General mean	0.45	3.80	17.91	18.64	10.81

P as a basal dose registered significantly maximum leaf area index and at par with 100 per cent of RDF and fertigation at every 2 days interval and 125 per cent RDF with fertigation of N and K at every 4 days interval. At last picking, also the 125 per cent RDF and fertigation of N and K at every 2 days interval registered significantly higher leaf area index but it was at par with 100 per cent RDF and fertigation at every 2 days interval.

During second year at 60 DAS, the combination of 125 per cent of RDF and fertigation of N and K at every 2 days interval obtained significantly higher leaf area index and at par with 100 per cent of RDF coupled with fertigation of N and K at every 2 days interval. While at 90 DAS, fertigation of 125 per cent of RDF and fertigation of N and K at every 2 days interval obtained significantly higher leaf area index and at par with 100 per cent of RDF coupled with fertigation of N and K at every 2 days interval and 4 days interval and 125 per cent of RDF with fertigation of N and K at every 4 days interval.

Table 4.12a. Interaction effect between fertigation levels and schedules on leaf area index of cucumber at 90 DAS and at last picking

(2011-12)

Treatment	Leaf area index					
	90 DAS			Last picking		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	15.59	18.86	19.65	8.60	12.20	13.58
Fertigation of R. D. of N and K at every 4 days interval in equal splits	15.03	18.14	19.28	7.75	10.12	11.38
Fertigation of R.D. of N and K at every 6 days interval in equal splits	13.46	14.46	14.67	4.32	5.30	6.23
SEm±	0.49			0.39		
C.D. at 5%	1.46			1.16		

Table 4.13a. Interaction effect between fertigation levels and schedules on leaf area index of cucumber at 60 DAS

(2012-13)

Treatment	Leaf area index					
	60 DAS			90 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	3.66	4.67	4.89	18.13	20.45	21.01
Fertigation of R. D. of N and K at every 4 days interval in equal splits	3.49	4.11	4.49	16.69	19.60	21.00
Fertigation of R.D. of N and K at every 6 days interval in equal splits	2.72	2.93	3.22	14.25	14.61	15.50
SEm±	0.13			0.48		
C.D. at 5%	0.38			1.42		

Table 4.13b. Interaction effect between fertigation levels and schedules on leaf area index of cucumber at last picking

(2012-13)

Treatment	Leaf area index		
	75% RDF	100% RDF	125% RDF
Fertigation level			
Fertigation schedule			
Fertigation of R.D. of N and K at every 2 days interval in equal splits	10.37	14.71	16.00
Fertigation of R. D. of N and K at every 4 days interval in equal splits	9.41	11.95	13.28
Fertigation of R.D. of N and K at every 6 days interval in equal splits	6.23	7.16	8.16
SEm±	0.47		
C.D. at 5%	1.41		

4.2 Physiological studies

4.2.1 Photosynthetic rate ($\mu \text{ mol m}^{-2} \text{ s}^{-1}$)

Data pertaining to the photosynthetic rate in cucumber leaves as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.14 and 4.15, respectively and graphically depicted in Fig 4.1 and 4.2. The mean photosynthetic rate was 14.64, 18.18, 22.32, 26.93, 28.92, 24.34, 19.91 and 12.17 $\mu \text{ mol m}^{-2} \text{ s}^{-1}$ at 30, 45, 60, 75, 90, 105, 120 and 135 days after sowing during first year and 15.99, 20.22, 23.34, 28.10, 30.02, 26.23, 20.29 and 12.85 $\mu \text{ mol m}^{-2} \text{ s}^{-1}$ during second year at respective growth stages.

4.2.1.1 Fertigation levels

The photosynthetic rate in cucumber leaves was influenced significantly due to the different fertigation levels at all the crop growth stages during both the years of investigation. Fertigation of 125 per cent of RDF recorded significantly maximum photosynthetic rate in cucumber leaves and at par with 100 per cent of RDF at all crop growth stages during both the years except at 45 DAS during first year and at 120 DAS during second year. Significantly minimum photosynthetic rate was noticed in 75 per cent of RDF at all the crop growth stages during both the years.

4.2.1.2 Fertigation schedules

The photosynthetic rate in cucumber leaves was influenced significantly due to different fertigation schedules at all the crop growth stages during both the years of experimentation. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose exhibited significantly higher photosynthetic rate at all the crop growth stages. However, it was at par with fertigation of recommended dose of N and K at every 4 days interval in equal splits upto 110 days + P as a basal dose at 60, 105 and 120 DAS during first year and at 30, 60 and 90 DAS during second year. Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose recorded significantly lowest photosynthetic rate in

Table 4.14 Periodical photosynthetic rate in cucumber leaves as influenced by different treatments

(2011-12)

Treatment	Photosynthetic rate ($\mu\text{ mol m}^{-2} \text{ s}^{-1}$)							
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)								
F ₁ - 75% RDF (75:37.5:37.5)	13.53	16.85	21.02	25.45	27.57	23.38	18.97	10.11
F ₂ - 100% RDF (100:50:50)	15.04	18.60	22.72	27.33	29.22	24.56	20.10	12.55
F ₃ - 125% RDF (125:62.5:62.5)	15.36	19.11	23.23	28.01	29.97	25.09	20.66	13.86
SEm±	0.17	0.18	0.23	0.25	0.47	0.40	0.31	0.29
C.D. at 5%	0.49	0.54	0.68	0.73	1.40	1.19	0.92	0.85
B. Fertigation schedule (up to 110 days)								
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	16.20	19.72	23.67	28.82	30.68	25.60	21.33	13.29
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	15.12	18.99	22.80	27.65	29.40	24.64	20.49	12.49
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	12.61	15.85	20.50	24.32	26.69	22.79	17.91	10.74
SEm±	0.17	0.18	0.23	0.25	0.47	0.40	0.31	0.29
C.D. at 5%	0.49	0.54	0.68	0.73	1.40	1.19	0.92	0.85
C. Interaction(AXB)	Sig.	Sig.	Sig.	Sig.	NS	NS	NS	NS
CV (%)	3.40	2.98	3.07	2.74	4.88	4.92	4.67	7.05
General mean	14.64	18.18	22.32	26.93	28.92	24.34	19.91	12.17

Table 4.15 Periodical photosynthetic rate in cucumber leaves as influenced by different treatments

(2012-13)

Treatment	Photosynthetic rate ($\mu \text{ mol m}^{-2} \text{ s}^{-1}$)							
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)								
F ₁ - 75% RDF (75:37.5:37.5)	15.20	19.36	22.42	26.46	28.80	25.23	19.14	10.78
F ₂ - 100% RDF (100:50:50)	16.15	20.38	23.50	28.65	30.21	26.31	20.47	13.14
F ₃ - 125% RDF (125:62.5:62.5)	16.62	20.92	24.11	29.17	31.05	27.15	21.26	14.64
SEm±	0.22	0.30	0.37	0.31	0.48	0.41	0.24	0.39
C.D. at 5%	0.67	0.88	1.10	0.92	1.44	1.22	0.70	1.16
B. Fertigation schedule (up to 110 days)								
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	16.99	21.63	24.79	29.72	31.94	28.03	21.75	14.15
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	16.37	20.80	23.84	28.61	30.67	26.57	20.40	12.97
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	14.60	18.24	21.40	25.95	27.45	24.09	18.72	11.45
SEm±	0.22	0.30	0.37	0.31	0.48	0.41	0.24	0.39
C.D. at 5%	0.67	0.88	1.10	0.92	1.44	1.22	0.70	1.16
C. Interaction(AXB)								
CV (%)	4.21	4.38	4.75	3.29	4.83	4.71	3.49	9.08
General mean	15.99	20.22	23.34	28.10	30.02	26.23	20.29	12.85

cucumber leaves at all the crop growth stages during both the year of investigation.

4.2.1.3 Interaction

The interaction effect between fertigation levels and schedules on photosynthetic rate was found significant at 30, 45, 60 and 75 DAS during first year (Table 4.14a, b) and 75 and 120 DAS during second year of experimentation (Table 4.15a). At 30 DAS, fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum photosynthetic rate in cucumber leaves during first year. Almost similar trend was observed at 45 DAS but it was at par with fertigation of N and K at every 4 days interval under same levels of fertigation and 100 per cent RDF with fertigation of N and K at every 2 days interval. At 60 and 75 DAS during first year and 75 and 120 DAS during second year similar trend was noticed as that of 45 DAS during first year. Significantly lowest photosynthetic rate was observed under 75 per cent of RDF and fertigation of N and K at every 6 days interval at all the respective growth stages during both the years.

Table 4.14a. Interaction effect between fertigation levels and schedules on photosynthetic rate in cucumber leaves at 30 and 45 DAS

(2011-12)

Treatment	Photosynthetic rate ($\mu \text{ mol m}^{-2} \text{ s}^{-1}$)					
	30 DAS			45 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	14.97	16.66	16.97	17.88	20.43	20.83
Fertigation of R. D. of N and K at every 4 days interval in equal splits	13.51	15.84	16.00	17.47	19.49	20.01
Fertigation of R.D. of N and K at every 6 days interval in equal splits	12.12	12.61	13.10	15.20	15.87	16.47
SEm \pm	0.03			0.31		
C.D. at 5%	0.09			0.93		

Table 4.14b. Interaction effect between fertigation levels and schedules on photosynthetic rate in cucumber leaves at 60 and 75 DAS

(2011-12)

Treatment	Photosynthetic rate ($\mu\text{ mol m}^{-2} \text{ s}^{-1}$)					
	60 DAS			75 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	21.70	24.33	24.98	26.79	29.53	30.14
Fertigation of R. D. of N and K at every 4 days interval in equal splits	21.32	23.25	23.84	25.75	28.31	28.90
Fertigation of R.D. of N and K at every 6 days interval in equal splits	20.05	20.58	20.88	23.81	24.15	25.00
SEm \pm	0.40			0.43		
C.D. at 5%	1.18			1.27		

Table 4.15a. Interaction effect between fertigation levels and schedules on photosynthetic rate in cucumber leaves at 75 and 120 DAS

(2012-13)

Treatment	Photosynthetic rate ($\mu\text{ mol m}^{-2} \text{ s}^{-1}$)					
	60 DAS			120 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	27.29	30.67	31.21	19.86	22.37	23.02
Fertigation of R. D. of N and K at every 4 days interval in equal splits	26.57	29.31	29.97	19.25	20.10	21.86
Fertigation of R.D. of N and K at every 6 days interval in equal splits	25.52	25.98	26.34	18.31	18.91	18.94
SEm \pm	0.53			0.41		
C.D. at 5%	1.58			1.22		

4.2.2 CO₂ concentration ($\mu \text{ mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$)

Data in respect to the CO₂ concentration in cucumber leaves as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.16 and 4.17, respectively and graphically depicted in Fig. 4.3 and 4.4. The mean CO₂ concentration was 371.52, 377.50, 380.25, 390.04, 396.41, 382.91, 369.95 and 365.20 $\mu \text{ mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$ at 30, 45, 60, 75, 90, 105, 120 and 135 days after sowing during first year and 374.72, 384.73, 386.44, 391.50, 403.04, 391.57, 377.12 and 367.95 $\mu \text{ mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$ at 30, 45, 60, 75, 90, 105, 120 and 135 days after sowing during second year.

4.2.2.1 Fertigation levels

The CO₂ concentration in cucumber leaves was influenced significantly due to the different fertigation levels at all the crop growth stages during both the years. Fertigation of 125 per cent of RDF recorded significantly higher CO₂ concentration in cucumber leaves at all the crop growth stages during both the years of the investigation and it was at par with 100 per cent of RDF at all crop growth stages except 30 DAS during second year. Significantly lowest CO₂ concentration in cucumber leaves was observed with 75 per cent of RDF at all the crop growth stages during both the years.

4.2.2.2 Fertigation schedules

The CO₂ concentration in cucumber leaves was influenced significantly due to different fertigation schedules. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly higher CO₂ concentration in cucumber leaves at all the crop growth stages. However, it was at par with fertigation of recommended dose of N and K at every 4 days interval in equal splits upto 110 days + P as a basal dose at all crop growth stages except 30 DAS during both the years and 120 DAS during first year. Significantly lowest CO₂ concentration in cucumber leaves was recorded with fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose during both the years.

Table 4.16 Periodical CO₂ concentration in cucumber leaves as influenced by different treatments

(2011-12)

Treatment	CO ₂ Conc. (μ mol CO ₂ m ⁻² s ⁻¹)							
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)								
F ₁ - 75% RDF (75:37.5:37.5)	369.05	374.39	377.38	387.71	394.24	380.38	366.44	361.19
F ₂ - 100% RDF (100:50:50)	372.29	378.63	380.74	390.48	396.74	383.57	371.21	365.47
F ₃ - 125% RDF (125:62.5:62.5)	373.20	379.48	382.63	391.93	398.25	384.80	372.21	368.94
SEm±	0.51	0.64	1.19	0.75	0.89	0.86	0.55	2.78
C.D. at 5%	1.51	1.89	3.54	2.24	2.65	2.54	1.63	8.26
B. Fertigation schedule (up to 110 days)								
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	374.47	380.45	383.76	393.27	399.34	386.50	373.57	367.76
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	372.97	378.56	381.46	391.20	397.35	384.30	371.99	365.24
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	367.10	373.49	375.52	385.65	392.55	377.94	364.29	362.61
SEm±	0.51	0.64	1.19	0.75	0.89	0.86	0.55	2.78
C.D. at 5%	1.51	1.89	3.54	2.24	2.65	2.54	1.63	8.26
C. Interaction(AXB)	NS	Sig.	NS	NS	NS	NS	Sig.	NS
CV (%)	0.41	0.51	0.94	0.58	0.67	0.67	0.44	2.28
General mean	371.52	377.50	380.25	390.04	396.41	382.91	369.95	365.20

Table 4.17 Periodical CO₂ concentration in cucumber leaves as influenced by different treatments

(2012-13)

Treatment	CO ₂ Conc. (μ mol CO ₂ m ⁻² s ⁻¹)							
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)								
F ₁ - 75% RDF (75:37.5:37.5)	371.90	382.82	383.34	389.13	400.27	388.86	374.63	363.33
F ₂ - 100% RDF (100:50:50)	374.84	384.91	386.79	391.71	403.33	392.04	377.71	368.66
F ₃ - 125% RDF (125:62.5:62.5)	377.43	386.46	389.18	393.67	405.53	393.81	379.03	371.87
SEm \pm	0.35	0.84	1.07	0.90	1.07	1.15	0.84	1.96
C.D. at 5%	1.05	2.49	3.18	2.68	3.19	3.42	2.50	5.84
B. Fertigation schedule (up to 110 days)								
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	378.44	387.77	390.55	395.38	406.88	395.51	380.49	373.15
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	376.24	386.06	387.72	392.96	404.45	392.46	378.21	369.00
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	369.49	380.36	381.04	386.17	397.81	386.74	372.67	361.70
SEm \pm	0.35	0.84	1.07	0.90	1.07	1.15	0.84	1.96
C.D. at 5%	1.05	2.49	3.18	2.68	3.19	3.42	2.50	5.84
C. Interaction(AXB)	Sig.	NS	NS	NS	NS	NS	NS	NS
CV (%)	0.28	0.65	0.83	0.69	0.80	0.88	0.67	1.60
General mean	374.72	384.73	386.44	391.50	403.04	391.57	377.12	367.95

4.2.2.3 Interaction

The interaction effect between fertigation levels and schedules on CO₂ concentration was found significant at 45 and 120 DAS during first year (Table 4.16a) and 30 DAS during second year (Table 4.17a). At 45 DAS, fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum CO₂ concentration in cucumber leaves and at par with fertigation interval at every 4 days under same fertigation level and 100 per cent fertigation level with every 2 days fertigation interval. Almost similar trend was noticed at 120 DAS during first year and 30 DAS during second year. Significantly lowest CO₂ concentration was observed under 75 per cent fertigation level with fertigation of N and K at every 6 days interval during both the years at respective growth stages.

Table 4.16a. Interaction effect between fertigation levels and schedules on CO₂ concentration in cucumber leaves at 45 and 120 DAS

(2011-12)

Treatment	CO ₂ Concentration (μ mol CO ₂ m ⁻² s ⁻¹)					
	45 DAS			120 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	375.63	382.49	383.23	368.51	375.82	376.39
Fertigation of R. D. of N and K at every 4 days interval in equal splits	374.74	379.75	381.21	367.72	373.47	374.79
Fertigation of R.D. of N and K at every 6 days interval in equal splits	372.81	373.64	374.00	363.09	364.35	365.44
SEm±	1.10			0.95		
C.D. at 5%	3.28			2.82		

Table 4.17a. Interaction effect between fertigation levels and schedules on CO₂ concentration in cucumber leaves at 30 DAS

(2012-13)

Treatment	CO ₂ Concentration (μ mol CO ₂ m ⁻² s ⁻¹)		
Fertigation level	75% RDF	100% RDF	125% RDF
Fertigation schedule			
Fertigation of R.D. of N and K at every 2 days interval in equal splits	374.85	379.59	380.88
Fertigation of R. D. of N and K at every 4 days interval in equal splits	373.13	376.59	378.99
Fertigation of R.D. of N and K at every 6 days interval in equal splits	367.71	368.35	372.42
SEm±	0.61		
C.D. at 5%	1.81		

4.2.3. Stomatal conductance (m mol m⁻² s⁻¹)

Data pertaining to stomatal conductance in cucumber leaves as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.18 and 4.19, respectively and graphically depicted in Fig. 4.5 and 4.6. The mean stomatal conductance was 0.258, 0.308, 0.381, 0.478, 0.513, 0.366, 0.220 and 0.161 m mol m⁻² s⁻¹ at 30, 45, 60, 75, 90, 105, 120 and 135 days after sowing during first year and 0.265, 0.339, 0.439, 0.489, 0.541, 0.404, 0.228 and 0.173 m mol m⁻² s⁻¹ during second year.

4.2.3.1 Fertigation levels

The stomatal conductance of cucumber leaves was influenced significantly due to the different fertigation levels at all the crop growth stages during both the years. Significantly maximum stomatal conductance in cucumber leaves was recorded with fertigation of 125 per cent of RDF and at par with 100 per cent of RDF at all crop growth stages during both the years. Fertigation of 75 per cent RDF recorded significantly minimum stomatal conductance in cucumber leaves at all crop growth stages during both the years.

Table 4.18 Periodical stomatal conductance in cucumber leaves as influenced by different treatments

(2011-12)

Treatment	Stomatal conductance ($\text{m mol m}^{-2} \text{ s}^{-1}$)							
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)								
F ₁ - 75% RDF (75:37.5:37.5)	0.227	0.282	0.344	0.447	0.470	0.337	0.201	0.132
F ₂ - 100% RDF (100:50:50)	0.267	0.314	0.391	0.485	0.526	0.375	0.226	0.171
F ₃ - 125% RDF (125:62.5:62.5)	0.279	0.327	0.407	0.503	0.542	0.385	0.233	0.190
SEm±	0.004	0.004	0.006	0.007	0.007	0.005	0.004	0.01
C.D. at 5%	0.012	0.013	0.017	0.022	0.022	0.014	0.011	0.02
B. Fertigation schedule (up to 110 days)								
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	0.286	0.342	0.432	0.515	0.548	0.412	0.244	0.183
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	0.271	0.326	0.397	0.495	0.530	0.387	0.231	0.161
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	0.216	0.256	0.313	0.425	0.460	0.299	0.185	0.140
SEm±	0.004	0.004	0.006	0.007	0.007	0.005	0.004	0.01
C.D. at 5%	0.012	0.013	0.017	0.022	0.022	0.014	0.011	0.02
C. Interaction(AXB)								
CV (%)	4.76	4.13	4.55	4.66	4.27	3.75	4.89	9.57
General mean	0.258	0.308	0.381	0.478	0.513	0.366	0.220	0.161

Table 4.19 Periodical stomatal conductance in cucumber leaves as influenced by different treatments

(2012-13)

Treatment	Stomatal conductance (m mol m ⁻² s ⁻¹)							
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)								
F ₁ - 75% RDF (75:37.5:37.5)	0.244	0.315	0.401	0.465	0.490	0.380	0.206	0.122
F ₂ - 100% RDF (100:50:50)	0.272	0.345	0.448	0.492	0.558	0.408	0.235	0.160
F ₃ - 125% RDF (125:62.5:62.5)	0.280	0.358	0.467	0.510	0.574	0.425	0.242	0.191
SEm±	0.004	0.005	0.005	0.006	0.008	0.007	0.003	0.01
C.D. at 5%	0.010	0.014	0.016	0.019	0.024	0.019	0.008	0.02
B. Fertigation schedule (up to 110 days)								
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	0.297	0.373	0.484	0.534	0.582	0.446	0.257	0.180
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	0.273	0.356	0.461	0.507	0.548	0.421	0.241	0.163
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	0.226	0.290	0.372	0.427	0.492	0.345	0.185	0.137
SEm±	0.004	0.005	0.005	0.006	0.008	0.007	0.003	0.01
C.D. at 5%	0.010	0.014	0.016	0.019	0.024	0.019	0.008	0.02
C. Interaction(AXB)	Sig.	NS	NS	NS	Sig.	NS	Sig.	NS
CV (%)	3.97	4.04	3.64	3.90	4.55	4.84	3.60	8.90
General mean	0.265	0.339	0.439	0.489	0.541	0.404	0.228	0.173

4.2.3.2 Fertigation schedules

The stomatal conductance in cucumber leaves was influenced due to different fertigation schedules at all the crop growth stages. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum stomatal conductance in cucumber leaves at all crop growth stages and at par with fertigation at every 4 days interval at 75 and 90 DAS during first year. Significantly minimum stomatal conductance in cucumber leaves was observed under fertigation of recommended dose of N and K at every 6 days interval in equal splits upto the 110 days + P as a basal dose during both the years.

4.2.3.3 Interaction

The interaction effect between fertigation levels and schedules on stomatal conductance was found significant at all crop growth stages except 45 and 75 DAS during first year (Table 4.18a, b, c) and 30, 60 and 120 DAS during second year of experimentation (Table 4.19a, b). At 30 DAS fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum stomatal conductance in cucumber leaves and at par with 100 per cent RDF with fertigation of N and K at every 2 days interval during first year. Similar trend was observed at 90 DAS during first year and 30 DAS during second year, at 60 DAS also the similar trend was observed as that 30 DAS, but in addition to that it was at par with 125 per cent RDF and fertigation of N and K at every 4 days interval. Similar trend was observed at 105 and 120 DAS during first year and 90 and 120 DAS during second year.

Table 4.18a. Interaction effect between fertigation levels and schedules on stomatal conductance in cucumber leaves at 30 and 60 DAS

(2011-12)

Treatment	Stomatal conductance ($\text{m mol m}^{-2} \text{ s}^{-1}$)					
	30 DAS			60 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	0.24	0.30	0.31	0.40	0.44	0.46
Fertigation of R. D. of N and K at every 4 days interval in equal splits	0.23	0.28	0.29	0.34	0.42	0.43
Fertigation of R.D. of N and K at every 6 days interval in equal splits	0.20	0.21	0.23	0.30	0.32	0.33
SEm \pm	0.007			0.01		
C.D. at 5%	0.021			0.03		

Table 4.18b. Interaction effect between fertigation levels and schedules on stomatal conductance in cucumber leaves at 90 and 105 DAS

(2011-12)

Treatment	Stomatal conductance ($\text{m mol m}^{-2} \text{ s}^{-1}$)					
	90 DAS			105 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	0.49	0.57	0.59	0.38	0.42	0.43
Fertigation of R. D. of N and K at every 4 days interval in equal splits	0.48	0.55	0.56	0.34	0.40	0.42
Fertigation of R.D. of N and K at every 6 days interval in equal splits	0.45	0.46	0.47	0.29	0.30	0.31
SEm \pm	0.013			0.008		
C.D. at 5%	0.037			0.024		

Table 4.18c. Interaction effect between fertigation levels and schedules on stomatal conductance in cucumber leaves at 120 DAS

(2011-12)

Treatment	Stomatal conductance ($\text{m mol m}^{-2} \text{ s}^{-1}$)		
Fertigation level \ Fertigation schedule	75% RDF	100% RDF	125% RDF
Fertigation of R.D. of N and K at every 2 days interval in equal splits	0.22	0.25	0.26
Fertigation of R. D. of N and K at every 4 days interval in equal splits	0.21	0.24	0.25
Fertigation of R.D. of N and K at every 6 days interval in equal splits	0.18	0.18	0.19
SEm \pm	0.01		
C.D. at 5%	0.02		

Table 4.19a. Interaction effect between fertigation levels and schedules on stomatal conductance in cucumber leaves at 30 and 90 DAS

(2012-13)

Treatment	Stomatal conductance ($\text{m mol m}^{-2} \text{ s}^{-1}$)					
Fertigation level \ Fertigation schedule	30 DAS			90 DAS		
	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation of R.D. of N and K at every 2 days interval in equal splits	0.28	0.30	0.31	0.52	0.61	0.62
Fertigation of R. D. of N and K at every 4 days interval in equal splits	0.24	0.29	0.29	0.47	0.58	0.59
Fertigation of R.D. of N and K at every 6 days interval in equal splits	0.22	0.23	0.23	0.47	0.49	0.51
SEm \pm	0.006			0.014		
C.D. at 5%	0.018			0.042		

Table 4.19b. Interaction effect between fertigation levels and schedules on stomatal conductance in cucumber leaves at 120 DAS**(2012-13)**

Treatment	Stomatal conductance ($\text{m mol m}^{-2} \text{ s}^{-1}$)		
Fertigation level	75% RDF	100% RDF	125% RDF
Fertigation schedule			
Fertigation of R.D. of N and K at every 2 days interval in equal splits	0.23	0.26	0.27
Fertigation of R. D. of N and K at every 4 days interval in equal splits	0.21	0.25	0.26
Fertigation of R.D. of N and K at every 6 days interval in equal splits	0.18	0.19	0.19
SEm±	0.005		
C.D. at 5%	0.014		

4.2.4 Transpiration rate ($\text{m mol H}_2\text{O m}^{-2} \text{ s}^{-1}$)

Data regarding transpiration rate in cucumber leaves as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.20 and 4.21, respectively and graphically depicted in Fig. 4.7 and 4.8. The mean transpiration rate was 4.82, 6.09, 6.89, 7.56, 8.28, 7.29, 6.55 and 5.79 $\text{m mol H}_2\text{O m}^{-2} \text{ s}^{-1}$ at 30, 45, 60, 75, 90, 105, 120 and 135 days after sowing during first year and 5.04, 6.33, 7.16, 7.93, 8.62, 7.42, 6.71 and 6.01 $\text{m mol H}_2\text{O m}^{-2} \text{ s}^{-1}$ during second year.

4.2.4.1 Fertigation levels

The transpiration rate in cucumber leaves was influenced significantly due to the different fertigation levels at all the crop growth stages during both the years. Fertigation of 125 per cent of RDF recorded significantly maximum transpiration rate in cucumber leaves and at par with 100 per cent of RDF at all crop growth stages during both the years. Significantly lower transpiration rate in

Table 4.20 Periodical transpiration rate in cucumber leaves as influenced by different treatments

(2011-12)

Treatment	Transpiration rate (m mol H ₂ O m ⁻² s ⁻¹)							
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)								
F ₁ - 75% RDF (75:37.5:37.5)	4.68	5.65	6.39	7.36	8.08	7.09	6.32	5.63
F ₂ - 100% RDF (100:50:50)	4.85	6.24	7.08	7.62	8.33	7.33	6.62	5.83
F ₃ - 125% RDF (125:62.5:62.5)	4.92	6.39	7.21	7.69	8.44	7.45	6.71	5.92
SEm±	0.05	0.06	0.08	0.05	0.09	0.07	0.05	0.08
C.D. at 5%	0.14	0.17	0.23	0.14	0.26	0.19	0.15	0.23
B. Fertigation schedule (up to 110 days)								
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	5.00	6.65	7.42	7.75	8.52	7.55	6.89	5.99
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	4.88	6.38	7.20	7.63	8.36	7.41	6.66	5.88
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	4.57	5.26	6.06	7.30	7.97	6.91	6.10	5.50
SEm±	0.05	0.06	0.08	0.05	0.09	0.07	0.05	0.08
C.D. at 5%	0.14	0.17	0.23	0.14	0.26	0.19	0.15	0.23
C. Interaction(AXB)								
CV (%)	3.03	2.88	3.36	1.81	3.13	2.68	2.24	3.93
General mean	4.82	6.09	6.89	7.56	8.28	7.29	6.55	5.79

Table 4.21 Periodical transpiration rate in cucumber leaves as influenced by different treatments

(2012-13)

Treatment	Transpiration rate (m mol H ₂ O m ⁻² s ⁻¹)							
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)								
F ₁ - 75% RDF (75:37.5:37.5)	4.92	6.00	6.83	7.78	8.43	7.18	6.56	5.88
F ₂ - 100% RDF (100:50:50)	5.07	6.41	7.23	7.97	8.67	7.47	6.73	6.05
F ₃ - 125% RDF (125:62.5:62.5)	5.13	6.57	7.42	8.04	8.77	7.60	6.82	6.11
SEm±	0.06	0.08	0.09	0.07	0.08	0.08	0.07	0.06
C.D. at 5%	0.16	0.23	0.28	0.21	0.25	0.23	0.20	0.19
B. Fertigation schedule (up to 110 days)								
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	5.20	6.72	7.58	8.10	8.88	7.76	6.92	6.24
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	5.10	6.51	7.32	7.98	8.70	7.62	6.77	6.09
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	4.83	5.75	6.58	7.71	8.28	6.87	6.43	5.72
SEm±	0.06	0.08	0.09	0.07	0.08	0.08	0.07	0.06
C.D. at 5%	0.16	0.23	0.28	0.21	0.25	0.23	0.20	0.19
C. Interaction(AXB)								
CV (%)	3.27	3.64	3.91	2.66	2.93	3.16	2.97	3.15
General mean	5.04	6.33	7.16	7.93	8.62	7.42	6.71	6.01

cucumber leaves was registered with 75 per cent of RDF at all crop growth stages during both the years.

4.1.4.2 Fertigation schedules

Different fertigation schedules influenced significantly the transpiration rate in cucumber leaves at all the crop growth stages during the period of investigation. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum transpiration rate and it was at par with fertigation at every 4 days interval at all crop growth stages during both the years except at 45 and 120 DAS during first year. Significantly lowest transpiration rate was noticed under fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose during both the years.

4.2.4.3 Interaction

The interaction effect between fertigation levels and schedules on transpiration rate was found significant at 45, 60, 75 and 120 DAS during first year and during second year it was found non significant at all the crop growth stages (Table 4.20a, b). At 45 DAS fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum transpiration rate and at par with fertigation at every 4 days interval under same fertigation level and 100 per cent RDF with fertigation at every 2 days interval. At 60 DAS, almost similar trend was noticed as that of 45 DAS, but in addition to that it was at par with fertigation of 100 per cent RDF with every 4 days interval. At 75 DAS and 120 DAS, also the similar trend was observed as that of 60 DAS.

Table 4.20a. Interaction effect between fertigation levels and schedules on transpiration rate in cucumber leaves at 45 and 60 DAS

(2011-12)

Treatment	Transpiration rate (m mol H ₂ O m ⁻² s ⁻¹)					
	45 DAS			60 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	6.10	6.87	6.97	6.72	7.74	7.80
Fertigation of R. D. of N and K at every 4 days interval in equal splits	5.79	6.60	6.74	6.59	7.43	7.57
Fertigation of R.D. of N and K at every 6 days interval in equal splits	5.05	5.25	5.46	5.85	6.05	6.26
SEm±	0.10			0.13		
C.D. at 5%	0.30			0.40		

Table 4.20b. Interaction effect between fertigation levels and schedules on transpiration rate in cucumber leaves at 75 and 120 DAS

(2011-12)

Treatment	Transpiration rate (m mol H ₂ O m ⁻² s ⁻¹)					
	75 DAS			120 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	7.43	7.86	7.95	6.67	6.97	7.03
Fertigation of R. D. of N and K at every 4 days interval in equal splits	7.36	7.72	7.80	6.26	6.80	6.92
Fertigation of R.D. of N and K at every 6 days interval in equal splits	7.29	7.30	7.33	6.03	6.08	6.19
SEm±	0.08			0.085		
C.D. at 5%	0.23			0.25		

4.2.4 Stomatal resistance ($\text{m mol m}^{-2} \text{s}^{-1}$)

Data regarding to stomatal resistance in cucumber leaves as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.22 and 4.23, respectively and graphically depicted in Fig. 4.9 and 4.10. The mean stomatal resistance was 3.98, 3.32, 2.69, 2.11, 1.97, 2.80, 4.64 and 6.54 $\text{m mol m}^{-2} \text{s}^{-1}$ at 30, 45, 60, 75, 90, 105, 120 and 135 days after sowing during first year and 3.84, 2.99, 2.32, 2.07, 1.87, 2.51, 4.50 and 6.78 $\text{m mol m}^{-2} \text{s}^{-1}$ during second year.

4.2.5.1 Fertigation levels

The stomatal resistance in cucumber leaves was influenced significantly due to the different fertigation levels at all the crop growth stages during both the years. Fertigation of 125 per cent of RDF recorded significantly minimum stomatal resistance in cucumber leaves at all the crop growth stages during both the years of study. Significantly maximum stomatal resistance in cucumber leaves was recorded under 75 per cent of RDF at all the stages of crop growth during both the years.

4.2.5.2 Fertigation schedules

The stomatal resistance in cucumber leaves was influenced significantly due to different fertigation schedules. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose recorded significantly minimum stomatal resistance at all the crop growth stages and at par with fertigation of recommended dose of N and K at every 4 days interval in equal splits upto 110 days + P as a basal dose during both the years. Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum stomatal resistance in cucumber leaves during both the years of investigation.

4.2.5.3 Interaction

The interaction effect between fertigation levels and schedules on stomatal resistance was found significant at 30 DAS during second year of experimentation

Table 4.22 Periodical stomatal resistance in cucumber leaves as influenced by different treatments

(2011-12)

Treatment	Stomatal resistance(m mol m ⁻² s ⁻¹)							
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)								
F ₁ - 75% RDF (75:37.5:37.5)	4.44	3.59	2.95	2.25	2.14	3.00	5.02	8.00
F ₂ - 100% RDF (100:50:50)	3.83	3.26	2.61	2.08	1.92	2.73	4.52	6.17
F ₃ - 125% RDF (125:62.5:62.5)	3.65	3.11	2.52	2.00	1.86	2.66	4.39	5.46
SEm±	0.06	0.05	0.05	0.03	0.03	0.03	0.08	0.23
C.D. at 5%	0.17	0.16	0.14	0.09	0.10	0.09	0.25	0.70
B. Fertigation schedule (up to 110 days)								
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	3.54	2.94	2.32	1.95	1.84	2.44	4.13	5.67
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	3.74	3.10	2.55	2.03	1.90	2.61	4.37	6.56
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	4.65	3.93	3.20	2.36	2.18	3.35	5.42	7.39
SEm±	0.06	0.05	0.05	0.03	0.03	0.03	0.08	0.23
C.D. at 5%	0.17	0.16	0.14	0.09	0.10	0.09	0.25	0.70
C. Interaction(AXB)								
CV (%)	4.41	4.86	5.25	4.50	4.99	3.35	5.34	8.21
General mean	3.98	3.32	2.69	2.11	1.97	2.80	4.64	6.54

Table 4.23 Periodical stomatal resistance in cucumber leaves as influenced by different treatments

(2012-13)

Treatment	Stomatal resistance (m mol m ⁻² s ⁻¹)							
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)								
F ₁ - 75% RDF (75:37.5:37.5)	4.15	3.21	2.51	2.17	2.05	2.66	4.91	8.48
F ₂ - 100% RDF (100:50:50)	3.74	2.94	2.28	2.06	1.81	2.49	4.36	6.41
F ₃ - 125% RDF (125:62.5:62.5)	3.63	2.83	2.17	1.98	1.76	2.40	4.24	5.46
SEm±	0.05	0.04	0.03	0.03	0.03	0.04	0.06	0.19
C.D. at 5%	0.15	0.13	0.08	0.09	0.09	0.13	0.19	0.57
B. Fertigation schedule (up to 110 days)								
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	3.38	2.69	2.08	1.88	1.73	2.25	3.92	5.85
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	3.71	2.82	2.18	1.98	1.85	2.38	4.18	6.50
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	4.44	3.46	2.70	2.35	2.04	2.91	5.41	7.99
SEm±	0.05	0.04	0.03	0.03	0.03	0.04	0.06	0.19
C.D. at 5%	0.15	0.13	0.08	0.09	0.09	0.13	0.19	0.57
C. Interaction(AXB)								
CV (%)	3.89	4.29	3.59	4.20	4.69	5.08	4.26	8.51
General mean	3.84	2.99	2.32	2.07	1.87	2.51	4.50	6.78

(Table 4.23a). Fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly minimum stomatal resistance in cucumber leaves than rest of the treatment combinations. Whereas, maximum stomatal resistance was observed under 75 per cent of RDF and fertigation of N and K at every 6 days interval.

Table 4.23a. Interaction effect between fertigation levels and schedules on stomatal resistance in cucumber leaves at 30 DAS

(2012-13)

Treatment	Stomatal resistance ($\text{m mol m}^{-2} \text{ s}^{-1}$)		
Fertigation level \ Fertigation schedule	75% RDF	100% RDF	125% RDF
Fertigation of R.D. of N and K at every 2 days interval in equal splits	3.63	3.32	3.19
Fertigation of R. D. of N and K at every 4 days interval in equal splits	4.23	3.49	3.40
Fertigation of R.D. of N and K at every 6 days interval in equal splits	4.59	4.42	4.30
SEm \pm	0.09		
C.D. at 5%	0.26		

4.2.6 Leaf temperature ($^{\circ}\text{C}$)

The leaf temperature in cucumber leaves as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.24 and 4.25, respectively and graphically depicted in Fig. 4.11 and 4.12. The mean leaf temperature was 24.93, 27.83, 29.11, 31.59, 32.78, 35.19, 39.69 and 40.48 $^{\circ}\text{C}$ at 30, 45, 60, 75, 90, 105, 120 and 135 days after sowing during first year and 27.65, 29.17, 30.72, 32.77, 33.59, 36.81, 37.24 and 38.61 $^{\circ}\text{C}$ during second year.

Table 4.24 Periodical leaf temperature in cucumber as influenced by different treatments

(2011-12)

Treatment	Leaf temperature ($^{\circ}$ C)							
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)								
F ₁ - 75% RDF (75:37.5:37.5)	25.52	28.24	29.66	32.21	33.86	35.93	40.64	41.22
F ₂ - 100% RDF (100:50:50)	25.27	27.96	29.36	31.73	33.12	35.44	39.79	40.42
F ₃ - 125% RDF (125:62.5:62.5)	24.00	27.28	28.30	30.84	31.36	34.21	38.66	39.78
SEm \pm	0.24	0.29	0.19	0.27	0.25	0.23	0.31	0.43
C.D. at 5%	0.70	0.86	0.56	0.80	0.73	0.69	0.91	1.27
B. Fertigation schedule (up to 110 days)								
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	22.75	26.92	27.92	30.36	30.65	33.74	37.93	39.81
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	25.54	28.10	29.37	31.91	33.29	35.42	40.02	40.55
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	26.50	28.46	30.03	32.51	34.40	36.41	41.13	41.07
SEm \pm	0.24	0.29	0.19	0.27	0.25	0.23	0.31	0.43
C.D. at 5%	0.70	0.86	0.56	0.80	0.73	0.69	0.91	NS
C. Interaction(AXB)								
CV (%)	2.85	3.12	1.94	2.55	2.26	1.98	2.31	3.17
General mean	24.93	27.83	29.11	31.59	32.78	35.19	39.69	40.48

Table 4.25 Periodical leaf temperature in cucumber as influenced by different treatments

(2012-13)

Treatment	Leaf temperature ($^{\circ}\text{C}$)							
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)								
F ₁ - 75% RDF (75:37.5:37.5)	28.10	29.73	31.21	33.31	34.46	37.56	38.33	39.45
F ₂ - 100% RDF (100:50:50)	27.82	29.30	30.91	32.90	33.82	36.98	37.77	38.45
F ₃ - 125% RDF (125:62.5:62.5)	27.05	28.50	30.05	32.11	32.50	35.89	35.64	37.93
SEm \pm	0.28	0.33	0.22	0.25	0.20	0.29	0.30	0.35
C.D. at 5%	0.84	0.98	0.64	0.75	0.61	0.85	0.88	1.03
B. Fertigation schedule (up to 110 days)								
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	26.82	28.05	29.73	31.66	31.97	35.23	34.39	37.86
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	27.87	29.39	30.92	33.01	33.72	37.09	37.75	38.81
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	28.28	30.07	31.52	33.65	35.08	38.11	39.59	39.18
SEm \pm	0.28	0.33	0.22	0.25	0.20	0.29	0.30	0.35
C.D. at 5%	0.84	0.98	0.64	0.75	0.61	0.85	0.88	1.03
C. Interaction(AXB)	NS	NS	NS	NS	Sig.	NS	Sig.	NS
CV (%)	3.06	3.38	2.11	2.32	1.83	2.33	2.38	2.70
General mean	27.65	29.17	30.72	32.77	33.59	36.81	37.24	38.61

4.2.6.1 Fertigation levels

The leaf temperature in cucumber leaves was influenced significantly due to different fertigation levels at all crop growth stages during both the years. Fertigation of 125 per cent of RDF recorded significantly minimum leaf temperature in cucumber followed by 100 per cent fertigation level at all the stages of crop growth during both the years of experimentation. Significantly maximum leaf temperature was recorded with fertigation of 75 per cent of RDF at all the crop growth stages during both the years.

4.2.6.2 Fertigation schedules

The leaf temperature in cucumber was influenced significantly due to different fertigation schedules. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly minimum leaf temperature at all the crop growth stages followed by fertigation of N and K at every 4 days interval during both the years of investigation. Significantly maximum leaf temperature in cucumber leaves was recorded under fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose at all crop growth stages during both the years.

4.2.6.3 Interaction

The interaction effect between fertigation levels and schedules on leaf temperature was found significant at 30, 45 and 90 DAS during first year (Table 4.24a, b) and 90 and 120 DAS during second year of experimentation (Table 4.25a). During first year at 30 DAS fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly minimum leaf temperature than rest of the treatment combinations. However, it was at par with fertigation at every 4 days interval in same fertigation level (125 % RDF) and 100 per cent RDF with fertigation interval at every 2 days interval. At 60 DAS, during first year and at 120 DAS during second year similar trend was observed as that of 30 DAS.

Table 4.24a. Interaction effect between fertigation levels and schedules on leaf temperature of cucumber at 30 and 60 DAS

(2011-12)

Treatment	Leaf temperature ($^{\circ}$ C)					
	30 DAS			60 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	22.95	22.79	22.51	28.02	27.88	27.85
Fertigation of R. D. of N and K at every 4 days interval in equal splits	26.63	26.28	23.71	30.14	29.79	28.19
Fertigation of R.D. of N and K at every 6 days interval in equal splits	26.99	26.73	25.78	30.83	30.40	28.87
SEm \pm	0.41			0.33		
C.D. at 5%	1.22			0.97		

Table 4.24b. Interaction effect between fertigation levels and schedules on leaf temperature of cucumber at 90

(2011-12)

Treatment	Leaf temperature ($^{\circ}$ C)		
	75% RDF	100% RDF	125% RDF
Fertigation level			
Fertigation schedule			
Fertigation of R.D. of N and K at every 2 days interval in equal splits	31.13	30.64	30.19
Fertigation of R. D. of N and K at every 4 days interval in equal splits	34.83	33.49	31.55
Fertigation of R.D. of N and K at every 6 days interval in equal splits	35.61	35.24	32.34
SEm \pm	0.43		
C.D. at 5%	1.27		

Table 4.25a. Interaction effect between fertigation levels and schedules on leaf temperature of cucumber at 90 and 120 DAS (2012-13)

Treatment	Leaf temperature ($^{\circ}\text{C}$)					
	90 DAS			120 DAS		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	32.37	32.04	31.50	34.63	34.49	34.04
Fertigation of R. D. of N and K at every 4 days interval in equal splits	34.86	33.44	32.87	39.54	38.44	35.29
Fertigation of R.D. of N and K at every 6 days interval in equal splits	36.15	35.97	33.13	40.81	40.39	37.57
SEm \pm	0.35			0.51		
C.D. at 5%	1.05			1.52		

At 90 DAS during both years, fertigation of 125 per cent RDF with fertigation of N and K at every 2 days interval in equal splits up to 110 days + P as a basal dose registered significantly lowest leaf temperature and at par with 100 per cent RDF along with fertigation interval at every 2 days.

4.2.7 Leaf water potential (Ψ)

The leaf water potential in cucumber as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.26 and 4.27, respectively. The mean leaf water potential was -5.31, -6.33, -7.45, -8.49 and -9.72 at 30, 60, 90, 120 days after sowing and at last picking during first year and -5.14, -6.09, -7.18, -8.40 and -9.32 during second year.

4.2.7.1 Fertigation levels

The leaf water potential in cucumber was influenced significantly due to different fertigation levels at all the crop growth stages. Fertigation of 125 per cent of RDF recorded significantly minimum leaf water potential in cucumber followed by 100 per cent of RDF at the crop growth stages during 2011-12 and

Table 4.26 Periodical leaf water potential in cucumber as influenced by different treatments

(2011-12)

Treatment	Leaf water potential (Ψ)				
	30 DAS	60 DAS	90 DAS	120 DAS	At last picking
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)					
F ₁ - 75% RDF (75:37.5:37.5)	-5.21	-6.13	-7.21	-8.25	-9.47
F ₂ - 100% RDF (100:50:50)	-5.32	-6.26	-7.37	-8.42	-9.65
F ₃ - 125% RDF (125:62.5:62.5)	-5.43	-6.59	-7.79	-8.82	-10.03
SEm±	0.07	0.11	0.12	0.12	0.13
C.D. at 5%	0.20	0.29	0.36	0.35	0.37
B. Fertigation schedule (up to 110 days)					
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	-5.61	-6.82	-8.02	-9.03	-10.27
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	-5.27	-6.21	-7.33	-8.37	-9.59
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	-5.07	-5.94	-7.03	-8.08	-9.29
SEm±	0.07	0.11	0.12	0.12	0.13
C.D. at 5%	0.20	0.29	0.36	0.35	0.37
C. Interaction(AXB)					
CV (%)	3.82	4.74	4.84	4.20	4.06
General mean	-5.31	-6.33	-7.45	-8.49	-9.72

Table 4.27 Periodical leaf water potential in cucumber as influenced by different treatments

(2012-13)

Treatment	Leaf water potential (Ψ)				
	30 DAS	60 DAS	90 DAS	120 DAS	At last picking
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)					
F ₁ - 75% RDF (75:37.5:37.5)	-4.99	-5.89	-6.96	-8.12	-9.05
F ₂ - 100% RDF (100:50:50)	-5.11	-6.03	-7.13	-8.30	-9.24
F ₃ - 125% RDF (125:62.5:62.5)	-5.20	-6.36	-7.45	-8.77	-9.67
SEm±	0.05	0.09	0.10	0.11	0.14
C.D. at 5%	0.16	0.26	0.29	0.32	0.40
B. Fertigation schedule (up to 110 days)					
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	-5.44	-6.54	-7.63	-9.02	-9.94
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	-5.06	-5.99	-7.09	-8.24	-9.18
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	-4.82	-5.75	-6.82	-7.93	-8.85
SEm±	0.05	0.09	0.10	0.11	0.14
C.D. at 5%	0.16	0.26	0.29	0.32	0.40
C. Interaction(AXB)					
CV (%)	3.18	4.32	4.07	3.82	4.26
General mean	-5.14	-6.09	-7.18	-8.40	-9.32

2012-13. Maximum and significantly higher leaf water potential was noticed under 75 per cent of RDF at all the stages of crop growth during the period of investigation.

4.2.7.2 Fertigation schedules

The leaf water potential in cucumber was influenced significantly due to different fertigation schedules at all the crop growth stages. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose exhibited significantly lower leaf water potential followed by fertigation at every 4 days interval. Significantly higher leaf water potential in cucumber was noticed under fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose throughout the crop growth stages during both the years.

4.2.7.3 Interaction

The interaction effect between fertigation levels and schedules were found non significant in respect of leaf water potential during both the years of experimentation.

4.2.8 Total chlorophyll content (%)

Data regarding to total chlorophyll content in cucumber leaves as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.28 and 4.29, respectively. The mean total chlorophyll content was 31.44, 34.00, 45.01, 48.44, 53.74, 48.30, 41.30 and 37.07 per cent at 30, 45, 60, 75, 90, 105, 120 and 135 days after sowing during first year and 31.74, 35.07, 46.30, 49.37, 54.89, 49.70, 42.67 and 38.59 per cent during second year.

4.2.8.1 Fertigation levels

The total chlorophyll content in cucumber leaves was influenced significantly due to different fertigation levels at all the crop growth stages during both the years. Fertigation of 125 per cent of RDF recorded significantly maximum total chlorophyll content in cucumber leaves at all the crop growth stages during first year except 90 and 120 during second year and at par with 100 per cent of RDF during both the years.

Table 4.28 Periodical total chlorophyll content in cucumber leaves as influenced by different treatments

(2011-12)

Treatment	Total chlorophyll content (%)							
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)								
F ₁ - 75% RDF (75:37.5:37.5)	30.33	32.89	43.72	47.00	51.22	46.67	40.11	35.11
F ₂ - 100% RDF (100:50:50)	31.67	34.22	45.05	48.78	54.11	48.67	41.33	37.22
F ₃ - 125% RDF (125:62.5:62.5)	32.33	34.89	46.26	49.56	54.89	49.56	42.44	38.89
SEm±	0.53	0.55	0.73	0.81	0.95	0.81	0.67	0.63
C.D. at 5%	1.56	1.63	2.16	2.40	2.83	2.40	1.98	1.88
B. Fertigation schedule (up to 110 days)								
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	33.00	35.67	47.23	50.56	55.89	50.56	43.33	38.22
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	31.89	34.33	45.54	49.00	54.67	49.22	41.78	37.44
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	29.44	32.00	42.27	45.78	50.67	45.11	38.78	35.56
SEm±	0.53	0.55	0.73	0.81	0.95	0.81	0.67	0.63
C.D. at 5%	1.56	1.63	2.16	2.40	2.83	2.40	1.98	1.88
C. Interaction(AXB)	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	5.01	4.84	4.84	4.99	5.31	5.02	4.84	5.11
General mean	31.44	34.00	45.01	48.44	53.74	48.30	41.30	37.07

Table 4.29 Periodical total chlorophyll content in cucumber leaves as influenced by different treatments

(2012-13)

Treatment	Total chlorophyll content (%)							
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS	135 DAS
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)								
F ₁ - 75% RDF (75:37.5:37.5)	30.89	34.00	44.81	47.89	51.22	48.00	41.44	36.22
F ₂ - 100% RDF (100:50:50)	31.78	35.22	46.63	49.67	55.11	50.11	42.78	38.89
F ₃ - 125% RDF (125:62.5:62.5)	32.56	36.00	47.48	50.56	56.56	51.00	43.78	40.67
SEm±	0.50	0.52	0.63	0.68	1.11	0.68	0.68	0.76
C.D. at 5%	1.48	1.55	1.87	2.01	NS	2.02	NS	2.25
B. Fertigation schedule (up to 110 days)								
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	32.89	36.56	48.57	51.11	57.44	52.00	44.44	40.22
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	32.11	35.56	47.35	50.00	55.22	50.22	43.11	38.89
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	30.22	33.11	42.99	47.00	52.00	46.89	40.44	36.67
SEm±	0.50	0.52	0.63	0.68	1.11	0.68	0.68	0.76
C.D. at 5%	1.48	1.55	1.87	2.01	3.29	2.02	2.04	2.25
C. Interaction(AXB)								
CV (%)	4.70	4.46	4.08	4.11	6.05	4.10	4.82	5.88
General mean	31.74	35.07	46.30	49.37	54.89	49.70	42.67	38.59

Significantly lowest total chlorophyll content in cucumber leaves was observed under 75 per cent of RDF at all crop growth stages during both the years.

4.2.8.2 Fertigation schedules

The total chlorophyll content in cucumber leaves was influenced significantly due to different fertigation schedules at all crop growth stages during both the years. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly higher total chlorophyll content and at par with fertigation of N and K at every 4 days interval in equal splits upto 110 days + P as a basal dose. Whereas, fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose reported significantly lowest total chlorophyll content in cucumber leaves at all crop growth stages during both the years.

4.2.8.3 Interaction

The interaction effect between fertigation levels and schedules was found non significant in respect of total chlorophyll content in cucumber leaves during both the years of experimentation.

4.3 Flowering and fruit setting

4.3.1 Days to first female flower initiation

Data in respect of number of days required to first female flower initiation as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.30 and 4.31, respectively. The mean number of days required to first female flower initiation were 46.88 and 47.61 during first year and second year, respectively.

4.3.1.1 Fertigation levels

The number of days to first female flower initiation in cucumber was influenced significantly due to the different fertigation levels during both the years. Fertigation of 75 per cent of RDF recorded significantly minimum number of days 45.67 and 46.09 to first female flower initiation followed by 100 per cent RDF (46.88 and 47.68 days). Maximum and significantly more number of days

Table 4.30 Number of days to flower initiation, internodal distance, days to first fruit set and harvest as influenced by different treatments

(2011-12)

Treatment	Days to first female flower initiation	Node No. at which 1 st female flower appeared	Internodal distance (cm)	No. of days to first fruit set	No. of days to first fruit harvest	No. of days to last fruit harvest
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)						
F ₁ - 75% RDF (75:37.5:37.5)	45.67	4.02	7.64	54.87	63.51	147.33
F ₂ - 100% RDF (100:50:50)	46.88	4.07	7.98	56.13	65.32	149.77
F ₃ - 125% RDF (125:62.5:62.5)	48.10	4.21	8.10	57.04	66.74	151.26
SEm±	0.43	0.08	0.13	0.47	0.60	0.96
C.D. at 5%	1.28	NS	0.37	1.40	1.79	2.85
B. Fertigation schedule (up to 110 days)						
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	48.65	4.27	8.29	57.56	66.79	152.67
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	48.01	4.25	7.99	56.64	65.34	150.43
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	47.48	4.24	7.95	57.60	65.23	145.27
SEm±	0.43	0.08	0.13	0.47	0.60	0.96
C.D. at 5%	1.28	NS	NS	NS	NS	2.85
C. Interaction(AXB)	NS	NS	NS	NS	NS	NS
CV (%)	2.77	5.85	4.75	2.52	2.76	1.92
General mean	46.88	4.05	7.91	56.01	65.19	149.45

Table 4.31 Number of days to flower initiation, internodal distance, days to first fruit set and harvest as influenced by different treatments (2012-13)

Treatment	Days to first female flower initiation	Node No. at which 1 st female flower appeared	Internodal distance (cm)	No. of days to first fruit set	No. of days to first fruit harvest	No. of days to last fruit harvest
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)						
F ₁ - 75% RDF (75:37.5:37.5)	46.09	4.17	7.70	56.84	65.52	153.94
F ₂ - 100% RDF (100:50:50)	47.68	4.23	8.02	58.35	67.41	157.31
F ₃ - 125% RDF (125:62.5:62.5)	49.07	4.39	8.17	59.29	69.38	158.70
SEm±	0.51	0.08	0.12	0.41	0.67	0.95
C.D. at 5%	1.51	NS	0.36	1.22	1.99	2.82
B. Fertigation schedule (up to 110 days)						
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	49.51	4.40	8.28	59.91	69.35	159.98
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	48.39	4.29	8.09	58.62	68.28	157.70
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	48.13	4.21	7.98	58.96	67.84	152.26
SEm±	0.51	0.08	0.12	0.41	0.67	0.95
C.D. at 5%	NS	NS	NS	NS	NS	2.82
C. Interaction(AXB)						
CV (%)	3.20	5.68	4.58	2.12	2.98	1.82
General mean	47.61	4.18	7.96	58.16	67.44	156.65

(48.10 and 49.07) to first female flower initiation in cucumber was noticed with 125 per cent of RDF during both the years.

4.3.1.2 Fertigation schedules

The number of days to first female flower initiation in cucumber was not influenced significantly due to different fertigation schedules during both the years. Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose registered numerically minimum number of days (47.48 and 48.13) to first female flower initiation in cucumber during 2011-12 and 2012-13, respectively.

4.3.1.3 Interaction

The interaction effect between fertigation levels and schedules was found non significant in respect of number of days to first female flower initiation in cucumber during both the years of experimentation.

4.3.2 Node number at which first female flower appeared

Data pertaining to node number at which first female flower appeared in cucumber as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.30 and 4.31, respectively. The mean node number 4.05 and 4.18 at which first female flower appeared in cucumber during 2011-12 and 2012-13, respectively.

4.3.2.1 Fertigation levels

The node number at which first female flower appeared in cucumber did not influenced significantly due to the different fertigation levels during both the years.

4.3.2.2 Fertigation schedules

The node number at which first female flower appeared in cucumber did not influenced significantly due to different fertigation schedules during both the years.

4.3.2.3 Interaction

The interaction effect between fertigation levels and schedules was found non significant in respect of node number at which first female flower appeared in cucumber during both the years of experimentation.

4.3.3 Internodal distance (cm)

Data regarding the internodal distance in cucumber vine as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.30 and 4.31, respectively. The mean internodal distance of cucumber vine was 7.91 and 7.96 cm during 2011-12 and 2012-13, respectively.

4.3.3.1 Fertigation levels

The internodal distance in cucumber vine was influenced significantly due to different fertigation levels during both the years. Fertigation of 125 per cent of RDF recorded significantly maximum internodal distance (8.10 and 8.17 cm) and at par with 100 per cent of RDF (7.98 and 8.02 cm) during 2011-12 and 2012-13, respectively. Significantly minimum internodal distance (7.64 and 7.70 cm) was noticed under 75 per cent of RDF during both the years.

4.3.3.2 Fertigation schedules

The internodal distance in cucumber vine did not influenced significantly due to different fertigation schedules during both the years. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered numerically maximum internodal distance (8.29 and 8.28 cm) during both the years.

4.3.3.3 Interaction

The interaction effect between fertigation levels and fertigation schedules was found non significant in respect of internodal distance in cucumber vine during both the years of experimentation.

4.3.4 Number of days to first fruit set

Data pertaining to number of days required to first fruit set in cucumber as influenced by different treatments during the year 2011-12 and 2012-13 are

presented in Table 4.30 and 4.31, respectively. The mean number of days were 56.01 and 58.16 required to first fruit set in cucumber during 2011-12 and 2012-13, respectively.

4.3.4.1 Fertigation levels

The number of days required to first fruit set in cucumber were influenced significantly due to the different fertigation levels during both the years. Fertigation of 75 per cent of RDF recorded significantly minimum number of days (54.87 and 56.84) to first fruit set followed by 100 per cent RDF (56.13 and 58.35 days) in cucumber during first and second year, respectively. Fertigation of 125 per cent of RDF indicated significantly maximum number of days (57.04 and 59.29) required to first fruit set in cucumber during both the years.

4.3.4.2 Fertigation schedules

The number of days to first fruit set in cucumber were not influenced significantly due to different fertigation schedules during both the years. Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose registered numerically minimum number of days (57.60 and 58.96) to first fruit set of cucumber during both the years.

4.3.4.3 Interaction

The interaction effect between fertigation levels and schedules were found non significant in respect of number of days to first fruit set during both the years of experimentation.

4.3.5 Number of days to first fruit harvest

Data pertaining to number of days to first fruit harvest in cucumber as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.30 and 4.31, respectively. The mean number of days were 65.19 and 67.44 to first fruit harvest in cucumber during first and second year, respectively.

4.3.5.1 Fertigation levels

The number of days to first fruit harvest in cucumber were influenced significantly due to the different fertigation levels during both the years.

Fertigation of 75 per cent of RDF recorded significantly minimum number of days 63.51 and 65.52 to first fruit harvest in cucumber during both the years followed by 100 per cent of RDF (65.32 and 67.41). Significantly more number of days to first fruit harvest were noticed under 125 per cent of RDF (66.74 and 69.38 days) during the period under study.

4.3.5.2 Fertigation schedules

The number of days to first fruit harvest in cucumber was not influenced significantly due to different fertigation schedules during both the years. Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose registered numerically minimum number of days (65.23 and 67.84) to first fruit harvest in cucumber during both the years.

4.3.5.3 Interaction

The interaction effect between fertigation levels and schedules was found non significant in respect of number of days required to first fruit harvest during both the years of experimentation.

4.3.6 Number of days to last fruit harvest

Data pertaining to number of days to last fruit harvest in cucumber as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.30 and 4.31, respectively. The mean number of days required to last fruit harvest were 149.45 and 156.65 during 2011-12 and 2012-13, respectively.

4.3.6.1 Fertigation levels

The number of days to last fruit harvest in cucumber was influenced significantly due to the different fertigation levels during both the years. Fertigation of 125 per cent of RDF recorded significantly maximum number of days (151.26 and 158.70) to last fruit harvest in cucumber and at par with 100 per cent of RDF (149.77 and 157.31) during both the years. Whereas, 75 per cent of RDF registered significantly minimum number of days (147.33 and 153.94) to last fruit harvest in cucumber during both the years of experimentation.

4.3.6.2 Fertigation schedules

The number of days required to last fruit harvest in cucumber was influenced significantly due to different fertigation schedules. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum number of days (152.67 and 159.58) to last fruit harvest and at par with fertigation of N and K at every 4 days interval during both the years. Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose registered significantly minimum number of days (145.27 and 152.26) to last fruit harvest during both the years.

4.3.6.3 Interaction

The interaction effect between fertigation levels and schedules was found non significant in respect of number of days to last fruit harvest of cucumber during both the years of experimentation.

4.4 Yield attributes and fruit yield

4.4.1 Yield attributes characters

Data pertaining to yield attributing characters *viz.*, number of fruits vine⁻¹, fruit length, fruit girth, average fruit weight and fruit weight vine⁻¹ as influenced by different treatments are presented in Table 4.32, 4.33 and 4.34, respectively.

4.4.1.1 Number of fruits vine⁻¹

Data pertaining to number of fruits vine⁻¹ as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.32, 4.33 and 4.34, respectively and graphically depicted in Fig. 4.13. The mean number of fruits vine⁻¹ of cucumber were 23.43, 24.45 and 23.94 during 2011-12, 2012-13 and on pooled mean, respectively.

4.4.1.1.1 Fertigation levels

The number of fruits vine⁻¹ of cucumber was influenced significantly due to the different fertigation levels during both the years. Fertigation of 125 per cent of RDF recorded significantly maximum number of fruits vine⁻¹ (24.96, 26.17 and 25.56) during 2011-12, 2012-13 and on pooled mean. While, 75 per cent of RDF

Table 4.32 Yield attributes of cucumber as influenced by different treatments

(2011-12)

Treatment	No. of fruits vine ⁻¹	Fruit length (cm)	Fruit girth (cm)	Average fruit wt. (g)	Fruit weight vine ⁻¹ (kg)
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)					
F ₁ - 75% RDF (75:37.5:37.5)	22.14	13.03	11.25	184.30	4.20
F ₂ - 100% RDF (100:50:50)	23.20	14.11	11.24	190.57	4.45
F ₃ - 125% RDF (125:62.5:62.5)	24.96	14.43	11.37	196.14	4.85
SEm±	0.37	0.13	0.11	2.11	0.09
C.D. at 5%	1.11	0.40	NS	6.27	0.26
B. Fertigation schedule (up to 110 days)					
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	24.87	14.83	11.57	199.99	5.01
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	23.84	14.45	11.35	193.85	4.80
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	21.55	12.30	11.29	177.17	3.69
SEm±	0.37	0.13	0.11	2.11	0.09
C.D. at 5%	1.11	0.40	NS	6.27	0.26
C. Interaction(AXB)					
CV (%)	4.79	2.92	3.07	3.32	5.87
General mean	23.43	13.86	11.02	190.34	4.50

Table 4.33 Yield attributes of cucumber as influenced by different treatments

(2012-13)

Treatment	No. of fruits vine ⁻¹	Fruit length (cm)	Fruit girth (cm)	Average fruit wt. (g)	Fruit weight vine ⁻¹ (kg)
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)					
F ₁ - 75% RDF (75:37.5:37.5)	22.94	14.24	12.18	194.45	4.59
F ₂ - 100% RDF (100:50:50)	24.23	15.20	12.26	200.93	4.83
F ₃ - 125% RDF (125:62.5:62.5)	26.17	15.53	12.47	207.37	5.33
SEm±	0.45	0.12	0.12	2.40	0.10
C.D. at 5%	1.34	0.36	NS	7.12	0.28
B. Fertigation schedule (up to 110 days)					
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	26.02	16.07	12.69	209.44	5.35
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	25.13	15.72	12.47	202.93	5.24
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	22.19	13.19	12.41	190.38	4.15
SEm±	0.45	0.12	0.12	2.40	0.10
C.D. at 5%	1.34	0.36	NS	7.12	0.28
C. Interaction(AXB)	Sig.	Sig.	NS	Sig.	Sig.
CV (%)	5.52	2.43	3.06	3.58	4.95
General mean	24.45	14.99	11.97	200.92	4.91

Table 4.34 Yield attributes of cucumber as influenced by different treatments

(Pooled mean)					
Treatment	No. of fruits vine ⁻¹	Fruit length (cm)	Fruit girth (cm)	Average fruit wt. (g)	Fruit weight vine ⁻¹ (kg)
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)					
F ₁ - 75% RDF (75:37.5:37.5)	22.54	13.64	11.71	189.37	4.39
F ₂ - 100% RDF (100:50:50)	23.72	14.66	11.75	195.75	4.63
F ₃ - 125% RDF (125:62.5:62.5)	25.56	14.98	11.92	201.76	5.09
SEm±	0.41	0.13	0.09	2.26	0.09
C.D. at 5%	1.21	0.37	NS	6.57	0.25
B. Fertigation schedule (up to 110 days)					
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	25.45	15.44	12.11	204.71	5.18
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	24.50	15.08	11.91	198.39	5.02
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	21.87	12.75	11.85	183.77	3.92
SEm±	0.41	0.13	0.09	2.26	0.09
C.D. at 5%	1.21	0.37	NS	6.57	0.25
C. Interaction(AXB)					
CV (%)	5.18	2.67	3.07	3.46	5.39
General mean	23.94	14.43	11.49	195.63	4.71

registered significantly minimum number of fruits vine⁻¹ of cucumber (22.14, 22.94 and 22.54) during both the years and on pooled mean. However, fertigation of 75 per cent and 100 per cent of RDF to cucumber were at par with each other during period under study.

4.4.1.1.2 Fertigation schedules

The number of fruits vine⁻¹ of cucumber was influenced significantly due to different fertigation schedules. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum number of fruits vine⁻¹ of cucumber (24.87, 26.02 and 25.45) during 2011-12, 2012-13 and on pooled mean. Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose registered significantly minimum number of fruits vine⁻¹ of cucumber (21.55, 22.19 and 21.87) during 2011-12, 2012-13 and on pooled mean.

4.4.1.1.3 Interaction

Fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days intervals in equal splits upto 110 days + P as a basal dose recorded significantly maximum number of fruits vine⁻¹ and at par with fertigation of recommended dose of N and K at every 4 and 6 days interval under same fertigation level and 100 per cent of RDF with fertigation of recommended dose of N and K at every 2 and 4 days intervals and 75 per cent of RDF with fertigation of N and K at every 2 days intervals during both the years of experiment. Almost similar trend was observed on pooled mean basis but in addition to that it was at par with 75 per cent RDF and fertigation of recommended dose of N and K at every 4 days interval. (Table 4.32a, b)

Table 4.32a. Interaction effect between fertigation levels and schedules on number of fruits vine⁻¹ of cucumber

Treatment	Number of fruits vine ⁻¹					
	2011-12			2012-13		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	24.06	25.05	25.50	24.91	26.42	26.74
Fertigation of R. D. of N and K at every 4 days interval in equal splits	22.52	24.22	24.89	24.06	25.26	26.08
Fertigation of R.D. of N and K at every 6 days interval in equal splits	19.83	20.34	24.48	19.84	21.04	25.68
SEm±	0.65			0.78		
C.D. at 5%	1.92			2.32		

Table 4.32b. Interaction effect between fertigation levels and schedules on number of fruits vine⁻¹ of cucumber

(pooled mean)

Treatment	Number of fruits vine ⁻¹		
Fertigation level	75% RDF	100% RDF	125% RDF
Fertigation schedule			
Fertigation of R.D. of N and K at every 2 days interval in equal splits	24.49	25.73	26.12
Fertigation of R. D. of N and K at every 4 days interval in equal splits	23.29	24.74	25.49
Fertigation of R.D. of N and K at every 6 days interval in equal splits	19.83	20.69	25.08
SEm±	1.21		
C.D. at 5%	3.47		

4.4.1.2 Fruit length (cm)

Data pertaining to fruit length of cucumber as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.32, 4.33 and 4.34, respectively and graphically depicted in Fig. 4.14. The mean fruit length of cucumber was 13.86, 14.99 and 14.43 cm during 2011-12, 2012-13 and on pooled mean, respectively.

4.4.1.2.1 Fertigation levels

The fruit length of cucumber was influenced significantly due to the different fertigation levels during both the years. Fertigation of 125 per cent of RDF recorded significantly maximum fruit length of cucumber 14.43, 15.53 and 14.98 cm during 2011-12, 2012-13 and on pooled mean, respectively. While, 75 per cent of RDF registered significantly minimum fruit length of 13.03, 14.24 and 13.64 cm during 2011-12, 2012-13 and on pooled mean, respectively, but the 75 per cent and 100 per cent of RDF were found at par with each other during both the years and on pooled mean.

4.4.1.2.2 Fertigation schedules

The fruit length of cucumber was influenced significantly due to different fertigation schedules during both the years. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum fruit length of cucumber of 14.83, 16.07 and 15.44 cm during 2011-12, 2012-13 and on pooled mean, respectively. Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose registered significantly minimum fruit length of cucumber (12.30, 13.19 and 12.75 cm) during both the years and on pooled mean.

4.4.1.2.3 Interaction

The interaction effect between fertigation levels and fertigation schedules was found significant in respect of fruit length of cucumber during both the years of experimentation and on pooled mean. Fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days intervals in equal splits upto 110 days + P as a basal dose recorded significantly maximum fruit length and at

Table 4.32c. Interaction effect between fertigation levels and schedules on fruit length of cucumber

Treatment	Fruit length (cm)					
	2011-12			2012-13		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	13.69	15.32	15.48	15.07	16.50	16.63
Fertigation of R. D. of N and K at every 4 days interval in equal splits	13.41	14.80	15.12	14.73	16.07	16.37
Fertigation of R.D. of N and K at every 6 days interval in equal splits	12.00	12.22	12.69	12.93	13.04	13.60
SEm±	0.23			0.21		
C.D. at 5%	0.69			0.63		

Table 4.32d. Interaction effect between fertigation levels and schedules on fruit length of cucumber**(pooled mean)**

Treatment	Fruit length (cm)		
Fertigation level	75% RDF	100% RDF	125% RDF
Fertigation schedule			
Fertigation of R.D. of N and K at every 2 days interval in equal splits	14.38	15.91	16.06
Fertigation of R. D. of N and K at every 4 days interval in equal splits	14.07	15.44	15.75
Fertigation of R.D. of N and K at every 6 days interval in equal splits	12.46	12.63	13.15
SEm±	0.39		
C.D. at 5%	1.13		

par with 125 per cent of RDF with fertigation of N and K at every 4 days intervals and 100 per cent of RDF alongwith fertigation of N and K at every 2 and 4 days intervals during both the years and on pooled mean. Application of 75 per cent RDF and fertigation of recommended dose of N and K at every 6 days interval registered significantly minimum fruit length during the period under study (4.32c, d).

4.4.1.3 Fruit girth (cm)

Data pertaining to fruit girth of cucumber as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.32, 4.33 and 4.34, respectively. The mean fruit girth of cucumber was 11.02, 11.97 and 11.49 cm during 2011-12, 2012-13 and on pooled mean, respectively.

4.4.1.3.1 Fertigation levels

The mean fruit girth of cucumber was not influenced significantly due to the different fertigation levels during both the years. But numerically 125 per cent of RDF recorded maximum fruit girth of cucumber (11.37, 12.69 and 11.92 cm) during both the years and on pooled mean, respectively.

4.4.1.3.2 Fertigation schedules

The mean fruit girth of cucumber was not influenced significantly due to different fertigation schedules. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose noticed numerically maximum fruit girth of cucumber (11.57, 12.69 and 12.11 cm) during both the years and on pooled mean.

4.4.1.3.3 Interaction

The interaction effect between fertigation levels and schedules was found non significant in respect of fruit girth of cucumber during both the years of experimentation and on pooled mean.

4.4.1.4 Average fruit weight

Data pertaining to average fruit weight of cucumber as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.32, 4.33 and 4.34, respectively and graphically depicted in Fig. 4.15. The mean

average fruit weight of cucumber was 190.34, 200.92 and 195.63 g during 2011-12, 2012-13 and on pooled mean, respectively.

4.4.1.4.1 Fertigation levels

The average fruit weight of cucumber was influenced significantly due to the different fertigation levels during both the years. Fertigation of 125 per cent of RDF recorded significantly maximum average fruit weight of 196.14, 207.37 and 201.76 g during 2011-12, 2012-13 and on pooled mean, respectively. However, it was at par with 100 per cent RDF during both the years and on pooled mean. While, 75 per cent of RDF registered significantly minimum average fruit weight 184.30, 194.45 and 189.37 g during 2011-12, 2012-13 and on pooled mean, respectively. The 75 per cent and 100 per cent of RDF were at par with each other during both the years and on pooled mean.

4.4.1.4.2 Fertigation schedules

Different fertigation schedules significantly influenced the average fruit weight of cucumber. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum average fruit weight 199.99, 209.44 and 204.71 g during 2011-12, 2012-13 and on pooled mean, respectively. Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose registered significantly minimum average fruit weight of 177.17, 190.38 and 183.77 g during 2011-12, 2012-13 and on pooled mean, respectively.

4.4.1.4.3 Interaction

Fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days intervals in equal splits upto 110 days + P as a basal dose recorded significantly maximum average fruit weight of cucumber and at par with fertigation of recommended dose of N and K at every 4 days interval under same fertigation level and 100 per cent of RDF coupled with fertigation of recommended dose of N and K at every 2 and 4 days intervals during both the years. Significantly minimum fruits weight was observed with 75 per cent RDF

Table 4.32e. Interaction effect between fertigation levels and schedules on average fruit weight of cucumber

Treatment	Average fruit weight (g)					
	2011-12			2012-13		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	189.82	203.80	206.33	200.87	212.91	214.54
Fertigation of R. D. of N and K at every 4 days interval in equal splits	183.09	196.88	201.58	190.37	207.28	211.15
Fertigation of R.D. of N and K at every 6 days interval in equal splits	179.98	171.03	180.51	192.10	182.61	196.42
SEm±	3.65			4.15		
C.D. at 5%	10.85			12.34		

Table 4.32f. Interaction effect between fertigation levels and schedules on average fruit weight of cucumber**(pooled mean)**

Treatment	Average fruit weight (g)		
	75% RDF	100% RDF	125% RDF
Fertigation level			
Fertigation schedule			
Fertigation of R.D. of N and K at every 2 days interval in equal splits	195.35	208.35	210.44
Fertigation of R. D. of N and K at every 4 days interval in equal splits	186.73	202.08	206.37
Fertigation of R.D. of N and K at every 6 days interval in equal splits	186.04	176.82	188.46
SEm±	6.93		
C.D. at 5%	19.90		

and fertigation of recommended dose of N and K at every 6 days interval + P as a basal dose during both the years and on pooled mean (Table 4.32 e, f).

4.4.1.5 Fruit weight vine⁻¹

Data pertaining to fruit weight vine⁻¹ of cucumber as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.32, 4.33 and 4.34, respectively and graphically depicted in Fig. 4.16. The mean fruit weight vine⁻¹ of cucumber was 4.50, 4.91 and 4.71 kg during 2011-12, 2012-13 and on pooled mean, respectively.

4.4.1.5.1 Fertigation levels

The fruit weight vine⁻¹ of cucumber was influenced significantly due to the different fertigation levels during both the years. Fertigation of 125 per cent of RDF recorded significantly maximum fruit weight vine⁻¹ of cucumber (4.85, 5.33 and 5.09 kg) during 2011-12, 2012-13 and on pooled mean. While, 75 per cent of RDF registered significantly minimum fruit weight vine⁻¹ of cucumber (4.20, 4.59 and 4.39 kg) during 2011-12, 2012-13 and on pooled mean. whereas, 75 per cent and 100 per cent of RDF were found at par with each other during the period under study.

4.4.1.5.2 Fertigation schedules

The fruit weight vine⁻¹ of cucumber was influenced significantly due to different fertigation schedules. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum fruit weight vine⁻¹ of cucumber (5.01, 5.35 and 5.18 kg) during 2011-12, 2012-13 and on pooled mean. Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose registered significantly minimum fruit weight vine⁻¹ of cucumber (3.69, 4.15 and 3.92 kg) during both the years and on pooled mean.

4.4.1.5.3 Interaction

Fertigation of 125 per cent of RDF coupled with fertigation of recommended dose of N and K at every 2 days intervals in equal splits upto 110 days + P as a basal dose registered significantly maximum fruit weight vine⁻¹ and at par with fertigation of N and K at every 4 days interval under same fertigation level and 100 per cent of RDF with fertigation of N and K at every 2 and 4 days intervals and 75 per cent of RDF coupled with fertigation of N and K at every 2 days intervals during first and second year of experiment. On pooled mean, almost similar trend was observed as that first and second year in addition to that it was at par with 75 per cent of RDF coupled with fertigation of recommended dose of N and K at every 2 and 4 days intervals (Table 4.32 g, h).

Table 4.32g. Interaction effect between fertigation levels and schedules on fruit weight vine⁻¹ of cucumber

Treatment	Fruit weight vine ⁻¹ (kg)					
	2011-12			2012-13		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	4.75	5.11	5.16	5.09	5.36	5.59
Fertigation of R. D. of N and K at every 4 days interval in equal splits	4.56	4.83	5.02	4.99	5.24	5.51
Fertigation of R.D. of N and K at every 6 days interval in equal splits	3.29	3.41	4.38	3.69	3.88	4.88
SEm±	0.15			0.14		
C.D. at 5%	0.45			0.42		

Table 4.32h. Interaction effect between fertigation levels and schedules on fruit weight vine⁻¹ of cucumber

(pooled mean)

Treatment	Fruit weight vine ⁻¹ (kg)		
Fertigation level	75% RDF	100% RDF	125% RDF
Fertigation schedule			
Fertigation of R.D. of N and K at every 2 days interval in equal splits	4.92	5.23	5.38
Fertigation of R. D. of N and K at every 4 days interval in equal splits	4.78	5.04	5.26
Fertigation of R.D. of N and K at every 6 days interval in equal splits	3.49	3.64	4.63
SEm±	0.25		
C.D. at 5%	0.72		

4.4.2 Fruit Yield

Data pertaining to fruit yield of cucumber as influenced by different treatments during both the years and on pooled mean are presented in Table 4.35 and graphically depicted in Fig. 4.17. The mean fruit yield per square meter (10.52, 11.27 and 10.90 kg m⁻²), per unit of polyhouse (8.25, 8.84 and 8.54 t) and per hectare (105.20, 112.72, 108.96 t ha⁻¹) during first year, second year and on pooled mean, respectively.

4.3.2.1 Fertigation levels

The fruit yield of cucumber was influenced significantly due to different fertigation levels during both the years and on pooled mean. Fertigation of 125 per cent of RDF registered significantly maximum fruit yield per square meter (11.22, 12.25 and 11.74 kg), fruit yield per unit area of polyhouse (8.80, 9.61 and 9.20 t) and fruit yield per hectare (112.24, 122.54 and 117.39 t ha⁻¹) during 2011-12, 2012-13 and on pooled mean, followed by 100 per cent RDF. Significantly lowest fruit yield per square meter (9.91, 10.49 and 10.20 kg), fruit yield per unit area of polyhouse (7.77, 8.22 and 8.00 t) and fruit yield per hectare (99.13, 104.88 and 102.00 t ha⁻¹) was obtained under 75 per cent of RDF during the both the years of

Table 4.35 Fruit yield of cucumber as influenced by different treatments

(2011-13 and pooled)

Treatment	Fruit yield (kg m ⁻²)			Fruit yield (t unit ⁻¹ of polyhouse)*			Fruit yield (t ha ⁻¹)		
	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)									
F ₁ - 75% RDF (75:37.5:37.5)	9.91	10.49	10.20	7.77	8.22	8.00	99.13	104.88	102.00
F ₂ - 100% RDF (100:50:50)	10.42	11.07	10.75	8.17	8.68	8.43	104.23	110.75	107.49
F ₃ - 125% RDF (125:62.5:62.5)	11.22	12.25	11.74	8.80	9.61	9.20	112.24	122.54	117.39
SEm±	0.20	0.25	0.22	0.16	0.20	0.18	2.01	2.52	2.22
C.D. at 5%	0.60	0.75	0.65	0.47	0.59	0.53	5.97	7.48	6.64
B. Fertigation schedule (up to 110 days)									
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	11.22	12.19	11.70	8.79	9.55	9.17	112.18	121.87	117.02
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	10.66	11.47	11.06	8.36	8.99	8.67	106.60	114.68	110.64
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	9.68	10.16	9.92	7.59	7.97	7.78	96.83	101.61	99.22
SEm±	0.20	0.25	0.22	0.16	0.20	0.18	2.01	2.52	2.22
C.D. at 5%	0.60	0.75	0.65	0.47	0.59	0.53	5.97	7.48	6.64
C. Interaction(AXB)	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
CV (%)	5.73	6.70	6.27	5.73	6.70	6.27	5.73	6.70	6.27
General mean	10.52	11.27	10.90	8.25	8.84	8.54	105.20	112.72	108.96

*area of polyhouse = 784 m²

experiment and on pooled mean. The fruit yield obtained under 75 per cent RDF and 100 per cent RDF were found at par with each other during both the years and on pooled mean.

4.4.2.2 Fertigation schedules

The fruit yield of cucumber was influenced significantly due to different fertigation schedules. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose recorded significantly maximum fruit yield per square meter (11.22, 12.19 and 11.70 kg), fruit yield per unit area of polyhouse (8.79, 9.55 and 9.17 t) and fruit yield per hectare (112.18, 121.87 and 117.02 t ha⁻¹) and it was at par with fertigation of recommended dose of N and K at every 4 days interval during both the years of experiment and on pooled mean. Among the different fertigation schedules, significantly minimum fruit yield per square meter (9.68, 10.16 and 9.92 kg), fruit yield per unit area of polyhouse (7.59, 7.97 and 7.78 t) and fruit yield per hectare (96.83, 101.61 and 99.22 t ha⁻¹) were obtained with fertigation of recommended dose of N and K at every 6 days interval.

4.4.2.3 Interaction

The interaction effect between fertigation levels and fertigation schedules was found significant in respect fruit yield of cucumber per square meter, per unit area of polyhouse and per hectare during both the years (Table 4.35a, b, c, d, e, f). Fertigation of 125 per cent of RDF coupled with fertigation schedule of recommended dose of N and K at every 2 days intervals in equal splits upto 110 days + P as a basal dose registered significantly maximum fruit yield of cucumber and at par with fertigation schedule at every 4 and 6 days intervals under same fertigation level and 100 per cent of RDF with fertigation of N and K at every 2 and 4 days intervals and 75 per cent of RDF with fertigation of N and K at every 2 days interval during both the years in respect of fruit yield per square meter. Almost similar trend was observed on pooled mean basis but in addition to that it was also at par with 75 per cent of RDF with fertigation of recommended dose of N and K at every 4 days interval + P as a basal dose. Almost similar trend was

Table 4.35a. Interaction effect between fertigation levels and schedules on fruit yield of cucumber

Treatment	Fruit yield (kg m ⁻²)					
	2011-12			2012-13		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	10.98	11.27	11.40	11.76	12.27	12.53
Fertigation of R. D. of N and K at every 4 days interval in equal splits	9.89	10.92	11.17	10.62	11.64	12.14
Fertigation of R.D. of N and K at every 6 days interval in equal splits	8.86	9.08	11.10	9.08	9.31	12.09
SEm±	0.35			0.44		
C.D. at 5%	1.03			1.30		

Table 4.35b. Interaction effect between fertigation levels and schedules on fruit yield of cucumber**(pooled mean)**

Treatment	Fruit yield (kg m ⁻²)		
	75% RDF	100% RDF	125% RDF
Fertigation level			
Fertigation schedule			
Fertigation of R.D. of N and K at every 2 days interval in equal splits	11.37	11.77	11.97
Fertigation of R. D. of N and K at every 4 days interval in equal splits	10.26	11.28	11.65
Fertigation of R.D. of N and K at every 6 days interval in equal splits	8.97	9.20	11.60
SEm±	0.67		
C.D. at 5%	1.93		

Table 4.35c. Interaction effect between fertigation levels and schedules on fruit yield of cucumber

Treatment	Fruit yield (t per unit of polyhouse (784m ²))					
	2011-12			2012-13		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	8.61	8.84	8.94	9.22	9.62	9.83
Fertigation of R. D. of N and K at every 4 days interval in equal splits	7.76	8.56	8.76	8.33	9.13	9.52
Fertigation of R.D. of N and K at every 6 days interval in equal splits	6.95	7.12	8.70	7.12	7.30	9.48
SEm±	0.27			0.34		
C.D. at 5%	0.81			1.01		

Table 4.35d. Interaction effect between fertigation levels and schedules on fruit yield of cucumber**(pooled mean)**

Treatment	Fruit yield (t per unit of polyhouse (784m ²))		
	75% RDF	100% RDF	125% RDF
Fertigation level			
Fertigation schedule			
Fertigation of R.D. of N and K at every 2 days interval in equal splits	8.91	9.23	9.38
Fertigation of R. D. of N and K at every 4 days interval in equal splits	8.04	8.84	9.14
Fertigation of R.D. of N and K at every 6 days interval in equal splits	7.03	7.21	9.09
SEm±	0.53		
C.D. at 5%	1.51		

Table 4.35e. Interaction effect between fertigation levels and schedules on fruit yield of cucumber

Treatment	Fruit yield (t ha ⁻¹)					
	2011-12			2012-13		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	109.84	112.70	113.97	117.57	122.72	125.33
Fertigation of R. D. of N and K at every 4 days interval in equal splits	98.92	109.15	111.71	106.22	116.43	121.38
Fertigation of R.D. of N and K at every 6 days interval in equal splits	88.61	90.84	111.02	90.83	93.10	120.90
SEm±	3.48			4.36		
C.D. at 5%	10.39			12.95		

Table 4.35f. Interaction effect between fertigation levels and schedules on fruit yield of cucumber**(pooled mean)**

Treatment	Fruit yield (t ha ⁻¹)		
	75% RDF	100% RDF	125% RDF
Fertigation level			
Fertigation schedule			
Fertigation of R.D. of N and K at every 2 days interval in equal splits	113.71	117.71	119.65
Fertigation of R. D. of N and K at every 4 days interval in equal splits	102.57	112.79	116.55
Fertigation of R.D. of N and K at every 6 days interval in equal splits	89.72	91.97	115.96
SEm±	6.73		
C.D. at 5%	19.32		

noticed as that of fruit yield per square meter in fruit yield per unit area of polyhouse and fruit yield per hectare during both the years and on pooled mean.

4.5 Dry matter vine⁻¹

Data pertaining to dry matter vine⁻¹ of cucumber as influenced by different treatments during the year 2011-12, 2012-13 and on pooled mean are presented in Table 4.36 and graphically depicted in Fig. 4.18. The mean dry matter vine⁻¹ of cucumber was 152.94, 163.81 and 158.37 g during 2011-12, 2012-13 and on pooled mean, respectively.

4.5.1 Fertigation levels

The dry matter vine⁻¹ of cucumber was influenced significantly due to different fertigation levels during both the years. Fertigation of 125 per cent of RDF recorded significantly maximum dry matter vine⁻¹ of cucumber (168.66, 183.25 and 175.96 g) during 2011-12, 2012-13 and on pooled mean. Among the fertigation levels, 75 per cent of RDF registered significantly lowest dry matter vine⁻¹ (133.82, 142.04 and 137.93 g) during both the years and on pooled mean.

4.5.2 Fertigation schedules

The dry matter vine⁻¹ of cucumber was influenced significantly due to different fertigation schedules during both the years and on pooled mean. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose exhibited significantly maximum dry matter vine⁻¹ (163.07, 176.93 and 170.00 g) during 2011-12, 2012-13 and on pooled mean. Significantly lowest dry matter vine⁻¹ (140.81, 147.33 and 144.07 g) was recorded under fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose during both the years and on pooled mean.

Table 4.36 Dry matter vine⁻¹ of cucumber as influenced by different treatments at last picking

Treatment	Dry matter (g vine ⁻¹)		
	2011-12	2012-13	Pooled
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)			
F ₁ - 75% RDF (75:37.5:37.5)	133.82	142.04	137.93
F ₂ - 100% RDF (100:50:50)	156.35	166.12	161.24
F ₃ - 125% RDF (125:62.5:62.5)	168.66	183.25	175.96
SEm±	2.84	3.48	2.25
C.D. at 5%	8.44	10.35	6.45
B. Fertigation schedule (up to 110 days)			
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	163.07	176.93	170.00
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	154.95	167.16	161.05
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	140.81	147.33	144.07
SEm±	2.84	3.48	2.25
C.D. at 5%	8.44	10.35	6.45
C. Interaction(AXB)			
CV (%)	5.57	6.38	6.02
General mean	152.94	163.81	158.37

4.5.3 Interaction

The interaction effect between fertigation levels and fertigation schedules was found significant during both the years of experimentation (Table 4.36a, b). Fertigation of 125 per cent of RDF coupled with fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum dry matter vine⁻¹ of cucumber and at par with fertigation of recommended dose of N and K at every 4 and 6 days interval under same fertigation level and 100 per cent RDF with fertigation of recommended dose of N and K at every 2 and 4 days interval during both the years and on pooled mean.

Table 4.36a. Interaction effect between fertigation levels and schedules on dry matter vine⁻¹ of cucumber

Treatment	Dry matter (g vine ⁻¹)					
	2011-12			2012-13		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	148.29	169.06	171.87	158.72	184.08	187.99
Fertigation of R. D. of N and K at every 4 days interval in equal splits	133.54	163.73	167.57	144.77	174.64	182.07
Fertigation of R.D. of N and K at every 6 days interval in equal splits	119.63	136.26	166.54	122.63	139.65	179.70
SEm±	4.92			6.04		
C.D. at 5%	16.62			17.93		

Table 4.36b. Interaction effect between fertigation levels and schedules on dry matter vine⁻¹ of cucumber

(pooled mean)

Treatment	Dry matter (g vine ⁻¹)		
Fertigation level	75% RDF	100% RDF	125% RDF
Fertigation schedule			
Fertigation of R.D. of N and K at every 2 days interval in equal splits	153.51	176.57	179.93
Fertigation of R. D. of N and K at every 4 days interval in equal splits	139.16	169.19	174.82
Fertigation of R.D. of N and K at every 6 days interval in equal splits	121.13	137.96	173.12
SEm±	9.36		
C.D. at 5%	26.88		

4.6 Fruit Quality

The fruit quality of cucumber was assessed in terms of fruit skin colour, fruit strip colour, fruit shape, fruit bitterness, presence of placental cavity, fruit density, flesh thickness, total soluble solids, during 2011-12 and 2012-13 and presented in Tables 4.37 and 4.38, respectively.

Fruit quality parameters *viz.*, fruit skin colour, fruit strip colour, fruit shape, fruit bitterness intensity and presence of placental cavity were not analyzed statistically as these parameters were judged by using minimum descriptors of cucumbers. From the data presented in Table 4.38. As per minimum descriptors of cucumber, in all the treatments of fertigation levels and schedules the colour of fruit was green without any strip (27 A 6). The shape of the marketable size fruit was oblong ellipsoid (2) in all the treatments. The fruit bitterness (0) and presence of placental cavity (0) was absent in all treatments during both the years.

Table 4.37 Fruit quality parameters of cucumber as influenced by different treatments

Treatment	Fruit skin colour		Fruit strip colour		Fruit shape		Fruit bitterness		Presence of placental cavity	
	2011-12	2011-12	2011-12	2011-12	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)										
F ₁ - 75% RDF (75:37.5:37.5)	Green (27 A 6)	Green (27 A 6)	Absent (0)	Absent (0)	Oblong ellipsoid (2)	Oblong ellipsoid (2)	Absent (0)	Absent (0)	Absent (0)	Absent (0)
F ₂ - 100% RDF (100:50:50)	Green (27 A 6)	Green (27 A 6)	Absent (0)	Absent (0)	Oblong ellipsoid (2)	Oblong ellipsoid (2)	Absent (0)	Absent (0)	Absent (0)	Absent (0)
F ₃ - 125% RDF (125:62.5:62.5)	Green (27 A 6)	Green (27 A 6)	Absent (0)	Absent (0)	Oblong ellipsoid (2)	Oblong ellipsoid (2)	Absent (0)	Absent (0)	Absent (0)	Absent (0)
B. Fertigation schedule (up to 110 days)										
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	Green (27 A 6)	Green (27 A 6)	Absent (0)	Absent (0)	Oblong ellipsoid (2)	Oblong ellipsoid (2)	Absent (0)	Absent (0)	Absent (0)	Absent (0)
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	Green (27 A 6)	Green (27 A 6)	Absent (0)	Absent (0)	Oblong ellipsoid(2)	Oblong ellipsoid(2)	Absent (0)	Absent (0)	Absent (0)	Absent (0)
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	Green (27 A 6)	Green (27 A 6)	Absent (0)	Absent (0)	Oblong ellipsoid(2)	Oblong ellipsoid(2)	Absent (0)	Absent (0)	Absent (0)	Absent (0)

(*Figures in parenthesis indicate descriptor number)

Table 4.38 Fruit quality parameters of cucumber as influenced by different treatments

Treatment	Fruit density (g cm ⁻³)		Flesh thickness (cm)		TSS (°Brix)	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)						
F ₁ - 75% RDF (75:37.5:37.5)	1.12	1.13	1.35	1.36	3.84	3.89
F ₂ - 100% RDF (100:50:50)	1.15	1.16	1.39	1.41	3.95	4.04
F ₃ - 125% RDF (125:62.5:62.5)	1.17	1.18	1.40	1.41	4.06	4.15
SEm±	0.02	0.01	0.02	0.02	0.05	0.06
C.D. at 5%	0.03	0.02	0.03	0.03	0.16	0.17
B. Fertigation schedule (up to 110 days)						
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	1.19	1.20	1.39	1.41	4.02	4.10
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	1.15	1.17	1.38	1.39	3.94	4.03
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	1.13	1.14	1.36	1.38	3.88	3.95
SEm±	0.02	0.01	0.02	0.02	0.05	0.06
C.D. at 5%	0.03	0.02	NS	NS	NS	NS
C. Interaction(AXB)	NS	NS	NS	NS	NS	NS
CV (%)	2.75	1.62	2.11	2.36	3.97	3.79
General mean	1.15	1.16	1.38	1.39	3.95	4.03

4.6.1 Fruit density (g cm⁻³)

The mean fruit density of cucumber fruit was 1.15 and 1.16 g cm⁻³ during first and second year, respectively.

4.6.1.1 Fertigation levels

The fruit density of cucumber was influenced significantly due to different fertigation levels during both the years. Fertigation of 125 per cent of RDF registered significantly maximum fruit density of 1.17 and 1.18 g cm⁻³ and at par with 100 per cent of RDF (1.15 and 1.16 g cm⁻³) during 2011-12 and 2012-13. Whereas, 75 per cent of RDF registered significantly lower fruit density of 1.12 and 1.13 g cm⁻³ during first and second year of experiment.

4.6.1.2 Fertigation schedules

The fruit density of cucumber was influenced significantly due to different fertigation schedules during both the years. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose recorded significantly maximum fruit density of 1.19 and 1.20 g cm⁻³ and at par with fertigation of recommended dose of N and K at every 4 days interval (1.15 and 1.17 g cm⁻³) during both the years.

4.6.1.3 Interaction

The interaction effect between fertigation levels and fertigation schedules was found non significant in respect of fruit density of cucumber during both the years of experimentation.

4.6.2 Flesh thickness (cm)

The mean flesh thickness of cucumber fruit was 1.38 and 1.39 cm during first and second year, respectively.

4.6.2.1 Fertigation levels

The flesh thickness of cucumber fruit was influenced significantly due to different fertigation levels during both the years. Fertigation of 125 per cent of RDF registered significantly maximum flesh thickness 1.40 and 1.41 cm and at par with 100 per cent of RDF (1.39 and 1.41 cm) during both the years.

Fertigation of 75 per cent of RDF registered significantly minimum flesh thickness (1.35 and 1.36 cm) during the both the years of experiment.

4.6.2.2 Fertigation schedules

The flesh thickness of cucumber fruit was not influenced significantly due to the different fertigation schedules during both the years. However numerically fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose recorded maximum flesh thickness (1.39 and 1.41 cm) during both the years.

4.6.2.3 Interaction

The interaction effect between fertigation levels and fertigation schedules was found non significant in respect of flesh thickness of cucumber fruit during both the years of experimentation.

4.6.3 Total soluble solids (^o Brix)

The mean total soluble solids of cucumber fruit was 3.95 and 4.03 ^obrix during 2011-12 and 2012-13, respectively.

4.6.3.1 Fertigation levels

The total soluble solids in cucumber fruit was influenced significantly due to different fertigation levels during both the years. Fertigation of 125 per cent of RDF registered significantly higher total soluble solids (4.06 and 4.15 ^obrix) and at par with 100 per cent of RDF (3.95 and 4.04 ^obrix) during 2011-12 and 2012-13. Significantly minimum TSS (3.84 and 3.89 ^obrix) was registered by 75 per cent of RDF during both the years experiment.

4.6.3.2 Fertigation schedules

The total soluble solids in cucumber fruit was not influenced significantly due to different fertigation schedules during both the years. However, numerically fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose recorded maximum TSS (4.02 and 4.10 ^obrix) during both the years.

4.6.3.3 Interaction

The interaction effect between fertigation levels and fertigation schedules was found non significant in respect of total soluble solids of cucumber fruit during both the years of experimentation.

4.7 Chemical studies

4.7.1 Nutrient uptake (kg ha^{-1})

Data pertaining to nutrient uptake by cucumber plant and fruit as influenced by different treatments during the year 2011-12 and 2012-13 are presented in Table 4.39 and 4.40. The mean total uptake of nitrogen, phosphorus and potassium by cucumber (plant and fruit) was 168.93, 36.19 and 143.5 kg ha^{-1} during first year, while during second year it was 185.68, 44.65 and 162.03 kg ha^{-1} , respectively.

4.7.1.1 Fertigation levels

The nutrient uptake by cucumber (plant and fruit) was influenced significantly due to different fertigation levels during both the years. Fertigation of 125 per cent of RDF recorded significantly higher total uptake of nitrogen (185.95 and 206.22 kg ha^{-1}), phosphorus (40.37 and 49.89 kg ha^{-1}) and potassium (156.98 and 178.55 kg ha^{-1}) by cucumber during 2011-12 and 2012-13, respectively followed by 100 per cent RDF. Significantly minimum total uptake of nitrogen, phosphorus and potassium by cucumber was recorded under 75 per cent of RDF during both the years.

4.7.1.2 Fertigation schedules

The nutrient uptake by cucumber (plant and fruit) was influenced significantly due to different fertigation schedules. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose exhibited significantly total higher uptake of nitrogen (187.07 and 208.20 kg ha^{-1}), phosphorus (41.24 and 51.07 kg ha^{-1}) and potassium (159.24 and 181.70 kg ha^{-1}) by cucumber during 2011-12 and 2012-13, respectively. The next best treatment for uptake of nutrients by cucumber was fertigation of recommended dose of N and K at every 4 days interval up to 110 days + P as a

Table 4.39 Nutrient uptake by cucumber (plant and fruit) as influenced by different treatments at last picking (harvest)

(2011-12)

Treatment	Nutrient uptake (kg ha ⁻¹)								
	Nitrogen			Phosphorus			Potassium		
	Plant	Fruit	Total	Plant	Fruit	Total	Plant	Fruit	Total
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)									
F ₁ - 75% RDF (75:37.5:37.5)	54.81	94.92	149.73	8.38	22.98	31.36	28.35	99.68	128.03
F ₂ - 100% RDF (100:50:50)	66.65	104.46	171.11	10.74	26.10	36.84	35.12	110.39	145.51
F ₃ - 125% RDF (125:62.5:62.5)	72.89	113.07	185.95	11.85	28.52	40.37	38.47	118.52	156.98
SEm±	1.68	2.73	4.32	0.23	0.52	0.74	0.97	2.45	3.37
C.D. at 5%	4.98	8.12	12.83	0.69	1.54	2.21	2.88	7.29	10.00
B. Fertigation schedule (up to 110 days)									
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	71.82	115.25	187.07	11.83	29.41	41.24	38.04	121.20	159.24
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	66.17	107.75	173.92	10.86	27.08	37.93	34.95	113.30	148.25
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	56.36	89.45	145.80	8.28	21.11	29.39	28.95	94.09	123.04
SEm±	1.68	2.73	4.32	0.23	0.52	0.74	0.97	2.45	3.37
C.D. at 5%	4.98	8.12	12.83	0.69	1.54	2.21	2.88	7.29	10.00
C. Interaction(AXB)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	7.77	7.87	7.67	6.76	6.02	6.16	8.55	6.72	7.04
General mean	64.78	104.15	168.93	10.32	25.87	36.19	33.98	109.53	143.51

Table 4.40 Nutrient uptake by cucumber (plant and fruit) as influenced by different treatments at last picking (harvest)

(2012-13)

Treatment	Nutrient uptake (kg ha ⁻¹)								
	Nitrogen			Phosphorus			Potassium		
	Plant	Fruit	Total	Plant	Fruit	Total	Plant	Fruit	Total
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)									
F ₁ - 75% RDF (75:37.5:37.5)	57.98	105.08	163.07	9.60	29.18	38.78	30.95	114.20	145.15
F ₂ - 100% RDF (100:50:50)	72.25	115.49	187.75	12.31	32.96	45.27	38.22	124.18	162.40
F ₃ - 125% RDF (125:62.5:62.5)	79.95	126.27	206.22	13.84	36.05	49.89	42.67	135.88	178.55
SEm±	1.81	3.07	4.85	0.35	0.87	1.20	1.12	3.51	4.56
C.D. at 5%	5.39	9.11	14.41	1.05	2.58	3.58	3.31	10.44	13.55
B. Fertigation schedule (up to 110 days)									
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	78.56	129.64	208.20	13.71	37.36	51.07	42.26	139.45	181.70
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	72.23	120.32	192.55	12.47	34.31	46.78	38.70	129.52	168.22
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	59.40	96.88	156.28	9.57	26.52	36.09	30.88	105.30	136.17
SEm±	1.81	3.07	4.85	0.35	0.87	1.20	1.12	3.51	4.56
C.D. at 5%	5.39	9.11	14.41	1.05	2.58	3.58	3.31	10.44	13.55
C. Interaction(AXB)									
CV (%)	7.76	7.95	7.83	8.91	7.95	8.09	8.98	8.45	8.44
General mean	70.06	115.62	185.68	11.92	32.73	44.65	37.28	124.75	162.03

basal dose. The extended fertigation interval *viz.*, fertigation of recommended dose of N and K at every 6 days interval recorded significantly minimum uptake of nutrients during both the years.

4.7.1.3 Interaction

The interaction effect between fertigation levels and schedules was found non significant in respect of nutrient uptake by cucumber (plant and fruit) during both the years of experimentation.

4.7.2 Soil chemical properties

The soil chemical properties such as pH, EC, organic carbon and available nitrogen, phosphorus, potassium and micronutrients such as copper, zinc, magnesium and iron influenced by different treatments during 2011-12 and 2012-13 and are presented in Table 4.41 and 4.42, respectively. The mean soil pH (7.74 and 7.80), EC (1.27 and 1.38 dSm⁻¹), organic carbon (0.56 and 0.54 %), and available nitrogen (269.68 and 287.66 kg ha⁻¹), phosphorus (21.27 and 22.46 kg ha⁻¹), potassium (420.95 and 412.63 kg ha⁻¹), iron (10.98 and 9.46 mg kg⁻¹ soil), manganese (17.89 and 16.39 mg kg⁻¹ soil), zinc (0.49 and 0.42 mg kg⁻¹ soil) and copper (2.40 and 2.36 mg kg⁻¹ soil) during 2011-12 and 2012-13, respectively.

4.7.2.1 Fertigation levels

The soil chemical properties were influenced significantly due to different fertigation levels, except soil pH during both the years. Fertigation of 125 per cent of RDF registered significantly maximum electrical conductivity (1.29 and 1.42 dS m⁻¹) organic carbon content (0.59 % and 0.56 %), soil available nitrogen (303.11 and 293.19 kg ha⁻¹), available phosphorus (24.11 and 24.65 kg ha⁻¹) and potassium (436.83 and 431.96 kg ha⁻¹) than rest of the fertigation levels during both the years. whereas, the 75 per cent of RDF registered significantly maximum values of micronutrients such as Fe (11.24 and 9.66 mg kg⁻¹ soil), Mn (19.47 and 17.51 mg kg⁻¹ soil), Zn (0.52 and 0.44 mg kg⁻¹ soil) and Cu (2.44 and 2.20 mg kg⁻¹ soil) during both the years. while significantly minimum values of these micronutrients were recorded under 125 per cent of RDF during both the years.

Table 4.41 Soil chemical properties as influenced by different treatments after harvest of crop

(2011-12)

Treatment	Soil chemical properties									
	pH	EC (dSm ⁻¹)	Organic carbon (%)	Nitrogen	Phosphorus	Potassium	Fe	Mn	Zn	Cu
				(kg ha ⁻¹)			(mg kg ⁻¹ soil)			
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)										
F ₁ - 75% RDF (75:37.5:37.5)	7.72	1.25	0.53	292.29	19.18	401.70	11.24	19.47	0.52	2.44
F ₂ - 100% RDF (100:50:50)	7.73	1.28	0.56	299.44	20.54	424.32	10.96	17.50	0.49	2.40
F ₃ - 125% RDF (125:62.5:62.5)	7.77	1.29	0.59	303.11	24.11	436.83	10.74	16.70	0.47	2.36
SEm±	0.04	0.01	0.01	2.28	0.21	3.55	0.09	0.44	0.01	0.03
C.D. at 5%	NS	0.02	0.02	6.77	0.62	10.56	0.27	1.32	0.03	0.06
B. Fertigation schedule (up to 110 days)										
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	7.78	1.29	0.57	301.62	21.57	425.17	10.65	15.59	0.48	2.37
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	7.74	1.26	0.56	297.07	21.20	420.66	10.85	17.45	0.49	2.40
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	7.71	1.27	0.55	294.93	20.96	415.02	11.44	20.63	0.51	2.43
SEm±	0.04	0.01	0.01	2.28	0.21	3.55	0.09	0.44	0.01	0.03
C.D. at 5%	NS	0.02	NS	NS	NS	NS	0.27	1.32	NS	NS
C. Interaction(AXB)										
CV (%)	1.64	1.23	2.76	2.29	2.95	2.53	2.45	7.43	6.38	3.22
General mean	7.74	1.27	0.56	298.28	21.27	420.95	10.98	17.89	0.49	2.40
Initial	7.40	1.09	0.67	323.12	22.09	469.87	12.62	19.46	0.56	2.53

Table 4.42 Soil chemical properties as influenced by different treatments after harvest of crop

(2012-13)

Treatment	Soil chemical properties									
	pH	EC (dSm ⁻¹)	Organic carbon (%)	Nitrogen	Phosphorus	Potassium	Fe	Mn	Zn	Cu
				(kg ha ⁻¹)			(mg kg ⁻¹ soil)			
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)										
F ₁ - 75% RDF (75:37.5:37.5)	7.76	1.36	0.52	280.88	20.55	394.78	9.66	17.51	0.44	2.20
F ₂ - 100% RDF (100:50:50)	7.80	1.37	0.54	288.92	22.19	411.16	9.48	16.15	0.41	2.14
F ₃ - 125% RDF (125:62.5:62.5)	7.85	1.42	0.56	293.19	24.65	431.96	9.22	15.51	0.40	2.07
SEm±	0.03	0.01	0.01	2.42	0.35	4.27	0.11	0.40	0.01	0.03
C.D. at 5%	NS	0.03	0.02	7.18	1.05	12.70	0.34	1.19	0.02	0.09
B. Fertigation schedule (up to 110 days)										
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	7.83	1.42	0.55	290.38	22.94	421.75	9.23	14.75	0.41	2.09
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	7.80	1.34	0.54	287.18	22.38	414.24	9.40	16.04	0.41	2.14
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	7.78	1.39	0.53	283.22	21.91	401.91	9.73	18.37	0.43	2.18
SEm±	0.03	0.01	0.01	2.42	0.35	4.27	0.11	0.40	0.01	0.03
C.D. at 5%	NS	0.03	NS	NS	NS	12.70	0.34	1.19	NS	NS
C. Interaction(AXB)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	1.16	2.29	2.83	2.52	4.72	3.11	3.62	7.33	5.78	4.24
General mean	7.80	1.38	0.54	287.66	22.46	412.63	9.46	16.39	0.42	2.14
Initial	7.62	1.18	0.59	310.23	23.01	449.62	10.98	17.89	0.54	2.36

4.7.2.2 Fertigation schedules

The soil chemical properties were not influenced significantly due to different fertigation schedules, except EC, Fe and Mn during first year and EC, potassium, Fe and Mn during second year. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly higher EC (1.29 and 1.42 dS m⁻¹). Whereas, fertigation of recommended dose of N and K at every 6 days interval registered significantly higher values of Fe (11.44 and 9.73 mg kg⁻¹ soil), Mn (20.63 and 18.37 mg kg⁻¹ soil) during both the years. However, soil available potassium was significantly higher under fertigation of recommended dose of N and K at every 2 days interval in equal splits + P as a basal dose during second year only.

4.7.2.3 Interaction

The interaction effect between fertigation levels and schedules were found non significant in respect of soil chemical properties during both the years of experimentation.

4.8 Economic studies

The economic evaluation of cucumber crop was assessed in terms of cost of cultivation, gross monetary returns, net monetary returns and B:C ratio during the period of experimentation and are presented in Table 4.43.

4.8.1 Cost of cultivation

The mean cost of cultivation was ` 63,283 and ` 64,458 unit⁻¹ of polyhouse during 2011-12 and 2012-13, respectively.

4.8.1.1 Fertigation levels

Fertigation of 125 per cent of RDF required more cost of cultivation ` 63,582 ha⁻¹ and ` 64,757 unit⁻¹ of polyhouse than 100 and 75 per cent of RDF during both the years.

Table 4.43 Economics of cucumber as influenced by different treatments

Treatment	Gross monetary returns (` unit ⁻¹ of polyhouse)*			Cost of cultivation (` unit ⁻¹ of polyhouse)*			Net monetary returns (` unit ⁻¹ of polyhouse)*			B:C ratio		
	2011-12	2012-13	Pooled	2011-12	2012-13	Mean	2011-12	2012-13	Pooled	2011-12	2012-13	Mean
A. Fertigation level (N, P₂O₅, K₂O kg ha⁻¹)												
F ₁ - 75% RDF (75:37.5:37.5)	156702	191225	173963	62984	64159	63571	93718	127066	110392	2.49	2.98	2.73
F ₂ - 100% RDF (100:50:50)	164481	202251	183366	63283	64458	63871	101197	137793	119495	2.60	3.14	2.87
F ₃ - 125% RDF (125:62.5:62.5)	174856	218191	196523	63582	64757	64169	111274	153434	132354	2.75	3.37	3.06
SEm±	2678	4110	3453	-	-	-	2697	4128	3465	-	-	-
C.D. at 5%	7957	12211	10355	-	-	-	8013	12266	10351	-	-	-
B. Fertigation schedule (up to 110 days)												
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	175880	220766	198323	63283	64458	63871	112597	156308	134452	2.78	3.42	3.10
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	169467	210440	189954	63283	64458	63871	106184	145982	126083	2.68	3.26	2.97
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	150692	180460	165576	63283	64458	63871	87409	116002	101706	2.38	2.80	2.59
SEm±	2678	4110	3453	-	-	-	2697	4128	3465	-	-	-
C.D. at 5%	7957	12211	10355	-	-	-	8013	12266	10351	-	-	-
C. Interaction(AXB)	Sig.	Sig.	Sig.				Sig.	Sig.	Sig.	-	-	-
CV (%)	4.86	6.05	5.64	-	-	-	7.93	8.88	8.66	-	-	-
General mean	165346	203889	184618	63283	64458	63871	102063	139431	120747	2.61	3.16	2.89

* area of polyhouse= 784 m²

4.8.1.2 Fertigation schedules

In all the fertigation schedules almost equal cost of cultivation ` 63,283 and ` 64,458 unit⁻¹ of polyhouse was required during first and second year, respectively.

4.7.2 Gross monetary returns

The mean gross monetary returns of ` 1,65,346, 2,03,889 and 1,84,618 unit⁻¹ of polyhouse was obtained during 2011-12, 2012-13 and on pooled, respectively.

4.8.2.1 Fertigation levels

The gross monetary returns were influenced significantly due to the different fertigation levels during both the years. Fertigation of 125 per cent of RDF obtained significantly maximum gross monetary returns (` 1,74,856, ` 2,18,191 and ` 1,96,523 unit⁻¹ of polyhouse) followed by 100 per cent of RDF (` 1,64,481, ` 2,02,251 and ` 1,83,366 unit⁻¹ of polyhouse) during 2011-12, 2012-13 and on pooled mean. Significantly minimum gross monetary returns were obtained under 75 per cent of RDF during both the years and on pooled mean.

4.8.2.2 Fertigation schedules

The gross monetary returns were influenced significantly due to the different fertigation schedules during both the years. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose recorded significantly maximum gross monetary returns (` 1,75,880, ` 2,20,766 and ` 1,98,323 unit⁻¹ of polyhouse) and it was at par with fertigation of recommended dose of N and K at every 4 days interval (` 1,69,467, ` 2,10,440 and ` 1,89,954 unit⁻¹ of polyhouse) during both the years. Significantly minimum gross monetary returns were obtained under fertigation of recommended dose of N and K at every 6 days interval during both the years of investigation and on pooled mean.

4.8.2.3 Interaction

The interaction effect between fertigation levels and fertigation schedules was found significant during both the years and on pooled mean. Fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose obtained significantly maximum gross monetary returns than rest of the treatment combinations. However, it was at par with fertigation of 125 per cent of RDF and fertigation of N and K at every 4 and 6 days interval and 100 per cent RDF with fertigation recommended dose of N and K at every 2 and 4 days interval and 75 per cent RDF combined with fertigation of recommended dose of N and K at every 2 days interval during both the years. Almost similar trend was noticed on pooled mean, but in addition to that it was also at par with 75 per cent of RDF and fertigation of recommended dose of N and K at every 4 days interval (Table 4.43a, b).

Table 4.43a. Interaction effect between fertigation levels and schedules on gross monetary returns

Treatment	Gross monetary returns (₹ unit ⁻¹ of polyhouse)					
	2011-12			2012-13		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	172202	176723	178714	215017	221289	225991
Fertigation of R. D. of N and K at every 4 days interval in equal splits	158953	174278	175169	194866	217586	218869
Fertigation of R.D. of N and K at every 6 days interval in equal splits	138951	142442	170684	163791	167878	209712
SEm±	4638			7118		
C.D. at 5%	13781			21150		

Table 4.43b. Interaction effect between fertigation levels and schedules on gross monetary returns**(pooled mean)**

Treatment	Gross monetary returns (` unit ⁻¹ of polyhouse)		
Fertigation level \ Fertigation schedule	75% RDF	100% RDF	125% RDF
Fertigation of R.D. of N and K at every 2 days interval in equal splits	193610	199006	202353
Fertigation of R. D. of N and K at every 4 days interval in equal splits	176910	195932	197019
Fertigation of R.D. of N and K at every 6 days interval in equal splits	151371	155160	190198
SEm±	10497		
C.D. at 5%	28956		

4.8.3 Net monetary returns

The mean net monetary returns of ` 1,02,063, ` 1,39,431 and ` 1,20,747 unit⁻¹ of polyhouse were obtained during 2011-12, 2012-13 and on pooled mean, respectively.

4.7.3.1 Fertigation levels

The net monetary returns were influenced significantly due to the different fertigation levels during both the years. Fertigation of 125 per cent of RDF obtained significantly maximum net monetary returns (` 1,11,274, 1,53,434 and 1,32,354 unit⁻¹ of polyhouse) than 75 per cent and 100 per cent of RDF during both the years and on pooled mean. However, Fertigation of 100 per cent of RDF and 75 per cent RDF were found at par with each other during both the years.

4.8.3.2 Fertigation schedules

The net monetary returns were influenced significantly due to the different fertigation schedules during both the years. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose

obtained significantly maximum net monetary returns (₹ 1,12,597, ₹ 1,56,308 and ₹ 1,34,452 unit⁻¹ of polyhouse) and at par with fertigation of recommended dose of N and K at every 4 days interval during both the years and on pooled mean. Significantly minimum net monetary returns were obtained under fertigation of recommended dose of N and K at every 6 days interval during both the years of investigation and on pooled mean.

4.8.3.3 Interaction

The interaction effect between fertigation levels and fertigation schedules was found significant during both the years and on pooled mean. Fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose obtained significantly maximum net monetary returns than rest of the treatment combinations during both the years and on pooled mean. However, it was at par with fertigation of 125 per cent of RDF and fertigation of N and K at every 4 and 6 days interval, 100 per cent RDF and fertigation of recommended dose of N and K at every 4 and 6 days interval and 75 per cent RDF with fertigation of recommended dose of N and K at every 2 days interval during both the years. Similar trend was noticed on pooled mean however, in addition to that it was at par with 75 per cent RDF and fertigation at every 2 and 4 days interval (Table 4.43c, d).

Table 4.43c. Interaction effect between fertigation levels and schedules on net monetary returns

Treatment	Net monetary returns (₹ unit ⁻¹ of polyhouse)					
	2011-12			2012-13		
Fertigation level	75% RDF	100% RDF	125% RDF	75% RDF	100% RDF	125% RDF
Fertigation schedule						
Fertigation of R.D. of N and K at every 2 days interval in equal splits	109218	113440	115132	150858	156831	161234
Fertigation of R. D. of N and K at every 4 days interval in equal splits	95970	110995	111587	130707	153128	154112
Fertigation of R.D. of N and K at every 6 days interval in equal splits	75967	79158	107102	99632	103420	144955

SEm±	4671	7150
C.D. at 5%	13879	21245

Table 4.43d. Interaction effect between fertigation levels and schedules on net monetary returns

(pooled mean)

Treatment	Net monetary returns (` unit ⁻¹ of polyhouse)		
Fertigation level	75% RDF	100% RDF	125% RDF
Fertigation schedule			
Fertigation of R.D. of N and K at every 2 days interval in equal splits	130038	135135	138183
Fertigation of R. D. of N and K at every 4 days interval in equal splits	113338	132061	132849
Fertigation of R.D. of N and K at every 6 days interval in equal splits	87799	91289	126029
SEm±	10498		
C.D. at 5%	28891		

4.8.4 B:C ratio

The mean B:C ratio was 2.61, 3.16 and 2.89 during 2011-12, 2012-13 and on pooled mean, respectively.

4.8.4.1 Fertigation levels

The B:C ratio was influenced due to the different fertigation levels during both the years. Fertigation of 125 per cent of RDF recorded maximum B:C ratio (2.75, 3.37 and 3.06) followed by 100 per cent of RDF (2.60, 3.14 and 2.87) during 2011-12, 2012-13 and on pooled mean. Minimum B:C ratio was obtained under 75 per cent of RDF during both the years and on pooled mean.

4.8.4.2 Fertigation schedules

The B:C ratio was influenced due to the different fertigation schedules during both the years. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose recorded maximum B:C ratio (2.78, 3.42 and 3.10) followed by fertigation of N and K every 4 days interval (2.68, 3.26 and 2.97) during both the years and on pooled mean.

Minimum B:C ratio was obtained under fertigation of recommended dose of N and K at every 6 days interval during both the years of investigation and on pooled mean .

4.9 Correlation studies:

Data pertaining to correlation coefficients studies between growth and yield parameters and physiological parameters were assessed at 60, 90 and 120 days after sowing during both the years and presented in Table 4.43 to 4.48.

At 60 days after sowing, positively and highly significant correlation was observed between growth and yield attributes (vine length, leaf area, number of fruits vine⁻¹, average fruit weight and fruit weight vine⁻¹) and photosynthetic rate, CO₂ concentration, stomatal conductance and transpiration rate. Whereas negative correlation was obtained between growth and yield attributes (vine length, leaf area, number of fruits vine⁻¹, average fruit weight and fruit weight vine⁻¹) and stomatal resistance and leaf temperature during both the years. This indicate that, as the physiological parameters *viz.*, photosynthetic rate, CO₂ concentration, stomatal conductance and transpiration rate increases the growth and yield attributes were increased. Whereas the leaf temperature and stomatal resistance increases the growth and yield attributes were decreases. Almost similar trend was observed at 90 and 120 days after sowing during both the years.

Table 4.44 Correlation coefficient between growth and yield attributes of cucumber and physiological parameters at 60 days after sowing**(2011-12)**

	Vine length	Leaf area (dm ²)	Photosynthetic rate	CO ₂ Conc.	Stomatal conductance	Stomatal resistance	Leaf temperature	Transpiration rate	No. of fruits vine ⁻¹	Avg. fruit Wt.	Fruit wt. vine ⁻¹
Vine length	1										
Leaf area	0.969**	1									
Photosynthetic rate	0.991**	0.974**	1								
CO ₂ Conc.	0.967**	0.991**	0.979**	1							
Stomatal conductance	0.976**	0.977**	0.967**	0.970**	1						
Stomatal resistance	-0.970**	-0.979**	-0.955**	-0.971**	-0.996**	1					
Leaf temperature	-0.737*	-0.813**	-0.743*	-0.807**	-0.807**	0.812**	1				
Transpiration rate	0.995**	0.982**	0.988**	0.976**	0.973**	-0.972**	-0.733*	1			
No. of fruits vine ⁻¹	0.823**	0.866**	0.812**	0.875**	0.844**	-0.861**	-0.883**	0.835**	1		
Avg. fruit wt.	0.959**	0.952**	0.959**	0.932**	0.954**	-0.939**	-0.759*	0.962**	0.820**	1	
Fruit wt. vine ⁻¹	0.873**	0.937**	0.861**	0.925**	0.895**	-0.920**	-0.826**	0.904**	0.952**	0.876**	1

*Level of significance at 5 %

** Level of significance at 1 %

Table 4.45 Correlation coefficient between growth and yield attributes of cucumber and physiological parameters at 90 days after**(2011-12)**

	Vine length	Leaf area (dm ²)	Photosynthetic rate	CO ₂ Conc.	Stomatal conductance	Stomatal resistance	Leaf temperature	Transpiration rate	No. of fruits vine ⁻¹	Avg. fruit Wt.	Fruit wt. vine ⁻¹
Vine length	1										
Leaf area	0.975**	1									
Photosynthetic rate	0.998**	0.970**	1								
CO ₂ Conc.	0.997**	0.962**	0.996**	1							
Stomatal conductance	0.981**	0.992**	0.979**	0.971**	1						
Stomatal resistance	-0.984**	-0.996**	-0.979**	-0.976**	-0.995**	1					
Leaf temperature	-0.827**	-0.751*	-0.838**	-0.851**	-0.755*	0.772*	1				
Transpiration rate	0.992**	0.969**	0.996**	0.992**	0.971**	-0.977**	-0.828**	1			
No. of fruits vine ⁻¹	0.857**	0.801**	0.853**	0.886**	0.798*	-0.834**	-0.905**	0.857**	1		
Avg. fruit wt.	0.966**	0.944**	0.957**	0.961**	0.960**	-0.952**	-0.804**	0.932**	0.820**	1	
Fruit wt. vine ⁻¹	0.917**	0.846**	0.905**	0.934**	0.845**	-0.875**	-0.840**	0.909**	0.952**	0.876**	1

*Level of significance at 5 %

** Level of significance at 1 %

Table 4.46 Correlation coefficient between growth and yield attributes of cucumber and physiological parameters at 120 days after sowing**(2011-12)**

	Vine length	Leaf area (dm ²)	Photosynthetic rate	CO ₂ Conc.	Stomatal conductance	Stomatal resistance	Leaf temperature	Transpiration rate	No. of fruits vine ⁻¹	Avg. fruit Wt.	Fruit wt. vine ⁻¹
Vine length	1										
Leaf area	1.000**	1									
Photosynthetic rate	0.987**	0.987**	1								
CO ₂ Conc.	0.976**	0.976**	0.974**	1							
Stomatal conductance	0.976**	0.976**	0.985**	0.989**	1						
Stomatal resistance	-0.980**	-0.980**	-0.989**	-0.992**	-0.997**	1					
Leaf temperature	-0.900**	-0.900**	-0.886**	-0.811**	-0.818**	0.829**	1				
Transpiration rate	0.963**	0.963**	0.979**	0.973**	0.983**	-0.986**	-0.852**	1			
No. of fruits vine ⁻¹	0.855**	0.855**	0.874**	0.820**	0.830**	-0.839**	-0.905**	0.842**	1		
Avg. fruit wt.	0.945**	0.945**	0.942**	0.964**	0.975**	-0.967**	-0.809**	0.968**	0.820**	1	
Fruit wt. vine ⁻¹	0.915**	0.915**	0.945**	0.889**	0.914**	-0.920**	-0.872**	0.897**	0.952**	0.876**	1

*Level of significance at 5 %

** Level of significance at 1 %

Table 4.47 Correlation coefficient between growth and yield attributes of cucumber and physiological parameters at 60 days after**(2012-13)**

	Vine length	Leaf area (dm ²)	Photosynthetic rate	CO ₂ Conc.	Stomatal conductance	Stomatal resistance	Leaf temperature	Transpiration rate	No. of fruits vine ⁻¹	Avg. fruit Wt.	Fruit wt. vine ⁻¹
Vine length	1										
Leaf area	0.996**	1									
Photosynthetic rate	0.994**	0.991**	1								
CO ₂ Conc.	0.986**	0.995**	0.985**	1							
Stomatal conductance	0.992**	0.986**	0.990**	0.972**	1						
Stomatal resistance	-0.988**	-0.978**	-0.989**	-0.961**	-0.997**	1					
Leaf temperature	-0.835**	-0.852**	-0.874**	-0.851**	-0.844**	0.840**	1				
Transpiration rate	0.998**	0.998**	0.996**	0.991**	0.992**	-0.987**	-0.863**	1			
No. of fruits vine ⁻¹	0.851**	0.848**	0.872**	0.819**	0.883**	-0.899**	-0.887**	0.866**	1		
Avg. fruit wt.	0.920**	0.930**	0.928**	0.936**	0.946**	-0.928**	-0.831**	0.930**	0.813**	1	
Fruit wt. vine ⁻¹	0.909**	0.898**	0.926**	0.874**	0.931**	-0.952**	-0.851**	0.917**	0.969**	0.841**	1

*Level of significance at 5 %

** Level of significance at 1 %

Table 4.48 Correlation coefficient between growth parameters of cucumber, physiological parameters and yield attributes at 90 days after sowing**(2012-13)**

	Vine length	Leaf area (dm ²)	Photosynthetic rate	CO ₂ Conc.	Stomatal conductance	Stomatal resistance	Leaf temperature	Transpiration rate	No. of fruits vine ⁻¹	Avg. fruit Wt.	Fruit wt. vine ⁻¹
Vine length	1										
Leaf area	0.983**	1									
Photosynthetic rate	0.996**	0.977**	1								
CO ₂ Conc.	0.996**	0.985**	0.995**	1							
Stomatal conductance	0.941**	0.926**	0.913**	0.928**	1						
Stomatal resistance	-0.934**	-0.924**	-0.907**	-0.924**	-0.997**	1					
Leaf temperature	-0.861**	-0.832**	-0.876**	-0.884**	-0.819**	0.843**	1				
Transpiration rate	0.999**	0.977**	0.996**	0.994**	0.938**	-0.930**	-0.860**	1			
No. of fruits vine ⁻¹	0.860**	0.831**	0.866**	0.878**	0.777*	-0.798**	-0.934**	0.849**	1		
Avg. fruit wt.	0.926**	0.935**	0.917**	0.935**	0.939**	-0.939**	-0.870**	0.916**	0.813**	1	
Fruit wt. vine ⁻¹	0.910**	0.905**	0.922**	0.927**	0.784*	-0.798**	-0.898**	0.899**	0.969**	0.841**	1

*Level of significance at 5 %

** Level of significance at 1 %

Table 4.49 Correlation coefficient between growth and yield attributes of cucumber and physiological parameters at 120 days after sowing**(2012-13)**

	Vine length	Leaf area (dm ²)	Photosynthetic rate	CO ₂ Conc.	Stomatal conductance	Stomatal resistance	Leaf temperature	Transpiration rate	No. of fruits vine ⁻¹	Avg. fruit Wt.	Fruit wt. vine ⁻¹
Vine length	1										
Leaf area	1.000**	1									
Photosynthetic rate	0.954**	0.954**	1								
CO ₂ Conc.	0.995**	0.995**	0.963**	1							
Stomatal conductance	0.971**	0.971**	0.939**	0.983**	1						
Stomatal resistance	-0.976**	-0.976**	-0.906**	-0.981**	-0.989**	1					
Leaf temperature	-0.851**	-0.851**	-0.840**	-0.843**	-0.814**	0.812**	1				
Transpiration rate	0.951**	0.951**	0.852**	0.929**	0.898**	-0.934**	-0.879**	1			
No. of fruits vine ⁻¹	0.870**	0.870**	0.756*	0.853**	0.795*	-0.843**	-0.839**	0.916**	1		
Avg. fruit wt.	0.894**	0.894**	0.887**	0.917**	0.922**	-0.898**	-0.838**	0.788*	0.813**	1	
Fruit wt. vine ⁻¹	0.911**	0.911**	0.792*	0.903**	0.866**	-0.917**	-0.823**	0.936**	0.969**	0.841**	1

*Level of significance at 5 %

** Level of significance at 1 %

5. DISCUSSION

The present experiment entitled “Effect of different fertigation levels and schedules on growth, yield and quality of cucumber (*Cucumis sativus* L.) under polyhouse condition” was carried out at Instructional Farm of Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri during *rabi* seasons of 2011-12 and 2012-13. The results obtained during the course of investigation are discussed in this chapter to have clear understanding about the effect of different fertigation levels and schedules on growth, yield and quality of cucumber grown under polyhouse condition. In discussion an attempt has been made to examine, evaluate the important observations in terms of cause and effect relationship and explain these in the light of available literature.

5.1 Soil and season

5.1.1 Soil

The experimental soil was well drained and sandy clay in texture. The chemical composition according to criteria laid by Muhr *et al.*, (1965) indicated that, the soil was moderate in available nitrogen ($279.11 \text{ kg ha}^{-1}$), medium in available phosphorus (18.81 kg ha^{-1}), very high in available potassium ($358.42 \text{ kg ha}^{-1}$) and moderate in Fe (12.62 mg kg^{-1} soil), Mn (19.46 mg kg^{-1} soil), Zn (0.56 mg kg^{-1} soil) and Cu (2.53 mg kg^{-1} soil). The soil was neutral to moderately alkaline in reaction (pH 7.7) with an average electrical conductivity of 0.25 dSm^{-1} . The field capacity, permanent wilting point and bulk density of soil was 22.18 %, 11.06 % and 1.40 g cm^{-3} , respectively. In general, the soil was non moisture retentive, showing quite less available water that was congenial for normal growth and development of cucumber crop.

5.1.2 Climate and weather condition

Data on weekly means of meteorological parameters during the experimental period *i.e. rabi* 2011-12 (Table 3.2) indicated that, there was no rainfall received during crop growth period during both the years. The mean maximum and minimum temperature ranged from 26.4 °C to 38.8 °C and 7.0 °C to 22.0 °C, respectively. The mean weekly morning relative humidity ranged from 36 to 82 per cent while, evening humidity ranged from 11 to 66 per cent. The maximum relative humidity (82 %) was observed during 1st meteorological week at morning hours, where as minimum relative humidity (11 %) was noticed during 12th meteorological week at evening hours. The maximum pan evaporation (9.7 mm) was observed during 15th meteorological week, while minimum (3.1 mm) during 52nd meteorological week. The pan evaporation (PE) was progressively increased with the advancement of crop growth. The wind velocity ranged between 1.2 to 3.3 km hr⁻¹, while the bright sunshine hours during crop growth period ranged from 8.0 to 10.6 hrs. throughout the crop growth period.

Perusal of data on weekly means of meteorological parameters during second season of experiment *i.e. rabi* 2012-13 (Table 3.3) revealed that, the rainfall was not received during the entire crop growth period. The mean maximum and minimum temperature ranged from 29.1 °C to 40.8 °C and 10.1 °C to 24.4 °C, respectively. The mean weekly morning relative humidity ranged from 36 to 68 per cent, while evening humidity ranged from 14 to 54 per cent. The maximum relative humidity (68 %) was observed during 5th meteorological week at morning hours, where as minimum relative humidity (14 %) was noticed during 14th and 15th meteorological week at evening hours. The pan evaporation was progressively increased with advancement of crop growth, the maximum pan evaporation (10.5 mm) was observed during 18th meteorological week, while minimum (3.8 mm) during 2nd and 5th meteorological week. The wind velocity

ranged between 0.6 to 5.2 km hr⁻¹. The bright sunshine hours during crop growth period ranged from 6.3 to 10.6 hrs. throughout the crop growth period.

Overall, the thermo-aero-hydro dynamic properties during crop seasons in both the years were not favourable for normal physiological activities of cucumber under open field condition. But the present experiment was conducted under Open Ventilated Polyhouse condition all the thermo-aero-hydro dynamic properties during crop seasons were maintained. The climatic factors like temperature, sunlight intensity, CO₂ concentration, humidity, aeration *etc.*, were controlled by using different mechanical system presented in polyhouse. During initial period of crop growth maximum temperature was maintained late opening of site ventilators and by keeping PE-shade net open, while during summer season this PE-shade net was kept close for some afternoon hours to avoid heating of polyhouse. Foggers also used during summer season to control temperature. Ventilators are provided at the top and at sidewalls of polyhouse which helps in aeration and maintaining temperature, humidity and CO₂ circulation within polyhouse. Ventilators was covered with insect proof (IP) net to protect the crop from insects and disease carrying vectors like white fly, aphids *etc.* in this way by modifying microclimate under polyhouse a favourable environment was made for cucumber crop growth throughout the growing season.

5.2 Effect of fertigation levels

5.2.1 Growth attributes

The various growth attributes of cucumber *viz.*, vine length (cm), number of branches vine⁻¹ and number of leaves vine⁻¹ as well as leaf area vine⁻¹ (dm²) was influenced significantly due to different fertigation levels during both years of investigation. The beneficial effect of fertigation level on growth and development of cucumber crop is well established with reference to different growth and yield attributes and yield.

Optimum and continuous supply of nutrient is essential for healthy plant growth which plays important role in different metabolic, mitotic and physiological functions.

5.2.1.1 Vine length

Vine length is important character of growth and development of crop canopy. The mean vine length was increased progressively with the advancement of age of plant due to indeterminate growth habit of cucumber. The plant growth rate in terms of vine length was more vigorous during the period of 30 to 105 days after sowing and thereafter it was increased slowly till last harvest of cucumber.

Data revealed that, the fertigation level of 125 per cent of RDF to cucumber exhibited significantly higher vine length at all the crop growth stages as compared to 75 and 100 per cent of RDF during both the years. It was reached to its maximum of 545.90 and 568.41 cm at last picking. This might be due to application of fertilizers directly in the vicinity of the root zone increases the availability and uptake of nutrients which leads to increase the cell elongation and multiplication resulted in increased vine length. Optimum supply of nutrients also resulted in maximum photosynthetic rate and stomatal conductance which ultimately reflected in healthy and vigorous plant growth. Significantly minimum plant height was recorded under fertigation of 75 per cent of RDF and it was recorded up to 499.95 and 523.86 cm at last picking during both the years. This might be due to inadequate availability of nutrients at respective growth stages for growth and development of crop. These results were in accordance with Rehman *et al.* (1995), Surve *et al.* (2002), Lee *et al.* (2005), Eifediyi and Remison (2009), Sharma *et al.* (2009) and Jilani *et al.* (2009).

5.2.1.2 Number of branches vine⁻¹

The number of branches is another important morphological character contributing for spread of canopy. Higher fertigation level (125 % RDF) recorded

significantly maximum number of branches vine⁻¹ of cucumber at all the crop growth stages and it was reached up to 14.24 and 14.66 vine⁻¹ at last picking and it was 19.26 and 13.03 per cent higher than 75 per cent of RDF during first and second year. Almost identical response was observed in 100 per cent RDF, while the lower level of fertigation (75 % RDF) showed minimum number of branches vine⁻¹ compared to both the higher fertigation levels at all the crop growth stages during the period of investigation.

The variation in number of branches vine⁻¹ may be due to varied nutrient supply levels. The adequate and optimum supply of nutrients in the vicinity of plant root leads to maximum absorption of nutrients and water which results in greater photosynthetic activity, increased cell division and higher turgor in leaf tissue resulted in higher number of branches vine⁻¹. The higher nutrient uptake right from early stage of crop growth may be one of the reason for improved vegetative growth attributes. These results are in accordance with Premalakshmi *et al.* (1998), Surve *et al.* (2002) and Eifediyi and Remison (2009).

5.2.1.3 Number of functional leaves and leaf area vine⁻¹

The higher level of fertigation (125 % RDF) found significantly superior to increase the number of functional leaves and leaf area vine⁻¹ throughout the crop growth period except at initial growth stage (15 DAS) during the period of investigation. The peak number of leaves (306.00 and 344.96) as well as in consonance maximum leaf area (680.11 and 737.19 dm⁻²) was noticed at 105 and 120 DAS, there after number of functional leaves and leaf area were reduced till last picking because of senescence of lower and older leaves. The higher number of leaves and leaf area might be due to increased supply of nutrient through fertigation leads accelerate plant metabolic activities and cell differentiation processes which reflected in better developmental changes *viz.*, increasing in number of branches, number of leaves and leaf area. The another reason is that, increased level of potassium through fertigation helps in increasing photosynthetic

rate, protein synthesis and assimilate translocation which activate enzyme activities. This results are in the line of Lee *et al.* (2005), Dai *et al.* (2011), Krup *et al.* (2011) and Ng'etich *et al.* (2013).

Inadequate supply of nutrients (75 % RDF) limits not only the size of individual leaves, but also number of leaves on indeterminate plant, reduction in photosynthetic activity and stomatal conductance, reduced synthesis of proteins and growth promoting metabolites which reflected in less number of leaves and leaf area vine⁻¹.

5.2.1.4 Dry matter vine⁻¹

Fertigation of 125 per cent of RDF recorded significantly maximum dry matter vine⁻¹ of cucumber (168.66, 183.25 and 175.96 g) after last picking of fruits during both the years and on pooled mean. This might be because of the growth attributes *viz.*, vine length, number of branches and leaf area vine⁻¹ were at higher magnitude under higher fertigation level which resulted in more biomass production. The reverse trend was noticed under lowest fertigation level *viz.*, 75 per cent of RDF wherein inadequate availability of nutrients for growth and development of crop registered significantly lowest dry matter accumulation vine⁻¹ (133.82, 142.04 and 137.93 g) during both the years and on pooled mean. These findings are in accordance with those reported by Espinola *et al.* (2001), Lee *et al.* (2005), Cengiz *et al.* (2005), Umamaheswarappa *et al.* (2006) and Sumathi *et al.* (2008).

5.2.1.5 Total chlorophyll content

Chlorophylls are photosynthetic pigments absorbs light energy for synthesis of carbohydrates and are important factor for plant productivity. The total chlorophyll content has direct influence on fruit production by affecting photosynthate production capacity of a plant.

The maximum total chlorophyll content in cucumber leaves (54.89 and 56.56 %) was noticed where higher level of fertigation was applied at all the stages of observations during the experimental period. At initial growth phase up to 90 DAS the uptake of nitrogen was more which resulted in higher total chlorophyll content and thereafter it declines towards the maturity in all the fertigation levels, however the response was more spectacular under higher level of fertigation.

The reduced level of fertigation (75 % RDF) registered significantly lowest chlorophyll content at all the stages of observations because of inadequate supply of required nutrients at responsive growth stages during both the years. These results are in line of Cengiz *et al.* (2005), Umamaheswarappa *et al.* (2006), Kamal *et al.* (2009) and Hamid *et al.* (2009).

5.2.1.6 Leaf water potential

The higher level of fertigation leads to increase the leaf water content ultimately reduces leaf water potential in cucumber leaves at all the growth stages during the period of study. The higher level of fertigation increase the nutrient availability at the root rhizosphere of crop, resulted in increase the uptake of nutrient and water which maintain the cell turgidity and decreases the leaf water potential. Whereas, under reduced level of fertigation the uptake of nutrients and water decreases, which reduce the leaf water content and increases leaf water potential at all the stages of observations. These results are in corroborated with Cengiz *et al.* (2005).

5.2.1.7 Flower initiation

The reduced level of fertigation (75 % RDF) registered significantly minimum number of days (45.67 and 46.09) to first female flower initiation followed by 100 per cent RDF during both the years. Under reduced level of fertigation crop experienced the nutrient stress during the initial stage because of

that the vegetative growth of crop was inhibited and initiate reproductive phase. Maximum and significantly more number of days (48.10 and 49.07) to first female flower initiation in cucumber was noticed with higher fertigation level (125 % RDF) because of prolonged vegetative growth. Similar trend was noticed by Umamaheswarappa *et al.* (2005) and Tiwari (2013).

5.2.1.8 Node number at which first female flower appeared and internodal distance

Node number at which first female flower appeared dose not influenced due to different fertigation levels and schedules whereas, internodal distance was differed significantly. The maximum internodal distance was reported by higher fertigation level (125 % RDF) because of adequate supply of nutrients, the cell elongation and multiplication were increased. The reverse trend was noticed under inadequate supply of nutrients *i.e.* reduced level of fertigation (75 % RDF) during both the years. These results are in accordance with Janapriya *et al.* (2010).

5.2.1.9 Number of days to fruit set and first fruit harvest

The reduced fertigation level (75 % RDF) recorded significantly minimum number of days (54.87 and 56.84) to fruit set, first fruit harvest (63.51 and 65.52) and last fruit harvest (147.33 and 153.94) in cucumber during both the years. The nutrient stress was occurs under reduced level of fertigation which forced to early flowering thereby early fruit set and fruit maturity. The total life cycle of crop was also shortens by a week period because of inadequate supply of nutrients. The higher levels of fertigation (125 % RDF) indicated significantly maximum number of days (57.04 and 59.29) required to fruit set, first fruit harvest (66.74 and 69.38) and last fruit harvest (151.23 and 158.70) during both the years. This might be due to increased supply of nutrients under higher fertigation levels prolong the vegetative phase thereby delayed reproductive phase which results in late flowering and fruit setting ultimately reflected in delayed harvesting. Similar trend

was noticed by Rehman *et al.* (1995), Umamaheswarappa *et al.* (2005) and Waseem *et al.* (2008).

5.2.1.10 Leaf area duration and Relative leaf area growth rate

The leaf area duration and leaf area growth rate was measured at 30 days interval to study the influence of fertigation levels and reported that the higher levels of fertigation (125 % RDF) recorded significantly maximum leaf area duration and relative leaf area growth rate compared to reduced fertigation level during both the years. This might be due to increased supply of nutrients in the root vicinity enhance the uptake of nutrients and moisture which increases the turgidity and multiplication of cell resulted in higher leaf area duration and relative leaf area growth rate of cucumber. These results are in line of Hamid *et al.* (2009).

5.2.2 Physiological studies

The physiological parameters such as photosynthetic rate, stomatal conductance, CO₂ concentration and transpiration rate were significantly more under higher level of fertigation (125 % RDF) and it was almost identical to 100 per cent RDF at all the stages of observations during both the years. The above parameters were increasing upto 90 DAS and thereafter declining towards maturity in all treatments. This might be because of more absorption of water and nutrients under higher fertigation level resulted in luxurious and healthy crop growth reflected in increasing the crop canopy there by more interception of PAR which accelerate the rate of photosynthesis. The reverse trend was noticed in case of leaf temperature and stomatal resistance at all the observational stages during both the years because of more relative water content decreases leaf temperature, similarly the stomata which is entry of point of water vapour and carbon dioxide remains open and increases the movement of water and carbon dioxide.

The reduced fertigation level found minimum values of photosynthetic rate, stomatal conductance, CO₂ concentration and transpiration rate and maximum

values of leaf temperature and stomatal resistance at all the growth stages because of less relative water content the stomata remains partially closed, hence the leaf temperature and resistance to entry of CO₂ and exit of H₂O was increased. The results are in accordance with Xiaoyu *et al.* (2009), Yang *et al.* (2009), Yinkun *et al.* (2010), Li *et al.* (2010), Zhang *et al.* (2011) and Dai *et al.* (2011).

5.2.3 Yield attributes

The yield attributes of cucumber *viz.*, numbers of fruits vine⁻¹ (24.96, 26.17 and 25.56), length of fruit (14.43, 15.53 and 14.98 cm), average fruit weight (196.14, 207.37 and 201.76 g) and fruit weight vine⁻¹ (4.85, 5.33 and 5.09 kg) were significantly higher in higher fertigation level *i.e.* fertigation of 125 per cent of RDF as compared to reduced level of fertigation during both the years of experimentation and on pooled mean.

The enhanced supply of nutrients through increased fertigation level in the root vicinity of plant maintain optimum nutrient concentration in the root zone throughout the crop growth period, which increases the uptake of moisture and nutrients resulted in increasing all the growth attributes of cucumber *viz.*, vine length, number of branches, number of functional leaves vine⁻¹, leaf area vine⁻¹ and dry matter vine⁻¹ which increases the absorbed APAR and photosynthetic rate resulted in more translocation of photosynthates towards reproductive part (sink) which ultimately increases the yield attributes of cucumber. Janapriya *et al.* (2010) also reported that significantly higher yield and yield attributes under increased fertigation level.

The reduced level of fertigation (75 % RDF) registered significantly minimum numbers of fruits vine⁻¹ (22.14, 22.94 and 22.54), fruit length (13.03, 14.24 and 13.64 cm), average fruit weight (184.30, 194.45 and 189.37) and fruit weight vine⁻¹ (4.20, 4.59 and 4.39 kg) during both years and on pooled mean. The limited supply of required nutrients affected the physiological activities like leaf

water content, chlorophyll content, absorbed PAR and photosynthetic rate resulted in inadequate photosynthates translocated towards reproductive parts compared to higher fertigation levels during the period of study. Similar results are also reported by Altunlu *et al.* (1999), Surve *et al.* (2002), Choudhari and More (2002), Lee *et al.* (2005), Al-Wable *et al.* (2006), Al-Jaloud *et al.* (2006), Waseem *et al.* (2008), Sharma *et al.* (2009), Dai *et al.* (2011) and Zhang *et al.* (2011).

5.2.4 Fruit yield

The final yield is the cumulative effect of vegetative and reproductive growth of the crop. The vegetative growth in terms of dry matter accumulation and reproductive growth in terms of yield attributing parameters *viz.*, numbers of fruits vine⁻¹, length and girth of fruit, average fruit weight and fruit weight vine⁻¹.

The higher fertigation level of 125 per cent of RDF proved its superiority by recording maximum fruit yield of 112.24, 122.54 and 117.39 t ha⁻¹ over 100 per cent RDF and 75 per cent RDF fertigation level and it was 13.22, 16.83 and 15.08 per cent higher than 75 per cent RDF during first year, second year and on pooled mean, respectively. The 100 per cent RDF was found second in rank in fruit yield of cucumber and recorded the fruit yield to the tune of 104.23, 110.75 and 107.49 t ha⁻¹ during first, second year and on pooled mean, respectively. The reduced level of fertigation resulted in lowest yield of cucumber fruit. This indicate that there was linear response of cucumber to fertigation levels, as the fertigation level increases the fruit yield of cucumber increased progressively.

Increased level of fertigation in the root vicinity of plant maintain optimum nutrient concentration in the root zone which create favourable environment to increase growth attributes *viz.*, vine length, leaf area, number of leaves vine⁻¹ and dry matter accumulation vine⁻¹. The higher rate of photosynthates translocation to cucumber fruits might have increased the numbers of fruits vine⁻¹, length and girth of fruit, average fruit weight and fruit weight vine⁻¹ which ultimately resulted in

higher yield. The decreasing trend in fruit yield under lower fertigation level might be due to adverse effect of under supply of essential nutrients for normal growth and development of plant. These results are in confirmity with those reported by, Altunlu *et al.* (1999), Choudhari and More (2002), Lee *et al.* (2005), Al-Wable *et al.* (2006), Al-Jaloud *et al.* (2006), Waseem *et al.* (2008), Sharma *et al.* (2009), Janapriya *et al.* (2010) and Zhang *et al.* (2011).

5.2.5 Fruit quality

The fruit quality of cucumber was assessed in terms of fruit skin colour, fruit strip colour, fruit shape, fruit bitterness, presence of placental cavity, fruit density, flesh thickness and total soluble solids.

Fruit quality parameters like fruit skin colour, fruit strip colour, fruit shape, fruit bitterness and presence of placental cavity did not influenced due to different fertigation levels.

The maximum fruit density, flesh thickness and total soluble solids was observed in 125 per cent of RDF. The maximum density of fruit was due to increase in length, girth and weight of fruit. The increased nutrient availability due to the higher fertigation level enhancing metabolic activities and photosynthetic rate which translocate the maximum photosynthates towards reproductive part resulted in increase in the flesh thickness and total soluble solids in cucumber fruits. While, 75 per cent of RDF registered lower fruit density, flesh thickness and total soluble solids during both the year. Similar results were recorded by Altunlu *et al.* (1999), Sawant (2005), Sharma *et al.* (2009) and Sumathi *et al.* (2011).

5.2.6 Nutrient uptake

The concentration of nitrogen, phosphorus and potassium in cucumber plant and fruit was almost statistically identical under different fertigation levels during both the years of investigation. The higher level of fertigation *i.e.* 125 per

cent of RDF recorded significantly higher uptake of nitrogen (185.95 and 206.22 kg ha⁻¹), phosphorus (40.37 and 49.89 kg ha⁻¹) and potassium (156.98 and 178.55 kg ha⁻¹) by cucumber during 2011-12 and 2012-13, respectively. Whereas, significantly minimum uptake of these nutrients was noticed under reduced level of fertigation *i.e.* 75 per cent of RDF during both the years. Increased supply of nutrients through increased fertigation level in the root vicinity of plant increases the mass flow around the root rhizosphere and diffusion resulted in higher uptake by plant. Similar results were reported by Ruiz and Romero (1999), Guler and Ibrikci (2002), Kotsiras *et al.* (2002), Choudhari and More (2002), Cengiz *et al.* (2005) and Suojala *et al.* (2005).

5.3 Effect of different fertigation schedules

5.3.1 Growth attributes

The various growth attributes of cucumber *viz.*, vine length (cm), number of branches vine⁻¹ and number of leaves vine⁻¹ as well as leaf area vine⁻¹ (dm⁻²) were influenced significantly due to different fertigation schedules during both years of investigation.

5.3.1.1 Vine length

Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose exhibited significantly maximum vine length at all the stages of crop growth and reached to its maximum of 556.56 and 583.84 cm at last picking during the year 2011-12 and 2012-13, respectively and similar trend was observed at every 4 days fertigation interval at all crop growth stages during both the years. The frequent application of recommended dose of N and K in 52 equal splits up to 110 days along with P as basal dose increases the availability of these nutrients leads to increases the uptake of N, P and K during growth period which increased protein and protoplasm synthesis for higher rate of mitosis resulted in increase the growth attributes. These results are

in agreement with those reported by Al-Jaloud *et al.* (1999) and Shinde *et al.* (2010). Significantly minimum vine length of cucumber were recorded with fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose during both the years.

5.3.1.2 Number of branches vine⁻¹

Fertigation of recommended dose of N and K at every 2 or 4 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum number of branches vine⁻¹ at all crop growth stages during both the years. This might be due to the continuous supply of nutrients in the vicinity of root zone through frequent split application (52 or 26 splits) up to fruiting period resulted in rapid growth owing to maximum cell multiplication reflected in higher number of branches vine⁻¹. Significantly minimum number of branches vine⁻¹ of cucumber were recorded where fertigation of recommended dose of N and K was applied through fertigation at every 6 days interval upto 110 days (18 splits) + P as a basal dose at all stages of observation because of interrupted supply of nutrients at the respective growth stages which minimize the plant metabolic activities and thereby less number of branches vine⁻¹. The similar results were reported by Mahapatra *et al.* (1996) and Sumathi *et al.* (2008).

5.3.1.3 Number of leaves and leaf area vine⁻¹

The maximum and significantly higher number of functional leaves and leaf area vine⁻¹ were registered by the frequent application of recommended dose of nitrogen and potassium at every 2 or 4 days interval in equal splits upto 110 days + P as a basal dose at all the stages of observation during the period under study. Both the growth parameters increased progressively up to 90 DAS and decline thereafter till last picking of fruits. The spectacular enhancement in increasing number of functional leaves and leaf area vine⁻¹ were recorded at 90 DAS during both the years. This might be because of extended and frequent

fertigation of nitrogen and potassium through water soluble fertilizers provide balanced nutrition which promotes cell multiplication and development resulted in increasing number of functional leaves and leaf area vine⁻¹. These results are in confirmity with those reported by Lee *et al.* (2005), Sawant (2005) and Jokinen *et al.* (2011).

5.3.1.4 Dry matter vine⁻¹

Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose was found to be significantly superior over rest of the fertigation schedules tried and obtained dry matter of 163.07, 176.93 and 170.00 g vine⁻¹ at last harvest during both the years and on pooled mean, respectively. The significant improvement in dry matter probably has resulted from better nutrition and higher availability of N and K which resulted in higher uptake of these nutrients because of frequent applications (52 splits) through drip resulted in increase the growth attributes *viz.*, vine length, number of branches vine⁻¹ and number of leaves and leaf area vine⁻¹. The dry matter accumulation is the cumulative effect of all the growth attributes. These findings are in accordance with those reported by Shinde *et al.* (2010). Significantly lowest dry matter vine⁻¹ (140.81, 147.33 and 144.07 g) at last harvest during 2011-12, 2012-13 and on pooled mean, respectively was recorded under fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose (18 splits). This might be because of extended interval added maximum nutrients than actual requirement at particular growth stages resulted in reduction in use efficiency of applied nutrients thereby decrease overall growth of crop and ultimately reduction in dry matter vine⁻¹. These results are in agreement with those reported by Spizewski and Knaflewski (2004) and Lee *et al.* (2005).

5.3.1.5 Total chlorophyll content

The maximum total chlorophyll content in cucumber leaves was observed where the fertigation of recommended dose of nitrogen and potassium was applied at every 2 or 4 days interval in equal splits upto 110 days + phosphorous as a basal dose. This might be because of split application of nitrogen coupled with potassium at every 2 or 4 days interval upto 110 days increased the nitrogen content in plant which leads to increase the chlorophyll content. Whereas, fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose indicated significantly lowest total chlorophyll content in cucumber leaves at all crop growth stages during both the years. Interrupted supply of nutrients specially nitrogen during grand growth period and at fruiting of crop inhibits physiological activities thereby reduction in chlorophyll content. The chlorophyll content in cucumber leaves increased progressively from 15 DAS to 90 DAS and thereafter starts declines towards maturity in all the fertigation schedule treatments. The results are in accordance with those reported by Yang *et al.* (2010).

5.3.1.6 Leaf water potential

The lowest leaf water potential was observed with frequent application of nutrients *i.e.* fertigation of recommended dose of nitrogen and potassium at every 2 days interval in equal splits upto 110 days + phosphorus as a basal dose followed by fertigation of nitrogen and potassium at every 4 days interval. This might be due to split application of nitrogen and potassium fertilizers up to 110 DAS meet out the nutritional requirement of crop and increase in vegetative growth in respect of number of leaves and leaf area vine⁻¹ resulted in higher evapotranspiration which create potential gradient between atmosphere and soil water for maximum uptake of moisture because of that plants cells becomes fully turgid which reduces leaf water potential throughout the crop growth period. Significantly higher leaf

water potential was noticed under fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose at all stages of observations during both the years. The results are in accordance with those reported by Cengiz *et al.* (2005).

5.3.1.7 Flower initiation

An early initiation of first female flower was noticed at 47.48 and 48.13 days under fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose. This might be due to fertigation at extended interval (every 6 days) crop experienced nutrient stress because of that the vegetative phase was completed earlier than frequent application of fertigation resulted in early initiation of reproductive phase. Whereas, frequent fertigation (at every 2 or 4 days) prolonge vegetative phase due to continuous supply of nutrients resulted in delayed initiation of flowering. These results are in accordance with Mahapatra *et al.* (1996).

5.3.1.8 Node number at which first female flower appeared and internodal distance

The first female flower was appeared almost at same node number in cucumber in all the fertigation schedules treatments during both the years.

The frequent application of fertigation of nitrogen and potassium at every 2 or 4 days interval in equal splits upto 110 days + phosphorus as a basal dose recorded significantly maximum internodal distance because of application of nitrogen was more than required at respective growth stages which increase the cell elongation and multiplication, ultimately increases the internodal distance. Almost reverse trend was observed under extended fertigation interval during both the years of experimentation. These results are in accordance with those reported by Mahapatra *et al.* (1996).

5.3.1.9 Number of days to fruit set and first fruit harvest

The number of days required to fruit set and harvest of first fruit was almost identical in all the fertigation schedule treatments because period required for flowering to fruit set and from fruit set to harvest of fruit was not altered due to fertigation schedules as these are the genetic characters of a hybrid. However, the frequent fertigation (at every 2 days) interval increases the number of pickings because of continuous supply of required quantity of nutrients for growth and development of fruit which extended the last picking by about one week during both the years than extended application of fertigation (at every 6 days).

5.3.1.10 Leaf area duration and Relative leaf area growth rate

Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly highest leaf area duration and relative leaf area growth rate at all the stages of crop growth. This might be due to frequent application of nitrogen and potassium improves cell metabolic activities and there by cell differentiation and development which resulted in increasing leaf area duration and relative leaf area growth rate. Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose recorded significantly lower leaf area duration and relative leaf area growth rate of cucumber during both the years. Hamid *et al.* (2009) also reported similar results.

5.3.2 Physiological studies

Nutrients applied to cucumber as per the fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose was found superior in respect of photosynthetic rate, stomatal conductance, CO₂ concentration as well as transpiration rate while, reverse trend was noticed in case of leaf temperature and stomatal resistance at all the observation stages during both the years. This might be due to frequent application of nitrogen and

potassium increases the vegetative growth in respect of number of functional leaves and leaf area vine⁻¹. Similarly the leaf water content was also higher because of that cell becomes fully turgid and stomata remains open which increases the transpiration rate and intake of CO₂. The chlorophyll content in leaves was increase due to frequent application of nutrients which increase the photosynthetic rate and decrease leaf temperature and stomatal resistance. Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose recorded significantly lower photosynthetic rate, stomatal conductance, CO₂ concentration, transpiration rate and higher stomatal resistance and leaf temperature in cucumber leaves at all the crop growth stages during both the year of investigation. Similar findings were also reported by Xiaoyu *et al.* (2009), Li *et al.* (2010), and Yang *et al.* (2010).

5.3.3 Yield attributes and yield

Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum numbers of fruits vine⁻¹ (24.87, 26.02 and 25.45), length of fruits (14.83, 16.07 and 15.44 cm), average fruit weight (199.99, 209.44 and 204.71 g) and fruit weight vine⁻¹ (5.01, 5.35 and 5.18 kg) during both the years and on pooled mean. This might be due to frequent application of nutrients up to peak fruiting period favoured to increase growth attributes accompanied with maximum APAR resulted in more photosynthetic rate. The photosynthates were effectively translocated from vegetative parts to fruiting parts resulted in increasing number of fruits vine⁻¹, average fruit weight and fruit weight vine⁻¹. Similar results were reported by Al-Jaloud *et al.* (1999), Spizewski and Knaflewski (2004), Babik and Kowalczyk (2009), Eifediyi and Remison (2009) and Shinde *et al.* (2010).

Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose registered significantly minimum numbers of fruits vine⁻¹, fruit length, average fruit weight and fruit weight vine⁻¹ of

cucumber during both the years and on pooled mean. The differences in yield components could be traced back to the differences in physiological characters at vegetative as well as reproductive phases of the crop growth. Significant differences in dry matter production and in its distribution into different plant parts (leaves, stem and fruits) at various growth stages were mainly found responsible for the differences in yield. Similar trend was registered by Al-Jaloud *et al.* (1999), Guler and Ibricki (2002), Sawant (2005), Guler *et al.* (2006) and Krup *et al.* (2011).

5.3.4 Fruit yield

The fruit yield obtained with fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose was significantly maximum (112.18, 121.87 and 117.02 t ha⁻¹) and it was 15.90, 19.98 and 17.94 per cent higher than fertigation of N and K at every 6 days interval. The fertigation of recommended dose of N and K at every 4 days interval was produced almost equal fruit yield during both the years and on pooled mean. This indicate that, fertigation interval of every four days was found more suitable than every two days and every six days interval to obtained maximum fruit yield of cucumber. This might be due to uniform application of required quantity of nutrients directly in vicinity of root zone upto peak fruiting period increased nutrient use efficiency which enhances all the crop growth and yield attributes coupled with increase in physiological activities and efficient translocation of photosynthates towards reproductive organ resulted in higher fruit yield of cucumber. Among the different fertigation schedules significantly minimum fruit yield (96.83, 101.61 and 99.22 t ha⁻¹) was noticed with fertigation of recommended dose of N and K at every 6 days intervals in equal splits up to 110 days. These results were in accordance with Al-Jaloud *et al.* (1999), Spizewski and Knaflewski (2004), Babik and Kowalczyk (2009), Eifediyi and Remison (2009) and Shinde *et al.* (2010).

5.3.5 Fruit quality

The fruit quality parameter *viz.*, fruit skin colour, fruit strip colour, fruit shape, fruit bitterness, and presence of placental cavity, flesh thickness and total soluble solids did not influenced due to the different fertigation schedules while, fruit density influenced significantly. Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose recorded significantly maximum fruit density (1.19 and 1.20 g cm⁻³), while flesh thickness and TSS shows a increasing trend with increasing number of splits during both the years. The more frequent application of nitrogen and potassium elements upto the fruiting period enabled maximum absorption of nutrients along with water which synergistically flourished translocation of photosynthates towards reproductive parts for increasing size and shape of fruit and reflected in increase in fruit density of cucumber fruits. These findings are in accordance with those reported by Sawant (2005) Sumathi *et al.* (2011).

5.3.6 Nutrient uptake

Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose exhibited significantly higher uptake of nitrogen (187.07 and 208.20 kg ha⁻¹), phosphorus (41.24 and 51.07 kg ha⁻¹) and potassium (159.24 and 181.70 kg ha⁻¹) by cucumber (plant and fruit) during 2011-12 and 2012-13, respectively. This might be attributed due to frequent application of nitrogen and potassium up to the fruiting stage to cucumber enabled to more absorption of water and nutrients resulted in increasing growth attributes *viz.*, length of vine, number of branches vine⁻¹, number of functional leaves vine⁻¹ and fruit yield vine⁻¹ which directly contributed to dry matter accumulation. The nutrient concentration of these nutrients were almost similar in all the fertigation schedule treatments but the dry matter accumulation was significantly more under frequent application of fertigation (at every 2 days) resulted in maximum uptake of

these nutrients by cucumber. The similar findings were reported by Papadopoulos (1986), Kotsiras *et al.* (2002) and Lee *et al.* (2005).

5.4 Interaction effect

5.4.1 Growth attributes

The interaction between fertigation levels and schedules were found significant in respect of all growth attributes *viz.*, vine length, number of branches vine⁻¹, number of functional leaves vine⁻¹ and leaf area vine⁻¹.

The interaction effect between fertigation levels and schedules were found significant at 60 and 75 DAS during first year and 75 and 105 DAS during second year of experimentation in respect of vine length. The fertigation of 125 per cent of RDF coupled with fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum vine length of cucumber and at par with 125 per cent RDF with 4 days fertigation interval and 100 per cent of RDF with every 2 and 4 days fertigation interval. This might be due to application of higher level of fertigation (125 % RDF) with maximum splits (52 or 26 splits) enhances the use efficiency of added nutrients which increases physiological and biochemical activities for healthy crop growth. Similar trend was noticed by Mahapatra *et al.* (1996) and Lee *et al.* (2005).

The interaction effect between fertigation levels and schedules on number of branches vine⁻¹ was found significant at 90 DAS during both the years and at last picking during first year. The fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days interval in equal splits upto 110 days + P as basal dose registered significantly maximum number of branches vine⁻¹ of cucumber and at par with 125 per cent RDF with every 4 days fertigation interval and 100 per cent RDF and every 2 and 4 days fertigation interval. The higher fertigation level (125 % RDF) with maximum splits (52 or 26 splits) increases the

uptake of nutrients along with water which maintains water and nutrients balance in root vicinity and within plant system which supports mitotic cell division. These results are in confirmity with Mahapatra *et al.* (1996) and Shinde *et al.* (2010).

The interaction effect between fertigation levels and schedules on number of functional leaves vine⁻¹ were found significant at 60, 105 and at last picking during first year and at 60 DAS and last picking during second year. The fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum number of functional leaves vine⁻¹ and at par with 100 per cent of RDF and fertigation at every 2 days interval and 125 per cent of RDF with fertigation at every 4 days interval during first year. With frequent application of N and K nutrients in the vicinity of plant by maximum splitting (52 or 26 splits) helps in maximum absorption and translocation of these essential nutrients towards different vegetative and reproductive parts which enhances different physiological activities like protein synthesis, photosynthesis, translocation of photosynthates from source to sink thereby increasing number of functional leaves and leaf area vine⁻¹. Almost quite similar trend was noticed at last picking during both the year of experiment and at 105 DAS during first year and 60 DAS during second year. These findings are in accordance with the Jokinen *et al.* (2011) and Krup *et al.* (2011).

5.4.2 Dry matter vine⁻¹

The interaction effect between fertigation levels and schedules on dry matter vine⁻¹ was found significant during both the years of experimentation. Fertigation of 125 per cent of RDF coupled with fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum dry matter vine⁻¹ of cucumber and at par

with fertigation of recommended dose of N and K at every 4 and 6 days interval under same fertigation level and 100 per cent RDF with fertigation of recommended dose of N and K at every 2 and 4 days interval during both the years and on pooled mean. This might be due to higher level of fertigation (125 or 100 % RDF) with maximum splits (52 or 26 splits) favours to luxurious growth of crop for maximum assimilation of photosynthates leads to maximum dry matter accumulation vine⁻¹. Similar trend was noticed by Lee *et al.* (2005) and Shinde *et al.* (2010).

5.4.3 Physiological studies

The interaction effect between fertigation levels and schedules on photosynthetic rate, CO₂ concentration, stomatal conductance, transpiration rate, stomatal resistance, and leaf temperature were found significant.

Fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose registered significantly maximum photosynthetic rate, CO₂ concentration, stomatal conductance and transpiration rate at par with fertigation of N and K at every 4 days interval under same level of fertigation and 100 per cent RDF with fertigation of N and K at every 2 days interval.

Significant and interactive effects between different fertigation levels and schedules at various growth stages during the period of the investigation postulated that the scheduling of fertigation of nitrogen and potassium at every 2 or 4 days interval upto the 110 days after sowing coupled with 125, 100 and 75 per of RDF recorded significantly higher photosynthetic rate, stomatal conductance, CO₂ concentration as well as transpiration rate whereas, registered reverse trend in respect of stomatal resistance and leaf temperature.

The increased splits of nitrogen and potassic fertilizers through drip upto the peak fruiting stage under optimum moisture condition continuously supplied

the required quantity of nutrients to cucumber resulted in increased number of leaves and leaf area vine⁻¹, while potassium acts as promoter in efficient utilization of nitrogen and other nutrients because it act as activator of more than 60 enzymes in plant cells owing to healthy and luxurious vegetative growth of plant and thereby more light interception reflected in maximum absorbed PAR. Healthy growing crop transpired more moisture resulting in less water potential *viz.*, higher water content in plant tissues. Thus, this transpiration pool maintained leaf temperature and cooling of canopy surface. Stomatal remained open to meet the evapotranspirational demands owing to higher stomatal conductance reflected in maximum absorption of CO₂ and less stomatal resistance which is essential for increasing photosynthetic rate and finally reflected in more dry matter accumulation and fruit yield of cucumber.

5.4.4 Yield attributes

The interaction effect between fertigation levels and schedules was found significant in respect of number of fruits plant⁻¹, fruit length, average fruit weight and fruit weight vine⁻¹ in cucumber during both the years of experimentation.

Higher level of fertigation (125 % RDF) coupled with fertigation of N and K at every 2 days intervals in equal splits upto 110 days + P as a basal dose recorded significantly maximum number of fruits vine⁻¹ and at par with fertigation of recommended dose of N and K at every 4 and 6 days interval under same fertigation level and 100 per cent of RDF with fertigation of recommended dose of N and K at every 2 and 4 days intervals and 75 per cent of RDF with fertigation at every 2 days intervals during both the years of experiment.

The interaction effect between fertigation levels and fertigation schedules was found significant in respect of fruit length, average fruit weight and fruit weight vine⁻¹ during both the years of experimentation and on pooled mean. Fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2

days intervals in equal splits upto 110 days + P as a basal dose recorded significantly maximum fruit length, average fruit weight and fruit weight vine⁻¹ and at par with 125 per cent of RDF with fertigation of N and K at every 4 days intervals and 100 per cent of RDF alongwith fertigation of N and K at every 2 and 4 days intervals during both the years and on pooled mean.

Fertigation of 125 per cent of RDF coupled with maximum splitting (52 splits) of fertigation of N and K at every 2 days intervals in equal splits upto 110 days + P as a basal dose recorded significantly maximum average fruit weight and at par with fertigation of recommended dose of N and K at every 4 days interval under same fertigation level and 100 per cent of RDF coupled with fertigation of recommended dose of N and K at every 2 and 4 days intervals during both the years.

The frequent application of nutrients as per requirement of crop growth stages enhances the physiological activities for luxurious and healthy crop growth for maximum production of biomass resulted in higher translocation of photosynthates towards yield attributes for their development. Similar findings were reported by Papadopoulos (1986), Nerson *et al.* (1997), Guler and Ibricki (2002), Spizewski and Knaflewski (2004), Sawant *et al.* (2005), Shinde *et al.* (2010).

5.4.5 Fruit yield

The interaction effect between fertigation levels and fertigation schedules was found significant in respect fruit yield of cucumber per meter square, per unit area of polyhouse and per hectare during both the years. Fertigation of 125 per cent of RDF coupled with fertigation of recommended dose of N and K at every 2 days intervals in equal splits (52 splits) upto 110 days + P as a basal dose registered significantly maximum fruit yield of cucumber and at par with fertigation of N and K at every 4 and 6 days intervals under same fertigation level

and 100 per cent of RDF with fertigation of N and K at every 2 and 4 days intervals and 75 per cent of RDF with fertigation of N and K at every 2 days interval during both the years. The fruit yield is cumulated effect of various yield attributes, the highest (125 % RDF) as well as reduced (75 % RDF) level of fertigation applied through maximum splits (52 splits) improve the use efficiency of added nutrients which favours for luxurious growth and increasing translocation of photosynthates towards reproductive part ultimately enhancing the fruit yield of cucumber. This indicating that, even application of reduced level of fertigation (75 % RDF) with maximum splits (52 splits) found equally beneficial to higher fertigation level for achieving maximum fruit yield of cucumber. As the yield response for higher fertigation level and maximum splits was found linearly increasing during both the year of study. This indicate that, there is a scope to increase the fertigation level beyond 125 per cent of RDF for harvesting maximum fruit yield in cucumber. These results are in consonance with Nerson *et al.* (1997), Guler and Ibricki (2002), Spizewski and Knaflewski (2004), Sawant *et al.* (2005).

5.5 Economics

The interaction effect between fertigation levels and fertigation schedules in respect of gross and net monetary returns was found significant during both the years and on pooled. Fertigation of 125 per cent of RDF coupled with fertigation at every 2 days interval in equal splits upto 110 days + P as a basal dose obtained significantly maximum gross monetary returns than rest of the treatment combinations. However, it was at par with fertigation level of 125 per cent of RDF and fertigation of N and K at every 4 and 6 days interval and 100 per cent RDF with fertigation of N and K at every 2 and 4 days interval and 75 per cent RDF combined with fertigation of N and K at every 2 days interval during both the years. Similar trend as that of gross monetary returns was noticed under net monetary returns during both the years. Shinde *et al.* (2010) registered similar trend.

5.6 Correlation studies

Correlation coefficients studies between growth and yield attributes and physiological parameters indicated that positively and highly significant correlation was observed between growth and yield attributes (vine length, leaf area, number of fruits vine⁻¹, average fruit weight and fruit weight vine⁻¹) and photosynthetic rate, CO₂ concentration, stomatal conductance and transpiration rate. Whereas, negative correlation was obtained between growth and yield attributes (vine length, leaf area, number of fruits vine⁻¹, average fruit weight and fruit weight vine⁻¹) and stomatal resistance and leaf temperature during both the years. This indicate that as the physiological parameters *viz.*, photosynthetic rate, CO₂ concentration, stomatal conductance and transpiration rate increases the growth and yield attributes were increased. Whereas the leaf temperature and stomatal resistance increases the growth and yield attributes were decreases. This is because of the acceleration of all the physiological activities in plant were directly related to increase in fruit yield of cucumber. The positive correlation between physiological parameters and growth and yield attributes imparted boosting influence on dry matter accumulation which ultimately resulted in obtaining higher fruit yield and the thus showed its positive correlation. These findings are in accordance with those reported by Christopher *et al.* (2000), Arunkumar *et al.* (2011) and Veena *et al.* (2013).

6. SUMMARY AND CONCLUSIONS

The field investigation entitled “Effect of different fertigation levels and schedules on growth, yield and quality of cucumber (*Cucumis sativus* L.) under polyhouse condition” was conducted during *rabi* season of 2011-12 and 2012-13 at Instructional Farm of Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri (MS).

The experimental soil was well drained and sandy clay in texture with moderate in available nitrogen ($279.11 \text{ kg ha}^{-1}$), medium in available phosphorus (18.81 kg ha^{-1}), very high in available potassium ($358.42 \text{ kg ha}^{-1}$) and moderate in Fe (12.62 mg kg^{-1} soil), Mn (19.46 mg kg^{-1} soil), Zn (0.56 mg kg^{-1} soil) and Cu (2.53 mg kg^{-1} soil). The field capacity, permanent wilting point and bulk density of soil was 22.18 %, 11.06 % and 1.40 g cm^{-3} , respectively. The soil was neutral to moderately alkaline in reaction (pH 7.7) with an average electrical conductivity of 0.25 dSm^{-1} and organic carbon content in soil was 0.57 per cent.

The present experiment laid out in Factorial Completely Randomized Design with three replications under polyhouse condition. The climatic factors *viz.*, CO₂ concentration, solar radiation, humidity and temperature are congenial for crop growth and development because of partially controlled condition under Open Ventilated Polyhouse. There were nine treatment combinations with three fertigation levels *viz.*, 75, 100 and 125 per cent of RDF and three fertigation schedules *viz.*, F₁: Fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose (52 splits), F₂: Fertigation of recommended dose of N and K at every 4 days interval in equal splits upto 110 days + P as a basal dose (26 splits), F₃: Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose (18 splits).

There was no rainfall received during investigation period. The climatic parameters such as mean maximum temperature (26.4 °C to 38.8 °C), minimum temperature (7.0 °C to 22.0 °C), relative humidity during morning hours (36 to 82 %) and evening hours (11 to 66 %) and wind velocity (1.2 to 3.3 km hr⁻¹) during first year. While during second year mean maximum temperature (29.1 °C to 40.8 °C), minimum temperature (10.1 °C to 24.4 °C), relative humidity during morning hours (36 to 68 %) and evening hours (14 to 54 %) and wind velocity (0.6 to 5.2 km hr⁻¹) this climatic conditions were not suitable for growing cucumber under open field condition because of off season however, the favourable conditions was maintained in the Open Ventilated Polyhouse during the study period.

The performance of cucumber assessed under different fertigation levels and fertigation schedules by recording periodical observations on growth, yield and quality attributes, physiological parameters and yield during both the year of experimentation. Apart from this, chemical analysis for determination of soil available N, P, K, Cu, Zn, Mn and Fe and nutrient content in plant was carried out during investigation. Correlations of the different growth and yield attributes as well as physiological parameters with dry matter and fruit yield were also assessed. The conclusions and inferences drawn from the observations of the study are summarized below.

6.1 Effect of fertigation levels

6.1.1 Growth attributes

Fertigation of 125 per cent of RDF exhibited significantly maximum number of leaves vine⁻¹ (306.00 and 344.96), leaf area vine⁻¹ (680.11 and 737.19 dm²), maximum internodal distance (8.10 and 8.17 cm), leaf area index (17.90 and 19.40), leaf area duration and relative leaf area growth rate at 90 DAS

whereas, higher vine length (545.90 and 568.41 cm), number of branches vine⁻¹ (14.24 and 14.66) and dry matter vine⁻¹ (168.66 and 183.25 g) at harvesting stage, than 75 per cent of RDF and at par with 100 per cent of RDF in respect of above growth attributes at respective growth stages during both the years of investigation.

Maximum and significantly higher chlorophyll content (54.89 and 56.56 %) and significantly minimum leaf water potential (-7.79 and -7.45 bars) *i.e.* maximum leaf water content was observed upto the 90 days after sowing due to fertigation of 125 per cent of RDF during the period of investigation.

The fertigation of 75 per cent of RDF registered early initiation of first female flower (45.67 and 46.09 days).

6.1.2 Yield attributes and yield

The reduced level of fertigation *i.e.* 75 per cent RDF required minimum number of days to first fruit set (54.87 and 56.84 days) and first fruit harvest (63.51 and 65.52 days) whereas, higher fertigation level (125 % RDF) registered significantly delayed harvesting of first fruit (66.74 and 69.38 days) but extended significantly maximum fruiting period (151.26 and 158.70 days) during both the years of investigation. Fertigation of 125 per cent of RDF produced significantly higher number of fruits vine⁻¹ (24.96, 26.17 and 25.56), fruit length (14.43, 15.53 and 14.98 cm), average fruit weight (196.14, 207.37 and 201.76 g) and fruit weight vine⁻¹ (4.85, 5.33 and 5.09 kg) of cucumber as compared to rest of the fertigation levels during both the years and on pooled mean. However, the fruit girth of cucumber was not influenced by different fertigation levels during the period of investigation. These yield attributes were significantly reduced under 75 per cent RDF compared to 100 and 125 per cent RDF during both the years

This enhancement in yield attributes due to fertigation of 125 per cent of RDF reflected in significantly maximum fruit yield per meter square (11.22, 12.25 and 11.74 kg), per unit area of polyhouse (8.80, 9.61 and 9.20 t unit⁻¹) and per hectare (112.24, 122.54 and 117.39 t ha⁻¹) during both the years and on pooled mean, followed by 100 per cent RDF. The increased magnitude in fruit yield per hectare under 125 per cent RDF over the 75 per cent RDF was 13.22, 16.83 and 15.08 per cent during first year, second year and on pooled mean, respectively. Significantly lowest fruit yield per meter square (9.91, 10.49 and 10.20 kg), per unit area of polyhouse (7.77, 8.22 and 8.00 t unit⁻¹) and per hectare (99.13, 104.88 and 102.00 t ha⁻¹) was noticed with 75 per cent of RDF during the both the years of experiment and on pooled mean.

6.1.3 Physiological studies

Cucumber crop fertigated with 125 per cent of RDF recorded significantly higher photosynthetic rate, stomatal conductance, CO₂ concentration as well as transpiration rate, while reverse trend was noticed in case of leaf temperature and stomatal resistance at all crop growth stages during both the years of the experimentation. However, it was at par with 100 per cent of RDF with respect to different physiological parameters at respective crop growth stages.

6.1.4 Fruit quality

Fruit quality parameters like fruit skin colour, fruit strips colour, fruit shape, fruit bitterness and presence of placental cavity did not influenced due to different fertigation levels, however maximum fruit density (1.17 and 1.18 g cm⁻³), flesh thickness (1.40 and 1.41 cm) and total soluble solids (4.06 and 4.15 °brix) were registered with fertigation of 125 per cent of RDF. While 75 per cent of RDF registered significantly minimum fruit density (1.12 and 1.13 g cm⁻³), flesh

thickness (1.35 and 1.36 cm) and total soluble solids (3.84 and 3.89 °brix) during both the year.

6.1.5 Nutrient uptake

The concentration of nitrogen, phosphorus and potassium in cucumber plant and fruit was almost identical under different fertigation levels during both the years of investigation. But the higher fertigation level (125 per cent of RDF) obtained significantly higher biomass and fruit yield of cucumber which reflected in significantly higher total uptake of nitrogen (185.95 and 206.22 kg ha⁻¹), phosphorus (40.37 and 49.89 kg ha⁻¹) and potassium (156.98 and 178.55 kg ha⁻¹) while, significantly minimum total uptake of nitrogen (149.73 and 163.07 kg ha⁻¹), phosphorus (37.36 and 30.95 kg ha⁻¹) and potassium (128.03 and 145.15 kg ha⁻¹) by cucumber was observed with 75 per cent of RDF during both the years.

6.2 Effect of fertigation schedules

6.2.1 Growth attributes

Frequent application of recommended dose of N and K at every 2 days interval in equal splits upto 110 days (52 splits) through fertigation + P as basal dose exhibited significantly maximum vine length (556.56 and 583.84 cm), number of branches vine⁻¹ (14.33 and 15.13) and dry matter vine⁻¹ (163.07 and 176.93 g) at last harvesting stage, whereas number of leaves vine⁻¹ (312.59 and 356.58), leaf area vine⁻¹ (697.48 and 757.05 dm⁻²), leaf area index (18.35 and 19.92), maximum internodal distance (8.29 and 8.28 cm) at 90 DAS were also significantly higher than fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days (18 splits) + P as basal dose. However, fertigation of recommended dose of N and K at every 4 days interval in equal splits upto 110 days + P as a basal dose found at par with fertigation at every 2

days interval in respect of above growth attributes at respective stages during both the years of investigation.

Significantly higher chlorophyll content and minimum leaf water potential *i.e.* maximum leaf water content was noticed under fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days + P as a basal dose at all the stages of crop growth, however it was declined after 105 days after sowing in all the treatments during the period of investigation. The fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days + P as a basal dose registered early initiation of first female flower (47.48 and 48.13 days) during both the years.

6.2.2 Yield attributes and yield

The yield attributes *viz.*, numbers of fruits vine⁻¹ (24.87, 26.02 and 25.45), fruit length of cucumber (14.83, 16.07 and 15.44 cm), average fruit weight (199.99, 209.44 and 204.71 g) and fruit weight vine⁻¹ (5.01, 5.35 and 5.18 kg) as well as fruiting period (152.67 and 153.94 days) were significantly maximum with fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days (52 splits) + P as a basal dose. Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days (18 splits) + P as a basal dose registered significantly minimum numbers of fruits vine⁻¹ (21.55, 22.19 and 21.87), fruit length (12.30, 13.19 and 12.75 cm), average fruit weight (177.17, 190.38 and 183.87 g) and fruit weight vine⁻¹ (3.69, 4.15 and 3.92 kg) of cucumber during both the years and on pooled mean.

This increased magnitude in yield attributing characters leads to significantly maximum fruit yield per square meter (11.22, 12.19 and 11.70 kg), per unit area of polyhouse (8.79, 9.55 and 9.17 t unit⁻¹) and per hectare (112.18, 121.87 and 117.02 t ha⁻¹) with fertigation of recommended dose of N and K at

every 2 days interval in equal splits upto 110 days (52 splits) + P as a basal dose and at par with fertigation at every 4 days interval (26 splits) during both the years of experiment and on pooled mean. The fruit yield per hectare increased by 15.85, 19.93 and 17.94 per cent in higher fertigation level (125 % RDF) over reduced level of fertigation (75 % RDF). Among the different fertigation schedules significantly minimum fruit yield per meter square (9.68, 10.16 and 9.92 kg), per unit area of polyhouse (7.59, 7.97 and 7.78 t unit⁻¹) and per hectare (96.83, 101.61 and 99.22 t ha⁻¹) was observed with fertigation of recommended dose of N and K at every 6 days interval + P as a basal dose.

6.2.3 Physiological studies

The fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days (52 splits) + P as a basal dose found superior in respect of photosynthetic rate, stomatal conductance, CO₂ concentration as well as transpiration rate at all the stages of crop growth during both the years. While, reverse trend was noticed in case of leaf temperature and stomatal resistance at all the observation stages during both the years. Fertigation of recommended dose of N and K at every 6 days interval in equal splits upto 110 days (18 splits) + P as a basal dose recorded significantly lowest photosynthetic rate, stomatal conductance, CO₂ concentration, transpiration rate and higher stomatal resistance and leaf temperature in cucumber leaves at all the crop growth stages during both the year of investigation.

6.2.4 Fruit quality

The fruit quality parameter *viz.*, fruit skin colour, fruit strip colour, fruit shape, fruit bitterness, and presence of placental cavity, flesh thickness and total soluble solids found almost identical under different fertigation schedules, except fruit density. Fertigation of recommended dose of N and K at every 2 days interval

in equal splits upto 110 days (52 splits) + P as a basal dose recorded significantly maximum fruit density (1.19 and 1.20 cm) during both the years than fertigation at 6 days interval (18 splits).

6.2.5 Nutrient uptake

Even though nutrient concentration in plant and fruit was not influenced significantly due to different treatments but due to increased trend in yield and dry matter vine⁻¹ under fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days (52 splits) + P as a basal dose recorded significantly higher total uptake of nitrogen (187.07 and 208.20 kg ha⁻¹), phosphorus (41.24 and 51.07 kg ha⁻¹) and potassium (159.24 and 181.70 kg ha⁻¹) by cucumber (plant and fruit) during both the years of investigation.

6.3 Interaction effect

6.3.1 Growth attributes

The interaction effect between different fertigation levels and schedules on growth attributes *viz.*, vine length, number of branches vine⁻¹, number of functional leaves vine⁻¹ and leaf area vine⁻¹ were found significant at 60 and 75 DAS during first year and 75 and 105 DAS during second year of experimentation. Fertigation of 125 per cent of RDF coupled with fertigation of recommended dose of N and K at every 2 days interval in equal splits upto 110 days (52 splits) + P as a basal dose registered significantly maximum growth attributes of cucumber and at par with 125 per cent RDF and fertigation at every 4 days interval, similarly 100 per cent of RDF with fertigation at every 2 and 4 days interval.

6.3.2 Yield attributes and yield

The interaction effect between different fertigation levels and schedules on yield attributes were found significant in respect of numbers of fruits vine⁻¹, fruit length, average fruit weight and fruit weight vine⁻¹ during both the years of investigation. All the yield attributes were significantly maximum under higher level of fertigation (125 % RDF) coupled with fertigation of N and K at every 2 days intervals in equal splits upto 110 days (52 splits) + P as a basal dose and at par with fertigation at every 4 and 6 days interval under same fertigation level and 100 per cent of RDF with fertigation of recommended dose of N and K at every 2 and 4 days intervals and 75 per cent of RDF with fertigation at every 2 days intervals during both the years of experiment.

The interaction effect between different fertigation levels and schedules on fruit yield of cucumber was found significant during both the years of investigation. Fertigation of 125 per cent of RDF coupled with fertigation of recommended dose of N and K at every 2 days intervals in equal splits upto 110 days (52 splits) + P as a basal dose registered significantly maximum fruit yield of cucumber and at par with fertigation at every 4 and 6 days interval under same fertigation level and 100 per cent of RDF with fertigation at every 2 and 4 days intervals and 75 per cent of RDF with fertigation schedule at every 2 days interval during both the years.

6.3.3 Physiological studies

The interaction effect between different fertigation levels and schedules on physiological parameters *viz.*, photosynthetic rate, CO₂ concentration, stomatal conductance, stomatal resistance, transpiration rate and leaf temperature were found significant during both the years of investigation. Fertigation of 125 per cent of RDF coupled with fertigation of N and K at every 2 days interval in equal splits

upto 110 days + P as a basal dose registered significantly maximum photosynthetic rate, stomatal conductance, CO₂ concentration as well as transpiration rate and minimum leaf temperature and stomatal resistance but it was at par with fertigation interval at every 4 days under same fertigation levels and 100 per cent RDF with every 2 days fertigation interval during both the years. Whereas, reduced fertigation level of 75 per cent RDF alongwith fertigation schedule at every 6 days interval in equal splits (18 splits) + P as a basal dose registered significantly higher leaf temperature and stomatal resistance at all the stages of observations during both the years.

6.4 Economics

The interaction effect between fertigation levels and fertigation schedules in respect of gross and net monetary returns was found significant during both the years and on pooled. Fertigation of 125 per cent of RDF coupled with fertigation at every 2 days interval in equal splits upto 110 days (52 splits) + P as a basal dose obtained significantly maximum gross monetary returns (` 2,02,353 unit⁻¹ of polyhouse), net monetary returns (` 1,38,183 unit⁻¹ of polyhouse) and B:C ratio (3.08) than rest of the treatment combinations. However, it was at par with 125 per cent of RDF and fertigation at every 4 and 6 days interval and 100 per cent RDF with fertigation interval at every 2 and 4 days and 75 per cent RDF combined with fertigation at every 2 days interval during both the years.

6.5 Correlation studies

The correlation coefficients studies between growth and yield attributes and physiological parameters indicated that, at 60 days after sowing positively and highly significant correlation was observed between growth and yield attributes (vine length, leaf area vine⁻¹, number of fruits vine⁻¹, average fruit weight and fruit weight vine⁻¹) and photosynthetic rate, CO₂ concentration, stomatal conductance

and transpiration rate. Whereas negative correlation was obtained between growth and yield attributes (vine length, leaf area vine⁻¹, number of fruits vine⁻¹, average fruit weight and fruit weight vine⁻¹) and stomatal resistance and leaf temperature during both the years. This indicated that, as the photosynthetic rate, CO₂ concentration, stomatal conductance and transpiration rate increases the growth and yield attributes were increased. Whereas the leaf temperature and stomatal resistance increases the growth and yield attributes were decreases. Almost similar trend was observed at 90 and 120 days after sowing during both the years.

6.6 Conclusions

1. Fertigation of 125 per cent of recommended dose of nitrogen (125 kg ha⁻¹) and potassium (62.5 kg ha⁻¹) at every 2 days interval in equal splits upto 110 days (52 splits) + phosphorus (62.5 kg ha⁻¹) as a basal dose recorded maximum growth attributes *viz.*, vine length, number of branches vine⁻¹, number of functional leaves vine⁻¹ and leaf area vine⁻¹.
2. The leaf area duration and relative leaf area growth rate was maximum with fertigation of 125 per cent of recommended dose of nitrogen (125 kg ha⁻¹) and potassium (62.5 kg ha⁻¹) at every 2 days interval in equal splits upto 110 days (52 splits) + phosphorus (62.5 kg ha⁻¹) as a basal dose.
3. The maximum photosynthetic rate, CO₂ concentration, stomatal conductance, transpiration rate and minimum leaf temperature and stomatal resistance were found with fertigation of 125 per cent of recommended dose of nitrogen (125 kg ha⁻¹) and potassium (62.5 kg ha⁻¹) at every 2 days interval in equal splits upto 110 days (52 splits) + phosphorus (62.5 kg ha⁻¹) as a basal dose.
4. The maximum fruiting period was observed in fertigation of 125 per cent of recommended dose of nitrogen (125 kg ha⁻¹) and potassium (62.5 kg ha⁻¹) at

every 2 days interval in equal splits upto 110 days (52 splits) + phosphorus (62.5 kg ha^{-1}) as a basal dose, while minimum number of days to first female flower initiation, fruit set and first fruit harvest were found in fertigation of 75 per cent of recommended dose of fertilizer at every 6 days interval in equal splits (18 splits) + P as basal dose.

5. Fertigation of 125 per cent of recommended dose of nitrogen (125 kg ha^{-1}) and potassium (62.5 kg ha^{-1}) at every 2 days interval in equal splits upto 110 days (52 splits) + phosphorus (62.5 kg ha^{-1}) as a basal dose recorded maximum yield attributes *viz.*, number of fruits vine⁻¹ (26.12), fruit length (16.06 cm), fruit girth (11.92 cm), average weight of fruit (210.44 g) and fruit weight vine⁻¹ (5.38 kg) and fruit yield of cucumber (119.65 t ha^{-1}).
6. The fruit yield of cucumber obtained with fertigation of recommended dose of nitrogen (100 kg ha^{-1}) and potassium (50 kg ha^{-1}) at every 2 days interval in equal splits upto 110 days (52 splits) + phosphorus (50 kg ha^{-1}) as a basal dose and fertigation of 75 per cent recommended dose of nitrogen (75 kg ha^{-1}) and potassium (37.5 kg ha^{-1}) at every 2 days interval in equal splits upto 110 days (52 splits) + phosphorus (37.5 kg ha^{-1}) as a basal dose were at par with each other, indicating 25 per cent saving of fertilizers under resource constraint situation.
7. The fruit quality parameters such as flesh thickness, fruit density and total soluble solids were improved under higher level of fertigation (125 % RDF). Whereas, fruit skin colour, fruit strip colour and fruit shape were not influenced by fertigation levels.
8. Positive and highly significant correlation was obtained between growth attributes *viz.*, vine length, leaf area, number of fruits vine⁻¹ and yield of cucumber and physiological parameters *viz.*, photosynthetic rate, CO_2

concentration, stomatal conductance and transpiration rate. Whereas negative correlation was obtained between growth attributes and leaf temperature and stomatal resistance.

- 9.** Maximum total uptake of nitrogen ($185.95 \text{ kg ha}^{-1}$), phosphorus (40.37 kg ha^{-1}) and potassium ($156.98 \text{ kg ha}^{-1}$) by cucumber (plant and fruit) was registered with fertigation of 125 per cent recommended dose of nitrogen (125 kg ha^{-1}) and potassium (62.5 kg ha^{-1}) at every 2 days interval in equal splits upto 110 days (52 splits) + phosphorus as a basal dose.
- 10.** Maximum gross monetary returns ($\text{₹ } 2,02,353 \text{ unit}^{-1}$ of polyhouse), net monetary returns ($\text{₹ } 1,38,113 \text{ unit}^{-1}$ of polyhouse) and B:C ratio (3.15) was obtained with fertigation of 125 per cent of recommended dose of nitrogen (125 kg ha^{-1}) and potassium (62.5 kg ha^{-1}) at every 2 days interval in equal splits upto 110 days (52 splits) + phosphorus (62.5 kg ha^{-1}) as a basal dose.

Based on two years of experimentation it could be concluded that, fertigation of 125 per cent of recommended dose of nitrogen (125 kg ha^{-1}) and potassium (62.5 kg ha^{-1}) at every 2 or 4 days interval in equal splits upto 110 days (52 or 26 splits) + phosphorus (62.5 kg ha^{-1}) as a basal dose found suitable for achieving maximum fruit yield with better quality and maximum monetary returns of cucumber under polyhouse in winter season.

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*Original not seen

APPENDICES

APPENDIX – I. Economics of cucumber cultivation under Open Ventilated Polyhouse (784 m²) during 2011-12

Sr. No.	Particular	Total cost (` Unit ⁻¹ of polyhouse)	Depreciation cost (` year ⁻¹)	Depreciation cost (` season ⁻¹)
I.	Non recurring contingency (NRC)			
1	Construction of polyhouse @ of ` 700 m ² (For life span of 20 years)	548800	27440	13720
2	Top : UV stabilized plastic sheets @ 65 m ² (For life span of 5 years)	104000	20800	10400
3	Drip system including automatic fertigation unit and centrifugal pump	As per appendix IV	11863	5931
	Total NRC	-	-	30051
II.	Recurring contingency (RC)	Treatment		
		F ₁	F ₂	F ₃
a.	Bed preparation and FYM application	6000	6000	6000
b.	Seeds and sowing	1980	1980	1980
c.	Intercultural operations including weeding and gapfilling	7050	7050	7050
d.	Chemical fertilizers	994	1326	1658
e.	Plant protection	7505	7505	7505
f.	Harvesting	8100	8100	8100
g.	Irrigation charges	900	900	900
h.	Polyhouse maintainance including electric charge	500	500	500
	Total RC	33029	33361	33693
	Grand total (NRC + RC)	63081	63413	63744

APPENDIX - II . Economics of cucumber cultivation under Open Ventilated Polyhouse (784 m²) during 2012-13

Sr. No.	Particular	Total cost (` Unit ⁻¹ of polyhouse)	Depreciation cost (` year ⁻¹)	Depreciation cost (` season ⁻¹)
I.	Non recurring contingency (NRC)			
1	Construction of polyhouse @ of ` 700 m ² (For life span of 20 years)	548800	27440	13720
2	Top : UV stabilized plastic sheets @ 65 m ² (For life span of 5 years)	104000	20800	10400
3	Drip system including automatic fertigation unit and centrifugal pump	As per appendix IV	11863	5931
	Total NRC	-	-	30051
II.	Recurring contingency (RC) (For a season)	Treatment		
		F ₁	F ₂	F ₃
a.	Bed preparation and FYM application	6300	6300	6300
b.	Seeds and sowing	1980	1980	1980
c.	Intercultural operations including weeding and gapfilling	7050	7050	7050
d.	Chemical fertilizers	994	1326	1658
e.	Plant protection	7130	7130	7130
f.	Harvesting	9300	9300	9300
g.	Irrigation charges	900	900	900
h.	Polyhouse maintainance including electric charge	550	550	550
	Total RC	34204	34536	34868
	Grand total (NRC + RC)	64256	64588	64919

APPENDIX- III. Prevailing market unit prices of inputs for cost of cultivation

Sr. No.	Particulars	Unit	Rate (₹ Unit ⁻¹)		
			2011-12	2012-13	
1.	Farmyard manure	tone ⁻¹	1200	1200	
2.	Neem cake	quintal ⁻¹	600	610	
3.	Hired labour	day ⁻¹	150	150	
4.	Seed	packet ⁻¹	420	440	
5.	Sutali	kg ⁻¹	60	62	
6.	Plant protection chemicals				
i.	Trichoderma plus	kg ⁻¹	150	158	
ii.	Phorate	kg ⁻¹	60	65	
iii.	Bavistin	kg ⁻¹	800	800	
iv.	Captan	kg ⁻¹	1600	1640	
v.	Quinalphos 25% EC	liter ⁻¹	350	350	
vi.	Contaf	liter ⁻¹	800	800	
vii.	Actra	kg ⁻¹	3400	3490	
viii.	Folicure	liter ⁻¹	1520	1520	
ix.	Confidor	liter ⁻¹	2100	2155	
x.	Topaz	liter ⁻¹	830	830	
xi.	Regent	liter ⁻¹	4200	4345	
xii.	Omite	liter ⁻¹	4000	4120	
xiii.	Cypermethrin	liter ⁻¹	550	550	
xiv.	Propenophos 50 EC	liter ⁻¹	700	700	
xv.	Trizophos 20% EC	liter ⁻¹	400	400	
xvi.	Copper oxychloride 50 % WP	Kg ⁻¹	700	700	
7.	Fertilizers				
i.	Urea	kg ⁻¹	5.62	5.62	
ii.	13:00:45	kg ⁻¹	98	98	
iii.	S.S.P.	kg ⁻¹	8	8	
8.	Output				
i.	Cucumber fruits (2011-12)	kg ⁻¹	13	12	

APPENDIX- IV. Economics of drip irrigation system unit⁻¹ (784 m²)

Sr. No.	Item	Speci- fication	Unit price (₹)	Quantity	Amount (₹)	Life (yr.)	Depreciation per annum @ 10 % (₹)	Interest @ 12 % p.a. (₹)	Repairs and maintenance @ 2 % p.a. (₹)
I.	Fixed cost								
1	Automatic fertigation unit		1000000	1	1000000	25	36000	4224	800
2	Centrifugal pumpset and accessories	3 HP	8000	1	8000	20	360	42	8
	Total fixed cost year ⁻¹ ha ⁻¹						41434		
	Total fixed cost year⁻¹ unit⁻¹ (A)						3248		
II.	Operating cost unit⁻¹								
1	Drip system with foggers @ 75 m ⁻²				58800	7	7560	887	168
	Total operating cost year⁻¹ unit⁻¹ (B)						8615		
III.	Total cost of drip irrigation system year⁻¹ unit⁻¹ (A+B)						11,863		

Appendices V. Nutrient concentration in cucumber (plant and fruit) as influenced by different treatments at last picking

(2011-12)

Treatment	Nutrient concentration (%)					
	Nitrogen		Phosphorus		Potassium	
	Plant	Fruit	Plant	Fruit	Plant	Fruit
A. Fertigation levels (N, P₂O₅, K₂O kg ha⁻¹)						
F ₁ - 75% RDF (75:37.5:37.5)	1.53	1.89	0.23	0.46	0.79	1.99
F ₂ - 100% RDF (100:50:50)	1.59	1.98	0.26	0.49	0.84	2.09
F ₃ - 125% RDF (125:62.5:62.5)	1.62	2.03	0.26	0.51	0.86	2.12
SEm±	0.02	0.02	0.002	0.002	0.01	0.02
C.D. at 5%	0.05	0.07	0.006	NS	0.03	0.05
B. Fertigation schedules (up to 110 days)						
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	1.65	2.05	0.27	0.52	0.87	2.16
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	1.60	1.99	0.26	0.50	0.84	2.09
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	1.58	1.93	0.22	0.44	0.77	1.96
SEm±	0.02	0.02	0.002	0.002	0.01	0.02
C.D. at 5%	0.05	0.07	0.006	NS	0.03	0.05
C. Interaction(AXB)	NS	NS	Sig.	NS	NS	Sig.
CV (%)	2.94	3.65	2.41	2.49	3.55	2.48
General mean	1.58	1.97	0.25	0.49	0.83	2.07

Appendices VI. Nutrient concentration in cucumber (plant and fruit) as influenced by different treatments at last picking

(2012-13)

Treatment	Nutrient concentration (%)					
	Nitrogen		Phosphorus		Potassium	
	Plant	Fruit	Plant	Fruit	Plant	Fruit
A. Fertigation levels (N, P₂O₅, K₂O kg ha⁻¹)						
F ₁ - 75% RDF (75:37.5:37.5)	1.53	1.97	0.25	0.55	0.81	2.15
F ₂ - 100% RDF (100:50:50)	1.62	2.05	0.27	0.58	0.85	2.21
F ₃ - 125% RDF (125:62.5:62.5)	1.63	2.08	0.28	0.59	0.87	2.24
SEm±	0.01	0.02	0.003	0.01	0.01	0.03
C.D. at 5%	0.03	0.06	0.008	0.02	0.03	0.07
B. Fertigation schedules (up to 110 days)						
S ₁ - Fertigation of R.D. of N and K at every 2 days interval in equal splits	1.66	2.11	0.28	0.61	0.89	2.27
S ₂ - Fertigation of R. D. of N and K at every 4 days interval in equal splits	1.61	2.06	0.27	0.59	0.86	2.22
S ₃ - Fertigation of R.D. of N and K at every 6 days interval in equal splits	1.51	1.98	0.24	0.57	0.82	2.17
SEm±	0.01	0.02	0.003	0.01	0.01	0.03
C.D. at 5%	0.03	0.06	0.008	0.02	0.03	0.07
C. Interaction(AXB)	Sig.	NS	Sig.	NS	NS	NS
CV (%)	2.07	2.81	3.03	2.97	3.46	3.36

General mean	1.59	2.04	0.27	0.57	0.85	2.20
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9. VITA

CHAITANYA DEVRAM TEKALE

A candidate for the degree

of

DOCTOR OF PHILOSOPHY (AGRICULTURE)

in

AGRONOMY

2014

Title of thesis	: Effect of different fertigation levels and schedules on growth, yield and quality of cucumber (<i>Cucumis sativus</i> L.) under polyhouse condition
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LIST OF ABBREVIATIONS

@	:	At the rate of
%	:	Per cent
₹	:	Rupees
⁰ C	:	Degree Celsius
C.D.	:	Critical Difference
cm	:	Centimeter (s)
DAT	:	Days After Transplanting
dSm ⁻¹	:	Deci seimens per meter
E.C.	:	Electrical Conductivity
<i>et al.</i>	:	And others (et alli)
Even.	:	Evening
Fig.	:	Figure
g	:	Gram (s)
ha	:	Hectare
hr.	:	Hour (s)
<i>i.e.</i>	:	Id est (that is)
K	:	Potassium
kg ha ⁻¹	:	Kilogram per hectare
kg	:	Kilogram (s)
m	:	Meter
Max.	:	Maximum
mg	:	Milligram (s)
Min.	:	Minimum
Morn.	:	Morning
N	:	Nitrogen
N.S.	:	Non-significant
P	:	Phosphorus
p.a.	:	per annum
RD	:	Recommended Dose
RH	:	Relative Humidity
S.Em.	:	Standard error of means
t ha ⁻¹	:	Tonnes per hectare
t	:	Tonne (s)
Temp.	:	Temperature
<i>viz.,</i>	:	Videlicet (Namely)

