Study on plant geometry, cultivar and fertilizer doses on growth, yield and quality of Cucumber (*Cucumis sativus* L.) under protected condition

THESIS

Submitted in partial fulfilment of the requirements for the

Award of the degree of

DOCTOR OF PHILOSOPHY

In

Horticulture (Vegetable Science)

By

BHOOPENDRA SINGH

DEPARTMENT OF HORTICULTURE
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CERTIFICATE OF ORIGINAL WORK

This is to certify that the studies conducted by **Mr. Bhoopendra Singh,** ID No. 16PHCHVS101, during 2016 to 2019, as reported in the present thesis was under my guidance and supervision. The results reported by him are genuine and the candidate has written the script of the thesis. His thesis entitled "Study on plant geometry, cultivar and fertilizer doses on growth, yield and quality of Cucumber (*Cucumis sativus* L.) under protected condition", therefore, is being forwarded for the acceptance in partial fulfillment for the award of the degree of **Doctor of Philosophy** in Horticulture (Vegetable Science) to the Department of Horticulture, Faculty of Agriculture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Allahabad), 211007 U.P.

Place: Prayagraj (Allahabad)
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Ph.D Final Defense Report

This is to certify that **Mr. Bhoopendra Singh,** ID No.16PHCHVS101, presented the oral defense for his thesis entitled, "Study on plant geometry, cultivar and fertilizer doses on growth, yield and quality of cucumber (*Cucumis sativus* L.) under protected condition", on **18.02.2020** at 12 pm (noon) in the Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Allahabad), 211007 U.P. The results are genuine, have considerable scientific importance and performance of the candidate was found satisfactory.

We, the following members of the Evaluation Board agree and recommend to the University that the degree of **Doctor of Philosophy** in Horticulture (Vegetable Science) may be awarded to Mr. Bhoopendra Singh.

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CERTIFICATE OF RECOMMENDATION BY STUDENT ADVISORY COMMITTEE

This thesis entitled, "Study on plant geometry, cultivar and fertilizer doses on growth, yield and quality of cucumber (*Cucumis sativus* L.) under protected condition", has been prepared and submitted by **Mr. Bhoopendra Singh** (ID.No.16PHCHVS101) for the award of the degree of **DOCTOR OF PHILOSOPHY** in Horticulture (Vegetable Science) to the Department of Horticulture, Faculty of Agriculture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Allahabad), U.P.

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2.	**Prof.(Dr.) V. M. Prasad** Professor & Ex. Head, Department of Horticulture (Co - Advisor)	Satisfactory/ Not Satisfactory	.....
3.	**Dr.Vijay Bahadur** Associate Professor & Head, Department of Horticulture (Member)	Satisfactory/ ~~Not Satisfactory~~	.....
4.	**Prof. (Dr.) Gautam Ghosh** Professor & Dean, Naini Agricultural Institute (Member)	Satisfactory/ Not Satisfactory	.....
5.	**Dr. G. M. Lal** Assistant Professor, Department of Genetics & Plant Breeding (Member)	Satisfactory/ Not Satisfactory	.....

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SELF ATTESTATION

This is to certify that I have personally worked on the thesis work entitled, **"**Study on plant geometry, cultivar and fertilizer doses on growth, yield and quality of cucumber (*Cucumis sativus* L.) under protected condition,**''** The data mentioned in this thesis have been collected during the experimental work and are genuine Data / information obtained from other agencies have been duly acknowledged. None of the finding/information pertaining to the work has been concealed. The results embodied in this thesis have not been submitted to any other University or Institute for the award of any degree or diploma.

Place: Prayagraj (Allahabad) **(BHOOPENDRA SINGH)**

Date: 20.08.2019

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Date: 18.02.2020

Place: Prayagraj **(Bhoopendra Singh)**

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LIST OF ABBREVIATIONS

%	:	Percentage
°C	:	Degree Celsius
/	:	Per
@	:	At the rate of
ANOVA	:	Analysis of variance
Av	:	Average
CD.	:	Critical Difference
cm	:	Centimeter
Con.	:	Concentration
d.f	:	Degree of freedom
Cv.	:	Cultivar
ESS	:	Error sum of square
i.e.	:	That is
et.al.	:	And others
etc.	:	And the rest
F.cal	:	Calculated value of 'F'
F.tab	:	Table value of 'F'
Fig.	:	Figure
g	:	Gram
ha	:	Hectare
i.e.	:	That is
J.	:	Journal
N	:	Nitrogen
P	:	Phosphorus
K	:	Potassium
kg	:	Kilogram

l	:	Litre
MSS	:	Mean sum of squares
ml	:	Millilitre
No.	:	Number
NS	:	Non-significant
ppm	:	Parts per million
RBD	:	Randomized Block Design
r	:	Replication
SE±	:	Standard error of mean
S	:	Significant
SS.	:	Sum of squares
Sp.	:	Species
wt.	:	Weight
viz	:	Vide licet
t	:	Tonnes
pH	:	Potentiel of Hydrogen

Study on plant geometry, cultivar and fertilizer doses on growth, yield and quality of cucumber under protected condition

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Abstract

The present investigation entitled **"study on plant geometry, cultivar and fertilizer doses on growth, yield and quality of cucumber (*cucumis sativus L.*) under protected condition"** conducted during winter season 2017-18 and 2018-19 was carried out at Vegetable Research Farm SHUATS, Prayagraj (Allahabad) U.P. Factorial RBD with three replications. In this way, the experiments were comprising of total twenty seven treatment combinations of three cultivars namely, Pant Parthenocarpic Cucumber 2 (V_1), Pant Parthenocarpic Cucumber 3 (V_2) and Hilton (V_3). Three plant geometry i.e. 60 x 30 cm (P_1), 60 x 40 cm (P_2) and *60* x *50* cm (P_3) and three NPK, fertilizers doses like, 20:10:22 kg/1000m^2 (D_1), 25:15:27 kg/1000m^2 (D_2) and 30:20:32 kg/1000m^2 (D_3). The fertilizers dose applies at twice a week. Similar treatments were applied during both the year.

The results revealed that all the treatments and their combinations had significantly influenced the growth, yield and quality of fruits during both the year of experimentation.Among the different cultivars used in the study, Pant Parthenocarpic Cucumber 3(V_2). were found statistically superior to enhance vine length (2.73 m) stem girth (0.80 cm) leaf area (412.34 cm^2) Internodal distance (8.38 cm) minimum days required to first flower bud initiation (42.14 DAS), days to first fruit harvest (55.42 DAS), number of fruits per vine (21.89), number of unmarketable fruits per plants (1.46) average weight of fruit (116.41 g), fruit length (18.35 cm) and fruit width (3.45 cm) which ultimately gave maximum yield per vine (2.82 kg per plant) during pooled , respectively. Further, among the various spacing treatments, spacing (P_3) 60 x 50 cm was found to be significantly superior with respect to vegetative growth, yield per plant and quality of fruits except yield per sq. meter in both the year .Significantly higher yield per sq. meter was recorded in spacing P_1 (60 x 30 cm) and least in P_3 (60 x 50 cm) during both the year. In case of dose of fertilizer application, the application of fertilizers through manually apply the root zone of plant was found superior to maximum fertilizers apply compared to minimum fertilizers apply during both the year. Maximum number of fruits per vine, average fruit weight (g), yield per vine (kg) and yield per sq. meter (kg) were recorded in both the year maximum fertilizers apply in

D_3 maximum nutrient content in the leaf as total nitrogen (3.66 %), total phosphorus (0.83 %) and total potassium (2.44 %) along with minimum nutrient residues in the soil after harvest were recorded in maximum NPK combination apply to minimum fertilizer apply both the year, respectively. Therefore, it is recommended that cucumber should be grown at a spacing of 60 x 50 cm along with D_3 NPK dose using cultivars (Pant Parthenocarpic Cucumber 3) during the winter season for sustaining higher fruit yield and quality cucumber under polyhouse condition. Whereas, on the basis of benefit cost ratio it could be recommended that cucumber cultivar 'Pant Parthenocarpic Cucumber 3' should be grown at a spacing of 60 x 50 cm along with the maximum NPK dose of fertilizers apply during both the year for attaining the maximum production of cucumber polyhouse condition.

Key Words: cucumber, parthenocarpic, polyhouse, cultivar, plant geometry, dose of fertilizers, yield, quality and BC ratio.

Chapter-1

INTRODUCTION

Cucumber (***Cucumis sativus*** L.) is one of the most important vegetable crops of the cucurbitaceace family and having a chromosome number 2n = 14. As a vegetable crop parthenocarpic cucumber has great economic importance. The immature fruit of cucumber are use as salad and for making pickles, pahari rayata and brined on commercial scale.(Bairagi 2013), The edible portion of fruit content about 93-95 % water and provides vitamins, potassium, sodium, magnesium, sulphur, silcon, fluorides etc. good quantity. The alkaline forming minerals in the cucumber represents 64.05 % and the acid forming minerals are about 35.95 %. This makes it useful in maintaining the alkalinity of the human blood. It is low energy and high water content salad crop. It content 0.6 g protein, 2.6 g carbohydrates, 12 cal energy, 18 mg Ca, 0.02 mg thiamin, 0.2 mg Fe, 0.02 mg riboflavin, 0.01 mg niacin and 10 mg vitamin C per 100g of edible portion (Rashid 1999). It is primary source of vitamins and minerals (AVRDC, 1999). The global production of cucumber is 71.36 million tons (FAOSTAT 2014) and commercially cultivated in countries like China, India, Turkey, Iran, Japan, Europe and United States. In the world more than 55 countries adopted protected cultivation technology; China has the largest area of 2.7 mha under protected cultivation Kacira (2011). The first exposure of India to hi-tech protected cultivation of vegetables and other high-value horticultural crops realized through the Indo-Israel Project under greenhouse cultivation, initiated at Indian Agricultural Research Institute (IARI) New Delhi in 1998, presently it is known as the Centre for Protected Cultivation Technology Pusa, New Delhi.

The total area of protected cultivation in India is approx 30,000 ha. contributes 0.23% of the total area under the horticulture crop cultivation in India at and of 11^{th} five year plan (Shweta et al.2014). Cucumber is a semi-tropical vegetable and grows best under polyhouse condition. Under favorable condition and stable environmental and nutritional condition when insect and pest are under control, the plant grow rapidly and produce heavily. The optimum temperature for better development of fruits is $14\text{-}20^{0}$ C .cucumber requires mild climate and as such does well under greenhouse condition.

The total area of cucumber growing In India 78,000 hectares with an annual production of 11.42 lakh MT (National Horticulture Board 2016-17). The main areas of cucumber cultivation are river beds of Yamuna, Ganges and Narmada in North and Kaveri, Krishna and Godavari in South

(Singh1998).This vegetable crop is gaining importance in cultivation due to higher yield and income in short period. In several part of country, especially in northern plains, the soil are highly fertile but extreme of temperature, ranging from 0-48^{0}C during the year do not allow year round outdoor cucumber cultivation. Similarly, in several part of the country biotic stresses do not allow successful cucumber cultivation in open condition. In upper reached of Himalayas, cool dessert condition prevail where the temperature extremely low range -5 to 30^0 C during the winter season and most of the region remain cut off from rest of the country from November to March due to very heavy snowfall. Therefore, it is very difficult to grow vegetable like cucumber in such a climate. Greenhouse is the most efficient mean to overcome climate diversity, greenhouse vegetable production makes the use of recent advances in technology to control the environment to maximize crop productivity per unit area and increasing the quality of vegetable production (*Singh* 2005) Polyhouse protect the crops from adverse conditions like excess solar radiation, extreme temperature, rain, pest and disease. It also increased the productivity and improved quality of produce due to increase in photosynthetic rate and better management. One of the main factors affecting crop productivity under polyhouse is plant population, improper nutrients leading to de-shaped fruits also and growing methods which is mainly governed by plant architecture. Greenhouse production technique of vegetable emphasizes the need for having appropriate plant density in order to boost up the production per unit area with good quality produce by utilizing the available space and nutrients applied.

Parthenocarpic cucumber cultivars increase the potential to yield a high fruit load in controlled environments resulting in a high harvest index. Plants exhibiting a high harvest index will more efficiently use the limited growing area in a polyhouse condition.The cucumber demand is increasing round the year which could not be met through open field cultivation. However, there is great potential of cucumber and possibility of growing three crops per year which in turn, can in increase the production and productivity many folds to meet the domestic demand and export. The production technology for open field is available region wise but, the information on production technologies under protected conditions in Indian context is very limited and only few reports are available in piece meal with regard to production technology of cucumber under protected cultivation. There is lack of complete package of water, major nutrient and growing methods for protected structures. Hybrid varieties of cucumber are predominantly used in the production system of many developed and developing countries. The proportion of hybrid varieties is continuously increasing and thus, gynoecious hybrids for open field cultivation and parthenocarpic cucumbers for

polyhouse cultivation are important for commercial cultivation. Sex inheritance plays an important role in cucumber hybrid breeding. Several researchers have worked on sex expression of cucumbers and reported that it was genetically determined but could be modified by growth substance application and also environmental factors (Krishnamoorthy, 1975; Lower and Edwards,1986; Kalloo,1988).

Greenhouse production technology of cucumber emphasizes the need of proper plant density in order to boost up the production per unit area by utilizing the available space and nutrients applied. There is need to assess the optimum plant density for the protected cultivation under polyhouse in various region. An appropriate training system will not only facilitate better management and uniform light to the plants but also permit closer planting, early ripening of fruits, higher yield of marketable size fruits and higher good quality yield. (Lal et.al.2014). Production technology like spacing, time of planting, water and nutrient management and plant protection to produce economic yield of good quality. For example, (Singh *et al.*2005) suggested that Hasan and Sarin cultivar of cucumber are ideal for winter, summer and rainy season, while Muhasan, Isatis, Dinar, Nun 9729, Nun 3019, Kian,PPC-3,PPC-2 and Hilton are successfully grown in winter season. They also recommended that 60 cm row to row and 40 cm plant to plant spacing is optimum for cultivation of cucumber under polyhouse condition.

Fertilizer application is an essential component of protected cultivation where fertilizers combined with irrigation is one of the most effective and convenient means of supplying nutrients and water to the plants according to specific requirement of the crop, whenever required .It reduces the cost of production and also lessens the ground water pollution which causes ecological disturbances and health risks by fertilizer leaching and accumulation of nitrates. As such, use of fertigation could really prove as blessing for Indian farming and may pave the way for another green revolution and provide coveted support to boost horticulture and agricultural exports.

Hence, the present investigation entitle "**Study on plant geometry, cultivar and fertilizer doses on growth, yield and quality of Cucumber (*Cucumis sativus*) under protected condition"** was undertaken in the Department of Horticulture Sam Higginbottom University of Agriculture, Technology & Science, Prayagraj (Allahabad) U.P during the year 2017-2019 with the following objectives-

- To identify the suitable variety **of** parthenocarpic **cucumber under protected condition**
- **To find out the most suitable dose of fertilizers on growth, yield and quality of cucumber under protected condition**
- **To standardize spacing of plant growth, yield and quality of cucumber under protected condition**
- **To study the economics of treatments related to the production technology of cucumber under protected condition**

Chapter-2

REVIEW OF LITERATURE

In this chapter, all the available and relevant review of literature pertaining to the **"*Study on plant geometry, cultivar and fertilizer doses on growth, yield and quality of Cucumber (Cucumis sativus L.) under protected condition*"** has been reviewed and presented under the following objects.

- Effect of protected cultivation on growth, yield and quality of cucubmer
- Effect of cultivar on growth, yield and quality **of cucumber**
- Effect of plant geometry on growth, yield and quality **of cucumber**
- Effect of fertilizer doses on growth, yield and quality **of cucumber**
- Economic of different treatments based on growth, yield and quality of cucumber

2.1 Effect of protected cultivation on growth, yield and quality

El-Aidy *et al.* (1983) reported that shade has a beneficial effect over no shade of hot and humid climate, which enhances flower number per plant, fruit set and yield with suggestion that 40% shade was optimum with an increase to 50% or 60% shade generally decrease plant growth and total yield.

Hawa *et al.* (1992) revealed that crop production under naturally ventilated polyhouse in tropics is necessary to replace unproductive open field crop production. The structure protects the crop against damages by environmental stress, high rainfall, strong wind, extreme solar radiation, weed growth, insects and diseases. In addition, the structure creates an in-house micro-climate conducive according to crop physiological and agronomics requirements. The important parameters under the structure that give crop better growth, high yield and quality are temperature, light intensity, humidity, oxygen level, carbon dioxide concentration, ventilation rate, crop water requirement and fertilizer.

Russo (1993) reported that shading increased the shoot dry weight and exhibited interaction effect with planting date and cultivar.

El-Gizawy *et al.* (1993) reported the number of days taken from sowing to flowering increased as the shading intensity increased, whereas the number of flowers per

plant decreased under all shading rates compared to full sunlight. The shading significantly increased the number of fruits per plant and total yield and the highest yield was obtained under 32 per cent shading.

Sharma and Tiwari (1993) ascribed that plant height, soil temperature, light intensity, fruit set, days to harvest, number and weight of fruits per plant and weight and diameter of fruit were significantly influenced by shading.

El-Gizawy *et al*. (1993) reported that shade significantly increased the number of fruits/plant and total plant yield and also improved the physical characteristics of fruits *viz*., the test weight, length, diameter and volume of fruits obtained from plants grown under 35 per cent shading. The titrable acidity of fruit was increased and soluble solids where as ascorbic acid content of the fruit were decreased with increasing shade.

Borowski (1994) found that in tomato plants, markedly decreased biomass and fruit production irrespective of the form of nitrogen applied. Franscescangeli *et al*. (1994) reported that all shading treatments tried reduced air, leaf and soil temperatures compared to control (unshaded greenhouse) but they also reduced light transmission from 81 per cent in control to 27, 31 and 47 per cent in the treatments. The light transmission and yield were highly correlated and the yield was reduced by all treatments tried.

El-Abd *et al*. (1994) stated that shading reduced the maximum and average air and soil temperatures and light intensity, but increased the relative humidity. Percentage of survival, plant height and leaf area were increased with increase in shade intensity, but leaf number and transpiration rate were reasonably decreased.

Nasiruddin *et al*. (1995) reported that plant height was increased with increasing period of shading and the varietal differences were also significant.

Nasiruddin *et al*. (1995) reported that shading delayed flowering in all the treatments but insignificantly only in partial shading in comparison with full exposure to sunlight in tomato varieties Roma and Marglobe.

Yanagi *et al*. (1995) recorded that the tomato plants exposed to 0, 50 and 70 per cent shading during summer exhibited decreased mean fruit weight throughout the fruit set order with increased shading

Nasiruddin *et al*. (1995) stated that fruit yield decreased significantly with the extension of shading period and TSS gradually declined with increased period of shading while, ascorbic acid decreased considerably.

Rubeiz and Freiwat (1995) reported that the tomato plants grown with black polyethylene mulch recorded higher early and total yields than under floating row covers.

Yanagi *et al*. (1995) reported that in summer and autumn crops, the reducing sugars of fruits and ascorbic acid significantly decreased with increased shading, whereas citric acid increased.

Kook *et al.* (1998) revealed that 30 per cent of shading increased the yield and quality of marketable fruits compared to other treatments in tomato.

Kook *et al.* (1998) noted that in tomato, shading reduced the air and leaf temperature inside the polyhouse. In an experiment with four cultivars of sweet pepper grown at 100, 70 or 35 per cent of natural light intensity, net photosynthetic rate was highest and respiratory rate was the lowest under 70 per cent light intensity.

Aldazabal Romero *et al.* (1999) found that the shade treatments delayed flowering when compared to plants grown in full sunlight in tomato.

Hamamota *et al*. (1999) investigated growth, photosynthesis and distribution pattern of ^{14}C assimilates in tomato plants grown under shaded condition and reported that number of leaves and flower trusses was reduced by about 30-40 per cent of water. The effects of three levels of irradiance (25, 60 and 100 per cent of full sunlight) in tomato and showed that shading increased stomatal conductance, plant height and internal CO_2 concentration. Plants at the flowering stage irradiated with 60% of the total sunlight exhibited increased net photosynthetic rate, total dry matter production and yield.

Zhao *et al.* (2002) noticed that shading at early and peak flowering stages reduced midday photosynthetic rate in tomato.

Cheema *et al. (*2004*)* studied the production of off-season tomato crop under net house conditions at Punjab Agricultural University, Ludhiana (India). The results revealed that the extended the fruit availability of tomato from last week of January to first week of June through net house cultivation. These studies have offered the

possibility of off-season tomato production and enhancing the fruit availability period by using non-chemical methods of pest management.

Singh *et al.* (2005) reported that nylon mesh screen reduced incidence of leaf curl virus and improved the yield in sweet pepper.

Kavitha *et al.* (2005) stated that in tomato the physiological parameters *viz*., total chlorophyll content and light reflection coefficient was increased with increase in the level of fertigation under 35 per cent shade net condition when compared to open condition.

Singh and Sirohi (2006) reported that insect proof net houses can be used for virus-free cultivation of chilli, tomato, sweet pepper and other vegetables mainly during the kharif season. These low input protective structures are also suitable for production of pesticide residue free green vegetables. Low cost greenhouses can be used for high value quality vegetable cultivation for long duration mainly in peri urban areas to fetch commensurate price of produces.

Singh *et al.* (2006) reported that protected structures covered with insect proof net provide a big opportunity of virus free vegetable cultivation even on attributes commercial scale, in such parts of the country where biotic stresses during rainy and post rainy season hinders the cultivation of vegetables.

Singh and Tomar (2007) reported that virus free vegetable production can be done using insect proof net house in northern India, when pre-monsoon showers enhances the infection of virus leading to damage of crops.

Singh *et al.* (2009) reported the production of high quality seed of the parental lines of pumpkin Pusa hybrid-1 under insect proof net house condition and compared with open field condition and observed significant difference for fruit development attributes, seed yield and quality attributes in female and male parental lines under insect proof net house conditions.

Nerson (2009) studied effects of growing season and cultivar on seed production and quality of polyhouse grown melons. Six open-pollinated melon varieties of different market types were raised in a partially controlled polyhouse during the four seasons over the year, to observe their seed production and qualities. A strong positive correlation was

observed between seed yield per plant and fruit yield, both of which were highest in khariff and lowest in summer and winter.

Medany *et al*. (2009) studied the effect of black and white insect-proof nets as a cover in greenhouse, replacing the polyethylene sheet in order to minimize the cost of glazing material in sweet pepper. The obtained results indicate that greenhouse with black net gave significantly the highest early yield, while greenhouse with white net gave significantly the highest leaves per plant, leaf area index and plant height and total yield compared to the other polyhouses.

Pervej *et al.* (2010) studied phenology behavior in tomato under polyhouse condition and concluded that fruit maturity in polyhouse plants was advanced by 5 days compared to the crop raised in open field condition. Polyhoused plants had higher flowers/plant, flowers/cluster, number of flower clusters/plant, fruit clusters/plant, fruits/plant, fruit length, fruit diameter, fruit weight, fruit weight/plant and total plant yield over open field condition.

Flemine (2010) evaluated the hybrid seed production of pumpkin under insect proof net house to open field condition and reported that for attaining better growth, good flowering, fruit set, fruit development, higher seed yield, high seed quality attributes and more net returns per unit area, the hybrid seed production should be undertaken under insect-proof net house conditions.

Singh *et al* (2011) evaluated hybrid seed production of bitter gourd under open field condition and insect proof net house showed that viable hybrid seed production can be organized in insect proof net house to achieve better economic returns through higher seed yield & better crop management.

Bihari *et al* (2012) has compared the production of high quality hybrid seed of summer squash under insect proof net house condition to open field condition and reported the significant difference for fruit development attributes, seed yield attributes and seed quality attributes under insect proof net house conditions.

Singh et. al (2017) Overall, the yield and quality of vegetable production in different growing media under protective structures have shown a huge improvement which is not possible under open field conditions. Moreover, protective structures offer off-season cultivation of vegetables when offered with measures for controlling the

microclimate. In the present study an attempt has been made to review the dynamic factors affecting performance of greenhouse cucumber cultivation.

Rolaniya et.al (2018) The results indicated significant variation in all the vegetative growth attributes and yield parameters in different drip irrigation and mulches. The maximum number of branches per vine, length of vine, number of leaves per vine and leaf area were recorded with 1.0 ETc as compared to other drip irrigation treatments at 60, 90 DAT and harvest.

2.2 Effect of fertilizers doses on growth, yield and quality

Parikh and Chandra (1969) reported that cucumber cv. Long Green produced maximum and minimum number of female and male flowers respectively, when nitrogen was applied at 80 kg ha^{-1}. However higher nitrogen rate (120 kg ha^{-1}) delayed the appearance of first female flowers.

Pandey and Singh (1973) reported that cv. Pusa Summer Prolific Long of bottle gourd resulted in higher fruit yields and fruit numbers with N at 100 kg ha^{-1}.

Srinivas and Doijode (1984) reported that in musk melon, application of 155 kg of N and 55 kg each of P and K per hectare produced maximum number of female flowers. Significant increase in the number of female flowers with application of 50: 60: 60 kg NPK ha^{-1}.

Papadopoulos (1986) revealed that the highest yield in polyhouse grown cucumber was obtained with 11.8 mmol N L^{-1} (31.5 g N $plant^{-1}$) due to increased number of fruit. 11.8 mmol N L^{-1}applied with each irrigation via the irrigation stream is adequate to cover the needs of polyhouse grown cucumber for high yield (9.42 kg $plant^{-1}$) over a harvesting period of 93 days.

Singh and Chhonkar (1986) reported that under Varanasi condition, an increased length of main creeper resulted with application of 100 kg N, 60 kg P_20_5 and 60 kg K_2O per hectare in musk melon.

Das *et al.* (1987) reported that in pointed gourd, application of 90 kg N and 60 kg P per ha significantly increased the number of fruits per vine, fruit length, diameter of fruit, weight of fruit and total yield (142 q ha^{-1}) over the control (59.3 q ha^{-1}). Application

of phosphorus and potassium each at 80 kg ha^{-1} tended to increased number of fruits per vine, fruit length and yield.

Rubeiz and Maluf (1989) studied the effect of intensively cropping polyhouses in semiarid region of Lebanese coast of the Mediterranean Sea on soil salinity and nitrogen fertilizer requirements of cucumber. Results were: NO_3-N = 225 ppm, NH_4-N = 56 ppm, pH = 7.0 and salinity (ECe) = 2.5 dS m^{-1}. Total fruit yield for the first 8 weeks of harvest was 71.4, 63.4 and 60.2 ton per ha for the plots receiving 0, 81 and 162 kg N ha^{-1}, respectively. Soil salinity has sufficient to cause reduction in yield for many polyhouse crops. In contrast soil mineral N has sufficient to meet the N requirement for an entire season for many annual crops.

Janse (1990) reported that shading reduced the percentage of unevenly coloured fruits from 13 to 6 and increased the shelf life from 4 to 6 days in tomato. The percentage of fruits with green or yellow shoulders and star shaped cracks was highly reduced as the degree of shading increased.

Gizawy *et al*. (1993) opined that shading significantly increased the number of fruits/plant and total yield and also improved the physical characteristics of fruits *viz*., the test weight, length, diameter and volume of fruits obtained from plants grown under 35 per cent shading. The titrable acidity of fruit was increased and soluble solids and ascorbic acid content of the fruit were decreased with increasing shade.

Rubeiz (1990) studied the response of greenhouse cucumber to mineral fertilizers on a high potassium and phosphorus soil. Result revealed that fruit yield over the two months of harvest was highest in plants receiving N alone, which yielded 57 t ha^{-1}. Yields of the plots receiving N+K, N+P+K and the control were 55.0, 54.0 and 39.5 t ha^{-1}, respectively.

Benzioni et al. (1991) reported that *Cucumis metuliferous* sown in mid-March set fruit in mid-May and gave a higher yield of export-quality fruits than plants sown in mid-April, which set fruit normally but produced a large proportion of small (<200 g) fruits.

The field trial conducted during late summer to study the effect of shading (0, 35, 50 or 63 per cent) in tomato revealed that shading increased the plant height and leaf area but reduced the leaf number and dry weight reported that shading increased the shoot dry weight and exhibited interaction effect with planting date and cultivar.

Papadopoulos (1993) suggested that fertilizers should properly used with the trickle irrigation system could help to increase crop yield and improve quality on a degradation-free and sustainable basis. Increase in water and fertilizer use efficiencies, with the fertigation technology, are particularly stressed.

Trimble and Knowles (1995) reported that leaf and main stem development, number of fruit per plant, and harvest index were enhanced by increasing P levels (90 to 720 mg P plant $^{-1}$week^{-1}) in green house cucumber.

Patil *et al.* (1996) reported that application of 150 kg N, 50 kg each of P and K ha^{-1} produced maximum vine length (563.7 cm, 463.1 cm and 464.0 cm respectively) and application of 150 kg N, 50 kg P and 100 kg K ha^{-1} produced maximum number of female flowers per vine (24.4, 21.5 and, 22.7 respectively) in bottle gourd.

Goswamy and Sharma (1997) reported that application of P at 60 kg ha^{-1} and K at 75 kg ha^{-1} significantly influenced on number of fruits per vine, fruit length, fruit diameter, fruit weight and yield in spine gourd.

Premalakshmi *et al.* (1997) reported that application of 150 kg N and 100 kg P per hectare recorded significantly highest vine length, number of branches per vine and number of leaves per vine in gherkin. Application of nitrogen at 125 kg ha^{-1} gave highest vine length, number of branches per vine and male flowers per vinein cucumber.

Kook *et al.* (1998) noted that in tomato, shading reduced the air and leaf temperature inside the polyhouse. In an experiment with four cultivars of sweet pepper grown at 100, 70 or 35 per cent of natural light intensity, net photosynthetic rate was highest and respiratory rate was the lowest under 70 per cent light intensity.

Patil *et al.* (l998) reported that application of 150:50:50 kg of N:P:K per hectare produced significantly highest vine length, number of branches per vine and earlier male flower (35.25 days) in cucumber cv. Himangi.

Romero *et al.* (1999) found that the shade treatments delayed flowering when compared to plants grown in full sunlight in tomato. Zhao *et al.* (2002) noticed that shading at early and peak flowering stages reduced midday photosynthetic rate in tomato.

Altunlu and Gul (1999) investigated on effects of different amounts of nitrogen and potassium nutrients on cucumber post harvest qualities. Fruits of cucumber cv. Alara grown in perlite media under 9 different nutrient doses containing N and K at combinations of 100, 200 or 300 ppm were used. Cucumbers harvested were packed into 2 kg perforated polyethylene bags and stored at 13±1°C and 85–90 per cent relative humidity. During storage, changes in fruit colour and weight loss of fruits were determined at three day intervals. It was concluded that a maximum of 200 ppm N and 200–300 ppm of K combined application to the nutrient solution may be responsible for increased shelf life of cucumber.

Kano (2000) revealed that percentage of bitter fruit was higher in cucumber in the bitter line than in the non-bitter line. Vegetative growth was more vigorous in the bitter than in the non bitter type. The total leaf nitrogen and amino acid levels were higher in the bitter line than in the non-bitter line, but the nitrate ion level was lower in the former in the latter. High total-N and amino acid-N levels in the leaf induce bitterness in leaves and fruits by enhancing nitrogen metabolism, which in turn favors the enzymatic synthesis of cucurbitacin C, the bitter factor.

Ayodele *et al* (2002) studied about influence of nitrogen fertilization on yield of *Amaranthus* species.Results showed that number of leaves produced, plant height, fresh and dry weights of plant parts increased with increased rate of nitrogen fertilizer. Application of 200 kg N ha^{-1} increased leaf production by 75 per cent and 60 per cent in *A. hybridus* and *A. hypochondriacus* respectively as compared to the control. While 114 per cent and 120 per cent increases in yield of edible portion at the vegetative stage were observed in *A.hypochondriacus* and *A.hybridus* treated with 200 kg ha^{-1}respectively. The unfertilized plants also had yellowish green coloration compared to the brighter green color observed in fertilized plants.

Babik and Elkner (2002) reported that higher rates of nitrogen of 400 and 600 kg N/ha increased the plant weight and the total yield of broccoli, as well as hastened the head formation and harvest time. Under the influence of irrigation and higher nitrogen nutrition broccoli heads had more attractive green colour.

Choudhary and More (2002) studied fertigation effect on tropical gynoecious cucumber hybrid - Phule Prachi. Result revealed that maximum number of fruits $vine^{-1}$(14.1), fruit weight (180 g), yield $plant^{-1}$ (2.538 kg) and yield ha^{-1} (49.039 t) were

recorded when 150: 90: 90 kg NPK ha^{-1} was applied through fertigation. Significantly highest yield of 49.039 t ha^{-1} was recorded in this treatment that yield level was 81.2 per cent higher than the control. The application of fertilizers through drip irrigation was found more efficient to sole solid fertilizer application, under drip and furrow irrigation method. Among the three straight fertilizers (100:75:75, 150:100:100, 200:125:125 kg NPK ha^{-1}) maximum vine length(205 cm), fruit diameter (3.9 cm), fruit weight (237.3 g), number of fruits $vine^{-1}$(13.4), yield $vine^{-1}$ (3.19 kg)and yield ha^{-1}(33.06 t), and maximum nutrient content in the crop and minimum nutrient residues in the soil after crop harvest were recorded when 200:125:125 kg NPK ha^{-1} was applied.

Guler and Ibrikci (2002) reported that drip fertigated cucumber plants gave a higher yield (78 t ha^{-1}) when compared to furrow irrigated plants (72 ton ha^{-1}). However, early yield (7.8 t ha^{-1}) was higher with furrow irrigation. Irrespective of the irrigation, 200 ppm nitrogen produced the highest yield (89.3 t/ ha). Although there was a significant difference between irrigation treatments for total number of fruits per plant, there was no significant effect on mean fruit weight. Nitrogen level had significant effects on both total number of fruits and mean fruit weight, both increased with increasing level of nitrogen. While diameter of stem was affected neither by irrigation nor by nitrogen treatment, root length was affected by irrigation treatment.

Xiaolei and Zhifeng (2004) reported that greenhouse cucumber, when the number of leaves kept was less than 13 per plant the leaf area index (LAI) was less than 3. In this case, although the average photosynthetic rate of a single leaf was high, the assimilation rate of the whole plant was low, which led to fruit aborting and lower yield. However, when the number of leaves kept more than 16, LAI was more than 3.5 which also resulted in low assimilation rate for the whole plant and lower yield. It was concluded that vines with 13-16 leaves each with LAI between 3-3.5, which capture more solar radiation and maintain an optimal assimilation rate for the whole plant, and have a higher yield.

Kavitha et.al. (2005) reported that the yield components like number of fruits per plant, fruit weight and polar diameter were the highest at 100 per cent water soluble fertilizer under shade. The highest yield per plot (189.6, 208.4 and 203.7 kg) and per hectare (99.8, 109.5 and 106.7 tonnes) during seasons I, II and III respectively were observed in the treatment with water soluble fertilizers under shaded condition.

Al-Jaloud *et al.* (2006) conducted an experiment on the effect of different levels of nitrogen, phosphorus and potassium on greenhouse cucumber yield. Result revealed that in the N experiment, the highest yield (49.5 t ha^{-1}) was obtained at 150 ppm N with 70 ppm P_2O_5 and 200 ppm K_2O (compared to 125, 175, 200 ppm N). In the P experiment, 60 ppm P_2O_5 with 200 ppm N and 200 ppm K_2O gave the best yield (42.0 t ha^{-1}) compared to 40, 50 and 70 ppm P. 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 (compared to 140, 160, 180 ppm K). Potassium levels increased yield linearly indicating higher K levels may still increase the total yield, whereas N and P showed a typical nutrients response curve and interaction.

Al-Wabel *et al.* (2006) reported that the highest yield was 33.74 t ha^{-1} from N_3 (180 mg L^{-1}) and the lowest 7.73 t ha^{-1} from the control treatment. Application of nutrients through fertigation found more effective than the conventional method (soil application) for improving the greenhouse cucumber production.

De Pascale *et al*. (2006) opined that increasing nitrogen fertilization from 0 to 200 kg N ha^{-1} resulted in improved yield and fruit quality in tomato.

Guler *et al.* (2006) investigated about the effect of the nitrogen concentrations (0-100-150-200-250 mg N L^{-1}) and their application frequencies (one and twice per week) on yield of drip fertigated cucumber under glass house condition. Result shown that the highest yield (75.2 t /ha) was obtained with the nitrogen application of 200 mg N L^{-1} twice per week. Irrespective of application frequency, the highest total yield (71.2 t ha^{-1}) was obtained with 200 mg N L^{-1} nitrogen concentration. Nitrogen application twice a week resulted in higher early yield as compared to once a week application. The highest fruit number (59.4 fruit m^{-2}) was obtained with 200 mg N L^{-1} nitrogen concentration.

Suojala *et al*. (2006) reported that fertilization with nitrogen of 120-140 kg ha^{-1} is usually sufficient to produce high yield in pickling cucumber. In years with optimal growing conditions, a higher dose of nitrogen may increase yield by 5-10 per cent. Nitrogen and potassium are recommended for fertigation, while other nutrients can be applied in pre-planting application. The average nutrient uptake in yield of 71-75 t ha^{-1} was 88-106:21-25:157-163 kg ha^{-1} of N: P: K in 2001-2003, respectively.

Beyaert *et al.* (2007) revealed that drip irrigation coupled with fertigation showing significant advantages in terms of total plant yield and economic returns as compared to overhead irrigation and conventional fertilizer application.

Souad El-Gengaihi (2007) revealed that higher fruit number with higher fresh and dry weight could be obtained by adding nitrogen at 200 kg /acre with potassium at a rate of 100 kg/acre. Polypeptide in immature fruits increased by nitrogen till 200 kg /acre and the combination of medium dose of nitrogen and any rate of potassium produced the highest polypeptide concentration.

Jilani *et al.* (2009) conducted an experiment to assess the effect of different doses of NPK on the growth and yield of cucumber hybrid. Application of NPK fertilizer (100-50-50 kg ha^{-1}) showed the best performance in almost all the levels studied, as it took least days to flowering (39.33), fruit setting (11.55), maturity (7.88), maximum fruit per plant (35.5), maximum fruit weight (136.03 g), maximum fruit length (18.36 cm) and yield per hectare (60.02 tons). Application of 120-60-60 kg ha^{-1} of NPK fertilizers also showed some beneficial effect on some parameters including vine length (3.85 m) and fruit weight (150.69 g). Controlled plots showed un-satisfactory results regarding all the parameters.

Sharma *et al*. (2009) reported that cucumber grown in the media comprising of soil: vermicompost: sand (2:1:1) with fertigation of 300 Kg NPK ha^{-1} resulted an increase in the yield 8.33 kg $plant^{-1}$ and 16.66 kg m^{-2} with enhanced quality fruits compared to fertigation levels of 100 kg and 200 kg NPK ha^{-1}.

Muhammad *et al.* (2009) conducted an experiment to assess the effect of different doses of NPK on the growth and yield of cucumber. appliance of NPK fertilizer (100-50-50) showed the best performance in most of the parameters studied, as it took least days to flowering (39.33), fruit setting (11.55), maturity (7.88), maximum fruits per plant (35.5), maximum fruit length (18.36 cm), maximum fruit weight (136.03 g) and yield per hectare (60.02) tons. Application of NPK fertilizers @ 120:60:60 kg ha–1 also showed some beneficial effect on some parameters including fruit weight (150.69 g) and vine length (3.85 m).

Janapriya *et al.* (2010) observed that in cucumber cv Green Long. The treatment of peat: vermin compost, sand + 100 per cent fertigation (T_2F_1) was found to have a positive influence on flowering, plant height, and yield per hectare in greenhouse as well

as open field cultivation as compared to other soilless media. The highest yield (113.89 t ha^{-1}) was registered in T_2F_1 (peat:vermicompost: sand + 100% fertigation) under naturally ventilated polyhouse and the highest yield of 96.11 t ha^{-1} was registered in T_2F_1 in open field cultivation. A yield increase of 18.45 per cent was observed with the cucumber grown in polyhouse under the treatment of T_2F_1. The benefit-cost ratio (3.43) was found to be highest for peat: vermin compost: sand with 100 per cent drip fertigation under polyhouse.

Shinde *et al*. (2010) reported that the length, width and density of cucumber fruits increased with increased fertilizer levels and number of splits, while fruit weight did not show any observable difference. Number of fruits per plant (10.40), yield of fruits (2.166 kg $plant^{-1}$) and (255.03 q ha^{-1}) were recorded as significantly higher with 100 per cent RDN through drip irrigation with 8 splits. Drip irrigation showed reduced water requirement values with an increased water use efficiency (10.13 q ha cm^{-1}). The treatment, 100 per cent RDN through fertigation with 8 numbers of splits recorded the maximum net returns (₹ 71465.6 ha^{-1}) with cost benefit ratio of 3.34.

Zhang *et al*. (2011) reported that the quality of cucumber fruit decreased with the increased application of irrigation water and nitrogen fertilization. The optimum irrigation level and nitrogen fertilizer application level for cucumber under sub-surface drip irrigation in the solar greenhouse in Southwest China were 0.8 *Ep* and 450 and 600 kg ha^{-1} respectively.

Mostafa et al. (2012) studied effect of 3 nitrogen levels consisting of N1 =75, N2= 150 and N3 =225 kg N/ha and three time application T1= ½ at 3 and 4 leaves and 1/2 before flowering, T2= 1/2 at 3 and 4 leaves and 1/2 at fruiting, and T3 = 1/3 at 3 and 4 leaves, 1/3 before flowering, and 1/3 after fruit to start were used as sub plot. Results reported that both rate and time of nitrogen application had a significant effect on fruit yield. The highest fruit yield was recorded at the rate of N3T3 treatment. Study also reviled that increasing nitrogen levels from 75 to 225 kg N/ha, the values of NPK in fruit increased.

Imran (2014) reported that Among four different levels of NPK (500,750, 1000 and 1250 gm / fertigation) application of NPK at 1000 gm / fertigation is the most suitable dose, which took least days to flowering 31.4, fruit setting 9.2, maturity 6.3, maximum fruit per plant 34.4, maximum fruit weight 134.6, maximum fruit length 18.1

cm grams and yield per hectare 58.8 tons. However, application of NPK fertilizers treatments at 1250 gm/fertigation also shown some positive effect on some parameters like fruit weight 149.1 g and vine length 3.8 m.

2.3 Effect of Cultivar on growth, yield and quality

Shalaby and Hussein (1994) observed that the Fl and F2 plants of cucumber cv. Katia- 2744 did not significantly differ in respect of total marketable yield under unheated plastic houses at Egypt, however, the F 1 plants significantly surpassed the F2 in the early yield. In respect of fruit quality (weight, length, shape index and colour), both FJ and F2 plants did not significantly differ.

AI-Harbi *et al.* (1996) reported that in the controlled greenhouse all four cucumber cultivars had almost similar vegetative growth characters, but cv. Sahara proved to be superior to the other cultivars in total yield expressed as fruit number and weight per plant. No significant differences were observed in total yield among the other cultivars.

Hochmuth and Leon (1996) evaluated twelve seedless cucumber cultivars in two seasons in a double layer polyethylene covered greenhouse. Total marketable yield in the fall trial ranged from 11.5 lb per plant for 'Aramon' to 15.2 lb per plant for 'Kalunga', whereas total arketable yield in the spring trial ranged from 16.1 lb per plant for 'Discover' to 19.7 lb per plant for 'Marianna'. No significant differences were detected for early yield (first three harvests) in either trial.

Dehua *et al.* (1997) reported that 'Jinyou-l' (F1 hybrid) is an early maturing cucumber for protected cultivation which gave yield of around 90 t/ha.

Muhammad *et al.* (1998) studied the relative performance of eleven parthenocarpic cucumber hybrids (Dala, Belcanto, ellando, Safa, Mubis, Taha,Luna, Pigal, Maram, Dina and Nibal) under ordinary plastic tunnels during the spring and autumn seasons. For spring cultivation Taha, Luna and Dala were found to be best, yielding 5.58, 4.48 and 4.17 kg /m^2, respectively. The cultivars found promising during the autumn season were Dala, Mubis and Luna which yielded 2.48, 2.30 and 2.24 kg /m^2, respectively.

Zhao *et al.* (1998) stated that Luhuanggua-ll is the most suitable cultivar of cucumber for protected cultivation.

Broeck *et al.* (1999) Evaluated eleven cucumber cultivars in a greenhouse condition. Highest crop yield was obtained for BS 19-59 (17.637 kg /m^2, 45.21 fruits /m^2), while BSK 19-63 obtained the longest fruits on stem (33.8 cm) and LD 97-71-04 obtained the longest fruits on branches (36.6 cm).

Sari *et al.* (1999) studied the effects of sowing dates on the yield and harvesting periods of pickling cucumber cultivars. The highest yields were obtained from sowing in the first week of April among the cultivars, Milglas, Niz 50-114, Fancipak and Ophix were the most productive while Marinda and Pict were the least. Significant effects of sowing time on fruit size were not observed, but cultivars 'Donja', 'Marinda', 'Ophix' and 'Fancipak' produced larger fruits than the others.

Wang *et al.* (1999) stated that a cucumber cultivar 'Jinyou No.2' is an early maturing, high yielding and highly resistant to downy mildew, powdery mildew and Fusarium wilt under solar greenhouse cultivation during winter and spring season. It takes about 70 days from sowing to first harvest with a total yield of 82.5 t/ ha. the average fruit weight of 200 g.

Jiang- yan *et al.* (2000) conducted an experiment by sowing cucumber seeds on 4 dates between 17 September and 6 October in a solar greenhouse in China. The number of female flowers in nodes 1 to 12 increased as sowing date was delayed, but sowing date had no effect on the number of female flowers in nodes 13 to 20. The effect of different sowing dates on yield of cucumber. Borah (2001) obtained maximum pooled yield 291 q/ha. from the 20 April sown crop which differed significantly from the rest of the sowing dates except the 20 May sowing Similarly, the effect of sowing time on growth, yield and quality of cucumber cv. AAUC2 and reported that the first sowing date (21 March) gave the best results in almost all parameters, except for the size of fruit as compared to 5th April and 20th April sowing. Howeverl for early crop point of view

Shaw *et al.* (2000) evaluated six Beta Alpha cucumber cultivars and three Dutch - type cultivars over three seasons in a double layer polyethylene – covered greenhouse with passive ventilation. All six Beta Alpha cultivars produced more early and total marketable yield in all seasons than the Dutch cultivars. Total marketable fruit numbers among all Beta Alpha cultivars were greater in the spring than in the fall. The Beta Alpha cultivar 'Alexander' produced high yield in all three seasons.

Pirog (2001) observed that greenhouse cucumber cultivars Rubin F1 and Marinda F1 differed with respect to yield. Significantly higher total (21.93 kg / m^2), marketable (21.39

kg / m^2) and first class (20.88 kg / m^2) yields were produced by Rubin FI than by Marinda F1 (20.44, 20.02 and 19.46 kg / m^2, respectively). The higher rate of the first class yield growth, had cv. Rubin F1. Mean mass of a Rubin F1 cucumber was by about 20% higher than that of cv. Marinda F1.

Cardoso (2002) evaluated four varieties (Branco coloniao, Caipira Hortec, Premio and Rubi) and three hybrids (Caipira AG -221, Guarani AG-370 and Safira) of cucumber under protected cultivation at Saomanuel experimental farm during summer and *winter* seasons. 'Safira' F_1 hybrid gave the highest yield during the summer (41.3 fruits /plant while 'Premio' FI hybrid had the lowest commercial yield (6.7 fruits/ plant) during winter. It was concluded that 'Safira' F_l hybrid was the best cultivar for the summer, while in the winter all cultivars presented lower yield.

Gao - Li Hong *et al.* (2002) Reported that European Asian hybrids showed advantages in the vegetative and reproductive growth, resulting in strorig growth, great vigour of root system and high yield. The European cultivars were superior to the Asian cultivars in their tolerance of low light intensity.

Cardoso and Silva (2003) Evaluated twelve cucumber hybrids in summer and 14 in autumn winter for their performance under protected cultivation at Brazil. The highest yielding hybrids in summer were 'Tsuyataro' (25.4 fruits / plant) and Rensei (25.3 fruits /plant. The highest yielding in autumn winter were 'Nikkey' (26.8 fruits / plant and 'Top Green' (23.4 fruits / plant. Higher yields were obtained in autum winter sowing than in summer.

Singh *et al.* (2002) obtained highest yield from cucumber and watermelon sown on 30 November compared to sowing on 10 and 20 December.

Hochmuth *et al.* (2004) conducted a greenhouse experiment during the winter season to evaluate the yield and fruit quality at harvest and during storage of 12 cucumber cultivars and observed that cv. 4419, Alamir, General, LDCB-845 and Manar were the highest yielding cultivars ranged from 1393 - 2637 g plant 'while, cv. Tenor recorded the lowest yield.

Yildirim and Guvenc (2004) studied to explore a suitable intercrop crop with cucumber *(Cucumis sativus*) for proper utilization of interspaces and resources under

greenhouse conditions. No significant differences were found among cropping systems in terms of fruit length, fruit diameter, fruit weight and fruits per plant in both years. However, inter cropping increased significantly the cucumber- equivalent yield compared to sale cropping. The results showed that inter cropped cucumber with Co lettuce, leaf lettuce or French bean had some yield advantage and a higher area – based productivity than when grown alone.

Siwek and Lipowiecka (2004) reported that the 'Marinda FI' cucumber resulted highest yield in plastic tunnels where soil was mulched with colored or black polyethylene film. The lowest yield was produced by crops shaded directly with perforated film. The gross margin of 2.42 PLN per m^2 was obtained; being three times greater than in the cultivation without covers. According to Korol (2005), the parthenocarpic cucumber hybrid variety 'kurazh' is suitable for both outdoor and protected cultivation not only as a spring summer crop but also as a winter - spring crop.

Singh *et al.* (2005) stated that Hasan and Sarig cultivars of cucumber are ideal for summer and rainy season, while, Muhasan, Isatis, Dinar, Nun 9729, Nun 3019 and Kian are successfully grown in winter season.

Biryukova and Maslovskaya (2006) reviewed two new parthenocarpic cucumber hybrids of which, the medium - early PI hybrid 'VHyaz' (medium–early F_1) had a yield of 14-15 kg m^2, is of medium height, has dark green leaves, and has oval to cylindrical cucumbers of 12-14 cm in length, whereas, 'Zhukovskii' (medium early F_1) had a yield of 15-17 kg m^2, has dark green leaves and produces short cucumbers of 10-12 cm in length.

Alsadon *et al.* (2006) reported significant differences among cultivars in fruit growth traits especially yield and its components. Highest values for fruit weight, early and total yield were recorded in 'Copra' followed by 'Alia' and 'Alasil', respectively.

Guncan *et al.* (2006) carried out an experiment to determine possibilities of cultivating organic cucumber under greenhouse conditions. They observed that spring growing season seems to be more appropriate for organic cucumber production in greenhouse conditions in Izmir. Total yield was determined as 16.46 kg m^2 in spring season as compared to 5.33 kg m^2 in autumn production period.

EI - Aidy *et al.*. (2007) carried out an experiment to study the influence of growing season on yields of two cucumber PI hybrids in protected cultivation. Two seasons were

tested, the first was the winter season and the second was the early summer season. Likewise, the dates of transplanting of cucumber under plastic houses were 10 October in the winter season and 2 February in the early summer season in both years. They concluded that the early summer season caused a highly significant increase in early and total fruit yield (as weight and number of fruits) when compared with the winter season in both the yeats.

Guo *et al.* (2008) conducted the two year greenhouse cucumber experiments to investigate seasonal effects on fruit yield with different fertilizer management. Seasonal effects were much greater than fertilizer effects, and winter - spring (WS) cucumber attained higher fruit yields and N uptake than autumn-winter (A W) cucumber due to lower cumulative air temperatures during fruit maturation in the A W season. The best quality cucumbers was obtained in the cultivation period – between April and August, due to the optimum climatic conditions for that species in greenhouse cultivation. Low intensity of irradiation during spring time was a significant cause of much lower yielding as compared to summer and autumn cultivations.

Diviya Sharma et.al (2018) The study of different levels of spacing and training on growth and yield of hybrid cucumber under polyhouse. The experiment was comprising of total 18 treatment combinations of two hybrids *viz.*, Kian and Isetis, three level of spacing *viz*., 60 x 30 cm (S1), 60 x 45 cm (S2) and 60 x 60 cm (S3) with three level of training *viz*., T1 (removal of one shoot), T2 (removal of two shoots) and T3 (removal of three shoots). Hybrid Isetis was significantly superior over Kian.

2.4 Effect of plant geometry and spacing on growth, yield and quality

Dimitrov and Kanazirska (1995) conducted trial on glasshouse cucumber with 3 cultivars planted at 1.2, 1.6 or *2.0/m^2* and observed that increasing density stimulated plant growth. There was a high positive correlation between density and stem and leaf development. Increasing plant density from 1.2 to *2.0/m^2* increased the early yield of cv. 'Sandra' by 26.5-40.8 percent and total yield by 16.7-17.4 percent; of cv. 'Sofia' by 29.9-32.1 percent and 7.8-15.6 percent, respectively; and of cv. 'Mustang' by 16.7-17.5 percent respectively. Planting density did not significantly affect the percentage of deformed fruits.

Etman (1995) conducted an experiment in unheated fibre glass greenhouse, over two growing seasons, to study the response of "Sahara" parthenocarpic cucumber to plant spacings of 25, 35 and 45cm, with one or two plants per hill. Yield per unit area (lm2) increased as the spacing among plants declined to 25cm and, also, with increasing number of

plants per hill to two plants per hill. The increase in yield was positively associated with fruit number. Increasing plant density decreased plant height, number of leaves per plant, yield and fruit number per plant. Significant correlation coefficients were found among the studied cucumber traits on unit area basis or per plant.

Lim (1997) conducted an experiment with cucumber cultivar 'Palmera' to study the effect growth and spacing (40, 60 or 80cm; giving plant densities of 4.6,3.1 and 2.3 plants m^2 respectively) on marketable yield ranged from 6.7 kg m^2 (2.3 plants m^2) to 8.8 kg m^2 (4.6 plants m^2).

Rimkevicius *et al.* (1999) studied the impact of planting distance on growth, yield, productivity, fruit size, contents of chlorophyll and dry matter in leaves of cucumber. They found that densely planted hybrid "Marinda" (every 25cm in a row) were more productive than plants established at wider distances. The yield was 15.9 percent higher. According to Akinci *et at.* (2000) highest yield (2108 kg/ha) and economic income (approximately 235 million tone) were obtained at a plant density of 20,000 plants/ha. The highest fruit number (47.15 fruits per plant) was observed at a spacing of 3350 plants per ha. The effect of plant density was insignificant on fruit weight. Similarly, Kanthaswamy *et al.* (2000) recorded maximum yield (125.82 t ha^{-1}) of cucumber under polyhouse conditions with the spacing of 60x60 cm.

Xizhen et al. (2001) studied the effects of N fertilizer rate and plant spacing on yield in cucumbers grown in a greenhouse. Computer simulation determined that a yield 67.5 t/ha required N at a rate of 390.9-627.9 *kg/ha* and a planting density of 50925-50915 plants/ha.

Choudhari and More (2002) recommended that 1.80 x 0.45 m spacing is optimum to obtain maximum number of fruits per vine, yield per vine and yield per ha in two tropical gynoecious hybrids of cucumbers namely "Phule Prachi" and "Phule Champa". The crop was feeded with 200:125:125 kg NPK/ha.

Fernandes *et al.* (2002) evaluated the yield and fruit quality of cucumber cv.'Aodai' grown in nutrient solutions in a greenhouse. Seedlings (21 days old and 10 cm in length) were grown in 8.6 litre plastic pots using a spacing of 0.40 x 0.70m.There were no significant difference between treatments. The average yield was 3.46 kg $plan^{-1}$corresponding to a yield of 123 t ha^{-1} year when considering the adopted spacing.

Peil and Lopez (2002) stated that increasing plant density decreased the total above ground biomass, the number of fruits and fruit biomass production per plant in cucumber plants grown under greenhouse condition. Similarly, Gebologlu and Saglam (2002) studied the effects of different plant spacings within row and mulching materials on the yield and quality of pickling cucumber during summer and autumn seasons. They found that transparent PE mulching materials and 20 cm plant spacing within row combination resulted in the highest yield.

Resende and Flori (2004) studied the effect of 3 plant spacings (0.20, 0.30 and 0.50 meter) on yield and quality of 5 pickling cucumber cultivars ('Calypso', 'Eureka', 'Supremo', 'Vlaspik' and 'Vlasset'). The yield of 'Eureka'' 'Vlaspik' and 'Vlasset' decreased with increased interplant spacing within rows, while 'Supremo' and 'Calypso' showed minimum and maximum quadratic effect points.

Wang-Shu *et al.* (2005) conducted an experiment to test the effects of spacing on the growth of cucumbers in solar greenhouse. Four treatments were designed. The dripper spacing (dripper discharges) 30cm (2.7 litres h^{-1}), 50 cm (2.7 Htres h), 30 cm (1.4 litres h^{-1}) and 50 cm (1.4 litres h^{-1}) and the results showed that yield in the four treatments were 80.63, 85.66,94.31, and 90.91 t/h m^2 respectively.

Maniutiu *et al.* (2006) recorded that the greenhouse cucumber cultivation at 28,000 plants per hectare on peat substrate resulted in an increase of about 29.3 percent early yield and 23.4 percent total yield as compared to control (cultivation on wheat straw and manure at 16,000 plants per hectare).

Vikram et al. (2017) the experiment was comprising of total 12 treatment combination and four level of plant geometry viz. 45x20 cm, 45x30 cm, 45x45 cm, and 45x60 cm. spacing 45x60 cm was best in regard to vegetative and yield attribute traits. The maximum number of fruits per vine (40.19), fruit weight (119.69 g), yield per vine (4.74 kg) were recorded in spacing 45x60 cm.

Dillip Kumar Dingal1 et.al (2018) An experiment was conducted to study the influence of different protected conditions on growth and yield of parthenocarpic cucumber (*Cucumis sativus* L.) hybrids to standardize the suitable growing condition for protected cultivation of parthenocarpic cucumber (*Cucumis sativus* L.) The results indicated a significant difference in all the vegetative growth and yield parameters studied.

2.5 Effect of fruit quality on growth, yield and quality

Ruiz and Romero (1998) stated the effect of rates of N (KNO_3 at 2.5,5,10,20 or 40g/m^2) on yield and quality of greenhouse cucumber cultivar Bunex. Fruits from the 10 and *20g/m^2* treatments were the best for human consumption and economic profit. N at *40g/m^2* produced fewer fruits of low quality. Lower N rates (2.5 and *5g/m^2)* produced poor yields of poor quality fruits.

Siwek and Capecka (1999) reported that the vegetative growth was greatest in plants in the tunnel where the thermal conditions were best. Early and total marketable yields were highest under the PE tunnel for all cultivars of cucumber. Yields under the PP cover were lower but exceeded those in the open field several fold. Yields were highest from Othello which was slightly earlier than Marinda. Gracius was the latest to reach harvest maturity and could not achieve full fruiting potential until late July. There were non significant differences in fruit chemical composition between cultivars. Dry weights and sugar contents were lower under tunnels.

Parks *et al.* (2004) observed the yield and fruit quality of mini cucumber *(Cucumis sativus* cv. Tandora) using different substrates in a run to waste system in a greenhouse experiment. There was no significant effect of substrate on plant dry weight, cucumber number, cucumber weight or average weight per cucumber, or on the fruit quality measurements. However, there were differences in colour, deformation, crush strength and dry matter between harvests.

Fernandez *et al.* (2004) evaluated greenhouse cucumber variety Tropico F_1 grown on perlite substrate or in a hydroponic system during the winter and summer seasons. grown fruits had darker and greener skin colour than the perlite grown fruits. Fruits grown during winter had darker and dull green skin colour, and were of better quality than fruits grown in spring. Fruit weight and diameter gradually increased during winter, but decreased after the third harvest during spring. The length of NFT and perlite grown fruits significantly varied only during some particular harvest dates during winter. However, perlite grown fruits were larger during spring than during winter. Skin colour was found to be the best index of fruit quality in cucumber, although acidity and firmness can also be used to monitor quality

particularly during spring.

Gomez *et al.* (2006) reported that cucumber fruits grown in a glasshouse during the winter had a darker and dull green skin colour, and showed better quality than during the spring. In general, fruit quality at harvest in spring was lower than during the winter, due to flesh whitening.

2.6 Effect of economics of the treatments used on growth, yield and quality

Engyndenyz (2000) concluded the costs and returns of organic cucumber production in a size of 12 x 32 m greenhouse in Menderes Turkey and developed a production budget for growers. Total costs of organic, greenhouse cucumber production were determined to be 1334 dollars. According to study, net return per square meter was determined to be 0.98 dollars for organic greenhouse cucumbers and net return per kilogram was calculated to be 0.07 dollars. But production and market risks both affect profitability and economic viability of organically grown vegetables.

Singh et al. (2006) conducted an experiment at the Indo-Israel project of the Indian Agricultural Research Institute, New Delhi under which two types of naturally ventilated greenhouses were evaluated for their techno-economic feasibility for year round cucumber cultivation. The first crop of parthenocarpic cucumber (Var. Hasan) was planted in the first week of August, the second crop in the first week of October (Var. Muhasan) and the third crop in the second week of February (Var. Sarig) in both the greenhouses and their cost of production and cost benefit ratio was calculated. The cost-benefit ratio of cucumber cultivation under the Israeli greenhouse system was worked out 1:1.13, where as the cost benefit ratio for the Indian greenhouses was 1:2.06 under Delhi conditions of India. It is concluded that the low cost naturally ventilated greenhouses are more suitable and economical for year-round cucumber cultivation in the northern plains of India.

Meena et. al (2017) Observations were recorded for different characteristics related to vegetative, yield and yield attributing and moisture content. Treatment T7 [(RDF + humic acid 10 kg /ha. soil application + humic acid 0.1% foliar spray + micronutrient mixture foliar spray (0.5% Zn + 0.2% B + 0.5% Mn)] was best in regards vegetative traits *viz.* vine length (cm), number of branch per plant and leaf area (cm^2). Yield and yield attributing characteristics like number of fruits per vine, fruit weight (g), fruit length (cm), fruit diameter (cm), volume of fruit (cc), yield per plant (kg) and yield per square meter (kg) were significantly influenced by effect of humic acid

Chapter-3

MATERIALS AND METHODS

The experiment has been carried out at the Vegetable Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology & Science, Prayagra (Allahabad), U.P. during the year 2017-18 and 2018-2019 in winter season on entitled **"*Study on plant geometry, cultivar and fertilizer doses on growth, yield and quality of Cucumber (Cucumis sativus) under protected condition*" .** The experimental site in the river basin of the Ganga and Yamuna. It is situated at 28^0.87' N latitude 81^0.15' E longitude with an altitude of 98 m above the mean sea level. Average annual rainfall is **1013.4** mm precipitating mostly in between middle of July to end of September, January is the coldest month when mercury may drop down to an average minimum of 5^0 C on the other hand May to June are the hottest month recording average high temperature between 46^0 C **– 48^0 C.**

3.1 SOIL CHARACHTERISTICS

For analyzing the physical and chemical characteristics of the under polyhouse soil, soil samples from different locations in polyhouse were drawn with the help of auger from the soil depth of 0-90 cm and were mixed together, air dried and finally grinded to powder.

The data presented in Table 3.1 indicates that the texture of the soil was sandy loam and the soil was neutral in reaction. The available nitrogen, potassium and phosphorus are at higher end where as available zinc is very low in range. The soil physical constants for these soils as presented in Table 3.2.

Table 3.1: MECHANICAL AND CHEMICAL ANALYSIS OF SOIL

S.No.	Parameter	Test value	Methods employed
(A)	**Mechanical Analysis**		
1	Sand (%)	60	International dispersion method (Piper, 1950)
2	Silt (%)	26	
3	Clay (%)	14	
(B)	**Chemical Analysis**		
1	pH	7.18	1:2 Soil water suspension (Jackson, 1973)
2	Electrical conductivity (dsm^{-1})	0.191	
3	Organic Carbon (%)	0.60	Walkley and blacks Method (Piper, 1966)
4	Available Nitrogen ($kg\text{-}ha^{-1}$)	290.26	Alkaline Potassium Permanganate Method Subbiah and Asija,1956)
5	Available phosphorous ($kg\text{-}ha^{-1}$)	25.25	Olsens Method (Olsen *et al.*1954)
6	Available potassium ($kg\text{-}ha^{-1}$)	157.62	Flame Photometer (Mervin and Peech, 1951)
7	Available calcium (K $kg\text{-}ha^{-1}$)	1.70	EDTA method
8	Zinc ($kg\ ha^{-1}$)	0.32	
9	Available Magnesium (mg/100g)	0.7	

Table 3.2: PHYSICAL CONSTANTS OF SOIL

S.No.	Soil physical constants	Values (on weight basis)
1	Bulk Density ($mg\ m^{-3}$)	1.33
2	Partical Density ($mg\ m^{-3}$)	2.45
3	Percentage Pore Space (%)	49.33
4	Water Holding Capacity (%)	43.50

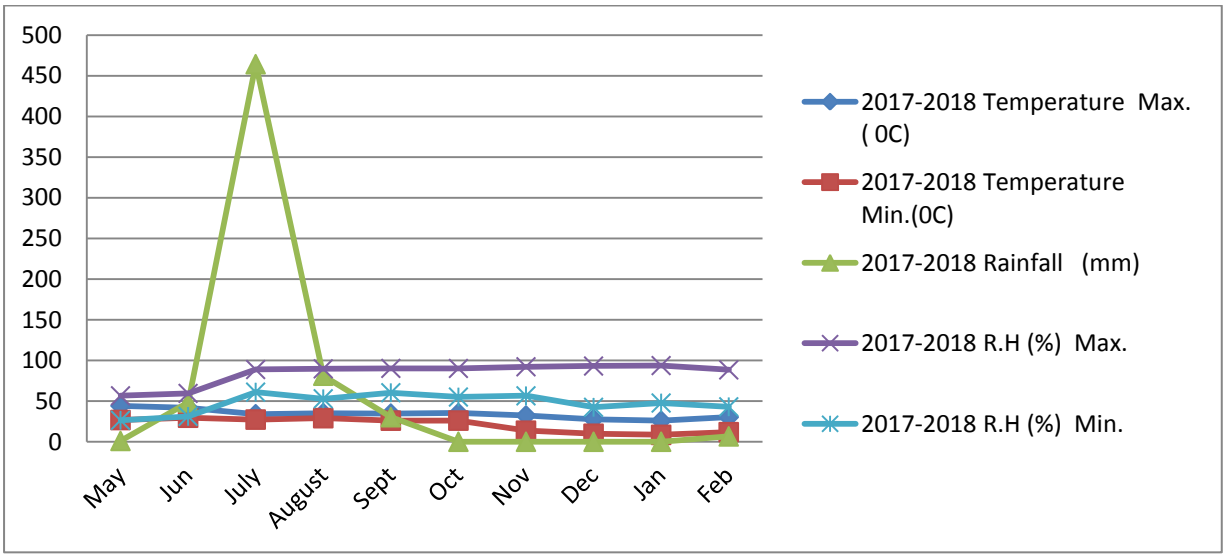
3.2 METROLOGICAL DATA

3.2.1 Meteorological observation

The meteorological observations of three conditions on temperature, relative humidity and light intensity recorded during crop period i.e. from the month of direct seed sowing under polyhouse (October) to last harvesting (February). The area of Allahabad district comes under subtropical belt in the South east of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46^0 C – 48^0 C and seldom falls as low as 4^0C – 5^0 C. The relative humidity ranges between 20 to 94 per cent. The average rainfall in this area are around 1013.4 mm annually. The meteorological data from (May, 2017 to February, 2018 and May, 2018 to February, 2019) with respect to total rainfall, maximum and minimum temperature, highest and lowest relative humidity is presented in table 3.3

Table 3.3: Agro Meteorological data during the months of May, 2017 to Feb., 2018

Month	2017-2018				
	Temperature Max. (^{0}C)	Temperature Min.(^{0}C)	Rainfall (mm)	R.H (%) Max.	R.H (%) Min.
May	44.20	26.70	1.00	56.52	26.37
Jun	41.77	29.54	48.40	59.43	31.20
July	33.81	27.26	464.20	88.74	61.00
August	35.06	28.99	81.20	89.65	52.84
Sept	34.60	25.95	30.20	90.20	60.27
Oct	35.22	26.00	0.00	90.13	54.97
Nov	32.27	13.55	0.00	92.20	56.47
Dec	27.63	9.77	0.00	93.07	42.33
Jan	25.77	8.42	0.00	93.63	47.63
Feb	30.24	11.69	6.60	88.32	42.96

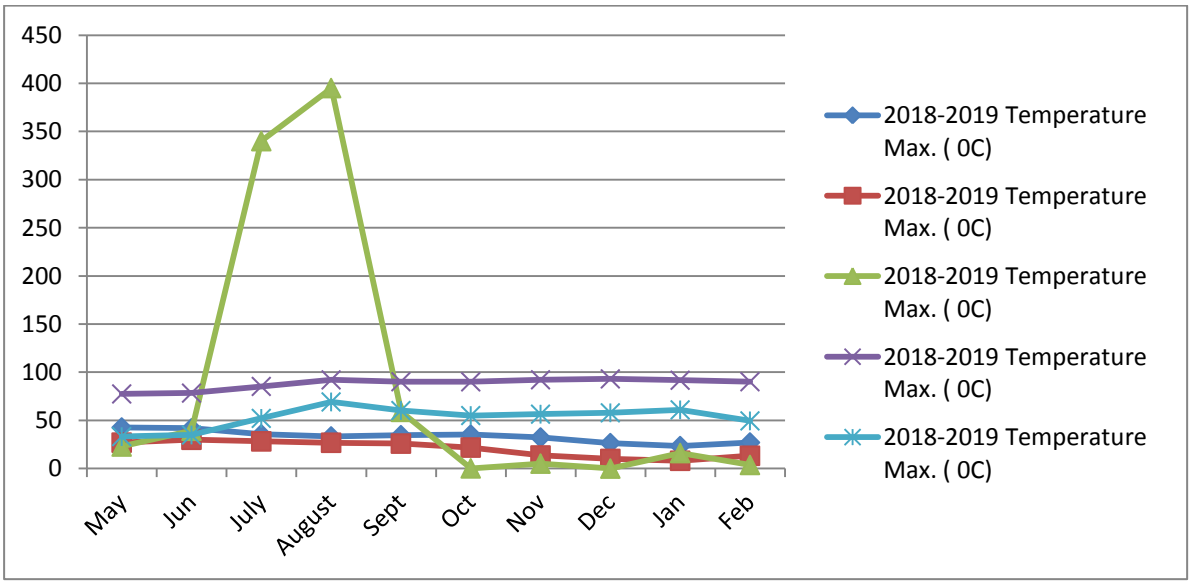


Source: Agro-meteorological Observatory Unit, College of Forestry & Environment, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad.

Fig. 3.1: Agro meteorological data during the months of May, 2017 to Feb., 2018

Table 3.4: Agro Meteorological data during the months of May, 2018 to Feb., 2019

Month	2018-2019				
	Temperature Max. (^{0}C)		Temperature Max. (^{0}C)		Temperature Max. (^{0}C)
May	42.65	26.89	22.91	77.48	33.16
Jun	41.79	29.90	39.26	78.36	34.86
July	35.47	28.23	340.02	85.29	52.12
August	33.36	26.79	395.14	92.09	69.17
Sept	34.63	25.94	58.9	90.20	60.26
Oct	35.23	21.81	0.20	90.06	55.06
Nov	32.26	13.55	5.17	92.20	56.46
Dec	26.40	9.98	00	93.12	57.87
Jan	23.34	8.09	16.10	91.70	60.96
Feb	27.06	13.27	3.76	90.18	49.52



Source:- Agro-meteorological Observatory Unit, College of Forestry & Environment, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad.

Fig. 3.2: Agro Meteorological data during the months of May, 2018 to April, 2019

3.3 DETAILS OF THE EXPERIMENT

Experimental Design : Randomised Block Design

Number of treatments : 27

Number of replications : 3

Season : Winter 2017-18 and winter 2018-2019

Total Area of the Experiment : Naturally ventilated polyhouse 220 m^2

Planting material : Three Parthenocarpic cucumber

Pant Parthenocarpic -2 (V1)

Pant Parthenocarpic -3 (V2)

Hilton (V3)

Treatment details : 3 Factors

Factor one - Plant geometry - 3

60 x 30 (P_1)

60 x 40 (P_2)

60 x 50 (P_3)

Factor two - Cultivar - 3

Pant Parthenocarpic Cucumber -2 **(V_1)**

Pant Parthenocarpic Cucumber -3 **(V_2)**

Hilton **(V_3)**

Factor three –Fertilizer doses – 3 Combinations of NPK (kg/1000 m^2)

20:10:22 kg **(D_1)**

25:15:27 kg **(D_2)**

30:20:32 kg **(D_3)**

Table 3.5: DETAILS OF TREATMENT COMBINATION IN CUCUMBER

No of treatments	Treatments combinations	Specification
T_1	V1+D1+P1	PPC -2 + 20:10:22 kg + 60 x 30 cm
T_2	V1+D1+P2	PPC -2 + 20:10:22 kg + 60 x 40 cm
T_3	V1+D1+P3	PPC -2 + 20:10:22 kg + 60 x 50 cm
T_4	V1+D2+P1	PPC -2 + 25:15:27 kg + 60 x 30 cm
T_5	V1+D2+P2	PPC -2 + 25:15:27 kg + 60 x 40 cm
T_6	V1+D2+P3	PPC -2 + 25:15:27 kg + 60 x 50 cm
T_7	V1+D3+P1	PPC -2 + 30:20:32 kg + 60 x 30 cm
T_8	V1+D3+P2	PPC -2 + 30:20:32 kg + 60 x 40 cm
T_9	V1+D3+P3	PPC -2 + 30:20:32 kg + 60 x 50 cm
T_{10}	V2+D1+P1	PPC -3 + 20:10:22 kg + 60 x 30 cm
T_{11}	V2+D1+P2	PPC -3 + 20:10:22 kg + 60 x 40 cm
T_{12}	V2+D1+P3	PPC -3 + 20:10:22 kg + 60 x 50 cm
T_{13}	V2+D2+P1	PPC -3 + 25:15:27 kg + 60 x 30 cm
T_{14}	V2+D2+P2	PPC -3 + 25:15:27 kg + 60 x 40 cm
T_{15}	V2+D2+P3	PPC -3 + 25:15:27 kg + 60 x 50 cm
T_{16}	V2+D3+P1	PPC -3 + 30:20:32 kg + 60 x 30 cm
T_{17}	V2+D3+P2	PPC -3 + 30:20:32 kg + 60 x 40 cm
T_{18}	V2+D3+P3	PPC -3 + 30:20:32 kg + 60 x 50 cm
T19	V3+D1+P1	Hilton + 20:10:22 kg + 60 x 30 cm
T20	V3+D1+P2	Hilton + 20:10:22 kg + 60 x 40 cm
T21	V3+D1+P3	Hilton + 20:10:22 kg + 60 x 50 cm
T22	V3+D2+P1	Hilton + 25:15:27 kg + 60 x 30 cm
T23	V3+D2+P2	Hilton + 25:15:27 kg + 60 x 40 cm
T24	V3+D2+P3	Hilton + 25:15:27 kg + 60 x 50 cm
T25	V3+D3+P1	Hilton + 30:20:32 kg + 60 x 30 cm
T26	V3+D3+P2	Hilton + 30:20:32 kg + 60 x 40 cm
T27	V3+D3+P3	Hilton + 30:20:32 kg + 60 x 50 cm

V1: Pant Parthenocarpic Cucumber -2 **V2:** Pant Parthenocarpic Cucumber -3 **V3** Hilton

P1: 60 x 30 **P2:** 60 x 40 **P3:** 60 x 50

D1: 20:10:22 Kg (NPK) **D2:** 25:15:27 Kg (NPK) **D3:** 30:20:32 Kg (NPK)

3.4 AGRONOMICAL PRACTICES:

3.4.1 SEED SOURCE

The seeds of Pant Parthenocarpic Cucumber -2 and Pant Parthenocarpic Cucumber -3 were obtained from Dr. D. K. Singh, Professor & Vegetable Breeder, Department of Vegetable Science, GBPUAT Pantnagar and Hilton cucumber seeds was obtained from Dr. Awani Kumar Singh, Principle Scientist, Centre for Protected Cultivation Technology (CPCT), Indian Agricultural Research Institute (IARI), New Delhi.

3.4.2 SOURCE OF FERTILIZER AND APPLICATION:

To meet the requirement of recommended doses of plant nutrients from urea (46:0:0), urea phosphate (17:44:0) and potassium sulphate (0:0:50) were taken as source of nitrogen, phosphorus and potassium respectively. The recommended fertilizer applied in 12 split doses as manually and starting after two weeks of sowing at weakly interval up to three months of sowing through manually application.

Different fertilizer calculation factors

Urea $= 100/46 = 2.173$ (For the supply of 1 kg nitrogen)

Urea phosphate $= 100/44 = 2.272$ (For the supply of 1 kg phosphorous)

Potassium sulphate $= 100/50 = 2.00$ (For the supply of 1 kg potassium)

1) D1 – 20:10:22 (kg/1000/$m^{2)}$

A. Phosphorus supplement

Urea phosphate requirement = $10 \times 2.272 = 22.72$ kg/1000/m^2

B. Nitrogen supplement

Nitrogen Supplied through urea phosphate 100 kg urea phosphate supplies 17 kg of N then 22.72 kg of urea phosphate supplies 'x'kg of N

$$X = (17 \times 22.72)/100 = 3.862 \text{kg}/1000\text{m}^2$$

$$X = 3.86 \text{ kg}/1000/\text{m}^2$$

Actual N requirement = $20 - 3.862 = 16.138$ kg

Urea requirement = $16.138 \times 2.173 = 35.072 \text{ kg}/1000\text{m}^2$

C. Potassium supplement

Potassium sulphate requirement = $22 \times 2 = 44 \text{ kg}/1000\text{m}^2$

2) D2– 25:15:27 (kg/1000m^2)

A. Phosphorus supplement

Urea phosphate requirement =$15 \times 2.272 = 34.08 \text{ kg}/1000\text{m}^2$

B. Nitrogen supplement

100kg urea phosphate supplies 17kg of N then 34.08g of urea phosphate supplies 'x'g of N

$$X = (17 \times 34.08)/100 = 5.793 \text{kg}/1000\text{m}^2$$

$$X = 5.793 \text{ kg}/1000\text{m2}$$

Actual N requirement = $25 - 5.793 = 19.207$ kg

Urea requirement = $19.207 \times 2.173 = 41.736 \text{ kg}/1000\text{m}^2$

C. Potassium supplement

Potassium sulphate requirement = $27 \times 2 = 54 \text{ kg}/1000\text{m}^2$

3) D3 – 30:20:32 (kg/1000 m^2) 30,20,32

A. Phosphorus supplement

Urea phosphate requirement = $20 \times 2.272 = 45.44 \text{ kg}/1000\text{m}^2$

B. Nitrogen supplement

100kg urea phosphate supplies 17kg of N then 45.44kg of urea phosphate supplies ‘X’g of N

$$X = (17 \times 45.44)/100 = 7.724 \text{kg}/1000\text{m}^2$$

$$X = 7.724 \text{ kg}/1000\text{m}^2$$

Actual N requirement = $30 - 7.724 = 22.276$ kg

Urea requirement = $22.276 \times 2.173 = 48.405 \text{ kg}/1000\text{m}^2$

C. Potassium supplement

Potassium sulphate requirement = $32 \times 2 = 64 \text{ kg}/1000\text{m}^2$

Table 3.6: Source and amount of fertilizer used to supplement recommended dose of NPK/1000m^2

Source	1st dose	2nd dose	3rd dose
Urea (kg)	35.072	41.736	48.405
Urea phosphate (kg)	22.72	34.08	45.44
Potassium sulphate (kg)	44	54	64

3.4.3 NATURALLY VENTILATED GREENHOUSE:

A naturally ventilated saw-tooth polyhouse of size 220 m^2 was installed at Department of Horticulture Sam Higginbottom University of Agriculture, Technology & Science Prayagraj (Allahabad), U.P was used for this PhD trial. The insect proof nylon net of 50 mesh was fixed from the ground level to 3.0 m in height in all the two sides of the structure. Rollable plastic curtains were fixed over the insect-proof net, which could be closed and opened as required for adjusting the climate inside the greenhouse manually.

3.4.4 TIME OF SOWING OF SEED

The seeds of cucumber were direct sown at natural ventilated polyhouse, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology & Science Prayagraj (Allahabad), U.P. from month of 10th November 2017-2018 and 2018-2019 respectively.

3.4.5 SPACING

The three spacing of 60 x 30 cm, 60 x 40 and 60 x 50 cm were followed in cucumber as according to experimental trial.

3.4.6 PRUNING AND TRAINING

The plants are trained upwards so that the main stem is allowed to climb to the overhead wire along a polythene twine. Wires are fixed 8 feet above the ground. The twine of each plant is alternatively tied to the horizontal overhead wires or steel cables running along with the length of the rows or over the beds. All the laterals are removed that appear for the first two feet. Pruning of the each plant based on the plant vigour and fruit load. The development of fruit is depended on the continuing production of leaf axils. weak and unproductive lateral are removed.

3.5.7 CROP MANAGEMENT

The plants were thinned out 15 days after sowing leaving a single healthy plant at a prescribed distance. The crop was kept weed free and three hand weeding were carried out during the crop growth period in polyhouse condition. Prior to hand weeding, hoeing operation was done at initial crop growth period. Proper soil moisture and plant nutrient was maintained throughout the crop growth period. The soil around the base of the plants was drenched with Redomil (0.03%) to overcome the incidence of collar rot. Bavistin (0.1%) was sprayed for 3 times at 30 days interval to control powdery mildew disease and incidence of sucking pests. Dithane M-45 (0.3%) was sprayed once to control downy mildew disease.

4.1 OBSERVATIONS RECORDED:

To assess the impact of various treatments on growth, yield and quality of parthenocarpic cucumber grown under polyhouse condition, the' following observations were recorded.

4.1 GROWTH CHARACTERS:-

4.1.1 PLANT HEIGHT (m):

The height of the plants was recorded with the help of a measuring tape from the base of the plant to its tip at the time of last picking and average length of plant was calculated and expressed in meter.

4.1.2LEAF AREA (cm^2) :

Five mature leaves from each tagged five plants were randomly selected and total leaf area of five leaves were measured with the help of Systronics leaf area meter and then average was worked out.

4.1.3 STEM GIRTH (cm) :

The plant stem girth of selected five randomly cucumber plants was measured with the help of vernier calipers at the final stage of harvesting. The average values for each treatment were then worked out and expressed in centimetres.

4.1.4 DAYS TO FIRST FLOWER BUD INITIATION (DAS):

The days of first flower bud initiation was recorded in each treatment then the number of days were counted from the date of direct sowing of cucumber under polyhouse.

4.2 QUANTITATIVE CHARACTERS:

4.2.1 DAYS OF FIRST FRUITS PICKING (DAS)

The number of days required to first picking from the date of sowing in each treatment was recorded as a days required to first fruit picking.

4.2.2 NUMBER OF FRUITS / PLANT:

The number of market suitable fruits harvested from five randomly selected cucumber plants were recorded at each picking and average number of fruits per vine was calculated

4.2.3 FRUIT LENGTH (cm):

The length of five randomly selected healthy fruits at marketable stage was measured from head end up to blossom scar by meter scale in each treatment then the average fruit length was calculated and expressed in centimetre.

4.2.4 WIDTH OF FRUIT (cm)

The width of five randomly selected healthy fruits at marketable stage was measured by meter scale in each treatment then the average fruit width was calculated and expressed in centimetre.

4.2.5 FRUIT WEIGHT (g)

Weight of five randomly selected healthy fruits from each treatment in each replication was measured using electronic balance, and the average fruit weight was recorded and expressed in gram (g).

4.2.6 YIELD / PLANT (g):

The mature fruits were harvested periodically in each treatment separately and the weight was recorded with the help of single pan balance. Then average total yield was calculated and expressed in kilogram per plant.

4.2.7 YIELD / m^2

The yield of marketable size fruits per sq. meter was calculated by multiplying the average yield of fruits per plant with the number of plants per sq. meter and expressed in kilogram per square meter.

4.3 QUALITATIVE CHARACTERS:

4.3.1 FRUIT COLOUR:

The healthy fruit skin colour was observed at the marketable stage by visual observation through panel of seven judges and expressed as green, light green, medium green and dark green colour.

4.3.2 NUMBER OF UNMARKETABLE FRUITS PER PLANT:

The number of unmarketable fruits count from five randomly selected plants were recorded at each picking and average number of fruits per vine was calculated

4.3.3 FRUITS SPECIFIC GRAVITY (g cm^{-3}) :

Specific gravity of five randomly selected healthy fruits from each treatment in each replication was calculated by the following formula:

$$\text{Specific gravity} = \frac{\text{Weight of the fruit (g)}}{\text{Volume of water displaced by the fruit (cc)}}$$

4.3.4 FRUIT VOLUME (cc) :

Volume of fruit was measured by water displacement method using a measuring cylinder of 1000 ml capacity. The average of five fruit from each replication was calculated and expressed in cubic centimeter (cc).

4.3.5 MOISTURE (%) :

The moisture content of fruits was determined by taking known weight of fresh fruits dried in oven at 60° C till constant weight was obtained. The moisture content of fruit was calculated by using following formula:

$$\text{Moisture\%} = \frac{\text{Fresh weight of fruits (g) - Dry weight of fruits (g)}}{\text{Fresh weight of fruits (g)}} \times 100$$

4.3.6 TOTAL SOLUBLE SOLIDS (^{o}Brix):

The juice was extracted from the fresh fruit with the help of hand extractor and strained through muslin cloth. The strained juice of each sample was thoroughly stirred before recording. Total soluble solids (TSS) content of the juice was determined with the help of Erma-hand refractometer (0-32^{o}Brix) wherein one drop of fruit juice was put on the prism of the refractometer and the per cent TSS was recorded directly and was expressed on per cent basis according to standard procedure as given.

4.3.7 ORGENOLEPTIC ACCEPTANCE:

Organoleptic acceptance of the fresh fruit was conducted by a panel of seven judges immediately after picking of fruits in each treatment, who scored on a *9.0* point Headonic scale (Amerine *et al. 1965).* The observations were recorded on the basis of score for flavour, colour, taste and general appearance of fruit and rated as bel

ORGENOLEPTIC SCORE **Rank Number**	**RATING**
9	Like extremely
8	Like very much
7	Like moderately
6	Like slightly
5	Neither like nor dis1ike
4	Dislike slightly
3	Dislike moderately
2	Dislike very much
1	Dislike extremely

4.4 LEAF NUTRIENT STATUS:

The plant leaves sample i.e. 5th leaf from the top were collected at 70 days after sowing (i.e. at peak fruiting period) from each treatment and dried in oven at 70 ^{0}C. After drying, the samples were grounded in sample grinder and N, P and K contents were determined by using following standard methods.

4.4.1 TOTAL NITROGEN IN LEAF (%)

Total nitrogen in the dried leaves was estimated with Nesler's reagent method. Digestion of sample was carried out with concentrated sulphuric acid. The black colour was removed with 30 per cent hydrogen peroxide. The volume of acid digest was made up to 100 ml. An aliquot of 5 ml was taken from diluted acid digest and to this, 2 ml of N sodium hydroxide and 1 ml of 10 per cent sodium silicate were added to neutralize the acidity and to prevent the turbidity, respectively. Then, colour was developed by adding 1.5 ml of Nesler's reagent. The transmittance of the colour was read with the help of Bausch and Lamp Spectronic 20 colorimeter at a wave length of 540 nm. The total nitrogen was calculated by comparing with a calibration curve, which had been prepared by using standard solution of pure ammonium sulphate (Snell and Snell, 1955).

4.4.2 TOTAL PHOSPHORUS IN LEAF (%)

Phosphorus was determined by wet digestion of samples with tri-acid mixture (nitric acid, sulphuric acid and perchloric acid in ratio of 10:1:3) and estimated for their constituents phosphorus was determined on spectronic 20 by using Vanadomolybdo phosphoric yellow colour method in nitric acid (Jackson,1973).

4.4.3 TOTAL POTASSIUM IN LEAF (%)

Potassium was determined by wet digestion of samples with tri-acid mixture (nitric acid, sulphuric acid and perchloric acid in ratio of 10: 1 :3) and estimated for their constituents

Potassium (%): Analysis of suitable aliquot of wet digested material was done with the help of flame photometer (Richards, 1968).

4.5 ECONOMICS:

In order to evaluate the most profitable treatment economics of different treatments was worked out in terms of net return, relative net return over control and net return per rupee investment. In calculating the economics, only fruit yield was considered as the economic value. First of all, cost of cultivation was calculated then gross return *was estimated* on the *basis* of the average *fruit yield* in kg *per 500 m^2* per treatment. Thus, the net return was obtained by adopting the following procedure:

Net return = Gross return - Total cost of cultivation (Rs per 1000 m^2.)

The relative net return over control was estimated to find out economically viable treatment. The cost of cultivation includes money spent on field preparation, seeds, organic manures, chemical fertilizers, sowing, transplanting, treatment cost, irrigation, hoeing and weeding, plant protection measures, polyhouse rent, picking and. transportation etc.

4.6 STATISTICAL ANALYSIS

The experiment was laid out in factorial randomized block design (FRBD) having 27 treatments, each replicated three times. The data recorded during the course of investigation were subjected to statistical analysis as per method of analysis of variance (Fisher, 1968). The significance and non-significance of the treatment effect were judged with the help of 'F' variance ratio test. Calculated 'F' value (variance ratio) was compared with the table value of 'F' at 5% level of significance. If calculated value exceeded the table value, the effect was considered to be significant.

The significant difference between the means was tested against the critical difference at 5% level of significance.

$$\sqrt{\text{S. Ed.}}$$

C.D. at 5% = S Ed. x t error degree of freedom at 5%

Skeleton of ANOVA table:

Source of variation	d. f.	S.S.	M.S.S.	F(cal)	F(tab)(0.05)	Result

Due to Replication	r-1	S.S.R	SSR/(r-1)	MSSR/MSSE		
Due to V (Variety)	n-1	SS.V	SSV/(n-1)	MSSL/MSSE		
Due to D (Doses of fertilizers)	f-1	S.S.D	SSD/(f-1)	MSSF/MSSE		
Due to P (Plant geometry)	a-1	S.S.P	SSP/(a-1)	MSSA/MSSE		
Due to interaction						
(V×D)	(n-1)(f-1)	S.S.(VD)	S.S.(VD)/ (l-1)(f-1)	MSSLF/MSSE		
(D×P)	(n-1)(a-1)	S.S.(DP)	S.S.(DP)/(l-1)(a-1)	MSSLA/MSSE		
(V×P)	(f-1)(a-1)	S.S.(VP)	S.S.(VP)/(f-1)(a-1)	MSSFA/MSSE		
(V×D×P)	(n-1)(f-1)(a-1)	S.S.(VDP)	S.S.(VDP)/(l-1)(f-1)(a-1)	MSSLFA/MSSE		
Due to Error	(r-1)(t-1)	S.S.E	SSE/(r-1)(lfa-1)	-	-	-
Total	(rnfa-1)	TSS	-	-	-	-

Where -

r = Replication

T = Treatment

T = Total

V = Name of Verity

D = Doses of fertilizer

P = Plant geometry

d. f. =degree of freedom

S.S.= sum of squar

T.S.S. = total sum of squar

SSR= sum of squar due to replication

SSV = sum of squar due to Verity

SSD = sum of squar due to doses of fertilizer

SSP= sum of squar due to plant geometry

SS (VDP) = sum of squar due to interaction of Verity, NPK fertilizers and plant geometry

CHAPTER -4
RESULTS & DISCUSSION

The study entitled **"Study on plant geometry, cultivar and fertilizer doses on growth, yield and quality of Cucumber (*Cucumis sativus* L.) under protected condition"**was carried out at Vegetable Research Farm SHUATS, Prayagraj, (Allahabad), U.P. during 2017-2018 and 2018-2019. Study was carried with 3 dose of fertilizer with 3 plant geometry and 3 cultivar under poly house condition the results obtained are discussed. The entire discussion of cultivar, Plant geometry, and doses of fertilizers for NPK combination on growth, yield, and quality and of parthenocarpic cucumber under poly house condition has been divided into the following heads

4.1 VEGETATIVE GROWTH CHARACTERSTICS

4.2 FLOWER CHARACTERISTICS

4.3 YIELD AND YIELD ATTRIBUTING CHARACTERISTICS

4.4 QUALITY CHARACTERISTICS

4.5 NUTRIENT STATUS OF CUCUMBER LEAVES

4.6 ECONOMICS

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4.1 VEGETATIVE GROWTH CHARACTERSTICS

The data presenting to plant height, stem girth, leaf area, internodal distance and days to first flower bud initiate presented here under

4.1.1 Plant height (m)

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on plant height of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.1 and Fig. 4.1. The analysis of variance is given in Appendix I, II and III.

(a) Effect of cultivars:

The data presented in Table 4.1 the plant height of parthenocarpic cucumber was significantly influenced by various cultivar treatment during both the years of experimentation of winter season however, on the basis of pooled data analysis the maximum plant height (2.37 m) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to minimum (2.69 m) in cultivar V_1 (Pant Parthenocarpic Cucumber-2).

(b) Effect of spacing:

Data presented in Table 4.1 indicated that the plant height of cucumber was significantly influenced by various spacing treatments during both the years of experimentation the pooled data showed that maximum plant height (2.74 m) was recorded in P_3 (60 x 40 cm) and minimum plant height (2.68 m) in P_1 (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.1 that dose of fertilizer application was significant effect on plant height of parthenocarpic cucumber during both the years of investigation. Maximum plant height (2.78 m) was observed in D_3 (30:20:32 kg/1000$m^{2)}$ as compared to minimum (2.68 m) in D_1 (20:10:22 kg/1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.2 showed significant increase in plant height during both the years of experiment. Further, T_{18} $V_2D_3P_3$ (PPC-3+30:20:32kg+ 60 X 50 cm) resulted in highest plant height (3.04 m). and was closely followed by $T_{17,}$ V_2+D_3+P_2 (2.90 m) and this was statically at par with T_{18} However, lowest plant height (2.59 m) was recorded in $V_1D_1P_1$ (PPC -2 + 20:10:22 kg + 60 X 30 cm) on pooled data basis.

Plant height (m)

Table 4.1: Effect of cultivars, spacing and dose of fertilizer application on vine length of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	2.63	2.74	2.69
V_2	Pant Parthenocarpic Cucumber -3	2.66	2.80	2.73
V_3	Hilton	2.67	2.80	2.73
	F – test	S	S	S
	S. Ed. (±)	0.012	0.010	0.002
	CD at 5%	0.025	0.020	0.003
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	2.58	2.77	2.68
D_2	25:15:27 kg	2.66	2.74	2.70
D_3	30:20:32 kg	2.72	2.83	2.78
	F – test	S	S	S
	S.Ed. (±)	0.012	0.010	0.002
	CD at 5%	0.025	0.020	0.003
Plant geometry (P)				
P_1	60 x 30	2.57	2.79	2.68
P_2	60 x 40	2.69	2.79	2.74
P_3	60 x 50	2.69	2.76	2.73
	F – test	S	S	S
	S. Ed. (±)	0.012	0.010	0.002
	CD at 5%	0.025	0.020	0.003

Table 4.2: Interaction effect of cultivars, spacing and dose of fertilizer application on plant height of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	2.42	2.76	2.59
T_2	$V_1+D_1+P_2$	2.68	2.78	2.73
T_3	$V_1+D_1+P_3$	2.54	2.68	2.61
T_4	$V_1+D_2+P_1$	2.62	2.79	2.71
T_5	$V_1+D_2+P_2$	2.79	2.71	2.75
T_6	$V_1+D_2+P_3$	2.68	2.72	2.70
T_7	$V_1+D_3+P_1$	2.68	2.78	2.73
T_8	$V_1+D_3+P_2$	2.68	2.74	2.71
T_9	$V_1+D_3+P_3$	2.56	2.74	2.65
T_{10}	$V_2+D_1+P_1$	2.42	2.69	2.56
T_{11}	$V_2+D_1+P_2$	2.58	2.87	2.73
T_{12}	$V_2+D_1+P_3$	2.64	2.65	2.65
T_{13}	$V_2+D_2+P_1$	2.54	2.68	2.61
T_{14}	$V_2+D_2+P_2$	2.60	2.85	2.73
T_{15}	$V_2+D_2+P_3$	2.67	2.60	2.64
T_{16}	$V_2+D_3+P_1$	2.65	2.78	2.72
T_{17}	$V_2+D_3+P_2$	2.88	2.92	2.90
T_{18}	$V_2+D_3+P_3$	2.96	3.12	3.04
T_{19}	$V_3+D_1+P_1$	2.54	2.88	2.71
T_{20}	V_3+D_1+P2	2.68	2.76	2.72
T_{21}	$V_3+D_1+P_3$	2.72	2.88	2.80
T_{22}	$V_3+D_2+P_1$	2.60	2.84	2.72
T_{23}	$V_3+D_2+P_2$	2.68	2.74	2.71
T_{24}	$V_3+D_2+P_3$	2.72	2.70	2.71
T_{25}	$V_3+D_3+P_1$	2.64	2.87	2.76
T_{26}	$V_3+D_3+P_2$	2.68	2.75	2.72
T_{27}	$V_3+D_3+P_3$	2.76	2.78	2.77
Interaction (Vx D x P)	F - test	S	S	S
	S. Ed (±)	0.037	0.030	0.005
	CD. at 5%	0.075	0.061	0.010

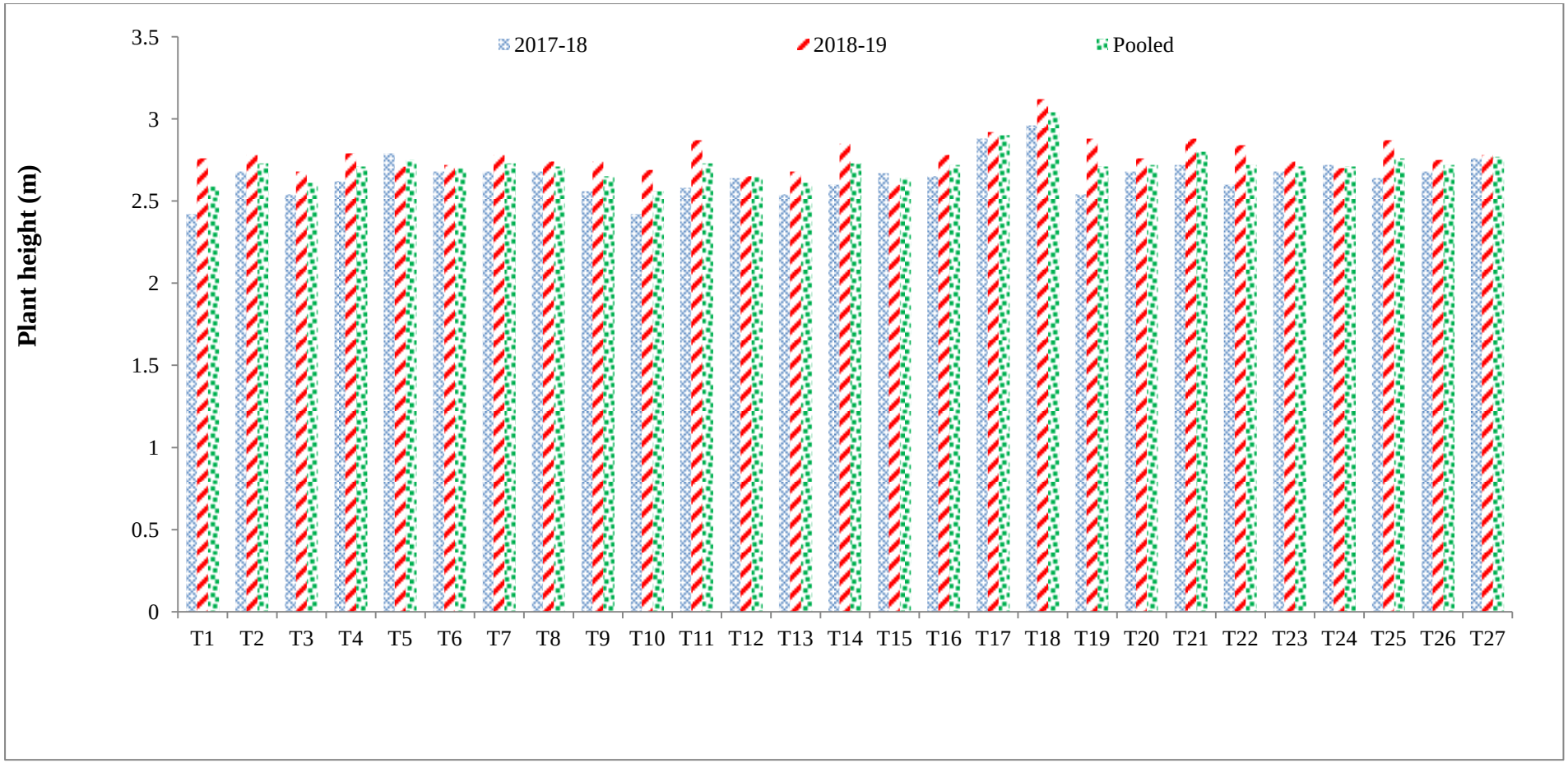

Fig 4.1: Interaction effect of cultivars, spacing and dose of fertilizer application on plant height of parthenocarpic cucumber under polyhouse condition during winter season**.**

4.1.2 Stem girth (cm)

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on stem girth of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.3 and Fig. 4.2. The analysis of variance is given in Appendix IV, V and VI

(a) Effect of cultivars:

The data presented in Table 4.3 the stem girth of parthenocarpic cucumber was significantly influenced by various cultivar during both the years of experiment of winter season however, on the basis of pooled data analysis the maximum stem girth (0.80 cm) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to minimum (0.77 cm) in cultivar V_1 (Pant Parthenocarpic Cucumber-2).

(b) Effect of spacing:

Data presented in Table 4.3 indicated that the stem girth of cucumber was significantly influenced by various spacing treatments during both the years of experiment. The pooled data showed that maximum stem girth (0.79 cm) was recorded in P_3 (60x50 cm) and minimum stem girth (0.78 cm) in P_1 (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.3 that dose of fertilizer application was significant effect on stem girth of parthenocarpic cucumber during both the years of investigation. Maximum stem girth(0.81cm) was observed in D_3(30:20:32 Kg/1000 m^2) as compared to minimum (0.76 cm) in D_1 (20:10:22 Kg/1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.4 showed significant stem girth during both the years of experiment. Further, $T_{18,}$ $V_2D_3P_3$ (PPC -3 + 30:20:32 kg + 60 X 50 cm) resulted in highest stem girth (0.85 cm). However, lowest stem girth (0.73 cm) was recorded in $V_1D_1P_1$ (PPC -2 + 20:10:22 kg + 60 X 30 cm) on pooled data basis.

Stem girth (cm)

Table 4.3: Effect of cultivars, spacing and dose of fertilizer application on stem girth of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	0.76	0.77	0.77
V_2	Pant Parthenocarpic Cucumber -3	0.79	0.81	0.80
V_3	Hilton	0.78	0.79	0.78
	F – test	S	S	S
	S. Ed. (±)	0.002	0.003	0.002
	CD at 5%	0.004	0.005	0.004
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	0.75	0.77	0.76
D_2	25:15:27 kg	0.77	0.79	0.78
D_3	30:20:32 kg	0.80	0.82	0.81
	F – test	S	S	S
	S Ed. (±)	0.002	0.003	0.002
	CD at 5%	0.004	0.005	0.004
Plant geometry (P)				
P_1	60 X 30	0.77	0.78	0.78
P_2	60 X 40	0.77	0.79	0.78
P_3	60X 50	0.78	0.80	0.79
	F – test	S	S	S
	S. Ed. (±)	0.002	0.003	0.002
	CD at 5%	0.004	0.005	0.004

Table 4.4: Interaction effect of cultivars, spacing and dose of fertilizer application on stem girth of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	0.72	0.74	0.73
T_2	$V_1+D_1+P_2$	0.74	0.75	0.75
T_3	$V_1+D_1+P_3$	0.76	0.78	0.77
T_4	$V_1+D_2+P_1$	0.75	0.78	0.77
T_5	$V_1+D_2+P_2$	0.76	0.76	0.76
T_6	$V_1+D_2+P_3$	0.77	0.78	0.78
T_7	$V_1+D_3+P_1$	0.76	0.77	0.77
T_8	$V_1+D_3+P_2$	0.78	0.80	0.79
T_9	$V_1+D_3+P_3$	0.78	0.80	0.79
T_{10}	$V_2+D_1+P_1$	0.74	0.76	0.75
T_{11}	$V_2+D_1+P_2$	0.78	0.78	0.78
T_{12}	$V_2+D_1+P_3$	0.76	0.78	0.77
T_{13}	$V_2+D_2+P_1$	0.78	0.80	0.79
T_{14}	$V_2+D_2+P_2$	0.78	0.82	0.80
T_{15}	$V_2+D_2+P_3$	0.80	0.82	0.81
T_{16}	$V_2+D_3+P_1$	0.82	0.81	0.82
T_{17}	$V_2+D_3+P_2$	0.82	0.84	0.83
T_{18}	$V_2+D_3+P_3$	0.84	0.86	0.85
T_{19}	$V_3+D_1+P_1$	0.78	0.78	0.78
T_{20}	V_3+D_1+P2	0.73	0.74	0.74
T_{21}	$V_3+D_1+P_3$	0.76	0.78	0.77
T_{22}	$V_3+D_2+P_1$	0.77	0.78	0.78
T_{23}	$V_3+D_2+P_2$	0.77	0.76	0.77
T_{24}	$V_3+D_2+P_3$	0.78	0.78	0.78
T_{25}	$V_3+D_3+P_1$	0.79	0.82	0.81
T_{26}	$V_3+D_3+P_2$	0.80	0.82	0.81
T_{27}	$V_3+D_3+P_3$	0.80	0.82	0.81
Interaction (V x D x P)	F – test	S	S	S
	S. Ed. (±)	0.006	0.008	0.007
	CD. at 5%	0.011	0.016	0.013

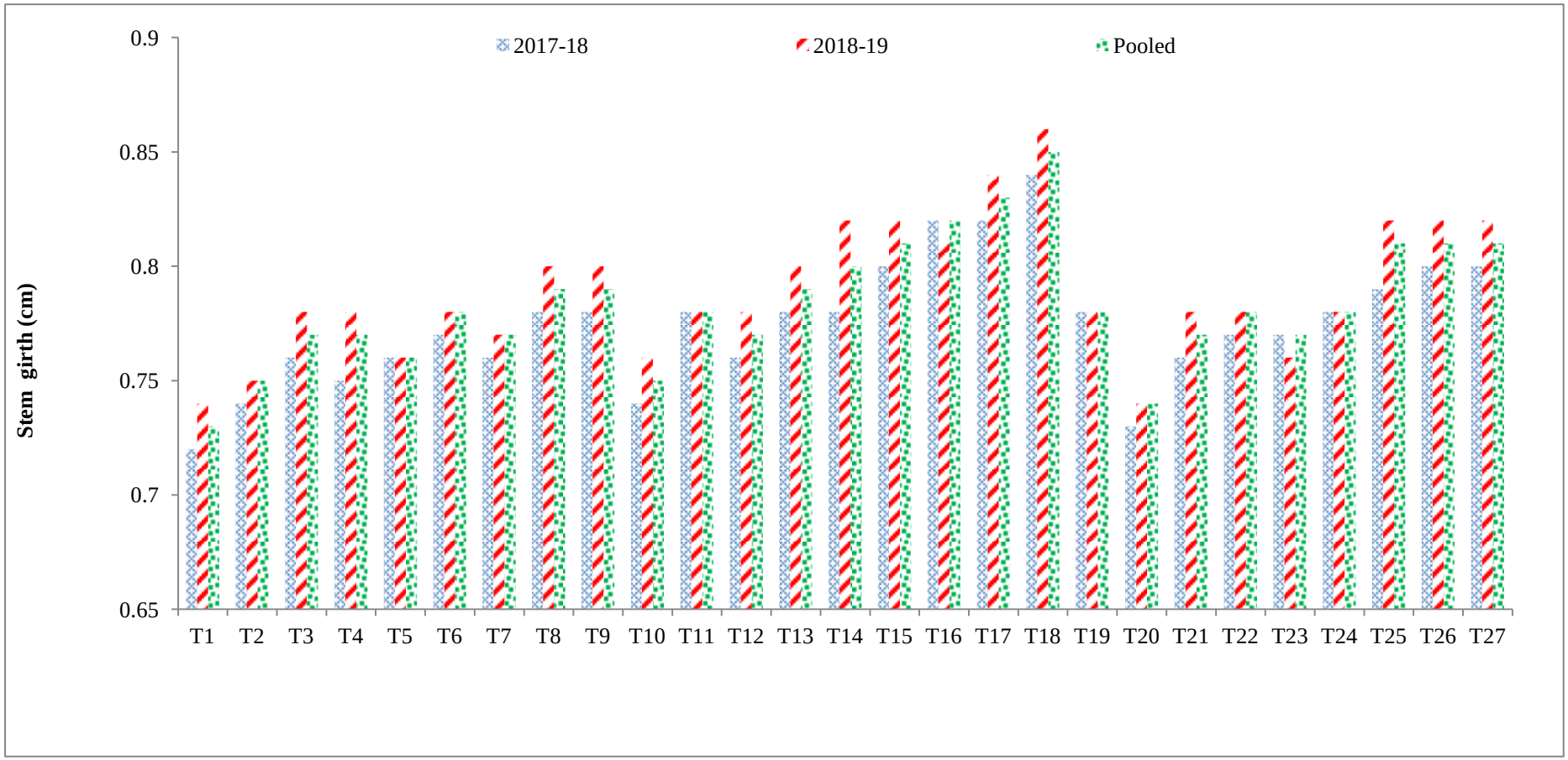

Fig 4.2: Interaction effect of cultivars, spacing and dose of fertilizer application on stem girth of parthenocarpic cucumber under polyhouse condition during winter season

4.1.3 Leaf area (cm^2)

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on leaf area of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.5 and Fig. 4.3. The analysis of variance is given in Appendix VII, VIII and IX.

(a) Effect of cultivars:

The data presented in Table 4.5 the leaf area of parthenocarpic cucumber was significantly influenced by various cultivar during both the years of experiment of winter season however, on the basis of pooled data analysis the maximum leaf area (412.34 cm^2) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to minimum (406.14 cm^2) in cultivar V_1 (Pant Parthenocarpic Cucumber-2).

(b) Effect of spacing:

Data presented in Table 4.5 indicated that the leaf area of cucumber was significantly influenced by various spacing treatments during both the years of experiment. The pooled data showed that maximum leaf area (411.56 cm^2) was recorded in P_3 (60 x 50 cm) and minimum leaf area (406.18 cm^2) in P_1 (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.5 that dose of fertilizer application was significant effect on leaf area of parthenocarpic cucumber during both the years of investigation. Maximum leaf area(412.27 cm^2) was observed in D_3 (30:20:32 Kg/1000 m^2) as compared to minimum (406.55 cm^2) in D_1 (20:10:22 Kg/1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.6 showed significant leaf area during both the years of experiment. Further, $T_{18,}$ $V_2D_3P_3$ (PPC -3 + 30:20:32 kg + 60 X 50 cm) resulted in highest leaf area (422.60 cm^2). However, lowest leaf area (0.73 cm^2) was recorded in $V_1D_1P_1$ (PPC -2 + 20:10:22 kg + 60 X 30 cm) on pooled data basis.

Leaf area (cm^2)

Table 4.5: Effect of cultivars, spacing and dose of fertilizer application on leaf area of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	405.76	406.52	406.14
V_2	Pant Parthenocarpic Cucumber -3	411.16	413.52	412.34
V_3	Hilton	407.29	408.74	408.02
	F – test	S	S	S
	S. Ed. (±)	0.10	0.12	0.01
	CD at 5%	0.21	0.24	0.03
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	405.44	407.66	406.55
D_2	25:15:27 kg	407.11	408.24	407.68
D_3	30:20:32 kg	411.64	412.89	412.27
	F – test	S	S	S
	S. Ed. (±)	0.10	0.12	0.01
	CD at 5%	0.21	0.24	0.03
Plant geometry (P)				
P_1	60 X 30	405.42	406.94	406.18
P_2	60 X 40	408.22	409.29	408.76
P_3	60X 50	410.56	412.56	411.56
	F – test	S	S	S
	S. Ed. (±)	0.31	0.35	0.04
	CD at 5%	0.64	0.71	0.09

Table 4.6: Interaction effect of cultivars, spacing and dose of fertilizer application on leaf area of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		**2017-18**	**2018-19**	**Pooled**
T_1	$V_1+D_1+P_1$	402.40	402.80	402.60
T_2	$V_1+D_1+P_2$	404.60	404.80	404.70
T_3	$V_1+D_1+P_3$	406.40	406.60	406.50
T_4	$V_1+D_2+P_1$	402.60	403.60	403.10
T_5	$V_1+D_2+P_2$	404.80	406.80	405.80
T_6	$V_1+D_2+P_3$	406.80	408.80	407.80
T_7	$V_1+D_3+P_1$	404.60	405.80	405.20
T_8	$V_1+D_3+P_2$	408.80	406.70	407.75
T_9	$V_1+D_3+P_3$	410.80	412.80	411.80
T_{10}	$V_2+D_1+P_1$	404.20	408.70	406.45
T_{11}	$V_2+D_1+P_2$	406.60	410.20	408.40
T_{12}	$V_2+D_1+P_3$	408.80	412.40	410.60
T_{13}	$V_2+D_2+P_1$	406.60	408.20	407.40
T_{14}	$V_2+D_2+P_2$	410.80	410.90	410.85
T_{15}	$V_2+D_2+P_3$	412.20	412.80	412.50
T_{16}	$V_2+D_3+P_1$	414.20	414.80	414.50
T_{17}	$V_2+D_3+P_2$	416.60	418.90	417.75
T_{18}	$V_2+D_3+P_3$	420.40	424.80	422.60
T_{19}	$V_3+D_1+P_1$	402.80	404.80	403.80
T_{20}	V_3+D_1+P2	404.80	406.40	405.60
T_{21}	$V_3+D_1+P_3$	408.40	412.20	410.30
T_{22}	$V_3+D_2+P_1$	404.60	404.90	404.75
T_{23}	$V_3+D_2+P_2$	406.80	408.20	407.50
T_{24}	$V_3+D_2+P_3$	408.80	410.00	409.40
T_{25}	$V_3+D_3+P_1$	406.80	408.90	407.85
T_{26}	$V_3+D_3+P_2$	410.20	410.70	410.45
T_{27}	$V_3+D_3+P_3$	412.40	412.60	412.50
Interaction (Vx D x P)	F – test	S	S	S
	S. Ed. (±)	0.31	0.35	0.04
	C. D. at 5%	0.64	0.71	0.09

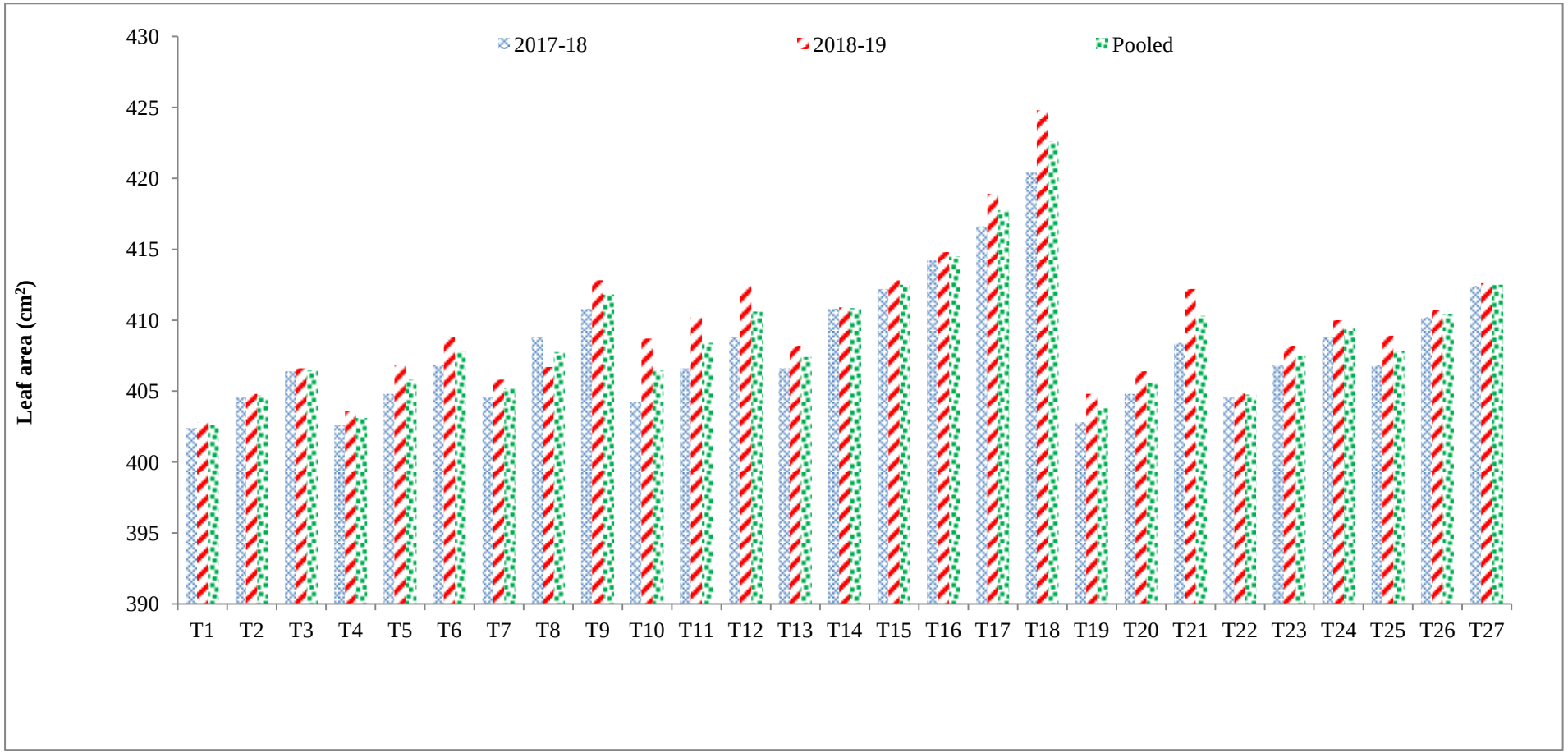

Fig 4.3: Interaction effect of cultivars, spacing and dose of fertilizer application on leaf area of parthenocarpic cucumber under polyhouse condition during winter season

4.1.4 Internodal Distance (cm)

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on Internodal distance (cm) of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.7 and Fig. 4.4. The analysis of variance is given in Appendix X, XI and XII

(a) Effect of cultivars:

The data presented in Table 4.7 the Internodal distance of parthenocarpic cucumber was significantly influenced by various cultivar treatment during both the years of experimentation of winter season however, on the basis of pooled data analysis the maximum Internodal distance (8.47 cm) was recorded in cultivar V_1 (Pant Parthenocarpic Cucumber-2) as compared to minimum internodal distance (8.34 cm) in cultivar V_3 (Hilton).

(b) Effect of spacing:

Data presented in Table 4.7 indicated that the internodal distance of cucumber was significantly influenced by various spacing treatments during both the years of experimentation the pooled data showed that minimum internodal distance (8.33 cm) was recorded in P_3 (60 x 40 cm) and maximum internodal distance (8.48 cm) in P_l (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.7 that dose of fertilizer application was significant effect on Internodal distance of parthenocarpic cucumber during both the years of investigation minimum Internodal distance (8.27 cm) was observed in D_3 (30:20:32 kg/1000$m^{2)}$ as compared to maximum Internodal distance (8.51 cm) in D_1 (20:10:22 kg/1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.8 showed significant increase in internodal distance during both the years of experiment. Further, T_{27} $V_3D_3P_3$ (Hilton+30:20:32 kg +60x50 cm) resulted in minimum internodal distance (8.11 cm) and was closely followed by $T_{18,}$ V_2+D_3+P_3 (8.12 cm) and this was statically at par with T_{27} However, highest Internodal distance (8.65 cm) was recorded in $V_1D_1P_1$ (PPC -2 + 20:10:22 kg + 60 X 30 cm) on pooled data basis.

Table 4.7: Effect of cultivars, spacing and dose of fertilizer application on internodal distance of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	8.50	8.44	8.47
V_2	Pant Parthenocarpic Cucumber -3	8.41	8.36	8.38
V_3	Hilton	8.37	8.32	8.34
	F – test	S	S	S
	S Ed. (±)	0.015	0.025	0.020
	CD at 5%	0.031	0.051	0.041
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	8.54	8.49	8.51
D_2	25:15:27 kg	8.44	8.38	8.41
D_3	30:20:32 kg	8.30	8.25	8.27
	F – test	S	S	S
	S. Ed. (±)	0.015	0.025	0.020
	CD at 5%	0.031	0.051	0.041
Plant geometry (P)				
P_1	60 X 30	8.51	8.45	8.48
P_2	60 X 40	8.42	8.36	8.39
P_3	60X 50	8.35	8.31	8.33
	F – test	S	S	S
	S. Ed. (±)	0.015	0.025	0.020
	CD at 5%	0.031	0.051	0.041

Table 4.8: Interaction effect of cultivars, spacing and dose of fertilizer application on internodal distance of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	8.68	8.62	8.65
T_2	$V_1+D_1+P_2$	8.57	8.51	8.54
T_3	$V_1+D_1+P_3$	8.51	8.47	8.49
T_4	$V_1+D_2+P_1$	8.59	8.52	8.56
T_5	$V_1+D_2+P_2$	8.48	8.41	8.45
T_6	$V_1+D_2+P_3$	8.42	8.36	8.39
T_7	$V_1+D_3+P_1$	8.47	8.39	8.43
T_8	$V_1+D_3+P_2$	8.41	8.36	8.39
T_9	$V_1+D_3+P_3$	8.38	8.32	8.35
T_{10}	$V_2+D_1+P_1$	8.63	8.58	8.61
T_{11}	$V_2+D_1+P_2$	8.52	8.47	8.50
T_{12}	$V_2+D_1+P_3$	8.47	8.42	8.45
T_{13}	$V_2+D_2+P_1$	8.51	8.42	8.47
T_{14}	$V_2+D_2+P_2$	8.42	8.36	8.39
T_{15}	$V_2+D_2+P_3$	8.36	8.32	8.34
T_{16}	$V_2+D_3+P_1$	8.38	8.31	8.35
T_{17}	$V_2+D_3+P_2$	8.27	8.22	8.25
T_{18}	$V_2+D_3+P_3$	8.12	8.11	8.12
T_{19}	$V_3+D_1+P_1$	8.58	8.52	8.55
T_{20}	V_3+D_1+P2	8.48	8.42	8.45
T_{21}	$V_3+D_1+P_3$	8.42	8.38	8.40
T_{22}	$V_3+D_2+P_1$	8.47	8.42	8.45
T_{23}	$V_3+D_2+P_2$	8.38	8.32	8.35
T_{24}	$V_3+D_2+P_3$	8.32	8.26	8.29
T_{25}	$V_3+D_3+P_1$	8.31	8.24	8.28
T_{26}	$V_3+D_3+P_2$	8.24	8.18	8.21
T_{27}	$V_3+D_3+P_3$	8.11	8.11	8.11
Interaction (Vx D x P)	F - test	NS	NS	NS
	S. Ed. (±)	0.046	0.075	0.060
	CD. at 5%	0.094	0.153	0.123

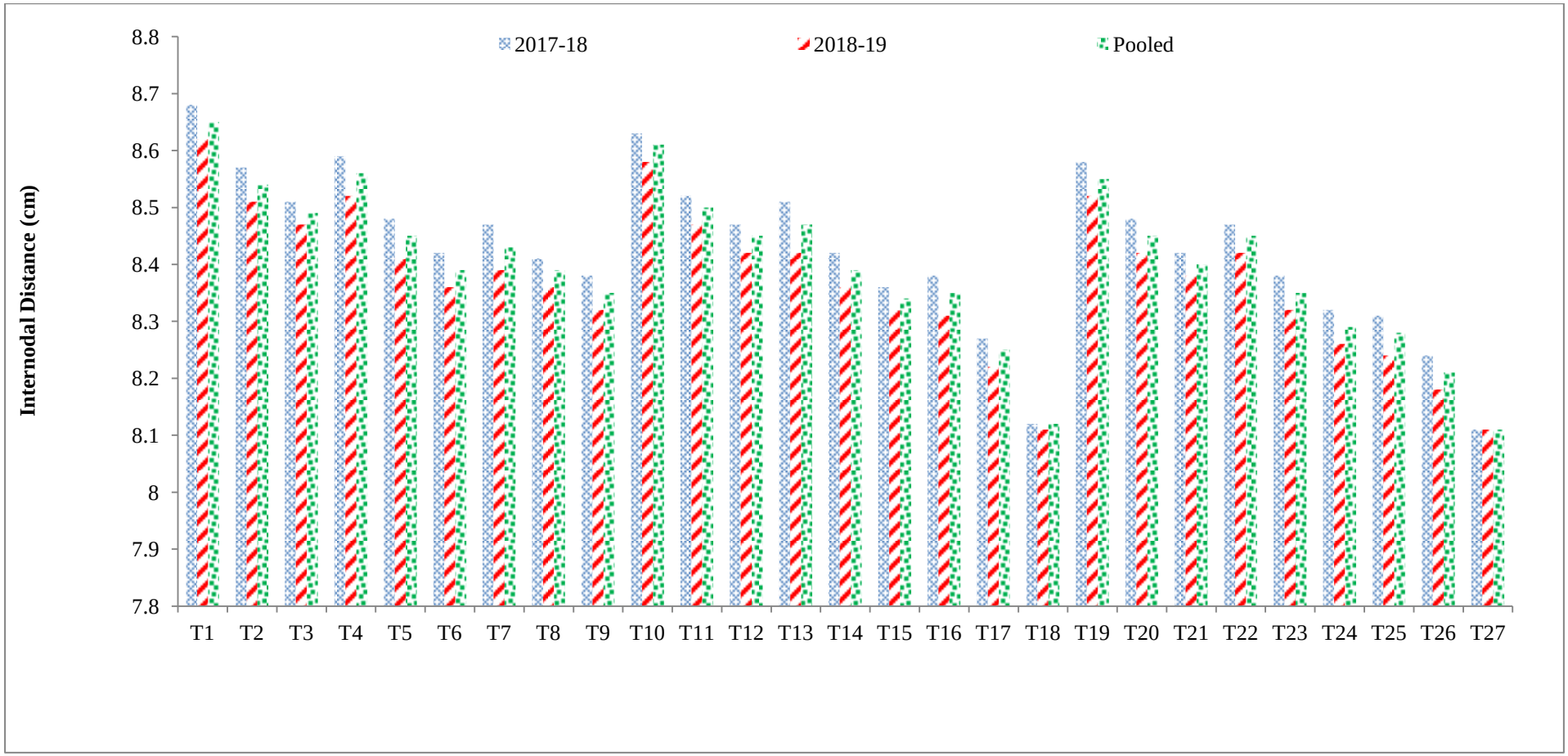

Fig 4.4: Interaction effect of cultivars, spacing and dose of fertilizer application on internodal distance of parthenocarpic cucumber under polyhouse condition during winter season

The above mentioned result, it has been revealed that the effect of cultivars a significant influence on plant height, stem girth, leaf area and internodal distance of cucumber under polyhouse condition. Maximum plant height (2.73 m), stem girth (0.80 cm), leaf area (412.34 cm^2), and internodal distance (41.14 cm) was measured in Pant Parthenocarpic Cucumber -3 (Table 4.1, 4.3, 4.5 and 4.7). It was due to the genetic makeup of the cultivars. However, polyhouse environment favourable condition the growth of the lines by modifying the natural environment and micro climatic conditions surrounding the plants (Abraham *et.al.)* 2002), Arora *et.al.* (2006) and Singh *et. al* (2002) reported similar results in tomato under protected conditions.

Plant geometry significantly affected the plant height, stem girth, leaf area and internodal distance of cucumber (Table 4.1, 4.3, 4.5 and 4.7). Plants at wider spacing (60 x 50 cm) gave maximum plant height (2.74 m), stem girth (0.79 cm), leaf area (411.56 cm^2), and internodal distance (8.33 cm) than closer spacing (60 x30 cm). This may be due to the availability of more space for the plants. Significant linear increase of main vine length, stem girth, leaf area and internodal distance was reported with increased spacing. The present results are supported by the findings of Ban *et. al.* (2006) and Maynard and Scott (1998) in melons.

The results obtained on effect of dose of fertilizer application on plant height, stem girth, leaf area and internodal distance of cucumber indicated that all the characters were significantly influenced (Table 4.1, 4.3, 4.5 and 4.7). Maximum dose of fertilizers application combination of NPK of cucumber adequately sustain favourable vegetative and reproductive growth as compar to minimum dose of fertilizers application. These results are in accordance with the finding of AI-Jaloud *et al.* (1999).

Interaction effect of cultivars, spacing and dose of fertilizers application on vine length of cucumber during winter season had a significant effect (Table 4.2, 4.4, 4.6 and 4.8). The maximum plant height (3.04 m) was reported in treatment T_{18}, $V_2S_3P_3$ (PPC-3+30:20:32kg+ 60X50 cm). Whereas, all these interactions significantly influenced the stem girth, leaf area and internodal distance of cucumber during winter season (Appendix X,XI and XII).

A perusal of data presented in (Table 4.1, 4.3, 4.5 and 4.7). clearly indicated that the cultivar PPC-3 (V_2) exhibited significantly higher plant height, stem girth, leaf area, internodal distance (3.04 m, 0.85 cm, 422.60 cm^2 and 8.11cm), respectively in spacing S_3 (60 x 50 cm) as compared to S_1 (60 x 30 cm) along with the D_3 maximum dose of fertilizers application. This difference in varietal performance of cucumber during winter season may be due to varietal characteristics. Singh *et al.* (2005) reported Isatis and Kian cultivars of cucumber is ideal for growing in winter season.

4.2 FLOWER CHARACTERISTICS

4.2.1 Days to first flower bud initiate (DAS)

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on days to first flower bud initiatation of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.9 and Fig. 4.5. The analysis of variance is given in Appendix XIII.XIV and XV.

(a) Effect of cultivars:

The data presented in Table 4.9 the days to first flower bud initiatation of parthenocarpic cucumber was significantly influenced by various cultivar during both the years of experiment of winter season however, on the basis of pooled data analysis the minimum days to first flower bud initiatation (42.14 DAS) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to maximum days to first flower bud initiatation (42.95 DAS) in cultivar V_3 (Hilton).

(b) Effect of spacing:

Data presented in Table 4.9 indicated that the days to first flower bud initiate of cucumber was significantly influenced by various spacing treatments during both the years of experiment. The pooled data showed that minimum days to first flower bud initiatation (441.06 DAS) was recorded in P3 (60 x 50 cm) and maximum days to first flower bud initiatation (44.31) in Pl (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.9 that dose of fertilizer application was significant effect on days to first flower bud initiate of parthenocarpic cucumber during both the years of investigation. Minimum days to first flower bud initiate (42.11 DAS) was observed in D_3 (30:20:32 kg/1000 m^2) as compared to maximum (42.67 DAS) in D_2 (25:15:27 kg/1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.10 showed significant days to first flower bud initiate during both the years of experiment. Further, T_{18}, $V_2D_3P_3$ (PPC -3 + 30:20:32 kg + 60 X 50 cm) resulted in minimum days to first flower bud initiate (39.35 DAS). However, maximum days to first flower bud initiatation (43.75 DAS) was recorded in $V_1D_1P_1$ (PPC -2 + 20:10:22 kg + 60 X 30 cm) on pooled data basis.

Table 4.9: Effect of cultivars, spacing and dose of fertilizer application on days to first flower bud initiate of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	42.47	42.18	42.32
V_2	Pant Parthenocarpic Cucumber -3	42.22	42.06	42.14
V_3	Hilton	43.04	42.86	42.95
	F – test	S	S	S
	S. Ed. (±)	0.096	0.110	0.103
	CD at 5%	0.196	0.223	0.209
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	42.79	42.48	42.63
D_2	25:15:27 kg	42.72	42.62	42.67
D_3	30:20:32 kg	42.22	41.99	42.11
	F – test	S	S	S
	S Ed. (±)	0.096	0.110	0.103
	CD at 5%	0.196	0.223	0.209
Plant geometry (P)				
P_1	60 X 30	44.47	44.16	44.31
P_2	60 X 40	42.17	41.91	42.04
P_3	60X 50	41.10	41.02	41.06
	F – test	S	S	S
	S. Ed. (±)	0.096	0.110	0.103
	CD at 5%	0.196	0.223	0.209

Table 4.10: Interaction effect of cultivars, spacing and dose of fertilizer application on days to first flower bud initiate of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	44.40	43.10	43.75
T_2	$V_1+D_1+P_2$	42.20	42.10	42.15
T_3	$V_1+D_1+P_3$	41.00	41.00	41.00
T_4	$V_1+D_2+P_1$	44.30	44.20	44.25
T_5	$V_1+D_2+P_2$	42.10	42.10	42.10
T_6	$V_1+D_2+P_3$	41.00	41.00	41.00
T_7	$V_1+D_3+P_1$	44.10	44.00	44.05
T_8	$V_1+D_3+P_2$	42.10	41.10	41.60
T_9	$V_1+D_3+P_3$	41.00	41.00	41.00
T_{10}	$V_2+D_1+P_1$	44.50	44.20	44.35
T_{11}	$V_2+D_1+P_2$	42.60	42.30	42.45
T_{12}	$V_2+D_1+P_3$	41.30	41.10	41.20
T_{13}	$V_2+D_2+P_1$	44.40	44.20	44.30
T_{14}	$V_2+D_2+P_2$	42.20	42.10	42.15
T_{15}	$V_2+D_2+P_3$	41.30	41.20	41.25
T_{16}	$V_2+D_3+P_1$	44.30	44.10	44.20
T_{17}	$V_2+D_3+P_2$	40.00	40.00	40.00
T_{18}	$V_2+D_3+P_3$	39.40	39.30	39.35
T_{19}	$V_3+D_1+P_1$	44.80	44.60	44.70
T_{20}	V_3+D_1+P2	42.70	42.40	42.55
T_{21}	$V_3+D_1+P_3$	41.60	41.50	41.55
T_{22}	$V_3+D_2+P_1$	44.80	44.50	44.65
T_{23}	$V_3+D_2+P_2$	42.90	42.60	42.75
T_{24}	$V_3+D_2+P_3$	41.50	41.70	41.60
T_{25}	$V_3+D_3+P_1$	44.60	44.50	44.55
T_{26}	$V_3+D_3+P_2$	42.70	42.50	42.60
T_{27}	$V_3+D_3+P_3$	41.80	41.40	41.60
Interaction (Vx D x P)	F – test	S	S	S
	S. Ed. (±)	0.289	0.329	0.309
	CD. at 5%	0.587	0.670	0.628

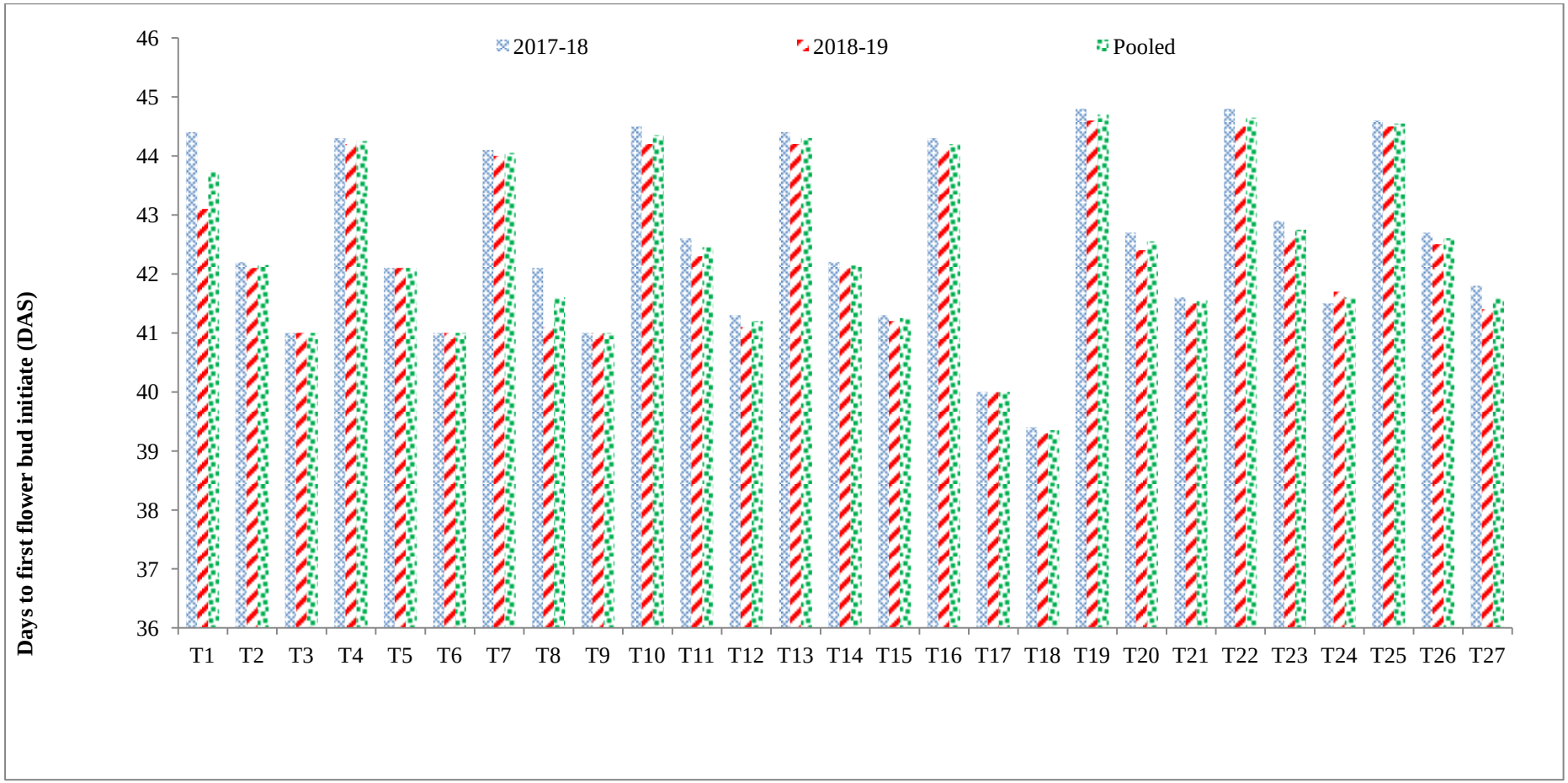

Fig 4.5: Interaction effects of cultivars, spacing and dose of fertilizer application on days to first flower bud initiate of parthenocarpic cucumber under polyhouse condition during winter season

The data presented in Table 4.9 to 4.10 clearly showed that effect of cultivars, spacing and dose of fertilizer along with their interaction effects had significantly influenced the minimum days to first flower bud initiation (42.13 DAS) was reported in cultivar V_2 (Pant parthenocarpic cucumber -2), spacing P_3 (41.06 DAS) which was found at par with spacing P_2 and P_1 (42.04 and 44.31 DAS respectively) and with Fertigation minimum days required to first flower bud initiation $D_{3,}$ (42.11 DAS). Interaction effect of cu1tivars, spacing and dose of fertilizer had a significant effect on minimum days required to flower bud initiation of cucumber. The findings of the present investigation are in close conformity with the findings of Gu1amuddin *et al.* (2006) in cucumber and Similar results have been reported by Suthar *et al.* (2006) in greenhouse grown cucumber.

4.3 YIELD AND YIELD ATTRIBUTING CHARACTERISTICS

4.3.1 Days of first fruits picking (DAS)

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on days to first fruit picking of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.11 and Fig.4.6. The analysis of variance is given in Appendix XVI.XVII and XVIII.

(a) Effect of cultivars:

The data presented in Table 4.11 the days to first fruit picking of parthenocarpic cucumber was significantly influenced by various cultivar during both the years of experiment of winter season however, on the basis of pooled data analysis the minimum days to first fruit picking (55.42 DAS) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to maximum days to first fruit picking (57.35 DAS) in cultivar V_1 (Pant Parthenocarpic Cucumber-2).

(b) Effect of spacing:

Data presented in Table 4.11 indicated that the days to first fruit picking of cucumber was significantly influenced by various spacing treatments during both the years of experiment. The pooled data showed that minimum days to first fruit picking (56.07 DAS) was recorded in P_3 (60 x 50 cm) and maximum days to first fruit picking (57.27 DAS) in P_1 (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.11 that dose of fertilizer application was significant effect on days to first fruit picking of parthenocarpic cucumber during both the years of investigation. minimum days to first fruit picking (55.71 DAS) was observed in D_3 (30:20:32 kg/1000 m^2) as compared to maximum first fruit picking (57.22 DAS) in D_1 (20:10:22 kg /1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.12 showed significant days to first fruit picking during both the years of experiment. Further, $T_{18,}$ $V_2D_3P_3$ (PPC-3 + 30:20:32 kg + 60 X 50 cm) resulted in minimum days to first fruit picking (52.40 DAS). However, maximum days to first fruit picking (58.25 DAS) was recorded in $T_{1,}$ $V_1D_1P_1$ (PPC-2 + 20:10:22 kg + 60 X 30 cm) on pooled data basis.

Table 4.11: Effect of cultivars, spacing and dose of fertilizer application on days to first fruit picking of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	57.43	57.27	57.35
V_2	Pant Parthenocarpic Cucumber -3	55.62	55.22	55.42
V_3	Hilton	57.26	57.00	57.13
	F – test	S	S	S
	S Ed. (±)	0.078	0.066	0.071
	CD at 5%	0.158	0.135	0.144
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	57.37	57.07	57.22
D_2	25:15:27 kg	57.11	56.83	56.97
D_3	30:20:32 kg	55.83	55.59	55.71
	F – test	S	S	S
	S Ed. (±)	0.078	0.066	0.071
	CD at 5%	0.158	0.135	0.144
Plant geometry (P)				
P_1	60 x 30	57.40	57.14	57.27
P_2	60 x 40	56.71	56.40	56.56
P_3	60 x 50	56.20	55.94	56.07
	F – test	S	S	S
	S Ed. (±)	0.078	0.066	0.071
	CD at 5%	0.158	0.135	0.144

Table 4.12: Interaction effect of cultivars, spacing and dose of fertilizer application on days to first fruit picking of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	58.30	58.20	58.25
T_2	$V_1+D_1+P_2$	57.80	57.40	57.60
T_3	$V_1+D_1+P_3$	57.60	57.20	57.40
T_4	$V_1+D_2+P_1$	58.20	58.00	58.10
T_5	$V_1+D_2+P_2$	57.40	57.20	57.30
T_6	$V_1+D_2+P_3$	57.20	57.10	57.15
T_7	$V_1+D_3+P_1$	57.20	57.10	57.15
T_8	$V_1+D_3+P_2$	57.00	56.80	56.90
T_9	$V_1+D_3+P_3$	56.20	56.40	56.30
T_{10}	$V_2+D_1+P_1$	57.20	57.00	57.10
T_{11}	$V_2+D_1+P_2$	56.20	55.80	56.00
T_{12}	$V_2+D_1+P_3$	56.00	55.60	55.80
T_{13}	$V_2+D_2+P_1$	57.00	56.40	56.70
T_{14}	$V_2+D_2+P_2$	56.20	56.00	56.10
T_{15}	$V_2+D_2+P_3$	55.80	55.20	55.50
T_{16}	$V_2+D_3+P_1$	55.40	55.00	55.20
T_{17}	$V_2+D_3+P_2$	54.20	53.80	54.00
T_{18}	$V_2+D_3+P_3$	52.60	52.20	52.40
T_{19}	$V_3+D_1+P_1$	58.20	57.80	58.00
T_{20}	V_3+D_1+P2	57.60	57.40	57.50
T_{21}	$V_3+D_1+P_3$	57.40	57.20	57.30
T_{22}	$V_3+D_2+P_1$	58.00	57.80	57.90
T_{23}	$V_3+D_2+P_2$	57.20	57.00	57.10
T_{24}	$V_3+D_2+P_3$	57.00	56.80	56.90
T_{25}	$V_3+D_3+P_1$	57.10	57.00	57.05
T_{26}	$V_3+D_3+P_2$	56.80	56.20	56.50
T_{27}	$V_3+D_3+P_3$	56.00	55.80	55.90
Interaction (Vx D x P)	F – test	S	S	S
	S. Ed. (±)	0.233	0.199	0.212
	C D. at 5%	0.473	0.404	0.431

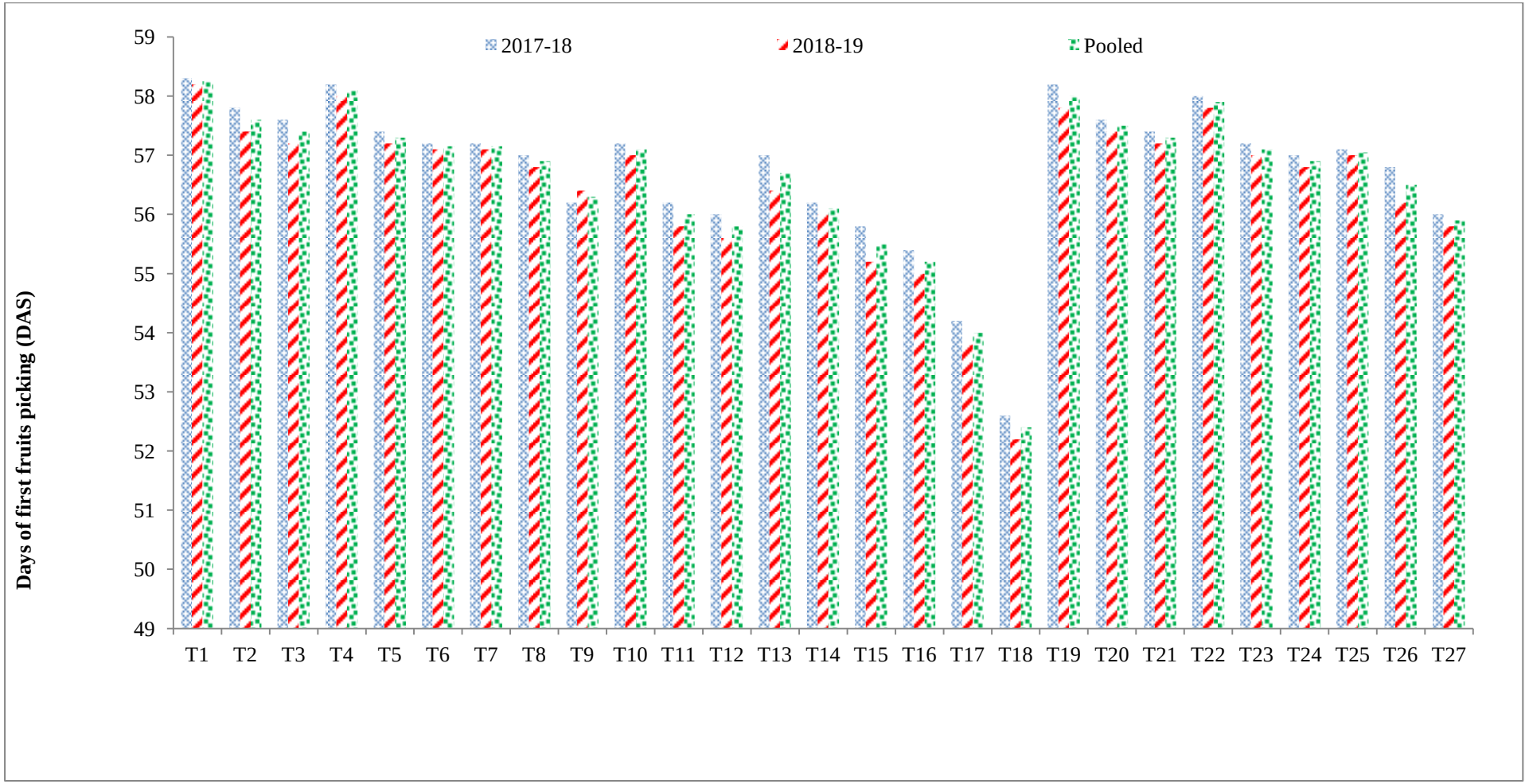

Fig 4.6 Interaction effect of cultivars, spacing and dose of fertilizer application on days to first fruit picking of parthenocarpic cucumber under polyhouse condition during winter season

4.3.2 Number of fruit per plant

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on No. of fruits per plant of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.13 and Fig. 4.7. The analysis of variance is given in Appendix IX, XX and XXI.

(a) Effect of cultivars:

The data presented in Table 4.13 the No. of fruits per plant of parthenocarpic cucumber was significantly influenced by various cultivar during both the years of experimentation of winter season however, on the basis of pooled data analysis the maximum No. of fruits per plant (21.89) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to minimum No. of fruits per plant (19.78) in cultivar V_1 (Pant Parthenocarpic Cucumber-2).

(b) Effect of spacing:

Data presented in Table 4.13 indicated that the No. of fruits per plant of cucumber was significantly influenced by various spacing treatments during both the years of experiment. The pooled data showed that maximum No. of fruits per plant (21.24) was recorded in P_3 (60 wx 50 cm) and minimum No. of fruits per plant (20.18) in P_1 (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.13 that dose of fertilizer application was significant effect No. of fruits per plant weight of parthenocarpic cucumber during both the years of investigation. Maximum No. of fruits per plant (21.58) was observed in D_3 (30:20:32 kg/1000 m^2) as compared to minimum No. of fruits per plant (19.91) in D_1 (20:10:22 kg /1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.14 showed significant No. of fruits per plant during both the years of experiment. Further, $T_{18,}$ $V_2D_3P_3$ (PPC-3 + 30:20:32 kg + 60 x 50 cm) resulted in maximum No. of fruits per plant (24.80). However, minimum No. of fruits per plant (18.70) was recorded in $T_{1,}$ $V_1D_1P_1$ (PPC-2 + 20:10:22 kg + 60 x 30 cm) on pooled data basis.

Table 4.13: Effect of cultivars, spacing and dose of fertilizer application on No. of fruit per plant of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	19.61	19.96	19.78
V_2	Pant Parthenocarpic Cucumber -3	21.56	22.23	21.89
V_3	Hilton	20.10	20.77	20.43
	F – test	S	S	S
	S Ed. (±)	0.054	0.062	0.058
	CD at 5%	0.111	0.126	0.118
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	19.58	20.24	19.91
D_2	25:15:27 kg	20.44	20.79	20.62
D_3	30:20:32 kg	21.24	21.92	21.58
	F – test	S	S	S
	S Ed. (±)	0.054	0.062	0.058
	CD at 5%	0.111	0.126	0.118
Plant geometry (P)				
P_1	60 x 30	19.87	20.50	20.18
P_2	60 x 40	20.43	20.94	20.69
P_3	60 x 50	20.97	21.51	21.24
	F – test	S	S	S
	S. Ed. (±)	0.054	0.062	0.058
	CD at 5%	0.111	0.126	0.118

Table 4.14: Interaction effect of cultivars, spacing and dose of fertilizer application on No. of fruit per plant of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	18.50	18.90	18.70
T_2	$V_1+D_1+P_2$	19.10	19.60	19.35
T_3	$V_1+D_1+P_3$	19.20	19.70	19.45
T_4	$V_1+D_2+P_1$	18.90	19.20	19.05
T_5	$V_1+D_2+P_2$	19.80	19.90	19.85
T_6	$V_1+D_2+P_3$	20.10	20.50	20.30
T_7	$V_1+D_3+P_1$	19.90	20.30	20.10
T_8	$V_1+D_3+P_2$	20.20	20.60	20.40
T_9	$V_1+D_3+P_3$	20.80	20.90	20.85
T_{10}	$V_2+D_1+P_1$	19.50	20.70	20.10
T_{11}	$V_2+D_1+P_2$	20.40	21.10	20.75
T_{12}	$V_2+D_1+P_3$	21.10	21.50	21.30
T_{13}	$V_2+D_2+P_1$	21.30	21.80	21.55
T_{14}	$V_2+D_2+P_2$	21.50	21.90	21.70
T_{15}	$V_2+D_2+P_3$	21.80	22.30	22.05
T_{16}	$V_2+D_3+P_1$	21.90	22.60	22.25
T_{17}	$V_2+D_3+P_2$	22.20	22.90	22.55
T_{18}	$V_2+D_3+P_3$	24.30	25.30	24.80
T_{19}	$V_3+D_1+P_1$	18.90	19.70	19.30
T_{20}	V_3+D_1+P2	19.80	20.30	20.05
T_{21}	$V_3+D_1+P_3$	19.70	20.70	20.20
T_{22}	$V_3+D_2+P_1$	19.60	19.90	19.75
T_{23}	$V_3+D_2+P_2$	20.20	20.70	20.45
T_{24}	$V_3+D_2+P_3$	20.80	20.90	20.85
T_{25}	$V_3+D_3+P_1$	20.30	21.40	20.85
T_{26}	$V_3+D_3+P_2$	20.70	21.50	21.10
T_{27}	$V_3+D_3+P_3$	20.90	21.80	21.35
Interaction (Vx D x P)	F - test	S	S	S
	S. Ed. (±)	0.163	0.187	0.175
	CD. at 5%	0.332	0.379	0.355

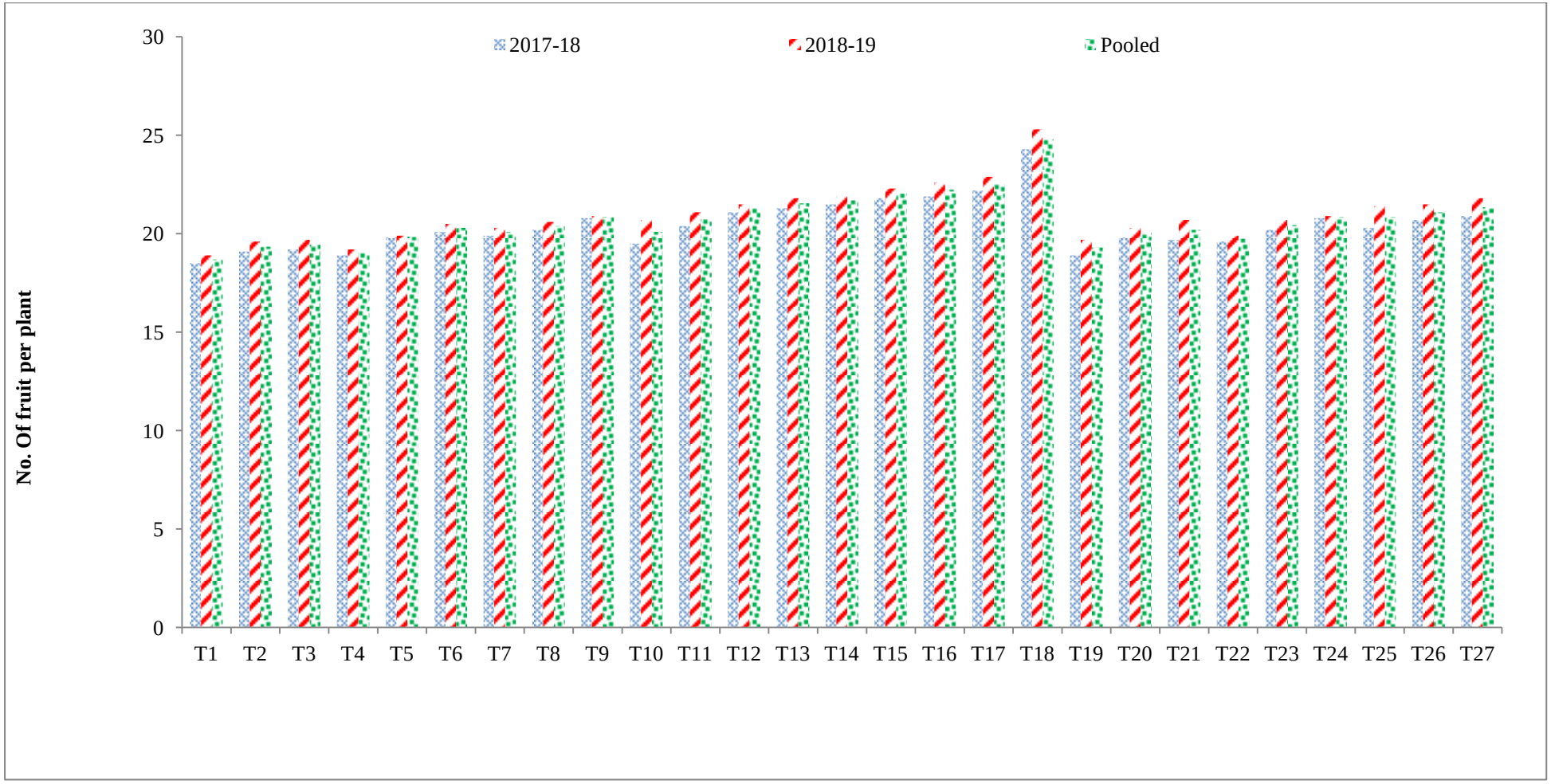

Fig 4.7: Interaction effect of cultivars, spacing and dose of fertilizer application on No. of fruit per plant of parthenocarpic cucumber under polyhouse condition during winters session.

4.3.3 Number of unmarketable fruits per plant

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on number of unmarketable fruits per plants of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.15 and Fig. 4.8. The analysis of variance is given in Appendix XXII, XXIII and XXIV.

(a) Effect of cultivars:

The data presented in Table 4.15 the number of unmarketable fruits per plant of parthenocarpic cucumber was significantly influenced by various cultivar treatments during both the years of experimentation of winter season however, on the basis of pooled data analysis the minimum number of unmarketable fruits per plant (1.46) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to maximum number of unmarketable fruits per plant (1.85) in cultivar V_3 (Hilton).

(b) Effect of spacing:

Data presented in Table 4.15 indicated that the number of unmarketable fruits per plant of cucumber was significantly influenced by various spacing treatments during both the years of experimentation. The pooled data showed that minimum number of unmarketable fruits per plant (1.51) was recorded in P_1 (60 x 30 cm) and maximum number of unmarketable fruits per plant (1.84) in P_3 (60 x 50 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.15 that dose of fertilizer application was significant effect number of unmarketable fruits per plants of parthenocarpic cucumber during both the years of investigation. Minimum number of unmarketable fruits per plants (1.53) was observed in D_3 (30:20:32 kg/1000 m^2) as compared to maximum number of unmarketable fruits per plants (1.81) in D_1 (20:10:22 kg /1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 16 showed significant number of unmarketable fruits per plants during both the years of experimentation. Further, $T_{18,}$ $V_2D_3P_3$ (PPC-3 + 30:20:32 kg + 60 X 50 cm) resulted in minimum number of unmarketable fruits per plants (1.10). However, maximum number of unmarketable fruits per plants (2.10) was recorded in $T_{27,}$ $V_3D_3P_3$ (Hilton + 30:20:32 kg + 60 X 50 cm) on pooled data basis.

Table 4.15: Effect of cultivars, spacing and dose of fertilizer application on number of unmarketable fruits per plants of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	1.78	4.63	1.66
V_2	Pant Parthenocarpic Cucumber -3	1.56	4.07	1.46
V_3	Hilton	1.92	5.33	1.85
	F – test	S	S	S
	S Ed. (±)	0.031	0.036	0.033
	CD at 5%	0.062	0.073	0.067
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	1.91	5.13	1.81
D_2	25:15:27 kg	1.72	4.60	1.63
D_3	30:20:32 kg	1.62	4.30	1.53
	F – test	S	S	S
	S Ed. (±)	0.031	0.036	0.033
	CD at 5%	0.062	0.073	0.067
Plant geometry (P)				
P_1	60 x 30	1.59	4.27	1.51
P_2	60 x 40	1.71	4.60	1.62
P_3	60 x 50	1.96	5.17	1.84
	F – test	S	S	S
	S Ed. (±)	0.031	0.036	0.033
	CD at 5%	0.062	0.073	0.067

Table 4.16: Interaction effect of cultivars, spacing and dose of fertilizer application on number of unmarketable fruits per plants of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	1.70	1.40	1.55
T_2	$V_1+D_1+P_2$	1.90	1.60	1.75
T_3	$V_1+D_1+P_3$	2.10	1.80	1.95
T_4	$V_1+D_2+P_1$	1.50	1.20	1.35
T_5	$V_1+D_2+P_2$	1.70	1.60	1.65
T_6	$V_1+D_2+P_3$	2.00	1.80	1.90
T_7	$V_1+D_3+P_1$	1.60	1.50	1.55
T_8	$V_1+D_3+P_2$	1.60	1.40	1.50
T_9	$V_1+D_3+P_3$	1.90	1.60	1.75
T_{10}	$V_2+D_1+P_1$	1.60	1.50	1.55
T_{11}	$V_2+D_1+P_2$	1.70	1.50	1.60
T_{12}	$V_2+D_1+P_3$	2.00	1.80	1.90
T_{13}	$V_2+D_2+P_1$	1.50	1.40	1.45
T_{14}	$V_2+D_2+P_2$	1.40	1.20	1.30
T_{15}	$V_2+D_2+P_3$	1.80	1.40	1.60
T_{16}	$V_2+D_3+P_1$	1.50	1.30	1.40
T_{17}	$V_2+D_3+P_2$	1.30	1.10	1.20
T_{18}	$V_2+D_3+P_3$	1.20	1.00	1.10
T_{19}	$V_3+D_1+P_1$	1.80	1.70	1.75
T_{20}	V_3+D_1+P2	2.10	2.00	2.05
T_{21}	$V_3+D_1+P_3$	2.30	2.10	2.20
T_{22}	$V_3+D_2+P_1$	1.60	1.40	1.50
T_{23}	$V_3+D_2+P_2$	1.90	1.80	1.85
T_{24}	$V_3+D_2+P_3$	2.10	2.00	2.05
T_{25}	$V_3+D_3+P_1$	1.50	1.40	1.45
T_{26}	$V_3+D_3+P_2$	1.80	1.60	1.70
T_{27}	$V_3+D_3+P_3$	2.20	2.00	2.10
Interaction (Vx D x P)	F - test	S	S	S
	S. Ed. (±)	0.092	0.108	0.098
	CD. at 5%	0.186	0.219	0.200

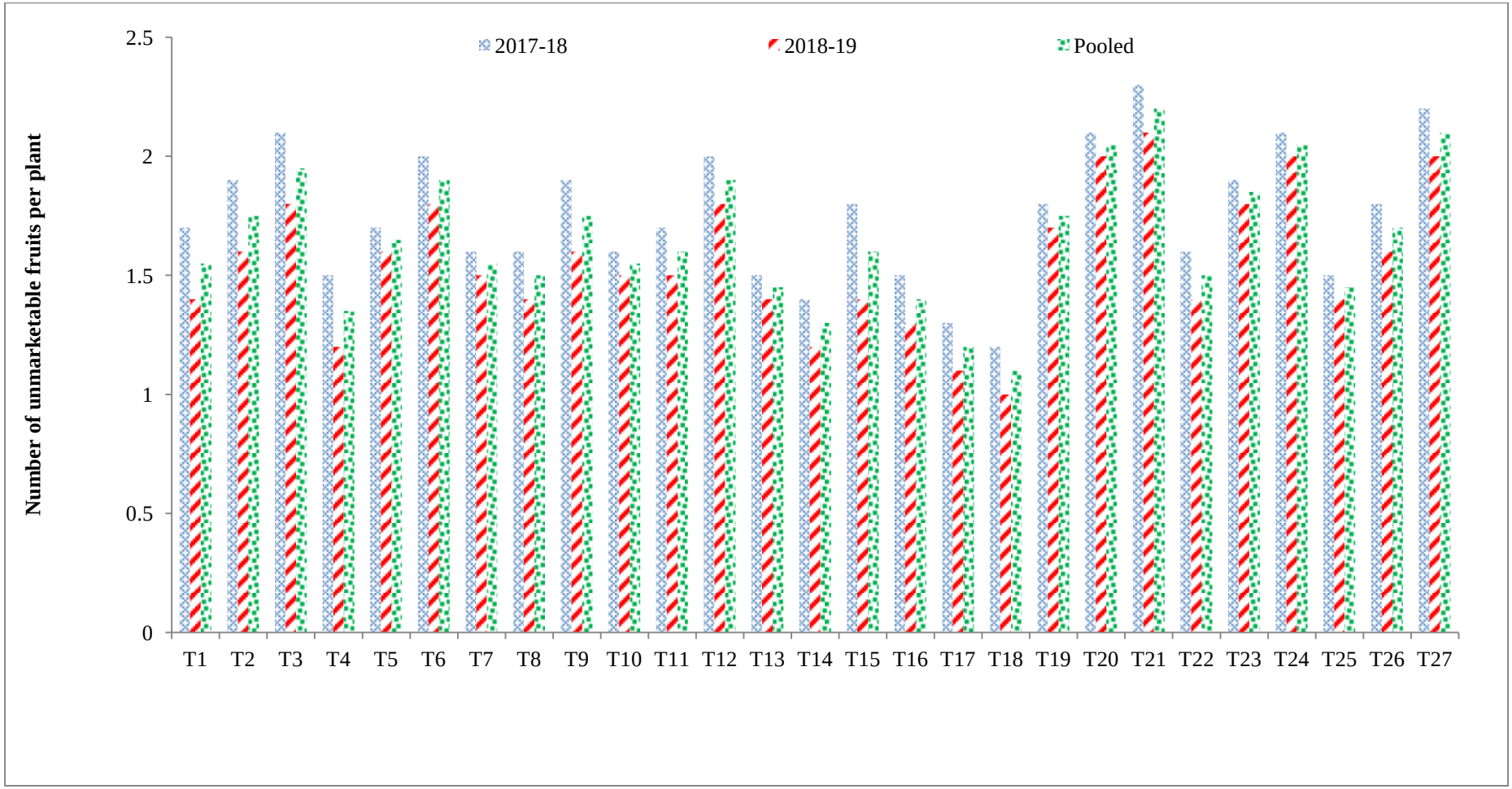

Fig 4.8: Interaction effect of cultivars, spacing and dose of fertilizer application on number of unmarketable fruits per plants of parthenocarpic cucumber under polyhouse condition during winter season.

4.2.4 Fruit weight (g)

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on av. fruit weight (g) of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.17 and Fig. 4.9. The analysis of variance is given in Appendix XXV, XXVI and XXVII.

(a) Effect of cultivars:

The data presented in Table 4.17 the av. fruit weight of parthenocarpic cucumber was significantly influenced by various cultivar during both the years of experiment of winter season however, on the basis of pooled data analysis the maximum Av. fruit weight (116.41 g) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to minimum Av. fruit weight (116.11) in cultivar V_1 (Pant Parthenocarpic Cucumber-2).

(b) Effect of spacing:

Data presented in Table 4.17 indicated that the Av. fruit weight of cucumber was significantly influenced by various spacing treatments during both the years of experiment. The pooled data showed that maximum av. fruit weight (118.45 g) was recorded in P_3 (60 x 50 cm) and minimum Av. fruit weight (113.42 g) in P_1 (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.17 that dose of fertilizer application was significant effect on Av. fruit weight of parthenocarpic cucumber during both the years of investigation. Maximum Av. fruit weight (117.96 g) was observed in D_3 (30:20:32 kg/1000 m^2) as compared to minimum Av. fruit weight (114.39) in D_1 (20:10:22 kg /1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.18 showed significant days to Av. fruit weight during both the years of experiment. Further, $T_{18,}$ $V_2D_3P_3$ (PPC-3 + 30:20:32 kg + 60 X 50 cm) resulted in maximum Av. fruit weight (120.50 g). However, minimum Av. fruit weight (112.35 g) was recorded in $T_{1,}$ $V_1D_1P_1$ (PPC-2 + 20:10:22 kg + 60 x 30 cm) on pooled data basis.

Table 4.17: Effect of cultivars, spacing and dose of fertilizer application on width of average fruit weight (g) of parthenocarpic cucumber under polyhouse condition during winter season

Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	116.04	116.18	116.11
V_2	Pant Parthenocarpic Cucumber -3	116.33	116.49	116.41
V_3	Hilton	116.18	116.36	116.27
	F – test	S	S	S
	S Ed. (±)	0.011	0.031	0.021
	CD at 5%	0.023	0.062	0.042
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	114.31	114.47	114.39
D_2	25:15:27 kg	116.36	116.53	116.44
D_3	30:20:32 kg	117.89	118.02	117.96
	F – test	S	S	S
	S. Ed. (±)	0.011	0.031	0.021
	CD at 5%	0.023	0.062	0.042
Plant geometry (P)				
P_1	60 x 30	113.33	113.50	113.42
P_2	60 x 40	116.86	116.99	116.92
P_3	60 x 50	118.37	118.53	118.45
	F – test	S	S	S
	S. Ed. (±)	0.011	0.031	0.021
	CD at 5%	0.023	0.062	0.042

Table 4.18: Interaction effect of cultivars, spacing and dose of fertilizer application on average fruit weight (g) of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	112.30	112.40	112.35
T_2	$V_1+D_1+P_2$	114.10	114.20	114.15
T_3	$V_1+D_1+P_3$	116.20	116.30	116.25
T_4	$V_1+D_2+P_1$	113.10	113.40	113.25
T_5	$V_1+D_2+P_2$	117.10	117.40	117.25
T_6	$V_1+D_2+P_3$	118.40	118.50	118.45
T_7	$V_1+D_3+P_1$	114.10	114.30	114.20
T_8	$V_1+D_3+P_2$	118.90	118.80	118.85
T_9	$V_1+D_3+P_3$	120.20	120.30	120.25
T_{10}	$V_2+D_1+P_1$	112.50	112.60	112.55
T_{11}	$V_2+D_1+P_2$	114.40	114.50	114.45
T_{12}	$V_2+D_1+P_3$	116.40	116.60	116.50
T_{13}	$V_2+D_2+P_1$	113.30	113.50	113.40
T_{14}	$V_2+D_2+P_2$	117.60	117.70	117.65
T_{15}	$V_2+D_2+P_3$	118.70	118.90	118.80
T_{16}	$V_2+D_3+P_1$	114.60	114.70	114.65
T_{17}	$V_2+D_3+P_2$	119.10	119.30	119.20
T_{18}	$V_2+D_3+P_3$	120.40	120.60	120.50
T_{19}	$V_3+D_1+P_1$	112.40	112.60	112.50
T_{20}	V_3+D_1+P2	114.20	114.40	114.30
T_{21}	$V_3+D_1+P_3$	116.30	116.60	116.45
T_{22}	$V_3+D_2+P_1$	113.20	113.30	113.25
T_{23}	$V_3+D_2+P_2$	117.30	117.40	117.35
T_{24}	$V_3+D_2+P_3$	118.50	118.70	118.60
T_{25}	$V_3+D_3+P_1$	114.50	114.70	114.60
T_{26}	$V_3+D_3+P_2$	119.00	119.20	119.10
T_{27}	$V_3+D_3+P_3$	120.20	120.30	120.25
Interaction (Vx D x P)	F - test	S	S	S
	S. Ed. (±)	0.033	0.092	0.062
	CD. at 5%	0.068	0.186	0.126

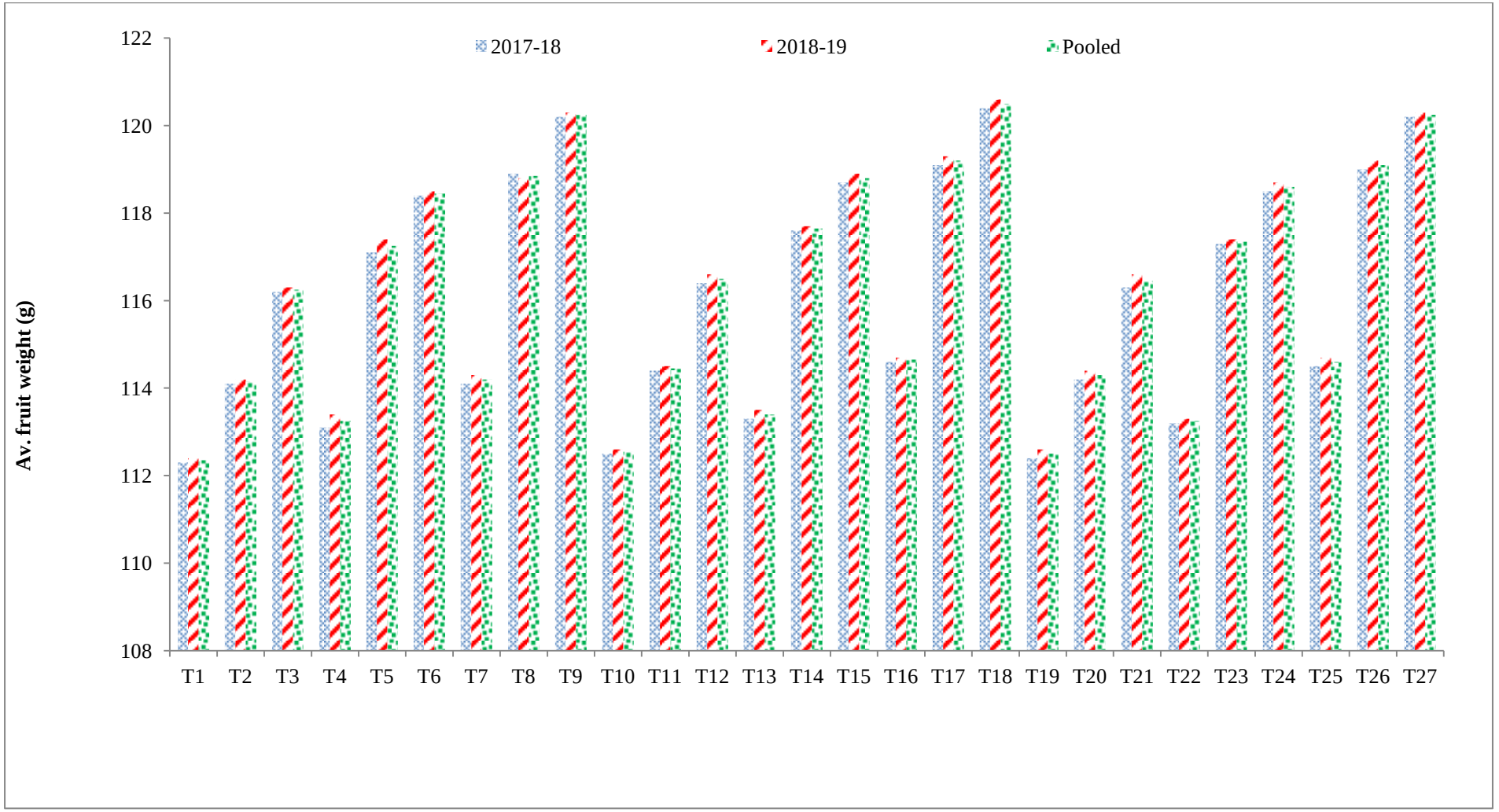

Fig 4.9: Interaction effect of cultivars, spacing and dose of fertilizer application on average fruit weight (g) of parthenocarpic cucumber under polyhouse condition during winter seas

4.2.5 Fruits yield per plant (kg)

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on fruits yield per plants of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.19 and Fig. 4.10. The analysis of variance is given in Appendix XXVIII, XXIX and XXX.

(a) Effect of cultivars:

The data presented in Table 4.19 the fruits yield per plants of parthenocarpic cucumber was significantly influenced by various cultivar treatments during both the years of experimentation of winter season however, on the basis of pooled data analysis the maximum fruits yield per plants (2.82 kg) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to minimum fruits yield per plants (2.58 kg) in cultivar V_1 (Pant Parthenocarpic Cucumber-2)

(b) Effect of spacing:

Data presented in Table 4.19 indicated that the fruits yield per plants of cucumber was significantly influenced by various spacing treatments during both the years of experimentation. The pooled data showed that maximum fruits yield per plants (2.81 kg) was recorded in P_3 (60 x 50 cm) and minimum fruits yield per plants (2.61 kg) in P1 (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.19 that dose of fertilizer application was significant effect fruits yield per plants of parthenocarpic cucumber during pooled data investigation maximum fruits yield per plants (2.85 kg) was observed in D_3 (30:20:32 kg/1000 m^2) as compared to minimum fruits yield per plants (2.56 kg) in D_2 (25:15:27 kg /1000m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.20 showed significant fruits yield per plants during both the years of experimentation. Further, $T_{18,}$ $V_2D_3P_3$ (PPC-3 + 30:20:32 kg + 60 X 50 cm) resulted in maximum fruits yield per plants (3.20 kg). and was closely followed by $T_{17,}$ $V_2+D_3+P_2$ (3.00 kg) and this was statically at par with T_{18} However, minimum fruits yield per plants (2.35 kg) was recorded in $T_{1,}$ $V_1D_1P_1$ (PPC-2 + 20:10:22 kg + 60 X 30 cm) on pooled data basis.

Table 4.19: Effect of cultivars, spacing and dose of fertilizer application fruits yield per plant of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	2.50	2.66	2.58
V_2	Pant Parthenocarpic Cucumber -3	2.72	2.92	2.82
V_3	Hilton	2.66	2.81	2.73
	F – test	S	S	S
	S Ed. (±)	0.018	0.009	0.014
	CD at 5%	0.037	0.018	0.028
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	2.46	2.66	2.56
D_2	25:15:27 kg	2.64	2.81	2.73
D_3	30:20:32 kg	2.78	2.92	2.85
	F – test	S	S	S
	S. Ed. (±)	0.018	0.009	0.014
	CD at 5%	0.037	0.018	0.028
Plant geometry (P)				
P_1	60 x 30	2.53	2.69	2.61
P_2	60 x 40	2.61	2.81	2.71
P_3	60 x 50	2.73	2.89	2.81
	F – test	S	S	S
	S Ed. (±)	0.018	0.009	0.014
	CD at 5%	0.037	0.018	0.028

Table 4.20: Interaction effect of cultivars, spacing and dose of fertilizer application on fruits yield per plant of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	2.30	2.40	2.35
T_2	$V_1+D_1+P_2$	2.30	2.50	2.40
T_3	$V_1+D_1+P_3$	2.40	2.60	2.50
T_4	$V_1+D_2+P_1$	2.40	2.50	2.45
T_5	$V_1+D_2+P_2$	2.50	2.70	2.60
T_6	$V_1+D_2+P_3$	2.60	2.80	2.70
T_7	$V_1+D_3+P_1$	2.50	2.70	2.60
T_8	$V_1+D_3+P_2$	2.70	2.90	2.80
T_9	$V_1+D_3+P_3$	2.80	2.80	2.80
T_{10}	$V_2+D_1+P_1$	2.40	2.70	2.55
T_{11}	$V_2+D_1+P_2$	2.50	2.80	2.65
T_{12}	$V_2+D_1+P_3$	2.60	2.80	2.70
T_{13}	$V_2+D_2+P_1$	2.60	2.70	2.65
T_{14}	$V_2+D_2+P_2$	2.70	2.90	2.80
T_{15}	$V_2+D_2+P_3$	2.90	3.10	3.00
T_{16}	$V_2+D_3+P_1$	2.80	2.90	2.85
T_{17}	$V_2+D_3+P_2$	2.90	3.10	3.00
T_{18}	$V_2+D_3+P_3$	3.10	3.30	3.20
T_{19}	$V_3+D_1+P_1$	2.40	2.50	2.45
T_{20}	V_3+D_1+P2	2.50	2.80	2.65
T_{21}	$V_3+D_1+P_3$	2.70	2.80	2.75
T_{22}	$V_3+D_2+P_1$	2.80	2.90	2.85
T_{23}	$V_3+D_2+P_2$	2.60	2.70	2.65
T_{24}	$V_3+D_2+P_3$	2.70	3.00	2.85
T_{25}	$V_3+D_3+P_1$	2.60	2.90	2.75
T_{26}	$V_3+D_3+P_2$	2.80	2.90	2.85
T_{27}	$V_3+D_3+P_3$	2.80	2.80	2.80
Interaction (Vx D x P)	F - test	S	S	S
	S. Ed. (±)	0.054	0.027	0.041
	CD. at 5%	0.111	0.055	0.083

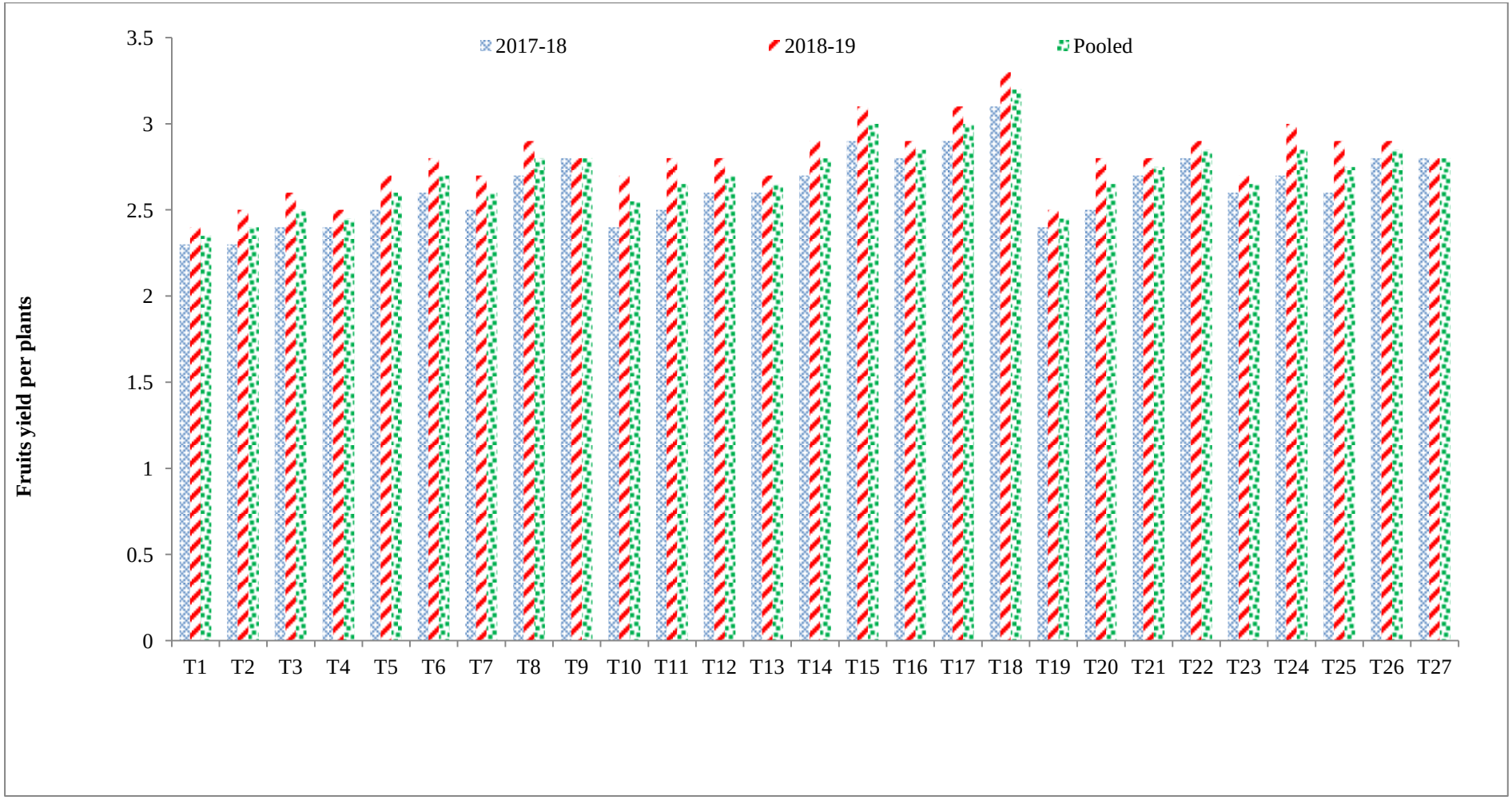

Fig 4.10: Interaction effect of cultivars, spacing and dose of fertilizer application on fruits yield per plant of parthenocarpic cucumber under polyhouse condition during winter season.

4.2.6 Yield per square meter (kg)

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on yield per sq.mtr of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.21 and Fig. 4.11. The analysis of variance is given in Appendix XXXI, XXXII and XXIII.

(a) Effect of cultivars:

The data presented in Table 4.21 the yield per sq.mtr of parthenocarpic cucumber was significantly influenced by various cultivar treatments during both the years of experimentation of winter season however, on the basis of pooled data analysis the maximum yield per sq.mtr (13.46 kg) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to minimum yield / m^2 (12.86 kg) in cultivar V_1 (Pant Parthenocarpic Cucumber-2)

(b) Effect of spacing:

Data presented in Table 4.21 indicated that the yield per sq.mtr of cucumber was significantly influenced by various spacing treatments during both the years of experimentation. The pooled data showed that maximum yield per sq.mtr (14.57 kg) was recorded in P_1 (60 x 30 cm) and minimum yield / m^2 (10.91 kg) in P_3 (60 x 50 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.21 that dose of fertilizer application was significant effect yield per sq.mtr of parthenocarpic cucumber during pooled data investigation maximum yield per sq.mtr (13.33 kg) was observed in D_3 (30:20:32 kg/1000 m^2) as compared to minimum yield per sq.mtr (12.89 kg) in D_1 (20:10:22 kg /1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.22 showed significant yield per sq.mtr during both the years of experimentation. Further, $T_{16,}$ $V_2D_3P_1$ (PPC-3 + 30:20:32 kg + 60 x 30 cm) resulted in maximum yield per sq.mtr (15.15 kg). and was closely followed by $T_{17,}$ $V_2+D_3+P_2$ (14.80 kg) and this was statically at par with T_{16} However, minimum yield per sq.mtr (10.65 kg) was recorded in $T_{27,}$ $V_3D_3P_3$ (Hilton + 30:20:32 kg + 60 x 50 cm) on pooled data basis.

Table 4.21: Effect of cultivars, spacing and dose of fertilizer application fruits yield /m^2 of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	12.78	12.93	12.86
V_2	Pant Parthenocarpic Cucumber -3	13.24	13.68	13.46
V_3	Hilton	12.88	12.99	12.93
	F – test	S	S	S
	S Ed. (±)	0.025	0.043	0.034
	CD at 5%	0.052	0.087	0.068
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	12.74	13.04	12.89
D_2	25:15:27 kg	12.91	13.14	13.03
D_3	30:20:32 kg	13.24	13.41	13.33
	F – test	S	S	S
	S Ed. (±)	0.025	0.043	0.034
	CD at 5%	0.052	0.087	0.068
Plant geometry (P)				
P_1	60 X 30	14.46	14.68	14.57
P_2	60 X 40	13.69	13.86	13.77
P_3	60X 50	10.76	11.07	10.91
	F – test	S	S	S
	S. Ed. (±)	0.025	0.043	0.034
	CD at 5%	0.052	0.087	0.068

Table 4.22: Interaction effect of cultivars, spacing and dose of fertilizer application on fruits yield / m^2 of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	14.20	14.40	14.30
T_2	$V_1+D_1+P_2$	13.40	13.60	13.50
T_3	$V_1+D_1+P_3$	10.30	10.50	10.40
T_4	$V_1+D_2+P_1$	14.30	14.40	14.35
T_5	$V_1+D_2+P_2$	13.50	13.60	13.55
T_6	$V_1+D_2+P_3$	10.60	10.80	10.70
T_7	$V_1+D_3+P_1$	14.40	14.50	14.45
T_8	$V_1+D_3+P_2$	13.60	13.70	13.65
T_9	$V_1+D_3+P_3$	10.70	10.90	10.80
T_{10}	$V_2+D_1+P_1$	14.50	14.80	14.65
T_{11}	$V_2+D_1+P_2$	13.60	13.80	13.70
T_{12}	$V_2+D_1+P_3$	10.50	11.50	11.00
T_{13}	$V_2+D_2+P_1$	14.60	14.90	14.75
T_{14}	$V_2+D_2+P_2$	13.60	13.80	13.70
T_{15}	$V_2+D_2+P_3$	10.90	11.80	11.35
T_{16}	$V_2+D_3+P_1$	14.90	15.40	15.15
T_{17}	$V_2+D_3+P_2$	14.70	14.90	14.80
T_{18}	$V_2+D_3+P_3$	11.90	12.20	12.05
T_{19}	$V_3+D_1+P_1$	14.30	14.50	14.40
T_{20}	V_3+D_1+P2	13.50	13.70	13.60
T_{21}	$V_3+D_1+P_3$	10.40	10.60	10.50
T_{22}	$V_3+D_2+P_1$	14.40	14.50	14.45
T_{23}	$V_3+D_2+P_2$	13.60	13.70	13.65
T_{24}	$V_3+D_2+P_3$	10.70	10.80	10.75
T_{25}	$V_3+D_3+P_1$	14.50	14.70	14.60
T_{26}	$V_3+D_3+P_2$	13.70	13.90	13.80
T_{27}	$V_3+D_3+P_3$	10.80	10.50	10.65
Interaction (Vx D x P)	F – test	S	S	S
	S. Ed. (±)	0.076	0.128	0.101
	CD. at 5%	0.155	0.260	0.204

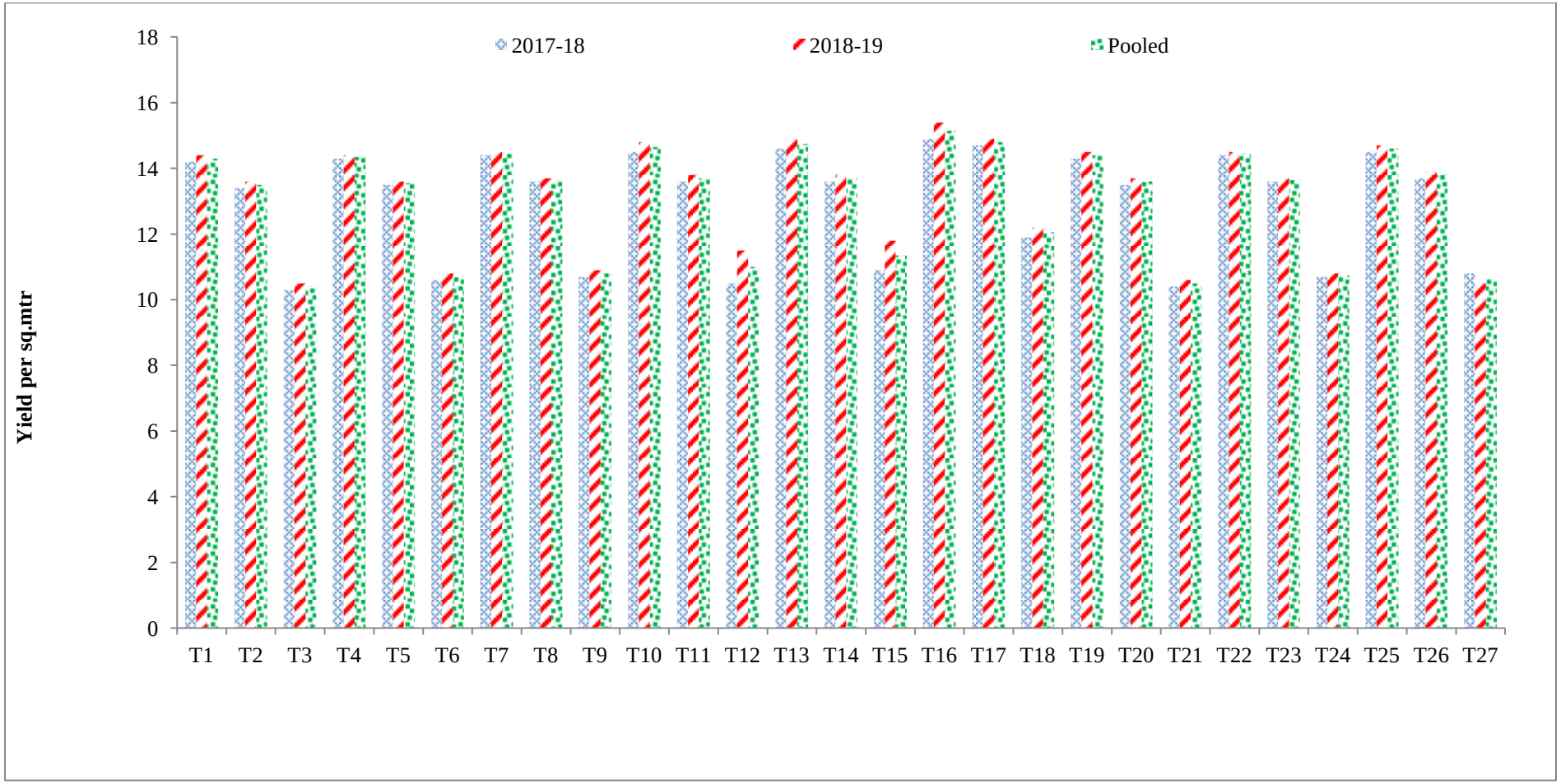

Fig 4.11: Interaction effect of cultivars, spacing and dose of fertilizer application on fruits yield / m^2 per sq.mtr of parthenocarpic cucumber under polyhouse condition during winter season.

The above data among the various yield attributing characters days to first fruit harvest, number of fruits per plant, number of unmarketable fruits per plants, average weight of fruit, yield per plant and yield per sq. meter were recorded in the present investigation.

The character days to first fruit harvest (DAS) was found to be significantly influenced by main effects as cultivars, spacing and dose of fertilizer during the winter session .Minimum number of days required to first fruit harvest (55.42 DAS) was observed in cultivar Pant Parthenocarpic Cucumber -3, in spacing P_3 (60 x 50 cm) with 56.07 days and 55.71 days through maximum dose of fertilizers, D_3 30:20:32 kg (Table 4.11). However, the interaction effects of cultivars, plant geometry and dose of fertilizer application, were found to have significant influence on minimum number of days required to first fruit harvest in treatment combination T_{18} (52.40 DAS) and was closely followed by T_{17} (54.00 DAS). The maximum days required to first fruit harvest treatment T_1 (58.25 DAS) show in (Table 4.12) the Similar result were quoted by Waseem *et al. (2008)* and Bakar *et al.* (2006) in cucumber crop.

The data presented in (Table 4.13 to 4.22) revealed that the various cultivars, plant geometry and dose of fertilizer had resulted in significant increase in number of fruits per plant, number of unmarketable fruits per plants and average fruit weight of cucumber under polyhouse condition during winter season. Among different cultivars, maximum number of fruits per plant (21.89), minimum number of unmarketable fruits per plants (1.46) and highest fruit weight (116.41 g) was obtained in cultivar Pant Parthenocarpic Cucumber -3. This might be due to more fruit set, more photosynthesis as it produced more vine length and leaf area during the processes. Shaw *et al. (2007)* reported significant interaction cultivar for marketable fruit number and weight per plant in green house grown cucumber. Number of fruits per vine, minimum number of unmarketable fruits per plants and average fruit weight were significantly influenced by plant geometry (Table 4.13 to 4.22). Maximum number of fruits per vine (21.24), and highest average fruit weight (118.45 g) was reported in 60 x 50 cm spacing (P_3) and minimum number of unmarketable fruits per plants (1.62) in P_2 (60 x 40 cm) as compared to lowest in P_1 (60 x 30 cm). The pooled analysis recorded P_3 as having significantly higher number of fruits per plant and average fruit weight and P_2 is minimum number of unmarketable fruits per plants This may be due to the availability of more space for the plants growth. The similar findings of increase average fruit weight and number of fruits per plant with wider spacing was reported by Mantur and Patil (2008) and Bahadur and Singh *(2005)* in tomato and Dasgan and Abak (2003).The results obtained in present investigation revealed that the dose of fertilizer application had a significant influence on number of fruits per vine, minimum number of unmarketable fruits per plants and average weight of fruit (Table 4.13 to 4.22). Higher number of fruits per plant

(21.58), minimum number of unmarketable fruits per plants (1.53) and maximum average fruit weight (117.96 g) was obtained in D_3 maximum dose of fertilizers (30:20:32 Kg) as compared to that in D_1 minimum dose of fertilizers application. This might be due to improvement *in the maximum* nutrient apply and water use efficiency of cucumber crop, (Bajracharya and Sharma, 2005, Veeranna *et al.* 2001). Interaction effect of cultivars, spacing and dose of fertilizer application on number of fruits per vine, minimum number of unmarketable fruits per plants and maximum average fruit weight were found to have a significant effect (Table 4.13 to 4.22). In combined treatment T_{18} V_2+D_3+P_3 (Pant Parthenocarpic Cucumber -3 + 60 x 50 cm + 30:20:32 Kg). Maximum number of fruits per plant, minimum number of unmarketable fruits per plants and maximum average fruit weight were reported in similar result of parthenocarpic cucumber hybrid namely Phule Prachi (Choudhari and More, 2002), El-Aidy *et al.* (2007). Different cultivars, plant geometry and dose of fertilizer application significantly influenced the yield per plant and yield per sq meter of cucumber under polyhouse condition during winter season (Table 4.13 to 4.22). Maximum yield per plant (2.82 kg) was noticed in cultivar (V_2) Pant Parthenocarpic Cucumber -3 , followed by (2.73 kg per plant) in Hilton which was found significantly at par with (2.58 kg per plant) cultivar Pant Parthenocarpic Cucumber -2. All the three cultivars had significant effect on yield per plant of parthenocarpic cucumber. The present findings are in accordance with the results of Shaw *et aI.* (2007) in cucumber. Alsadon *et al.* (2006) also found significant differences among cultivars of greenhouse cucumber cultivation for fruit growth traits especially yield and its components. Yield per vine was significantly affected by various spacing treatments. Maximum yield per plant (2.81 kg) was observed in spacing P_3 (60 x50 cm) as compared to 2.61 kg per plant in P_1 (60x30 cm). It is concluded that total yield significantly increased as the spacing between plants within rows was increased. The results of the present study are in the close confonnity with Mantur and Patil, 2008 and Bahadur and Singh (2005) in tomato crop. Dose of fertilizer application was found to have a significant effect on yield per plant of cucumber. Higher yield (2.85 kg per plant) was reported in maximum dose of fertilizers as compared to 2.56 kg per plant in minimum dose of fertilizers .(Table 4.13 to 4.22) Choudhari and More (2002) recorded maximum yield per plant (kg) and yield per ha (t) in cucumber hybrid when 150:90:90 kg NPK per hectare was applied through fertigation. The increased in yield attributes under fertigation may be attributed to· better water utilization and higher uptake of nutrients (Bafna *et al.* 1993) in tomato. Interaction of cultivars, spacing and dose of fertilizer had significant influence on yield per vine of cucumber (Table 4.13 to 4.22). Maximum yield per vine (3.20 kg per vine) was obtained in combined treatment T_{18} V_2+D_3+ P_3(Pant Parthenocarpic Cucumber -3 + 60 x 50 cm +30:20:32 Kg). This might be due to more

fruit set percentage as it produced more number of fruits per plant. Moccia and Katcherian (1999) observed that tomato fruit yield per unit area increased linearly with increase in planting density while yield per plant decreased. Increasing plant density increased the number of trusses, flowers and fruits harvested but decreased the average fruit weight. Papadopoulos and Pararaja sing ham (1997) and Alsadoll *et at.* (2006) also obtained higher fruit yield per unit area in tomato at narrow spacing compared with the wider spacing. They stated that the main factors responsible for the increase in fruit yield per unit area at narrow spacing were due to greater crop biomass. These results indicated that maximum yields are functions of greater number of plants per unit area.

4.4 QUALITY CHARACTERISTICS

4.4.1 Length of fruit (cm)

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on length of fruit (cm) of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.23 and Fig. 4.12. The analysis of variance is given in Appendix XXXIV, XXXV and XXVI.

(a) Effect of cultivars:

The data presented in Table 4.23 the length of fruit (cm) of parthenocarpic cucumber was significantly influenced by various cultivar during both the years of experiment of winter season however, on the basis of pooled data analysis the maximum length of fruit (18.35cm) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to minimum length of fruit (16.38 cm) in cultivar V_1 (Pant Parthenocarpic Cucumber-2).

(b) Effect of spacing:

Data presented in Table 4.23 indicated that the length of fruit of cucumber was significantly influenced by various spacing treatments during both the years of experiment. The pooled data showed that maximum length of fruit (17.87 cm) was recorded in P_3 (60 x 50 cm) and minimum length of fruit (17.07 cm) in P_l (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.23 that dose of fertilizer application was significant effect on length of fruit of parthenocarpic cucumber during both the years of investigation. Maximum length of fruit (18.20 cm) was observed in D_3 (30:20:32 kg/1000 m^2) as compared to minimum length of fruit (16.68 cm) in D_1 (20:10:22 kg /1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.24 showed significant days to length of fruit during both the years of experiment. Further, $T_{18,}$ $V_2D_3P_3$ (PPC-3 + 30:20:32 kg + 60 X 50 cm) resulted in maximum length of fruit (19.50 cm). However, minimum length of fruit (15.30 cm) was recorded in $T_{1,}$ $V_1D_1P_1$ (PPC-2 + 20:10:22 kg + 60 X 30 cm) on pooled data basis.

Table 4.23: Effect of cultivars, spacing and dose of fertilizer application on length of fruit (cm) of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	16.27	16.49	16.38
V_2	Pant Parthenocarpic Cucumber -3	18.24	18.46	18.35
V_3	Hilton	17.67	17.89	17.78
	F – test	S	S	S
	S Ed. (±)	0.041	0.013	0.023
	CD at 5%	0.082	0.027	0.047
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	16.60	16.77	16.68
D_2	25:15:27 kg	17.47	17.78	17.62
D_3	30:20:32 kg	18.11	18.29	18.20
	F – test	S	S	S
	S Ed. (±)	0.041	0.013	0.023
	CD at 5%	0.082	0.027	0.047
Plant geometry (P)				
P_1	60 x 30	16.98	17.17	17.07
P_2	60 x 40	17.42	17.71	17.57
P_3	60 x 50	17.78	17.96	17.87
	F – test	S	S	S
	S. Ed. (±)	0.041	0.013	0.023
	CD at 5%	0.082	0.027	0.047

Table 4.24: Interaction effect of cultivars, spacing and dose of fertilizer application on length of fruit (cm) of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	15.20	15.40	15.30
T_2	$V_1+D_1+P_2$	15.60	15.80	15.70
T_3	$V_1+D_1+P_3$	16.20	16.20	16.20
T_4	$V_1+D_2+P_1$	15.80	16.00	15.90
T_5	$V_1+D_2+P_2$	16.40	16.80	16.60
T_6	$V_1+D_2+P_3$	16.80	17.20	17.00
T_7	$V_1+D_3+P_1$	16.40	16.40	16.40
T_8	$V_1+D_3+P_2$	16.80	17.20	17.00
T_9	$V_1+D_3+P_3$	17.20	17.40	17.30
T_{10}	$V_2+D_1+P_1$	16.80	16.90	16.85
T_{11}	$V_2+D_1+P_2$	17.40	17.60	17.50
T_{12}	$V_2+D_1+P_3$	17.80	18.00	17.90
T_{13}	$V_2+D_2+P_1$	17.80	18.40	18.10
T_{14}	$V_2+D_2+P_2$	18.40	18.60	18.50
T_{15}	$V_2+D_2+P_3$	18.60	18.80	18.70
T_{16}	$V_2+D_3+P_1$	18.80	18.80	18.80
T_{17}	$V_2+D_3+P_2$	19.20	19.40	19.30
T_{18}	$V_2+D_3+P_3$	19.40	19.60	19.50
T_{19}	$V_3+D_1+P_1$	16.40	16.60	16.50
T_{20}	V_3+D_1+P2	16.80	17.20	17.00
T_{21}	$V_3+D_1+P_3$	17.20	17.20	17.20
T_{22}	$V_3+D_2+P_1$	17.40	17.60	17.50
T_{23}	$V_3+D_2+P_2$	17.80	18.20	18.00
T_{24}	$V_3+D_2+P_3$	18.20	18.40	18.30
T_{25}	$V_3+D_3+P_1$	18.20	18.40	18.30
T_{26}	$V_3+D_3+P_2$	18.40	18.60	18.50
T_{27}	$V_3+D_3+P_3$	18.60	18.80	18.70
Interaction (Vx D x P)	F – test	NS	S	S
	S. Ed. (±)	0.122	0.039	0.069
	CD. at 5%	0.247	0.080	0.141

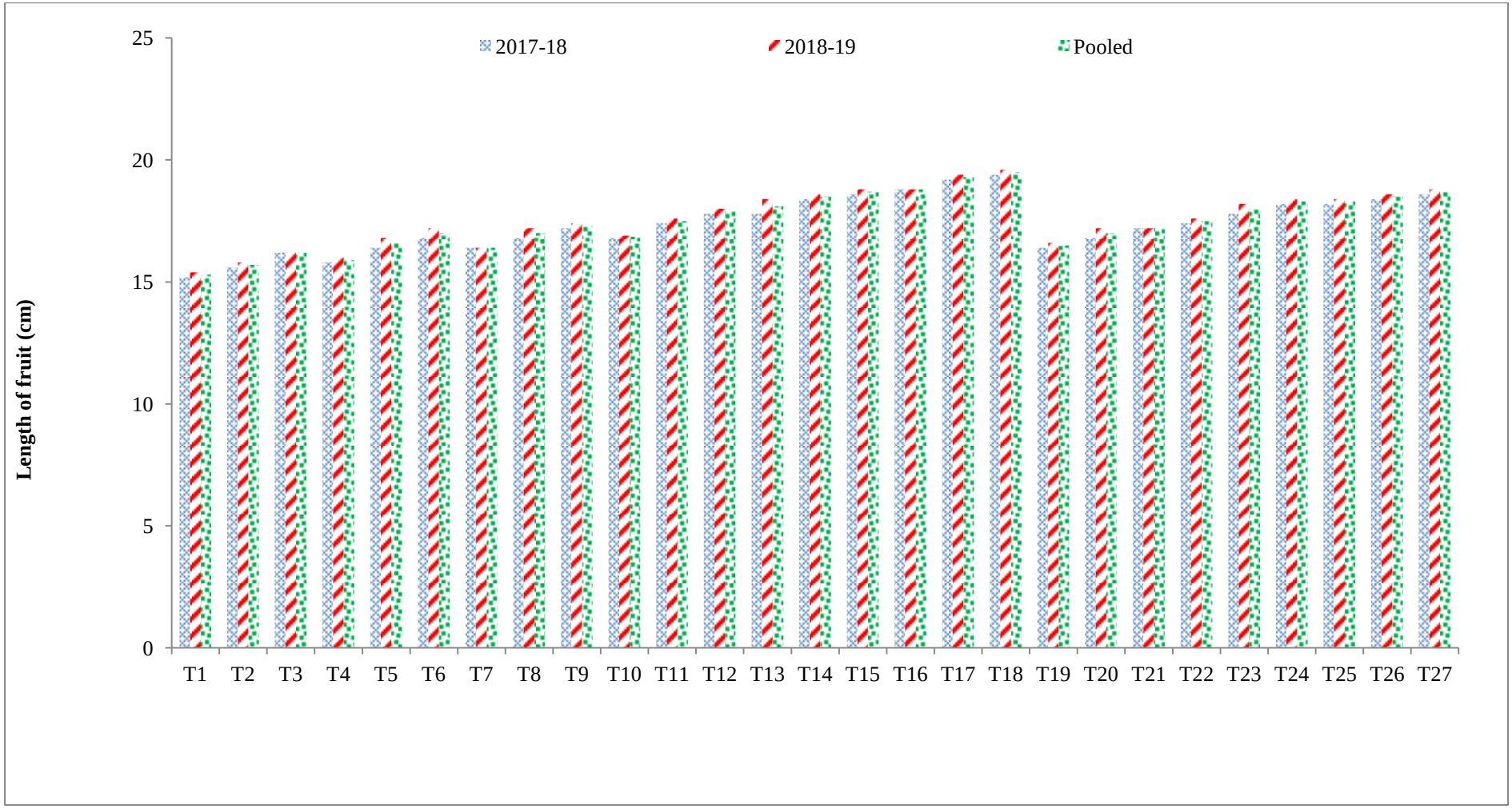

Fig 4.12: Interaction effect of cultivars, spacing and dose of fertilizer application on length of fruit (cm) of parthenocarpic cucumber under polyhouse condition during winter season.

4.4.2 Width of fruit (cm)

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on width of fruit (cm) of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.25 and Fig. 4.13. The analysis of variance is given in Appendix XXXVII, XXXVIII and XXXIX.

(a) Effect of cultivars:

The data presented in Table 4.25 the width of fruit (cm) of parthenocarpic cucumber was significantly influenced by various cultivar during both the years of experiment of winter season however, on the basis of pooled data analysis the maximum width of fruit (3.45 cm) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to minimum width of fruit (3.39 cm) in cultivar V_1 (Pant Parthenocarpic Cucumber-2).

(b) Effect of spacing:

Data presented in Table 4.25 indicated that the width of fruit of cucumber was significantly influenced by various spacing treatments during both the years of experiment. The pooled data showed that maximum width of fruit (3.45 cm) was recorded in P_3 (60 x 50 cm) and minimum width of fruit (3.40 cm) in P_2 (60 x 40 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.25 that dose of fertilizer application was significant effect on width of fruit of parthenocarpic cucumber during both the years of investigation. Maximum width of fruit (3.46 cm) was observed in D_3 (30:20:32 Kg/1000 m^2) as compared to minimum width of fruit (3.38 cm) in D_1 (20:10:22 kg /1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.26 showed significant days to width of fruit during both the years of experiment. Further, $T_{18,}$ $V_2D_3P_3$ (PPC-3 + 30:20:32 kg + 60 x 50 cm) resulted in maximum width of fruit (3.55 cm). However, minimum width of fruit (3.32 cm) was recorded in $T_{1,}$ $V_1D_1P_1$ (PPC-2 + 20:10:22 kg + 60 X 30 cm) on pooled data basis.

Table 4.25: Effect of cultivars, spacing and dose of fertilizer application on width of fruit (cm) of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	3.38	3.39	3.39
V_2	Pant Parthenocarpic Cucumber -3	3.43	3.47	3.45
V_3	Hilton	3.40	3.42	3.41
	F – test	S	S	S
	S Ed. (±)	0.002	0.002	0.002
	CD at 5%	0.004	0.003	0.003
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	3.36	3.39	3.38
D_2	25:15:27 kg	3.40	3.41	3.41
D_3	30:20:32 kg	3.44	3.48	3.46
	F - test	S	S	S
	S Ed. (±)	0.002	0.002	0.002
	CD at 5%	0.004	0.003	0.003
Plant geometry (P)				
P_1	60 x 30	3.38	3.40	3.39
P_2	60 x 40	3.40	3.41	3.40
P_3	60 x 50	3.44	3.47	3.45
	F - test	S	S	S
	S. Ed. (±)	0.002	0.002	0.002
	CD at 5%	0.004	0.003	0.003

Table 4.26: Interaction effect of cultivars, spacing and dose of fertilizer application on width of fruit (cm) of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	3.31	3.33	3.32
T_2	$V_1+D_1+P_2$	3.34	3.36	3.35
T_3	$V_1+D_1+P_3$	3.38	3.39	3.39
T_4	$V_1+D_2+P_1$	3.36	3.37	3.37
T_5	$V_1+D_2+P_2$	3.38	3.30	3.34
T_6	$V_1+D_2+P_3$	3.41	3.44	3.43
T_7	$V_1+D_3+P_1$	3.39	3.42	3.41
T_8	$V_1+D_3+P_2$	3.42	3.45	3.44
T_9	$V_1+D_3+P_3$	3.46	3.48	3.47
T_{10}	$V_2+D_1+P_1$	3.39	3.41	3.40
T_{11}	$V_2+D_1+P_2$	3.39	3.42	3.41
T_{12}	$V_2+D_1+P_3$	3.43	3.46	3.45
T_{13}	$V_2+D_2+P_1$	3.42	3.45	3.44
T_{14}	$V_2+D_2+P_2$	3.39	3.43	3.41
T_{15}	$V_2+D_2+P_3$	3.45	3.49	3.47
T_{16}	$V_2+D_3+P_1$	3.42	3.48	3.45
T_{17}	$V_2+D_3+P_2$	3.48	3.51	3.50
T_{18}	$V_2+D_3+P_3$	3.51	3.59	3.55
T_{19}	$V_3+D_1+P_1$	3.32	3.37	3.35
T_{20}	V_3+D_1+P2	3.33	3.36	3.35
T_{21}	$V_3+D_1+P_3$	3.39	3.41	3.40
T_{22}	$V_3+D_2+P_1$	3.38	3.39	3.39
T_{23}	$V_3+D_2+P_2$	3.40	3.41	3.41
T_{24}	$V_3+D_2+P_3$	3.43	3.45	3.44
T_{25}	$V_3+D_3+P_1$	3.41	3.42	3.42
T_{26}	$V_3+D_3+P_2$	3.43	3.46	3.45
T_{27}	$V_3+D_3+P_3$	3.48	3.49	3.49
Interaction (Vx D x P)	F - test	S	S	S
	S. Ed. (±)	0.005	0.005	0.005
	CD. at 5%	0.011	0.009	0.010

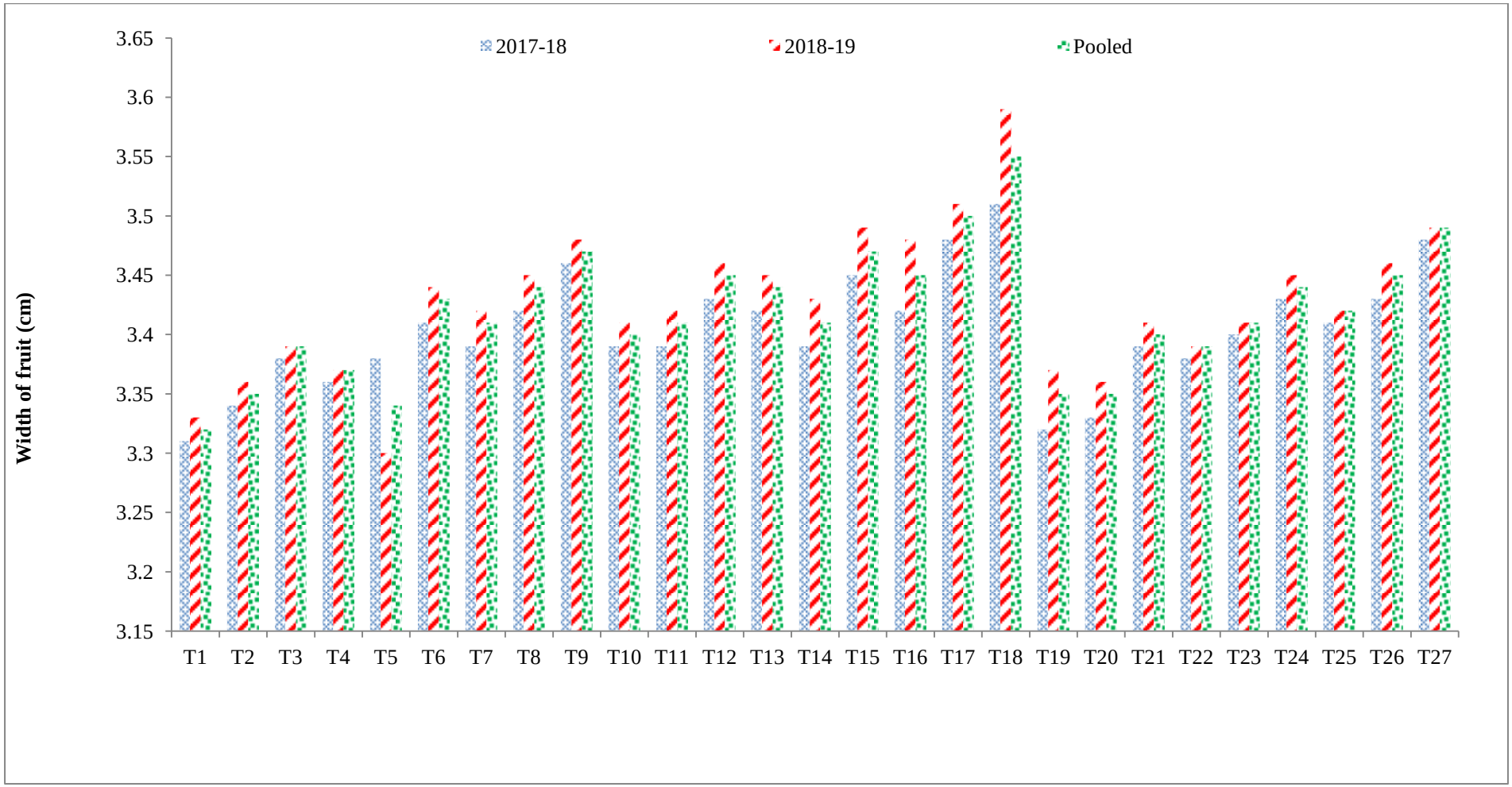

Fig 4.13: Interaction effect of cultivars, spacing and dose of fertilizer application on width of fruit (cm) of parthenocarpic cucumber under polyhouse condition during winter season.

4.4.3 Moisture percentage

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on moisture percentage of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.27 and Fig. 4.14. The analysis of variance is given in Appendix XL, XLI and XLII.

(a) Effect of cultivars:

The data presented in Table 4.27 the moisture percentage of parthenocarpic cucumber was significantly influenced by various cultivar treatments during both the years of experimentation of winter season however, on the basis of pooled data analysis the maximum moisture percentage (94.57) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to minimum moisture percentage (93.90) in cultivar V_3 (Hilton)

(b) Effect of spacing:

Data presented in Table 4.27 indicated that the moisture percentage of cucumber was non significantly influenced by various spacing treatments during both the years of experimentation. The pooled data showed that maximum moisture percentage (94.25) was recorded in P_3 (60 x 50 cm) and minimum moisture percentage (94.18) in P1 (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.26 that dose of fertilizer application was significant effect moisture percentage of parthenocarpic cucumber during pooled data investigation maximum moisture percentage (94.55) was observed in D_1 (20:10:22 kg/1000 m^2) as compared to minimum moisture percentage (94.00) in D_3 (30:20:32 kg /1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.28 showed significant moisture percentage during both the years of experimentation. Further, $T_{12,}$ $V_2D_1P_3$ (PPC-3 + 20:10:22 kg + 60 x 50 cm) resulted in maximum moisture percentage (95.75). However, minimum moisture percentage (93.05) was recorded in $T_{27,}$ $V_3D_3P_3$ (Hilton + 30:20:32 kg + 60 x 50 cm) on pooled data basis.

Table 4.27: Effect of cultivars, spacing and dose of fertilizer application moisture percentage of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	94.04	94.30	94.17
V_2	Pant Parthenocarpic Cucumber -3	94.50	94.64	94.57
V_3	Hilton	93.64	94.16	93.90
	F – test	S	S	S
	S. Ed. (±)	0.064	0.016	0.039
	CD at 5%	0.131	0.032	0.079
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	94.37	94.73	94.55
D_2	25:15:27 kg	93.98	94.21	94.09
D_3	30:20:32 kg	93.84	94.16	94.00
	F – test	S	S	S
	S. Ed. (±)	0.064	0.016	0.039
	CD at 5%	0.131	0.032	0.079
Plant geometry (P)				
P_1	60 x 30	94.03	94.32	94.18
P_2	60 x 40	94.08	94.36	94.22
P_3	60 x 50	94.08	94.42	94.25
	F – test	NS	S	NS
	S. Ed. (±)	0.064	0.016	0.039
	CD at 5%	0.131	0.032	0.079

Table 4.28: Interaction effect of cultivars, spacing and dose of fertilizer application on moisture percentage of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	94.20	94.30	94.25
T_2	$V_1+D_1+P_2$	94.50	94.70	94.60
T_3	$V_1+D_1+P_3$	94.60	94.90	94.75
T_4	$V_1+D_2+P_1$	94.40	94.60	94.50
T_5	$V_1+D_2+P_2$	93.80	94.20	94.00
T_6	$V_1+D_2+P_3$	93.50	93.80	93.65
T_7	$V_1+D_3+P_1$	94.20	94.60	94.40
T_8	$V_1+D_3+P_2$	93.50	93.70	93.60
T_9	$V_1+D_3+P_3$	93.70	93.90	93.80
T_{10}	$V_2+D_1+P_1$	94.40	94.80	94.60
T_{11}	$V_2+D_1+P_2$	94.60	94.90	94.75
T_{12}	$V_2+D_1+P_3$	95.50	95.80	95.65
T_{13}	$V_2+D_2+P_1$	94.80	94.40	94.60
T_{14}	$V_2+D_2+P_2$	94.50	93.70	94.10
T_{15}	$V_2+D_2+P_3$	94.20	94.70	94.45
T_{16}	$V_2+D_3+P_1$	93.50	93.90	93.70
T_{17}	$V_2+D_3+P_2$	94.40	94.70	94.55
T_{18}	$V_2+D_3+P_3$	94.60	94.90	94.75
T_{19}	$V_3+D_1+P_1$	93.80	94.50	94.15
T_{20}	V_3+D_1+P2	93.50	93.80	93.65
T_{21}	$V_3+D_1+P_3$	94.20	94.90	94.55
T_{22}	$V_3+D_2+P_1$	93.50	93.90	93.70
T_{23}	$V_3+D_2+P_2$	93.70	94.80	94.25
T_{24}	$V_3+D_2+P_3$	93.40	93.80	93.60
T_{25}	$V_3+D_3+P_1$	93.50	93.90	93.70
T_{26}	$V_3+D_3+P_2$	94.20	94.70	94.45
T_{27}	$V_3+D_3+P_3$	93.00	93.10	93.05
Interaction (Vx D x P)	F - test	S	S	S
	S. Ed. (±)	0.193	0.048	0.117
	C.D. at 5%	0.393	0.097	0.238

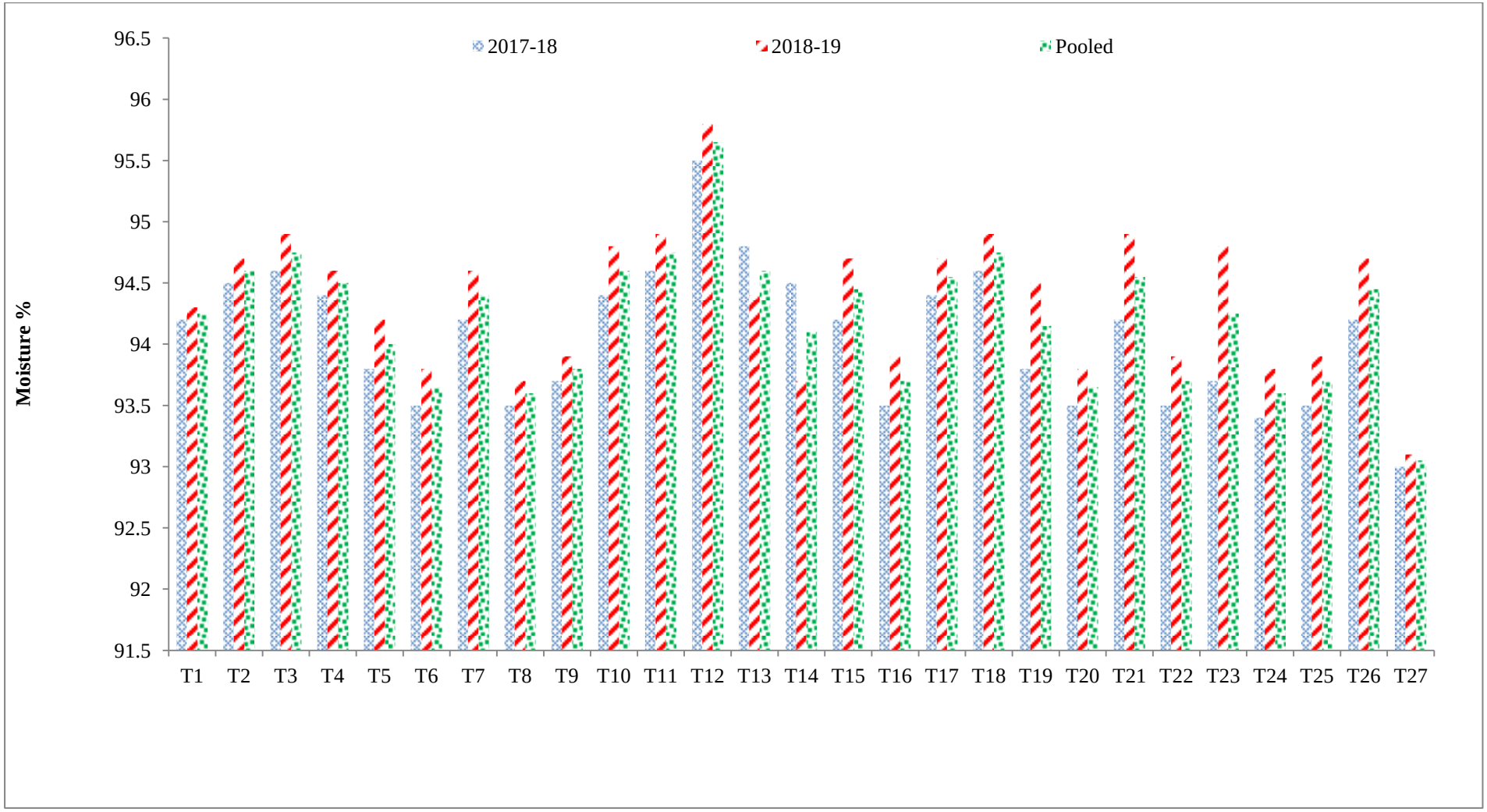

Fig 4.14 Interaction effect of cultivars, spacing and dose of fertilizer application on moisture percentage of parthenocarpic cucumber under polyhouse condition during winter season

4.4.4 Organoleptic acceptance

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on Organoleptic acceptance of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.29 and Fig. 4.15. The analysis of variance is given in Appendix XLIII, XLIV and XLV.

(a) Effect of cultivars:

The data presented in Table 4.29 the Organoleptic acceptance of parthenocarpic cucumber was significantly influenced by various cultivar treatments during both the years of experimentation of winter season however, on the basis of pooled data analysis the maximum Organoleptic acceptance (7.52) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to minimum Organoleptic acceptance (7.18) in cultivar V_3 (Hilton)

(b) Effect of spacing:

Data presented in Table 4.29 indicated that the organoleptic acceptance of cucumber was significantly influenced by various spacing treatments during both the years of experimentation. The pooled data showed that maximum Organoleptic acceptance (7.49) was recorded in P_3 (60 x 50 cm) and minimum Organoleptic acceptance (7.30) in P1 (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in 4.29 that dose of fertilizer application was significant effect Organoleptic acceptance of parthenocarpic cucumber during pooled data investigation maximum Organoleptic acceptance (7.50) was observed in D_3 (30:20:32 kg/1000 m^2) as compared to minimum Organoleptic acceptance (7.31) in D_2 (25:15:27 kg /1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.30 showed significant organoleptic acceptance during both the years of experimentation. Further, $T_{18,}$ $V_2D_3P_3$ (PPC-3 + 30:20:32 kg + 60 x 50 cm) resulted in maximum Organoleptic acceptance (8.75). However, minimum Organoleptic acceptance (7.20) was recorded in $T_{27,}$ $V_3D_3P_3$ (Hilton + 30:20:32 kg + 60 x 50 cm) on pooled data basis.

Table 4.29: Effect of cultivars, spacing and dose of fertilizer application orgenoleptic acceptance of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	7.31	7.62	7.47
V_2	Pant Parthenocarpic Cucumber -3	7.40	7.64	7.52
V_3	Hilton	7.09	7.27	7.18
	F – test	S	S	S
	S Ed. (±)	0.059	0.062	0.060
	CD at 5%	0.119	0.126	0.122
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	7.26	7.47	7.36
D_2	25:15:27 kg	7.18	7.43	7.31
D_3	30:20:32 kg	7.37	7.63	7.50
	F – test	S	S	S
	S. Ed. (±)	0.059	0.062	0.060
	CD at 5%	0.119	0.126	0.122
Plant geometry (P)				
P_1	60 x 30	7.18	7.42	7.30
P_2	60 x 40	7.28	7.48	7.38
P_3	60 x 50	7.34	7.63	7.49
	F – test	S	S	S
	S. Ed. (±)	0.059	0.062	0.060
	CD at 5%	0.119	0.126	0.122

Table 4.30: Interaction effect of cultivars, spacing and dose of fertilizer application on orgenoleptic acceptance of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		**2017-18**	**2018-19**	**Pooled**
T_1	$V_1+D_1+P_1$	7.30	7.40	7.35
T_2	$V_1+D_1+P_2$	7.80	7.90	7.85
T_3	$V_1+D_1+P_3$	7.20	7.40	7.30
T_4	$V_1+D_2+P_1$	7.80	7.90	7.85
T_5	$V_1+D_2+P_2$	7.00	7.40	7.20
T_6	$V_1+D_2+P_3$	7.10	7.70	7.40
T_7	$V_1+D_3+P_1$	7.00	7.60	7.30
T_8	$V_1+D_3+P_2$	7.00	7.40	7.20
T_9	$V_1+D_3+P_3$	7.60	7.90	7.75
T_{10}	$V_2+D_1+P_1$	7.20	7.30	7.25
T_{11}	$V_2+D_1+P_2$	7.20	7.50	7.35
T_{12}	$V_2+D_1+P_3$	7.10	7.60	7.35
T_{13}	$V_2+D_2+P_1$	7.00	7.40	7.20
T_{14}	$V_2+D_2+P_2$	7.70	7.50	7.60
T_{15}	$V_2+D_2+P_3$	7.00	7.40	7.20
T_{16}	$V_2+D_3+P_1$	7.00	7.30	7.15
T_{17}	$V_2+D_3+P_2$	7.80	7.90	7.85
T_{18}	$V_2+D_3+P_3$	8.60	8.90	8.75
T_{19}	$V_3+D_1+P_1$	7.10	7.40	7.25
T_{20}	V_3+D_1+P2	7.20	7.40	7.30
T_{21}	$V_3+D_1+P_3$	7.20	7.30	7.25
T_{22}	$V_3+D_2+P_1$	7.00	7.20	7.10
T_{23}	$V_3+D_2+P_2$	6.80	7.20	7.00
T_{24}	$V_3+D_2+P_3$	7.20	7.20	7.20
T_{25}	$V_3+D_3+P_1$	7.20	7.30	7.25
T_{26}	$V_3+D_3+P_2$	7.00	7.10	7.05
T_{27}	$V_3+D_3+P_3$	7.10	7.30	7.20
Interaction (Vx D x P)	F - test	S	S	S
	S. Ed. (±)	0.176	0.186	0.179
	CD. at 5%	0.358	0.377	0.365

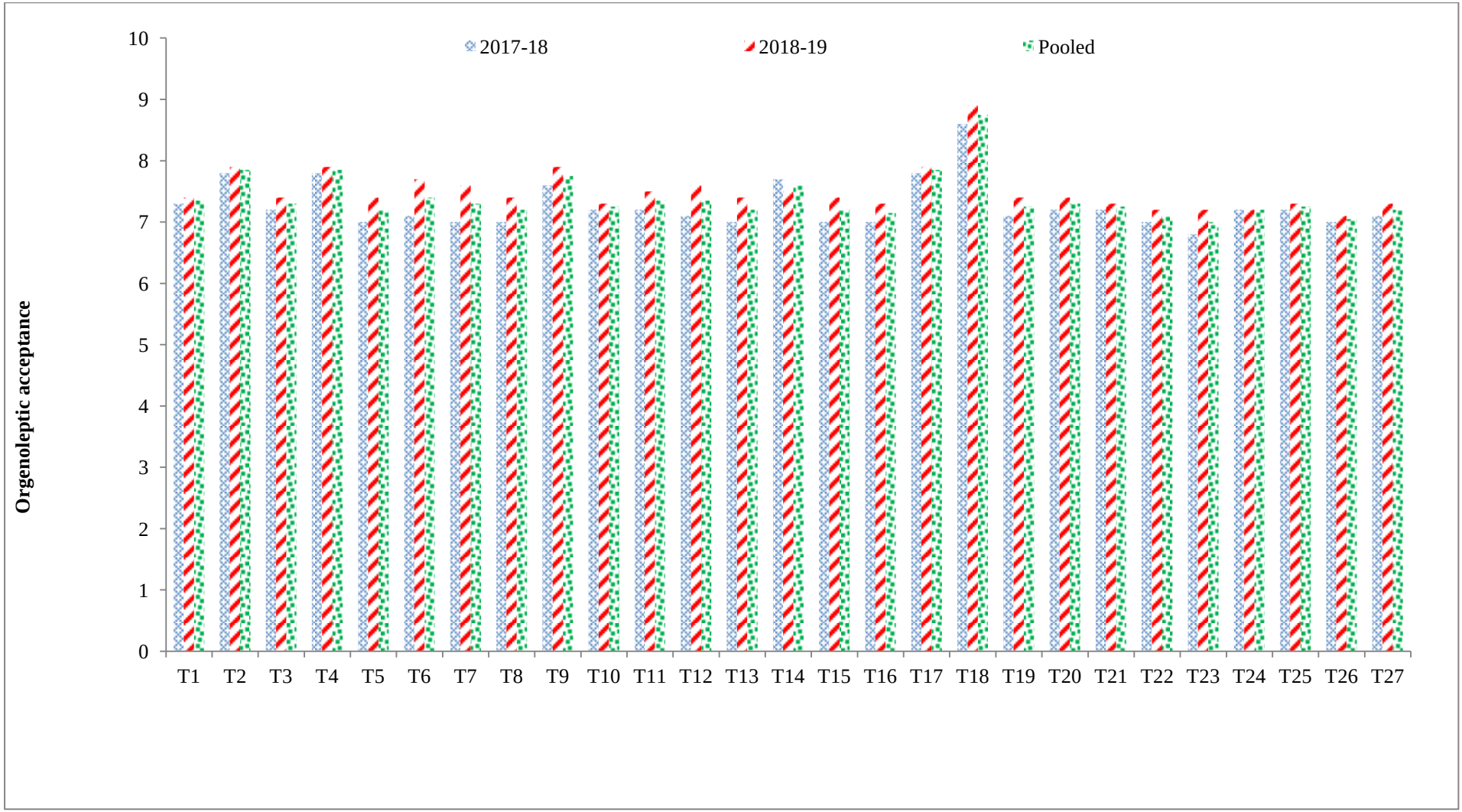

Fig 4.15: Interaction effect of cultivars, spacing and dose of fertilizer application on orgenoleptic acceptance of parthenocarpic cucumber under polyhouse condition during winter season.

4.4.5 Total soluble solids (˚Brix)

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on total soluble solids of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.31 and Fig. 4.16. The analysis of variance is given in Appendix XLVI,XLVII and XLVIII.

(a) Effect of cultivars:

The data presented in Table 4.31 the total soluble solids of parthenocarpic cucumber was significantly influenced by various cultivar treatments during both the years of experimentation of winter season however, on the basis of pooled data analysis the maximum total soluble solids (3.41˚Brix) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to minimum total soluble solids (3.22˚Brix) in cultivar V_1 (Pant Parthenocarpic Cucumber-2).

(b) Effect of spacing:

Data presented in Table 4.31 indicated that the total soluble solids of cucumber was significantly influenced by various spacing treatments during both the years of experimentation. The pooled data showed that maximum total soluble solids (3.35˚Brix) was recorded in P_3 (60 x 50 cm) and minimum total soluble solids (3.29˚Brix) in P1 (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.31 that dose of fertilizer application was significant effect total soluble solids of parthenocarpic cucumber during pooled data investigation maximum total soluble solids (3.40˚Brix) was observed in D_3 (30:20:32 kg/1000 m^2) as compared to minimum total soluble solids (3.24˚Brix) in D_1 (20:10:22 kg /1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.32 showed non significant total soluble solids during both the years of experimentation. Further, $T_{18,}$ $V_2D_3P_3$ (PPC-3 + 30:20:32 kg + 60 x 50 cm) resulted in maximum total soluble solids (3.57˚Brix). However, minimum total soluble solids (3.15) was recorded in $T_{1,}$ $V_1D_1P_1$ (PPC-2 + 20:10:22 kg + 60 x 30 cm) on pooled data basis.

Table 4.31: Effect of cultivars, spacing and dose of fertilizer application total soluble solids (˚Brix) of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber - 2	3.18	3.26	3.22
V_2	Pant Parthenocarpic Cucumber - 3	3.36	3.46	3.41
V_3	Hilton	3.29	3.38	3.33
	F – test	S	S	S
	S Ed. (±)	0.023	0.012	0.017
	CD at 5%	0.047	0.024	0.034
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	3.20	3.29	3.24
D_2	25:15:27 kg	3.27	3.36	3.32
D_3	30:20:32 kg	3.35	3.45	3.40
	F – test	S	S	S
	S Ed. (±)	0.023	0.012	0.017
	CD at 5%	0.047	0.024	0.034
Plant geometry (P)				
P_1	60 x 30	3.24	3.33	3.29
P_2	60 x 40	3.28	3.37	3.32
P_3	60 x 50	3.30	3.40	3.35
	F – test	NS	S	S
	S Ed. (±)	0.023	0.012	0.017
	CD at 5%	0.047	0.024	0.034

Table 4.32: Interaction effect of cultivars, spacing and dose of fertilizer application on total soluble solids (˚Brix) of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	3.12	3.18	3.15
T_2	$V_1+D_1+P_2$	3.15	3.19	3.17
T_3	$V_1+D_1+P_3$	3.16	3.23	3.20
T_4	$V_1+D_2+P_1$	3.15	3.25	3.20
T_5	$V_1+D_2+P_2$	3.18	3.27	3.23
T_6	$V_1+D_2+P_3$	3.19	3.27	3.23
T_7	$V_1+D_3+P_1$	3.19	3.29	3.24
T_8	$V_1+D_3+P_2$	3.22	3.31	3.27
T_9	$V_1+D_3+P_3$	3.26	3.36	3.31
T_{10}	$V_2+D_1+P_1$	3.21	3.31	3.26
T_{11}	$V_2+D_1+P_2$	3.25	3.36	3.31
T_{12}	$V_2+D_1+P_3$	3.28	3.39	3.34
T_{13}	$V_2+D_2+P_1$	3.32	3.41	3.37
T_{14}	$V_2+D_2+P_2$	3.36	3.47	3.42
T_{15}	$V_2+D_2+P_3$	3.39	3.48	3.44
T_{16}	$V_2+D_3+P_1$	3.41	3.53	3.47
T_{17}	$V_2+D_3+P_2$	3.47	3.59	3.53
T_{18}	$V_2+D_3+P_3$	3.51	3.62	3.57
T_{19}	$V_3+D_1+P_1$	3.19	3.28	3.24
T_{20}	V_3+D_1+P2	3.21	3.32	3.27
T_{21}	$V_3+D_1+P_3$	3.23	3.33	3.28
T_{22}	$V_3+D_2+P_1$	3.26	3.35	3.31
T_{23}	$V_3+D_2+P_2$	3.28	3.37	3.33
T_{24}	$V_3+D_2+P_3$	3.31	3.41	3.36
T_{25}	$V_3+D_3+P_1$	3.35	3.41	3.38
T_{26}	$V_3+D_3+P_2$	3.38	3.46	3.42
T_{27}	$V_3+D_3+P_3$	3.39	3.49	3.44
Interaction (Vx D x P)	F - test	NS	NS	NS
	S. Ed. (±)	0.070	0.035	0.050
	CD at 5%	0.142	0.071	0.101

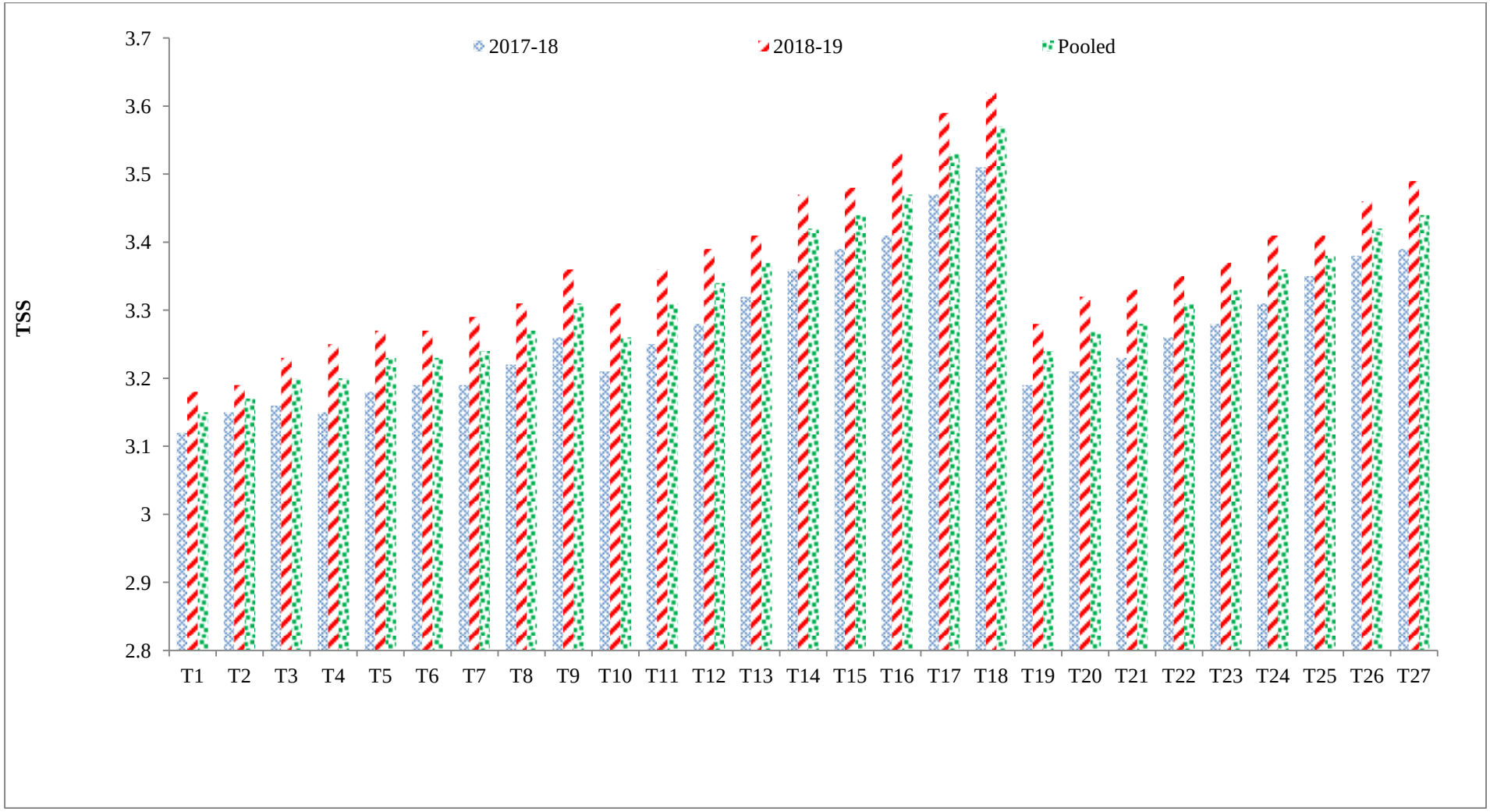

Fig 4.16: Interaction effect of cultivars, spacing and dose of fertilizer application on total soluble solids (˚Brix) of parthenocarpic cucumber under polyhouse condition during winter season.

4.4.6 Fruit volume (cc)

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on fruit volume of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.33 and Fig. 4.17. The analysis of variance is given in Appendix XLIX, L and LI.

(a) Effect of cultivars:

The data presented in Table 4.33 the fruit volume of parthenocarpic cucumber was non significantly influenced by various cultivar treatments during both the years of experimentation of winter season however, on the basis of pooled data analysis the maximum fruit volume (125.33) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to minimum fruit volume (125.26) in cultivar V_1 (Pant Parthenocarpic Cucumber-2)

(b) Effect of spacing:

Data presented in Table 4.33 indicated that the fruit volume of cucumber was significantly influenced by various spacing treatments during both the years of experimentation. The pooled data showed that maximum fruit volume (126.39) was recorded in P_3 (60 x 50 cm) and minimum fruit volume (124.26) in P1 (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.33 that dose of fertilizer application was significant effect fruit volume of parthenocarpic cucumber during pooled data investigation maximum fruit volume (125.34) was observed in D_3 (30:20:32 kg/1000 m^2) as compared to minimum fruit volume (125.25) in D_1 (20:10:22 kg /1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.34 showed significant fruit volume during both the years of experimentation. Further, $T_{18,}$ $V_2D_3P_3$ (PPC-3 + 30:20:32 kg + 60 x 50 cm) resulted in maximum fruit volume (126.50). However, minimum fruit volume (124.22) was recorded in $T_{1,}$ $V_1D_1P_1$ (PPC-2 + 20:10:22 kg + 60 x 30 cm) on pooled data basis.

Table 4.33: Effect of cultivars, spacing and dose of fertilizer application fruit volume (cc) of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	125.25	125.27	125.26
V_2	Pant Parthenocarpic Cucumber -3	125.31	125.34	125.33
V_3	Hilton	125.27	125.29	125.28
	F – test	NS	NS	NS
	S Ed. (±)	0.221	0.227	0.216
	CD at 5%	0.450	0.460	0.439
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	125.23	125.26	125.25
D_2	25:15:27 kg	125.27	125.29	125.28
D_3	30:20:32 kg	125.33	125.35	125.34
	F – test	NS	NS	NS
	S Ed. (±)	0.221	0.227	0.216
	CD at 5%	0.450	0.460	0.439
Plant geometry (P)				
P_1	60 x 30	124.25	124.27	124.26
P_2	60 x 40	125.20	125.23	125.21
P_3	60 x 50	126.38	126.40	126.39
	F – test	S	S	S
	S. Ed. (±)	0.221	0.227	0.216
	CD at 5%	0.450	0.460	0.439

Table 4.34: Interaction effect of cultivars, spacing and dose of fertilizer application on fruit volume (cc) of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	124.21	124.23	124.22
T_2	$V_1+D_1+P_2$	125.12	125.15	125.14
T_3	$V_1+D_1+P_3$	126.31	126.35	126.33
T_4	$V_1+D_2+P_1$	124.23	124.24	124.24
T_5	$V_1+D_2+P_2$	125.17	125.19	125.18
T_6	$V_1+D_2+P_3$	126.36	126.37	126.37
T_7	$V_1+D_3+P_1$	124.28	124.29	124.29
T_8	$V_1+D_3+P_2$	125.19	125.21	125.20
T_9	$V_1+D_3+P_3$	126.37	126.38	126.38
T_{10}	$V_2+D_1+P_1$	124.24	124.26	124.25
T_{11}	$V_2+D_1+P_2$	125.16	125.18	125.17
T_{12}	$V_2+D_1+P_3$	126.37	126.39	126.38
T_{13}	$V_2+D_2+P_1$	124.27	124.29	124.28
T_{14}	$V_2+D_2+P_2$	125.18	125.22	125.20
T_{15}	$V_2+D_2+P_3$	126.39	126.42	126.41
T_{16}	$V_2+D_3+P_1$	124.29	124.29	124.29
T_{17}	$V_2+D_3+P_2$	125.42	125.49	125.46
T_{18}	$V_2+D_3+P_3$	126.49	126.51	126.50
T_{19}	$V_3+D_1+P_1$	124.22	124.25	124.24
T_{20}	V_3+D_1+P2	125.14	125.18	125.16
T_{21}	$V_3+D_1+P_3$	126.34	126.36	126.35
T_{22}	$V_3+D_2+P_1$	124.26	124.28	124.27
T_{23}	$V_3+D_2+P_2$	125.18	125.19	125.19
T_{24}	$V_3+D_2+P_3$	126.39	126.41	126.40
T_{25}	$V_3+D_3+P_1$	124.29	124.31	124.30
T_{26}	$V_3+D_3+P_2$	125.23	125.26	125.25
T_{27}	$V_3+D_3+P_3$	126.39	126.40	126.40
Interaction (Vx D x P)	F - test	NS	NS	NS
	S. Ed. (±)	0.664	0.680	0.648
	CD. at 5%	1.350	1.381	1.317

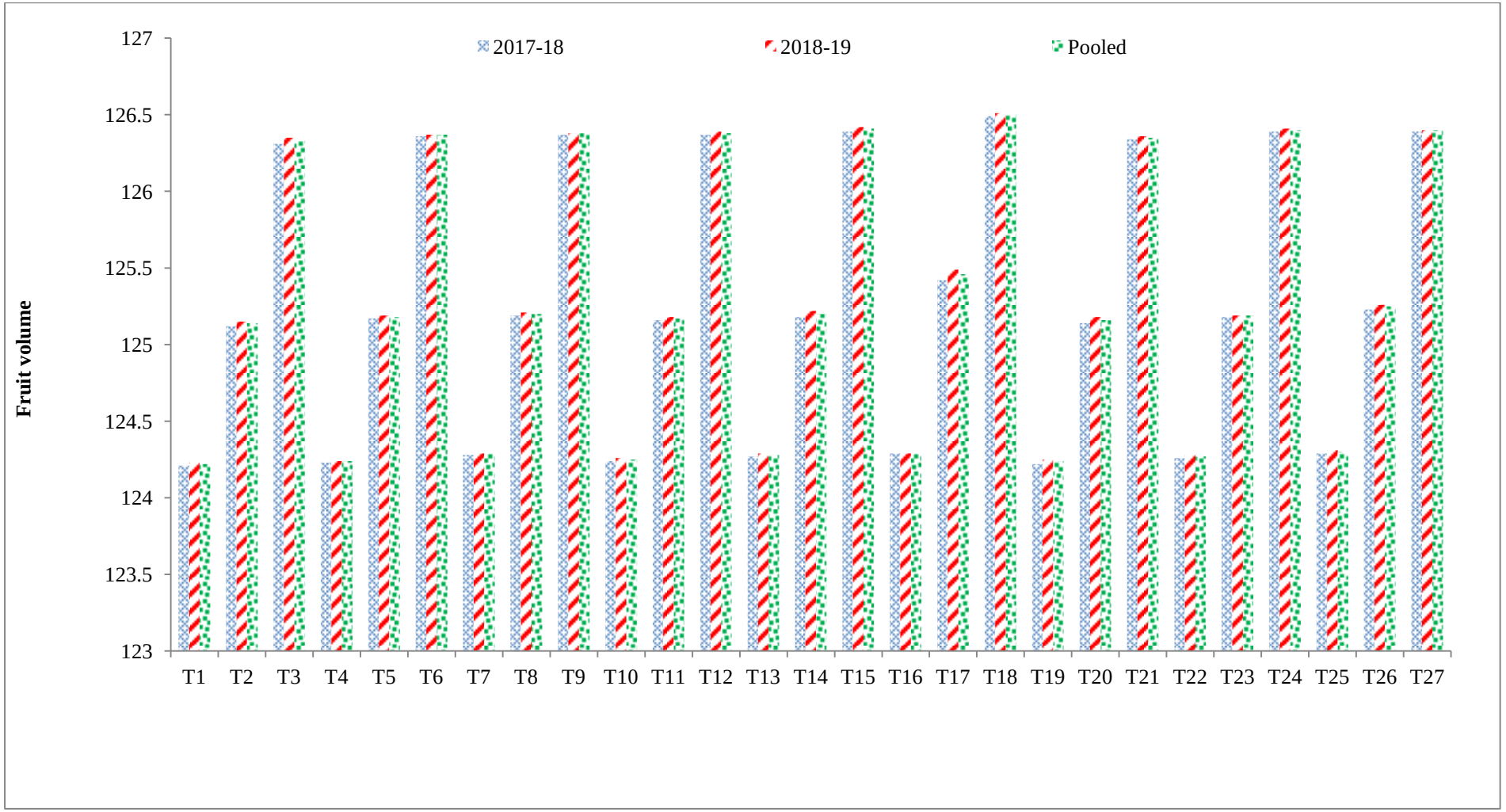

Fig 4.17: Interaction effect of cultivars, spacing and dose of fertilizer application on fruit volume of parthenocarpic cucumber under polyhouse condition during winter season.

4.4.7 Fruits specific gravity (g cm^{-3})

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on Fruits specific gravity of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.35 and Fig. 4.18. The analysis of variance is given in Appendix LII, LIII and LIV.

(a) Effect of cultivars:

The data presented in Table 4.35 the Fruits specific gravity of parthenocarpic cucumber was non significantly influenced by various cultivar treatments during both the years of experimentation of winter season however, on the basis of pooled data analysis the same specific gravity (0.93) was recorded in all cultivar like V_2 (Pant Parthenocarpic Cucumber-3), V_1 (Pant Parthenocarpic Cucumber-2) and V_3 (Hilton).

(b) Effect of spacing:

Data presented in Table 4.35 indicated that the Fruits specific gravity of cucumber was significantly influenced by various spacing treatments during both the years of experimentation. The pooled data showed that maximum fruits specific gravity (0.94) was recorded in P_3 (60 x 50 cm) and minimum Fruits specific gravity (0.91) in P1 (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.35 that dose of fertilizer application was significant effect Fruits specific gravity of parthenocarpic cucumber during pooled data investigation maximum Fruits specific gravity (0.94) was observed in D_3 (30:20:32 kg/1000 m^2) as compared to minimum Fruits specific gravity (0.91) in D_1 (20:10:22 kg /1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.36 showed significant Fruits specific gravity during both the years of experimentation. Further, $T_{18,}V_2D_3P_3$ (PPC-3 + 30:20:32 kg + 60 x 50 cm) resulted in maximum Fruits specific gravity (0.95). However, minimum Fruits specific gravity (0.91) was recorded in $T_{1,}$ $V_1D_1P_1$ (PPC-2 + 20:10:22 kg + 60 x 30 cm) on pooled data basis.

Table 4.35: Effect of cultivars, spacing and dose of fertilizer application fruits specific gravity of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	0.93	0.93	0.93
V_2	Pant Parthenocarpic Cucumber -3	0.93	0.93	0.93
V_3	Hilton	0.93	0.93	0.93
	F – test	NS	NS	NS
	S Ed. (±)	0.003	0.002	0.003
	CD at 5%	0.007	0.005	0.006
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	0.91	0.91	0.91
D_2	25:15:27 kg	0.93	0.93	0.93
D_3	30:20:32 kg	0.94	0.94	0.94
	F – test	S	S	S
	S. Ed. (±)	0.003	0.002	0.003
	CD at 5%	0.007	0.005	0.006
Plant geometry (P)				
P_1	60 x 30	0.91	0.91	0.91
P_2	60 x 40	0.93	0.93	0.93
P_3	60 x 50	0.94	0.94	0.94
	F – test	S	S	S
	S. Ed. (±)	0.003	0.002	0.003
	CD at 5%	0.007	0.005	0.006

Table 4.36: Interaction effect of cultivars, spacing and dose of fertilizer application on fruits specific gravity of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	0.90	0.90	0.90
T_2	$V_1+D_1+P_2$	0.91	0.91	0.91
T_3	$V_1+D_1+P_3$	0.92	0.92	0.92
T_4	$V_1+D_2+P_1$	0.91	0.91	0.91
T_5	$V_1+D_2+P_2$	0.94	0.94	0.94
T_6	$V_1+D_2+P_3$	0.94	0.94	0.94
T_7	$V_1+D_3+P_1$	0.92	0.92	0.92
T_8	$V_1+D_3+P_2$	0.95	0.95	0.95
T_9	$V_1+D_3+P_3$	0.95	0.95	0.95
T_{10}	$V_2+D_1+P_1$	0.91	0.91	0.91
T_{11}	$V_2+D_1+P_2$	0.91	0.91	0.91
T_{12}	$V_2+D_1+P_3$	0.92	0.92	0.92
T_{13}	$V_2+D_2+P_1$	0.91	0.91	0.91
T_{14}	$V_2+D_2+P_2$	0.94	0.94	0.94
T_{15}	$V_2+D_2+P_3$	0.94	0.94	0.94
T_{16}	$V_2+D_3+P_1$	0.92	0.92	0.92
T_{17}	$V_2+D_3+P_2$	0.95	0.95	0.95
T_{18}	$V_2+D_3+P_3$	0.95	0.95	0.95
T_{19}	$V_3+D_1+P_1$	0.90	0.91	0.91
T_{20}	V_3+D_1+P2	0.91	0.91	0.91
T_{21}	$V_3+D_1+P_3$	0.92	0.93	0.92
T_{22}	$V_3+D_2+P_1$	0.91	0.91	0.91
T_{23}	$V_3+D_2+P_2$	0.94	0.94	0.94
T_{24}	$V_3+D_2+P_3$	0.94	0.94	0.94
T_{25}	$V_3+D_3+P_1$	0.92	0.92	0.92
T_{26}	$V_3+D_3+P_2$	0.95	0.95	0.95
T_{27}	$V_3+D_3+P_3$	0.95	0.95	0.95
Interaction (Vx D x P)	F - test	NS	NS	NS
	S. Ed. (±)	0.010	0.007	0.008
	CD. at 5%	0.020	0.015	0.017

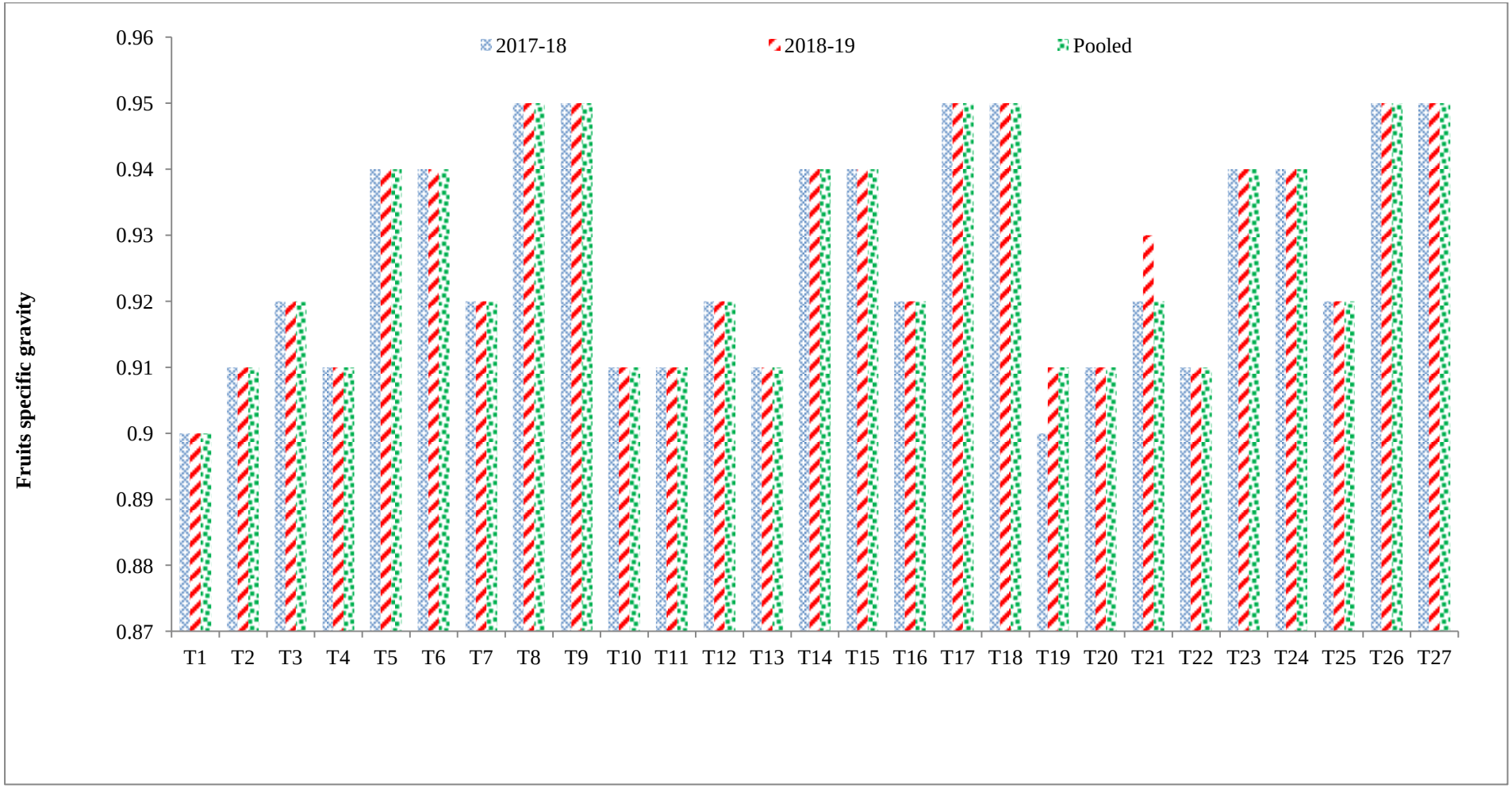

Fig 4.18: Interaction effect of cultivars, spacing and dose of fertilizer application on fruits specific gravity of parthenocarpic cucumber under polyhouse condition during winter season.

The above finding strong effect of the season on cucumber fruit quality, irrespective of the hydroponic culture used was also found by Femandez Tmjillo *et al.* (2003). It is well known that radiation and temperature influence fruit growth and quality (Gruda, 2005), because of the well-known relationship with photosynthesis, transpiration and growth rate (Mareelis and Gijzen, 1998). So, in a non-stressed greenhouse culture without Co_2 enrichment and with adequate relative humidity controlled by ventilation, temperature and intercepted radiation are the only climatic variables that interact with the cucumber plant system (Gruda, 2005).

However, cucumber fruits grown during the winter had a darker green skin colour and showed better quality. This result has also been reported by Gomez-Lopez *et al.* (2006) in cucumber. In the present investigation, two cultivars (Pant parthenocarpic cucumber-3 and Pant parthenocarpic cucumber-2) expressed the dark green colour and test one i.e. Hilton exhibited light green colour. Fruit colour is the most important pointer to the freshness of vegetables. It is clear from the results presented in preceding chapter that various cultivars, plant geometry and dose of fertilizer significantly improve the quality characteristics of fruits like fruit length and fruit width of cucumber under polyhouse condition during winter season.

As per pooled analysis, maximum fruit length (18.35 cm) and fruit width (3.45 cm) was obtained in cultivar Pant parthenocarpic cucumber-3 (Table 4.23 and 4.25) which was found significantly at par with Hilton. According to Shaw *et al.* (2000) in cucumber, quality measurements as fruit length and fruit width were found significantly cultivars. It may be that for certain green house cucumber cultivars the fruit characteristics of length and width are dependent on plant age and or changes in the environment and thus fruit size varies during the season. The perusal of analysis of variance revealed significant differences for fruit length and fruit width of glass house grown capsicum (Pandey *et al.*, 2005). As the winter season progresses, the average temperature is getting cooler and day length shortens, both factors which cause the fruit to develop more slowly which leads to longer fruit ill some cultivars.

Fruit length and fruit width were found to be significantly influenced by spacing treatments. Maximum fruit length (17.87 cm) and width (3.45 cm) were obtained in P_3, 60 x 50 cm spacing as compared to lowest fruit length and width (17.07 and 3.39 cm) in P_1, 60 x 30 cm spacing; respectively. This might be due to availability of more space in *60 x 50* cm spacing as compared to in 60 x 30 cm, (Table 4.23 and 4.25) which provides suitable conditions for proper fruit growth and development. Similar results were also obtained in tomato by Bahadur and Singh (2005).Increase in size in terms of length and width of fruits with wider spacing and maximum apply of nutrients may be due to enhanced vegetative growth and photosynthesis which led to the accumulation of more carbohydrates and other metabolites ultimately trans

locating towards the fruit tissue. Fertilizer application had significant influence on fruit length and width of green house grown cucumber during both the year. Highest fruit length and width (18.20 cm and 3.46 cm) were recorded in maximum NPK, fertilizers application D_3, 30:20:32 kg (Table 4.23 and 4.25). Interaction effect of cultivars, spacing and dose of fertilizer had a significant influence on fruit length and fruit width of cucumber during both the year, as per pooled data (Table 4.24 and 4.26*).* The maximum fruit length (19.50 cm) was recorded in treatment T_{18}, $V_2+D_3+P_3$ (Pant parthenocarpic cucumber -3 + 60 x 50 cm + 30:20:32 kg). as compare to T_1 treatment combination. It is explicit from the results presented in preceding chapter that various cultivars, spacing and dose of fertilizer with all the interaction effects were found to have a significantly influence on moisture content and Organoleptic acceptance of cucumber during both the year (Table 4.27 and 4.29). However, maximum moisture content (94.57 %) and highest rating in Organoleptic acceptance (7.52) was found in cultivar V_2 (Pant parthenocarpic cucumber -3) among all the cultivars used in the experimentation. The data presented in (Table 4.27 and 4.29).reveals that the moisture content and Organoleptic value of the fruit was significantly affected due to interaction effect of cultivars, spacing and dose of fertilizer application. On the basis of pooled data, treatment T_{18}, $V_2+D_3+P_3$ (Pant parthenocarpic cucumber -3 + 60 x 50 cm + 30:20:32 kg).Exhibited higher moisture content (95.65 %) in T_{12}, $V_2+D_1+P_3$ and Organoleptic acceptance (8.75) during pooled (Table 4.28 and 4.30). Pevicharova and Velkov (2007) reported significant variation of the varieties, harvest time and its interactions on all sensory characters in cucumber. The results obtained in present investigation revealed that the various cultivars, spacing and dose of fertilizer application had non-significantly influenced the TSS, fruit volume and specific gravity of parthenocarpic cucumber under polyhouse condition during pooled data analysis. (Appendices XLVI, XLVII, XLVIII and XLIX,L,LI), respectively. Significant differences were observed in quality of brix in melon cultivar trial by Cantliffe *et al.* (2001).Fernandez-Trujillo *et al.* (2003) found better pickling cucumber fruit quality during the winter than in the spring, and also a linear increase in TSS content during the winter from 3.80 to 4.20 Brix (in 6 weeks), while the opposite trend was observed in spring (from 4.1 0 to 3.4 °Brix in 5 weeks). These results indicate that the effect of nutrients on fruit quality may vary depending on the season and cultivars used. Among the used cultivars in the present investigation, maximum TSS (3.41 ^{0}Barix), maximum fruit volume (125.337) and fruit specific gravity (0.938) was reported in cultivar (V2) Pant parthenocarpic cucumber -3 as compared to Hilton and Pant parthenocarpic cucumber -2 during both the year.

This might be due to varietal characteristics of cucumber. Interaction of cultivar, spacing and dose of fertilizers of TSS, fruit volume and fruit specific gravity of cucumber was also non-significantly influenced with the pooled data analysis (Appendices LII,LIII and LIV), Utrestarazu and Mazuela (2005).

4.5 NUTRIENT STATUS OF CUCUMBER LEAVES

4.5.1 Total nitrogen in leaf (%)

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on total nitrogen in leaf (%) of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.37 and Fig. 4.19. The analysis of variance is given in Appendix LV, LVI and LVII.

(a) Effect of cultivars:

The data presented in Table 4.37 the total nitrogen in leaf (%) of parthenocarpic cucumber was significantly influenced by various cultivar treatments during both the years of experimentation of winter season however, on the basis of pooled data analysis the maximum total nitrogen in leaf (3.55 %) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to minimum total nitrogen in leaf (3.48 %) in cultivar V_1 (Pant Parthenocarpic Cucumber-2)

(b) Effect of spacing:

Data presented in Table 4.37 indicated that the total nitrogen in leaf (%) of cucumber was significantly influenced by various spacing treatments during both the years of experimentation. The pooled data showed that maximum total nitrogen in leaf ((3.58 %) was recorded in P_3 (60 x 50 cm) and minimum total nitrogen in leaf (3.41 %) in P_1 (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.37 that dose of fertilizer application was significant effect total nitrogen in leaf (%) of parthenocarpic cucumber during pooled data investigation maximum total nitrogen in leaf (3.66 %) was observed in D_3 (30:20:32 kg/1000 m^2) as compared to minimum total nitrogen in leaf (3.33 %) in D_1 (20:10:22 kg /1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.38 showed significant total nitrogen in leaf (%) during both the years of experimentation. Further, $T_{18,}$ $V_2D_3P_3$ (PPC-3 + 30:20:32 kg + 60 X 50 cm) resulted in maximum total nitrogen in leaf (3.81 %). and was closely followed by T_{27} , V_3+D_3+P_3 and $T_{17,}$ V_2+D_3+P_2 (3.71 %) same value this was both statically at par with T_{18} However, minimum total nitrogen in leaf (3.22 %) was recorded in T_1 $V_1D_1P_1$ (PPC-2 +20:10:22 kg + 60 X 30 cm) on pooled data basis.

Table 4.37: Effect of cultivars, spacing and dose of fertilizer application total nitrogen in leaf (%) of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	3.47	3.49	3.48
V_2	Pant Parthenocarpic Cucumber -3	3.53	3.56	3.55
V_3	Hilton	3.49	3.52	3.51
	F - test	S	S	S
	S Ed. (±)	0.008	0.001	0.005
	CD at 5%	0.017	0.002	0.009
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	3.32	3.35	3.33
D_2	25:15:27 kg	3.52	3.54	3.53
D_3	30:20:32 kg	3.65	3.68	3.66
	F - test	S	S	S
	S Ed. (±)	0.008	0.001	0.005
	CD at 5%	0.017	0.002	0.009
Plant geometry (P)				
P_1	60 x 30	3.40	3.43	3.41
P_2	60 x 40	3.53	3.55	3.54
P_3	60 x 50	3.56	3.59	3.58
	F - test	S	S	S
	S. Ed. (±)	0.008	0.001	0.005
	CD at 5%	0.017	0.002	0.009

Table 4.38: Interaction effect of cultivars, spacing and dose of fertilizer application on total nitrogen in leaf (%) of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	3.21	3.23	3.22
T_2	$V_1+D_1+P_2$	3.32	3.34	3.33
T_3	$V_1+D_1+P_3$	3.34	3.36	3.35
T_4	$V_1+D_2+P_1$	3.35	3.37	3.36
T_5	$V_1+D_2+P_2$	3.58	3.59	3.59
T_6	$V_1+D_2+P_3$	3.59	3.61	3.60
T_7	$V_1+D_3+P_1$	3.54	3.55	3.55
T_8	$V_1+D_3+P_2$	3.61	3.64	3.63
T_9	$V_1+D_3+P_3$	3.67	3.69	3.68
T_{10}	$V_2+D_1+P_1$	3.34	3.37	3.36
T_{11}	$V_2+D_1+P_2$	3.39	3.41	3.40
T_{12}	$V_2+D_1+P_3$	3.37	3.39	3.38
T_{13}	$V_2+D_2+P_1$	3.39	3.42	3.41
T_{14}	$V_2+D_2+P_2$	3.58	3.59	3.59
T_{15}	$V_2+D_2+P_3$	3.61	3.66	3.64
T_{16}	$V_2+D_3+P_1$	3.59	3.67	3.63
T_{17}	$V_2+D_3+P_2$	3.69	3.73	3.71
T_{18}	$V_2+D_3+P_3$	3.79	3.83	3.81
T_{19}	$V_3+D_1+P_1$	3.22	3.27	3.25
T_{20}	V_3+D_1+P2	3.33	3.36	3.35
T_{21}	$V_3+D_1+P_3$	3.36	3.39	3.38
T_{22}	$V_3+D_2+P_1$	3.37	3.38	3.38
T_{23}	$V_3+D_2+P_2$	3.59	3.59	3.59
T_{24}	$V_3+D_2+P_3$	3.64	3.68	3.66
T_{25}	$V_3+D_3+P_1$	3.58	3.59	3.59
T_{26}	$V_3+D_3+P_2$	3.67	3.68	3.68
T_{27}	$V_3+D_3+P_3$	3.69	3.72	3.71
Interaction (Vx D x P)	F - test	S	S	S
	S. Ed. (±)	0.025	0.003	0.014
	CD. at 5%	0.051	0.006	0.028

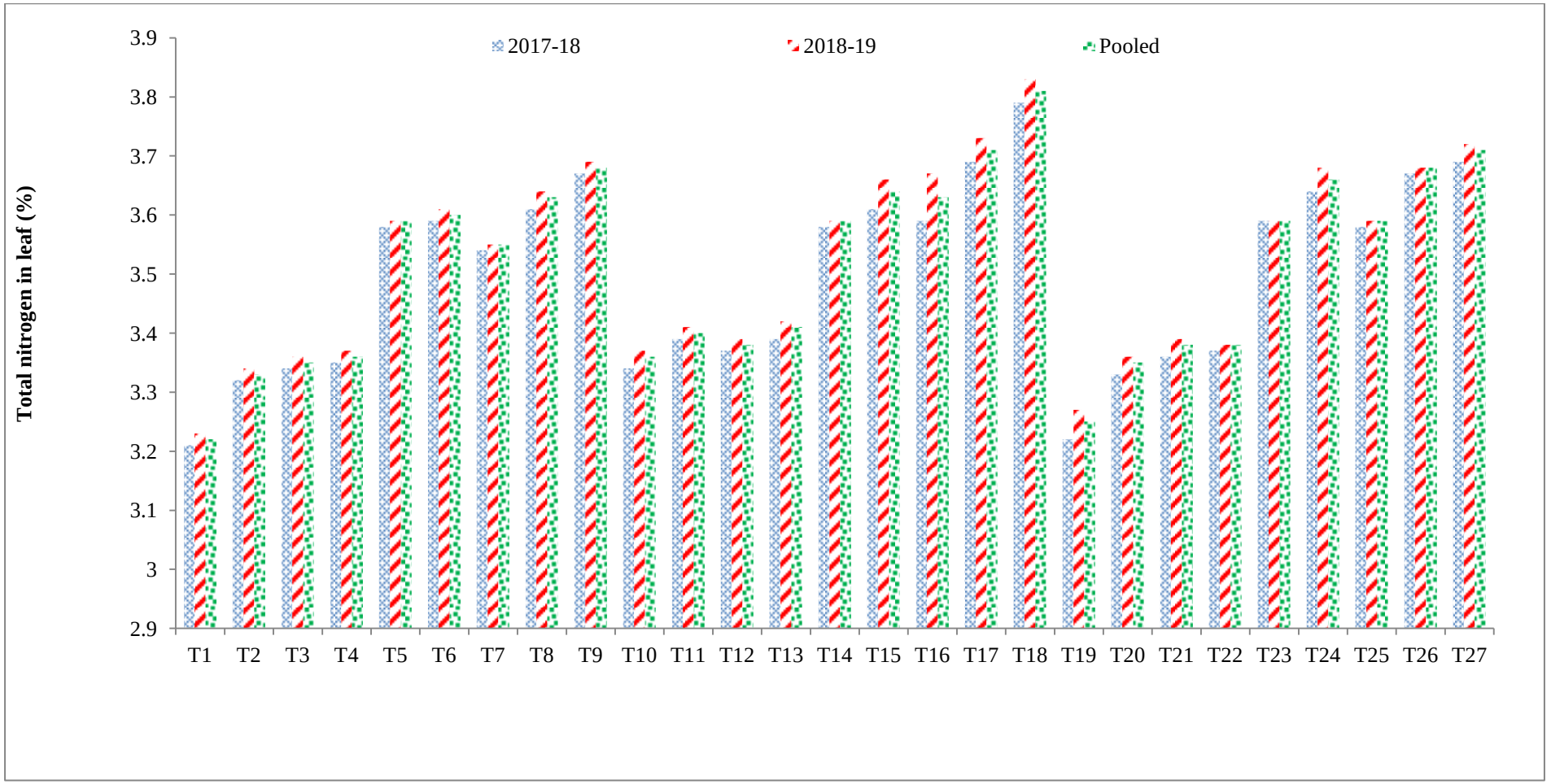

Fig 4.19: Interaction effect of cultivars, spacing and dose of fertilizer application on total nitrogen in leaf (%) of parthenocarpic cucumber under polyhouse condition during winter season.

4.5.2 Total phosphorus in leaf (%)

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on total phosphorus in leaf (%) of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.39 and Fig. 4.20. The analysis of variance is given in Appendix LVIII, LIX and LX.

(a) Effect of cultivars:

The data presented in Table 4.39 the total phosphorus in leaf (%)of parthenocarpic cucumber was significantly influenced by various cultivar treatments during both the years of experimentation of winter season however, on the basis of pooled data analysis the maximum total phosphorus in leaf (%) (0.81 %) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to minimum total phosphorus in leaf (%) (0.78 %) in cultivar V_1 (Pant Parthenocarpic Cucumber-2)

(b) Effect of spacing:

Data presented in Table 4.39 indicated that the total Phosphorus in leaf (%) (%) of cucumber was significantly influenced by various spacing treatments during both the years of experimentation. The pooled data showed that maximum total Phosphorus in leaf (%) ((0.81 %) was recorded in P_3 (60 x 50 cm) and minimum total phosphorus in leaf (0.78 %) in P_1 (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.39 that dose of fertilizer application was significant effect total phosphorus in leaf (%) of parthenocarpic cucumber during pooled data investigation maximum total phosphorus in leaf (0.83 %) was observed in D_3 (30:20:32 Kg/1000 m^2) as compared to minimum total phosphorus in leaf (0.77 %) in D_1 (20:10:22 Kg /1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.40 showed non significant total phosphorus in leaf (%) during both the years of experimentation. Further, $T_{18,}$ $V_2D_3P_3$ (PPC-3 + 30:20:32 kg + 60 x 50 cm) resulted in maximum total phosphorus in leaf (0.85%). and was closely followed by $T_{27,}$ V_3+D_3+P_3 and $T_{17,}$ V_2+D_3+P_2 (0.84 %) same value this was both statically at par with T_{18} However, minimum total phosphorus in leaf (0.75 %) was recorded in T_1 $V_1D_1P_1$ (PPC-2 +20:10:22 kg + 60 x 30 cm) on pooled data basis.

Table 4.39: Effect of cultivars, spacing and dose of fertilizer application total phosphorus in leaf (%) of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	0.77	0.79	0.78
V_2	Pant Parthenocarpic Cucumber -3	0.80	0.82	0.81
V_3	Hilton	0.79	0.81	0.80
	F – test	S	S	S
	S Ed. (±)	0.001	0.001	0.001
	CD at 5%	0.003	0.002	0.003
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	0.76	0.78	0.77
D_2	25:15:27 kg	0.79	0.80	0.79
D_3	30:20:32 kg	0.81	0.84	0.83
	F - test	S	S	S
	S Ed. (±)	0.001	0.001	0.001
	CD at 5%	0.003	0.002	0.003
Plant geometry (P)				
P_1	60 x 30	0.77	0.79	0.78
P_2	60 x 40	0.79	0.81	0.80
P_3	60 x 50	0.80	0.82	0.81
	F - test	S	S	S
	S. Ed. (±)	0.001	0.001	0.001
	CD at 5%	0.003	0.002	0.003

Table 4.40: Interaction effect of cultivars, spacing and dose of fertilizer application on total phosphorus in leaf (%) of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	0.74	0.75	0.75
T_2	$V_1+D_1+P_2$	0.75	0.76	0.76
T_3	$V_1+D_1+P_3$	0.76	0.77	0.77
T_4	$V_1+D_2+P_1$	0.76	0.77	0.77
T_5	$V_1+D_2+P_2$	0.78	0.79	0.79
T_6	$V_1+D_2+P_3$	0.79	0.80	0.80
T_7	$V_1+D_3+P_1$	0.79	0.81	0.80
T_8	$V_1+D_3+P_2$	0.79	0.82	0.81
T_9	$V_1+D_3+P_3$	0.81	0.84	0.83
T_{10}	$V_2+D_1+P_1$	0.75	0.78	0.77
T_{11}	$V_2+D_1+P_2$	0.77	0.79	0.78
T_{12}	$V_2+D_1+P_3$	0.79	0.81	0.80
T_{13}	$V_2+D_2+P_1$	0.78	0.79	0.79
T_{14}	$V_2+D_2+P_2$	0.79	0.81	0.80
T_{15}	$V_2+D_2+P_3$	0.81	0.83	0.82
T_{16}	$V_2+D_3+P_1$	0.82	0.84	0.83
T_{17}	$V_2+D_3+P_2$	0.83	0.85	0.84
T_{18}	$V_2+D_3+P_3$	0.84	0.86	0.85
T_{19}	$V_3+D_1+P_1$	0.75	0.78	0.77
T_{20}	V_3+D_1+P2	0.76	0.79	0.78
T_{21}	$V_3+D_1+P_3$	0.77	0.79	0.78
T_{22}	$V_3+D_2+P_1$	0.77	0.78	0.78
T_{23}	$V_3+D_2+P_2$	0.79	0.80	0.80
T_{24}	$V_3+D_2+P_3$	0.80	0.81	0.81
T_{25}	$V_3+D_3+P_1$	0.81	0.82	0.82
T_{26}	$V_3+D_3+P_2$	0.82	0.84	0.83
T_{27}	$V_3+D_3+P_3$	0.82	0.85	0.84
Interaction (Vx D x P)	F - test	S	S	NS
	S. Ed. (±)	0.004	0.004	0.004
	CD. at 5%	0.008	0.007	0.008

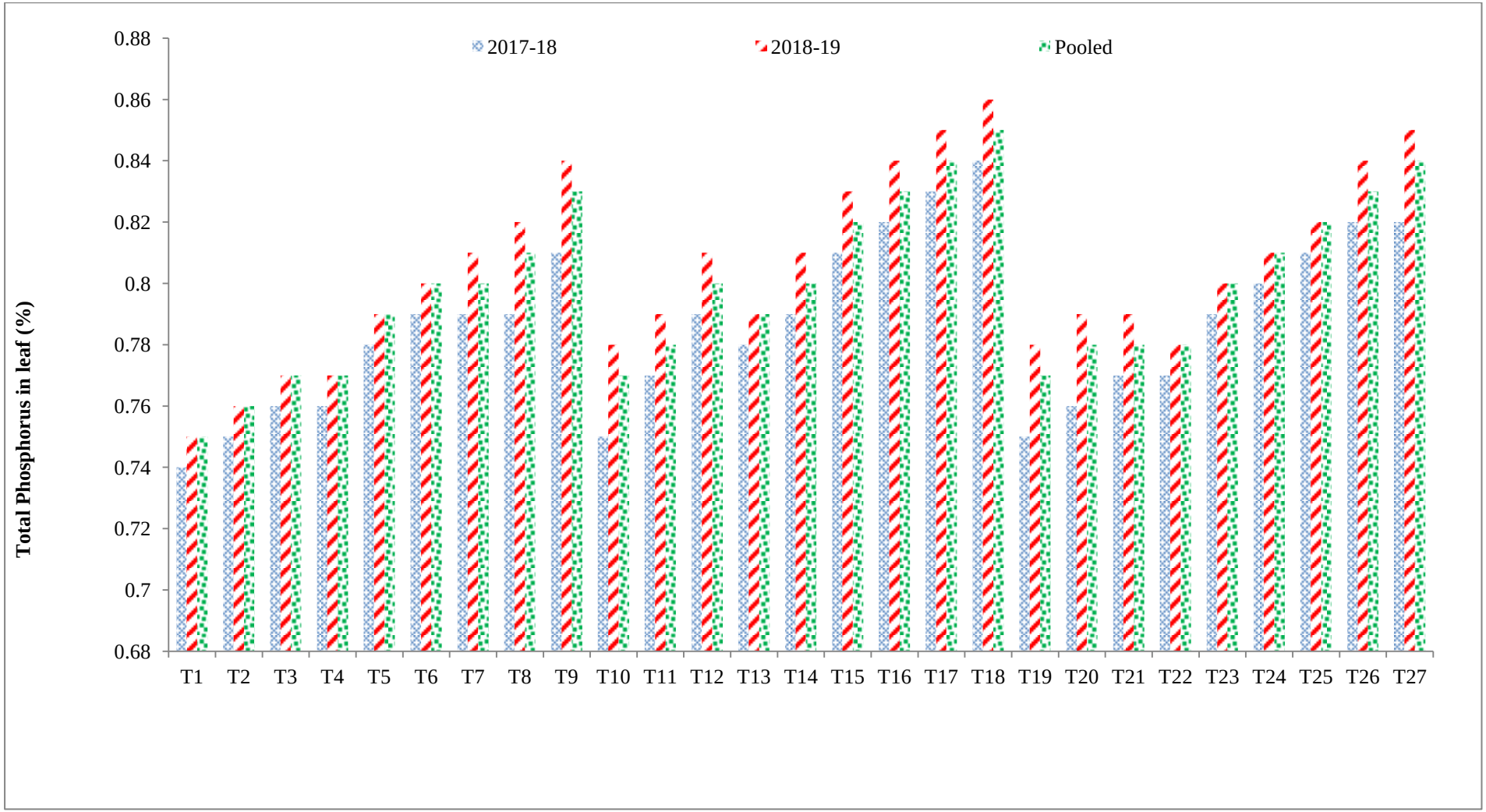

Fig 4.20: Interaction effect of cultivars, spacing and dose of fertilizer application on total phosphorus in leaf (%) of parthenocarpic cucumber under polyhouse condition during winter season.

4.5.3 Total potassium in leaf (%)

The data regarding effect of cultivars, spacing and dose of fertilizer application and their interaction effects on total potassium in leaf (%) of parthenocarpic cucumber under polyhouse condition during the winter season are presented in Table 4.41 and Fig. 4.21. The analysis of variance is given in Appendix LXI, LXII and LXIII.

(a) Effect of cultivars:

The data presented in Table 4.41 the total potassium in leaf (%)of parthenocarpic cucumber was significantly influenced by various cultivar treatments during both the years of experimentation of winter season however, on the basis of pooled data analysis the maximum total potassium in leaf (2.42 %) was recorded in cultivar V_2 (Pant Parthenocarpic Cucumber-3) as compared to minimum total potassium in leaf (2.39 %) in cultivar V_1 (Pant Parthenocarpic Cucumber-2)

(b) Effect of spacing:

Data presented in Table 4.41 indicated that the total potassium in leaf (%) (%) of cucumber was significantly influenced by various spacing treatments during both the years of experimentation. The pooled data showed that maximum total potassium in leaf ((2.44 %) was recorded in P_3 (60 x 50 cm) and minimum total potassium in leaf (2.39 %) in P_1 (60 x 30 cm).

(c) Effect of dose of fertilizer application:

The data presented in Table 4.41 that dose of fertilizer application was significant effect total potassium in leaf (%) of parthenocarpic cucumber during pooled data investigation maximum total potassium in leaf (2.44 %) was observed in D_3 (30:20:32 kg/1000 m^2) as compared to minimum total potassium in leaf (2.37 %) in D_1 (20:10:22 kg /1000 m^2) as on the basis of pooled analysis.

(d) Interaction effect of cultivars, spacing and dose of fertilizers application:

Interaction effect of cultivars, spacing and dose of fertilizer application presented in Table 4.42 showed non significant total potassium in leaf (%) during both the years of experimentation. Further, $T_{18,}$ $V_2D_3P_3$ (PPC-3 + 30:20:32 kg + 60 x 50 cm) resulted in maximum total potassium in leaf (0.85%). and was closely followed by $T_{27,}$ V_3+D_3+P_3 and $T_{17,}$ V_2+D_3+P_2 (2.50 %) and was closely followed by $T_{27,}$ V_3+D_3+P_3 (2.47 %) and this was statically at par with T_{18} However, minimum total potassium in leaf (2.33 %) was recorded in T_1 $V_1D_1P_1$ (PPC-2 +20:10:22 kg + 60 x 30 cm) on pooled data basis.

Table 4.41: Effect of cultivars, spacing and dose of fertilizer application total potassium in leaf (%) of parthenocarpic cucumber under polyhouse condition during winter season

Factor		2017-18	2018-19	Pooled
Variety (V)				
V_1	Pant Parthenocarpic Cucumber -2	2.38	2.40	2.39
V_2	Pant Parthenocarpic Cucumber -3	2.41	2.44	2.42
V_3	Hilton	2.40	2.42	2.41
	F – test	S	S	S
	S Ed. (±)	0.004	0.003	0.004
	CD at 5%	0.008	0.007	0.007
NPK (kg/1000m^2) (D)				
D_1	20:10:22 kg	2.36	2.38	2.37
D_2	25:15:27 kg	2.40	2.42	2.41
D_3	30:20:32 kg	2.43	2.46	2.44
	F – test	S	S	S
	S Ed. (±)	0.004	0.003	0.004
	CD at 5%	0.008	0.007	0.007
Plant geometry (P)				
P_1	60 x 30	2.37	2.40	2.39
P_2	60 x 40	2.39	2.41	2.40
P_3	60 x 50	2.43	2.45	2.44
	F – test	S	S	S
	S. Ed. (±)	0.004	0.003	0.004
	CD at 5%	0.008	0.007	0.007

Table 4.42: Interaction effect of cultivars, spacing and dose of fertilizer application on total potassium in leaf (%) of parthenocarpic cucumber under polyhouse condition during winter season

Treatment combination		2017-18	2018-19	Pooled
T_1	$V_1+D_1+P_1$	2.32	2.33	2.33
T_2	$V_1+D_1+P_2$	2.34	2.35	2.35
T_3	$V_1+D_1+P_3$	2.39	2.41	2.40
T_4	$V_1+D_2+P_1$	2.36	2.39	2.38
T_5	$V_1+D_2+P_2$	2.38	2.39	2.39
T_6	$V_1+D_2+P_3$	2.41	2.44	2.43
T_7	$V_1+D_3+P_1$	2.39	2.43	2.41
T_8	$V_1+D_3+P_2$	2.41	2.44	2.43
T_9	$V_1+D_3+P_3$	2.44	2.46	2.45
T_{10}	$V_2+D_1+P_1$	2.34	2.37	2.36
T_{11}	$V_2+D_1+P_2$	2.36	2.39	2.38
T_{12}	$V_2+D_1+P_3$	2.41	2.43	2.42
T_{13}	$V_2+D_2+P_1$	2.39	2.42	2.41
T_{14}	$V_2+D_2+P_2$	2.42	2.44	2.43
T_{15}	$V_2+D_2+P_3$	2.43	2.47	2.45
T_{16}	$V_2+D_3+P_1$	2.41	2.45	2.43
T_{17}	$V_2+D_3+P_2$	2.43	2.48	2.46
T_{18}	$V_2+D_3+P_3$	2.48	2.51	2.50
T_{19}	$V_3+D_1+P_1$	2.33	2.38	2.36
T_{20}	V_3+D_1+P2	2.35	2.36	2.36
T_{21}	$V_3+D_1+P_3$	2.40	2.42	2.41
T_{22}	$V_3+D_2+P_1$	2.39	2.40	2.40
T_{23}	$V_3+D_2+P_2$	2.39	2.41	2.40
T_{24}	$V_3+D_2+P_3$	2.42	2.44	2.43
T_{25}	$V_3+D_3+P_1$	2.41	2.43	2.42
T_{26}	$V_3+D_3+P_2$	2.43	2.45	2.44
T_{27}	$V_3+D_3+P_3$	2.46	2.48	2.47
Interaction (Vx D x P)	F – test	NS	NS	NS
	S. Ed. (±)	0.012	0.010	0.011
	CD. at 5%	0.024	0.020	0.022

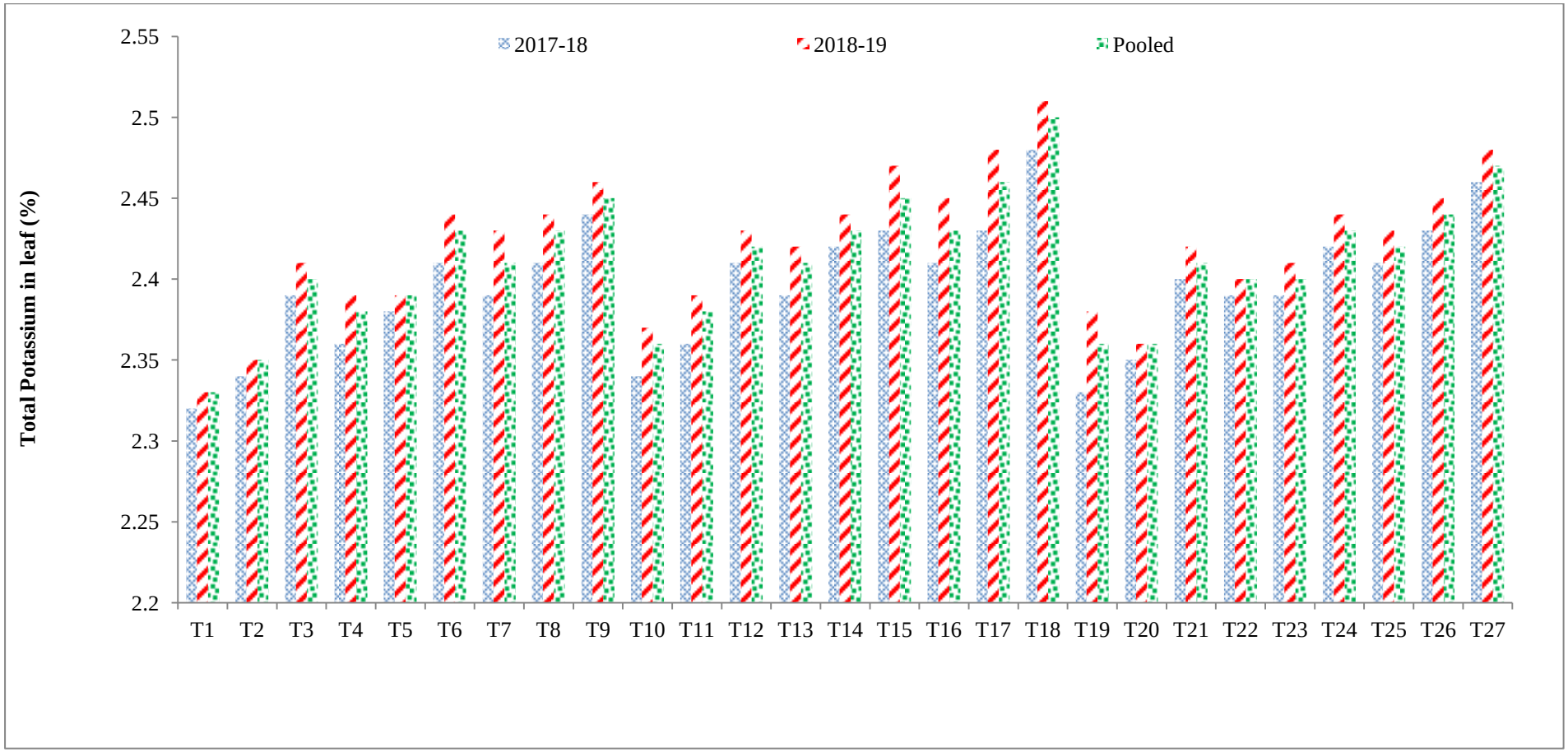

Fig 4.21: Interaction effect of cultivars, spacing and dose of fertilizer application on total potassium in leaf (%) of parthenocarpic cucumber under polyhouse condition during winter season.

Pursuant to the above mentioned results of leaf nutrient status with respect to nitrogen; phosphorus and potassium content were significantly influenced by cultivars, plant geometry and dose of fertilizer during both the year experiments. Maximum values of nitrogen (3.55 %), phosphorus (0.81 %) and potassium (2.42 %) contents of leaf were recorded in cultivar V_2, Pant Parthenocarpic Cucumber -3 during both the year. In the reference of spacing, maximum values (3.58 % nitrogen, 0.81 % phosphorus and 2.44 % potassium) of nutrient contents of leaf were obtained in maximum plant geometry (P_3) i.e. 60 x 50 cm as compared to minimum spacing as P_1 60 x 30 cm. Similarly, maximum nitrogen content of leaf (3.66 %), phosphorus (0.83 %) and potassium (2.44 %) contents were obtained in D_3, maximum use of NPK combination as compared to minimum use of NPK combination fertilizers during the both year (Table 4.37,4.39 and 4.41). This might be due to the reason that application of maximum apply of NPK combination fertilizers were effectively utilized by the plants as these inputs were placed near crop root zone area and also applied at desired amount (Singh and hupe *et al., 2005).* (Shinde *et al.* 2001, Singh and hupe and Brahmanand) 2001 and Singh and hupe *et al.) 2003).*

Maximum nutrient contents in cucumber crop along with the minimum nutrient residues in the soil after harvest were reported in a fertigation experiment as conducted by Choudhari and More, 2002. Interaction effect of cultivars, spacing and dose of fertilizer application were found to significant influence on leaf nitrogen and phosphorus content. Maximum value of nitrogen T_{18}, $V_2+D_3+P_3$ (3.81 %), followed by nearest value of T17 and T_{27}, (3.71 %) and minimum nitrogen percentage in treatment T_1, $V_1D_1P_1$, (3.2 %), maximum phosphorus content of leaf (0.85 %) was recorded treatment T_{18}, $V_2+D_3+P_3$ (Pant parthenocarpic cucumber -3 + 60 x 50 cm +30:20:32 kg) during both the year (Table 4.38, 4.40 and 4.42). However, leaf potassium content was non-significantly influenced during (Appendix LXI,LXII and LXIII) in both the year.

4.6 ECONOMICS OF TREATMENTS

4.8.1 Economics on parthenocarpic cucumber under polyhouse per (1000 m^2)

All the treatments were evaluated for analysis of cost and return variables, the data is calculated per 10000 m^2 area of polyhouse and presented year wise in Table 4.43, 4.44, 4.45, 4.46, 4.47 and 4.48. The common cost concepts of agricultural economics are used to interpret the results. The various inputs used in the cultivation of cucumber were divided into two components i.e. variable cost and fixed cost. There costs were worked out for different treatments separately. Variable costs include cost of chemical fertilizers that has been used as treatment doses. Fixed cost includes rent paid on leased out land and interest paid on working capital, cleaning of polyhouse, tube well charges, labour charges and fertilizer charges as basal dose. Gross returns were obtained by multiplying total production per 1000 m^2 polyhouse per treatment multiplied by prevailing market price. Net returns were arrived at subtracting total cost of cultivation from gross returns. Likewise, benefit: cost ratio was calculated by dividing net returns by total cost of cultivation.

Effect of various treatments on cost benefit ratio of cucumber cultivation under protected condition has been recorded during two years of the study (2017-18 and 2018-19) and presented in table 4.49, 4.50 and 451.An inquisition of the first year data revealed that Maximum benefit cost ratio of (1:3.50) was obtained under T_{10} (V2+D1+P3) cultivar Pant Parthenocarpic Cucumber -3 with fertilizers dose 20:10:22 kg per 1000 m^2 of polyhouse along with plant geometry 60 x 50 cm treatment combination. Treatment comprising followed by benefit cost ratio of (1:3.43) obtained under treatment T_{19} (V_3+D_1+P_1) cultivar Hilton with 20:10:22 kg fertilizers apply in 1000 m^2 area of polyhouse and plant geometry 60 x 30 cm. minimum benefit cost ratio of (1:2.10) was obtained under T_{27} (V3+D3+P3) cultivar Pant Parthenocarpic Cucumber -3 with fertilizers dose 30:20:32 kg per 1000 m^2 of polyhouse along with plant geometry 60 x 50 cm and similar result of second year and pooled data. Lowest cost of cultivation was recorded under control (T_{27}) during both the years of the experiment, where as net returns were highest with the treatment combination T_{10} during both the year of experiment, (T_{10}), Maximum benefit: cost ratio was obtained with the application of treatment (T_{10}) and was closely followed by T_{19}, during both the year Similar results were reported by **Singh *et al.* (2011),** in parthenocarpic cucumber under protected condition.

Table 4.43: Cost of cultivation of parthenocarpic cucumber (*cucumis sativus* L.) per 1000 m^2 (Fixed cost for all treatment under polyhouse condition) first year 2017-18

Sl. No.	Particulars	Unit	Qty.	Rate /unit (Rs.)	Cost (Rs/ha)
A	**Land preparation**				
1	Ploughing with mould board	Hours	4	500	2,000
2	Labelling and bed preparation	Hours	2	500	1,000
3	Labour for layout of field	Labour	4	350	1,400
4	Wiring of polyhouse	Labour	4	350	1,400
B.	**Seed sowing and Fertilizers application**				
1	Seed sowing	Labour	2	350	700
2	Fertilizers application	Labour	2	350	700
C.	**Other materials**				
1	Wire	kg	05	150	750
2	Jute rope (sutali)	kg	10	150	1,500
D.	**After care**				
1	Weeding and hoeing (4 Nos.)	Labour	10	350	3,500
E.	Plant protection measures				
1	Cost of insecticide/fungicide	ml	200	200	400
2	Labour of spry	Labour	4	350	1,400
F.	**Irrigation**				
1	Tubell charge -5 irrigation (1/2 hrs per irrigation)	Hours	2.5	400	1,000
2	Labour for irrigation	Labour	5	350	1,750
G.	**Picking- 5**	Labour	10	350	3,500
H	**Other charges**				
1	Packaging materials	-	-	-	2,500
2	Loading and unloading	Labour	2	350	700
3	Transportation	Mini truck	3 times	500	1500
I	**Supervision charges**	Month	3	2000	6,000
J	**Rental of polyhouse**	Month	3	5000	15,000
Total fixed cost (Rs./ 1000 M^2 polyhouse)					**39200**

Table 4.44: Cost of cultivation of parthenocarpic cucumber (*cucumis sativus* L.) per 1000 m^2 (Fixed cost for all treatment under polyhouse condition) – first year 2018-19

Sl.No.	Particulars	Unit	Qty.	Rate //unit (Rs.)	Cost (Rs/ha)
A	**Land preparation**				
1	Ploughing with mould board	Hours	4	500	2,000
2	Labelling and bed preparation	Hours	2	500	1,000
3	Labour for layout of field	Labour	4	350	1,400
4	Wiring of polyhouse	Labour	4	350	1,400
B.	**Seed sowing and Fertilizers application**				
1	Seed sowing	Labour	2	350	700
2	Fertilizers application	Labour	2	350	700
C.	**Other materials**				
1	Wire	kg	05	150	750
2	Jute rope (sutali)	kg	10	150	1,500
D.	**After care**				
1	Weeding and hoeing (4 Nos.)	Labour	10	350	3,500
E.	Plant protection measures				
1	Cost of insecticide/fungicide	100 ml	200	250/100 ml	500
2	Labour of spry	Labour	4	350	1,400
F.	**Irrigation**				
1	Tubell charge -5 irrigation (1/2 hrs per irrigation)	Hours	2.5	400	1,000
2	Labour for irrigation	Labour	5	350	1,750
G.	**Picking- 5**	Labour	10	350	3,500
H	**Other charges**				
1	Packaging materials	-	-	-	2,500
2	Loading and unloading	Labour	2	350	700
3	Transportation	Mini truck	3 times	800	2400
I	**Supervision charges**	Month	3	2000	6,000
J	**Rental of polyhouse**	Month	3	6000	18,000
Total fixed cost (Rs./ 1000 M^2polyhouse)					**43200**

Table 4.45: Cost of cultivation of parthenocarpic cucumber (*cucumis sativus* L.) per 1000 m^2 (Fixed cost for all treatment under polyhouse condition) – pooled

Sl.No.	Particulars	Unit	Qty.	Rate //unit (Rs.)	Cost (Rs/ha)
A	**Land preparation**				
1	Ploughing with mould board	Hours	4	500	2,000
2	Labelling and bed preparation	Hours	2	500	1,000
3	Labour for layout of field	Labour	4	350	1,400
4	Wiring of polyhouse	Labour	4	350	1,400
B.	**Seed sowing and Fertilizers application**				
1	Seed sowing	Labour	2	350	700
2	Fertilizers application	Labour	2	350	700
C.	**Other materials**				
1	Wire	kg	05	150	750
2	Jute rope (sutali)	kg	10	150	1,500
D.	**After care**				
1	Weeding and hoeing (4 Nos.)	Labour	10	350	3,500
E.	Plant protection measures				
1	Cost of insecticide/fungicide	ml	200	200	450
2	Labour of spry	Labour	4	350	1,400
F.	**Irrigation**				
1	Tubell charge -5 irrigation (1/2 hrs per irrigation)	Hours	2.5	400	1,000
2	Labour for irrigation	Labour	5	350	1,750
G.	**Picking- 5**	Labour	10	350	3,500
H	**Other charges**				
1	Packaging materials	-	-	-	2,500
2	Loading and unloading	Labour	2	350	700
3	Transportation	Mini truck	3 times	500	1,950
I	**Supervision charges**	Month	3	2000	6,000
J	**Rental of polyhouse**	Month	3	5000	16,500
Total fixed cost (Rs./ 1000 M^2 polyhouse)					**41200**

Table 4.46: Total Cost of cultivation of parthenocarpic cucumber (*cucumis sativus* L.) per 1000 m^2 (Treatment combination wise under polyhouse condition) – I Year 2017-18

Treatment	**Treatment combination**	**Urea**	**Urea phosphate**	**Potassium sulphate**	**Total variable cost**	**Fixed Cost**	**Interest**	**Total Cost**
T_1	V1+D1+P1	35.072	22.72	44	7260.096	39200	1858.404	48318.5
T_2	V1+D1+P2	35.072	22.72	44	7260.096	39200	1858.404	48318.5
T_3	V1+D1+P3	35.072	22.72	44	7260.096	39200	1858.404	48318.5
T_4	V1+D2+P1	41.736	34.08	54	9134.448	39200	1933.378	50267.83
T_5	V1+D2+P2	41.736	34.08	54	9134.448	39200	1933.378	50267.83
T_6	V1+D2+P3	41.736	34.08	54	9134.448	39200	1933.378	50267.83
T_7	V1+D3+P1	48.405	45.44	64	11008.89	39200	2008.356	52217.25
T_8	V1+D3+P2	48.405	45.44	64	11008.89	39200	2008.356	52217.25
T_9	V1+D3+P3	48.405	45.44	64	11008.89	39200	2008.356	52217.25
T_{10}	V2+D1+P1	35.072	22.72	44	7260.096	39200	1858.404	48318.5
T_{11}	V2+D1+P2	35.072	22.72	44	7260.096	39200	1858.404	48318.5
T_{12}	V2+D1+P3	35.072	22.72	44	7260.096	39200	1858.404	48318.5
T_{13}	V2+D2+P1	41.736	34.08	54	9134.448	39200	1933.378	50267.83
T_{14}	V2+D2+P2	41.736	34.08	54	9134.448	39200	1933.378	50267.83
T_{15}	V2+D2+P3	41.736	34.08	54	9134.448	39200	1933.378	50267.83
T_{16}	V2+D3+P1	48.405	45.44	64	11008.89	39200	2008.356	52217.25
T_{17}	V2+D3+P2	48.405	45.44	64	11008.89	39200	2008.356	52217.25
T_{18}	V2+D3+P3	48.405	45.44	64	11008.89	39200	2008.356	52217.25
T_{19}	V3+D1+P1	35.072	22.72	44	7260.096	39200	1858.404	48318.5
T_{20}	V3+D1+P2	35.072	22.72	44	7260.096	39200	1858.404	48318.5
T_{21}	V3+D1+P3	35.072	22.72	44	7260.096	39200	1858.404	48318.5
T_{22}	V3+D2+P1	41.736	34.08	54	9134.448	39200	1933.378	50267.83
T_{23}	V3+D2+P2	41.736	34.08	54	9134.448	39200	1933.378	50267.83
T_{24}	V3+D2+P3	41.736	34.08	54	9134.448	39200	1933.378	50267.83
T_{25}	V3+D3+P1	48.405	45.44	64	11008.89	39200	2008.356	52217.25
T_{26}	V3+D3+P2	48.405	45.44	64	11008.89	39200	2008.356	52217.25
T_{27}	V3+D3+P3	48.405	45.44	64	11008.89	39200	2008.356	52217.25

Table 4.47: Total Cost of cultivation of parthenocarpic cucumber (*cucumis sativus* L.) per 1000 m^2 (Treatment combination wise under polyhouse condition) – II Year 2018-19

Treatment	Treatment combination	Urea	Urea phosphate	Potassium sulphate	Total variable cost	Fixed Cost	Interest	Total Cost
T_1	V1+D1+P1	35.072	22.72	44	7260.096	43200	1858.404	52318.5
T_2	V1+D1+P2	35.072	22.72	44	7260.096	43200	1858.404	52318.5
T_3	V1+D1+P3	35.072	22.72	44	7260.096	43200	1858.404	52318.5
T_4	V1+D2+P1	41.736	34.08	54	9134.448	43200	1933.378	54267.8
T_5	V1+D2+P2	41.736	34.08	54	9134.448	43200	1933.378	54267.8
T_6	V1+D2+P3	41.736	34.08	54	9134.448	43200	1933.378	54267.8
T_7	V1+D3+P1	48.405	45.44	64	11008.89	43200	2008.356	56217.2
T_8	V1+D3+P2	48.405	45.44	64	11008.89	43200	2008.356	56217.2
T_9	V1+D3+P3	48.405	45.44	64	11008.89	43200	2008.356	56217.2
T_{10}	V2+D1+P1	35.072	22.72	44	7260.096	43200	1858.404	52318.5
T_{11}	V2+D1+P2	35.072	22.72	44	7260.096	43200	1858.404	52318.5
T_{12}	V2+D1+P3	35.072	22.72	44	7260.096	43200	1858.404	52318.5
T_{13}	V2+D2+P1	41.736	34.08	54	9134.448	43200	1933.378	54267.8
T_{14}	V2+D2+P2	41.736	34.08	54	9134.448	43200	1933.378	54267.8
T_{15}	V2+D2+P3	41.736	34.08	54	9134.448	43200	1933.378	54267.8
T_{16}	V2+D3+P1	48.405	45.44	64	11008.89	43200	2008.356	56217.2
T_{17}	V2+D3+P2	48.405	45.44	64	11008.89	43200	2008.356	56217.2
T_{18}	V2+D3+P3	48.405	45.44	64	11008.89	43200	2008.356	56217.2
T_{19}	V3+D1+P1	35.072	22.72	44	7260.096	43200	1858.404	52318.5
T_{20}	V3+D1+P2	35.072	22.72	44	7260.096	43200	1858.404	52318.5
T_{21}	V3+D1+P3	35.072	22.72	44	7260.096	43200	1858.404	52318.5
T_{22}	V3+D2+P1	41.736	34.08	54	9134.448	43200	1933.378	54267.8
T_{23}	V3+D2+P2	41.736	34.08	54	9134.448	43200	1933.378	54267.8
T_{24}	V3+D2+P3	41.736	34.08	54	9134.448	43200	1933.378	54267.8
T_{25}	V3+D3+P1	48.405	45.44	64	11008.89	43200	2008.356	56217.2
T_{26}	V3+D3+P2	48.405	45.44	64	11008.89	43200	2008.356	56217.2
T_{27}	V3+D3+P3	48.405	45.44	64	11008.89	43200	2008.356	56217.2

Table 4.48: Total Cost of cultivation of parthenocarpic cucumber (*cucumis sativus* L.) per 1000 m^2 (Treatment combination wise under polyhouse condition) – pooled

Treatment	Treatment combination	Urea	Urea phosphate	Potassium sulphate	Total variable cost	Fixed Cost	Interest	Total Cost
T_1	V1+D1+P1	35.072	22.72	44	7260.096	41200	1858.404	50318.5
T_2	V1+D1+P2	35.072	22.72	44	7260.096	41200	1858.404	50318.5
T_3	V1+D1+P3	35.072	22.72	44	7260.096	41200	1858.404	50318.5
T_4	V1+D2+P1	41.736	34.08	54	9134.448	41200	1933.378	52267.8
T_5	V1+D2+P2	41.736	34.08	54	9134.448	41200	1933.378	52267.8
T_6	V1+D2+P3	41.736	34.08	54	9134.448	41200	1933.378	52267.8
T_7	V1+D3+P1	48.405	45.44	64	11008.89	41200	2008.356	54217.2
T_8	V1+D3+P2	48.405	45.44	64	11008.89	41200	2008.356	54217.2
T_9	V1+D3+P3	48.405	45.44	64	11008.89	41200	2008.356	54217.2
T_{10}	V2+D1+P1	35.072	22.72	44	7260.096	41200	1858.404	50318.5
T_{11}	V2+D1+P2	35.072	22.72	44	7260.096	41200	1858.404	50318.5
T_{12}	V2+D1+P3	35.072	22.72	44	7260.096	41200	1858.404	50318.5
T_{13}	V2+D2+P1	41.736	34.08	54	9134.448	41200	1933.378	52267.8
T_{14}	V2+D2+P2	41.736	34.08	54	9134.448	41200	1933.378	52267.8
T_{15}	V2+D2+P3	41.736	34.08	54	9134.448	41200	1933.378	52267.8
T_{16}	V2+D3+P1	48.405	45.44	64	11008.89	41200	2008.356	54217.2
T_{17}	V2+D3+P2	48.405	45.44	64	11008.89	41200	2008.356	54217.2
T_{18}	V2+D3+P3	48.405	45.44	64	11008.89	41200	2008.356	54217.2
T_{19}	V3+D1+P1	35.072	22.72	44	7260.096	41200	1858.404	50318.5
T_{20}	V3+D1+P2	35.072	22.72	44	7260.096	41200	1858.404	50318.5
T_{21}	V3+D1+P3	35.072	22.72	44	7260.096	41200	1858.404	50318.5
T_{22}	V3+D2+P1	41.736	34.08	54	9134.448	41200	1933.378	52267.8
T_{23}	V3+D2+P2	41.736	34.08	54	9134.448	41200	1933.378	52267.8
T_{24}	V3+D2+P3	41.736	34.08	54	9134.448	41200	1933.378	52267.8
T_{25}	V3+D3+P1	48.405	45.44	64	11008.89	41200	2008.356	54217.2
T_{26}	V3+D3+P2	48.405	45.44	64	11008.89	41200	2008.356	54217.2
T_{27}	V3+D3+P3	48.405	45.44	64	11008.89	41200	2008.356	54217.2

Table 4.49: Effect of cultivars, spacing and dose of fertilizer application on Economics and Benefit: cost ratio for parthenocarpic cucumber under polyhouse condition – I Year, 2017-2018

Treatments	Cost of cultivation (Rs/1000 m^2)	Total yield (kg/m^2)	Total yield (q/1000m^2)	Selling rate (Rs/q)	Gross return (Rs/1000 m^2)	Net return Rs./ 1000 m^2)	Benefit cost ratio
T1	48318	14.20	142	1500	213000	164682	3.40
T2	48318	13.40	134	1500	201000	152682	3.15
T3	48318	10.30	103	1500	154500	106182	2.19
T4	50268	14.30	143	1500	214500	164232	3.26
T5	50268	13.50	135	1500	202500	152232	3.02
T6	50268	10.60	106	1500	159000	108732	2.16
T7	52217	14.40	144	1500	216000	163783	3.13
T8	52217	13.60	136	1500	204000	151783	2.90
T9	52,217	10.70	107	1500	160500	108283	2.07
T10	48318	14.50	145	1500	217500	168182	3.50
T11	48318	13.60	136	1500	204000	155682	3.22
T12	48318	10.50	105	1500	157500	109182	2.25
T13	50,268	14.60	146	1500	219000	168732	3.35
T14	50268	13.60	136	1500	204000	153732	3.05
T15	50268	10.90	109	1500	163500	113232	2.25
T16	52217	14.90	149	1500	223500	171283	3.28
T17	52217	14.70	147	1500	220500	168283	3.22
T18	52217	11.90	119	1500	178500	126283	2.41
T19	48318	14.30	143	1500	214500	166182	3.43
T20	48318	13.50	135	1500	202500	154182	3.19
T21	48318	10.40	104	1500	156000	107682	2.22
T22	50268	14.40	144	1500	216000	165732	3.29
T23	50268	13.60	136	1500	204000	153732	3.05
T24	50268	10.70	107	1500	160500	110232	2.19
T25	52217	14.50	145	1500	217500	165283	3.16
T26	52217	13.70	137	1500	205500	153283	2.93
T27	52217	10.80	108	1500	162000	109783	2.10

Table 4.50: Effect of cultivars, spacing and dose of fertilizer application on Economics and Benefit: cost ratio for parthenocarpic cucumber under polyhouse condition – II Year, 2018-2019

Treatments	Cost of cultivation (Rs/1000 m^2)	Total yield (kg/m^2)	Total yield (q/1000m^2)	Selling rate (Rs/q)	Gross return (Rs/1000 m^2)	Net return Rs./ 1000 m^2)	Benefit cost ratio
T1	52318.5	14.40	144	1500	216000	163681.5	3.12
T2	52318.5	13.60	136	1500	204000	151681.5	2.89
T3	52318.5	10.50	105	1500	157500	105181.5	2.01
T4	54267.8	14.40	144	1500	216000	161732.2	2.98
T5	54267.8	13.60	136	1500	204000	149732.2	2.75
T6	54267.8	10.80	108	1500	162000	107732.2	1.98
T7	56217.2	14.50	145	1500	217500	161282.8	2.86
T8	56217.2	13.70	137	1500	205500	149282.8	2.65
T9	56217.2	10.90	109	1500	163500	107282.8	1.90
T10	52318.5	14.80	148	1500	222000	169681.5	3.24
T11	52318.5	13.80	138	1500	207000	154681.5	2.95
T12	52318.5	11.50	115	1500	172500	120181.5	2.29
T13	54267.8	14.90	149	1500	223500	169232.5	3.11
T14	54267.8	13.80	138	1500	207000	152732.5	2.81
T15	54267.8	11.80	118	1500	177000	122732.8	2.26
T16	56217.2	15.40	154	1500	231000	174782.8	3.10
T17	56217.2	14.90	149	1500	223500	167282.8	2.97
T18	56217.2	12.20	122	1500	183000	126782.8	2.25
T19	52318.5	14.50	145	1500	217500	165181.5	3.15
T20	52318.5	13.70	137	1500	205500	153181.5	2.92
T21	52318.5	10.60	106	1500	159000	106681.5	2.03
T22	54267.8	14.50	145	1500	217500	163232.2	3.00
T23	54267.8	13.70	137	1500	205500	151232.2	2.78
T24	54267.8	10.80	108	1500	162000	107732.2	1.98
T25	56217.2	14.70	147	1500	220500	164282.8	2.92
T26	56217.2	13.90	139	1500	208500	152282.8	2.70
T27	56217.2	10.50	105	1500	157500	101282.8	1.80

Table 4.51: Effect of cultivars, spacing and dose of fertilizer application on Economics and Benefit: cost ratio for parthenocarpic cucumber under polyhouse condition – pooled

Treatments	Cost of cultivation (Rs/1000 m^2)	Total yield (kg/m^2)	Total yield (q/1000m^2)	Selling rate (Rs/q)	Gross return (Rs/1000 m^2)	Net return Rs./ 1000 m^2)	Benefit cost ratio
T1	50318.5	14.30	143	1500	214500	164181.5	3.26
T2	50318.5	13.50	135	1500	202500	152181.5	3.02
T3	50318.5	10.40	104	1500	156000	105681.5	2.10
T4	52267.2	14.35	143.5	1500	215250	162982.8	3.11
T5	52267.2	13.55	135.5	1500	203250	150982.8	2.88
T6	52267.2	10.70	107	1500	160500	108232.8	2.07
T7	54217.2	14.45	144.5	1500	216750	162532.8	2.99
T8	54217.2	13.65	136.5	1500	204750	150532.8	2.77
T9	54217.2	10.80	108	1500	162000	107782.8	1.98
T10	50318.5	14.65	146.5	1500	219750	169431.5	3.36
T11	50318.5	13.70	137	1500	205500	155181.5	3.08
T12	50318.5	11.00	110	1500	165000	114681.5	2.27
T13	52267.2	14.75	147.5	1500	221250	168982.5	3.23
T14	52267.2	13.70	137	1500	205500	153232.8	2.93
T15	52267.2	11.35	113.5	1500	170250	117982.8	2.25
T16	54217.2	15.15	151.5	1500	227250	173032.8	3.19
T17	54217.2	14.80	148	1500	222000	167782.8	3.09
T18	54217.2	12.05	120.5	1500	180750	126532.8	2.33
T19	50318.5	14.40	144	1500	216000	165681.5	3.29
T20	50318.5	13.60	136	1500	204000	153681.5	3.05
T21	50318.5	10.50	105	1500	157500	107181.5	2.13
T22	52267.2	14.45	144	1500	216000	163732.8	3.13
T23	52267.2	13.65	136.5	1500	204750	152482.8	2.91
T24	52267.2	10.75	107.5	1500	161250	108982.8	2.08
T25	54217.2	14.60	146	1500	219000	164782.8	3.03
T26	54217.2	13.80	138	1500	207000	152782.8	2.81
T27	54217.2	10.65	106.5	1500	159750	105532.8	1.94

CHAPTER -5
SUMMARY & CONCLUSION

Results of the present investigation entitled "**Effect of study on plant geometry, cultivar and fertilizer doses on growth, yield and quality of cucumber under protected condition" was carried out at vegetable Research Farm of the Department of Horticulture,** Sam Higginbottom University of Agriculture, Technology & Science, Prayagraj, Allahabad (U.P.) during the year 2017-18 and 2018-2019 in winter session. Showed significant variation in vegetative growth, flowering characteristics, fruit quality, yield and other related parameters experiment. Efforts have been made to discuss the significant findings of the experimental results on pooled basis in this chapter.

- Vegetative growth parameters as vine length, stem girth, leaf area and Internodal distance were significantly influenced by interaction effect of cultivars, spacing and dose of fertilizer application during both the year experimentation. pooled maximum vine length (3.04 m), stem girth (0.85 cm) leaf area (422.60 cm^2) and pooled minimum Internodal distance (8.11 cm) were recorded in treatment T_{18},$V_2D_3P_3$ (PPC -3 + 30:20:32 kg + 60 x 50 cm) in winter season .

- Flowering characteristics as days to flower bud initiation were significantly affected by cultivars, spacing and dose of fertilizer application in both the year of experimentation. The Pooled minimum number of days required to flower bud initiation (39.35 DAS) were observed in T_{18}, $V_2D_3P_3$ (PPC -3 + 30:20:32 kg + 60 X 50 cm). in winter season.

- Days to first harvest were significantly affected by cultivars, spacing and dose of fertilizer application in both the year of experimentation. The Pooled minimum number of days required to first fruit harvest (52.40 DAS) were observed in T_{18},$V_2D_3P_3$ (PPC -3 + 30:20:32 kg + 60 X 50 cm) in winter season.

- The interaction effect of cultivars, spacing and dose of fertilizer application had a significant influence on length of fruit and width of fruit of cucumber during both the year. The pooled maximum length of fruit (19.50 cm) and pooled maximum width of fruit (3.55 cm) were recorded in treatment T_{18}, $V_2D_3P_3$ (PPC -3 + 30:20:32 kg + 60 Xx 50 cm) during winter season.

- The interaction effect of cultivars, spacing and dose of fertilizer application had a significant influence on number of fruits per vine, average fruit weight and number of unmarketable fruits per plants of cucumber during both the year. The pooled maximum number of fruits per vine (24.80) and pooled highest average fruit weight (120.50 g) and minimum unmarketable fruits per plants (1.10) were recorded in treatment T_{18} $V_2D_3P_3$ (PPC -3 + 30:20:32 kg + 60 x 50 cm) during winter season.

- The TSS, fruit volume and fruit specific gravity of cucumber were non- significantly influenced by combined interaction of cultivars, spacing and dose of fertilizer application during both the year of investigation.

- The interaction effect of cultivars, spacing and dose of fertilizer application had a significant influence on moisture content of cucumber during both the year. The pooled maximum moisture content (95.65 %) were recorded in treatment T_{12}, $V_2D_1P_3$ (PPC -3 + 20:10:22 kg + 60 x 50 cm) during winter season.

- The interaction effect of cultivars, spacing and dose of fertilizer application had a significant influence on orgenoleptic acceptance of cucumber during both the year. The pooled maximum rating of Organoleptic acceptance (8.75) were recorded in treatment T_{18}, $V_2D_3P_3$ (PPC -3 + 30:20:32 kg + 60 x 50 cm) during winter season.

- The pooled highest yield per vine (3.20 kg) was recorded in treatment T_{18} $V_2D_3P_3$ (PPC -3 + 30:20:32 kg + 60 x 50 cm) during winter season and pooled highest yield /m^2 (14.80 kg) were recorded in treatment T_{17}, $V_2D_3P_2$ (PPC -3 + 30:20:32 kg + 60 X 40 cm) during winter season.
- The combined interaction of cultivars, spacing and dose of fertilizer application had a significant influence on available nitrogen, available phosphorus and available

potassium content in leaf in percentage during both the year. The maximum available nitrogen in leaf (3.81 %), The maximum available phosphorus in leaf (0.85 %) were recorded in treatment T_{18} $V_2D_3P_3$ (PPC -3 + 30:20:32 kg + 60 x 50 cm) and the maximum available potassium in leaf (2.47 %) T_{27}, $V_3D_3P_3$ (Hilton + 30:20:32 kg + 60 x 50 cm) during winter season.

CONCLUSION

Thus, on the basis of results, summarized above, it can be concluded that T_{18} (PPC-3 + 30:20:32 kg + 60 x 50 cm) was found significantly superior in respect of growth, flowering, yield and quality parameters. Most of the parameters and yield attributes also attained significantly greater values under higher plant population with spacing 60cm x 50cm were found to be appropriate spacing and fertilizer dose 30:20:32 level, respectively. The cucumber variety Pant Parthenocarpic-3 was produced highly productive as compared to Hilton and Pant Parthenocarpic-2 of cucumber (*Cucumis sativus*) under the protected polyhouse condition. It was found optimum for achieving higher yield and the highest benefit cost ratio was recorded in the treatment (V_2+D_3+P_3**)** as compared to rest of the treatments.

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APPENDIX

1. Plant height (m) 90 DAS

ANOVA: I

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.01	0.00	1.75	3.18	**NS**
Variety (V)	2	0.03	0.01	6.20	3.18	**S**
NPK (D)	2	0.27	0.13	66.12	3.18	**S**
Plant geometry (P)	2	0.29	0.14	70.92	3.18	**S**
Int. (V x D)	4	0.25	0.06	30.51	2.55	**S**
Int. (D x P)	4	0.03	0.01	3.36	2.55	**S**
Int. (V x P)	4	0.14	0.03	16.81	2.55	**S**
Int.(V x D x P)	8	0.08	0.01	4.83	2.12	**S**
Error	52	0.11	0.00	-	-	-
Total	80	1.19		-	-	-

ANOVA: II

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.01	0.00	2.01	3.18	**NS**
Variety (V)	2	0.05	0.03	19.12	3.18	**S**
NPK (D)	2	0.12	0.06	45.64	3.18	**S**
Plant geometry (P)	2	0.01	0.01	4.33	3.18	**S**
Int. (V x D)	4	0.19	0.05	35.63	2.55	**S**
Int. (D x P)	4	0.10	0.02	17.69	2.55	**S**
Int. (V x P)	4	0.19	0.05	34.74	2.55	**S**
Int.(V x Dx P)	8	0.18	0.02	16.36	2.12	**S**
Error	52	0.07	0.00	-	-	-
Total	80	0.91		-	-	-

ANOVA: III

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.00	0.00	0.39	3.18	**NS**
Variety (V)	2	0.04	0.02	488.89	3.18	**S**
NPK (D)	2	0.15	0.08	1995.16	3.18	**S**
Plant geometry (P)	2	0.07	0.03	865.84	3.18	**S**
Int. (V x D)	4	0.22	0.05	1427.75	2.55	**S**
Int. (D x P)	4	0.03	0.01	227.84	2.55	**S**
Int. (V x P)	4	0.11	0.03	729.60	2.55	**S**
Int.(V x Dx P)	8	0.08	0.01	274.03	2.12	**S**
Error	52	0.00	0.00	-	-	-
Total	80	0.70		-	-	-

2. Stem girth (cm)

ANOVA: IV

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.0002	0.0001	1.99	3.18	**NS**
Variety (V)	2	0.0150	0.0075	161.74	3.18	**S**
NPK (D)	2	0.0295	0.0147	317.50	3.18	**S**
Plant geometry (P)	2	0.0034	0.0017	36.13	3.18	**S**
Int. (V x D)	4	0.0031	0.0008	16.75	2.55	**S**
Int. (D x P)	4	0.0002	0.0000	0.96	2.55	**NS**
Int. (V x P)	4	0.0028	0.0007	15.31	2.55	**S**
Int.(V x Dx P)	8	0.0056	0.0007	15.13	2.12	**S**
Error	52	0.0024	0.0000	-	-	-
Total	80	0.06		-	-	-

ANOVA: V

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.0004	0.0002	2.04	3.18	**NS**
Variety (V)	2	0.0163	0.0081	91.33	3.18	**S**
NPK (D)	2	0.0340	0.0170	190.76	3.18	**S**
Plant geometry (P)	2	0.0048	0.0024	27.04	3.18	**S**
Int. (V x D)	4	0.0046	0.0012	13.02	2.55	**S**
Int. (D x P)	4	0.0023	0.0006	6.48	2.55	**S**
Int. (V x P)	4	0.0046	0.0012	13.02	2.55	**S**
Int.(V x Dx P)	8	0.0028	0.0004	3.96	2.12	**S**
Error	52	0.0046	0.0001	-	-	-
Total	80	0.07		-	-	-

ANOVA: VI

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.0003	0.0001	2.02	3.18	**NS**
Variety (V)	2	0.0155	0.0078	117.67	3.18	**S**
NPK (D)	2	0.0317	0.0159	240.10	3.18	**S**
Plant geometry (P)	2	0.0040	0.0020	30.46	3.18	**S**
Int. (V x D)	4	0.0029	0.0007	11.15	2.55	**S**
Int. (D x P)	4	0.0008	0.0002	3.07	2.55	**S**
Int. (V x P)	4	0.0035	0.0009	13.17	2.55	**S**
Int.(V x Dx P)	8	0.0033	0.0004	6.32	2.12	**S**
Error	52	0.0034	0.0001	-	-	-
Total	80	0.07		-	-	-

3. Leaf area (cm2)

ANOVA: VII

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.57	0.28	1.93	3.18	**NS**
Variety (V)	2	418.16	209.08	1423.54	3.18	**S**
NPK (D)	2	555.92	277.96	1892.51	3.18	**S**
Plant geometry (P)	2	356.72	178.36	1214.38	3.18	**S**
Int. (V x D)	4	132.16	33.04	224.96	2.55	**S**
Int. (D x P)	4	6.64	1.66	11.30	2.55	**S**
Int. (V x P)	4	1.76	0.44	3.00	2.55	**S**
Int.(V x Dx P)	8	9.44	1.18	8.03	2.12	**S**
Error	52	7.64	0.15	-	-	-
Total	80	1489.01		-	-	-

ANOVA: VIII

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.58	0.29	1.59	3.18	**NS**
Variety (V)	2	690.89	345.44	1889.01	3.18	**S**
NPK (D)	2	443.75	221.87	1213.29	3.18	**S**
Plant geometry (P)	2	428.87	214.43	1172.60	3.18	**S**
Int. (V x D)	4	154.09	38.52	210.66	2.55	**S**
Int. (D x P)	4	21.51	5.38	29.41	2.55	**S**
Int. (V x P)	4	1.99	0.50	2.72	2.55	**S**
Int.(V x Dx P)	8	53.71	6.71	36.71	2.12	**S**
Error	52	9.51	0.18	-	-	-
Total	80	1804.90		-	-	-

ANOVA: IX

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.00	0.00	0.00	3.18	**NS**
Variety (V)	2	545.83	272.91	95608.92	3.18	**S**
NPK (D)	2	495.09	247.55	86721.45	3.18	**S**
Plant geometry (P)	2	389.85	194.93	68287.90	3.18	**S**
Int. (V x D)	4	130.61	32.65	11439.25	2.55	**S**
Int. (D x P)	4	11.92	2.98	1043.78	2.55	**S**
Int. (V x P)	4	1.41	0.35	123.88	2.55	**S**
Int.(V x Dx P)	8	18.67	2.33	817.74	2.12	**S**
Error	52	0.15	0.00	-	-	-
Total	80	1593.54		-	-	-

4. Internodal Distance (cm)

ANOVA: X

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.0125	0.0062	1.95	3.18	**NS**
Variety (V)	2	0.2518	0.1259	39.52	3.18	**S**
NPK (D)	2	0.7916	0.3958	124.25	3.18	**S**
Plant geometry (P)	2	0.3820	0.1910	59.96	3.18	**S**
Int. (V x D)	4	0.0438	0.0109	3.44	2.55	**S**
Int. (D x P)	4	0.0063	0.0016	0.50	2.55	**NS**
Int. (V x P)	4	0.0062	0.0015	0.48	2.55	**NS**
Int.(V x Dx P)	8	0.0191	0.0024	0.75	2.12	**NS**
Error	52	0.1656	0.0032	-	-	-
Total	80	1.68		-	-	-

ANOVA: XI

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.0353	0.0176	2.08	3.18	**NS**
Variety (V)	2	0.2138	0.1069	12.60	3.18	**S**
NPK (D)	2	0.7717	0.3858	45.47	3.18	**S**
Plant geometry (P)	2	0.2729	0.1364	16.08	3.18	**S**
Int. (V x D)	4	0.0317	0.0079	0.93	2.55	**NS**
Int. (D x P)	4	0.0053	0.0013	0.16	2.55	**NS**
Int. (V x P)	4	0.0019	0.0005	0.06	2.55	**NS**
Int.(V x Dx P)	8	0.0151	0.0019	0.22	2.12	**NS**
Error	52	0.4412	0.0085	-	-	-
Total	80	1.79		-	-	-

ANOVA: XII

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.0224	0.0112	2.05	3.18	**NS**
Variety (V)	2	0.2324	0.1162	21.30	3.18	**S**
NPK (D)	2	0.7811	0.3905	71.58	3.18	**S**
Plant geometry (P)	2	0.3250	0.1625	29.78	3.18	**S**
Int. (V x D)	4	0.0374	0.0094	1.72	2.55	**NS**
Int. (D x P)	4	0.0048	0.0012	0.22	2.55	**NS**
Int. (V x P)	4	0.0036	0.0009	0.17	2.55	**NS**
Int.(V x Dx P)	8	0.0156	0.0020	0.36	2.12	**NS**
Error	52	0.2837	0.0055	-	-	-
Total	80	1.71		-	-	-

5. Days to first flower bud initiate (DAS)

ANOVA: XIII

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.44	0.22	1.76	3.18	**NS**
Variety (V)	2	9.63	4.81	38.43	3.18	**S**
NPK (D)	2	5.18	2.59	20.68	3.18	**S**
Plant geometry (P)	2	159.86	79.93	638.20	3.18	**S**
Int. (V x D)	4	8.23	2.06	16.43	2.55	**S**
Int. (D x P)	4	1.28	0.32	2.56	2.55	**S**
Int. (V x P)	4	1.89	0.47	3.78	2.55	**S**
Int.(V x Dx P)	8	4.81	0.60	4.80	2.12	**S**
Error	52	6.51	0.13	-	-	-
Total	80	197.83		-	-	-

ANOVA: XIV

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.60	0.30	1.83	3.18	**NS**
Variety (V)	2	10.03	5.01	30.79	3.18	**S**
NPK (D)	2	5.95	2.97	18.27	3.18	**S**
Plant geometry (P)	2	140.81	70.40	432.33	3.18	**S**
Int. (V x D)	4	6.51	1.63	10.00	2.55	**S**
Int. (D x P)	4	4.25	1.06	6.53	2.55	**S**
Int. (V x P)	4	2.21	0.55	3.39	2.55	**S**
Int.(V x Dx P)	8	4.19	0.52	3.22	2.12	**S**
Error	52	8.47	0.16	-	-	-
Total	80	183.01		-	-	-

ANOVA: XV

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.52	0.26	1.80	3.18	**NS**
Variety (V)	2	9.77	4.89	34.08	3.18	**S**
NPK (D)	2	5.41	2.71	18.87	3.18	**S**
Plant geometry (P)	2	150.13	75.07	523.72	3.18	**S**
Int. (V x D)	4	7.25	1.81	12.64	2.55	**S**
Int. (D x P)	4	2.50	0.63	4.37	2.55	**S**
Int. (V x P)	4	1.90	0.48	3.32	2.55	**S**
Int.(V x Dx P)	8	3.66	0.46	3.19	2.12	**S**
Error	52	7.45	0.14	-	-	-
Total	80	188.60		-	-	-

6. Days of first fruits picking (DAS)

ANOVA: XVI

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.19	0.09	1.17	3.18	**NS**
Variety (V)	2	53.82	26.91	331.57	3.18	**S**
NPK (D)	2	36.44	18.22	224.53	3.18	**S**
Plant geometry (P)	2	19.58	9.79	120.65	3.18	**S**
Int. (V x D)	4	7.85	1.96	24.19	2.55	**S**
Int. (D x P)	4	2.36	0.59	7.28	2.55	**S**
Int. (V x P)	4	1.95	0.49	6.01	2.55	**S**
Int.(V x Dx P)	8	1.46	0.18	2.25	2.12	**S**
Error	52	4.22	0.08	-	-	-
Total	80	127.88		-	-	-

ANOVA: XVII

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.22	0.11	1.83	3.18	**NS**
Variety (V)	2	66.70	33.35	563.14	3.18	**S**
NPK (D)	2	34.08	17.04	287.74	3.18	**S**
Plant geometry (P)	2	19.82	9.91	167.30	3.18	**S**
Int. (V x D)	4	8.72	2.18	36.83	2.55	**S**
Int. (D x P)	4	1.21	0.30	5.11	2.55	**S**
Int. (V x P)	4	2.55	0.64	10.77	2.55	**S**
Int.(V x Dx P)	8	2.30	0.29	4.86	2.12	**S**
Error	52	3.08	0.06	-	-	-
Total	80	138.69		-	-	-

ANOVA: XVIII

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.20	0.10	1.50	3.18	**NS**
Variety (V)	2	60.07	30.04	445.44	3.18	**S**
NPK (D)	2	35.25	17.63	261.39	3.18	**S**
Plant geometry (P)	2	19.68	9.84	145.97	3.18	**S**
Int. (V x D)	4	8.19	2.05	30.35	2.55	**S**
Int. (D x P)	4	1.68	0.42	6.22	2.55	**S**
Int. (V x P)	4	2.19	0.55	8.11	2.55	**S**
Int.(V x Dx P)	8	1.73	0.22	3.20	2.12	**S**
Error	52	3.51	0.07	-	-	-
Total	80	132.50		-	-	-

7. No. Of fruit per plant

ANOVA: XIX

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.17	0.08	2.08	3.18	**NS**
Variety (V)	2	55.25	27.62	689.48	3.18	**S**
NPK (D)	2	37.52	18.76	468.25	3.18	**S**
Plant geometry (P)	2	16.34	8.17	203.92	3.18	**S**
Int. (V x D)	4	4.53	1.13	28.29	2.55	**S**
Int. (D x P)	4	1.40	0.35	8.74	2.55	**S**
Int. (V x P)	4	1.91	0.48	11.94	2.55	**S**
Int.(V x Dx P)	8	3.49	0.44	10.88	2.12	**S**
Error	52	2.08	0.04	-	-	-
Total	80	122.69		-	-	-

ANOVA: XX

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.21	0.11	2.05	3.18	**NS**
Variety (V)	2	71.98	35.99	689.03	3.18	**S**
NPK (D)	2	39.56	19.78	378.74	3.18	**S**
Plant geometry (P)	2	13.87	6.93	132.77	3.18	**S**
Int. (V x D)	4	4.84	1.21	23.19	2.55	**S**
Int. (D x P)	4	1.29	0.32	6.18	2.55	**S**
Int. (V x P)	4	1.76	0.44	8.41	2.55	**S**
Int.(V x Dx P)	8	5.28	0.66	12.64	2.12	**S**
Error	52	2.72	0.05	-	-	-
Total	80	141.51		-	-	-

ANOVA: XXI

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.19	0.09	2.07	3.18	**NS**
Variety (V)	2	63.13	31.56	689.52	3.18	**S**
NPK (D)	2	38.06	19.03	415.69	3.18	**S**
Plant geometry (P)	2	15.05	7.53	164.39	3.18	**S**
Int. (V x D)	4	4.48	1.12	24.49	2.55	**S**
Int. (D x P)	4	1.32	0.33	7.22	2.55	**S**
Int. (V x P)	4	1.82	0.45	9.92	2.55	**S**
Int.(V x Dx P)	8	3.91	0.49	10.68	2.12	**S**
Error	52	2.38	0.05	-	-	-
Total	80	130.34		-	-	-

8. Number of unmarketable fruits per plants

ANOVA: XXII

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.05	0.03	2.08	3.18	**NS**
Variety (V)	2	1.84	0.92	73.31	3.18	**S**
NPK (D)	2	1.16	0.58	46.25	3.18	**S**
Plant geometry (P)	2	1.88	0.94	74.90	3.18	**S**
Int. (V x D)	4	0.18	0.04	3.54	2.55	**S**
Int. (D x P)	4	0.14	0.03	2.74	2.55	**S**
Int. (V x P)	4	0.50	0.12	9.90	2.55	**S**
Int.(V x Dx P)	8	0.44	0.06	4.40	2.12	**S**
Error	52	0.65	0.01	-	-	-
Total	80	6.85		-	-	-

ANOVA: XXIII

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.07	0.03	1.87	3.18	**NS**
Variety (V)	2	2.42	1.21	69.16	3.18	**S**
NPK (D)	2	1.07	0.53	30.60	3.18	**S**
Plant geometry (P)	2	1.24	0.62	35.56	3.18	**S**
Int. (V x D)	4	0.31	0.08	4.45	2.55	**S**
Int. (D x P)	4	0.22	0.06	3.21	2.55	**S**
Int. (V x P)	4	0.76	0.19	10.85	2.55	**S**
Int.(V x Dx P)	8	0.42	0.05	2.97	2.12	**S**
Error	52	0.91	0.02	-	-	-
Total	80	7.41		-	-	-

ANOVA: XXIV

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.06	0.03	2.02	3.18	**NS**
Variety (V)	2	2.10	1.05	72.29	3.18	**S**
NPK (D)	2	1.11	0.56	38.35	3.18	**S**
Plant geometry (P)	2	1.54	0.77	53.14	3.18	**S**
Int. (V x D)	4	0.22	0.06	3.84	2.55	**S**
Int. (D x P)	4	0.17	0.04	2.92	2.55	**S**
Int. (V x P)	4	0.62	0.15	10.63	2.55	**S**
Int.(V x Dx P)	8	0.38	0.05	3.28	2.12	**S**
Error	52	0.76	0.01	-	-	-
Total	80	6.97		-	-	-

9. Av. fruit weight (g)

ANOVA: XXV

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.01	0.00	1.99	3.18	**NS**
Variety (V)	2	1.13	0.56	337.63	3.18	**S**
NPK (D)	2	173.98	86.99	52034.56	3.18	**S**
Plant geometry (P)	2	360.22	180.11	107733.18	3.18	**S**
Int. (V x D)	4	0.03	0.01	4.65	2.55	**S**
Int. (D x P)	4	20.76	5.19	3105.11	2.55	**S**
Int. (V x P)	4	0.06	0.01	8.64	2.55	**S**
Int.(V x Dx P)	8	0.18	0.02	13.62	2.12	**S**
Error	52	0.09	0.00	-	-	-
Total	80	556.46		-	-	-

ANOVA: XXVI

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.05	0.03	2.08	3.18	**NS**
Variety (V)	2	1.32	0.66	52.35	3.18	**S**
NPK (D)	2	172.17	86.08	6851.62	3.18	**S**
Plant geometry (P)	2	359.03	179.51	14287.88	3.18	**S**
Int. (V x D)	4	0.19	0.05	3.80	2.55	**S**
Int. (D x P)	4	19.74	4.93	392.74	2.55	**S**
Int. (V x P)	4	0.05	0.01	1.02	2.55	**NS**
Int.(V x Dx P)	8	0.24	0.03	2.41	2.12	**S**
Error	52	0.65	0.01	-	-	-
Total	80	553.44		-	-	-

ANOVA: XXVII

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.02	0.01	2.07	3.18	**NS**
Variety (V)	2	1.22	0.61	104.74	3.18	**S**
NPK (D)	2	173.07	86.53	14913.14	3.18	**S**
Plant geometry (P)	2	359.62	179.81	30987.79	3.18	**S**
Int. (V x D)	4	0.07	0.02	2.99	2.55	**S**
Int. (D x P)	4	20.24	5.06	872.15	2.55	**S**
Int. (V x P)	4	0.04	0.01	1.56	2.55	**NS**
Int.(V x Dx P)	8	0.16	0.02	3.42	2.12	**S**
Error	52	0.30	0.01	-	-	-
Total	80	554.73		-	-	-

10. Fruits yield per plants (kg)

ANOVA:XXVIII

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.02	0.01	2.08	3.18	**NS**
Variety (V)	2	0.70	0.35	78.87	3.18	**S**
NPK (D)	2	1.42	0.71	159.00	3.18	**S**
Plant geometry (P)	2	0.55	0.27	61.65	3.18	**S**
Int. (V x D)	4	0.14	0.03	7.74	2.55	**S**
Int. (D x P)	4	0.07	0.02	3.99	2.55	**S**
Int. (V x P)	4	0.04	0.01	2.50	2.55	**NS**
Int.(V x Dx P)	8	0.18	0.02	4.93	2.12	**S**
Error	52	0.23	0.00	-	-	-
Total	80	3.35		-	-	-

ANOVA: XXIX

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.00	0.00	2.08	3.18	**NS**
Variety (V)	2	0.97	0.48	435.30	3.18	**S**
NPK (D)	2	0.97	0.48	435.30	3.18	**S**
Plant geometry (P)	2	0.55	0.27	246.60	3.18	**S**
Int. (V x D)	4	0.11	0.03	24.96	2.55	**S**
Int. (D x P)	4	0.11	0.03	24.96	2.55	**S**
Int. (V x P)	4	0.11	0.03	24.96	2.55	**S**
Int.(V x Dx P)	8	0.33	0.04	36.94	2.12	**S**
Error	52	0.06	0.00	-	-	-
Total	80	3.21		-	-	-

ANOVA: XXX

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.01	0.01	2.08	3.18	**NS**
Variety (V)	2	0.83	0.41	165.07	3.18	**S**
NPK (D)	2	1.18	0.59	235.96	3.18	**S**
Plant geometry (P)	2	0.54	0.27	107.83	3.18	**S**
Int. (V x D)	4	0.12	0.03	11.65	2.55	**S**
Int. (D x P)	4	0.04	0.01	4.33	2.55	**S**
Int. (V x P)	4	0.07	0.02	7.32	2.55	**S**
Int.(V x Dx P)	8	0.19	0.02	9.65	2.12	**S**
Error	52	0.13	0.00	-	-	-
Total	80	3.12		-	-	-

11. Yield per sq.mtr (kg)

ANOVA: XXXI

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.04	0.02	2.08	3.18	**NS**
Variety (V)	2	3.26	1.63	186.82	3.18	**S**
NPK (D)	2	3.50	1.75	200.57	3.18	**S**
Plant geometry (P)	2	205.94	102.97	11801.62	3.18	**S**
Int. (V x D)	4	1.96	0.49	56.16	2.55	**S**
Int. (D x P)	4	0.58	0.14	16.62	2.55	**S**
Int. (V x P)	4	0.12	0.03	3.44	2.55	**S**
Int.(V x Dx P)	8	0.52	0.07	7.45	2.12	**S**
Error	52	0.45	0.01	-	-	-
Total	80	216.37		-	-	-

ANOVA: XXXII

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.09	0.04	1.82	3.18	**NS**
Variety (V)	2	9.29	4.64	188.58	3.18	**S**
NPK (D)	2	1.94	0.97	39.39	3.18	**S**
Plant geometry (P)	2	193.45	96.72	3928.25	3.18	**S**
Int. (V x D)	4	1.59	0.40	16.18	2.55	**S**
Int. (D x P)	4	0.41	0.10	4.20	2.55	**S**
Int. (V x P)	4	1.87	0.47	18.95	2.55	**S**
Int.(V x Dx P)	8	0.43	0.05	2.20	2.12	**S**
Error	52	1.28	0.02	-	-	-
Total	80	210.35		-	-	-

ANOVA:XXXIII

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.06	0.03	1.97	3.18	**NS**
Variety (V)	2	5.86	2.93	192.92	3.18	**S**
NPK (D)	2	2.66	1.33	87.54	3.18	**S**
Plant geometry (P)	2	199.62	99.81	6569.83	3.18	**S**
Int. (V x D)	4	1.76	0.44	29.02	2.55	**S**
Int. (D x P)	4	0.33	0.08	5.49	2.55	**S**
Int. (V x P)	4	0.68	0.17	11.22	2.55	**S**
Int.(V x Dx P)	8	0.35	0.04	2.91	2.12	**S**
Error	52	0.79	0.02	-	-	-
Total	80	212.12		-	-	-

12. Length of fruit (cm)

ANOVA:XXXIV

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.07	0.03	1.57	3.18	**NS**
Variety (V)	2	55.85	27.92	1260.36	3.18	**S**
NPK (D)	2	31.05	15.52	700.69	3.18	**S**
Plant geometry (P)	2	8.68	4.34	195.78	3.18	**S**
Int. (V x D)	4	1.14	0.28	12.84	2.55	**S**
Int. (D x P)	4	0.31	0.08	3.51	2.55	**S**
Int. (V x P)	4	0.23	0.06	2.61	2.55	**S**
Int.(V x Dx P)	8	0.06	0.01	0.35	2.12	**NS**
Error	52	1.15	0.02	-	-	-
Total	80	98.54		-	-	-

ANOVA:XXXV

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.01	0.00	1.12	3.18	**NS**
Variety (V)	2	55.34	27.67	11965.59	3.18	**S**
NPK (D)	2	32.41	16.20	7006.95	3.18	**S**
Plant geometry (P)	2	8.81	4.40	1904.17	3.18	**S**
Int. (V x D)	4	0.77	0.19	83.60	2.55	**S**
Int. (D x P)	4	0.03	0.01	2.88	2.55	**S**
Int. (V x P)	4	0.37	0.09	40.36	2.55	**S**
Int.(V x Dx P)	8	0.81	0.10	43.96	2.12	**S**
Error	52	0.12	0.00	-	-	-
Total	80	98.67		-	-	-

ANOVA:XXXVI

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.03	0.01	1.96	3.18	**NS**
Variety (V)	2	55.59	27.80	3856.39	3.18	**S**
NPK (D)	2	31.64	15.82	2194.81	3.18	**S**
Plant geometry (P)	2	8.69	4.35	602.84	3.18	**S**
Int. (V x D)	4	0.94	0.23	32.53	2.55	**S**
Int. (D x P)	4	0.12	0.03	4.20	2.55	**S**
Int. (V x P)	4	0.26	0.06	8.94	2.55	**S**
Int.(V x Dx P)	8	0.30	0.04	5.13	2.12	**S**
Error	52	0.37	0.01	-	-	-
Total	80	97.94		-	-	-

13. Width of fruit (cm)

ANOVA:XXXVII

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.0002	0.0001	2.08	3.18	**NS**
Variety (V)	2	0.0328	0.0164	368.66	3.18	**S**
NPK (D)	2	0.0865	0.0432	971.44	3.18	**S**
Plant geometry (P)	2	0.0513	0.0256	576.08	3.18	**S**
Int. (V x D)	4	0.0038	0.0009	21.22	2.55	**S**
Int. (D x P)	4	0.0035	0.0009	19.72	2.55	**S**
Int. (V x P)	4	0.0008	0.0002	4.37	2.55	**S**
Int.(V x Dx P)	8	0.0044	0.0006	12.42	2.12	**S**
Error	52	0.0023	0.0000	-	-	-
Total	80	0.19		-	-	-

ANOVA:XXXVIII

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.0001	0.0001	1.95	3.18	**NS**
Variety (V)	2	0.0854	0.0427	1404.37	3.18	**S**
NPK (D)	2	0.1108	0.0554	1821.95	3.18	**S**
Plant geometry (P)	2	0.0630	0.0315	1036.10	3.18	**S**
Int. (V x D)	4	0.0043	0.0011	35.44	2.55	**S**
Int. (D x P)	4	0.0091	0.0023	74.89	2.55	**S**
Int. (V x P)	4	0.0019	0.0005	15.71	2.55	**S**
Int.(V x Dx P)	8	0.0126	0.0016	51.60	2.12	**S**
Error	52	0.0016	0.0000	-	-	-
Total	80	0.29		-	-	-

ANOVA:XXXIX

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.00	0.00	2.05	3.18	**NS**
Variety (V)	2	0.06	0.03	766.54	3.18	**S**
NPK (D)	2	0.10	0.05	1328.96	3.18	**S**
Plant geometry (P)	2	0.06	0.03	772.70	3.18	**S**
Int. (V x D)	4	0.00	0.00	14.14	2.55	**S**
Int. (D x P)	4	0.00	0.00	33.98	2.55	**S**
Int. (V x P)	4	0.00	0.00	1.82	2.55	**NS**
Int.(V x Dx P)	8	0.00	0.00	16.08	2.12	**S**
Error	52	0.00	0.00	-	-	-
Total	80	0.22		-	-	-

14. Moisture %

ANOVA: XL

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.15	0.08	1.37	3.18	**NS**
Variety (V)	2	9.90	4.95	88.11	3.18	**S**
NPK (D)	2	3.98	1.99	35.40	3.18	**S**
Plant geometry (P)	2	0.04	0.02	0.32	3.18	**NS**
Int. (V x D)	4	0.60	0.15	2.66	2.55	**S**
Int. (D x P)	4	3.92	0.98	17.44	2.55	**S**
Int. (V x P)	4	2.26	0.56	10.05	2.55	**S**
Int.(V x Dx P)	8	3.81	0.48	8.48	2.12	**S**
Error	52	2.92	0.06	-	-	-
Total	80	27.56		-	-	-

ANOVA: XLI

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.01	0.01	2.08	3.18	**NS**
Variety (V)	2	3.41	1.70	494.11	3.18	**S**
NPK (D)	2	5.49	2.74	795.79	3.18	**S**
Plant geometry (P)	2	0.14	0.07	20.31	3.18	**S**
Int. (V x D)	4	1.15	0.29	83.16	2.55	**S**
Int. (D x P)	4	3.73	0.93	270.74	2.55	**S**
Int. (V x P)	4	4.81	1.20	349.07	2.55	**S**
Int.(V x Dx P)	8	6.77	0.85	245.60	2.12	**S**
Error	52	0.18	0.00	-	-	-
Total	80	25.69		-	-	-

ANOVA: XLII

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.07	0.03	1.59	3.18	**NS**
Variety (V)	2	6.17	3.09	150.28	3.18	**S**
NPK (D)	2	4.67	2.34	113.69	3.18	**S**
Plant geometry (P)	2	0.07	0.04	1.72	3.18	**NS**
Int. (V x D)	4	0.33	0.08	3.99	2.55	**S**
Int. (D x P)	4	3.64	0.91	44.25	2.55	**S**
Int. (V x P)	4	3.28	0.82	39.89	2.55	**S**
Int.(V x Dx P)	8	4.64	0.58	28.24	2.12	**S**
Error	52	1.07	0.02	-	-	-
Total	80	23.93		-	-	-

15. Orgenoleptic acceptance

ANOVA: XLIII

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.11	0.06	1.22	3.18	**NS**
Variety (V)	2	1.39	0.69	14.88	3.18	**S**
NPK (D)	2	0.49	0.24	5.22	3.18	**S**
Plant geometry (P)	2	0.38	0.19	4.08	3.18	**S**
Int. (V x D)	4	2.07	0.52	11.08	2.55	**S**
Int. (D x P)	4	2.37	0.59	12.73	2.55	**S**
Int. (V x P)	4	1.29	0.32	6.94	2.55	**S**
Int.(V x Dx P)	8	3.59	0.45	9.64	2.12	**S**
Error	52	2.42	0.05	-	-	-
Total	80	14.12		-	-	-

ANOVA: XLIV

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.18	0.09	1.70	3.18	**NS**
Variety (V)	2	2.43	1.21	23.49	3.18	**S**
NPK (D)	2	0.62	0.31	6.00	3.18	**S**
Plant geometry (P)	2	0.65	0.32	6.26	3.18	**S**
Int. (V x D)	4	1.61	0.40	7.81	2.55	**S**
Int. (D x P)	4	1.87	0.47	9.07	2.55	**S**
Int. (V x P)	4	1.23	0.31	5.94	2.55	**S**
Int.(V x Dx P)	8	1.69	0.21	4.10	2.12	**S**
Error	52	2.69	0.05	-	-	-
Total	80	12.96		-	-	-

ANOVA: XLV

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.14	0.07	1.48	3.18	**NS**
Variety (V)	2	1.85	0.92	19.12	3.18	**S**
NPK (D)	2	0.54	0.27	5.61	3.18	**S**
Plant geometry (P)	2	0.49	0.24	5.04	3.18	**S**
Int. (V x D)	4	1.72	0.43	8.91	2.55	**S**
Int. (D x P)	4	2.10	0.52	10.85	2.55	**S**
Int. (V x P)	4	1.13	0.28	5.83	2.55	**S**
Int.(V x Dx P)	8	2.36	0.29	6.10	2.12	**S**
Error	52	2.51	0.05	-	-	-
Total	80	12.83		-	-	-

16. TSS (˚Brix)

ANOVA: XLVI

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.03	0.02	2.08	3.18	**NS**
Variety (V)	2	0.42	0.21	29.07	3.18	**S**
NPK (D)	2	0.32	0.16	21.80	3.18	**S**
Plant geometry (P)	2	0.05	0.02	3.11	3.18	**NS**
Int. (V x D)	4	0.04	0.01	1.48	2.55	**NS**
Int. (D x P)	4	0.00	0.00	0.04	2.55	**NS**
Int. (V x P)	4	0.00	0.00	0.12	2.55	**NS**
Int.(V x Dx P)	8	0.00	0.00	0.02	2.12	**NS**
Error	52	0.38	0.01	-	-	-
Total	80	1.25		-	-	-

ANOVA: XLVII

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.0047	0.0024	1.30	3.18	**NS**
Variety (V)	2	0.5521	0.2760	152.47	3.18	**S**
NPK (D)	2	0.3606	0.1803	99.59	3.18	**S**
Plant geometry (P)	2	0.0546	0.0273	15.08	3.18	**S**
Int. (V x D)	4	0.0291	0.0073	4.02	2.55	**S**
Int. (D x P)	4	0.0022	0.0005	0.30	2.55	**NS**
Int. (V x P)	4	0.0041	0.0010	0.57	2.55	**NS**
Int.(V x Dx P)	8	0.0025	0.0003	0.17	2.12	**NS**
Error	52	0.0941	0.0018	-	-	-
Total	80	1.10		-	-	-

ANOVA:XLVIII

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.015	0.007	1.98	3.18	**NS**
Variety (V)	2	0.486	0.243	65.44	3.18	**S**
NPK (D)	2	0.339	0.169	45.66	3.18	**S**
Plant geometry (P)	2	0.050	0.025	6.72	3.18	**S**
Int. (V x D)	4	0.034	0.008	2.26	2.55	**NS**
Int. (D x P)	4	0.001	0.000	0.10	2.55	**NS**
Int. (V x P)	4	0.003	0.001	0.21	2.55	**NS**
Int.(V x Dx P)	8	0.001	0.000	0.04	2.12	**NS**
Error	52	0.193	0.004	-	-	-
Total	80	1.12		-	-	-

17. Fruit volume (cc)

ANOVA: XLIX

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	2.03	1.02	1.54	3.18	**NS**
Variety (V)	2	0.06	0.03	0.04	3.18	**NS**
NPK (D)	2	0.12	0.06	0.09	3.18	**NS**
Plant geometry (P)	2	61.18	30.59	46.21	3.18	**S**
Int. (V x D)	4	0.03	0.01	0.01	2.55	**NS**
Int. (D x P)	4	0.02	0.00	0.01	2.55	**NS**
Int. (V x P)	4	0.01	0.00	0.00	2.55	**NS**
Int.(V x Dx P)	8	0.03	0.00	0.01	2.12	**NS**
Error	52	34.42	0.66	-	-	-
Total	80	97.91		-	-	-

ANOVA: L

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	2.88	1.44	2.08	3.18	**NS**
Variety (V)	2	0.07	0.04	0.05	3.18	**NS**
NPK (D)	2	0.11	0.05	0.08	3.18	**NS**
Plant geometry (P)	2	61.32	30.66	44.22	3.18	**S**
Int. (V x D)	4	0.04	0.01	0.01	2.55	**NS**
Int. (D x P)	4	0.03	0.01	0.01	2.55	**NS**
Int. (V x P)	4	0.02	0.01	0.01	2.55	**NS**
Int.(V x Dx P)	8	0.05	0.01	0.01	2.12	**NS**
Error	52	36.05	0.69	-	-	-
Total	80	100.58		-	-	-

ANOVA: LI

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	2.44	1.22	1.94	3.18	**NS**
Variety (V)	2	0.06	0.03	0.05	3.18	**NS**
NPK (D)	2	0.11	0.06	0.09	3.18	**NS**
Plant geometry (P)	2	61.25	30.62	48.61	3.18	**S**
Int. (V x D)	4	0.03	0.01	0.01	2.55	**NS**
Int. (D x P)	4	0.03	0.01	0.01	2.55	**NS**
Int. (V x P)	4	0.02	0.00	0.01	2.55	**NS**
Int.(V x Dx P)	8	0.04	0.01	0.01	2.12	**NS**
Error	52	32.76	0.63	-	-	-
Total	80	96.74		-	-	-

18. Fruits specific gravity (g cm-3)

ANOVA: LII

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.00	0.00	2.08	3.18	**NS**
Variety (V)	2	0.00	0.00	0.17	3.18	**NS**
NPK (D)	2	0.01	0.01	36.97	3.18	**S**
Plant geometry (P)	2	0.01	0.00	33.21	3.18	**S**
Int. (V x D)	4	0.00	0.00	0.01	2.55	**NS**
Int. (D x P)	4	0.00	0.00	2.17	2.55	**NS**
Int. (V x P)	4	0.00	0.00	0.01	2.55	**NS**
Int.(V x Dx P)	8	0.00	0.00	0.02	2.12	**NS**
Error	52	0.01	0.00	-	-	-
Total	80	0.03		-	-	-

ANOVA: LIII

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.00	0.00	1.99	3.18	**NS**
Variety (V)	2	0.00	0.00	0.28	3.18	**NS**
NPK (D)	2	0.01	0.01	49.02	3.18	**S**
Plant geometry (P)	2	0.01	0.00	46.02	3.18	**S**
Int. (V x D)	4	0.00	0.00	0.03	2.55	**NS**
Int. (D x P)	4	0.00	0.00	2.86	2.55	**S**
Int. (V x P)	4	0.00	0.00	0.01	2.55	**NS**
Int.(V x Dx P)	8	0.00	0.00	0.04	2.12	**NS**
Error	52	0.01	0.00	-	-	-
Total	80	0.03		-	-	-

ANOVA: LIV

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.00	0.00	1.99	3.18	**NS**
Variety (V)	2	0.00	0.00	0.28	3.18	**NS**
NPK (D)	2	0.01	0.01	49.02	3.18	**S**
Plant geometry (P)	2	0.01	0.00	46.02	3.18	**S**
Int. (V x D)	4	0.00	0.00	0.03	2.55	**NS**
Int. (D x P)	4	0.00	0.00	2.86	2.55	**S**
Int. (V x P)	4	0.00	0.00	0.01	2.55	**NS**
Int.(V x Dx P)	8	0.00	0.00	0.04	2.12	**NS**
Error	52	0.01	0.00	-	-	-
Total	80	0.03		-	-	-

19. Total nitrogen in leaf (%)

ANOVA: LV

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.002	0.001	1.21	3.18	**NS**
Variety (V)	2	0.049	0.024	25.68	3.18	**S**
NPK (D)	2	1.477	0.738	777.02	3.18	**S**
Plant geometry (P)	2	0.402	0.201	211.61	3.18	**S**
Int. (V x D)	4	0.016	0.004	4.24	2.55	**S**
Int. (D x P)	4	0.067	0.017	17.66	2.55	**S**
Int. (V x P)	4	0.002	0.001	0.58	2.55	**NS**
Int.(V x Dx P)	8	0.020	0.003	2.64	2.12	**S**
Error	52	0.049	0.001	-	-	-
Total	80	2.09		-	-	-

ANOVA: LVI

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.0001	0.0000	2.08	3.18	**NS**
Variety (V)	2	0.0803	0.0401	3335.08	3.18	**S**
NPK (D)	2	1.4975	0.7487	62203.38	3.18	**S**
Plant geometry (P)	2	0.3908	0.1954	16231.38	3.18	**S**
Int. (V x D)	4	0.0188	0.0047	390.00	2.55	**S**
Int. (D x P)	4	0.0795	0.0199	1651.38	2.55	**S**
Int. (V x P)	4	0.0081	0.0020	168.46	2.55	**S**
Int.(V x Dx P)	8	0.0128	0.0016	133.15	2.12	**S**
Error	52	0.0006	0.00001	-	-	-
Total	80	2.09		-	-	-

ANOVA: LVII

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.0008	0.0004	1.34	3.18	**NS**
Variety (V)	2	0.0635	0.0318	112.92	3.18	**S**
NPK (D)	2	1.4869	0.7435	2642.60	3.18	**S**
Plant geometry (P)	2	0.3960	0.1980	703.74	3.18	**S**
Int. (V x D)	4	0.0160	0.0040	14.21	2.55	**S**
Int. (D x P)	4	0.0726	0.0182	64.52	2.55	**S**
Int. (V x P)	4	0.0046	0.0011	4.07	2.55	**S**
Int.(V x Dx P)	8	0.0155	0.0019	6.90	2.12	**S**
Error	52	0.0146	0.0003	-	-	-
Total	80	2.07		-	-	-

20. Total Phosphorus in leaf (%)

ANOVA: LVIII

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.0001	0.0000	2.08	3.18	**NS**
Variety (V)	2	0.0074	0.0037	160.33	3.18	**S**
NPK (D)	2	0.0401	0.0200	868.11	3.18	**S**
Plant geometry (P)	2	0.0081	0.0040	174.78	3.18	**S**
Int. (V x D)	4	0.0007	0.0002	7.94	2.55	**S**
Int. (D x P)	4	0.0005	0.0001	5.06	2.55	**S**
Int. (V x P)	4	0.0003	0.0001	3.61	2.55	**S**
Int.(V x Dx P)	8	0.0005	0.0001	2.89	2.12	**S**
Error	52	0.0012	0.0000	-	-	-
Total	80	0.06		-	-	-

ANOVA: LIX

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.00008	0.00004	1.88	3.18	**NS**
Variety (V)	2	0.01056	0.00528	261.84	3.18	**S**
NPK (D)	2	0.04536	0.02268	1125.07	3.18	**S**
Plant geometry (P)	2	0.00962	0.00481	238.69	3.18	**S**
Int. (V x D)	4	0.00071	0.00018	8.82	2.55	**S**
Int. (D x P)	4	0.00044	0.00011	5.51	2.55	**S**
Int. (V x P)	4	0.00024	0.00006	3.03	2.55	**S**
Int.(V x Dx P)	8	0.00049	0.00006	3.03	2.12	**S**
Error	52	0.00105	0.00002	-	-	-
Total	80	0.07		-	-	-

ANOVA: LX

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.0001	0.0000	2.03	3.18	**NS**
Variety (V)	2	0.0089	0.0045	211.38	3.18	**S**
NPK (D)	2	0.0423	0.0212	1004.97	3.18	**S**
Plant geometry (P)	2	0.0088	0.0044	209.41	3.18	**S**
Int. (V x D)	4	0.0003	0.0001	3.69	2.55	**S**
Int. (D x P)	4	0.0003	0.0001	3.49	2.55	**S**
Int. (V x P)	4	0.0003	0.0001	3.30	2.55	**S**
Int.(V x Dx P)	8	0.0004	0.0000	2.11	2.12	**NS**
Error	52	0.0011	0.0000	-	-	-
Total	80	0.06		-	-	-

21. Total Potassium in leaf (%)

ANOVA: LXI

2018

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.00090	0.00045	2.08	3.18	**NS**
Variety (V)	2	0.00896	0.00448	20.78	3.18	**S**
NPK (D)	2	0.06442	0.03221	149.50	3.18	**S**
Plant geometry (P)	2	0.04309	0.02154	99.99	3.18	**S**
Int. (V x D)	4	0.00038	0.00009	0.44	2.55	**NS**
Int. (D x P)	4	0.00244	0.00061	2.84	2.55	**S**
Int. (V x P)	4	0.00031	0.00008	0.36	2.55	**NS**
Int.(V x Dx P)	8	0.00116	0.00014	0.67	2.12	**NS**
Error	52	0.01120	0.00022	-	-	-
Total	80	0.13		-	-	-

ANOVA: LXII

2019

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.0006	0.0003	1.97	3.18	**NS**
Variety (V)	2	0.0173	0.0086	56.83	3.18	**S**
NPK (D)	2	0.0794	0.0397	261.32	3.18	**S**
Plant geometry (P)	2	0.0385	0.0192	126.60	3.18	**S**
Int. (V x D)	4	0.0009	0.0002	1.54	2.55	**NS**
Int. (D x P)	4	0.0017	0.0004	2.85	2.55	**S**
Int. (V x P)	4	0.0011	0.0003	1.76	2.55	**NS**
Int.(V x Dx P)	8	0.0023	0.0003	1.92	2.12	**NS**
Error	52	0.0079	0.0002	-	-	-
Total	80	0.15		-	-	-

ANOVA: LXIII

Pooled

Source	d. f.	S. S.	M. S. S.	F. Cal.	F. Tab. 5%	Result
Replication	2	0.0007	0.0004	2.06	3.18	**NS**
Variety (V)	2	0.0126	0.0063	35.02	3.18	**S**
NPK (D)	2	0.0717	0.0358	199.11	3.18	**S**
Plant geometry (P)	2	0.0406	0.0203	112.85	3.18	**S**
Int. (V x D)	4	0.0002	0.0001	0.34	2.55	**NS**
Int. (D x P)	4	0.0017	0.0004	2.33	2.55	**NS**
Int. (V x P)	4	0.0006	0.0001	0.83	2.55	**NS**
Int.(V x Dx P)	8	0.0010	0.0001	0.66	2.12	**NS**
Error	52	0.0094	0.0002	-	-	-
Total	80	0.14		-	-	-

VIEW OF EXPERIMENT UNDER POLYHOUSE


Pant Parthenocarpic
Cucumber 3

	**T_{18} Best treatment combination (Pant parthenocarpic-3+30:20:32 kg + 60 X 50 cm)**
	**Treatment , T_1 (Pant parthenocarpic-2+20:10:22 kg + 60 X 30 cm)**
	**Second best treatment, T_{17} combination (Hilton +30:20:32 kg + 60 X 40 cm)**

VIEW OF AFTER HARVESTING AND DATA COLLECTING