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EFFECT OF CROP GEOMETRY AND FERTIGATION ON QUALITY AND YIELD OF PARTHENOCARPIC CUCUMBER CULTIVARS UNDER PROTECTED CONDITIONS

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ABSTRACT

The present investigation was conducted at Centre of Excellence for Vegetables, Kartarpur, Jalandhar during September-December in 2014 and 2015 to study the probable effect of plant spacing and fertigation on cucumber under Naturally Ventilated Polyhouse. The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications, consisting of thirty treatment combinations i.e. five cultivars (Multistar, Hilton, Isatis, Kian and KUK-9), three plant spacings (40 cm x 30 cm, 40 cm x 40 cm and 40 cm x 50 cm) and two fertigation levels of NPK kg acre^{-1} (F1-70:40:90 and F2-100:50:125). All the cucumber cultivars under evaluation showed significant variations for almost all the characters investigated. The study revealed that Multistar cultivar was found to be superior to other cultivars with regard to more number of branches (9.42), maximum fruit length (15.89cm), more number of fruits vine^{-1} (43.75), better fruit diameter (4.72 cm), maximum average fruit weight (117.87 g) and better total fruit yield vine^{-1} (4.86 kg). Maximum vine length (3.71 m) was recorded in cultivar KUK-9 followed by cultivar Multistar (3.66 m). Among different spacing treatments, spacing of 40 cm x 50 cm showed significantly lesser number of days to first fruiting as compared to other spacing treatments whereas node number at which first female flower appears was observed at 40 cm x 30 cm. The study also revealed the better values for all the parameters under study with the application of 100:50:125 Kg of NPK acre^{-1} except node number at which first female flower appears.

From the present investigation it is thus concluded that cucumber should be grown at spacing of 40 cm x 50 cm (S3) along with fertigation treatment F2 (100:50:125 kg of NPK acre^{-1}) using parthenocarpic cucumber hybrids Multistar (V1) during autumn season for getting higher fruit yield and quality cucumber under naturally ventilated polyhouse in Punjab.

(Keywords: Cucumber, fruit, fertigation, spacing, yield, NVPH)

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is a member of the family Cucurbitaceae, which comprises 117 genera and 825 species. It is grown in summer season. It is thought to be one of the oldest vegetable crops and has been under cultivation for over 3000 years in India. Cucumber plant is one of major crops cultivated under greenhouses, it represents about 75% of the total area of the greenhouses that is about 960 hectare (FAO- Regional working Group Greenhouse Crop Production in the Mediterranean Region-1997). Cucumber is a thermophillic and frost-susceptible crop, growing best at temperature above 20^{o}C. The crop is grown throughout the world and is the fourth most important vegetable crop after tomato (*Solanum esculentum* L.), Cabbage (*Brassica oleracea* L. var. *capitata*), and onion (*Allium cepa* L.) and the second most widely cultivated cucurbit after water melon. It is known to have originated in India because of the fact, that *Cucumis sativus* var *hardwickii*, progenitor of cultivated cucumber is found in the Himalayan foothills of India. The major challenge for the modern technology is to make vegetable cultivation economically viable. Beside production of vegetables there is a need to improve the quality of vegetables. For this we need to have precision farming. The main objective of precision farming of vegetable production is to create a conducive micro-climate for the sustained growth of plants so as to realize its maximum potential even in adverse climatic conditions. Vegetable growers can substantially increase their income by protected cultivation of vegetables in off-season as the vegetables produced during their normal season generally do not fetch good returns due to large availability of these vegetable in the markets. Off-season cultivation of cucurbits under protected structures is one of the most profitable technologies. The cucumber responds like a semitropical plant. It grows best under conditions of high temperature and light intensity and with an uninterrupted supply of water and essential elements.

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Protected cultivation not only ensures good quality and high productivity of produce but it also provides opportunity to capture the market in off-season during early summer.

The success of protected cultivation of vegetables is largely dependent on level and quality of applied technology and the factors such as local climate, purchasing power of consumers, transport organization, market intelligence and access to local and international market.

Protected cultivation offers several advantages to produce vegetables of high quality and yields-particularly during the off-season when prices are higher, thus using the land and other resource more efficiently. However, growing vegetables under protected conditions requires high input cost and good management practices and proper planning to achieve maximum benefits which have direct bearing on the economic viability of production system. Since cucumber is the one of the important vegetable crop which has high demand for throughout the year. Fruit quality is very important and to have best quality fruits polyhouse production is the best choice. Advantages of polyhouse cultivation are like protection from excess rainfall, wind current, scorching sun light and extreme cold conditions, under minimum space we can have maximum production of crop, humidity is maintained, efficient use of CO_2, efficient utilisation of irrigation water and fertilizers, labour efficient, diseases and insect-pests can be controlled easily, production of crop throughout the year, labour cost is reduced, quality of product is better.

In general, greenhouse cucumbers are irrigated through drip system and fertilizers are also applied with irrigation water. The amount of fertilizers varies with crop growth and season of cultivations. Being shallow rooted it is heavy feeder crop and plants easily suffer root damage from fertilizer overdose or extreme fluctuations in fertilizer supply. Unbalanaced nutrition regime may cause excessive vegetativeness or overbearing of the plant resulting in sub optimal performance of the crop. Insufficient potassium will result in misshapen fruit or "bottlenecks" known as crooked fruits. Likewise, application of less nitrogen restricts growth, modifies the length-to-diameter ratio of fruit, reduces fruit set and colour development. Plant density and spacing also contribute to marketable yield in various ways such as ability of plants to obtain the sunlight needed for growth and adequate air circulation around the plants to minimize the threat of fungal and insects attacks.

Cucumber cultivation under protected structure is becoming popular in Punjab and its demand is increasing. At present there are number of varieties/hybrids of cucumber released by both public and private sectors, yet the information on the performance of cucumber varieties/ hybrids and its production technology under protected cultivation is meagre.

The present investigation was conducted to identify a suitable cucumber cultivar for protective cultivation, to standardised the fertigation and plant geometry.

MATERIALS AND METHODS

A field experiment entitled "Effect of crop geometry and fertigation on quality and yield of parthenocarpic cucumber cultivars under protected conditions" was conducted at Centre of Excellence for Vegetables, (An Indo-Israel Project) Kartarpur, Jalandhar during 2014-2015 and 2015-2016. The experimental site is located at 31.44^0N latitude, 75.45^0E longitude with an elevation of 230 m above sea level. The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications. The size of the naturally ventilated polyhouse was 62.5 m x 32.0 m which was covered with 200 micron thick UV stabilized polythene sheet. The experiment was comprised of five cultivars namely Multistar (V_1), Hilton (V_2), Isatis (V_3), Kian (V_4) and KUK-9 (V_5) and three treatments of spacings viz., 40 cm × 30 cm (S_1), 40 cm × 40 cm (S_2) and 40 cm × 50 cm (S_3) and two levels of fertigation viz., 70:40:90 kg of N:P:K + 20 kg Ca NO_3 $acre^{-1}$ (F1) and 100:50:125 kg of N:P:K+ 40 kg Ca NO_3+ 50 kg $MgSO_4$ $acre^{-1}$ (F2). For protected cultivation of cucumber the seeds of all five cultivars were sown in plastic plug trays having 99 cells using soilless media having Cocopeat : Vermiculite : Perlite in ratio of 3:1:1, respectively in Hi-tech polyhouse on August 20 of every year in 2014 and 2015. The seedlings were ready for transplanting in 15 days. The seedlings were transplanted on 5th September inside the Naturally Ventilated Polyhouse equipped with drip irrigation facility. The land was thoroughly dug up by harrows and tillers and brought to fine tilth. Raised beds of 1.0 metre width and 27 metre length were prepared at 2 m spacing from bed to bed. Then these beds were sterilised with 4% formalin and covered with polythene sheet for 15 days. After removing sheet, beds are raked with triphali to remove fumes of formalin. Cucumber plants were fertigated half an hour to one hour daily with drip irrigation system with emitters of 2.4 litres $hour^{-1}$ discharge each spacer at 40 cm distance.

Data on Vegetative characters, yield attributing characters, quality characters such as number of branches, internode distance (cm), vine girth (cm), vine length (m), node number at which first female flower appears, number of days to first fruiting, fruit length (cm), fruit weight (g), fruit diameter (cm), number of fruits $vine^{-1}$, marketable number of fruits $vine^{-1}$, total fruit yield $vine^{-1}$ (kg), TSS (%), fruit firmness (lbf) and Vitamin C (mg 100 ml^{-1} juice) were recorded from randomly selected five tagged plants from each treatment and further analysed.

RESULTS AND DISCUSSION

Effects of cultivar, spacing and fertigation significantly influenced the vegetative characters, yield attributing characters and quality characters.

Vegetative characters

The data presented in table1 revealed that number of branches were significantly higher (9.42) in Multistar followed by KUK-9 (9.07), Hilton (8.68), Isatis (7.95), Kian

(7.76). The response of different cucumber cultivars is due to the varietal differences. These results are in line with the findings of Yadav *et al.* (2012), who reported variation for number of branches among all the genotypes and found maximum and minimum in CC-5 and CC-3 respectively. Among different spacing treatments, significantly highest numbers of branches (9.09) were produced under wider spacing i.e. 40 cm x 50 cm. In different fertilizer treatments, more numbers of branches (9.02) were produced with the application of 100:50:125 kg of NPK acre^{-1} which was significantly higher.

Significantly lesser internode distance was recorded in cultivar Multistar (9.12) cm) followed by cultivar Kian (9.13 cm) as compared to Hilton (9.33 cm), Isatis (9.15 cm) and KUK 9 (9.17 cm). These results were similar to the studies of Umeh and Onovo (2015).They also revealed great variation in morphological traits among different genotypes. Plant spacing between row to row and plant to plant also had significant effect on the internodal distance. It is confirmed that wider spacing (40 cm x 50 cm) resulted in shorter internodal distance (9.17 cm) over the rest of the spacing treatments. Similar findings were also reported by Kasrawi (1989) that wider plant density is best to get higher yield. Fertigation treatments have non significant effect on internode distance.

It is pertinent to mentioned that vine girth was significantly influenced by cultivars; being maximum in Multistar cultivar (1.75 cm) which was statistically at par with cultivar Hilton (1.71 cm), Isatis (1.63 cm) and KUK-9 (1.64 cm). The vine girth also increased significantly when plants were planted at different spacing, out of which the maximum vine girth was recorded at the wider spacing of 40 cm x 50 cm (1.72 cm), followed by 40 cm x 40 cm (1.66 cm) and 40 cm x 30 cm (1.61 cm); however, 40 cm x 30 cm and 40 cm x 40 cm were statistically at par with each other. The vine girth was more at wider spacing this might be due to availability of more space for plant growth, proper moisture, nutrients and less competition for light, air and water. Similarly trend was also observed by Cook *et al.* (1991), that the mean values of vegetative parameters increase significantly with increase in plant spacing. Fertigation @ 100:50:125 kg of NPK acre^{-1} recorded significantly maximum vine girth (1.75 cm) in comparison to 2nd treatment (1.58 cm). Interaction effect between cultivars, spacing and fertilizer treatments was found to be significant. Results obtained are in line with the findings of Tiwari (2013) that vine girth is maximum at higher dose of fertilizers.

Significantly maximum vine length was recorded in cultivar KUK-9 (3.70 m) followed by Multistar (3.66 m), Hilton (3.43 m), Isatis (3.16 m), Kian (2.82 m). This maximum vine length in Multistar cultivar as compared to other one might be due to its varietal character. Similar findings earlier reported by Kumar *et al.* (2017) that maximum vine length (4.56 m) was exhibited by KUK-9. Plant spacing also had the significant effect on vine length and it was recorded maximum at spacing of 40 cm x 50 cm (3.49 m) this might be due to the availability of more space for growth. Similar observations were also reported by Aniekwe and Anike (2015), who observed maximum vine length at plant spacing of 50 cm x 40 cm. Maximum vine length (3.49 m) was observed when fertilizer dose of 100: 50:125 kg of NPK acre^{-1} was applied over 70:40:90 kg of NPK acre^{-1} (3.22 m). Similarly findings were also confirmed by Choudhari and More (2002). They reported significant increase in vine length with fertigation technique at higher doses of fertilizers.

Cucumber cultivars produced first female flower was varied in term of position of nodes. Cultivar Kian recorded better position of node number at which first female flower appears (3.47) followed by Isatis (3.89), Hilton (3.98), Multistar (4.03) and KUK-9 (4.06). Such variation of nodes of female flower appearance in different cultivars is due to genetic constitution of different cultivars. Similar findings were also reported by Lajurakar *et al.* (2015), who reported that appearance of first female flower at early node is a good character in cucumber.

Yield attributing characters

With regard to number of days to first fruiting all the cultivars and all the treatments under study showed non significant effect.

Fruit length is another important character in cucumber crop which is considered a crucial component that markedly effected the fruit yield. Data regarding fruit length as affected by different treatments are presented in table 2. Maximum fruit length was recorded in cultivar Multistar (15.89 cm) which was significantly higher than Hilton (14.69 cm), Isatis (14.73 cm), Kian (13.85 cm) and was statistically at par with cultivar KUK-9 (15.55 cm). These results are in line with the findings of Monisha *et al,* (2014), who reported significant variation in fruit length among different cucumber hybrids. Maximum fruit length of 15.43 cm was recorded in plant spacing of 40 cm x 50 cm ; followed by 15.00 cm in plant spacing of 40 cm x 40 cm and 14.40 cm in 40 cm x 30 cm .These results are in conformity with the findings of Sharma *et al.* (2011), who also reported an enhancement in fruit length with the increased in plant to plant spacing distance. The application of 100:50:125 kg of NPK acre^{-1} produced significantly more fruit length (15.81 cm) as compared to application of 70:40:90 kg of NPK acre^{-1} (14.07 cm). Similar results were recorded by Jilani *et al.* (2009), who reported higher fruit length in cucumber at higher doses of NPK.

Maximum fruit number vine^{-1} was recorded in Multistar cultivar (43.70) followed by KUK-9 (42.18), Hilton (41.06), Isatis (37.93) and Kian (36.78). These results are in close similarity with Kumar *et al.* (2017), who also reported maximum number of fruits vine^{-1} in cultivar Multistar (34.77). The plants spaced at 40 cm x 50 cm recorded significantly maximum number of fruits vine^{-1} (41.83) in comparison to spacing of 40 cm x 40 cm (40.27) and at 40 cm x 30 cm value was (38.88). This might be due to less competition for light, nutrients, water and space in wider row spacing as compared to closer spacing. Similar results were also reported by Shaheen *et al.*(2017), who reported that wider spacing

produced more number of fruits vine^{-1}. The application of 100:50:125 kg of NPK acre^{-1} gave significantly more number of fruits vine^{-1} (42.35) as compared to the application of 70:40:90 Kg of NPK acre^{-1} having 38.29 number of fruits vine^{-1}. Similar results were also reported by Sharma *et al.* (2011), who observed maximum number of fruits vine^{-1} with the application of higher dose of fertilizers through drip irrigation.

It is observed that Multistar cultivar gave significantly maximum fruit weight (117.87 g). Fruit weight in cultivars Hilton (109.01 g), Isatis (108.02 g) and KUK-9 (108.78 g) were statistically at par with each other. The significantly lesser fruit weight was recorded in cultivar Kian i.e. 101.98 g. Varietal difference for this character have also been reported by Shah *et al.* (2016). With respect to different plant spacing treatments, plant spacing of 40 cm x 50 cm recorded significantly more fruit weight (111.68 g) as compared to plant spacing 40 cm x 30 cm (106.45 g). Similarly, plant spacings treatments 40 cm x 30 cm and 40 cm x 40 cm were also statistically at par with each other. Higher fruit weight may be due to less competition among plants for growth factors in wider spacing as reported by Kishor *et al.* (2010). The significantly maximum fruit weight was recorded with the application of 100:50:125 kg of NPK acre^{-1} (112.68 g) as compared to the application of 70:40:90 kg of NPK acre^{-1} (105.57 g). The results obtained are in line with the findings of Jilani *et al.* (2009), who reported maximum fruit weight of 136.03 g with the application of highest level of NPK.

Fruits obtained from the cultivar Multistar had significant higher fruit diameter (4.72 cm) as compared to other cultivars under study. Cultivar Kian had smaller fruit diameter (4.16 cm) than all other cultivars under study. The varietal differences for this character was also earlier reported by Vian (2016). Fruits produced at spacing of 40 cm x 50 cm gave significantly maximum fruit diameter to the tune of 4.58 cm. The lowest fruit diameter was recorded at 40 cm x 30 cm (4.12 cm). This might be due to less competition among plants for growth attributes in wider spacing. These results were also earlier reported by Shaheen *et al.* (2007), who reported fruit diameter of 6.21 cm at wider spacing. Fruit diameter was also influenced by different fertilizer treatments significantly. The maximum fruit diameter 4.62 cm was recorded with the application of 100:50:125 kg of NPK acre^{-1} as compared to the application of 70:40:90 kg of NPK acre^{-1} (4.07 cm). Similarly, Arun and Kumar (2014) reported maximum fruit diameter of 4.6 cm with the application of 125% dose of fertilizers applied through water soluble fertilizers.

The cultivar Multistar produced maximum number of marketable fruits vine^{-1} (37.88) as compared to rest of the cultivars. The cultivars Hilton, Isatis and Kian with respect to marketable number of fruits vine^{-1} were statistically at par with each other. These results are conformity with Santi *et al.* (2013), who observed wide range of variability among different cucumber cultivars and found maximum number of marketable fruits plant^{-1}. The higher number of marketable fruits vine^{-1} (35.21) was recorded at wider plant spacing of 40 cm x 50 cm. The spacing of 40 cm x 40 cm (33.41) and 40 cm x 30 cm (32.35) gave the fruit number which were statistically at par with each other. More number of marketable number of fruits might be due to increased availability of inputs at 40 cm x 50 cm spacing. Similar findings earlier reported by Nweke *et al.* (2013) that plant spacing of 50 cm x 30 cm gave the highest values for number of marketable fruits vine^{-1}. Application of 100:50:125 kg of NPK acre^{-1} gave significantly higher number of marketable fruits vine^{-1} (34.87) as compared to the application of 70:40:90 kg of NPK acre^{-1} (32.44). Results obtained are in accordance with Watcharasak and Thammasak (2005), who observed maximum number of marketable fruits vine^{-1} at higher dose of nitrogen and potassium.

The total fruit yield vine^{-1} obtained from cultivar Multistar was significantly higher (4.86 kg) which was statistically at par with cultivars KUK-9 (4.75 kg), Hilton (4.68 kg) and Isatis (4.65 kg). The cultivars Multistar, Hilton, Isatis and KUK-9 were significantly higher than Kian (4.29 kg). This might be due to the fact that higher fruit yield vine^{-1} and comparative better performance of Multistar in yield contributing characters such as number of fruits vine^{-1}, fruit length, fruit diameter and fruit weight. These results are in close conformity with Monisha *et al.* (2014), who reported higher total yield in cucumber Malini hybrids (590.76 q). Plant spacing also had significant effect on total fruit yield vine^{-1}. The crop planted at plant spacing of 40 cm x 50 cm recorded significantly higher total fruit yield vine^{-1} (5.22 kg) as compared to 40 cm x 40 cm (4.64 kg) and 40 cm x 30 cm (4.07 kg). This higher total fruit yield vine^{-1} might be due to the less competition for light, nutrients, water and space in wide row spacing compared to closer one. Similar results were also reported Kanthaswamy *et al.* (2000), who reported maximum yield at plant spacing of 60 cm x 60 cm. The effect of fertilizer treatments also showed significant effect on total fruit yield vine^{-1} during the study. Application of (100:50:125 kg) of NPK acre^{-1} recorded significantly higher total fruit yield vine^{-1} (5.23 kg) over the application of (70:40:90 kg) of NPK acre^{-1} (4.06 kg). Watcharasak and Thammasak (2005) also observed similar results, who observed higher fruit yield vine^{-1} at higher dose of nitrogen and potassium.

Quality characters

Higher TSS percentage is desirable for processing purpose. Total soluble solids were significantly varied in different cucumber cultivars under study. The cultivar Multistar possessed the highest total soluble solids (3.77 %). The least value of TSS was recorded in Kian (2.92 %). The reason for higher TSS recorded by Multistar may be due to more production and translocation of synthesized carbohydrates into fruits which is the resultant of better growth of the plants of Multistar. Similar observations were reported by Shah *et al.* (2016), who reported maximum TSS in strain K-90 which is desirable for processing. The study also indicated that TSS content was significantly influenced by plant spacing. Plants spaced at 40 cm x 50 cm recorded

significantly higher (3.43 %) TSS as compared to other spacing of 40 cm x 30 cm and 40 cm x 40 cm. This might be due to the effective utilization of sunlight which in turn improved the rate of photosynthesis and translocation of carbohydrates to developing fruits. These results are supported by the work of Nerson (1998), who reported higher TSS content in cucumber at wider plant spacing. The plants applied with the fertilizers (100: 50:125 kg) of NPK acre^{-1} had recorded significantly the highest TSS to the tune of 3.47 % as compared to the application of (70:40:90 kg) of NPK acre^{-1} and values were 3.16 %. Al-Moshileh *et al.* (2017) also reported increased TSS content with higher dose *et al.et al.* of potassium.

Fruit firmness is one of the criteria of fruit quality and is one of the texture which is a complex sensory attribute that also included crispiness and juiciness and important character for storage life and keeping quality. Significantly maximum fruit firmness was observed in cultivar Multistar (14.20 lbf) and the least firmness was observed in cultivar Kian (11.20 lbf). This might be due to the genetic constituent of cultivars. Cucumber cultivars planted under different plant spacings also showed significant effect on fruit firmness. Wider plant spacing had higher values and depict that fruits were firm in texture. Plant spacing of 40 cm x 50 cm recorded fruits firmness of 13.15 lbf and the least fruit firmness was recorded at 40 cm x 30 cm (11.32 lbf). Maximum fruit firmness (12.74 lbf) was recorded in the plants where fertilizers were applied at the rate of (100:50:125 kg) of NPK acre^{-1} as compared to the application of (70:40:90 kg) of NPK acre^{-1} and the value was (11.77 lbf).

Vitamin-C is another parameter of quality of cucumber. The maximum content of vitamin-C was recorded in cultivar Multistar (6.39 mg 100 g^{-1}) which was significantly higher than rest of the cultivars followed by KUK-9 (5.23 mg 100 g^{-1}) and the least vitamin-C content was recorded in cultivar Kian (3.39 mg 100 g^{-1}). The maximum content of vitamin-C was recorded in plant spacing of 40 cm x 50 cm. This is due to the varietal genetical characteristics

Table 1. Effect of spacing and fertigation treatments on vegetative characters in parthenocarpic cucumber (*Cucumis sativus* L.) cultivars

Treatments	No. of Branches	Internode Distance (cm)	Vine Girth (cm)	Vine Length (m)	Node No. at which first female flower opens
Cultivars					
V_1-Multistar	9.42	9,12	1.75	3.66	4.03
V_2-Hilton	8.68	9.33	1.71	3.43	3.98
V_3-Isatis	7.95	9.15	1.63	3.16	3.89
V_4-Kian	7.76	9.13	1.59	2.82	3.47
V_5-KUK-9	9.07	9.17	1.64	3.70	4.06
SE m(±)	0.151	0.095	0.051	0.072	0.072
CD at 5 %	0.44	-	0.15	0.21	0.21
Spacing					
S_1- 40 cm x 30 cm	7.99	9.19	1.61	3.24	3.67
S_2- 40 cm x 40 cm	8.64	9.20	1.66	3.33	3.87
S_3- 40 cm x 50 cm	9.09	9.17	1.72	3.49	4.14
SE m(±)	0.117	0.067	0.120	0.055	0.058
CD at 5%	0.34	-	0.35	0.16	0.17
Fertilizer					
F1-70:40:90 kg of NPK acre^{-1}	8.13	9.18	1.58	3.22	3.72
F2-100:50:125 kg of NPK acre^{-1}	9.02	9.18	1.75	3.49	4.05
SE m(±)	0.093	0.072	0.162	0.045	0.048
CD at 5%	0.27	-	0.47	0.13	0.14

and more efficient metabolism process in the cultivar as reported by Shah *et al.* (2016) .The plants applied with the fertilizers of (100: 50:125 kg) of NPK acre^{-1} had recorded significantly the highest Vitamin C to the tune of 5.21 mg 100 g^{-1} as compared to the application of (70:40:90 kg) of NPK acre^{-1} and values were 4.05 mg 100 g $^{-1}$. The results obtained are in line with findings of Narayanamma *et al.* (2010), who reported highest vitamin C with the application of 100:50:50 kg of NPK acre^{-1}.

Table 2. Effect of spacing and fertigation treatments on yield attributing characters in parthenocarpic cucumber (*Cucumis sativus* L.) cultivars

Treatments	No. of days to first fruiting	Fruit length (cm)	No. of fruits vine^{-1}	Fruit weight (g)	Fruit diameter (cm)	Marketable No. of fruits vine^{-1}	Total fruit yield vine^{-1} (kg)
Cultivars							
V_1-Multistar	36.90	15.89	43.70	117.87	4.72	37.88	4.86
V_2-Hilton	36.56	14.69	41.06	109.01	4.26	32.33	4.68
V_3-Isatis	37.56	14.73	37.93	108.02	4.17	32.42	4.65
V_4-Kian	36.60	13.85	36.78	101.98	4.16	31.55	4.29
V_5-KUK-9	37.56	15.55	42.18	108.78	4.43	34.12	4.75
SE m(±)	0.542	0.300	0.662	1.675	0.780	0.590	0.086
CD at 5 %	-	0.87	1.92	4.86	0.24	1.71	0.25
Spacing							
S_1- 40 cm x 30 cm	37.02	14.40	38.88	106.45	4.12	32.35	4.07
S_2- 40 cm x 40 cm	37.07	15.00	40.27	109.25	4.35	33.41	4.64
S_3- 40 cm x 50 cm	37.03	15.43	41.83	111.68	4.58	35.21	5.22
SE m(±)	0.483	0.231	0.511	1.304	0.066	0.459	0.066
CD at 5%	-	0.67	1.48	3.78	0.19	1.33	0.19
Fertilizer							
F1-70:40:90 kg of NPK acre^{-1}	37.04	14.07	38.29	105.57	4.07	32.44	4.06
F2-100:50:125 kg of NPK acre^{-1}	37.03	15.81	42.35	112.68	4.62	34.87	5.23
SE m(±)	0.511	0.187	0.418	1.059	0.052	0.373	0.056
CD at 5%	-	0.54	1.21	3.07	0.15	1.08	0.16

Table 3. Effect of spacing and fertigation treatments on quality characters in parthenocarpic cucumber (*Cucumis sativus* L.) cultivars

Treatments	TSS (%)	Fruit firmness (lbf)	Vitamin C (mg 100 g $^{-1}$ juice)
Cultivars			
V_1-Multistar	3.77	14.20	6.39
V_2-Hilton	3.26	11.77	4.51
V_3-Isatis	3.23	11.35	3.62
V_4-Kian	2.92	11.20	3.39
V_5-KUK-9	3.41	12.76	5.23
SE m(±)	0.045	0.259	0.066
CD at 5 %	0.13	0.75	0.19
Spacing			
S_1- 40 cm x 30 cm	3.21	11.32	3.58
S_2- 40 cm x 40 cm	3.31	12.30	4.62
S_3- 40 cm x 50 cm	3.43	13.15	5.70
SE m(±)	0.004	0.204	0.052
CD at 5%	0.01	0.59	0.15
Fertilizer			
F1-70:40:90 kg of NPK acre^{-1}	3.16	11.77	4.05
F2-100:50:125 kg of NPK acre^{-1}	3.47	12.74	5.21
SE m(±)	0.069	0.166	0.045
CD at 5%	0.20	0.48	0.13

REFERENCES

Al-Moshileh, A.M., M.A. Errebhi and H.A. Obiaddalla-Ali, 2017. Effect of potassium fertilization on tomato and cucumber plants under greenhouse conditions. Biosci. Res. **14** (1): 68-78.

Aniekwe, N.L. and N.T. Anike, 2015. Effects of Different Mulching Materials and Plant Densities on the Environment, Growth and Yield of cucumber. J. Agric. and Veterinary Sci. **8 (2)**: 64-72.

Arun, S. and R.J. Kumar, 2014. Influence of nutrient management systems on yield attributes of cucumber (*Cucumis sativus* L. var Beit Alpha) cultivated in polyhouse conditions. Trends in Biosci.**7** (21)**:** 3450-34.

Choudhari, S.M., and T.A. More, 2002. Fertigation,Fertilizer and spacing requirement of tropical gynoecious cucumber hybrid. Acta hortic. 588 (588): 233-240.

Cook, K.L., L.M. Pike and D.A. Bender, 1991. Optimum plant density and harvest time for "little life and "little leaf" hybrid pickling cucumbers for once-over mechanical harvest. Hort. Sci. **26**: 708 (Abstr.).

Jilani, M.S., A. Bakar, K. Waseem and M. Kiran, 2009. Effect of different levels of NPK on the Growth and yield of cucumber (*Cucumis sativus*) under the plastic tunnel. J. Agric. Soc. Sci. **5**(3): 99-101.

Kanthaswamy, V., N. Singh, D. Veeragavathatham, K. Srinivasan and S Thiruvudainambi, 2000. Studies on growth and yield of cucumber and sprouting broccoli under polyhouse condition. South Indian Horti. **48**(1/6) :47-52.

Kasrawi, M. 1989. Response of cucumbers grown in plastic greenhouses to plant density and row management. J. Hort. Sci. **64** (5): 573-579.

Kishor, S., B.S. Tomar, S. Balraj and A.D. Munshi, 2010. Effect of season, spacing and planting time on seed yield and quality in cucumber. Indian. J. Hort. **67** (1): 66-69.

Kumar, S., V.I. Chaudhari, S.N. Saravaiya and D. Raj, 2017. Potentiality of greenhouse cucumber cultivars for economic and nutritional realization. International J. Farm Sci. **7**(1): 1-7.

Lajurkar, V., V. Magar and M. Padekar, 2015. Evaluation of cucumber F1 hybrids in naturally ventilated polyhouse. Lambert Academic Publishing

Monisha, R., S.K. Maurya, P.K. Singh and R. Maurya, 2014. Screening of improved cultivars of cucumber in naturally ventilated polyhouse under tarai condition of Uttarakhand. J. Hill Agri. **5**(1): 72-75.

Narayanamma, M., C.H. Chiranjeevi, R. Ahmed and A. Chaturvedi, 2010. Influence of integrated nutrient management on the yield, nutrient status and quality of cucumber (*Cucumis sativus* L.). Veg. Sci. **37**(1): 61-63.

Nerson, H. 1998. Responses of "little leaf" vs. normal cucumber to planting density and chlorflurenol. Hort. Sci. **33**(5): 816-818.

Nweke, I.A., E.C. Orji and S.I. Ijearu, 2013. The effect of Staking and Plant Spacing on the growth and yield of cucumber (*Cucumis sativus* L.). IOSR- J. Environ. Sci. Toxicol. Food. Technol. **3** (4): 26-31.

Santi, A., W. Scarmuzza, D. Soares, J.F. Scarmuzza, R. Dallacort, W. Krause and R.C. Tiepo, 2013. Performance and growth of conduction of Japenese cucumber in protected environment. Hortic.Bras. **31** (4)**:** 649-653.

Shaheen, I., M.A. Baloch and A.F Baloch, 2007. Effect of inter and intra row spacing on the yield of cucumber (*Cucumis sativus* L.). Life Sci.Int.J. **1**(2): 131-135.

Shah, K.N., D.K. Rana and V. Singh, 2016. Evaluation of different cucumber strain for various horticultural traits under valley condition of Garhwal Himalya. J.Plant Dev.Sci . **8**(12): 599-603.

Sharma, A., R.A. Kaushik, D.K. Sarolia and R.P, Sharma, 2011. Response of cultivars, Plant gemetry and methods of fertilizers application on parthenocarpic cucumber (*Cucumis sativus* L.) under zero energy Polyhouse condition. Veg. Sci. **38**(2): 215-217

.

Tiwari,S.P.2013.Impact of different fertigation levels on morphophysiological traits and yield of cucumber under greenhouse conditions. Hort. Flora Res. Spec.**2**(2):180-181.

Umeh, O.A. and J.C. Onovo, 2015. Comparative study of the germination and morphological characteristics of four cucumber (*Cucumis sativus* L.) genotypes in Keffi, Nasarawa State, Nigeria. Int. J. Curr. Res. Biosci. Plant Biol. **2**(7): 43-46.

Vian, D.A. 2016. Response of some cucumber hybrid cultivars (*Cucumis sativus* L.) grown in plastic house. Polytechnic. **6**(1): 1-6.

Watcharasak, S. and T. Thammasak, 2005**.** Effect of nitrogen and potassium concentration in fertigation on growth and yield of cucumber. Kamphaengsaen Acad. J. **3(1)**: 18-29.

Yadav, Y.C., S. Kumar and R. Singh, 2012. Studies on genetic variability heritability and genetic advance in cucumber (*Cucumis sativus* L.) Hort.Flora. Res. Spec. **1**(1): 34-37.

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