



## RESEARCH PAPER

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## Impact of climatic variations on the growth, yield and quality of different Strawberry varieties

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**Key words:** *Fragaria × ananass*, Vegetative parameters, Reproductive parameters, Organoleptic, Climatic variations

<http://dx.doi.org/10.12692/ijb/16.1.417-426>

Article published on January 30, 2020

### Abstract

Climate variation disturbs the crop patron, yield and its quality. To study impacts of climate variation an experiment was conducted to study the development, yield and quality reactions of three strawberry assortments under various developing conditions in passage and field condition. Sprinters of three strawberry assortments were developed in various developing conditions stayed for 5 months as a term of research. Plant stature, number of leaves, leaf region, new and dry loads of leaves, crisp load of plant, dry load of plant, crown size, number of supports, and number of blossoms were development parameters. Number of natural products, organic product size, natural product weight and yield were measured while dissolvable solids, titratable sharpness and ascorbic corrosive were quality parameters. Normal (field) conditions were contrasted and secured condition. Programming Statistix 8.1 was used for measurable investigation Leaf yield was higher under ideal soil dampness conditions, contrasted with half and 25% soil dampness levels in the two situations. Organic product yield was higher in field condition contrasted with burrow condition and plants gave lower natural product yield burrow condition. Two-way examination demonstrated solid connections among qualities. In the two developing situations, leaf zone were altogether corresponded (1.60\*), organic product yield was fundamentally connected with absolute petiole length (8.89\*\*), plant stature (6.6\*\*), leaf number (9.93\*\*). It is presumed that natural pressure and the term of pressure effectively affected distinctive development parameters. Besides, plants developed in field conditions were progressively fit for adapting to regular changes to the plants developed in burrow condition.

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## Introduction

The most ordinarily expended berry natural product crop worldwide and is esteemed for its one of a kind flavor and wholesome quality. Strawberries are costly and loaded up with nutrients, fiber, and cancer prevention agents (Muhammad Azam *et al.*, 2019).

Advancement of strawberry cultivars and development frameworks under plastic passages and in nurseries. The physiological impacts on plant engineering and engendering. Strawberry cultivators are confronting environmental change with developments in developed assortments and social systems, and by the incorporation of the diverse creation territories, with their particular ideal yield seasons (Neri *et al.*, 2012). It was demonstrated that germplasm is the key wellspring of variety and single most significant factor that impact the development, yield and nature of organic product. Late strawberry involves around 500 financially developed cultivars around the world (Rahman *et al.*, 2015). Qureshi *et al.* (2012) has suggested this cultivation systems effects on different vegetative traits i.e. crown size, crown size, root length, number of trusses, number of fruits, fruit weight, number of fruits, fruit size, and measures viz., total sugars, total TSS (total soluble sugars), vitamin C were found expressively higher under tunnel condition as compared to other cultivation systems.

Aguero *et al.* (2015) has reported this in yearly production system, at same place fruit quality suffer with the growing season as consequences of the combination genomic, nutritional and environmental parameters and their interactions. In an area genotype will be main reason to express the characteristics of strawberry.

The versatility of berries to various climatic conditions (distinctive scope, soil conditions, creation cycle, light piece, and so on.) speak to the natural factor that impact organic product quality. At long last, likewise the supposed agronomic variables, identified with the development frameworks (open field or ensured or soilless development, natural or regular development) (Di Vittori *et al.*, 2018). To think about hereditary variety and the connection

among yield and its segment utilizing a randomized complete block design. The outcomes indicated noteworthy fluctuation among genotypes everything being equal (Mishra *et al.*, 2015).

The objectives of this study was to evaluate the impact of climate on strawberry plant growth, yield and quality. To evaluate acclimatization ability of different strawberry varieties in different regions. To estimate the climatic changes to improve the growth, yield and quality of strawberry. To search for good potential varieties that cope with changing climate.

## Materials and methods

### Plant materials

Runners of three varieties of strawberry Chandler, Seascape and Camnio Real were acquired from strawberry farm in horticulture section Agriculture Research Institute Mingora Swat, Pakistan.

### Methods

The experiment was conducted in natural (Arid Agriculture University Rawalpindi, Pakistan,) and protected (tunnels, department of horticulture, conditions. Plants were developed in pots in reasonable soil blend and each pot was loaded up 3 kilograms soil. Two distinct systems of condition levels were applied to be specific (tunnel) and (field) (normal irrigation) with three replication. As far as seasonal intensity increases with time, 4 months duration to observe plants responses to the seasonal change. Data was collected every 10 days in each of tunnel and field plants. Fertilizer was applied in the ratio of 5-5-5 (N-P-K) or 7-7-7 (N-P-K) in the form of liquid. Fungicide (Chlorpyrifos) (CPS) was showered on plants at regular intervals on the other hand to maintain a strategic distance from presence of growth and bugs. parameters, for example, eleven morphological attributes, for example, Plant stature (cm), crown size (cm), Petiole length (cm), number of leaves per plant, brackets per plant, number of sprinters per plant, leaf region (cm<sup>2</sup>), weight of crisp leaves (g), weight of dry leaves (g), weight of new plants (g), weight of dry plants (g), Plant spread (cm), Days taken to initially bloom, blossom per plant, organic product set per plant, level of natural product

set per plant, number of natural product per plant, size of organic product (cm), weight of natural product (g), complete soluble solids (TSS °Brix), Ascorbic corrosive and titratable causticity were investigated.

#### *Parameters evaluated*

Following growth, yield and quality parameters were studied; plant height, number of leaves, crown diameter, plant spread, number of runners, days to flower initiation, numbers of flowers, number of fruit set/plant, percentage fruit set, fruit weight (g) and fruit size (cm). Total soluble solids (TSS °Brix), ascorbic acid contents (mg/ml) and titratable acidity was determined by standard procedures.

*Height of plant (cm):* Measured from the soil base up to the tip of the plant.

*Size of crown (cm):* measured with Vernier caliper

*Length of petiole (cm):* measured with foot.

*Number of leaves per plant:* The numbers of leaves were counted.

*Trusses per plant:* The numbers of trusses were counted.

*Number of runners per plant:* The numbers of runners were counted.

*Area of leaf (cm<sup>2</sup>):* measured with digital leaf area meter.

*Weight of fresh leaves (g):* measured with digital weighing balance.

*Weight of dry leaves (g):* measured with digital weighing balance after drying the leaves in oven at 60°C.

*Weight of fresh plants (g):* measured with digital weighing balance.

*Weight of dry plants (g):* measured with digital weighing balance after drying the fresh plants in oven at 60°C.

*Plant spread (cm):* measured with foot scale

*Days taken to first flower:* noted plantation date to first flowering date and counted difference between these two dates.

*Flower per plant:* The numbers of flowers were counted.

*Fruit set per plant:* The numbers of fruit were counted.

*Percentage of fruit set per plant:* Calculated using the following formula:

Percentage of fruit set = Total fruit set ÷ Total number of flowers × 100

*Number of fruit per plant:* To calculate a total fruits, observed fruits of each selected plants.

*Size of fruit (cm):* Vernier caliper was used to estimate the size (cm) of fruits.

*Weight of fruit (g):* Fruits per plant were weighed.

*Total soluble solids (TSS °Brix):* Hand Refractometer used to evaluate the total soluble solids (TSS).

*Ascorbic acid:* Spectrophotometer was used to evaluate ascorbic acid.

*Titratable acidity:*

$$\text{Titratable Acidity (\%)} = \frac{N \times T \times 0.0064 \times 100}{S \times D}$$

*Statistical analysis*

Software Statistix 8.1 and Excel 2013 software were used to analyze the data in this study

## **Results and discussion**

*Plant height (cm)*

The statistical data showed in (Table 1). In second treatment (field condition) having variety three (Camino Real) was major effective to contribute the plant height 6.68cm followed by the treatments (field condition) having remaining two varieties (Chandler and Seascape) that produces height 5.94cm and 5.92cm respectively. While the minimum outcomes was noticed in tunnel condition having the height of 5.85cm in Chandler variety, 4.74cm in Seascape variety and Camino Real had 4.62cm. At tunnel condition Camino Real variety significantly differ rest of two varieties chandler and seascape. In same manner variety one (chandler) differ plant height from other two varieties. It was cultivated that the most extreme stature was contributed by Camino Real variety in field condition and the relative effect with the environment. This work in line with the (Rahman *et al.*, 2013) variation in plant height might be due to the genetic makeup.

*Crown Diameter (cm)*

Mean results of crown diameter of variety one chandler significantly differ from variety two (seascape) and variety three (Camino Real). Treatment two (field conditions) results of crown diameters were significantly differ by ( $p < 0.05$ ). The results obtained on total number of fruits presented in (Table 1) proved that field condition produces a maximum crown size of 9.40cm by Camnio Real variety while two varieties (Chandler and Seascape) shows an un-significant results of crown size, adding value 8.65cm and 6.90cm crown size. In tunnel condition, Chandler variety amounted maximum height 9.13cm and Seascape contributed 7.36 cm while Camnioreal shows value 7.60cm. this work parallel to work of (Rahman *et al.*, 2013) variation in plant height might be due to the genetic makeup.

*Petiole length (cm)*

It was observed (Table 1) that the treatment one (tunnel condition) having variety one (Chandler) produces highest petiole length (4.26cm) while other two varieties (Seascape and Camnio Real) in treatment one exhibit the petiole length are (4cm) and (3.26cm) respectively. In treatment two (open field) the maximum value (3.76cm) for the petiole length are presented by variety one (Chandler) and remaining two varieties (Seascape and Camnio Real) in treatment produces (3.64cm) and ( 3.56cm) petiole length. In treatment one mean results of chandler variety significantly differ from seascape and Camino

Real varieties but treatment two (field condition) showed non-significant results. Biometrical analysis confirmed that significant job of photoperiod and temperature on petiole length. Cultivars are contrastingly touchy to ecological elements for their vegetative development conduct with respect to blossoming or runner production. Petiole length was affected by the interaction of cultivar, GA<sub>3</sub> and photoperiod (Paroussi *et al.*, 2002).

*Number of leaves per plant*

Results of three kinds in treatment one (tunnel) showed non-significant behavior but the results of treatment two (field) chandler significantly differ from rest of two varieties.

The highest number of leaves per plant was counted in treatment two (field condition) having variety two (Seascape) beard maximum number of leaves (5.5) while the other two varieties (Chandler and Seascape) show low values that is (4.13) and (4.10) in treatment two (field environment). In tunnel grown (treatment one) three varieties (Chandler, Seascape and Camnio Real) shown little difference among the number of leaves per plant. The number of leaves in variety one are (4.56), in variety two (Seascape) 4.53 leaves and the variety three (Camnio Real) have the number of leaves 4.06 (Table 1). Probably due to receiving less time for vegetative growth. The results of present research consonant with the (Kadir, Carey & Ennahli, 2006).

**Table 1.** Effect of climatic variations on plant height, crown diameter, petiole length, No. of leaves, No. of trusses and No. of runners of three cultivars of strawberry (*Fragaria × ananassa*)

Parameter	Leaf Area (cm <sup>2</sup> )		Fresh Wt. of Leaves (g)		Dry Wt. of Leaves (g)		Fresh Wt. of Plant (g)		Dry Wt. of Plant (g)		Plant spread (cm)	
	HT	Field	HT	Field	HT	Field	HT	Field	HT	Field	HT	Field
Chandler	2.8a	1.6bc	0.14cd	0.13e	0.39bc	0.43ab	12.40 c	8.75e	8.75e	8.75e	10.8c	8.8d
Seascape	1.8b	1.5cd	0.17b	0.150c	0.35c	0.41bc	11.22d	18.9a	18.9a	18.9a	11.1bc	11.26b
Camino real	1.33d	1.60bc	0.14d	0.2a	0.44ab	0.49a	18.6a	13.63b	13.6b	13.63b	10.9c	12.16a

*Number of Trusses per plant*

It shows that the number of trusses per plant vary in both treatments (open and field condition). In treatment one (tunnel condition) having variety one (Chandler) produces maximum number of trusses per

plant while the remaining two varieties (Seascape and Camnio Real) in treatment one produces number of trusses per plant are (7.44) and (7.1) respectively. But results of treatment two (open field condition) as compare to treatment one (tunnel condition) are no

too good. In treatment two having variety one and two (Chandler and Seascope) produces same number of trusses (6.67) and the variety three (Camnio Real) beard (5.77) trusses per plant (Table 1). Results of three varieties in treatment one and two differ significantly. The findings predicted that in treatment one (tunnel condition), the vegetative growth of varieties (Chandler and Seascope) have increased. Comparison among varieties in treatment one and treatment two shown that the treatment one was best with respect to number of trusses per plant. The highest number of trusses per plant were noticed in open condition. The interaction of growth condition and varieties was also significant on flower trusses per plant (Kumar *et al.*, 2011).

#### Number of runners per plant

In treatment two (field condition) the maximum number of runners (9.93) produced by variety one (Chandler) while the remaining two varieties (Seascope and Camnioreal) in treatment two (field condition) bead number of runners per plant are (9.49) and (7.2) respectively. In treatment two (tunnel environment) having variety three (Camnio Real) developed maximum number of runners per plant (4.63) while the Chandler (variety one) produced (4.40) and variety two (Seascope) beard (4.13) number of runners per plant (Table 1). Results of treatment one present non-significantly but treatment two seascope variety results differ significantly from variety one and three.

Interaction of varieties and growth condition also significantly affected the runner's number. Our findings integrated with the results of (Salame, Santos, Chandler, & Sargent, 2010) has claimed that plant produced large area of the leaf, leaf number and runner's number under tunnel and field conditions.

#### Leaf area (cm<sup>2</sup>)

Results of leaf area treatment one and treatment two differ significantly. The data related to leaf area (cm<sup>2</sup>) is presented in (Table 2). It conclude that the treatment one (tunnel condition) exhibited the largest value of leaf area (2.80cm<sup>2</sup>) for variety one (Chandler) while in treatment one having two varieties (Seascope and Camnio Real) shows non-significant results. Camnio Real variety in treatment one (in tunnel) attained lowest leaf area (1.33cm<sup>2</sup>). The results of treatment two (field condition) shows little difference among the leaf area of three varieties.

The variety one (Chandler) shows leaf area (1.6cm<sup>2</sup>) and the second variety (Seascope) produces leaf area (1.68cm<sup>2</sup>) while third variety exhibited the leaf (1.50cm<sup>2</sup>). The assessment of results predicted that tunnel condition was feasible for leaf area. Our findings integrated with the results of (Salame, Santos, Chandler & Sargent, 2010). Plants shown large leaf area, number of leaves and number of runners under HT (high tunnels) and OP (open field). Variety had no effected leaf area (LA), leaf and root biomass (Kadir, Carey & Ennahli, 2006).

**Table 2.** Plant spread (cm)

Paramete	Plant Height (cm)		Crown Diameter (cm)		Petiole Length (cm)		No. of Leaves		No. of Trusses		No. of Runners	
	HT	Field	HT	Field	HT	Field	HT	Field	HT	Field	HT	Field
Chandler	5.82b	5.92b	9.13a	8.56b	8.89a	6.67bc	4.40c	9.93a	4.26a	3.76c	4.06b	4.13b
Seascope	4.74c	5.94b	7.36c	6.9d	7.44b	6.67bc	4.13c	9.46a	4b	3.64d	4.53ab	5.50a
Camino real	4.62c	6.68a	7.60c	9.40a	7.51b	5.77c	4.63c	7.20b	3.60e	3.56f	4.56ab	4.10b

Means not sharing a letter differ significantly at  $P < 0.05$ .

#### Fresh weight of leaves (g)

The results of fresh weight of three varieties in treatment one (tunnel) differ significantly on same manner the results of treatment two differ significantly by  $p < 0.05$ . The treatment one (tunnel) and treatment two (field condition) shows variation in fresh weight of leaves of three varieties.

In treatment two (open field) variety three (Camnio Real) attained maximum fresh weight (0.20g) and variety one (Chandler) gained lowest fresh weight of leaves (0.13g). One (tunnel condition) having variety two (Seascope) carried maximum fresh weight of leaves (FWL) (0.17 g) while the variety one (Chandler) have fresh weight of leaves (0.14g) and third variety

(Camnio Real) attained fresh weight of leaves (0.14g) (Table 2). The outcomes of this research matched with the results of (Qureshi, Hassan, Qureshi, Chughtai, & Saleem, 2012) has mentioned that the maximum fresh weight of leaves (FWL) was noticed at tunnel condition.

#### *Dry weight of leaves (g)*

The significant Fig.s related to dry weight of leaves (g) is presented in (Table 2) It illustrate that the treatment two (field condition) having variety three (Camnio Real) attained maximum dry weight of leaves (0.49g) while variety one (Chandler) gained dry weight of leaves (0.43g) and variety two (Seascape) contributing dry weight of leaves (0.41g). It illustrate that the treatment two (field condition) having variety three (Camnio Real) attained maximum dry weight of leaves (0.49g) while variety one (Chandler) gained dry weight of leaves (0.43g) and variety two (Seascape) contributing dry weight of leaves (0.41g). At both conditions, i.e. treatment one (tunnel) and treatment two (field), the optimum dry weight value for leaves is the same. The varietal performance shows that all varieties perform well in the field as compare tunnel. Dry matter of leaves affected the dry weight of leaves it differed from season to season and year to year. It showed that there were significant differences among cultivars for weight of dry leaves (Daugaard, 2007). Qureshi, Hassan, Qureshi, Chughtai & Saleem, (2012) predicted that the maximum dry weight was attained by leaves of strawberry in HT.

#### *Weight of fresh plants (g)*

The treatment one (tunnel) and treatment two (field) had three varieties (Chandler, Seascape and Camnio Real), fresh weight of three varieties differ significantly among treatments' and also among varieties. It confirmed that treatment two (field condition) having variety two (Seascape) exhibit maximum fresh weight of plant (18.9g) while the variety three (Camnio Real) gained fresh weight of plants (13.7g) and the variety one (Chandler) have lowest fresh weight (8.7g). In the treatment one (tunnel) having variety three (Camnio Real) gained optimum fresh weight of plants (18.6g) while the

remaining varieties (Chandler and Seascape) achieve fresh weight of plants (12.4g and 11.2g) respectively (Table 2). The treatment one (field condition) having variety one and variety three exhibited more difference in fresh weight of plants. Overall results predicted that in treatment one (tunnel) strawberry produces fresh biomass. The consequences of our study were matched with the results of (Palha, Campo & Oliveira, 2010) has stated that plant growth. At a statistical level, the fresh weight presented an interaction between environments and variety.

#### *Dry weight of plants (g)*

Significant results indicated that treatment one (tunnel) and treatment two (field condition) having varieties (Chandler, Seascape and Camnio Real) have same results. The dry weight of plant for variety one (Chandler) 8.75g while the dry weight of plants for variety two (Seascape) 18.90g, and the third variety (Camnio Real) 13.63g. There is no difference between two treats for dry weight of plants but in each treatment varieties show variation. The maximum dry weight of plants in both conditions (field and tunnel) attained by Seascape variety (18.90g) while Camnio Real variety exhibit dry weight of plants (13.63g) and the dry weight achieved by most common variety of strawberry (Chandler) was 8.75g (Table 2). Our results related to the work of (Menzel *et al.* 2014) has reported that there was an adjustment in the conveyance of plant dry issue over the developing season. The extent of dry issue distributed to the leaves, roots and crowns diminished as the plant goes toward development

#### *Plant spread (cm)*

The significant results of plant spread is presented in (Table 2) the maximum plant canopy size display by treatment two (field condition) having variety three (Camnio Real) 12.16cm while the results of the variety one (Chandler) 8.80cm and the plant spread for variety two (Seascape) 11.26cm. In treatment one (tunnel condition) the optimum canopy size gained by Seascape variety (11.20cm), the remaining varieties (Chandler and Camnio Real) in treatment one (tunnel condition) show canopy size as fallow 10.8cm (Chandler) and 10.9cm (Camnio Real) respectively.

Results indicated that varieties in treatment one show little difference plant spread (cm) but the treatment two shows more variation among varieties for strawberry canopy size. Outcomes of experiment in lined with the work of (Rahman *et al.*, 2013). Interaction between main factors was not significant for plant spread in the tunnel and open field (OP).

#### *Number of Flowers per plant*

Results pointed that treatment one (tunnel condition) having variety one (Chandler) beard maximum flowers (2.80) while the variety two beard (1.80) and the third variety beard (1.33) respectively. The highest number of flowers in treatment two (field condition) beard by variety one (Chandler) (1.60), while the variety two (Seascape) have number of flower per plant are (1.60) and the variety three get less number of flowers per plant (1.50) Table 3). The treatment two (field condition) results are not significant but in treatment one (tunnel) all results significantly differ. Verheul *et al.*, (2006) explained that treatment plants of strawberry taken 47 days to flower. Flowering days affected by the interaction of temperature, photoperiod and plant age. As compared older plant younger plant come into flowering early.

#### *Crop load/ Number of fruits set*

The results arranged in (Table 3) represented that the highest number of fruits per plant of strawberry attained by Chandler variety (3.13) in treatment two (field condition) while the treatment two having varieties (Seascape and Camnio Real) set number of fruits per plants of strawberry (3.03) by variety one

and (3.10) by variety three. The same varieties in treatment one (tunnel condition) show variation in number of fruit set per plant of strawberry. In treatment two (field condition) the optimum number of fruit set exhibited by Chandler variety (3.13) while the variety two (Seascape) set number of fruits per plant are (2.50) and variety three (Camnio Real) have number of fruit set per plant are (2.40) respectively. All of three varieties in treatment one (tunnel) showed significant results but treatment two differ non-significantly. The assessment showed that our results matched with the findings of (Aguero, Salazar, Kirschbaum, & Jerez, 2015) has suggested that fruit set (crop load) was affected by the interaction of following environmental parameters i.e. seasonal patterns, cultivar, harvest date and variation among cultivars.

#### *Fruit size (cm)*

The results of treatment one (tunnel condition) having variety one (Chandler) gained optimum fruit size (32.5cm) while the Seascape variety attained fruit size is (28.8cm) and the variety Camnio Real exhibit fruit size is (23.53cm). In treatment two (field condition) having variety one (Chandler) present maximum fruit size (29.8cm) while the variety two (Seascape) achieved fruit size (26.0cm) and the variety three (Camnio Real) presented fruit size is (24.1cm) (Table 3). Sonstebly, Opstad & Heide, (2013) told that the fruit size depended upon the number of fruits set and this was noticed in 'korona' which beard a large number of small fruits. In differentiate, there was a noteworthy variety in natural product size over the season in singular years.

**Table 3.** Effect of climatic variations on days taken to flower, No of flowers, No of fruit set, percentage of fruit set, fruit size and fruit weight of three cultivars of strawberry (*Fragaria × ananassa* Duch.).

Parameters	No. of Flowers		No. of Fruit Set		Fruit size (cm)		Fruit Wt. (g)	
	HT	Field	HT	Field	HT	field	HT	Field
Chandler	2.80a	1.60bc	3.13b	3.53a	32.5a	29.8b	11.8a	10.2b
Seascape	1.8b	1.50cd	2.53c	3.04b	28.8c	26.6d	10.2b	10.2b
Camino real	1.33d	1.60bc	2.40d	3.16b	23.53f	24.1e	8.59c	8.59c

Means not sharing a letter differ significantly at  $P < 0.05$ .

#### *Fruit weight*

The results of LSD (least significant difference) conclude that the treatment one (tunnel) having variety one (Chandler) perceive maximum fruit

weight (11.87g) while the varieties (Seascape and Camnio Real) achieved fruit weight are as fallow (10.25g) and 8.59g) respectively. In treatment two (open field) the maximum fruit weight attained by

Chandler (10.27g) while variety two (Seascape) got fruit weight (6.99g) and the variety three (Camnio Real) estimate fruit weight was (10.27g) (Table 3). Our data revealed that results were related with the study of (Ledesma, Nakata & Sugiyama, 2008). Results of treatment one (tunnel) showed significant results but treatment two (two) presented non-significant behavior.

The size and fresh weight of strawberry fruits were affected by day/night temperatures. Aguero, Salazar & Kirschbaum (2015) reported that the inverse effect of fruit load and air temperature on fruit weight

#### *Total fruits per plant*

Significant results of (yield) Results of treatment one and treatment two pointed that the treatment two (field condition) having variety (Seascape) beard total number of fruits per plant (23.03) while the variety three (Camnio Real) have total number of fruits per plant are (13.6) and the variety one (Chandler) exhibit total number of fruits per plant are (21.36) respectively. The treatment one (tunnel) entail variety two (Seascape) produced total number of fruits per plant were (22.23) while the variety three (Camnio Real) produce (17.06) and the variety one (Chandler) had number of fruits per plants (20) (Table 3). The findings proved that our results related with the results of (Singh *et al.*, 2012).

The reason to produced high no of fruit in the field the optimum intensity of light gained by plants but in tunnel plant cannot fulfill their optimum light intensity. Rahman *et al.*, (2015) observed that average fruit per plant varied among varieties

#### *Total soluble solids (TSS)*

The statistical data presented in (Table 4) of total soluble solids of strawberry fruit were pointedly affected by treatment and growing condition. The results describes that the treatment two (field condition) having varieties (Camnio Real and Seascape) contained total soluble solids are (4.70°Brix) while the Chandler variety comprise the total soluble solids are (4.66°Brix). In treatment one (tunnel) the highest total soluble solids are present by

Chandler variety (4.2°Brix) and rest of two varieties (Seascape and Camnio Real) contain total soluble solids are (3.63°Brix) and (2.63°Brix) respectively. In treatment one variety three differ significantly from rest of two varieties but treatment two varieties totally showed non-significant results. The findings of our research were similar with the findings of (Salame *et al.*, 2010). Total soluble solid (TSS) depended upon the production system. Adak, Gubbuk & Tetik, (2018) reported that TSS of fruit suffered from stress conditions at this condition (6.68%) and at the controlled condition the status of TSS was 8.42% among cultivars, highest was recorded in Albion followed by Amiga, Rubgem and Camarosa.

#### *Ascorbic acid (Vitamin C)*

The results predict that the treatment two (field condition) having variety three (Camnio Real) contain highest value of Ascorbic acid (3.6mg /100ml) while the rest of two varieties (Chandler and Seascape) in treatment two contain ascorbic acid as fallow (1.04mg/100ml) and (2.1mg/100ml). in treatment one (tunnel) comprise of variety one (Chandler) show optimum value of ascorbic acid (1.04mg/100ml) while the rest of varieties (Seascape and Camnio Real) show lowest values of ascorbic acid content in strawberry fruits (0.39mg/100ml) and (0.28mg/100ml) respectively (Table 4).

Treatment two (field) all varieties displayed significant results but in case of treatment one , variety one (Chandler) ascorbic acid content results differ significantly with respect to rest of varieties while treatment one showed non-significant results. The results of my research work were in lined with the results of (Gros *et al.*, 2003) has proposed that in the closed system (tunnel), strawberries were rich with the ascorbic acid (AsA).

The cultivar 'Senga Sengana' had concentration of ascorbic acid (vitamin C) was 32-54 mg/100 ml being higher while the lowest ascorbic acid content founded in Senga-VP (Hakala *et al.*, 2003). High temperature and treatments had a significant effect on the ascorbic acid, whereas ripening temperatures were non-significantly different.

**Table 4.** Effect of climatic variations on total No. of fruits, TSS and vitamin C of three cultivars of strawberry (*Fragaria × ananassa* Duch).

Parameters	Total No. of fruits		(TSS) °Brix		Vitamin C		(TA)	
			Environments					
Varieties	HT	Field	HT	Field	HT	Field	HT	Field
Chandler	20.4d	21.3c	4.2ab	4.6a	1.04c	1.04c	0.01c	0.15a
Seascape	22.2b	23.03a	3.63b	4.7a	0.39d	2.10b	0.03bc	0.02bc
Camino real	17.067e	13.60f	2.63c	4.7a	0.28d	3.06a	0.38bc	0.06b

#### *Titrateable acidity*

Titrateable acidity was pointedly affected by treatment (Table 4). The highest value of titrateable acidity attain by Camnio Real variety (0.38%) in treatment one (tunnel) and rest of two varieties (Seascape and Chandler) the titrateable acidity values as fallow (0.019%) and (0.32%).

The treatment two (open field) having variety one (Chandler) exhibit the titrateable acidity is (0.154%) while the remaining two varieties (Seascape and Camnio Real) present the value of titrateable acidity are as fallow (0.025%) and (0.064%). All varieties of treatment showed non-significant results but in treatment two all varieties showed significant results of titrateable acidity. Results of present study correlated with the results of (Aguero, Salazar, Kirschbaum & Jerez, 2015) has mentioned that seasonal pattern each year changed and cultivars also showed variation among them. Yommi, Borquez, Quipildor & Kirsch, (2003) explained that the 'Camarosa' variety presented more TA concentration. The positive relation between air temperature and TA.

#### **Conclusion**

yield of the strawberry plants gave positive connections the entirety of the vegetative and conceptive factors, with the exception of the individual load of the organic products, which introduced a negative relationship. 'Chandler' exhibited a better return than 'Camino Real' because of a higher vegetative energy spoke to in the entirety of the assessed factors, just as a high number of regenerative structures.

The innovation of the high-burrow framework can possibly build yield through a decrease of misfortunes and of harm chiefly brought about by precipitation; in

any case, a precaution control of sickness, for example, fine mold, a differential administration in the fertigation and the choice of cultivars that are appropriate for this condition are fundamental, as found on account of 'Seascape'.

#### **Acknowledgments**

Thanks to all teachers, friends, I want to say thanks especially my supervisor support me in my whole research.

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