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# Effect of Cultivation Method and Plant Density on Bitter Gourd in Egypt

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**Abstract**: Bitter gourd (*Momordica charantia* L.) belongs to the family Cucurbitaceae and it is an untraditional and new medicinal crop in Egypt. This study aimed to determine the best cultivation methods (traditional cultivation on terraces and climbing as vertical training) and three plant densities (5000, 10000, and 15000 plant/fed.) under the conditions of the Ras Sudr region, Egypt, during 2021-2022 seasons. Our results illustrated that the cultivation method as a climber plant (as vertical training) was the best compared with the other method on terraces (as horizontal traditional cultivation). The plant density at 1000 plant/fed. score the best values of most characters. The climber plant (as vertical training) combined with plant density at 10000 and 15000 plant/fed. gave the height values, especially the economic yield of fruit in both seasons, respectively. Also, the best-recorded data on phytochemical components phenolic, flavonoid, terpenoids, alkaloids, and saponins were obtained when bitter gourd was cultivated as vertical training at 15000 plant/fed. as plant density.

**Key words**: Bitter gourd, *Momordica charantia*, cultivation method, plant density, Cucurbitaceae

## INTRODUCTION

Recent years have seen an exponential rise in the use of herbal medicine, and these therapies are becoming more popular in both developed and developing nations due to their natural origins and lack of side effects when compared to chemical sources. The bitter gourd (*Momordica charantia* L.) is a native of Asia's tropical and subtropical plant zones. The bitter gourd is a member of the Cucurbitaceae taxonomic family. The bitter gourd was referred to locally as bitter melon and balsam-pear, balsam-apple, Balsambirne, balsamito, peria, Paria, pare and karalla in different countries. These reflect that Bitter gourd is globally recognized as a vegetable and medicinal plant (**Taylor,**

**2002 and Goo *et al.*, 2016**). It's popular in South and Southeast Asia, China, Africa, and the United States. It is currently cultivated as a commercial crop close to metropolitan areas. Furthermore, it may be cultivated in any type of soil with enough drainage. The plant is a climbing permanent with elongated fruit that resembles a warty gourd or cucumber. When fruit is unripe, it has a bitter flavor that gets stronger as it ripens. Triterpenes, proteins, steroids, alkaloids, saponins, flavonoids, and acids are just a few of the biologically active plant chemicals found in *Momordica charantia*. As a result, the plant has anti-fungal, anti-bacterial, anti-parasitic, anti-viral, anti-fertility, anti-tumorous, anti-tumorous, hypoglycemic, and anti-carcinogenic properties. Fruits are used as a kind of traditional medicine to treat a number of ailments, including colic, worms, rheumatism, and liver and spleen ailments. Additionally, it is effective in the curing of diabetes and cancer. Alkaloids, peptides that resemble insulin and a combination of steroidal sapogenins known as charantin make it a powerful hypoglycemic drug. **(Ahmad *et al.*, 2017; Beloin *et al.*, 2005; Grover and Yadav 2004; Longo *et al.*, 2011 and Shaw *et al.*, 2010).** Bitter gourd is low in calories but dense with precious nutrients. On the other hand, it is a rich source of vitamins (B1, B2, B3, C) Mg, Zn, P, Mn, Fe, and folic acid and has high dietary fiber**.** It contains twice the beta-carotene of broccoli, twice the calcium of spinach, and twice the potassium of a banana**.** Bitter gourd is very low in calories (17 calories/100 g). Nevertheless, its pods are rich in phytonutrients like anti-oxidants, dietary minerals, fiber, and vitamins **(Keding and Krawinkel, 2006; Aboa *et al.*, 2008; Wu and Ng, 2008; Klomann *et al.*, 2010 and Krishnendu and Nandini, 2016).**

Plant density is the number of plants in the unit of cultivation area. Plant density affects how much nutrients, water, soil, light, air and other environmental influences a plant gets, as well as the extent of weed growth. So plant density has remarkable effects on yield and quality in medicinal plants. The sowing density and the emergence rate determine the plant density at emergence. The uniformity of plant distribution during emergence, for a given plant density, may have a major influence on both the competition amongst plants and weeds. **(Olsen *et al.*, 2006 & Olsen and Weiner, 2007).** Maintaining the optimum plant population and competition in field crops right from germination to harvesting is one of the important tasks for efficient utilization of resources and to get the highest economic yield **(Pant and Kumar, 2020)**. Increasing plant density from 4780 to 9560 plant/hectare resulted in significantly greater fruit number and yield of Pumpkin **(Abd El-Hamed and Elwan, 2011).** The recorded data indicated that, the lowest level of plant density (1750 plant/fed.) gave the highest weight of fresh and dry shoots, average fruit weight, average fruit length and N content in shoots and fruits. However, the significantly highest values of fruit yield and fruit number/faddan resulted from the high plant population (3500 plant/fed.) **(El-Seifi *et al.*, 2015).** Bitter gourd is a new crop in Egypt, The farmers differed on the best way to plant it, especially under the conditions of climate change and the emergence of dry agricultural areas, Is it a climber or on terraces? what is the best spacing between plants? That is why it was necessary to conduct this research to determine the best method of planting bitter gourd in the Egyptian environment.

## MATERIAL AND METHODS

This study was conducted at the Experimental Farm at Ras-Sudr, South Sinai Governorate, Egypt, during the two successive summer seasons 2021 and 2022 to rate the effect of cultivation methods and plant density on bitter gourd in Egypt. Seeds of bitter gourd were collected from mature fruits growing at the Floriculture Nursery of Horticulture Department, Faculty of Agriculture, Benha University. Seeds were planted in seedling trays, lightly covered and kept in a polyethylene greenhouse until they germinated. Seedling trays were relocated under a saran greenhouse (63% shade) after germination until they reached the optimum size for transplanting, which took about 50 days. Seedlings with 2-3 pairs of true leaves and a height of 7 cm were transplanted into the experimental field. The soil of the cultivation location was saline and calcareous, its texture was sandy loam, pH 7.4, EC 4.65 mS $cm^{-1}$, CaCO3 54.21%. Physical and chemical properties of the soil were determined according to **Burt** (**2004)**. Plants were irrigated with water (2300 ppm).

This experiment as factorial experiments in split-plot design included six treatments which were the combinations of two cultivation methods (horizontal traditional cultivation on terraces and climbing as vertical training) and three plant densities (5000, 10000, 15000 plant/fed.) arranged in a split-plot design with three replications, the cultivation methods were assigned in the main plots but plant densities in the sub-plots.

### Growth and yield parameters measurements

Data on bitter gourd growth was collected after three months of transplanting. Early harvesting was practiced; vine length (cm) and plant/branch count were noted before harvest. After harvest, plants were taken out for sampling and measurements of fresh herbs, including the No. of fruit, the average fruit weight, the length and thickness of the fruit, and the fruit yield per plant and fed. Photosynthetic pigments chlorophyll a, b and total chlorophyll were determined according **to Saric *et al.* (1967)** in the fresh samples of bitter gourd leaves**.** Samples were air-dried in the shade to determine the percentage of nutrient elements. The modified micro-Kjeldahle technique, as reported by **A.O.A.C. (1980)**, was used to measure nitrogen. Phosphorus was determined using the ammonium molybdate method according to **Murphy and Riley (1962).** Potassium was estimated using the flam photometric method according to **Cottenie *et al.* (1982).**

### Determination of active compounds

The total phenolic of Bitter gourd aerial parts was determined using colorimetrically according to **Pa_sko *et al.* (2009)**. The total flavonoid content of Bitter gourd aerial parts was determined using a colorimetric technique as described by **Gorinstein *et al.* (2007).** Terpenoids were determined according to **Indumathi *et al.* (2014).** Total alkaloids of Bitter gourd aerial parts were measured quantitatively according to the method reported by **Harbone (1973).** Determination of total saponin contents was According to **Ajiboye *et al.*** (**2013**).

### Statistical analysis

The collected data for both seasons were combined and statistically analyzed by analysis of variance (ANOVA) using the MSTATC program was used to analyze the results. Means were compared using the L.S.D. test at 0.05 level according to **Snedecor and Cochran (1989**).

## RESULTS

### Growth Parameters

According to data in Table (1) demonstrated that the vegetative growth measurements i.e. vine length and number of branches of bitter gourd significantly increased by using the climbing method of cultivation compared with cultivation on terraces.

Referring to, all vegetative growth mentioned above was greatly affected when plant density was 10000 plant/fed. compared with the lowest level at 5000 plants/fed. and the highest level at 15000 plant/fed.

Furthermore, the interaction effect between climbing cultivation and plant density revealed that the highest values of vine length obtained when climbing cultivation was used at 1000 plants/fed. only in the first season but in the second season the density at 5000 plant/fed. was significant too. This trend was different in a number of branches, a treatment where the second level of plant density gave the highest significant values with two methods of cultivation in the first only. In the second season the cultivation on terraces combined with plant density at 5000 plant/fed. and the treatment combined the climbing cultivation method with the third level of plant density at 15000 plant/fed. scored the lowest values from a number of branches compared with other treatments which are of equal significance.

**Table (1). Effect of cultivation method, plant density and their interaction treatments on vine length and number of branches of bitter gourd during 2021 and 2022 seasons**

| Treatments | | Vine length | | Number of branches | |
|---|---|---|---|---|---|
| M | D | 2021 | 2022 | 2021 | 2022 |
| M1 | | 138.52 | 139.00 | 6.11 | 8.67 |
| M2 | | 178.38 | 180.34 | 6.34 | 8.11 |
| LSD at 0.05 % | | 5.007 | 6.758 | 1.263 | 1.300 |
| | D1 | 156.59 | 161.29 | 5.45 | 8.11 |
| | D2 | 167.62 | 166.32 | 7.67 | 9.33 |
| | D3 | 151.19 | 151.78 | 5.33 | 7.33 |
| LSD at 0.05 % | | 2.926 | 2.123 | 1.135 | 1.053 |
| M1 | D1 | 136.44 | 139.78 | 4.89 | 7.00 |
| | D2 | 150.56 | 149.67 | 7.56 | 9.22 |
| | D3 | 128.44 | 127.61 | 6.11 | 8.89 |
| M2 | D1 | 176.78 | 182.89 | 6.11 | 9.11 |
| | D2 | 184.56 | 183.00 | 7.78 | 9.33 |
| | D3 | 173.89 | 175.89 | 4.67 | 5.78 |
| LSD at 0.05 % | | 4.138 | 3.002 | 1.605 | 1.490 |

M: cultivation method, D: plant densities, M1: traditional cultivation on terraces, M2: climbing as vertical training, D1: 5000 plant/fed, D2: 10000 plant/fed, D3: 15000 plant/fed.

## Yield Characteristics

Table (2) shows that the climbing method of cultivation was outperformed significantly cultivation on terraces for most tasted parameters like the number of fruit, average fruit weight and fruit length fruit thickness of bitter gourd except for fruit thickness which the two cultivation methods were equal for it.

It is clear that the plant density at 10000 plant/fed. scored the highest values of the number of fruits compared with the other treatments, but the highest values of average fruit weight, fruit length and fruit thickness were obtained from the same treatment jointly with cultivation at 5000 plant/fed. as climbing plants.

Additionally, data in Table (2) recorded that all interactions between cultivation methods (on tresses and climbing) and plant density levels treatments statistically affected the number of fruit, average fruit weight, fruit length and fruit thickness of bitter gourd. However, the highest values of the number of fruits were recorded when the bitter gourd plants were cultivated as climbing plants at 10000 plant/fed. in both seasons. The highest values of average fruit weight, fruit length and fruit thickness were obtained from the same treatment jointly with cultivation at 5000 plant/fed. in the two seasons with both cultivation methods (on tresses and climbing).

**Table (2). Effect of cultivation method, plant density and their interaction treatments on the number of fruits, average fruit weight, fruit length and fruit thickness of bitter gourd during the 2021 and 2022 seasons**

| Treatments | | No. of fruits/Vine | | Av. Fruit weight/Vine | | Fruit length | | Fruit thickness | |
|---|---|---|---|---|---|---|---|---|---|
| **M** | **D** | **2021** | **2022** | **2021** | **2022** | **2021** | **2022** | **2021** | **2022** |
| **M1** | | 16.11 | 16.89 | 47.81 | 49.19 | 6.04 | 6.18 | 0.584 | 0.636 |
| **M2** | | 19.85 | 20.30 | 55.52 | 56.67 | 7.30 | 7.11 | 0.649 | 0.673 |
| **LSD at 0.05 %** | | 3.055 | 0.321 | 4.312 | 4.828 | 1.118 | 0.574 | 0.1814 | 0.1283 |
| | **D1** | 17.22 | 17.78 | 52.55 | 54.00 | 6.67 | 6.50 | 0.672 | 0.708 |
| | **D2** | 20.61 | 21.72 | 53.33 | 54.28 | 7.50 | 7.33 | 0.650 | 0.678 |
| | **D3** | 16.11 | 16.28 | 49.11 | 50.50 | 5.83 | 6.11 | 0.528 | 0.577 |
| **LSD at 0.05 %** | | 1.261 | 1.497 | 3.791 | 3.078 | 0.872 | 0.966 | 0.0421 | 0.0842 |
| | **D1** | 16.44 | 17.00 | 51.00 | 52.67 | 6.00 | 6.110 | 0.6433 | 0.673 |
| **M1** | **D2** | 19.22 | 20.22 | 48.78 | 49.67 | 6.56 | 6.663 | 0.6100 | 0.657 |
| | **D3** | 12.67 | 13.44 | 43.66 | 45.22 | 5.56 | 5.777 | 0.5000 | 0.577 |
| | **D1** | 18.00 | 18.56 | 54.11 | 55.34 | 7.33 | 6.89 | 0.700 | 0.743 |
| **M2** | **D2** | 22.00 | 23.22 | 57.89 | 58.89 | 8.45 | 8.00 | 0.690 | 0.700 |
| | **D3** | 19.55 | 19.11 | 54.56 | 55.78 | 6.11 | 6.45 | 0.557 | 0.577 |
| **LSD at 0.05 %** | | 1.783 | 2.118 | 5.362 | 4.353 | 1.233 | 1.366 | 0.0595 | 0.1191 |

M: cultivation method, D: plant densities, M1: traditional cultivation on terraces, M2: climbing as vertical training, D1: 5000 plant/fed, D2: 10000 plant/fed, D3: 15000 plant/fed.

### Fruit Yield

Data in Table (3) showed that, using climbing methods as a cultivation method demonstrated to be the most productive for growing bitter gourds and the maximum fruit yield per plant in both seasons.

Referring to the used plant density the cultivation at 10000 plant/fed. produced the highest fruit yield/plant of bitter gourd followed by 5000 plant/fed. in the first season, while the highest fruit yield/fed. obtained from cultivation at 15000 plant/fed. only in the first, and from the same treatment with no significant differences with 10000 plant/fed. in the second season.

Concerning the interaction between the cultivation method and plant density, it was found that the combination of climbing cultivation method and plant density at 10000 plant/fed. increased the fruit yield/plant in both seasons recorded at 1273.58 and 1367.43 g, respectively. While the heights fruit yield/fed. produced from the treatment of the climbing cultivation method combined with plant density at 15000 plant/fed. recorded 15999.75 and 15989.40 kg in the first and second seasons, respectively, flowed by cultivation as a climbing plant at 10000 plant/fed.

**Table (3). Effect of cultivation method, plant density and their interaction treatments on fruit yield/plant (g) and fruit yield/fed. (Kg) of bitter gourd during the 2021 and 2022 seasons**

| Treatments | | Fruit yield/vine | | Fruit yield/ fed. | |
|---|---|---|---|---|---|
| **M** | **D** | **2021** | **2022** | **2021** | **2022** |
| **M1** | | 776.77 | 836.62 | 7233.55 | 7886.75 |
| **M2** | | 1105.06 | 1153.40 | 11210.67 | 11590.10 |
| **LSD at 0.05 %** | | 245.91 | 82.28 | 7714.33 | 1186.67 |
| | **D1** | 906.62 | 961.33 | 4450.40 | 4806.25 |
| | **D2** | 1106.05 | 1186.86 | 11060.33 | 11860.40 |
| | **D3** | 810.10 | 836.76 | 12150.67 | 12550.67 |
| **LSD at 0.05 %** | | 79.63 | 103.13 | 888.93 | 1006.80 |
| **M1** | **D1** | 839.73 | 896.40 | 4032.45 | 4480.55 |
| | **D2** | 937.65 | 1005.67 | 9376.73 | 10050.95 |
| | **D3** | 552.88 | 608.42 | 8292.82 | 9126.33 |
| **M2** | **D1** | 973.46 | 1027.53 | 4867.90 | 5133.67 |
| | **D2** | 1273.58 | 1367.43 | 12735.80 | 13674.30 |
| | **D3** | 1066.65 | 1065.96 | 15999.75 | 15989.40 |
| **LSD at 0.05 %** | | 112.64 | 145.84 | 1257.55 | 1423.23 |

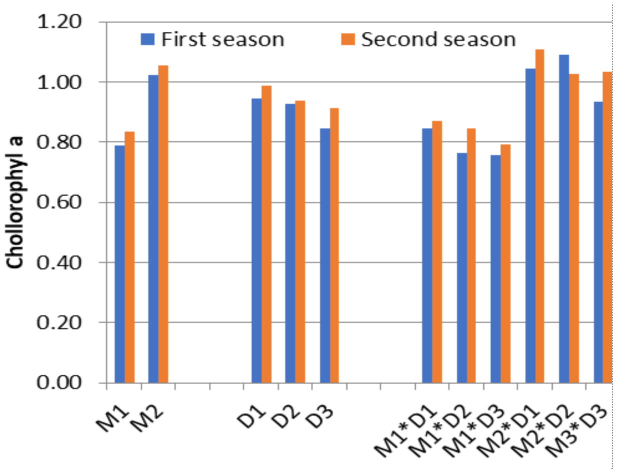
M: cultivation method, D: plant densities, M1: traditional cultivation on terraces, M2: climbing as vertical training, D1: 5000 plant/fed, D2: 10000 plant/fed, D3: 15000 plant/fed.

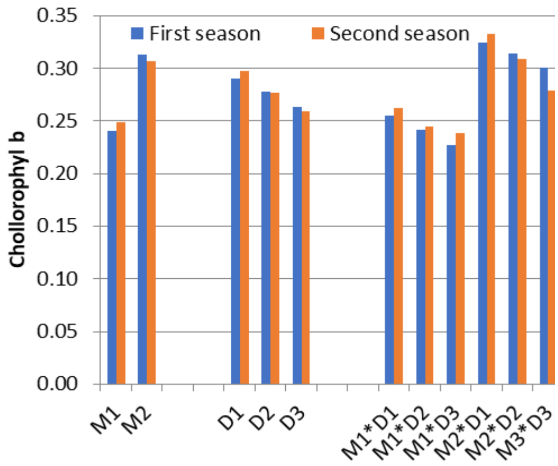
### Photosynthetic pigments

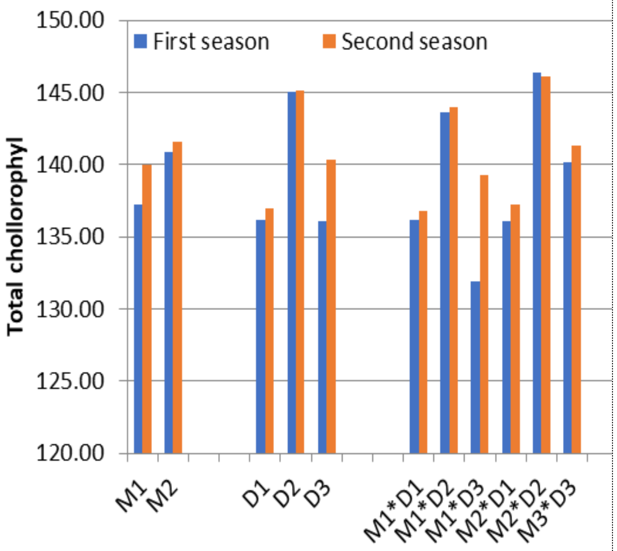
Data presented in Fig.1 declare that Photosynthetic pigments i.e. (chlorophyll a, b, total chlorophyll) were affected by using the climbing cultivation method which registered significant values for chlorophyll a and b in both seasons and total chlorophyll in the first season only.

Referring to, plant density the first and the second levels (5000 and 10000 plant/fed.) gave the heights values of chlorophyll a in both seasons without any differences and the treatment at 5000 plant/fed. recorded the height values of chlorophyll b in both seasons. Meanwhile, the highest values of total chlorophyll resulted from cultivation density at 10000 plant/fed.

However, the highest values of chlorophyll a were recorded by using the combined treatment between climbing cultivation method and plant density at two levels (5000 and 10000/ plant/fed.) in the first season only, but the combined treatment between climbing cultivation method and plant density at 5000 plant/fed. recorded the height values of chlorophyll b. The previous cultivation method combined with plant density at 10000 plant/fed. registered the height value of total chlorophyll.




M: cultivation method, D: plant densities, M1: traditional cultivation on terraces, M2: climbing as vertical training, D1: 5000 plant/fed, D2: 10000 plant/fed, D3: 15000 plant/fed.

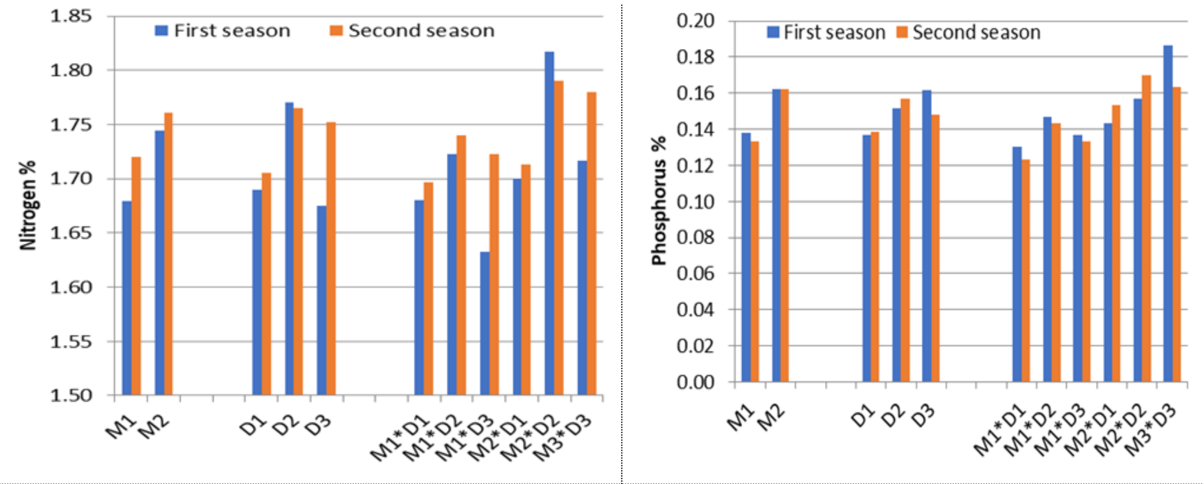
**Fig.1. Effect of cultivation method and plant density and their interaction treatments on chl. a, chl. b and total chl. of bitter gourd during 2021 and 2022 seasons**

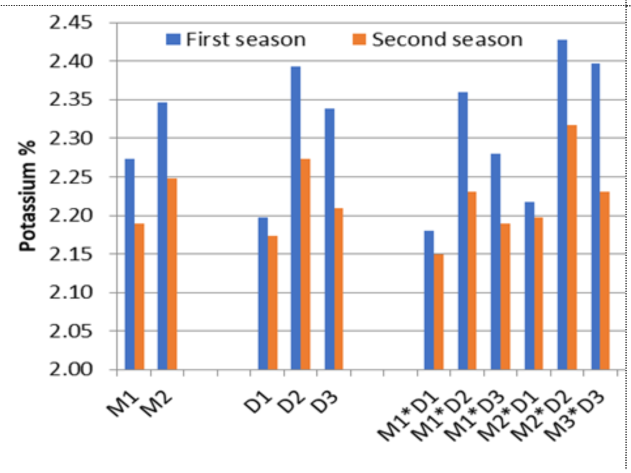
**Nitrogen, Phosphorus and Potassium content**

According to data presented in Fig. 2 it could be concluded that, the climbing cultivation method gave significant values of nitrogen, phosphorus and potassium in both seasons.

Moreover, the treatment of plant density at 10000 plant/fed. recorded the highest values of all previous estimates in both seasons except the phosphorus in the first season which resulted from plant density at 15000 plant/fed.

In a similar trend to the previous one, data recorded that, the highest values of nitrogen, phosphorus and potassium in both seasons resulted when bitter gourd was cultivated as a climbing plant at 10000 plant/fed., except the phosphorus in the first season which resulted from plant density from climbing cultivation method combined with plant density at 15000 plant/fed.




M: cultivation method, D: plant densities, M1: traditional cultivation on terraces, M2: climbing as vertical training, D1: 5000 plant/fed, D2: 10000 plant/fed, D3: 15000 plant/fed.

**Fig.2. Effect of cultivation method and plant density and their interaction treatments on nitrogen, phosphorus and potassium of bitter gourd during 2021 and 2022 seasons**

### Active constituents

Data illustrated in Table (4) showed the concentration of phenolic, flavonoid, terpenoids, alkaloids, and saponins after plant harvesting with different treatments of cultivation methods combined with plant density.

**Table (4). Effect of cultivation method and plant density and their interaction treatments on total active constituents of Bitter gourd during 2021 and 2022 seasons**

| Treatments | Phenolic acids mg/g GAE | Flavonoid contents mg/g QE | Terpenoids percentage | Alkaloids percentage | Saponins percentage |
|---|---|---|---|---|---|
| **T1 (M1*D1)** | 3.07 ± 0.16 | 1.36 ± 0.19 | 0.367 ± 0.21 | 0.240 ± 0.15 | 0.290 ± 0.19 |
| **T2 (M1*D2)** | 5.36 ± 0.24 | 1.59 ± 0.21 | 0.690 ± 0.42 | 0.296 ± 0.04 | 0.399 ± 0.30 |
| **T3 (M1*D3)** | 4.23 ± 0.10 | 1.76 ± 0.08 | 0.420 ± 0.20 | 0.267 ± 0.13 | 0.321 ± 0.31 |
| **T4 (M2*D1)** | 3.12 ± 0.22 | 1.43 ± 0.15 | 0.520 ± 0.16 | 0.243 ± 0.19 | 0.419 ± 0.21 |
| **T5 (M2*D2)** | 5.46 ± 0.24 | 2.06 ± 0.20 | 0.243 ± 0.23 | 0.267 ± 0.34 | 0.230 ± 0.34 |
| **T6 (M2*D3)** | 5.82 ± 0.02 | 2.93 ± 0.31 | 0.694 ± 0.56 | 0.302 ± 0.24 | 0.503 ± 0.24 |

M1: traditional cultivation on terraces, M2: climbing as vertical training, D1: 5000 plant/fed, D2: 10000 plant/fed, D3: 15000 plant/fed.

The treatment T6 (M2*D3) showed a higher concentration of all components of phenolic, flavonoid, terpenoids, alkaloids, and saponins (5.82 mg GAE /g, 2.93 mg QE/g, 0.694, 0.302, and 0.503 %). In this study, the response of T6 (M2*D3) is better than other treatments, this is reflected in its phytochemical constituent to achieve the best concentrations followed by T5 (M2*D2) and T2 (M1*D2) in most constituents.

## DISCUSSION

Plant density is a very important factor affecting the growth and productivity of plants and their chemical constituents, The results obtained here indicated that the plant density affected significantly all tested parameters i.e., vine length, number of branches, No. of fruits/vines, average fruit weight/vine, fruit length, fruit thickness, fruit yield/vine, fruit yield/ fed., photosynthetic pigments, N, P and K. Similar results recorded by **Peil *et al.* (2014),** the increase in the yield of the densest crops is due to a greater interception of the photosynthetically active light and higher levels of photosynthesis, which stimulates the growth of the plants, increases the total photoassimilates and favors the growth of fruit. Low plant densities produced the maximum yield and this corroborates the results of several studies **(Gonsalves *et al.*, 2011; Campagnol *et al.*, 2012; Peil *et al.*, 2014)** in Solanaceae and Cucurbitaceae species. Plant density affects plant development because it has a significant impact on how well solar energy is absorbed by the leaves' surfaces. The reduced rate of photosynthesis and leaves that result from too little space can have an impact on vegetative development and crop output. **(Gardner *et al.*, 1991).** This result confirms what was indicated by **Díaz *et al.* (1999) and Ayala-Tafoya *et al.*, (2019),** who made observed that when density rises, biomass output declines as a result of increased plant competition for light, $CO_2$, water, and minerals. The production of foliar biomass of the cucumber plant is directly related to the foliar area that develops the crop, having as resources the water, light and nutrients of the soil that intervene in their physiological processes **(Ayala-Tafoya *et al.*, 2019). Favela and Ssnchez (2003)** revealed negligible impacts of plant density on the development of several vegetables' fruits and they saw that the modest distance between plants and furrows had minimal impact on the length, breadth, and pericarp thickness of the fruit, according to **Lopez-Elias *et al.* (2015),** the studied plant densities had alike cucumber fruit length and diameter, firmness, and soluble solids content. It should be emphasized, nevertheless, that despite the rise in yield brought on by the tighter spacing, the cultivation of plants at extremely high densities is not always adequate because it hampers management activities, increases the need for pruning, increases the probability of phytopathogenic bacteria and fungi, and makes monitoring and control difficult **(Gomes *et al.*, 2017).**

Climbing cultivation of bitter gourd is a potential solution to increase the agricultural sector productivity and sustainability. Vertically on net trailing method as a cultivation method of bitter gourd took a minimum of days to flower, while maximum fruit length, vine length, fruit diameter, fruit weight, yield/plot and fruit yield **(Khan *et al.*, 2022).** In field experiments, cucumber plants (*Cucumis sativus* L.) that were vertically trained (staked) outperformed vining plants (unstaked) in terms of yield. Compared to vining plants, vertically trained plants produced more female flowers set and matured into marketable fruits. Before the first harvest, the staked plants' main stems' fresh weight, length, and width were all greater than those of the unstaked plants. Although both plants had the same number of female flowers, the fresh weight of staked plants was considerably higher before the first harvest and after the last harvest than that of unstaked plants. Plant spacing inside a row was decreased from 30 to 15 cm, which greatly boosted the yield **(Hanna and Adams, 1987). Hilli *et al.* (2009)** In comparison to the traditional method (without trailing), the findings showed that the telephone method of trailing recorded much more vine length, number of leaves dry matter, and higher fruit and seed yield. Trellising's impact on cucumber (*Cucumis sativus* L.) yield was examined, in comparison to ground culture, trellising increased total and marketable output at both locations. Trellising is a practical management strategy for small-scale cucumber production, according to an economic study **(Russo, 1991). El-Zawily *et al.* (2000)** showed that, in comparison to a creeping planting, vertically trained planting enhanced the stem length, leaf area, and fresh and dry weight of the fifth leaf from the growing tip. While there were no appreciable changes in phosphorus content across the various treatments, the nitrogen and potassium content of vertically trained plants was higher than that of ground-creeping plants. Decreasing plant density and the vertical training system increased the number of pistillate flowers and decreased the staminate ones. **Sharma *et al.* (2016)** the obtained data showing that, the trailing method had much higher vine length, number of leaf/vine, leaf area, and number of nodes/vine. the shorter time required in trailing compared to the traditional method from anthesis to the first male bloom (49.8 days) and female flower (54.6 days). The two growth techniques used in the treatments are the horizontal and vertical methods. The studies' outcomes showed that the analyzed parameters varied significantly. Regarding growing methods, vertically trained plants produced the maximum vine length, number of leaves vine$^{-1}$, number of fruit set vine$^{-1}$, fruit weight, fruit length, number of seeds fruit$^{-1}$, seed weight fruit$^{-1}$, and seed yield, while horizontally trained plants produced the minimum values of the previous traits (**Ahmed *et al.*, 2021).**

## Conclusion

It can be concluded that the climbing cultivation (as vertical training) was the best for improving growth and yield of Bitter gourd (*Momordica charantia* L.) compared with traditional cultivation on terraces, the same trend was recorded when the bitter gourd was cultivated at plant density 10000 plants/fed. The combination between previous two treatments gave the maximum values of growth and yield of Bitter gourd in most traits in both seasons.

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