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# Effect of spacing on growth and yield of watermelon

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**Abstract**
A field experiment was conducted during summer season of 2018 – 2019 at Instructional Farm, Department of Vegetable Science, Faculty of horticulture Dr. PDKV, Akola to study the effect of spacing on growth and yield of watermelon. The experiment was laid out in Randomized Block Design (RBD) with four replications and five treatments *viz*. $T_1$ (0.45 × 2.0 m) $T_2$ (0.60 m × 2.0 m), $T_3$ (0.75 m × 2.0 m), $T_4$ (0.90 m × 2.0 m) and $T_5$ (1.0 m × 2.0 m). In respect of growth parameter closer plant spacing i.e. higher plant density produced maximum length of main stem and internodal distance. Whereas, wider plant spacing was produced maximum number of leaves, number of primary branches and chlorophyll index. Treatment $T_5$ (1.0 m × 2.0 m) was found superior in respect of fruits weight and yield per plant. While treatment $T_1$ (0.45 m × 2.0 m) produced the maximum yield per plot and yield per hectare.

**Keywords:** Watermelon, *Citrullus lanatus*, plant spacing, growth, yield.

## Introduction
Cucurbits is a popular group of vegetable in many part of the world, occupy a large area under cultivation in India. Cucumber, melon, pumpkin, squash and gourds belong to the cucurbitaceae family. Among the cucurbits, the watermelon (*Citrullus lanatus* thumb.) is one of the important vegetables crop grown extensively in India and in tropical and sub tropical countries of Asia and Africa. Watermelon (*Citrullus lanatus*) is believed to have originated in Africa and spread to other parts of world. Global area under watermelon cultivation is 3,477,285 ha with annual production of 118,413,465 tons. (FAOSTAT 2017) [2]. In India current status of area is 100.88 $mha^{-1}$ with production 2479.71 MT. In India, Uttar Pradesh is first in area 13.07 $mha^{-1}$ and production is 588.54 MT and Maharashtra is sixth in number with area 6.12 mha and production is 176.31MT (NHB Database 2017-18).
Watermelon has high nutritive value, rich in vitamin 'C' which is good for health, low in sugar and calories because of high percent of water. A watermelon is a type of edible fruit with 92% water. About 7.55 Carbohydrates (g), 30 Calories (kcal), 0.62 Protein (g) and other essential minerals. Watermelon is rich in caretenoids. Some of the caretenoides in watermelon include lycopene, phytofluence, phytotene, betacarotene, lutein, and neurosporene. Lycopene makes up the majority of the caretenoides in watermelon. The caretenoid content varies depending on the variety of the watermelon. Caretenoides have antioxidant activity, free radical scavenging property. Lycopene may also reduce risks of cardiovascular disease. Watermelon seeds are excellent sources of protein (essential and non- essential amino acids) and oil. Watermelon seed is about 35% protein, 50% dietary fibre. Watermelon seed is also rich in micro and macro - nutrients such as magnesium, calcium, potassium, iron, phosphorous, zinc, etc.
Crop growth is largely influenced by spacing. Evidence suggested that, spacing affect the growth and yield of watermelon. Shorter internodes, thinner branches without epical dominance, fruit setting and tertiary branches were all affected by spacing. Growth and yield parameters are under the influence of spacing. Measurable difference among plants is visible only when plants develop enough and compete for nutrients. Also, the vine length, diameter, number of leaves and number of branches linearly increased with increased in spacing (Dean *et al*. 2011, Mangata and Mausia, 2006) [3, 6].

## Materials and Methodology
The experiment was conducted at department of Vegetable Science, Faculty of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during summer season of 2018 - 2019. The experiment was laid out in randomized block design with four replications on medium black soil with uniform in texture, colour and having good drainage. The treatments constituted of five different plant spacings *viz*. $T_1$ (0.45 × 2.0 m) $T_2$ (0.60 m × 2.0 m), $T_3$ (0.75 m × 2.0 m), $T_4$ (0.90 m × 2.0 m) and $T_5$ (1.0 m × 2.0 m).

The watermelon seedlings were transplanted on 20th January 2019. Farm yard manure twenty tons per hectare and N:P:K 200:100:100 kg/ha were applied thorough the cropping period in split applications. All the observations of growth and yield characters were taken monthly at 30, 60, 90 and at days after planting and at harvest. The harvested watermelons were picked up and were separated and analysed.

**Results and Discussion**

The result of effect of spacing on growth and yield of watermelon are presented in Table 1 and 2.

Maximum length of main stem was observed in T1 (0.45 × 2.0 m) which was at par with T2 (0.60 × 2.0 m) narrow spacing gave the tallest plant than wider plant spacing and length of main stem decreased with increase in plant spacing this is due to the fact that under closer spacing. This is due to the fact that under closer spacing, plant might have adjusted its canopy in the vertical space by increasing inter nodal length. While in wider spacing, there was less interplant competition resulting in greater horizontal spread. Similar results were reported by Adlan and Asim (2018) [1] in watermelon.

Number of leaves per plant at harvest, number of primary branches, internodal distance (cm) and chlorophyll index tends to decreased in closer plant spacing (Table 1). Maximum numbers of leaves per plant (252.68) were recorded in the treatment $T_5$ (1.0 m × 2.0 m) which was statistically found at par with (251.98) treatment $T_4$ (0.90 m × 2.0 m). Wider plant spacing produced significantly more number of leaves per plant than closer plant spacing. This might be due to the fact that wider spacing gave an opportunity for more availability of nutrients, moisture and better interception of light for development of more number of leaves. Similar results were also reported by Rodriguez *et al*. (2007) [8] and Nagala *et al.* (2019) [7] in watermelon.

Maximum numbers of primary branches (6.50) were recorded in the treatment $T_5$ (1.0 m × 2.0 m) which was statistically found at par with (6.35) treatment $T_4$ (0.90 m × 2.0 m). It is observed from the data, that wider plant spacing produced significantly more primary branches than closer plant spacing. Under wider spacing, there might be sufficient availability of nutrients, moisture, space and better interception of sunlight within the plant canopy than closer spacing. These results are in line with the findings of Nagala *et al.* (2019) [7] in watermelon.

Maximum internodal distance (5.85 cm) was recorded in the treatment $T_1$ (0.45 m × 2.0 m) which was statistically found at par with (5.80 cm) and (5.70 cm) in treatment $T_4$ (0.90 m × 2.0 m) and treatment $T_3$ (0.75 m× 2.0 m). Plants having less internodal distance and more number of nodes are desired for getting higher yield. Present findings are supported with that of Dogra (2012) [4] and Sharma *et al*. (2018) [9] in hybrid cucumber.

Maximum chlorophyll index (60.40) was recorded in the treatment $T_5$ (1.0 m × 2.0 m) which was statistically found at par with (60.30) and (59.93) in treatment $T_4$ (0.90 m × 2.0 m) and treatment $T_3$ (0.75 m× 2.0 m). Wider plant spacing produced maximum chlorophyll index than closer plant spacing. Highest chlorophyll index in wider plant spacing may be due to better nourishment and availability of space and less competition of nutrients, sunlight between the plants.

**Table 1:** Effect of spacing on growth of watermelon

| Treatments | Length of main stem at harvest (cm) | Number of leaves at harvest | Number of primary branches | Internodal distance (cm) | Chlorophyll index of leaves |
|---|---|---|---|---|---|
| $T_1$ - 0.45 m × 2.0 m | 245.29 | 248.90 | 5.20 | 5.85 | 59.27 |
| $T_2$ - 0.60 m × 2.0 m | 244.43 | 250.15 | 5.67 | 5.80 | 59.48 |
| $T_3$ - 0.75 m × 2.0 m | 243.29 | 250.58 | 5.87 | 5.70 | 59.93 |
| $T_4$ - 0.90 m × 2.0 m | 242.33 | 251.98 | 6.35 | 5.58 | 60.30 |
| $T_5$ - 1.0 m × 2.0 m | 241.23 | 252.68 | 6.50 | 5.15 | 60.40 |
| SE(m)± | 0.80 | 0.61 | 0.14 | 0.13 | 0.23 |
| CD at 5% | 2.46 | 1.87 | 0.43 | 0.41 | 0.70 |

**Table 2:** Effect of spacing on yield of watermelon

| Treatments | Days required for edible maturity | Number of fruits per plant | Average fruit weight (kg) | Fruit yield (Kg/plant) | Fruit yield per hectare (tons) |
|---|---|---|---|---|---|
| $T_1$ - 0.45 m × 2.0 m | 77.00 | 2.91 | 2.47 | 6.74 | 74.89 |
| $T_2$ - 0.60 m × 2.0 m | 75.50 | 2.77 | 2.55 | 7.57 | 63.08 |
| $T_3$ - 0.75 m × 2.0 m | 78.00 | 2.95 | 2.80 | 8.36 | 55.69 |
| $T_4$ - 0.90 m × 2.0 m | 73.32 | 3.00 | 3.15 | 9.55 | 53.05 |
| $T_5$ - 1.0 m × 2.0 m | 72.22 | 3.06 | 3.30 | 10.09 | 50.46 |
| SE(m)± | 1.09 | 0.07 | 0.17 | 0.53 | 5.21 |
| CD at 5 % | 3.36 | 0.23 | 0.51 | 1.63 | 16.04 |

The days required for edible maturity (72.22) was found to be superior among all the treatment in spacing $T_5$ (1.0 m × 2.0 m) and statistically found at par with (73.32) and (75.50) in treatment $T_4$ (0.90 m × 2.0 m) and treatment $T_2$ (0.60 m × 2.0 m).

Maximum number of fruits per plant (3.06) was recorded in the treatment $T_5$ (1.0 m × 2.0 m), which was statistically found at par with (3.00) and (2.95) in treatment $T_4$ (0.90 m × 2.0 m) and treatment $T_3$ (0.75 m × 2.0 m). The results revealed that, wider spacing provides larger area for development of a plant as well as possibility for more lush growth and development of fruit full branches due to less competition for nutrients, water and light Adlan *et al.* (2018) [1] in watermelon.

Maximum average fruit weight (3.30) was recorded in the treatment $T_5$ (1.0 m × 2.0 m), which was statistically found at par with (3.15) and (2.80) in treatment $T_4$ (0.90 m × 2.0 m) and treatment $T_3$ (0.75 m × 2.0 m). It is well evident from the present findings that, in wider spacing the plant attained more length and branches to accommodate the fruits having larger size. More over the wider spacing also provided more space to the developing fruits to grow into a bigger size. These results are supported by the findings of Tuncer *et al.* (2014) also found increased fruit weight with wider spacing in watermelon.

Maximum fruit yield kg per plant (10.09 kg) was recorded in the treatment $T_5$ (1.0 m × 2.0 m) which was statistically found at par with (9.55 kg) treatment $T_4$ (0.60 m × 2.0 m). As spacing increased, fruit yield per plant also increased probably because wider spacing created less inter plant competition. These findings are in line with Kultar *et al.* (2001) [5] in muskmelon.

Maximum fruit yield per hectare (74.89 t) was recorded in the treatment $T_1$ (0.45 m × 2.0 m) which was statistically found at par with (63.08 t) treatment $T_2$ (0.60 m × 2.0 m). The results revealed that higher number of plants under closer spacing clearly demonstrated advantage in fruit yield per hectare as compared to wider spacing. Similarly, results were reported by Adlan *et al.* (2018) [1] in watermelon.

## Conclusion

On the basis of present findings it can be concluded that spacing has significant effect on growth and yield parameters of watermelon. Regarding the growth parameters, treatment $T_1$ – 0.45 m × 2.0 m was found to be best in respect of length of main stem and internodal distance. While for number of leaves per plant, number of primary branches and chlorophyll index treatment $T_5$ – 1.0 m × 2.0 m was found to be superior. In respect to yield parameters watermelon days required for edible maturity, Number of fruits per plant, average fruit weight and fruit yield per plant were superior in treatment $T_5$ – 1.0 m × 2.0 m. While, fruit yield per hectare was found maximum in treatment $T_1$ – 0.45 m × 2.0 m.

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