



## Effect of Inter-cultivation and Physical Barriers on Growth, Yield and Disease occurrence in Zucchini (*Cucurbita pepo* L.)

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### Authors' contributions

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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### ABSTRACT

The present investigation was performed to study the effect of inter-cultivation and physical barriers on growth, yield and disease occurrence in zucchini during January-March, 2022. The field trial was laid out in Randomized Block Design (RBD) with three replications keeping the plot size 1.5 m x 1.5 m. During the experiment, observations for plant height, number of leaves, number of nodes, days to flower initiation (staminate and pistillate), total number of staminate and pistillate flowers, number of fruits per plant, weight of fruits, yield per hectare etc were recorded. The results revealed that the treatment T4 Zucchini + Aluminium foil (On the ridge) recorded maximum plant height (38.33 cm at 30 DAS, 49.75 cm at 45 DAS, 62.75 cm at 60 DAS), number of nodes (21.08), number of leaves per plant (19.58), minimum number of days to flower initiation (39.00 in case of staminate flowers and 44.83 in case of pistillate flowers), maximum number of staminate flowers (8.58) and pistillate flowers (13.00), maximum number of fruits per plant (5.33), maximum weight of fruits per plant (0.749 kg), maximum weight of fruits per plot (1.99 kg) and yield per hectare (7.49 t/ha<sup>-1</sup>).

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## 1. INTRODUCTION

Zucchini, is botanically a fruit. However, in gastronomic terms, it is considered to be a vegetable. Zucchini has been regarded as highly polymorphic vegetable grown during warm season crop in tropics and subtropics and harvested when the fruits are physiologically immature. Zucchini are easy to grow, short season crop, best adopted to temperate and sub tropical region. The shape of zucchini resembles that of ridged cucumber and features numerous seeds. Zucchini has its origin in America and is available in the market in yellow, light green or dark green colours. The taste of Zucchini squash must be savoured by most of the people, and available in markets round the year. Zucchini is also called as "Courgette", fully grown courgette is known as "Marrow".

India is second largest producer of vegetable next to China in the world. In India, in fiscal year 2021, the total production of vegetables was estimated to be at approximately 196.27 million metric tons. These vegetables include potatoes, onions, zucchini, eggplants and cabbages among others. In India, Zucchini is cultivated in the states of Punjab, Haryana, Delhi, Uttar Pradesh, Jammu and Kashmir, Himachal Pradesh, and West Bengal. The production of Zucchini in India is 4695 thousand tons from an area of 502 thousand ha. (Source: FAO)

Zucchini is a temperate, small plant that can grow upto 2 meters, having leaves 8-30 cm across, with 3-7 dissected lobes that have notches. The plant is monoecious and bears orange flowers. Leaves are quite large with more notches per leaf and are characterized by having light greenish gray splotches and streaks. The stems and leaves are hairy. The fruits of zucchini are cylindrical (Size: 5-16 inch in length and 3-4 inch in diameter) and have a thin, smooth, and waxy exterior. The colour of the fruit ranges from light green to dark green.

"One medium-sized Zucchini has just 25 calories in it. Zucchini helps cure asthma, as it contains Vitamin C, which is a powerful antioxidant and has anti-inflammatory properties. Regular intake of Zucchini lowers high homocysteine levels in the human body. Zucchini have high water content (95%), high nutritious value, and contain

low amount of calories, so they make the perfect snack item for people on diet. The vegetable contains useful amounts of foliate, potassium, and vitamin A, necessary for proper functioning of the human body. Zucchini contains lutein, which is known to be good for the eyes. Eating Zucchini is known to help the body in supporting the arrangement of capillaries. Zucchini is believed to be beneficial in preventing heart disease and related symptoms, such as high cholesterol. The rind of Zucchini contains the nutrient beta-carotene, which is known to be full of antioxidant properties and thus, helps protect cells against oxidation damage. The vegetable is a good source of magnesium and phosphorus, the nutrients essential for building and maintaining healthy bones".

"Insecticides have become such an important part of insect pest management that they are the first line of defence considered whenever a problem develops. As a result, producers and consumers have become quite dependent on insecticides for the production of inexpensive and aesthetically pleasing food. The availability, relatively low cost, high efficiency and ease of application of insecticides continue to ensure that they will remain the control method of choice, despite the known deleterious effects on human and environmental health. However, increasing public and media awareness of the negative side effects, erosion of the existing pesticide arsenal, and the steady development of insecticide resistance have encouraged and led to a renewal of interest in alternative control methods".

Before the advent of modern insecticides, insect control relied heavily on innovative physical control methods and inter-cultivation practices. Many of these approaches are becoming popular again or are being re-examined for further development and improvement. Among the main factors shaping this revival are shifts in economics and pest-disease management philosophies, as well as growing desperation for effective control options in certain vegetables.

A physical barrier may be defined as a structure made up of wood, metal, plastic or any other material (including living barriers) used to obstruct or close a passage or to fence in a space. Many attributes or characteristics of physical barriers have been traditionally considered negative because the attention was

focused on comparing their efficiency and application methods to chemical insecticides. Now that integrated pest management (IPM) is being considered as an essential component of agricultural sustainability, physical barriers are being seen in a more positive light. They are often highly compatible with other alternative methods and insecticides [1,2].

Intercropping is an economical method of pest-disease management and has become popular, particularly among the small and marginal farmers. Intercropping was chosen on the basis of their wide cultivation among small-holder farmers. The possible success of these crops in ensuring profit and reducing damage by the diseases of zucchini was expected to stimulate adoption of the intercropping practice by the target farmers. The study was thus, specifically targeted for small-scale vegetable growers for the eco-friendly management of diseases of zucchini along with the utilisation of physical barriers.

## 2. MATERIALS AND METHODS

The present investigation was conducted at Vegetable Research Farm, Department of Horticulture, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (U.P.) during 2022. All the facilities necessary for cultivation, including labour was made available in the department. The area of Prayagraj district comes under sub-tropical belt in the South East of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches upto 42°C-46.5°C and seldom falls as low as 6°C-8°C. The relative humidity ranges between 20-94%. The average rainfall in this area is around 1013.4 cm annually.

The experiment was laid out in Randomized Block Design (R.B.D.) with three replications. The crop was directly sown on ridges at a spacing of 60 cm x 60 cm in a plot size of 1.5 m x 1.5 m keeping 4 plants per plot. The treatment details consists of (T0) Zucchini (control), (T1) Zucchini + Marigold (1:2) (On the edges of the ridge) , (T2) Zucchini + Marigold (1:4) (Around the zucchini plants) , (T3) Zucchini + Aluminium foil (Around the plant only), (T4) Zucchini + Aluminium foil (On the ridge), (T5) Zucchini + Green net, (T6) Zucchini + Application of neem oil. Data on parameters such as plant height, number of leaves, number of nodes, days to

flower initiation (staminate and pistillate), total number of staminate and pistillate flowers, number of fruits per plant, weight of fruits, yield per hectare were recorded at different stages of growth periods. The data was statistically analyzed by the method suggested by Fisher and Yates. The significant difference between the means was tested against the critical difference at 5% level of significance.

## 3. RESULTS AND DISCUSSION

### 3.1 Growth Parameters

The data on growth parameters in different treatment combinations was recorded (Table 1). The maximum plant height was recorded in T4 Zucchini + Aluminium foil (On the ridge) (38.33 cm at 30 DAS, 49.75 cm at 45 DAS and 62.75 cm at 60 DAS) being significantly superior while minimum to the T0 control (25.75 cm at 30 DAS, 34.67 cm at 45 DAS and 49.75 cm at 60DAS). Noticeable height increases observed with aluminium foil mulch application was because of ability to retain moisture and keep soil wet which enhanced better water use efficiency by seedlings. Mulching in general has a positive effect on height, leaf numbers and size, shoot diameter and dry matter. Water is essential for plant development. The leaves help plants suck up water and dissolved nutrients from the soil to support the plant's growth. Such information on plant height was also available from the studies of Abd – El- Gaid et al. [3], Parmer et al. [4] and Dadeech et al. [5].

The maximum number of nodes was observed in T4 Zucchini + Aluminium foil (On the ridge) (21.08) and the minimum number of nodes was in T0 control (14.75). Number of nodes are the contributors of yield as they bear the leaves, which fix the carbon dioxide through photosynthetic mechanism. As far as zucchini is concerned, the leaf production is an important phenomenon especially for all the developing fruits. The results were in concurrence with the earlier findings of Rodriguez et al. [6] and Dadeech et al. [7].

The maximum number of leaves per plant was observed in treatment T4 Zucchini + Aluminium foil (On the ridge) i.e., (19.58) and the minimum was observed in T0 control (14.25). This may be attributed to the prevailing favourable climate which helped the plants in better utilization of solar radiation, nutrients and water for the synthesis of photosynthates and the prevailing

temperature might have helped in faster multiplication of cells and cellular elongation resulting in better growth of roots and shoots, which helped better vegetative growth including number of leaves. Reflective mulches like aluminium foil utilize the entire light spectrum, thereby boosting the available amount of light and heat to plants resulting in vegetative growth and higher yields. The results were in concurrence with the earlier findings of Ansary and Roy [7], Chen and Blakenship [8] Rodriguez et al. (2018) and Dadeech et al. [7].

The maximum number of days to initiation of first staminate flower was taken by T5 Zucchini + Green net (43.25) and the minimum number of days taken was observed in T4 Zucchini + Aluminium foil (On the ridge) (39.00). And the maximum number of days taken to initiation of first pistillate flower was observed in T5 Zucchini + Green net (50.00) and the minimum number of days was taken by T4 (44.83). Days taken to initiation of first staminate and pistillate flowers is more in T5 Zucchini + Green net because 50% shading green net was used due to which light availability to the plants might have reduced. Whereas during flowering time more light is required. The above results are in close conformity with Patil and Patil (2000) in cucumber.

The maximum number of staminate flowers was observed in T4 Zucchini + Aluminium foil (On the ridge) (8.58) and the minimum number of staminate flowers was observed in T5 Zucchini + Green net (6.08). The maximum number of pistillate flowers was observed in T4 Zucchini + Aluminium foil (On the ridge) (13.00) and the minimum number of pistillate flowers was observed in T5 Zucchini + Green net (6.92). The total number of staminate and pistillate flowers were more might be because of the aluminium foil which acted as a mulch and might have reduced the leaching down of the nutrients thereby enhancing the proper nutrient availability to the plants which might have resulted in better vegetative growth, followed by early flowering and a greater number of flowers. The results are in concurrence with earlier findings of Hamid et al. [9].

### 3.2 Yield Parameters

The maximum number of fruits per plant was observed in T4 Zucchini + Aluminium foil (On the ridge) (5.33) and the minimum number of fruits per plant was observed in T5 Zucchini + Green

net (2.58). The higher number of fruits observed in case of T4 Zucchini + Aluminium foil (On the ridge) might be due to pollination and reflective nature of aluminium foil mulch to reflect back the ultraviolet rays into the plant canopy, thereby providing sunlight for the shady underside of the leaves which in turn enhances the photosynthetic process. Less number of fruits were observed in T5 Zucchini + Green net might be because of the green net which acted as a barrier not only for harmful pests but also for beneficial insects such as honey bee, butterflies etc due to which pollination could not take place which may have resulted in less fruits with small shapes. This was an agreement to the findings of Resende and Floria [10] in cucumber and Ansary and Roy [7].

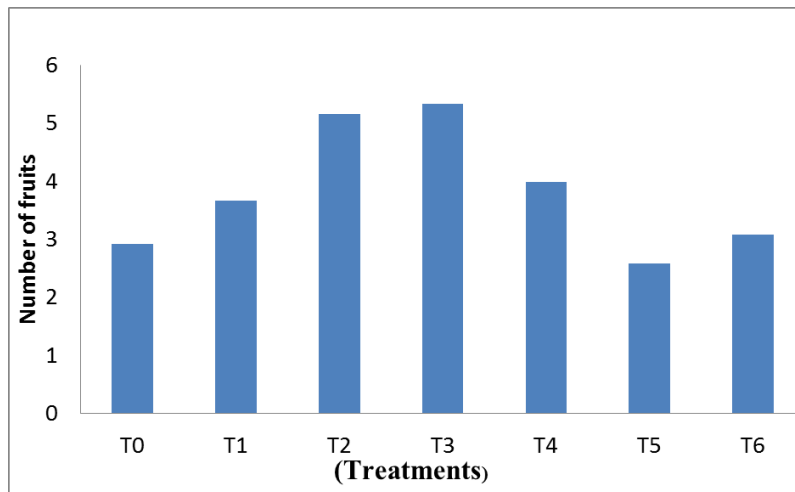
The maximum weight of fruits per plant (in kg) was recorded in treatment T4 Zucchini + Aluminium foil (On the ridge) (0.749 kg) whereas, the minimum weight of fruits per plant (in kg) was recorded in T5 Zucchini + Green net (0.454 kg). The maximum fruit weight per plant might be due to the increased growth and flower attributes which in turn lead to the increased photosynthetic activity and accumulation of photosynthates and dry matter production. The results are in close conformity with the findings of Resende and Floria (2003) in cucumber, Ansary and Roy [7] and Rodriguez et al. [6].

The maximum weight of fruits per plot (in kg) was recorded in treatment T4 Zucchini + Aluminium foil (On the ridge) (1.99 kg) whereas, the minimum weight of fruits per plot (in kg) was recorded in treatment T5 Zucchini + Green net (0.34 kg). The maximum weight of fruits per plot (in kg) in T4 Zucchini + Aluminium foil (On the ridge) might be due to increased yield per plant (in kg). The results are in close conformity with the findings of Czinsky et al. [11], Yoltas et al. [12], Resende and Floria (2003) in cucumber, and Rodriguez et al. [6].

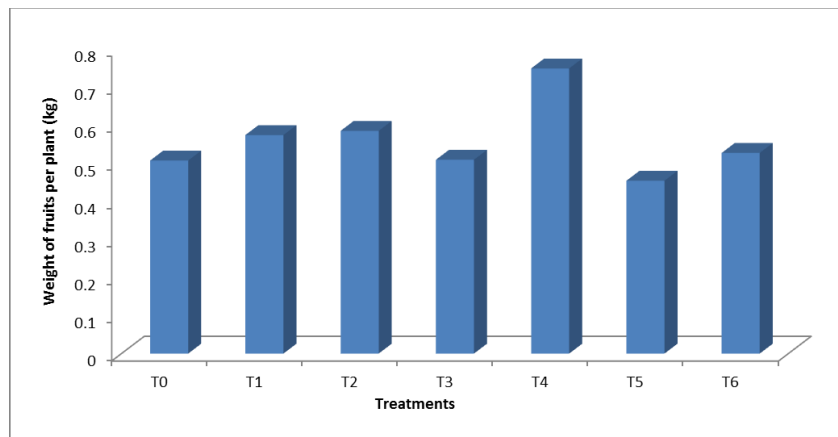
The maximum yield per hectare was recorded in T4 Zucchini + Aluminium foil (On the ridge) (7.49 t/ha) which was significantly superior whereas, the minimum yield per hectare was recorded in T5 Zucchini + Green net (4.54 t/ha). This might be due to the plant population, maximum number of fruits per plant, fruit weight, environmental factors and congenial microclimate in T4 Zucchini + Aluminium foil (On the ridge) as compared to other treatments. These findings are in close conformity with Ansary and Roy [7], Summers et al. [13], Hutton and Handley [14] and Eifediya and Remison [15] in cucumber.

**Table 1. Effect of Inter-cultivation and Physical barriers on growth traits in Zucchini**

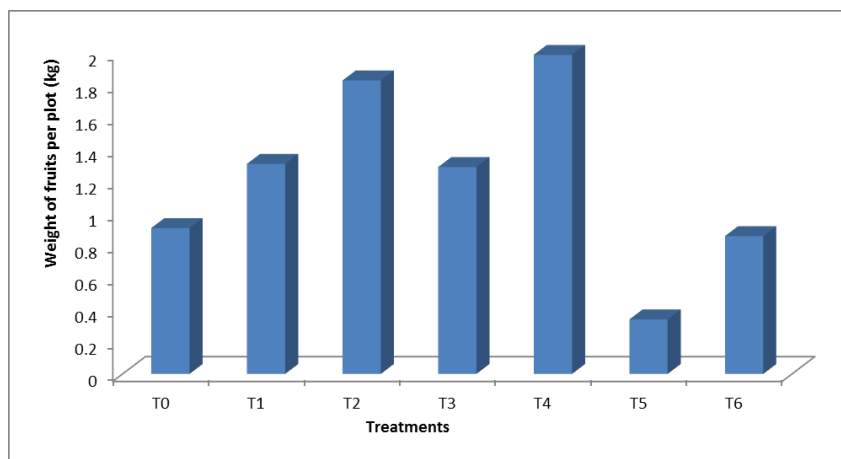
| Treatments              | Treatment combinations                                    | Plant height (cm) |        |        | No of nodes | No of leaves per plant | Days to initiation of first staminate flower | Days to initiation of first pistillate flower | Total number of staminate flowers | Total number of pistillate flowers |
|-------------------------|---|-------------------|--------|--------|-------------|------------------------|--|---|-----------------------------------|------------------------------------|
|                         |   | 30 DAS            | 45 DAS | 60 DAS |             |                        |  |   |                                   |                                    |
| T <sub>0</sub>          | Control   | 25.75             | 34.67  | 49.75  | 14.75       | 14.25                  | 42.42  | 49.08   | 7.67                              | 9.17                               |
| T <sub>1</sub>          | Zucchini + Marigold (1:2)<br>(On the edges of the ridge)  | 30.08             | 45.58  | 53.17  | 18.67       | 17.58                  | 38.50  | 45.90   | 7.83                              | 11.83                              |
| T <sub>2</sub>          | Zucchini + Marigold (1:4)<br>(Around the zucchini plants) | 37.50             | 48.92  | 54.83  | 18.83       | 18.17                  | 39.33  | 48.75   | 7.92                              | 12.58                              |
| T <sub>3</sub>          | Zucchini + Aluminium foil<br>(Around the plant only)      | 32.42             | 46.00  | 54.42  | 17.92       | 14.92                  | 39.50  | 45.92   | 7.83                              | 12.42                              |
| T <sub>4</sub>          | Zucchini + Aluminium foil<br>(On the ridge)               | 38.33             | 49.75  | 62.75  | 21.08       | 19.58                  | 39.00  | 44.83   | 8.58                              | 13.00                              |
| T <sub>5</sub>          | Zucchini + Green net                                      | 28.58             | 38.17  | 57.92  | 18.00       | 16.00                  | 43.25  | 50.00   | 6.08                              | 6.92                               |
| T <sub>6</sub>          | Zucchini + neem oil                                       | 35.08             | 41.00  | 50.33  | 17.75       | 16.83                  | 42.40  | 46.17   | 6.25                              | 10.08                              |
| <b>F- test</b>          |   | NS                | S      | S      | S           | S                      | S  | S   | S                                 | S                                  |
| <b>S. Ed. (±)</b>       |   | 25.279            | 2.378  | 2.161  | 0.797       | 1.671                  | 1.242  | 0.948   | 0.309                             | 1.523                              |
| <b>C. D. (P = 0.05)</b> |   | 52.176            | 4.908  | 4.460  | 1.645       | 3.449                  | 2.563  | 1.957   | 0.637                             | 3.143                              |



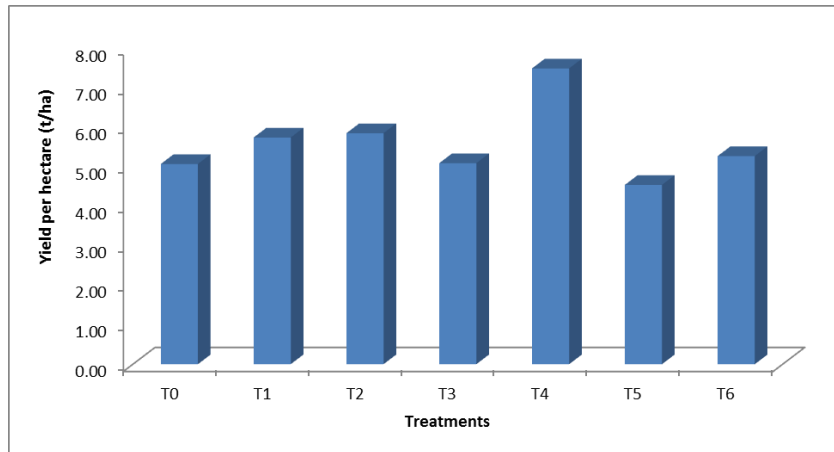
**Fig. 1. Effect of Inter-cultivation and Physical barriers on “number of fruits” in Zucchini**



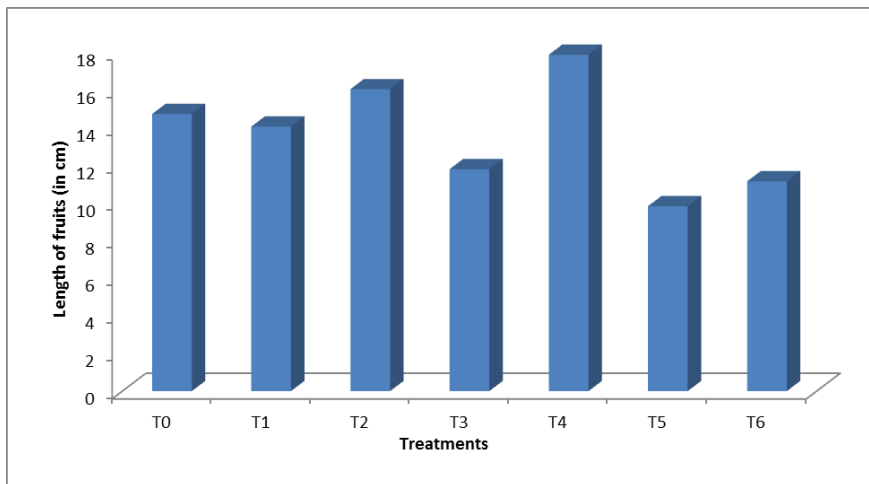
**Fig. 2. Effect of Inter-cultivation and Physical barriers on “weight of fruits per plant (kg)” in Zucchini**



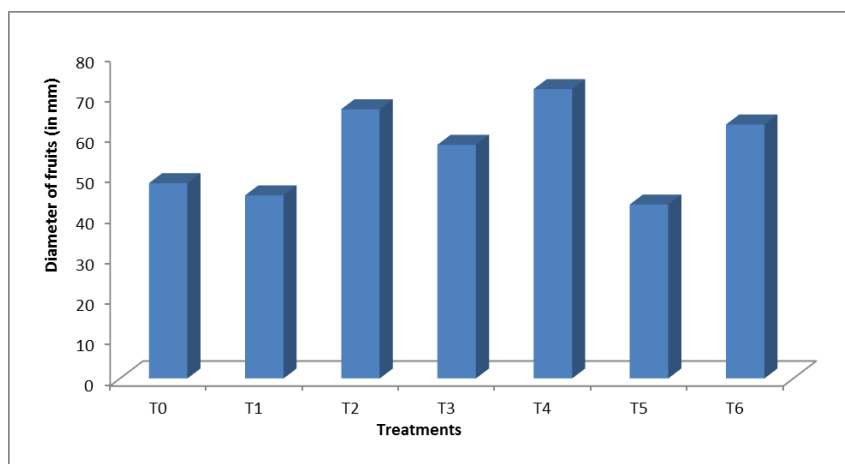
**Fig. 3. Effect of various treatments Inter-cultivation and Physical barriers on “weight of fruits per plot (kg)” in Zucchini**



**Fig. 4. Effect of Inter-cultivation and Physical barriers on “yield per hectare (t/ha)” of Zucchini**



**Fig. 5. Effect of Inter-cultivation and Physical barriers on “length of fruits (in cm)” in Zucchini**



**Fig. 6. Effect of Inter-cultivation and Physical barriers on “diameter of fruits (in mm)” in Zucchini**

**Table 2. Disease Occurrence in Zucchini**

| Treatments              |  | Disease Occurrence (%)<br>At 60 DAS |
|-------------------------|--|-------------------------------------|
| T <sub>0</sub>          | Control  | 30.08                               |
| T <sub>1</sub>          | Zucchini + Marigold (1:2) (On the edges of the ridge)  | 23.26                               |
| T <sub>2</sub>          | Zucchini + Marigold (1:4) (Around the zucchini plants) | 21.05                               |
| T <sub>3</sub>          | Zucchini + Aluminium foil (Around the plant only)      | 20.12                               |
| T <sub>4</sub>          | Zucchini + Aluminium foil (On the ridge)               | 18.33                               |
| T <sub>5</sub>          | Zucchini + Green net                                   | 24.66                               |
| T <sub>6</sub>          | Zucchini + Neem oil                                    | 28.41                               |
| <b>F- test</b>          |  | <b>S</b>                            |
| <b>S. Ed. (±)</b>       |  | <b>0.792</b>                        |
| <b>C. D. (P = 0.05)</b> |  | <b>1.645</b>                        |

The maximum length of fruits was recorded in T4 Zucchini + Aluminium foil (On the ridge) (17.88 cm) whereas, the minimum length of fruits was recorded in T5 Zucchini + Green net (9.83 cm). The maximum fruit length in treatment T4 Zucchini + Aluminium foil (On the ridge) was might due to the availability of higher levels of nitrogen. The minimum fruit length in treatment T5 Zucchini + Green net was might be due to poor pollination caused by the green net which acted as a barrier for the pollinators and which resulted in small and oddly shapes of the fruits. Similar results were reported by Resende and Floria (2003) in cucumber and Summers et al. [13].

The maximum diameter of fruit was recorded in T4 Zucchini + Aluminium foil (On the ridge) (71.50 mm) whereas, the minimum diameter of fruit was recorded in T5 Zucchini + Green net (43.00 mm). The maximum fruit diameter in treatment T4 Zucchini + Aluminium foil (On the ridge) was might due to the light intensity which might have affected the cell division and cell expansion of the fruits. The results were in concurrence with the findings of Resende et al. [10] and Summers et al. [13].

The maximum disease incidence (%) was recorded in T0 (30.08) and minimum disease incidence (%) was recorded in T4 Zucchini + Aluminium foil (On the ridge) (18.33). The maximum disease incidence in treatment T0 might due to absence of trap crops such as marigold and physical barriers. The crop was mainly affected by yellow vein mosaic virus. The characteristic symptom of this disease is the yellowing of the entire network of veins in the leaf blade. In severe infections the younger leaves

turn yellow, become reduced in size and the plant is highly stunted. The veins of the leaves will be cleared by the virus and interveinal area becomes completely yellow or white. In a field, most of the plants may be diseased and the infection may start at any stage of plant growth. Infection restricts flowering and fruits, if formed, may be smaller and harder. The affected plants produce fruits with yellow or white colour and they are not fit for marketing. The minimum disease incidence in treatment T4 Zucchini + Aluminium foil (On the ridge) might be due to the aluminium foil mulch which was placed on the ridges. Aluminium foil being reflective in nature is great at keeping leaf sucking and chewing insects like aphids, whiteflies etc away from the main crop by confusing insects' ability to locate their hosts. Aluminium foil mulch has helped in controlling mainly viral diseases such as mosaic virus in cucurbits, ringspot virus and yellow vein mosaic virus. Similar results were reported by Boyhan and Brown [16], Walters et al. [17] and Summers et al. [14].

#### 4. CONCLUSION

Based on the results of the experiment, it was concluded that T4 Zucchini + Aluminium foil was found superior in terms of growth, flowering and yield factors. Also in terms of disease occurrence, T4 (Aluminium foil on the ridge) was found to be the best for controlling pest and disease attack.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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