Effect of Organic Manures and Chemical Fertilizers on the Growth, Yield and Quality Traits of Summer Squash (Cucurbita pepo L.)" cv. Punjab ChappanKaddu

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Authors’ contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The present investigation was conducted during 2019 at DAV University, Jalandhar, to find out the effect of organic manures and chemical fertilizers on the growth and yield of summer squash (Cucurbita pepo L.) cv. Punjab Chappan Kaddu. The experiment consisted of eleven treatments and three replications. Out of these, an application of 25% of the recommended dose of chemical fertilizer + vermi-compost 15t/ha (T8) had a beneficial effect on minimum days to the first female flower (74.67 days), minimum days to the first fruit set (76.33), minimum days to the first fruit harvest (78.33). The maximum plant height (122.85cm) was recorded in 25% of the recommended dose of chemical fertilizer + FYM 25t/ha (T5). 75% of the recommended dose of chemical fertilizer + EM (Effective Micro-organism) Bokashi 2.5q/ha (T9) resulted in minimum days to male flower appearance. The maximum sex ratio (0.38), was obtained with the application of 50% of the recommended dose of chemical fertilizer + EM Bokashi 3q/ha (T10). The maximum number of pickings (26) and number of fruit per plant (9.85) were obtained with the application of 50% of the recommended dose of chemical fertilizer + EM Bokashi 3q/ha (T10). The maximum fruit yield per plant (2.20 kg), fruit yield per plot (26.26 kg), fruit yield per ha (405.57q) were recorded with the

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application of 50% of the recommended dose of chemical fertilizer + vermi-compost 15t/ha (T₇). The maximum Total Soluble Solids (TSS) (2.40B°) were recorded with the application of 75% of the recommended dose of chemical fertilizer + FYM 20t/ha (T₃) while, the ascorbic acid was maximum (52.50 mg/100g) when 25% of the recommended dose of chemical fertilizer + vermi-compost 15t/ha (T₅) were applied. The highest net returns and benefit: cost (4.5) were obtained when 50% of recommended dose of chemical fertilizer + FYM 25t/ha (T₄) was applied.

Keywords: Summer squash; FYM; vermi-compost; EM Bokashi.

1. INTRODUCTION

Summer squash (Cucurbita pepo L.), is an important crop of the family Cucurbitaceae. It is grown during summer in tropical and subtropical conditions throughout the world. Its immature fruits are harvested for consumption as cooked vegetable and curries. It also possesses a medicinal value and thus used as medicinal plant [1]. The total global area under pumpkin, squash and gourd is 204.29 Million Hectares and global production is 2764.39 Metric Ton [2]. India produces about 556.98 Metric Ton of pumpkin, squash and gourd from an area of 58.02 Million Hectares [2]. In Punjab, Cucurbits occupy 5th rank in the area (17.01 thousand ha) and production (270.45 thousand ton) among different vegetable crops [3]. Summer squash is a rich source of fiber, potassium, calcium, vitamin A, B and C, carotene and carbohydrates. Per 100g edible portion contains 94.8g moisture, 3.5g carbohydrates, 0.5g protein, 0.1g fat, 0.02mg thiamin, 18g vitamin C, 1mg calcium and 0.6mg iron [4]. It also helps in preventing cancer, heart disease and asthma [5].

All living beings require food for their growth and development. To meet the increasing population we need to increase agricultural production through various types of cultivations and practices, including type and method of fertilization. With the indiscriminate use of fertilizers the productivity of land has been compensated. Therefore, there is a need for only safe/effective fertilization method which is low cost and environmental friendly. Equilibrium of nutrients in plant roots environment plays a vital role in plant growth and high yield crop. Organic manures sustain cropping systems through better nutrient recycling and improve the physical, chemical and biological properties of soil. Commonly used organic manures are FYM (Farm Yard Manure), vermi-compost, poultry manure, biogas slurry, urine and liquid manure etc [6]. Though a single nutrient source may not supply the rest of the required nutrients for the plant but integrated use of all sources is required for balanced plant nutrition and it is necessary to make the judicious use of fertilizers in the right proportion for harvesting better yield. Thus it has been realized that chemical fertilizers must be integrated through more economic and eco-friendly organic manure to achieve sustainable productivity with high quality and minimum deterioration of the environment. Keeping in view the above-mentioned facts and figures the present investigation was planned to find out the effect of organic manures and chemical fertilizers on the growth, yield and quality traits on summer squash (C. pepo L.).

2. MATERIALS AND METHODS

The present experiment was laid out in Randomized Block Design and three replications. The variety grown for the investigation was Punjab Chappan Kaddu. Total eleven treatments consisting of different combinations of organic (FYM, Vermicompost and EM Bokashi) and chemical fertilizer NPK (Nitrogen Phosphorous Potash) at different levels (75% , 50% and 25% of the recommended dose of each nutrient) viz, T₁ (Absolute control), T₂ (100% of the recommended dose of fertilizer (NPK100:50:40kg/ha), T₃ (75% of the recommended dose of chemical fertilizer + FYM 20t/ha), T₄ (50% of the recommended dose of chemical fertilizer + FYM 25t/ha), T₅ (25% of the recommended dose of chemical fertilizer + FYM 25t/ha), T₆ (75% of the recommended dose of chemical fertilizer + vermi-compost10t/ha), T₇ (50% of the recommended dose of chemical fertilizer + vermi-compost 15t/ha), T₈ (25% of the recommended dose of chemical fertilizer + vermi-compost 15t/ha), T₉ (75% of the recommended dose of chemical fertilizer + EM Bokashi 2.5q/ha), T₁₀ (50% of the recommended dose of chemical fertilizer + EM Bokashi 3q/ha), T₁₁ (25% of recommended dose of chemical fertilizer + EM Bokashi 3q/ha). The organic manure (FYM, Vermi-compost and EM Bokashi) and inorganic fertilizers (Urea, DAP and MOP) were applied in the experimental field as per the treatments wise and all the cultural practices
were done as per the package of practices of Punjab Agricultural University. The obtained data were statically analyzed with using standard statistical method as suggested by Gomez and Gomez [7].

3. RESULTS AND DISCUSSION

Analysis of Variance (ANOVA) revealed that the treatments significantly influenced all the characters viz., Plant height, days to the first male flower appearance, sex ratio, days to the first fruit set, days to the first fruit harvest, number of picking, number of fruit per plant, fruit yield per plant, fruit yield per plot (kg/plot), fruit yield per hectare (q/ha), TSS and ascorbic acid except harvest duration.

3.1 Plant Height (cm)

Plant height was reported to be significantly influenced by different combination doses of organic and inorganic nutrient sources in terms of integrated nutrient management as compared to control. Perusal of data revealed maximum plant height (122.85 cm) in T₅ which was statistically at par with T₈ (114.13cm), T₉ (109.43cm), T₁₁ (101.45cm), T₂ (101.18cm) and T₆ (100.87cm). Minimum plant height (69.85 cm) was recorded in T₁ which was significantly at par with T₁₀ (71.00cm), T₇ (72.45cm), T₄ (90.65cm) and T₃ (91.97cm).

Plant height was maximum when plants were supplied with 25% of the recommended dose of chemical fertilizer + FYM 25t/ha and minimum in control where no fertilizer was applied to plants. This may be due to the fact that the combined application of FYM and inorganic fertilizers increased the absorption of nutrients especially nitrogen which enhanced the cell division and cell elongation resulting in increased plant height [8]. These findings corroborate the finding of Vishwakarma et al. [9], Mahmoud et al. (2009) and Das et al. [10]. The finding are also in line with the finding of earlier researchers viz., Martinetti and Paganini [11], Pradhu et al. (2006), Mulani et al. [12], Azarmi et al. [13], Eifediyi and Remison (2010), Thiveni et al., [14], Singh et al. [15], Geethu et al. [16], Dash et al. [17] and Baghel et al. [8] who also reported increased plant height with the use of Integrated Nutrient Management in other cucurbits.

3.2 Days to First Male Flower Appearance

The data revealed that T₉ showed minimum days to first male flower i.e 65.00. It was statistically at par with T₈ in which male flower appeared after 67.33 days and T₃ which resulted in first male flower production after 68.67 days. Maximum days to first male flower appearance (74.33) was observed in T₁ which was statistically at par with all the treatments except T₇ (71.00), T₃ (68.67) and T₈ (67.33). T₉ (75% of the recommended dose of chemical fertilizer + EM Bokashi 2.5q/ha) resulted in minimum days to male flower appearance and the maximum days were observed in T₁. The earliness in flowering may be due to the better translocation of nutrients to the aerial parts of the plants and enhancement of the reproductive phase due to the combined effect of organic and inorganic fertilizers as compared to exclusive inorganic fertilizers [18]. The results are in line with the findings of Martinetti and Paganini [11], Ezzo et al. [19], Thiveni et al. [14], Vishwakarma et al. [9], Anjanappa et al. [20] and Singh et al. [21] who observed earliness with Integrated Nutrient Management.

3.3 Days to First Female Flower Appearance

Significant effect of different treatments was observed for days to the first female flower appearance. Minimum days to the first female flower (74.67) was observed in T₈ which was significantly at par with all other treatments except T₁ which produce the first female flower after 83 days. Maximum number of days to the first female flower was observed in T₁ which was significantly highest among all.

Earliness is an important character in summer squash as it will help the farmers to fetch higher price in the market. Though earliness is considered as a genetically controlled trait, other factors like environmental, cultural practices and nutrition of plants can also influence it to an appreciable extent. Among the major nutrients, Phosphorous plays a vital role in imparting earliness. The results clearly indicate better translocation of nutrients to aerial parts of the plants when fertilizers were applied in the integrated forms i.e. combination of organic and inorganic fertilizers which resulted in earlier female flower appearance in all the treatment combinations than the absolute control in which no fertilizers were applied. This might be due to the better nutritional status of the plants which was favoured by the treatments. Increased production of leaves might help to elaborate more photosynthates and induce flowering stimulus, thus affecting early initiation of a flower.
bud. Early vigorous growth seen in treatments with organic manures would have helped to synthesize more cytokinin by these plants which might have helped the translocation of these synthesized cytokinins as well as more quantity of available phosphorus through xylem vessels and accumulation of cytokinin and phosphorus in these axillary buds would have favoured the plants to enter into the reproductive phase [22]. The results are in line with the findings of Martinetti and Paganini [11], Ezzo et al. [19], Kumar et al. [23], Thriveni et al. [14], Vishwakarma et al. [9], Anjanappa et al. [20] and Singh et al. [21].

### 3.4 Sex Ratio

It was observed that treatments showed significant difference for sex ratio. Highest sex ratio (0.38) was recorded in T10 and T7 which was statistically at par with T9 and T2 showing 0.34 sex ratio. Lowest sex ratio (0.19) was observed in T8 which was statistically at par with T1 showing sex ratio 0.23.

Sex ratio which is expression of the ratio of female flowers to male flowers was maximum when 75% of the recommended dose of chemical fertilizer + FYM 20t/ha or 50% of the recommended dose of chemical fertilizer + vermi-compost 15t/ha was applied to the plants. Lowest sex ratio was observed when 25% the recommended dose of chemical fertilizer + vermi-compost 15t/ha was applied. The reason behind the more number of female flowers may be due to the supply of nitrogen, phosphorous and potassium through the organic and inorganic sources of nutrients at an optimum level [24]. It was minimum when no fertilizers were applied. The lowest sex ratio may be due to the production of almost the same number of pistillate flowers as that of staminate flowers. The results are in conformity with the finding of Anjanappa et al. [20], Gill et al. [25] and Singh et al. [21] who also reported higher sex ratio in integrated nutrient management.

### 3.5 Days to First Fruit Set

Significant difference was observed among treatments for days to first fruit set. Minimum days to first fruit set (76.33) were recorded in T8 and T10 which were statistically at par with all other treatments except T9 producing first fruit after 78 days, T11 producing fruits after 78.33 days. T1 produced fruits after 84 days which, was significantly maximum among all the treatments.

Minimum days to the first fruit set was observed when plants were supplied with 25% of the recommended dose of chemical fertilizer + vermi-compost 15t/ha and 50% of the recommended dose of chemical fertilizer + EM Bokashi 3q/ha. Days to first fruit set shows the similar trend as shown by days to female flower appearance. The earliness might be also due to the enhanced production of growth-promoting substances like gibberellic acid, IAA (Indole Acetic Acid) by the application of vermi-compost which induces the earliness of female flower production [Sreenivas et al. (2000) and Kameswari et al. [26]. Bokashi is an organic fertilizer produced by fermentation of organic material such as rice bran. It contains both decomposed and undecomposed organic matter, microbial biomass and intermediate and ultimate substances produced by microbes produced during fermentation (Yamada et al., 2003). The earliness in fruit setting in the plants supplied with 50% of recommended dose of chemical fertilizer + EM Bokashi 3q/ha could be due to the presence of microbes which could have enhanced the production of growth-promoting substances like gibberellic acid, IAA as observed with the application of vermi-compost. The integrated approach of nutrient application has improved earliness in fruiting as compared to unfertilized plot. These findings are in line with the finding of Arshad et al. [27] and Moharana et al. [28]. The results of present finding revealing earliness included the application of organic and inorganic fertilizers in an optimum level corroborate with the finding of earlier researcher Martinetti and Paganini [11], Ezzo et al. (2012), Kumar et al. [23], Thriveni et al. [14], Vishwakarma et al. [9], Anjanappa et al. [20] and Singh et al. [21].

### 3.6 Days to First Fruit Harvest

The results revealed that the minimum days to first fruit harvest (78.33) were recorded with treatment T8. This was statistically at par with T10 which resulted first fruit harvest after 78.67 days, T2, T3, T7 and T4 which resulted first fruit harvest after 79 days. Minimum days to first fruit harvest 87.00 were observed in T1, which was significantly highest among all.
Table 1. Effect of organic manures and chemical fertilizers on growth, yield and quality of Summer squash (*Cucurbita pepo* L.)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant Height (cm)</th>
<th>Days to first male flower appearance</th>
<th>Days to first female flower appearance</th>
<th>Sex ratio</th>
<th>Days to first fruit set</th>
<th>Days to first fruit harvest</th>
<th>Harvest Duration</th>
<th>Number of picking</th>
<th>Number of fruit per plant</th>
<th>Fruit yield per plant(kg)</th>
<th>Fruit yield per plot(kg)</th>
<th>Fruit yield/ha(q)</th>
<th>TSS</th>
<th>Ascorbic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>69.85</td>
<td>74.33</td>
<td>83.00</td>
<td>0.23</td>
<td>84.00</td>
<td>87.00</td>
<td>48.67</td>
<td>15.67</td>
<td>3.97</td>
<td>0.39</td>
<td>4.86</td>
<td>75.13</td>
<td>1.23</td>
<td>15.67</td>
</tr>
<tr>
<td>T2</td>
<td>101.18</td>
<td>71.00</td>
<td>75.67</td>
<td>0.34</td>
<td>76.67</td>
<td>79.00</td>
<td>53.00</td>
<td>23.00</td>
<td>5.67</td>
<td>0.65</td>
<td>17.07</td>
<td>263.51</td>
<td>1.73</td>
<td>38.33</td>
</tr>
<tr>
<td>T3</td>
<td>91.97</td>
<td>68.67</td>
<td>75.67</td>
<td>0.29</td>
<td>77.00</td>
<td>79.00</td>
<td>53.67</td>
<td>24.33</td>
<td>8.60</td>
<td>0.50</td>
<td>6.13</td>
<td>94.86</td>
<td>2.40</td>
<td>41.67</td>
</tr>
<tr>
<td>T4</td>
<td>90.65</td>
<td>71.33</td>
<td>75.33</td>
<td>0.29</td>
<td>76.67</td>
<td>79.00</td>
<td>53.67</td>
<td>17.67</td>
<td>9.33</td>
<td>1.87</td>
<td>22.48</td>
<td>346.98</td>
<td>0.73</td>
<td>36.67</td>
</tr>
<tr>
<td>T5</td>
<td>122.85</td>
<td>71.00</td>
<td>76.00</td>
<td>0.25</td>
<td>77.00</td>
<td>79.67</td>
<td>53.00</td>
<td>24.67</td>
<td>6.97</td>
<td>1.82</td>
<td>21.97</td>
<td>339.15</td>
<td>0.93</td>
<td>31.67</td>
</tr>
<tr>
<td>T6</td>
<td>100.87</td>
<td>70.33</td>
<td>77.33</td>
<td>0.33</td>
<td>78.33</td>
<td>81.00</td>
<td>52.33</td>
<td>22.67</td>
<td>8.23</td>
<td>1.49</td>
<td>17.88</td>
<td>276.05</td>
<td>1.93</td>
<td>25.00</td>
</tr>
<tr>
<td>T7</td>
<td>72.45</td>
<td>71.00</td>
<td>75.67</td>
<td>0.38</td>
<td>76.67</td>
<td>79.00</td>
<td>49.00</td>
<td>11.00</td>
<td>9.22</td>
<td>2.20</td>
<td>26.26</td>
<td>405.57</td>
<td>1.80</td>
<td>28.33</td>
</tr>
<tr>
<td>T8</td>
<td>114.13</td>
<td>67.33</td>
<td>74.67</td>
<td>0.19</td>
<td>76.33</td>
<td>78.33</td>
<td>53.00</td>
<td>25.67</td>
<td>5.75</td>
<td>1.62</td>
<td>19.47</td>
<td>298.29</td>
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<tr>
<td>T9</td>
<td>109.43</td>
<td>65.00</td>
<td>76.00</td>
<td>0.34</td>
<td>78.00</td>
<td>80.00</td>
<td>54.33</td>
<td>24.33</td>
<td>5.13</td>
<td>1.45</td>
<td>17.38</td>
<td>268.40</td>
<td>1.70</td>
<td>36.23</td>
</tr>
<tr>
<td>T10</td>
<td>71.00</td>
<td>67.33</td>
<td>75.00</td>
<td>0.38</td>
<td>76.33</td>
<td>78.67</td>
<td>54.33</td>
<td>26.00</td>
<td>9.85</td>
<td>0.90</td>
<td>10.71</td>
<td>163.39</td>
<td>1.73</td>
<td>26.23</td>
</tr>
<tr>
<td>T11</td>
<td>101.45</td>
<td>72.67</td>
<td>77.00</td>
<td>0.30</td>
<td>78.33</td>
<td>80.00</td>
<td>51.33</td>
<td>25.00</td>
<td>5.06</td>
<td>1.67</td>
<td>20.08</td>
<td>310.00</td>
<td>2.20</td>
<td>40.83</td>
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<tr>
<td>SEm±</td>
<td>11.2</td>
<td>2.34</td>
<td>1.34</td>
<td>0.05</td>
<td>1.05</td>
<td>0.77</td>
<td>1.86</td>
<td>1.88</td>
<td>1.05</td>
<td>0.07</td>
<td>0.94</td>
<td>14.45</td>
<td>0.27</td>
<td>6.78</td>
</tr>
<tr>
<td>CD 5%</td>
<td>23.52</td>
<td>4.91</td>
<td>2.83</td>
<td>0.04</td>
<td>0.74</td>
<td>1.09</td>
<td>N/A</td>
<td>3.96</td>
<td>2.20</td>
<td>0.16</td>
<td>1.98</td>
<td>30.37</td>
<td>0.56</td>
<td>14.25</td>
</tr>
</tbody>
</table>
4. HARVEST DURATION

Harvest duration gives us information about the time period starting from first harvest to the last harvest. The effect of organic and inorganic fertilizer was non-significant for harvest duration. It was maximum (54.33 days) in T₆ (25% of the recommended dose of chemical fertilizer + FYM25t/ha) and T₈ (25% of the recommended dose of chemical fertilizer + Vermi-compost15t/ha) while it was minimum (47.67 days) in T₁ (Absolute control). The non-significant effect of organic and inorganic fertilizer for harvest duration in the current study indicated that plants were provided with enough nutrients to continue fruit production irrespective of the components of different fertilizer treatments as per the potential of the cultivar.

4.1 Number of Picking

Number of pickings signifies the frequency of harvesting. The data indicates that the treatment combination revealed significant difference for number of picking. It was noticed that T₁₀ showed maximum (26) number of picking. This was statistically at par with all the treatments except T₄ showing 17.67 pickings, T₁ resulting 15.67 pickings. Minimum (11.00) number of picking was observed in T₃ which was significantly lowest among all the treatments. More number of picking is related to earliness and more number of female flowers in a particular treatment. The reason behind the more number of female flowers in almost all the treatments may be attributed to the supply of nitrogen, phosphorous and potassium through the organic and inorganic sources of nutrients at an optimum level. These results are in close conformity with the experimental findings of Vishwakarma et al., [7] in spine gourd, Mohan et al., [29] and Singh et al., [24] in cucumber who also reported early harvesting with integrated nutrient management.

4.2 Number of Fruit per Plant

Significant differences for number of fruit per plant per picking were observed among treatments. Data revealed maximum number of fruit per plant (9.85) in T₁₀. It was statistically at par with T₄ producing 9.33 fruits per plant per picking, T₇ (9.22), T₆ (8.23) and T₃ (8.60). The minimum number of fruits per plant per picking (3.97) was observed in T₁ which was statistically at par with T₈ (5.75), T₂ (5.67) and T₉ (5.13).

It was observed that number of fruits per plant was higher in plants which were supplied with integrated use of organic manures and chemical fertilizers than in cases where only inorganic fertilizers (T₂) were supplied and when no fertilizers were supplied (T₁). This could be due to the fact that integrated use of organic manures and chemical fertilizers increased major elements like nitrogen, phosphorous and potassium through organic manures application which might have accelerated the synthesis of chlorophyll and amino acids leading to more translocation of photosynthates from leaves to fruits resulting in increased number of fruits per plant. Enhanced number of fruits per plant with the use of organic and inorganic fertilizers in combinations were also recorded by Martinetti and Paganini [11], Multani et al. (2007), Azarmi et al. [13], Efiediyi and Remison [30], Mohan et al. [29] and Mohrana et al. (2017).

4.3 Fruit Yield Per Plant (kg)

Significant difference for fruit yield per plant was observed among treatments. Perusal of data reveals maximum fruit yield (2.20 kg) in T₇ which was statistically at par with T₄ producing 1.87 kg fruit yield per plant. Minimum fruit yield per plant (0.39 kg) was observed in T₁ which was statistically at par with T₃ resulting in 0.50 kg fruits per plant.

Aggrandized yield in T₇ (50% of the recommended dose of chemical fertilizer + Vermi-compost15t/ha) (2.20 kg) may be caused due to an ample concentration of endogenous plant growth regulators like auxin, vitamins and mineral in vermi-compost which may have contributed to superior fruit characteristics encouraging more number of fruits per plant resulting in increased fruit yield per plant. Endogenous auxins are known to stimulate more number of female flowers in the plant as revealed from the higher sex ratio in T₇, could be the reason of the maximum fruit yield per plant. The results are in close conformity with the findings of
Kameswari et al., [26]. Similar findings were quoted from the experimental trial conducted by Shreeniwas et al., [2000] in ridge gourd, Prabhu et al., [31] and Narayanamma et al., [32] in cucumber. Likewise, the possible reason behind the higher number of fruits resulting in the highest fruit yield in T7 may be attributed to the earliness in female flower emergence, allowing maximum number of female flowers throughout the life span leading to more number of fruits which has ultimately contributed to the highest yield in T7. These findings are in congruence with the findings of Anjanappa et al., [20] in cucumber, Thriveni et al., (2017) in bitter gourd and Singh et al., [24] in cucumber.

4.4 Fruit Yield per Plot (kg)

Treatments revealed significant difference for fruit yield per plot. Maximum fruit yield per plot (26.26 kg) was observed in T7 which was significantly higher than all other treatments except T4 which resulted in 22.48 kg fruit yield per plot. Minimum fruit yield per plot (4.86 kg) was found in treatment T1 which was significantly lowest among all the treatments except T3 producing 6.13 kg per plot yield. The higher yield due to integrated nutrient management was reported earlier in pumpkin by Ghayal et al. [33] in cucumber, Bindiya et al. [34], in sponge gourd and ridge gourd by Nair and Nair [35], in bitter gourd by Mulani et al. [12] and Sood and VidyaSagar [5]. The results are in confirmary with the finding of earlier researchers viz., Sreeniwas et al. (2008), Prabhu et al. [31], Azarmi et al. [13], Sunaryo [36], Narayanamma et al. [32], Kumar et al. (2012), Bindiya (2014), Tavali et al. (2014), Das et al. (2015), Thriveni et al. (2015), Mohan et al. [23], Kanaiyia and Daniel (2016), Fawaz et al. (2016) Nayak et al. [37], Nager et al. [38], Kumar et al. [39] and [40] who observed increased yield with the application of vermi-compost as an organic source of fertilizers.

4.5 Fruit Yield Per Hectare (q/ha)

Treatments revealed significant difference for fruit yield per hectare. The highest fruit yield (405.57q) was observed in T7 which was statistically at par with T4 resulting 346.98 q/ha yield. Minimum fruit yield per hectare (75.13 q) was observed in Treatment T1 which was significantly at par with T3 resulting 94.86 q/ha yield.

As observed in fruit yield per plant and fruit yield per plot, fruit yield per hectare was maximum in plants supplied with 50% of the recommended dose of chemical fertilizer +vermi-compost15t/ha. It might be due to a balanced nutrition, better uptake of nutrients by the plants which helped for better fruit set and fruit yield. More number of fruits per plant and fruit yield per plant, fruit yield per plot ultimately resulted in the highest fruit yield per ha. The maximum yield of summer squash in present study could be due to the influence of vermi-compost in combination with NPK (nitrogen, phosphorus, and potassium) enhanced the synthesis of photosynthate by increasing the growth hormones and amino acids. These findings are in close conformity with earlier results obtained by Sreeniwas et al. (2008), Prabhu et al. [31], Azarmi et al. [13], Sunaryo [36], Narayanamma et al. [32], Kumar et al. (2012), Bindiya (2014), Tavali et al. (2014), Das et al. (2015), Thriveni et al. (2015), Mohan et al. [23], Kanaiyia and Daniel (2016), Fawaz et al. (2016) Nayak et al. [37], Nager et al. [38], Kumar et al. [39] and [40] who observed increased yield with the application of vermi-compost as an organic source of fertilizers.

Table 2. Economics of summer squash cultivation as influenced by various nutrient combinations

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total cost of cultivation (Rs/ha)</th>
<th>Gross returns (Rs/ha)</th>
<th>Net return (Rs/ha)</th>
<th>B:C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>53335</td>
<td>68300</td>
<td>14965</td>
<td>1.2</td>
</tr>
<tr>
<td>T2</td>
<td>62335</td>
<td>239560</td>
<td>177225</td>
<td>3.8</td>
</tr>
<tr>
<td>T3</td>
<td>70835</td>
<td>86240</td>
<td>15405</td>
<td>1.2</td>
</tr>
<tr>
<td>T4</td>
<td>69845</td>
<td>315440</td>
<td>245595</td>
<td>4.5</td>
</tr>
<tr>
<td>T5</td>
<td>68325</td>
<td>308320</td>
<td>239995</td>
<td>4.5</td>
</tr>
<tr>
<td>T6</td>
<td>130835</td>
<td>250960</td>
<td>120125</td>
<td>1.9</td>
</tr>
<tr>
<td>T7</td>
<td>164345</td>
<td>368700</td>
<td>204355</td>
<td>2.2</td>
</tr>
<tr>
<td>T8</td>
<td>162825</td>
<td>273180</td>
<td>110355</td>
<td>1.6</td>
</tr>
<tr>
<td>T9</td>
<td>150835</td>
<td>244000</td>
<td>93165</td>
<td>1.6</td>
</tr>
<tr>
<td>T10</td>
<td>167345</td>
<td>148540</td>
<td>-18805</td>
<td>0.8</td>
</tr>
<tr>
<td>T11</td>
<td>165825</td>
<td>281820</td>
<td>115995</td>
<td>1.6</td>
</tr>
</tbody>
</table>
4.6 TSS

Treatments revealed significant difference for Total Soluble Solids. It was noticed that TSS was maximum (2.40) in T3 which was statistically at par with T8 and T11 which resulted in TSS to the tune of 2.23 and 2.20, respectively. Minimum TSS (0.73) was found in T4 which was statistically at par with T1 and T5 showing TSS to the tune of 1.23 and 0.93, respectively.

Among the treatments the quality as influenced by various INM treatments in huge conduct when contrasted with control. Quality characters like TSS in summer squash fruit were enhanced in a favorable way due to application of inorganic fertilizer and organic manure in an integrated manner. Treatment combinations consisting of FYM and vermi-compost have resulted in the higher TSS content. It might be due to the fact that the combined application of FYM, vermi-compost and inorganic fertilizers might have led to a balance C: N ratio which resulted in satisfactory nutrient availability and increased plant metabolism, which ultimately lead to increased carbohydrate accumulation in fruits resulting in the higher TSS. Similar findings were reported by Triveni et al. [14], Singh et al. [21] and Shree et al. [41]. Positive influences of substitution of inorganic fertilizer with different organic manures on TSS content have been reported by Vishwakarma et al. [9]. Kameswari and Narayanamma (2011) stated that the application of poultry manure along with the recommended dose of nitrogenous fertilizers and vermi-compost improved the quality characters like TSS content in ridge gourd. According to Azarmi et al. [13], Kanajia and Daniel (2016) vermi-compost had positive influences on the growth, yield and quality of cucumber. From these reports, it is evident that the results of the present investigation are well supported by the findings of the earlier workers.

4.7 Ascorbic Acid

It was observed that influence of organic manures and chemical fertilizers were significant for ascorbic acid. The maximum ascorbic acid (52.50 mg/100g) was observed in T8 which was statistically at par with T3 (41.67 mg/100g), T11 (40.83mg/100g) and T2 (38.33mg/100g). The minimum ascorbic acid (15.67) was observed in treatment T1 which was statistically at par with T7 (28.33mg/100g) and T10 (26.23mg/100g). This might be due to the more availability of micronutrient like B, Cu, Mn, Zn etc. with the application of vermi-compost in integrated nutrient management which might have increased ascorbic acid content of fruit. These results are in accordance with the findings of Triveni et al. (2015) in bitter gourd, Das et al. [10] in bottle gourd and Kameswari and Narayanamma (2011) in ridge gourd.

4.8 Relative Economics

Relative economics in summer squash was calculated and presented in Table 2. Perusal of data on relative economics based on yield revealed that treatment T7 (50% of the recommended dose of chemical fertilizer + vermi-compost@ 15t/ha) recorded maximum gross returns (368700) followed by T4 (50% of the recommended dose of fertilizer + FYM 20t/ha) and T5 (25% of the recommended dose of chemical fertilizers + FYM 25t/ha). Maximum Benefit-cost ratio was revealed in treatment with maximum (4.5) in T4 (50% of the recommended dose of chemical fertilizer + FYM25t/ha) and T5 (25% of the recommended dose of chemical fertilizer +FYM@ 20t/ha). Minimum benefit-cost ratio (0.9) was observed in T11 (25% of the recommended dose of chemical fertilizer + EM Bokashi@3q/ha) followed by T3 (75% of the recommended dose of chemical fertilizer +FYM@ 20t/ha) and T1 (Absolute control). These results are also in conformity with finding of Patle et al. 2018.

5. CONCLUSION

It may be concluded that with the application of T7 (50% of the recommended dose of chemical fertilizer + vermi-compost(15t/ha) the highest gross return was observed due to maximum yield per plant, yield per plot, yield per ha. However, with the application of 50% of the recommended dose of chemical fertilizers + FYM @ 25t/ha and 25% of the recommended dose of chemical fertilizer + FYM @ 25t/ha there has been found the highest net returns and Benefit: cost was observed. This was due to the lower cost of cultivation with the application of FYM.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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