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Effect of Organic Manure and Bio-Fertilizers on Growth and Yield of Summer Squash (*Cucurbita pepo* L.)

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ABSTRACT

The present investigation was conducted during 2022 at DAV University, Jalandhar, to find out the effect of organic manure and bio-fertilizer on growth and yield of summer squash (*Cucurbita pepo* L.). The experiment consisted of twelve treatments viz. T_1 (FYM @ 20 t/ha), T_2 (Vermicompost @ 5 t/ha), T_3 (Neem cake @ 2.5 t/ha), T_4 (*Azotobacter* @ 4 kg/ha), T_5 (*Azotobacter* @ 2 kg/ha + FYM @ 10 t/ha), T_6 (*Azotobacter* @ 2 kg/ha + Vermicompost @2.5 t/ha), T_7 (*Azotobacter* @ 2 kg/ha + neem cake @1.25 t/ha), T_8 (PSB @ 4 kg/ha), T_9 (PSB @ 4 kg/ha + FYM @ 20 t/ha), T_{10} (PSB @ 4 kg/ha + Vermicompost @ 5 t/ha), T_{11} (PSB @ 4 kg/ha + Neem cake @ 2.5 t/ha), T_{12} (Control : RDF 60:125:25 kg NPK) and one variety (Green ball) and laid in RBD with three replications. Observations were recorded on growth parameters like plant height, number of days to male flower appearance, number of days to female flower appearance, number of days to fruit set, number of days to fruit harvest, sex ratio, number of branches, number of fruits per plant per picking, average fruit weight (g), yield parameter like marketable yield (q/ha) and quality parameter like TSS. It was observed that plants which were treated with (T_6) *Azotobacter* @ 2 kg/ha + Vermicompost @ 2.5 t/ha resulted better in most of the growth, yield and quality parameters.

Keywords Summer squash, Vermicompost, *Azotobacter*, Phosphate solubilizing bacteria (PSB), Farm yard manure, Neem cake.

INTRODUCTION

Summer squash (*Cucurbita pepo* L.) locally known as "Chappan kaddu" is one of the most diversified cucurbitaceous crop grown during the summer season in tropical and subtropical conditions (Sarhan *et al.* 2011). It is nutritionally rich vegetable and 100 g of edible portion of summer squash contains 19 calories, 94 g moisture, 4.2 g carbohydrates, 1.1 g protein, 28 mg calcium, 0.2 g fat, 29 mg phosphorus, 1 mg sodium, 0.4 mg iron, 202 mg potassium, 1 mg sodium, 16 mg magnesium, 410 IU of vitamin A, 0.05 mg thiamine, 0.36 mg pantothenic acid, 31 mg folvac acid, 0.9 mg riboflavin, 1 mg niacin and 22 mg ascorbic acid (Ibraheem *et al.* 2019). It is mainly grown in Punjab, Haryana, Himachal Pradesh and Uttar Pradesh. In India pumpkin and squash was grown in an area of 106 (thousand hectare) with a production of 2218 MT in India (Anonymous a 2021-22). In Punjab, the production of pumpkin and squash was 7.82 (thousand tonnes) in an area of 0.45 (thousand ha) (Anonymous b 2021-22).

Since this is a short duration and earliest cucurbit

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that reaches the market during the onset of summer season, therefore it fetches higher remunerations. The farmers generally apply the chemical/synthetic fertilizers in high and improper quantity for increasing the production ignoring the concern of its harmful aftermaths on human health leading to many diseases. Summer squash requires orderly application of fertilizers which also harms the environment and soil (Sarhan *et al.* 2011). To sustain the production and conserve the soil quality, it has become important to use organic and bio-fertilizers in lieu of chemical/synthetic fertilizers. Organic manures and bio-fertilizers supply the micro nutrients along with NPK, which is important for the production and are not harmful for human health as they have natural content. The organic sector is one of the fastest growing sectors all over the world. The organic manures play a vital role in increasing growth, yield and yield components of many crops. Organic manure besides being rich in plant nutrients also contains growth promoting principles like enzymes and hormones which helps in improving soil fertility and productivity. Bio-fertilizer is a medium containing living microorganisms which when applied to seed, plant root or soil, colonize in the rhizosphere zone and promote growth by increasing the availability of nutrients to the host plant. Bio-fertilizers also help in elevating free living nitrogen-fixing bacteria, enhance the supply of other nutrients, such as phosphorus, potassium, sulfur and micronutrients, produce plant hormones like cytokinnins, Indole Acetic acid and Gibberillins (Hassan *et al.* 2019). Keeping in view the importance of the crop and need of switching over from inorganic to organic farming for sustainable production the present investigation was planned and executed with the objective to study the effect of organic manure and bio-fertilizer on growth and yield of summer squash (*Cucurbita pepo* L.).

MATERIALS AND METHODS

The variety Green Ball of summer squash was grown to carry out the experiment on effect of organic manure and bio-fertilizers on growth and yield of summer squash (*Cucurbita pepo* L.) which was laid out in Randomized Block Design (RBD) with three replications having twelve treatments at the experimental farm of Faculty of Agricultural Sciences, DAV University, Jalandhar in summer season of 2022. The treatments included T_1 (FYM @ 20 t/ha), T_2 (vermicompost @ 5 t/ha), T_3 (Neem cake @ 2.5 t/ha), T_4 (*Azotobacter* @ 4 kg/ha), T_5 (*Azotobacter* @ 2 kg/ha + FYM @ 10 t/ha), T_6 (*Azotobacter* @ 2 kg/ha + Vermicompost @ 2.5 t/ha), T_7 (*Azotobacter* @ 2 kg/ha + Neem cake @ 1.25 t/ha), T_8 (PSB @ 4 kg/ha), T_9 (PSB @ 4 kg/ha + FYM @ 20 t/ha), T_{10} (PSB @ 4 kg/ha + Vermicompost @ 5 t/ha), T_{11} (PSB @ 4 kg/ha + Neem cake @ 2.5 t/ha), and T_{12} (Control : RDF 60:125:25 kg NPK). The seedlings were transplanted in the field on 25th Feb 2022 with the spacing 90×60 cm. Treatment wise application of fertilizers was done manually. All the fertilizers were applied to individual plots as per the treatments. First irrigation was done immediately after the transplanting. Weeds in summer squash were controlled by hand hoeing at 10-15 days interval. The observations were recorded on the basis of various growth and quality parameters viz. plant height (cm), days to first male flower appearance, days to first female flower appearance, sex ratio, days to first fruit set, days to first fruit harvest, number of branches per plant, number of fruits per plant per picking, average fruit weight (g), marketable yield (q/ha) and TSS. Data analysis was done on OPSTAT software.

RESULTS AND DISCUSSION

Analysis of variance

Analysis of variance (ANOVA) revealed significant differences among treatments for all the character (Table 1).

Table 1. Analysis of variance for growth and yield parameters of radish.

Observations	Replication	Treatments	Error
Plant height (cm)	75.807	4583.117*	9.556
Days to first male flower appearance	0.222	27.889*	14.444
Days to first female flower appearance	6.500	42.333*	32.167
Days to first fruit set	20.389	93.222*	1.611
Days to first fruit harvest	9.389	260.889*	11.944
Sex ratio	0.011	0.236*	0.023
Number of branches on plant	2.007	7.213*	0.420

Table 1. Continued.

Observations	Replication	Treatments	Error
Number of fruits per plant per picking	0.035	12.859*	0.011
Average fruit weight (g)	158.136	339.483*	18.041
Yield per plant (kg)	0.002	0.010*	0.001
Yield per plot (kg)	0.001	0.161*	0.000
Yield per hectare (q/ha)	0.217	28.980*	0.083
TSS (˚B)	0.001	1.876*	0.000

Plant height (cm)

The observations on plant height as affected by organic manures and bio-fertilizers are presented in Table 2. Perusal of data revealed maximum plant height (128.53 cm) in T_6 (*Azotobacter* @ 2 kg/ha + Vermicompost @ 2.5 t/ha) which was significantly highest among all the treatments. Minimum plant height (90.33 cm) was observed in T_4 (*Azotobacter* @ 4 kg/ha) which was significantly lowest among all the treatments.

Vermicompost has been found effective for improving soil aggregation, structure, fertility, increasing soil microbial diversity, populations, enzymes, improving moisture-holding capacity and thus leading to improved crop growth and yield. Besides this enhanced plant height with the application of vermicompost can be attributed to the fact that it contains large amount of humic substances which affects the plant growth in the similar manner as affected by the plant growth regulators (Azarmi *et al.* 2008, Kumar *et al.* 2015). *Azotobacter* is responsible for nitrogen fixation delivering combined nitrogen to the plant and the production of phytohormone like substances that alter the plant growth and bacteria nitrate reduction, which increases nitrogen accumulation in inoculated plants and finally improve the growth of plant. Similar effects on plant height with the application of vermicompost and *Azotobacter* has also been reported by earlier researchers viz., Ahmad *et al. (*2019), Patle *et al.* (2019) and Das *et al.* (2015) in bottle gourd, Thriveni *et al.* (2015), Prasad *et al.* (2009), Patel *et al.* (2020) in bitter gourd. Prabhu *et al.* (2006), Mohan *et al.* (2016), Kumar *et al.* (2017) and Singh *et al.* (2020) in cucumber and Nayak *et al.* (2016) in pointed Gourd and Mehdi (2022) and Singh *et al*. (2015) in straw berry and Sharma *et al.* (2013) in tomato.

Number of days to first male flower and first female flower appearance

The observations on number of days to first male and female flower appearance as affected by organic manures and bio-fertilizers are presented in Table 2. Minimum number of days to first male flower appearance (27.00) was observed in T_9 (PSB @ 4 kg/ha + FYM @ 20 t/ha) which was statistically at par with T_6 (*Azotobacter* @ 2 kg/ha + Vermicompost @ 2.5 t/ha) (27.33), T_4 (*Azotobacter* @ 4 kg/ha) (28.00), T_8 (PSB @ 4 kg/ha) (28.00), T_{10} (PSB @4 kg/ha + Vermicompost @ 5 t/ha) (28.00). T_6 (*Azotobacter* @ 2 kg/ha + Vermicompost @ 2.5 t/ha) resulted in minimum number of days to first female flower appearance (33.66) which was statistically at par with T_8 (PSB @ 4 kg/ha) (34.00), T_9 (PSB @ 4 kg/ha + FYM @ 20 t/ha) (34.00), T_{10} (PSB @ 4 kg/ha + Vermicompost @ 5 t/ha) (34.00) and T_4 (*Azotobacte*r @ 4 kg/ha) (34.66). Maximum number of days to first male flower appearance (30.00) was observed in T_{12} (control RDF 60 : 125 : 25 kg NPK) which was statistically at par with T_{11} (PSB @ 4 kg/ha + Neemcake @ 2.5 t/ha) (29.33), T_7 (*Azotobacter* @ 2 kg/ha + Neemcake @ 1.25 t/ha) (29.33), T_5 (*Azotobacter* @ 2 kg/ha + FYM @ 10 t/ha) (29.33), T_3 (neemcake @ 2.5 t/ha) (29.33), T_2 (Vermicompost @ 5 t/ha) 29.00 and T_1 (FYM @ 20 t/ha) (29.00). Maximum number of days to first female flower appearance (37.00) was observed in T_{12} (control RDF 60:125:25 kg NPK) which was statistically at par with T_1 (FYM @ 20 t/ha) (36.33), T_5 (*Azotobacter* @ 2 kg/ha + FYM @ 10 t/ha) (36.33), T_3 (Neemcake @ 2.5 t/ha) (36.00), T_{11} (PSB @ 4 kg/ha + Neemcake @ 2.5t/ha) (36.00), T_2 (Vermicompost @ 5 t/ha) (35.00) and T_7 (*Azotobacter* @ 2 kg/ha + Neemcake @1.25 t/ha) (35.00).

Earliness with the application of PSB and FYM might be due to the enhanced production of growth substances like gibberellic acid, indole acetic acid, dihydrozeatin from bio-fertilizers which had positive influence on the physiological activity of plants (Prasad *et al.* 2009). Promotion of early flowering might be due to enhancement in reproductive phase

Table 2. Effect of organic manure and bio-fertilizers on growth parameters of summer squash.

Notation	Plant height	Days to male flower	Days to female flower	Days to fruit set	Days to fruit harvest
T_1	108.93	29.00	36.33	39.00	45.00
T_2	92.33	29.00	35.00	38.00	44.33
T_3	103.68	29.33	36.00	38.00	45.66
T_4	90.33	28.00	34.66	35.00	39.66
T_5	100.20	29.33	36.33	37.00	44.00
T_6	128.53	27.33	33.66	34.66	39.00
T_7	102.60	29.33	35.00	37.00	45.00
T_8	86.13	28.00	34.00	37.00	44.00
T_9	93.20	27.00	34.00	36.00	40.33
T_{10}	96.93	28.00	34.00	36.33	43.33
T_{11}	110.93	29.33	36.00	39.00	47.00
T_{12}	112.26	30.00	37.00	40.33	48.00
CD	1.12	1.38	2.06	0.38	0.50
SE(m)	0.38	0.46	0.69	0.13	0.17

due to treatment of relevant combination of *Azotobacter*. Early flowering with the application of bio-fertilizers was also observed by Bindiya *et al.* (2006) in cucumber and Das *et al*. (2015) and Ahmad *et al.* (2019) and Rabari *et al.* (2019) in bottle gourd. Mulani *et al.* (2007) also observed early female flower appearance in the treatment containing Vermicompost and *Azotobacter*. The findings are lined up with Ahmad *et al*. (2019), Das *et al.* (2015) and Rabari *et al.* (2019) in bottle gourd, Prasad *et al.* (2009) in bitter gourd and Singh *et al.* (2020) in cucumber.

Days to first fruit set and fruit harvest

The observations on days to first fruit set and fruit harvest as affected by organic manures and bio-fertilizers are presented in Table 2. Data depicted minimum days to fruit set (34.66) and first fruit harvest (39.00) was observed in T_6 (*Azotobacter* @2 kg/ha + Vermicompost @ 2.5 t/ha) which was statistically at par with T_4 (*Azotobacter* @ 4 kg/ha) (35.00 for days to first fruit set) and (39.66 days to first fruit harvest). Maximum days to first fruit set (40.33) was observed in T_{12} (control RDF 60:125:25 kg NPK) which was significantly highest among all the treatments. It was statistically at par with T_1 (FYM @ 20 t/ha) (39.00) and T_{11} (PSB @ 4 kg/ha + Neemcake @2.5t/ha) (39.00). While T_{12} (control RDF 60 : 125 : 25 kg NPK) resulted in maximum days to first fruit harvest (48.00) which was significantly maximum among all the treatments.

Higher returns are the main objective of any research program. Higher returns can be obtained by two ways either by enhancing the yield or by fetching the early market. Earliest harvest was observed when plants were supplied with *Azotobacter* @ 2 kg/ha + Vermicompost @ 2.5 t/ha. This can be attributed to the fact that the judicious integration of vermicompost and bio-fertilizers are capable of supplying optimum level of nutrient along with better soil structure leading to early fruit set and fruit harvest. Tripathi *et al.* (2015) suggested that early fruit set with the application of vermicompost and *Azotobacter* could be on account of prolonged growth of plants in their presence. *Azotobacter* is expected to hasten the plant development (Singh *et al.* 2015). Thus accumulation of ample food material for transformation of buds into floral buds resulting in early flowering and ensuring early fruit set. The finding are supported by results observed by Khurshid *et al.* (2021) in chilli, Prasad *et al*. (2009) in bitter gourd and Mohan *et al.* (2016) in cucumber.

Presence of organic acids, enzymes and phytohormones like auxins and other growth regulators in vermicompost play a key role in early fruiting and thus leading to early harvesting. The results are in consonance with the finding of Singh *et al.* (2020) in cucumber, Prasad *et al.* (2009) in bitter gourd and Dutta *et al*. (2020) in okra.

Sex ratio

The observations on sex ratio as affected by organic manures and bio-fertilizers are presented in Table 3. Perusual of data inferred that T_8 (PSB @ 4 kg/ha) resulted in maximum sex ratio (0.76) which was significantly highest among all the treatments. Whereas, minimum sex ratio (0.46) was observed in T_5 (*Azotobacter* @ 2 kg/ha + FYM @ 10 t/ha) which was statistically at par with sex ratio observed in T_7 (*Azotobacter* @ 2 kg/ha + Neemcake @1.25t/ha) (0.50).

Sex ratio was calculated as male : Female ratio. So minimum sex ratio is desirable for better yield

Table 3. Effect of organic manure and bio-fertilizers on yield and yield contributing and quality parameters of summer squash.

Notation	Sex ratio	No. of branches/ plant	No. of fruits/ plant/picking	Average fruit weight	Yield per plant (kg)	Yield per plot (kg)	Yield per hectare (q/ha)	TSS
T_1	0.60	1.20	5.11	74.97	0.35	1.91	25.46	2.09
T_2	0.60	1.53	5.11	77.19	0.38	1.98	26.46	1.92
T_3	0.53	1.53	5.32	75.80	0.38	1.97	26.33	1.81
T_4	0.66	1.80	5.40	79.91	0.39	2.02	26.90	2.19
T_5	0.46	2.20	5.49	79.81	0.40	2.04	27.23	1.72
T_6	0.53	2.86	6.96	83.91	0.42	2.14	28.50	2.39
T_7	0.50	2.26	6.73	82.19	0.38	2.09	27.90	2.24
T_8	0.76	1.40	5.54	76.91	0.38	1.96	26.10	1.69
T_9	0.60	1.60	5.41	77.20	0.38	2.00	26.60	2.22
T_{10}	0.60	1.60	5.09	75.49	0.39	1.96	26.16	1.80
T_{11}	0.70	1.40	5.62	73.80	0.36	1.92	25.56	1.95
T_{12}	0.60	1.80	6.13	74.09	0.37	1.92	25.60	1.74
CD	0.05	0.23	0.03	1.54	0.01	0.00	0.10	0.00
SE(m)	0.01	0.08	0.01	0.52	0.00	0.00	0.03	0.00

performance. Mulani *et al.* (2007) observed that in bittergourd maximum sex ratio as indicated by female: Male ratio was observed when *Azotobacter* was supplied to the plants. Das *et al*. (2015) observed in bottle gourd that with the application of vermicompost combination with bio-fertilizers, there was increased female: male ratio. Prasad *et al.* (2009) calculated that with the application of bio-fertilizers there was enhanced production of growth substances like Gibberellic acid and Indole Acetic acid which had positive influence on physiological activity of plants to induce more female flowers. So the results of present experiment are in good agreement with the above mentioned findings.

Number of branches per plant

Effect of organic manures and bio-fertilizers on number of branches per plant is presented in Table 3. It was observed that T_6 (*Azotobacter* @ 2 kg/ha + Vermicompost @ 2.5 t/ha) resulted in significantly maximum number of branches per plant (2.86) among all the treatments. Minimum number of branches (1.20) was observed in T_1 (FYM @ 20 t/ha) which was statistically at par with T_8 (PSB @ 4 kg/ha) (1.40) and T_{11} (PSB @ 4 kg/ha + Neemcake @ 2.5 t/ha) (1.40).

Maximum number of branches with the application of *Azotobacter* was also observed by Prasad *et al.* (2009) in bitter gourd. Thriveni *et al.* (2015) reported maximum number of branches in bitter gourd with the application of vermicompost. The results of present study where maximum number of branches was observed with the application of vermicompost and *Azotobacter* can be attributed the fact that vermicompost enhances the soil fertility and nutrient uptake and when it is supplemented with bio-fertilizer it also increases the availability of nutrients to the plants. Vermicompost with bio-fertilizers was shown to increase the number of branches in other crops like Rumex and *Capsicum annuum* (Khan and Pariari 2012) and Kalpana *et al.* (2019) and Khurshid *et al.* (2021) in chilli, Anjanappa *et al*. (2012) in cucumber; Beenish *et al.* (2018) in mustard, Mehdi (2022), Patil and Narayana (2017) in gherkin and Chaudhary *et al.* (2019) in bottle gaourd.

Number of fruits per plant per picking

The observations on number of fruits per plant per picking as affected by organic manures and bio-fertilizers are presented in Table 3. Perusal of data revealed that T_6 (*Azotobacter* @ 2 kg/ha + Vermicompost @ 2.5 t/ha) resulted in maximum number of fruits per plant per picking (6.96) which was significantly highest among all the treatments whereas, minimum number of fruits per plant per picking (5.09) was observed in T_{10} (PSB @ 4 kg/ha + Vermicompost @ 5 t/ha) which was statistically at par with T_1 (FYM @ 20 t/ha) (5.11) and T_2 (Vermicompost @ 5 t/ha) (5.11).

Increased number of fruits per plant per picking is a contributing trait of number of fruits per plant. More the number of fruits per plant more will be the total number of fruits. Highest number of fruits per plant per picking with application of vermicompost and *Azotobacter* might be due to favorable effect of organic manures by supplying essential nutrient in balanced ratio and improving physical, chemical and biological properties of soil which helps in better nutrient absorption and utilization by plant. The findings are supported by the results observed by Raturi *et al*. (2019) in capsicum, Patle *et al.* (2019) in bottle gourd, Gupta and Tripathi (2012) in strawberry, Thriveni *et al*. (2015), Saeed *et al.* (2015) and Mohan *et al.* (2016) in cucumber and Hassan *et al.* (2019) in squash, Khalil and Agah *et al.* (2017) in strawberry, Malo *et al.* (2022) in cucumber and Ujjwal *et al.* (2022) in brinjal.

Average fruit weight (g)

Effected of organic manures and bio-fertilizers on average fruit weight are presented in Table 3. Perusal of data revealed maximum average fruit weight (83.91 g) in T_6 (*Azotobacter* @ 2 kg/ha + Vermicompost @ 2.5 t/ha) which was significantly highest among all the treatments. It was statistically at par with T_7 (*Azotobacter* @ 2 kg/ha + Neemcake @ 1.25 t/ha) (82.19 g). Minimum average fruit weight (73.80 g) was observed in T_{11} (PSB @ 4 kg/ha + Neemcake @ 2.5 t/ha) which was statistically at par with average fruit weight observed in T_{12} (control RDF 60:125:25 kg NPK) (74.09 g).

Fruits having greater fruit length and width generally have greater fruit weight. Mohan *et al.* (2016) observed higher fruit length and width in treatment combination containing vermicompost and *Azotobacter* leading to maximum fruit weight in cucumber. Higher average fruit weight with the application of vermicompost could be due to availability of necessary nutrients in adequate quantity as it improves the soil quality. Role of *Azotobacter* in increasing the average fruit weight can be seen its role in protection against the non parasitic pathogens and production of biological active substances like auxins and gibberellins and transforming unavailable mineral and organic compounds into available forms to the plants. Khurshid *et al.* (2021) concluded that increase in average fruit weight with the integrated use of vermicompost and bio-fertilizer can be attributed to better availability and more uptakes of nutrients. Increased availability of nitrogen might have increased amino acid synthesis which function as the substrate for plant hormone synthesis and in turn resulted in more plant growth including cell division, cell elongation and cell enlargement. The results are in agreement with the findings of Patel *et al.* (2015) and Thriveni *et al.* (2015) in bitter gourd, Singh *et al.* (2014) in strawberry, Kumar *et al.* (2016), Singh *et al.* (2020) in cucumber, Raturi *et al.* (2019) in bell pepper, Ahmad *et al*. (2019) in bottle gourd and Mehdi *et al.* (2022).

Yield per plant, per plot (kg) and per hectare (q/ha)

Effect of organic manures and bio-fertilizers on yield per plant and per plot are presented in Table 3. Data indicated that T_6 (*Azotobacter* @ 2 kg/ha + vermicompost @ 2.5 t/ha) resulted in maximum yield per plant (0.42 kg), yield per plot (2.14 kg) and yield per hectare (28.50 q/ha) which was significantly highest among all the treatments. Minimum yield per plant (0.35 kg) and yield per plot (1.91 kg) was observed in T_1 (FYM @ 20 t/ha) which was statistically at par with T_{11} (PSB @ 4 kg/ha + Neemcake @ 2.5 t/ha) (0.36 kg yield per plant and 1.92 kg per plot). T_{12} (control RDF 60:125:25 kg NPK) was also at par with T_1 (FYM @ 20 t/ha) for yield per plot (1.92 kg) and yield per hectare (25.60 q/ha).

Yield contributing traits viz, number of fruits per plant, fruit weight, fruit yield per plant might have lead to the increased yield per plot and yield per hectare. The incremental role of *Azotobacter* and vermicompost in yield per plant per plot and per hectare could be due the increased photosynthetic ability of plants with the enhanced growth parameters in the same treatment (Tripathi *et al.* 2015). When *Azotobacter* is applied it multiply and forms a thick sheath of bacterial population in the roots and in due cause of line fixes nitrogen (Prasad *et al.* 2017). This released nitrogen is absorbed by the roots which ultimately help in increased fruit weight and thus enhanced yield. Combined application of vermicompost and *Azotobacter* could have caused additive

effect in terms of facilitating better soil condition like improved soil fertility and nitrogen fixation which ultimately enhanced the activities of other microbes and release of other growth stimulator as well (Chaudhary *et al.* 2015). The results are in line with the findings of Ahmad *et al.* (2019) in bottle gourd, Sahu *et al.* (2020), Prabhu *et al*. (2006), Singh *et al.* (2020) in cucumber, Raturi *et al*. (2019) in capsicum, Singh *et al.* (2015) and Kumar *et al.* (2015) in strawberry, Malo *et al.* (2020) in cucumber, Mishra *et al.* (2021) in cabbage and Smriti *et al.* (2018) in okra.

Total soluble solids (TSS) (˚B)

Table 3 represents the observations on TSS as affected by organic manures and bio-fertilizers. Perusal of data revealed maximum TSS (2.39˚B) in T_6 (*Azotobacter* @ 2 kg/ha + Vermicompost @ 2.5 t/ha) which was significantly highest among all the treatments. Minimum TSS (1.69) was observed in T_8 (PSB @ 4 kg/ha) which was significantly lowest among all the treatments.

Increased TSS with the application of *Azotobacter* and vermicompost may be attributed to the quick metabolic transformation of starch and pectin into soluble compounds and rapid translocations of sugars from leaves to the developing fruits. The findings are supported by the results observed by Meena *et al.* (2017) in tomato, Meena *et al*. (2017) in broccoli and Kaur and Singh (2019) in onion.

CONCLUSION

The discussion mentioned earlier about the effect of organic manure and bio-fertilizer on growth and yield of summer squash brought down to the one fact that use of organic manure and bio-fertilizer plays an important role in terms of growth and yield. It may be concluded that with the application of *Azotobacter* @ 2 kg/ha + Vermicompost @ 2.5 t/ha gave better results in growth, yield and quality parameters can be obtained.

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