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## Studies on the effect of growth regulator and vermicompost on growth and yield of different cultivars of strawberry (*Fragaria x ananassa* Duch)

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**ABSTRACT :** The present investigation was carried out at the Horticulture Research Center, of the Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut during 2013-2014. The maximum number of fruits (20.85) were recorded in the variety Chandler which was significantly superior to the rest of the varieties and followed by Gorella, Selva and Confictura. The maximum fruit yield per plant (385.57g) was recorded in the variety Chandler which was superior to the rest of the varieties and was followed by Selva, Confictura and Douglas. The minimum fruit yield per plant (177.79g) was noted in Gorella variety. The maximum fruit weight (18.41g) was recorded in the variety Chandler which was significantly superior to the rest and followed by Confictura, Selva and Douglas. Application of gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 100q/ha was found to be the best treatment in response to fruit weight among different varieties of strawberry and recorded 16.48g. The maximum fruit yield (171.36q/ha) was recorded in the variety Chandler which was significantly superior to the rest and was followed by Selva, Confictura and Douglas; however, Selva and Confictura were statistically at par to each other. Variety Chandler responded maximum effect on fruit yield per hectare *i.e.* 205.357q/ha with the spray of gibberellic acid (GA<sub>3</sub>) 100 ppm and application of vermicompost @ 100q/ha. The maximum total soluble solids (10.68°Brix) was recorded in the variety Douglas which was superior to the rest and was followed by Confictura, Selva and Gorella. The minimum TSS value (9.41°Brix) was noted in Chandler variety. Douglas responded maximum effect on TSS value *i.e.* 11.50°Brix with the spray of gibberellic acid (GA<sub>3</sub>) 100 ppm and application of vermicompost @ 100q/ha as basal dose which was statistically significant to other treatments and followed by Confictura, Selva and Gorella. Viewing the above observations, Chandler, Confictura and selva were found promising for commercial cultivation, however, Gorella was found to be earliest among all.

**KEY WORDS :** Growth regulator, Vermicompost, Growth, Yield, Cultivars

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**S**trawberry (*Fragaria x ananassa* Duch) belongs to the family Rosaceae. The cultivated strawberry is one of the most important soft fruit of the world

and all the cultivated varieties are octaploid (2n=56). Strawberry gives back returns in the shortest possible time and is adopted to highly varied agro-climatic

conditions. The fruit is a good source of vitamin A (60 IU/100g) and vitamin C (30-120 mg/100g). In India it is commercially grown in Mahabaleshwar (Maharashtra), Jammu and Kashmir, Himachal Pradesh, Uttarakhand, plains of Haryana, Punjab, Delhi and western Uttar Pradesh. In the present strawberry cultivation scenario, an ideal variety is one that grows well in different climatic conditions, produce firm and large fruits of good quality and attractive colour with good processing and dessert quality. Strawberry is basically a fruit plant of temperate climate. However, during the recent years, there has been phenomenal increase in its area and production in tropical and subtropical plains of India (Sharma and Sharma, 2004). Gibberellic acid improves berry size and fruit yield; while vermicompost improves soil texture, water holding capacity, improves disease resistance and helps in better plant growth. The present investigation was undertaken to study the most suitable variety of strawberry as well as appropriate treatment of growth regulator and vermicompost for quality parameters of strawberry.

## RESEARCH METHODS

The present experiment was conducted during 2013-14 in the Department of Horticulture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (Uttar Pradesh). The strawberry varieties as Chandler, Gorella, Selva, Douglas and Confictura were collected from Dr. Y.S. Parmar University of Horticulture and Forestry Nauni Himachal Pradesh during September 2013 and they were planted at 45x50cm in well prepared field incorporated with vermicompost @ 1kg/sqm and 2kg/sqm accordingly with the design of the treatments as basal dose. The two way Factorial experimental design was adapted with GA<sub>3</sub> 25 ppm + Vermicompost 50 q/ha, GA<sub>3</sub> 50 ppm + vermicompost 50 q/ha, GA<sub>3</sub> 100ppm + vermicompost 50 q/ha, GA<sub>3</sub> 25 ppm +vermicompost 100 q/ha, GA<sub>3</sub> 50 ppm + vermicompost 100 q/ha, GA<sub>3</sub> 100 ppm + vermicompost 100 q/ha and control. various observations pertaining to vrgetative growth flowering and fruiting, behaviour were recorded periodically.

## RESEARCH FINDINGS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

### Plant height :

The maximum plant height (23.87cm) was recorded in the variety Gorella which was followed by Confictura,

Douglas and Selva (Table 1). However, Confictura and Douglas were statistically at par with each other. The minimum plant height (22.46 cm) was recorded in variety Chandler which was statistically inferior to other varieties.

Data further exists marked variation among the treatments evince that the gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 100 q/ha was found to be the best treatment and was statistically significant in response to plant height of different treatments of strawberry and recorded 28.13 cm as per pooled data and it was followed by the treatment gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 50 q/ha, gibberellic acid (GA<sub>3</sub>) 50 ppm + vermicompost @ 50 q/ha and gibberellic acid (GA<sub>3</sub>) 25 ppm + vermicompost @ 100 q/ha.

Further a minute observation showed that the variety Confictura had achieved the maximum height (29.67cm) with the spray of gibberellic acid (GA<sub>3</sub>) 100 ppm and application of vermicompost @ 100 q/ha as basal dose during time of field preparation which was followed by Douglas, Gorella and Selva. The minimum plant height was recorded with control in all the cultivars under study. The maximum plant height and leaf area were recorded in the variety Gorella which was followed by Confictura, Douglas and Selva. The variability among the varieties were due to genetic make up of the different varieties. Further the treatments evince that the gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 100 q/ha was found to be the best treatment and was significantly superior than that of control.

The increase in plant height, number of leaves and leaf area might be due to fact that the vermicompost has the higher water holding capacity and make available almost all the essential elements to the plant for their better growth and development. Vermicompost contains more organic matter than other substrates and provide sufficient nutrient supply to plant which resulted in increased vegetative growth. The increase in plant height and leaf number during the present investigations with 100' ppm GA<sub>3</sub> application may be due to increase in cell elongation and corresponding increase in stem length. The increase in the cell elongation with GA<sub>3</sub> application might be due to increased synthesis of auxin in the strawberry' plant system (Singh and Phogat, 1983 and Dwivedi, 1987).

### Leaves per plant:

The maximum leaves per plant (18.23) were recorded in the variety Selva which was followed by

Confictura, Gorella and Douglas. The minimum leaves (17.09) was recorded in variety Chandler (Table 2).

Observation recorded among the treatments evince that the application of gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 100 q/ha was found to be the best treatment in response to number of leaves per plant among different varieties of strawberry and recorded 20.00 as per pooled data and it was followed by the treatment gibberellic acid (GA<sub>3</sub>) 50ppm + vermicompost @ 100 q/ha, gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 50q/ha and gibberellic acid (GA<sub>3</sub>) 25 ppm + vermicompost @ 100 q/ha.

Further a minute observation showed that the variety Confictura and Douglas responded similar effect on number of leaves per plant *i.e.* 20.66 with the spray of gibberellic acid (GA<sub>3</sub>) 100 ppm and application of vermicompost @ 100 q/ha as basal dose during time of field preparation which was followed by Gorella and Selva again both the varieties responded the same pattern

of production. The minimum leaves were recorded in the cultivar Chandler under study.

#### Days to flower initiation :

The earliest flower was noted in variety Chandler followed by confictura, Selva and Douglas under control (Table 3). However, flower initiation was delayed under gibberellic acid (Ga<sub>3</sub>) 100 ppm + vermicompost @ 100 q/ha treatment in all the varieties, As, increasing doge of gibberellic acid (Ga<sub>3</sub>) and vermicompost delayed the flower initiation in almost all the varieties and the plants become healthier than control.

The maximum fruit setting period (6.95 days) was recorded in the variety Chandler which was followed by Gorella, Confictura and Selva (Table 4). The minimum time (5.57days) taken by Douglas variety. So, it was found to be the earliest in the of fruit setting.

A minute observation recorded among the treatments evince that the application of gibberellic acid

**Table 1 : Average plant height of different varieties of strawberry**

Treatments	Plant height (cm)					
	Chandler	Gorella	Selva	Douglas	Confictura	Pooled
Control	19.33	21.67	20.00	21.00	20.33	20.47
GA <sub>3</sub> (25ppm)+VC @50q/ha	20.66	22.67	21.33	21.67	22.00	21.67
GA <sub>3</sub> (50ppm)+VC @50q/ha	22.33	23.67	22.33	22.67	22.67	22.73
GA <sub>3</sub> (100ppm)+VC @50q/ha	23.00	24.33	23.33	23.67	23.67	23.60
GA <sub>3</sub> (25ppm)+VC @100q/ha	22.33	23.00	23.67	22.33	22.67	22.80
GA <sub>3</sub> (50ppm)+VC @100q/ha	23.00	23.67	24.00	23.00	23.67	23.47
GA <sub>3</sub> (100ppm)+VC @100q/ha	26.67	28.00	27.33	29.00	29.67	28.13
Gen. Mean	22.46	23.87	23.13	23.33	23.54	23.27
C.D. (P=0.05) for variety	0.60					
C.D. (P=0.05) for treatment	0.71					
C.D. (P=0.05) for variety x treatment	1.59					

**Table 2 : Average number of leaves per plant of different varieties of strawberry**

Treatments	No. of leaves per plant					
	Chandler	Gorella	Selva	Douglas	Confictura	Pooled
Control	15.000	15.333	16.333	14.333	15.667	15.333
GA <sub>3</sub> (25ppm)+VC @50q/ha	16.000	16.333	17.000	15.667	16.333	16.267
GA <sub>3</sub> (50ppm)+VC @50q/ha	17.000	17.333	18.000	16.333	17.333	17.200
GA <sub>3</sub> (100ppm)+VC @50q/ha	18.333	18.667	18.667	17.333	18.333	18.267
GA <sub>3</sub> (25ppm)+VC @100q/ha	17.000	17.333	18.333	18.333	17.333	17.667
GA <sub>3</sub> (50ppm)+VC @100q/ha	17.667	18.333	19.333	19.000	19.000	18.667
GA <sub>3</sub> (100ppm)+VC @100q/ha	18.667	20.000	20.000	20.667	20.667	20.000
Gen. Mean	17.095	17.619	18.238	17.381	17.810	17.629
C.D. (P=0.05) for variety	0.52					
C.D. (P=0.05) for treatment	0.61					
C.D. (P=0.05) for variety x treatment	1.38					

(GA<sub>3</sub>) 100 ppm + vermicompost @ 100 q/ha was found to be the best treatment in response to time of fruit setting among different varieties of strawberry and recorded 5.26 days as per pooled data and it was followed by the treatment gibberellic acid (GA<sub>3</sub>) 50 ppm + vermicompost @ 100 q/ha, gibberellic acid (GA<sub>3</sub>) 25 ppm + vermicompost @ 100 q/ha and gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 50 q/ha. The maximum fruit setting period was taken under control among all the varieties.

Further an observation showed that the variety Douglas responded hastening effect on fruit setting *i.e.* 4.33 days with the spray of gibberellic acid (GA<sub>3</sub>) 50 ppm and application of vermicompost @ 100 q/ha as basal dose during time of field preparation which was followed by Confictura and Selva both were found to be the same period of fruit setting. The maximum time was taken for fruit setting by Gorella variety within the same treatment. However, it was recorded maximum days in almost all the varieties under control.

Fruit setting had increased in the every treatment as compared to that of control. The maximum fruit setting period (6.95 days) was recorded in the variety Chandler;

however it was statistically at par with Gorella and was followed by Confictura and Selva. The minimum time for fruit setting (5.57days) was recorded in Douglas variety. So, this variety was found to be the earliest in the response of fruit setting. Further marked variation among the treatments evince that the application of gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @100 q/ha was found to be the best treatment in response to time of fruit setting among different varieties of strawberry and recorded 5.26 days the earliest; however, it was statistically at par with gibberellic acid (GA<sub>3</sub>) 50ppm + vermicompost @ 100 q/ha and gibberellic acid (GA<sub>3</sub>) 25 ppm + vermicompost @ 100 q/ha. The maximum fruit setting period was observed under control among all the varieties.

The various treatments registered significant influence onflowering and berry set, in present study. Gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 100 q/ha treatment resulted in maximum number of flowers and increased berry set. This might be due to the fact that such treatment being rich in nutrients induced good vegetative growth and flower bunch hence initiated higher number of flowers and per cent berry set. This

**Table 3 : Effect of Ga<sub>3</sub> and vermicompost on days to flower initiation**

Treatments	Days to flower initiation				
	Chandler	Gorella	Selva	Douglas	Confictura
GA <sub>3</sub> (25ppm)+Vermicompost@50q/ha	28.01.14	04.02.14	24.01.14	30.01.14	25.01.14
GA <sub>3</sub> (50ppm)+Vermicompost@50q/ha	29.01.14	05.02.14	25.01.14	01.02.14	25.01.14
GA <sub>3</sub> (100ppm)+Vermicompost@50q/ha	30.01.14	05.02.14	25.01.14	01.02.14	26.01.14
GA <sub>3</sub> (25ppm)+Vermicompost@100q/ha	28.01.14	08.02.14	27.01.14	31.01.14	26.01.14
GA <sub>3</sub> (50ppm)+Vermicompost@100q/ha	31.01.14	10.02.14	28.01.14	03.02.14	29.01.14
GA <sub>3</sub> (100ppm)+Vermicompost@100q/ha	02.02.14	12.02.14	28.01.14	03.02.14	30.01.14
Control	22.01.14	03.02.14	25.01.14	30.01.14	23.01.14

**Table 4 : Average time of fruit setting of different varieties of strawberry**

Treatments	Fruit setting peak time (days)					
	Chandler	Gorella	Selva	Douglas	Confictura	Pooled
Control	6.667	6.667	7.333	6.667	7.667	7.000
GA <sub>3</sub> (25ppm)+VC @50q/ha	7.000	6.667	6.667	6.000	7.333	6.733
GA <sub>3</sub> (50ppm)+VC @50q/ha	7.667	6.333	6.333	7.000	6.667	6.800
GA <sub>3</sub> (100ppm)+VC @50q/ha	7.667	6.000	5.667	5.667	6.333	6.267
GA <sub>3</sub> (25ppm)+VC @100q/ha	7.333	7.333	5.000	4.667	4.667	5.800
GA <sub>3</sub> (50ppm)+VC @100q/ha	6.667	7.000	5.333	4.333	4.333	5.533
GA <sub>3</sub> (100ppm)+VC @100q/ha	5.667	6.000	5.000	4.667	5.000	5.267
Gen. Mean	6.952	6.571	5.905	5.571	6.000	6.200
C.D. (P=0.05) for variety	0.54					
C.D. (P=0.05) for treatment	0.64					
C.D. (P=0.05) for variety x treatment	1.43					

could also be attributed to the improvement in the water retention in the medium, better uptake of nutrients and water, which might increased photosynthetic rate causing maximum berry production.

#### Days to first fruit harvesting:

The maximum fruit harvesting period (74.47days) was recorded in the variety Confictura which was followed by Chandler, Douglas and Selva (Table 5). The minimum period of fruit harvesting (41.61 days) was recorded in Gorella. So, it was found to be the earliest in the response of fruit harvesting.

Further, treatments evince that the application of gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 100 q/ha was found to be the best treatment in response to delaying of fruit harvesting among different varieties of strawberry and recorded 65.20 days as per pooled data and it was followed by the treatment gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 50 q/ha, gibberellic

acid (GA<sub>3</sub>) 50ppm + vermicompost @ 100 q/ha and gibberellic acid (GA<sub>3</sub>) 25 ppm + vermicompost @ 100 q/ha. The minimum time of fruit harvesting was under control among all the varieties.

Further an observation showed that the variety Confictura responded maximum effect on delaying of fruit harvesting *i.e.* 80.00 days with the spray of gibberellic acid (GA<sub>3</sub>) 100 ppm and application of vermicompost @ 100 q/ha as basal dose during time of field preparation which was followed by Chandler, Douglas and Selva. The earliest fruit harvesting was noted under control among all the varieties.

Marked variation among the treatments evince that the application of gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 100 q/ha delayed fruit harvesting among different varieties of strawberry and recorded 65.20 days as per pooled data and it was followed by the treatment gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 50q/ha, gibberellic acid (GA<sub>3</sub>) 50 ppm + vermicompost @

**Table 5 : Average days of fruit harvesting of different varieties of strawberry**

Treatments	First fruit harvesting (days)					
	Chandler	Gorella	Selva	Douglas	Confictura	Pooled
Control	64.00	37.67	52.00	55.67	71.33	56.13
GA <sub>3</sub> (25ppm)+VC @50q/ha	64.66	40.67	54.00	62.33	72.67	58.86
GA <sub>3</sub> (50ppm)+VC @50q/ha	68.67	42.67	54.33	63.33	73.67	60.53
GA <sub>3</sub> (100ppm)+VC @50q/ha	71.33	44.00	56.67	66.33	74.67	62.60
GA <sub>3</sub> (25ppm)+VC @100q/ha	67.67	40.33	56.00	60.00	73.33	59.46
GA <sub>3</sub> (50ppm)+VC @100q/ha	70.00	42.67	56.67	65.33	75.67	62.06
GA <sub>3</sub> (100ppm)+VC @100q/ha	74.33	43.33	61.67	66.67	80.00	65.20
Gen. Mean	68.667	41.619	55.05	62.81	74.47	60.69
C.D. (P=0.05) for variety	0.87					
C.D. (P=0.05) for treatment	1.02					
C.D. (P=0.05) for variety x treatment	2.30					

**Table 6 : Average fruit weight of different varieties of strawberry**

Treatments	Fruit weight (g)					
	Chandler	Gorella	Selva	Douglas	Confictura	Pooled
Control	17.300	8.333	15.400	14.200	15.133	14.073
GA <sub>3</sub> (25ppm)+VC @50q/ha	17.667	8.733	16.100	15.400	16.000	14.780
GA <sub>3</sub> (50ppm)+VC @50q/ha	17.967	9.067	16.933	15.900	16.667	15.307
GA <sub>3</sub> (100ppm)+VC @50q/ha	18.800	9.500	17.267	16.467	17.367	15.880
GA <sub>3</sub> (25ppm)+VC @100q/ha	18.100	9.267	16.433	15.800	16.667	15.253
GA <sub>3</sub> (50ppm)+VC @100q/ha	18.933	9.767	16.933	16.333	17.233	15.840
GA <sub>3</sub> (100ppm)+VC @100q/ha	20.100	10.233	17.367	17.000	17.733	16.487
Gen. Mean	18.410	9.271	16.633	15.871	16.686	15.374
C.D. (P=0.05) for variety	0.31					
C.D. (P=0.05) for treatment	0.36					
C.D. (P=0.05) for variety x treatment	0.81					

100 q/ha and gibberellic acid (GA<sub>3</sub>) 50ppm + vermicompost @ 50 q/ha. The minimum fruit harvesting period was observed under control among all the varieties. These observations are supported by the findings of Verma and Sharma (2010); Hiradeve *et al.* (2011); Athani and Revanappa (2009); Liu *et al.* (2014) and Aubert and Bosc (2014).

#### Fruit weight (g):

The maximum fruit weight (18.41g) was recorded in the variety Chandler which was followed by Confictura, Selva and Douglas (Table 6). The minimum fruit weight (9.27g) was noted in Gorella variety. So, it was found to be the lowest in the response of fruit weight.

Data further evince that the application of gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 100 q/ha was found to be the best treatment in response to time of fruit setting among different varieties of strawberry and recorded 5.26 days as per pooled data and it was followed by the treatment gibberellic acid (GA<sub>3</sub>) 50 ppm +

vermicompost @ 100 q/ha, gibberellic acid (GA<sub>3</sub>) 25 ppm + vermicompost @ 100 q/ha and gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 50 q/ha. The maximum fruit setting period was taken under control among all the varieties. This might be due to the fact that such treatment being rich in nutrients induced good vegetative growth and flower bunch hence initiated higher number of flowers and per cent berry set. This could also be attributed to the improvement in the water retention in the medium, better uptake of nutrients and water, which might increased photosynthetic rate causing maximum fruit weight. These observations are supported by the findings of Verma and Sharma (2010) who reported that higher fruit weight was associated with *santulit* vermicompost and farm yard manure applications in apple than the normal soil.

#### Fruit length (mm):

The maximum fruit length (34.04mm) was recorded in the variety Chandler which was followed by Douglas,

**Table 7 : Average fruit length of different varieties of strawberry**

Treatments	Fruit length (mm)					
	Chandler	Gorella	Selva	Douglas	Confictura	Pooled
Control	29.000	27.000	27.000	27.667	27.667	27.667
GA <sub>3</sub> (25ppm)+VC @50q/ha	33.000	31.000	30.667	32.000	31.667	31.667
GA <sub>3</sub> (50ppm)+VC @50q/ha	34.000	33.000	32.000	33.333	33.000	33.067
GA <sub>3</sub> (100ppm)+VC @50q/ha	36.000	34.667	33.000	34.667	35.000	34.667
GA <sub>3</sub> (25ppm)+VC @100q/ha	34.000	33.000	33.333	34.333	34.000	33.733
GA <sub>3</sub> (50ppm)+VC @100q/ha	35.667	34.667	35.333	35.667	35.333	35.333
GA <sub>3</sub> (100ppm)+VC @100q/ha	36.667	37.000	36.333	37.667	37.000	36.933
Gen. Mean	34.048	32.905	32.524	33.619	33.381	33.295
C.D. (P=0.05) for variety	0.71					
C.D. (P=0.05) for treatment	0.84					
C.D. (P=0.05) for variety x treatment	1.89					

**Table 8 : Average fruit width of different varieties of strawberry**

Treatments	Fruit width (mm)					
	Chandler	Gorella	Selva	Douglas	Confictura	Pooled
Control	26.00	18.00	26.67	29.00	27.66	25.46
GA <sub>3</sub> (25ppm)+VC @50q/ha	27.33	19.00	27.67	30.00	28.66	26.53
GA <sub>3</sub> (50ppm)+VC @50q/ha	27.67	19.67	28.67	31.00	30.00	27.40
GA <sub>3</sub> (100ppm)+VC @50q/ha	28.33	20.33	29.67	30.66	30.33	27.86
GA <sub>3</sub> (25ppm)+VC @100q/ha	27.67	20.00	28.67	30.33	30.33	27.40
GA <sub>3</sub> (50ppm)+VC @100q/ha	28.67	21.67	29.33	31.66	31.00	28.46
GA <sub>3</sub> (100ppm)+VC @100q/ha	29.33	24.00	29.67	32.00	31.66	29.33
Gen. Mean	27.87	20.31	28.61	30.66	29.95	27.49
C.D. (P=0.05) for variety	0.62					
C.D. (P=0.05) for treatment	0.74					
C.D. (P=0.05) for variety x treatment	1.66					

Confictura and Gorella (Table 7). The minimum fruit length (32.52 mm) was recorded in Selva variety.

Application of gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 100q/ha was found to be the best treatment in response to fruit length among different varieties of strawberry and recorded 36.93 mm as per pooled data and it was followed by the treatment gibberellic acid (GA<sub>3</sub>) 50 ppm + vermicompost @ 100 q/ha, gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 50q/ha and gibberellic acid (GA<sub>3</sub>) 50 ppm + vermicompost @ 50 q/ha. The minimum fruit length was recorded under control among all the varieties.

Further an observation showed that the variety Douglas responded maximum effect on fruit length *i.e.* 37.66 mm with the spray of gibberellic acid (GA<sub>3</sub>) 100 ppm and application of vermicompost @ 100 q/ha as basal dose during time of field preparation which was followed by Gorella and Confictura. However, both showed the same response with fruit length. The

minimum fruit length 30.66 mm was recorded in the cultivar Selva under study.

#### Fruit width (mm):

The maximum fruit width (30.66 mm) was recorded in the variety Douglas which was followed by Confictura, Selva and Chandler (Table 8). The minimum fruit width (20.31mm) was recorded in Gorella variety.

A minute observation recorded among the treatments evince that the application of gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 100 q/ha was found to be the best treatment in response to fruit width among different varieties of strawberry and recorded 29.33 mm as per pooled data and was followed by the treatment gibberellic acid (GA<sub>3</sub>) 50 ppm + vermicompost @ 100q/ha, gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 50 q/ha and gibberellic acid (GA<sub>3</sub>) 25 ppm + vermicompost @ 100q/ha. The minimum fruit width was recorded under control among all the varieties.

**Table 9 : Average number of fruits per plant of different varieties of strawberry**

Treatments	Fruits per plant					
	Chandler	Gorella	Selva	Douglas	Confictura	Pooled
Control	17.667	17.000	14.000	12.667	14.000	15.067
GA <sub>3</sub> (25ppm)+VC @50q/ha	19.000	17.333	14.333	13.000	15.333	15.800
GA <sub>3</sub> (50ppm)+VC @50q/ha	20.333	19.000	15.333	14.333	16.000	17.000
GA <sub>3</sub> (100ppm)+VC @50q/ha	22.000	20.333	17.000	15.000	16.667	18.200
GA <sub>3</sub> (25ppm)+VC @100q/ha	21.333	19.000	16.333	15.333	16.333	17.667
GA <sub>3</sub> (50ppm)+VC @100q/ha	22.667	20.333	18.333	16.000	17.667	19.000
GA <sub>3</sub> (100ppm)+VC @100q/ha	23.000	21.000	20.333	16.333	18.000	19.733
Gen. Mean	20.857	19.143	16.524	14.667	16.286	17.495
C.D. (P=0.05) for variety	0.80					
C.D. (P=0.05) for treatment	0.95					
C.D. (P=0.05) for variety x treatment	2.12					

**Table 10 : Average fruit yield per plant of different varieties of strawberry**

Treatments	Yield per plant (g)					
	Chandler	Gorella	Selva	Douglas	Confictura	Pooled
Control	306.20	137.27	215.77	180.83	212.00	210.41
GA <sub>3</sub> (25ppm)+VC @50q/ha	335.93	151.40	230.73	200.07	245.33	232.69
GA <sub>3</sub> (50ppm)+VC @50q/ha	365.87	172.33	259.80	227.90	266.73	258.52
GA <sub>3</sub> (100ppm)+VC @50q/ha	413.63	193.17	296.80	247.20	289.60	288.08
GA <sub>3</sub> (25ppm)+VC @100q/ha	386.57	176.17	263.67	228.57	272.33	265.46
GA <sub>3</sub> (50ppm)+VC @100q/ha	428.73	198.93	310.03	261.63	304.37	300.74
GA <sub>3</sub> (100ppm)+VC @100q/ha	462.06	215.30	352.80	277.80	319.16	325.42
Gen. Mean	385.57	177.79	275.65	232.00	272.79	268.76
C.D. (P=0.05) for variety	14.82					
C.D. (P=0.05) for treatment	17.53					
C.D. (P=0.05) for variety x treatment	39.21					

Further an observation showed that the variety Douglas responded maximum effect on fruit width *i.e.*, 32.00 mm with the spray of gibberellic acid (GA<sub>3</sub>) 100 ppm and application of vermicompost @ 100 q/ha as basal dose during time of field preparation and was followed by Confictura, Selva and Chandler. The minimum fruit width was recorded in the cultivar Gorella under study. However, the minimum fruit width was noted under control among all the varieties. Baba *et al.* (2010) studied on the effect of inorganic and biofertilizers on soil physico chemical properties and micronutrient availability in strawberry, Ali and Gaur (2007); Kumar *et al.* (2012); Sonkar *et al.* (2012); Karimi *et al.* (2013); Kumar *et al.* (2014) also studied on the present investigation.

**Fruits per plant:**

The maximum fruits (20.85) were recorded in the variety Chandler which was followed by Gorella, Selva and Confictura (Table 9). The minimum fruits (14.66)

per plant was taken in Douglas variety.

Observation recorded among the treatments evince that the application of gibberellic acid (GA<sub>3</sub>) 100 ppm + vermicompost @ 100 q/ha was found to be the best treatment in response to number of fruits among different varieties of strawberry and recorded 19.73 fruits as per pooled data and it was followed by the treatment gibberellic acid (GA<sub>3</sub>) 50 ppm + vermicompost @ 100 q/ha, gibberellic acid (GA<sub>3</sub>) 50 ppm + vermicompost @ 50 q/ha and gibberellic acid (GA<sub>3</sub>) 25ppm + vermicompost @ 50 q/ha. The minimum fruits was taken under control among all the varieties.

Further an observation showed that the variety Chandler responded maximum effect on fruits per plant *i.e.* 23.00 with the spray of gibberellic acid (GA<sub>3</sub>) 100 ppm and application of vermicompost @ 100 q/ha as basal dose during time of field preparation which was followed by Gorella, Selva and Confictura. The minimum fruits per plant were recorded in the cultivar Douglas

**Table 11 : Average fruit yield per hectare of different varieties of strawberry**

Treatments	Yield (q/ha)					
	Chandler	Gorella	Selva	Douglas	Confictura	Pooled
Control	136.08	61.00	95.89	80.36	94.22	33.51
GA <sub>3</sub> (25ppm)+VC @50q/ha	149.30	67.28	102.54	88.91	109.03	103.41
GA <sub>3</sub> (50ppm)+VC @50q/ha	162.60	76.58	115.46	101.28	118.54	114.89
GA <sub>3</sub> (100ppm)+VC @50q/ha	183.83	85.84	131.90	109.86	128.70	128.02
GA <sub>3</sub> (25ppm)+VC @100q/ha	171.80	78.29	117.17	101.58	121.03	117.97
GA <sub>3</sub> (50ppm)+VC @100q/ha	190.54	88.40	137.78	116.27	135.27	133.65
GA <sub>3</sub> (100ppm)+VC @100q/ha	205.35	95.68	156.79	123.23	141.86	144.58
Gen. Mean	171.36	79.01	122.50	103.07	121.23	110.86
C.D. (P=0.05) for variety	7.93					
C.D. (P=0.05) for treatment	9.38					
C.D. (P=0.05) for variety x treatment	20.98					

**Table 12 : Average total soluble solids of different varieties of strawberry**

Treatments	TSS value (°Brix)					
	Chandler	Gorella	Selva	Douglas	Confictura	Pooled
Control	8.87	9.13	8.77	10.13	9.57	9.29
GA <sub>3</sub> (25ppm)+VC @50q/ha	9.10	9.20	8.87	10.26	9.80	9.44
GA <sub>3</sub> (50ppm)+VC @50q/ha	9.26	9.33	9.03	10.46	9.87	9.59
GA <sub>3</sub> (100ppm)+VC @50q/ha	9.40	9.46	9.50	10.70	10.10	9.83
GA <sub>3</sub> (25ppm)+VC @100q/ha	9.43	9.40	9.80	10.73	9.93	9.86
GA <sub>3</sub> (50ppm)+VC @100q/ha	9.70	9.56	10.37	10.96	10.60	10.24
GA <sub>3</sub> (100ppm)+VC @100q/ha	10.17	10.27	10.67	11.50	11.27	10.77
Gen. Mean	9.41	9.48	9.57	10.68	10.12	9.86
C.D. (P=0.05) for variety	0.08					
C.D. (P=0.05) for treatment	0.09					
C.D. (P=0.05) for variety x treatment	0.21					



(13.00 fruit) under study. However, the minimum fruits were noted under control among all the varieties.

#### Yield per plant:

The maximum fruit yield per plant (385.57g) was recorded in the variety Chandler which was followed by Confictura and Selva (Table 10). The minimum fruit yield (177.79g) was noted in Gorella variety. So, it was found to be the low in the response of fruit yield.

Data among the treatments evince that the application of gibberellic acid ( $GA_3$ ) 100ppm + Vermicompost @ 100 q/ha was found to be the best treatment in response to fruit yield among different varieties of strawberry and recorded 325.42g as per pooled data and was followed by the treatment gibberellic acid ( $GA_3$ ) 50 ppm + vermicompost @ 100 q/ha, gibberellic acid ( $GA_3$ ) 100 ppm + vermicompost @ 50q/ha and gibberellic acid ( $GA_3$ ) 25ppm + vermicompost @ 100 q/ha.

Further an observation showed that the variety Chandler responded maximum effect on fruit yield per plant *i.e.* 462.06 g with the spray of gibberellic acid ( $GA_3$ ) 100 ppm and application of vermicompost @ 100 q/ha which was followed by Confictura, Selva and Douglas. The minimum fruit yield was recorded in the cultivar Gorella (151.40 g) under study. However, the minimum fruit yield was noted under control among all the varieties.

Variety Chandler responded maximum effect on fruit yield per plant *i.e.* 462.06 g with the spray of gibberellic acid ( $GA_3$ ) 100 ppm and application of vermicompost @100 q/ha as basal dose which was significantly superior to the others and was followed by Selva, Confictura and Douglas. The least fruit yield (177.79g) was noted in the cultivar Gorella under study. However, the minimum fruit yield was noted under control among all the varieties. Higher number of fruits / plant large berry size and weight of berries in the present study under different combinations of vermicompost and gibberellic acid may be accounted for increase in yield. These observations are also supported by the findings of Verma and Sharma (2010); Hiradeve *et al.* (2011); Athani and Revanappa (2009); Liu *et al.* (2014) and Aubert and Bosc (2014).

#### Yield (q/ha):

The maximum fruit yield per hectare (171.36q/ha) was recorded in the variety Chandler which was followed by Selva and confictura Douglas which were statistically

significant with one another (Table 11). The minimum fruit yield (79.01q/ha) was recorded in Gorella variety. So, it was found to be the lowest in the response of fruit yield.

Observation recorded among the treatments evince that the application of gibberellic acid ( $GA_3$ ) 100 ppm + vermicompost @ 100 q/ha was found to be the best treatment in response to fruit yield among different varieties of strawberry and recorded 144.58 q/ha as per pooled data and was followed by the treatment gibberellic acid ( $GA_3$ ) 50 ppm + vermicompost @ 100 q/ha, gibberellic acid ( $GA_3$ ) 100 ppm + vermicompost @ 50 q/ha and Gibberellic acid ( $GA_3$ ) 25 ppm + vermicompost @ 100q/ha.

Further an observation showed that the variety Chandler responded maximum effect on fruit yield *i.e.* 205.35 q/ha with the spray of gibberellic acid ( $GA_3$ ) 100 ppm and application of vermicompost @ 100 q/ha and was followed by Selva, Confictura and Douglas. The minimum fruit yield was recorded in the cultivar Gorella under study. However, the minimum fruit yield was noted under control among all the varieties. This might be due to the fact that such treatment being rich in nutrients induced good vegetative growth and flower bunch hence, initiated higher number of flowers and per cent fruit set. This could also be attributed to the improvement in the water retention in the medium, better uptake of nutrients and water, which might increase photosynthetic rate causing maximum fruit yield. These observations are supported by the findings of Verma and Sharma (2010) who reported that higher fruit weight was associated with *santulit* vermicompost and farm yard manure applications in apple than the normal soil.

The maximum TSS value (10.68 °Brix) was recorded in the variety Douglas which was followed by Confictura, Selva and Gorella. The minimum total soluble solids (9.41 °Brix) was recorded in Chandler variety (Tabld 12).

Data among the treatments evince that the application of gibberellic acid ( $GA_3$ ) 100 ppm + vermicompost @100 q/ha was found to be the best treatment in response to TSS value among different varieties of strawberry and recorded 10.77 °Brix per pooled data and it was followed by the treatment gibberellic acid ( $GA_3$ ) 50 ppm + vermicompost @ 100 q/ha, gibberellic acid ( $GA_3$ ) 25 ppm + vermicompost @ 100 q/ha and gibberellic acid ( $GA_3$ ) 100 ppm + vermicompost @ 50 q/ha.

Further an observation showed that the variety

Douglas responded maximum effect on TSS fruit yield *i.e.* 11.50 °Brix with the spray of gibberellic acid (GA<sub>3</sub>) 100 ppm and application of vermicompost @ 100 q/ha which was followed by Confictura, Selva (8.87 °Brix) and Gorella. The minimum TSS value was recorded in the cultivar Chandler under study. However, the minimum TSS value was noted under control among all the varieties.

Thakur *et al.* (1991) pointed out that exactly how growth regulators are involved in metabolic reactions which are related to the improvement of fruit quality while working on strawberry. However, they stated that bioregulators at metabolic levels might be regulating the physiological and biochemical processes, seems to be of primary cause of quality improvement in strawberry. Besides above, there was no direct correlation between of growth regulators and protein levels in strawberry fruits. These observations are supported by the findings of Hiradeve *et al.* (2011); Athani and Revanappa (2009); Liu *et al.* (2014) and Aubert and Bosc (2014).

#### Conclusion :

Under present study Chandler, Confictura and selva were found promising for commercial cultivation. However, Gorella was found to be earliest among all.

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