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Effect of fertilizers and planting time on growth and flowering of Zucchini (*Cucurbita pepo* L.) in Assam agro climatic condition

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Abstract
A field experiment was conducted in Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2019-20 with a view to standardized the conducive planting time and fertilizer rates for the growth and flowering of zucchini (*Cucurbita pepo*). The seeds were sown, and the seedlings were transplanted on three planting dates P_1 (1st December); P_2 (15th December); and P_3 (1st January) under four fertilizer treatments applied as basal *viz*. T_0 (control); T_1 (45: 48: 48: NPK Kg/ha); T_2 (60:64:64:NPK Kg/ha); and T_3 (75: 80: 80: NPK Kg/ha). The experiment was laid out in split-plot design with three replications. The results revealed that maximum plant height, number of leaves per plant, plant spread, petiole length, nodal position of the first male flower and female flower, days to initiation of the first male and first female flower, number of male flowers and female flowers per plant were observed in fertilizer treatment (T_3). The minimum sex ratio and highest number of days required from female flower anthesis to harvesting were also recorded in T_3. In respect to date of planting the first planting (P_1 1st December) reflected maximum results for crop growth parameters and flowering attributes, i.e. plant height, number of leaves per plant, plant spread, petiole length, number of female flowers per plant and minimum Sex ratio. Therefore, it is concluded that interaction effect of T_3 P_1 performed best in terms of growth and flowering parameters of zucchini.

Keywords: Zucchini, planting time, fertilizer, growth, flowering

Introduction

Vegetables play an important role in the human diet. It provides essential vitamins and minerals needed by our body for health and is also known as protective food as it can prevent nutritional deficiency disorders and diseases upon consumption. Globally, India is the world's second-largest producer of vegetables next to China. India's vegetable crops occupy 10.35 million hectares, producing 191.77 million tons of vegetables (2019-20). India shares 13.8% of the world's production of vegetables with a productivity of about 18.5 tons per hectare (PIB, 2020) [13]. Zucchini/summer squash is monoecious in nature and considered as an exotic crop of India, originated from North America, having chromosome number 2n = 40. It has been grown widely in different states of India like Haryana, Punjab and Maharashtra. The golden yellow hue zuccchini, are quick-growing and early-yielding cucurbit. The male flower can be identified by its long slender stem with stamen, while the female flower has miniature fruit (ovary) at its base and is borne on a short stem. Fruits are fleshy, unilocular, free central cavity, green, dark green and yellow in colour. Plants are annual bush, trailing habit, shortened internodes, and set fruits in closed succession. Zucchini fruits are often harvested when less than 20 cm long, and the seeds are still soft and immature when used for food. Generally, it is grown in the months of February-March, June-July and October-January in plains and April-May in hills. Planting time is one of the most crucial aspects to produce a successful crop as it influences vegetative growth (Maragal *et al*., 2018) [6] and flowering habit (Agbaje *et al.*, 2012) [1] due to temperature, humidity, rainfall and photoperiodic activity. The planting time also influences the viral disease severity and other pathogen-related infestations (Kone *et al.*, 2017; Mohamed 2011) [5, 7]. Fertilizers too have an impact on crop production and development. Inadequate amounts of the nutrients such as nitrogen, phosphorous and potassium cause poor vegetative growth and poor fruit setting. Nitrogen substantially impacts plant height, stem diameter, number of leaves, leaf area, and yield (Ng'etich *et al.*, 2013) [9].

The Phosphorous fertilizer increase the chlorophyll contents in leaves and enhances its vegetative growth (Tartoura *et al.*, 2014) [15]. The potassium fertilizers also influence the sex expression of squash plants by enhancing the female flower counts (Fekry 2016) [2] as it plays vital role in activating abundant enzymes which enhance photosynthesis. The cucurbitaceous crop zucchini is suitable for cultivation under agro climatic conditions of Assam. Being a new crop in the region the experiment was conducted to find the out the feasible time of planting and optimum fertilizer dose for high and quality production of zucchini in Assam condition.

Materials and Methods

The present study entitled, "Effect of fertilizers and planting time on growth and flowering of Zucchini (*Cucurbita pepo* L.) In Assam agro climatic condition" was conducted in the Experimental farm, Department of Horticulture, Assam Agricultural University, Jorhat located at 26º 47' North latitude, 94º 12' East longitude at an altitude of 86.6 m above MSL during the year 2019-20. The experimental design used was split plot design with three replications. The zucchini variety 'Priyanka' was planted in plot size 1.8m x 1.8m at a spacing of 60cm x 60cm on three different planting dates 1st December, 15th December, 1st January, and fertilizers treatments were given as T_0 (control); T_1 (45:48:48: NPK Kg/ha); T_2 (60: 64: 64: NPK Kg/ha); and T_3 (75:80:80: NPK Kg/ha). The predominant weather condition of Jorhat, Assam, is a sub-tropical climate with hot, humid summer and relatively dry and cool winter. The mean monthly rainfall is about 160.93 mm, unevenly distributed throughout the year. The pre-monsoon shower commences in mid-March, and normal monsoon rain starts from June and continues up to September. The rainfall intensity generally decreases from October onwards and reaches a minimum during December and January. Temperature variation is not extreme, the maximum being around 34.36 °C during summer and the minimum around 7 °C during winter. The experimental area's soil was acidic in nature in of reaction (Table 5). The data recorded from different observations during the field experiment was analyzed statistically using analysis of variance by split-plot design. The significance and non-significance of the variance due to different treatments were determined by calculating the respective F values (Panse and Sukhatme 1978) [12].

Results

Plant height (cm)

Data presented in Table 1 revealed that among all the fertilizer treatments,T_3 at 30 DAT and 60 DAT showed maximum results for plant height (27.02 cm, 61.25 cm), whereas T_0 gave the lowest value (22.86 cm, 49.63 cm) respectively. However, the influence due to planting time and the interaction effect of both planting time and fertilizer levels showed non-significant results.

Number of leaves per plant

The number of leaves (Table 1) at 30 DAT showed significant results, with the highest value (11.97) obtained in P1 and the lowest (10.37) in P3. The number of leaves influenced by fertilizer were found to be significant with highest value showed in T3 (11.94) and lowest in T_0 (10.11). Similarly, at 60, DAT reported the highest number of leaves in first planting P1 (21.92) and higher fertilizer level T_3 (21.94) compared to lowest in P3 (20.37) and T_0 (20.11). The interaction impact of planting time and fertilizer levels on the number of leaves revealed non-significant changes.

Plant spread (m)

The highest plant spread (Table 2) at 30 DAT was obtained in P_1 (0.91 m), and the lowest (0.56 m) in P_3. The maximum plant spread influenced by fertilizer was found in T_3 (0.78 m), and the lowest was found in T_0 (0.63 m). Similarly at 60 DAT the treatments were significantly different with highest data recorded in planting time P_1 (1.00 m), and fertilizer level T_3 (1.00 m), the lowest in P_3 (0.84 m) and T_0(0.83 m).However, the interaction effect of both planting time and fertilizer levels on plant spread showed non-significant results.

Petiole Length (cm)

Petiole length presented in Table 2 showed a significant difference among the treatments influenced by planting time and fertilizers. The highest petiole length was recorded in P_1 (39.37 cm) and the lowest in P_3 (18.95 cm). Similarly, the highest petiole length (30.13 cm) was found in T_3, and the lowest petiole length (23.69 cm) in T_0. The interaction effect T_3 P_1 (43.58 cm) showed highest, and T_0 P_3 (16.91 cm) recorded the lowest for both planting time and fertilizer levels which were significantly different.

Flowering parameters

Days of initiation of the first male flower

The variations of days of initiation of the first male flower influenced by fertilizer were found to be significant. T_3 had the most days of first male flower initiation (27.63), while T_0 had the least days of first male flower initiation (23.25) (Table 2). However, the variations due to planting time and interaction effect were found to be non-significant.

Days of initiation of the first female flower

The days of initiation of the first female flower influenced by fertilizer were found to be significant. Among the treatments the highest days of initiation of first female flower were found in T_3 (37.10), and the lowest in T_0 (29.83) (Table 3). The interaction effect of planting time and fertilizer levels showed non-significant results.

Nodal position of first male flower (cm)

The data (Table 3) revealed that the nodal position of the first male flower influenced by fertilizer were found to be significant. T_3 had the greatest nodal position for the first male bloom (7.05 cm), and T_0 had the lowest (4.88 cm). The treatments as influenced by planting time and the interaction effect showed non-significant results.

Nodal position of the first female flower

The effects of fertilizer (Table 3) on the nodal point of the first female flower resulted significantly higher value in T_3 (16.75 cm), and the lowest was found in T_0 (12.91 cm). The interaction effect for both the factors showed non-significant result.

Number of male flowers per plant

The present data revealed (Table 3) the highest number of male flowers found in P_3 (37.06) and the lowest found in P_1 (33.73). The variations were found to be significantly different. Fertilizer treatment T_3 (35.98) recorded the highest number of male flowers compared to the lowest in control T_0 (35.09). The interaction effect of both planting time and fertilizer levels on the number of male flowers showed non-significant variations.

Number of female flowers per plant

The highest number of female flowers per plant (Table 4) was found in P_1 (8.84), and the lowest in P_3 (7.87). The variations in the number of female flowers obtained lowest in T_0 (8.23) and highest in T_3 (8.61) as influenced by fertilizer. Similarly, the interaction effect of both planting time and fertilizer levels showed lowest number of female flowers in T_0 P_3 (7.77) and highest in T_3 P_1 (8.96).

Sex Ratio

The variations in sex ratio (Table 4) influenced by fertilizer were showed significant result with highest sex ratio in T_0 (4.28), and lowest in T_3 (4.19). The sex ratio data recorded to be lowest in first planting P_1 (3.81) and highest in P_3 (4.70). The interaction effect of both planting time and fertilizer levels on sex ratio showed significant variations amongst the treatments with lowest sex ratio in T_3 P_1 (3.79) and highest in T_1 P_3 (4.72).

Table 1: Influence of planting time and fertilizers on plant height and number of leaves per plant

Treatments	**Plant height (cm)**								**Number of leaves per plant**							
	30 DAT				**60 DAT**				**30 DAT**				**60 DAT**			
Fertilizer levels (T)	**Planting time (P)**				**Planting time (P)**				**Planting time (P)**				**Planting time (P)**			
	P_1 (1st Dec)	**P_2 (15th Dec)**	**P_3 (1st Jan)**	**Mean**	**P_1 (1st Dec)**	**P_2 (15th Dec)**	**P_3 (1st Jan)**	**Mean**	**P_1 (1st Dec)**	**P_2 (15th Dec)**	**P_3 (1st Jan)**	**Mean**	**P_1 (1st Dec)**	**P_2 (15th Dec)**	**P_3 (1st Jan)**	**Mean**
T_0 (control)	22.66	26.66	19.25	22.86	54.41	50.16	44.33	49.63	11.33	9.58	9.41	10.11	21.33	19.58	19.41	20.11
T_1 (45:48:48:NPK Kg/ha)	25.58	22.66	21.75	23.33	57.75	58.25	54.58	56.86	11.41	10.25	10.25	10.63	21.41	20.25	20.25	20.63
T_2 (60:64:64:NPK Kg/ha)	28.91	24.66	19.58	24.38	60.50	57.00	55.41	57.63	12.00	10.62	10.58	11.06	21.80	20.62	20.58	21.00
T_3 (75: 80: 80: NPK Kg/ha)	30.33	28.58	22.16	27.02	59.31	62.08	57.08	61.25	13.16	11.41	11.25	11.94	23.16	21.41	21.25	21.94
Mean	26.87	25.64	20.68		59.31	56.87	52.85		11.97	10.46	10.37		21.92	20.46	20.37	
	Result	S.E.M±	$C.D_{5\%}$		Result	S.E.M±	$C.D_{5\%}$		Result	S.E.M±	$C.D_{5\%}$		Result	S.E.M±	$C.D_{5\%}$	
Planting time (P)	NS	-	-		NS	-	-		SIG	0.31	1.26		SIG	0.30	1.23	
Fertilizer levels (T)	SIG	0.95	2.86		SIG	1.27	3.80		SIG	0.17	0.51		SIG	0.16	0.49	
Interactions (PXT)	NS	-	-		NS	-	-		NS	-	-		NS	-	-	
T_P	-	2.88	-		-	3.16	-		-	0.62	-		-	0.61	-	
P_T	-	2.03	-		-	2.48	-		-	0.40	-		-	0.39	-	

* NS = non-significant; SIG = significant; C. $D_{5\%}$ = critical difference at 5%; S.E.M+ = standard mean error; T_P = factor (T) at the same level of P; P_T = factor (P) at the same level of T; N = Nitrogen; P = Phosphorous; K = Potassium; Dec = December, Jan = January, Kg = kilograms; Ha = hectare

Table 2: Influence of planting time and fertilizers on plant spread, petiole length and days of initiation of first male flower

Treatments	**Plant spread (m)**								**Petiole length**				**Days of initiation of first male flower**			
	30 DAT				**60 DAT**				**30 DAT**							
Fertilizer levels (T)	**Planting time (P)**				**Planting time (P)**				**Planting time (P)**				**Planting time (P)**			
	P_1 (1st Dec)	**P_2 (15th Dec)**	**P_3 (1st Jan)**	**Mean**	**P_1 (1st Dec)**	**P_2 (15th Dec)**	**P_3 (1st Jan)**	**Mean**	**P_1 (1st Dec)**	**P_2 (15th Dec)**	**P_3 (1st Jan)**	**Mean**	**P_1 (1st Dec)**	**P_2 (15th Dec)**	**P_3 (1st Jan)**	**Mean**
T_0 (control)	0.82	0.59	0.48	0.63	0.93	0.81	0.75	0.83	33.58	20.58	16.91	23.69	23.50	23.41	22.83	23.25
T_1 (45: 48: 48: NPK Kg/ha)	0.89	0.64	0.52	0.68	0.98	0.93	0.82	0.91	37.91	22.91	17.91	26.25	24.58	24.41	24.16	24.38
T_2 (60: 64: 64: NPK Kg/ha)	0.94	0.69	0.59	0.74	1.01	0.97	0.90	0.96	42.41	24.83	19.50	28.91	25.41	25.33	26.41	25.72
T_3 (75: 80: 80: NPK Kg/ha)	0.97	0.75	0.64	0.78	1.08	1.01	0.92	1.00	43.58	25.33	21.50	30.13	27.667	27.917	27.333	27.63
Mean	0.91	0.67	0.56		1.00	0.93	0.84		39.37	23.41	18.95		25.29	25.27	25.18	
	Result	S.E.M±	$C.D_{5\%}$		Result	S.E.M±	$C.D_{5\%}$		Result	S.E.M±	$C.D_{5\%}$		Result	S.E.M±	$C.D_{5\%}$	
Planting time (P)	SIG	0.033	0.13		SIG	0.02	0.08		SIG	1.56	6.29		NS	-	-	
Fertilizer levels (T)	SIG	0.012	0.03		SIG	-	0.02		SIG	0.50	1.5		SIG	0.23	0.70	
Interactions (PXT)	NS	-	-		NS	-	-		SIG	-	-		NS	-	-	
T_P	-	0.066	-		-	0.042	-		-	3.12	-		-	0.46	-	
P_T	-	0.038	-		-	0.025	-		-	6.65	-		-	0.42	-	

*NS = non-significant; SIG = significant; $C.D_{5\%}$ = critical difference at 5%; S.E.M+ = standard mean error; T_P = factor (T) at the same level of P; P_T = factor (P) at the same level of T; N = Nitrogen; P = Phosphorous; K = Potassium; Dec = December, Jan = January, Kg = kilograms; Ha = hectare

Table 3: Influence of planting time and fertilizers on days of initiation of first female flower, nodal position of first male and female flower and total number of male flowers

Treatments	Days of initiation of first female flower				Nodal position of first male flower (cm)				Nodal position of first female flower (cm)				Total number of male flowers per plant			
Fertilizer levels (T)	Planting time (P)				Planting time (P)				Planting time (P)				Planting time (P)			
	P_1 (1st Dec)	P_2 (15th Dec)	P_3 (1st Jan)	Mean	P_1 (1st Dec)	P_2 (15th Dec)	P_3 (1st Jan)	Mean	P_1 (1st Dec)	P_2 (15th Dec)	P_3 (1st Jan)	Mean	P_1 (1st Dec)	P_2 (15th Dec)	P_3 (1st Jan)	Mean
T_0 (control)	25.16	29.70	34.58	29.83	5.25	5.00	4.41	4.88	12.25	12.83	13.66	12.91	33.46	35.26	36.54	35.09
T_1 (45: 48: 48: NPK Kg/ha)	30.00	31.00	35.50	32.16	4.83	5.58	4.83	5.08	13.33	12.00	14.75	13.36	33.57	35.47	37.09	35.38
T_2 (60: 64: 64: NPK Kg/ha)	31.58	33.41	36.66	33.88	6.25	5.43	5.66	5.78	14.08	14.83	15.16	14.69	33.84	36.40	37.23	35.72
T_3 (75: 80: 80: NPK Kg/ha)	34.91	35.98	40.41	37.10	7.33	7.08	6.75	7.05	15.83	16.66	17.75	16.75	34.04	36.52	37.37	35.98
Mean	30.41	32.53	36.79		5.91	5.77	5.41		13.87	14.08	15.33		33.73	35.84	37.06	
	Result	S.E.M±	$C.D_{5\%}$		Result	S.E.M±	$C.D_{5\%}$		Result	S.E.M±	$C.D_{5\%}$		Result	S.E.M±	$C.D_{5\%}$	
Planting time (P)	NS	-	-		NS	-	-		NS	-	-		SIG	0.40	1.62	
Fertilizer levels (T)	SIG	0.68	2.05		SIG	0.18	0.55		SIG	0.41	1.25		SIG	0.08	0.25	
Interactions (PXT)	NS	-	-		NS	-	-		NS	-	-		NS	-	-	
T_P	-	2.80	-		-	1.09	-		-	2.96	-		-	0.80	-	
P_T	-	1.74	-		-	0.61	-		-	1.61	-		-	0.42	-	

*NS = non-significant; SIG = significant; $C.D_{5\%}$ = critical difference at 5%; S.E.M+ = standard mean error; T_P = factor (T) at the same level of P; P_T = factor (P) at the same level of T; N = Nitrogen; P = Phosphorous; K = Potassium; Dec = December, Jan = January, Kg = kilograms; Ha = hectare

Table 4: Influence of planting time and fertilizers on total number of female flowers and sex ratio

Treatments	Total number of female flowers per plant				Sex ratio			
Fertilizer levels (T)	Planting time (P)				Planting time (P)			
	P_1 (1st Dec)	P_2 (15th Dec)	P_3 (1st Jan)	Mean	P_1 (1st Dec)	P_2 (15th Dec)	P_3 (1st Jan)	Mean
T_0 (control)	8.73	8.18	7.77	8.23	3.83	4.30	4.70	4.28
T_1 (45: 48: 48: NPK Kg/ha)	8.79	8.27	7.85	8.30	3.81	4.28	4.72	4.27
T_2 (60: 64: 64: NPK Kg/ha)	8.90	8.64	7.92	8.49	3.80	4.18	4.70	4.22
T_3 (75: 80: 80: NPK Kg/ha)	8.96	8.91	7.96	8.61	3.79	4.09	4.69	4.19
Mean	8.84	8.50	7.87		3.81	4.21	4.70	
	Result	S.E.M±	$C.D_{5\%}$		Result	S.E.M±	$C.D_{5\%}$	
Planting time (P)	SIG	0.012	0.04		SIG	0.042	0.168	
Fertilizer levels (T)	SIG	0.01	0.03		SIG	0.012	0.035	
Interactions (PXT)	SIG	-	-		SIG	-	-	
T_P	-	0.02	0.05		-	0.083	0.079	
P_T	-	0.01	0.06		-	0.045	0.175	

*NS = non-significant; SIG = significant; $C.D_{5\%}$ = critical difference at 5%; S.E.M+ = standard mean error; T_P = factor (T) at the same level of P; P_T = factor (P) at the same level of T; N = Nitrogen; P = Phosphorous; K = Potassium; Dec= December, Jan = January, Kg = kilograms; Ha = hectare

Table 5: Chemical properties of the experimental soil before planting (Soil test based report)

Particulars	Values	Results	Methods used
Available N (Kg/ha)	163.07	Low	Kjeldahl Method (Jackson, 1973) [4]
Available P_2O_5 (kg/ha)	56.67	High	Bray's-I Method (Jackson, !973) [4]
Available K_2O (Kg/ha)	116.21	Low	Flame Photometric Method (Jackson, 1973) [4]
pH	5.1		Glass Electrode Method (Jackson, 1973) [4]
Organic Carbon (%)	0.43		Walkey and Black Method (Jackson, 1973) [4]

Discussion

The influence of plating time on plant height showed non-significant variations, while a higher level of fertilizer treatments significantly increased plant height. This might be due to better utilization of carbon synthesis that further assimilates the formation and translocation of carbohydrates in the plants. Similarly, higher levels of fertilizers might have enhanced vegetative growth leading to more leaves per plant and plant spread. The findings commemorate the results in watermelon that revealed that the fertilizer rate of 200 kg NPK/ha showed the highest plant height and number of leaves than the other doses and the control (Sabo *et al.*, 2013) [14]. The number of leaves and plant spread significantly varied due to the influence of planting time, as the more sunshine hours and cooler temperature owed to better vegetative growth. This might be due to smaller quantities photosynthates are utilized for respiration in short dark hours, and a large portion of photosynthates are being used up for luscious vegetative growth. Similar observations were obtained in spaghetti squash (Wadas and Kalinowski 2010) [16] studied in Poland, where the highest yield per hectare was noticed on the earlier sowing date. The higher dose of fertilizer, especially nitrogen and more sunshine hours in the early planting favors healthy vegetative growth owing to an increase in petiole length. It is evident from the trend of the study that there was a delay in initiation of the first male flower in P_1 in contrast to later plantings P_2 and P_3, although days of initiation of the first female flower were high in P_1. The variations of days of initiations of male and female flowers and their respective nodal positions, which denote the earliness of flowering, were insignificant. Fertilizer treatment T_3 was recorded with maximum nodal positions of male and female flowers and minimum in T_0. Higher dose of fertilizer application T_3 significantly increased days of initiations of both the first male and female flower. This might be due to excess and faster vegetative growth, which resulted delay in the reproductive phase of the crop. The work done on watermelon also showed more numbers of female flowers per vine (14.50) in higher fertilizer dose 90: 55: 90 kg NPKha^{-1} (Hazarika *et al.*, 2012) [3] and the highest number of female flowers (8.06) of zucchini was obtained in fertilizer treatment of 100: 50: 50 kg NPKha^{-1} (Narke *et al.*, 2015) [8]. The results concerning the total number of male and female flowers per plant and the sex ratio may be attributed to the promotion of flowers with increased nitrogen and phosphorous fertilizers. High nitrogen levels increase the carbon dioxide assimilation, while phosphorous prevents premature leaf fall and encourages new shoots or branches. Thus delays the overall life span of the crop owing to increase in total number of male and female flowers per plant. Such results were found to be in conformity with the findings of Niyokuri *et al.*, 2013 [10] where, number of male and female flowers was found to be more between 13.9-30% and 7.5-63.5%, respectively, compared to the control under fertilizer treatment 120 kg Nha^{-1} in zucchini. The female flowers were found to be significantly higher in 1st December planting P_1 (8.84), followed by P_2 (8.50) and P_3 (7.87). On the contrary, the prevalence of male flowers per plant were significantly more in the later plantings P_3 (37.06) followed by P_2 (35.84) and P_1 (33.73). This might be due to the instability of the male flowers of cucurbits in response to a higher temperature. Besides, the interaction effect on producing a total number of female flowers per plant was significant. It is statistically evident that the increase in female flowers per plant with a higher level of fertilizers led to a significant decrease in sex ratio. In addition, the increase in male flowers per plant in the later planting time led to a significant increase in the sex ratio. Oloyede and Adebooye 2005 [11], revealed similar results in *Trichosanthes cucumeria*, where a lower number of aborted flowers and a higher number of flowers were recorded in the early season (April-July) compared to the late season (Aug-Nov).

Conclusion

In conclusion, the present experiment portrayed that a higher level of fertilizer treatment (T_3; 75: 80: 80 NPK kg/ha) gave the best results for growth parameters and flowering parameters. Planting time of zucchini in P_1 (1st December) gave better results for growth parameters, i.e. a number of leaves, plant spread and petiole length. Among the flowering parameters, the sex ratio was found to be best in earlier planting (P_1), which in turn is responsible for more fruits per plant and consequently enhances the crop yield. Besides, the interaction effects of planting time and fertilizer varied significantly on petiole length, the total number of female flowers per plant and the sex ratio. Therefore, zucchini performs better in relatively cooler climatic condition and responsive to higher fertilizer dose.

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