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Response of fertilizer and planting time on yield and economics of Zucchini (*Cucurbita pepo*) in Assam condition

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Abstract

In the agricultural sector, the vitally important factors to achieve higher production in a crop are fertilizer management and planting time. To maintain healthy plant growth and to boost crop production and productivity, fertilizer application, and planting dates have a pivotal role in the present scenario of climate change. However, the effect of fertilizer and planting dates on zucchini in agro-climatic conditions of Assam has not been properly studied. So, during the year 2019-20, it was assessed in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat. Four fertilizer treatments 45: 48: 48 kg NPK/ha, 60: 64: 64 kg NPK/ha, 75: 80: 80 kg NPK/ha and keeping one treatment as control with three planting dates 1st December, 15th December, 1st January was imposed in twelve treatment combinations. The zucchini seedlings were planted at a 60 cm x 60 cm distance in a plot size of 3.24 m^2 in a split-plot design. During the growing period, the diameter of fruit, length of fruit, weight of fruit, number of days to opening of flower to harvest, number of days to first harvest, number of days to last harvest, number of harvests, number of fruits per plant and fruit yield per plant/ plot/ hectare were recorded. From this trial, it is concluded that early planting and maximum fertilizer dose were better in terms of the above physical and yield attributes. Therefore, based on the findings of the experiment, it is hereby inferred that planting of zucchini on the 15th of December with a fertilizer dose of 75: 80: 80 kg NPK/ha showed the best result with maximum yield (82.59 t) per hectare area with (3.46) B:C ratio in Assam growth condition.

Keywords economics, fertilizers, planting dates, production, yield, zucchini

Introduction

India is considered a vegetarian country as 40% of the population is vegetarian and hence vegetables are an elementary part of agriculture which plays a significant role in food and nutritional security [1]. In India due to the large growing population, demand for vegetables is also increasing. Consumption of vegetables provides taste, and delectability, increases appetite, provides fiber for digestion, and helps to relieve constipation problems. The North Eastern region of India is full of flora and fauna and suitable for the cultivation of a wide range of vegetables. Among the seasonal vegetables zucchini or squash (*Cucurbita pepo* L.), is considered a highly polymorphic exotic vegetable crop, cultivated all over the world [2] for its economic importance and nutritional value [3].

They are low in calories but rich in vitamins, minerals, phenolic compounds, micronutrients, carotenoids, and antioxidants that are beneficial for the development of human health [4]. It has also anti-radical, anti-carcinogenic, anti-inflammatory, antiviral, antimicrobial, and analgesic properties [5] for which it is used for medication of the common cold and pain relief [6]. Whitaker and Bohn in 1950 [7] defined Zucchini as the "edible fruit" used as table fruit when immature. Different value-added products like candied fruits and snacks are also produced from zucchini due to the easy digestibility of carbohydrates [8]. This exotic crop is popularized in India due to its health benefit properties, good yield, soil and climatic conditions. The optimum temperature for zucchini cultivation is ranging from 24°C-27°C. Zucchini cultivation in the greenhouse is also increasing due to the high demand for fresh fruits throughout the year in the local and international markets [9]. To get a successful crop the most crucial aspect is the planting time as it exerts influence on vegetative growth, flowering habit, and quality of fruits and allows the plant to grow and respond over a certain quantum of period and produce more yield. Similarly, fertilizers have an impact on crop development, production, color, form, size, flavor, shelf life, and processing qualities. Due to poor and inconsistent use of fertilizer multiple nutritional deficits have emerged, causing poor vegetative growth and fruit development, unsatisfactory fruit quality, and low nutritional quality [10]. Therefore, efficient use of water and fertilizer is of utmost importance to fulfill the anticipated expanding demand of an ever-increasing population. Though the agro climatic condition of Assam is ideal for zucchini production, its growth, and development are veritably unknown under Assam geographic conditions. Considering its importance in human diet and market demand this experiment was intended to be carried out to standardize the agricultural practices of zucchini cultivation in Assam region.

Methodology

The climate of Assam is tropical to sub-tropical type with heavy monsoon and high humidity. The pre-monsoon rainfall starts from Feb-March and continues up to September. The soil type is highly fertile with an acidic nature suitable for the cultivation of all types of vegetables. During the year 2019-20 the current investigation entitled, "Response of fertilizer and planting time on yield and economics Zucchini (*Cucurbita pepo*) in Assam condition" was carried out in split plot design. Seedlings were raised in the polybags containing garden soil and organic manure in a 1:1 ratio as a growing medium treated with fungicides (Carbendazim 12% + Mancozeb 63% WP). After germination, the seedlings were sprayed with NPK 19-all at the rate of 2g/L to provide nutrients. Fifteen to twenty days old seedlings were transplanted on three planting dates: 1st of December, 15th of December, and 1st of January in the main field at a spacing of 60 cm x 60 cm treated with three fertilizer levels 45: 48: 48; 60: 64: 64 and 75: 80: 80 NPK kg/ha which were applied as basal at the time of land preparation. To keep the plots free from weeds mulching was done with synthetic mulching material. All the relevant data including fruit diameter(cm), length of fruit (cm), fruit weight (g), number of days required from opening of female flowers to harvesting, days to first harvest, number of harvests, number of fruits per plant, fruit yield per plant (kg), fruit yield per plot (kg), fruit yield per hectare (t) were collected from randomly selected five numbers of plant from each plot size of 1.8m x 1.8m which were statistically analyzed. The significance and non-significance of the variance due to different treatments were determined by calculating the respective F values. The significance of the difference between the mean values of the characters of the treatments was tested by computing critical difference (CD).

Results and Discussion

Data on the physical parameters of zucchini (cv. Priyanka) under the effect of fertilizers and planting time are presented in Table 1. The fertilizer effect on fruit diameter, fruit length and fruit weight were showed significant results. Whereas, the effect of planting time on fruit weight and fruit length showed non-significant results except for fruit diameter. The later planting (P_1) treated with 75: 80: 80 NPK kg/ha (T_3) recorded maximum fruit diameter (5.38 cm, 5.33 cm), fruit length (18.98 cm, 18.74 cm), and fruit weight (303.07 g, 350.18 g) respectively. These results are in accordance with the results of Waseem et al., [11] who reported maximum fruit length, and vine length in cucumber at a high dose (100 kg N/ha) of nitrogen

fertilizer. However, the interaction effect (Table 2) of fertilizer and planting time on fruit length and fruit weight was significant except for fruit diameter, which was non-significant. This effect might be due to high carbon dioxide assimilation as the photosynthetic rate increases with a greater number of chlorophyll synthesis induced by the supply of nitrogen fertilizers and congenial climatic conditions. Higher levels of phosphorous fertilizers help in the translocation of carbohydrates from source to sink which leads to better growth and development of fruits. These results are supported by the findings of Hamaad [12] in squash; Niyokuri et al., [13] in zucchini; Shareef et al., [14] in summer squash.

Table 1. Effect of fertilizer and spacing on yield parameters

Treatments	Fruit Diameter (cm)	Fruit length (cm)	Fruit weight (g)	Days to the opening of flower to harvest	Days to first harvest	Days to last harvest
Fertilizers						
T_o	4.71	16.53	243.70	7.77	54.66	66.39
T_1	4.88	17.61	270.08	7.86	55.98	66.78
T_2	5.07	18.36	295.61	7.91	56.29	67.39
T_3	5.33	18.74	350.18	8.01	56.93	68.60
SEm ±	0.07	0.228	2.79	-	0.06	0.02
CD 5%	0.211	0.684	8.36	0.02	0.18	0.06
Planting time						
P_1	5.38	18.98	303.07	7.85	53.67	67.36
P_2	4.93	17.63	292.07	7.89	57.00	67.31
P_3	4.67	16.81	274.54	7.92	57.23	67.19
SEm ±	0.095	-	6.41	0.01	0.06	0.02
CD 5%	0.395	-	-	0.04	0.26	0.09

Table 2. Interaction effect of fertilizer and spacing on yield parameters

Interaction Treatments	Fruit Diameter (cm)	Fruit length (cm)	Fruit weight (g)	Days to the opening of flower to harvest	Days to first harvest	Days to last harvest
T_0P_1	5.12	16.64	249.41	7.72	52.64	66.48
T_0P_2	4.66	16.94	242.44	7.79	55.47	66.44
T_0P_3	4.36	16.03	239.24	7.80	55.86	66.24
T_1P_1	5.26	18.65	289.53	7.81	53.60	66.93
T_1P_2	4.77	17.46	272.47	7.88	57.08	66.87
T_1P_3	4.61	16.73	248.23	7.89	57.27	66.56
T_2P_1	5.44	19.90	318.73	7.88	54.16	67.17
T_2P_2	5.00	17.71	291.51	7.90	57.32	67.12
T_2P_3	4.76	17.46	276.59	7.96	57.41	67.90
T_3P_1	5.72	20.76	354.60	7.99	54.30	68.87
T_3P_2	5.30	18.41	361.86	8.01	58.12	68.84
T_3P_3	4.98	17.04	334.09	8.04	58.38	68.08
SEm ±	0.19	0.97	12.82	0.023	0.13	0.04
CD 5%	-	1.45	18.01	-	0.36	0.12

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that the number of days to opening of flower to harvesting, the number of days to the first harvest, and the number of days to the last harvest (Table 1) showed significant results due to the effect of planting time and fertilizer. It can be revealed from the findings that the plants subjected to higher fertilizer dose and later planting took maximum days to opening of flower to harvest (8.01 and 7.92) and minimum days (7.77 and 7.85) in lesser fertilizer dose and early planting respectively. The fertilizer effect on days to the first harvest was recorded early (54.66) and days to the last harvest were the least (66.39) in T_0. Whereas, the number of days to the first harvest and the number of days to the last harvest showed maximum value in T_3(56.93, 68.60) respectively. The effect of planting time on days to first harvest was recorded minimum in P_1(53.67) and maximum in P_3(57.23) and days to last harvest obtained maximum in

P_1(67.36) and minimum in P_3(67.19). This result could be attributed to an increase in the juvenile phase and utilization of higher levels of nitrogen and phosphorous in the production of vegetative parts that led to a delay in the opening of female flowers as well as a delay in the first and last harvest. However, in the later plantings, higher temperature induces more staminate flowers and adversely affects fruit set owing to delay in first harvesting. The interaction effect (Table 2) of both planting times and fertilizers on the number of days to first harvest and last harvest showed significant results whereas the same showed non-significant results on the number of days to opening of flower to harvest. Similar results were reported by Hem [15], and Narke et al., [16] in zucchini. Table 3 shows the effect of fertilizer and planting time on the number of harvests. The results revealed that the number of harvests recorded more in early planting (P_1 9.22) and higher level of fertilizers (T_3 9.20) and less in late planting and low fertilizer dose. Such an effect is attributed to the long juvenile phase and healthy vegetative growth with the higher number of female flowers due to higher fertilizer application. In addition, the optimum temperature and long sunshine hours prevailed during early planting which encouraged a greater number of female flowers. The effect of the interaction of fertilizer and planting time on the number of harvests (Table 4) was significantly higher in T_3P_1(9.29) followed by T_2P_1 and T_1P_1. These results are in accordance with those of NeSmith et al., [17] in summer squash; Hazarika et al., [18] in watermelon; and Jilani et al., [19] in cucumber. It is evident from Table 3 that a significant maximum number of fruits per plant was observed in the first planting (P_1, 8.16) and higher levels of fertilizers (T_3, 8.21).

Table 3 Effect of fertilizer and spacing on yield parameters

Treatments	Number of harvests	No of fruits per plant	Fruit yield per plant (kg)	Fruit yield per plot (kg)	Fruit yield per hectare (ton)
Fertilizers					
T_o	8.89	7.91	1.93	17.36	53.60
T_1	8.92	8.06	2.17	19.61	60.53
T_2	9.08	8.16	2.41	21.72	67.05
T_3	9.20	8.21	2.87	25.90	79.94
SEm ±	0.005	0.009	0.02	0.20	0.64
CD 5%	0.01	0.028	0.07	0.62	1.92
Planting Time					
P_1	9.22	8.16	2.48	22.32	68.85
P_2	9.13	8.07	2.36	21.28	65.68
P_3	8.72	8.02	2.20	19.86	61.31
SEm ±	0.005	0.009	0.05	0.46	1.43
CD 5%	0.02	0.036	0.20	1.87	5.76

The same trend was also observed in treatment combination T_3P_1 (Table 4) with the maximum number of fruits (8.27). This might be due to the availability of higher nutrients and an increase in fruit set due to congenial climatic conditions in December planting. Analogous reports were obtained by Jan et al. [20] in bottle gourd and Karde [21] in zucchini. Amino acids are the precursor of growth substances and the direct application of amino acids and their products stimulates nitrogen uptake and assimilation [22] that support plant growth and nutrient availability. The use of amino acids as plant hormones for both plant and soil microorganisms gives rise to the transportation and absorption of nutrients in the inner part of the plant making the cell membrane permeable [23]. It is noticeable from Tables 3 and 4 that higher levels of fertilizer T_3 treatments and first planting P_1 showed better results for the parameters in terms of fruit yield per plant (2.87kg, 2.48 kg), per plot (25.90kg, 22.32kg) and thereby fruit yield per hectare (79.94 t, 68.85 t) respectively. The results are consistent with the findings of Brahma et al., [24], Singh [25], and Ouda et al., [26]. The application of increased levels of NPK accelerated nutrient uptake to plants leading to an increase in the rate of photosynthesis and supply of sugar and starch to plants increasing the fruit weight and total yield per hectare. Thereby the interaction treatment T_3P_2 (82.59 t) followed by T_3P_1 (81.49 t) showed maximum yield per hectare area with the highest B:C of 3.46 and 3.40 respectively. This is ascribed to higher fruit numbers per plant and an increase in fruit length, diameter, and weight.

These results corroborated with the findings of Maluki et al., [27] in watermelon and Eifediyi and Remison [28] in cucumber.

Table 4 Interaction effect of fertilizer and spacing on yield parameters

Interaction	Number of harvests	No of fruits per plant	Fruit yield per plant (kg)	Fruit yield per plot (kg)	Fruit yield per hectare (ton)	B:C
T_0P_1	9.12	8.06	2.01	18.10	55.88	2.13
T_0P_2	9.05	7.86	1.91	17.15	52.95	1.97
T_0P_3	8.52	7.82	1.87	16.84	51.97	1.91
T_1P_1	9.20	8.12	2.35	21.16	65.33	2.58
T_1P_2	9.11	8.08	2.20	19.81	61.15	2.35
T_1P_3	8.46	7.99	1.98	17.85	55.11	2.02
T_2P_1	9.27	8.21	2.61	23.56	72.72	2.96
T_2P_2	9.17	8.15	2.37	21.39	66.02	2.59
T_2P_3	8.80	8.12	2.24	20.22	62.41	2.40
T_3P_1	9.29	8.27	2.97	26.40	81.49	3.40
T_3P_2	9.20	8.21	2.93	26.76	82.59	3.46
T_3P_3	9.12	8.16	2.72	24.54	75.76	3.09
SEm ±	0.01	0.01	0.10	0.92	2.86	-
CD 5%	0.02	0.05	0.14	1.33	4.12	-

Conclusion

Based on the results of the current investigation it can be concluded that early planting on the 1st December combined with the application of fertilizer 75: 80: 80 kg NPK/ha exhibited marked influence on yield and physical attributes of zucchini. Hence, T3P1 and T3P2 treatment combinations can be recommended to get a high yield with a maximum benefit-cost ratio in the Assam condition.

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