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Effect of Spacing and Fertilizer Levels on Flowering and Yield of Zucchini (*Cucurbita pepo* L.)

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Zucchini (*Cucurbita pepo* L.) belongs to the family Cucurbitaceae and has been regarded as a highly polymorphic vegetable. A field research was conducted to study the effect of spacing and fertilizer levels on flowering and yield of zucchini. Trial was conducted in a split plot design with four spacing and three nitrogen levels. The parameters assessed were flowering and yield characters. Results showed that the interaction effects of spacing and nitrogen treatments had significant effect on flowering and yield traits. Highest number of female flowers (8.85), lowest sex ratio (15.33), highest number of fruits per plant (8.21), fruit yield per plant (3.86 kg), yield per plot (138.45 kg) and yield per hectare (74.78 t) was recorded in S_2 (60cm x 60cm). Among the various nitrogen levels, treatment N_3 (150 kg N ha^{-1}) produced maximum days to last harvest (68.05 days), highest number of fruits per plant (6.66), fruit yield per plant (3.19 kg), yield per plot (99.82 kg) and yield per hectare (53.9 t). Treatment combination S_2N_3 (60 cm x 60 cm and 150 kg N ha^{-1}) produced significantly highest number of fruits per plant (8.26), fruit yield per plant (3.92 kg), yield per plot (139.94 kg) and yield per hectare (75.59 t). Based on the results of this study, it is recommended to apply 150 kg N ha^{-1} and follow 60 cm x 60 cm spacing for getting highest production of Zucchini.

*(**Key words**: Fertilizer, Spacing, Flowering, Yield, Zucchini)*

Zucchini (*Cucurbita pepo* L.) belongs to the family Cucurbitaceae and has been regarded as a highly polymorphic vegetable grown during summer in tropical and subtropical conditions and harvested when the fruits are physiologically immature (Kathiravan *et al*., 2006). Zucchini has its origin in America and is available in the market in yellow, light green or green colors. It is eaten as vegetable, either boiled or fried or stuffed. A basic concern during crop production is determining the optimum plant population for maximum yield and fruit quality (Bleasdale, 1966). The use of optimum spacing in crop production is very important because it reduces competition for sunlight, water and fertilizers between weeds and plants.

Therefore, plant population can affect the yield directly or indirectly. Fertilizers influence growth yield and quality of horticultural crops, particularly colour, shape, size, taste, shelf life and processing characteristics. Nitrogen is an essential nutrient for crop production and important for plant growth. Konkan region of Maharashtra is well known for cucurbitaceous crops and zucchini being a member of cucurbitaceous family is much suitable for cultivation under agro-climatic conditions of Konkan. Being a new crop for this region, there is need for standard cultivation practices. Therefore, this experiment was conducted to find out the best spacing and fertilizer N level and to formulate an economic nutrient management schedule for zucchini in Konkan's lateritic soil.

MATERIALS AND METHODS

The present investigation was conducted at Educational Research Farm, Department of Horticulture, College of Agriculture, Dapoli, during *rabi* season of 2015-2016. The experiment was laid out in split plot design with four main treatments *i.e*. spacing S_1 (45 x 60 cm), S_2 (60 x 60 cm), S_3 (90 x 60 cm), S_4 (90 x 90 cm) and three sub-plot treatments *i.e.* nitrogen levels: N_1 -100 kg N ha^{-1}, N_2 - 125 kg N ha^{-1} and N_3 - 150 kg N ha^{-1}. Thus, in all 12 treatment combinations were replicated thrice. The basal application of required fertilizer doses as per treatment details was done. The remaining dose of nitrogen was applied in two splits *i.e.* 20 and 40 days after transplanting as per treatment details through urea. Crop was sown in portrays containing sterilized cocopeat as growing medium. Sixteen days old seedlings were transplanted on flatbed as per treatment details. Observation on flowering behavior and yield characters were recorded from five randomly selected plants of each

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treatment and replication. Data was statistically analysed for the effect of spacing and fertilizer levels on flowering and yield of zucchini as per the methods prescribed by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Effect of spacing

Data presented in Table 1 revealed that the days for initiation of first female flower, number of days required from opening of female flower to harvesting, total number of male and female flowers, sex ratio varied significantly except days of initiation of first male flower and nodal position. Highest number of male flowers was observed in S_1 (136.11), whereas highest number of female flowers (8.85) was recorded in S_2 and the lowest number of female flowers (6.94), as well as lowest number of male flower (112.32) was observed in S_4. Further, the lowest days required from opening of female flower to harvesting (6.74 days) were also observed in S_4 whereas, the highest (8.23 days) in S_1. The lowest sex ratio (15.33) was recorded in S_2 and highest (17.06) in S_1.

Data presented in Table 2 revealed the significant effect of spacing on yield. The lowest number of days required for first harvest (32.70 days) and the highest days to last harvest (69.89 days) was recorded in wider spacing S_4 whereas, the highest days to first harvest (36.50 days) and the lowest days (66.01 days) was recorded in very close spacing S_1. Significantly maximum number of harvest (9.20) was recorded in S_4. However, maximum number of fruits per plant (8.21), fruit yield per plant (3.86 kg), yield per plot (138.45 kg), and yield per hectare (74.78 t) was recorded in spacing S_2. Whereas, lowest number of fruits per plant (5.15), fruit yield per plant (2.45 kg), yields per plot (39.27 kg), yield per hectare (21.21 t) was recorded at wider spacing of S_4.

In case of S_2, early completion of vegetative growth and early flowering and more number of female flowers might be due to suitable plant population. Similar results were also reported by Sabo *et al*. (2013) in watermelon and Narke *et al*. (2015) in zucchini.

Effect of nitrogen levels

While observing flowering behavior various nitrogen levels had non-significant effect on days for initiation of first male and female flowers, total number of male flowers and days required from opening of female flower to harvesting. However significant variation was recorded for total number of female flower and sex ratio. N_1 recorded in highest (8.11) total number of female flowers and the lowest in N_3 (8.00). Similarly, the lowest sex ratio was recorded in N_1 (15.82) and highest in N_3 (16.28).

Different nitrogen levels applied under this study had significant effect on the yield and yield contributing character except number of harvest. Maximum days to first harvest (34.30 days), days to last harvest (68.05 days), number of fruits per plant (6.66), fruit yield per plant (3.19 kg), yield per plot (99.82 kg), and yield per hectare (53.91 t) was observed in N_3 whereas, lowest days to first harvest (33.64 days), days to last harvest (66.53 days) , number of fruits per plant (6.40), fruit yield per plant (3.03 kg), yield per plot (94.58 kg) and yield per hectare (51.08 t) was observed in N_1. Nitrogen had been reported to produce more male flowers as compared to female flowers. Increased levels of nitrogen resulted in highest fruit length diameter, weight and resulted in more yield. These findings were in close conformity with those reported by Agbaje *et al.* (2012) in pumpkin, Ng'etich *et al.* (2013), Karde *et al*. (2014) and Narke *et al.* (2015) in zucchini.

Effect of interactions

The interaction of N dose and spacing on the yield of zucchini was statistically significant. Among various treatment combinations significant difference for total number of female flowers and sex ratio was recorded. S_2N_1 (8.92) recorded the highest female flowers. Further, the lowest sex ratio was recorded in S_2N_1 (15.13) and highest in S_1N_1(17.27), whereas observation on other flowering behaviour *viz.,* days for initiation for flowering, total number of male flower, nodal position of flower showed non-significant effect. Interaction of spacing S_2 (60 x 60 cm) and nitrogen level N_3 (150 kg N ha^{-1}) showed significant difference. The highest number of fruits per plant (8.27), highest fruit yield per plant (3.92 kg) highest yield per plot (139.94 kg) and highest yield per hectare (75.59 t) was noticed in S_2N_3. The result of the study revealed that flowering and yield of zucchini can be enhanced by the application of optimum nitrogen dose and spacing. The results are in close conformity with the findings of Sabo *et al.* (2013) in watermelon, who reported increase in flowering, number of fruits and yield component of watermelon due to optimum spacing and increased level of NPK.

Table 1. *Effect of spacing and nitrogen levels on flowering of zucchini (Cucurbita pepo L.)*

Treatments	Days for initiation		Nodal Position		Total Number of		Sex ratio	Days required from opening of female flower to harvesting
	1st Male Flower	1st Female Flower	1st Male Flower	1st Female Flower	Male Flower	Female Flower		
Spacing Levels								
S_1 (45 cm x 60 cm)	25.47	24.73	2.33	6.04	136.11	7.99	17.06	8.23
S_2 (60 cm x 60 cm)	25.44	24.09	2.24	5.89	135.61	8.85	15.33	7.97
S_3 (90 cm x 60 cm)	25.24	24.02	2.22	5.89	131.17	8.42	15.58	7.43
S_4 (90 cm x 90 cm)	25.11	23.89	2.11	5.69	112.32	6.94	16.18	6.74
SEm ±	0.37	0.16	0.09	0.1	1.25	0.01	0.15	0.23
CD (P = 0.05)	–	0.57	–	–	4.33	0.04	0.52	0.06
Nitrogen Levels								
N_1 (100 kg N ha^{-1})	25.22	24.20	2.30	5.98	128.02	8.11	15.82	7.53
N_2 (125 kg N ha^{-1})	25.30	24.25	2.23	5.86	128.56	8.04	16.01	7.61
N_3 (150 kg N ha^{-1})	25.43	24.10	2.15	5.79	129.83	8.00	16.28	7.64
SEm ±	0.1	0.07	0.09	0.11	1.08	0.05	0.08	0.06
CD (P = 0.05)	–	–	–	–	–	0.16	0.25	–
Interaction (Spacing x Nitrogen Levels)								
S_1N_1	25.40	24.73	2.40	6.13	136.99	7.93	17.27	8.30
S_1N_2	25.33	24.87	2.33	6.07	135.73	8.02	16.95	8.27
S_1N_3	25.67	24.60	2.27	5.93	135.60	8.01	16.96	8.13
S_2N_1	25.33	24.13	2.33	6.07	134.93	8.92	15.13	7.90
S_2N_2	25.53	24.20	2.27	5.72	135.17	8.83	15.31	7.97
S_2N_3	25.47	23.93	2.13	5.90	136.73	8.78	15.57	8.03
S_3N_1	25.13	24.07	2.27	5.93	129.87	8.57	15.15	7.37
S_3N_2	25.20	24.00	2.20	6.00	131.77	8.37	15.75	7.43
S_3N_3	25.40	24.00	2.20	5.73	131.87	8.33	15.83	7.50
S_4N_1	25.00	23.87	2.20	5.80	110.27	7.02	15.71	6.57
S_4N_2	25.13	23.93	2.13	5.67	111.57	6.95	16.05	6.77
S_4N_3S	25.2	23.87	2.00	5.60	115.13	6.87	16.77	6.90
SEm ±	0.08	0.07	0.04	0.1	1.38	0.05	0.16	0.1
CD (P = 0.05)	–	–	–	–	–	0.03	0.49	–

Table 2. *Effect of spacing and nitrogen levels on yield of zucchini (Cucurbita pepo L.)*

Treatments	Days to 1st Harvest	Days to last Harvest	Number of harvests	Number of fruits per plants	Fruit yield per plant (kg)	Fruit yield per plot (kg)	Fruit yield per ha (t)
Spacing levels							
S_1 (45 cm x 60 cm)	36.5	66.01	8.62	5.80	2.69	129.23	69.8
S_2 (60 cm x 60 cm)	33.72	67.00	9.12	8.21	3.86	138.45	74.78
S_3 (90 cm x 60 cm)	33.21	67.09	9.18	6.92	3.45	82.52	44.57
S_4 (90 cm x 90 cm)	32.70	69.89	9.20	5.15	2.45	39.27	21.21
SEm ±	0.19	0.26	0.12	0.01	0.01	0.51	0.27
CD (P = 0.05)	0.66	0.92	0.42	0.06	0.04	1.75	0.95
Nitrogen Levels							
N_1 (100 kg N ha^{-1})	33.64	66.53	8.96	6.40	3.03	94.58	51.08
N_2 (125 kg N ha^{-1})	34.16	67.91	8.99	6.51	3.12	97.70	52.77
N_3 (150 kg N ha^{-1})	34.3	68.05	9.14	6.66	3.19	99.82	53.91
SEm ±	0.4	0.96	0.11	0.03	0.1	0.46	0.25
CD (P = 0.05)	1.19	2.9	–	0.09	0.59	1.37	0.74
Interaction (Spacing x Nitrogen Levels)							
S_1N_1	35.87	64.80	8.55	5.60	2.55	122.24	66.02
S_1N_2	36.53	67.17	8.47	5.85	2.73	131.20	70.86
S_1N_3	37.10	66.07	8.83	5.95	2.80	134.24	72.51
S_2N_1	33.10	65.80	9.05	8.12	3.80	136.94	73.95
S_2N_2	34.47	67.60	9.11	8.23	3.85	138.5	74.80
S_2N_3	33.6	67.60	9.20	8.27	3.92	139.94	75.59
S_3N_1	32.87	66.47	9.13	6.67	3.38	81.12	43.81
S_3N_2	33.27	67.53	9.17	6.97	3.46	81.88	44.23
S_3N_3	33.50	67.27	9.23	7.14	3.52	84.56	45.67
S_4N_1	32.73	69.07	9.10	5.21	2.38	38.03	20.54
S_4N_2	32.37	69.33	9.20	4.98	2.45	39.25	21.20
S_4N_3	33.00	71.27	9.30	5.27	2.53	40.53	21.89
SEm ±	0.44	0.68	0.07	0.03	0.03	0.91	0.49
CD (P = 0.05)	–	–	–	–	0.1	2.74	1.48

CONCLUSION

Thus, from the present investigation it was revealed that zucchini responded to various spacing and different levels of nitrogen application. It was observed that spacing of 60 cm x 60 cm and application of nitrogen @ 150 kg N ha^{-1} was superior as compared to other treatments in influencing the flowering, fruit yield and yield contributing characters of zucchini.

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