INTERNATIONAL JOURNAL OF SCIENCE AND NATURE

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EFFECT OF SPACING AND FERTILIZER LEVELS ON GROWTH AND YIELD OF ZUCCHINI (*Cucurbita pepo* L.)

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ABSTRACT
Zucchini (*Cucurbita pepo* L.) belong to the family Cucurbitaceae and is available in the market in various colors. A field experiment was conducted in Konkan region of Maharashtra to standardize nutrient management schedule for zucchini. Trial was conducted in split plot design with four spacing and three nitrogen levels. While observing the effect of spacing, highest vegetative growth was recorded in S_4 (90 x 90cm) whereas highest number of female flowers, lowest sex ratio, highest number of fruits per plant , fruit yield per plant , yield per plot and yield per hectare was recorded in S_2 (60cm x 60cm). Among the various nitrogen levels N_3 (150 kg N/ha) noticed significantly highest vegetative growth, maximum days to last harvest, highest number of fruits per plant, fruit yield per plant, yield per plot and yield per hectare. Treatment combination S_2N_3 (60cm x 60cm and 150 kg N/ha) 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). Therefore, based on the result of this findings, it is hereby concluded that the use of 150 kg/ha nitrogen and 60 cm x 60 cm spacing was the best treatment for the production of zucchini.

KEYWORDS: Fertilizer, Spacing, Growth, Flowering, Yield, Zucchini.

INTRODUCTION

Zucchini (*Cucurbita pepo* L.) belong to the family Cucurbitaceae and grown throughout the world in both temperate and tropical climatic zones. Zucchini has its origin in America and is available in the market in yellow, light green or green colors. Zucchini has various health benefits to human as well as medicinal potentials (Mohammad *et al*., 2011). One of the most important factors in flourishing crop plant is correct spacing because it allows plant to develop to their full potential above and underneath the ground. The use of 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. Zucchini being a member of cucurbitaceous is much, suitable for cultivation under agro climatic conditions of Konkan region. Being this crop is new for this region there is need of standard cultivation practices. Therefore, the aims of this experiment were to find the best spacing and fertilizer levels for zucchini in Konkan's lateritic soil.

MATERIALS & METHOD

The present investigation was conducted at Educational Research Farm, Department of Horticulture, College of Agriculture Dapoli, Dist. Ratnagiri 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- treatment *i.e.* nitrogen levels N_1 -100 N (kg/ha), N_2 - 125 N (kg/ha) and N_3- 150 N (kg/ha). Phosphorus and potassium were incorporated as basal dose 50 kg ha^{-1}each. Thus, in all 12 treatment combinations replicated thrice. The spot 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 through urea. Crop was sown in portrays containing sterilized coco peat as growing medium. Sixteen days old seedlings were transplanted on flat bed as per treatment details. The growth observations *viz*., plant height, number of leaves and plant spread, flowering observations like days for initiation of first male flower, days for initiation of first female flower, nodal position of first male flower, nodal position of first female flower, total number of male flowers, total number of female flowers, sex ratio, yield and yield attributing characters were recorded. For recording observations, five plants per treatment were selected randomly from each replication. The mean values of observations recorded during investigation were worked out. The fruits were harvested at full grown but tender stage suitable for vegetable purpose. Data was statistically analyzed for the effect of spacing and fertilizer levels on growth and yield of zucchini as per the methods prescribed by Panse and Sukhatme (1985).

RESULTS & DISCUSSION

Effect of spacing (S) on growth and yield of zucchini

Data on effect of spacing on vegetative growth are presented in Table 1. All attributes like highest plant height (52.43 cm), plant spread (1.96 m), highest petiole length (31.92 cm) was recorded in wider spacing S_4 whereas maximum number of leaves were recorded in S_2. Wider spacing in S_4 provided favorable environment which reduced the competition for nutrients resulting in increased height. The similar results are reported by Kanwar *et al.* (1993) in squash melon and Karde (2014) in zucchini.

Data on effect of spacing on flowering represented in Table 2 revealed that highest number of male flowers was observed in S_1 (136). The highest number of female flowers (8.85) was recorded in S_2. 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. It might be due to suitable plant population early flowering and more number of female flowers. The similar results were also reported by Sabo *et al*. (2013) in watermelon and Narke *et al*. (2015) in zucchini.

Data on effect of spacing on yield presented in Table 3 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. The 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 and lowest were observed in case of S_4.This variation in yield might be due to the plant population, fruit set percentage, higher number of fruits per plant, environmental factors and congenial microclimate in S_2 as compared to other treatments. These findings are in close conformity Kanawar *et al*. (1993) in squash melon, Karde (2014) in zucchini, and Narke *et al*. (2015) in zucchini.

Effect of nitrogen levels (N) on growth and yield of zucchini

Among the various nitrogen levels the highest plant height (52.31cm), highest plant spread (1.61m) and highest petiole length (31.92cm) was recorded in N_3 (Table 1). While observing flowering behavior (Table 2) various nitrogen levels had non- significant effect on days for initiation for first male and female flower, 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 lowest sex ratio (15.82). Different nitrogen levels applied under 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 noticed in N_3. Increased nitrogen levels produced higher fruit yield per plant might be due to more availability of nutrients to the plant which ultimately resulted in highest fruit length, diameter, higher fruit weight, higher fruit yield per plot and eventually higher fruit yield per hectare. These findings were and in close conformity with Ngetich *et al.* (2013), Karde *et al*. (2014) and Narke *et al.* (2015) in zucchini.

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Effect of interactions (N x S) on growth and yield of zucchini

In interaction of spacing and fertilizers, various growth parameters *viz.* plant height, number of leaves, petiole length showed non- significant effect except plant spread.S_4N_3 (2.09 m) registered maximum plant spread, whereas lowest plant spread in S_1N_1 (1.21m). Among various treatment combinations significant difference was recorded for total number of female flower and sex. S_2N_1 (8.92) recorded the highest female flower, lowest sex ratio (15.13) whereas other flower observation *viz.* days for initiation for flowering, total number of male flower, nodal position of flower showed non- significant effect. 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 nitrogen levels and spacing. The findings are in close conformity with Sabo *et al.* (2013) in watermelon who reported increase in flowering, number of fruits and yield component of watermelon in respond to spacing and increased level of NPK.

TABLE 1: Effect of spacing and nitrogen levels on vegetative growth of zucchini (*Cucurbita Pepo* L.)

Treatments	Plant Height (cm)	Number of leaves	Plant spread (m)	Petiole length (cm)
Spacing levels (S)				
S_1 (45cm x 60cm)	51.79	31.00	1.27	30.49
S_2 (60cmx 60cm)	52.06	30.84	1.39	31.62
S_3 (90cm x60cm)	52.25	30.64	1.54	31.65
S_4 (90cm x 90cm)	52.43	30.56	1.96	31.92
S.Em±	0.12	0.13	0.008	0.29
C.D. @ 5%	0.43	0.43	0.029	1.00
Nitrogen Levels (N)				
N_I (100kg/ha)	51.94	30.45	1.46	31.26
N_2 (125kg/ha)	52.15	30.72	1.55	31.45
N_3(150kg/ha)	52.31	31.12	1.61	31.56
S.Em±	0.19	0.2	0.09	0.15
C.D. @ 5%	0.56	0.6	0.55	-
Interaction (Spacing x Nitrogen Levels)				
S_1N_1	51.61	30.67	1.21	30.30
S_1N_2	51.76	31.00	1.29	30.53
S_1N_3	52.01	31.33	1.31	30.65
S_2N_1	51.95	30.53	1.36	31.43
S_2N_2	52.10	30.73	1.38	31.67
S_2N_3	52.13	31.27	1.44	31.77
S_3N_1	52.01	30.33	1.47	31.45
S_3N_2	52.20	30.60	1.53	31.67
S_3N_3	52.55	31.00	1.61	31.83
S_4N_1	52.18	30.27	1.79	31.85
S_4N_2	52.55	30.53	1.99	31.93
S_4N_3	52.57	30.87	2.09	31.99
S.Em±	0.18	0.4	0.05	0.12
C.D. @ 5%	0.56	1.21	0.15	-

TABLE 2: 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)								
S_1 (45cm x 60cm)	25.47	24.73	2.33	6.04	136.11	7.99	17.06	8.23
S_2 (60cmx 60cm)	25.44	24.09	2.24	5.89	135.61	8.85	15.33	7.97
S_3 (90cm x60cm)	25.24	24.02	2.22	5.89	131.17	8.42	15.58	7.43
S_4 (90cm x 90cm)	25.11	23.89	2.11	5.69	112.32	6.94	16.18	6.74
S.Em±	0.37	0.16	0.09	0.1	1.25	0.01	0.15	0.23
C.D. @ 5%	-	0.57	-	-	4.33	0.04	0.52	0.06
Nitrogen Levels (N)								
N_I (100kg/ha)	25.22	24.2	2.3	5.98	128.02	8.11	15.82	7.53
N_2 (125kg/ha)	25.3	24.25	2.23	5.86	128.56	8.04	16.01	7.61
N_3(150kg/ha)	25.43	24.1	2.15	5.79	129.83	8.00	16.28	7.64
S.Em±	0.1	0.07	0.09	0.11	1.08	0.05	0.08	0.06
C.D. @ 5%	-	-	-	-	-	0.16	0.25	-
Interaction (S x N)								
S_1N_1	25.4	24.73	2.4	6.13	137	7.93	17.27	8.3
S_1N_2	25.33	24.87	2.33	6.07	135.7	8.02	16.95	8.27
S_1N_3	25.67	24.6	2.27	5.93	135.6	8.01	16.96	8.13
S_2N_1	25.33	24.13	2.33	6.07	134.9	8.92	15.13	7.9
S_2N_2	25.53	24.2	2.27	5.72	135.2	8.83	15.31	7.97
S_2N_3	25.47	23.93	2.13	5.9	136.7	8.78	15.57	8.03
S_3N_1	25.13	24.07	2.27	5.93	129.9	8.57	15.15	7.37
S_3N_2	25.2	24	2.2	6	131.8	8.37	15.75	7.43
S_3N_3	25.4	24	2.2	5.73	131.9	8.33	15.83	7.5
S_4N_1	25	23.87	2.2	5.8	110.3	7.02	15.71	6.57
S_4N_2	25.13	23.93	2.13	5.67	111.6	6.95	16.05	6.77
S_4N_3	25.2	23.87	2	5.6	115.1	6.87	16.77	6.9
S.Em±	0.08	0.07	0.04	0.1	1.38	0.05	0.16	0.1
C.D. @ 5%	-	-	-	-	-	0.03	0.49	-

TABLE 3: Effect of spacing and nitrogen levels on yield of zucchini (*Cucurbita Pepo* L.)

Treatments	DAYS						
	1st Harvest	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 (45cm x 60cm)	36.5	66.01	8.62	5.8	2.69	129.2	69.8
S_2 (60cmx 60cm)	33.72	67.00	9.12	8.21	3.86	138.45	74.78
S_3 (90cm x60cm)	33.21	67.09	9.18	6.92	3.45	82.52	44.57
S_4 (90cm x 90cm)	32.70	69.89	9.20	5.15	2.45	39.27	21.21
S.Em±	0.19	0.26	0.12	0.01	0.01	0.51	0.27
C.D. @ 5%	0.66	0.92	0.42	0.06	0.04	1.75	0.95
Nitrogen Levels							
N_I (100kg/ha)	33.64	66.53	8.96	6.4	3.03	94.58	51.08
N_2 (125kg/ha)	34.16	67.91	8.99	6.51	3.12	97.7	52.77
N_3(150kg/ha)	34.30	68.05	9.14	6.66	3.19	99.82	53.91
S.Em±	0.4	0.96	0.11	0.03	0.1	0.46	0.25
C.D. @ 5%	1.19	2.9	-	0.09	0.59	1.37	0.74
Interaction (S x N)							
S_1N_1	35.87	64.8	8.55	5.6	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	37.1	66.07	8.83	5.95	2.8	134.24	72.51
S_2N_1	33.1	65.8	9.05	8.12	3.8	136.94	73.95
S_2N_2	34.47	67.6	9.11	8.23	3.85	138.5	74.8
S_2N_3	33.6	67.6	9.2	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	33.5	67.27	9.23	7.14	3.52	84.56	45.67
S_4N_1	32.73	69.07	9.1	5.21	2.38	38.03	20.54
S_4N_2	32.37	69.33	9.2	4.98	2.45	39.25	21.2
S_4N_3	33	71.27	9.3	5.27	2.53	40.53	21.89
S.Em±	0.44	0.68	0.07	0.03	0.03	0.91	0.49
C.D. @ 5%	-	-	-	-	0.1	2.74	1.48

CONCLUSION

Thus, from the above investigation it could be concluded that zucchini responded greatly to various spacing and different levels of nitrogen application. A significant interaction was also noticed at medium spacing 60cm x 60cm and application of nitrogen dose 150 kg N/ha when applied along with basal dose of phosphorus and potassium @50 kg /ha each .This treatment combination was found superior as compared to other treatments which influenced the flowering, fruits, yield and yield contributing characters and resulted in higher production of zucchini.

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