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EFFECT OF PLANT GEOMETRY AND NITROGEN ON GROWTH, YIELD AND QUALITY OF BOTTLE GOURD (*LAGENARIA SICERARIA* MOL. STANDL.) CV. PUSA NAVEEN

V. S. Pawar *et al.,*

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V. S. PAWAR*, J. R. VADODARIA AND YOGESH PAWAR
Department of Vegetable Science,
College of Horticulture, S. D. Agricultural University, Sardarkrushinagar - 385 506 (Gujarat) INDIA
e-mail: sunnyrajepatil@gmail.com

ABSTRACT

Present investigation was executed at Horticulture Instructional Farm, Sardar krushinagar Dantiwada Agricultural University, Sardarkrushi nagar with three plant spacing *viz.*, 2.0 m x 1.0 m (S_1), 2.0 m x 1.5 m (S_2) and 2.0 m x 2.0 m (S_3) and five Nitrogen levels *viz.*, 50 kg/ha (N_1), 75 kg/ha (N_2), 100 kg/ha (N_3), 125 kg/ha (N_4) and 150 kg/ha (N_5). The results revealed that plant geometry of 2.0 m x 1.0 m (S_1) exerted the great influence on various flowering and yield parameters *viz.*, highest fruits per plant (8.82), fruit weight (601.03 g), yield per plant (5.34 kg) and yield per hectare (267.10 q). The supplementation of Nitrogen @ 100 kg/ha recorded superior for flowering parameters and number of fruits per plant (9.55), average weight of fruit (641.38 g), yield per plant (6.13 kg), yield per hectare (225.08 q), length of fruit (29.84 cm), diameter of fruit (8.47 cm) and fruit volume (552.56 cc). Findings of the present investigation concluded that plant geometry of 2.0 m x 1.0 m along with application of Nitrogen @ 100 kg/ha achieved superior growth, yield and quality parameters of bottle gourd cv. Pusa Naveen.

***Corresponding author**

INTRODUCTION

Bottle gourd (*Lagenaria siceraria* Mol. Standl.) belongs to the family cucurbitaceae and it is grown extensively throughout tropical and subtropical regions of the world. The growth and yield of any cultivated crop plant is mainly influenced by two principal factors *viz.*, genetical and cultural or management factors. Both these factors have been exploited by various research workers working on this crop with varied success. Efforts are still continued in this direction to gain higher yield, with better quality of marketable fruits.

In view of the requirements of the increasing population of our country and for maintaining the income of our farming community, it is quite essential to increase the crop production. Spacing generally depends upon crop variety, climatic condition, soil fertility status and management. Crop geometry and plant population plays important role in obtaining higher yield (Kumari, 2015; Ughade and Mahadkar, 2015). Higher plant population can be achieved by reducing distance between two rows and also two plants within the row. Yield increase with higher plant population (*i.e.* decrease in spacing) have been reported by Khristov (1973).

The use of manures and fertilizers in appropriate quantity is one of the essential requirements for increasing the yield of vegetable crops. Among the three major plant nutrients, a yield response of bottle gourd to Nitrogen is assumed to be of greater importance. Nitrogen is also a major element of nucleic acid, co-enzymes and membranes and it is involved in many metabolic processes *viz.*, cell division, photosynthesis, protein synthesis and expansion of shoot and root growth in plants and has an active role during vegetative growth (Tripathy *et al*., 1993). Efficient use of nitrogen plays a major role in successful crop production (Silberbush, 2002). Patil *et al*. (1996) recommended that nitrogen at the rate of 100 g plant^{-1} may be applied to bottle gourd for better growth and development. Singh and Chonkar (1996) applied 150 kg N ha^{-1} and recorded the highest vegetative growth of plants, including vine length, number of branches compared to lower doses of 50 and 100 kg ha^{-1}. Umamaheshwarappa *et al*. (2003) reported that significantly higher fruit yield recorded with the application of 120 kg nitrogen ha^{-1} compared to control. Adequate and judicious application of Nitrogen is the surest way of increasing the growth, yield and improving the quality of bottle gourd.

In the present context of higher prices of fertilizers, it is necessary to work out the optimum and economical dose of Nitrogen requirement for the bottle gourd crop. Keeping into consideration the above facts in mind present investigation was planned and executed to assess the effect of plant geometry and Nitrogen levels on growth, flowering, yield and quality parameters of bottle gourd cv. Pusa Naveen.

MATERIALS AND METHODS

The experiment was conducted at Horticulture Instructional Farm, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushi nagar, District- Banaskantha during summer season *i.e.* from February to June 2012 under open field condition. Due to potentiality and popularity among the

growers, the cultivar Pusa Naveen was selected for experimentation. The seeds of Pusa Naveen variety were obtained from Indian Agricultural Research Institute, New Delhi. Experiment was laid out in Split Plot Design and replicated thrice. Experiment consists of total fifteen treatment combinations with three plant spacing *viz.,* 2.0 m x 1.0 m (S_1), 2.0 m x 1.5 m (S_2) and 2.0 m x 2.0 m (S_3) and five Nitrogen levels *viz.,* 50 kg/ha (N_1), 75 kg/ha (N_2), 100 kg/ha (N_3), 125 kg/ha (N_4) and 150 kg/ha (N_5) keeping spacing as main plot and Nitrogen as sub plot treatments.

Half of the Nitrogen dose was applied before sowing as a basal dose and the remaining half was applied one month after sowing as per top dressing around each plant. The phosphorus and potash were applied each at the rate of 50 kg per hectare as a basal dose in the form of single superphosphate and muriate of potash, respectively. The recommended package of practices was applied to grow crop successfully. The various treatments were evaluated on the basis of growth, yield and quality characters and data were recorded from five tagged plants. Leaf area per plant was measured with the help of leaf area index machine (Systromics, leaf area meter, 211). The length of vine, fruit and diameter parameters were measured with the help of measuring scale. The recorded data were subjected to statistical analysis using the analysis of variance technique (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

Growth and flowering parameters

Data pertaining to growth and flowering of bottle gourd are presented in Table 1 and it showed that maximum length of main vine (325.64 cm) and number of primary branches per plant (6.82) at 90 DAS was observed with the medium spacing *i.e.* S_2 (2.0 m x 1.5 m). Maximum number of leaves per plant (41.98) and leaf area per plant at 45 DAS (3241.08 cm^2) was observed with the widest plant spacing *i.e.* S_3 (2.0 m x 2.0 m).

Minimum days taken to initiation of first female flower (49.46), number of nodes on which first female flower appeared (10.65), days taken from flower initiation to first picking (12.09) and days taken from first picking after sowing (61.49) were noticed with the closest plant spacing *i.e.* S_1 (2.0 m x 1.0 m). With the help of these trends, it could be concluded that closer plant spacing reduced period for female flower emergence and

Table 1: Effect of plant geometry and Nitrogen on growth and flowering parameters of bottle gourd

Treatments	Length of vine (cm) at 90 DAS	Number of primary branches per plant at 90 DAS	Number of leaves per plant at 45 DAS	Leaf area per plant (cm^2) at 45 DAS	Days taken to initiation of first female flower	Number of nodes on which first female flower appeared	Number of male flowers per plant	Number of female flowers per plant	Sex ratio of male and female flowers	Days taken from flower initiation to first picking
Spacing										
S_1	313.47	5.74	38.26	2917.22	49.46	10.65	130.53	33.79	3.87	12.09
S_2	325.64	6.82	40.28	3039.16	51.80	11.92	136.74	32.87	4.16	12.95
S_3	319.90	6.34	41.98	3241.08	53.10	12.70	143.37	31.60	4.53	13.38
S.Em. ±	2.10	0.12	0.49	26.90	0.29	0.21	0.88	0.23	0.04	0.20
C.D. at 5%	8.27	0.49	1.94	105.61	1.13	0.84	3.46	0.91	0.16	0.81
Nitrogen										
N_1	284.12	5.37	34.15	2773.39	49.77	11.96	116.78	29.44	3.98	12.70
N_2	305.75	5.73	36.44	2936.58	48.07	11.08	127.47	31.71	4.02	12.09
N_3	326.90	6.31	40.30	3089.62	51.13	10.27	138.51	35.32	3.94	11.26
N_4	346.65	7.38	43.61	3200.01	53.31	12.41	147.13	34.06	4.33	13.64
N_5	334.92	6.69	46.34	3329.50	55.00	13.06	154.51	33.25	4.66	14.35
S.Em. ±	2.51	0.16	0.54	41.07	0.31	0.19	1.13	0.29	0.05	0.21
C.D. at 5%	7.34	0.46	1.57	119.87	0.90	0.57	3.29	0.84	0.15	0.62
Interaction										
S_1N_1	272.33	4.50	32.27	2674.83	47.20	11.22	115.50	30.32	3.81	11.50
S_1N_2	307.17	4.63	33.16	2685.33	44.83	9.67	124.22	32.39	3.84	11.00
S_1N_3	306.90	5.97	39.48	3026.72	49.27	7.50	126.47	36.90	3.43	10.00
S_1N_4	336.28	7.05	42.25	3045.56	52.07	12.17	139.94	34.93	4.01	13.28
S_1N_5	344.67	6.54	44.11	3153.66	53.94	12.69	146.55	34.40	4.26	14.67
S_2N_1	293.03	5.82	34.65	2798.03	49.97	12.10	116.78	29.61	3.94	12.89
S_2N_2	292.69	6.77	37.05	3002.62	48.66	11.34	127.97	31.53	4.06	12.83
S_2N_3	340.40	6.80	40.33	3040.44	52.47	11.20	141.05	35.55	3.97	11.77
S_2N_4	352.05	8.23	43.81	3085.46	53.20	11.83	143.89	34.57	4.16	13.63
S_2N_5	350.03	6.47	45.55	3269.27	54.72	13.10	154.00	33.11	4.65	13.61
S_3N_1	287.00	5.80	35.54	2847.30	52.13	12.57	118.07	28.39	4.17	13.70
S_3N_2	317.40	5.80	39.11	3121.79	50.72	12.22	130.23	31.20	4.18	12.43
S_3N_3	333.40	6.17	41.09	3201.70	51.67	12.11	148.00	33.51	4.42	12.00
S_3N_4	351.63	6.87	44.77	3469.00	54.67	13.23	157.55	32.69	4.82	14.00
S_3N_5	310.07	7.07	49.36	3565.57	56.67	13.38	163.55	32.23	5.06	14.78
S.Em. ±	4.36	0.27	0.93	71.13	0.53	0.34	1.95	0.50	0.09	0.37
C.D. at 5%	12.71	0.79	NS	NS	1.55	0.99	5.69	NS	0.26	1.08

Table 2: Effect of plant geometry and Nitrogen on yield and quality attributes of bottle gourd

Treatments	Days taken for first picking after sowing	Average weight of fruit (g)	Number of fruits per plant	Yield per plant (kg)	Yield per hectare (q)	Length of fruit (cm)	Diameter of fruit (cm)	Fruit volume (cc)
Spacing								
S_1	61.49	601.03	8.82	5.34	267.10	28.49	8.11	535.46
S_2	64.77	581.90	8.38	4.92	163.87	27.45	7.79	516.15
S_3	66.42	561.77	7.85	4.45	111.25	26.68	7.43	507.40
S.Em. ±	0.34	2.58	0.07	0.06	1.95	0.11	0.13	1.44
C.D. at 5%	1.37	10.15	0.29	0.23	7.67	0.45	0.50	5.64
Nitrogen								
N_1	62.37	519.06	7.04	3.66	135.41	25.36	7.26	493.29
N_2	60.17	550.61	7.60	4.19	154.77	26.23	7.60	506.51
N_3	62.31	641.39	9.55	6.13	225.08	29.84	8.47	552.56
N_4	66.93	615.94	9.16	5.65	208.27	28.84	7.89	529.46
N_5	69.35	580.83	8.41	4.89	180.16	27.05	7.68	516.53
S.Em. ±	0.41	2.95	0.06	0.05	1.88	0.23	0.08	2.76
C.D. at 5%	1.20	8.60	0.19	0.14	5.50	0.68	0.22	8.06
Interaction								
S_1N_1	58.39	536.83	7.50	4.03	201.50	26.47	7.50	512.83
S_1N_2	55.83	570.83	8.07	4.61	230.50	27.33	7.90	517.39
S_1N_3	59.28	657.67	10.03	6.60	330.00	30.50	8.93	585.17
S_1N_4	65.33	637.33	9.67	6.16	308.00	29.08	8.17	541.94
S_1N_5	68.61	602.50	8.83	5.32	266.00	27.94	8.03	520.00
S_2N_1	62.89	520.83	7.13	3.71	123.65	25.55	7.27	484.20
S_2N_2	61.50	551.50	7.60	4.19	139.65	25.87	7.60	509.44
S_2N_3	64.33	642.00	9.50	6.10	203.31	30.00	8.47	543.67
S_2N_4	66.78	611.00	9.30	5.68	189.31	28.87	7.90	524.67
S_2N_5	68.33	584.17	8.39	4.90	163.31	26.97	7.73	518.77
S_3N_1	65.83	499.50	6.50	3.24	81.00	24.07	7.00	482.83
S_3N_2	63.17	529.50	7.13	3.78	94.50	25.50	7.30	792.70
S_3N_3	63.33	624.50	9.11	5.69	142.25	29.03	8.00	528.84
S_3N_4	68.67	599.50	8.50	5.09	127.25	28.57	7.60	521.78
S_3N_5	71.11	555.83	8.00	4.45	111.25	26.23	7.27	510.83
S.Em. ±	0.71	5.10	0.11	0.08	3.26	0.40	0.13	4.78
C.D. at 5%	2.09	NS	NS	NS	9.52	NS	NS	13.96

starting of first picking. Minimum number of male flowers per plant (130.53), maximum number of female flowers per plant (33.79) and lowest sex ratio of male and female flowers (1:3.87) was also noticed with the closer plant spacing *i.e.* S_1 (2.0 m x 1.0 m).

Further view of data suggested that the superiority of Nitrogen @ 125 kg/ha on growth characters *viz.,* length of main vine (346.65 cm), number of primary branches per plant (7.38) and also, superiority of Nitrogen @ 150 kg/ha on growth characters like number of leaves per plant (46.34) and leaf area per plant (3329.50 cm^2).

The improvement in growth as a result of spacing and Nitrogen might be shows that less number of plants per unit area enhance the vine length and number of primary branches per plant. This might be due to the great competition for space and light thereby forcing the plants to grow taller. Arora and Malik (1989) in ridge gourd and Negi *et al.* (2003) in bitter gourd have observed similar effect of spacing on number of leaves and leaf area per plant.

Remarkable decrease in the days taken to initiation of first female flower (48.07) and days taken for first picking after sowing (60.17) was observed with Nitrogen application and it was minimum with the application of 75 kg N/ha *i.e.* N_2. Number of nodes on which first female flower appeared (10.27) and days taken from flower initiation to first picking (11.26) was noticed minimum with the application of 100 kg N/ha *i.e.* N_3. Minimum number of male flowers per plant (116.78) was recorded with the application of 50 kg N/ha *i.e.* N_1. Maximum number of female flowers per plant (35.32) was revealed with the application of 100 kg N/ha *i.e.* N_3. Lowest sex ratio of male and female flowers (1:3.78) was noticed with the application of 100 kg N/ha (N_3).

The more number of days required for emergence of first female flower might be due to high dose of Nitrogen which has promoted vegetative growth but delayed flower initiation and flower bud differentiation. Lower dose of Nitrogenous fertilizer had reduced the period of first female flower emergence.

Interaction effect revealed that, significantly maximum values for length of main vine (352.05 cm) and number of primary branches per plant at 90 days after sowing (8.23) were with treatment combination of spacing with 2.0 m x 1.5 m + Nitrogen @ 125 kg/ha.

The higher doses of Nitrogen resulted in to beneficial effects on growth parameters *viz.,* length of main vine and number of primary branches were produced more under higher level of

Nitrogen. This could be explained that Nitrogen is a basic mineral element which is the associated with the synthesis of protoplasm and in primary synthesis of amino acids. As a result, meristematic activity increases faster, where higher dose of Nitrogen applied, resulting in to more vegetative growth. But, over dose of Nitrogen effect adversely and reduced the growth. Further, it is also an established fact that plants supplied with optimum amount of Nitrogen would assimilate more carbohydrates resulting in to increase vegetative growth. The present findings are in agreement with the results of Thakarda (1993) in bottle gourd, Jaksungnaro and Sema (2001) and Choudhari and More (2002) in cucumber.

Yield and quality attributes

Data pertaining to yield parameters of bottle gourd are presented in Table 2 and proved that, number of fruits per plant (8.82), average weight of fruit (601.03 g), yield per plant (5.34 kg) and yield per hectare (267.10 q) was found maximum with the more number of plants per unit area.

Highest number of fruits per plant (9.55), maximum average weight of fruit (641.39 g), yield per plant (6.13 kg), yield per hectare (225.08 q), length of fruit (29.84 cm), diameter of fruit (8.47 cm) and fruit volume (552.56 cc) was recorded with the application of 100 kg N/ha *i.e.* N_3. Lacking or excess amount of Nitrogen reduce female flower per plant which directly reflects on number of fruits per plant and also reduce fruit size, weight of fruit etc. ultimately reduced yield.

The superiority of the closer spacing with reference to total yield per plant and yield per hectare was mainly due to the higher plant population per unit area. Maximum average weight of fruit under the optimum dose of Nitrogen may be attributed to the higher assimilation and translocation of photosynthesis to the reproductive organ which ultimately help in the enlargement of fruits finally resulting in higher fruit weight. Increasing in yield per plant and yield per hectare at optimum level of Nitrogen was due to the increase in size of fruit, weight of fruit and number of fruits per plant.

The present findings are in agreement with the results of Singh and Chhonkar (1986) and Singh *et al*. (1995) in muskmelon, Shukla and Prabhakar (1987), Thakarda (1993) in bottle gourd, Arora and Malik (1989) in ridge gourd, Negi *et al*. (2003) in bitter gourd, Patil *et al*. (1998), Selvakumar and Sekar (2000), Jaksungnaro and Sema (2001) and Choudhari and More (2002) in cucumber, Srinivas *et al*. (1991) and Patel *et al*. (2009) in water melon.

Thus it may be concluded that plant geometry of 2.0 m x 1.0 m along with supplementation of Nitrogen @ 100 kg/ha leads to superiority in growth, flowering, yield and quality attributes of bottle gourd cv. Pusa Naveen.

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