Advances in Bioresearch
Adv. Biores., Vol 10 (6) November 2019: 111-117
©2019 Society of Education, India
Print ISSN 0976-4585; Online ISSN 2277-1573
Journal's URL:http://www.soeagra.com/abr.html
CODEN: ABRDC3
DOI: 10.15515/abr.0976-4585.10.6.111117

Advances in Bioresearch

ORIGINAL ARTICLE

Studies on different Spacings and Nitrogen rates on growth, Quality and yield of water melon.

Sreedhar Devarakonda*, Nagaraju Rachakunta and Y. Sharath Kumar Reddy
Horticulture Research Station, Anantharajupeta. Railway Kodur, Kadapa dist, Andhra Pradesh, India.
Corresponding author: shreedevarakonda@gmail.com

ABSTRACT
Watermelon (Citrillus lanatus L.) is a member of the family: cucurbitaceae, kingdom; plantae, order: cucurbitales, Genus: citrullus and species: lanatus. It refers to both fruit and plant of vine like (Climber or Trailer) herb. The global consumption of watermelon [Citrullus lanatus (Thunb.) Matsum & Na- kai] is greater than that of any other cucurbit (Robinson and Decker-Walters, 1997). It is a popular cash crop grown by farmers mainly during summer due to its high benefits , especially regions of Ananthapur, Kadapa and Kurnool districts of Andhra Pradesh. Regarding mulching, Mulch conserves soil moisture, retained heat as well as it suppresses weed growth and enhances faster crop development and earlier harvest. Therefore, considering the importance of mulching with different spacing and nitrogen levels the present investigation was carried out to study the effect of different spacing and nitrogen rates on growth, yield and quality of watermelon. The field experiments was conducted with 'MAXx ' F1 hybrid (BASF and Nunhems) during January, 2018. The treatments were factorial combinations of three paired row plant spacings (0.45, 0.60, and 0.75 m) and four Nitrogen rates (75, 100, 125 and 150 kg·ha^{-1}). Nitrogen was applied partly (35kg·ha^{-1}) as preplant and the remaining nitrogen was applied as four splits through ferigation. Length of the vine increased linearly as N rate increased from75to150kg·ha^{-1},and also with plant spacing increased from 45 cm to 75 cm. Whereas, highest weight of fruit (5613.90 g), highest weight of pulp (3017.27 g) was found with S_2N_4 i.e Spacing of 60 cm with nitrogen dose of 150 Kg per ha in 4 splits. Yield per hectare was found highest (44.15 t) in S_1N_4 i.e Spacing of 45 cm with nitrogen dose of 150 Kg per ha in 4 splits. Regarding the quality parameters TSS (soluble solid content) was relatively high (on the average 11.87 ^{o}Brix), and it was not affected by the spacing or N rate applied.
Keywords; Watermelon, Nitrogen Rates, row plant spacings

Received 12.08.2019 Revised 18.10.2019 Accepted 12.11.2019

How to cite this article:
S Devarakonda, N Rachakunta and Y. S Kumar Reddy. Studies on different Spacings and Nitrogen rates on growth, Quality and yield of water melon. Adv. Biores., Vol 10 [6] November 2019. 111-117.

INTRODUCTION

Watermelon (*Citrullus lanatus*) is one of the most widely cultivated crops in the world. Its global consumption is greater than that of any of the cucurbit family member . Watermelons are a good source of water in the diets of human beings, but can also be used for making jams and other preservatives including jell preparation. They are also useful in flavoring drinks and smoothies. Watermelon is rich in vitamin 'B6' and 'C' as well as low in sugar and calories because of high percentage of water in the fruits, which are useful for those who want to, reduce body weight. It also contains high potassium and low sodium. The antioxidants in watermelons help reduce the risk of heart attack [3]. Enhanced earliness and higher yields in watermelon crop has been achieved through improvement of cultural practices like mulching and drip irrigation [21, 1]. Both technologies have been developed to enhance crop growth and improve water use efficiency [2, 8]. Specially mulching was used now a days as mulch retained heat as well as it suppresses weed growth and also conserves soil moisture .

Watermelon is a heavy feeder of nutrients especially nitrogen. NPK compound fertilizer to be applied before sowing, followed by application of nitrogenous fertilizers at 5 weeks at intervals up to flowering stage [15]. Optimum supply of N is associated with high photosynthetic activity, more vegetative growth and dark green colour of the leaves [12].

However, the suggested nitrogen rates varied considerably. Srinivas *et al.* [20] found that N up to 120 kg·ha^{-1} increased vine length, more number of fruits and fruit yield, whereas Hochmuth and Cordasco [11] who observed response of watermelon to N, found that in majority of trials optimum yields were achieved with N rates from 134 to 145 kg·ha^{-1}. Generally, it was observed that in watermelon the yield and number of fruit per unit area increased significantly with increased crop density, whereas the yield and number of fruits per plant decrease [2, 5, 17, 14, 16, 13, 19, 20]. The increased number of fruit per area is probably the yield component mostly contributing to a greater yield under high planting density [5, 14]. However, some studies showed that average fruit weight decreases with increasing plant density [2, 13, 19].

The impact of both N rate and plant density on yields of water melon has been reported in the literature frequently, yet there is insufficient knowledge about their interaction, especially regarding N fertigation is used. It is likely that optimal N rate would differ for different watermelon planting densities. Therefore, the objective of this study was to study the effects of different rates of N and planting density on growth and yield of watermelon.

MATERIAL AND METHODS

The field experiments was conducted at Horticultural Research Station, Anantharajupeta, Kadapa dist of Andhra Pradesh, India during summer season. The F1 hybrid used was "MaxX" belongs to BASF and Nunhems which is popularly called as Icebox type "watermelons, with duration 65-70 days. Seeds were sown during January 2018 on polyethylene mulch (thickness 30 mm; width 100 cm). Drip tape was placed beneath the polyethylene mulch, and with emitter spacing at 40 cm (capacity of 4 L h^{-1}) and plants were irrigated as needed. Pests and disease were controlled according to common practices and Weeds between rows were removed by hand if necessary.

The treatments were factorial combinations of three paired row plant spacings (0.45, 0.60, and 0.75 m) and four N rates (75, 100, 125 and 150 kg·ha^{-1}). The rows were 2.0 m apart, and in-row paired plant spacing was 0.45, 0.60, or 0.75 m. Initially part of the N (35 kg·ha^{-1}) was applied as preplant and the remaining nitrogen was fertigated as per the schedule. Remaining N for the four N treatments was fertigated in the form of ammonium-nitrate (35%N) in four applications. The first application (I) was during 7 to 10 d after planting, second (II) application at the early runner phase, third (III) application when the diameter of fruit was about 50 mm, and fourth (IV) application when 10% of fruit reached the full size. To achieve targeted levels of N, the fertigation was scheduled as 1: 3: 1: 1 ratio in the I, II, III and IV stages of the crop respectively. All measurements like vegetative flowering and quality were taken on a subsample of five plants per plot. The total soluble solids content was determined from juice using a hand refractometer at fruit heart section. one representative melon was measured per plot in the main harvest. The observations on growth, yield and quality parameters were recorded and subjected to statistical analysis of variance technique.

RESULTS AND DISCUSSION

Paired row plant spacing had an significant effect on the vine length of the plant. In general, early watermelon cultivars have a shorter vegetative period and less vegetative growth than late cultivars. In the present study, an early watermelon cultivar was planted. The length of the vine was more (2.62 m) in spacing 0.75 m as it was less (2.12 m) in Spacing 0.45 m (Table 1). The results showed that as spacing increased and watermelon main vine length increased due to low competition with nutrients, water and light between crops. These results are in agreement with the findings of Efediyi *et al*., [6] who reported that the spacing has positive effect on height of the plant. These results get support from the work done by Dean *et al*., [4] who mentioned that in-row plant spacing has a significant effect on the growth, quality and yield of watermelon. These results are supported by Sabo *et al*., [18] who reported that an increase in vine length of water melon with an increase in spacing this explain the reason why the longest vine was observed on plant under spacing of 0.75 m.

In water melon, vine length was increased with increasing N fertigation. Vine length was highest (202.67 cm) at N fertigation at the rate of 150 kg/ha. Nitrogen is known to promote vegetative growth. More leaves translate to better chlorophyll development and higher stomatal conductance hence enhanced photosynthesis. This therefore leads to more photosynthates being manufactured leads to more vine growth. But regarding the other growth parameters Leaf length, Leaf width, number of branches there was no significant difference observed in different spacings and different N fertigation rates (Table 2,3,4) except there was significant of nitrogen. The nitrogen @ 125 kg/ha

recorded the highest leaf length (20.28 cm) . These results get support from the work done by Sabo *et al*., (2013) observed that there is no significant difference in all the level of spacing (1m x 1m, 1m x 1.5m and 1m x 2 m) used in promoting number of branches and number of leaves in watermelon.

Yield, yield components and fruit quality

The yield per hectare were significantly increased with an increase in Nitrogen dose from 75 to 150 kg·ha^{-1}. Highest fruit yield per hectare (44.15 t/ha) was found with N rate 150kg/ha (Table 15).

In our study, fruit yield increased with N rates above 150 kg·ha^{-1}which is similar to earlier findings [10, 20]. Total yields achieved at the N rate 150 kg·ha^{-1} in the present study were partly the result of splitting N application, which may have made better utilization of the given N rate as it was found on strawberry [11]. Nitrogen is known to promote vegetative growth of the plant. More leaves translate to more content of chlorophyll development and more stomatal conductance hence enhanced photosynthesis. This therefore leads to more photosynthates being manufactured. More photosynthates were translocated to the sinks leading to earlier maturity of more and heavier fruits subsequently leading to high yields. This is in agreement to the findings from Elmstorm *et al.* [7] who noticed that cucumber grown in increasing levels of nitrogen fertilizers lead to a significant decrease in their sex ratio signifying an increase in female flowers. The decreasing sex ratio leads to a greater potential fruit yield because of the increase in the number of female flowers per plant which develops into fruits.

Paired row plant spacing had a stronger effect on the yield of Water melon. The total yields per hectare were decreased with an increase in plant spacing from 0.45 to 0.75 m. The yields per hectare was highest (44.15 t/ha) with spacing of 0.45 m (Table 14). On contrary with an increase in plant density the yield and number of fruit per plot linearly increased. But size of the fruit reduced. Our results confirmed the findings of other studies, which suggest that fruit yield increases with an increase in plant density due to an increase in the number of fruits per plot [2, 13, 19, 9, 4, 14]. The mean size of the fruit was increased with increased plant spacing from 0.45 to 0.75 m. Whereas, highest size of the fruit (5613.90 g) was observed with S2 spacing (0.60 m) whereas it was lowest (3074.10 g) with S1 spacing (0.45 m). Frequently, the average fruit weight decreases with an increase in the plant density [2, 13, 19, 9]. Regarding the quality parameters TSS (soluble solid content) was relatively high (on the average 11.87 ^{o}Brix), and it was not affected by the spacing or N rate applied.

There is no interactions between plant spacing and nitrogen doses is somewhat surprising because we expected such interaction to occur at least under high density planting. However, the threshold density above which watermelon yield per area starts to decline was not reached in our study. Similarly, Srinivas *et al*. [20] did not report the significant interaction between plant spacing and N fertilization on watermelon yield.

Table1: Effect of different spacing's and nitrogen levels on vine length (cm) of Water melon

Spacings	nitrogen levels				
	N1	N2	N3	N4	MEAN
S1	1.76	2.33	2.13	2.24	2.12
S2	1.92	2.58	2.53	2.48	2.38
S3	2.19	2.75	2.80	2.72	2.62
MEAN	1.96	2.55	2.49	2.48	
	S	0.39	S.Em±	0.13	
	N	0.45		0.15	
	S*N	NS		0.27	

Table2: Effect of different spacing's and nitrogen levels on leaf length (cm) of Water melon

Spacings	nitrogen levels				
	N1	N2	N3	N4	MEAN
S1	17.16	19.54	20.33	19.37	19.10
S2	19.49	18.57	19.51	20.30	19.47
S3	16.49	20.88	20.99	19.87	19.56
MEAN	17.71	19.66	20.28	19.84	
	S	NS	S.Em±	0.53	
	N	1.81		0.62	
	S*N	NS		1.07	

Table3: Effect of different spacing's and nitrogen levels on leaf width (cm) of Water melon

Spacings	nitrogen levels				
	N1	N2	N3	N4	MEAN
S1	17.23	16.50	20.43	20.67	18.71
S2	20.37	19.00	19.93	20.54	19.96
S3	20.67	21.67	19.03	21.17	20.63
MEAN	19.42	19.06	19.80	20.79	
	S	NS	S.Em±	0.66	
	N	NS		0.76	
	S*N	NS		1.32	

Table 4: Effect of different spacings and nitrogen levels on number of branches of Water melon

Spacings	nitrogen levels				
	N1	N2	N3	N4	MEAN
S1	3.33	3.33	4.00	4.33	3.75
S2	4.00	3.67	3.00	4.33	3.75
S3	3.00	3.67	3.67	3.33	3.42
MEAN	3.44	3.56	3.56	4.00	
	S	NS	S.Em±	0.16	
	N	NS		0.18	
	S*N	NS		0.32	

Table 5: Effect of different spacings and nitrogen levels on fruit weight (in gm)of Water melon

Spacings	nitrogen levels				
	N1	N2	N3	N4	MEAN
S1	3918.63	3344.17	3588.20	3074.10	3481.28
S2	3625.63	4912.43	4379.73	5613.90	4632.93
S3	4031.47	4670.93	5229.57	5230.60	4790.64
MEAN	3858.58	4309.18	4399.17	4639.53	
	S	198.02	S.Em±	67.52	
	N	228.65		77.96	
	S*N	396.04		135.03	

Table 6: Effect of different spacings and nitrogen levels on fruit length (in cm)of Water melon

Spacings	nitrogen levels				
	N1	N2	N3	N4	MEAN
S1	22.73	23.40	24.07	23.28	23.37
S2	24.53	28.46	24.19	30.32	26.88
S3	25.73	26.77	28.31	28.69	27.38
MEAN	24.33	26.21	25.52	27.43	
	S	0.92	S.Em±	0.31	
	N	1.06		0.36	
	S*N	1.83		0.63	

Table 7: Effect of different spacings and nitrogen levels on fruit width (in cm)of Water melon

Spacings	nitrogen levels				
	N1	N2	N3	N4	MEAN
S1	16.00	16.27	16.10	16.40	16.19
S2	16.77	18.60	16.63	18.47	17.62
S3	16.43	17.41	18.33	18.27	17.61
MEAN	16.40	17.42	17.02	17.71	
	S	0.46	S.Em±	0.16	
	N	0.53		0.18	
	S*N	0.91		0.31	

Table 8: Effect of different spacings and nitrogen levels on pulp weight (in gm) of Water melon

Spacings	nitrogen levels				
	N1	N2	N3	N4	MEAN
S1	1926.57	1670.83	1968.27	1652.08	1804.44
S2	1786.31	2520.75	2402.26	3017.27	2431.65
S3	2045.49	2407.66	2846.47	2779.65	2519.82
MEAN	1919.45	2199.75	2405.67	2483.00	
	S	107.07	S.Em±	36.50	
	N	123.63		42.15	
	S*N	214.13		73.01	

Table 9: Effect of different spacings and nitrogen levels on length of pulp (cm) of Water melon

Spacings	nitrogen levels				
	N1	N2	N3	N4	MEAN
S1	20.38	21.31	21.39	21.07	21.04
S2	21.93	25.73	21.64	27.06	24.09
S3	23.26	24.37	24.72	24.17	24.13
MEAN	21.86	23.80	22.58	24.10	
	S	0.82	S.Em±	0.28	
	N	0.95		0.32	
	S*N	1.64		0.56	

Table 10: Effect of different spacings and nitrogen levels on width of pulp (cm) of Water melon

Spacings	nitrogen levels				
	N1	N2	N3	N4	MEAN
S1	13.39	13.31	13.33	13.24	13.32
S2	13.99	15.49	13.74	14.99	14.55
S3	13.24	14.49	15.19	14.96	14.47
MEAN	13.54	14.43	14.09	14.40	
	S	0.53	S.Em±	0.18	
	N	0.61		0.21	
	S*N	1.05		0.36	

Table 11: Effect of different spacings and nitrogen levels on TSS(°Brix) of Water melon

Spacings	nitrogen levels				
	N1	N2	N3	N4	MEAN
S1	11.73	11.57	11.43	11.33	11.52
S2	11.37	11.40	11.37	11.53	11.42
S3	10.73	11.87	11.60	10.93	11.28
MEAN	11.28	11.61	11.47	11.27	
	S	NS	S.Em±	0.15	
	N	NS		0.18	
	S*N	NS		0.31	

Table 12: Effect of different spacings and nitrogen levels on number of fruits per plant of Water melon

Spacings	nitrogen levels				
	N1	N2	N3	N4	MEAN
S1	1.67	2.33	2.67	2.67	2.33
S2	2.00	2.67	2.33	2.67	2.42
S3	2.33	2.33	2.67	2.67	2.50
MEAN	2.00	2.44	2.56	2.67	
	S	NS	S.Em±	0.16	
	N	NS		0.19	
	S*N	NS		0.33	

Table 13: Effect of different spacings and nitrogen levels on fruit yield per plot (16 sq.m) (Kg) of Water melon

Spacings	nitrogen levels				
	N1	N2	N3	N4	MEAN
S1	58.97	62.20	65.50	70.64	64.33
S2	41.76	49.67	52.53	61.76	51.43
S3	37.42	39.87	46.24	47.47	42.75
MEAN	46.05	50.58	54.76	59.96	
	S	1.82	S.Em±	0.62	
	N	2.11		0.72	
	S*N	3.65		1.24	

Table 14: Effect of different spacings and nitrogen levels on fruit yield per ha (Tonn) of Water melon

Spacings	nitrogen levels				
	N1	N2	N3	N4	MEAN
S1	36.86	38.88	40.94	44.15	40.20
S2	26.10	31.04	32.83	38.60	32.14
S3	23.39	24.92	28.90	29.67	26.72
MEAN	28.78	31.61	34.22	37.47	
	S	1.14	S.Em±	0.39	
	N	1.32		0.45	
	S*N	2.28		0.78	

Table 15: Effect of different spacings and nitrogen levels on benefit cost ratio of Water melon

Spacings	nitrogen levels				
	N1	N2	N3	N4	MEAN
S1	1.84	1.94	2.04	2.20	2.00
S2	1.48	1.76	1.86	2.18	1.82
S3	1.55	1.65	1.92	1.97	1.77
MEAN	1.62	1.78	1.94	2.12	
	S	0.07	S.Em±	0.02	
	N	0.08		0.03	
	S*N	0.14		0.05	

CONCLUSIONS

Based on our data, it is concluded that highest yield per acre (44.15 t ha^{-1}) was obtained with plant spacing of 0.45m, whereas mean average fruit weight (5613.90 g) was highest with spacing of 0.60m. Highest fruit yield per hectare (44.15 t ha^{-1}) was obtained with N rate of 150 kg ha^{-1} with plant spacing of 0.45m. So, it is recommended to follow the spacing based on the consumer preference of the fruit size in the area.

REFERENCES

1. Ban, D., Zanic, K., Dumicic, G., Gotlin, C.T. and Goreta, B.S. (2009). The type of polyethylene mulch impacts vegetative growth, yield, and aphid populations in watermelon production. J. Food Agric. Environ. 7:543-550.
2. Brinen, G.H., Locascio ,S.J. and Elmstrom, G.W. (1979). Plant and row spacing, mulch, and fertilizer rate effects on watermelon production. J. Amer. Soc. Hort. Sci. 104:724–726.
3. Choudhury, B. (2000). Vegetable production, National Book Trust pub. New Delhi, , 150-151.
4. Dean Ban, Smiljana, G. B., Milan, O., Josipa, H., Bruno Novak, Katja, Z. and Dragan, Z. 2011. Growth and Yield Response of Watermelon to in-row Plant Spacings and Mycorrhiza. Chilean J. Agric.Res. vol.71 (4):14-17.
5. Duthie, J.A., Roberts,B.W., Edelson, J.V. and Shrefler, J.W. 1999. Plant density-dependent variation in density, frequency,and sizeofwatermelon fruits. Crop Sci. 39:412–417.
6. Efediyi, E.K. and Samson, U.R. 2009. Effect of inorganic fertilizer on the yield of two varieties of cucumber (*Cucumis sativum* L.), Report and opinion. 5: 74-79.
7. Elmstrom, G.W., Locascio S.J. and Myers, J.M. 1981. Watermelon response to drip and sprinkler irrigation. Proc. Fla. State Hort. Soc. 94:161–163.
8. Elmstrom, G.W., Fiskell, J.G.A. and Martin FG. 1973. Nutrient distribution in soil and watermelon plant uptake: Effect of fertilizer timing, rate, and placement. Soil Crop Sci. Fla. Proc. 32:154-158.
9. Goreta, S., Perica, S., Dumicic, G., Bućan, L. and Zanic, K. 2005. Growth and yield of watermelon on polyethylene mulch with different spacings and nitrogen rates. HortScience 40:366-369.
10. Hochmuth, G.J., Albregts, E.E., Chandler, C.C., Cornell, J. and Harrison, J. 1996. Nitrogen fertigation requirements of drip-irrigated strawberries. J. Amer. Soc. Hort. Sci. 121: 660–665.

11. Hochmuth, G.J and Cordasco, K. (2000). A summary of N, P, and K research with watermelon in Florida. Fla. Coop. Ext. Serv. HS-755. 24 Aug. 2004. http: //edis.ifas. ufl.edu/ pdffiles/CV/CV23200.
12. John, L.W., Jamer, D.B., Samuel, L.T. and Warner, L.W. 2004. Soil Fertility and Fertilizers: An Introduction to Nutrient Management,. Pearson Education, India, 106–53.
13. Motsenbocker, C.E. and Arancibia, R.A. 2002. In- row spacing influences triploid watermelon yield and crop value. HortTechnology 12:437–440.
14. NeSmith, D.S. 1993. Plant spacing influences water melon yield and yield components. HortScience 28:885–887.
15. Rice, R.P., Rice, L.W. and Tindal, H.D. 1986.Fruit and Vegetable Production in Africa, 221. Macmillan Publications.
16. Robinson, R.W. and Decker-Walters, D.S. 1997. Cucurbits. CAB Intl., Wallingford, U.K.
17. Lu, W., Edelson, J.V. Duthie, J.A. and Roberts, B.W. 2003. A comparison of yield between high- and low-intensity management for three watermelon cultivars. HortScience 38:351–356.
18. Sabo, M.U., Wailare, M.A., Aliyu, M., Jari, S. And Shuaibu, Y. M. 2013. The effect of NPK fertilizer and spacing levels on growth and yield of Watermelon (*Citrillus lanatus L*). Scholarly Journal of Agricultural Science, 3(8), pp. 325-330.
19. Sanders, D.C., Cure, J.D. and Schultheis, J.R. 1999. Yield response of watermelon to planting density, planting pattern, and polyethylene mulch. HortScience 34:1221–1223.
20. Srinivas, K., Hegde, D.M. and Havanagi, G.V. 1989. Effect of nitrogen and plant population on yield, quality, nutrient uptake, and water use of watermelon (*Citrullus lanatus* Matsum et Nakai) under drip and furrow irrigation. Gartenbauwis senschaft 53:220–223.
21. Soltani, N., Anderson, J.L. and Hamson, A.R. 1995. Growth analysis of watermelon plants grown with mulches and rowcovers. J. Amer. Soc. Hort. Sci. 120:1001–1009.