



Research Article

Effect of different spacing on weed interference and performance of watermelon (*Citrullus Lanatus*) in South Western Nigeria Rainforest Zone

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Abstract

The spatial distribution of plants in a crop community is an important determinant of yields. An attempt was made to evaluate the effect of different spacing on weed interference, growth and yield of watermelon in Ikorodu agro-ecology during the rainy season of 2019. Three different spacing namely: 1m x 1m, 1m x 0.5m, and 1m x 1.5m replicated three times were used. Data collected included weed fresh weight, weed cover score, weed density, vine length, number of leaves, vine girth at 3, 6 and 9 weeks after planting (WAT) and number of fruit, fruit diameter and yield per plot at harvest. Data collected were subjected to one-way analysis of variance (ANOVA) and where significant difference exist, means of treatments were compared using Duncan Multiple Range Test (DMRT) at 5% level of probability. Results showed that sowing watermelon at 1m x 0.5m produced plants with thicker vines (4.10cm) and weed cover score (4.00) compared to sowing at 1m x 1m (3.86cm) and (6.66) respectively. Watermelon spaced at 1m x 1m spacing has the highest number of fruit (6.67) and fruit diameter (11.99cm) follow by 1m x 0.5m (4.67) and (10.79cm) and 1m x 1.5m having the least number of fruit and fruit diameter respectively. For optimum weed suppression which will in turn increase yield of the crop, it is therefore suggested that farmers should adopt 1m x 0.5m spacing in watermelon production. Further study in other humid agro ecological zone is equally recommended.

Introduction

Watermelon (*Citrullus lanatus*) belongs to the family Cucurbitaceae [1] with its centre of origin traced to both the Kalahari and Sahara deserts in Africa [2]. In Nigeria, watermelon cultivation has considerably increased in the last one decade with the major production areas located in the Sahel, Sudan and Guinea agro-ecological zones. In recent times, its cultivation has stretched down to the forest belts of south western Nigeria [3].

Like many other tropical countries, most cropping systems in Nigeria are traditional and varies across agro-ecological zones and diverse according to cultural food needs

of resource-poor farmers. Watermelon is commonly planted in rows of varying spaces; less effort has been made to plant at optimum densities to maximize its productivity in different agro-ecological zones. Yield variables of crops are influenced by plant competition or by changes in plant population density.

Plant population or plant spacing is a crucial factor for attainment of maximum crop yield which is influenced by inter and intra row crops spacing. Normally, yield per unit area tends to increase as plant density increases up to a point and then declines [4]. Reducing the space between neighbour rows at any particular plant population has several potential advantages. First, it reduces competition among plants within rows for light, water and nutrients due to a more equidistant plant

arrangement [5]. Secondly, light interception maximization from early canopy closure also decreases transmittance through the canopy, et al. [6]. The smaller amount of sunlight striking the ground decreases the prospective weed interference, especially for shade-intolerant species [7]. Thirdly, the faster shading of soil water being lost by evaporation [8]. This is particularly important under favourable soil surface moisture conditions since it allows crop plants to exploit photosynthesis and the amount of water that is requires for growth processes rather than been evaporated from the soil [9]. Besides, earlier crop cover provided by smaller row width is contributory to enhance soil protection, diminishing water runoff and soil erosion [10]. The nutrient use efficiency can be improved with the use of optimum plant population [11].

The results of many studies have also shown that spacing altered the plant architecture, photosynthetic efficiency of leaves, fruit size and fruit production pattern. According to Heuvelink, et al. [12], both too narrow and too wide spacing do affect crops yield through competition and shading effect. Olson and Sander [5] opined that the major reason for increasing yields in narrow-row systems is the decrease of struggle among crop plants for light, nutrients and water due to an equidistant spatial arrangement of them.

Implementation of plant density strategies and nutrient management has been reported to have a positive impact on watermelon yield by suppressing weed infestation [13]. So it is imperative to develop inter and intra row-spacing recommendation which may help the crop plant to utilize resources more effectively and efficiently towards increased production, productivity and fruit quality [14]. Although watermelon is cultivated almost in all parts of Nigeria, little work has been done on knowing the methods of cultivation and crop raising patterns to get the high plant production in the different agro climatic zones. Therefore, the main objective of the present study was to know the effect of different spacing on weed interference and performance of watermelon (*Citrullus lanatus*) in the south western Nigeria rain forest.

Materials and methods

Description of the experimental site

The experiments were carried out at Teaching and Research Farm, Lagos State Polytechnic, Ikorodu which is geographically lies between Latitude 5°10'N and Longitude 3°16'E in the humid rainforest agro ecological zone at elevation of 50 meters above sea level. The average minimum and maximum temperature for the aforementioned growing season was 25°C and 29°C respectively. The annual rainfall ranges between 1670mm to 2200mm, and relative humidity between 65% and 68%. The experimental plot was cropped with maize over two years without any forms soil amendments and subsequently left to fallow for a year prior to the trial.

Experimental design and treatments

The experiment was arranged in a randomized complete block design (RCBD) with three levels of spacing: 1m x 1m (15 plants/plot), 1m x 0.5m (30 plants/plot) and 1m x 1.5m (10

plants/plot) and replicated thrice on 234m² area of land. The size of each experimental plot was 3m x 5m² accommodating 15, 30 and 10 plant/plot for 1m x 1m, 1m x 0.5m and 1m x 1.5m intra row spacing respectively with a distance of 1m between the replicates. Prior to sowing, the experimental plot was ploughed and harrowed to obtained a fine tilth and 8 plots with size of 3m x 5m was measured and laid out. Watermelon seeds (Kaolack cultivar) obtained from Agro-allied store Sabo market, Ikorodu, Lagos was planted on the main field in accordance with different treatments. All agronomic/cultural practices such as thinning, supplying, weeding, pest and diseases control necessary for watermelon cultivation were carried out as when necessary and per the recommendation.

Data collection and statistical analysis

Five (5) plant stands were randomly sampled and tagged per plot for data collection to determine some growth parameters, while yield characteristics were measured during the harvesting period of the crop. Growth parameters measured include vine length (cm), vine girth (cm) number of leaves/plant, and number of vegetative branches/plant. At 3, 6 and 9 weeks after planting (WAP) Yield parameters such as number of fruits/plant, fruit diameter (cm), fruit weight (g) and total yield (tons/ha).

Weed density was determined by using a 1 m² quadrat placed at random in each plot at 3, 6 and 9 weeks after sowing (WAS). Then the number of weeds in the portion were the quadrant was placed in the plot were harvested and counted [15]. Weed cover score was determined at 3, 6, and 9 WAP using visual rating base on 0–9 scale where 10 represents full weed cover, 3 represented sparse weed coverage; 5 represented intermediate weed coverage; 6 represented high weed coverage; 8 represented severe weed coverage; and 0 represented no weed cover [15]. Fresh weight of weeds was recorded by weighing weeds collected from the treatment plots by uprooting them from the ground and remove the soil from the root part of plant and weigh immediately.

Data analysis

All data collected were subjected to one-way analysis of variance (ANOVA) following statistical procedures of SAS software program version 9.2 [15] and where treatment effects were significant, the means were separated using the Duncan Multiple Range Test procedures at 5% probability ($p < 0.05$) level [17].

Results

Effect of spacing on vine length and girth of watermelon

Result shows that vine length of watermelon was not significantly ($p < 0.05$) affected at 6 and 9 WAP by different spacing adopted (Table 1). However, vine girth was significantly ($p < 0.05$) affected by spacing at 3WAP compared to the non-significant ($p < 0.05$) difference observed at 6, and 9 WAP (Table 1). Though, longest vine was recorded from watermelon spaced at 1m x 1.5m at 3WAP (26.09cm) and least length recorded from 1m x 1m spacing (24.42cm), similar trend was recorded at



9WAP. Highest vine girth was observed in watermelon spaced 1m x 1.5m at 3 WAP (4.53cm) and 9 WAP (10.57) respectively (Table 1).

Effect of spacing on number of leaves and branches of watermelon

Table 2 shows that number of leaves and branches of watermelon were not significantly ($p < 0.05$) affected at 3, 6, and 9 WAP. The result obtained express that number of leaves increases progressively even at reproductive stage as watermelon planted at 1m x 1m recorded the highest (73.23) follow by 1m x 0.5m (71.53) and 1m x 1.5m spacing having the least (65.73). The result also shows that large-spaced plot has the lowest number of branches (Table 2). At 3 WAP, watermelon spaced at 1m x 0.5m has the highest number of branches (2.8) follow by 1m x 1m (2.67) then 1m x 1.5m having the least (2.6). While at 6 and 9 WAP, 1m x 1.5m has the highest number of branches (3.4) and (4.2) follow by 1m x 0.5m (4.07) and 1m x 1m (3.87) respectively.

Effect of spacing on weed competition

Table 3 shows that weed cover score and weed density was significantly affected by different spacing at 3 and 9WAP respectively. While weed fresh weight was significantly ($p < 0.05$) different at 3WAP. Watermelon planted with 1m x 1m spacing has the highest weed cover score (6.67) at 9WAP follow by 1m x 1.5m (5.0) then 1m 0.5m (4.0) having the least. Highest weed density was recorded in watermelon spaced at 1m x 1m (20.33) follow by 1m x 0.5m (10.67) and 1m x 1.5m (7.67) at 6WAP. At 9WAP, 1m x 1.5m recorded the higher weed density

Table 1: Effect of spacing on vine length and girth of watermelon.

Treatments	Vine length weeks (cm)			Vine girth (cm)		
	3WAP	6WAP	9WAP	3WAP	6WAP	9WAP
1m x 1m	24.42	94.60	108.84	3.86b	7.22	9.87
1m x 0.5m	25.17	87.63	135.37	4.10a	7.033	9.74
1m x 1.5m	26.09	86.79	126.37	4.53ab	5.90	10.57
F-Test	ns	ns	ns	*	ns	ns
SE	1.27	5.56	10.44	0.15	0.15	0.15

* - significant at 5%; ns- not significant; WAP: Weeks After Planting

Each value is the mean ± standard error of the three replicates. Values in the same column with same letter(s) do not differ significantly at $p > 0.005$ using Turkey's honest significance test

Table 2: Effect of spacing on number of leaves and branches of watermelon.

Treatments	Number of leaves Weeks after planting			Number of branches Weeks after planting		
	3	6	9	3	6	9
1m x 1m	9.60	30.00	73.23	2.67	3.33	3.87
1m x 0.5m	8.27	52.40	71.53	2.80	3.27	4.07
1m x 1.5m	8.33	31.33	65.73	2.60	3.40	4.20
F-Test	ns	ns	ns	ns	ns	ns
SE	1.10	8.06	3.37	0.08	0.17	4.20

Each value is the mean ± standard error of the three replicates. Values in the same column with same letter(s) do not differ significantly at $p > 0.005$ using Turkey's honest significance test

Table 3: Effect of spacing on vine length and girth of watermelon.

Treatments	Weed cover score			Weed fresh weight (g)			weed density	
	3WAP	6WAP	9WAP	3WAP	6WAP	9WAP 3WAP	6WAP	9WAP
1m x 1m	5.67a	5.67	6.66a	42.67a	34.00	16.33	20.33a 15.33	4.67b
1m x 0.5m	6.33a	5.33	4.00b	16.67b	21.3	19.67 10.67ab	13.00	6.67b
1m x 1.5m	3.67b	5.67	5.00ab	7.33b	34.67	32.00 7.67b	12.00	13.33a
F-Test	*	ns	*	*	Ns	Ns *	Ns	*
SE	0.19	0.81	0.35	6.14	9.57	7.34 3.22	2.63	1.58

* - significant at 5%; ns - not significant, WAP - Weeks After Planting, SE: Standard Error

Each value is the mean ± standard error of the three replicates. Values in the same column with same letter(s) do not differ significantly at $p > 0.005$ using Turkey's honest significance test

follow by 1m x 0.5m and 1m x 1m. From the result in Table 3, highest weed fresh weight (32,0g) was obtained from 1m x 1.5m plot followed by 1m x 0.5m (19.67g) and then 1m x 1m having the least but comparable with 1m x 0.5m.

Effect of spacing on yield attributes of watermelon

Figures 1 shows that yield attributes of watermelon (number of fruits, fruit diameter and fruit weight) were not significantly ($p < 0.05$) affected by the different spacing evaluated in the present study. However, watermelon planted with 1m x 1m spacing has the highest number of fruit (6.67) and fruit diameter (11.99cm) follow by 1m x 0.5m spacing (4.67) and (10.79cm) and 1m x 1.5m spacing having the least number of fruit and fruit diameter respectively. While, highest fruit yield per hectare was obtained from watermelon in 1m x 0.5m plots follow by those in 1m x 1m and 1m x 1.5m having the least.

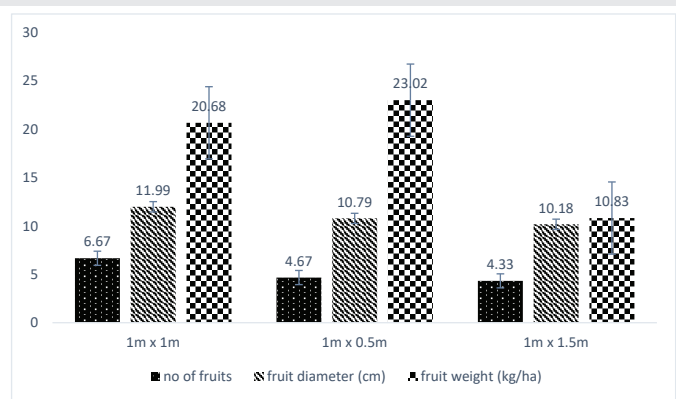


Figure 1: Effect of spacing on yield attributes of watermelon.

Discussion

Manipulation of plant populations, through row spacing is a critical agricultural factor and management tool that can be used to modify crop productivity has great effect on crop growth and the yield components of individual plants [18]. Plant spacing correctly identified has a great effect on growth, development, seed yield and yield components.

Wider spacing in the study give rise to higher weed infestation on the plots. The implication of the result obtained is that choosing narrow spacing in watermelon increases plant population thereby lower weed density than planting at wider spacing [19]. This finding is in consonant with the that of Dalley, et al. [20] who detected that narrowing spacing increases light interception by the crop particularly in the early growing season, thereby leading to increased crop growth rates and earlier canopy closure thereby suppressed weed growth. This study also aligned with the findings of Adigun [21] who observed that spacing of 30 cm resulted in significantly lower weed cover score than those of 45 cm intra row spacing in tomato. Various study had shown that increase in plant density reduces the likelihood of the effect of weed struggle with crops and improved light interception with crops; thus leading to improved crop growth and earlier canopy closure which accordingly increase in crop yield [22,23]. Wider spacing recorded significant highest weed fresh weight compared to closed spacing. Evidently, crop canopy closure developed much earlier in plots with closer spacing of 1m x 0.5m resulting in shade that reduced weed density and dry matter. Street, et al. [24] reported reduced dry matter production with increased cotton density.

The highest vine girth was recorded from the highest inter and intra row spacing and the lowest girth from the lowest intra row spacing respectively. The girth of watermelon increases progressively with the age of plant. These confirm that large-spaced plot has appreciable effect on vine girth development. The result shows that with an increase in spacing, that the wider area planted crops can exploit more nutrients and moisture for growth and development that results for vine growth. This finding is in agreement with the report of Ossom, et al. [25] who reported that larger spacing in watermelon indices increases vine girth growth. Similarly, Dean, et al. [26] also observed that in-row plant spacing has a significant effect on the growth and yield of watermelon. In another study, and Enujike [27] reported that maize plants sown at a spacing of 35cm were superior in stem girth over those sown at narrower or smaller spacing possibly because the plants obtained more soil moisture and nutrients than narrower-spaced plants. While, Dalley, et al. and Azam [28], reported that wider-spaced maize plants obtained more soil moisture and nutrients than narrower plants.

It was understood that vine length increases as age increases in this study and that watermelon spaced at 1m x 0.5m have the longest vine length, which is in agreement with the findings of Efediyi, et al. [29] who reported that the spacing has positive effect on plant height. These results also support the work done by Dean, et al. [26] who observed that in-row plant spacing has a significant effect on the growth and yield of water melon. However, these results are not in agreement with Sabo, et al. [13] who reported an increase in watermelon vine length with an increase in spacing.

Smith and Hamel [30] indicated that branching is important characteristics by which plants may adapt their size to the availability of resources. Result obtained from this study shows

spacing did not significantly affect the number of branches produced but show that large-spaced plot has the lowest number of branches. This report negates Cushman, et al. [31] who reported that larger spacing improves number of branches in watermelon. The result is also against the submission of Dean, et al. [26], Mangala and Mausia [32], who found out that number of branches increases as spacing increases.

The result obtained express that number of leaves of watermelon increases progressively even at reproductive stage as watermelon planted at 1m x 1m spacing recorded the highest number of leaves (73.23). These results get support from the work done by Sabo, et al. [13] who reported that there is no significant difference in all the level of spacing used in promoting number of leaves of watermelon.

Highest fruit yield per hectare was recorded on watermelon spaced at 1m x 0.5m. This result seems to be in contrary with some theories as it is believed that large-spaced plot should have the highest fruit yield per hectare due to less plant population coupled with large feeding area. The low yield could be due to weed infestation on large-spaced plot. Wider spacing of a cover crop does not suppress weed growth; it enhances weed growth instead due to large space on the plot. On this note, weed infestation could reduce the yield of the large-spaced plot (1m x 1.5m). The highest yield recorded from small spaced could be due to increase in plant population. This result was confirmed by several studies [2, 33–36], who noticed that decrease in plant population due to wider planting distance, increased shoot fresh mass which is a known vegetative component of watermelon, vine lengths and number of leaves as well as number of fruits and fruit yield of watermelons were significantly affected by the planting spacing. This result is supported by Motsenbocker and Arancibia [34], who reported that wider spacing decrease number of plant per area and decrease fruit number per plant and yield of watermelon.

Conclusion

Different levels of spacing significantly affected the growth and yield of watermelon as shown in the results obtained from this study. Watermelon spaced at 1m x 0.5m provided the best weed suppression and high fruits yield. Hence, for optimum weed suppression which will in turn increases yield of the crop, it is suggested that farmers in the study area should adopt 1m x 0.5m spacing in *Citrullus lanatus* production. Also it is recommended that further study be conducted in other humid agro ecological zone of Nigeria in other to explore the possibilities of having uniform spacing for the cultivation of water melon.

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