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Plant population density effect on muskmelon (*Cucumis melo* L.) growth and yield

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ABSTRACT

Improvements in crop growth and productivity have been partly ascribed to the effect of plant population on spacing and the number of plants stand^{-1} in a field. In a field experiment conducted at the Teaching and Research Farm of Ekiti State University in Ado-Ekiti, Nigeria, the growth and yield of muskmelon were determined using four different spacings (1×1, 1×1.33, 1×2, and 2×2 m), and 1 or 2 plants stand^{-1} to attain 2,500 - 20,000 plants ha^{-1} population. Using a Randomized Complete Block Design with three replicates, the experiment's 4×2 factorial was established. The number of leaves, leaf area, vine length, branches, branch length, flowering, number of fruits hectare^{-1}, fruit weight, fruit yield, and fruit pulp width were all measured. The 2,500 plants ha^{-1} produced the longest vine (131.50 cm) and branches (111.78 cm), while the 5,000 plants ha^{-1} (2 plants stand^{-1}) generated the most significant number of leaves (81.83) and largest leaf area (156.33 cm^2). The 1 plant stand^{-1} group produced more leaves, more significant leaf areas, and longer vines and branches. At larger plant densities, fruit yield and number per hectare per year increased. However, fruit size decreased. 20,000 plants ha^{-1} (2 plants stand^{-1}) of muskmelons produced the most significant number of fruits (20,803.30) and fruit output (10.29 t ha^{-1}); hence it is recommended that this setting be utilized for muskmelons production.

Keywords: Muskmelon**,** plant density, and plant stand

INTRODUCTION

Muskmelon (*Cucumis melo* L.), sometimes known as cantaloupe, is a member of the Cucurbitaceae family cultivated in tropical and subtropical regions of the world (Thakur *et al.,* 2019). It is an excellent source of vitamin C, beta-carotene, folic acid, potassium (K), carbs, sugar, and protein (Sadek *et al.,* 2019; Manchali et al., 2021). The high water content of the fruit makes it an excellent choice for those looking to stay hydrated, and folic acid helps pregnant women have healthy babies. Vitamin K is linked to a reduction in blood pressure (Manchali *et al.,* 2020). Muskmelon is famous for its nutritional and medical uses (Naaz *et al.,* 2022). The climatic conditions of Nigeria favour the production of Cucurbitaceae such as watermelon, cucumber, egusi, pumpkin, and muskmelon have been widely reported (Gado *et al.,* 2019; Falodun and Ogedegbe, 2019; Adenubi and Sanni, 2020; Ogunyemi *et al.,* 2020; Ayeni *et al.,* 2021). However, despite the production of varying cucurbits in Ekiti State, there was a paucity of information on the production of muskmelon in the State (Aluko *et al.,* 2020a).

The growth and yields of horticulture crops in the field and under covers depend on plant spacing and population densities. Since muskmelons can grow up to 3 meters in length (Singh *et al.,* 2021), there must be sufficient spacing between plants for optimal growth, fruiting, and fruit production. Singh *et al.,* (2021) observed that when the number of plants per hectare increased from 33,333 (50 × 60 cm) to 66,667 (50 × 30 cm), the vine length significantly decreased from 3.80 m to 3.13m. However, Falodun and Ogedegbe (2019) reported a significant increase in vine length in lower plant density (10,000 plants ha^{-1}) with no significant effect on the number of leaves, leaf area, stem diameter, and number of branches. Muskmelon yielded 25.7 t ha^{-1} (40,000 plants ha^{-1}) at the closest spacing of 50 × 50 cm and leaf area plant^{-1} (84.25 cm^2) at harvest, as opposed to 7.01 t ha^{-1} produced with the conventional 1 × 1 m (10,000 plants ha^{-1}) spacing, which had higher fruit weight plant^{-1} (350.13 g). In comparison to 25 × 25 cm (160,000 plants ha^{-1}) and 30 × 30 cm (111,111 plants ha^{-1}), 50 × 50 cm planting spacing (40,000 plants ha^{-1}) was found to be optimal for growth and yield in sweet melon by Adeyeye *et al.* (2017). According to Falodun and Ogedegbe (2019) and Singh *et al.* (2021) muskmelons produce more fruit as plant population density increases, but the marketable yield decreases. The suggested population density ha^{-1} for muskmelon in the United States is 6173 - 11111 plants acquired with 1.5-1.8 × 0.6-0.9 m spacings (Rutgers, 2019), whereas the recommended population density ha^{-1} for muskmelon in India is 8000 - 16000 plants obtained with 1.2-2 × 0.5-0.6 m, (Meena *et al.,* 2018). Ayeni *et al.* (2021) suggested

16667 plants ha^{-1} (1.0 × 0.6 m spacing) to produce muskmelons in Nigeria. As part of the data required to generate agronomic recommendations for muskmelon production in Ado-Ekiti, Nigeria, this study aimed to examine muskmelon growth under variable plant population densities resulting from different plant spacings and plant stand^{-1}.

MATERIALS AND METHODS

2.1. *Experimental site:*

The trials were conducted on the experimental plot of the Department of Crop, Horticulture, and Landscape Design in the Teaching and Research Farm, Ekiti State University, Ado-Ekiti during the rainy seasons of 2018 and 2019. The experimental site is located at 7°43'N and 5°15'E, 530 m above sea level, in the upland rainforest zone. It has a tropical climate defined by a rainy season from March to October, with a brief 2-3 weeks break in August (August break), and a dry season from November to February. The soil is a slightly acidic (pH 5.32), loamy sand with 29.2 g kg^{-1} organic matter, low nitrogen (0.70 g kg^{-1}) and moderate potassium (0.28 mg kg^{-1}) and available phosphorus (28.54 mg kg^{-1}) concentrations (Aluko *et al*., 2020a).

2.2. *Experimental design and treatments:*

The experiment consisted of three replicates of a 4×2 factorial arranged in a Randomized Complete Block Design (RCBD). Four spacings: 1 1, 1 1.33, 1 2, and 2 2 m were employed for muskmelon (*cantalupensis* group) sown at 1 or 2 plants stand^{-1} to achieve plant population densities ranging from 2,500 to 20,000 plants ha^{-1}. The experimental plot was tilled and harrow-divided into four-by-four-meter subplots separated by one-meter roads. As an initial nitrogen boost for the plants, 20 t ha^{-1} of poultry manure was applied to each plot two weeks before seeding. Four weeks after sowing (WAS), the NPK 15:15:15 fertilizer was administered, and the plants were sprayed with pesticide (25 g Lambda Cyhalothrin l-1) twice before blooming. The plots were manually weeded every two weeks. The number of leaves, leaf area, number of branches, vine and branch length, yield and yield components (number of fruits, fruit length and diameter, fruit weight, pulp width, number of seeds, and seed number), and yield and yield components (number of fruits, fruit length and diameter, fruit weight, pulp width, number of seeds, and seed number) were collected weekly from three randomly selected plants in each subplot. The number of days to first flower and 50% flowering was determined by observing the first sprout of the flower and when about 50% of plants in each subplot had flowered.

2.3. *Statistical analysis:*

All acquired data were subjected to analysis of variance utilizing a SAS (Statistical Analysis System) generalized linear model. The treatment means were distinguished using Duncan's Multiple Range Test at a probability level of 0.05.

RESULTS

3.1. *Effect of treatments on some growth parameters and* flowering:

Table 1 displays the effects of plant populations (2500-20000 plants ha^{-1}) reached with varying spacings and stand densities on the growth of muskmelons. The higher number of leaves in plant populations at each plant density (1 plant stand^{-1} and 2 plants stand^{-1}) did not differ at 5 and 6 WAS. However, the number of leaves at 5 and 6 WAS in 2 plants stand^{-1} differ significantly from 1 plants stand^{-1} with no variation at each stand density. At 7-10 WAS, the higher number of leaves was produced in 5,000 plants ha^{-1} (2 plants stand^{-1}) with the highest at 10 WAS (81.83) which differs significantly from other densities examined. The number of leaves produced at 7- 0 WAS at both plant stand densities did not show any distinct significance as each plant density produced leaves that differed in number from one to another. The 5,000 plants ha^{-1} at 2 plant stand^{-1} produced the most remarkable leaf area at 5 WAS (104.00 cm^2), differing from the 20,000 (87.09 cm^2) and 10,000 plants ha^{-1} (1 plant stand^{-1}) (83.44 cm^2). At 6 WAS 5,000 plants ha^{-1} (1 plant stand^{-1}) produced the greatest leaf area (128.28 cm^2), comparable to 2,500 plants ha^{-1} (115.94 cm^2) and 5,000 plants ha^{-1} (2 plant stand^{-1}) (115.57 cm^2). At 7 WAS, the leaf area produced by 2,500 and 5,000 plants ha^{-1} (2 plant stand^{-1}) was more than that produced by 15,000 and 20,000 plants ha^{-1}. The leaf area produced by 5,000 plants ha^{-1} (1 plant stand^{-1}) (151.85 cm^2) differed significantly from that produced by 2 plant stand^{-1} (118.58 cm^2) at 8 WAS. 5,000 plants ha^{-1} (1 plant stand^{-1}) at 10 WAS yielded the greatest leaf area (156.33 cm^2), which did not differ from other populations.

Table 2 demonstrates the effect of plant populations obtained at various spacings and stand densities on vine yield. The longest stem vine produced by 5000 plants ha^{-1} (2 plants stand^{-1}) (12.83 cm) at 5 WAS did not differ substantially (P > 0.05) from other densities. However, the increases in stem vine length became significant as the plants matured. At 6 WAS 2500 plants ha^{-1} produced the longest vines (32.55 cm) compared to 7,500, 10,000, and 20,000 plants ha^{-1}. At 6-10 WAS, 2,500 plants ha^{-1} produced significantly longer vines, and at 10 WAS the longest vine of 131.50 cm, which was considerably different from the other populations was produced. The number of branch vines produced increased with plant age. Still, it was only significant at 5 and 6 WAS, where 10000 plants ha^{-1} (2 plants $stand^{-1}$) had the highest values (4.50) that did not differ from those attained with 2 plants $stand^{-1}$ for the other plant population densities. The higher number of branch vines (6.00) generated at 5000 plants ha^{-1} (2 plants $stand^{-1}$) did not differ significantly from the different plant population densities at 7-10 WAS. At each measurement interval, the branch length decreased with increasing plant population density. The muskmelons with the longest branches (10.67 and 28.67 cm) were formed with 2500 plants ha^{-1}, which did not differ from 9.93 cm (5000 plants ha^{-1}) at 5 WAS and 24.85 cm at 5000 plants ha^{-1} (1 plant $stand^{-1}$) at 6 WAS. At 7 WAS 5000 plants ha^{-1} (2 plants $stand^{-1}$) produced the highest value of 42.00 cm, which differs significantly from 2500 plants ha^{-1} and 2 plants $stand^{-1}$ populations. The longer branches produced by 2500 plants ha^{-1} at 8-10 WAS differ significantly from those produced by other plant densities.

The main effects of plant $stand^{-1}$ on several growth characteristics are shown in Figure 1. Two plants per unit area produced 6% more leaves than one plant per unit area. At 10 WAS, the higher number of 76.38 in 2 plant $stand^{-1}$ substantially differed from the lowest number of 68.13 in 1 plant $stand^{-1}$. In 5 WAS, the leaf area of 2 plants $stand^{-1}$ was significantly greater than that of 1 plant $stand^{-1}$ (94.46 cm^2 vs 92.48 cm^2), but at 6-10 WAS, the tendency was reversed as 1 plant stand-1 produced significantly higher values. At 10 WAS, the maximum leaf area of 156.24 cm^2 produced by 1 plant $stand^{-1}$ decreased to 140.95 cm^2. From 5 WAS, the vine length for 2 plant $stand^{-1}$ was 11.61 cm, which was considerably greater than 11.13 cm for 1 plant $stand^{-1}$. However, at 6-10 WAS, 1 plant $stand^{-1}$ generated significantly longer vines. The longest vine grown at 10 WAS was 116.65 cm, much longer than the 107.89 cm generated by 2 plants $stand^{-1}$. At 5, 6, 9, and 10 WAS, 2 plants $stand^{-1}$ produced considerably more branches than 1 plant $stand^{-1}$. At 7 and 8 WAS, the higher number of branches in 2 plants $stand^{-1}$ (5.29) did not statistically differ from 1 plant $stand^{-1}$ (4.92). At 9 and 10 WAS, 2 plant $stand^{-1}$ produced a significantly greater number of branches (5.79) than 1 plant $stand^{-1}$ (5.17). However, 1 plant $stand^{-1}$ produced significantly longer branches than 2 plant $stand^{-1}$, with the most extended branch produced by 1 plant $stand^{-1}$ at 10 being 94.50 cm compared to 83.23 cm produced by 2 plant $stand^{-1}$.

3.2. ***Effects of treatments on yield components:***

The effects of plant population density on fruit yield and yield components are outlined in Figure 2. The number of fruits increased as plant population increased, such that 10000 and 20000 plants ha^{-1} yielded the highest values for densities attained with 1 plant (11300) and 2 plants $stand^{-1}$ (20803.3) while 2500 plants ha^{-1} produced the lowest (3195). At the same population density, the number of fruits produced by 1 or 2 plants $stand^{-1}$ did not differ. For example, 5000 plants ha^{-1} at 1 plant $stand^{-1}$ produced 5569.7 which did not differ from 5343 produced at 5000 plants ha^{-1} at 2 plant $stand^{-1}$. The longest fruits produced at 5000 plants ha^{-1} (1 plant $stand^{-1}$) (14.98 cm) did not significantly differ from those produced at 2500 to 10000 plants ha^{-1} at either 1 and 2 plants $stand^{-1}$. Also, fruit diameter decreased as plant population density increased, and the widest fruits produced at 5000 plants ha^{-1} (1 plant $stand^{-1}$) (10 cm) were not significantly different from those produced at 2500, 7500, and 20000 plants ha^{-1} (9.02, 8.97and 8.88 cm). The average fruit weight decreased as plant population density increased, with the heaviest fruits produced at 5000 plants ha^{-1} (1 plant $stand^{-1}$) (o.69 kg) and the lightest fruits produced at 15000 plants ha^{-1} (0.46 kg). The combination of these parameters produced a total fruit yield that increased with plant density, such that the highest fruit yield (10.29 t ha^{-1}) was produced by a population of 20000 plants ha^{-1}, a 367.7% increase over the lowest fruit yield (2.20 t ha^{-1}) produced by a population of 2500 plants ha^{-1}. The density of 2500 plants ha^{-1} produced a higher number of seeds $fruit^{-1}$ (538.17), significantly higher than the density of 15000 plants ha^{-1}. The fruits produced by 10000 plants ha^{-1} (2 plants $stand^{-1}$) had the widest pulp (2.45 cm), but this did not differ significantly from the pulp width of other plant densities. The average seed weight per fruit at 10000 plants ha^{-1} was 1.73 g, which was not significantly ($P > 0.05$) greater than at 5000 plants ha^{-1} (1 plant $stand^{-1}$).

Table 3 shows the effects of plant population and plant $stand^{-1}$ on muskmelon flowering. There were no significant effects of plant population and plant $stand^{-1}$ on flowering and days to 50% flowering (P 0.05). The 2,500 plants ha^{-1} bloomed earlier (39.75 DAS), which did not differ significantly from the 20,000 plants ha^{-1} (41.17 DAS).

Table 1. Effect of population density on number of leaves and leaf area produced by muskmelon at Ado-Ekiti

Density (plants ha^{-1})	Week after sowing					
	5	6	7	8	9	10
	Number of leaves					
2500	14.00b	24.67b	40.17cd	56.17c	73.67ab	77.00ab
5000	15.00b	25.33b	37.33cde	53.67cd	60.17cd	69.00bc
7500	14.33b	23.83b	35.00de	49.50de	56.17d	62.83c
10000	14.00b	23.33b	33.00e	46.33e	53.17d	63.67c
5000*	21.00a	35.50a	55.67a	66.67a	78.00a	81.83a
10000*	22.00a	35.00a	51.83ab	62.83ab	71.00ab	75.50ab
15000*	21.50a	33.83a	47.33b	59.67bc	68.83abc	75.17ab
20000*	20.00a	32.50a	41.50c	57.50bc	67.17bc	73.00abc
	Leaf area					
2500	95.34abc	115.94ab	135.65a	143.79ab	151.00a	139.60a
5000	99.50ab	128.28a	133.46ab	151.85a	150.16a	156.33a
7500	91.40abc	108.02b	117.87ab	139.82abc	135.70bc	135.27a
10000	83.44c	105.08b	118.28ab	113.83abc	144.39abc	132.62a
5000*	104.00a	115.57ab	138.43a	118.58c	135.55bc	137.65a
10000*	95.70abc	113.30b	118.89ab	128.90bc	125.73c	140.76a
15000*	90.95abc	103.98b	113.53b	122.84bc	143.97abc	145.43a
20000*	87.09bc	102.18b	114.04b	124.27bc	134.58bc	135.29a

*2 plants stand^{-1}. Means with the same letter(s) on the same column are not significantly different at 5% probability using Duncan's Multiple Range Test.

Table 2. Effect of population density on muskmelon vine production at Ado-Ekiti

Density (plants ha^{-1})	**Week after sowing**					
	5	**6**	**7**	**8**	**9**	**10**
	Stem vine length (cm)					
2500	12.17a	32.55a	61.90a	96.27a	118.83a	131.50a
5000	11.33a	32.15a	51.67b	77.00bc	102.05bc	116.50b
7500	10.87a	25.00c	46.33bc	75.33bc	101.78bc	115.78b
10000	10.30a	20.42d	38.45d	68.33cd	90.17cd	106.00c
5000*	12.83a	29.58ab	59.73a	83.20b	100.17bc	120.00b
10000*	11.17a	29.65ab	45.67bc	67.17cd	104.32b	116.33b
15000*	11.50a	30.50a	43.17cd	56.00de	88.00d	104.17c
20000*	11.50a	26.17bc	37.83d	53.00e	71.50e	90.83d
	Branch vine number (cm)					
2500	1.83cd	3.17c	4.83a	4.83a	5.33a	5.33a
5000	2.17bcd	3.83abc	5.17a	5.17a	5.50a	5.50a
7500	1.83cd	3.33bc	5.00a	5.00a	5.00a	5.00a
10000	1.50d	3.33bc	4.67a	4.67a	4.83a	4.83a
5000*	2.83ab	4.00abc	5.67a	5.67a	6.00a	6.00a
10000*	3.17a	4.50a	5.33a	5.33a	5.83a	5.83a
15000*	2.33abcd	4.50a	5.33a	5.33a	6.00a	6.00a
20000*	2.50abc	4.33ab	4.83a	4.83a	5.33a	5.33a
	Branch vine length (cm)					
2500	10.67a	28.67a	33.33abc	86.95a	89.98a	111.78a
5000	9.33ab	24.85a	31.67bc	69.28b	82.50ab	100.17ab
7500	8.50b	18.67b	30.22bc	62.67bc	70.85b	88.03bcd
10000	8.42b	13.50b	25.00c	53.67cd	68.83bc	77.33de
5000*	9.93a	17.17b	42.00a	59.67bc	81.17ab	97.67bc
10000*	8.12b	16.12b	36.43ab	52.17cd	67.12bc	85.17cd
15000*	8.45b	16.93b	36.17ab	45.27d	69.50bc	82.78d
20000*	8.10b	15.50b	38.83ab	44.33d	53.38c	67.67e

*2 plants stand^{-1}. Means with the same letter(s) on the same column are not significantly different at 5% probability using Duncan's Multiple
Range Test

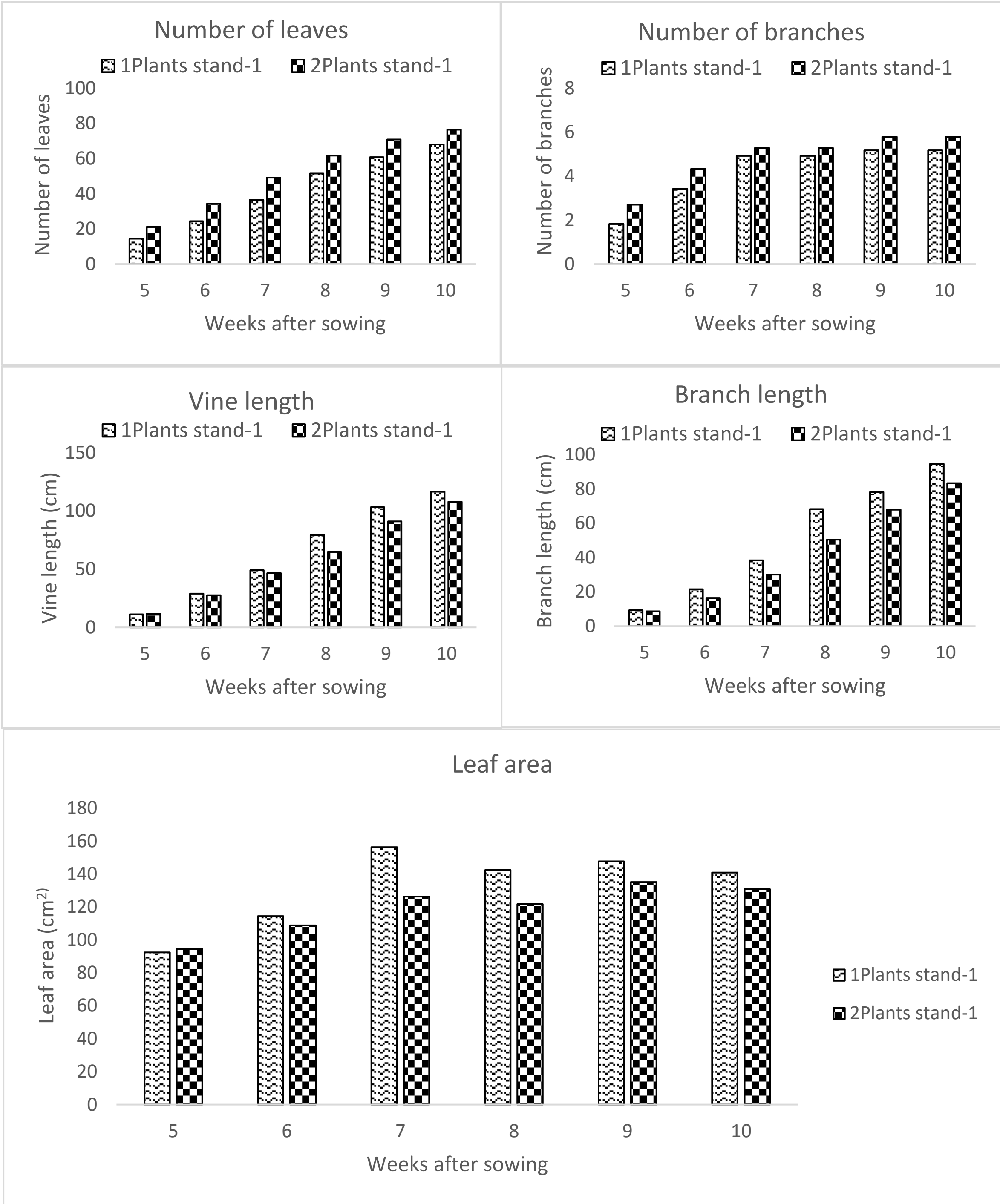

Fig. 1. Effects of stand density on growth parameters of muskmelon

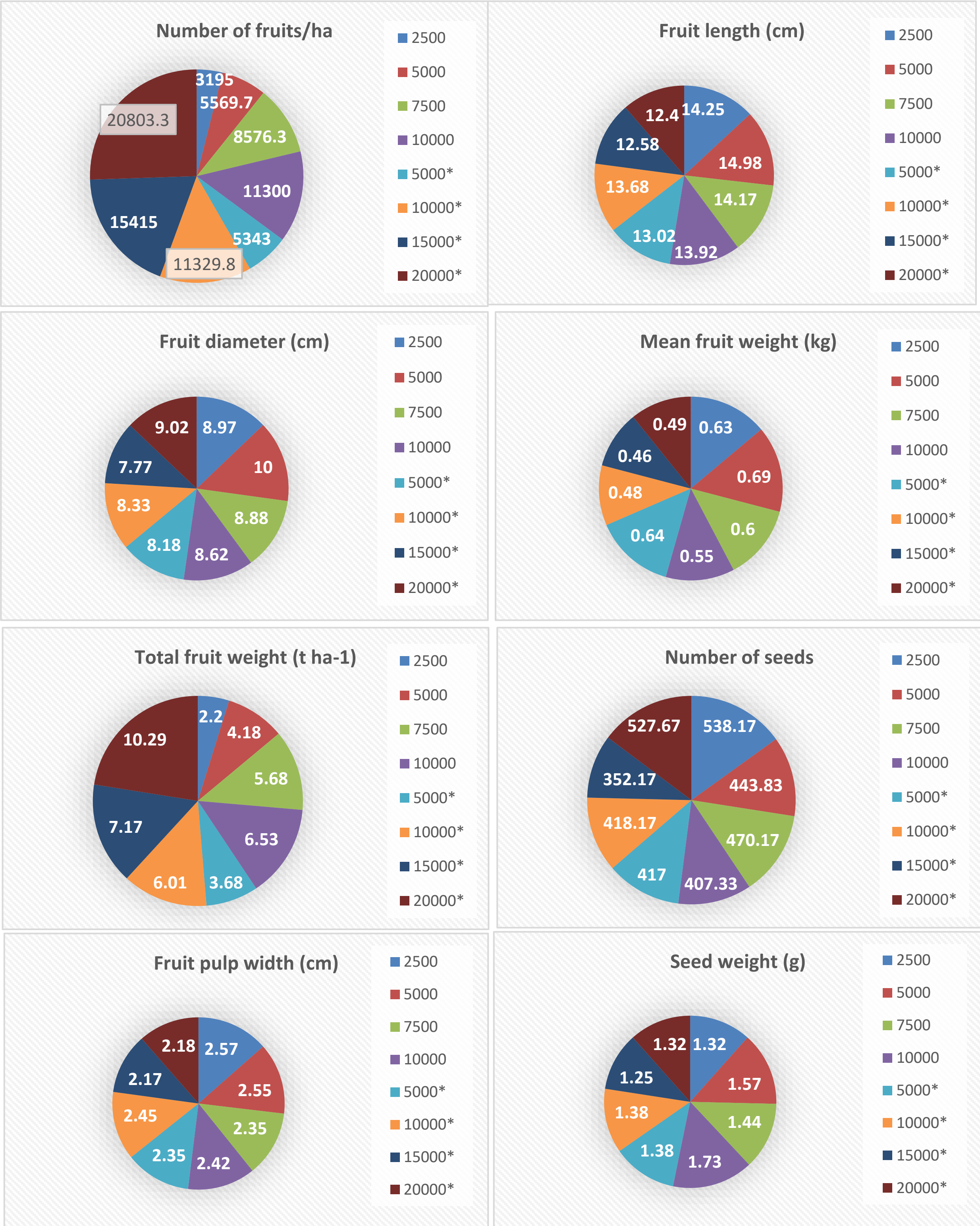

Fig. 2. Effect of population density on muskmelon yield and yield components. *2 plants stand-1

Table 3. Effect of plant density, plant stand^{-1} application on flowering in muskmelon

Density (plants ha^{-1})	Days to first flowering	Days to 50% flowering
2500	39.75a	44.65a
5000	40.17a	45.17a
7500	40.58a	45.58a
10000	41.00a	46.12a
5000*	40.33a	45.00a
10000*	40.33a	45.17a
15000*	40.67a	45.33a
20000*	41.17a	46.00a
Plants stand^{-1}		
1	40.21±0.006	45.54±0.006
2	40.54±0.006	45.79±0.006
Sig.	**	**

*2 plants stand^{-1}. Means with the same letter(s) on the same column are not significantly different at 5% probability using Duncan's Multiple Range Test. ** Not significant

Figure 3 displays the principal effects of plant stand^{-1} on yield components. 2 plants stand^{-1} produced significantly more fruits ha^{-1} (14,022.80) which was about twice the number of fruits produced by 1 plant stand^{-1} and fruit yield (8.41 t ha^{-1}) than 1 plant stand^{-1}. However, 1 plant stand^{-1} had significantly larger fruits (0.62 kg), pulp width (2.47 cm), number of seeds (456.54), and seed weight (1.52 g) than 2 plant stand^{-1}.

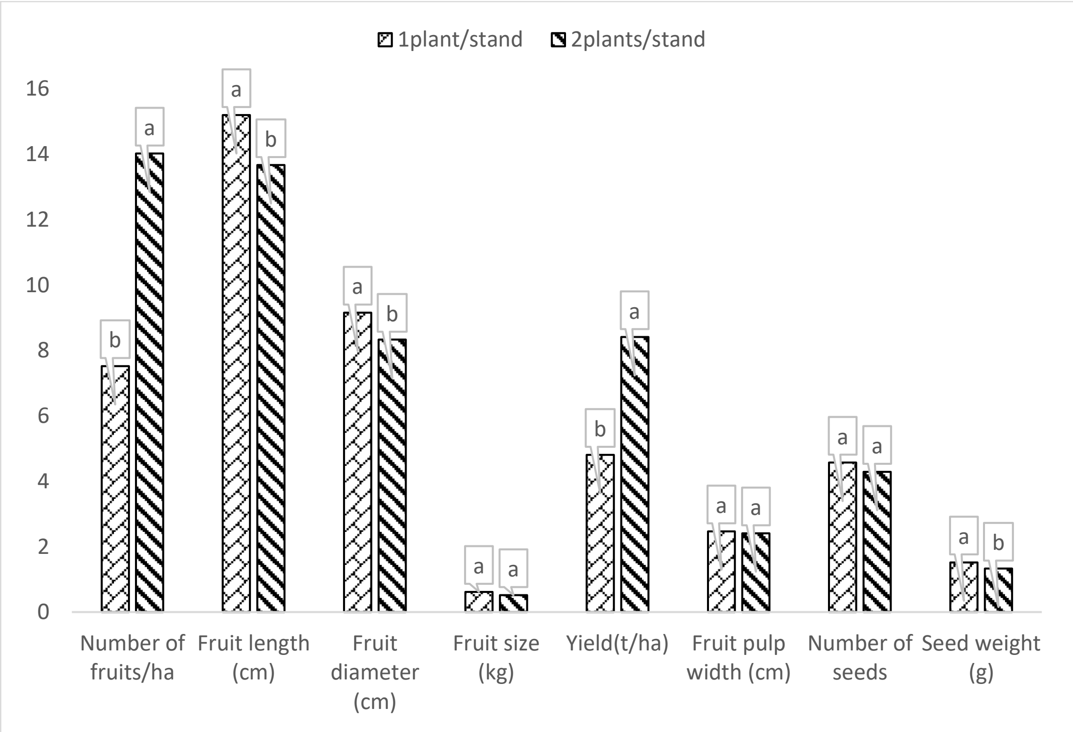

Fig. 3. Effect of plants stand^{-1} on yield and yield components of muskmelon

DISCUSSION

One of the agronomic requirements of crops is population density, as determined by spacing and plant stand^{-1}, which contributes to the yield gap between the actual yield levels of average farmers and the yield levels of the best farmers (Lobell *et al.,* 2009). The number of leaves, main stem (vine) length, and number and length of branch vines increased linearly with age in muskmelons; these are the growth parameters that can be readily modified by spacing and population density to increase fruit yield (Falodun and Ogedegbe, 2019; Ajani *et al.,* 2020). This study demonstrated that plant population significantly influenced the growth and yield of muskmelons. Higher-population plants had less vegetative growth, whereas lower-population plants had broader leaves, longer main vines (stems), and a greater number and length of branch vines. At the lower population density, plant spacing was wider, resulting in less competition for water, light, and nutrients, allowing optimal aeration, photosynthesis, and nutrition (Aluko *et al.,* 2020b; Singh *et al.,* 2022). In contrast, plants at a higher population density tended to produce more leaves of smaller sizes. It was obvious from the study that plant stand density has a significant influence on the growth of muskmelon. 1 plant stand^{-1} has produced broader leaves and longer vines which resulted in the quality of fruits produced.

As the number of seedlings stand^{-1} increased, the number of leaves increased, causing substantial changes in leaf area plant^{-1}. This research concurs with Ayodele and Salami (2006) that there was a significant effect of the number of plants stand^{-1} on the number of leaves in egusi, as the field with two plants stand^{-1} produced more leaves than the field with one plant stand^{-1} at the same population density. The results contradicted the findings of Singh *et al.* (2021 and 2022) who observed that an increase in the number of seedlings per stand^{-1} and plant population density led to shorter stems and vine branches. At lower plant densities in the greenhouse, Anwar *et al.* (2019) observed significantly longer vines but only marginal increases in the number of leaves on muskmelons. The number of branches was not significantly influenced by plant density, corroborating the findings of Singh *et al.* (2021), who found that the number of shoots and fruits vine^{-1} was not affected by plant spacing.

The yield parameters with the lowest minimum and maximum values resulted from the lowest plant population. The maximum yield in this study is at the lower extreme of the yield attainable (20-30 t ha^{-1}) when the issues of variety, seed selection, sow/transplanting, water, nutrients, and crop protection measures (weeds, pest, and disease control) needed to close the crop management-based yield gap have been resolved (van Dijk et al., 2017). The reduction in fruit yield at lower plant densities in this study agrees with the observations that the higher the plant density, the higher the fruit yield ha^{-1} (Ajani *et al.,* 2020; Adenubi and Sanni, 2020; Dahake *et al.,* 2020; Singh *et al.,* 2021).

The effect of plant population density was significant in determining the total number of fruits per hectare. In contrast, plant population density did not affect the number of fruits produced per plant. It concurs with Rodriguez *et al.* (2007), who found that the number of fruits per plant was unaffected by plant density. In contrast, the marketable yield increased linearly with the plant population. Adenubi and Sanni (2020) observed a linear increase in the number of fruits per plant as the plant population density decreased. At a higher plant population density, the total number of fruits produced per hectare would increase because each node (vine) would produce at least one fruit with a smaller average weight and size. The larger fruits produced by 1 plant stand^{-1} were not significantly different from those produced by 2 plant stand^{-1}, likely due to the plants' competition for available nutrients.

Lower-population plants produced larger fruits due to better vegetative growth, whereas higher-population plants produced more fruits and total yield ha^{-1}, as indicated for watermelon (Anwar *et al.,* 2019). The greater size of the fruits produced by plants with a lower population density was not significantly different from the size of the fruits produced by plants with a higher population density due to the tremendous vegetative growth facilitated by the spacing advantage (Singh *et al.,* 2021). Regina and Richard (1997) and Maynard and Scott (1998) found that plant density did not affect the number of fruits produced per plant and the fruit's mass. This study demonstrated, however, that the number of fruits per hectare increased linearly with plant density, corroborating the findings of Falodun and Ogedegbe (2019) and Ajani *et al.* (2020). They reported a higher muskmelon fruit yield with increasing plant density.

The edible portion comprises 45-80% of the mature fruit (van der Vossen *et al.,* 2004), but since this was not determined, the width of the pulp can be used as a proxy. In this study, the effect of plant population density on fruit pulp width (the edible portion of the fruit), the number of seeds fruit^{-1}, and seed weight were insignificant. Even though Nerson (2002) reported high seed yield indices from high plant densities due to producing numerous but smaller fruits, this was not the case.

However, the total quantity of fruits at densities below 10,000 plants ha^{-1} was less than at higher densities, and thus commercial production systems may not be suitable at these densities. The 1 × 1 m spacing to achieve 10,000 plants ha^{-1} is within the 1.5-1.8 m between rows and 0.6-0.9 m in-row (Rutgers, 2019) and 1.2-2 m between rows and 0.5-0.6 m in-row (8,000 - 16,000 plants ha^{-1}) spacing recommendations (Meena *et al.,* 2018).

CONCLUSION

Significant influences on the growth and yield of muskmelons were exerted by the main effects and interactions of plant population density and the number of plants stand^{-1}. At a population density of 10,000 plants ha^{-1} and a stand density of 2 plants, stand^{-1} resulted in the highest fruit yield and the most significant number of fruits per hectare, despite similar fruit size, compared to other plant densities. Therefore, for optimal production of muskmelons, a spacing of 1 m by 1 m with a plant density of 2 plants stand^{-1} to attain 20,000 plants ha^{-1}, is recommended, as it produces superior growth and higher yield.

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