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Influence of Season and Variety on Functional Traits, Seed Setting Efficiency and Consumptive Water Use of Watermelon

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ABSTRACT

Field study was conducted to examine the Effect of Season and Varieties on Plant Functional Traits, (PFT), Seed setting Efficiency (SSE), Consumptive Water Use (CWU) and Crop Water Productivity (CWP) of Watermelon. The experiment was a 5x2 factorial combination arranged in a Randomized Complete Block Design (RCBD) and replicated 5 times to make a total of 50 plots. Five water melon varieties were selected on the basis of contrasting characters for (PFT), (SSE), (CWU), (WUE) and (CWP) in the early and the late rainy season of 2018. The five tested water melon varieties were: Crimson Spineless, Charleston Grey, .Kaolac, Anderson and Sugar Baby. The seeds of water melon were sown in the first week of June, 2018 for the early rainy season crop while the late season crops were sown on the fourth week of September, 2018. The soil water-holding capacity (WHC) was measured through laboratory tests to determine the crop's root depth and soil volume. The total available water (TAW) was estimated by multiplying the water holding capacity (WHC) by the soil volume to estimate the crop's water uptake pattern and daily water requirements. The result shows a significantly higher Consumptive water use for Charleston Grey (369.29 m^3/ha). This was closely followed by Sugar Baby (336.59 m^3/ha) while the Kaolac had the lowest (CWU) as recorded in the late rainy season. Similarly, higher Seed Setting Efficiency (SSE) was recorded for Sugar Baby (0.75%).The Crop Water Productivity (CWP) was significantly higher for Charleston Grey (1.67kg/m^3) over other varieties. This was closely followed by Sugar Baby (1.63 Kg/m^3) with the least (CWP) recorded for (Kaolac 1.14kg/m^3). The Water Use Efficiency (WUE) was significantly higher for Charleston Grey and Sugar Baby (1.39 kg/m^3 and 1.36 kg/m^3) respectively while significantly lower value was recorded for Kaolac (0.98 kg/m^3). The farmland water consumption or Soil Moisture Storage (SMS) followed similar trend with Sugar Baby having the highest SMS (26.29%). The study showed that Charleston Grey and Sugar Baby varieties are better with highest fruit yield in both seasons. These varieties also had higher CWU, SSE, CWP, and SMS, suggesting that they are more efficient in using water to produce higher yields. However, the higher CWU also implies a higher risk of water stress, especially in water-scarce environments. The interaction effect between variety and season showed significant differences, suggesting that the effect of variety on these traits is influenced by the season. It is therefore recommended that Farmers should consider planting Charleston Grey and Sugar Baby varieties due to their high fruit yield. Charleston Grey and Sugar Baby varieties are more productive under water-limited conditions due to their ability to maintain yield despite water stress. Furthermore, they have higher consumptive water use (CWU), efficient soil moisture storage ability and better WUE which translated into higher yield.

Keywords: *Season, Seed setting Efficiency, Consumptive water use, Crop water productivity, Varieties*

INTRODUCTION

Watermelon (*Citrullus lanatus*) is a vital crop in Nigeria, with high demand for its nutritious fruit. However, its production is challenged by soil and weather factors on the plants functional traits and Consumptive Water Use in South West Nigeria (Adelana *et al*, 2019). Understanding these factors' impact on different varieties is crucial for improving yields and quality. (Adebayo *et al*., 2020; Akintunde *et al*., 2019). The impact of these factors on functional traits, seed setting efficiency, and performance of different varieties is not well understood (Kumar *et al*., 2018). According to Adebayo *et al*. (2020), Functional traits refer to the characteristics of a plant that determine its ability to grow, reproduce, and respond to environmental stimuli. In watermelon, functional traits such as vine length, leaf area, and fruit size are critical for determining yield and fruit quality. Seed setting efficiency, on the other hand, refers to the ability of a plant to produce viable seeds, which is essential for ensuring adequate fruit set and yield (Zhang *et al*., 2020). Soil and weather factors play a crucial role in determining the functional traits, seed setting efficiency, and performance of watermelon varieties (Adelana *et al*., 2019. Agele et al., 2017). Watermelon is a warm-season crop that is sensitive to environmental factors such as temperature, moisture, and soil type (Meyer *et al*., 2013). Understanding the impact of these factors on watermelon production is essential for optimizing crop yields and improving fruit quality. Soil factors such as texture, pH, and nutrient availability can significantly impact watermelon production (Wang *et al*, 2019). For example, watermelon prefers well-drained, sandy loam soils with a pH between 6.0 and 6.8 (Hartz, 2017). Soil nutrient availability, particularly nitrogen and phosphorus, can also have impact watermelon yield and fruit quality (Liu and Zhang, 2020). Precipitation and irrigation can also affect watermelon yield and fruit quality, with excessive water leading to reduced fruit set and increased disease incidence (Zhang *et al*., 2020, Oyewusi, et al, 2020). Consumptive water use (CWU) is the amount of water used by a crop for evapotranspiration, and it is an important parameter in water resource management (Alfonso *et al*., 2019). Water use efficiency (WUE) is the ratio of biomass production to CWU, and it is a key indicator of crop water productivity (Condom *et a.*, 2004). Therefore, the objectives of this study are to (i).evaluate the effect of season and varieties on functional traits of watermelon, (ii), assess the seed setting efficiency of different watermelon varieties in two seasons and (iii), estimate the consumptive water use, and Crop water productivity of watermelon varieties in two seasons with respect to its overall performance.

MATERIALS AND METHODS

The study was carried out at the Teaching and Research Farm of the Federal Polytechnic, Ado-Ekiti, a humid rainforest zone of Southwest Nigeria. The mean annual rainfall ranges between 1300-1600 mm and with an average temperature of 30ºC. The relative humidity ranges between 85 % during the rainy season and less than 60 % during the dry season. The study was carried out in May, 2018 due to the preponderance and high frequency of occurrence of insect pest infestation in the study area.

Land preparation and sowing

A portion of land was cleared in a farm field in the early rainy season of 2018. It was subsequently ploughed and harrowed to soften the land. The experiment was measured from the ploughed and harrowed farm land. The experiment was a 5x2 factorial combination arranged in a

Randomized Complete Block Design (RCBD) and replicated 5 times to make a total of 50 plots. Each plot has an average length of 20m. In this experiment, 2 seeds of each water melon variety were planted per hole at the depth of 5 cm and at a spacing of 1m×1m.The experiment field plot measures 33x23m with an alley way of 1m between plots and replicates. Five water melon varieties were selected on the basis of contrasting characters for Seed Setting Efficiency (SSE), Consumptive Water Use (CWU), Water Use Efficiency (WUE) and on Functional Traits (FT) in the early and late rainy season of 2018. Pre planting soil analysis was carried out, as soil samples were collected randomly from the experimental site, bulked, and taken to the labouratory for routine chemical analysis.

Source of Experimental Materials and Treatments

The five tested water melon varieties were: Crimson Spineless (CS), Charleston Grey (CG), .Kaolac (KL), Anderson (AD) and Sugar Baby (SB) while the seasons were the early rainy season (ERS) and the late Rainy season (LRS).The seeds of three varieties were procured from the National Institute of Horticulture (NIHORT) Kano while the other two varieties were obtained from the Seed Processing Unit of the Ministry of Agriculture (ADP).

The seeds of water melon were sown in the first week of June, 2018 for the rainy season crop (RSC) while the late season crop (LSC) were sown on the fourth week of September, 2018.

Weed and Pest Control

Weed control was by both manual weeding at 3, 7 and 10 weeks after planting and chemical control which was done at the planting stage, vegetative stage and reproductive stage of growth. The herbicide used was glyphosate applied at 30l/ha. Pests were controlled through application of Cypermethrine at 500l/ha while spraying commenced at the onset of flowering and at weekly interval till the termination of the experiment.

Data Collection and Analysis

Data collection on growth and yield charters commenced from the third week after planting 3 (WAP) and was terminated at the 12 (WAP) when fruits were harvested. Data were taken on vine length, number of leaves and branches, leaf area development, days to first flowering, days to first fruiting, fruit girth and length and fruit weight.

Determination of Soil Moisture Storage (SMS)

Farmland water consumption (FWC) and Water Use Efficiency (WUE). The soil water-holding capacity (WHC) was measured through laboratory tests to determine the crop's root depth and soil volume. The total available water (TAW) was estimated by multiplying the WHC by the soil volume to estimate the crop's water uptake pattern and daily water requirements. (Allen *et al*, 2019). The soil moisture levels were monitored through the use of tensiometers, to calculate the soil moisture storage (SMS) by subtracting the crop's water uptake from the TAW. Before the planting of watermelon and at maturity, the soil samples were taken from the middle of the ridge. The Soil moisture content of 0-20cm soil was measured by a drying method. The soil was taken at 20cm intervals. A total of 10 layers of the sampled soil were analyzed for soil water consumption during the crop growth period while the result was estimated by the water balance formular (Adeboye *et al*, 2015)

$ET = P + U - R - F + DW + 1$ …………………1

Where DW is Soil water storage consumption,

P is precipitation in this period (mm) for the early and the late season crops

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U is the amount of ground water supplied to crops through the capillary action (mm), F is the ground water supplied (mm) and I is the rain water amount received by the soil throughout the duration of crop growth (mm). (Vereecken *et al*, 2020)

Determination of Crop Water Productivity (CWP)

This was estimated as follows:

Crop =Y/ET ……………………………….2

Where Y is seed yield (kghm^{-2}) and ET is Total water consumption throughout the growth period of the crop (m^{3}hm^{-2}) (Meyer *et al*, 2010)

Determination of Harvest Index

$$HI = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100\% \quad ……………………..3$$

(Allen *et al*, 2019)

Determination of Seed Setting Efficiency (SSE) was estimated as follows:

$$SSE = \frac{\text{Number of seed formed}}{\text{Total number of flowers pollinated}} \times 100\% \quad …………………...…………4$$

(Zhang *et al*, 2020)

Determination of Consumptive Water Use (CWU) was estimated as follows

CWU=Total Water Applied-Water Lost through Evaporation and Run off.……………………………………...…5

(Allen *et al*, 2019)

The WUE was estimated as:

$$WUE = \frac{\text{Biomass or Yield produced}}{\text{Water consumed}} \quad …………...…….6$$

(Vereecken *et al*, 2020)

The statistical significance of the data collected on Functional Traits and other indices were subjected to analysis of variance (ANOVA) to estimate the variance components due to the varieties of water melon with their seasonal effects and their interactions on the variables examined. Treatment means were separated using Duncan's New Multiple Range Test (DMRT)

Results and Discussion

Variations in weather pattern in the early and late planting season of 2018

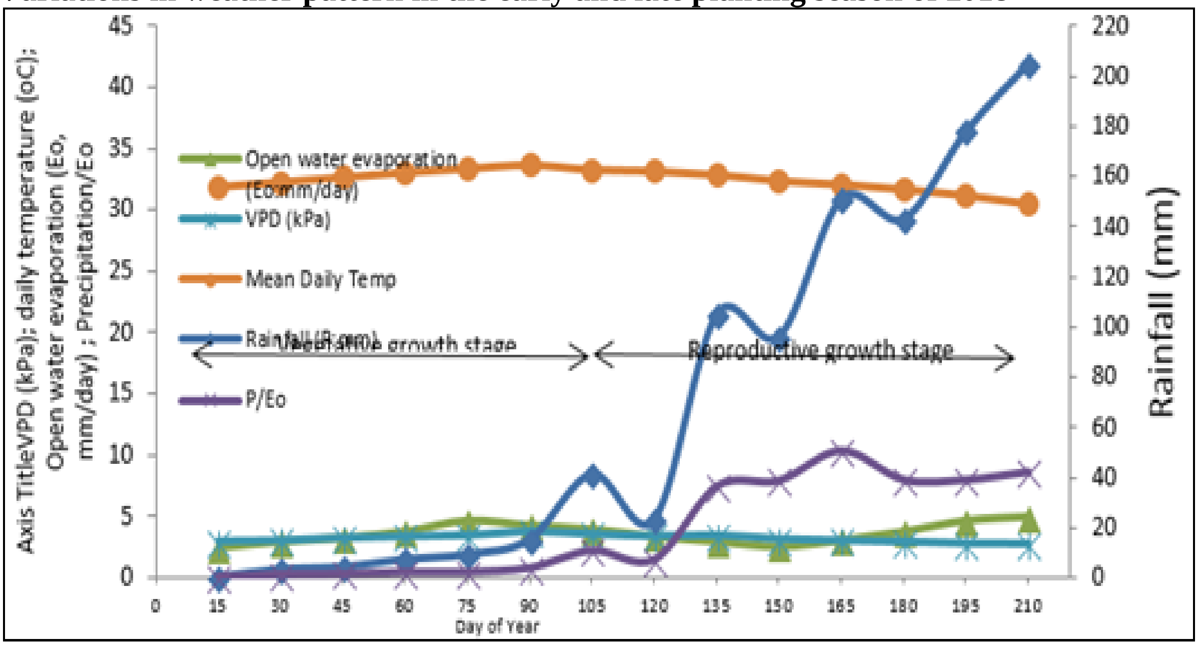

Figure 1: Important weather variables during early rainy season

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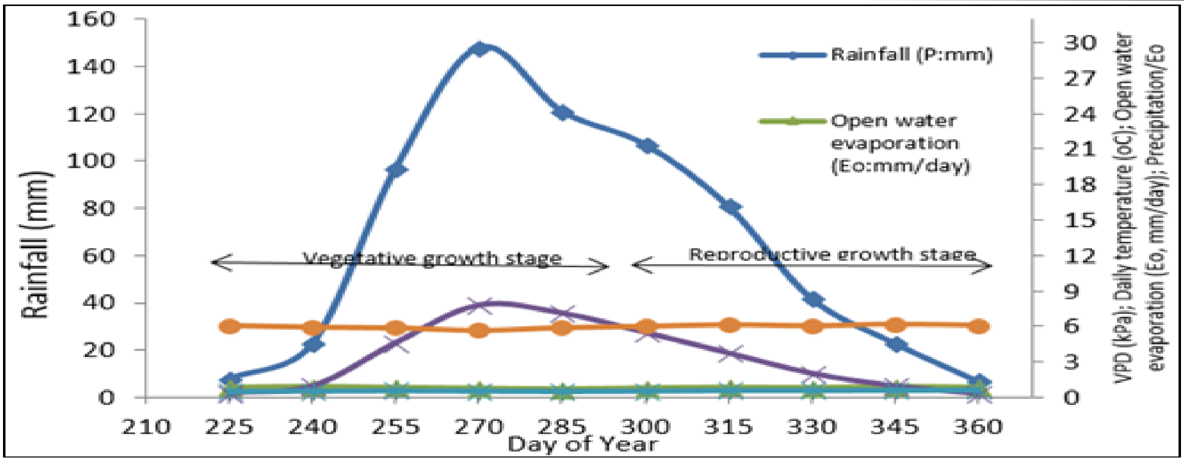

Figure 2: Important weather variables during late rainy season

Some meteorological variables during the growth of water melon in the respective early and late rainy cropping seasons of 2018 are presented in Figure 1 and 2. There were dry spells between rainfall episodes particularly in the early part of the early and the latter part of the late rainy seasons. Compared with the late rainy season, the late season is characterized by high climatic demand (high vapour pressure deficit: vpd), crop water demand (open water evaporation: Eo) and temperatures in addition to low and scanty rainfall particularly towards the close of the growing season which coincided with reproductive growth phase of watermelon. The earlier part of the rainy and later part of the late season was characterized by concurrent stresses of high intensities of soil moisture and vapour pressure deficits (atmospheric demand). The rainy season is characterized by increasing trends in rainfall amounts and open water evaporation (Eo) and atmospheric demand during the vegetative and the reproductive growth phases of water melon. (Figure 1). However, the earlier part of the rainy season which coincided with the establishment phase is characterized by low rainfall amount and high temperatures. However, during the late rainy season, environmental conditions were the opposite of the early rainy season; there were decreases in rainfall amounts and high temperatures, vapor pressure deficits and open water evaporation (Figure 2). However, concurrent and increasing intensities of stress factors of high evaporative demand and temperatures characterized the later part of the late season (the reproductive phase of watermelon)

Table 1 showed the result of soil chemical properties before the experiment. The pH of the soil was 6.95 which is slightly acidic. Organic matter contents analyzed was 4.01%. Nitrogen content was 0.38 g/kg. The available P content in the soil was 16.1 mg/kg, K (0.38 cmol/kg), Na (1.80 cmol/kg), Ca (5.40cmol/kg) and Mg (2.50 cmol/kg).The results showed that the soil was sandy loam in texture with high proportion of sand (82.3%) with a bulk density of 1.32g/cm3. This implies that basic cations such as Ca, K, Na and Mg would be leached more easily as texture determines the degree of retention or ease of leaching of basic cations (Adebayo *et al*, 2020). The soil was slightly acidic in pH (5.95) with low organic carbon; total nitrogen and available P were also low in the soil. Low organic carbon and organic matter in the soil of the experimental site was probably as a result of high proportion of sand content of the soil.

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Effect of variety on Plant Functional Traits of water melon in the early rainy season

The result of effect of variety on plant functional traits of water melon in the early rainy season is presented in Table 2. The result shows that there is no significant difference in the number of branches, total biomass, number of fruit rots, number of cracked fruits, fruit weight and harvest index in the tested watermelon varieties. Conversely, highest vine length was recorded for Charleston Grey (235.10cm).There was no significant difference between the days to first flowering and fruiting for Charleston Grey and Sugar Baby with shorter days recorded.(35 days, 50days) respectively.

Effect of variety on Plant Functional Traits of water melon in the late rainy season

The result of effect of variety on plant functional traits of water melon in the late rainy season is presented in Table 3. The result shows that there is no significant difference in the number of branches, total biomass, number of fruit rots, number of cracked fruits, fruit weight and harvest index in the tested watermelon varieties. Conversely, highest vine length was recorded for Charleston Grey (219.77cm). There was no significant difference between the days to first flowering and fruiting between Charleston Grey and Sugar Baby with shorter days recorded.(38 days, 58days) respectively.

Consumptive Water Use, Seed Setting Efficiency and Crop Water Productivity in the early rainy season of five water melon varieties

Table 4 shows the Consumptive Water Use, Seed Setting Efficiency and Crop Water Productivity in the early rainy season of five water melon varieties. The result shows a significantly higher Consumptive water use for Charleston Grey (382.91 m^3/ha). This was closely followed by Sugar Baby (373.85 m^3/ha) while the Kaolac had the lowest CWU as recorded in the early rainy season. Similarly, higher Seed Setting Efficiency (SSE) was recorded for Charleston Grey (0.81%) and Sugar Baby (0.79%) respectively while the lowest SSE was recorded for Kaolac (0.69%).The Crop Water Productivity (CWP) which is the measure of efficiency of water produced per unit of water used was significantly higher for Charleston Grey (1.83kg/m^3) over other varieties. This was closely followed by Sugar Baby (1.79 Kg/m^3) with the least CWP) recorded for (Kaolac 1.37kg/m^3). The Water Use Efficiency (WUE) was significantly higher for Charleston Grey and Sugar Baby (1.49 kg/m^3 and 1.46 kg/m^3) respectively while significantly lowest value was recorded for Kaolac 1.07 kg/m^3). The farmland water consumption or Soil Moisture Storage (SMS) which is the amount of water held in the soil profile, available for plant growth and evapotranspiration followed similar trend

Consumptive Water Use, Seed Setting Efficiency and Crop Water Productivity in the late rainy season of five water melon varieties

Table 5 shows the Consumptive Water Use, Seed Setting Efficiency and Crop Water Productivity in the late rainy season of five water melon varieties. The result shows a significantly higher Consumptive water use for Charleston Grey (369.29 m^3/ha). This was closely followed by Sugar Baby (336.59 m^3/ha) while the Kaolac had the lowest CWU as recorded in the late rainy season. Similarly, higher Seed Setting Efficiency (SSE) was recorded for Sugar Baby (0.75%). There is no significant difference between SSE for Crimson Sweet and Charleston Grey (0.71%) while the lowest SSE was recorded for Kaolac

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(0.65%). The Crop Water Productivity (CWP) was significantly higher for Charleston Grey (1.67kg/m^3) over other varieties. This was closely followed by Sugar Baby (1.63 Kg/m^3) with the least CWP) recorded for (Kaolac 1.14kg/m^3). The Water Use Efficiency (WUE) was significantly higher for Charleston Grey and Sugar Baby (1.39 kg/m^3 and 1.36 kg/m^3) respectively while significantly lower value was recorded for Kaolac (0.98 kg/m^3). The farmland water consumption or Soil Moisture Storage (SMS) followed similar trend with Sugar Baby having the highest SMS (26.29%).

Interaction Effect of Variety and Season on Plant Functional Traits of water melon

The Interaction Effect of Variety and Season on Plant Functional Traits of water melon is presented in Table 6.The result shows that there is no significant difference on number of branches, total biomass, number of fruit rots, number of cracked fruits and harvest index. Conversely, significant difference were recorded for number of leaves, vine length, days to first flowering and fruiting, number of flowers, fruit diameter and fruit weight.

Interaction effect of Seasons on Plant Functional Traits of water melon

The Interaction Effect of Seasons on Plant Functional Traits of water melon is presented in Table 7.The result shows that there is no significant difference on number of branches, total biomass, number of fruit rots, number of cracked fruits and harvest index. Conversely, significant difference were recorded for number of leaves, vine length, days to first flowering and fruiting, number of flowers, fruit diameter and fruit weight.

Interaction effect variety and season on Consumptive Water Use, Seed Setting Efficiency and Crop Water Productivity of watermelon

The Interaction effect of variety and season on Consumptive Water Use, Seed Setting Efficiency and Crop Water Productivity of watermelon is presented in Table 8.The result shows that there is a significant difference between the plant total biomass, SSE, WUE, CWU, CWP and SMS

Interaction effect of seasons on Consumptive Water Use, Seed Setting Efficiency and Crop Water Productivity of watermelon

The Interaction effect of seasons on Consumptive Water Use, Seed Setting Efficiency and Crop Water Productivity of watermelon is presented in Table 9. The result shows a significant difference in the CWU, CWP and SMS of watermelon varieties. The result from this study revealed that the higher consumptive water use (CWU) recorded for Charleston Grey and Sugar Baby varieties in both seasons suggests that these varieties require more water to produce higher yields. This is in line with the findings of Irmak *et al*. (2017) who reported a positive correlation between CWU and fruit yield in watermelon. However, the higher CWU also implies a higher risk of water stress, especially in water-scarce environments (Fereres *et al*. 2018).The seed setting efficiency (SSE) was also higher for Charleston Grey and Sugar Baby varieties in both seasons. This is consistent with the findings of Zhang *et al*. (2019), and Oyewusi, et al, (2020) who reported a positive correlation between SSE and fruit yield in watermelon. The higher SSE suggests that these varieties are more efficient in converting flowers into fruits, which is a critical factor in watermelon production (Wang *et al*. 2020, Oyewusi, et al, 2020).The crop water productivity (CWP) and water use efficiency (WUE) were also higher for Charleston Grey and Sugar Baby varieties in both seasons. This suggests that these varieties are more efficient in using water to produce higher yields, which is critical in water-scarce environments (Kumar *et al*. (2018).The soil moisture storage (SMS) was higher for Charleston Grey and Sugar Baby varieties in both seasons .This suggests that these varieties are more efficient in storing soil moisture, which is critical in water-scarce environments (Li *et al*. 2020).The interaction effect between variety and season on CWU, SSE, CWP, and SMS showed significant differences for total biomass, SSE, WUE, CWU, CWP, and SMS . This suggests that the effect of variety on these traits is influenced by the season, which is consistent with the findings of Oyebanji *et al*. (2020) who reported significant interaction effects between variety and season on plant functional traits in watermelon. The results show that the late rainy season had lower SMS values compared to the early rainy season. This is consistent with previous studies that showed that soil water content decreases as the season progresses due to increased evapotranspiration and water use by crops (Allen *et al*., 2019). In this study, Charleston Grey had the highest WUE values in both seasons. This is consistent with previous studies that showed that some crop varieties are more water-use efficient than others due to differences in their physiological and morphological characteristics (Condon *et al*., 2004, Wang *et al*, 2020, Oyewusi, et al, 2020). The results show that the early rainy season had higher CWU values compared to the late rainy season. This is consistent with previous studies that showed that crops use more water during the early growth stages (Meyer *et al*., 2013). Charleston Grey had the highest CWP values in both seasons. This is consistent with previous studies that showed that some crop varieties are more productive under water-limited conditions due to their ability to maintain yield despite water stress (Cheng, *et al*, 2022, Adelana *et al*. 2019). Overall, the early rainy season gave better results in terms of SWC, CWU, and CWP. This is because the early rainy season typically has more favorable weather conditions, such as cooler temperatures and more rainfall, which promotes crop growth and water, use (Singh *et al*, 2020). Charleston Grey performed better than the others in terms of WUE and CWP. This is because Charleston Grey has a higher yield potential and is more water-use efficient, which enables it to maintain yield despite water stress.

Conclusion and recommendation

The study revealed that Charleston Grey and Sugar Baby varieties had higher vine length, total biomass, shorter days to first flowering, highest number of flowers, and highest fruit yield in both early and late rainy seasons. These varieties also had higher CWU, SSE, CWP, and SMS, suggesting that they are more efficient in using water to produce higher yields. However, the higher CWU also implies a higher risk of water stress, especially in water-scarce environments. The interaction effect between variety and season on CWU, SSE, CWP, and SMS showed significant differences, suggesting that the effect of variety on these traits is influenced by the season. Based on the discussion above, the following recommendations can be made: Farmers in the derived savannah agro-ecologies should consider planting Charleston Grey and Sugar Baby watermelon varieties due to their higher vine length, total biomass, shorter days to first flowering, highest number of flowers, and highest fruit yield. These varieties should be planted in both early and late rainy seasons, as they have shown to perform well in both seasons. Farmers should ensure adequate water supply for Charleston Grey and Sugar Baby varieties, as they have higher consumptive water use

(CWU). Farmers should adopt efficient irrigation systems and water management practices to minimize water stress and optimize water use efficiency (WUE). Soil moisture storage (SMS) should be optimized through conservation agriculture practices, such as mulching and cover cropping, to reduce soil moisture loss and improve water availability for watermelon production. Further research should be conducted to explore the potential of other watermelon varieties in the derived savannah agro-ecologies and to develop more efficient irrigation systems and water management practices. Extension services should be provided to farmers to educate them on the benefits and management requirements of Charleston Grey and Sugar Baby varieties. Policy makers should consider promoting the adoption of water-efficient irrigation systems and conservation agriculture practices through incentives and subsidies. Further studies should be conducted to explore the interaction effects between variety and season on plant functional traits in watermelon and to develop more accurate crop water productivity (CWP) models. The development of drought-tolerant watermelon varieties should be prioritized to improve watermelon production in water-scarce environments.

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Table 1: Physical and chemical properties of the soil at experimental site

Properties	**Values**
Ph	5.95
Total N (%)	0.38
Available P (mg/kg)	16.10
Exchangeable cations (Cmol.kg^{-1})	
Ca^{2+}	5.40
Mg^{2+}	2.50
K^{+}	1.07
Na^{2+}	0.38
Organic Carbon (%)	1.80
Organic matter (%)	0.59
H+	0.20
CEC	2.96
Particle size distribution	
Sand	82.30
Silt	10.50
Clay	7.20
Texture	Sandy loam
Bulk density (g/cm^3)	1.32

Table 2: Effect of variety on Plant Functional Traits of water melon in the early rainy season

Varieties	No of leaves	No. of branches	Vine length (cm)	Total biomass (kg)	Days to first flowering	No of flowers	Days to first fruiting	No of fruit rots	Fruit diameter (cm)	No of cracked fruit	Fruit weight (kg)	Harvest Index
Crimson Sweet	30.56^b	2.68^a	160.12^c	3.43^a	38.00^b	20.65^b	55.00^b	0.33^a	27.11^c	0.00^a	1.28^a	0.35^a
Charleston Grey	35.76^a	3.10^a	235.10^a	3.73^a	35.00^c	25.90^a	50.00^c	1.28^a	36.28^b	0.32^a	1.53^a	1.53^a

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Varieties	No of leaves	No. of branches	Vine length (cm)	Total biomass (kg)	Days to first flowering	No of flowers	Days to first fruiting	No of fruit rots	Fruit diameter (cm)	No of cracked fruit	Fruit weight (kg)	Harvest Index
Kaolac	25.55^{c}	2.94^{a}	205.89^{b}	3.63^{a}	43.00^{a}	15.15^{c}	60.00^{a}	1.10^{a}	42.10^{a}	0.80^{a}	1.39^{a}	1.39^{a}
Anderson	30.03^{b}	2.38^{a}	121.58^{e}	3.86^{a}	38.00^{b}	20.56^{b}	55.00^{b}	0.50^{a}	44.17^{a}	0.00^{a}	1.70^{a}	1.70^{a}
Sugar Baby	35.84^{a}	2.35^{a}	152.60^{d}	3.38^{a}	35.00^{c}	24.43^{a}	50.00^{c}	0.00^{a}	43.13^{a}	0.00^{a}	1.08^{a}	1.08^{a}
Mean	31.55	2.69	174.86	3.61	37.20	21.54	54.00	0.64	38.58	0.22	1.39	1.21
SD	4.31	0.33	53.19	0.13	4.62	4.49	4.47	0.58	7.35	0.38	0.23	0.57
SE±	1.93	0.15	24.29	0.06	2.07	2.01	2.00	0.26	3.29	0.17	0.10	0.26
LSD (0.05)	5.73	0.45	72.41	0.19	6.17	5.99	5.96	0.78	9.83	0.51	0.29	0.78
CV	13.72	12.31	30.93	3.51	12.45	20.83	8.29	90.63	19.07	172.73	16.55	70.37

Means carrying the same alphabet along the same columns are not significantly different at 5% probability level.SD-Standard Deviation.CV-Coefficient of Variability.

Table 3: Effect of variety on Plant Functional Traits of water melon in the late rainy season

Varieties	No of leaves	No. of branches	Vine length (cm)	Total biomass (kg)	Days to first flowering	No of flowers	Days to first fruiting	No of fruit rots	Fruit diameter (cm)	No of cracked fruit	Fruit weight (kg)	Harvest Index
Crimson Sweet	23.56^{b}	3.65^{a}	208.49^{b}	3.48^{a}	48.00^{a}	15.45^{a}	63.00^{b}	0.33^{a}	47.14a	0.00^{a}	1.63^{a}	0.47^{a}
Charleston Grey	28.76^{a}	3.09^{a}	219.77^{a}	3.88^{a}	38.00^{c}	20.56^{a}	58.00^{c}	0.39^{a}	40.78^{b}	0.32^{a}	2.10^{a}	0.54^{a}
Kaolac	18.10^{c}	2.78^{a}	192.89^{c}	3.72^{a}	48.00^{a}	10.95^{c}	68.00^{a}	1.00^{a}	36.18^{d}	0.80^{a}	1.24^{a}	0.33^{a}
Anderson	23.93^{b}	2.86^{a}	189.93^{d}	3.83^{a}	43.00^{b}	15.10^{a}	63.00^{b}	0.68^{a}	40.12^{b}	0.00^{a}	1.22^{a}	0.46^{a}
Sugar Baby	28.56^{a}	2.49^{a}	209.10^{b}	3.79^{a}	38.00^{c}	20.07^{a}	58.00^{c}	0.34^{a}	43.19^{c}	0.00^{a}	1.41^{a}	0.32^{a}

Varieties	No of leaves	No. of branches	Vine length (cm)	Total biomass (kg)	Days to first flowering	No of flowers	Days to first fruiting	No of fruit rots	Fruit diameter (cm)	No of cracked fruit	Fruit weight (kg)	Harvest Index
Mean	25.58	3.17	205.24	3.74 a	43.2	16.46	62	0.55	41.4	0.22	1.52	0.42
SD	4.31	0.44	23.19	0.19	5.13	4.49	5.03	0.35	4.59	0.38	0.43	0.12
SE±	1.93	0.20	10.37	0.09	2.31	2.01	2.25	0.16	2.06	0.17	0.19	0.05
LSD (0.05)	5.73	0.59	30.94	0.27	6.83	5.99	6.63	0.47	6.17	0.51	0.57	0.15
CV	16.8	13.92	11.31	5.08	11.86	27.31	8.13	63.64	11.09	172.73	28.29	28.57

Means carrying the same alphabet *al*ong the same columns are not significantly different at 5% probability level.SD-Standard Deviation.CV-Coefficient of Variability.

Table 4: Consumptive Water Use, Seed Setting Efficiency and Crop Water Productivity in the early rainy season of five water melon varieties

Variety	Total biomass (kg)	SSE (%)	WUE kg/m^3	CWU m^3/ha	CWP kg/m^3	SMS (%)	HI (%)
Crimson Sweet	3.43	0.75	1.23	345.12	1.56	25.56	0.35
Charleston Grey	3.73	0.81	1.49	382.91	1.83	27.19	1.53
Kaolac	3.63	0.69	1.07	313.59	1.37	22.15	1.39
Anderson	3.86	0.73	1.21	335.19	1.52	25.03	1.70
Sugar Baby	3.38	0.79	1.46	373.85	1.79	27.84	0.81
Mean	3.61	0.75	1.23	340.33	1.61	26.14	1.21
SD	0.18	0.06	0.16	33.45	0.21	2.33	0.53
SE±	0.08	0.03	0.07	15.21	0.10	1.07	0.24
LSD (0.05)	0.35	0.12	0.32	65.49	0.43	4.69	1.06
CV	5.01	8.00	13.00	9.86	13.04	8.96	55.21

SSE - Seed setting efficiency.WUE -Water use efficiency.CWU - Consumptive water use.SMS - Soil moisture storage. CWP - Crop water productivity. H I- Harvest Index

Table 5: Consumptive Water Use, Seed Setting Efficiency and Crop Water Productivity in the late rainy season of five water melon varieties

Variety	Total biomass (kg)	SSE (%)	WUE kg/m^3	CWU m^3/ha	CWP Kg/m^3	SMS (%)	HI (%)
Crimson Sweet	3.48	0.71	1.15	311.59	1.41	23.19	0.47
Charleston Grey	3.88	0.77	1.39	369.29	1.67	25.39	0.54
Kaolac	3.72	0.65	0.98	281.19	1.13	20.59	0.33

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Variety	Total biomass (kg)	SSE (%)	WUE kg/m^{3}	CWU m^{3}/ha	CWP Kg/m^{3}	SMS (%)	HI (%)
Anderson	3.83	0.69	1.12	304.39	1.38	23.43	0.46
Sugar Baby	3.79	0.75	1.36	336.59	1.63	26.29	0.32
Mean	3.74	0.73	1.20	320.49	1.44	24.58	0.42
SD	0.14	0.06	0.18	34.69	0.20	2.51	0.11
SE±	0.06	0.03	0.08	15.69	0.09	1.14	0.05
LSD (0.05)	0.29	0.12	0.35	68.39	0.41	4.96	0.22
CV	3.74	8.22	15.00	10.83	13.89	10.21	26.19

SSE - Seed setting efficiency.WUE -Water use efficiency.CWU - Consumptive water use.SMS - Soil moisture storage. CWP - Crop water productivity. H I- Harvest Index

Table 6: Interaction Effect of Variety and Season on Plant Functional Traits of water melon

Variety (V)	Season (S)	No of leaves	No. of branches	Vine length (cm)	Total biomass (kg)	Days to first flowering	No of flowers	Days to first fruiting	No of fruit rots	Fruit diameter (cm)	No of cracked fruit	Fruit weigh (kg)	Harvest Index
Crimson Sweet	Early	30.56^{b}	2.68^{a}	160.12^{f}	3.43^{a}	38.00^{c}	20.65^{b}	55.00^{e}	0.33^{a}	27.11^{e}	0.00^{a}	1.28^{ab}	0.35^{a}
	Late	23.56^{e}	3.65^{a}	218.49^{b}	3.48^{a}	48.00^{a}	15.45^{c}	63.00^{b}	0.33^{a}	47.14^{a}	0.00^{a}	1.63^{ab}	0.47^{a}
Charleston Grey	Early	35.76^{a}	3.10^{a}	235.10^{a}	3.73^{a}	33.00^{d}	25.90^{a}	50.00^{f}	1.28^{a}	36.28^{d}	0.32^{a}	1.53^{ab}	1.53^{a}
	Late	28.76^{c}	3.09^{a}	206.77^{c}	3.88^{a}	38.00^{c}	20.56^{b}	58.00^{d}	0.39^{a}	40.78^{c}	0.32^{a}	2.10^{a}	0.54^{a}
Kaolac	Early	25.55^{d}	2.94^{a}	205.89^{c}	3.63^{a}	43.00^{b}	15.15^{c}	60.00^{c}	1.10^{a}	42.10^{b}	0.80^{a}	1.39^{ab}	1.39^{a}
	Late	18.10^{d}	2.78^{a}	192.89^{d}	3.72^{a}	48.00^{a}	10.95^{d}	68.00^{a}	1.00^{a}	36.18^{d}	0.80^{a}	1.24^{ab}	0.33^{a}
Anderson	Early	30.03^{b}	2.38^{a}	121.58^{h}	3.86^{a}	38.00^{c}	20.56^{b}	55.00^{e}	0.50^{a}	44.17^{b}	0.00^{a}	1.70^{ab}	1.70^{a}
	Late	23.93^{e}	2.86^{a}	189.93^{e}	3.83^{a}	43.00^{b}	15.10^{c}	63.00^{b}	0.68^{a}	40.12^{c}	0.00^{a}	1.22^{ab}	0.46^{a}
Sugar Baby	Early	35.84^{a}	2.35^{a}	152.60^{g}	3.38^{a}	33.00^{d}	25.43^{a}	50.00^{f}	0.00^{a}	43.13^{b}	0.00^{a}	1.08^{ab}	1.08^{a}
	Late	28.56^{c}	2.49^{a}	219.10^{b}	3.79^{a}	38.00^{c}	20.07^{b}	58.00^{d}	0.34^{a}	43.19^{b}	0.00^{a}	1.41^{ab}	0.32^{a}
VxS													
LSD (0.05)		12.56 *	1.46 NS	68.33 *	0.46 NS	12.61 *	10.93 *	10.73 *	0.85 NS	12.61 *	0.85 NS	0.85 *	0.85 NS

Means carrying the same alphabet along the same columns are not significantly different at 5% probability level.SD-Standard Deviation.CV-Coefficient of Variability. * Significant at 5% level of probability. NS: Not significant

Table 7: Interaction effect of Seasons on Plant Functional Traits of water melon

Season	No of leaves	No. of branches	Vine length (cm)	Total biomass (kg)	Days to first flowering	No of flowers	Days to first fruiting	No of fruit rots	Fruit diameter (cm)	No of cracked fruit	Fruit weight (kg)	Harvest Index
Early Season	157.74	13.45	875.29	18.03	185.00	107.69	270.00	3.21	192.79	1.12	9.22	6.05
Late Season	122.91	14.87	1027.18	18.70	215.00	82.13	310.00	2.74	207.41	2.24	7.60	2.12
ESx LS	140.33	14.16	951.24	18.37	200.00	148.76	290.00	2.98	200.10	1.68	8.41	4.09
LSD (0.05)	24.14	1/00	105.93	0.47	20.73	18.03	27.70	0.33	9.69	0.78	1.14	2.72
	*	NS	*	NS	*	*	*	NS	*	NS	*	NS

* Significant at 5% level of probability. NS: Not significant.

Table 8. Interaction effect variety and season on Consumptive Water Use, Seed Setting Efficiency and Crop Water Productivity of watermelon

Variety (V)	Season (S)	Total biomass (kg)	SSE (%)	WUE kg/m^3	CWU m^3/ha	CWP Kg/m^3	SMS (%)	HI (%)
Crimson Sweet	Early	3.43	0.75	1.23	345.12	1.56	25.56	0.35
	Late	3.48	0.71	1.15	311.59	1.41	23.19	0.47
Charleston Grey	Early	3.73	0.81	1.49	382.91	1.83	27.19	1.53
	Late	3.88	0.77	1.39	369.29	1.67	25.39	0.54
Kaolac	Early	3.63	0.69	1.07	313.59	1.37	22.15	1.39
	Late	3.72	0.65	0.98	281.19	1.13	20.59	0.33
Anderson	Early	3.86	0.73	1.21	335.19	1.52	25.03	1.70
	Late	3.83	0.69	1.12	304.39	1.38	23.43	0.46
Sugar Baby	Early	3.38	0.79	1.46	373.85	1.79	27.84	0.81
	Late	3.79	0.75	1.36	336.59	1.63	26.29	0.32
VxS LSD (0.05)		0.46 *	0.14 *	0.42 *	68.33 *	0.46 *	4.67 *	0.85 NS

* Significant at 5% level of probability. NS: Not significant. SSE - Seed setting efficiency.WUE -Water use efficiency.CWU - Consumptive water use.SMS - Soil moisture storage. CWP - Crop water productivity. H I- Harvest Index

Table 9. Interaction effect of seasons on Consumptive Water Use, Seed Setting Efficiency and Crop Water Productivity of watermelon

Season	Total biomass (kg)	SSE (%)	WUE kg/m^3	CWU m^3/ha	CWP Kg/m^3	SMS (%)	HI (%)
Early Season (ES)	3.61	0.75	1.23	340.33	1.61	26.14	1.21
Late Season (LS)	3.74	0.73	1.20	320.49	1.44	24.58	0.42
ESxLS							
LSD (0.05)	0.14	0.03	0.42	26.86	0.24	2.06	1.08
	NS	NS	NS	*	*	*	NS

* Significant at 5% level of probability. NS: Not significant. SSE - Seed setting efficiency.WUE -Water use efficiency.CWU - Consumptive water use.SMS - Soil moisture storage. CWP - Crop water productivity. H I- Harvest Index