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Evaluation of Exotic Watermelon Varieties under Irrigation in Agro-pastoral Area

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Abstract

A field experiment was conducted in the year 2022 under irrigation conditions at Selamago Woreda, Omo Kuraz farm to evaluate exotic watermelon varieties for fruit yield and yield components and to select adaptable varieties to the study area. Four exotic watermelon verities (Crismon sweet, Avalon, Lahat and Polimer) were used as treatment and arranged in a randomized complete block design with four replications. According to the result of ANOVA, varieties had significant ($P \leq 0.05$) differences in all parameters considered in this study except vine length. The shortest time taken for 50% days to flowering (53.75) and 90% days to maturity (100), maximum number of fruit per plant (2.2) and fruit yield per hectare (32.54 ton h^{-1}) were recorded on the variety Polimer. In addition, the maximum total return (325,400 ETB), and net return (280,690 ETB) were recorded from Polimer followed by Polimer and vice-versa with Benefit Cost ratio. Based on the results of this study, the variety polimer and Avalon are performed best in terms of maturity, and fruit yield parameters and economically profitable for production in South Omo lowland agro-climate conditions.

Keywords: Agro-pastoral, Fruit-Yield, Irrigation, Performance, Varieties, Vegitable, and Watermelon.

1. Introduction

Watermelon (*Citrullus lanatus*) is a vine-like flowering plant that belongs to the family Cucurbitaceae (Joy *et al*., 2020; Narine *et al*., 2019). Evidence confirmed that watermelon originated in Southern Africa (Fatondji *et al*., 2008). Now a day it has been cultivated in warm areas of the world for its juicy and sweet flesh of mature fruit (Fatondji *et al*., 2008; Mujaju, 2011; Sheikh *et al*., 2024). As it is a warm-season crop, it tolerates hot weather and requires more heat, dry weather, and plenty of sunshine and grows best on sandy loam soils (Mujaju, 2011; Yimer and Tehulie 2020). It has great economic importance in Africa. According to the report of FAOSTAT, (2017), from an area of 257,449 hectares about 6,212,003 tons of watermelon were produced in Africa in the year 2017.

However, the exact time for the introduction of watermelon to Ethiopia is unknown; farmers in east Shoa described that the crop was started to produce in the 1950s by Italians. Currently, Watermelons are becoming a very important source of income for small-scale farmers and investors and started to produce out of the limited area (Asfaw, 2022) after the promotion of different irrigation systems, which is linked with the production of fruits and vegetable all over the country, watermelon production in the South Omo zone especially in lowland areas is coming into know. It is an important crop to attain food insecurity and malnutrition which are the major concernment issue of Ethiopia, especially agro-pastoral areas. Because, the fruit of watermelon is an important part of the healthy diet for humans since it has very high concentrative nutrients with free of cholesterol, low calories and thirst-quenching. Its fruit contains 93% water, 5% carbohydrate and 2% composition from Fiber, Fat, Protein, Thiamin, Pantothenic Acid, and Vitamins and minerals (Adojutelegan *et al*., 2015; Joy *et al*., 2020).

However, improved watermelon cultivars are not yet sufficiently put under production and most of the farmers are using unknown varieties (Mujaju, 2011). As a result, production is characterized by low yield and quality (Yimer and Tehulie, 2020; Zia *et al*., 2026). There for, this research aimed to evaluate exotic watermelon varieties for fruit yield and adaptability to the target area. Making use of adaptable and high-yielding watermelon varieties may help to cope with food insecurity and malnutrition as well as increase the incomes of farmers/agro-pastorals through improving production and creating diversification.

2. Material and Methods

Description of Study Area

Field experiments were conducted in 2022 under irrigation conditions at Selamago Woreda, Omo Kuraz Irrigation schism. Selamago Woreda is found in the Southern Nations and Nationalities Regional State in South Omo Zone Ethiopia. Geographically, it is found at 5.32-6.460 N and 35.81-36.450 E and the altitude of the district ranges between 485 and 2500 m, a.s.l. The Wereda comprised 37% midland and 67% of the area is low land with a mean annual temperature that ranges from 20 to 37.5°C. The mean annual rainfall ranges between 400 mm and 1600 mm and receives bimodal rainfall.

Experimental Design and Treatments:

The experiment was done using a complete randomized block design with three replications by using four varieties as a treatment. The varieties were Crismon Sweet, Lahat, Polimer and Avalan, which are available commercially on the market. The plot size was 6m*6m and consist of three rows and six plants per row having a spacing of 2.m*1m between row and plant respectively which consist of 18 potential stands per plot. The spacing between the experimental unit and replication was 1.5m apart.

Experimental procedure and field management

The experimental field 30 m × 30 m, was first cleared manually and plowed and harrowed by the tractor. Planting furrows were manually made using a spacing of 2m between adjacent furrows. Two seeds were planted on the mid part of one side ridge using spacing 1m between plants. The crop was irrigated by using a furrow irrigation system until the crop was harvested. Water was applied at 3 days intervals at the initial stage and once within a week after the crop becomes mature. No fertilizer was applied to the trials, but weeding was performed at three-week intervals till flower formation.

Data collected and analysis

Different phenological, growth and agronomic data were collected to evaluate watermelon varieties. Days to flowering and days to maturity were recorded as the number of days from sowing to the time when 50% of the plant population produces flowers and when 90% of the plant population per plot turned yellowish or showed senescence maturity respectively. Vine length was measured from 5 plants randomly taken from harvestable rows of plots at harvesting time. The number of fruits per plant was determined by counting the number of fruit from randomly selected sample plants. The fruit length was recorded by measuring the sample fruit from the point where the tendril attached to the blossom end in centimeters, whereas the fruit width was recorded by measuring the largest diameter after cutting the cross-section of the fruit of sampled fruits. To get fruit yield per hectare, all harvested fruits per sample size were weighed bulky and converted to yield per hectare and divided the weighted result by the total number of harvested fruit from the sample given average fruit weight. The mean value for all treatment parameters was calculated and subjected to ANOVA using SAS 9.2 software. A test of mean separation was employed depending on the significance of the analysis of variance. Mean separation was done by using LSD.

3. Result and discussion

Growth and phenological parameters

The ANOVA revealed that vine lengths were not significantly (P > 0.05) influenced by varieties. However, the varieties had significant (P<0.05) differences for both 50% days to flowering and 90% days to maturity (**Table 1**). Accordingly, the shortest time taken for 50% days to flowering (53.7) and for 90% days to maturity (100) were observed on Polimer; whereas Avalon, Crismon sweet, and Lahat took longer days to 50% of flowering at 60, 61.2 and 62 days and 60, 61.2 and 62 days to 90% maturity respectively **Table 2**. Variation between varieties in terms of days to flowering and maturity could be attributed to the genetic difference among varieties). Watermelon varieties being categorized as early, medium and late sets of flowering and maturing which were associated with the genetic makeup, were also observed by (Joy *et al*. 2020; Tegen *et al*. 2021).

Table 1: The analysis of variance results of different exotic watermelon varieties on yield and yield-related parameters.

Source of	**DF**	**Mean square**							
Variation		50%DF	90%DH	VL	FD	FL	AFW	NFPP	Y/H
Replication	3	5.66	4.16	15860.9	0.74	11.13	0.16	0.34	106.57
Treatment	3	56.5^{*}	45.83^{**}	7948.9^{ns}	3.49^{**}	37.27^{*}	1.13^{**}	0.86^{**}	122.37^{*}
Error	9	9.83	5.55	8430.9	0.38	6.46	0.14	0.10	22.26

*= significance difference, ** highly significance difference= DF= degree of freedom, 50%DF = 50% days to flowering, 90%DH= 90 days to harvesting, VL= vine length, FD= fruit diameter, FL= fruit length, AFW= average fruit weight, NFPP= number of fruit per plant, FYPH= fruit yield per hectare.

Yield-related trait performances

The result of ANOVA revealed that fruit diameter, fruit length, Average fruit weight and number of fruits per plant had significant (p<0.05) differences among varieties (**Table 1**). Polimer had a significantly lower mean value of fruit diameter (18.29 cm), fruit length (29.35 cm) and average fruit weight (3.65 kg) than Avalon which had not statistically different from Lahat and Crismon sweet. However, the maximum (2.2) number of fruits per plant was recorded on the variety Polimer; while the minimum (1.09) fruit number was counted from Crismon sweet which had a statically similar mean result with Avalon and Lahat (**Table 2**). The variation in fruit number per plant might be due to the response of varieties for sex ratio and fruit set percentage in a given environment. (Walters *et al*., 2021) also stated that the variation in the number of fruit per plant also creates variability in fruit size which had directly proportional to average fruit weight because of the translocation of photosynthetic resources into each fruit. Similar observations were also made by (Dalorima *et al*., 2022; Joy *et al*., 2020).

Table 2: Mean value of different exotic watermelon varieties on yield and yield-related parameters.

Varieties	**50%DF**	**90%DH**	**VL (cm)**	**FD (cm)**	**FL (cm)**	**AFW(k.g)**	**NFPP**	**Yield ton h^{-1}**
Polimer	53.75b	100.0b	394	18.29b	29.35b	3.67b	2.2a	32.54a
Avalon	60.0a	106.2a	480	20.35a	32.2ab	4.88a	1.4bc	28.82a
Lahat	62.0a	107.5a	490	20.18a	36.7a	4.65a	1.68b	30.81a
C.sweet	61.2a	106.2a	477.5	19.73a	33.1ab	4.61a	1.09c	20.09b
Cv	5.29	2.24	19.	3.17	7.74	8.61	19.8	16.81
Mean	59.25	105	460.3	19.64	32.85	4.45	1.6	28.06
LSD	5.01	3.77	146.8	0.99	4.06	0.61	0.51	7.54

50% DF = 50% days to flowering, 90% DH= 90 days to harvesting, VL= vine length, FD= fruit diameter, FL= fruit length, AFW= average fruit weight, NFPP= number of fruit per plant, FYPH= fruit yield per hectare.

Fruit yield performance

Significant differences (P<0.05) among the varieties were observed in fruit yield (**Table 1**). The overall yield in watermelon is often associated with fruit number and size which increases a significant fruit weight from a single plant. The variety Polimer which produces the maximum number of fruit per plant resulted in a significantly higher fruit yield (32.54 ton h^{-1}) which is considered a good yield for this study area, but not had a statistical difference from Lahat (30.81 ton h^{-1}) and Avalon (28.82 ton h^{-1}). While the lower (20.09 ton h^{-1}) fruit yield was obtained from the variety Crismon sweet (**Table 2**). This study shows that the four watermelon varieties differed in fruit yield due to the varietal effect on important agronomic traits evaluated. Tegen *et al,* (2021*)* also found significant yield variability from 36.3 ton h^{-1} to 13.2 ton h^{-1} among watermelon varieties with different plant density interactions. However, the report of Oraegbunam *et al*. (2016) on the fruit yield of watermelon was slightly lower than the current result.

Cost-benefit analysis

The main production cost of watermelon varieties is seed, operation of the tractor, labor and fixed cost (land rent). The sum of all cost of production for each variety varies and the cost of Polimer, Avalon, Lahat and Crismon sweet were 44710, 35070, 42350and 30870 ETB per hectare respectively (**Table 3**).

Table 3: Cost-benefit analysis of watermelon varieties.

Returns and expenses	Watermelon varieties			
Expenses (ETB/ha)	Polimer	Avalon	Lahat	Crismon sweet
Seed	15,840	6,200	13,480	2,000
Tractor operator & fuel	9000	9000	9000	9000
Labor	17870	17870	17870	17870
Fixed cost	2000	2000	2000	2000
Total expenses	44710	35070	42350	30870
Returns (ETB/ha)				
Yield	325400	288200	308100	200900
Total return	325400	288200	308100	200900
Gross margin	323400	286200	306100	198900
Net return (ETB/ha)	280,690	253,130	265,750	170,030
Benefit to cost ratio	6.28	7.22	6.27	5.51

The higher total return (325,400 ETB) and net return (280,690 ETB) were obtained from Polimer followed by Lahat 308,100ETB and 265,750 ETB per hectare respectively whereas, Crismon sweet gave the lower total return (200,900 ETB) and net return (170,030 ETB) result. The benefit-cost ratio indicates the benefit of investing in each watermelon variety is economically viable.

Moreover, the higher value of the benefit-cost ratio is preferred over others and, in this case, Avalon is better than Polimer but in terms of yield potential Polimer is better than Avalon (**Table 3**).

4. Conclusion

This study revealed that the varieties Polimer followed by Avalon were found to be the most promising varieties concerning their early maturing and better fruit yield over the other varieties. In terms of Cost-benefit analysis, Avalon has a superior benefit-cost ratio over Polimer but in terms of total return and net return, Polimer is higher than Avalon. Therefore, Polimer and Avalon were found to be the better option for agro-pastoral and investors for cultivation in South Omo lowland area agro-climatic condition. Moreover, experiments need on irrigation frequency and different planting seasons of watermelon to solve fruit cracking which was the main problem faced during the experimental process; this might be due to the effect of high temperature and/or irrigation level.

Ethics approval and consent to participate

This study was conducted in accordance with ethical standards. Approval for the research methodology and materials used was obtained from the South Ethiopia Agricultural Research Institute and the Ethiopia Institute of Agricultural Research Joint Annual Review. Informed consent was secured from all participants involved in the research.

5. Author Contributions

Authors designed and conducted the experiments, collected and analyzed the data, and wrote the original manuscript; prepared and analyzed the socio-economic and preference data, interpreted the results, and contributed to the writing; contributed to the conceptualization, acquired funding, and edited the manuscript; provided supervision, validation, and visualization. All authors reviewed and approved the final manuscript.

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7. Conflicts of Interest

All authors have reviewed the final version and agree to its publication in this journal and the authors declare that there are no conflicts of interest

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