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Effect of improved tomato cultivars on productivity and profitability in Morogoro region, Tanzania

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1 SUMMARY

The objective of this study was to assess yield, revenue and profit from F1 hybrid tomato cultivars compared to farmers' preferred open pollinated local tomato cultivars grown in Tanzania. Seeds of local and F1 hybrid tomato varieties were sourced from local agro-dealers. The experiment was laid out in a randomized complete block design with four treatments (cv. Assila, Eden, Shanty and Oxyl Premium) and four controls consisting of local tomato cultivars (cv. Tengeru 97, Tanya, Cal-J and Riogrande). A treatment was replicated three times each with 12 plants. The seedlings were planted at a spacing of 60 cm x 60 cm in an open field at Sokoine University of Agriculture during the rainy and dry seasons. Data on total and marketable fruit yields were analyzed using Genstat statistical software version 15 and treatment means were separated based on Fisher's unprotected LSD test at $p \leq 0.05$. Seed and production costs were computed based on real cost while revenues and net profits were estimated based on fruit marketable yield and retail prices of TSh. 700 and 1000 per kilogram (One USD = TSh. 2000). Results indicated that cv. Assila significantly ($p = 0.002$) produced higher total and marketable fruit yields than all local tomato cultivars during both the dry and rainy seasons. Moreover, cv. Eden significantly ($p = 0.002$) produced higher total and marketable fruit yields than all local cultivars during the dry season only while cv. Shanty produced higher marketable yields than all local cultivars during the rainy season only. The production costs of F1 hybrid tomato cultivars were higher than those of local tomato cultivars during both seasons. Tomato cv. Assila produced higher revenue and net profit than all local cultivars during both seasons while cv. Shanty produced higher revenue and net profit than all local tomato cultivars during the rainy season only. It is therefore recommended that farmers in Morogoro region should grow cv. Assila during both the rainy and dry seasons, and cv. Shanty during the rainy season only.

2 INTRODUCTION

Tomato (*Solanum lycopersicon* Mill.) is among the most important vegetable crops produced in Tanzania. The crop is largely produced for domestic markets with most of the cultivars being open pollinated roma type. The average tomato yield under smallholder farming ranges from 2.2 to 16 t/ha (FAOSTAT, 2014) while in large commercial farms the production ranges from 40 to 60 t/ha. Morogoro region is the largest producer of tomato in the country with the area under tomato cultivation of 6519 ha (Match Marker Associates, 2008). The low tomato yield under small-scale farming is largely due to diseases. The most common tomato diseases are fusarium wilt (*Fusarium oxysporum*), late blight (*Phytophthora infestans*), early blight (*Alternaria solani*), bacterial wilt (*Ralstonia solanacearum*), septoria leaf spot (*Septoria lycopersici*) and tomato yellow leaf curl virus. Rainy season disposes tomato to heavy disease infestations with diseases like alternaria leaf spot, late blight, septoria leaf spot and fusarium wilt being enhanced by wet condition during the rainy season. On the contrary, the dry season encourages powdery mildew and tomato yellow leaf curl virus infestations (Gleoson and Edmunds, 2006). Pesticide application is the major pest control strategy (Maerere *et al.*, 2006) though it is limited by inadequate availability of effective pesticides in the country, inability of small-scale farmers to afford effective pesticides and inadequate knowledge on appropriate usage of pesticides (Mtui *et al.*, 2010). Several F1 hybrid tomato cultivars have been introduced in the country for their high yield and diseases resistance, especially fusarium wilt, early blight and tomato yellow leaf curl virus (Hazera Genetics, 2009; Seminis, 2010a, Seminis, 2010b). F1 hybrid tomato seeds are usually very expensive and therefore are often unaffordable by the majority of small-scale farmers in the country. However, no cost-benefit analysis has been carried out to evaluate F1 hybrid tomato productivity and profitability compared with local tomato cultivars. The objective of this study was to evaluate the productivity and profitability of F1 hybrid tomato cultivars in Morogoro region.

3 MATERIALS AND METHODS

3.1 Materials: Open pollinated tomato cv. 'Tengeru 97' (semi-indeterminate type), 'Tanya', 'Cal-J' and 'Riogrande' (roma type), and F1 hybrid tomato cultivars (Assila, Eden, Shanty and Oxyl Premium) were sourced from local agro-dealers. Seeds were sown in sterilized forest soil filled in 4-inch diameter plastic polytubes. After seed germination, application of Selecron® (Profenofos) and Ridomyl® (Metalaxyl +Mancozeb) at a dose of 1mL/L and 2g/L was done when needed for management of insect pests and fungal diseases, respectively.

Figure 1: *Hybrid F1 tomato*: A = cv. Eden, B - cv. Shanty, C = Oxyl Premium and D = cv. Assila

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3.2 Experimental design and crop management: The experiment was laid out in a randomized completely block design with four treatments (cv. Assila, Eden, Shanty and Oxyl Premium) and four controls (cv. 'Tengeru 97', 'Tanya', 'Cal-J' and 'Riogrande'). A treatment was replicated three times each with 12 plants per plot. The seedlings were planted at a spacing of 60 cm x 60 cm in an open field at Sokoine University of Agriculture during the rainy and dry seasons. All tomato cultivars received similar cultural management except cv. Tengeru 97, which in addition, was desuckered to retain one main stem per plant and staked to support stems using wooden poles. Water was supplied to plants twice per week using furrow irrigation method. Fertilizer application was carried out two times with the first application during transplanting consisting of Diammonium phosphate (46% P_2O_5) at a dose of 150 kg/ha while the last fertilizer application was conducted using Urea (46% N) five weeks after transplanting at a dose rate of 60 kg per hectare. Field pests were managed using Selecron® (Profenofos) at a dose of 1 mL/L of water while fungal diseases were controlled using Ridomil® (Metalaxyl +Mancozeb) at a dose of 2g/L of water. The spraying of pesticides was conducted when needed.

3.3 Data collection and analysis: Tomato fruits were harvested at a breaker stage and data were collected on total yield per plant. Moreover, the harvested fruits were sorted and data were recorded on marketable and unmarketable fruits. Seed and total production costs were recorded and then converted to production costs per hectare based on a plant population of 19,000. Produce was sold on-farm and therefore postharvest losses along the supply chain were not considered. Revenues and net profits were computed based on tomato marketable yield and on-farm retail prices of TSh. 700 and 1000 per kilogram (One US Dollar = TSh. 2000). Data analysis was performed using Genstat statistical software version 15 and treatment means were separated based on Fisher's unprotected Least Significant Difference (LSD) test at p≤ 0.05.

4 RESULTS AND DISCUSSION

Seasons had a significant (p = 0.001) effect on total and marketable tomato yields. The dry season produced higher total and marketable yields than the rainy season (Table 1).

Table 1: Effects of cropping seasons on total and marketable yield of different tomato cultivars

Season	Total fruit yield (kg/ha)	Marketable yield (kg/ha)
Dry	46068b	34059b
Rainy	5805a	4630a
Difference	40263^s	29429^s
P-value	0.001	0.001

Numbers within a column followed by same letter (s) do not differ significantly according to Fisher's unprotected LSD test at P ≤ 0.05. LSD = Least significantly different

Tomato cultivars had a significant (p = 0.016) effect on total and marketable yields (Table 2). F1 hybrid cv. Assila significantly (p = 0.002) produced higher total and marketable yields than all local tomato cultivars. Moreover, F1 hybrid cv. Eden significantly (p = 0.002) produced higher total yield than local tomato cv. Riogrande and Tengeru 97, and higher marketable yield than local tomato cv. Cal-J, Riogrande and Tengeru 97. On the contrary, F1 hybrid tomato cv. Shanty and Oxyl Premium produced same (p = 0.05) yield as local tomato cultivars.

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Table 2: Effects of tomato cultivars on total and marketable yields

Cultivar	**Total fruit yield (kg/ha)**	**Marketable fruit yield**	
		(kg/ha)	**(%)**
Cal-J (Control)	26726bc	15393a	57.6
Riogrande (Control)	20530ab	15397a	75.0
Tanya (Control)	26011bc	17928ab	68.9
Tengeru 97 (Control)	12925a	10352a	80.1
Shanty	22873ab	20787a-c	90.9
Oxyl Premium	19934ab	18548ab	93.0
Eden	38070cd	26491bc	69.6
Asilla	40422d	29858c	73.9
P-value	0.002	0.016	

Numbers in columns followed by same letter (s) do not differ significantly according to Fisher's unprotected LSD test at P ≤ 0.05. LSD = Least significantly different.

Season and tomato cultivar interactions had a significant (p = 0.002) effect on total and marketable yields (Table 2). F1 hybrid tomato cv. Eden and Assila significantly (p = 0.002) produced higher total and marketable yields than local tomato cultivars during the dry season. Moreover, cv. Shanty and Assila produced higher total and marketable yields than all local tomato cultivars during the rainy season. Conversely, F1 hybrid tomato cv. Shanty produced higher marketable yield than all local tomato cultivars during the rainy season.

Table 3: Interactions of effect of seasons and tomato cultivars on total and marketable yields

Season x Variety interaction	**Total fruit yield (kg/ha)**	**Marketable fruit yield**	
		(kg/ha)	(%)
Dry x Cal-J (Control)	52702c	30108c	57.1
Dry x Riogrande (Control)	36783b	26627b	72.4
Dry x Tanya (Control)	50122b	34087c	68.0
Dry x Tengeru 97 (Control)	23433ab	18287a	78.0
Dry x Shanty	29953ab	26568b	88.7
Dry x Oxyl Premium	37608b	34873c	92.7
Dry x Asilla	63344d	50078d	79.1
Dry x Eden	74600e	51843d	69.5
p-value	0.001	0.018	-
Rainy x Cal-J (Control)	250a	226b	90.4
Rainy x Riogrande (Control)	4008ab	3871c	96.6
Rainy x Tanya (Control)	1240ab	1136c	91.6
Rainy x Tengeru 97 (Control)	2030ab	2030c	100.0
Rainy x Shanty	15788c	14960e	94.8
Rainy x Oxyl Premium	1952ab	1881c	96.4
Rainy x Eden	1508ab	1075c	71.3
Rainy x Asilla	17355c	9577d	55.2
P-value	0.002	0.014	-

Numbers in columns followed by same letter(s) within the season do not differ significantly according to Fisher's unprotected LSD test at P ≤ 0.05. LSD = Least significantly different

The production costs of F1 hybrid tomato cultivars were higher than those of those of local tomato cultivars during the dry and rainy seasons. The higher production costs of F1 hybrid tomato cultivars were due to higher seed costs with an average of TSh. 1077953 per hectare. . F1 hybrid tomato cv. Eden and Assila produced higher revenue and net profit than the local tomato cultivars during the dry season. Similarly, F1 hybrid tomato cv. Oxyl Premium produced higher revenue and profit than local tomato cv. Tengeru 97 and Riogrande whereas cv. Shanty produced higher revenue and net profit than cv. Tengeru 97 during the dry season only. On the contrary, cv. Shanty and Assila produced higher revenue and profits than local tomato cultivars during the rainy season while cv. Eden and Oxyl Premium produced lower revenues and net profits than local tomato cv. Riogrande and Tengeru 97 during the same season.

Table 4: Cost, revenue and profit from F1 hybrid tomato cultivars during the dry and rainy seasons

Season x Variety interaction	Seed cost (TSh.)/ha	Cost of production (TSh./ha)	Total revenue (TSh./ha)	Net profit (TSh/ha)
Dry x Cal-J (Control)	17231	1148720	21075600	19926880
Dry x Riogrande (Control)	11434	1143400	18638900	17495500
Dry x Tanya (Control)	14914	1147200	23860900	22713700
Dry x Tengeru 97 (Control)	14914	1147200	12800900	11653700
Dry x Shanty	1044960	2177000	18597600	16420600
Dry x Eden	949392	2082000	36290100	34208100
Dry x Oxyl Premium	949392	2082000	24411100	22329100
Dry x Asilla	1367500	2500000	35054600	32554600
Rainy x Cal-J (Control)	16487	1648720	226000	-1422720
Rainy x Riogrande (Control)	11504	1643400	3871000	2227600
Rainy x Tanya (Control)	14825	1647200	1136000	-511200
Rainy x Tengeru 97 (Control)	14825	1647200	2030000	382800
Rainy x Shanty	1044030	2677000	14960000	12283000
Rainy x Eden	950176	2582000	1075000	-1507000
Rainy x Oxyl Premium	950176	2582000	1881000	-701000
Rainy x Asilla	1368000	3000000	9577000	6577000

One US Dollar = TSh. 2000

This study indicates that there were low total and marketable yields of tomato during the rainy season than the dry season. The low total and marketable tomato yields during the rainy season are associated with wet conditions, which favour high incidence of fungal diseases (Maerere *et al.*, 2006). The most popular tomato diseases, which are associated with rainy and flooding conditions in Tanzania are early and late blights, septoria leaf spot and fusarium wilt (Gleoson and Edmunds, 2006). Successful tomato production during the rainy season requires the use of disease resistant cultivars, rain shelters or high tunnels, tomato grafted onto flood and disease-resistant rootstocks and timely application of effective pesticides (Black *et al.*, 2003). For instance, tomato grafting on a resistant rootstock coupled with the use of rain shelters increased tomato yield by 340% over grafted tomato plants grown in open fields (Aganon *et al.*, 2002). In this study, cv. Eden and Assila produced higher total and marketable yields during the dry season while cv. Shanty produced higher marketable yield than the local tomato cultivars during the rainy season.

Reports show that cv. Eden is high yielder (40–50t/ha) and tolerant to alternaria stem cancer, verticilium wilt, fusarium wilt, root knot nematodes, gray leaf spots and bacterial speck diseases (Seminis, 2010a). Similarly, cv. Assila is high yielder (50 t/ha) cultivar and tolerant to fusarium wilt, verticilium wilt, tomato yellow leaf curl mosaic virus and root knot nematodes (Seminis, 2010b). Reports also show that cv. Shanty has very high yield potential (110t/ha), resistant to tomato yellow leaf curl virus, and produces fruits with long shelf life (Hazera Genetics, 2009). The big difference in yields of cv. Shanty in this study and that reported elsewhere underscores the need to conduct multi-locational studies before its wider dissemination in the country. The total production costs of F1 hybrid tomato cultivars in this study were higher than those of local tomato cultivars during the dry and rainy seasons due to high seed costs, which accounts for 44 % of the total production cost. In tomato cv. Assila, the higher seed cost is justified by higher revenue and net profit during both the dry and rainy seasons whereas in tomato cv. Shanty the seed cost is justified by higher revenue and net profit during the rainy season only. On the contrary, the cultivation of cv. Eden and Oxyl premium during the rainy season in this study resulted in a loss of profits.

5 CONCLUSION

The findings from this study indicate that farmers in Morogoro region should grow F1 hybrid tomato cv. Assila during the dry and rainy seasons, and F1 hybrid tomato cv. Shanty during the rainy season only in order to get high revenue and profit. This is the first study in which production cost, yield, revenue and profit of F1 hybrid tomato cultivars are compared with those of local tomato cultivars. These findings provide a guide for farmers to select profitable tomato cultivars to grow in respect to seasons. The high total and marketable yields of cv. Shanty during the rainy season further guarantee farmers' net profits because tomatoes have higher demand and better prices during the rainy season.

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