PERFORMANCE OF SNAP BEANS VARIETIES IN LOWLAND OF MOROGORO IN TANZANIA.

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Abstract

Snap beans (*Phaseolus vulgaris* L.) are among the important vegetable crops grown in Tanzania, but the yield is low (2 to 8 t ha^{-1}) as snap beans mostly are grown in highland of that country. The aim of the study was to evaluate the growth and yield of snap bean varieties in lowland areas of Morogoro, in Tanzania. The trial was conducted in 3 different seasons at Sokoine University of Agriculture (SUA) from 13th July 2010 to 25th June 2011. Four snap bean varieties (Serengeti, Teresa, HS 215 and HS 217) were tested in a randomized complete block design replicated three times. Measurements were recorded including plant height, branches number, harvesting duration and pods weight per plant. Collected data were subjected to ANOVA, mean separation was done based on Student-Newman-Keuls using statistical software COSTAT6.4 ($p \leq 5\%$). The results showed that seasons differed significantly ($p \leq 0.001$) and first season gave the tallest plant (49.65 cm), highest pods weight per plant (193.33g), longer harvesting duration (23.40 days) but branches number were equal in all seasons. Snap bean varieties also varied in their performance, with the tallest height, longest period of harvest and highest pods weight per plant observed in Teresa variety; while the contrast was observed in HS 217 in almost all seasons. From these results, growing snap bean especially Teresa variety in season one gave high yield and best pods quality compared to other seasons. Therefore, it is advised to the farmers of Morogoro to maximize their income and yield from snap bean varieties by growing them in season starting from July up to September.

Key words: Snap beans (*Phaseolus vulgaris* L.), high temperature, lowland, growth, yield

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Introduction

Snap beans (*Phaseolus vulgaris* L.) are one of the most important and commonly consumed horticultural vegetable crops in the world (Myers and Baggett, 1999). Snap beans are produced for their edible, whole pods rather than dry seeds (Blair *et al*., 2010). In Tanzania, European seed companies are producing snap bean in Arusha-Moshi area (Singh, 1999) for export to European markets. Between year 2000 and 2005, Tanzania exported 2,722 tons of green beans (USAID, 2007). Elsewhere in Tanzania, the vegetable is almost unfamiliar. In East Africa, Tanzania included, low yield of beanswas observed (Hillocks *et al*., 2006) and was mainlyattributed to harsh environmental condition, such ashigh temperatures and low rain, poor seed quality, poorperformance of the local landraces, mainly due to theirsusceptibility to insect pests, diseases and poor cropmanagement (Hillocks *et al*., 2006). According to Omae *et al.* (2006), heat stress is among principal limitingfactors of the adaptability and productivity of the crops.Kumar *et al.* (2007) reported that high temperature is usually accompanied by water stress, which induce yields reduction in snap beans. On the other hand, high temperatures during the reproduction stage result in a reduction in pod and seed set due to enhanced abscission of flower buds, flowers, and pods (Monterroso and Wien, 1990). Optimal growth of snap beans is said to occur at 22-25°C (Messiaen and Seif, 2004).

However, the study done by Suzuki *et al*., (2001) demonstrated that some snap beans cultivar has excellent productivity under high temperature conditions and Haibushi cultivar has reported to be heat tolerant up to temperatures above 29°C. Therefore, there is a need to identify among present varieties in Tanzania, the suitable ones for enhancing productivity of snap beans under different season conditions. This study aims to evaluate the response of four snap bean varieties in low land area of Morogoro, this is a way to choose and recommend suitable varieties and good season to increase pods yield in the lowland conditions. Growth and yield of snap beans under different growing seasons of lowland region of Morogoro, Tanzania were evaluated during this study.

Materials and Methods

1. Location

The snap bean cropping experiments was conducted in three different seasons from July 2010 to June 2011 at Sokoine University of Agriculture. Cropping trials were conducted at crop Museum of Department of Crop Science and Production. Crop museum is located at latitude 6°50'S and longitude 37°39'E and at the altitude of 526 m. a.s.l. The location has a sub-humid tropical type of climate and bimodal rainfall pattern. The short and the lighter rains usually last from November to January with the pick in December and the long and heavy rains starting from March to May with a peak in April. The experimental site had a soil pH of 5.7 which is moderately strong acid, with medium soil organic C of 1.7 to 1.8%, and low total N (0.04 to 0.14 %); the available P ranged from 7.7 to 8.3 mg kg-1 while exchangeable K is high (0.7 cmol (+) kg-1) (Mourice *et al.*2014*).* All the measured soil fertility parameters decreased with depth. The textural class of surface soil is sandy clay and clay content increased with depth, which is not expected to limit maize growth and yield. Generally, the fertility status of the experimental site is low due to acidic pH, low N, and P (Mourice *et al.2014).* The temperatures are lowest in June and July, and highest in November to February. The mean monthly temperature ranges between 25 and 28°C with daily mean minimum of 26°C and mean maximum of 30°C. The actual mean monthly temperature when conducting the experiment ranged between 22.4°C and 27.55°C and are presented in Table 1.

2. Land preparation and sowing

Ploughing, harrowing, and levelling were done by a hand hoe. Two seeds per hill (Serengeti, Teresa, HS 215 and HS 217 snap bean varieties) were planted. First season sowing was done on 13th July 2010, and for second and third seasons on 1st December 2010 and 24th March 2011 respectively. Where gapes occur because of seeds failing to germinate, refilling was done during the first week after germination.

Table 1: Mean monthly temperature andtotal rainfall

Month	Year	Maximum temperature (° C)	Minimum temperature (° C)	Mean Temperature (° C)	Total monthly rainfall (mm)
July	2010	28.70	16.30	22.50	13.90
August	2010	28.90	16.90	22.90	1.30
September	2010	31.70	17.20	24.45	0.00
December	2010	32.70	21.70	27.20	181.60
January	2011	31.70	21.40	26.55	52.80
February	2011	32.00	21.70	26.85	73.70
March	2011	31.60	23.50	27.55	111.20
April	2011	29.30	21.10	25.20	194.20
May	2011	28.70	20.20	24.45	58.80

Source: SUA Meteorological Centre

3. Snap bean seeds source

Four snap bean varieties (Serengeti, Teresa, HS215 and HS217) were used in this study. These varieties were obtained from Rotian Seed Company at Arusha in Tanzania. The immature pods of those varieties are string-less and are commercially grown in highlands areas of Kenya and Tanzania (Arusha) for export to European markets.

4. Experimental design

The field experiment was laid in a split plot arranged in randomized complete block design (RCBD) with 3 replications. The main factor was different seasons and sub factor was snap bean varieties. Snap bean varieties were randomly assigned in each replicate and grown in different seasons. The plot size was 3.6 m x 2 m = 7.2 m^2 and plants were spaced at 60 x 20 cm, 1 m separated two replications and 1 m separated plots. The area for the entire experiment was 74.2 × 16.8 m^2 =155.2 m^2.

5. Crop management practices

Application of fertilizer was done two times in each season. Firstly, a Di-ammonium phosphate (DAP) (46% P) at the rate of 30 kg/ha was applied during sowing. Two weeks after sowing, nitrogenous fertilizer in the form of Urea (46% N) at the rate of 30 kg/ha was applied as top dressing. Furrow irrigation was done after each fertilizer application. First hand hoe weeding was done two weeks from sowing and subsequent weeding were done whenever need aroused. Irrigation was done once a day using pipes except when sufficient rain was received. A systemic fungicide, Ridomil at a rate of 5 g /L of water and an insecticide Selecron at a rate of 2 ml/L of water were applied. The insects control was done throughout the planting seasons while fungicides to control diseases were applied once the severity reaches the economic threshold level.

Data collection

All data were collected from a sampling unit of twenty plants from each variety per plot in every season: (i) Plant height was measured using a ruler from the ground level to the tip of the main shoot at the last immature pod harvest day, (ii) The number of branches per plant was counted and recorded from twenty plants, randomly sampled and marked from each plot, (iii) Harvesting duration was calculated as the difference of number of days between first harvest and the last pod harvest and (iv) Pods weight per plant (g/plant) was calculated by summation of weights of all pods harvested on each plant. The data collected were subjected to statistical analysis of variance (ANOVA) using statistical software COSTAT6.4 (Cohort Software, Minneapolis, USA, 2006). All statistical tests for level of significance means were carried out at 5% level of significance and mean separation were done, using Student-Newman-Keuls to determine differences among treatment means.

Results and discussion

In this study, final plant height at the last day of harvest, numbers of branches, length of harvest period and pods weight per plant were used as major developmental characteristics of the snap beans. Mean results showing the effect of season on the varieties and difference between varieties are given in Table 2. Results of final plant height at the last day of harvest show the great significant difference due to seasons (Table 1). The tallest plant was observed in the first season with (49.65 cm) and second season gave shorter plant of (35.73 cm). Tallest plant observed in first season probably was due to the climate of low temperatures that were favourable for the growth of snap beans as confirmed by Kercher and Sytsma (2000). In addition, it was observed in this study that plant height was negatively correlated to the temperature increase. During the period of high temperatures (26.87 ^{o}C), experienced in season two, plants were short and less vigorous. This was a response of plant to heat stress. Negative effects of temperature on plant height have also been reported by Khattak and Pearson (2005) and Lafta and Lorenzen (1995) in their report that plant height decreased as the temperature increased.

The results of the number of branches for the same varieties tested, season did not affect snap bean varieties in-terms of number of branches (Table 1). This was possibly due to the high temperature observed in all seasons compared to the temperature required for the growth of snap bean. Hatfield and Prueger (2015) reported that increased temperature exhibit a larger impact on grain yield than on vegetative growth.

Table1. Mean values of snap bean developmental characteristics according to season

Varieties	Plant height (cm)	Number of branches	Harvesting duration (Days)	Pod weight/plant (g)
Season 1	49.65^{a}	6.10a	23.40^{a}	193.33a
Season 2	35.73^{c}	6.23a	12.30^{c}	70.55c
Season 3	39.14^{b}	6.30a	18.59^{b}	96.44b
Mean	41.51	6.21	18.11	120.11
LSD0.05	2.53	0.96	1.76	15.99
F-test	***	ns	***	***
Season*varieties	***	***	***	***
CV (%)	14.18	30.60	32.31	53.01

Means followed by the same letters(s) within the column are not significant at 5% level based on Student-Newman-Keuls. Ns =not significant,*= significant ($p < 0.05$), **= highly significant ($p \leq 0.01$), ***= very highly significant ($p \leq 0.001$)

Results of length of harvest period show the great significant difference due to seasons. The longer harvest period (23.40 days) was observed in the first season while second season gave shorter harvest period with 12.30 days (Table 1). Longer harvest duration in the first season may have resulted from low mean seasonal temperature (23.28 ^{o}C) which increased vegetative growth and therefore longer flowering and harvesting duration (Borosic *et al*., 2000). The shorter harvesting period in the second season may be a result of high average seasonal temperature (26.87 ^{o}C), as it was similarly observed by Mori *et al.* (2010). Other researchers *viz.,* Giulioni *et al.* (1997) reported that high temperature is a factor that accelerates the ending of the crop cycle. In this study the harvesting of immature pods induced the prolongation of vegetative growth, flowering period and allowed longer multiple picking as also explained by Silbernagel *et al.* (1991) and Messiaen and Seif (2004).

The difference among snap bean varieties in pods yield per plant was highly significant ($p \leq 0.001$) due to the effect of season (Table 1). The highest pod yield per plant was observed in the first season with 193.33 g followed by the third season with 96.44 g (Table 1). The highest yield of pods in the first season could have been due to a longer vegetative life cycle (Gifford and Evans, 1981). The second season was carried out during the period from December to February. During this time weather was characterized by high temperature and low rainfall conditions that may not be favourable for snap bean production. Similar results were reportedby Tsukaguchi *et al.* (2003), Pekşen (2007), Omae *et al.* (2005) and Omae *et al.* (2006) who reported the reduction in snap bean yield due to high temperature.

Table 2. Mean values of yield and yield components of snap bean varieties as observed among season

Seasons	Varieties	Plant height (cm)	Number of branches	Harvesting duration (days)	Pod weight(g/ plant)
First season	HS 217	49.02^{b}	6.67a	21.55^{c}	186.31^{b}
	HS 215	47.21^{b}	6.62a	24.52^{a}	203.46^{ab}
	Teresa	53.29^{a}	6.23a	24.72^{a}	226.42^{a}
	Serengeti	49.11^{b}	4.88b	22.82^{b}	157.11^{c}
	Mean	49.65	6.1	23.4	193.33
	LSD0.05	2.05	0.57	1.16	27.67
	F-test	***	***	***	***
	CV (%)	11.46	26.16	13.81	39.79
Second season	HS 217	33.46^{c}	5.35b	10.50^{c}	66.37^{b}
	HS 215	32.17^{c}	6.75a	9.83^{c}	65.91^{b}
	Teresa	40.14^{a}	6.58a	16.29^{a}	101.74^{a}
	Serengeti	37.17^{b}	6.25a	12.67^{b}	48.16^{b}
	Mean	35.74	6.23	12.30	70.55
	LSD0.05	2.12	0.69	1.55	23.46
	F-test	***	***	***	***
	CV (%)	16.48	31.06	34.83	92.47
Third season	HS 217	35.44^{c}	5.35b	15.87^{b}	85.28^{b}
	HS 215	33.84^{c}	6.53a	18.43^{ab}	98.07^{ab}
	Teresa	48.53^{a}	6.33a	20.87^{a}	108.96^{a}
	Serengeti	38.75^{b}	6.98a	19.20^{ab}	93.46^{ab}
	Mean	39.14	6.3	18.59	96.44
	LSD0.05	2.02	0.75	3.09	16.34
	F-test	***	***	*	*
	CV (%)	14.36	33.05	46.33	47.10

Means with the same letters(s) in column are not significant at 5% level. Ns =not significant,*, = s highly significant ($p < 0.01$), ***= very highly significant ($p \leq 0.001$).

According to the visual observation, high number of flowers and young pods were produced in the second season, and a large number of them aborted and fell down in all varieties. The attitude was attributed to high temperatures of second season. However, the 1st and 3rd seasons with lower temperatures allowed varieties to produce many pods due to lower abscission of the flower buds, flowers and young pods. This agrees with the results of Pekşen (2007) who found that plants produced many flowers, but only a limited number of them developed into pods at high temperature.

Concerning the variation among varieties tested within season, results are shown in Table 2. Significant difference was observed among the four varieties tested within seasons, and variety Teresa was the tallest with height ranging between 53.29 cm and 40.14 cm, had a longer harvesting period in all seasons (24.72-16.29 days) and gave higher pods weight per plant (226.42g -101.74 g) in all seasons. Variety HS 215 was the shortest (47.21-32.17 cm) in almost all seasons while variety HS 217 had a shorter harvesting period in almost all season. This difference was possibly attributed to genetic background of Teresa variety associated with the response of this variety to the environment; leading to the production of higher pods yield. This result is similar to the results of Omae *et al.* (2006) and Hatfield and Prueger (2015) who reported that high temperature affected morphological characters and change yield and yield components in snap bean especially in heat susceptible cultivar. In this study, the variation among snap bean varieties could explain the variety adaptability to different temperatures observed in different seasons. The results of this study was related to the findings of Porch and Jahn (2001) when they compared responses of heat tolerant and sensitive genotypes, they demonstrated that genetic variability exists for heat tolerance in common bean. Therefore, replications of this study have to be done to evaluate if the season of July-September will remain the best in different years for snap bean production for home consumption and for local market.

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