

Selection for pod quality, pod yield and disease resistance in climbing snap beans

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Abstract

Although climbing snap bean have the potential of increasing productivity and competitiveness in domestic and export markets, suitable varieties with market demanded pod quality characteristics and preferred agronomic traits are not available to smallholder farmers in Kenya and other countries in east, central and west Africa. The objective of the study was to select climbing snap beans with market preferred pod quality characteristics, pod yield and disease resistance from locally developed breeding populations and advanced lines. Twenty F_{5,7} lines with type IV growth habit were evaluated at Mwea and Embu during the 2013 long rain and short rain seasons. Diseases were scored on 1 to 9 disease scale, where scores of 1-3 were considered resistant; 4 to 6, intermediate; and 7 to 9, as susceptible. After pod formation, plots were harvested every other day. Pods were graded as extra-fine, fine and bobby using standard commercial criteria. Data was analyzed using Genstat Version 15. Results showed that there were significant genotypic differences for plant vigour, disease resistance, days to first picking, pod yield, pod length and market grades among the new lines. Plant vigor scores varied from 1 to 7 at Embu, and 1.7 to 3.5 Mwea. Check varieties were the most vigorous lines in both sites but they were not the highest yielders. Anthracnose and angular were the most severe diseases especially at Embu where sprinkler irrigation was used. Except for KSV27-69-4-1-2T, all other lines showed resistant reactions to anthracnose and angular leaf spot. Rust incidence was low throughout the season and all genotypes showed resistant reactions. Duration to 50% flowering varied from 43.5 to 52 days in Embu, and 31.8 to 48.5 days in Mwea. This may have contributed to differences in days to first picking which varied from 56 to 60 days after planting. Pod yield over 9 harvests in Embu varied from 3,252 to 10,626 kg ha⁻¹. The total yield over 18 harvests in Mwea varied from 16214 to 23724 kg ha⁻¹. Average yield of all the test lines out yielded the average yield of the checks by 56.6%. The new lines produced an average of 44.1% premium grades. However, this varied with genotypes and was not significantly influenced by number of harvests. The results of this study indicate that new climbing snap bean varieties with market demanded pod characteristics, high yield potential and resistance to major diseases can be developed from the selected lines. Exploitation of the longer harvest period of climbing beans can contribute to higher yields and better returns to investment especially for smallholder farmers, and to the overall competitiveness of the snap bean sub-sector.

Key words: Diseases, climbing bean, pod quality, snap bean

Résumé

Bien que le haricot rampant ait le potentiel d'accroître la productivité et la compétitivité sur les marchés locaux et d'exportation, des variétés adaptées aux marchés exigent des caractéristiques de qualité de la gousse. Les traits agronomiques préférés ne sont pas disponibles pour les petits exploitants agricoles au Kenya et à d'autres pays de l'Afrique de l'Est, du Centrale et Occidentale. L'objectif de l'étude était de sélectionner les haricots rampant possédant les caractéristiques préférés du marché pour la qualité de gousses, le rendement en gousses et la résistance aux maladies, à partir des populations cultivées et développées localement et les lignées avancées. Vingt F_{5,7} lignées de type IV de l'habitude de croissance ont été évaluées à Mwea et à Embu au cours des longue et courte saisons des pluies de 2013. Les maladies ont été notées sur une échelle de 1 à 9 de la notation de maladie, parmi lesquelles les notations 1-3 étaient considérées comme résistants; 4 à 6, intermédiaire; et 7 à 9, comme sensibles. Après la formation des gousses, les parcelles ont été récoltées tous les jours. Les gousses ont été classées comme extra-fine, fine et moins fine, utilisant des critères commerciaux standards. Les données ont été analysées à l'aide Genstat Version 15. Les résultats ont montré qu'il y avait des différences génotypiques significatives pour la vigueur de la plante, la résistance aux maladies au premier jour de la récolte, au rendement en gousses, à la longueur de la gousse et aux niveaux de marché entre les nouvelles lignées. Les scores de plantes vigoureuses variaient de 1 à 7 à Embu, et 1.7 à 3.5 à Mwea. Les tests de variétés étaient les lignées les plus vigoureuses dans les deux sites, mais elles n'étaient pas les plus productives. L'anthracnose et les taches angulaires sont les maladies les plus graves en particulier à Embu, où l'irrigation par aspersion a été utilisé. Sauf pour KSV27-69-4-1-2T, toutes les autres lignées ont montré des réactions résistantes à l'anthracnose et à la tâche angulaire. L'incidence de la rouille a été faible tout au long de la saison et tous les génotypes ont montré des réactions résistantes. La durée de 50% de floraison variait de 43,5 à 52 jours à Embu, et de 31,8 à 48,5 jours à Mwea. Cela peut avoir contribué aux différences dans les jours de la première cueillette, et qui a varié de 56 à 60 jours après la plantation. Le rendement de gousses sur 9 récoltes à Embu variait de 3252 à 10626 kg ha⁻¹. Le rendement total de plus de 18 récoltes de Mwea variait de 16.214 à 23.724 kg ha⁻¹. Le rendement moyen de l'ensemble des lignées testées a donné le rendement moyen des tests de 56,6%. Les nouvelles lignées ont produit une moyenne de 44,1% de qualités haut de gamme. Toutefois, ce pourcentage variait avec les génotypes et n'a pas été significativement influencé par le nombre de récoltes. Les résultats de cette étude indiquent que les nouvelles variétés de haricots rampants, avec les caractéristiques de gousses exigées par le marché, le potentiel élevé de rendement et la résistance aux principales maladies, peuvent être élaborés à partir des lignées sélectionnées. L'exploitation de la longue période de récolte de haricots grimpants peut contribuer à des rendements plus élevés et de meilleurs bénéfices sur l'investissement, en particulier pour les petits exploitants, et à la compétitivité globale du sous-secteur de haricot.

Mots clés: maladies, haricot grimpant, la qualité de gousse, haricot nain

Background

Snap bean production in eastern Africa is dominated by bush types. Most of the available varieties are susceptible to diseases especially rust, angular leaf spot and anthracnose which can lead to losses of up to 100%. Climbing types which have a potential 3:1 productivity advantage due to their longer harvest periods and plant size compared to bush types, could be expected to be of particular interest to smallholder farmers wishing to intensify return by use of family labour (CIAT, 2008). Previous work in Kenya showed that climbing snap bean selections were more tolerant to diseases such as angular leaf spot (*Phaeoisariopsis griseola*), anthracnose (*Colletotrichum lindemuthianum*) and rust (*Uromyces appendiculatus*) as compared to bush types and hence a good source of the climbing habit and disease resistance (Wahome *et al.*, 2013). However, climbing snap bean varieties popular in some of the North and South American markets have flat pods that are not suitable for European markets (Schoonhoven & Voysest, 1991). Thin, round podded and locally adapted climbing snap bean varieties have not been developed for farmers in eastern Africa (Chemining'wa *et al.*, 2012).

Literature summary

Gitta and Kata (2012), state that Myanmar is the leading snap bean supplier with 51.68% market share globally. Other leading producers include China (20.43%); Colombia (7.07%); Thailand (5.5%) and Australia (2.85%). East and Central African countries on the other hand have smaller market shares. For example, Tanzania has 1.48%, Rwanda 0.31%, Kenya 0.19% and Uganda 0.07%. These low production volumes result from production constraints and reliance on the susceptible bush snap beans that lead to high post-harvest losses.

Various studies have suggested that climbing growth habit could play a critical role in snap bean productivity. For example, Checa and Blair (2012) reported that snap beans with climbing growth habit (type IV) are high yielding as compared to bush snap beans with yield advantage of 3:1. Climbing beans are associated with continuous growth of the guide shoots, continuous flowering, need for vertical support, high productivity and longer harvest periods. Studies on selection of climbing snap beans in Kenya reported by Wahome *et al.* (2013) showed that rust was the most limiting disease recording the highest severity for bush and climbing snap bean varieties at Mwea and KARI- Thika. Results showed that although the climbing snap bean line HAV 130 has a combined resistance to rust, angular leafspot and anthracnose, it had thick and flat pods, hence poor pod quality. The objective of this study was to select climbing snap bean genotypes with market preferred pod quality characteristics, pod yield and disease resistance from locally developed breeding populations and advanced lines.

Study description

This study was conducted at Mwea (1159masl) and Embu (1350masl) during long rain season (March-May) and short rain season (October- December 2013) short rain season. Mwea has mean annual rainfall 1037mm in Mwea compared to 1206mm for Embu. However, because of the poor rainfall distribution, the trials at both sites received supplementary irrigation; furrow irrigation at Mwea and sprinkler at Embu.

The $F_{5,6}$ progenies of climbing snap beans originated from single plant selections of F_5 bulk populations developed at Kabete Field Station from crosses between six climbing lines introduced from CIAT and four bush snap bean lines with rust resistant genes (BelMiDak RR4, BelMiDak RR8, BelMiNeb 4) and six commercial varieties (Morelli, Samantha, Morgan, Paulista, Teresa and Amy) with good pod traits. The progeny rows were evaluated in farmer participatory trials during the 2011 long rain season. A total of 20 climbing lines were selected from the segregating lines and evaluated during the long rains and short rains 2013 at Mwea and Embu. Two commercial varieties were used as checks in both locations. The trials were laid out in randomized complete block design (RCBD) with two replications in both trial sites. The plot sizes were 3 m x 2 m while row and plant spacing was 50 cm x 20 cm, respectively, with four rows per plot.

The advanced climbing lines were evaluated for pod yield, pod quality and disease resistance. Data was collected on pod traits, pod yield, pod length, market classes, pod weight per market class and reaction to rust, anthracnose and angular leafspot. Pod length and pod width were used to determine market grades (extra fine, fine and bobby). Lines with market preferred pod traits, and high pod yield were evaluated for resistance to rust, angular leaf spot and anthracnose.

Research application

All the climbing lines showed combined resistance to rust, angular leafspot and anthracnose, despite high disease pressure due to angular leafspot in Embu (Table 1). They also had better levels of resistance to diseases compared to the checks in both sites (Table 1). The

Table 1. Mean disease severity scores and pod lengths of new climbing snap bean lines at Mwea and Embu, Kenya.

Genotype	Rust		Angular leafspot		Anthracnose		Pod length (cm)	
	Mwea	Embu	Mwea	Embu	Mwea	Embu	Mwea	Embu
KSV01-2M	1.0	1.5	1.5	1.0	1.0	1.0	9.2	9.4
KSV03-2-1-1T	1.0	1.0	1.0	1.0	2.0	2.5	9.3	9.4
KSV20-145-3-1M	2.0	1.5	1.0	1.0	1.0	1.0	9.2	9.7
KSV25-1-1T	1.0	1.0	1.0	1.0	1.0	1.0	8.6	9.1
KSV27-69-4-1-2T	1.0	1.0	1.5	1.0	2.0	3.0	9.2	10.1
KSV41-1-2T	3.0	1.0	1.0	1.0	1.0	2.0	8.0	10.1
KSV42-2M	1.0	1.0	2.3	1.0	1.3	1.0	8.6	9.4
KSV43-1-2-3M	1.0	1.0	1.0	1.0	1.0	1.0	9.3	9.4
KSV44-1-2T	1.0	1.0	1.0	1.0	1.0	1.0	9.0	9.8
KSV46-1-2T	1.0	1.0	2.0	1.0	1.0	1.0	9.9	9.3
Samantha	3	1	6	7	4	3.5	8.1	11.6
Teresa	2	1	5	4.5	5	1	12.2	11.8
Mean	1.3	1.1	1.3	0.0	1.3	1.2	8.8	8.5
LSD _{0.05}	1.5	0.5	2.2	0.0	2.1	1.0	1.6	6.1

Table 2. Pod yield and grade distribution of climbing snap bean lines grown at Mwea and Embu.

Genotype	Grade distribution (%)						Yield (kg ha ⁻¹)		Mean
	Extra Fine		Fine		Bobby				
	Mwea	Embu	Mwea	Embu	Mwea	Embu	Mwea	Embu	
KSV01-2M	3.4	77.9	60.1	10.8	36.5	11.3	23,724	9,322.6	16,523.3
KSV42-2M	4.0	38.4	44.0	6.0	52.0	55.7	23,506	9,232.9	16,369.5
KSV44-1-2T	2.9	39.1	42.0	19.1	55.1	41.8	21,989	9,422.3	15,705.7
KSV43-1-2-3M	2.3	32.5	67.4	14.2	30.3	53.4	22,793	6,556.1	14,674.6
KSV03-2-1-1T	5.4	30.0	60.9	27.8	33.7	42.2	22,430	6,684.8	14,557.4
KSV41-1-2T	1.5	27.1	46.6	26.8	51.9	46.2	19,734	9,357.7	14,545.9
KSV46-1-2T	1.2	39.6	35.7	13.7	63.1	46.7	21,885	6,937.0	14,411.0
KSV25-1-1T	0.4	36.7	35.3	6.9	64.3	56.4	21,972	6,638.0	14,305.0
KSV27-69-4-1-2T	0.3	31.3	58.4	19.8	41.3	48.9	22,757	5,810.4	14,283.7
KSV20-145-3-1M	2.0	29.9	53.5	11.4	44.5	58.7	17,604	10,626.1	14,115.1
Samantha	4.13	18.87	57.73	53.12	38.15	28.01	16,474	4,841.0	12,110.5
Teresa	8.5	29.83	54.44	49.14	37.06	21.03	16,214	8,007.0	10,657.5
Trial mean	1.87	33.4	37	13.6	61.1	50.4	21,203	6,049	13,626.0
LSD _{0.05}	3.844	37.36	35.85	17.97	37.9	44.04	4550	6866.2	

results showed that the climbers out yielded the bush check varieties at both sites (Table 1). Climbing snap bean lines had an average yield of 21.3 tons ha⁻¹ compared to 16.3 t ha⁻¹ for the checks. The higher yield of climbers was attributed to bigger plant size, longer pod bearing stems and longer harvest period. The test lines had 44.1% of extra fine and fine grades and could be harvested more frequently. More frequent harvests could minimise the proportion of bobby grade. The climbing growth habit and the multiple disease resistance can contribute to higher productivity, reduced losses due to diseases, and better returns to investment in labour and other inputs.

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