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PERFORMANCE AND ADAPTABILITY OF NEW YARD-LONG BEAN VARIETY: *GANNORUWA A9 MAE*

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ABSTRACT

Production and marketing of yardlongbean in Sri Lanka are hindered by low yield, collar rot disease and poor shelf life of pods. Studies on yield, adaptability, quality and collar rot resistanceof locally developed yardlong bean lines were carried outfor seven consecutive seasons from *Yala* 2010 to 2014 *Yala*. Preliminary yield and yield attributes wereevaluated in replicated trials from 2010-2011 at the Horticultural Crops Research and Development Institute (HORDI). Stability and adaptability of five selectedlines were evaluated at six research centers and forty five farmer locations representing major agro ecological regionsfrom *Maha* 2011/12 to *Yala* 2014. Significant varietal and seasonal effect were found for number of pods per plant and single plant yield. Line 39- 9 gavethe highestpod number (40) and single plant yield (731.8g). Higher yield stability was recorded in lines 39-12 and 39-9 over locations. Lines 39-9 and39-12 showedwide adaptability to diverse agro-ecological zones in on farm yield evaluations. There was no Genetic X Environment interaction over locations. The line 39-9 showed field resistances to collar rot disease over seasons. Line 39-9 exhibited better acceptance in sensory evaluation and along shelf-life under both ambient and refrigerated conditions. Farmers preferred line 39-9 owing to pod characters and whereas consumers preferred it due to pod colour, taste and keeping quality. Yardlong bean line39-9, produced high yield (20.3-25.3 t/ha), showedfield resistance to collar rot disease, high adaptability and producedlong fleshy green pods with greater shelf-life. Hence, line 39-9 was released as "*Gannoruwa A9 Mae*" for islandwide cultivation.

Keywords: Yard-long bean, Quality, Yield Adaptability, Collar rot disease

INTRODUCTION

Yard-long bean is avegetable crop that is grown widely in low country wet, intermediate and dry zones of Sri Lanka. The annual extent under Yard-long beancultivation is about 7,495 ha with anannual production of about 71,000 t. There are three climbing type varieties namely Hawari, Polonand GannoruwaHawari, and four bush type varieties namely Bushsitao, BS-1, Sena and Bush Polon, recommended by the Department of Agriculture (DOA)for cultivation. However, all of these varieties are susceptible to collar rot disease, which affects the crop from the seedling stage. The occurrence of this disease reduces the net income of farmers, accounting for 10-40%, depending on the climatic conditionsprevailed duringthe cropping season. Furthermore, poor keeping quality of currently available Yard-long bean is another problem encountered by traders and consumers. Hence, there is a need to develop a high yielding,collar rot disease resistant/tolerant Yard-long bean varieties having good quality characteristics.

Most breeding programs are aimed to improve the economic value of crop by improving the yield (Ogunkanmi *et al*., 2013). Yield is strongly correlated with pod length and number of pods per plant in vegetable cowpea. Thus, increase in pod length and number of pods results in a corresponding increase in yield (Hazra *et al*., 2007; Ogunkanmi *et al*., 2007).The genotype × environment interaction (GE) is one of the major challenges in plant breeding, either in the selection procedure or in cultivarrecommendation, when the performance of genotypes over environments is not constant (Suinaga *et al*., 2006). Adaptability of a genotype is described as its ability to perform in diverse environments. Recommendation of crop cultivars with wide adaptability is essential for countries with diverse environments or agro-ecological regions and seasons. Hence, when recommending, new varieties should be assessed for their production stability and adaptability under diverse environmental conditions (Simmonds, 1991;Maleia *et al*., 2010).

In view of these issues, a program was initiated with the objective of developing a superior Yard-long bean variety forcommercial cultivation using local and exotic germplasm.As the first step, germplasmwere screened for agronomic characters, pest and diseases resistance and yield traitsto identify suitableparental lines. Selected

crosses were made subsequently and promising lines were identified after adopting a rigorous selection procedure for several generations. The lines showingresistance to collar rot disease in the laboratory and field conditions at F_4 generation were selected for further yield and quality evaluation.

Objectives of thisstudywas to evaluate these promising lines for yield, quality, adaptability and disease resistance with the aim of identifying a suitable Yard-long bean variety for Sri Lankan farmers.

MATERIALS AND METHODS

Yield characteristics

A series of field experiments were conducted during three consecutive seasons from 2010 to 2011 at the Horticultural Crops Research and Development Institute (HORDI), Gannoruwa,Peradeniya. Elevation of the experiment site is 510 m above mean sea level and the mean day and night temperature in this area were 28 ºC and 25 °C respectively.Seven improved lines, 39-1, 39-2, 39-8, 39-9, 39-11, 39-12and 39-13were evaluated along with the recommended checkvarietiesHawariand Polon. Experimental design used was randomized complete block design with three replicates. Seeds were sown at 90 X 30 cm in 3.2 X 3.0 m plots. Before planting, 15 kg N/ha as urea, 60 kg P_2O_5/ha as triple super phosphate and 20 kg K2O/ha as muriate of potash were applied to each plots. Four weeks after planting, 25 kg N/ha as urea and 20 kg K2O/ha as muriate of potash were applied as a top dressing. Pests and diseases were controlled as per the departmental recommendations. Pods at the correct maturity stage were harvested in two day intervals. Length, circumference and weight ofpod, pod number and yield per plantwere determined. Records on number of podsand yield per plantwere taken from six randomly selected plantswhile pod length,circumference and weightwere obtained from ten freshpods randomly selected from each plot.Data were analyzed using SAS 9.0 package using the ANOVAprocedure. Mean separation was done by the Duncan's Multiple Range Test.

Varietal Stability

Field experiments were conducted during three consecutive seasons from *Maha* 2011/2012 to *Maha* 2012/2013 at six research stations at;HORDI, Gannoruwa;Regional Agricultural Research and Development Center, Girandurukotte; Field Crops Research and Development Institute (FCRDI), Mahaillupallama;Grain Legume and Oil Crops Research and Development Center (GLORDC), Angunakolapelessa;Agriculture Research Station (ARS),Kalpitiyaand ARS, Thelijjawila. Five promising lines, 39-1, 39-2, 39-9, 39-12 and 39-13 were evaluated along with the recommended variety Hawarias the check varietyin this study. Randomized complete block design was used with three replicates. Seeds were sown at 90 X 30 cm in 3.2X 3.0 m plots.Crop management practices were carried out as per the departmental recommendations.

Mean deviation across environments and stability parameter derived by partitioning Genotype Environment interaction variance into components were estimated to assess the stability of varieties (Abeysiriwardenaet *al*., 1991). Yield data were analyzed using plot deviation of yield from the environment mean.

VarietalAdaptability

On farm evaluations were carried out during four consecutive seasons from *Maha*2012/2013 to*Yala* 2014at forty five farmer locations in major Yard-long bean growing areas. Five promising lines, 39-1, 39-2, 39-9, 39-12 and 39-13 were evaluated along with the recommended variety Hawari(control) in this study. These varieties were arranged in a randomized complete block design with two replicates. Seeds were sown at 90 X 30 cm in 3.6 X 3.0 m plots. Fertilizer was applied according to DOA recommendation. Crop management was totally handled by the farmers. Least mean deviation (D) and non-significant stability parameter (S2) were assessed by analyzing yield data using plot deviation of each variety from the best plot yield in each location(Abeysiriwardena *et al*., 1991).

Disease resistance

Two promising Yard-long bean lines, 39-9 and 39-12, selected based on the performance in stability studies during *Maha* 2011/12, were evaluated along with two popular recommended varieties namelyPolon and Hawari under field conditions of natural inoculation. Varieties were evaluated during both 2012 *Yala* (Dry season) and 2013/ 2014 *Maha* (Wet season) in a field which has been repeatedly used for growing Yard-long bean and reported to be severely infected with common collar rot and root rot causing fungal pathogens such as *Rhizoctonia solani, Fusariun* spp. and *Sclerotium rolfsii*. Wilted plants due to the infection of collar and root rot disease were recorded during each season. Percent disease incidence for each variety was statistically analyzed to find out the vulnerability of varieties to collar and root rot diseases under field conditions.

Quality Characteristics

Quality characteristics of the selected lines, 39-9 and 39-12 wereevaluated at the Food Research Unit, Gannoruwa. Acceptabilityof the varieties was assessed by32randomly selected individuals including both farmers and consumers. Each person was asked to evaluate the varieties using the tabulated scores. A 3-level hedonic test was used;1=not acceptable, 2= acceptable and 3= highly preferred. Appearance and taste were the criteria used in the evaluation. Friedman test was used to analyze the data. All means were compared using Fischer's least significant difference test. The shelf life of the most promising variety, 39-9 was evaluated under ambient and refrigerator conditions in the dry zone. Chi square test was performed to analyze the data.

RESULTS AND DISCUSSION

Yield performance.

Length of pods and pod circumference variedsignificantlyamong the testedlinesbutseasonal effect was not significant for these twotraits except for line 39 - 1 ($P < 0.05$). The highest pod length was recorded in the line 39-2 (67.0 cm) while the shortest pod length wasobserved in variety, Polon (35.1 cm). All improved lines and variety Hawariproduced significantly longer pods than that of variety Polon(Table 1) while the highest circumference in podswas observed in line 39-8 (Table 2). Significant

differences in number of pods/plant were observed among different lines and seasons (Table 3). The highest number of pods per plant was observed in line 39-9 while the lowest was recorded in line 39-8.

Table 1. Variation in pod length of Yard-long bean lines and check varieties in three consecutive seasons.

Variety/ Line	Pod length (cm)					
	2010 *Yala*	**2010/11 *Maha***	**2011 *Yala***	**Mean**	**CV%**	**Pr> F**
39-1	63.1a1	60.3a1	68.5ab 1	63.9	3.55	0.1270
39-2	66.1a 1	62.6a 1	72.4a 1	67.0	7.05	0.1403
39-8	66.5a 1	63.2a 1	67.0 ab1	65.6	11.15	0.7980
39-9	63.0a 1	66.6a 1	64.3b 1	64.6	3.36	0.2419
39-11	61.4 a 1	64.8a 1	66.8ab 1	64.3	7.08	0.4263
39-12	68.2a 1	63.2a 1	67.9ab 1	66.4	3.80	0.1244
39-13	66.9a 1	59.4a 1	70.9ab 1	65.7	11.99	0.2964
Hawari	68.8a 1	60.1a 1	66.7ab 1	65.2	6.27	0.1220
Polon	35.4b 1	33.9b 1	36.1c1	35.1	16.31	0.8952
CV %	6.31	8.64	8.71			
Pr≥ F	<.0001	<.0001	<.0001			

Note: Means followed by different letters in a column and numbers in a row are significantly different at $P \geq 0.05$ level

Single pod weight differed significantly among the lines but there was no significant seasonal effect to be observed (Table 4). Single plant yield varied significantly among the lines and seasons, yet line 39-9 showed no significant seasonal effect on single plant yield.

Table 2. Variation in pod circumference of Yard-long bean lines and check varieties in three consecutive seasons.

Variety/ Lines	Pod circumference (cm)					
	2010 *Yala*	2010/11 *Maha*	2011 *Yala*	Mean	CV%	Pr> F
39-1	3.4a 1	2.9ab 2	3.3ab 1	3.2	5.52	0.0420
39-2	3.4a 1	2.8ab 1	3.2ab 1	3.1	7.70	0.1177
39-8	3.4a 1	3.2a 1	3.5a 1	3.4	4.12	0.1329
39-9	3.2ab 1	3.0 a 1	3.1abc 1	3.1	3.57	0.1386
39-11	3.1ab 1	3.0 a 1	2.7cd 1	2.9	13.27	0.3942
39-12	2.9bc 1	2.8ab 1	3.0 bc 1	2.9	13.54	0.8425
39-13	3.2ab 1	2.8ab 1	3.0 bc 1	3.0	10.69	0.3994
Hawari	2.6c 1	2.1c 1	2.2d 1	2.3	11.77	0.1309
Polon	2.9bc 1	2.5bc 1	2.7cd 1	2.7	8.93	0.2044
CV %	7.93	9.36	9.68			
Pr≥ F	0.0218	0.0029	0.0017			

Note: Mean values followed by different letters in a column and numbers in a row are significantly different at P ≥ 0.05 level

Table 3. Variation inpod number per plantof Yard-long bean lines and check varieties in three consecutive seasons.

Variety/ Lines	Number of pods/plant					
	2010 *Yala*	2010/11 *Maha*	2011 *Yala*	Mean	CV%	Pr> F
39-1	28.7ab 1	38.5 ab 1	25.0b 2	30.7	5.12	0.0499
39-2	27.7b 1	37.9 ab 1	22.0 b1	29.2	17.28	0.1555
39-8	18.7ab 1	31.8 b 1	16.5 ab 1	22.3	10.25	0.2054
39-9	39.3a 1	42.1 ab 1	38.8 a 1	40.0	8.60	0.5173
39-11	27.0b 2	46.1 a 1	23.8 b 2	32.3	12.44	0.0377
39-12	24.5b 1	35.3 ab 1	30.3 ab 1	30.0	17.79	0.1558
39-13	27.5b 1	38.6 ab 1	34.5 ab 1	33.5	20.11	0.4669
Hawari	23.5b 1	36.7 ab 1	31.1 ab 1	30.4	14.72	0.2139
Polon	19.3b 1	38.7 ab 1	32.0 ab 1	30.0	22.57	0.1582
CV %	14.48	19.50	14.98			
Pr≥ F	0.0198	0.0417	0.0326			

Note: Mean values followed by different letters in a column and numbers in a row are significantly different at P ≥ 0.05 level

Table 4. Variation in single pod weight of Yard-long bean lines and check varieties in three consecutive seasons.

Variety/ Lines	Weight/pod (gram)					
	2010 *Yala*	**2010/11 *Maha***	**2011 *Yala***	**Mean**	**CV%**	**Pr> F**
39-1	20.1 b 1	24.3ab 1	21.6 b 1	22.0	9.21	0.1712
39-2	22.0 b 1	24.7ab 1	21.8 b 1	22.8	6.24	0.1496
39-8	20.9 b 1	22.2 b 1	19.7bc 1	20.9	9.38	0.2439
39-9	29.2 a 1	30.1 a 1	29.7 a 1	29.6	7.74	0.1761
39-11	20.7 b 1	23.6 b 1	21.4 b 1	21.9	8.47	0.0926
39-12	26.4 a 1	27.8 a 1	23.7 b 1	25.9	10.29	0.0896
39-13	21.8 b 1	24.9ab 1	22.5 b 1	23.0	10.41	0.1764
Hawari	14.5 c 1	15.8 c 1	13.9 c 1	14.7	11.64	0.0764
Polon	15.5 c 1	16.3 c 1	14.7 c q	15.5	8.37	0.1279
CV %	7.24	9.47	14.98			
Pr≥ F	0.0267	0.0128	0.0326			

Note: Mean values followed by different letters in a column and numbers in a row are significantly different at P ≥ 0.05 level.

Table 5. Variation in single plant yield ofYard-long bean lines and check varieties in three consecutive seasons.

Lines / Variety	Yield/plant (gram)					
	2010 *Yala*	**2010/11 *Maha***	**2011 *Yala***	**Mean**	**CV%**	**Pr> F**
39-1	517.6 b 2	838.0 a 1	645.1 ab 2	666.9	11.91	0.0382
39-2	569.7 b 2	785.9 a 1	596.6 b 2	650.7	10.27	0.0268
39-8	496.3 b 2	740.6 ab 1	388.4 c 2	541.7	8.28	0.0195
39-9	678.0 a 1	782.1 a 1	735.4 a 1	731.8	7.32	0.6724
39-11	577.3 b 2	728.0 ab 1	547.7 bc 1	617.6	9.89	0.0437
39-12	326.3 c 2	928.3 a 1	679.9 ab 1	644.8	13.24	0.0489
39-13	463.0 bc 2	819.3 a 1	672.0 ab 2	651.4	10.88	0.0367
Hawari	163.3 d 2	417.5 c 1	310.4 c 2	297.0	12.21	0.0217
Polon	143.7 d 3	417.4 c 1	320.6 c 2	293.9	10.01	0.0118
CV %	10.14	13.97	9.85			
Pr> F	0.0258	0.0192	0.0145			

Note: Mean values followed by different letters in a column and numbers in a row are significantly different at P ≥ 0.05 level.

The highest mean single plant yield was recorded in line 39-9 (731.8 g) while the lowest mean yield of 293.9 was recorded in Polon (Table 5). Pod yield of vegetable cowpea (*Vignaung uiculata sub sp.sesquipedalis*) is highlyvariable complex associated with a number of component characters (Ullah *et al*., 2011).The pod length, pod weight andnumber of pods/plantwere reported as important yield attributing factors in vegetable cowpea (Kar *et al*., 1995; Hazral *et al*., 2007; Nwofia,2012;Pekşen and Pekşen, 2012).It was also reported that pod length is one of the major criteria in identifying a better variety for high yield and a good selection index to be used in breeding programmes. Pekşen (2004) stated thatpod number per plant is one of the most important yield components in vegetable cowpea.Yield variation observed among different lines andvarietiesin this study would havebeen associated with the variation in number of pods/plant (mean variation form 22 to 40) and this observation isin agreement with Nwofia (2012). Braithwaite (1982) reported that this yield component could be used as a primary criterion for selection at a late stage in a breeding programme.

In this study, all the linestest produced high yields and lengthy pods. However, the line 39-8 and 39-11 showed segregation even after F_6 generation. In general, segregation does not occur beyond F6generation in self pollinated crops and if any progeny segregates, it is rejected unless it is very promising (Chaudhary, 1982). The lines which showed a significant varietyX season interaction for the traits showed that the seasonal influence on traits. The non-significant interaction effect is an indication that the varieties were consistent in their response for traits. Hence,lines 39-1, 39-2, 39-9, 39-12 and 39-13 were selected to study their stability and adaptability under diverse environmental conditions.

Varietal stability

Stability of fivepromising lines was studied in six diverse environments from *Maha* 2011/12 to *Maha* 2012/13 (3 seasons). Mean yields of all tested varieties during Maha seasons (two seasons) and Yala season (one season) was 19.05 t/ha and 13.92 t/ha respectively (Table 6). When considers the mean yields of all tested locations during both seasons, line 39-9 gave the highest yield followed by 39-12whereas the lowest mean yield was recorded in the variety Hawari. These results indicate the presence

of adequate location and seasonal differences to evaluate varietal adaptability across the diverse environmental

Table 6. Mean yields (t/ha) of promising Yard-long bean lines grownfrom*Maha*2011/12 to*Maha*2012/13(3 seasons) atsix research locations.

Lines / Variety	Mean Yield (t/ha)		
	Maha	***Yala***	**Mean**
39-1	17.92	13.31	15.62
39-2	19.64	14.39	17.02
39-9	21.63	17.17	19.40
39-12	21.44	16.19	18.82
39-13	20.78	13.14	16.96
Hawari	12.89	9.31	11.10
Mean	19.05	13.92	

Selection of highly adaptable varieties was done based on the high positive mean deviation across environments (D), non-significant interaction with the environment (S^2) and other agronomic performances. Results revealed that the line 39-12 showed a high positive mean deviation (4.564) followed by line39-9 (3.891) whereasHawarishowing anegative mean deviation (-7.041)(Table 7). All other tested lines showed positive mean deviations, however, the values were significantly lower compared to lines 39-12 and 39-9. There was no significant genotype x environment interaction observed in stability testing.Further, less incidences of collar rot disease was reported in the tested lines compared to variety, Hawari at all locations.Evaluation of lines in contrasting environments andacross years is an essential step in determining theirstability and mean response of lines acrossdifferent environments indicate their wide scope of adaptation (Nwofia, 2012). Results obtained in this study showed significant yield variation among varieties. The best performinggenotypeswith regard to yield were 39-12 and 39-9 while variety, Hawariproduced low yield.In addition,lines 39-12 and 39-9 expressed high positive mean deviation and non-significant stability parameters, hence both lines can be considered as stable.

Table 7. Mean deviation (D) and stability parameter (S2) values of tested lines from *Maha* 2011/12 *to Maha* 2012/13 (3 seasons)at six different locations.

Lines / Variety	Mean Yield (t/ha)	
	D	S^2
39-1	1.701 b	37.6418
39-2	0.993 b	29.1812
39-9	3.891 a	19.9586
39-12	4.564 a	21.9843
39-13	1.217 b	24.9039
Hawari	-7.041 c	22.6479

Means with the same letters in a column are not significantly different at 5% probability level.

Varietal adaptability

With the intention of confirming the adaptability, lines 39-1, 39-2, 39-9, 39-12 and 39-13were evaluated at farmer fields underdiverse agro ecological environments. On-farm yield evaluation conducted from *Maha* 2012/2013 to *Yala* 2014 (4 seasons) gave amean yield of 23.61 and 22.84 t/ha respectively for lines 39-9 and 39-12 while the lowest yield was obtained from variety, Hawari across all the environments.

Table8. Mean yields (t/ha) of promising Yard-long bean lines at different farmer locations *Maha*2012/2013 to *Yala 2014* (4 seasons)

Lines/Variety	Mean Yield (t/ha)						
	Maha			Yala			
	DZ	MC	LCWZ	DZ	MC	LCWZ	Mean
39-9	23.50	25.36	24.27	23.64	24.63	20.3	23.61
39-12	21.13	23.93	24.35	24.20	23.60	19.85	22.84
39-2	17.46	18.12	15.33	13.67	14.68	17.41	16.11
39-13	16.47	19.10	17.49	12.20	12.85	13.20	15.21
39-1	15.84	16.18	15.21	13.68	15.24	13.80	14.99
Hawari	11.13	11.99	13.6	10.96	13.18	8.65	11.58
Mean	17.58	19.11	18.37	16.39	17.36	15.53	

Yield data were analyzed using plot deviation of each variety from the best plot yield at each location. The variety with the least mean deviation (D) and non-significant stability parameter (S^2) was identified as the best variety. Lines 39-1, 39-2 and 39-13 had not shown good yield performance at diverse farmer conditions hence adaptability of these lines were not assessed.During *Maha*, the line 39-9 showed the least mean deviation of 1.642and 3.030 in mid country (MC) and low country wet zone (LCWZ) respectively while the least mean deviation of 2.319was shown by line 39-12 in dry zone (DZ) (Table 9). Furthermore, 39-9 displayed the lowest least mean deviation in all the agro ecological zones tested followed by 39-12 (Table 9). However the differences in mean deviation between these two lines were not significant during both seasons except for DZ during *Maha*. The variety, Hawari had shown the highest mean deviation in all agro ecological zones throughout the tested period. There was no collar rot disease reported by farmers in 39-9 and 39-12during the study period.

Table 9. Mean deviation (D) of tested varieties in different farmer locations *Maha* 12/13to *Yala* 14 (4 seasons)

Lines/Variety	D					
	Maha			Yala		
	DZ	MC	LCWZ	DZ	MC	LCWZ
39-9	3.990 b	1.642 c	3.030 b	3.269 b	1.479 b	0.965 b
39-12	2.319 c	2.079 b	3.074 b	3.415 b	2.517 b	1.246 b
Hawari	20.645 a	15.052a	15.911 a	17.280 a	14.629 a	12.166 a

Means with the letters in a column are not significantly different at 5% probability level

Table 10. Stability parameter (S2) values of tested varieties in different farmer locations from *Maha* 2012/2013 to *Yala* 2014 (4 seasons)

Lines/ Variety	S2					
	Maha			Yala		
	DZ	MC	LCWZ	DZ	MC	LCWZ
39-9	52.432	5.467	13.820	2.400	2.009	1.121
39-12	12.275	15.495	6.197	2.136	3.152	1.195
Hawari	224.912	76.976	53.535	25.944	13.019	4.3242

The ability of some crop varieties to perform well over a wide range of environmental conditions has long been recognized (Finlay and Wilkinson, 1963) and yield reliability from year to year is of great interest to subsistence farmers compare to wide spatial adaptation (Ambrose and Hedley, 1984; Dashiell *et al*., 1994; Ma *et al*., 1998). In the present study, there was no genotype x environment interaction observed across the tested agro ecological regions during both *Yala* and *Maha* seasons (Table 10). Moreover, lines39-9 and 39-12 showed the least mean deviation and non- significant stability parameter, hence they can be considered as widely adaptable varieties. Yield evaluation usually involves the consideration of other characters that determine the overall performance of the cultivars. This is important because yield is a quantitative trait and hence, influenced by other traits acting singly or interacting together. Hence determination of other characteristics is vital before selecting varieties for commercial cultivation.

Disaese resistant

Root rot and collar rot are important disease in cowpea (Pan and Das, 2011). Field response of varieties to collar and root rot disease differed significantly from one to the other. In general, more disease incidence was observed during *Maha* (wet season) compared to the Yala (dry season) irrespective of varieties. Disease incidence across lines during *Maha* season varied from 4.26 to 41.37 percent while 2.13 to 27.56 percent during *Yala*.

Table 11. Collar rot disease incidences in tested varieties during 2012 *Yala* and 2012/13 *Maha* seasons

Variety	% disease incidence (2012 Yala)	% disease incidence (2012/13 Maha)
39-9	2.13(0.328)* d	4.26(0.629) d
39-12	8.27(0.975) c	11.50(1.060) c
Polon	27.56(1.440) a	41.37(1.616) a
Hawari	16.87(1.221) b	19.10 (1.281) b
Pr≥ F	0.0231	0.0124

Means with the letters in a column are not significantly different at 5% probability level
*Data in parenthesis are log transformed values.

Both recommend varieties showed increased susceptibility to root rot disease compared to newly develop promising lines (Table 11). Line 39-9 showed the highest level of field resistance (2.13 and 4.26 percent disease incidence respectively) during Yala and Maha. Vavilapalliet al., (2014) demonstrated a similar variation in resistance as he reported that 12 Yard-longg bean accessions and 6 cowpea varieties were moderately resistant to the collar rot disease out of 44 accessions tested in India.

Quality characteristics

None of the Yard-long bean varietywas rated as a not preferred variety (Table 12). However, line 39-9 ranked higher compared to other varieties in all evaluations. The appearance of 39-9 was rated as highly preferred by 81.3% of the participants whereas only 34.4 % rated varietyHawarias having a good appearance. Similarly the taste of 39-9 was rated as highly preferred while line 39-12 and variety, Hawariwere highly preferred by only 59% of the respondents.

Table 12. Cross tabulation of scores and Friedman test for Appearance and Taste of tested varieties

Treatment	No of participants	Appearance				Taste			
		HP (%)	AC (%)	NP (%)	Median	HP (%)	AC (%)	NP (%)	Median
39-9	32	81.3	18.7	0.0	4.7	71.9	28.1	0.0	4.1
39-12	32	61.1	38.9	0.0	2.9	59.8	40.2	0.0	2.7
Hawari	32	34.4	65.6	0.0	1.4	59.4	40.6	0.0	2.6
P≥ F					0.015				0.004

HP- Highly Preferred, Ac-Acceptable, NP-Not preferred

According to Friedman test (Table 12), the variety with the highest median score is considered as the best variety. The line, 39-9 scored the highest median value (4.7) for appearance followed by line 39-12 (2.9) while variety, Hawari scored the lowest median value (1.4). Similar results were obtained for taste where line 39-9 scored the highest median value (4.1).

Table 13. Shelf life of tested varieties in dry zone during *Yala* 2014

Variety	Avg. days to colour change		Avg. days to shrinkage	
	Ambient temperature	Refrigerator	Ambient temperature	Refrigerator
39-9	2.2	6.2	3.2	8.2
Hawari	1.5	5.0	2.2	5.7
P≥ F	0.0031	0.0175	0.0369	0.0284

Further, pods of line 39-9 took longer time for colour change and to shrink under both ambient temperature and refrigerated conditions compared to the variety Hawari. (Table 13).These results revealed that line 39-9 was preferredfor better quality characteristics by the users.

Green colour and long fleshy pods make marketing of line 39-9 easy and fetching good prices.This could be the reason for high farmeracceptability of this variety. Likewise, consumers highly preferred this variety due to podcolour, taste and keeping quality. This is in accordance withPandeyet *al*., (2006) that green color, big, lengthy, tender and fibreless pods were preferred by farmers and consumers.

CONCLUSIONS

The improvedYard-long bean lines, 39-9and 39-12 gave higher yields (23.6 and 22.8 t/ha) and showed good pod length, circumference, single pod weight, pod number and pod yield over seasons. These lines also showed wide adaptability and stabilityin diverse agro ecological conditions. Line 39-9 showed field resistance to collar rot disease during both *Yala* and *Maha* seasons. Itrecorded the highest median scoreand higher ranksin respect ofappearance and taste in the sensory evaluation. This lineproduced long fleshy green pods with long shelf-life with high acceptance from farmers and consumers. Hence, line 39-9 wasreleased as "*Gannoruwa A9 Mae*" for island-wide cultivation in 2015.

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