SCREENING WINGED BEAN (*Psophocarpus tetragonolobus* (L) DC) ACCESSIONS USING AGRONOMIC CHARACTERS.

ABSTRACT

Aim: This research aimed at screening winged bean accessions using morphological characters.

Study design: The experiment was laid out in Randomized Complete Block Design and replicated three times.

Place and Duration of study: The experiment was carried out at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso situated on longitude $8^0$7' N, latitude $4^0$14' E, and at altitude of 323.5 m above sea level.

Methodology: Seeds of thirty-eight accessions of winged bean were obtained from International Institute of Tropical Agriculture, Ibadan and were evaluated. Data were collected on germination count at 2, 3 and 4 weeks after planting (WAP), days to first and 50% flowering, days to first and 50% podding, top leaflet length, petiole length, secondary vine lengths at 8 and 9 WAP, pod length, and number of seeds per pod and were subjected to analyses variance.

Results: Accessions exhibited significant ($P \leq 0.05$) variation for flowering and podding dates, petiole length and top leaflet length. Days to first flowering varied from 68 to 114 days after planting (DAP) with an average of 76 days while days to 50% flowering ranged between 78 and 121 days with a mean of 83 days. Number of seeds per pod varied from 7 to 15 seeds per pod among the accessions with a mean of 12.5 seeds per pod while pod length varied from 12.3 cm to 25.6 cm with a mean pod length of 22.2 cm. Accessions TPT 26 and TPT 32 were consistent for early flowering and high seed yield and are therefore recommended for further adaptation and nutritional trials.

Keywords: Accessions; Malnutrition; Winged bean; Screening.

INTRODUCTION

Winged bean is a tropical crop that is listed as one of the under-exploited legumes (1). It has exceptionally high protein content and has been suggested as a potential food source for the tropics (2). It is unique among leguminous crops in that, several parts of the plant including leaves, pods, seeds and tubers are edible and rich in protein (3, 4). The tubers contain 20% protein in dry weight, an amount that is superior to other tubers such as Yam (2%), Cassava (1%), and Sweet potato (2%). The percentage of crude protein of the seeds (29.8-37.5%) is comparable to that of other legumes (4). Furthermore, winged bean can be grown in poor, sandy or clay soils without addition of fertilizer because bacteria that grow on its roots are capable of capturing large amounts of atmospheric nitrogen and converting it to a usable form for the plant (1). Klu in year 2000 reported that winged bean as an underutilized leguminous crop has received less research attention but much later in 2018, Wong and Wilson (5) reported that it has drawn worldwide attention of scientists mainly due to its food value.

This plant is of high economic importance to the local people in most of the developing countries where it is cultivated and even to the international community, but has been often neglected due to lack of documented information. Several characters of wild plants such as indeterminate growth habit, photosensitivity, pod shattering (when dry on the vine), presence of anti-nutritional substances in the raw dry beans and in the rind of the tubers, uneven germination rate, low yield, and above all, tremendous diversity of form in characters still exists in most of the available winged bean accessions (6). To overcome most of these undesirable wild characters, conventional plant breeding techniques and tissue culture can play a significant role. A thorough knowledge of the floral biology of the plant is necessary because flowers are the reproductive organs of a plant and the knowledge of various parts of a typical flower is necessary to understand plant sexual reproduction.

Information is limited about the morphological and nutritional characteristics of winged bean that can be exploited for the nutritional need of the sky-rocketing population of the world. Research is needed to assess the morphology and nutritional qualities that occurs within and across the existing accessions of winged bean so as to validate desirable plant forms and nutritional attribute of each accession. This will enable utilization of the crop for supplementation of the nutritional requirement of the resource poor families as well as provide further understanding of cultivation of winged bean. This research therefore aimed at screening available 38 winged bean accessions for morphological variations and identifying which among them will adapt and perform better in Nigeria, which may lead to further works on it to fill food security and nutrition gap.

MATERIALS AND METHODS

The experiment was carried out at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso situated on longitude $8^0$7' N, latitude $4^0$14' E, and at altitude of 323.5 m above sea level. Ogbomoso belongs to the derived savannah Agro ecology of Nigeria. Seeds of the 38 accessions of winged bean used in this study were obtained from the Genetic Resources Centre of The International Institute of Tropical Agriculture (IITA) Ibadan, their name and source as obtained from IITA are presented on Table 1. Seeds of each accession of winged bean were scarified mechanically by cutting through the seed coat opposite the micropyle with a scalpel blade so as to allow water imbibition to break external dormancy and hasten germination. Each accession was sown in three 4 m row plots spaced at 1 m within and between rows and laid out in a Randomized Complete Block Design (RCBD) and replicated three times. Two seeds were sown per hole and later thinned to one plant per stand at 4 weeks after planting (WAP).

After planting, agro-morphological data were collected using the International Board for Plant Genetic Resources descriptors (IBPGR) as a standard norm for plant morphological characterization guide. Data were collected on number of germinated seeds at 2, 3 and 4 WAP, petiole length, number of days to first and 50% flowering, number of days to first and 50% podding, top leaflet length on each vine, secondary vine length at 8 and 9 WAP while the yield related data recorded include pod length, pod width, seed length, seed width and number of seeds per pod. Data recorded were subjected to analysis of variance (ANOVA) using PROC GLM in SAS (7). Trait means for each accession was computed using PROC TABULATE in SAS (7); Pearson's correlation coefficient between every pair of traits using accession trait means was computed using PROC CORR in SAS.

RESULTS

Analyses of variance **(**ANOVA) of the vegetative and yield traits of the 38 winged bean accessions evaluated in this study are presented in Table 2 and 3 respectively. The accessions exhibited non-significant variations for the germination counts at 2, 3 and 4 WAP as well as the length of secondary vine at 8 and 9 WAP. However, significant ($P \leq 0.05$) variation existed in respect of number of days to first and 50% flowering, number of days to first and 50% podding, petiole and top leaflet length. All the measured yield and yield traits had significant ($P \leq 0.05$) variation across the accessions.

The top and bottom 10 accessions vegetative traits means of the 38 winged bean accessions evaluated are presented in Table 4. Number of days to first flowering varied from 68 to 114 days after planting (DAP) with an average of 76 days while number of days to 50% flowering ranged between 78 and 121 days with a mean of 83 days. Number of days to first podding however spanned between 85 and 124 DAP with a mean of 90 days while number of days to 50% podding was between 93 and 136 DAP with a mean of 100 DAP. Top leaflet length varied from 6.9 cm to 11.1 cm with a mean of 9.7 cm.

Yield and yield traits mean of the top and bottom 10 accessions out of the 38 winged bean accessions evaluated are presented in Table 5. Pod length varied from 12.3 to 25.6 cm with a mean pod length of 22.2 cm while pod width varied from 1.9 to 5.9 mm with a mean pod width of 3.4 mm. Number of seeds per pod ranged between 7 and 15 seeds across the accessions with a mean of 12.5 seeds per pod. Seed length however ranged between 6.5 and 10.4 mm with a mean seed length of 9.4 mm while seed width varied from 4.9 to 9.7 mm with an average of 8.7 mm.

Pearson correlation coefficients between every pair of measured trait of the 38 winged bean accessions are presented in Table 6. Germination count at 2 WAP was significantly and highly correlated with germination counts at 3 and 4 WAP (r = 0.93 and 0.91, respectively; $P \leq 0.0001$), it was however significantly but negatively correlated with seed length (r = - 0.22; $P \leq 0.05$). Number of days to first flowering was significantly and positively correlated with number of days to 50% flowering (r = 0.92; $P \leq 0.0001$), number of days to first podding (r = 0.90; $P \leq 0.0001$) and number of days to 50% podding (r = 0.92; $P \leq 0.0001$) however it was negatively and significantly correlated to petiole length, leaflet length, pod length, pod width, seed length, seed width and number of seeds per pod (Table 6).

DISCUSSION

Underutilized species can increase food security, especially, if they are adapted. Many such crops including winged bean have important nutritional qualities, such as high oil content, high quality proteins, a high level of minerals and vitamins (8, 6). Winged bean is therefore a complement to the existing pool of arable crops in Nigeria. The observed significant variations in some of the studied traits in this study is an indication of the presence of inherent genetic variation for these traits among the evaluated accessions. This may suggest that the accessions exhibited differential performance for these traits. However, there were rank changes among the accessions between the vegetative traits and the yield traits denoting that some of the accessions that performed well for the vegetative traits may not perform well for the studied yield traits. This observation agreed with the report of (9, 10) on common bean, that inherent genetic diversity influences morphologically diversity. This may further suggest that the accessions exhibited differential responses to the environment which may be attributed to the likelihood of occurrence of genotype by environment interaction (G × E). The confounding effects of G × E in crop evaluation has been reported by several previous workers (11, 12, 13). In addition, observed rank changes among accessions from one trait to the other will make selection for high-yielding and stable accessions challenging.

Early flowering accessions have larger leaflet sizes, but there was no marked increase in the length of secondary vine between 8 and 9 WAP. This could indicate that some of these accessions with more seed production potentials have strategies to limit vegetative growth and compensate for it by allocating energy to seed production. Also, they could have taken advantages of their large leaves to accomplish better photosynthesis in favour of pod and seed development resulting from more assimilates generated during this physiological activity of the plants. In earlier work on bambara groundnut, (14) mentioned that the timing of flowering period is a determinant factor for the final yield, this could therefore explain that early flowering may have positively favoured seed yield of these winged bean accessions. This attribute of early flowering has been noted as a worthy agronomic feature of crops for early maturity and uniformity of yield production in general (15). Thus, accessions that flower early can be considered in the production of winged bean as it is the practice in other leguminous crops including bambara groundnut (16).

The strong correlation coefficients between some evaluated traits may allow for simultaneous selection for the traits as well as the use of the related traits interchangeably in selection. The strongly correlated traits are possibly under the influence of the same genes as reported by (17, 10). During germplasm improvement, if two strongly correlated traits are desired, both can be selected simultaneously based on one of the traits. Significant correlation observed between number of days to 50% flowering and number of days to first podding suggests that increase in the number of days to 50% flowering could lead to increase in number of days to first podding hence selection of accessions with earlier flowering dates for further screenings will enhance reduction in the number of days to maturity of winged bean. In the same vein, number of seed per pod has negative correlation with flowering dates, an indication that late flowering accessions produced lower number of seed per pod.

CONCLUSION

In this study, accessions expressed differential performance for some of the observed traits, signifying the existence of inherent variability among them. It is obvious from this study that accessions have variability for the studied traits in the studied environment and that some traits are highly correlated to seed yield. This is indicative that winged bean accessions evaluated especially the top 10 ones can be further worked on, for better information on its nutrition and subsequent addition to the pool of available arable crops.

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Table 1: Thirty-eight (38) winged bean accessions evaluated in the study and their source.

Accession	Source	Accession	Source
TPT 2	IITA, Nigeria	TPT 18	
TPT 3	IITA, Nigeria	TPT 48	
TPT 5	IITA, Nigeria	TPT 3-B	IITA, Nigeria
TPT 6	IITA, Nigeria	TPT 14	Unknown
TPT 9		TPT 51	Thailand
TPT 10	IITA, Nigeria	TPT 43	
TPT 11	Sri Lanka	TPT 154	
TPT 16	Sri Lanka	TPT 7	
TPT 21	IITA, Nigeria	TPT 11-A	
TPT 22	Papua New Guinea	TPT 26	Papua New Guinea
TPT 30		TPT 15-4	
TPT 32		TPT 31	Papua New Guinea
TPT 42		TPT 33	
TPT 53	Thailand	TPT 6-A	
TPT 125		TVU 153	
TPT 15	Unknown	TPT 1A	
TPT 17	Unknown	TPT 19	Unknown
TPT 4-A	IITA, Nigeria	TPT 126	
TPT 12	Sri Lanka	TPT 2A	IITA, Nigeria

Table 2: Mean squares for vegetative traits of 38 winged bean accessions evaluated in the study

Source	Degree of freedom	Germination count at 2 WAP	Germination count at 3 WAP	Germination count at 4 WAP	Number of days to first flower	Number of days to 50% flower	Number of days to first pod	Number of days to 50% pod	Petiole length (cm)	Length of secondary vine at 8WAP (cm)	Length of secondary vine at 9WAP (cm)	Top leaflet length (cm)
Rep	2	18.4ns	22.7ns	19.0ns	161.6ns	51.6ns	263.8*	220.6ns	0.2ns	0.4ns	1.0ns	4.2*
Accession	37	22.3ns	18.0ns	18.0ns	162.7*	168.0*	140.2**	155.7**	2.5*	0.3ns	0.4ns	1.8*
Error	74	19.3	14	14.9	89.2	89.6	72.8	79.3	1.4	0.5	0.4	1

**, * Data significant at $P \leq 0.01$, and 0.05, respectively; ns = data not significant.

WAP= Weeks after planting

Table 3: Mean squares for yield and yield traits of 38 winged bean accessions

Source	Degree of freedom	Pod length (cm)	Pod width (cm)	Seed length (mm)	Seed width (mm)	Number of seeds per pod
Rep	2	14.0ns	0ns	2.4ns	1.3ns	2.1ns
Accession	37	19.8**	0.9*	1.5**	1.8**	7.4*
Error	74	9.9	0.5	0.8	0.8	4.1

**, * Data significant at $P \leq 0.01$, and 0.05, respectively; ns = data not significant.

Table 4: Vegetative traits of the top 10 and bottom 10among the 38 winged bean accessions based on days to 50% flowering

Accession	**Number of days to 50% flowering**	**Germination count at 2 WAP**	**Germination count at 3 WAP**	**Germination count at 4 WAP**	**Number of days to first flowering**	**Number of days to first podding**	**Number of days to 50% podding**	**Petiole length (cm)**	**Length of secondary vine at 8 WAP (cm)**	**Length of secondary vine at 9 WAP (cm)**	**Top leaflet length (cm)**
Top Ten											
TPT 33	77.7	18.3	19.7	19.7	67.7	85.0	93.0	12.0	4.2	4.2	10.0
TPT 53	78.3	21.7	22.3	22.3	72.7	85.0	96.0	10.9	4.2	4.2	10.7
TPT 154	78.3	17.0	17.7	16.7	70.0	88.0	95.7	11.8	4.3	4.7	9.9
TPT 26	78.5	21.5	21.5	20.5	72.5	88.0	97.5	11.4	4.2	4.2	9.6
TPT 2	79.0	21.7	23.7	23.7	73.3	88.7	95.7	10.1	4.2	4.2	9.7
TPT 21	79.0	20.7	22.7	23.3	74.7	87.0	97.0	11.5	4.0	4.0	10.1
TPT 32	79.0	23.3	23.7	24.0	72.7	89.0	98.7	10.8	4.5	4.5	9.7
TPT 15	79.0	18.0	19.5	19.0	75.5	87.0	95.0	10.9	4.4	4.6	9.1
TPT 48	79.3	20.7	22.0	22.3	71.7	88.7	96.7	10.1	4.4	4.5	8.3
TPT 51	79.3	22.3	23.3	22.3	76.0	88.3	95.7	11.2	4.3	4.3	9.4
Bottom Ten											
TPT 4-A	83.7	23.7	23.3	24.3	73.3	92.0	102.7	11.8	4.4	4.5	9.7
TPT 10	84.0	19.3	21.0	21.3	79.0	92.0	101.7	10.8	4.8	4.8	9.9
TPT 14	84.0	21.0	20.3	20.3	75.3	89.0	98.7	12.0	4.6	4.8	10.7
TPT 31	84.3	22.7	22.3	19.7	77.0	93.7	102.0	10.8	4.4	4.5	9.4
TPT 43	84.7	19.0	18.3	18.3	77.0	92.0	101.0	10.8	5.3	5.0	9.3
TPT 11-A	84.7	11.0	13.3	13.3	76.3	91.7	102.0	10.5	4.4	4.4	9.7
TPT 42	85.3	20.0	22.7	21.7	78.3	97.3	101.3	10.8	3.7	3.7	10.1
TPT 15-4	89.0	19.7	20.7	20.7	77.0	95.7	104.0	10.9	4.3	4.5	10.7
TPT 126	102.3	19.3	20.0	20.7	90.0	105.3	116.7	9.7	4.1	4.1	8.9
TPT 3	120.7	24.7	24.0	22.7	114.0	124.3	136.0	7.3	4.5	4.5	6.9
Statistics											
Mean	83	20.8	21.6	21.4	75.5	90	99.6	10.9	4.3	4.4	9.7
SE	9.5	4.4	3.7	3.9	9.4	8.5	8.9	11.2	0.7	0.6	1.0
$LSD_{0.05}$	15.4	8.7	6.1	6.3	15.4	13.9	4.5	1.9	1.2	1.0	1.6
CV (%)	11.4	21.2	117.3	18.1	12.5	9.4	8.9	10.9	16.1	14.7	10.4

CV = coefficient of variation (%); SE = standard error; LSD = least significant difference at $P \leq 0.05$.

Table 5: Yield and yield traits mean of the Top 10 and bottom 10 accessions among the 38 winged bean accessions based on number of seed per pod

Accession	Number of seed per pod	Pod length (cm)	Pod width (cm)	Seed length (mm)	Seed width (mm)
Top ten					
TPT 125	14.9	21.4	3.3	9.5	9.1
TPT 32	14.1	22.1	3.4	9.3	8.9
TPT 12	14.1	23.4	3.3	9.5	8.6
TPT 22	14.0	24.0	3.8	9.0	8.3
TPT 7	13.9	25.1	3.3	9.1	8.4
TPT 3-B	13.8	23.7	3.1	9.9	8.9
TPT 15-4	13.8	25.6	5.9	9.4	8.5
TPT 4-A	13.7	22.2	3.3	9.9	8.6
TPT 26	13.7	21.2	2.8	10.4	9.5
TPT 16	13.5	20.8	3.5	9.4	8.9
Bottom ten					
TPT 14	11.7	21.9	3.4	9.2	8.9
TPT 10	11.5	25.4	3.6	9.7	9.4
TPT 33	11.5	23.3	3.5	9.7	8.5
TPT 19	11.3	19.9	3.2	9.9	9.0
TPT 154	11.2	20.9	3.3	10.0	9.0
TPT 18	11.1	21.6	3.0	8.8	8.4
TPT 51	10.9	19.2	3.5	9.9	9.5
TPT 6-A	10.3	21.3	3.5	9.9	9.3
TPT 126	8.4	15.7	2.4	8.9	7.4
TPT 3	6.9	12.3	1.9	6.5	4.9
Statistics					
Mean	12.5	22.2	3.4	9.4	8.7
SE	2.0	3.1	0.7	0.9	0.9
$LSD_{0.05}$	3.3	5.1	1.2	1.5	1.5
CV (%)	16.2	14.2	21.9	9.3	10.1

CV = coefficient of variation (%); SE = standard error; LSD = least significant difference at $P \leq 0.05$.

Table 6: Pearson correlation coefficient between measured traits of the 38 winged bean accessions evaluated

Trait	Germination count at 2 WAP	Germination count at 3 WAP	Germination count at 4 WAP	Number of days to first flowering	Number of days to 50% flowering	Number of days to first podding	Number of days to 50% podding	Petiole length (cm)	Secondary vine 8WAP	Secondary vine 9WAP	Top leaflet length (cm)	Pod length (cm)	Pod width (cm)	Seed length (cm)	Seed width (cm)	Seed per pod
G3WAP	0.93***															
G4WAP	0.91***	0.94***														
DFF	0.07ns	0.09ns	0.05ns													
DFTF	0.06ns	0.04ns	0.03ns	0.92***												
DFP	0.12ns	0.12ns	0.09ns	0.90***	0.92***											
DFTP	0.09ns	0.09ns	0.06ns	0.92***	0.95***	0.95***										
PELT	-0.06ns	-0.09ns	-0.06ns	-0.55***	-0.58***	-0.52***	-0.54***									
SV8WAP	0.08ns	0.03ns	0.01ns	-0.07ns	-0.07ns	-0.05ns	-0.05ns	0.14ns								
SV9WAP	0.05ns	-0.01ns	-0.02ns	-0.13ns	-0.10ns	-0.10ns	-0.09ns	0.16ns	0.95***							
LTLFT	0.08ns	0.04ns	0.08ns	-0.47***	-0.51***	-0.50***	-0.49***	0.62***	0.24**	0.24*						
PDLT	-0.04ns	0.02ns	-0.01ns	-0.59***	-0.64***	-0.61***	-0.60***	0.49***	-0.03ns	-0.02ns	0.45***					
PDWDT	-0.11ns	-0.05ns	-0.07ns	-0.32**	-0.32**	-0.30**	-0.30**	0.25**	0.02ns	0.02ns	0.28**	0.50***				
SDLT	-0.22*	-0.20*	-0.21*	-0.62***	-0.57***	-0.61***	-0.61***	0.38***	0.16ns	0.19*	0.32**	0.36***	0.22*			
SDWT	-0.14ns	-0.15ns	-0.17ns	-0.74***	-0.74***	-0.73***	-0.75***	0.57***	0.12ns	0.13ns	0.43***	0.49***	0.32**	0.79***		
SPP	0.04ns	0.05ns	0.06ns	-0.42***	-0.43***	-0.43***	-0.39***	0.30**	0.14ns	0.13ns	0.37***	0.51***	0.22*	0.24*	0.33**	
SDOIL	0.25**	0.21*	0.22*	0.13ns	0.09ns	0.17ns	0.16ns	-0.14ns	0.04ns	-0.05ns	0.01ns	-0.03ns	0.08ns	-0.31**	-0.23*	-0.01ns

*, **, *** = r values significant at $P \leq 0.05$, 0.01 and 0.0001, respectively, ns = r not significant

WAP= Weeks after planting