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Production and disease status of three climbing beans varieties in the monomodal humid forest of Cameroon

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Abstract

The availability of beans at a relatively cheaper price compared to meat and other protein sources cater for the protein requirements of people with low purchasing power. This study was carried out on three climbing beans varieties PNN, DOR 701 and MCX to evaluate growth, yield and disease prevalence across two growing seasons. The design of the experiment was complete randomized block design with the three replicates, 15 plants were randomly selected and tagged from each variety per plot for data collection on growth, yield, diseased incidence and severity. The results showed that irrespective of the planting season, all the growth parameters of the climbers, with the exception of the number of leaves per plant, varied significantly (P = 0.05) with beans variety. The highest plant height (171.6 cm), number of grains per pod was highest (8), the highest pod length (13.3 cm) and the least mean number of branches per plant (4) was recorded with the variety PNN. All yield and yield components were found to vary significantly (P = 0.05) with the bean varieties. The highest yield (3.0 Mg/ha) was recorded by MCX. Disease incidence and severity did not vary significantly (P = 0.05) across varieties. Disease incidence and severity were significantly higher in the early planting season (91.7% and 37.7% respectively) than in the late planting season (69.4% and 16.7% respectively). Cultivation of beans should be done in the late planting season, using MCX variety with high yield.

Keywords: Common Beans; Production; Growth; Yield; Disease; Seasons.

1. Introduction

Common bean is among the most popular and important lowland legume cropped worldwide mainly grown for human consumption [1]. It is the second most important source of human dietary protein after soyabeans and is the third most widely consumed legume after groundnut and cowpea [2]. The common beans are high in starch, iron, zinc, dietary fibre and are an excellent source of potassium, selenium, molybdenum, thiamine, vitamin B6, and folic acid [3]. Within the African regions, bean products tend to be consumed at various stages of plant development, and thus, offer a staggered and prolonged food supply in the form of leaves, green pods, fresh grain, as well as dry grains [4]. Compared to other vegetables, common bean has the highest value for human nutrition [5]. Bean consumption reduces colon and breast cancer and heart diseases [6]. Beyond promoting food, health and nutritional security, beans provide a steady and lucrative source of income for many rural households, with the value of bean sales now exceeding US$ 500 million annually [7]. The availability of beans at a relatively cheaper price compared to meat and other protein sources can therefore cater for the protein requirements of people with low purchasing power. This research therefore evaluates the adaptation of three climbing beans varieties in the monomodal humid forest zone of Cameroon.

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2. Material and methods

2.1. The Study Area

This study was carried out at the experimental field of the Department of Plant Sciences, Faculty of Science, University of Buea. Buea is located in the Eastern slopes of Mount Cameroon, between latitudes 4° 28′ 30" N and 3° 54′ 26" N and longitudes 8° 57′ 10" and 9° 30′ 49" E and the Experimental farm is at an elevation of about 450m to 600m above sea level. The site has a mountainous terrain with fertile volcanic soils suitable for agriculture. The location has a humid tropical climate with an annual rainfall of about 2800 mm [8]. It has a mean annual temperature of 28°C and an average humidity of 86%. The annual sunshine is estimated between 900-1200 hours per annum [9].

2.2. Field layout and sowing

Land was prepared and plots were made with a dimension of 3m x 3m with an area of $9m^2$. Plots were separated 1m within blocks and 2m between blocks. Seeds of three 'climbing' beans varieties included; MCX, (White beans), PNN (Senegalese black), and DOR 701 (Merengeh beans) were selected. These varieties are highly produced in the humid savanna zone of Cameroon and therefore their grains are transported and sold in the study area where there is high consumption.

A planting distance of 40 x 25cm was used and 3 seeds were planted per hole at a depth of 2.5cm and thinned two weeks after sowing to 2 plants per stand, giving a plant density of 90 plants/plot. Staking was done three weeks after planting. Planting was done in early (March) and late (September) planting seasons. The research design was a completely randomized block design with three replicates.

2.3. Data collection

2.3.1. Growth parameters

Fifteen (15) plants for each variety were randomly selected per plot and tagged for data collection for the height, collar diameter, number of leaves, pod length and number of seeds per pod. This was done as from 2weeks after planting (WAP) and weekly till the period of harvest. The height of the plant was determined by measuring the plant from the base of the stem above the ground to the tip of the tallest shoot with the aid of a measuring rod, number of leaves and branches were counted on each tagged bean plant, collar diameter was determined using a vernier caliper at the base of the stem at the first node.

2.3.2. Yield and yield components

The pods were harvested at physiological maturity by handpicking and the number of pods per plant determined. The pod length was measured with a ruler and the number of grains per pods assessed. The seeds were sun dried separately to 12% moisture content. The grained yield was then determined by weighing the harvested grain/plot, The weight of 100 grains per variety was carried out using a sensitive balance.

2.3.3. Disease incidence

Disease incidence refers to the number of visibly diseased plants, usually in relation to the total number of plants assessed and expressed as the proportion or percentage of plants in a plot with symptoms on a scale of 0–100 (%). This technique was used to calculate the incidence of disease symptoms on the field. The various diseased plants were recorded and disease incidence was calculated using the formula;

$$\%\ Disease\ incidence = \frac{Number\ of\ infected\ plants}{Total\ number\ of\ plants\ assessed} \times \frac{100}{1} \ldots\ldots\ldots\ldots\ldots (1)$$

2.3.4. Disease Severity

Ten (10) bean plants were taken randomly from each variety along a diagonal and observed for disease symptoms. Phenotypic data on host reaction were recorded in terms of symptom expression following a five-point scoring scale modified by [10] (Table 1).

Table 1 Disease severity scale

Severity rating	Range of disease severity (%)	Symptom description
1	0	Symptomless; all plant parts free from any visual symptom
2	0 – 15	Disease at initial stage of establishment; spots starting to appear on vines, tendrils withering from tip of at least one vine, spots appearing on fruits (<0.25cm)
3	16 – 40	Elongated spots at multiple sites of the vines, more than 5 spots per fruit (>0.5 cm), at least 1 auxiliary vine completely blighted
4	41 – 75	Expanding lesions on infected vines show distinct phases of diseases tissue, wounds with dead bark and vine tips dying rapidly. Fruit on infected plant wither and start dropping off prematurely
5	76 – 100	The plant is completely dead or rapidly dying. Infection on both main vines (where 2 are retained) > 75% plants defoliated. >50% of fruits shrivelled and dropping prematurely.

Assessments of beans disease incidence, and severity were all based on the accurate and reliable visual assessment of symptoms.

2.4. Data Analysis

The data collected were presented on frequency tables, graphs and charts. Descriptive statistics was used to describe shapes, growth and yield parameters and disease situation. The R statistical package at 5% probability level and the analysis of variance (one-way ANOVA) was used to statistically infer if there were any significant differences in the growth and productivity. Turkey's test was used for mean separation.

3. Results

3.1. Growth performance of three climbing beans varieties for the late planting season

3.1.1. Plant height

Generally, plant height increased with time for all beans varieties. Plant height showed an exponential growth after 2 weeks of planting for MCX and PNN varieties while DOR showed an exponential growth in height 3 weeks after planting (Figure 1).

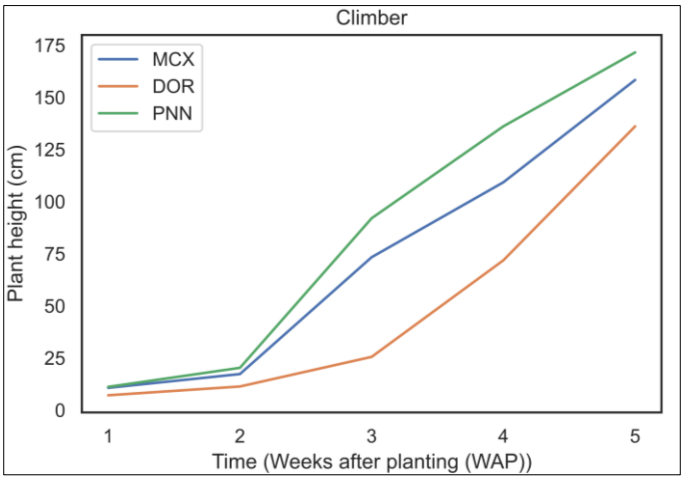

Figure 1 Growth patterns of three varieties of climbing beans

3.1.2. Number of leaves

The mean number of leaves per plant increased with time for all varieties of beans. An exponential growth was observed as from the second week after planting up to the end of the experimental period as observed in Figure 2. The number drastically increased for all varieties after 2weeks of planting.

Figure 2 Variation of the mean number of leaves for the three climbing beans varieties

3.1.3. Collar diameter

There was a gradual growth in collar diameter for all the varieties (Figure 3).

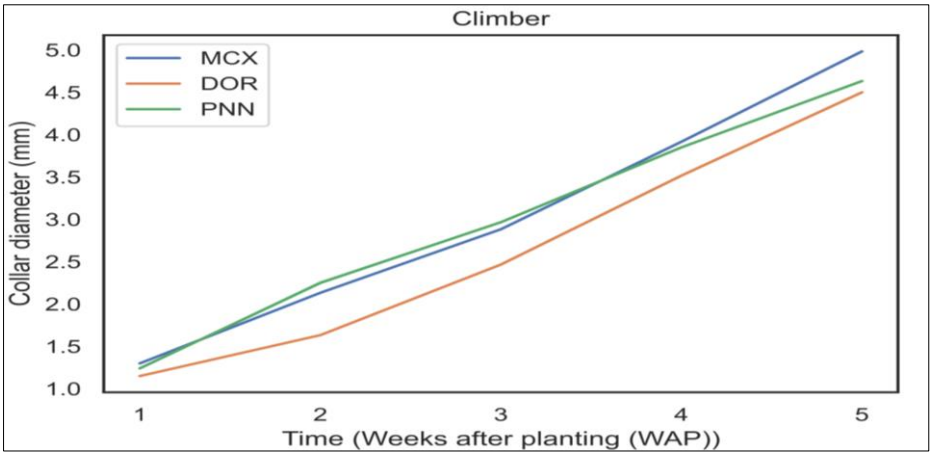

Figure 3 Variation of the collar diameter of the climbing varieties of common beans

3.1.4. Number of branches

The number of branches started increasing after the second week of measurements and showed exponential growth. At three weeks after planting, PNN and DOR began recording increase in growth at a decreasing rate while MCX maintained a constant growth rate throughout the experimental period (Figure 4).

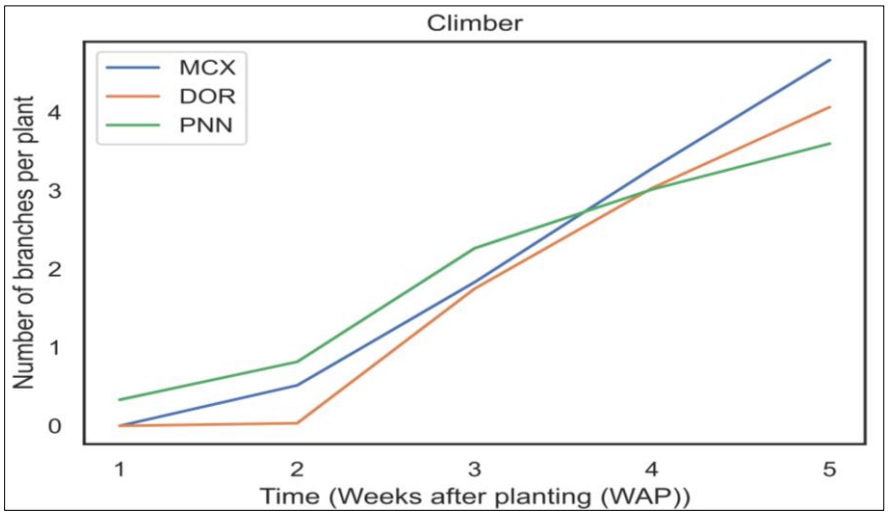

Figure 4 Variation of number of branches of three climbing varieties of common beans

3.1.5. Mean Morphological growth parameters for the early planting season

In the early planting season, all growth parameters of the climbers varied significantly (P = 0.05) with beans varieties at the 5% level of significance with the exception of number of leaves per plant for which was not significant (P = 0.05) (Table 2). The highest plant height (141.9 cm) was recorded in MCX while the least (112.7 cm) was recorded in variety DOR. The mean number of branches per plant was highest (5) for MCX and least (4) for PNN variety. The highest collar diameter (5 mm) was recorded by DOR while the least (4.3 mm) was recorded in PNN variety.

Table 2 Mean morphological growth characters of three varieties of beans at 37 days after sowing in the early planting season (values are means ± SD)

Beans type	Variety	Plant height (cm)	Number of branches	Number of leaves	Collar diameter (mm)
Climber	PNN	141.1 ± 13.6a	4.4 ± 0.9b	39 ± 6.5a	4.3 ± 0.9b
	MCX	141.9 ± 44.8a	5.0 ± 0.7a	38.7 ± 6.0a	4.9 ± 0.8a
	DOR	112.7 ± 13.2b	4.9 ± 0.8a	35.3 ± 7.4a	5.0 ± 0.9a
	Mean	131.1 ± 16.6	4.8 ± 0.4	37.7 ± 2.0	4.7 ± 0.5
	P-value	< 0.001	0.018	0.063	0.010
	Significance	***	*	ns	*

Means with the same letter within a column are not significantly different from each other. *** Significant at the 0.1% level of significance.

3.1.6. Mean Morphological growth parameters for the late planting season

In the late planting season, all growth parameters of the climbers varied significantly (P < 0.01) with beans varieties at the 0.1% level of significance with the exception of number of leaves per plant for which no significant (P = 0.05) variation was recorded at the 5% level of significance (Table 3). The highest plant height (202 cm) was recorded for PNN while the least plant height (159.9 cm) for DOR. Variety MCX recorded the highest mean number of branches per plant (4) while the least per plant (3) was recorded by variety PNN. The highest collar diameter (5.1 mm) was recorded for MCX while the least (4.03 mm) was recorded for DOR (Table 3).

Table 3 Mean morphological growth characters of three varieties of beans at 37 days after sowing in the late planting season (values are means ± SD)

Beans type	Variety	Plant height (cm)	Number of branches	Number of leaves	Collar diameter (mm)
Climber	PNN	202.0 ± 46.3a	2.8 ± 0.9b	32.7 ± 10.9a	4.9 ± 0.7a
	MCX	174.7 ± 27.1b	4.3 ± 0.7a	30.5 ± 7.4a	5.1 ± 1.0a
	DOR	159.5 ± 40.6b	3.2 ± 1.0b	32.3 ± 7.5a	4.03 ± 0.7b
	Mean	178.7 ± 21.6	3.5 ± 0.8	31.8 ± 1.15	4.7 ± 0.6
	P-value	< 0.001	< 0.001	0.598	< 0.001
	Significance	***	***	ns	***

Means with the same letter within a column are not significantly different from each other. *** Significant at the 0.1% level of significance.

3.1.7. Mean morphological growth parameters of the varieties irrespective of planting season

Irrespective of the planting season, all the growth parameters of the climbers, with the exception of the number of leaves per plant, varied significantly ($P < 0.05$) with beans variety at the 5% level of significance (Table 4). The highest plant height (171.6 cm) was recorded for PNN while the least plant height (136.1 cm) was recorded for DOR. Variety DOR recorded the highest mean number of branches per plant (5) while the least mean number of branches per plant (4) was recorded by the variety PNN. The highest mean collar diameter (5 mm) was recorded for MCX while the least (4.5 mm) was recorded in DOR (Table 4).

Table 4 Mean morphological growth characters of three varieties of beans at 37 days after sowing irrespective of planting season (values are means ± SD)

Beans type	Variety	Plant height (cm)	Number of branches	Number of leaves	Collar diameter (mm)
Climber	PNN	171.6 ± 48.3a	4.1 ± 1.3b	35.8 ± 9.5a	4.6 ± 0.9ab
	MCX	158.3 ± 40.2a	4.7 ± 0.8a	34.6 ± 7.8a	5.0 ± 0.9a
	DOR	136.1 ± 38.2b	4.9 ± 0.8a	33.8 ± 7.5a	4.5 ± 0.9b
	Mean	155.3 ± 17.9	4.1 ± 0.5	34.7 ± 1.0	4.7 ± 0.2
	P-value	< 0.001	< 0.001	0.339	0.013
	Significance	***	***	ns	*

Means with the same letter within a column are not significantly different from each other. *** Significant at the 0.1% level of significance. ^{ns} Not significant

3.1.8. Seasonal variation of Growth parameters on beans irrespective of variety

There was a significant difference in plant height and number of branches in the two seasons while there was no significant difference in number of leaves and collar diameter (Table 5).

Table 5 Seasonal variation of Growth parameters on beans irrespective of variety

Season	Plant height (cm)	Number of branches	Number of leaves	Collar diameter (mm)
Early planting season	131.1 ± 16.6	5.0 ± 0.4	38.7 ± 2.0	4.7 ± 0.5
Late planting season	178.7 ± 21.6	4.0 ± 0.8	32.8 ± 1.15	4.7 ± 0.6
P-value	< 0.001	< 0.001	0.331	< 0.001
Significance	***	***	ns	ns

3.2. Yield and yield components

3.2.1. Yield and yield components in the early planting season

In the early planting season, all yield and yield components of the climbers were found to vary significantly ($P < 0.05$) with beans variety at the 5% level of significance with the exception of the number grains per pod did not vary significantly ($P > 0.05$) across varieties at the 5% level of significance. The highest pod length (13.8 cm) was recorded by PNN while the least (11.3 cm) was recorded by MCX.

Hundred seed weight is an important yield component which reflects the magnitude of seed development. The highest weight per 100 grains (3.0g) was recorded in DOR while the least (2.0g) was recorded in both PNN and MCX. The highest total yield (3.0 Mgs/ha) was recorded in MCX while the least (1.0 Mg/ha) was recorded in DOR (Table 6).

Table 6 Yield and yield components of three varieties of common bean grown in the early planting season

Beans type	Variety	Pod length (cm)	Number of grains per pod	Weight per 100 grains (g)	Yield (Mg/ha)
Climber	PNN	13.8 ± 2.1a	7.8 ± 2.8a	2.0 ± 0.04b	1.5 ± 0.3b
	MCX	11.3 ± 1.2b	6.7 ± 1.6a	2.0 ± 0.03b	3.1 ± 0.7a
	DOR	11.4 ± 0.6b	7.0 ± 1.1a	3.0 ± 0.03a	1.0± 0.1c
	Mean	12.2 ± 1.4	7.2 ± 0.6	2.3 ± 0.06	1.8 ± 0.6
	P-value	0.001	0.442	0.017	< 0.001
	Significance	**	ns	*	***

Means with the same letter within a column are not significantly different from each other. *** Significant at the 0.1% level of significance ns Not significant

3.2.2. Yield and yield components in the late planting season

In the late planting season, pod length and number of grains per pod of the climbers were found to vary significantly ($P = 0.001$) with beans variety at the 0.1% level of significance while seed weight per 200 seeds and the total yield (Mg/ha) were not significantly ($P = 0.05$) different across varieties at the 5% level of significance. The highest pod length (13.8 cm) was recorded in PNN variety while the least (10.3 cm) was recorded in MCX variety. The mean number of grains per pod was highest (8) in PNN while the least (5) was recorded in MCX. The highest total yield (4.8Mg/ha) was recorded in MCX variety while the least total yield (3.3Mg/ha) was recorded in the variety DOR (Table 7).

Table 7 Yield and yield components of three varieties of common bean grown in the monomodal humid forest of Cameroon in the late planting season

Beans type	Variety	Pod length (cm)	Number of grains per pod	Weight per 100 grains (g)	Yield (Mg/ha)
Climber	PNN	13.8 ± 1.6a	7.7 ± 1.7a	3.0 ± 0.08a	2.5 ± 0.5a
	MCX	10.3 ± 2.2b	5.2 ± 1.4c	2.0 ± 0.04a	3.2 ± 0.7a
	DOR	11.1 ± 1.1b	6.3 ± 1.3b	3.0 ± 0.04a	2.2 ± 0.9a
	Mean	11.3 ± 1.8	6.4 ± 1.3	2.6 ± 0.06	2.63 ± 1.8
	P-value	< 0.001	< 0.001	0.123	0.083
	Significance	***	***	ns	Ns

Means with the same letter within a column are not significantly different from each other. *** Significant at the 0.1% level of significance ns Not significant

3.2.3. Seasonal variation of yield and yield components on beans irrespective of variety

All yield and yield components of the climbers were found to vary significantly ($P < 0.05$) with seasons at the 5% level of significance with the exception of weight per 100 grains which did not vary significantly ($P > 0.05$) across varieties at the 5% level of significance (Table 8).

Table 8 Seasonal variation of yield and yield components on beans irrespective of variety

Season	Pod length (cm)	Number of grains per pod	Weight per 100 grains (g)	Yield (Mg/ha)
Early planting season	12.2 ± 1.4	7.2 ± 0.6	2.3 ± 0.06	1.8 ± 0.6
Late planting season	11.3 ± 1.8	6.4 ± 1.3	2.6 ± 0.06	2.63 ± 1.8
P-value	< 0.001	< 0.001	0.123	< 0.001
Significance	***	***	ns	***

Means with the same letter within a column are not significantly different from each other. *** Significant at the 0.1% level of significance. ns Not significant

3.2.4. Combined yield and yield components for late and early planting seasons for the varieties

Irrespective of the planting season, all yield and yield components of the climbers were found to vary significantly (P < 0.05) with beans variety at the 5% level of significance (Table 7). The highest pod length (13.3 cm) was recorded by PNN while the least (10.9 cm) was recorded by both MCX and DOR. The mean number of grains per pod was highest (8) for PNN while the least (6) was recorded for MCX. The highest weight per 100grains (3.0g) was recorded by DOR while the least (2.0g) was recorded by MCX. The highest yield (3.0Mg/ha) was recorded by MCX while the least (1.1 Mg/ha) was recorded by DOR (Table 9).

Table 9 Yield and yield components of three varieties of climbing bean grown in the monomodal humid forest of Cameroon irrespective of the planting season

Beans type	Variety	Pod length (cm)	Number of grains per pod	Weight per 100 grains (g)	Yield (Mg/ha)
Climber	PNN	13.3 ± 2.1a	7.6 ± 2.0a	2.5 ± 0.08ab	2.0 ± 0.7b
	MCX	10.9 ± 1.8b	6.1 ± 1.6b	2.0 ± 0.04b	3.0± 1.6a
	DOR	10.9 ± 1.1b	6.3 ± 1.3b	3.0 ± 0.04a	1.1 ± 1.6a
	Mean	11.7 ± 1.4	6.7 ± 0.8	2.5 ± 0.05	2.0 ± 1.5
	P-value	< 0.001	< 0.001	0.017	0.001
	Significance	***	***	*	**

Means with the same letter within a column are not significantly different from each other. *** Significant at the 0.1% level of significance.

3.2.5. Disease Status

The disease incidence and severity were high in the early planting season as the leaves, stems and beans pods were well affected. Disease incidence and severity were found to vary significantly with season at (P = 0.001) (Table 10). Disease incidence was significantly higher in the early planting season (91.7%) than in the late planting season (69.4%). Similarly, disease severity was significantly higher in the early planting season (37.7%) than in the late planting season (16.56%).

Table 10 Seasonal variation of disease incidence and severity on beans irrespective of variety

Season	Disease incidence (%)	Disease severity (%)
Early planting season	91.7 ± 13.8	37.7 ± 17.1
Late planting season	69.4 ± 14.3	16.56 ± 5.22
P-value	< 0.001	< 0.001
Significance	***	***

*** Significant at the 0.1% level of significance.

Disease incidence and severity were not significantly different (P = 0.05) across all the climber varieties at the 5% level of significance in both the early and late planting seasons as well as in both seasons combined (Table 11).

Table 11 Variation of disease incidence and severity with beans grown in the monomodal humid forest of Cameroon.

Variety	General		Late planting season		Early planting season	
	Disease incidence (%)	Disease severity (%)	Disease incidence (%)	Disease severity (%)	Disease incidence (%)	Disease severity (%)
PNN	70 ± 16.7a	21 ± 10.9a	60 ± 0a	14 ± 2a	80 ± 20a	28 ± 12a
MCX	85 ± 17.6a	25 ± 12.4a	70 ± 10a	14 ± 2a	100 ± 0a	36 ± 4a
DOR	85 ± 15.2a	25 ± 9.8a	80 ± 20a	20 ± 8a	90 ± 10a	30 ± 10b
Mean	80 ± 8.7	23.7 ± 2.3	70 ± 10	16 ± 3.5	90 ± 10	31.3 ± 4.3
P-value	0.226	0.773	0.244	0.296	0.244	0.579
Significance	Ns	ns	ns	ns	ns	Ns

Means with the same letter within a column are not significantly different from each other. *** Significant at the 0.1% level of significance. ^{ns} Not significant

4. Discussion

Presence and high magnitude of genetic variability in crop germplasm is a very important basic requirement for launching a crop improvement program [11]. Characterization of germplasm that is conserved in gene banks for various traits is essential for its practical application and exploitation in various breeding programs [12]. In the present study, an effort was made to evaluate the growth attributes and disease prevalence of three climbing beans varieties sold and consumed in the humid forest zone of Cameroon region. Substantial variations were recorded for various morphological traits of these climbing varieties of common bean. These results are in accordance with earlier published results of [13] and [14]. When compared to broader common bean's germplasm collection and morpho-phenological descriptions of [15] and [16], the results of this study showed that a relatively high level of phenotypic diversity was included for both qualitative and quantitative traits. This result suggests that seed yield is related to the number of leaves and the shoot length. Plant height and the number of leaves were important indicators of the rate of growth of the plant. The number of leaves influences the yield, due to the role played by the leaves in photosynthesis and consequently in the accumulation of food reserves [17]. Increase in the rate of photosynthesis increases productivity.

The traits which are directly responsible for crop yield such as length of pods, seeds/pod and 200 seed weight also showed diverse behaviours [18]. Similar findings were examined by [19] for these three variables.

This study showed a significant and positive correlation in yield attributes including pod length and number of seeds per pod. Similar findings of positive correlation between yield attributes were recorded by [20]. Seed/pod was also found to depict a diverse pattern across the different varieties, ranging from 4 to 8 seeds/pod. These observations had great similarity with the findings of [21] who recorded 2 to7 grains per pod and [22] who recorded 3 to 6 grains per pod. The encouraging diversity exposed by the different varieties studied for different morpho-agronomic traits depicted a significant genetic variation [23]. A set of characteristics are evaluated for defining a variety rather than a single parameter which could help selecting adapted variety. The number of pods per plant is one of the major yield components that determine productive potentials of the common beans and it could be influenced by nutrient availability and the ability of bean varieties to pick up nutrients from the soil, which in turn stimulate the plants to produce pods [24, 25].

In the late planting season, all yield and yield components of the varieties were found to vary significantly with the exception of the number grains per pod which were not significantly different across varieties. The highest pod length (13.8 cm) was recorded in PNN variety while the least (11.3 cm) was recorded in MCX variety. The highest weight per 100 grains (3.0g) was recorded in DOR variety while the least (2.0g) was recorded in both PNN and MCX varieties. The highest total yield (7.5 Mg/ha) was recorded in MCX while the least (3 Mg/ha) was recorded in DOR. The yields in the late planting season were greater than that of the early planting season and this could be due to the fact that the late planting season was characterized by alternate rainfall and maximum irradiance that encouraged growth, photosynthesis and seed production. The variation of yield between the two growing seasons could be as a result of severe flower abortion in the early planting season; as many flowers may have been washed off by severe rains [26].

No variety was found free from disease infection. Disease symptoms were observed in all the plots both in the early and late plant. The presence of diseases in this well managed field can be due to the fact that this land, the seeds and the soil

were not pathogen free. There was also the presence of pasture legumes and soya bean (glycine max) that appeared to be reservoirs of diseases and insect pests. Opportunistic insect pests migrated from the nearby field that contained an earlier bean crop, along with cabbage and other leafy vegetable crops. Disease incidence and severity were found to vary significantly with season. Disease incidence was significantly higher in the early planting season than in the late planting season. This could be due to the fact that dry conditions are not conducive for pathogen development. High prevalence of diseases caused by pathogens such as fungi, thrive better in wet conditions unlike in dry conditions where their spread is reduced [27]. Disease severity depend mostly on environmental effects (soil, air humidity and temperature). Disease symptoms were low during the late planting season which was dry. Though a good management strategy was put in place in the experiment, the disease incidence and severity were high. The results obtained can be due to the fact that severity measurements are subjective and can sometimes be prone to bias and experimental errors. Also, visual assessment of disease usually tends to overestimate disease severity [28].

5. Conclusion

Adoption of improved and resistant varieties will have a great potential as a sustainable way to improve yield among resource poor beans farmers in this study area. The climbing bean varieties MCX was the best in terms of yield and disease resistant. In particular, results from this work highlight the potential infection risk to climbing beans, resulting in a drop in productivity, and underscore the need for a better seed source and management practices. The problem of disease does exist in the beans production and must be taken into account when planning for any large-scale production.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

No conflict of interest among the authors of this work.

General Comments

To cultivate climbing beans, special attention must be paid to cropping history of the field and crop rotation to minimize the impact of pest and disease problems which is the cause of reduction in yield. For beans production to be effective, efforts must be made to ensure that pest management issues are dealt with properly.

Authors Contribution

Egbe and Ondoua perceive the idea, Design and supervised the field work, Arrey and Agwe carried out the field work and wrote the draft manuscript and all authors proofread and corrected the manuscript.

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