

Agronomic Performance of Four Cowpea (*Vigna unguiculata* L. Walp) Varieties under Different Inter-row Spacings in Buea, Cameroon

Original Research Article

ABSTRACT

Aims: Two field trials were conducted to investigate the effect of inter-row spacing on the growth and yield of cowpea.

Study Design: The first trial was set up as a randomized complete block design with three replications. The second trial was set up as a split-plot arrangement in a randomized complete block design and the treatments were replicated three times.

Place and Duration of Study: The trials were conducted at the Teaching and Research Farm of the University of Buea in 2014 and 2016–2017.

Methodology: In the first trial, the variety VYA was grown at three inter-row spacings (45, 75 and 90 cm). The second trial comprised three inter-row spacings (45, 60 and 75 cm) and four varieties (RIL 69, RIL 79, RIL 265 and VYA). In both trials, the intra-row spacing was 25 cm.

Results: Inter-row spacing significantly influenced ($P < 0.05$) the performance of cowpea. In 2014, cowpea on rows spaced 75 and 90 cm apart produced more leaves and fodder yield than 45 cm. In both trials, cowpea on rows spaced 60, 75 and 90 cm apart produced taller plants with larger stems than that on rows spaced 45 cm apart. However, grain yield increased with a decrease in inter-row spacing for all varieties; the highest yield (6.04 tons^{-1}) was recorded for RIL 69 on rows spaced 45 cm apart. Among the varieties, RIL 69 had the highest fodder yield (4.7 tons^{-1}).

Conclusion: The results of this study indicate that cowpea should be sown in rows spaced 45 cm apart, for optimum grain yield production in Buea.

Keywords: Cameroon; cowpea; inter-row spacing; performance.

1. INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp) also known as southern pea or black eye pea is an important grain legume in the tropics. It is a valuable component of the traditional cropping systems in the semi-arid tropics covering Asia, Africa and Central America [1][2]. It is second in importance after groundnut in West and Central Africa, and Nigeria accounts for 70% of the total production in the world [3]. In Cameroon, cowpea is the third most important legume after groundnut and

common bean [4]. All parts of the plant used as food are nutritious and provide protein and vitamins; immature pods and leaves are used as vegetables while several snacks and main dishes are prepared from the grains [5].

Cowpea grain yield in farmers' fields is low in West Africa due to several biotic and abiotic factors which include poor soil fertility, drought, inadequate planting systems/practices, inappropriate cultivars and lack inputs [6]. However, higher yields have been reported in the

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savannas of Africa [7][8][9]. Among the various agronomic factors that limit yield, plant population is considered the most important [10]. An increase in crop yield can be attained by maintaining the appropriate plant spacing/density through different hectare patterns. Therefore, the optimization of plant density for high yielding genotypes through the use of suitable inter- and intra-row spacing is essential.

It is also necessary to determine the optimum plant density for different locations and varieties [11]. Low plant population per unit area has been reported as a major factor responsible for the poor yields obtained from smallholder farming systems in sub-Saharan Africa [12]. According to Ndiaga [13], cowpea varieties with different types of morphology require different optimum densities to express their full seed yield potential. Researchers have also shown that seeding rate and cultivar are important factors that affect the yield and quality of grain legumes [14][15][16]. The optimum density for cowpea depends on the growth habit, morphology and maturation period. Previous studies indicated that optimal yield was produced by erect types at a high population and by semi-erect types at a low population [17]. Plant spacing is an effective management tool for maximizing grain yield by increasing the amount of solar radiation captured within the canopy [18]. Although there are reports in the literature on the effect of plant spacing/ density on the performance of cowpea [19], this information is lacking in Cameroon.

The objectives of this study were to determine the effect of inter-row spacing on the agronomic performance of four cowpea varieties, and if the response to different spacings depends on the varieties. It is hoped that results obtained would help farmers to adopt the appropriate inter-row spacing for the varieties available, in order to obtain the optimal yield.

2. MATERIALS AND METHODS

2.1 Experimental Site

Two trials were conducted at the University of Buea Teaching and Research Farm from March to June 2014 and from November 2016 to March 2017. Buea is found in the mono-modal humid forest agro-ecological zone of Cameroon with an equatorial climate and two major seasons (rainy and dry). The rainy season runs from March to October and the dry season from November to March.

2.2 Experimental Design, Inter-row Spacings and Cowpea Varieties

The first trial was set up as a randomized complete block design with three replications. The trial consisted of one variety of cowpea 'VYA' and three inter-row spacings (45, 75 and 90 cm). The intra-row spacing was 25 cm. The plants were spaced as follows:

- i. 45 cm × 25 cm: 88,888 plants/ha (high population density)
- ii. 75 cm × 25 cm: 53,333 plants/ha (medium population density)
- iii. 90 cm × 25 cm: 44,444 plants/ha (low population density)

The second trial was set up as a split-plot arrangement in a randomized complete block design and the treatments were replicated three times. There were three inter-row spacings and four cowpea varieties. The main plots consisted of the inter-row spacings while the sub-plots were the varieties. The intra-row spacing was 25 cm. The plants were spaced as indicated below:

- i. 45 cm × 25 cm: 88,888 plants/ha (high population density)
- ii. 60 cm × 25 cm: 66,666 plants/ha (medium density population)
- iii. 75 cm × 25 cm: 53,333 plants/ha (low population density)

The four cowpea varieties used were: RIL 69, RIL 265, RIL 79 and VYA. The first three are early-maturing varieties (65–75 days) that were developed in the International Institute of Tropical Agriculture. The fourth is a medium-maturing (75–85 days) variety, which is a local variety commonly grown on farmers' fields.

2.3 Land Preparation, Planting and Crop Maintenance

For both trials, the land was ploughed and harrowed using a tractor and beds were raised manually using a hoe. The size of each plot was 4 m × 3 m. Two seeds of each cowpea variety were sown per hole and the seedlings were thinned to one per stand two weeks after planting (WAP). Weeds were controlled manually by hoeing after every two weeks from 2 to 8 WAP. The insecticide K-Optimal [Lamda-cyhalothrin (15 g/l) and Acetamipride (20 g/l)] was applied to control insect pests weekly from 2 to 7 WAP in the first trial, and at 2, 4 and 6 WAP in the second trial.

2.4 Evaluations

Ten plants were randomly selected from the centre rows of each plot to obtain data on growth, phenology and yield parameters of the cowpea varieties. The growth data collected at 7 WAP were plant height, number of trifoliate leaves, number of branches and stem diameter. The phenology data obtained were number of days to 50% flowering and 90% maturity. The yield data collected at harvest were number of pods/plant, number of seeds/pod, grain yield, 100-seed weight and fodder yield.

Plant height (cm) was measured from the surface of the soil to the tip of the tallest leaf using a metre rule. The number of trifoliate leaves was determined by counting those that were fully expanded. The number of branches was obtained by counting. The stem diameter (mm) was measured using a Vernier caliper at the base of the plant. The number of days to 50% flowering was obtained by counting the days from planting to when 50% of the plants in each plot produced at least one flower. Number of days to 90% maturity was obtained by counting the days from planting to when 90% of the plants in each plot were matured.

At maturity, the dry pods were harvested, threshed and weighed to obtain the grain yield (tons ha⁻¹). The pods on each sampled plant were counted before being threshed. The number of seeds/pod was obtained from ten pods randomly selected from each plot and threshed. The seeds were counted and the mean number of seeds/pod calculated. Three sets of 100 seeds were counted from each plot at random and weighed using a sensitive balance, to determine the 100 seed weight (g). Grain yield data for variety VYA could not be obtained as a result of damage by birds. However, the fodder yield (tons ha⁻¹) was obtained. The leaves and stems from the harvested plants were sun dried on each plot for one week after which they were weighed to determine the fodder yield.

2.5 Statistical Analyses

The data collected were subjected to analysis of variance using SPSS version 21 and the treatment means were separated using the Tukey HSD test at 5% level of probability. Simple

correlation coefficients were calculated to determine the effects of other yield traits on grain yield.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Plant height

The results of the first trial revealed that plant height for variety VYA differed significantly ($P=0.05$) at the different spacings at 7 WAP (Table 1). Plants on rows spaced 75 and 90 cm apart were taller than those on rows spaced 45 cm apart. These observations indicate that the plants were taller when sown at wide than at close spacing.

In the second trial, there was no significant ($P=0.05$) interaction between inter-row spacing and variety for plant height at 7 WAP. However, there were significant ($P=0.05$) differences between the inter-row spacings and cowpea varieties. Plants on rows spaced 60 and 75 cm apart were taller than those spaced 45 cm apart (Table 2). These results indicated that at 7 WAP, the plants were taller at wide than at close spacing. Hence, the results of the second trial are consistent with those of the first. However, these results do not agree with previous findings which indicated that intra-row spacing did not affect the height of cowpea [20]. In general, the mean height of all the plants increased as they advanced in growth (data not shown). Varieties VYA and RIL 79 had similar and taller plants than RIL 69 and RIL 265 which also had a comparable height (Table 3). The former varieties were 1.6 times taller than the latter ones. Previous studies have also indicated that there were differences in the height of cowpea genotypes when sown at different spacings [20].

3.1.2 Number of trifoliate leaves

Results of the first trial indicated that there were significant ($P=0.05$) differences in the number of trifoliate leaves produced at the different inter-row spacings at 7 WAP (Table 1). Plants on rows spaced 75 and 90 cm apart produced more leaves than those spaced 45 cm apart.

Table 1. Effects of inter-row spacing on the growth parameters of cowpea at 7 weeks after planting and fodder yield in 2014 in Buea, Cameroon

Plant height (cm)	Number of trifoliate leaves	Number of branches	Stem diameter	Fodder yield (tons ha ⁻¹)
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45	102.8b	94.3b	7.7	10.9b	5.3b
75	119.7a	111.2b	7.7	11.9a	7.2a
90	126.0a	122.2a	7.3	12.2a	5.0b
<i>P</i>	0.02	0.04	0.50	0.03	0.04

Table 2. Effects of inter-row spacing on the growth parameters of cowpea at 7 weeks after planting and some phenology and yield traits from 2016 to 2017 in Buea, Cameroon

Inter-row spacing (cm)	Plant height (cm)	Number of trifoliolate leaves	Number of branches	Stem diameter	Days to 50% flowering	Days to 90% maturity	Number of pods/plant	100-Seed weight (g)
45	81.9b	31.8	4.2b	10.4	42.4	61.7	27.2	15.7
60	90.5a	33.6	4.1b	9.5	42.1	61.4	24.9	15.3
75	94.0a	28.0	5.6a	10.4	42.1	61.4	24.6	15.2
<i>P</i>	0.05	0.40	0.01	0.60	0.80	0.61	0.54	0.48

Table 3. Effects of cowpea varieties on the growth parameters of cowpea at 7 weeks after planting and some phenology and yield traits in Buea, Cameroon

Varieties	Plant height (cm)	Number of leaves	Number of branches	Stem diameter (mm)	Days to 50% flowering	Days to 90% maturity	Number of pods/plant	100-Seed weight (g)
RIL 69	77.18a	31.8	4.2b	10.4	41.7b	63.1a	30.54a	18.20a
RIL 79	116.8b	28.0	5.6a	10.4	41.5b	57.7b	24.12ab	13.07c
RIL 265	59.2a	33.6	4.1b	9.5	42.1ab	63.2a	21.98b	14.93b
VYA	102.0b	37.5	4.3b	9.4	43.5a	—	—	—
<i>P</i>	0.004	0.17	0.01	0.09	0.01	0.01	0.01	0.01

In the second trial, the interactions between inter-row spacing and variety had no significant effect ($P=0.05$) on the number of trifoliolate leaves produced at 7 WAP. Inter-row spacing had no significant effect on the number of trifoliolate leaves produced (Table 2). This observation is contrary to that obtained in the first trial. The mean number produced across the different inter-row spacings was 31.1 trifoliolate leaves. These results are in agreement with those of previous studies which indicated that inter-row spacing did not affect the number of leaves of cowpea [21][22]. The varieties significantly influenced the number of trifoliolate leaves produced. The highest number of trifoliolate leaves was recorded for varieties VYA and RIL 79 (Table 3). The number of trifoliolate leaves produced by RIL 69 and RIL 265 was similar and 1.3 times less than that produced by the other two varieties.

3.1.3 Number of branches/plant

The number of branches did not differ significantly ($P=0.05$) at the different spacings in the first trial (Table 1). The average number across the different spacings was 7.6

branches/plant. These results are similar to those obtained by earlier researchers who reported that the number of branches/plant was not affected by plant spacing [23].

Results of the second trial revealed that there was no significant ($P=0.05$) interaction between inter-row spacing and variety for the number of branches/plant. Inter-row spacing significantly ($P=0.05$) affected the number of branches/plant (Table 2). Cowpea produced the highest number of branches at an inter-row spacing of 75 cm. The number of branches produced by plants spaced 45×25 cm and 60×25 cm was similar. These results suggest that the number of branches produced by cowpea was more at wide than close spacing. This observation contradicts that obtained in the first trial. However, this is not surprising because the first trial involves only one variety while the second involves several varieties which could respond differently due to their various growth habits. Previous studies have also indicated that number of branches was influenced by plant spacing [24]. The varieties also had a significant effect on the number of branches/plant (Table 3). The variety RIL 79 had the highest number of branches. Varieties VYA,

RIL 69 and RIL 265 produced a similar number of branches (4.2).

3.1.4 Stem diameter

In the first trial, the stem diameter for variety VYA differed significantly with inter-row spacing (Table 1). Plants spaced 75 × 25 cm and 90 × 25 cm had a larger diameter than those spaced 45 × 25 cm. These results indicate that the stem diameter was larger at wide than at narrow spacing.

Results of the second trial revealed that the interaction between inter-row spacing and variety had no significant ($P=0.05$) effect on the stem diameter of cowpea at 7 WAP. Also, the stem diameter was not influenced by inter-row spacing (Table 2). The average stem diameter at the different spacings was 10.1 mm. Stem diameter was not significantly affected by cowpea varieties (Table 3). The average stem diameter across the four varieties was 9.9 mm.

3.2 Phenology Parameters

3.2.1 Number of days to 50% flowering

In the second trial, the interaction between inter-row spacing and variety had no significant effect on the mean number of days taken by 50% of the plants to flower, in the second trial (Table 2). Inter-row spacing did not affect the number of days taken by 50% of the plants to flower. Across the different spacings, the mean number of days taken by 50% of the plants to flower was 42.2 days. These observations are similar to those obtained by Salih [25] who reported that the number of days taken by 50% of the plants to flower was similar when cowpea was sown at low and high densities.

The number of days taken by 50% of the plants to flower was significantly affected by the cowpea varieties (Table 3). Variety VYA took the highest number of days to flower (43.5). The other three varieties took a similar number of days (mean=41.8 days). This may be attributed to the genetic characteristics of the cowpea varieties. Thus, these three varieties are early-maturing varieties while VYA is not.

3.2.2 Number of days to 90% maturity

The interaction between inter-row spacing and variety also had no significant ($P=0.05$) effect on the mean number of days taken by 90% of the plants to reach maturity. Inter-row spacing did not influence the number of days taken by 90%

of the plants to reach maturity (Table 2). Across the three spacings, 90% of the plants took 61.5 days to reach maturity.

The cowpea varieties significantly affected ($P=0.05$) the number of days taken by 90% of the plants to reach maturity (Table 3). The varieties RIL 69 and RIL 265 took more days than RIL 79. These results indicate that although these three varieties were early-maturing, RIL 79 took a shorter time to reach maturity than the others.

3.3 Yield and Yield Components

3.3.1 Number of pods/plant

The interaction between inter-row spacing and variety had no significant ($P=0.05$) effect on the number of cowpea pods/plant in the second trial. Inter-row spacing had no significant ($P=0.05$) effect on the mean number of pods/plant (Table 2). The average number of pods/plant across all spacings was 25.6.

The varieties were significantly ($P=0.05$) affected by the number of pods/plant (Table 3). The variety RIL 69 recorded the highest number of pods/plant. The varieties RIL 265 and RIL 79 had a similar number of pods/plant. These results are in line with those reported by earlier scientists [26].

3.3.2 Number of seeds/pod

The interaction between inter-row spacing and variety significantly affected the number of cowpea seeds/pod in the second trial (Fig. 1). The variety RIL 69 had the highest number of seeds/pod at the different inter-row spacings. The variety RIL 79 produced the least number of seeds/pod; the order was RIL 69>RIL 265>RIL 79. The number of seeds/pod in varieties RIL 265 and RIL 79 increased with an increase in the inter-row spacing and the highest was recorded when the crop was spaced 75 cm × 25 cm. Previous research has also revealed that the number of seeds/pod increased significantly with an increase in inter-row spacing [26]. However, these findings contradict those of other authors who found that plant population had little or no effect on the number of seeds per pod [25]. These observations further indicate that the response of plants to different spacings/densities depends on the morphology of the varieties involved.

3.3.3 Grain yield

There was a significant ($P=0.05$) interaction between inter-row spacing and variety for the

grain yield of cowpea (Fig. 2). These results suggest that the cowpea varieties performed differently at different inter-row spacings. In general, grain yield decreased with an increase in inter-row spacing. All the varieties had the highest grain yield when sown at 45 cm × 25 cm and the lowest yield at 75 cm × 25 cm. These results showed that a decrease in inter-row spacing (or an increase in the plant population) led to a corresponding increase in grain yield. Results of some earlier studies also revealed that higher grain yield was obtained at close (high plant density) than at wide (low plant density) spacing [19][26] [27]. Overall, the highest grain yield was recorded for RIL 69 when sown at 45 cm × 25 cm (6.0 tons ha⁻¹). Similarly, RIL 69 had the highest yield at the different inter-row spacings. The lowest yield (1.5 tons ha⁻¹) was recorded for RIL 265 spaced 75 cm × 25 cm and RIL 79 spaced 60 cm × 25 cm and 75 cm × 25 cm. Previous studies have also indicated that there were significant differences in grain yield between cowpea genotypes [19].

There were highly significant ($P \leq 0.01$) positive correlations between the grain yield and number of pods/plant ($r=0.8$), number of seeds/plant ($r=0.7$) and fodder yield ($r=0.5$).

3.3.4 100-Seed weight

The interaction between inter-row spacing and variety was not significant ($P=0.05$) for 100–seed weight of cowpea. Inter-row spacing had no significant effect ($P=0.05$) on 100–seed weight (Table 2). The average value for 100–seed weight across all spacings was 15.4 g. There were significant variations among the cowpea

varieties for 100–seed weight (Table 3). One hundred seed weight for RIL 69 and RIL 265 was higher than that for RIL 79. Variety RIL 69 had the highest 100–seed weight (18.20g) while RIL 79 had the least (13.07 g). These results are similar to those of other researchers who reported that cowpea genotypes were significantly affected by the mean 100–seed weight [19].

3.3.5 Fodder yield

During the first season, there were significant ($P=0.05$) differences in the fodder yield of cowpea at the different inter-row spacings (Table 1). Plants spaced 75 cm × 25 cm and 90 cm × 25 cm had higher fodder yield than those spaced 50 cm × 25 cm. These results indicate that the fodder yield was more at wide than at close spacing. These findings do not agree with those of other studies which indicated that cowpea fodder yield was more at close than at wide spacing [19].

During the second season, there was no interaction between inter-row spacing and variety for cowpea fodder yield. Inter-row spacing had no influence on fodder yield. The mean fodder yield across the various inter-row spacings was 2.8 tons ha⁻¹. The varieties had a significant effect ($P=0.05$) on the fodder yield. Variety RIL 69 had higher fodder yield (4.7 tons ha⁻¹) than VYA (1.7 tons ha⁻¹) and RIL 265 (2.0 tons ha⁻¹) (Fig. 3). The fodder yield for the different varieties was in the order RIL 69>RIL 79>RIL 265=VYA.

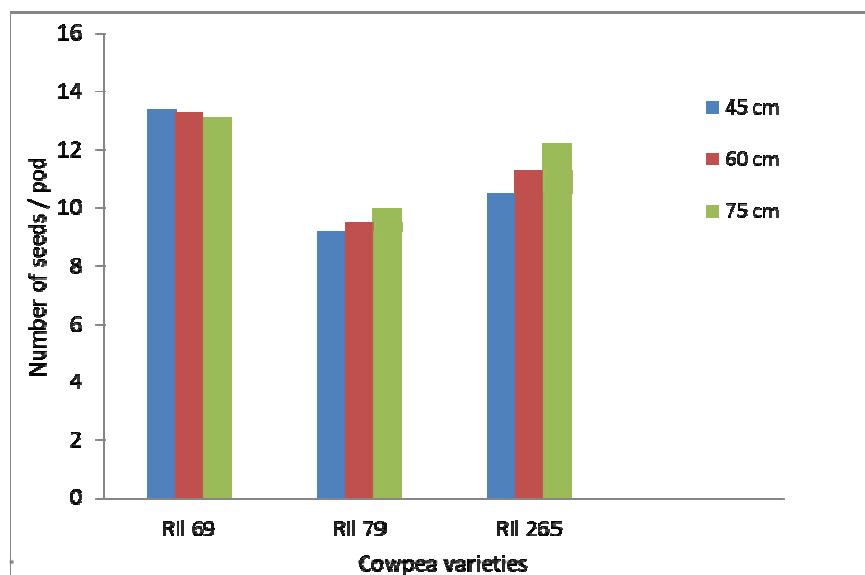


Fig. 1. Effect of inter-row spacing and variety on the number of cowpea seeds/pod

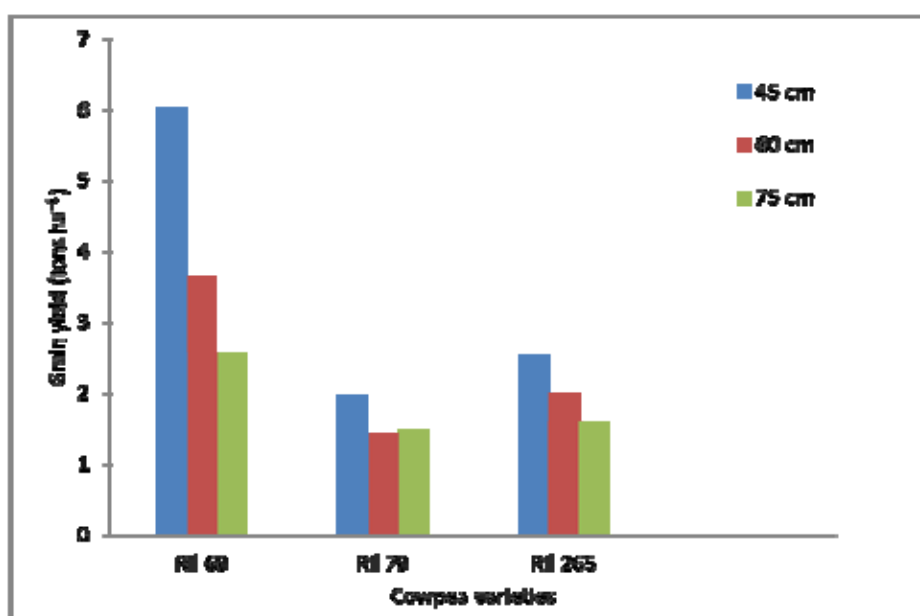


Fig. 2. Effect of inter-row spacing and variety on the grain yield of cowpea

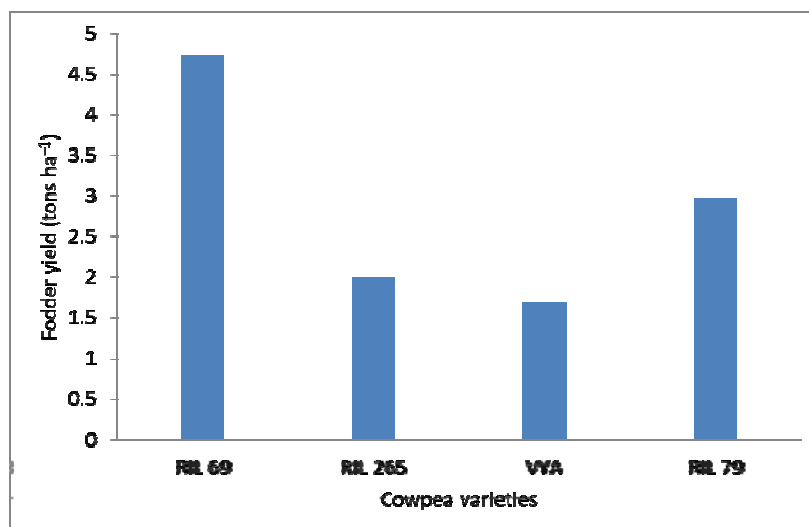


Fig. 3. Effect of variety on the fodder yield of cowpea

4. CONCLUSION

The results of this study revealed that there was no significant interaction between inter-row spacing and cowpea varieties for the growth and phenology traits. This suggests that the varieties responded similarly to inter-row spacing. However, inter-row spacing had a significant influence on the yield of the cowpea varieties. All the varieties had outstanding yield performance when sown at a spacing of 45 cm × 25 cm. The variety RIL 69 spaced 45 cm × 25 cm (88,888 plants/ha) gave higher grain yield (6.0 tons ha⁻¹) than all other varieties. Therefore cowpea should be sown at close spacing to obtain optimal yield in Buea.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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