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Evaluating the Effect of Different Planting Dates on Growth and Yield Performance of Cowpea [*Vigna unguiculata* (L.)] Walp in Buea, Cameroon

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Cowpea (*Vigna unguiculata*, (L) Walp) is an important grain legume widely grown in sub-Saharan Africa including Cameroon, providing food for humans and livestock. Timing of planting is an important cultural practice that increases plant growth and yields. This study therefore, aimed at planting cowpeas different dates in order to determine the most appropriate planting time for this crop in terms of growth and yield performance in Buea. Research The research was carried out

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from March to June and September to December cropping seasons of 2021. It was a Randomized Complete Block Design with four replications in which, a medium maturing cowpea variety "Fekem" was sown at four planting dates (15th March, 22nd March, 5th April and 12th April) in the first season and (7th September, 14th September, 21st September and 28th September) in the second season. Two hundreds seeds were sown per experimental unit. Data for growth parameters include number of leaves, number of branches and weight of plant biomass while that for yield components include number of flowers, number of pods, weights of pods and seeds. Data obtained was subjected to descriptive analysis, analysis of variance using the SPSS statistical package and means separated using Duncan test at 5% probability. Results showed that there was a significant difference (P>0.05) in number of leaves of cowpeas planted during the first season compared to the second season. The number of branches significantly different (P>0.05) in the second season compared to first season. The weight of plant biomass had a significant difference (P>0.05) in the first season compared to second season. In terms of yield components, flowers, pods and grain weight were significantly higher in the second season compared to the first season. Overall, it is preferable to plant cowpea in the second season because grain quantity and quality will be higher and thereby, farmers will generate more income from their fields.

Keywords: Planting dates; growth; yield; cowpea; performance.

1. INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp) belongs to the Fabaceae and grown in the sub-tropical and tropical regions worldwide with origin from Sub-Saharan Africa [1]. It is the most important food and forage legume in the semi-arid tropics, including Asia, Southern Europe, the Southern United States, Central, and South America, and Africa including Cameroon [2]. In many cowpea accessions, the flower initiation and development are dependent on the photoperiod, providing food for humans and livestock, and serving as a valuable and dependable revenue-generating commodity for farmers and grain traders [3]. Cowpea is a nutritious food source rich in protein (24%), dietary fiber (11 %) and potassium (1112 mg/100g) while being low in lipids (<2%) and sodium (16 mg/100 g) [4]. Cowpea is a staple food in Cameroon, providing essential nutrients such as proteins, income to the rural farmers, seeds made into porridge and a traditional steamed cake (khoki) wrapped in plantain leaves and also used as fodder for livestock.

It can produce good yields under a wide range of moisture, and can withstand drought but for forage purposes, rainfall of 750 mm to 1100 mm is preferable [5]. Excessive rainfall also results in high production of haulm, delays ripening, and decreases grain yields. The crop performs best at optimum temperatures of 20^0C to 35^0C [6] and high temperatures influenced by planting date reduce the sensitivity to photoperiod. The yield potential varies in different varieties and is influenced by crop maintenance and ecological conditions [7]. A good cowpea crop yields about 1200kg – 1500kg of grains and 5000kg – 6000kg of straw per hectare and if raised for fodder purposes, 25000kg – 35000kg of green fodder is produced per hectare (Directorate of Pulse Development [DPD], 2020). Cameroon is ranked 6th in the World's cowpea production with 185,832 metric tons while Nigeria remains the World's largest cowpea producer [8]. Cowpea yield per hectare in Cameroon is quite low when compared to other countries like Nigeria with a yield of 2,606,912 metric tons [8]. The low yield in Cameroon is attributed to drought, low or erratic rainfall, soil nutrient deficiency, biological constraints and minimal adoption of improved varieties but the most important abiotic constraints are rainfall variations. Sowing date is one of the important agronomic practices that results in the greatest differences in crop growth, quantitative and qualitative parameters [9,10] and Abudulai et al. [11], noted that early sowing of cowpea gave the best yields. Although there are reports on the effect of planting date on the performance of cowpea in other regions of the country, this information is lacking in Buea, South West Region, which is one of the cowpea production hubs. Only scanty information is available on the effects of planting time on crop yield and growth. So, there is no reliable document in Buea, particularly. This study, therefore, aimed at determining the appropriate planting date for cowpeas in Buea that would increase yield and grain quality, as well as increase the farmer's income. Therefore, the main objective of this study was to analyze the growth and yield characteristics of cowpeas grown at different times in Buea.

2. MATERIALS AND METHODS

2.1 Experimental site

This study was conducted from March to June and September to December (2021), at the Teaching and Research Farm of the Faculty of Agriculture and Veterinary Medicine, University of Buea. Buea is located at the foot of Mount Cameroon, Southwest Region Cameroon, situated between latitudes 4º10" North of the equator and longitudes 9º20" East and 900m above sea level. The farm has a mono-modal rainfall regime with a less pronounced dry season 80% to 85 % relative humidity, and sunshine between 900 to 12000 hours per annum. The rainy season starts from March to mid-November and the dry season from mid-November to March with meteorological data of Buea in 2021 for rainfall was 2200 mm and monthly temperature ranges from 23^0C to 33^0C.The soils are formed from lavas, pyroclastic flows and lahars transported as mudflows from the top of the volcano. Suh et al. [12] and Manga et al. [13] report the bull-rock composition of the rocks of Mount Cameroon to fall within the total alkalis versus silica field of basalt, basanite-trachybasalt, phonotephrite and basaltic trachyandesite. They also report that Mount Cameroon magmas are of intraplate-type with characteristically high concentrations of high-field strength elements Titanium, Niobium and Tantalum.

2.2 Site Preparation and Experimental Design

A surface area of 210 m^2 with grasses and maize stalks were cleared. The experiment was laid out in a Randomized Complete Block design with four treatments comprising of different planting dates per season in March-April, 2021 (15th Mar, 22nd Mar, 5th April and 12th April) and 7th, 14th, 21st and 28th of September, 2021. Each treatment was replicated four times making a total of 16 experimental units in the experimental area. Each experimental unit (plot) was 3 m x 3 m using a meter tape and raised during ploughing to a height of 30 cm. The planting distance for the cowpea was 30 cm x 30 cm in March 2021 and the same in the next planting season (September 2021).

2.3 Sowing

The Fekem cowpea variety seeds were obtained from the Institute of Agricultural Research and Development (IRAD) and sown three/mounds and later thinned to two, seven days after planting thereby, having two plants per stand, 10 stands per row, making a total of 100 plant stands/bed and 1600 stands on the whole plot (3200 plants). Weeding was done as necessary while nets were suspended above the beds to prevent birds from damaging the cowpea pods. The plants were not irrigated and no fertilizer application.

2.4 Data Collection

2.4.1 Quantification of growth and yield performance of cowpea

a) Growth parameters

The numbers of leaves data were collected on five tagged plants per plot at weekly intervals from 21 to 49 days after planting. Also, the number of branches was collected by counting all the branches on the five tagged cowpea plants from day 21 after planting at weekly intervals.

At 80 DAP, five cowpea plants were uprooted with pods and flowers intact on each plot and weighed using a numerical weighing balance.

b) Yield components

The numbers of flowers were collected by counting all the opened flowers on all the five tagged plants per plot from flower initiation. Dates of flowering were noted when plants of each treatment produce their first flowers.

The number of pods was counted in five tagged plants per plot weekly. The dates of pods were noted when plants of each treatment produced their first pods.

The total number of fresh cowpea pods per plot was weighed at harvest and then sun dried for 2 weeks. The dry pods weights were determined by a numerical weighing scale which was manufactured by Archimedes.

2.4.2 Monthly weather conditions of the first and second seasons

The data for monthly weather conditions (precipitation, humidity, minimum and maximum temperatures) were obtained using the historical-meteo.net of Buea for 2021.

2.5 Data Analyses

All data collected was subjected to Analysis of Variance (ANOVA), and then analyzed using the SPSS statistical package (version 23). Treatment means were separated using Duncan test at 5% probability level and graphs plotted using Microsoft Excel for Windows (version 2013).

Plate 1. Measurement of plant biomass of cowpea plants using a numerical weighing balance

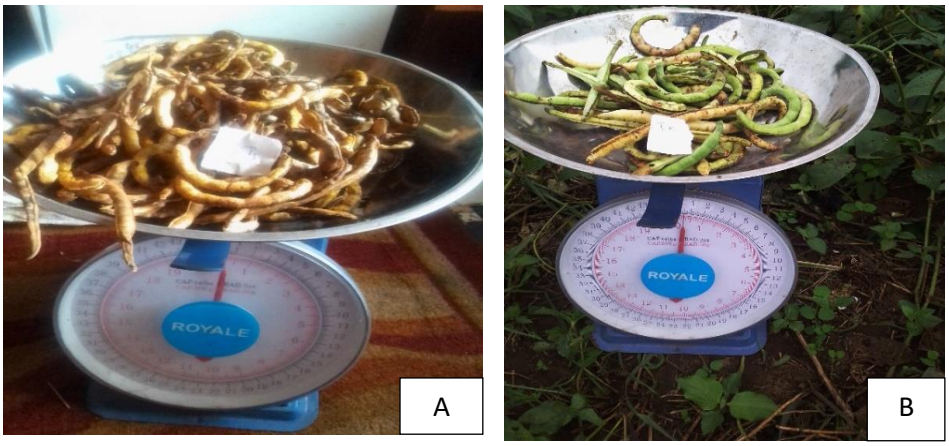

Plate 2. Taking weight of the dry (A) and fresh (B) pods of cowpea using a numerical weighing balance

At harvest, (above 80 DAP), 100 fresh seeds were weighed and later dried in the sun for 2 weeks for weight assessment using a digital weighing balance which was manufactured by Richard Loshbough and Edward Pryor

Plate 3. Taking the weight of seeds with a digital weighing balance

3. RESULTS AND DISCUSSION

3.1 Cowpea Growth and Yield Parameters under Different Planting Dates of the First and Second Seasons

3.1.1 Number of leaves

The number of leaves of cowpea planted on 15th March, 22nd March 5th April and 12th April differed significantly (P<0.05) however, cowpea planted on 15th March and 12th April had a similar number of leaves, 17.6 and 17.4 respectively, and same as those of 22nd March and 5th April with similar results, 16.3 and 16.2 respectively, in the first season (Table 1). During the second season, there were no significant differences (P>0.05) between the number of leaves and planting dates of 14th September (14.1) 21st September (14.3) and 28th September (14.3) but significantly different (P<0.05) in planting date of 7th September with a mean value of 13.3. The results of the number of leaves in the first season were higher with a mean value of 16.9 compared to those of the second season (14.0).

In the first season, there were significant differences between number of leaves and planting dates of cowpea. The number of leaves increased with number of days after planting as expected as the rainy season progressed and increase in number of cowpea leaves are very important which serves as vegetables to humans and fodder for livestock. A progressive increased in number of leaves from 15th March might be due to higher rainfall from March to June leading to dense vegetative growth but fewer pods. In contrast to the first cropping season, cowpea of the second season had fewer and smaller leaves but more pods. This implies that during the first season most of the photosynthetic dissimilate was used for leaf production while in the second season it was used for pod production. This is in agreement with the report given by Adediran et al, [14], that leaves of cowpea plants sown in September were smaller due to the effect of planting dates. Mojaddam and Nouri [15] reported that delay in sowing of cowpea decreased the length of vegetative and reproductive growth stages of cowpea.

3.1.2 Number of branches

During the first season, the number of branches of cowpeas planted on 15th March, 22nd March 5th April, and 12th April were similar and did not differ significantly (P>0.05) but cowpeas planted on 15th March and had the highest number of branches (2.8 branches). The result of the number of branches on the planting date of 12th April (2.6) was lower than those of the first planting date but significantly higher than those of 22nd March (2.5) and 5th April (2.5). During the second season, there were significant differences (P<0.05) between the number of branches and planting. The planting dates of the 7th, 14th, and 21st of September had similar mean values of branches of 3.1, 3.3 and 3.6 respectively, which differed from the mean number of branches (2.7) on the 28th of September (Table 1). The number of branches in the second season was significantly higher (3.2) compared to those of the first season with a mean value of 2.6.

Significant differences in planting dates with regards to branches mean counts suggest that planting on 15th March produced the highest number of branches in the first season. A progressive cooler weather conditions prevailing during the vegetative growth of cowpea from mid-March might have resulted in more number of branches. The results also showed clearly that cowpea planted in the second cropping season had highly significant increase in the number of branches compared to the first season. This increment in number of branches eventually could be due to that the second season was more favorable to cowpea growth since cowpea is a drought tolerant crop and Iwuagwa *et a*l., [16] reported that the effects of drought vary depending on the intensity, developmental stage and duration of stress as well as the adaptive strategy that the plant possesses to tolerate this stress.

3.1.3 Number of flowers

Cowpea planted during the second season started flowering at 42 DAP which was significantly earlier than 46 to 53 DAP for the cowpea of the first season. Cowpeas planted on 15th March (5.2) had a significantly higher number of flowers followed by cowpeas on 22nd March (5.1) and the lowest in cowpeas on 5th April (2.9) but higher than those of 12th April (2.4) in the first planting season. During the second season, there was a significantly higher number of flowers compared with the first planting season with mean values of 9.7, 9.0, 8.1 and 8.6 for 7th, 14th, 21st and 28th of September, respectively. Cowpea sown on 7th September planting had a significantly higher number of flowers, followed by that of 14th, 28th and 21st of September. There were significant differences between the number of flowers and planting

dates in the second season with a mean value of 8.9 and a lower mean value of 3.9 in the first season (Table 1).

Cowpea planted during the second season started flowering at 42 DAP which was significantly earlier than 46 to 53 DAP for the cowpea of the first season. Similarly, the second season cowpea planted in September produced more flowers than the first season. This shows that the second season has more favorable climatic conditions for cowpea flowering which might have resulted in translocation of more photosynthates to flower. These results are in accordance with those of Agele et al., [17], that cowpea planted in the late rainy season were early to mature with respect to days to attain 50% flowering and seed yield production compared with the early rainy season crop. Differences in growth and flowering in the Fekem variety can be attributed to prevailing weather conditions of the growing seasons which enabled the second season cowpea to start flowering about 4 – 10 days earlier than over the first season crop. The shortened reproductive phase along with the unfavorable prevailing weather conditions during the first season could have shortened the period of photosynthetic assimilates devoted to flowers and pod production.

3.1.4 Number of pods

Cowpea planted during the second season started pods at 46 DAP which was also significantly earlier than 50 to 53 DAP for the cowpea of the first season. During the first season, there was a moderate increase in the number of pods across the planting dates with cowpea of 15th March having the highest number of pods compared to the other planting dates. There were significant differences between numbers of pods and planting with highest pods recorded in 15th March (6.7) followed by 12th April (5.5) and the lowest in 22nd March. The results on the number of pods presented between different planting dates showed significant differences (P<0.05) in the second season compared with the first season (Table 1). Cowpea sown on the 14th (8.9) and 21st September (8.9) had a significantly higher number of pods and the lowest pods recorded on cowpea of 7th September (4.9). There was a significant increase in number of pods in the second season (7.8) compared to those of the first season with mean value of 5.8 (Table 1). Since the second season cowpea flowered earlier than that of the first season, it also started producing pods earlier than the first season as expected. Cowpea planted in the second season had a remarkable increased in number of pods compared to the first season. Cowpea is a short day plant which requires less than 12 hours of daylight to flower and produce pods but during the first season, there were low temperatures due to abundant rainfall which led to decrease in daylight and longer day length and as a result of this it led to delay to flowering and pod production. During the second season, the critical day length became shorter with high temperatures which led to quick stimulation of flowers leading to pod production. These results were in accordance with those of El- Sayed et al., [18] that favorable climatic conditions prevailing during sowing dates reflected on the stimulation of cowpea production in Egypt.

Table 1. Mean Standard Deviation of Number of Leaves, Branches, Flowers and Pods on Cowpea Planted at Different Dates of the First and Second Seasons of 2021

Planting Season	Planting dates	Leaves	Branches	Flowers	Pods
First	15 March	17.6±1.6^{a}	2.8±0.4^{a}	5.2±0.9^{a}	6.7±1.3^{a}
	22 March	16.3±1.9^{b}	2.5±0.3^{a}	5.1±1.0^{a}	4.9±1.5^{b}
	5 April	16.2±2.9^{b}	2.5±0.4^{a}	2.9±0.9^{b}	6.2±2.3^{a}
	12 April	17.4±0.7^{a}	2.6±0.1^{a}	2.4±0.8^{b}	5.5±1.6^{ab}
Mean values per season	-	16.9±1.8^{a}	2.6±0.3^{b}	3.9±0.9^{b}	5.8±1.8^{b}
Second	7 September	13.3±3.0^{b}	3.1±0.7^{a}	9.7±1.3^{a}	4.9±1.5^{b}
	14 September	14.1±1.4^{a}	3.3±0.3^{a}	9.0±1.4^{a}	8.9±1.4^{a}
	21 September	14.3±0.8^{a}	3.6±0.9^{a}	8.1±1.4^{b}	8.9±1.0^{a}
	28 September	14.3±0.8^{a}	2.7±0.2^{b}	8.6±1.7^{b}	8.5±0.7^{a}
Mean values per season	-	14.0±2.0^{b}	3.2±0.5^{a}	8.9±1.5^{a}	7.8±1.2^{a}

Values in the same column with different letters are significantly different between seasons according to Duncan test (P<0.05)

Table 2. Mean Standard Deviation of Plant Biomass (g), Fresh pods (g), Dry pods (g) and Dry seeds (g) (100 seeds) at different dates of the first season of 2021

Planting season	Planting dates	Plant biomass (g)	Fresh pods (g)	Dry pods (g)	Fresh seeds (g)	Dry seeds (g)
First	15 March	2550.0±645.4^{a}	650.0±310.9^{a}	357.5±232.1^{a}	-	18.5±1.7^{a}
	22 March	2125.0±478.7^{a}	575.0±309.5^{a}	277.5±220.6^{a}	-	17.7±0.5^{a}
	5 April	2825.0±602.0^{a}	500.0±294.3^{a}	237.5±179.6^{a}	-	17.5±0.5^{a}
	12 April	2500.0±969.5^{a}	400.0±141.4^{a}	177.0±121.2^{a}	-	18.2±0.5^{a}
Second	7 Sept	790.0±400.1^{a}	425.0±50.0^{a}	177.5±47.8^{a}	30.4±0.9^{a}	16.8±1.0^{a}
	14 Sept	700.0±200.2^{a}	900.00±258.1^{b}	450.0±129.0^{b}	33.4±0.9^{b}	19.3±1.1^{b}
	21 Sept	1400.0±800.0^{b}	700.0±244.9^{ab}	268.7±219.2^{ab}	31.9±1.2^{ab}	18.2±0.5^{b}
	28 Sept	870.0±199.1^{a}	625.0±221.7^{ab}	250.0±108.0^{ab}	31.4±1.7^{a}	18.0±0.2^{ab}

Values in the same column with different letters are significantly different between seasons according to Duncan test (P<0.05)

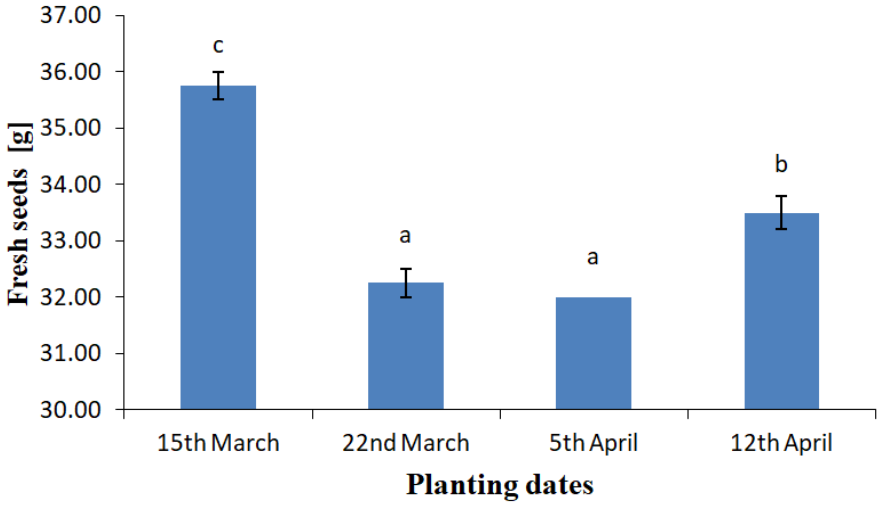

Fig. 1. Graph of treatments against fresh seeds (g) (100 seeds)

3.2 Plant biomass, pods and seeds weight of the first and second season of 2021

3.2.1 Plant biomass (g)

During the first season, plant biomass was recorded at 80 DAP in each planting date and cowpea of 5th April had the highest plant biomass weight (2825.0g (2.8 kg)) followed by those planted on 15th March (2550.0 g) and 12th April (2500.0 g) and the lowest recorded on cowpea of 22nd March (2125.0g). During the second season, there was a significant difference (*P*<0.05) between the plant biomass and different planting dates. Cowpea of 21st September had the highest plant biomass (1400.0 g) recorded at 80 DAP. This was followed by plant biomass weights obtained from the 28th, 7th and 14th September planting dates. There was a significant increase of plant biomass in the first season compared to those of the second season. Plant biomass in the first season was significantly higher than that of the second season. This could be attributed to the high amount of rainfall received by these plants during the first cropping season which resulted in extensive vegetative growth. The significant lower biomass obtained in second season was conceivably because most of the photosynthetic assimilate was used for pod production and Agele et al., [17], reported that under non-water-stressed conditions of the rainy season, cowpea gave higher biomass yields and longer vegetative and reproductive growth than under water-stressed conditions of the late rainy season.

3.2.2 Pods weights (g)

Similarly, cowpea of the 15th March produced significantly heavier fresh weight (650.0) and dry weight (357.0) of pods compared to that of 22nd March (575.0 fresh and 277.0 dry weights of

pods) and 5th April (500.0 fresh and 237.0 dry weights of pods) and the lowest recorded on cowpea of 12th April (400.0 fresh weight and 177.0 dry weight).Weights of fresh and dry pods were significantly different ($p<0.05$) between the planting dates in the second season. The highest mean values of fresh and dry weights of pods was obtained from 14th September planting date (900.0 and 450.0) fresh and dry pods, respectively. There was a significant higher fresh and dry pods weights in the first planting season compared to the second season. These results might be attributed to the fact that the plants absorbed a lot of water in the first season leading to their high weights and Atakora *et al*., [19] noted that, cowpea pod yield largely depends on the variety and in particular, field conditions and growing seasons. High temperatures in the second season led to decrease weights of the pods.

3.2.3 Hundred seed weight (g)

Finally, the heaviest dry seeds weight was recorded on cowpea planted on 15th March (18.5) and the lowest on cowpea of 12th April (18.2) but higher than those of 5th April (17.5) and 22nd March (17.7). Significant differences ($p<0.05$) were shown between fresh and dry seeds (100 seeds) and the planting dates, with cowpea of 14th September having the highest mean weight of fresh and dry seeds (33.4 and 19.3), respectively. Concerning the weights of fresh and dry seeds, fresh seeds weights was high in the first season and dry seeds weight in the second season. High weight of dry seeds in the second season might be due to quality of the seeds since during first season, most of the pods got rot caused by frequent rainfall, thereby reducing the quality of the seeds [20]. This high weight of fresh seeds was attributed to cold and moist conditions caused by frequent rainfall in the first season and Cobbinah et al., [21] reported that differences in 100-seed weight of cowpea varieties may be due to rainfall as a major factor in the weather conditions experienced in the field.

3.2.4 Fresh seeds (100 seeds / g) of first season of 2021

Results illustrated in Fig.1 summarized the weight of fresh seeds of cowpea planted at different dates. There was a significant increase of fresh seeds on cowpea of 15th March followed by those planted on 12th April, 22nd March and 5th April.

4. CONCLUSION AND RECOMMENDATION

From the result of this study, it was concluded that, the traditional planting date of cowpea (from March in first season) often used by farmers in the study area was not appropriate to plant cowpea since the crop planted at this time produced high plant biomass but low grain yields. However, to use leaves as vegetables, the first season would be better. And late planting of cowpea from late September resulted to early flowering and production of more pods that resulted in higher grain yields. Therefore, late sowing of cowpea in the second cropping season in Buea was the more favorable period for planting the crop. Based on the conclusion, it could be recommended that, cowpea should be planted preferably during the second season since cowpea is a drought-tolerant crop which can lead to high yields and also generate income to farmers. And for increased quantity of leaves, cowpea should be planted in the first season since they are consumed as vegetables and serve as feed to livestock.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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