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Effect of sowing date on improved cowpea (*Vigna unguiculata* L. Walp.) varieties growth and yield components

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Abstract

Farmers are regularly faced to climate change and variability characterised by early or late onset of rains. Late onset of rains may have damageable impact on crops yield. It is important to investigate the effect of sowing date on improved cowpea varieties selected regarding their early or medium maturity cycle. A field experiment was conducted using a randomized completed block design with three replications during rainy season of 2020 in soudanian and soudano-sahelian zones of Burkina Faso to assess the effect of two sowing date, normal and late on agro-morphological characters of four improved cowpeas (*Vigna unguiculata* L. Walp.) varieties. The results showed that in both locations, characters such harvest index, fodder yield and grain yield were statistically similar within the location for normal and late sowing date. Also, it is observed that the varieties were inherently different in term of grain yield and location had significant influence on this trait. The average grain yield at Farako-Ba was 987.03 and 1010.57 kg/ha for normal and late sowing date, the variety *Komcalle, Neerwaya, Tiligre* and KVx745-11P recorded 1106.99, 1085.58, 981.61 and 821.02 kg/ha grain yield, respectively. At Kamboinse, the average grain yield was 1159.96 and 1140.03 kg/ha for normal and late sowing date, the variety *Komcalle, Neerwaya, Tiligre* and KVx745-11P recorded 1286.36, 1207.73, 1195.06 and 910.81 kg/ha, respectively. This study pointed out that soudano-sahelian zone is more favourable to cowpea production than soudanian. Then, farmers could use improved varieties in case of late onset of rains.

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Introduction

Cowpea (*Vigna unguiculata* (L.) Walp.) is a multifunctional crop providing food for humans and livestock (Xiong *et al.*, 2016 ; Da Silva *et al.*, 2018). All the parts of this legume (fresh leaves, immature pods and grains) provide various compounds such as protein, carbohydrate, vitamins and minerals. Cowpea is one of the most preferred crops and a valuable component in a farming systems among poor rural households in Sub-Saharan Africa (SSA) (Molosiwa *et al.,* 2016). According to FAOSTAT (2022), about 8,901,644 tons of cowpea dry seeds was produced on approximately 16,056,435 hectares. The main cowpea-growing countries in SSA are Nigeria (3,647,115 tons), Niger (2,637,486 tons) and Burkina Faso (606,023 tons) (FAOSTAT, 2022). Millions of impoverished farmers produce cowpea to lift themselves from poverty to prosperity (NAS, 2006). In Burkina Faso, cowpea is an internal and external trade product. It is exported to countries like Côte d'Ivoire, Ghana, Benin Republic, Togo and Cameroon and provides cash income to smallholder farmers dominated by women. Although cowpea production is important in Burkina Faso, the productivity is generally very low because of many biotic and abiotic constraints. However, the inappropriate agricultural practices (Inappropriate planting date, low planting density, low or no fertilizer use, etc.) is also identified as a major factors constraining cowpea production (Ishikawa *et al.*, 2013; Kamara *et al.*, 2018). Rainfall is reported as the major determinants of sowing dates in West Africa, where agriculture is mainly rainfed (Adediran *et al.*, 2018). Identification of the appropriate timing of sowing a crop in any particular location is an important agronomic requirement needed for high and sustained productivity Akande *et al.* (2012). Climate resilient crop like cowpea could help farmers to minimize the adverse effects of climate variability and change. Many studies have been undertaken in Burkina Faso in the area of breeding which resulted in the release of improved cowpea varieties with good yielding and resistant to some biotic and abiotic constraints. These improved cowpea varieties which are generally erect or semi-erect and are early and medium maturing could mitigate the consequences of erratic rainfall often characterized by late onset of rains.

In this paper, the effect of two sowing date, normal and late on growth and yield components of improved cowpea varieties was determined in soudanian and soudano-sahelian agroecological zones (AEZ) of Burkina Faso.

Materials and methods

Experimental sites

The experiment was conducted during the rainy season (July-October) of 2020 at Research Station of Farako-Ba (11°5'N, 4°18'W; altitude 439 m) and Kamboinse (12°.46'N, 1°.54'W; Altitude: 293 m). Farako-Ba belongs to Soudanian AEZ with an annual rainfall above 900 mm while Kamboinse is located at the soudano-sahelian AEZ with an annual rainfall between 600 and 900 mm (Longueville *et al.*, 2016).

Cowpea cultivars and experimental procedure

Four improved cowpea varieties released by the Institute of Environment and Agricultural Research (INERA) were used as plant material. These varieties were selected by using Participatory Rural Appraisal (PRA) method and are farmers' preferred varieties. The varieties were: KVx780-6 (*Neerwaya*); KVx442-3-25 (*Komcalle*); KVx775-33-2G (*Tiligre*) or KVx745-11P. *Neewaya* and *Tiligre* are semi-erected varieties with large size and white colour of grains. *Komcalle* is an erected variety with medium size of grains while Kvx745-11P is a dual purpose variety with small size of grain.

The experimental plot was ploughed, harrowed and manually levelled. The experiment was conducted in an arrangement of a randomized complete block design, replicated three times. Prior to sowing, seeds were treated with *chlorpyrifos-ethyl* and *thiram* (*Calsio*), a combination of insecticide and fungicide at a rate of 20 g/kg of seeds. Each cowpea variety was sown in 6 rows of 3.2 m. The size of each main plot was 12.8 m^2 [(5 * 0.8 m = 4 m) × 3.2 m] and sowings were done 10 days apart in each location. The experiment was established at Farako-Ba on July 28 and August 7 while sowing was done on July 26 and August 5 at Kamboinse. Mineral fertilizer NPK (14-23-14) was applied by micro-dose at a rate of 100 kg/ha. For insects and pest management, a pesticide *Deltamethrin* was applied at the dose of 1l/ha in two sprays time. The first spraying was done at 5 Weeks After Sowing (WAS) and the second at 7 WAS.

Experimental sites weather characteristic

The meteorological data were obtained from National Meteorological Agency. The weather data (temperatures and rainfall) of the two locations during the experimental period are shown in Fig. 1 and 2 for Farako-Ba and Kamboinse, respectively. In Farako-Ba, the average minimum and maximum temperatures were 22.05 and 31.33° C, respectively. The total rainfall recorded in this location was 937 mm. In Kamboinse, the average minimum and maximum temperatures were 23.90 and 33.58°C, respectively. The total rainfall recorded was 874 mm.

Physical and chemical property of soils in Farako-Ba and Kamboinse

The physico-chemical properties of soils are shown in Table 1. It indicates that soil of Farako-Ba was sandy-loam with particles size distribution of 63.37% sand, 21,18% silt and 15.45% clay. In Kamboinse, the soil texture was loamy with particles size distribution of 46.75% sand, 40.54% silt and 12.71% clay. Soils pH were 6.59 and 6.13 for Farako-Ba and Kamboinse, respectively. These values are close to neutral pH. The organic carbon percent were 0.50 and 0.64 at Farako-Ba and Kamboinse, respectively. Nitrogen content in soil of Farako-Ba and Kamboinse were 0.047 and 0.051, respectively. The available P recorded was 4.89 and 3.45 for Farako-Ba and Kamboinse.

Data collection and statistical analysis

Data were collected from net plot made with two innermost rows of each main plot in each replication. Observations were recorded on mean of plant height at 9 WAS, average number of branches per plant at 9 WAS, on average number of leaves per plant at 6 WAS, on average leaves chlorophyll content at 6 WAS.

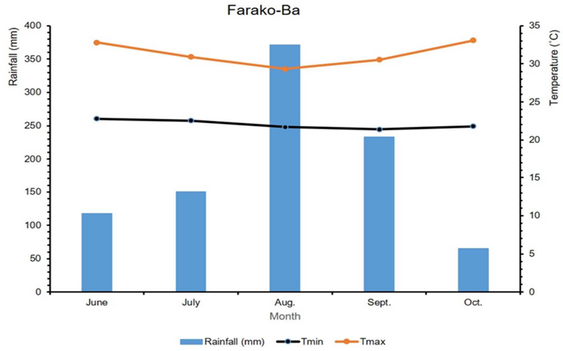

Fig. 1. Total rainfall, minimum and maximum temperature during 2020 experimental period at Farako-Ba

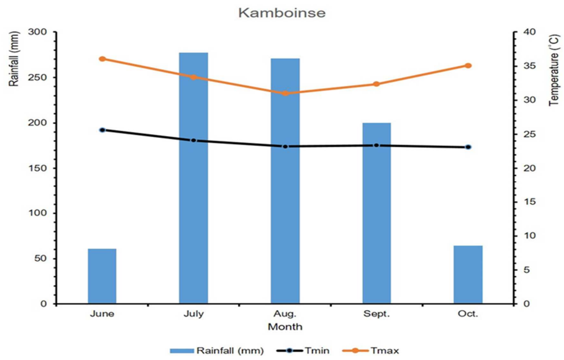

Fig. 2. Total rainfall, minimum and maximum temperature during 2020 experimental period at Kamboinse

Table 1. Initial physical and chemical soil properties at the experimental sites

Parameters	Zones	
Soil physical properties	Farako-Ba	Kamboinse
Sand (%)	63.37	46.75
Silt (%)	21.18	40.54
Clay (%)	15.45	12.71
Texture class	Sandy-Loam	Loamy
Soil chemical properties		
pH	6.59	6.13
Organic C (%)	0.50	0.64
Total N (%)	0.047	0.051
Available P (mg/Kg)	4.89	3.45
Ex. cations ($cmol^+/Kg$)		
K^+	0.15	0.13
Na^+	0.10	0.06
Ca^{++}	1.40	1.55
Mg^{++}	0.43	0.60
EA ($cmol^+/Kg$)	0.02	0.09
CEC ($cmol^+/Kg$)	2.09	2.43

Likewise, data on 50% flowering, 95 % maturity, average pod length (cm) per plant, average number of seeds per pod, 100 seeds weight (g) as well as harvest index (HI), shelling percentage (SP%) fodder yield (kg/ha) and grain yield (kg/ha). The collected data were subjected to appropriate statistical analysis. Analysis of variance (ANOVA) was done by using JMP Pro 2017 statistical package, where Student Newman's Keuls (SNK) test was used to sort out significant differences among treatments ($P \leq 0.05$).

Results

Sowing dates and varietal effect on growth components

In Farako-Ba as well as Kamboinse, sowing date effect on plant height was not significant at semi-maturity (9 WAS) (Table 2). At Farako-Ba, the average plant height was 66.60 cm for normal sowing date and 66.71 cm for late sowing date. For Kamboinse, the average was 68.88 cm and 62.23 cm, for normal and late sowing date, respectively. The sowing date and variety interaction effect on plant height was significant for the experimental sites.

Sowing date did not significantly affect the average number of branches per plant at Farako-Ba and Kamboinse. The mean was 4.31 and 4.23 for normal and late sowing date at Farako-Ba, while in Kamboinse it was 4.58 and 4.42 for normal and late sowing date, respectively (Table 2).

A slight high variation of average number of leaves per plant was observed if locations are compared, sowing date had significant effect on this character at Kamboinse. For Farako-Ba, the effect was not significant. The values recorded were 32.72 and 31.83 for normal and late sowing date at Farako-Ba, while in Kamboinse it was 33.54 and 36.42 for normal and late sowing date, respectively (Table 3).

The effect of sowing date on leaves chlorophyll content was contrasted at Farako-Ba and Kamboinse. No significant difference was found for this character in Farako-Ba, the average values were 53.77 and 50.54 for normal and late sowing date.

In Kamboinse the difference was significant with the values of 55.01 and 65.72 for normal and late sowing date. Also, the interaction was not significant (Table 3).

Sowing dates and varietal effect on reproductive and grain yield components

For Farako-Ba site, the results indicated that 50% flowering was significantly impacted by sowing date with an average 39.08 and 37.92 for normal and late sowing date. At Kamboinse site, none significant difference was found as the effect of the factor on 50% flowering, the mean was 38.50 and 38.83 for normal and late sowing date, respectively (Table 4). The interaction between sowing date and variety was significant at Farako-Ba and not significant at Kamboinse.

The trait 95% maturity was not significantly affected by sowing date at Farako-Ba while at Kamboinse, significant effect was highlighted (Table 4). The interaction between sowing date and cowpea variety was not significantly affected 95% maturity in both locations. The results showed that cowpea varieties are quite different when analyzed 95% maturity in the locations.

The average means recorded for pod length was 15.67 cm and 16.31 cm for normal and late sowing date at Farako-Ba. At Kamboinse, the values were 17.01 cm and 16.58 cm for normal and late sowing date (Table 4). The values recorded for this character on both locations are statistically similar. The interaction sowing date and cowpea variety was not significant. However, this character revealed significant difference if varieties were compared.

The shelling percentage, the average number of seeds per pod as well as 100 seeds weight recorded statistically similar values for normal and late sowing date at Farako-Ba and Kamboinse, then interaction between sowing date and cowpea variety was not significant. However, significant differences were observed as response of varietal effect on characters mentioned above (Table 5).

Table 2. Effect of sowing date on plant height (cm) and average number of branches per plant at Farako-Ba and Kamboinse

Treatments		Plants height (cm) at 9 WAS		Number of branches at 9 WAS	
		Farako-Ba	Kamboinse	Farako-Ba	Kamboinse
Sowing Date (SD)	Normal SD	66.60	68.88	4.31	4.58
	Late SD	66.71	62.23	4.23	4.42
	SE±	1.901	2.539	0.164	0.092
	Probability	0.9678	0.0828	0.7241	0.0828
Cowpea Varieties (V)	Komcalle	17.35b	18.54c	4.29	4.33
	Neerwaya	84.77a	88.67a	4.42	4.54
	Tiligre	85.48a	86.42a	4.38	4.67
	KVx745-11P	79.01a	68.58b	4.00	4.46
	SE±	2.689	3.592	0.232	0.130
	Probability	<.0001	<.0001	0.5909	0.4979
Interaction	SD*V	0.0311	0.0001	0.9278	0.0001

Means followed by the same letter (s) within a treatment group are not significantly different at 5% level of probability using Student Newman Keuls (SNK) test.

Table 3. Effect of sowing date on number of leaves and leaves chlorophyll content at Farako-Ba and Kamboinse

Treatments		Number of leaves		Chlorophyll content	
		Farako-Ba	Kamboinse	Farako-Ba	Kamboinse
Sowing Date (SD)	Normal SD	32.72	33.54	53.77	55.01b
	Late SD	31.83	36.42	50.54	65.72a
	SE±	0.423	0.882	1.087	1.149
	Probability	0.1592	0.0287	0.0519	<.0001
Cowpea Varieties (V)	Komcalle	26.29c	29.00c	53.21	56.91b
	Neerwaya	35.25a	37.62ab	53.83	61.24ab
	Tiligre	31.71b	38.91a	49.92	62.20a
	KVx745-11P	35.85a	34.62b	51.67	61.10ab
	SE±	0.598	1.247	1.537	1.625
	Probability	<.0001	0.0002	0.3106	0.1402
Interaction	SD*V	0.0098	0.5485	0.1794	0.9076

Means followed by the same letter (s) within a treatment group are not significantly different at 5% level of probability using Student Newman Keuls (SNK) test.

Table 4. Effect of sowing date on 50% flowering, 95% maturity and pods length (cm) at Farako-Ba and Kamboinse

Treatments		50% Flowering		95% Maturity		Pods length (cm)	
		Farako-Ba	Kamboinse	Farako-Ba	Kamboinse	Farako-Ba	Kamboinse
Sowing Date (SD)	Normal SD	39.08a	38.50	64.42	62.33b	15.67	17.01
	Late SD	37.92b	38.83	64.58	64.25a	16.31	16.58
	SE±	0.167	0.132	0.601	0.276	0.234	0.299
	Probability	0.0001	0.0926	0.8470	0.0002	0.0702	0.3292
Cowpea Varieties (V)	Komcalle	37.33b	37.50c	61.83b	59.83c	14.30b	15.15b
	Neerwaya	38.67a	38.50b	64.33ab	63.00b	18.26a	17.95a
	Tiligre	39.17a	39.17a	66.00a	65.00a	17.76a	17.98a
	KVx745-11P	38.83a	39.50a	65.83a	65.33a	13.64b	16.10b
	SE±	0.236	0.186	0.850	0.391	0.331	0.422
	Probability	0.0003	<.0001	0.0110	<.0001	<.0001	0.0003
Interaction	SD*V	0.0140	0.1361	0.7390	0.6679	0.5144	0.9049

Means followed by the same letter (s) within a treatment group are not significantly different at 5% level of probability using Student Newman Keuls (SNK) test.

Table 5. Effect of sowing date on shelling percentage, number of seeds per pod and 100 seeds weight at Farako-Ba and Kamboinse

Treatments		Shelling percentage (%)		Number of Seeds per pod		100 Seeds weight (g)	
		Farako-Ba	Kamboinse	Farako-Ba	Kamboinse	Farako-Ba	Kamboinse
Sowing Date (SD)	Normal SD	68.09	75.17	11.30	11.48	15.19	17.61
	Late SD	67.44	74.90	11.48	11.72	15.51	16.97
	SE±	0.743	0.860	0.168	0.146	0.210	0.417
	Probability	0.5494	0.8302	0.4524	0.2579	0.3023	0.2932
Cowpea Varieties (V)	Komcalle	69.85a	79.75a	10.60b	11.07b	17.93b	16.55b
	Neerwaya	69.13ab	75.49b	11.53a	11.05b	18.03a	20.73a
	Tiligre	66.15bc	72.26b	11.40a	11.43b	9.78c	19.90a
	KVx745-11P	65.94c	72.64b	12.03a	12.83a	17.93a	11.97c
	SE±	1.050	1.216	0.238	0.206	0.297	0.590
	Probability	0.0344	0.0017	0.0053	<.0001	<.0001	<.0001
Interaction	SD*V	0.6388	0.8097	0.9872	0.0777	0.8167	0.7250

Means followed by the same letter (s) within a treatment group are not significantly different at 5% level of probability using Student Newman Keuls (SNK) test.

Table 6. Effect of sowing date on harvest index, fodder yield, grain yield, at Farako-Ba and Kamboinse

Treatments		Harvest index (%)		Fodder yield (kg/ha)		Grain yield (kg/ha)	
		Farako-Ba	Kamboinse	Farako-Ba	Kamboinse	Farako-Ba	Kamboinse
Sowing Date (SD)	Normal SD	21.07	23.27	3812.88	4037.88	987.03	1159.96
	Late SD	20.52	23.60	4035.84	3960.15	1010.57	1140.03
	SE±	0.317	0.443	95.337	73.864	11.878	15.871
	Probability	0.2373	0.5971	0.1177	0.4676	0.1802	0.3877
Cowpea Varieties (V)	Komcalle	24.70a	29.20a	3386.48b	3274.44b	1106.99a	1286.36a
	Neerwaya	22.18b	22.96b	3893.15a	4282.60a	1085.58a	1207.74b
	Tiligre	19.48c	23.14b	4166.75a	4108.72a	981.61b	1195.06b
	KVx745-11P	16.81d	18.45c	4251.08a	4330.30a	821.02c	910.82c
	SE±	0.448	0.627	134.827	104.461	16.798	22.445
	Probability	<.0001	<.0001	0.0014	<.0001	<.0001	<.0001
Interaction	SD*V	0.7766	0.2393	0.9806	0.0407	0.8258	0.1254

Means followed by the same letter (s) within a treatment group are not significantly different at 5% level of probability using Student Newman Keuls (SNK) test.

The results indicated that sowing date effect was statistically similar on harvest index, fodder yield and grain yield within the location, also interaction between sowing date and variety was not significant (Table 6). However, this study showed that cowpea varieties are different at Farako-Ba and Kamboinse, regarding harvest index, fodder yield and grain yield. The highest values of harvests index were recorded with variety Komcalle at Farako-Ba (24.70) and Kamboinse (29.20) while KVx745-11P recorded the lowest values which were 16.81 and 18.45 for Farako-Ba and Kamboinse respectively.

In Farako-Ba, the variety Neerwaya, Tiligre and KVx745-11P recorded statistically similar values of fodder yield which were 3893.15 kg/ha, 4166.75 kg/ha and 4251.08 kg/ha while Komcalle recorded the lowest fodder yield (3386.48 kg/ha). The same trend was observed at Kamboinse where fodder yield was 3274.44 kg/ha, 4282.60 kg/ha, 4108.72 kg/ha and 4330.30 kg/ha for Komcalle, Neerwaya, Tilligre and KVx745-11P, respectively. For grain yield, significant differences were observed between cowpea varieties. At Farako-Ba, grain yield recorded were 1106.99 kg/ha, 1085.58 kg/ha, 981.61 kg/ha and 821.02 kg/ha for Komcalle, Neerwaya, Tilligre and KVx745-11P, respectively. Grain yield obtained at Kamboinse follow the same trend as observed at Farako-Ba even if relative high means were recorded in that location. The average grain yield was 1286.36

kg/ha, 1207.74 kg/ha, 1195.06 kg/ha and 910.82 kg/ha for Komcalle, Neerwaya, Tilligre and KVx745-11P, respectively.

Discussion

The study indicated that there was variation of growth and yield characters. Great variations were observed across the two growing environment while slight variations within the sowing date in the same environment were noticed. Weather data showed that the total annual rainfall was greater in Farako-Ba than Kamboinse, in opposite the average minimum and maximum temperatures were lower in Farako-Ba when compared to Kamboinse. The differences observed in cowpea growth and yield characters across locations could be attributed to temperature, rainfall, relative humidity and sunlight variations across locations. The variation within and across the locations on cowpea growth and yield characters could be more or less important depending on weather patterns (Mohammed *et al.*, 2021). Soils samples of two locations results showed that their chemical properties are quite similar. The soil texture of Farako-Ba was sandy-loam while Kamboinse was loam and their pH are close to neutral is range from favorable soil pH condition for cowpea production. Kiprotich *et al.* (2015), Santos *et al.* (2015) as well as Ishikawa *et al.* (2022) demonstrated that rainfall patterns and edaphic conditions lead to site specificity which can influence crops growth and yield characters. However, these results differ to those found by Olatunji *et al.* (2016) who conducted experiment and noted that the average cowpea number of leaves and plant height were not significantly impacted by location. The average plant height was almost similar within and across the locations, this result is different with the findings of Toğay *et al.* (2014) where plant height was statistically significant across locations.

Harvest index was higher in Kamboinse than Farako-Ba for normal and late sowing date but within the location, the difference was statistically insignificant. This result is comparable to the findings of Atakora *et al.* (2023) who found that harvest index may be significantly influenced by location as well as growing season.

The average yield per cowpea variety was greater in Kamboinse than Farako-Ba over the two sowing date. Soudano-sahelian agro-ecological zone appears to be more favourable to cowpea production than soudanian. According to Traore (2014) and Kiprotech *et al.* (2015), differences in climate zones may induce significant variations of crop yield. In fact, changes in climatic conditions affect the biochemical, physiological and metabolic activities of plants which are directly correlated to growth and yield traits Omomowo and Babalola (2021). Ours results are also consistent with the findings of Ewansiha and Tofa (2016) who concluded that early and medium maturing varieties were more or less stable at all sowing dates in rainy season. In the same trend, Kamara *et al.* (2010) demonstrated that early and medium cowpea varieties could be sown from late July to mid-August and get a good yield in the savannah of north-eastern Nigeria which characteristics are close to ours experimental locations. In contrast, Useni *et al.* (2014) and Ezeaku *et al.* (2015) were reported that the delay in cowpea sowing led to lower grain yield. Ntare *et al.* (1993) observed that sowing date x cowpea cultivars interaction was significantly different for all variables except reproductive cycle duration. Some cowpea varieties are known to be photosensitive, in this study, the period in which sowing date was delayed for ten days did not allow concluding about photosensitive status of varieties. Indeed, they were not significant variations in flowering and maturity cycle of varieties. This was not consistent with findings of Matoso *et al.* (2018) who observed that delay in cowpea sowing date strongly increase the cycle of cowpea cultivars. Significant differences in growth attributes among the varieties could be explained by their genetic make-up. Indeed, among cowpea varieties, they are erect and semi-erect ones with some differences in growth habits. According to Ali *et al.*, 2009; Nwofia *et al.* (2015), growth traits such average number of branches and plants height is dependent on variety type. Also, in the same trend, studies conducted by Akande *et al.* (2012) and

Adediran *et al.* (2018) have reported that genetic difference of varieties is expressed on growth and yield attributes. Comparison of fodder yield, grain yield and some yield characters such as pod length, 100 seeds weight and harvest index showed significant difference between varieties. Shimelis and Shiringani (2010) and Nwofia *et al.* (2015) observed that legume yield and yield characters is the results of genotypic traits and environmental interaction.

Conclusion

The assessment of the effect of sowing date on growth and yield characters of four improved cowpea varieties in two AEZ, allow us to conclude that fodder and grain yields as well as yield attributes of the varieties are more or less stable in each location regarding sowing date. Also, this study highlights genetic difference between varieties and showed that the higher cowpea yields were obtained in soudano-sahelian AEZ. Adoption of improved varieties which are erect or semi-erect with early or medium maturity cycle could mitigate the impact late onset of rainfall.

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