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Effect Of Planting Dates On The Yield And Yield Components Of Cowpea In The Guinea Savannah Agroecology Of Nigeria

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ABSTRACT

The study evaluated the effect of different planting dates on the yield and yield components of six improved cowpea varieties in three locations (Makurdi, Abuja, and Zaria) and three cropping seasons (2019-2021) within the Guinea Savanna Agro-ecological zone of Nigeria. A split-plot design was used for the experiment. Treatments consists of planting dates as the main plot, varieties as subplots with three replications. All data were analyzed using SAS (SAS Institute, 2003). Results showed significant location and variety effects on all the measured traits. The year effect was also significant for measured traits. Planting date significantly influenced on all measured traits except 100-grain weight. The interaction of these sources of variation (Year, Planting date Variety, and Location) had significant effects on yield components. The 3rd planting date (29th August) produced the highest seed yield for all the varieties except IT89KD-288, which recorded the highest seed yield at the 2nd planting date (22nd August). Contrarily, in Makurdi and Zaria, the first date of planting (15th August) produced the highest seed yield for all the varieties, except for IT99K-573-1-1 and IT89KD-288, which recorded the highest seed yield at the 2nd and 3rd planting dates, respectively. It is therefore important that adequate predictions regarding accurate weather conditions are well disseminated to the farmers before onset of farming seasons to guide them appropriately on suitable planting time to obtain optimal yield in cowpea production to boost food security.

Keywords: *Cowpea, Yield components, Planting date, Food security*

INTRODUCTION

The effect of climate change on cropping season and overall plant productivity cannot be over-emphasized. In general, change in climatic conditions has led to significantly modification of cropping seasons in different regions and the effect of this change is variation in the performance of crop species grown in diverse agro-ecologies [1]. The shift in rainfall pattern due to climate change affects the intensity and frequency of rainfall and this has a direct effect on the productivity of the crops [2]. The alteration in planting dates also implies that certain crop varieties adapted to farmers growing areas may no longer be suitable to the new season durations [3]. This therefore necessitates the need for diversification of the crop base to be used by subsistence farmers in an effort to increase on-farm agro-biodiversity and resilience. To achieve this, comprehensive strategies should consider the challenges of food and nutritional insecurity that is prevalent in rural households [3].

The time of planting have been shown to impact significantly on developmental growth and optimum yields of crops [3].

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This is particularly important during the critical development phases where plants require adequate moisture and ideal temperatures at sowing, seedling establishment, flowering, and fruit formation. Inappropriate time of planting will result in reduced yield especially where crops are subjected to water and heat stress during dry spells at critical growth stages. Hence the need to determine appropriate planting dates for better crop performance and ultimately minimize farming risk among subsistence farmers [3].

In Nigeria, the major cowpea producing areas is the savannah belt. Its yield in the Guinea Savannah is influenced by some environmental factors including rainfall, hence it is seasonal. Therefore identifying the appropriate time for planting a crop in a particular location is thus an essential agronomic requirement needed for high and sustained productivity [4]. Many researchers have reported alteration of planting dates to be an effective strategy for reducing pest damage [5,6]. The effects of year, locations, planting dates, and climatic factors on crop production, particularly legume crops has been reported [7]. This has prompted the International Institute of Tropical Agriculture (IITA) to engage in the development of varieties possessing diverse combinations of plant characteristics, diverse crop maturity, and broad spectrum resistance to diseases, insect pests, and parasitic weeds in addition to possessing desirable end-user agronomic traits [8]. Subjecting these newly developed improved cowpea varieties to multi-environmental trials will help to identify superior and stable cowpea varieties as well as understand the effect of variety and environment on cowpea performance. It is against this background that the current study was initiated to evaluate six varieties of cowpea in the Guinea Savannah agro-ecological environment, with a view to selecting the varieties that adapt to the conditions of this agricultural zone using Makurdi, Abuja, and Zaria environments as a case study. Variations in the performance of crop species grown in these environments at different planting dates will result in significant modifications of cropping seasons, which according to [9] that will help farmers adapt their farming methods and mitigate the impact of climate change on cowpea production [4]. The objectives of this study therefore were to determine the effects of planting dates on the yield and yield components of cowpea.

MATERIALS AND METHODS

Experimental Sites

The study was conducted at three locations; Makurdi, Abuja, and Zaria in the 2019, 2020, and 2021 cropping seasons. The three locations are within the Guinea Savanna agroecological zone of Nigeria, a region not considered for cowpea production. At Makurdi, the experimental field was located at the Teaching and Research Farm of the College of Agronomy (7.41°N, 8.37°E, 97m a.s.l.), IITA/IAR Teaching and Research Farm, Samaru, Zaria (11.086° N, 7.719° E, 675 m a.s.l) and IITA Teaching and Research Farm, Kubwa, Abuja (9.076° N, 7.399° E, 476m a.s.l). All three locations in the Guinea Savanna ecological zone are characterized by an annual rainfall of 1000 to 1500 mm. The soil type in the locations is Alfisols on Argillaceous sediments [10]. Meteorological data was collected from the three locations for the three years of study. Field trials were conducted during the growing seasons of 2019, 2020, and 2021 at Abuja, Makurdi, and Zaria, under the rainfed condition.

Experimental Design and Planting

The experimental fields at each location were plowed, and harrowed with a tractor twice to a fine tilth, and thereafter, ridges were also made with a tractor. The experiment was laid out in a split-plot design with planting dates as the main plot and varieties as subplots, with three replications per treatment. The plot size for each treatment comprised four rows of 5m length, spaced 0.75m row apart to give a gross plot size of $15m^{2.}$ Each year, six improved cowpea varieties (IT99K-573-1-1, IT99K-573-2-1, IT89KD-288, UAM09-1055-6, UAM09-1046-6-1, and UAM09- 1051-1.) were planted for four planting dates (15th August, 22nd August, 29th August, and 5th September) across the three locations. Three seeds were planted per hill at 25 cm spacing between plants and thinned to two, 2 weeks after seedling emergence, providing a uniform plant population of about 106,667 plants ha−1. A recommended fertilizer rate of 30 kg/ha P_2O_5 in the form of a single super phosphate was applied at planting.

Post-planting activities included fertilizer application, weeding, and application of plant protectants (Cypermethrin + Dimethoate- Best Action).

Data Collection

Data were collected from the net plot (two central rows leaving the two outer rows and first plants at the beginning and the last plant at the end of each row to serve as borders. Field observations were made on the following: number of pods per plant and number of seeds per pod. The 100 seed weight (g) and grain yield per net plot were measured using top loading MP10001 electronic balance (Shanghai Scientific Instrument Co. Ltd) while grain yield (kg ha^{-1}) was obtained using the formula [11] given as follow:

$$\text{Grain yield (kg ha}^{-1}) = \frac{\textit{Grain yield per netplot}}{\textit{Netplot area}(\text{m2})} x 10{,}000\text{m}^2$$

Data Analysis

All data were analyzed using SAS procedure, and Standard Error was used to separate the treatment means. Pearson's correlation coefficient between grain yield and the other traits was also computed using PROC CORR of SAS [12].

RESULTS

Effects of Sources of Variation on Yield Components

There was a significant location effect on all the measured traits (table 1). The year effect was also significant for measured traits. Planting date significantly influenced all measured traits except for 100-grain weight. The varietal effect was significant for all measured traits of cowpeas. Year x Planting date x Variety had a significant effect only on grain yield (kg/ha), while Location x Planting date x Variety had a significant effect on grain number per m^2, grain number per pod and grain yield (kg/ha). Planting date x Variety effect was significant for measured traits. Location x Year x Variety had significant effect on measured traits except for 100 grain weight. Year x Variety had significant effect on measured traits except for 100 grain weight and grain number per pod. Location x Variety effect was significant for measured traits. Location x Year x Planting date had significant effect on grain number per m^2 and grain yield (kg/ha). Year x Planting date effect was significant for grain number per m^2 and grain yield kg/ha). Location x Planting date had significant effect on grain number per m^2, grain number per pod and grain yield (kg/ha). Location x Year effect was significant for measured traits.

Table 1: Effects of Multifactorial Sources on Yield Components

Source	100-grain weight (g)	grain number/m-2	Pod number/m-2	Grains pod^{-1}	Grain Yield (kg ha^{-1})
Location (L)	<.0001	<.0001	0.0119	<.0001	0.0004
Year (Y)	0.0016	<.0001	0.0005	<.0001	0.0084
L x Y	<.0001	<.0001	0.0076	<.0001	0.0006
Planting date (PD)	0.8431	<.0001	0.0029	0.0002	<.0001
L x PD	0.2486	<.0001	0.0973	0.0004	<.0001
Y x PD	0.5066	0.0012	0.1054	0.5265	0.0369
L x Y x PD	0.7664	<.0001	0.4108	0.4064	<.0001
Variety (V)	<.0001	<.0001	<.0001	<.0001	<.0001
L x V	<.0001	<.0001	<.0001	0.0004	<.0001
Y x V	0.7610	<.0001	<.0001	0.4125	<.0001
L x Y x V	0.0950	<.0001	0.0264	0.0050	<.0001
PD x V	0.0057	<.0001	0.0009	0.0007	<.0001
L x PD x V	0.4483	0.0002	0.1198	<.0001	<.0001
Y x PD x V	0.3437	0.3242	0.7786	0.9453	0.0056
L x Y x PD x V	0.7068	0.0513	0.5575	0.9024	0.1349

Effects of Planting Dates on Number of Pods and Seeds

In the Abuja location, the highest number of pods was recorded at PD3 (third planting date) in 2019 (124 pods); and PD2 in 2020 and 2021 (123.6 pods). Pod production was affected by a variety of influences and UAM15-1046-6-1 produced the highest number of pods (119.3 – 136.4 pods) in the three seasons (table 2). Planting dates and varieties also affected seed production. The number of seeds was highest at PD1 in 2019 (691.seeds) as well as PD3 in 2020 (1013.2 seeds) and 2021 (858.8 seeds). Top seed-producing varieties were: UAM15-1055-6 which produced 803 seeds in 2019; IT99K-573-1-1 (952 seeds in 2020) and IT99K-573-2-1 (945 seeds in 2021).

In the Makurdi location, the highest number of pods was recorded at PD1 (first planting date) in 2019 (114 pods); PD2 in 2020 (114 pods), and 2021 (138 pods). Pod production was affected by variety influences in which IT99K-573-1-1 produced the highest number of pods (116-124 pods) in the first and second seasons while IT99K-573-2-1 was the highest in 2021 with 123 pods (table 3). Planting dates and varieties also affected seed production. Number of seeds was highest at PD1 in the three seasons (743 – 781.seeds). Seed production was influenced by variety and season. Top seed-producing varieties were season-dependent: UAM09-1051-1 (820 seeds in 2019), UAM09-1055-6 (837 seeds in 2020), and IT99K-573-1-1 (820 seeds in 2021)

In the Zaria location, the highest number of pods was recorded at PD1 (first planting date) in the three seasons (104-128 pods). Pod production was affected by a variety of influences in which IT99K-573-2-1 produced the highest number of pods (97-98 pods) in the first two seasons while IT89KD-288 was the highest in 2018 with 128 pods (table 4). Planting dates and varieties also affected seed production. Number of seeds was highest at PD1 in the first two seasons (834 – 837 seeds) and PD3 in the 2021 season (136 seeds). Seed production reduced drastically in the 2021 season. Top seed-producing varieties were: IT99K-573-2-1 (733 seeds in 2019), IT99K-573-2-1 (672 seeds in 2020), and IT89KD-288 (128 seeds in 2021).

Effects of Planting Dates on 100 Seed Weight

In the Abuja location, varieties planted at PD4 (fourth planting date) had the highest 100-grain weight in 2019 (18.2g) and 2020 (17g) whereas all planting dates recorded insignificant weight grain differences. IT99K-573-1-1 and IT99K-573-2-1 varieties had the highest grain weight in the three seasons (table 5). In the Makurdi location, varieties planted at PD4 (fourth planting date) had the highest 100-grain weight in the three planting seasons. IT99K-573-1-1 variety had the highest grain weight in the three seasons while UAM09-1055-6 had the lowest (table 6). In the Zaria location, varieties planted at PD4 (fourth planting date) had the highest 100-grain weight in 2019 (21.5g) as well as PD1 in 2020 (20.2g) and 2021 (20.9g). The highest grain weight was recorded in UAM09-1055-6 in 2019 (24.3g) while all varieties except IT89KD-288 produced heavy grains in the subsequent seasons (table 7).

Effects of Planting Dates on Grain Yield

In the Abuja location, crops at PD2 (second planting date) produced the highest grain yield (1473kg/ha) in the 2019 season. In the subsequent seasons, crops at PD3 produced the highest grain yield in 2020 (1663kg/ha) and 2021 (1609 kg/ha). The yield also had a variety effect in which IT99K-573-1-1 was the topmost yielding variety in two consecutive seasons producing 1529 kg/ha in 2019 and 15521kg/ha in 2020 while UAM09-1051-1 had the highest grain yield in the 2021 season with 1489 kg/ha followed by IT99K-573-1-1 that yielded 1481 kg/ha grain (table 8). In the Makurdi location, crops in PD1 (first planting date) produced the highest grain yield (1302 kg/ha) in the 2019 season. In the subsequent seasons, crops at PD3 produced the highest grain yield in 2020 (1449kg/ha) and 2021 (1603 kg/ha). Yield also had a variety of effects. The first ranked varieties in grain yield were IT99K-573-1-1 in 2019 (1578 kg/ka); IT99K-573-1-1 and UAM09-1051-1 in 2020 (1427 kg/ha) as well as UAM09-1051-1 (1469 kg/ha) and IT99K-573-2-1 (1468 kg/ha) in 2021 (table 9). In the Zaria location, crops planted in PD1 (first planting date) produced the highest grain yield in the three seasons (1451-1526 kg/ha). Yield also had a variety of effects. IT99K-573-1-1 produced the highest yield in 2019 (1277 kg/ha) whereas UAM09-1055-6 produced the highest yield in 2020 with 1272 kg/ha. In the 2021 season, the duo of IT99K-573-1-1 and IT99K-573-2-1 were the best in grain yield (1208 kg/ha) as given in Table 10.

Table 2: Effect of Planting Date on Number of Pods and Number of Seeds of Six Cowpea Varieties at Abuja

	Planting Date (PD)														
	2019					2020					2021				
Variety (V)	PD1	PD2	PD3	PD4	Mean	PD1	PD2	PD3	PD4	Mean	PD1	PD2	PD3	PD4	Mean
	Number of pods/m^{-2}														
IT99K-573-1-1	110.0	149.3	130.9	79.1	117.3	102.0	120.4	80.0	80.9	95.8	101.6	122.7	80.0	80.9	96.3
IT99K-573-2-1	101.1	130.9	149.3	57.1	109.6	96.0	123.1	124.4	125.1	117.2	96.0	123.1	124.4	125.1	117.2
IT89KD-288	105.8	105.1	103.8	94.9	102.4	109.8	174.9	83.1	85.1	113.2	109.8	174.9	83.1	85.1	113.2
UAM15-1046-6-1	141.1	131.1	142.9	130.4	136.4	98.9	121.1	126.9	130.2	119.3	99.1	118.9	129.1	130.2	119.3
UAM15-1051-1	139.8	123.6	124.4	106.0	123.4	73.3	118.4	114.9	115.3	105.5	74.0	118.4	114.9	115.3	105.7
UAM15-1055-6	87.8	86.0	94.0	73.6	85.3	129.1	83.6	114.2	117.6	111.1	129.1	83.6	114.2	117.6	111.1
Mean	114.3	121.0	124.2	90.2		101.5	123.6	107.3	109.0		101.6	123.6	107.6	109.0	
	Number of seeds/m^{-2}														
IT99K-573-1-1	654.9	834.9	585.1	582.9	664.4	996.2	995.8	1290.4	526.9	952.3	862.9	995.8	1157.1	638.0	913.4
IT99K-573-2-1	789.6	426.7	711.8	388.2	579.1	957.3	707.1	1104.2	566.4	833.8	957.3	929.3	1170.9	722.0	944.9
IT89KD-288	889.1	578.9	561.6	763.3	698.2	464.2	1048.7	585.6	174.4	568.2	397.6	559.8	74.4	18.9	262.7
UAM15-1046-6-1	633.1	759.1	621.3	620.7	658.6	742.2	547.1	975.1	628.7	723.3	742.2	836.0	952.9	762.0	823.3
UAM15-1051-1	584.4	656.0	471.1	455.1	541.7	761.3	1024.2	1146.0	664.9	899.1	761.3	1002.0	1079.3	642.7	871.3
UAM15-1055-6	597.6	879.6	988.4	744.4	802.5	677.1	433.8	978.0	386.2	618.8	677.1	858.2	778.0	364.0	669.3
Mean	691.4	689.2	656.6	592.4		766.4	792.8	1013.2	491.3		733.1	863.5	868.8	524.6	

Table 3: Effect of Planting Dates on Number of Pods and Number of Seeds of Some Cowpea Varieties at Makurdi

	2019					2020					2021				
	Planting Date (PD)														
Variety (V)	PD1	PD2	PD3	PD4	Mean	PD1	PD2	PD3	PD4	Mean	PD1	PD2	PD3	PD4	Mean
Number of pods/m^{-2}															
IT99K-573-1-1	156.7	162.9	116.7	60.0	124.1	112.2	140.4	131.6	81.3	116.4	102.0	187.1	86.7	80.9	114.2
IT99K-573-2-1	163.1	129.6	91.1	73.1	114.2	98.9	117.6	112.7	58.0	96.8	96.0	143.1	126.7	125.1	122.7
IT89KD-288	41.6	18.2	11.8	4.0	18.9	81.1	98.4	97.1	99.3	94.0	82.0	174.9	94.2	89.6	110.2
UAM09-1046-6-1	135.1	107.1	116.0	93.6	112.9	118.7	126.7	122.9	102.4	117.7	98.9	121.1	131.3	130.2	120.4
UAM09-1051-1	103.8	136.0	136.0	61.6	109.3	134.4	112.4	106.9	101.6	113.8	73.3	116.2	119.3	119.8	107.2
UAM09-1055-6	85.8	60.4	59.3	45.6	62.8	90.0	86.0	96.2	75.8	87.0	129.1	83.6	116.4	117.6	111.7
Mean	114.3	102.4	88.5	56.3		105.9	113.6	111.2	86.4		96.9	137.7	112.4	110.5	
Number of seeds/m^{-2}															
IT99K-573-1-1	1085.1	995.8	668.2	460.2	802.3	779.7	812.7	740.7	627.3	740.1	1085.1	1018.0	757.1	460.2	830.1
IT99K-573-2-1	957.3	707.1	570.9	499.8	683.8	900.2	529.6	711.8	388.2	632.5	957.3	707.1	570.9	557.3	698.2
IT89KD-288	464.2	159.8	172.9	18.9	203.9	773.6	641.3	561.6	763.3	684.9	239.8	242.9	141.3	218.4	210.6
UAM09-1046-6-1	742.2	547.1	619.6	628.7	634.4	644.2	858.3	665.8	620.7	697.2	742.2	613.8	619.6	685.1	665.2
UAM09-1051-1	761.3	1024.2	790.4	702.9	819.7	673.3	777.5	560.0	522.0	633.2	761.3	1046.4	790.4	612.2	802.6
UAM09-1055-6	677.1	433.8	378.0	319.6	452.1	767.3	855.1	981.8	744.4	837.2	677.1	522.7	453.1	399.3	513.1
Mean	781.2	644.6	533.3	438.3		756.4	745.8	703.6	611.0		743.8	691.8	555.4	488.8	

Table 4: Effect of Planting Dates on Number of Pods and Number of Seeds of Some Cowpea Varieties at Zaria

	2019					2020					2021				
	Planting Date (PD)														
Variety (V)	PD1	PD2	PD3	PD4	Mean	PD1	PD2	PD3	PD4	Mean	PD1	PD2	PD3	PD4	Mean
Number of pods/m^{-2}															
IT99K-573-1-1	85.9	90.7	80.4	80.2	84.3	106.9	85.3	71.8	62.7	81.7	134.7	83.8	188.9	99.6	126.7
IT99K-573-2-1	131.9	80.5	93.7	81.4	96.9	140.0	95.1	83.8	72.2	97.8	136.4	109.8	142.4	100.7	122.3
IT89KD-288	81.8	84.1	75.4	53.9	73.8	87.6	75.1	67.3	48.2	69.6	133.3	105.3	127.8	146.4	128.2
UAM09-1046-6-1	88.4	102.4	69.7	56.7	79.3	107.3	91.6	62.2	50.7	77.9	115.3	88.0	127.6	97.3	107.1
UAM09-1051-1	115.4	90.8	90.8	64.5	90.4	110.0	81.1	81.1	51.1	80.8	115.1	88.9	108.4	167.8	120.1
UAM09-1055-6	119.6	83.0	75.2	54.4	83.1	106.9	94.9	67.1	48.4	79.3	133.1	90.0	123.1	128.4	118.7
Mean	103.8	88.6	80.9	65.2		109.8	87.2	72.2	55.6		128.0	94.3	136.4	123.4	
Number of seeds/m^{-2}															
IT99K-573-1-1	1000.0	1070.2	482.8	377.6	732.7	790.4	612.0	420.0	346.0	542.1	134.7	83.8	188.9	99.6	126.7
IT99K-573-2-1	1018.7	694.9	513.8	440.5	667.0	979.6	728.0	493.8	485.1	671.6	136.4	109.8	142.4	100.7	122.3
IT89KD-288	515.7	550.0	635.9	626.1	582.0	697.3	530.7	549.8	362.7	535.1	133.3	105.3	127.8	146.4	128.2
UAM09-1046-6-1	846.2	770.8	461.7	373.2	613.0	832.2	696.9	467.8	348.9	586.4	115.3	88.0	127.6	97.3	107.1
UAM09-1051-1	773.2	508.3	425.8	438.6	536.4	868.0	622.2	515.6	438.4	611.1	115.1	88.9	108.4	167.8	120.1
UAM09-1055-6	867.0	709.7	568.5	263.1	602.1	833.8	685.8	595.6	233.1	587.1	133.1	90.0	123.1	128.4	118.7
Mean	836.8	717.3	514.8	419.9		833.6	645.9	507.1	369.0		128.0	94.3	136.4	123.4	

Table 5: Effect of Planting Dates on 100-Grain Weight of Some Cowpea Varieties at Abuja

	2019					2020					2021				
	Planting Date (PD)														
Variety (V)	PD1	PD2	PD3	PD4	Mean	PD1	PD2	PD3	PD4	Mean	PD1	PD2	PD3	PD4	Mean
						100-grain weight (g)									
IT99K-573-1-1	19.4	18.9	19.4	19.4	19.3	17.3	18.2	17.8	19.3	18.1	16.6	15.9	17.0	17.1	16.6
IT99K-573-2-1	17.6	18.0	17.9	18.9	18.1	16.8	17.6	17.4	18.6	17.6	17.9	16.3	16.3	16.5	16.8
IT89KD-288	17.8	17.9	17.5	18.0	17.8	17.2	17.0	16.4	16.8	16.8	14.8	15.7	16.6	14.9	15.5
UAM09-1046-6-1	18.3	18.5	18.6	18.2	18.4	15.7	16.3	17.7	15.6	16.3	16.0	15.4	16.2	16.1	15.9
UAM09-1051-1	17.4	17.6	17.9	17.3	17.6	15.9	15.8	16.6	17.0	16.3	15.6	16.0	15.2	14.9	15.4
UAM09-1055-6	15.1	15.8	16.3	18.0	16.3	13.3	12.8	13.0	14.7	13.4	14.6	13.7	14.2	13.7	14.0
Mean	17.6	17.8	17.9	18.3		16.0	16.3	16.5	17.0		15.9	15.5	15.9	15.5	

Table 6: Effect of Planting Dates on 100-Grain Weight of Some Cowpea Varieties at Makurdi

	2019						2020						2021				
	Planting Date (PD)																
Variety (V)	PD1	PD2	PD3	PD4	Mean		PD1	PD2	PD3	PD4	Mean		PD1	PD2	PD3	PD4	Mean
						100-grain weight (g)											
IT99K-573-1-1	17.26	18.20	17.76	19.30	18.13		18.40	17.53	19.43	19.36	18.68		15.93	16.77	17.33	17.63	16.92
IT99K-573-2-1	16.80	17.56	17.43	18.63	17.61		17.60	18.03	17.40	18.93	17.99		15.27	15.30	16.77	17.00	16.09
IT89KD-288	17.20	17.03	16.40	16.76	16.85		17.80	17.93	18.13	18.30	18.04		16.67	14.86	15.47	16.67	15.92
UAM09-1046-6-1	15.73	16.33	17.66	15.60	16.33		17.93	18.20	18.60	17.86	18.15		16.43	15.87	16.33	16.20	16.21
UAM09-1051-1	15.86	15.76	16.63	17.00	16.31		17.40	17.63	17.93	17.26	17.56		15.00	16.03	15.57	15.97	15.64
UAM09-1055-6	13.26	12.80	12.96	14.73	13.44		15.06	15.83	16.26	18.00	16.29		13.73	16.23	15.13	15.63	15.18
Mean	16.02	16.28	16.47	17.00			17.37	17.53	17.96	18.29			15.51	15.84	16.10	16.52	15.99

Table 7: Effect of Planting Dates on 100-Grain Weight of Some Cowpea Varieties at Zaria

	2019						2020						2021				
	Planting Date (PD)																
Variety (V)	PD1	PD2	PD3	PD4	Mean		PD1	PD2	PD3	PD4	Mean		PD1	PD2	PD3	PD4	Mean
						100-grain weight (g)											
IT99K-573-1-1	22.20	19.83	19.26	19.43	20.18		21.37	19.83	19.27	19.33	19.95		22.06	20.53	19.96	19.80	20.59
IT99K-573-2-1	19.93	20.06	19.10	18.80	19.47		19.93	20.07	19.77	19.63	19.85		20.63	20.76	21.00	20.00	20.60
IT89KD-288	20.63	18.50	17.93	15.36	18.11		20.37	18.50	17.60	15.37	17.96		21.06	19.20	18.30	16.06	18.66
UAM09-1046-6-1	20.43	20.23	19.93	17.66	19.56		19.50	20.23	20.10	18.70	19.63		20.13	20.93	20.93	19.50	20.37
UAM09-1051-1	20.33	19.96	21.56	18.26	20.03		20.63	19.97	21.00	18.20	19.95		21.33	20.66	21.70	18.90	20.65
UAM09-1055-6	19.46	18.96	19.43	39.30	24.29		19.47	18.97	19.20	18.20	18.96		20.16	19.66	19.90	18.90	19.66
Mean	20.50	19.59	19.54	21.47			20.21	19.59	19.49	18.24			20.90	20.29	20.30	18.86	

Table 8: Effect of Planting Dates on Grain Yield of Some Cowpea Varieties at Abuja

	2019						2020						2021				
	Planting Date (PD)																
Variety (V)	PD1	PD2	PD3	PD4	Mean		PD1	PD2	PD3	PD4	Mean		PD1	PD2	PD3	PD4	Mean
IT99K-573-1-1	1482.7	1547.0	2104.1	979.1	1528.2		1339.1	1732.6	2018.7	1114.8	1551.3		1139.9	1562.6	1905.5	1315.0	1480.7
IT99K-573-2-1	1192.7	1164.7	1508.0	1012.8	1219.6		934.7	1469.2	1643.2	1146.5	1298.4		993.8	1445.1	1885.2	1194.4	1379.6
IT89KD-288	867.4	1192.6	1251.8	993.8	1076.4		672.9	1845.7	1203.5	781.0	1125.8		874.5	1651.8	1102.9	780.4	1102.4
UAM09-1046-6-1	1147.5	1400.8	1378.4	1256.0	1295.7		1069.6	1348.5	1654.2	1159.3	1307.9		869.1	1332.7	1584.4	1170.7	1239.2
UAM09-1051-1	1352.3	1169.6	1327.4	1217.0	1266.6		1215.3	1479.2	1845.0	1111.2	1412.7		1145.9	1595.1	1849.1	1366.5	1489.1
UAM09-1055-6	882.7	1089.9	1269.3	996.3	1059.5		1099.1	1310.2	1617.2	1121.8	1287.1		1057.2	1256.6	1330.5	1080.2	1181.1
Mean	1154.2	1260.8	1473.2	1075.8			1055.1	1530.9	1663.6	1072.4			1013.4	1474.0	1609.6	1151.2	

Table 9: Effect of Planting Dates on Grain Yield of Some Cowpea Varieties at Makurdi

	2019						2020						2021				
	Planting Date (PD)																
Variety (V)	PD1	PD2	PD3	PD4	Mean		PD1	PD2	PD3	PD4	Mean		PD1	PD2	PD3	PD4	Mean
IT99K-573-1-1	2136.8	1914.2	1514.4	745.1	1577.6		1502.8	1368.3	1876.1	960.9	1427.0		1419.4	1815.3	1740.4	829.5	1451.2
IT99K-573-2-1	1818.3	1231.3	1408.8	799.3	1314.4		1274.4	1265.1	1425.6	1106.3	1267.9		1252.2	1544.2	1876.0	1199.2	1467.9
IT89KD-288	364.5	99.8	217.0	19.9	175.3		615.9	1012.9	1115.1	1247.1	997.8		750.6	1129.2	854.9	536.5	817.8
UAM09-1046-6-1	1374.2	1156.3	1592.7	740.3	1215.8		1080.4	1442.8	1114.5	1228.4	1216.5		1158.8	1399.0	1699.0	1140.3	1349.3
UAM09-1051-1	1214.8	1193.3	1614.5	685.6	1177.1		1175.2	1285.3	1961.8	1284.7	1426.7		1370.7	1839.4	1722.5	944.3	1469.2
UAM09-1055-6	900.6	657.8	657.8	422.2	659.6		870.5	1201.2	1201.7	1094.3	1091.9		1357.4	1489.5	1723.1	869.7	1359.9
Mean	1301.5	1042.1	1167.5	568.7			1086.5	1262.6	1449.1	1153.6			1218.2	1536.1	1602.6	919.9	

Table 10: Effect of Planting Dates on Grain Yield of Some Cowpea Varieties at Zaria

Variety (V)	2019					2020					2021				
	Planting Date (PD)														
	PD1	PD2	PD3	PD4	Mean	PD1	PD2	PD3	PD4	Mean	PD1	PD2	PD3	PD4	Mean
IT99K-573-1-1	1394.8	1662.6	1146.6	901.8	1276.5	1512.8	1105.4	816.9	607.1	1010.5	1599.6	778.0	1382.0	1072.3	1208.0
IT99K-573-2-1	1460.9	1006.0	987.1	748.5	1050.6	1502.1	1150.4	1190.4	888.0	1182.7	1502.5	824.6	1452.1	1051.9	1207.8
IT89KD-288	1120.4	1072.0	1487.2	1170.6	1212.6	1062.7	1057.9	827.8	585.6	883.5	1385.2	831.0	1223.8	1125.6	1141.4
UAM09-1046-6-1	1477.0	1340.9	1188.7	944.9	1237.9	1638.4	1332.5	958.3	686.0	1153.8	1502.0	871.1	1293.4	1030.7	1174.3
UAM09-1051-1	1660.4	1359.7	1144.9	748.3	1228.3	1559.8	1022.0	857.1	800.2	1059.8	1563.8	919.3	1123.4	1005.1	1152.9
UAM09-1055-6	1593.7	1424.3	1148.3	713.1	1219.9	1881.4	1359.0	1085.7	763.1	1272.3	1192.3	963.1	1281.9	952.6	1097.5
Mean	1451.2	1310.9	1183.8	871.2		1526.2	1171.2	956.0	721.7		1457.6	864.5	1292.8	1039.7	

DISCUSSION

Presently in this study, cowpea varieties revealed variations in yield and yield components as affected by planting dates. This is therefore an indication that the various cowpea varieties studied were sensitive to the environment. Suggestive of the fact that most varieties had the capacity to yield well depending on the planting date. The differences observed in yield patterns among varieties across experimental locations as observed in this study are as expected, and validates the need to evaluate crop species with distinct biotic and abiotic potentials in different environments [13]. Variation in grain yield of cowpea varieties indicates that planting date, variety, and the various interactions had a significant influence on seed yield. Cowpea seeds planted on 29th August (PD3) recorded the highest average seed yield in all the study years in Abuja (See Table 8). The same trend was observed in Makurdi, in 2020 and 2021 while in the Zaria location; planting date 1 (August 15th) gave the highest grain yield across the three years of the study. It therefore means the 29th August planting favors the cowpea production in both Abuja and Makurdi which are in the Southern part of the Guinea Savanna while the northern part (Zaria) was favored by the 15th August. Observable significant difference exist in the average seed yield that were produced among the 4 levels of plantings across years. Significant differences in seed yield among varieties were also observed. For example, in 2019, IT99K-573-1-1 gave the highest seed yield when planted on 15th August while UAM09-1055-6 had the lowest (1059.5 kg/ha ha−1) at the same time. In 2020, IT99K-573-1-1 had the highest seed yield (1551.3 kg/ha ha−1) on 29th August while IT89KD-288 had the lowest (1125.8 kg/ha ha−1) on 22nd August whereas in 2021 IT99K-573-1-2 had the highest seed yield of 1489.1 kg/ha ha−1 at 29th August while IT89KD-288 had the lowest at 5th September. The observation above therefore appears that the cowpea varieties planted between 15th and 29th August at all locations received sufficient but not excessive precipitation for growth allowing for adequate maturation and uniform drying of pods and seeds into the beginning of the dry season. This provides an opportunity for thorough drying and eventual reduction in pest and pathogenic incidence. A similar study carried out in Kano, Nigeria, reported that planting cowpeas in the last week of August appeared to give the best results [14]. Another author [15] also reported low yields of cowpeas planted early in the season in Uganda, with heavy rains favoring excessive vegetative growth of crop, few pods, and reduced grain yields). When planting is done too early and the soil temperature is cooler than 19^{0}C, damage caused by excessive cold can result in incomplete and slow emergence [16].

However, in a planting date study in okra yield of okra was significantly influenced by dates of planting, with the first sowing date producing the tallest plant when three planting dates were considered [17]. The variety, IT89KD-288 significantly produced higher grain and fodder yield during the early season plantings (15th and 22nd August), particularly in the Abuja location while considerable reduction were observed for yield and yield components traits in the late planting seasons (29th August and 5th September) making it a variety that adapts narrow to early season planting. This agrees with another finding [18] who reported that late planting of Congo jute contributed in the production of shorter plants and lower yields of dry fiber.

The differential responses of cowpea with respect to number of seeds per pod is in agreement with [19], who reported that there is often a significant variation in the number of seeds per pod following the inability of some cowpea plants to develop and produce mature pods. He further showed that the response of the number of seeds per pod to effect of sowing date was not consistent with yield. The results differ from those of [20] where seed number as an important yield component is greatly associated with yield. In the same vein [15], higher grain yield was observed for the best performing variety during the late planting season in Uganda as compared to early planting season, and this was attributed to the different prevailing weather conditions in the two seasons. The first season was characterized with heavy rains which supported too much vegetative growth, fewer pods, and thus lower grain yields.

Results from the current study indicated that yield and yield components of cowpeas were best obtained in early planting dates (15th, 22nd, and 29th August) but decreased in late planting dates (5th September), especially in Makurdi and Zaria locations.

Yield and yield components traits recorded significant reductions especially when variety IT89KD-288 which is a late maturing variety was planted on 5th September in Abuja and Zaria locations across the study years. This is basically attributed to moisture deficiency prevalent during the crop reproductive stage and pod-filling period of the crops. This observation is in agreement with that of [21] who reported that decreasing moisture availability during seed development stages of plant reduces dry matter accumulation. This observation also agrees with the findings of [22] who reported that, planting soybean at the early season produced higher seed yield significant better than late planting. Similar results [23,24] were obtained on cowpeas, with yield differences attributed to high amount of solar radiation, increased leaf area index and appreciably lower insect pest population in the early planting season.

This result corroborates the above findings except for yield differences between the three seasons that could also be attributed to rainfall variations since the crop reproductive phase was longer in the early planting dates than at the late planting due to inadequate water. This opinion was supported [25] noting that in early sowing, cowpeas were enabled to escape unfavorably hot temperatures prevalent during the flowering stages when the crop was sensitive to heat and the crop would attain maturity before the cessation of rains.

The extended duration of pod filling observed in the early season could be responsible for the significant higher grain yield of planting date 1 (15th August) observed in Makurdi in 2019 and Zaria across years of study. It also implies that early flowering of cowpea varieties can play significant role to help plants escape drought in some locations and years, ultimately resulting in high yields. Similar finding [26] reported that extended duration of growth periods leads to higher photosynthetic activities and better crop performance. Another study [27], reported that yield advantage of early over late maturing varieties of soybean was not influenced by planting date. Nevertheless, delay in planting of early maturing varieties greatly delayed maturity, eliminating the potential benefit of early harvest of the early planted and early maturing varieties [28]. Early sowing can provide the advantage of increased grain yields of cowpea by enabling the crop to escape hot weather conditions which can hamper reproductive development [29]. Alternatively, planting too late could cause losses due to limited time for the pod formation. This could affect crude protein content, leading to a loss in quality and quantity of grain yield and ultimately loss of germplasm. Where the minimum temperature favors germination, cowpeas can be planted in the early season if the objective is for green pastures, green manure or silage [30].

CONCLUSION

Planting date and its interaction with many sources of variation (Year, Variety, Location) had a significant effect on all yield traits. The 3rd planting date (29th August) produced the highest seed yield for all the varieties except IT89KD-288, which recorded the highest seed yield at the 2nd planting date (22nd August). Contrarily, in Makurdi and Zaria, the first planting date (15th August) produced the highest seed yield for all the varieties, except for IT99K-573-1-1 and IT89KD-288, which recorded the highest seed yield at the 2nd and 3rd planting dates, respectively. It is therefore important that farmers are adequately informed about accurate weather predictions before the beginning of planting season to guide them appropriately on suitable time to plant and obtain optimal yield in cowpea production to boost food security.

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