OPTIMUM PLANTING DATE FOR SESAME (SESAMUM INDICUM L) IN THE TRANSITION ZONE OF SOUTH WEST NIGERIA

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Abstract

Experiments to evaluate the optimum sowing date for two varieties (Yandev 55 and E8) of sesame (Sesamum indicum L.) were carried out during the late rainy-season cropping in 1998 and 1999 in south west Nigeria. Yandev 55 is a local adapted variety, whilst E8 is an improved variety. Both varieties were sown in early July, mid July, late July, mid August and late August as late season crops in both years. Rainfall distribution and amount were greater in 1999 than 1998 during cultivation. Consequently, both varieties performed better in 1999 than 1998. In 1998, var. E8 flowered earlier and was also shorter than Yandev 55 whilst in 1999 both varieties had similar growth attributes, except days to physiological maturity and height at 50% flowering. Yield components of both varieties were similar in 1999, except number of branches per plant. However, in 1998, E8 performed better than Yandev 55, except for grain yield per hectare. Variation in sowing dates significantly affected the performance of the two varieties in both years. Sesame sown in early July elongated faster and produced significantly greater weight of capsules and seeds per plant, number of capsules per plant and weight of seeds per plant in both years, compared with other sowing dates. Yandev 55 and E8 produced maximum grain yields when sown in early July and mid July, respectively, in 1998 whilst both varieties gave maximum grain yields in early July in 1999. Grain yield was positively and significantly correlated with height at physiological maturity and weight of capsules and seeds per plant in both years. Sowing sesame between early July and mid July is, therefore, recommended for sustainable cultivation in the forest – savanna transition zone.

Key words: sesame varieties, plant production, *Sesamum indicum L.,* West Nigeria

INTRODUCTION

Sesame *(Sesamum indicum L.)* is an oilseed crop generally cultivated on small holdings by poor-resource farmers in the tropics. The crop was first grown in the middle belt of Nigeria in the late 1940s following the mandate given to West African Oilseeds Mission to investigate the possibility for the production of groundnut and other oilseeds (Idowu, 2002). The traditional agro-ecozone of sesame cultivation is between latitudes 6^{o} and 10^{o} N (Agboola, 1979), which falls within the guinea savanna where the annual rainfall is usually below 1000 mm. However, sesame had been successfully cultivated in areas with annual rainfall above 1000 mm and its yields are comparable both in quality and quantity to those recorded in the traditional growing areas (Ogunremi, 1985; Ogunremi and Ogunbodede, 1986).

Although, the crop was not given adequate cultural management practice and recognition as an important oilseed crop initially (Weiss, 1983), it has started to receive wide acceptance in recent times among farmers. This is because of the economic importance of its oil in the international market. The crop is now grown mainly for its seeds which contain 50–52% oil, 17–19% protein and 16–18% carbohydrate (Ustimenko-Bakumovsky, 1983), and are used mainly for cooking purposes, salad oils and margarine (Coote, 1998). The oil contains about 47% oleic and 39% linoleic acid and is also used in the manufacture of soaps, paints, perfumes, pharmaceuticals and insecticides (Oplinger et al., 1990).

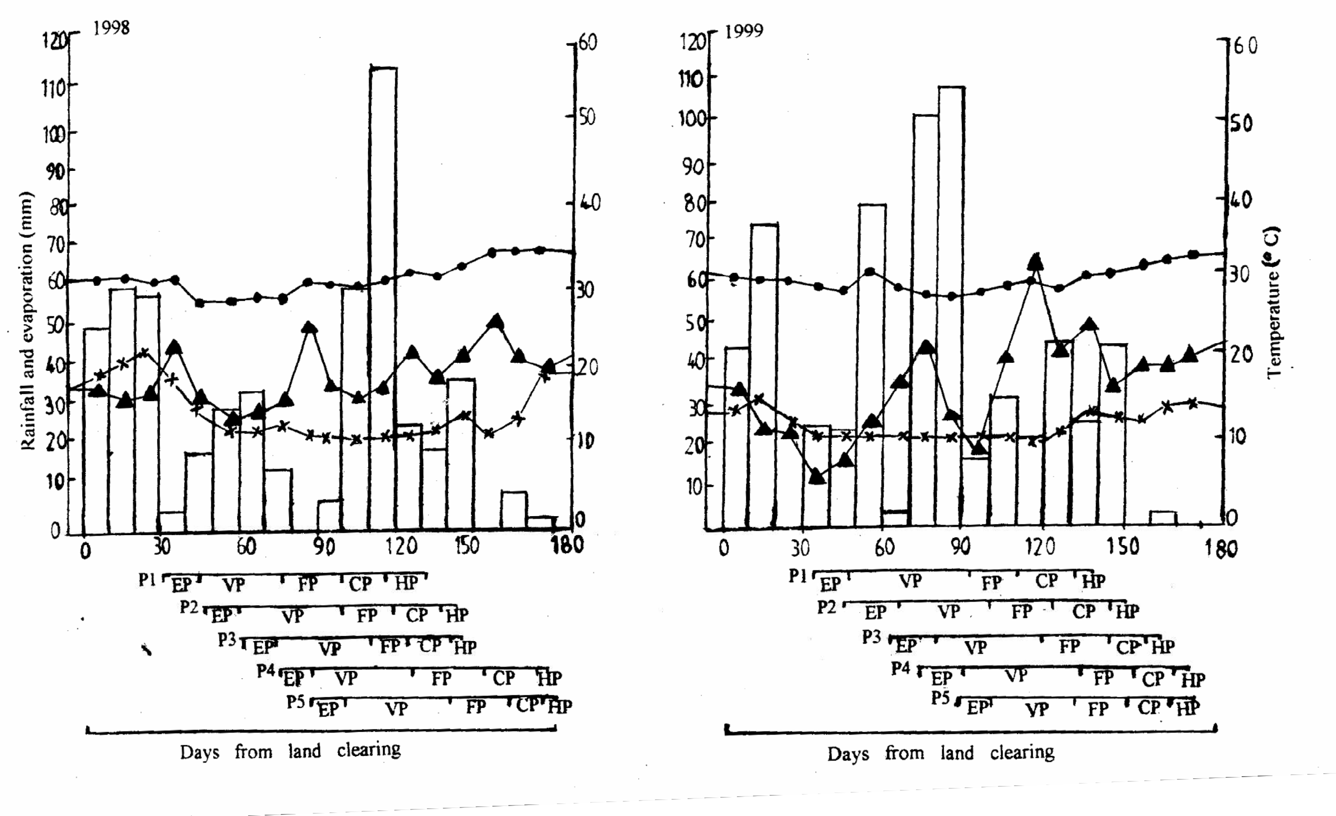
The performance of sesame has been reported to be strongly influenced by sowing date in Korea (Park and Ree, 1964) and United States of America (Mulkey et al., 1987). In Nigeria, optimum sowing dates have been determined for sesame in locations within the northern guinea savanna (Katung et al., 1988, Kaigama et al., 1988), southern guinea savanna (Busari and Ajewole, 1993; Adeyemo and Ogunwolu, 1996) and forest (Ogunremi, 1985). However, similar information is not available in the forest-savanna transition zone of the country, where most of the staple food and oil crops are cultivated. The recent increase in awareness, production and cultivation of sesame in the forest – savanna transition zone, has therefore, necessitated the need to evaluate the agronomic practice for the crop in the zone. The agro-climatic potential of the forest-savanna transition zone for guinea savanna crops such as sorghum and cowpea has been evaluated (Bello, 1997 and 1999, Okeleye et al., 1999). In these studies, however, sesame was not among the commodity crops evaluated in relation to climatic conditions and the accompanying effects on their cultural production. This study was, therefore, carried out to obtain information necessary to develop effective strategies for sesame production in the forest–savanna transition zone of Nigeria.

MATERIALS AND METHODS

Field experiments were conducted during the late cropping seasons in 1998 and 1999 at the Teaching and Research Farm of the University of Agriculture, Abeokuta (7°15´N, 3°25´E) located in the forest–savanna transition zone of south west Nigeria at an altitude of about 144 metres above sea level. The sites were previously cropped to maize. The soil had 86.4% sand, 8.0% silt and 5.6% clay with a pH of 5.9, 1.04% organic matter, 0.064% total nitrogen, 3.48 mg/kg available P (Bray1 P) and 0.17 cmol(+)/kg exchangeable K. The pH of 5.9 falls within the range of 5.5-8.0 which is considered tolerable by sesame (Weiss, 1983). The treatments consisted of two widely cultivated indeterminate open pollinated and medium maturing sesame varieties (E8 and Yandev 55) and five sowing dates. E8 is an improved variety, while Yandev 55 is a local adapted variety. These treatments were factorially combined using randomized complete block design and replicated thrice. Each plot size was 5 × 1.8 m. Sesame was sown at 0.05 m spacing in rows 0.60 m apart (Olowe and Busari, 1994), giving 333,000 plants ha^{-1} on 1 July, 15 July, 29 July, 12 August, and 26 August, 1998 and on 2 July, 14 July, 27 July, 11 August and 25 August, 1999. Foliage diseases of sesame such as bacteria blight incited by Xanthomonas compestries pv. Sesami (Sabet and Dawson) and leaf spot caused by Cercospora sesami Zimm. were controlled particularly in 1999 with Apron plus 50DS, a fungicide/insecticide seed treatment which contained 10% metalaxyl, 6% carboxin and 34% furathiocarb. Sesame seedlings were thinned to one per stand at 28 days after planting (DAP). Weeding was done twice, at 28 and 56 DAP in each year.

The weather records: rainfall, evaporation and screen maximum and minimum temperatures during the period of study were collected at Ogun–Oshun River Basin Development Authority, an agrometeorological station 2 km from the experimental site. In order to determine the accummulated temperature from sowing to flowering and maturity, 18°C was considered as the threshold tempe-

Figure 1: Decadal rainfall and evaporation, mean minimum and maximum temperature from the time of land clearing to harvesting of sesame planted at five different sowing dates in the forest – savanna transition zone of Nigeria in 1998 and 1999



= rainfall, -▲- - = evaporation, -✕- = minimum temperature, -●- = maximum temperature, P1 - 5 = Sowing dates, EP = Establishment period, VP = Vegetative period, FP = Flowering period, CP = Capsule formation period, H = Harvesting period rature for sesame growth and development (Shilling and Catan, 1991). Accummulated temperature gives an approximate index for comparing the thermal needs of plants and the suitability of a location for specific crops. At 28 DAP, five plants were randomly selected within the middle rows for data collection. Data collected included number of days to 50% flowering (when at least half of the plants on a plot have fully flowered) and physiological maturity (when at least 90% of the capsules on a plant have matured), height at 50% flowering and physiological maturity, number of capsules and branches per plant, weight of capsules and seeds per plant and grain yield. According to Tewolde *et al.* (1994), a sesame capsule is mature when the subtending leaf defoliates due to normal senescence. Plants were harvested at maturity (i.e. when over 95% of the capsules were mature). The vegetative and reproductive stages of sesame were measured from sowing to 50% flowering and 50% flowering to physiological maturity, respectively (Mulkey et al., 1987). The five earlier tagged plants were harvested separately and used for yield component analysis. Data collected were subjected to analysis of variance. Simple correlation analysis was also carried out to determine the level of relationship between height at 50% flowering and physiological maturity, weight and number of capsules per plant, weight of seeds per plant and number of seeds per plant and grain yield. Means of significant treatments were compared using the standard error of means (Steel and Torrie, 1985).

RESULTS

Weather conditions

The rainfall and evaporation values and mean of ten-day values for minimum and maximum temperatures as related to the main stages of vegetative and reproductive development of sesame sown at the different dates in 1998 and 1999 are presented in Figure 1. Similarly, rainfall totals from date of sowing to 50% flowering and 50% flowering to physiological maturity, accummulated temperature from sowing to 50% flowering and physiological maturity as related to grain yield at the five sowing dates are presented on Table 1. Rainfall totals recorded during the vegetative stage across the five sowing dates, except late August sowing were markedly lower in 1998 than 1999. However, the reverse was the case during the reproductive stage for sesame sown between early July and late July in 1999. Mid July sown sesame in 1998 received 254 mm rainfall during the reproductive stage and produced the highest grain yield of 425 kg/ha, whilst early July sown sesame in 1999 recorded the highest rainfall and grain yield of 115 mm and 646 kg/ha, respectively (Table 1).
Temperatures were cooler and evaporation lower in 1999 than 1998, especially during land preparation and establishment – early vegetative period of sesame sown in early and mid July (Figure 1). Evaporation was highest in mid August and early November in 1998 (48 mm) and late September in 1999 (63 mm). In general, the late cropping season of 1998 was warmer than that of 1999. The mid and late August sown sesame recorded relatively higher accummulated temperatures from sowing to physiological maturity, compared with other earlier sown plants in both years (Table 1).

Varietal effects

In 1998, significant varietal differences were detected for number of days to 50% flowering, height at 50% flowering and physiological maturity, weight of capsules per plant and grain yield, whilst number of days to physiological maturity, height at 50% flowering, number of branches per plant and grain yield recorded significant varietal differences in 1999 (Table 2 and 3). E8 attained 50% flowering 5 days earlier and was significantly shorter than Yandev 55 by 24 and 21% at 50%

Tab.1: Rainfall totals from sowing to50% flowering and 50% flowering to physiological maturity, accumulated temperature to 50% flowering and physiological maturity, and grain yields of two sesame varieties planted at five different sowing dates in 1998 and 1999

Sowing date	Rainfall totals (mm				Accumulated temperature (°C) to				Grain yield (kg/ha)	
	sowing to 50% flowering		50% flowering to physiological maturity		50% flowering		physiological maturity			
	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999
Early July	104.1	319.0	190.3	115.0	199.8	140.4	315.0	274.7	355.07	645.61
Mid July	87.2	306.6	254.2	173.4	146.2	120.4	285.0	214.4	425.07	175.55
Late July	108.4	288.6	177.5	126.0	124.4	148.0	170.2	311.3	117.92	177.50
Mid August	195.6	317.6	79.6	81.0	136.8	129.7	334.2	352.9	18.23	352.67

Late August	259.0	147.1	20.6	47.5	188.0	180.2	406.0	375.2	29.73	334.45

Threshold temperature computed for sesame growth and development was 18°C
Source: Shilling and Catan, 1991

Tab. 2: Growth attributes of two sesame varieties planted at five different sowing dates in 1998 and 1999

Treatment	Number of days to				Height (cm) at			
	50% flowering		physiological maturity		50% flowering		physiological maturity	
Sowing date	1998	1999	1998	1999	1998	1999	1998	1999
Yandev 55	63	62	103	109	79.65	112.10	141.00	137.10
Early July	65	55	105	106	93.53	73.80	143.47	99.80
Mid July	54	63	87	105	94.78	69.33	127.20	75.63
Late July	56	58	111	103	76.87	74.47	115.97	91.30
Mid August	59	61	97	94	83.33	87.07	103.47	95.83
Late August	63	62	103	109	79.65	112.10	141.00	137.10
E 8								
Early July	53	56	98	111	72.21	104.33	132.03	130.87
Mid July	56	53	97	108	72.67	64.80	124.90	85.23
Late July	51	66	84	105	76.37	65.20	110.27	77.13
Mid August	52	60	112	105	61.57	72.57	81.50	99.20
Late August	63	60	106	98	61.93	83.27	79.30	103.23
SE ± (18 D.F) (Variety x Sowing date)	1.56	1.63	2.37	0.45	6.39	3.82	5.55	6.59
Yandev 55(mean)	60	60	100	103	85.63	83.35	126.22	99.93
E8 (mean)	55	59	99	105	68.95	78.03	105.60	99.13
SE± (18 D.F) (Variety)	0.70	0.73	1.05	0.20	2.85	1.71	2.48	2.94
Early July (mean)	58	59	100	109	75.93	108.22	136.51	133.98
Mid July (mean)	61	54	101	107	83.10	69.30	134.18	92.52
Late July (mean)	53	65	86	105	85.57	67.27	118.73	76.38
Mid August (mean)	54	59	111	103	69.22	73.52	98.73	95.25
Late August (mean)	61	60	101	96	72.63	85.17	91.38	99.53
SE± (18 D.F) (Sowing date)	1.01	1.16	1.67	0.45	4.52	2.70	3.93	4.65

flowering and physiological maturity, respectively in 1998. However, in 1999, E8 matured two days later and was about 7% shorter than Yandev 55 at 50% flowering (Table 2). E8 produced significantly higher weight of capsules and number of branches per plant than Yandev 55 in 1998 and 1999, respectively (Table 3).

Sowing date effects

Sowing date significantly influenced number of days to 50% flowering and physiological maturity, and height at 50% flowering and physiological maturity in both years (Table 2). Sesame sown in late July and late August in 1998 attained 50% flowering earlier by 5–7 days compared with other sowing date treatments. However, in 1999, sesame sown in mid July flowered by 5–11 days earlier than others sown at later dates with the late July sown sesame recording the largest value (65 DAP).

Sowing date effects were significant for grain yield and all the yield attributes in 1998 and 1999 with early July sowing recording the highest values, except for grain yield in 1998 (Table 3). The highest grain yields of 425 and 646 kg/ha were produced from mid July and early July sown sesame in 1998 and 1999, respectively. Whereas, in 1998, the lowest grain yields were recorded from the mid August and late August sown sesame (Table 3).

Variety versus sowing date effect

There were significant interactions between variety and sowing date on the number of days to 50% flowering and physiological maturity and height at 50% flowering and physiological maturity of sesame in 1998 and 1999 (Table 2). Similarly, weight of capsules and seeds per plant, number of capsules per plant and grain yield were

Tab. 3: Grain yield and some yield attributes of two sesame varieties planted at five different sowing periods in 1998 and 1999

Treatment	Weight/plant(g)				Number of capsules/plant		Number of branches/ plant	Grainyield (kg/ha)	
	capsules		seeds						
Sowing date	1998	1999	1998	1999	1998	1999	1999	1998	1999
Yandev 55									
Early July	16.86	11.93	4.42	5.69	85	84	7	462.17	674.76
Mid July	7.55	1.37	2.74	0.43	39	14	3	386.37	144.44
Late July	6.79	1.61	2.40	0.22	40	9	1	101.03	75.00
Mid August	3.17	2.20	0.69	1.01	19	26	2	28.27	198.67
Late August	2.87	1.47	0.89	0.54	21	12	2	56.97	317.77
E 8									
Early July	26.24	15.17	8.53	7.05	102	70	9	247.97	616.45
Mid July	20.48	1.53	7.94	0.62	69	17	2	464.97	206.66
Late July	8.35	2.89	2.19	3.54	40	9	3	134.80	279.99
Mid August	0.51	2.60	0.19	1.05	3	14	3	8.20	506.67
Late August	8.93	3.12	1.99	1.52	42	14	4	2.50	351.11
SE ± (18 D.F) (Variety x Sowing date)	4.40	2.46	1.79	1.49	14.21	10.6	0.64	32.05	107.24
Yandev 55(mean)	7.45	3.71	2.23	1.58	41	29	3	206.96	282.13
E8 (mean)	12.90	5.06	4.17	2.76	51	24	4	171.69	392.11
SE± (18 D.F) (Variety)	1.96	1.09	0.80	0.67	6.36	4.7	0.29	14.23	47.95
Early July (mean)	21.55	13.55	6.47	6.37	94	77	9	355.07	645.60
Mid July (mean)	14.02	1.45	5.34	0.53	54	15	2	425.07	175.55
Late July (mean)	7.57	2.25	2.29	1.88	40	9	2	117.92	177.50
Mid August (mean)	1.84	2.40	0.44	1.03	11	20	2	18.23	352.67
Late August (mean)	5.90	2.29	1.44	1.03	32	13	3	29.73	334.45
SE± (18 D.F) (Sowing date)	3.11	1.74	1.26	0.06	14.21	7.5	0.45	22.66	75.83

significantly affected by variety x sowing date interactions (Table 3). In 1998, Yandev 55 and E8 sown in late July attained 50% flowering earlier than those sown later. In 1999, late August sown sesame reached physiological maturity by 7–17 days before those sown earlier. Late July sown sesame grew tallest at 50% flowering in 1998 whilst in 1999 the early July sown sesame grew tallest. At physiological maturity, mid-July sown Yandev 55 grew tallest in 1998, whilst early-July sown E8 was the tallest in both years.

Relationship between grain yield and some agronomic characteristics

Significant positive relationships between grain yield and height at physiological maturity, weight of seeds and capsules per plant were recorded in 1998. Similarly, in 1999, height at 50% flowering and physiological maturity, weight and number of capsules, weight of seeds per plant and number of branches per plant were significantly correlated with grain yield (Table 4).

Tab. 4: Correlation coefficients among some agronomic characteristics of sesame in 1998 and 1999

Traits	Height at flowering	Height at physiological maturity	Weight of capsules per plant	Number of capsules per plant	Weight of seeds per plant	Number of branches per plant
Grain yield	0.51 (0.95**)	0.93** (0.95**)	0.87* (0.92**)	0.79 (0.93**)	0.95** (0.87*)	– (0.90*)
Height at flowering	–	0.63 (0.96**)	0.34 (0.92**)	0.32 (0.91*)	0.44 (0.87*)	– (0.90*)
Height at physiological maturity		–	0.86* (0.91*)	0.82* (0.94**)	0.92* (0.83*)	– (0.91*)
Weight of capsules per plant			–	0.99** (0.99**)	0.98** (0.99**)	– (0.99**)
Number of capsules per plant				–	0.94** (0.99**)	– (0.93**)
Weight of seeds per plant					–	– (0.99**)
Number of branches per plant						–

*and **significant at 5 and 1%, respectively values in parentheses correspond to 1999

Weight and number of capsules per plant and number of seeds per plant were significantly ($P < 0.01$) correlated with each other in both years. Number of branches per plant was significantly related to all the measured agronomic characteristics in 1999.

DISSCUSION

Comparatively, rainfall amount recorded from the period of land clearing to harvesting was greater in 1999 (722 mm) than 1998 (545 mm). The values for both years were within recommended range of 500–800 mm of rainfall (Schilling and Catan, 1991) for successful production of sesame in tropical Africa. The vegetative period of sesame sown on 2 July, 14 July and 27 July 1999 and the establishment period of those sown on 11 August 1999 experienced higher rainfall compared with their corresponding plants sown on 1 July, 15 July, 29 July and 12 August 1998. This is due to the relatively high rainfall (215 mm) in August 1999 as against the low rains (48 mm) in 1998. Adequate moisture in the soil during the vegetative period is desirable because the number of branches per plant and number of seeds per plant are usually determined during this period. However, during the reproductive stage, sesame sown on 1 July, 15 July and 29 July 1998 received higher rainfall totals than those sown on 2 July, 14 July and 27 July 1999. At this stage adequate moisture in the soil enhanced enlargement of seeds and consequently increased sesame grain yield.

Sesame is generally a warm region plant and the temperatures recorded during this study were optimum for sesame growth and development in both years. A temperature range of 25°–27°C encourages rapid germination, initial growth and flower formation, whilst temperature below 18°C inhibit germination and growth (Shilling and Catan, 1991). The maximum temperature (35° and 33°C for 1998 and 1999, respectively) recorded in the latter part of the reproductive stage of sesame sown in mid July and late August were below the critical temperature level (40°C) which adversely affects flower fertilization and capsule production (Schilling and Catan, 1991). There was minimal variation in the thermal needs of sesame sown during the late season of 1998 and 1999 because the mean decadal temperature ranged between 19.8°–25.3°C and 19.8°–24.5°C, respectively. Evaporation was lowest during the late July and early August period, coinciding with the vegetative stage of early and mid July sown sesame and with the establishment stage of late July sown plants in 1998. Whereas, evaporation was lowest in early-mid July, 1999 and coincided with the establishment and early vegetative period of 2 July sown sesame. Low evaporation rates coincided with periods of relatively high rainfall and cool temperatures.

E8, an improved variety, flowered five days earlier and was significantly shorter than Yandev 55 in 1998. This suggests that Yandev 55 being a local adapted variety could be more adaptable to less rainfall and higher temperature than E8, as recorded in 1998. Consequently, Yandev 55 recorded significantly higher grain yield than E8 by 20% in 1998. However, in 1999 when total rainfall in October was 116 mm as against 83 mm in 1998, E8 produced significantly 39% higher grain yield than Yandev 55 indicating that E8 required greater amount of water for seed production.

Sesame sown in late July and mid August in 1998 flowered earlier by 5–7 days than those sown later in the season. This was probably because of the short dry spell in August (third decade of August) and the relatively high evaporation rate which could have reduced the vegetative duration, thereby hastening flowering. In this study, number of days to maturity was significantly reduced when sesame was sown in late July 1998 and late August 1999. This finding agrees with the reports of Mulkey et al. (1987) and Adeyemo and Ogunwolu (1996) who opined that days to maturity were reduced with delayed plantings.

Sesame sown in early July in both years were the tallest, whilst those sown in late August 1998 and late July 1999 were the shortest. This could be attributed to adequate moisture in the soil during the establishment/vegetative periods of early July sown sesame in both years. Consequently, sesame sown in early July recorded significantly higher weight of capsules and seeds per plant, number of capsules per plant and grain yield in both years than those sown at other dates, except weight of seeds per plant in 1998. Further delay in sowing date till late August significantly reduced number of branches per plant in 1999.

The highest grain yield values of 425 and 647 kg/ha compare favourably with the current average world yield of 383 kg/ha (FAO 2000). Grain yields from early and mid July plantings were higher than the latter plantings probably because the plants had enough vegetative growth, adequate photosynthetic activity and assimilates than those sown later in the season. Sesame is basically a short day plant that is well adapted to late-rainy season production in the tropics (Oplinger et al., 1990). The significant reduction in mean grain yields recorded for mid and late July plantings in 1999 for both varieties could be attributed to the short dry spell in the first decade of August. Grain yields of mid August and late August sown sesame in 1998, especially E8 were drastically low because of the dry spell (low rainfall 14.2 mm) experienced during the sowing and establishment stages. Earlier studies have also reported significant yield reductions from early July and late August sown sesame in the forest and guinea savanna by Ogunremi (1985) and Adeyemo and Ogunwolu (1996).

The significant interaction effects of variety and sowing date recorded on the growth, yield attributes and grain yield of sesame is an indication that the two varieties responded differently to sowing dates. Under the more favourable growing conditions of 1999, all the measured agronomic characteristics were positively and significantly related to grain yield, whilst in 1998 height at flowering and number of capsules per plant did not record significant relationship with grain yield. Highly significant correlation coefficients recorded between number and weight of capsules per plant and number of seeds per plant in both years and number of branches per plant in 1999 indicate that these traits concurrently increased grain yield of sesame. Delgado and Yermanos (1975) had earlier reported significant positive correlation between grain yield and number and weight of capsules per plant, height at physiological maturity and number of branches per plant. Furthermore, number of capsules per plant, weight of seeds per plant and height at physiological maturity were strongly recommended for selection for high yielding capacity in Nigerian sesame (Ogunremi and Ogunbodede, 1980).

CONCLUSION

The findings of these experiments confirm that there is potential for sesame cultivation during the late rainy-season cropping in the forest – savanna transition zone of south west Nigeria. However, E8 (improved variety) performed better than Yandev 55 (a local adapted variety) under wetter and cooler weather conditions, whereas Yandev 55 did better than E8 under relatively drier and hotter conditions. Therefore, for sustainable sesame production, sowing the crop between early and mid July is recommended for late rainy-season cropping in the transition zone of Nigeria.

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