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Comparative Response of Photoperiod Sensitive and Insensitive Sorghum (*Sorghum bicolor* L. Moench) Varieties to Delayed Sowing in a Semi-arid Tropical Environment

Vergleichende Untersuchung von photoperiodisch sensitiven und nicht sensitiven Hirse-Sorten auf späte Aussaat in einer tropisch semi-ariden Region

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1 Introduction

The sowing time for grain sorghum in northern Nigeria depends on when the rains become established, which varies from year to year and from place to place. The year-to-year variability in the length of the growing season in the tropics therefore can be quite considerable. Although early sowing generally produces larger sorghum yields, reasons for this, which have not been sufficiently elucidated, are likely to be quite varied.

The ability to flower at almost the same time each year is considered as an important adaptive feature of most Nigerian sorghums. The decline in yield of late-sown sorghum has been associated with this adaptive feature (BUNTING and CURTIS, 1968; KASSAM and ANDREWS, 1975). Heading in such photoperiod-sensitive sorghum varieties is said to be primarily in response to photoperiod, even though time of sowing may also have a definite additional effect (ANDREWS, 1973). While tropical sorghums have been described as being essentially sensitive to photoperiod (CURTIS, 1965), DOGGETT (1970) concluded that neither classic photoperiodic responses plus temperature responses nor interactions between these satisfactorily explains the reactions of some Nigerian sorghums to time of flowering.

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Generally, the local farmers' practice is to sow sorghum soon after the beginning of the rains, but this timing may not necessarily be applicable in the case of photoperiod-insensitive varieties. It is therefore yet to be ascertained experimentally when best to sow photoperiod-insensitive, early-maturing sorghum under an extended growing season. The optimum sowing time should be adhered to as the sorghum grain is often mouldy and attacked by insects if planting is done too early, such that heading occurs earlier than the end of local rains; while grain fails to fill completely, due to lack of soil moisture, in varieties which head too late (KASSAM and ANDREWS, 1975).

Presently there is a dearth of information about the effect of sowing date on growth, development and yield of photoperiod-sensitive sorghum (ANDREWS, 1973; KASSAM, 1974; KASSAM and ANDREWS, 1975). Even more lacking is experimental evidence on how date of sowing affects the growth, development and yield performance of photoperiod-insensitive sorghum varieties under a semi-arid tropical environment. While earlier work emphasized photoperiod-sensitive local sorghum varieties, investigations comparing this type of sorghum with the photoperiod-insensitive type are yet to be reported.

The present investigation was therefore undertaken to compare the growth and yield responses of photoperiod-sensitive and insensitive sorghum varieties to delayed sowing in a semi-arid tropical environment. It was also to elucidate the reasons for such responses in terms of growth physiology.

2 Materials and Methods

Field trials were conducted at the experimental farm of the Institute for Agricultural Research, Samaru (11° 11'N, 07° 38'E; 686 m above sea level), Nigeria during the 1981 and 1982 cropping seasons. Treatments tested each year include six sowing dates at 10-day intervals from 15 June to 6 August in 1981 and from 9 June to 29 July in 1982, using two sorghum varieties, namely, L.187 and HP3. Sorghum variety L.187 is semi-dwarf photoperiod-sensitive pure-line while HP3 is a dwarf early-maturing photoperiod-insensitive variety. A randomised complete block design with four replications was used. The gross and net plot sizes were 41.0 m^2 and 27.3 m^2 respectively.

The experiment was conducted on a well-drained, leached ferruginous tropical soil. The average chemical characteristics of the 20-cm top soil of the experimental site were: pH (H_2O) of 5.8, 0.04% mineral N, 12.82 ppm available P, 42.4 ppm exchangeable K, 377.0 ppm Ca and 65.0 ppm Mg.

Sorghum varieties HP3 and L.187 were sown in 75 cm rows at intra-row spacing, and thinned to one plant per hill at three weeks after emergence. Each year the same experimental site was used and it received prior to sowing a basal fertilizer dressing of 17.5 kg P and 33 kg K per hectare as single superphosphate and muriate of potash respectively. Nitrogen (as calcium ammonium nitrate) at the rate of 50 kg N/ha was side-dressed in two split doses, half at three weeks and half at eight weeks. All plots were clean-weeded throughout the growing season and given eight weekly sprays of carbaryl at 1.12 kg a.i./ha against stem-borer (*Busseola fusca*) attack.

Plants were dated for major phenological events such as head emergence, 50% flowering, and physiological maturity by making daily observations starting from the first sign of flag leaf appearance. Date of head emergence was taken as the time when more than half of the total number of plants in a plot showed emerging heads (ANDREWS, 1973) and 50% flowering was when about half the number of plants within a plot had shed pollen from their inflorescences. Physiological maturity was taken as when black layer had been formed at the base of sorghum grain (EASTIN et al., 1973) and length of grain filling was the time period between 50% flowering and physiological maturity (EASTIN, 1972)

At 16 weeks after emergence, each plot was scored for shootfly (*Atherigona soccata* Rondani) infestation on a scale of 0 to 5 (where 0 = complete freedom from infestation, and 5 = very severe infestation). The percentage of shootfly infestation was also determined on the basis of the percentage deadhearts within the plot. Crop harvesting was done progressively after maturity and after grain moisture content had dropped to a satisfactory level. Stalks were also cut and air-dried in the field before weighing. Yield-related parameters considered include grain and straw yields and various components of yield.

Data collected were subjected to analysis of variance to test for the significance of treatment effects. Treatment means were compared using the Duncan's Multiple Range Test.

3 Results and Discussion

3.1 Climate

Climate data for Samaru during the 1981 and 1982 cropping seasons are presented in Fig. 1. The year 1981 was wetter than 1982 in terms of total precipitation but the rains ceased sooner (in September) in the former year than in the latter (in October). The months of July and August were the wetest in the two years. During the period of April to mid June, and also in October, of each year pan evapotranspiration exceeded precipitation markedly, a condition that was likely to have subjected sorghum plants to a certain degree of moisture stress. Under normal circumstances moisture stress is not likely to occur during mid July — mid September at Samaru. However, crops sown later than normal are likely to suffer from limited soil moisture supply in this environment if their active growth falls within a period that is after mid September.

Mean daily sunshine hours fluctuated quite considerably during the 1981 cropping season, having varied between 4.8 h in late July and 9.4 h in late October. However, in 1982, mean daily sunshine hours were much less variable, with values ranging from 5.6 to 8.8 h during the same period.

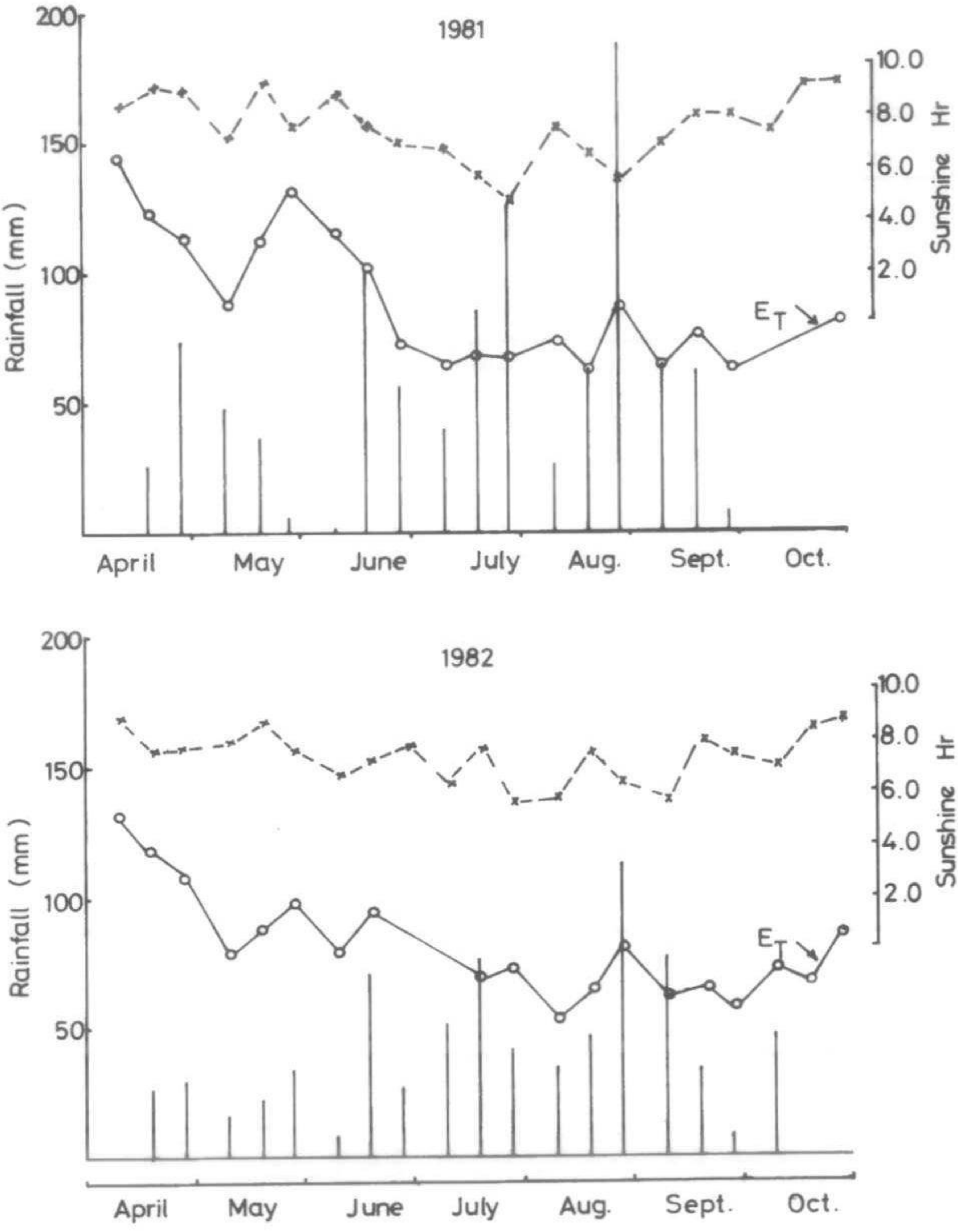

Fig. 1: Climate data for Samaru during the 1981 and 1982 cropping seasons

3.2 Phenological development

Plants of photoperiod-insensitive sorghum tended to emerge heads later with delayed sowing but this was not so in the photoperiod-sensitive sorghum, which headed sooner with delayed sowing (Table 1). When the sowing of var. L.187 was delayed till 16 July in 1981 and 9 July in 1982, number of days to heading was shortened by 18 and 11 days respectively. It appears that heading in var. L.187 is under a stronger control of photoperiod response. Flowering responded to delayed sowing in the same manner as heading. Generally, time to flowering was lengthened in var. HP3 as sowing was delayed while flowering was hastened in var. L.187. Although ADESIYUN (1980) failed to observe a definite response of heading in photoperiod-insensitive sorghum to sowing date at Samaru, more recently, delayed sowing consistently hastened heading in sorghum varieties (K.A. ELEMO pers. comm.). This is contradicted by the present result in that delayed sowing delayed heading in the photoperiod-insensitive sorghum. However, our result corroborates the results of CURTIS (1968a) and SASTRY and KRISHNAMURTHY (1985), who had reported hastened heading and flowering in photoperiod-sensitive sorghum. As crops sown late are likely to experience more short days, it is logical to expect that heading will be hastened by delayed sowing.

Table 1: Sowing date effect on phenological events in grain sorghum var. HP3 and L.187 at Samaru 1981 and 1982

	Days to heading (No.)		Days to 50% flowering (No.)		Days to physiol. maturity (No.)		Length of grain filling (days)	
Sowing date	HP3	L.187	HP3	L.187	HP3	L.187	HP3	L.187
1981								
SD1 - 15 June	65.2 a	111.2 h	69.0 a	114.2 g	95.8 a	146.5 e	26.8 abc	32.2 bcde
SD2 - 25 June	76.5 bcd	112.8 h	79.0 b	115.0 g	104.0 ab	151.0 e	25.0 ab	36.0 de
SD3 - 6 July	75.8 bcd	102.3 g	80.5 bc	106.0 f	110.2 bc	141.0 de	29.8 abcd	35.0 de
SD4 - 16 July	73.2 bc	93.0 f	76.5 ab	97.2 e	105.0 ab	133.2 d	29.0 abcd	36.0 de
SD5 - 27 July	78.8 cd	88.0 ef	81.0 bc	93.0 de	105.2 ab	130.8 d	24.2 a	37.8 e
SE6 - 6 Aug.	69.8 ab	82.2 de	73.2 ab	87.0 cd	95.8 a	120.2 c	22.5 a	33.2 cde
mean	73.2	98.2	76.5	102.1	102.7	137.1	26.2	35.0
1982								
SD1 - 9 June	68.5 ab	108.8 g	69.2 ab	112.5g	95.0 a	152.5 e	24.5 a	40.0 bcd
SD2 - 19 June	64.5 a	103.0 f	72.0 bc	106.5 f	101.5 a	144.2 cde	29.5 abc	37.8 abcd
SD3 - 29 June	69.2 ab	100.2 ef	73.0 bc	103.5 f	102.0 a	134.0 c	29.0 abc	27.2 ab
SD4 - 9 July	64.8 a	97.5 e	67.0 a	104.2 f	100.5 a	140.5 cde	31.0 abc	36.2abcd
SD5 - 19 July	72.2 b	97.2 e	76.8 c	102.2 f	106.0 a	147.2 de	29.2 abc	45.0 d
SD6 - 29 July	78.0 c	91.5 d	82.0 d	95.5 e	121.2 b	137.0 cd	39.2 bcd	41.5 cd
Mean	69.5	99.7	73.3	104.1	104.4	142.6	30.4	38.0

Figures followed by the same letter(s) within the columns and rows in the same year are not significantly different at 5% level of probability according to the Duncan's Multiple Range Test.

Time to physiological maturity was shortened as the sowing of var. L.187 was delayed (Table 1); possibly in response to unfavourable soil moisture supply conditions towards the end of the growing season. The onset of dry harmattan weather no doubt also contributed to the hastening of maturity in the late-sown L.187 crops. Such weather and soil moisture conditions had lesser effects on HP3, the early-maturing photoperiod-insensitive variety, except in the last sowings, where maturity was delayed by as much as 15-26 days. The effect of sowing date on length of grain filling period was not clearly defined; response appears to be quadratic for both varieties in 1981 and for var. L.187 only in 1982. This suggests that a number of environmental factors, which are likely to vary from year to year, might influence response to sowing date.

3.3 Crop yield and grain characteristics

Grain yields of the two varieties declined as sowing was delayed from 15 June through 6 August in 1981 and from 9 June through 29 July in 1982 (Table 2). However, the two varieties responded differentially to delayed sowing. In 1981, grain yield of var. HP3 did not decline appreciably until sowing was delayed up to 27 July and beyond; whereas in var. L.187 there was marked yield decline right from the 6 July sowing. Grain yield declined by as much as 82-87% when sowing of this photoperiod-sensitive variety was delayed by 40-54 days. Sorghum seedlings tend to develop rather slowly during the peak of the rains in late July to early August at Samaru because of cool weather. Unfavourable soil moisture supply occurs towards the end of the growing season, when late-sown L.187 was in its drought-sensitive reproductive phase. ANDREWS (1973) believed that factors which explain the larger yields generally obtained with early sowing iclude leaching of mineralized nutrients, lower incoming radiation and cooler temperatures.

In 1982, a year with a better rainfall, var. L.187 was also more sensitive to delayed sowing than var. HP3. When the sowing of var. HP3 was delayed till 19 July a decent grain yield was produced; whereas yield of var. L.187 was a mere 2% of that of the first sowing (i.e. 9 June). MIRHADI and KOBAYASHI (1981) attributed reduced grain yield in late sown sorghum to decreased translocation of assimilates to grain. The decline in grain yield due to late sowing var. L.187 may be associated with the fact that this variety is strongly adapted to flowering at the end of the rains (CURTIS, 1968a). The degree of sensitivity to delayed sowing was greater in the wetter year than the drier one, suggesting that factors other thas soil moisture supply alone must be at play. Straw yield also declined in response to delayed sowing, except that straw yield of var. HP3 did not respond to sowing date in 1981. In that same year, however, straw yield of L. 187 declined steadily with delay in sowing up to 6 July. In the following year, both varieties produced less straw as planting was being delayed up to 9 July. As much as 1 ton per ha dry matter yield loss for every week delay in planting of cold-tolerant sorghum in years with heavy early rains was observed by ARKEL (1980) in the Kenyan highlands.

Table 2: Sowing date effect on grain and straw yields, grain number and grain weight in grain sorghum var. HP3 and L.187 at Samaru, 1981 and 1982

	Grain yield (kg ha^{-1})		Straw yield ±(q ha^{-1})		No. grains per panicle		1000-grain wt. (g)	
Sowing date	HP3	L.187	HP3	L.187	HP3	L.187	HP3	L.187
1981								
SD1 - 15 June	1071 bcd	1444 d	30.3 a	62.5 c	1300 cde	1054 bcd	16.7 a	39.6 d
SD2 - 25 June	982 bcd	1343 cd	23.3 a	58.3 bc	1312 cde	937 bc	16.7 a	37.5 cd
SD3 - 6 July	905 bcd	874 bcd	19.1 a	46.8 b	1632 e	916 bc	17.6 a	38.8 d
SD4 - 16 July	855 bcd	602 ab	25.6 a	26.8 a	1461 de	618 ab	17.3 a	35.1 bc
SD5 - 27 July	816 bc	256 a	19.7 a	23.6 a	1414 cde	332 a	18.7 a	34.0 bc
SE6 - 6 Aug.	685 ab	187 a	18.6 a	18.3 a	1390 cde	190 a	17.1 a	33.0 b
mean	885.7	784.3	22.8	39.4	1418.2	674.5	17.4	36.3
1982								
SD1 - 9 June	1565 de	2216 f	66.4 c	98.2 d	2074 g	1169 def	21.2 b	42.3 f
SD2 - 19 June	1776 ef	1734 ef	64.1 c	73.4 c	2228 g	1201 def	18.1 a	41.8 f
SD3 - 29 June	1071 cd	907 c	41.2 b	63.8 c	1504 f	662 bc	17.9 a	40.4 ef
SD4 - 9 July	1089 cd	146 a	30.7 ab	43.4 b	1436 ef	203 a	15.7 a	34.7 c
SD5 - 19 July	737 bc	45 a	16.9 a	31.7 ab	1045 cde	116 a	17.4 a	36.0 cd
SD6 - 29 July	342 ab	63 a	19.6 a	30.4 ab	826 bcd	144 a	21.3 b	38.3 de
Mean	1096.7	851.8	39.8	56.8	1518.8	582.5	18.6	38.9

Figures followed by the same letter(s) within the columns and rows in the same year are not significant different at the 5% level of probability according to the Duncan's Multiple Range Test.

Variety HP3 was less responsive to delayed sowing in terms of reduction in grain number than did var. L.187 (Table 2). In 1981, for instance, delayed sowing had no significant effect on the grain number of var. HP3 while in var. L.187 it was drastically reduced when delay was up to 16 July (i.e. by 30 days) or beyond. Sorghum panicles were virtually empty when sowing was delayed by 50 days. In 1982, however, grain number of var. HP3 declined as sowing was delayed but maintained a reasonable number of grains up to the 29 July sowing. In the case of var. L.187, however, there was a drastic reduction in grain number when sowing was delayed up to 29 June and its panicles were almost devoid of grains. Seed set failure has been found to be the most important factor causing yield losses in late-sown sorghum in northern Ghana (MERCER-QUARSHIE, 1969).

Delayed sowing did not affect grain weight (i.e. 1000-grain weight)in var. HP3 except in 1982, when the grain weights for the first and last sowings were either at par or greater than any of the other sowings. While var. HP3 has greater potential for more grains per panicle than var. L.187, its average grain weight is much lower than that of var. L.187. Grain weight in L.187 declined in both years as sowing was being delayed. As a result of the relatively longer total growth cycle of var. L.187, a depletion of soil moisture during the latter part of the growing season probably accounted for the lower weights of panicle and grain. ANDREWS (1973) had observed that the later the sowing of photoperiod-sensitive sorghum, the later will the grains begin to fill; the late-sown crop having formed its grain under worse conditions of soil moisture supply.

Generally, number of panicles per square meter, weight per panicle, grain weight per panicle and panicle length declined as sowing date was delayed in both varieties (Table 3). In the photoperiod-sensitive variety, however, panicle number declined 47.0 and 52.3% when

Table 3: Sowing date effect on panicle characters in grain sorghum var. HP3 and L.187 at Samaru, 1981 and 1982

	No. panicles m^{-2}		Wt. per panicle (g)		Grain wt. $panicle^{-1}$ (g)		panicle length (cm)	
Sowing date	HP3	L.187	HP3	L.187	HP3	L.187	HP3	L.187
1981								
SD1 - 15 June	4.7 c	3.4 b	39.5 bc	66.0 e	22.2 bc	42.1 f	26.0 b	27.1 b
SD2 - 25 June	4.5 c	3.8 bc	45.4 cd	59.6 de	21.6 bc	34.8 def	26.2 b	25.7 b
SD3 - 6 July	3.2 b	3.2 cd	46.2 cd	65.8 e	28.9 cde	35.7 ef	25.5 b	25.6 b
SD4 - 16 July	3.3 b	2.8 b	47.1 cd	53.5 cde	25.2 cde	21.8 bc	25.2 ab	27.0 b
SD5 - 27 July	3.0 b	1.8 a	46.7 cd	25.4 ab	26.7 cde	11.8 ab	25.2 ab	24.6 ab
SE6 - 6 Aug.	3.0 b	1.2 a	39.7 bc	11.1 a	23.3 bcd	6.1 a	24.6 ab	23.0 a
mean	3.6	2.7	44.1	54.2	24.6	25.4	24.4	25.5
1982								
SD1 - 9 June	4.8 fg	4.4 efg	67.4 fg	79.2 g	44.2 d	49.5 d	26.4 bc	30.2 e
SD2 - 19 June	4.5 fg	3.5 def	57.7 ef	81.2 g	39.4 d	49.9 d	26.1 b	29.4 de
SD3 - 29 June	4.0 efg	3.1 cde	46.7 cde	50.4 de	27.0 c	26.9 c	26.1 b	28.9 cde
SD4 - 9 July	4.9 g	2.1 abc	37.4 bcd	18.7 a	22.6 c	7.1 ab	26.8 bcd	27.2 bcd
SD5 - 19 July	4.2 efg	1.1 a	32.1 abc	18.6 a	18.3 c	4.2 a	25.1 b	24.4 b
SD6 - 29 July	2.4 bcd	1.3 ab	27.8 ab	24.8 ab	16.7 bc	5.5 a	20.0 a	25.7 b
Mean	4.1	2.6	44.8	45.5	28.0	23.8	25.1	27.6

Figures followed by the same letter(s) within the columns and rows in the same year are not significantly different at the 5% level of probability according to the Duncan's Multiple Range Test.

sowing was delayed until 27 July in 1981 and until 9 July in 1982 respectively. ANDREWS (1973) also observed significant decline in number of heads per unit area in sorghum when sowing was delayed beyond the optimum date; this being more severe in the year with a relatively heavier shootfly infestation.

Reduction in head number was partly associated with this pest infestation. Panicle weight was reduced by as much as 44.5% when sowing of the photoperiod-insensitive variety was delayed till 9 July. Grain weight per panicle declined with delayed sowing in both years and in both varieties but decline was more drastic in the photoperiod-sensitive variety. It was only in 1982 that grain weight per panicle declined in the photoperiod-insensitive variety when sowing was delayed till 9 July. Delayed sowing caused reduction in panicle length only in 1982, reducing it by 6.4 and 4.5 cm in the photoperiod-insensitive and sensitive varieties respectively.

Table 4: Sowing date effect on shootfly infestation, shootfly score and grain: stover ration in grain sorghum var.HP3 and L.187 at Samaru, 1981 and 1982

	Shootfly infestation (%)		Shootfly score		Grain: stover ratio	
Sowing date	HP3	L.187	HP3	L.187	HP3	L.187
1981						
SD1 - 15 June	5.6 a	7.2 a	-	-	.34 cd	.24 b
SD2 - 25 June	3.4 a	19.4 bc	-	-	.41 de	.23 b
SD3 - 6 July	11.0 ab	42.6 d	-	-	.49 e	.23 b
SD4 - 16 July	19.6 bc	56.4 e	-	-	.34 cd	.26 bc
SD5 - 27 July	23.2 c	79.0 f	-	-	.40 de	.09 a
SE6 - 6 Aug.	36.2 d	92.4 g	-	-	.37 cd	.04 a
mean	16.5	49.5	-	-	.39	.18
1982						
SD1 - 9 June	4.9 a	6.9 a	0.0 a	0.0 a	.32 j	.23 f
SD2 - 19 June	4.8 a	14.1 ab	0.0 a	0.1 a	.28 i	.24 g
SD3 - 29 June	21.2 b	46.4 c	1.0 b	2.1 c	.27 h	.13 d
SD4 - 9 July	36.4 c	73.9 d	1.8 c	2.9 d	.36 k	.03 b
SD5 - 19 July	47.3 c	92.6 e	2.2 c	3.8 e	.43 l	.02 a
SD6 - 29 July	64.8 d	95.6 e	2.8 d	4.0 e	.18 e	.05 c
Mean	29.9	54.9	1.3	2.2	.31	.12

Figures followed by the same letter(s) within the columns and rows in the same year are not significantly different at the 5% level of probability according to the Duncan's Multiple Range Test.

3.4 Shootfly infestation and grain production efficiency

Shootfly infestation became more severe as sowing was delayed past the optimum sowing date (Table 4). it was observed that the two varieties differed quite markedly in their susceptibility to shootfly infestation. Variety L.187 was more susceptible to shootfly than var. HP3 was. In 1981, when sowing was delayed until 6 August, 36 and 92% shootfly infestation levels were observed in var. HP3 and L.187 respectively. Once sowing of var. L.187 was delayed till late June or early July at Samaru, shootfly infestation became noticeable on the crop of this variety; whereas this was not so in var. HP3 until sowing was delayed up to late July of thereafter. Shootfly infestation scores also revealed that var. HP3 was able to escape infestation reasonably well in contrast to var. L.187. Plants of var. HP3 sown in June virtually escaped infestation while those of var. L.187 in the latter part of the same month suffered from it.

The susceptibility of var. L.187 as reflected in drastic grain yield reduction can be traced to the severe shootfly infestation of young plants under later sowing conditions. Both grain and straw yields declined correspondingly with increased shootfly infestation in 1981 and 1982. The observed negative correlation between yields and shootfly infestation was more significant in 1982 than in 1981. Pooled over years and varieties the correlation coefficient values for shootfly infestation with grain and straw yields were r = -.684** and r = -.409** respectively. Similar negative correlations between sorghum grain or straw yield and shootfly infestation had been reported by MOTE (1985). Shootfly population, which usually builds up during the latter part of the growing season, is able to infest late-sown sorghum crops and thereby cause severe reductions in grain yield (MERCER-QUARSHIE, 1969; ADESIYUN, 1977; BA-ANGOOD and HUBAISHAN, 1985). Although BA-ANGOOD and HUBAISHAN (1985) had observed similar varietal differences in susceptibility to sorghum shootfly infestation in Yemen, ANDREWS (1973) did not in Nigeria. The use of sowing date as a cultural method for the control of cereal pests has also been practised successfully elsewhere (JOTWANI, 1979; BA-ANGOOD and STEWARD, 1980). It is possible that information on the varietal responses to shootfly in relation to different sowing dates would be of great help in formulation pest management programmes for grain sorghum pests.

Variety HP3 is genetically more efficient than var. L.187 in terms of its capability to accumulate dry matter in the grains. Grain: stover ratio was less affected by sowing date in var. HP3, and was even increased when sowing of this variety was delayed until 29 July in 1982 (Table 4). In var. L.187, however, grain: stover ratio was reduced markedly when sowing was delayed till 27 July in 1981 and until 29 June in 1982. The reason is that shootfly attacks the primary shoots of late-sown susceptible sorghums, which react by producing numerous tillers (ADESIYUN, 1977), many of which may either be unproductive or plants may be unable to support panicles to full maturity.

Grains of var. HP3 sown early did not escape damage by high humidity as panicles developed and grains matured during the rains and therefore produced seeds of poor quality. As a result of the high atmospheric humidity under such conditions, the panicles become mouldy, especially caused by *Fusarium* spp and *Alternaria* sp. infections (CURTIS, 1968b; KASSAM and ANDREWS, 1975). Such grains do not store well and are also not fit for human consumption (CURTIS, 1968b). The higher yields of early-sown early-maturing varieties will therefore be at the expense of grain quality. It can be concluded that if grain sorghum is to be unavoidably sown late, then, photoperiod-insensitive varieties should be used. However, if sown too early, increased grain yield may be at the cost of reduced grain quality.

The result of the experiment shows that major causes of yield loss in late-sown photoperiod-sensitive sorghums in the Nigerian savanna include shootfly infestation and unfavourable soil moisture conditions.

Summary

Field trials were conducted at Samaru, Nigeria during the 1981 and 1982 cropping seasons to study the yield and growth responses of photoperiod-sensitive and insensitive sorghum varieties to delayed sowing. Six sowing dates at 10-day intervals were compared each year starting in mid-June. Grain yield of the photoperiod-sensitive variety (L.187) declined by 82–87% when sowing was delayed by 40-45 days. The photoperiod-insensitive variety (HP3) was less responsive to delayed sowing. Greater grain yield in early-sown var. HP3 was at the expense of grain quality. Straw yield and grain number declined in var. L.187 in

response to delayed sowing but not in var. HP3. Number of panicles, weight per panicle, grain weight per panicle and panicle length declined in both varieties but more so in var. L.187. Severe shootfly infestation in late-sown crops, particularly in var. L.187, was associated with heavy yield loss. Photoperiod-insensitive sorghum headed and flowered later in late-sown than in early-sown crops. If photoperiod-sensitive late-maturing sorghum varieties are to be grown, it is advisable that sowing be done as soon as the rains are established.

Zusammenfassung

In Samaru, Nigeria, wurden 1981 und 1982 während der Anbausaison Feldversuche mit photoperiodisch sensitiven und nicht sensitiven Hirsesorten durchgeführt um den Einfluß der verspäteten Aussaat auf Ertrag und Wachstum festzustellen. Sechs Saattermine mit 10tägigen Intervallen beginnend Mitte Juni wurden in den Jahren verglichen. Der Kornertrag der photoperiodisch sensitiven Sorte (L.187) fiel um 82-87% bei mit 40-45 Tagen verspäteter Aussaat. Die photoperiodisch nicht sensitive Sorte (HP3) war weniger anfällig auf späte Aussaat. Höherer Kornertrag der Sorte HP3 bei früher Aussaat ging zu Lasten der Kornqualität. Strohertrag und Anzahl der Körner fiel bei der Sorte L187, abhängig von den Aussaatterminen, was bei der Sorte HP3 nicht der Fall war. Die Anzahl der Rispen, das Gewicht pro Rispe, das Korngewicht pro Rispe und der Rispenlänge fielen bei beiden Sorten, stärker aber bei L187. Schwerer Hirseschößlingslfliegen-(*Atherigona soccata Rondani*)-Befall bei später Aussaat, speziell bei L187, brachte großen Ertragsverlust.

Photoperiodisch sensitiver Sorghum schob und blühte später bei später Aussaat. Sollen photoperiodisch sensitive spätreife Sorghum-Sorten angebaut werden, so wird die Aussaat gleich nach Beginn der Regenfälle empfohlen.

Key words: *Sorghum bicolor* L., sowing date, photoperiod sensitivity, yield, growth, phenology

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