Effects of Soil Temperature Pattern on the Performance of Cucumber Intercrop with Maize in a Tropical Wet-and-Dry Climate of Nigeria

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ABSTRACT

Maize and cucumber were intercropped in simple randomized complete block design (RCBD) with three replicates in two field trials in early and late planting seasons of 2004. The result showed that mean soil temperature of 33°C and 31°C at 5 and 10cm during late season could be said to have enhanced the productivity of cucumber yield by about 50% compared to early season with mean soil temperature of 30°C and 29°C at 5cm and 10cm below soil surface. The mean cucumber yield of 9t/ha and 6.1t/ha for mono and mixed crop respectively during early season trial was significantly lower ($P<0.05$) than the mean cucumber yield of 15.34t/ha and 12.34t/ha for late season. [Researcher. 2009;1(2):24-36]. (ISSN: 1553-9865).

Keywords: Soil Temperature Pattern; Cucumber Intercrop; Maize; Nigeria

INTRODUCTION

In most parts of the tropical wet and dry climate, thermal meteorological parameters such soil and air temperatures are part of critical considerations in crop production and they are equally important component of the plant environment in a tropical wet-and-dry climate. For instance timing of phenological events had been confirmed to be clearly correlated with different climatic factors such as air temperature and soil temperature. (Wielgolaski, 2001). Also, many studies agreed that accumulated temperature was recognized as the main factor influencing year-to-year variation in major plants physiological phases (Galan et al., 2001; Schaber and Badeck, 2003).). Consequently, the present study sought to investigate the effects of soil temperature pattern on the performance of two grown crops (Maize and Cucumber) in the study area using the inter-cropping system which occupies a great percentage of cultivated land in West Africa (Wahua, 1986).

Maize and cucumber are two important food crops in Nigeria as well as in other parts of the world. Over the years maize has been useful as a food, construction material, and medicinal or decorative plant. With the industrial development, it increasingly became an industrial raw material for the production of starch, gluten, oil, flour, alcohol and lignocelluloses for further processing into a whole range of products and byproducts. On the other hand, cucumber is a major fruit vegetable that is eaten raw (in salad) or cooked. It can also be put in vinegar; the crop serves as a major source of vitamins for people in developing countries. (Ayotamuno et al, 2000)

MATERIALS AND METHODS

Study area

Location of the experiment

The experiment was conducted at the University of Agriculture Abeokuta along Alabata road in Odeda local government area of Ogun state, south western Nigeria. The field experiment was conducted during the early and late growing season of 2004 at the Agro Meteorological Teaching and Research Farm land located adjacent to the meteorological station within the vicinity of the College of Environmental Resources Management University of Agriculture (7° 15¹ N, 3° 25¹E). The location map of the study area is shown in Figure 1.

Planting and crop maintenance

Maize cultivars, Suwan1(M1) and TZ Comp4 (M2) and cucumber were intercropped in two field trails in early and late planting season of 2004. Early planting was done in May 2004 while late planting was done in August 2004 planting season, usually after the establishment of rains. According to Stern *et al.* (1981) the time of establishment of the rains is marked by the period when two days were not followed by a

continuously dry period of say 5, 7 or 10days. Between three and four seeds of maize and cucumber were planted at a depth of 2.5cm in each stand and the stands on the row for maize were spaced at 2.5cm between stands while between stands for cucumber were spaced at 50cm.
Three weeks after planting the maize and cucumber seedling were thinned to two and one per stand respectively following the recommended thinning procedure (Kowal and Andrews, 1973) and this resulted in a plant population of 26,666plantha^{-1} and 13,333plantha^{-1} for maize and cucumber, respectively. The plots were hand hoed and weeded manually at 3 and 6 weeks after planting. All plots received a basal dressing of 70kg N/ha urea.

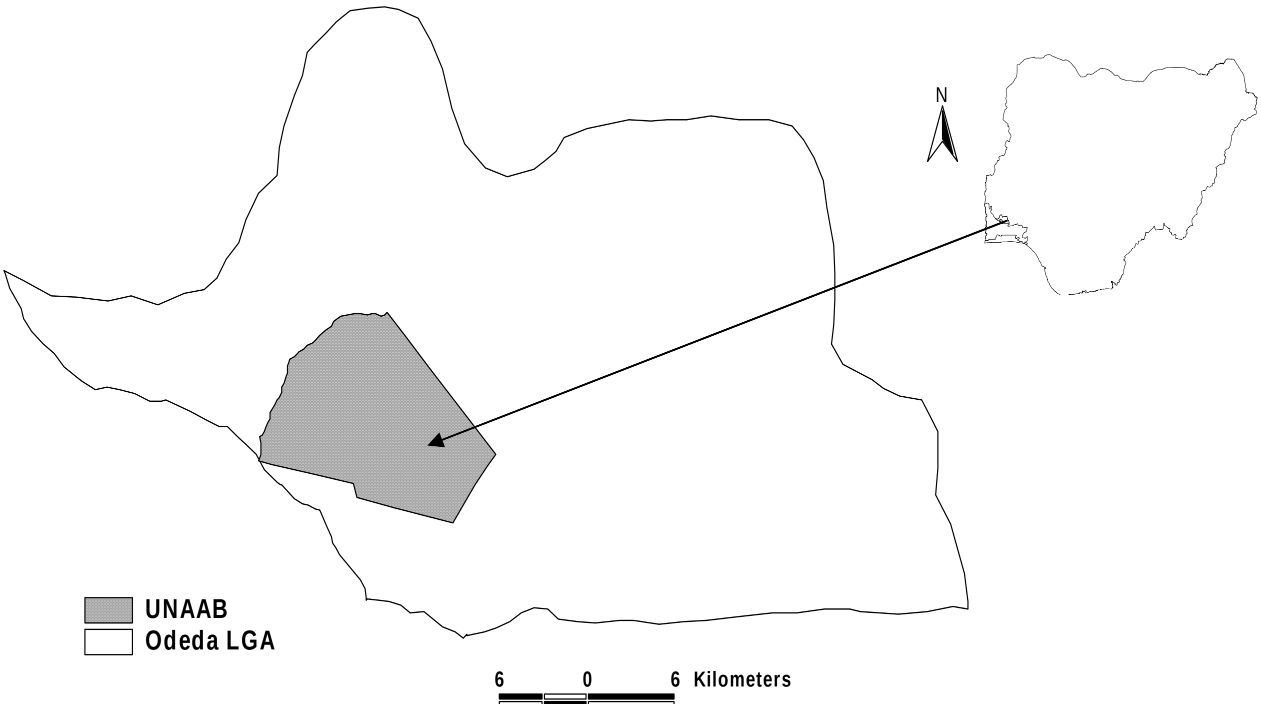

Fig.1: Location of University of Agriculture, Abeokuta within Odeda Local Govt. Area in Ogun State, Southwest Nigeria.

Lay out of experimental plot

Experimental plots were arranged in simple randomized complete block design (RCBD) with three replicates for early and late growing seasons in 2004. Cropping systems, early and late planting seasons as the main factors. Each plot was 5 x 2.25m with 1m walking path between the adjacent plots.

Data collection and analysis
During the phenological stages, data were collected on soil temperature at 5 and 10cm from the soil surface along with other agrometeorological data from the meteorological station adjacent to the experimental plots except soil temperature that were measured on the experimental plots. Data were also collected on some important phenological crop growth parameters and yield characters.

Growth parameters
Plant height: This was taken from a sample of four plants (maize) tagged within the two central rows of each plot. The mean from the four plants was then determined.

Leaf area: The leaf area shall be determined by the non destructive length x width method described by Saxena and Singh, (1985) using the relation: Leaf area = 0.75 (length x width), where 0.75 is a constant. Five leaves were measured for each treatment plot and the mean leaf area determined. The leaf area for cucumber was measured by the girth system whereby graph sheets were used to trace the area (surface) of five leaves in each treatment plot and the mean determined.

Days to 50% flowering: The effect of treatment on the flowering period of maize and cucumber were measured by recording the days from planting to when 50% of both plants flowered.

Yield parameters

Fruit length: The lengths of five fruits weighed were measured and the mean determined.

Fruit weight: Five cucumber fruits from each plot were weighed separately and the mean determined. Also, weekly harvest totals were recorded for analysis.

Fresh cob weight: Five fresh maize cobs from each plot were weighed separately and the mean determined. This was done to give a good estimate of the total yield of fresh maize.

Weight of seeds per cob: Five maize cobs from each plot were allowed to dry in the field to 14% moisture content and then harvested. The seeds were removed from the cobs and weighed. The mean was then determined.

Data analysis

Data collected were subjected to analysis of variance (ANOVA) to evaluate the effects of seasonal variations and their interactions on the response variables. The significant difference of treatment means were determined using least significance difference (LSD) at 5% level of probability (Steel and Torrie, 1988).

RESULTS

Hydrothermal characteristics during the early cropping season 2004

Decadal rainfall and air temperature for the early season were related to the main phases of vegetative growth and reproductive development of maize-cucumber in Fig 2. The peak rainfall (150mm) was observed at about 30 days after planting and this period coincide with the plant establishment and vegetative stages during the early life of maize and flowering stage of cucumber plants revealing that moisture was not limiting at these critical stages of plant life. Another lesser peak of 69.8mm was also observed at about 80 days after planting which also showed that at maturity stage of the maize plants life moisture stress was also not pronounced while cucumber had completed its life cycle and no more on the field. The critical rainfall for maximum yield at these periods could be said to range between 150-69.8mm. Temperature also differed slightly during maize-cucumber growth stages in the early cropping season of 2004. Minimum and maximum temperature varied between 22 – 24^{o}C and 29 - 32^{o}C respectively. Temperature was higher during planting, establishment and early vegetative growth (32^{o}C –29^{o}C) than during reproductive growth in the early cropping season. (24^{o}C-22^{o}C). The cumulative amount of rainfall for the period between sowing and 50% flowering was 324.6mm, accordingly the rainfall for the period between 50% flowering and maturity (reproductive phase) was 261.4mm in the early season crops. Minimum and maximum temperature of 23^{o}C and 32^{o}C were recorded in the early season at planting.

Hydrothermal characteristics during the late cropping season 2004

As shown in Figure 3 late season rainfall trends revealed lowest rainfall amount was observed for the period between 3rd and 9th decades corresponding to 30days after planting to 90days after planting (16mm to 64.6mm) with peak rainfall at 50days after planting (5th decade) (114.9mm). This implies that moisture stress at the later part of plants life was less pronounced than that at the initial stage of plants life during the late growing season. Temperature differed slightly in the late cropping season. Minimum and maximum temperature varied between 21^{o}C-23^{o}C and 28 ^{o}C -32 ^{o}C respectively. Temperature was low during planting, establishment and early growth than during flowering, i.e 21°C -22 °C and 29°C – 32 °C respectively. The amount of rainfall for period between sowing and 50% flowering was 176.30mm. Accordingly, the rainfall for the period between 50% flowering and maturity (reproductive phases) was 214.10mm. Rainfall was therefore much larger during both vegetative and reproductive phase in the early season than late-season. The late-season can be defined as dry since the rainfall curve remains below the maximum temperature curve for most periods during both the vegetative and flowering phases as shown in figure 2. The minimum and maximum temperatures at planting in the late-season were 22°C and 28°C respectively.

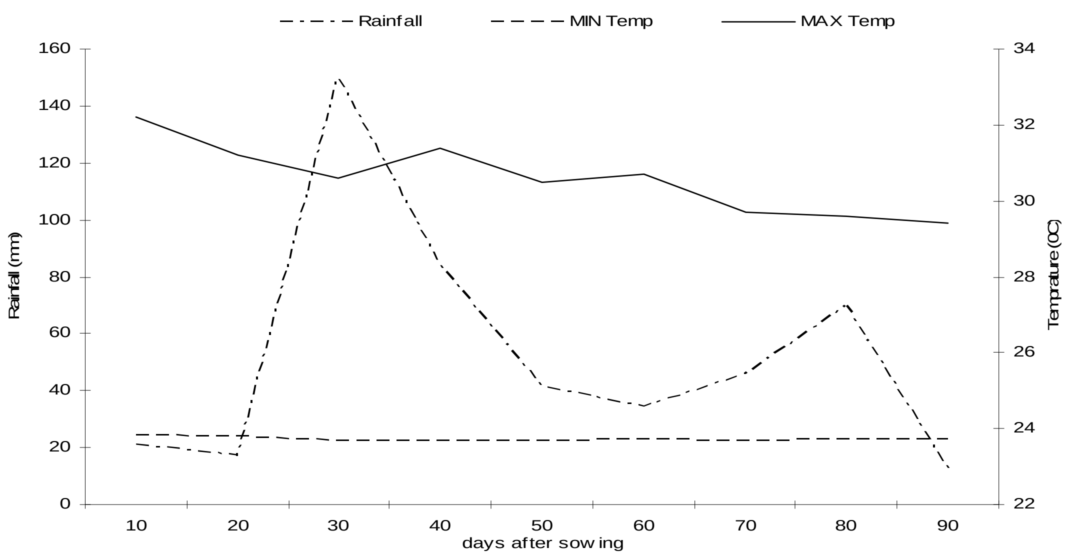

Figure 2: Decadal rainfall, minimum and maximum air temperatures during the growth of cucumber/maize at Alabata, UNAAB in the early season (May – July) of 2004

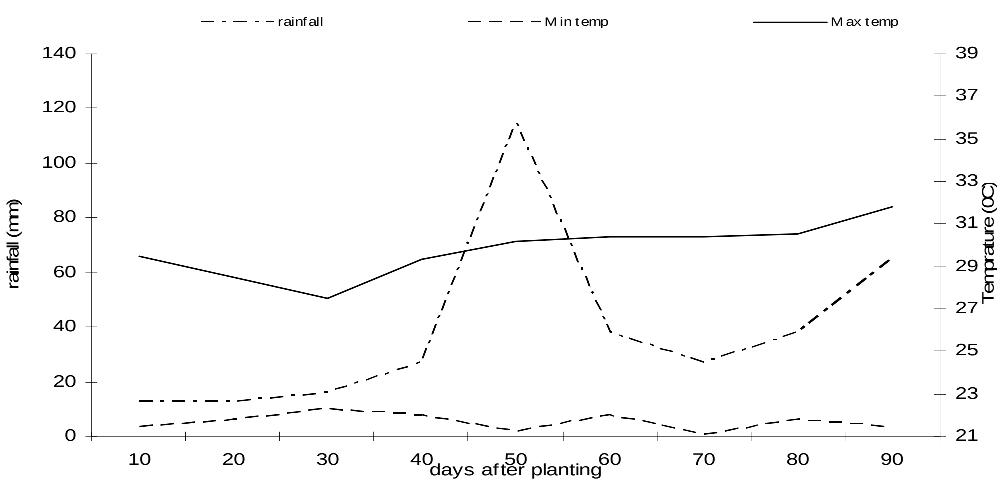

Figure 3: Decadal rainfall, minimum and maximum air temperatures during the growth of cucumber/maize at Alabata, UNAAB in the late season (August – October) of 2004.

Figure 4 shows the amount of rainfall at each phenological stage. Rainfall at pre-sowing period, establishment, flowering, 50% maturity and first harvest for early season were 27mm, 11mm, 324.6mm, 84.5mm respectively and 76.8mm against 12.6mm, 16mm, 206.5mm, 64.6mm and 37.8mm respectively for late season . This showed that early season moisture maize-cucumber plants experience no moisture deficiency throughout the entire period.

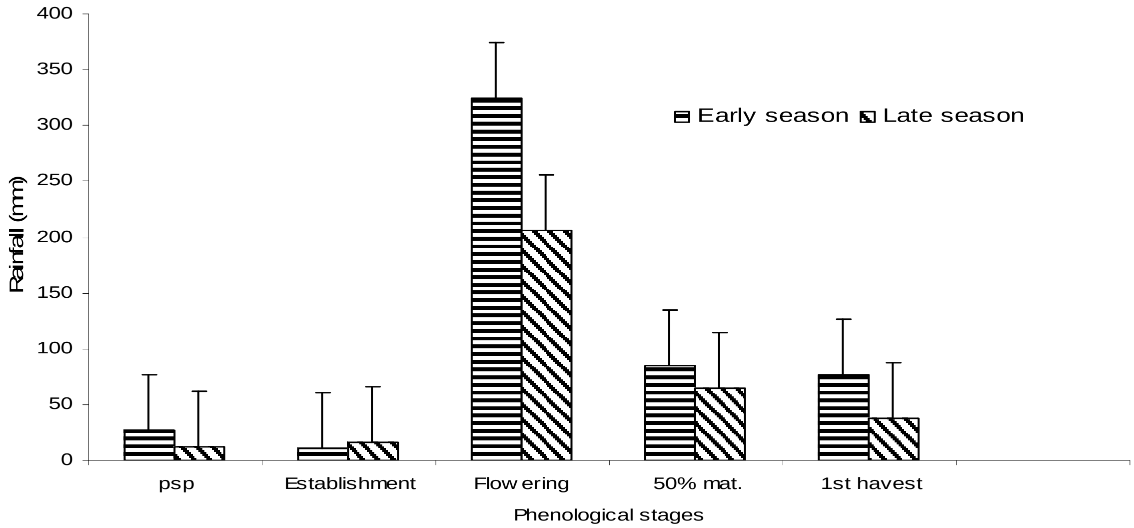

Figure 4: Rainfall at major phenological stages during the growth of cucumber/maize at Alabata, UNAAB in 2004 cropping season

Figures 5 and 6 shows soil temperature at 10cm below soil surface during the growth of cucmber/maize at Alabata, UNAAB in 2004 cropping season. Soil temperature did not vary significantly under both mono and mixed cropping. Highest temperature (32°C) was recorded at vegetative and flowering stages followed by that at maturity stage of about 26°C. Soil temperature was however higher at the early stage than at later stage of the plant life. This means that soil heat flux was higher at vegetative and flowering stages than at maturity stage, this is an indication that water absorption rate was higher at these periods.

Figures 7 and 8 shows soil temperature at 5cm during the growth of cucumber /maize at Alabata, UNAAB in 2004 cropping season. Soil temperature on both mono and mixed cropping was similar at all sampling occasions. During the early season slight difference started at vegetative stage and flowering stage. Late season soil temperature at 5cm was almost the same on both mono and mixed cropping especially at sowing, establishment and vegetative stages, slight difference was observed around flowering stage and this was maintained till harvest. The result showed that mean soil temperature of 33°C and 31°C at 5 and 10 cm during late season may be said to have enhanced the productivity of cucumber crop.

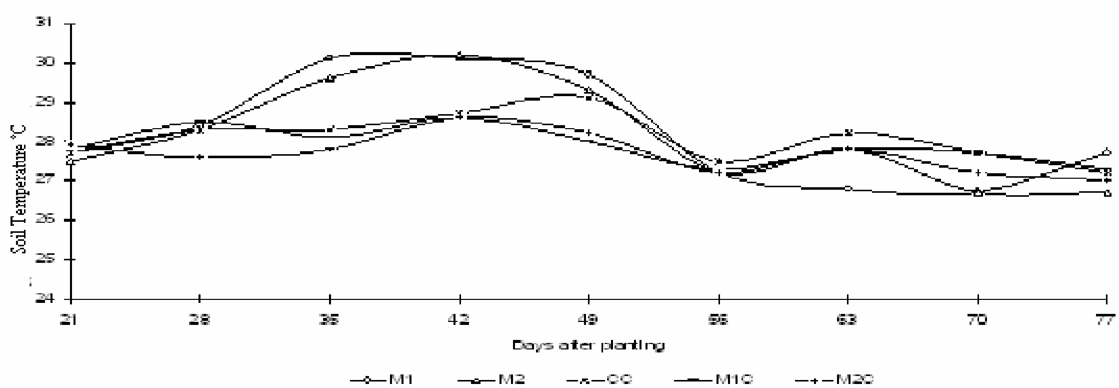

Figure 5: Soil temperature at 10cm depth during early season of 2004

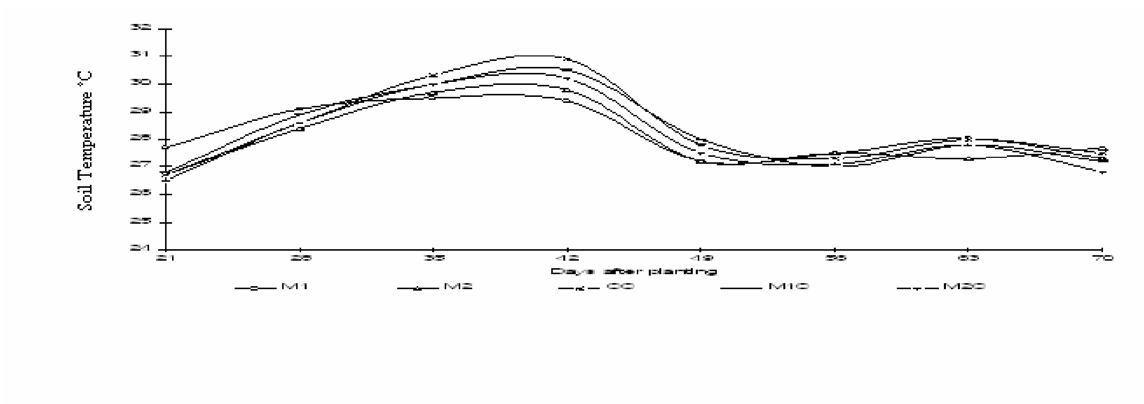

Figure 6 : Soil temperature at 10cm depth during late season of 2004

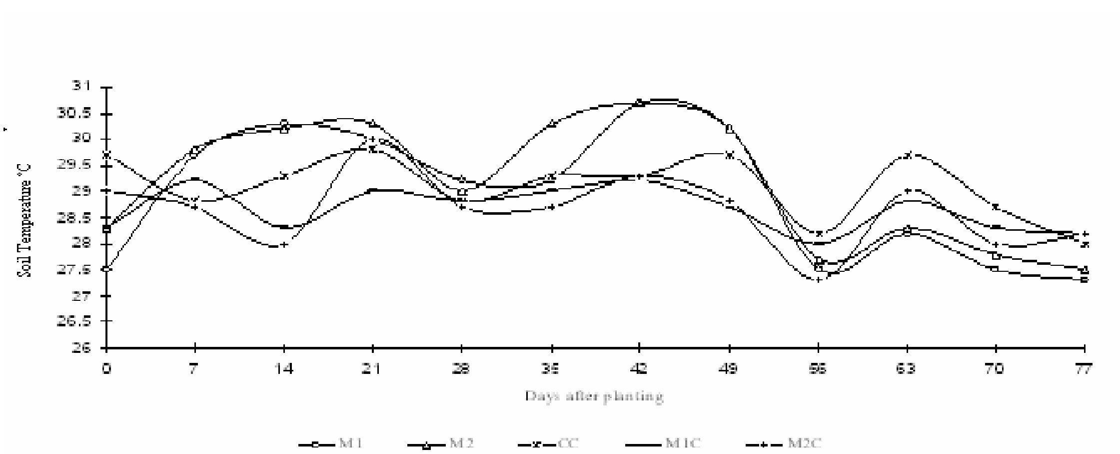

Figure7 : Soil temperature at 5cm depth during early season of 2004

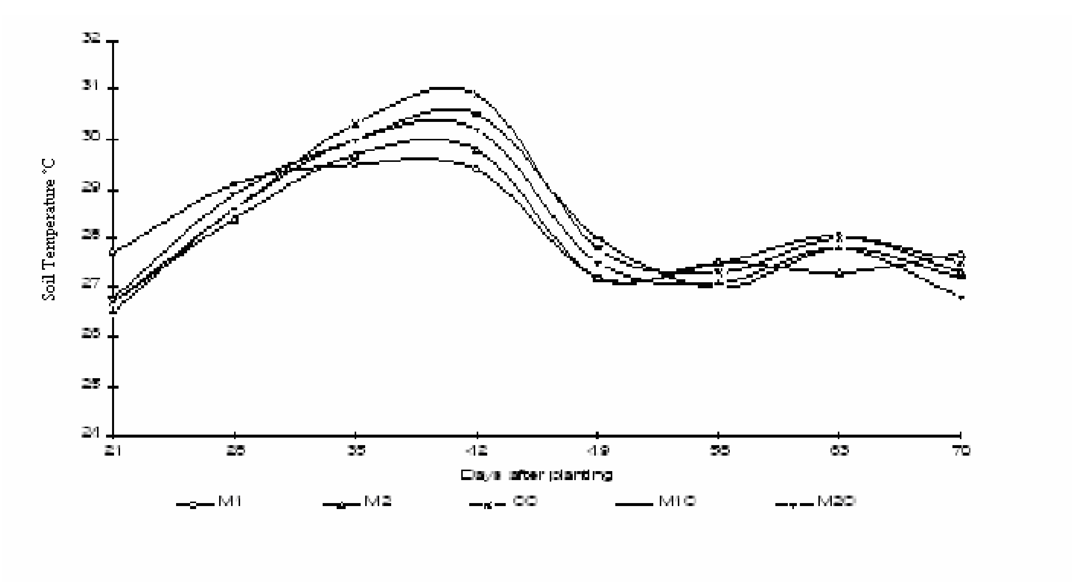

Figure 8 : Soil temperature at 5cm depth during late season of 2004

Growth Parameters

Leaf area of Maize (Early season)

Leaf area of maize in monoculture and mixed stands at 3, 4, 5, 6, 7, and 8 weeks after planting for both early and late season is presented in Table 1. The table shows difference between the leaf area of the maize cultivar Suwan-1 in monoculture and mixed stand at 3 weeks after planting while the difference was not statistically significant in the leaf area of TZCOMP4. The difference was not significant at 4, 5, 7 and 8 weeks after planting. Cultivar TZECOMP4 had a much bigger leaf area than its counterpart Suwan-1 in both monoculture and mixed cropping at all the sampling periods. In monoculture from 3 weeks after planting to 8 weeks after planting the leaf area of TZECOMP4 ranged between 230.94cm^2 to 535.00cm^2 while it was between 224.77cm^2 to 518.04c.m^2 for the leaf area of cultivar Suwan-1. In mixed stand the leaf area of TZECOMP4 ranged between 217.82cm^2 to 522.82 cm^2 while for Suwan-1 it ranged between 180.15cm^2 to 476.67cm^2. Also in monoculture, TZCOMP4 reached its largest value (535.12cm^2) at 7 weeks after planting while Suwan-1 attained peak value of (518.04cm^2) at 8 weeks after planting. However, in mixed stand Suwan-1 attained peak (477.00cm^2) at 8 weeks after planting while TZECOMP4 attained peak (524.82cm^2) at 8weeks after planting.

Late season

Table 1 also shows that the difference in leaf area of maize in monoculture and mixed stand was not significant in all the sampling occasions. Cultivar TZECOMP4 (M2) had a much bigger leaf area than its counterpart Suwan-1(M1) in both monoculture and maize/cucumber mixtures at all the sampling periods. In monoculture from 3weeks after planting to 8weeks after planting the leaf area of TZECOMP4 (M2) ranged between 150.59cm^2 to 636.91cm^2 while it was between 129.64cm^2 to 588.61cm^2 for the leaf area of cultivar Suwan-1 (M1). In TZECOMP4-cucumber mixtures (M2C) it ranged between 182.56cm^2 to 686.42cm^2 while for Suwan-1-cucumber mixture (M1C) ranged between 128.04cm^2 to 588.61cm^2. Also in monoculture, TZCOMP4 (M2) reached its largest value (636.91cm^2) at 6weeks after planting while suwan-1(M1) attained peak value (588.61cm^2) at 7 weeks after planting. However, in mixed stand suwan-1(M1C) attained peak (588.61cm^2) at 7 weeks after planting so also is TZECOMP4 (M2) attained peak (686.42cm^2) at 7 weeks after planting.

Table 1: Effect of seasons and cropping system on the leaf area (cm ^{2}) of maize at Alabata (UNAAB), 2004 cropping season

EARLY SEASON						LATE SEASON						
Cropping system	**3***	**4***	**5***	**6***	**7***	**8***	**3***	**4***	**5***	**6***	**7***	**8***
M1	225	241	300	486	444	518	130	309	519	572	589	574
M2	231	258	374	491	535	530	151	332	580	637	614	613
M1C	180	208	321	398	448	477	128	338	550	567	589	546
M2C	218	234	314	445	504	523	183	364	645	683	686	670
LSD (0.05)	35**	55	77	94**	96	61	57	60	129	120	99	127

* Week After Planting M1- Sole Maize (Suwan 1) M2- Sole Maize (TZComp 4)
M1C- Suwan 1/ Cucumber M2C- Tzcomp4/ Cucumber **- significant

Plant height (Early season)

Presented in Table 2 is plant height of maize in monoculture and maize/cucumber mixtures at 3, 4, 5, and 7 weeks after planting. The difference was not significant at 3, 4, and 5 weeks after planting. In monoculture from 3weeks after planting to 7weeks after planting the plant height of TZECOMP4 (M2) ranged between 58.00cm to 201.58cm while it was between 55.72cm to 186.67cm for the plant height of cultivar Suwan-1(M1). In mixed stand from 3weeks after planting to 7weeks after planting the plant height of cultivar TZECOMP4 (M2C) ranged between 57.78cm to 170.83cm while for Suwan-1(M1C) it ranged between 57.77cm to 192.17cm. Also in monoculture, TZCOMP4 (M2) and Suwan-1(M1) reached peak value of 201.58cm and 186.67cm respectively at 7weeks after planting. In mixed stand Suwan-1(M1C) attained peak (192.17cm) while TZECOMP4 (M2C) attained peak (170.83cm) also at 7weeks after planting.

Late season

The result on Table 2 also shows no significant difference in plant height of both Suwan-1(M1) and TZCOMP4 (M2) in monoculture and maize/cucumber mixtures at all observation points. Cultivar Suwan-1(M1) was generally taller than its counterpart TZCOMP4 (M2) in monoculture except for the 4th week whereas TZCOMP4 was higher in mixed cropping than Suwan-1 at all the sampling occasions. In monoculture from 3weeks after planting to 7weeks after planting the plant height of TZECOMP4 (M2) ranged between 28.37cm to 207.48cm while it was between 32.80cm to 216.03cm for the plant height of cultivar Suwan-1(M1). In maize/cucumber mixtures the plant height of cultivar TZECOMP4 (M2C) ranged between 32.83cm to 211.30cm while for Suwan-1(M1C) it ranged between 28.03cm to 200.77cm. Also in monoculture, TZCOMP4 (M2) and Suwan-1(M1) reached peak value of 207.48cm and 216.03cm respectively at 7weeks after planting. In mixed stand suwan-1(M1) attained peak (200.77cm) while TZECOMP4 (M2) attained peak (211.30cm) also at 7weeks after planting.

Yield parameters

Weight of maize seeds / cob

Early season weight of seeds / cob of the two maize cultivars (Table 3) were not significantly different in sole maize and maize-cucumber intercropped. Grain yield/ ear of Suwan-1 mixed with cucumber (M1C) had the highest amount (107g) while sole Suwan-1 (M1) had lowest (84g). Between these extremes are sole TZCOMP4 (M2) and TZCOMP4 mixed with cucumber (M2C) of 93g and 91g respectively. Late season grain yield/ ear of TZCOMP4 mixed with cucumber (M2C) had the highest amount (72g) while sole Suwan-1 (M1) had lowest (58g) followed by sole TZCOMP4 (M2) (66g) and Suwan-1 mixed with cucumber (M1C) of 61g. Differences of means were not significant at $P<0.05$.

Fresh maize cob weight

Early season cob weight is another maize yield character presented in Table 3. Suwan-1 mixed with cucumber (M1C) had highest cob weight (263g) followed by sole Suwan-1 (M1) (253g) and sole TZCOMP4 (M2) (240g) while TZCOOMP4 mixed with cucumber (M2C) had lowest of 203g. Late season yield of TZCOMP4 mixed with cucumber (M2C) had highest cob weight (266g) followed by Suwan-1-cucumber mixtures (M1C) (263g) and sole TZCOMP4 (M2) (250g) while sole Suwan-1 (M1) had lowest of 224g.

Cucumber fresh fruit characters

Early season fruits yield revealed that the variation in the fruit weight of cucumber was significantly different at $P<0.05$ with fruits from sole cucumber (CC) having much bigger fruit weight (296g) followed by cucumber-TZCOMP4 mixtures (M2C) (200g) while cucumber-Suwan-1 mixtures (M1C) has lowest fruit weight of 167g (Table 4). Fruit Length is another fruit character showed in Table 4. Fresh fruit from sole cucumber (CC) plot was highest (21cm) followed by fruit from Cucumber-Suwan-1 mixtures (M1C) (15cm) while its counterpart; cucumber-TZCOMP4 mixtures (M2C) had lowest fruit length of 13cm. The differences in fruit length between cucumber sole and cucumber-maize mixtures was significant at $P<0.05$.

Late season

Late season fruit yield in Table 4 showed that the variation in the fruit weight of cucumber was not significantly different (P<0.05) with fruits from sole cucumber (CC) having bigger fruits (321g) followed by cucumber-Suwan-1 mixtures (M1C) (292g) while cucumber-TZCOMP4 mixtures (M2C) has lowest fruit weight of 271g.
Fruit length is another fruit character shown in Table 4. Fresh fruit from sole cucumber (CC) plot also maintained highest (25cm) followed by fruit from cucumber-TZCOMP4 mixtures (M2C) (18cm) while its counterpart; cucumber-Suwan-1 mixtures (M1C) had lowest length fruit of 18cm. The differences in length fruit between cucumber sole and cucumber-maize mixtures was significant at P<0.05.

Figure 9 shows yield in t/ha of maize across the seasons. Early season maize yield of suwan-1 mixed with cucumber (M1C) has the highest grain yield (5.69t/ha) followed by sole TZCOMP4 (M2) (4.98t/ha) then TZCOMP4 mixed with cucumber (M2C) had 4.48t/ha while sole suwan-1 (M1) had lowest of 4.5t/ha. However, late season maize yield of TZCOMP4 mixed with cucumber (M2C) has the highest grain yield (3.81t/ha) followed by sole TZCOMP4 (M2) (3.50t/ha) and suwan-1-cucumber mixtures (M1C) (3.25t/ha) while sole suwan-1 (M1) had lowest yield of 3.10t/ha

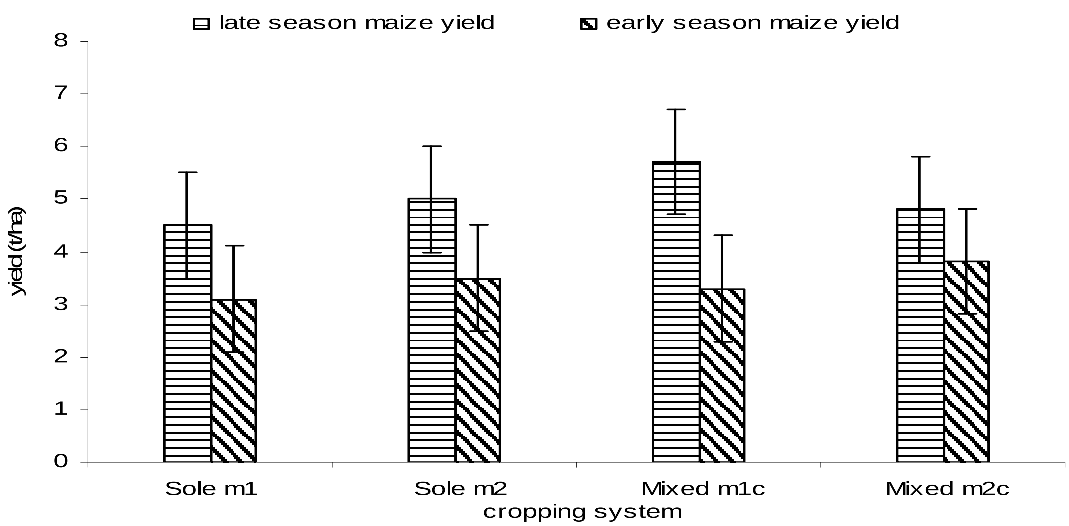

Figure 9: Maize yield under mono and maize-cucumber mixtures

Figure 10 shows fresh cucumber yield in t/ha across the seasons. Early season cucumber yield of sole cucumber (CC) has the highest yield (13.53t/ha) followed by cucumber mixed with TZCOMP4 (M2C) (6.08t/ha) while cucumber mixed with Suwan-1 (M1C) had lowest yield of 3.09t/ha. Similar trend was observed during late season cucumber yield with sole cucumber (CC) having the highest yield (23.01t/ha) followed by cucumber mixed with TZCOMP4 (M2C) (10.33t/ha) while cucumber mixed with Suwan-1 (M1C) had lowest of 8.92t/ha. Generally cucumber yield in the late season was higher than the early season yield across both mono and mixed culture.

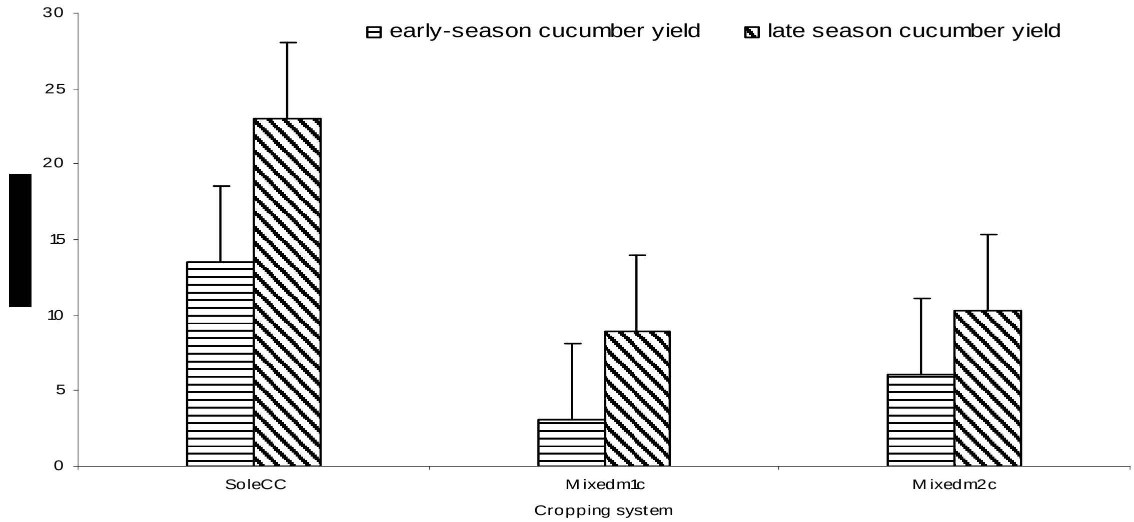

Figure 10: Cucumber yield under mono and maize-cucumber mixtures

Table 2: Effect of season and cropping system on the plant height of maize at Alabata, (UNAAB) 2004 cropping season

	EARLY SEASON					LATE SEASON				
Cropping system	3*	4*	5*	6*	7*	3*	4*	5*	6*	7*
M1	56	72	101	141	187	33	72	109	152	216
M2	58	81	103	149	202	28	78	105	146	207
M1C	58	73	105	167	192	28	72	103	143	201
M2C	58	66	90	122	171	33	81	119	160	211
LSD (0.05)	5	18	21	56**	29**	7	13	19	23	17

Table 3: Maize yield characters in mixed and monoculture

	EARLY SEASON		LATE SEASON	
Cropping system	Weight of seeds / cob (g)	Fresh Cob Weight (g)	Weight of seeds / cob (g)	Fresh Cob Weight(g)
M1	84	253	58	224
M2	93	240	66	350
M1C	107	263	61	263
M2C	91	203	72	266
LSD (0.05)	27	68	17	131

Table 4: Cucumber yield characters in mixed and monoculture

	EARLY SEASON		LATE SEASON	
Cropping system	Fruit Weight (g)	Fruit Length cm)	Fruit Weight (g)	Length Fruit(cm)
CC	296	21	321	25
M1C	167	15	292	18
M2C	200	13	271	18
LSD (0.05)	98**	5**	55	5**

DISCUSSION

The present study agreed with Ayotamuno et al. (2000) that though many factors serve to limit crop growth including soil types, nutrient contents, and climate, water has been observed to be the principal yield limiting factor. The early season rainfall amount was higher across most of the phenological stages than their corresponding amount recorded during the late season period. This pattern was favourable to maize plant but not too favourable for cucumber as it does not require high humidity for its optimal performance.

Minimum temperature for both the early and late planting season falls within the optimal temperature range required by cucurbits as this is in agreement with the work of Larkcom (1991) and Desai and Musmade (1998) at a minimum temperature of 18^{o}C during early growth is preferred with 24-27^{o}C being optimum. This range has been confirmed with prolific growth occurring at day / night temperatures of 28-35 / 20-25^{o}C and severe reduction in growth at night temperatures of 16^{o}C. Cucumber therefore requires heat to produce maximum yield replicate of which was prevalent during late cropping season. In both seasons, the effects of high daily mean temperatures were, greater on cucumber plants grown in monoculture than mixed stands, particularly the intercropped cucumber produced about the same numbers of fresh fruits during later stages of growth with the monoculture. It thus appears that the cool environment observed in mixtures with maize provided a favorable period conducive for cucumber flowers to open and probably for pollination and fruit formation to take place. The increased and prolonged vegetative growth of the late-season crops lengthened periods of flowering and fruiting, probably increased the assimilates available for fruit formation and development. Conversely, in the early-season crops the more shortened vegetative growth period resulting in fewer leaves and smaller leaf area possibly decreased radiation interception and photosynthesis. Also, the shorter periods of flowering and fruiting in the early-season crops probably decreased the amount of assimilate available for reproduction growth.

Furthermore, the yields of fresh edible fruit of cucumber in both cropping systems were higher in the late-season crops than in the early-season crops perhaps due to higher mean soil temperature of 33°C and 31°C at 5 and 10 cm during late season which enhanced the productivity of cucumber yield by about 50% compared with early season when mean soil temperature was 30°C and 29°C at 5 and 10 cm respectively. However, relatively lower yield of cucumber in early season can be attributed to heavy rainfall that coincided with flowering stage thereby leading to flower abortion. Thus the maximum economic returns from cucumber in either monoculture or mixed stand were greater in late-season crops than early-season-crops. The seasons of cultivation therefore, need to be taken into account when growing cucumber for maximum edible fruit and economic returns.

Intercropping with cucumber did not affect phenological growth stages (i.e. vegetative growth, flowering and fruiting) of the cucumber and growth and grain yield of associated maize in both seasons. This may be probably due to the differences in the stages of growth and development in relation to resources requirement and utilization of both crops. Cucumber had largely reached physiological maturity before growth of the maize was maximal. Similar observation was made by Olasantan and Bello (2004) on intercropping okra with cassava. Moreover, maize was able to grow properly after cucumber harvest to fully benefit from full sunlight, extra residual soil nutrient and moisture. Part of nutrient removed by cucumber during crop association would also be released to the soil by decomposition of cucumber residue for maize to use.

Furthermore, there are reasonable ecological benefits in intercropping cucumber with maize in relation to soil environment modification and weed control. Growing cucumber between maize rows suppressed weed growth and maintained cooler and moister soil and canopy environment in the maize. This may have been due to the ground cover provided by the associated cucumber, which reduced radiant flux to the soil surface and minimized water loss by evaporation during the day, and the inversion of soil temperature at night (Olasanatan, 1988). Such environmental conditions favored growth and fruit formation in intercropped cucumber when planting was later, particularly during late -season crops in 2004. It seems that the associated cucumber largely utilized the solar radiation, water and nutrients, which presumably otherwise would have been wasted and / or used by weeds in the maize inter-row space. Growing cucumber between maize rows thus appears to be an effective complementary biological method for weed control, soil and canopy environment improvement, judicious land use and increasing land productivity. It also generates income for resource-poor farmers and improves starch-based diets of the people.

In conclusion, the result indicated that the pattern in the distribution of hydrothermal parameters led to reduction in the maize yield during the late season and early season cucumber yield for both sole and mixed crop.

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