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Analysis of Leaf Parameters of Rain-Fed Maize Cultivars

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Abstract: Leaf area index (LAI), specific leaf area (SLA) and leaf dry matter content (LDMC) are plant/crop physiological variables which could be used to differentiate among and select maize cultivars suitable for specific environmental conditions, particularly in rain-fed agriculture. The leaf area index, SLA, LDMC and total dry matter (TDM) were estimated for the three rain-fed maize cultivars (Golden Crystal, Mamaba and Obatanpa) during the major and minor cropping seasons. The experimental design used was the completely randomized block design in four replicates, with maize cultivars as treatments. This study was undertaken to assess differences or similarities in the time course of LAI, SLA and LDMC as an assessment of the response of the three maize cultivars to rain-fed conditions during the major and minor cropping seasons in a coastal savannah agro-ecological environment. Additionally, the linear correlation analysis was used to assess the association between LAI and SLA, LAI and LDMC, SLA and LDMC, SLA and LDMC, TDM and LAI as well as between TDM and LDMC for the three rain-fed maize cultivars. Generally, Obatanpa and Mamaba maize cultivars produced comparatively higher LAI which peaked at about 1.30 and 2.00 on 84 DAE during the major and minor cropping seasons, respectively. The maize cultivars had mean peak SLA values of 1.20 $m^2 g^{-1}$ on 14 DAE and 1.60 $m^2 g^{-1}$ on 28 DAE during the major and minor cropping seasons, respectively. With regards to LCMD, all the maize cultivars had peak values on 28 DAE, with the value for Golden Crystal being 0.70 g g^{-1} during the major season and 0.65 g g^{-1} for Mamaba during the minor cropping season. During the major cropping season the linear regression between SLA and LDMC for Obatanpa (R = 0.948) and for Mamaba (R = 0.222) were positive but positive and poor for Golden Crystal (R = 0.059). For the minor cropping season, the correlation between SLA and LDMC remained positive and fairly good for Obatanpa (R = 0.702), Mamaba (R = 0.861) and positive but poor for Golden Crystal (R = 0.363). However, for the combined cropping seasons, R value was positive and good for Obatanpa (R = 0.701) and Mamaba (R = 0.861) while that for Golden Crystal was poor (R = 0.363). Such a poor linear correlation between SLA and LDMC for Golden Crystal is an indication that the maize cultivar is poorly adapted to the rain-fed coastal savannah agro-ecological environment and, therefore, not suitable for the cropping environment. Additionally, the correlation between TDM and LAI was positive but poor in all the crop growing seasons, with R values ranging from 0.423 for Obatanpa, 0.524 for Mamaba and 0.562 for Golden Crystal. Furthermore, R value was 0.507 for the combined cropping seasons and all the maize cultivars. Analyses of leaf parameters have provided insight into the different responses of these maize cultivars to rain-fed conditions in a coastal savannah agro-ecological environment.

Key words: Leaf area index · Specific leaf area · Leaf dry matter content · Maize cultivars · Rain-fed

INTRODUCTION

Leaves are the site of photosynthetic activities of crops through which biomass are produced, partitioned among various parts of crops and stored for crop productivity. Typically, some of the leaf parameters of interest for crop production include the leaf area index (LAI), specific leaf area (SLA) and leaf dry matter content (LDMC). Specifically, LAI is one of the growth parameters used for assessing crop growth response [1], crop characteristics as well as the adaptability of crops to diverse environmental conditions.

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Generally, LAI, SLA and LDMC are associated with critical aspects of crop growth and survival [2-4] and these physiological parameters are indicator traits for resource-use strategies by crops. Therefore, variation in biomass accumulation and crop productivity by different crop species and cultivars could be associated to LAI, SLA and LDCM, which have impact on crop growth rate and net assimilation.

Under rain-fed conditions, maize cultivars could have variations in LAI, SLA and LDMC development in response to the environmental conditions. Adapted and productive rain-fed maize cultivars under such conditions are those that could maintain stable development and growth of LAI, SLA and LDMC, especially in environments characterized by generally low seasonal rainfall and poor erratic rainfall patterns. The adaptability and productivity of rain-fed maize cultivars to drought/water-stress environment, therefore, would depend more or less on the ability of the maize cultivars to sustain the development of LAI, SLA and LDMC under limiting soil water conditions for photosynthetic activity required for the production of assimilates for growth and productivity.

This study was conducted to assess the pattern, dynamics as well as differences in LAI, SLA and LDMC of rain-fed maize cultivars in an environment characterized by low seasonal rainfall and poor erratic rainfall patterns. We also assessed if there is a linear correlation between LAI and SLA, LAI and LDMC and SLA and LDMC, TDM and LAI as well as between TDM and LDMC.

MATERIALS AND METHODS

The experiment is part of a major one conducted by Frimpong *et al.* [5] to assess the productivity and water use by three maize cultivars under rain-fed conditions in a coastal savannah agro-ecological environment of Ghana.

Study Area: Field experiments were conducted at the research farm of the Biotechnology and Nuclear Agriculture Research Institute of the Ghana Atomic Energy Commission, Kwabenya-Atomic (Ghana). The site lies on latitude 05° 40'N and longitude 0° 13'W, elevated at 76 m above sea level. The study area is located in the coastal savannah agro-ecological environment of Ghana and receives an annual rainfall less than 1000 mm [6]. The soil at the site is the Haatso series, a well-drained savannah ochrosol, described as the Ferric Acrisol by FAO/UNESCO [7], which is derived from quartzite schist. The μMETOS®, a micro electronic weather station (Pessl Instruments GmbH, Weiz, Austria) located about 50 m away from the experimental plots, recorded daily weather variables including maximum and minimum air temperatures, relative humidity, solar radiation, wind speed and precipitation. The summary of some of the chemical and physical characteristics of the soil at the experimental site is presented in Table 1.

Maize Cultivars: Maize cultivars Golden Crystal, Mamaba and Obatanpa bred for high grain yield and improved nutritional status (Aflakpui *et al.* [8]; Osei *et al.* [9] were used for the experiment. Mamaba is a three-way hybrid quality protein maize [10] while Golden Crystal and Obatanpa are normal open pollinated maize [8].

Sowing of Seeds: Seeds of the maize cultivars were sown on April 28, 2008 and September 1, 2008 for the major and minor cropping season, respectively. Seeding was done at a planting distance of 0.4 m within rows and 0.8 m between rows. Seedlings were thinned to 2 plants per hill one week after seedling emergence to obtain 78,750 plants ha^{-1}. A total of 275.0 kg ha^{-1} of 15:15:15 NPK fertilizer was split-applied by broadcasting two and four weeks after germination [8]. Weeds were controlled mechanically by hoeing whenever necessary. A 100 mL broad spectrum insecticide, Pyrinex 48 EC (O, O-Diethyl 0-3, 5, 6-

Table 1: Some of the chemical and physical properties of the soil at the experimental site

Soil Layer (cm)	pH (H_2O) (1:2)	Org. C (%)	Total N (%)	Avail. P (mg kg^{-1})	K (cmol+kg^{-1})	Sand %	Silt %	Clay %	Bulk density (kgm^{-3})
0-20	7.33	1.06	0.36	11.07	0.41	41.4	43.2	15.4	1.34
20-40	7.39	0.50	0.34	6.79	0.30	40.4	44.7	14.9	1.22
40-60	7.83	0.50	0.31	4.28	0.25	45.3	43.8	10.9	1.41
60-80	7.99	0.39	1.26	3.89	0.19	48.0	41.1	11.1	1.33
80-100	7.79	0.36	0.42	2.40	0.21	46.3	43.0	10.7	1.47
100-120	7.85	0.23	1.13	2.10	0.22	55.8	36.4	7.8	1.38

Source: Frimpong *et al.*, 2011.

richloro-2-pyridylphosphorothionate) in 100 L of water was split-applied five and seven weeks after crop establishment during the major and minor cropping seasons. The experimental design used was the randomized complete block design in four replicates, with the three maize cultivars as treatments. Each sub-plot measured 10.0 m by 10.0 m. The soil water in the crop root zone was monitored throughout the crop growing periods using the soil water neutron probe, CPN 503DR model of the Campbell Pacific, USA.

Leaf Area Index, Specific Leaf Area and Leaf Dry Matter Content: Eight maize plants were sampled from inner rows during the major and minor cropping seasons on 28, 42, 56, 70, 84 and 98 days after emergence (DAE) each time from an area of 1.28 m^2 in each sub-plot for total dry matter determination. Sub-samples of fresh plants (about 500 g) were oven-dried at 70°C until constant weight was obtained before the weight of the dry matter was recorded. The area of leaves of plant samples per unit area was also measured using an area meter (Area Meter AM300, BioScientific Ltd, England, UK.). Additionally, dry weight of leaves, whose areas were measured, were oven-dried at 70°C until constant weights were obtained for the estimation of the following parameters:

$$LAI = \frac{TLA}{AOL} \quad (1)$$

and

$$SLA = \frac{LAI}{ML\_LAI} \quad (2)$$

where LAI is the leaf area index, SLA is specific leaf area (m^2 g^{-1}), ML_LAI is dry mass (g) of leaves used for estimating LAI, TLA is the area of the total leaf (m^2) in AOL and AOL is the land area (m^2)from which total leaves area was used for LAI estimation.

Also, the leaf dry matter content (LDMC), g g^{-1}, was estimated as:

$$LDMC = \frac{LDM}{LFM} \quad (3)$$

where LDM and LFM is the mass of dry leaves (g) and mass of fresh of leaves (g), respectively. The total dry matter (TDM) was also estimated.

Analysis: The time course of LAI, SLA and LDMC were plotted for each maize cultivars to facilitate the analysis of the dynamics of the leave parameters during the major and minor cropping seasons. Additionally, linear regression analyses were used to assess the functional relationship between TDM and LAI, SLA and LAI, TDM and LDMC, SLA and LDMC and LAI and LDMC. Additionally, linear correlation analyses were performed between TDM and LAI, SLA and LAI, TDM and LDMC, SLA and LDMC as well as LAI and LDMC to assess the linear correlation coefficient between each of the specified relations for the three rain-fed maize cultivars in a coastal savannah agro-ecological environment.

RESULTS

Weather Conditions for Major and Minor Cropping Seasons: Mean maximum and minimum air temperatures were generally higher during the minor cropping season compared to values recorded for the major cropping season. Specifically, the mean maximum and minimum air temperatures were 30.5°C and 23.5°C for the major cropping season (April-July), respectively, as against corresponding values of 31.9°C and 23.6°C for the minor cropping season (September-December). The mean solar radiation was 212.1W m^{-2} and 229.7 W m^{-2} for the major and minor cropping seasons, respectively. The mean relative humidity was 81.4% and 78.2% during the major and minor cropping seasons, respectively. Additionally, the seasonal rainfall was 595.8 mm during the major cropping season while 295.2 mm of seasonal rainfall occurred during the minor cropping season. The amount of the seasonal rainfall during the major cropping season was not only comparatively higher and better than that of the minor cropping season but its distribution was better as well (Fig.1).

Dynamics of Leaf Area Index: Leaf area indices (LAI) for the maize cultivars remained fairly constant from 14 to 56 DAE during the major cropping season (Fig. 2a) as growth rates were fairly constant in response to the rainfall patterns observed, The leaf area index of Obatanpa peaked at a value of about 1.20 on 70 DAE, while Mamaba and Golden Crystal had their LAI peaking at a value of about 1.40 on 84 DAE. The leaf area index for the maize cultivars was lowest at a value of 0.15 at crop maturity on 98 DAE. The indication is that the three maize cultivars generally had a similar time course of LAI during the major cropping season, except that the peak LAI for Obatanpa occurred on 70 DAE at a value of about 1.30.

A similar time course of LAI were observed among the maize cultivars during the minor cropping season, except that LAI peaked on 84 DAE, being about 2.0 for Obatanpa and Mamaba and 1.7 for Golden Crystal

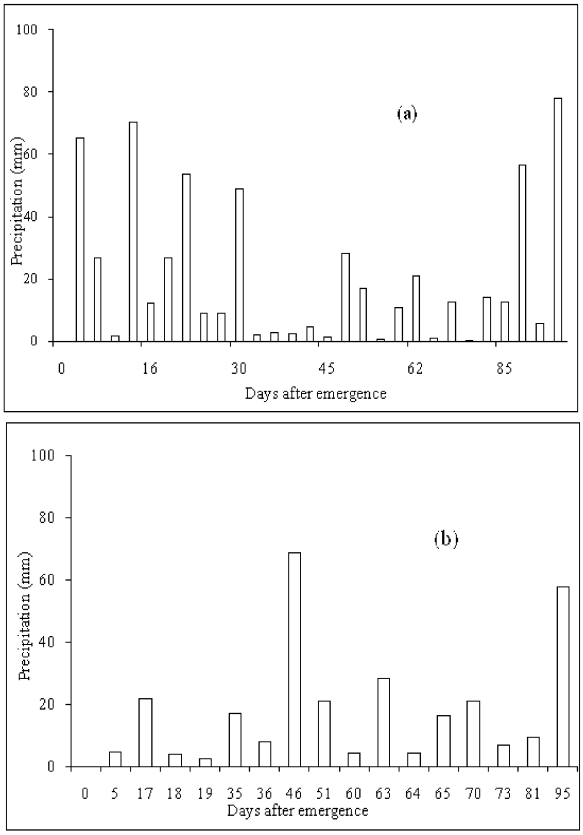

Fig. 1: Daily precipitation during the (a) major and (b) minor cropping seasons in a coastal savannah agro-ecological environment.

(Fig. 2b). Also, LAI for the maize cultivars during the minor season increased at higher rates, resulting in a comparatively higher LAI for all the maize cultivars, suggesting that the maize cultivars had higher growth rates during the minor cropping season.

Dynamics of the Specific Leaf Area: The specific leaf area (SLA) of the maize cultivars declined gradually during the major cropping season, except that SLA of Obatanpa dropped sharply on 28 DAE to the lowest value of 0.40 $m^2 g^{-1}$ and all the maize cultivars had the lowest SLA value on 98 DAE (Fig. 3 a). For the minor cropping season, however, SLA values for all the maize cultivars dropped on 42 DAE and then increased and remained fairly constant to the end of the crop growing season for Mamaba and Obatanpa (Fig. 3b).Thus, Mamaba and Obatanpa exhibited a fairly constant photosynthetic activity with respect to leaf biomass production from 58 to 98 DAE in contrast to Golden

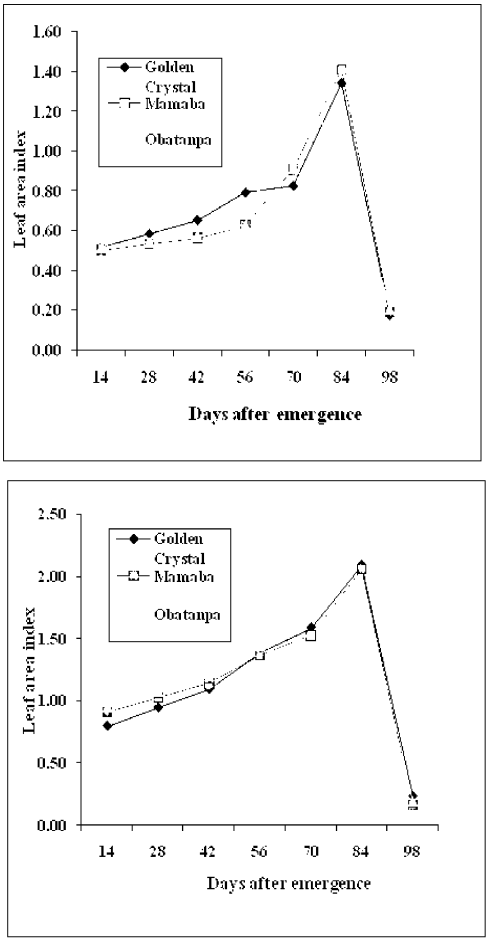

Fig. 2: Time course of leaf area index of three maize cultivars during the (a) major and (b) minor cropping seasons in a coastal savannah agro-ecological environment.

Crystal which had its S1LA value of 1.00 $m^2 g^{-1}$ on 58 DAE reducing gradually as its growth progressed to crop maturity on 98 DAE, with SLA value of about 0.50 $m^2 g^{-1}$ (Fig. 3b).

Dynamics of Leaf Dry Matter Content: Generally, leaf dry matter content (LDMC) for the major cropping season increased from 14 DAE to a peak value of 0.70 g g^{-1} for Obatanpa and 0.30 g g^{-1} for Mamaba on 28 DAE. The leaf dry matter content (LDMC) for Golden Crystal, however, peaked at 0.35 g g^{-1} on 42 DAE and 98 DAE during the major cropping season. The peak LDMC values generally declined gradually to the lowest values on 98 DAE, LDMC values being 0.35, 0.15 and 0.12 g g^{-1} for Golden Crystal, Mamaba and Obatanpa, respectively (Fig. 4a).

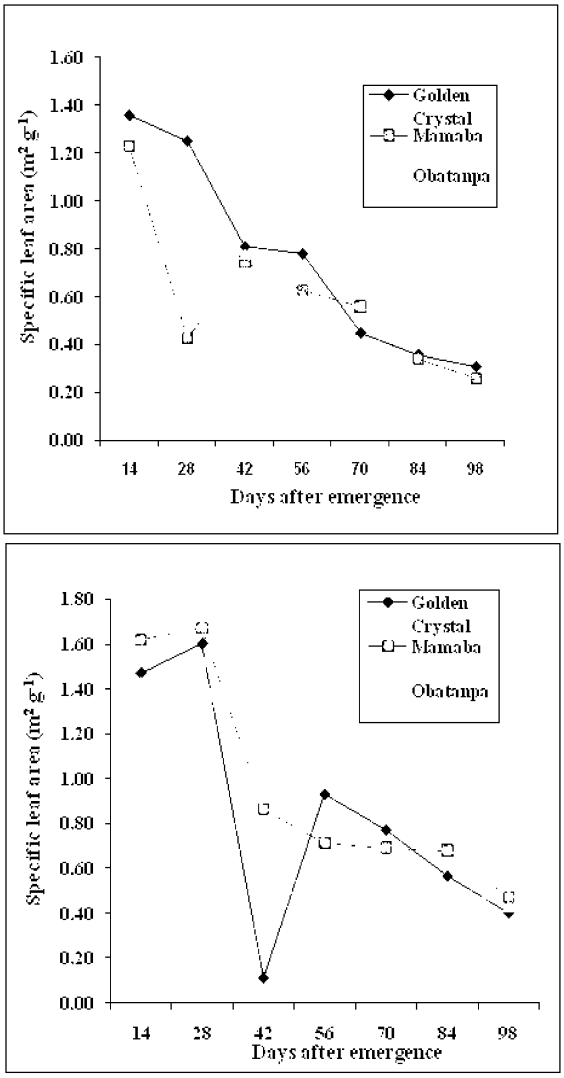

Fig. 3: Time course of the specific leaf area of three maize cultivars during the (a) major and (b) minor cropping seasons in a coastal savannah agro-ecological environment.

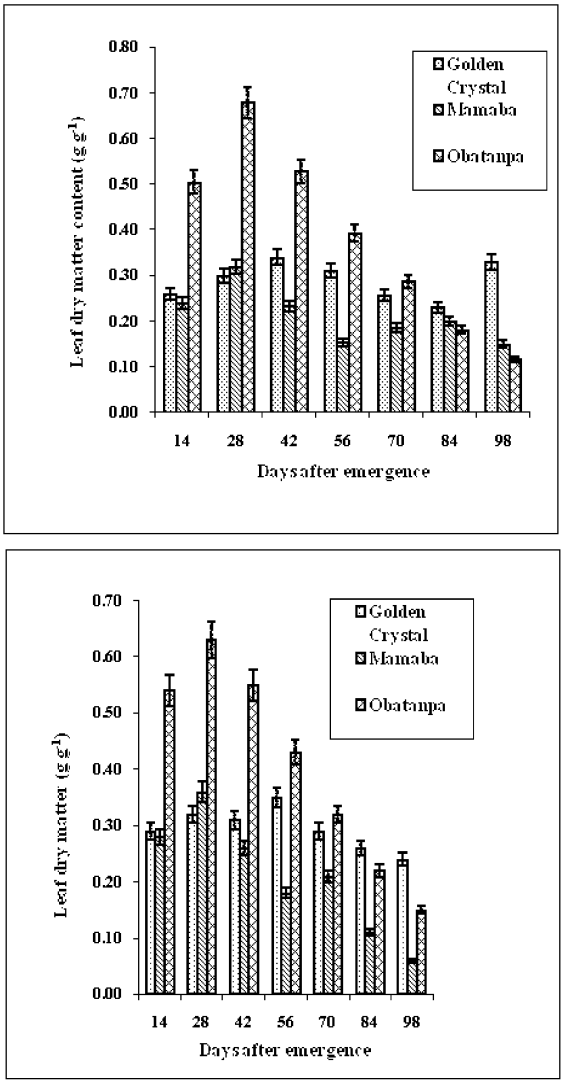

Fig. 4: Time course of leaf dry matter content of three maize cultivars during the (a) major and (b) minor cropping seasons in a coastal savannah agro-ecological environment.

A similar trend, but generally higher LDMC values, was observed for the maize cultivars during the minor cropping season. Specifically, Golden Crystal, Mamaba and Obatanpa had their LDMC values peaking on 28 DAE. However on 98 DAE, Mamaba had the lowest LDMC value of 0.05 g g^{-1} as against LDMC values of 0.28 and 0.15 g g^{-1} for Golden Crystal and Obatanpa, respectively, during the minor cropping season (Fig. 4b). Additionally, it was generally observed that the three rain-fed maize cultivars had a fairly similar LDMC values regardless of the seasonal rainfall observed in the major and minor cropping seasons.

DISCUSSION

The specific leaf area (SLA) and LDMC are indicator traits for resource use by crops [4] and are sensitive to environmental changes [11]. However, SLA and LDMC of the maize genotypes were not sensitive to the environmental conditions. This could be attributed to adjustment to the rain-fed conditions by the maize cultivars during the major and minor cropping seasons under the coastal savannah agro-ecological environment. According to Li *et al.* [4] and Wilson *et al.* [11], LDMC is more sensitive to variations in soil resources.

Table 2: Linear relationships between the specific leaf area (SLA) and leaf dry matter content (LDMC) for three rain-fed maize cultivars during the major and minor cropping seasons and for the combined seasons in a coastal savannah agro-ecological environment

Cropping season (s)	Maize cultivar(s)	Linear model	Correlation coefficient (R)	P-value
Major	Golden Crystal	SLA = 0.60 x LDMC + 0.58	0.059	≥ 0.899
Major	Mamaba	SLA = 1.22 x LDMC + 0.34	0.222	≥ 0.632
Major	Obatanpa	SLA = 1.92 x LDMC--0.11	0.948	≥0.001**
Minor	Golden Crystal	SLA = 5.39 x LDMC-0.75	0.363	≥ 0.422
Minor	Mamaba	SLA = 4.06 x LDMC + 0.11	0.861	≤ 0.013*
Minor	Obatanpa	SLA = 1.92 x LDMC-0.02	0.702	≥ 0.079
Major + Minor	Golden Crystal	SLA = 2.79 x LDMC-0.02	0.223	≥ 0.422
Major + Minor	Mamaba	SLA = 3.31 x LDMC + 0.08	0.608	≤ 0.013*
Major + Minor	Obatanpa	SLA = 1.94 x LDMC-0.07	0.809	≥ 0.079
Major + Minor	All combined	SLA = 1.36 x LDMC + 0.35	0.427	≤0.005**

* Significant

**Highly significant

Table 3: Linear relationships between the total dry matter (TDM) and leaf area index (LAI) for three rain-fed maize cultivars during the major and minor cropping seasons and for the combined seasons in a coastal savannah agro-ecological environment

Cropping season (s)	Maize cultivar(s)	Linear model	Correlation coefficient (R)	P-value
Major	Golden Crystal	TDM = 452.48x LAI-41.09	0.662	≥ 0.105
Major	Mamaba	TDM = 388.12 x LAI-23.13	0.638	≥ 0.123
Major	Obatanpa	TDM = 382.48 x LAI-2.91	0.895	≥ 0.540
Minor	Golden Crystal	TDM = 293.14 x LAI + 7.72	0.528	≥ 0.223
Minor	Mamaba	TDM = 221.09 x LAI + 78.01	0.433	≥ 0.331
Minor	Obatanpa	TDM =175.65 x LAI + 144.66	0.310	≥ 0.496
Major + Minor	Golden Crystal	TDM = 230.65 x LAI + 33.75	0.562	≤ 0.037*
Major + Minor	Mamaba	TDM = 255.05 x LAI + 52.78	0.524	≥ 0.054
Major + Minor	Obatanpa	TDM = 230.65 x LAI-33.75	0.562	≤ 0.037*
Major + Minor	All combined	TDM = 263.44 x LAI + 57.77	0.507	≤0.001**

*Significant

**Highly significant

Therefore, under rain-fed conditions where crops are grown with limited or without fertilizer inputs, coupled with inadequate amount of seasonal rainfall which is poorly distributed during the cropping season, LDMC is likely to be sensitive to the challenging environmental condition.

Results of our study revealed that Obatanpa and Mamaba, comparatively, had higher SLA and LDMC values than Golden Crystal (Fig. 2, 3 and 4), an indication that these two maize cultivars are potentially more highly productive than Golden Crystal [11-13], especially under rain-fed conditions in a coastal savannah agro-ecological environment. Consequently, Obatanpa and Mamaba, which had comparatively higher SLA, LAI and LDMC, have the propensity to do better in resource-rich environments while Golden Crystal having comparatively lower SLA, LAI and LDMC during the minor cropping season, could perform better as well under resource-poor environment, particularly, for total biomass production, according to Li *et al.* [4]. This proposition supports results of our earlier study [5] in which Golden Crystal produced comparatively higher total biomass but poor grain yield during the minor cropping season because of its sensitivity to low seasonal rainfall, which resulted in a poor biomass partitioning for the production of grains observed by Frimpong *et al.* [5].

The linear relationship between SLA and LDMC was positive, with good R value of 0.948 for Obatanpa while R values for Mamaba and Golden Crystal were 0.22 and 0.06, respectively and very poor, during the major cropping season (Table 2). A similar trend in the linear relationship between SLA and LDMC was positive during the minor cropping season, with fairly good R value for Obatanpa (0.702) and Mamaba (0.861), while a poor R value of 0.363 was observed for Golden Crystal (Table 2). Additionally, the linear relationship between SLA and LDMC was positive for the combined cropping seasons; the associated R values being 0.702 for Obatanpa, 0.863 for Mamaba and a very poor value of 0.363 for Golden Crystal (Table 2). For the combined cropping seasons and all the

Table 4: Linear relationships between the specific leaf area (SLA) and leaf area index (LAI) for three rain-fed maize cultivars during the major and minor cropping seasons and for the combined seasons in a coastal savannah agro-ecological environment

Cropping season (s)	Maize cultivar(s)	Linear model	Correlation coefficient (R)	P-value
Major	Golden Crystal	SLA =-0.30 x LAI + 0.97	0.251	≥ 0.586
Major	Mamaba	SLA =-0.16 x LAI + 0.70	0.184	≥ 0.693
Major	Obatanpa	SLA =-0.30 x LAI + 0.83	0.256	≥ 0580
Minor	Golden Crystal	SLA =-0.10 x LAI + 0.95	0.103	≥ 0.825
Minor	Mamaba	SLA =-0.08 x LAI + 1.06	0.101	≥ 0.829
Minor	Obatanpa	SLA =-0.12 x LAI +0.90	0.125	≥ 0.790
Major + Minor	Golden Crystal	SLA =-0.08 x LAI + 0.88	0.094	≥ 0.749
Major + Minor	Mamaba	SLA =-0.08 x LAI + 0.70	0.099	≥ 0.737
Major + Minor	Obatanpa	SLA =-7.63 x LAI + 22.50	0.170	≥ 0.562
Major + Minor	All combined	SLA =-0.02 x LAI + 0.77	0.020	≥= 0.901

Table 5: Linear relationships between the total dry matter (TDM) and leaf dry matter content (LDMC) for three rain-fed maize cultivars during the major and minor cropping seasons and for the combined seasons in a coastal savannah agro-ecological environment

Cropping season (s)	Maize cultivar(s)	Linear model	Correlation coefficient (R)	P-value
Major Golden	Crystal	TDM =-2520.94 x LDMC + 1005.26	0.425	≥ 0.342
Major	Mamaba	TDM =-2293.01 x LDMC + 725.93	0.577	≥ 0.175
Major	Obatanpa	TDM =-991.82 x LDMC + 639.49	0.798	≤ 0.031*
Minor	Golden	Crystal TDM =-2739.16 x LDMC + 1154.72	0.306	≥ 0.505
Minor	Mamaba	TDM =-2023.95 x LDMC + 758.44	0.697	≥ 0.082
Minor	Obatanpa	TDM =-1241.57 x LDMC +848.00	0.795	≤ 0.032*
Major + Minor	Golden Crystal	TDM =-251.37 x LDMC + 1053.85	0.339	≥ 0.235
Major + Minor	Mamaba	TDM =-2102.98 x LDMC +730.29	0.644	≤ 0.013*
Major + Minor	Obatanpa	TDM =-1084.81 x LDMC + 729.82	0.170	≤0.001**
Major + Minor	All combined	TDM =-877.23 x LDMC + 562.81	0.463	≤ 0.002*

* Significant

** Highly significant

Table 6: Linear relationships between leaf area index (LAI) and leaf dry matter content (LDMC) for three rain-fed maize cultivars during the major and minor cropping seasons and for the combined seasons in a coastal savannah agro-ecological environment

Cropping season (s)	Maize cultivar(s)	Linear model	Correlation coefficient (R)	P-value
Major	Golden	Crystal LAI =-5.89 x LDMC + 2.40	0.679	≥ 0.093
Major	Mamaba	LAI =-0.21 x LDMC + 0.72	0.003	≥ 0.946
Major	Obatanpa	LAI =-0.35 x LDMC + 0.83	0.183	≤ 0.695
Minor	Golden Crystal	LAI = 1.01 x LDMC + 0.403	0.104	≥ 0.824
Minor	Mamaba	LAI = 0.23 x LDMC + 1.12	0.040	≥ 0.931
Minor	Obatanpa	LAI = 0.40 x LDMC + 0.97	0.144	≤ 0.759
Major + Minor	Golden Crystal	LAI =-1.53 x LDMC + 1.38	0.109	≥ 0.711
Major + Minor	Mamaba	LAI =-0.19 x LDMC + 0.96	0.034	≤ 0.907
Major + Minor	Obatanpa	LAI = 0.06 x LDMC + 0.88	0.025	≤ 0.934
Major + Minor	All combined	LAI = 0.42 x LDMC + 0.70	0.107	≤ 0.464

maize cultivars, however, R value for the linear correlation between SPA and LCMD was still positive but poor as R = 0.427 (Table 2). The positive correlation observed between SLA and LDMC was in contrast to results obtained by Li *et al.* [4] for annual and perennials grown on sand dunes in China. Poor nutrient status and harsh environmental conditions of the sand dunes could have contributed to the negative linear correlation between SPA and LDMC reported by Li *et al.* [4] for annuals and perennials grown on sand dunes.

A negative linear relationship existed between SLA and LAI, with only Obatanpa having fairly good R values during the major and minor cropping seasons (Table 4). Additionally, a poor R value was observed for the combined cropping seasons (major and minor) and for all the three maize cultivars (Table 4). This negative linear model between SLA and LAI was due to biomass being accumulated progressively during the cropping seasons. A similar trend was observed for the linear relationship between TDM and LMCD for the combined cropping seasons and all the three maize cultivars with a poor R value of 0.463 (Table 5). Furthermore, the linear relationship between LAI and LDMC was poor, leading to a corresponding poor R value for each of the maize cultivars in each of the cropping seasons as well as for the combined cropping seasons (Table 6).

Generally, the linear models developed for SLA and LAI as well as for TDM and LDMC for the combined cropping seasons could be used to estimate or predict dependent and independent parameters using independent parameters as inputs for each of the maize cultivars, regardless of the cropping seasons, a result of good R and significant P values (Tables 4 and 5).

CONCLUSION

Leaf area index (LAI), SLA and LDMC are plant/crop physiological parameters influencing the capture of solar radiation leading to the production of photosynthetates. Leaf area index (LAI), SLA and LDMC of rain-fed maize cultivars (Golden Crystal, Mamaba and Obatanpa) in a coastal savannah agro-ecological environment were estimated during both the major and minor cropping seasons. Generally, leaf parameters peaked at observed DAEs, which were different for each maize cultivar, declined from peak values to lowest values at crop maturity, with leaf parameter values for Golden Crystal consistently being the lowest. These observations suggest that Mamaba and Obatanpa are stable and better adapted to the low seasonal and erratic rainfall patterns of the coastal savannah agro-ecological environment in terms of effective use of low and erratic rainfall for biomass and grain yield production. The Golden Crystal, on the other hand, generally had the lowest leaf parameters comparatively, which suggests that this maize cultivar is not well adapted and therefore, could not be suitable for the coastal savannah agro-ecological environment, particularly during the minor cropping season, characterized by comparatively few rainfall events and poor erratic rainfall patterns.

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