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Allometric relationship between some morpho-physiological characteristics of corn under different tillage systems and sowing dates

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ABSTRACT- Field experiments were conducted to determine the relationship between plant leaf area as the dependent variable with leaves number, leaf dry weight, and total vegetative components dry weight and plant height as the independent variables. Treatments were two tillage systems (conventional and no-tillage) as main plots, and seven sowing dates (11 May, 18 May, 25 May, 1 June, 8 June, 15 June and 22 June) as sub plots. This research was carried out at the Research Farm of Shiraz University during 2014 and 2015 growing seasons. The interaction between sowing date and tillage system was significant. The highest leaf area, leaf number, leaf dry weight, total dry weight and plant height were obtained in earlier sowing dates (11 May, 18 May, 25-May and 1-Jun) in both tillage systems and the lowest were obtained in the latest sowing date (22 Jun) in no-tillage in both years. Using polynomial equation for determining algometric relationship between leaf area and vegetative characteristics showed a significant relationship between leaf area with leaf number (R^2=0.96 and R^2=0.98), leaf dry weight (R^2=0.98 and R^2=0.98), total vegetative components dry weight (R^2=0.96 and R^2=0.96) and finally plant height (R^2=0.98 and R^2=0.95). These allometric relationships contribute to a better understanding of plant growth and development in corn, which is necessary for optimal management of the crop and for genetic improvement.

INTRODUCTION

Corn (*Zea mays* L.) is one of the three main crops in the world and is crucial to diets of the people in developing countries and one of the most efficient field crops for producing a superior amount of dry matter per unit area (Sezar et al., 2009). Corn is an important crop in Iran, especially in Fars province (Naderi, 2011).

The simulation models of crops are mathematical expression of growth processes and stages under different environmental and managerial factors. Leaf area index is a necessary variable in the models based on crop growth mechanism, which is used to predict biomass production (Soltani et al., 2006). Allometric relationships in plants uncover size-correlated variation in form and development and characterize the relative growth of a part of a plant in comparison with the whole and/or other plant parts. These relationships in intraspecific comparisons are often based on data from mature plants. Stable allometric relationships in ontogeny can be used as a component of crop simulation models and to estimate plant variables that are difficult to measure (Bakhshandeh et al., 2012). Use of allometric relationships, such as determination of equations to estimate leaf area using measured plant characteristics, is a method to determine leaf area. Number of leaves in stem and leaf dry weight, total vegetative components (leaves and stem) dry weight and plant height are plant characteristics that can be used to find equations for the leaf area estimation (Nehbandani et al., 2013). Such equations have been successfully used in a variety of crops such as soybean (Bakhshandeh et al., 2010), wheat (Bakhshandeh et al., 2012) and pea (Rahemi et al., 2006).

Considering the insufficiency of studies about allometry data on corn in Iran, this research was conducted to find the relationships between some of morpho-physiological characteristics of corn under different tillage systems and sowing dates. These relationships can widely be used in crop simulation.

MATERIALS AND METHODS

The experiment was carried out in 2 years (2014 and 2015) at research farm of College of Agriculture, Shiraz University. The experiment was arranged as a split-plot based on randomized complete block design with three replicates. Treatments were two tillage systems (conventional and no-tillage) as main plots, and seven sowing dates (11 May, 18 May, 25 May, 1 June, 8 June, 15 June and 22 June) as sub plots. Corn seeds (hybrid SC704) were hand planted in 3×5 m plots at 5 cm depth. Each sub plot consisted of five 4 m rows with 75 cm and 15 cm between and within rows in wheat stubble mulch for no-tillage and without mulch for conventional tillage. Plots were located on a silty clay loam soil (9.28% sand, 34.72% clay and 56% silt) with 2.38% organic matter, 1.382% organic carbon, 0.132% total N, 32 p.p. m phosphorus, 420 ppm potassium, pH of 7.36, and EC of 0.682 dS m^{-1}. Prior to sowing date, triple super phosphate was mixed into the top 0.25 m of soil (150 kg ha^{-1}) and 600 kg ha^{-1} urea was top-dressed in three times as sowing time, when the plants had 6-8 fully exposed leaves and beginning of grain filling. During the growing season, all plots were irrigated (every seven days interval) and all weeds were controlled by herbicides Paraquat or Gromoxone (1 kg ha^{-1}) which was used two weeks before first sowing date and 2,4-D MCPA (1.5 kg h^{-1}) was used when the height of plant was 15-25 cm. Corn leaf area (m^2) and leaf dry weight (kg p^{-1}), leaf number, plant height (m) and total dry weight of plant (kg p^{-1}) were measured during each growing season based on developmental stages of corn. These stages included vegetative stages (1- when the plants had 3-4 fully exposed leaves, 2- when the plants had 6-8 fully exposed leaves, 3- tassel initiation) and reproductive stage (beginning stage of grain filling). To measure leaf dry weight, leaf area, number of leaves, plant height and total dry weight of plant, three plants were harvested randomly from each plot and their height were measured and the number of leaves on each plant was counted; then, the average height and average number of leaves were calculated. To measure leaf area, we used leaf area meter (Delta-T Device).

To find the allometric relationship between leaf area and vegetative characteristics of corn, we investigated several linear and non-linear regression equations and finally, a polynomial equation was fitted between leaf area and vegetative characteristics as follow:

$$y=y_0+ax+bx^2 \quad (1)$$

where y is leaf area, x is leaf dry weight (kg p^{-1}) or leaf number or plant height (m) or total dry weight of plant (kg p^{-1}), y_0, a and b are constants.

To obtain allometric relationships, fitting of different mathematical functions was checked for the data. Function fitting was checked for 4 forms: 1) each sowing date under each tillage system, 2) sowing dates combination on each tillage system, 3) tillage systems combination for each sowing date and 4) a general function for all sowing dates and tillage systems.

To compare the equation precision, R^2 and Root Mean Square Error (RMSE) were checked.

$$RMSE = \text{sqrt}\left(\frac{\sum(p-o)^2}{n}\right) \quad (2)$$

P is predicted data, o is observed data and n is number of data.

$$R^2=1-(SS\ \text{regression}/\ SS\ \text{total}) \quad (3)$$

SS regression is the sum of squared distances between the actual and predicted data value and SS total is the sum of squared distances between the actual data values and their means.

Higher R^2 and lower RMSE show the higher precision of the equation to define the allometric relationship. All analyses were performed using SAS 9.1 (64) and Sigma Plot (12.3 soft 98).

RESULTS AND DISCUSSION

The results indicated that there was no significant difference between conventional tillage and no-tillage system on leaf area, leaf number, leaf dry weight, total vegetative components (leaves and stem) dry weight and plant height in two years (Tables 1 and 2). It was probably caused by soil fertilizer, good soil physical conditions and high soil organic matter and organic carbon. Results showed that the highest leaf area, leaf number, leaf dry weight, total dry weight and plant height were obtained in conventional tillage compared with no-tillage in both years but means comparison indicated that sowing date affected plant height, leaf area, leaf number, leaf dry weight and total dry weight significantly (Tables 1 and 2). The interaction between sowing date and tillage system was significant. The highest leaf area, leaf number, leaf dry weight, total dry weight and plant height were obtained in earlier sowing dates(11 May, 18 May, 25 May and 1 Jun) in both tillage systems and the lowest was obtained in later sowing date (22 Jun) in no-tillage in both years (Data not shown).

Baghdadi et al. (2012) showed that the highest stem height and number of leaves were obtained in conventional tillage (223.01 cm and 12.78 cm, respectively) and the lowest stem height and number of leaves were obtained in no-tillage (203.92 cm and 11.00 cm, respectively). Aikins et al. (2012) showed that the disc harrowing plots produced the tallest plant, highest number of leaves per plant and highest leaf area index. On the other hand, the no-tillage plots presented the shortest plant, lowest number of leaves per plant and lowest leaf area index.

At the end of the growing season, a significant decrease in plant height was observed in both years. This decrease following the delay in sowing date can be associated with higher temperatures that the plants at the seventh sowing date experienced which limited their growing period and assimilate-building because of the early maturity of plants. Thus, the plants did not have adequate opportunity for photosynthesis and their height capacity decreased. The highest leaf number, leaf dry weight, total dry weight and leaf area were obtained in the earlier sowing dates compared with later sowing dates and the lowest of them were obtained in the latest sowing date.

Earlier planting increases the length of time during which plants can take advantage of favorable growing conditions and accumulate biomass. Thus, the plants had adequate elements and adequate opportunity for photosynthesis and growth; so, the plants approximately had similar dry matter accumulation (above ground, leaf and stem dry weight) and leaf number.

Table 1. Mean comparison for the main effect of sowing date and tillage system in the beginning stage of grain filling on leaf area, leaf number, plant height, total dry weight and leaf dry weight in 2014

Treatment / Tillage system	Plant Height (m)	Leaf Number	Total Dry Weight (kg p^{-1})	Leaf Dry Weight (kg p^{-1})	Leaf Area (m^2)
Conventional	2.54	14.52	2.45	0.058	0.581
No-tillage	2.48	14.00	2.38	0.056	0.571
LSD	0.13	0.74	0.37	0.006	0.03
Sowing date					
11-May	2.6	14.67	2.75	0.060	0.613
18-May	2.5	14.67	2.70	0.057	0.606
25-May	2.6	14.50	2.48	0.064	0.599
1-Jun	2.4	14.33	2.61	0.064	0.594
8-Jun	2.5	13.50	2.30	0.054	0.560
15-Jun	2.5	14.00	2.22	0.052	0.536
22-Jun	2.3	14.17	1.85	0.049	0.524
LSD	0.14	1.01	0.29	0.007	0.04

Table 2. Means comparison for the main effect of sowing date and tillage system at the beginning stage of grain filling on leaf area, leaf number, plant height and total dry weight and leaf dry weight in 2015

Treatment / Tillage system	Plant Height (m)	Leaf Number	Total Dry Weight (kg p^{-1})	Leaf Dry Weight (kg p^{-1})	Leaf Area (m^2)
Conventional	2.40	14.71	2.20	0.052	0.588
No-tillage	2.40	13.95	2.06	0.049	0.558
LSD	0.03	1.24	0.16	0.003	0.003
Sowing date					
11 May	2.45	14.33	2.38	0.058	0.600
18 May	2.42	14.83	2.30	0.054	0.587
25 May	2.49	14.67	2.24	0.052	0.584
1 Jun	2.49	14.33	2.26	0.050	0.577
8 Jun	2.40	14.71	2.20	0.052	0.588
15 Jun	2.40	13.95	2.06	0.049	0.558
22 Jun	0.03	1.24	0.16	0.003	0.003
LSD					

A study was conducted by Aderi and Ndaeyo (2011) to evaluate the possible effect of organic manuring on dry matter production of maize with changes in sowing date. Their results showed that leaf, stem and total dry weight decreased with delayed sowing date. The general decline in dry matter production of maize in later sowing dates compared with early sowing dates indicated that conditions of growth became less favorable with lateness in sowing. Moosavi et al. (2012) showed that changes in sowing date and plant density significantly affected LAI at tasseling stage so that delay in sowing from July 4 to August 6 decreased significantly the leaf area index (42.1%).

Relationship Between Leaf Area and Leaf Number

In this study, we used the leaf area and leaf number on the stem from appearance of 4 leaves on the stem until the point of maximum leaf number on the stem (approximately 85 days after sowing) to fit the equation. The results showed that there were strong allometric relationships between leaf area and leaf number in two years (Table 3). Results indicated that stronger allometric relationships between leaf area and leaf number were in the first sowing date (11 May) and conventional system (R^2=0.99 and RMSE=0.05) in 2014 and in the second sowing date (18 May) and conventional system (R^2=0.997 and RMSE=0.01) and in the fourth sowing date (1 June) and no-tillage system (R^2=0.998 and RMSE=0.03 in 2015 (Table 2). R^2 values for sowing dates combination on each tillage system was 0.96-0.99, R^2 values for a general function for all sowing dates and tillage systems was 0.96-0.98 and R^2 values for tillage systems combination for each sowing date was 0.96-0.99 in two years (Data not shown).

Nehbandani et al. (2013) showed a strong correlation between leaf area and leaf number according to the nonlinear model in soybean. Sinclair (1984) used a nonlinear model to describe leaf area versus node (or leaf) number in main stem. Hammer et al. (1993) used a power equation to describe leaf area versus node (or leaf) number in main stem. Maddah-Yazdi et al. (2008) in wheat, Soltani et al. (2006) and Rahemi et al. (2006) in chickpea (*Cicera rietinum*) showed a strong relationship between leaf area and leaf number.

Relationship Between Leaf Area and Plant Height

We used data of leaf area and plant height from appearance of 4 leaves on the stem until appearance of flag leaf to fit the equation. Fitting the polynomial equation showed there were strong allometric relationships between leaf area and plant height in two years (Table 4).

Our Results showed that in the sixth sowing date (15 Jun) and no-tillage system, allometric relationships between leaf area and plant height were stronger (R^2=0.997 and RMSE=0.01 in 2014 and R^2=0.998 and RMSE=0.02 in 2015) than other sowing dates and conventional system in two years. Bakhshandeh et al. (2012) in wheat used from segmented nonlinear regression model, Rahemi et al. (2006) in chickpea, Akram-Ghaderi and Soltani (2007) in cotton, used nonlinear regression model to describe the relationship between leaf area and plant height. R^2 values for sowing dates combination on each tillage system were 0.95-0.98, R^2 values for a general function for all sowing dates and tillage systems were 0.95-0.98 and R^2 values for tillage systems combination for each sowing date were 0.95-0.99 in two years (Data not shown).

Table 3. The coefficient (y_0, a, b) of polynomial equation between leaf area and leaf number in two tillage systems and seven sowing dates.

	Sowing date	Conventional					No-tillage				
		y_0±se	a±se	b±se	R^2	RMSE	y_0±se	a±se	b±se	R^2	RMSE
2014	11 May	-0.28±0.05	0.08±0.01	-0.001±0.0008	0.99	0.05	-0.42±0.08	0.12±0.02	-0.0003±0.0001	0.98	0.04
	18 May	-0.21±0.08	0.06±0.02	-0.0002±0.001	0.98	0.05	-0.29±0.1	0.08±0.03	-0.0001±0.002	0.95	0.06
	25 May	-0.30±0.10	0.08±0.02	-0.001±0.001	0.96	0.05	-0.20±0.1	0.05±0.02	0.0001±0.001	0.98	0.04
	1 Jun	-0.34±0.10	0.09±0.02	-0.002±0.001	0.94	0.06	-0.19±0.08	0.04±0.02	0.0003±0.001	0.99	0.03
	8 Jun	-0.24±0.09	0.06±0.02	-0.0009±0.001	0.97	0.04	-0.12±0.09	0.02±0.02	0.002±0.001	0.98	0.04
	15 Jun	0.15±0.12	0.03±0.03	0.001±0.001	0.97	0.04	-0.23±0.1	0.05±0.03	0.00003±0.001	0.97	0.04
	22 Jun	-0.33±0.07	0.09±0.02	-0.002±0.001	0.98	0.04	-0.31±0.09	0.08±0.02	-0.001±0.001	0.98	0.08
2015	11 May	-0.36±0.03	0.1±0.009	-0.002±0.0005	0.99	0.02	-0.39±0.05	0.11±0.01	-0.003±0.0004	0.99	0.02
	18 May	-0.35±0.02	0.1±0.006	-0.003±0.0003	0.99	0.01	-0.41±0.04	0.12±0.01	-0.004±0.0006	0.99	0.02
	25 May	-0.34±0.04	0.1±0.01	-0.002±0.0005	0.99	0.08	-0.41±0.03	0.12±0.008	-0.004±0.0004	0.99	0.01
	1Jun	-0.39±0.04	0.1±0.01	-0.003±0.0006	0.99	0.02	-0.39±0.03	0.11±0.007	-0.003±0.0004	0.99	0.02
	8 Jun	-0.37±0.07	0.1±0.01	-0.003±0.001	0.98	0.03	-0.38±0.04	0.11±0.01	-0.003±0.0006	0.99	0.02
	15 Jun	-0.37 ±0.03	0.1±0.009	-0.003±0.0005	0.99	0.02	-0.24±0.08	0.06±0.02	-0.0003±0.001	0.98	0.03
	22 Jun	-0.38±0.03	0.1±0.007	-0.003±0.0004	0.99	0.02	-0.11±0.07	0.03±0.02	0.001±0.001	0.98	0.03

Relationship Between Leaf Area and Leaf Dry Weight

Leaf dry weight can easily be measured; thus, determining the relationship between leaf dry weight and leaf area index results in the estimation of leaf area index (Nehbandani et al., 2013). In this study, the data of leaf area and leaf dry weight from appearance of 4 leaves on the stem until the point of maximum leaf number on the stem (approximately 85 days after sowing) were used to fit the equation. The results showed there were strong allometric relationships between leaf area and leaf dry weight in two years (Table 5).

Our results indicated that stronger allometric relationships between leaf area and leaf number were in the seventh sowing date (22 Jun) and conventional system (R^2=0.99 and RMSE=0.02 in 2014 and second sowing date (18 May) R^2=0.99 and RMSE=0.01 in 2015), and in sowing date 6 (15 June) and no-tillage system (R^2=0.998 and RMSE=0.01) in 2014 and in sowing date 4 (1 June) and no-tillage system (R^2=0.995 and RMSE=0.02) in 2015 (Table 5).

Bakhshandeh et al. (2010) calculated soybean leaf area and described the relationship between leaf area and leaf dry matter using a linear equation. Nehbandani et al. (2013) used a nonlinear relationship to describe the relationship between soybean leaf area and leaf dry weight. Bakhshandeh et al. (2012) used a segmented correlation to describe the relationship between wheat leaf area and leaf dry weight.

R^2 values for sowing dates combination on each tillage system were 0.97-0.99; R^2 values for a general function for all sowing dates and tillage systems were 0.98 and R^2 values for tillage systems combination for each sowing date were 0.96-0.99 in two years (Data not shown).

Relationship Between Leaf Area and Total Vegetative Components Dry Weight

Fitting the polynomial equation showed that there were strong allometric relationships between leaf area and plant dry weight in two years (Table 6).

Results indicated that stronger allometric relationships between leaf area and total vegetative components dry weight were in the third sowing date (25 May) and conventional system (R^2=0.99 and RMSE=0.03) in 2014 and in the seventh sowing date (22 Jun) and conventional system (R^2=0.98 and RMSE=0.03) in 2015, and in the sixth sowing date (15 June) and no tillage system (R^2=0.99 and RMSE=0.03 in 2014 and R^2=0.998 and RMSE=0.02 in 2015).

R^2 values for sowing dates combination on each tillage system were 0.96-0.97; R^2 values for a general function for all sowing dates and tillage systems were 0.96 and R^2 values for tillage systems combination for each sowing date were 0.95-0.98 in two years (Data not shown). Akram-Ghaderi and Soltani (2007) in cotton and Rahemi et al. (2006) in chickpea used nonlinear equations and Bakhshandeh et al. (2010) in soybean linear equation to describe the relationship between leaf area and total components dry weight.

CONCLUSIONS

Results indicated that the interaction between sowing date and tillage system had a significant effect on plant height, leaf area, leaf number, leaf dry weight and total dry weight. Generally, there were strong allometric relationships between leaf area and leaf number, leaf dry weight, plant height and total vegetative components dry weight in corn in all treatments.

Table 4. The coefficient (y_0, a, b) of polynomial equation between leaf area and plant height in two tillage systems and seven sowing dates

	Sowing date	Conventional					No-tillage				
		y_0±se	a±se	b±se	R^2	RMSE	y_0±se	a±se	b±se	R^2	RMSE
2014	11 May	-0.02±0.02	0.37±0.07	-0.05±0.03	0.99	0.03	-0.05±0.02	0.50±0.06	-0.1±0.02	0.99	0.03
	18 May	-0.03±0.01	0.45±0.05	-0.08±0.02	0.99	0.02	-0.01±0.02	0.37±0.04	-0.05±0.02	0.98	0.03
	25 May	-0.11±0.02	0.74±0.08	-0.2±0.03	0.99	0.02	0.02±0.03	0.16±0.12	0.03±0.04	0.98	0.03
	1 Jun	-0.03±0.04	0.37±0.13	-0.06±0.05	0.98	0.04	-0.01±0.03	0.31±0.15	-0.03±0.06	0.98	0.04
	8-Jun	-0.01±0.04	0.29±0.15	-0.03±0.05	0.96	0.05	-0.06±0.02	0.49±0.09	-0.09±0.03	0.99	0.02
	15 Jun	-0.04±0.03	0.40±0.11	-0.06±0.04	0.98	0.04	-0.05±0.01	0.46±0.04	-0.09±0.02	0.99	0.01
	22 Jun	-0.06±0.02	0.52±0.06	-0.1±0.02	0.99	0.03	-0.05±0.02	0.44±0.08	-0.08±0.03	0.99	0.03
2015	11 May	-0.10±0.04	0.77±0.12	0.2±0.05	0.97	0.04	-0.05±0.04	0.58±0.11	-0.1±0.04	0.95	0.05
	18 May	-0.08±0.04	0.75±0.13	0.2±0.05	0.96	0.04	-0.05±0.05	0.60±0.16	-0.15±0.06	0.94	0.06
	25 May	-0.13±0.03	0.85±0.09	-0.2±0.03	0.99	0.03	-0.02±0.05	0.54±0.06	-0.1±0.06	0.93	0.06
	1 Jun	-0.10±0.04	0.81±0.14	-0.2±0.05	0.97	0.04	-0.06±0.05	0.67±0.15	-0.2±0.06	0.95	0.05
	8 Jun	-0.10±0.05	0.89±0.19	-0.3±0.07	0.95	0.05	-0.02±0.03	0.51±0.11	-0.1±0.04	0.96	0.05
	15 Jun	-0.04±0.05	0.61±0.15	-0.1±0.06	0.95	0.05	-0.05±0.009	0.51±0.02	-0.1±0.008	0.99	0.02
	22 Jun	-0.03±0.02	0.55±0.08	-0.1±0.03	0.97	0.04	-0.05±0.02	0.45±0.03	-0.09±0.01	0.98	0.03

Table 5. The coefficient (y_0,a,b) of polynomial equation between leaf area and leaf dry weight in two tillage systems and seven sowing dates

	Sowing date	Conventional					No-tillage				
		y_0±se	a±se	b±se	R^2	RMSE	y_0±se	a±se	b±se	R^2	RMSE
2014	11 May	0.02±0.02	13.10±3.43	-64.47±50.58	0.98	0.03	0.01±0.01	17.69±2.06	-137.09±32.16	0.99	0.03
	18 May	0.01±0.01	18.56±3.34	-152.52±52.69	0.98	0.03	0.008±0.01	19.50±1.86	-164.04±27.95	0.99	0.03
	25 May	0.01±0.01	16.20±2.87	-122.77±44.34	0.98	0.03	0.03±0.01	13.34±1.53	-71.63±21.45	0.98	0.03
	1 Jun	0.03±0.02	15.38±2.85	-119.06±45.13	0.97	0.04	0.03±0.01	14.38±1.55	88.58±22.97	0.99	0.03
	8 Jun	0.02±0.02	17.48±4.65	-153.10±84.85	0.96	0.04	0.009±0.009	18.31±1.33	-148.27±22.09	0.99	0.02
	15 Jun	0.03±0.01	17.70±2.60	-139.23±46.70	0.98	0.03	0.003±0.008	20.58±1.56	-201.93±30.18	0.99	0.01
	22 Jun	0.006±0.01	22.94±2.22	-241.55±41.68	0.99	0.02	0.007±0.01	18.23±3.20	-147.85±63.66	0.99	0.02
2015	11 May	0.01±0.01	17.06±1.31	-125.43±19.48	0.99	0.02	0.003±0.01	16.22±1.40	-102.5±23.76	0.99	0.02
	18 May	0.01±0.008	18.65±0.89	-156.31±14.19	0.99	0.01	0.008±0.01	18.34±1.48	-145.23±27.69	0.99	0.02
	25 May	0.008±0.01	16.66±1.60	-113.81±27.13	0.99	0.02	0.01±0.01	20.59±1.46	-196.53±27	0.99	0.02
	1 Jun	0.004±0.01	20.60±1.62	-180±28.37	0.99	0.02	0.004±0.01	20.95±1.35	-201.31±25.16	0.99	0.02
	8 Jun	0.004±0.01	21.12±2.38	-195.41±49.88	0.99	0.03	0.002±0.01	17.52±0.30	-133.43±23.04	0.99	0.02
	15 Jun	0.004±0.01	20.59±2.25	-185.68±46.78	0.99	0.03	-0.003±0.02	13.37±2.62	-34.83±51.53	0.98	0.03
	22 Jun	0.003±0.01	18.91±1.39	-164.75±26.41	0.99	0.02	0.0004±0.02	10.08±3.47	64.38±78.78	0.96	0.04

Table 6. The coefficient (y_0, a, b) of polynomial equation between leaf area and total vegetative components dry weight in two tillage systems and seven sowing dates

	Sowing date	Conventional					No-tillage				
		y_0±se	a±se	b±se	R^2	RMSE	y_0±se	a±se	b±se	R^2	RMSE
2014	11 May	0.05±0.02	3.25±0.38	-4.68±1.00	0.97	0.04	0.04±0.01	3.79±0.34	-5.29±1.61	0.98	0.04
	18 May	0.06±0.01	2.98±0.29	-4.05±0.80	0.98	0.04	0.05±0.02	3.48±0.51	-6.17±2.61	0.98	0.04
	25 May	0.05±0.01	4.32±0.41	-9.19±1.14	0.99	0.03	0.04±0.01	3.62±0.81	-5.47±1.57	0.96	0.05
	1 Jun	0.05±0.02	3.55±0.43	-6.27±1.30	0.96	0.05	0.05±0.01	3.37±0.53	-6.46±1.05	0.98	0.03
	8 Jun	0.05±0.02	2.62±0.66	-3.14±2.34	0.96	0.05	0.03±0.01	3.97±0.43	-7.40±1.52	0.99	0.03
	15 Jun	0.05±0.01	3.44±0.47	-6.85±1.66	0.98	0.03	0.03±0.01	4.73±0.37	-10.79±1.35	0.99	0.03
	22 Jun	0.04±0.01	5.29±0.51	-13.37±2.26	0.98	0.03	0.03±0.01	5.17±0.47	-12.78±1.88	0.98	0.03
2015	11 May	0.06±0.03	4.27±0.81	-8.31±2.51	0.95	0.05	0.03±0.02	4.90±0.71	-10.85±2.47	0.97	0.04
	18 May	0.06±0.02	4.13±0.70	-8.25±2.22	0.95	0.05	0.04±0.02	4.99±0.78	-11.71±2.86	0.97	0.04
	25 May	0.04±0.02	4.16±0.53	-8.03±1.83	0.98	0.04	0.05±0.02	4.43±0.67	-9.74±2.43	0.96	0.04
	1 Jun	0.05±0.02	4.12±0.63	-7.97±2.12	0.97	0.04	0.04±0.02	4.89±0.68	-11.43±2.49	0.97	0.04
	8 Jun	0.05±0.02	4.26±0.71	-8.82±2.25	0.95	0.05	0.03±0.01	4.57±0.54	-10.08±2.11	0.98	0.03
	15 Jun	0.04±0.02	4.62±0.69	-10.31±2.76	0.97	0.04	-0.0008±0.008	5.17±0.22	-12.17±0.9	0.99	0.02
	22 Jun	0.03±0.02	5.47±0.64	-14.89±2.95	0.98	0.03	0.005±0.01	4.22±0.41	-8.47±1.77	0.98	0.05

The presented allometric relationship and information reported in this study can be used to predict leaf production in crop simulation models of corn. These allometric relationships might contribute to a better understanding of plant growth and development in corn, which is necessary for optimal management of the crop and genetic improvement.

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رابطه آلومتریک بین برخی صفات مورفوفیزولوژیک ذرت تحت تاثیر سیستم های خاکورزی و تاریخ کاشت

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چکیده- آزمایشی مزرعه ای به منظوربررسی رابطه میان سطح برگ ذرت با تعداد برگ،وزن خشک برگ وزن خشک کل اجزای رویشی و ارتفاع بوته انجام شد. تیمارها شامل دو سیستم خاکورزی (خاکورزی متداول و بی خاکورزی) و هفت تاریخ کشت (۲۱ اردیبهشت، ۲۸ اردیبهشت، ۴ خرداد، ۱۱خرداد، ۱۸ خرداد، ۲۵خردادو ۱ تیر) بود. این مطالعه درمزارع تحقیقاتی دانشکده کشاورزی دانشگاه شیراز در سالهای زراعی ۹۴-۹۳ انجام شد. اثر برهمکنش میان تاریخ کشت و سیستم خاکورزی معنی داربود و در هر دو سال بیشترین سطح برگ،تعدادبرگ،وزن خشک برگ،وزن خشک کل اجزای رویشی و ارتفاع بوته درتاریخ کشت های زود هنگام درهردو سیستم کشت و کمترین مقدار آن ها درآخرین تاریخ کشت (۱ تیرماه) و درسیستم بی خاکورزی مشاهده شد.به منظور تعیین روابط آلومتری بین سطح برگ و صفات رویشی از معادله پلی نومیال استفاده شد که نتایج رابطه معنی داری را بین سطح برگ وتعداد برگ (R^2=۰/۹۶ و R^2= ۰/۹۸)، وزن خشک برگ (R^2=۰/۹۸ و R^2= ۰/۹۸)، وزن خشک کل اجزای ر ویشی (R^2=۰/۹۶ و R^2= ۰/۹۶) و ارتفاع بوته (R^2=۰/۹۶ و R^2= ۰/۹۶) نشان داد. ازروابط آلومتری می توان در جهت درک بهتر رشد و نمو ذرت که لازمه مدیریت بهینه گیاه زراعی وبهبود وضعیت ژنتیکی آن است استفاده کرد.