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Effects of Cultural System (Organic and Conventional) on Growth, Photosynthesis and Yield Components of Sweet Corn (*Zea mays* L.) under Semi-Arid Environment

Aspasia EFTHIMIADOU[1)], Dimitrios BILALIS[2)], Anestis KARKANIS[2)]
Bob FROUD-WILLIAMS[1)], Ilias ELEFTHEROCHORINOS[3)]

[1)] *University of Reading, School of Biological Sciences, Reading, Berksire, RG6 6AH, United Kingdom; infosec@met.reading.ac.uk*

[2)] *Agricultural University of Athens, Laboratory of crop production, Iera Odos 75, 11855 Athens, Greece; bilalisdimitrios@yahoo.gr (corresponding author)*

[3)] *University of Thessalonici, Laboratory of Agronomy, School of Agriculture, Aristotle 54124, Thessaloniki, Greece; info@agro.auth.gr*

Abstract

Organic sweet maize consists of a new industrial crop product. Field experiment was conducted to determine the effects of cultural systems on growth, photosynthesis and yield components of sweet maize crop (*Zea mays* L. F_1 hybrid 'Midas'). A randomized complete block design was employed with four replicates per treatment (organic fertilization: cow manure (5, 10 and 20 t ha^{-1}), poultry manure (5, 10 and 20 t ha^{-1}) and barley mulch (5, 10 and 20 t ha^{-1}), synthetic fertilizer (240 kg N ha^{-1}): 21-0-0 and control). The lowest dry weight, height and leaf area index and soil organic matter were measured in the control treatment. Organic matter content was proportionate to the amount of manure applied. The control plots had the lowest yield (1593 kg ha^{-1}) and the double rate cow manure plots the had greatest one. (6104 kg ha^{-1}). High correlation between sweet corn yield and organic matter was registered. Moreover, the lowest values of 1000-grain weight were obtained with control plot. The fertilizer plot gave values, which were similar to the full rate cow manure treatment. The photosynthetic rate of the untreated control was significantly lower than that of the other treatments. The photosynthetic rate increased as poultry manure and barley mulch rates decreased and as cow manure increased. Furthermore, the untreated control had the lowest stomatal conductance and chlorophyll content. Our results indicated that sweet corn growth and yield in the organic plots was significantly higher than those in the conventional plots.

Keywords: sweet corn, manure, mulch, synthetics fertilizers, growth, photosynthesis, yield components.

Introduction

Organic agriculture employs a combination of the best methods of traditional agriculture and modern technology. Present- day organic growers use tried and tested practices, such as crop rotation, growing a diversity of crops, planting cover crops and green manures (Karkanis *et al.*, 2007). At the time, most organic production systems include use of modern equipment, improved cultivars, and new technologies such as drip-irrigation (Bilalis *et al.*, 2009). In contrast to "conventional agriculture", organic farming relies on preventive rather than corrective practices.

Nitrogen is applied worldwide to produce plant food. Nitrogen for agriculture includes inorganic fertilizers, biologically fixed, manure, recycled crop residues, and soil-mineralized N. At present, inorganic fertilizers with N are a major source of N, and animal manure N is inefficiently used. Potential environmental impacts of N excreted by humans are increasing rapidly with increasing world population. Where needed, N must be efficiently used, because N can be transported to immense distances and transformed into soluble and /or gaseous forms that pollute water resources and cause greenhouse effects (Eid *et al.*, 2000; Kim *et al.*, 1999). The use of manure and mulching are two of the basic cultivation techniques of Organic Agriculture. Moreover, mulch application presents opportunities for utilizing a range of organic or other wastes that may benefit crop, soil and water relations (Lee, 1997). The results obtained by other researchers (Bahrani *et al.*, 2007; Beri *et al.*, 1995; Sharma and Prasad, 2008; Sidhu and Beri, 1989; Surekha *et al.*, 2006) showed that the incorporation of cereals residue not only improved the soil physicochemical properties but also increased the yield of crops significantly.

Manure is an organic matter used as fertilizer in agriculture. Manure has proved to be very beneficial for the soil because it contains a rich and wide range of minerals and nutrients. It provides abundant amounts of the three main chemicals that plants require- nitrogen, phosphorus, and potassium. Importantly, it also contains many of the micro-nutrients (trace elements) (Akinrinde *et al.*, 2006). The second benefit of manure is that it improves the composition of the soil. It contains both animal waste and straw (or sometimes sawdust). Celik *et al.* (2004) reported that manure treated plots had significantly decreased soil bulk density and increased soil organic matter and available water content. Data obtained by other researchers (Blaise *et al.*, 2005; Rasool *et al.*, 2008; Yusuff *et al.*, 2007) clearly demonstrated the beneficial effects of manure on the yields of crops (cotton, sweet maize, maize, wheat).

Sweet corn is favourable for fresh consumption because of its delicious taste, soft and sugary texture compared to other corn varieties. Sweet corn has been wide spread in the world. At optimum market maturity stage, sweet corn will contains 5 to 6% of sugar, 10 to 11% of starch, 3% of water soluble polysaccharides, 70% of water, moderate levels of protein, vitamin A and potassium (Oktem and Oktem, 2005). Sweet corn is a fairly heavy feeder, and proper soil fertility is critical for high yield (Fernandez Santos *et al.*, 1992).

The main objective of this study was to evaluate the effect of various organic and inorganic amendments on growth, photosynthesis and yield components of sweet corn grown under organic or conventional agriculture regimes. Also we intended to evaluate the various Greek traditional organic practices.

Materials and methods

Experimental design

Field experiments were carried out in southern Greece (Oropos, 60 km away from Athens, Lat: 34°, Long: 23°) in 2005 and 2006. Sweet corn (*Zea mays* L.) F_1 hybrid 'Midas' was planted. The experimental site had previously been cropped with vegetables. The soil was a clay loam. The experiments were carried out under semi-arid Mediterranean climatic conditions, where soils typically have low organic matter content and weak structure, resulting in low infiltration rates and low moisture retention. Some meteorological data of the experimental site are presented in Fig. 1. The precipitation during growing season (April-August) in 2005 (151mm) was higher than those in 2006 (76 mm).

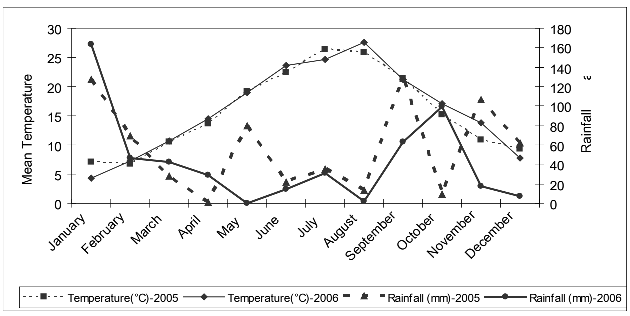

Fig. 1. Meteorological data in the experimental sites (Temperature: °C and rainfall: mm)

A randomized complete block design was employed with four replicates per treatment. Each year two experiments of approximately 2700 m^2 were conducted. The plot size was 4.0 x 6.0 m. The three kinds of amendments used were: cow manure (CM), poultry manure (PM), barley residues (B) and fertilizer (F). All were subject to chemical analysis:

<u>Cow manure</u>: the cow manure that has been used had natural outdoor fermentation (composting) for 6-8 months. It contained 1.21% of nitrogen.

<u>Poultry manure</u>: An industrially processed, standardised and dry product was used. It contained 0.74% of nitrogen.

<u>Barley</u>: Fresh barley was used, which was harvested just before the establishment of the experiments. It was harvested immature prior to flowering and contained 0.69% of nitrogen.

<u>Fertilizer:</u> Chemical fertilizer 21-0-0 (ammonium sulphide, $(NH_4)_2SO_4$).

The incorporation after the establishment of the treatments was done twice with a rotary hoe in each plot separately.

According to a bibliographic search and the local practice the optimum level of nitrogen for the cultivation of sweet corn is 240 kg N ha^{-1}. The treatments were:

1. Fertilization with 240 kg N/ha (fertilizer 21-0-0: 1143 kg ha^{-1}): F,
2. Poultry manure 5 t ha^{-1} (35 kg N): PMo X/2,
3. Poultry manure 10 t ha^{-1} (70 kg N): PMo X,
4: Poultry manure 20 t ha^{-1} (140 kg N): PMo 2X,
5. Cow manure 5 t ha^{-1} (60 kg N): CMo X/2,
6. Cow manure 10 t ha^{-1} (120 kg N): CMo X,
7. Cow manure 20 t ha^{-1} (240 kg N): CMo 2X,
8. Barley mulch 5 t ha^{-1} (35 kg N): Bo X/2,
9. Barley mulch 10 t ha^{-1} (70 kg N): Bo X,
10. Barley mulch 20 t ha^{-1} (140 kg N): Bo 2X,
11. Control (no treatment): C.

Planting, irrigation and weed control

The maize was sown manually. In 2005 and 2006 the corn was sown on the same dates (25/4/2005 and 25/4/2006). Corn was planted at an 80-cm row spacing and 16 cm plant spacing, at an approximate density of 78125 plants ha^{-1}.

We used sprinkler irrigation system (overhead irrigation). The main pipe was 50 mm diameter, the secondary pipes 24 mm diameter and the pipes of the sprinklers 6mm diameter. The water flow was 4 L min^{-1} per sprinkler and the sprinklers were placed every 4 m. Irrigation dose was 50 mm (500 m^3 ha^{-1}) and the irrigation frequency every 3-7 days depending on rainfall. Each time the irrigation lasted for 150 min. Analysis showed that pH of the water was 7.4 and its salinity 1000 (April)-1400 (August) µS cm^{-1}.

The weeds were destroyed and weed seed return was prevented by two inter-row cultivations with a rotary hoe during the experimental period. The weeds on the row were destroyed manually.

Samplings, measurements and methods

Organic matter: It was an important measurement because manure and mulches were incorporated into the soil. The organic matter was defined by the Walkey-Black method, for 0-15 cm depth for every plot (Walkey and Black, 1934). The Walkey-Black method calculates the C that oxidizes.

Vegetative traits: Plant height (cm), Leaf area index (LAI), dry weight (kg ha^{-1}).

For the computation of leaf area, dry weight and height 5 plants were randomly selected in each plot. The dry weights of all plant parts were determined after drying for 72 h at 65°C. Leaf area was measured using an automatic leaf area meter (Delta-T Devices Ltd). Thus, the measurements of plant basis (cm^2 per plant) were converted into a lea area index (LAI) by multiplying by the average crop density of each plot.

Yield and yield components: yield (kg ha^{-1}), 1000 grain-weight (g), grains per rank.

Yield and yield components: 10 plants were harvested per plot and all yield measurements were made at 14% seed moisture content. 1000-grain weight was estimated by randomly taking 4x100 grains from each plot which were then weighed and the average value multiplied by ten. For the computation of grains per rank ten ears per plot were measured.

Physiological characteristics: Photosynthetic rate (μmol CO_2 m^{-2} s^{-1}), Stomatal conductance (mol m^{-2} s^{-1}), chlorophyll content.

Measurements of photosynthetic rate and stomatal conductance were undertaken between the hours 10.30-14.30, and five measurements per plot, at 36, 51 and 66 days after sowing. They were measured with the LCi Leaf Chamber Analysis System (ADC, Biosientific, Hoddedson, UK).

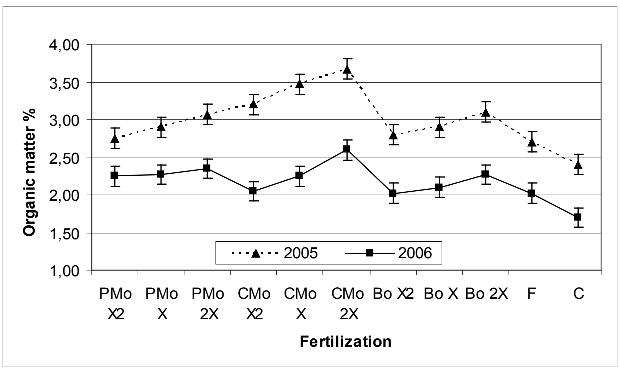

Fig. 2. The effect of organic amendments and fertilizer on soil organic matter %, 41 DAS (Days after sowing), X: 10 t ha^{-1-} (I:LSD5%).

The chlorophyll content was measured 36, 51 and 66 days after sowing It was measured in the field (SPAD value), using the portable Chlorophyll Fluorometer CCM-200 (Opti-Sciences, Inc). This device measures the light absorbance in order to calculate the chlorophyll leaf concentration. The chlorophyll concentration was measured after the model curve was found. The ability to predict chlorophyll content on a leaf area basis from SPAD readings was demonstrated in tobacco crop (Bilalis *et al.*, 2009). In order to produce the model curve (according to Lichtenhaler and Wellburn, 1983) pieces of corn leaves, for which we had measured the SPAD value, were transferred to the laboratory in a portable fridge with dry ice. Then small circular pieces, of 1 cm diameter, were cut (four pieces per leaf) and then the chlorophyll was extracted (each leaf separately) with 80% acetone. This procedure was done under a green safety light at 2-4°C. Afterwards the extract was centrifuged for 5 min at 4000 rpm. Finally the light absorbance at 646, 663 and 720 nm was measured using a spectrophotometer. The chlorophyll concentration was measured with the equalization (mg/ml of extract):

Total Chlorophyll: $Ca + Cb = 17.32 \times A_{646.8} + 7.18 \times A_{663.2}$

(A646.8=Absorbance646-Absorbance 720 and A663.2=Absorbance663-Absorbanse646)

Statistical analysis

The plan of the experiment was done after random placement of the plots. The data were subjected to statistical analysis according to the randomized complete block design. Differences between treatment means were compared at P = 5%, with ANOVA, to find significant differences and LSD to compare the plots. The statistical analysis of the data was performed with the "STATGRAPHICS Plus 5.1" logistic package.

Results

Organic matter

In both years, 41 Days after sowing the lowest concentration of organic matter ($P<0.05$) was determined for the control plot (Fig. 2), while the highest ($P<0.05$) was found in the double rate cow manure treatment, which was significantly different from the other treatments. Organic matter content was proportionate to the amount of manure applied.

Plant characteristics

Height

The height measurement (81 DAS) of 2005 demonstrated that the plants in the Barley plots remained shorter in comparison to the control ($P<0.05$). Plant height in the poultry manure plots was similar to the control plot, but shorter than those from the cow manure and fertilizer treatment (Tab.1.). In 2006, all treatments produced taller plants than the control. Double rate cow manure plot gave

Tab. 1. The effect of organic amendments and fertilizer on maize height (cm), dry weight (kg ha^{-1}) and leaf area index (LAI), 81 DAS (Days after sowing), X: 10 t ha^{-1}

Treatments	Plant Height		Dry weight		LAI	
	2005	2006	2005	2006	2005	2006
Poultry Manure X2	138.75	128.25	9906	7734	1.24	0.56
Poultry Manure X	142.75	135.75	10078	8266	1.40	0.66
Poultry Manure 2X	139.75	138.75	8148	9063	1.05	0.90
Cow Manure X2	149.75	137.75	10961	8734	1.66	0.68
Cow Manure X	160.25	140.5	11523	9648	2.03	1.01
Cow Manure 2X	165.75	150.25	12719	11625	2.42	1.68
Barley Mulch X2	125	131.5	8008	8359	0.28	0.64
Barley Mulch X	130.25	134.5	7617	8828	0.20	0.78
Barley Mulch 2X	129	139.75	6836	10586	0.19	1.29
Fertlizer 21-0-0	152.5	131.5	11523	8617	1.88	0.59
Control	136	127.5	6328	6504	0.36	0.30
$LSD_{5\%}$	4.21	1.76	427	426	0.06	0.09

The LSD (P=0.05) for fertilization treatments are also sown.

Tab. 2. The effect of organic amendments and fertilizer on maize yield (Kg/ha), 1000-grain weight, grain per rank, 81 DAS (Days after sowing) X: 10 t ha^{-1}

Treatments	Yield		1000-grain weight		Grain per rank	
	2005	2006	2005	2006	2005	2006
Poultry Manure X2	4491	2205	0.145	0.132	30.1	17
Poultry Manure X	4304	2404	0.159	0.139	25.9	17.6
Poultry Manure 2X	4002	2703	0.144	0.141	26.2	19.2
Cow Manure X2	4028	2505	0.154	0.140	26.6	18.5
Cow Manure X	4696	2893	0.160	0.138	29.4	21
Cow Manure 2X	6104	3705	0.163	0.145	35.3	25.2
Barley Mulch X2	3064	2297	0.143	0.133	21.8	17.3
Barley Mulch X	2998	2606	0.141	0.136	21.3	18.9
Barley Mulch 2X	2405	3202	0.134	0.142	17.7	21.9
Fertlizer 21-0-0	5483	2402	0.158	0.138	33.2	18
Control	2106	1593	0.131	0.125	17.6	14.1
$LSD_{5\%}$	133.79	74.25	0.001	0.001	1.40	0.20

The LSD (p=0.05) for fertilization treatments are also sown.

the tallest plants. while the half rate poultry manure, fertilizer and control plots ,brought out the shortest plants ($P<0.05$).

Leaf area index

In 2005, the LAI (Tab. 1.) was the lowest for the untreated control ($P<0.05$) and the highest for the double cow manure treatment. In 2006 experiment , the lowest LAI ($P<0.05$) was again obtained for the control plot and the highest for the double rate cow manure treatment. LAI increased as the amount of Poultry Manure, Cow Manure and Barley were increased.

Dry weight

In 2005, the lowest dry weight was measured in the control treatment ($P<0.05$) and the highest in the double cow manure treatment ($P<0.05$). The fertilizer treatment was better than all rates of poultry manure and barely mulch ($P<0.05$). In the second experiment , the control treatment had the lowest dry weight ($P<0.05$), and the double rate cow manure had the highest biomass ($P<0.05$). The dry weight of plants obtained with fertilizer treatment was lower than that of those grown on the full, double poultry manure, cow manure and barley mulch plots.

Yield and yield components

1000-Grain weight

In 2005, the lowest values of 1000-grain weight were obtained with the untreated control ($P<0.05$). The greatest value was associated with the double rate cow manure (Tab. 2.) and half rate poultry manure treatments ($P<0.05$). The double, full rate poultry manure and double rate barley mulch gave lower values in comparison to the half rate treatments ($P<0.05$). Double rate cow manure had a higher value comparing with the half and full rate treatments. The fertilizer plot, gave similar values to the full rate cow manure treatment. In 2006, the maximum values of 1000-grain weight were lower than the maximum values recorded in 2005. The control plot had the lowest value ($P<0.05$) while not all differences were statistically significant. Double rate cow manure treatment produced the greatest value while 1000-grain weight increased as the rates of amendment in the poultry manure and barley mulch treatments increased (Tab. 2.).

Grains per rank

In 2005, the lowest value was obtained with the control plot.($P<0.05$). The untreated control had the lowest value (Tab. 2.) but was not significantly different from the double rate barley treatment. The greatest value was observed for double rate cow manure ($P<0.05$).

In 2006, in comparison to the previous year, the maximum number of grains per rank was lower, with great differences between treatments. The control had thelowest number of grains per ear ($P<0.05$), while the highest number was recorded in the double rate cow manure plot, double rate barley mulch. Number of grains per rank was directly related to the amounts of soil amendment applied.

Tab. 3. The effect of organic amendments and fertilizer on maize photosynthetic rate (μmol CO_2 m^{-2} s^{-1}), 35, 51 and 66 DAS (Days after sowing), X: 10 t ha^{-1}

Treatments	Photosynthetic rate					
	35 DAS		51 DAS		66 DAS	
	2005	2006	2005	2006	2005	2006
Poultry Manure X2	43.13	35.37	42.75	31.25	42	21.13
Poultry Manure X	42.13	37.12	42.25	37.12	39.5	33.13
Poultry Manure 2X	41.13	38.12	35	38.12	28	36.13
Cow Manure X2	41.13	36.12	35.25	32.12	32	34.13
Cow Manure X	43.13	37.12	39	36.12	38	36.75
Cow Manure 2X	43.13	39.12	42.5	37.12	44.25	37.25
Barley Mulch X2	42.75	36.12	43.25	28.12	41.25	25.13
Barley Mulch X	41.13	38.12	39.5	35.12	38.25	33.13
Barley Mulch 2X	39.13	40.4	33.25	38.12	29.75	36.13
Fertlizer 21-0-0	40.75	31.25	42.5	29.12	36.75	30.25
Control	23.50	21.75	29.5	27	25.37	21.88
$LSD_{5\%}$	1.34	1.34	1.66	1.04	1.23	1.21
The LSD (P=0.05) for fertilization treatments are also sown.						

Tab. 4. The effect of organic amendments and fertilizer on maize stomatal conductance (mol m^{-2} s^{-1}), 35, 51 and 66 DAS (Days after sowing), X: 10 t ha^{-1}

Treatments	Stomatal Conductance					
	35 DAS		51 DAS		66 DAS	
	2005	2006	2005	2006	2005	2006
Poultry Manure X2	3.08	0.97	1.79	0.81	1.16	0.75
Poultry Manure X	2.88	1.31	1.69	1.11	0.93	1.01
Poultry Manure 2X	2.39	1.40	0.78	1.21	0.46	1.11
Cow Manure X2	2.99	1.21	0.87	1.01	0.68	0.60
Cow Manure X	3.13	1.41	1.04	1.21	0.64	0.65
Cow Manure 2X	3.63	1.61	1.17	1.61	0.95	1.25
Barley Mulch X2	1.02	0.65	1.74	1.21	1.43	1.01
Barley Mulch X	0.83	0.81	1.29	1.31	1.29	1.21
Barley Mulch 2X	0.67	1.61	0.96	1.71	1.21	1.44
Fertlizer 21-0-0	2.39	1.36	1.28	1.21	1.01	1.04
Control	1.05	0.91	0.78	0.71	0.63	0.50
$LSD_{5\%}$	0.16	0.16	0.18	0.11	0.17	0.15
The LSD (P=0.05) for fertilization treatments are also sown.						

Yield

In 2005, the control plot had the lowest yield (Tab. 2.) and the double rate cow manure plot had the greatest ,(P<0.05) followed by the fertilizer treatments. The second lower yield after the control was with double rate barley mulch.

In 2006, yields were reduced in comparison to the previous year, when organic and inorganic fertilizers were used. The control had the lowest yield (P<0.05) and the double rate cow manure plot the greatest (P<0.05). As the amount of poultry manure, cow manure and barley mulch was increased, yield also increased in contrast with the 2005 experiment.

Physiological characteristics

Photosynthesis

In 2005, 35 and 51 DAS the photosynthetic rate of the untreated control was significantly lower (Tab. 3.) than the other treatments (P<0.05). The photosynthetic rate increased as poultry manure and barley mulch rate decreased and as cow manure rate increased. 66 DAS, the lowest photosynthetic rate was obtained in control and double barley mulch plots and the highest ,in double cow manure plot (P<0.05). In 2006, the highest photosynthetic rate was obtained in the double rate barley mulch and double rate cow manure (P<0.05) and lowest, in the control plot.

Stomatal conductance

In 2005, at first assessment (35 DAS) the lowest values were obtained in all barley mulch treatments. The values of stomatal conductance in full and double rate barley mulch were even lower than the control (P<0.05). The highest value was obtained in double rate cow manure plots (P<0.05). The all values of stomatal conductance in cow manure, poultry manure and fertilized treatments were greater than the control plot.(Tab. 4.). At the second (51 DAS) and third assessment (66 DAS) the values of stomatal conductance in poultry manure, cow manure and fertilizer plots were lower in comparison to the first measurement. In plots with barley treatments an increase in comparison to the first measurement was observed. The lowest values were obtained in the double rate poultry manure and control treatments (P<0.05) and the highest in half rate barley residues and half rate poultry manure plots (P<0.05).

In 2006, values of stomatal conductance were also lower comparing to 2005. For 36 DAS the lowest value was obtained with half rate barley mulch (P<0.05) while for 51 and 66 DAS the lowest value (P<0.05) was for the control. For the all three measurements in 2006, it was ob-

Tab. 5. The effect of organic amendments and fertilizer on maize chlorophyll content (μgcm^{-2}), 35, 51 and 66 DAS (Days after sowing), X: 10 tonha^{-1}

Treatments	Chlorophyll content					
	35 DAS		51 DAS		66 DAS	
	2005	2006	2005	2006	2005	2006
Poultry Manure X2	126.82	77.33	140.25	102.33	156.7	102.5
Poultry Manure X	120.15	84.33	130	104	151.7	106.75
Poultry Manure 2X	110.57	85.25	130.88	104.83	150.1	107.57
Cow Manure X2	121.92	84.33	133.25	101.08	147.6	106.75
Cow Manure X	117.75	85.25	137.75	104.75	153.7	108.5
Cow Manure 2X	131.57	93.5	150.75	109.9	157.1	124.85
Barley Mulch X2	116.75	78	139.75	104.75	159.1	89.92
Barley Mulch X	114.25	83.13	133.75	110.25	151.7	100.67
Barley Mulch 2X	101.75	87.5	126.13	108.75	142.5	104.75
Fertlizer 21-0-0	124.42	81.5	141.5	104.25	156.7	102.75
Control	79.75	74.5	89.75	80.25	99.75	81.25
$LSD_{5\%}$	9.06	4.49	5.16	12.1	6.23	5.47
The LSD (P=0.05) for fertilization treatments are also sown.						

served that stomatal conductance increased as the amount of amendment increased

Chlorophyll content

We related the model between the SPAD values and the real values of chlorophyll concentration. The correlation between SPAD values and chlorophyll content per unit leaf area was linear. The equations that describe this are:

2005: *Chlorophylcontent*(μgcm-2ofleaf)=0.2811 *SPAD*-1.973 (R^2=0.596)

2006: *Chlorophylcontent*(μgcm-2ofleaf)=1.3566 *SPAD* +26.29 (R^2=0.581)

In 2005, the untreated control plots had the lowest chlorophyll content ($P<0.05$). The highest value was found in half rate poultry manure (Tab. 5.), double rate cow manure and half rate barley mulch ($P<0.05$). The half rate poultry manure and half rate barley mulch had greater chlorophyll concentration in comparison to full and double ($P<0.05$). In addition, within the cow manure treatments, double rate cow manure had greater chlorophyll content. Furthermore, high chlorophyll values were also measured in the fertilizer plot.

In 2006, the difference of the control relative to other treatments was reduced in comparison to 2005, but remained the lowest value ($P<0.05$). Chlorophyll concentration was directly related to the amount of poultry manure, cow manure and barley mulch, at all assessments. The fertilized plots had high chlorophyll values (Tab. 5.).

Discussion

Organic soil amendment increases the levels of soil orgOrganic soil amendment increases the levels of soil organic matter. The influence of organic matter on soil physical properties is dependent on the amount and type of added organic materials (Barzegar *et al.*, 2002; Nelson and Oades, 1998). In both years, the lowest concentration of organic matter was determined for the control (untreated) plot, while the highest was found in the double rate cow manure treatment, which was significantly different from the other treatments. Organic matter content was proportionate to the amount of manure applied. Overall cow, poultry manure and barley mulch increased soil organic matter in comparison to inorganic fertilizer and control (no treatment).

In a similar study, Shirani *et al.* (2002) reported that manure application decreased soil bulk density and increased soil organic matter and hydraulic conductivity. Sidhu *et al.* (1989) have also observed that the incorporation of wheat residues improved the soil physicochemical properties. Moreover, Sharma and Prasad (2008) reported that the return of rice and wheat residues can recycle up to 20-30% of the N absorbed by crops. However, their wide C:N ratio can temporary immobilize native and applied N. To overcome this immobilization, wheat-straw application was supplemented with the incorporation of Sesbania green manure and mungbean residues.

Inorganic fertilizer maintained high percentages of organic matter during the whole cultivation period comparing with the control treatment . This can be sustained by looking at the plant growth data. Inorganic fertilization promotes plant growth in comparison to the unfertilized plots. Better plant growth also means better root growth, which increases soil organic matter. It is also reported that organic fertilizers promote root growth and activity of sweet corn plants compared with inorganic fertilizers or to lack of application (Xu *et al.*, 1997). It is logical that a plant with a larger root system can absorb more water and support photosynthesis.

Maize nitrogen requirement for optimum vegetative and reproductive growth ,is considerable comparing to the other nutrients need. Many physiological processes associated with maize growth are enhanced by N supply. The relationship between N nutrition and maize photosynthesis is confirmed by Correia *et al.* (2005). The photosynthetic rate (Tab. 3.), stomatal conductance (Tab. 4.) and chlorophyll content (Tab. 5.) of the untreated control was significantly lower than that of the other treatments ($P<0.05$). High correlation between photosynthetic rate and stomatal conductance or chlorophyll content was measured (Tab. 6.). The toxicity of barley mulches influences stomatal conductance at 35 DAS, in 2005. The dou-

Tab. 6. Correlation coefficients[a] between yield, plant characteristics, photosynthesis and organic matter

	Experiment 2005	Experiment 2006
Yield X 1000 Grain weight	0.90***	0.89***
Yield X Grain per rank	0.92***	0.99***
Yield x Dry weight	0.94***	0.99***
Yield x Photosynthetic rate	0.66*	0.85***
Dry weight x Photosynthetic rate	0.63*	0.83**
LAI x Photosynthetic rate	0.45ns	0.78**
Organic matter x Yield	0.86***	0.76**
Organic matter x Dry weight	0.86***	0.77**
Photosynthetic rate x Stomatal conductance	0.81**	0.79**
Photosynthetic rate x Chlorophyll content	0.93***	0.89***

[a]r was calculated using the linear equation. ns: not significant. *, ** and *** significant at P=0.05, P=0.01, P=0.001, respectively.

ble rate cow manure (240 kg N ha^{-1}) rate was one of the best treatments. Selvaraju and Iruthayaraj (1995) reported that stomatal conductance and transpiration rate of maize plants were increased with N application. Moreover, other investigators have reported high stomatal conductance, transpiration and photosynthetic rates for plants (sunflowers, tobbaco and tomato) under nitrogen application (Cechin and Terezinha, 2004; Guidi *et al.*, 1998; Karkanis *et al.*, 2007).

The reduced photosynthetic rate resulted in a significant reduction in growth of sweet corn. High correlation between photosynthetic rate and LAI or dry weight was observed. The lowest height, leaf area index and dry weight of sweet corn were measured in control plots. The double rate cow manure (240 kg N ha^{-1}) had the highest biomass. Nitrogen deficiency decreased maize leaf area index, resulting in shorter plants with less dry matter accumulation (Zhao *et al.*, 2003). The dry weight of plants obtained on fertilizer treatment was lower than the full, double poultry manure, cow manure and barley mulch plots. High correlation between organic matter and biomass was registered (Tab. 6.).

The lowest values of 1000-grain weight and grain for rank were obtained in the control plot. The double rate cow manure (240 kg N ha^{-1}) had the highest values of 1000-grain weight and grains per rank. Oktem and Oktem, (2005) reported that increasing N applications increased ear length, kernel number per ear and single fresh ear weight of sweet corn.

Sweet corn yield was significantly increased by the manure and barley mulch incorporation. Yield was influenced by the type and the quantity of the amendment. High correlation between sweet corn yield and 1000-grain weight or grains per rank was registered. The double rate cow manure plot (240 kg N ha^{-1}) had the highest yield. Akbar *et al.* (2002) reported that the highest yield of sweet corn was recorded for 200 kgN ha^{-1}. Moreover, Oktem and Oktem (2005) found that, for a sweet corn density of 79370 plants ha^{-1}, the highest fresh ear height was obtained from 200-250 kg ha^{-1}.

In 2006, yields were reduced in comparison to the previous year, when organic and inorganic fertilizers were used. As the amount of poultry manure, cow manure and barley mulch were increased, yield also increased in contrast with 2005 year. High correlation between yield and photosynthetic rate was registered (Tab. 6.). Rasool et al. (2008) observed that grain yield and uptake of N, P and K by maize were higher with the application of farmyard manure and inorganic fertilizers than in control plots. Moreover, management of cereal residues for corn planting is an important issue. Bahrani *et al.* (2007) reported that the highest grain yield (15.73 t ha^{-1}) and grain per ear of corn (709.3) were obtained when 25-50% of wheat residues were soil incorporated. It is recommended that complete residue removal or burning should be avoided.

Conclusions

Our results indicate that manures had greatly affected the growth, yield and photosynthesis of sweet corn. The most significant impact was observed when cow manure was applied to soil. The lowest dry weight, height and leaf area index and soil organic matter were measured in the control treatment. The photosynthetic rate increased as poultry manure and barley mulch decreased and as cow manure increased. Organic soil amendments increased the levels of soil organic matter. Overall, cow, poultry manure and barley mulch increased soil organic matter in comparison to inorganic fertilizer and control (no treatment). High correlation between sweet corn yield and organic matter was registered.

Concerning the organic agriculture system the manure and barley mulch can affect the sweet corn growth. Final, the choice of suitable amounts of organic fertilizers can also affect the yield of sweet corn.

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