

HOW MUCH, LEAVES NEAR THE EAR CONTRIBUTE ON YIELD AND YIELD COMPONENTS OF MAIZE ?

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ABSTRACT. In order to study the role of leaf position on yield and yield component of maize, this research was conducted based on randomized complete block design with three replicates at the research field of Urmia University, Urmia, Iran, in 2011. For determine the role of leaf position in maize yield, we used the leaf removing (clipping) treatments. Leaf clipping treatments contain ear leaf clipping, above ear leaf clipping, below ear leaf clipping and control (without leaf clipping) that imposed at one week after ear initiation. Leaf removing had a significant effect on all measured traits (number of seed per row, row number per ear, ear length, 1000 seed weight, seed yield, biological yield), except harvest index. Removing of above leaves decreased 6.68% the number of seeds on ear compare to control. The highest 1000 seed weight (274 g) was observed in plants without leaf clipping. Ear leaf clipping and below ear leaf defoliation ranked second for 1000 seed weight. Whereas plants without any leaf clipping had the utmost seed yield (8.77 t ha⁻¹) but defoliating of leaf above ear lead to lower seed yield (6.77 t ha⁻¹). Leaf removal above ear decreased 22.80% biological yield compared to control. The correlation analysis showed that all traits had positive correlation with seed yield. The most

correlation was between ear length and number of row per ear ($r=0.89^{**}$). Also, number of seed per row ($r=0.71^{**}$), 1000 seed weight ($r=0.67^{**}$), ear length ($r=0.65^{**}$), biological yield and harvest index ($r=0.59^{**}$) showed the most correlation with seed yield, respectively. Results revealed that the most reduction in all traits accrued in maize plants with above ear leaf clipping, this results indicated that the important roles of leaves position especially the role of above ear leaves in yield and yield components of maize.

Key words: Ear leaf; Leaf above ear; Leaf clipping; Seed yield.

INTRODUCTION

Leaves are vitally essential organs for photosynthesis, which is a major process affecting crop growth rates and is affected by either the number or the area of the leaves. Since the productivity of a plant depends on the efficiency of its photosynthetic processes, the growth and development of leaves (Karadogan and Akgun, 2009).

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Maize is staple food in most part of the world and has third position after wheat and rice (Zamir *et al.*, 2013). Maize yield is strongly depended on leaves efficiency for absorption of solar radiation for photosynthesis process (Mouhamed and Ouda, 2006). Leaf photosynthesis can be influenced by many plant factors such as leaf age, leaf position, sink effects, and mutual shading, as well as environmental factors such as light, temperature, nutrition, and water availability (Lieth and Pasian, 1990).

Defoliation or leaf damage, such as that associated with hail, frost, wind, chemicals for crop protection and insects, can decrease assimilate availability during grain filling, seed and biological yield (Echarte *et al.*, 2006). Different types of leaf clipping have various influences on dry matter accumulation when the leaf clipping occurs at the primary stage of grain development (Wang, 1996). Maize leaf clipping at early season significantly decreased the stem length and leaf area but it did not have any effect on leaf emergence (Prioul and Dugue, 1992). It was noticed that when the maize defoliation is severe and its time is closer to silking stage, forage yield would be decreased greatly (Burton *et al.*, 1995).

Although, the previous studies indicated that some effects of defoliation on yield and yield component of maize, but there is dearth of information about the contribution rate of leaf position in maize yield and yield component.

Therefore, this study was carried out to evaluate the role of leaf near of maize ear on yield.

MATERIALS AND METHODS

The study was conducted during 2011 at the Research Field of Urmia University (37° 39'N, 44° 58' E), Urmia, Iran. The experiments were arranged in RCBD with three replicates. The treatments consist of four leaf clippings (without leaf clipping, ear leaf clipping, above ear leaf clipping and below ear leaf clipping). Leaf clipping was carried out at one week after ear initiation (BBCH 63) (Lancashire *et al.*, 1991).

Maize seeds were planted in the field with plot size of 12 m² (4 × 3 m) with five rows, where each row was 4 m long with 60 cm row spacing and maize seeds were sown in hills spaced 25 cm on ridges at the 5th of March 2011. The soil texture was silty clay with a pH 7.12. The soil N, P and K (mg kg⁻¹) were 0.38, 9.8 and 195, respectively. The maize variety was S.C 704. For all treatments, nitrogen fertilizer (as urea) on the basis of 100 kg ha⁻¹; phosphorus fertilizer (as phosphate ammonium), 150 kg ha⁻¹ was applied. Pesticides, herbicides and fungicides, for controlling pests, weeds and diseases, during the growing seasons, were not used. Weeds were managed by hand weeding throughout the growing season. Plots were irrigated every 10 days with equal amount of water.

Agronomic traits of maize such as row number per ear, seed number in row, ear length, were measured at harvest time in 10 plants. At physiological maturity, three central rows in each plot were harvested. The ears were dehusked, dried and threshed. Seed and biological weight was recorded and then converted into t ha⁻¹. Five hundred dry seed (with 12%

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moisture) from each plot were weighed to determine the 1000 kernel weight. Harvest index was calculated by the following formula: Harvest index (%) = (seed yield /biological yield) × 100

Analysis of variance was conducted on data with the software SAS 9.1. Correlation coefficients were calculated for the relationship between yield and yield components of maize. The means differences among treatments were compared by Duncan Multiple Comparison Test at 0.05 level of probability.

RESULTS AND DISCUSSION

Results showed that number of seed per row, row number per ear, ear length, 1000 seed weight, seed yield, biological yield of corn plants in leaf clipping treatments have significant differences compared to mean control value (*Table 1*).

Number of seed per row is an important yield determining factor in maize (*Cheema et al., 2010*). Although, the most number of seed per row was obtained in maize plants without clipping, but, plants treated with all three types of leaf clipping had the same number of seed per row (*Table 2*). As shown in *Table 2*, the highest mean value of number of seeds per row (36.36) obtained by maize plants without leaf clipping and the lowest (33.90) belonging to the plants with above ear leaf clipping. In fact, removing of above leaves decreased 6.68% the number of seeds on ear compare to control (*Table 2*). In corn, seed number is determined in the range of silking and in this period there is high sensitivity is to provide

assimilate (*Minami, 1991*). Also, reported that maize defoliation caused the seed yield reduction because of the seed number decrease (*Allison and Watson, 1966*).

Row number per ear is one of the very important agronomic traits, related to maize yield (*Liu et al., 2010*). The row numbers per ear affected by above ear leaf clipping, so removing of leaves above ear had the minimum value (12.33) and plant with non-defoliation had the maximum (13.23) of it (*Table 2*). The results illustrate that above leaves of ear were most effective than other leaves for this trait. *Barimavandi et al. (2010)* noted that the number of rows per ear affected by complete leaf removal, whereas one or more leaves had no impact on this trait.

Ear length is one of the important factors contributing to seed yield. Mean comparing of the ear length in leaf clipping treatments showed that the highest ear length (18.6 cm) was observed in without leaf clipping and above ear leaf clipping had the lowest ear length (17.13 cm). It is indicated that ear length is most affect by some factor such as intensity of defoliation and position of leaves on the plant (*Barimavandi et al., 2010*).

The effect of leaf clipping treatments on the 1000 seed weight was significant (*Table 1*). The highest 1000 seed weight (274 g) was observed in without leaf clipping. Ear leaf clipping and below ear leaf defoliation ranked second for 1000 seed weight (*Table 2*).

Table 1 - Analysis of variance for yield and yield components of maize affected by bio-organic seed priming and leaf clipping

Source of variation	Df	Mean square						
		Number of seed per row	Row number per ear	Ear length	1000 seed weight	Seed yield	Biological yield	Harvest index
Replicate	2	17.78	0.86	3.40	17.33	5.29	1.96	59.70
Leaf clipping	3	3.56*	0.54*	1.11**	421.41**	2.01**	19.56*	8.60 ^{ns}
Error	6	0.58	0.42	0.063	28.66	0.079	3.48	15.53
C.V (%)		2.19	2.06	1.40	2.05	3.65	8.61	11.04

ns, means non-significant values, * significant at 5%, and ** at 1% probability; Df: Degrees of freedom.

Table 2 - Mean comparison of yield and yield components of maize affected by leaf clipping

Leaf clipping	Number of seed per row	Row number per ear	Ear length (cm)	1000 seed weight (g)	Seed yield (t ha ⁻¹)	Biological yield (t ha ⁻¹)	Harvest index (%)
Ear leaf clipping	34.33 ^b	13.13 ^{ab}	18.00 ^a	256 ^{bc}	7.63 ^b	21.06 ^{ab}	36.43 ^a
Above ear leaf clipping	33.90 ^b	12.33 ^c	17.13 ^c	246 ^c	6.77 ^c	18.4 ^b	36.99 ^a
Below ear leaf clipping	34.50 ^b	12.63 ^{bc}	18.10 ^{ab}	263 ^{ab}	7.64 ^b	23.0 ^a	33.21 ^a
Without leaf clipping	36.36 ^a	13.23 ^a	18.6 ^a	274 ^a	8.77 ^a	24.26 ^a	36.16 ^a

The same letters in each column shows non-significant differences.

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Table 3 - Pearson's correlation coefficients among studied traits in maize under different defoliation treatments

	NSR	RNE	EL	SW	SY	BY	HI
NSR	1	0.33	0.89**	0.48	0.71**	0.58*	0.24
RNE	0.33	1	0.37	0.54	0.83**	0.37	0.62*
EL	0.89**	0.37	1	0.62*	0.65**	0.60*	0.16
SW	0.48	0.54	0.62*	1	0.67*	0.71**	0.10
SY	0.71**	0.83**	0.65**	0.67*	1	0.59*	0.59*
BY	0.58*	0.37	0.60*	0.71**	0.59*	1	-0.30
HI	0.24	0.62*	0.16	0.10	0.59*	-0.30	1

NSR, RNE, EL, SW, SY, BY and HI are number of seed per row, ear row number, ear length, 1000 seed weight, seed yield, biological yield and harvest index; *Correlation is significant at the 0.05 level; **Correlation is significant at the 0.01 level.

Seed yield is a function of interaction among various yield components that are affected differentially by the growing conditions and crop management practices (Cheema *et al.*, 2010). Results showed that plants without any leaf clipping had the utmost seed yield (8.77 t ha^{-1}) but defoliating of leaf above ear lead to lower seed yield (6.77 t ha^{-1}). Therefore removing of above leaves decreased 22.8% the seed yield compare to control (*Table 2*). In any crop, the degree of yield reduction is directly proportional to the percentage of leaf area destroyed. The loss in the functional leaf area results in loss of photosynthetic area of the plant and reduces the assimilate availability (Walpole and Morgan, 1970). Then there is an imbalance between source (leaves) and sink (seed) which leads to reduction in seed yield and quality. In fact, seed yield is dependent on the number and weight of the seeds per ear, duration of seed filling, supply and rate of incorporation of photosynthesis into its structure from anthesis to fully development of seed (Walpole and Morgan, 1970). Also, reported that, the percentage yield loss is depending on factors such as on the amount of removed leaves, leaf position on plant and also defoliation time (Shapiro *et al.*, 1986).

The effect of leaf clipping treatments on the biological yield weight was significant (*Table 1*). Data recorded for leaf clipping treatment in *Table 2* showed that the highest (24.26 t ha^{-1}) mean value of biological

yield was obtained from the plants without any defoliation. Ear leaf clipping and below ear leaf defoliation ranked in second grouping for biological yield. Removing of leaf above ear decreased 24.15% biological yield compared to control (*Table 2*).

Harvest index, which denotes the proportion of economically produced part to the above ground biomass, is not affected by leaf clipping treatments. But the highest (36.99 %) and lowest (33.21 %) of it was observed in plants with above and below ear leaf clipping, respectively (*Table 2*). This suggests that plants maintained a higher supply of photosynthesis to reproductive part as compared to vegetative biomass to sustain higher harvest index.

Correlation coefficient

Knowledge on the association of yield with other agronomical traits may provide good information necessary for breeders, when, selection is based on two or more traits simultaneously. Information obtained from correlation coefficients were estimated to evaluate the importance of different agronomical traits in crops (Joshi, 2005). It was reported that ear length, number of seed rows per ear, number of seeds per row and 1000 seed weight positively influenced the yield directly and also indirectly through several components (Devi *et al.*, 2001).

The correlation analysis revealed that all traits in this research, had positive and meaningful correlation

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with yield. The most correlation was between ear length and number of row per ear ($r=0.89^{**}$) (Table 3). These results are in agreement with other researcher (Devi *et al.*, 2001). Results showed that ear row number has the most positive correlation ($r=0.83^{**}$) with grain yield. After this trait, number of seed per row ($r=0.71^{**}$), 1000-seed weight ($r=0.67^{**}$), ear length ($r=0.65^{**}$), biological yield and harvest index ($r=0.59^{**}$) showed the most correlation with grain yield, respectively. The high correlation of grain yield with 1000 seed weight and the number of rows per ear is reported by other researchers (Khayatnezhad *et al.*, 2010; Mohammadi *et al.*, 2003). Traits that had positive correlation with grain yield may be considered as important traits in selection programing to maize yield improvement and the breeder may consider these traits as main selection criteria.

CONCLUSIONS

Results showed that falling off of the most maize yield attributes as a consequence of leaves removed from the above ear of maize plants causes a more marked reduction of the number of seed per row, row number per ear, ear length, 1000 seed weight, seed yield and biological yield than the other leaf removal treatments.

In comparison with no leaf clipping treatment, a reduction of 5.58, 6.76 and 5.11 percent in number of seed per row, 0.75, 6.80 and 4.53 percent in row number per ear, 3.22,

7.90 and 2.68 percent in ear length, 6.56, 10.21 and 4.01 percent in 1000 seed weight, 12.99, 22.80 and 12.88 percent in seed yield and 13.19, 24.15 and 5.19 percent in biological yield, were recorded due to defoliation of ear leaf clipping, above ear leaf clipping and below ear leaf clipping, respectively.

Generally, results showed that the most reduction in all traits accrued in maize plants with above ear leaf clipping, this comparisons indicated that the important role of above leaf ear in yield and yield components of maize. After this leaves, ear leaf also had the most important role in maize yield.

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