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FRESH BIOMASS PRODUCTION OF DOUBLE CROP MAIZE (*Zea mays* L.) HYBRIDS CULTIVATED IN MOARA DOMNEASCA, ILFOV

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Abstract

Double crops system constitutes a means by which the vegetation factors can be more efficiently exploited (Tiru, 1973). In Romania the specie most used for double crops is maize, because it can be harvested as grain or as fresh biomass if the climatic conditions do not ensure the attainment of physiological maturity. To reach physiological maturity the double crop of maize needs between 900 and 1800°C (Tiru, 1973) and a irrigation regime of 2000 m^3 water/ha (Hulpoi, 1966). Also the fertilization levels play an important role in the attainment of physiological maturity (Budoi, 1988). The research done has the purpose of establishing the optimal precocity of the hybrids used for double crops in the pedo-climatic conditions of Moara Domneasca, Ilfov and also to assess the importance of the fertilization levels and irrigation regime on double crops. In the conditions of 2013, the maize double crop was harvested as fresh biomass, yielding between 28 and 64 t/ha, considering the hybrid, fertilization level and irrigation regime.

Key words*: Zea mays L., double crops, fertilization levels, irrigation regime, sum of biological useful degree temperature.*

INTRODUCTION

The biological particularities and outstanding food quality led maize cultivation in various parts of the world, nowadays occupying the third place in surface cultivated after wheat and rice (Ion, 2012).

The importance of maize is given mainly by its nutritional qualities, both for human nutrition and for animal feed. Using maize silage is the most effective way of feeding animals during stabulation, having a very high degree of expendability (Ion, 2012).

Another important feature of maize is the possibility to be cultivated in double crops, after species that are harvested early (Ion, 2012).

Double crops system constitutes a means by which the vegetation factors can be more efficiently exploited (Tiru, 1973).

In areas with heavy rainfall and even in other areas, in the rainy years, without irrigation after straw cereals, the forage crops can be cultivated, which can increase the efficiency of agricultural land up to 30% or more (Taru, 1973, Zhu Zixi et al., 1994). Under irrigation condition, increased yields can be obtained for forage maize as well as for grain production.

Navarro et al. (2012) showed the double crops system profitability.

They calculated the prices obtained by farmers for main crop per acre and two crops in the double crops system.

Thus, they observed that a soybean main crop brings in a profit of $ 80 / acre, when double crops of sorghum fresh biomass grown after grain wheat, brings together a profit of $ 244 / acre.

This is because the farmer operates in two markets, grain and forage. Of course, this increase of profit is dependent of the obtained production, of the sales prices and of the relationship between these two.

Double crops system is an alternative for the future of agriculture in the context of the climatic changes. Meza (2012) suggest, after some simulations to see the impact of climate change on agriculture, that double crop of maize could become a common practice due to the extension of the vegetation as a result of global warming.

The only inconvenience is the necessity of irrigation, creation and use of hybrids that are drought and heat tolerant.

The maize, having a high capacity of production, a high tolerance to drought and heat, and

being a culture with minimal risk for the farmer, having uses such as grain or fresh biomass, represents an important crop for irrigated double crops system.
The most important quality of maize in the double crops system is that it can be harvested as fresh biomass if it does not have the necessary conditions to reach grain maturity. The losses in this case are determined only by the use of production, because its value in units nutrients may be even higher for fresh biomass compared to the same culture harvested for grain (Taru, 1973).
The maize is a heat-loving plant that needs about 900-1800^{o}C for the whole vegetation period according to the hybrid maturity group. So, to reach grain maturity and to have a good production in double crops system, the maize hybrids should be from a early maturity group (Kratochvil et al., 2006).
Over time, it has been created highly productive hybrids from all the maturity groups and even hybrids especially for double crops system (Sarca et al., 1980).
Due to higher temperatures and faster growth of the stem and root, the double crop of maize requires about 2000 m^3 water/ha (Hulpoi et al., 1966; Taru, 1973) and also a higher demand in nutrients, especially nitrogen (Taru, 1973; Budoi et al., 1988).

MATERIALS AND METHODS

The research was conducted in 2013 at the Moara Domneasca Teaching Farm, Ilfov.
The experience was three-factorial type, the three factors were: the hybrid, the irrigation regime and the fertilization.
The arrangement of the experience was performed by the method of subdivided parcels.
The maize hybrids used were: a_1: LG 22.44 (FAO 240) – as control, a_2: LG 30.290 (FAO 290) and a_3: LG 30.489 (FAO 470).
Irrigation regimes studied were b_1: non-irrigated (control), b_2: irrigated with 450 m^3/ha and b_3: irrigated with 900 m^3/ha (a mildly irrigation regime).
The fertilization presented four graduations: c_1: no fertilization (control), c_2: nitrogen 80 kg/ha active substance, c_3: nitrogen 80 kg/ha active substance plus foliar fertilization and c_4: foliar fertilization. For the nitrogen fertilization it was used urea, and for the foliar fertilization it was used the product Hortifor with applications at a dose of 2.5 kg/ha.
The maize hybrids were used in double crop after winter wheat. The soil was prepared for sowing with disc harrow and combiner.
Sowing was on 18th of July, slightly delayed due to weather conditions that delayed the harvesting of the wheat.
Weed control was achieved by herbicide Dual Gold (pre-emergence) and Ceredin Super (post-emergence) and by an application of a mechanical weeding.
The irrigations were applied every 10-15 days depending on rainfall, in small quantities of about 200 and 250 m^3 water/ha.
Maize plants were harvested on 7th of October, this it was imposed by the low temperatures in early October.

RESULTS AND DISCUSSIONS

The climatic data, for the vegetation period of the double crop maize (July-September 2013), are presented in Figure 1.
From its analysis it can be seen that the temperatures were higher than the normal average temperatures of the area, the sum of useful degree temperature was 1180^{o}C with 55^{o}C more than the area normal.
Regarding rainfall, in July and August they were below normal, with 40 mm in July and 15 mm in August. In September 2013, the rainfall was higher than the normal by 16 mm.

FRESH BIOMASS PRODUCTION IN DOUBLE CROP MAIZE

In Table 1 are presented the productions of fresh biomass production (t/ha) recorded for the double crop maize, depending on the hybrid, irrigation regime and the fertilization level.
The highest values of fresh biomass production were recorded for the hybrid LG 22.44 (from 28.37 t/ha at b_1c_1 to 64.86 t/ha b_3c_3). The hybrid from the highest maturity group (LG 30 489) registered the lowest values.
The fertilization level plays an important role in the yields obtained for the double crop maize, therefore, as the level of the fertilization increases the fresh biomass production increases.

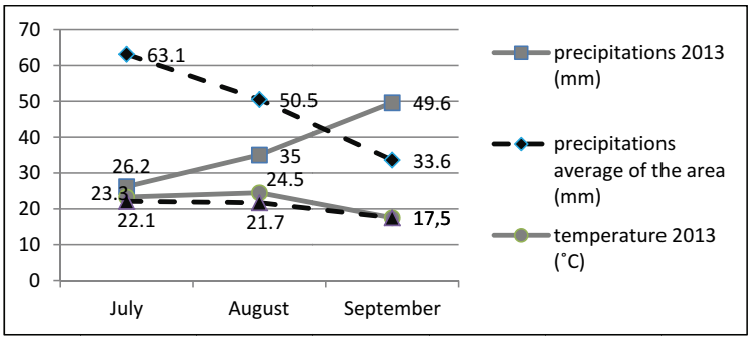

Figure 1. Climatic conditions of the period July – September 2013 (Ganeasa, Ilfov, Weather Station)

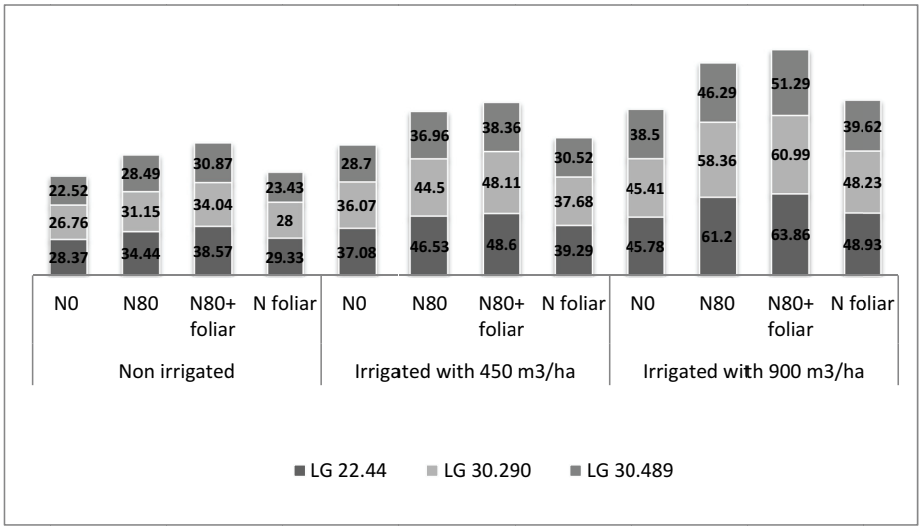

Figure 2. Double crop maize fresh biomass production (t/ha), Moara Domneasca-2013

The differences from the non-fertilized variants are ranging between 0.96 t/ha and 18.08 t/ha. In the same measure, the irrigation regime is important for a high yield of the double crop maize.

The highest values according to hybrid (63.86 t/ha, 60.99 t/ha and 51.29 t/ha) were recorded for the irrigation norm of 900 m^3/ha.

In table 2 and figure 2, are presented the differences of the fresh biomass production (t/ha) between the earliest hybrid (LG 22.44) and the other two hybrids (LG 30 290 and 30 489 LG).

Thus from Table 2 it can be observed the gradual decrease of productions in the same time with increasing the maturity group of the hybrids regardless of the fertilization levels or the irrigation regimes analyzed.

For non-irrigated regime, the maximum difference between the hybrid LG 22.44 and the hybrid LG 30.290 was 4.53 t/ha, and the hybrid LG 30.489 was 7.7 t/ha.

At the irrigation regime of 450 m^3/ha, the difference with LG 30.489 increased to 10.24 t/ha, reaching to 14.91 t/ha at the irrigation regime of 900 m^3/ha. These differences show that for the early hybrids the accumulation speed of the biomass is higher.

Table 1. The influence of the hybrid, fertilization and irrigation on biomass production of double crop maize

Variant		Hybrids								
		LG 22.44			LG 30.290			LG 30.489		
Irrigation regime	Fertilization	Biomass prod. t/ha	%	Dif. t/ha	Biomass prod. t/ha	%	Dif. t/ha	Biomass prod. t/ha	%	Dif. t/ha
Non irrigated	N0	28.37	100	Mt	26.76	100	Mt	22.52	100	Mt
	N80	34.44	121	6.07	31.15	116	4.39	28.49	126	5.97
	N80+ foliar fertilization	38.57	135	10.2	34.04	127	7.28	30.87	137	8.35
	Foliar fertilization	29.33	103	0.96	28	104	1.24	23.43	104	0.91
LSD 5% =1.3 t/ha LSD 1% =1.75 t/ha LSD 0.1% = 2.33 t/ha										
Irrigated with 450 m3/ha	N0	37.08	100	Mt	36.07	100	Mt	28.7	100	Mt
	N80	46.53	125	9.45	44.5	123	8.42	36.96	128	8.26
	N80+ foliar fertilization	48.6	131	11.53	48.11	133	12.04	38.36	133	9.66
	Foliar fertilization	39.29	105	2.22	37.68	104	1.61	30.52	106	1.82
LSD 5% = 0.68 t/ha LSD 1% = 0.92 t/ha LSD 0.1% = 1.22 t/ha										
Irrigated with 900 m3/ha	N0	45.78	100	Mt	45.41	100	Mt	38.5	100	Mt
	N80	61.2	133	15.42	58.36	128	12.95	46.29	120	7.79
	N80+ foliar fertilization	63.86	139	18.08	60.99	134	15.59	51.29	133	12.79
	Foliar fertilization	48.93	106	3.15	48.23	106	2.82	39.62	102	1.12
LSD 5% = 0.72 t/ha LSD 1% = 0.98 t/ha LSD 0.1% = 1.3 t/ha										

Table 2. The influence of the maturity group on the biomass production (t/ha) in double crop maize – Moara Domneasca, Ilfov

Variant		Hybrids								
		(FAO 240) LG 22.44			(FAO 290) LG 30.290			(FAO 470) LG 30.489		
Irrigation regime	Fertilization	Biomass prod. t/ha	%	Control	Biomass prod. t/ha	%	Dif. t/ha	Biomass prod. t/ha	%	Dif. t/ha
Non irrigated	N0	28.37	100	Mt	26.76	94.33	-1.61	22.52	79.36	-5.86
	N80	34.44	100	Mt	31.15	90.45	-3.29	28.49	82.72	-5.95
	N80+ foliar fertilization	38.57	100	Mt	34.04	88.26	-4.53	30.87	80.04	-7.7
	Foliar fertilization	29.33	100	Mt	28	95.47	-1.33	23.43	79.87	-5.9
LSD 5% =1.3 t/ha LSD 1% =1.75 t/ha LSD 0.1% = 2.33 t/ha										
Irrigated with 450 m3/ha	N0	37.08	100	Mt	36.07	97.29	-1	28.7	77.41	-8.38
	N80	46.53	100	Mt	44.5	95.64	-2.03	36.96	79.44	-9.57
	N80+ foliar fertilization	48.6	100	Mt	48.11	98.99	-0.49	38.36	78.92	-10.24
	Foliar fertilization	39.29	100	Mt	37.68	95.89	-1.61	30.52	77.67	-8.77
LSD 5% = 0.68 t/ha LSD 1% = 0.92 t/ha LSD 0.1% = 1.22 t/ha										
Irrigated with 900 m3/ha	N0	45.78	100	Mt	45.41	99.18	-0.37	38.5	84.1	-7.28
	N80	61.2	100	Mt	58.36	95.35	-2.85	46.29	75.64	-14.91
	N80+ foliar fertilization	63.86	100	Mt	60.99	95.51	-2.87	51.29	80.31	-12.58
	Foliar fertilization	48.93	100	Mt	48.23	98.57	-0.7	39.62	80.97	-9.31
LSD 5% = 0.72 t/ha LSD 1% = 0.98 t/ha LSD 0.1% = 1.3 t/ha										

CONCLUSIONS

From experiments conducted in 2013 on the double crop maize, it results that the precocity of the hybrids used is very important to ensure a high production of fresh biomass in a short time.

The precocity group FAO 240 (LG 22.44) has recorded positive difference up to 14.91 t/ha compared to the semi-late hybrid, LG 30 489 (FAO 470).

In the same measure, both the irrigation regime and the fertilization level are significant for a high production of fresh biomass. The best results has occurred for irrigation regime of 900 m^3/ha water and at fertilization level of 80 kg N/ha plus foliar fertilization.

In terms of 2013 year, at Moara Domneasca, for the double crop maize, the best yields results were obtained by the hybrid LG 22.44.

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