THE INFLUENCE OF CLIMATIC CONDITIONS x FORERUNNER PLANT x FERTILISATION LEVEL INTERACTION ON BIOMASS ACCUMULATION IN WINTER WHEAT CULTIVATED ON BROWN LUVIC SOILS

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Abstract

The forerunner plant is a decisive factor influencing growth and development of wheat. The role of forerunner plant on wheat growth and development is stressed out by several authors: Pop (1967), Popescu (1980), Milică et al (1968), Zăhan, Zăhan (1969, 1989).

Plant growth is fundamental in obtaining yield and is related vegetation and technological factors, the level of yield being reflected in the intensity of biomass accumulation.

In the majority of cases, total growth of green mass is considered on the assumption that a maximum yield is obtained by increasing total dry weight biomass production and by a favourable repartition of it among plant's organs.

Key words: crop rotation, fertilization, phenophase, phytomass, forerunner plant, climatic conditions.

INTRODUCTION

The crop rotation together with other appropriate agricultural practices contribute to the favourableness of growth and development conditions of wheat root system, to an improved synthesis of specific organic compounds and their improved translocation to plant's organs.

The situation of the wheat cultures at the beginning of winter is determined by the weather conditions of the whole period of vegetation in autumn. In the winter period in the wheat plants physiological processes take place, processes connected to the absorbtion of nourishing mineral principles, their accumulation in the spare tissues or even their use in the elaboration of plastic materials.

At the low temperature during winter, the process of photosynthesis does not stop, but the content of chlorophyll decreases, the content of ascorbic acid increases, the concentration of the cellular juice increases, the percent of dry substance increases, which points out a better adaptation to the conditions during winter (Salisbury, 1995; Soltner, 1990).

The intensity of the growth of wheat plants in spring stands under the influence of the moisture and temperature conditions, important differences in the quantity of dry substance accumulated by the wheat plants being determined by the mineral and organic-mineral nutrition factors. (Bandici, 1997; Bandici et al, 2003).

Plant growth is fundamental in obtaining yield and is related vegetation and technological factors, the level of yield being reflected in the intensity of biomass accumulation. In the majority of cases, total growth of green mass is considered on the assumption that a maximum yield is obtained by increasing total dry weight biomass production and by a favourable repartition of it among plant's organs (Dincă, 1971; Domuta et al, 2008).

However, as a known fact roots are not only absorbing water and nutrients from soil but play a key role in plant's general metabolism. Roots harbour the biosynthesis of some essential compounds for the rest of the plant to which they send the biosynthetic products (Lazany, 2000).

The conclusions that were reached with regard to a normal development of plants, point the importance of a balanced NP fertilisation. This ensures the avoidance of disturbances caused by drought during the vegetation period which decrease plant's resistance. Also, a balanced fertilisation promotes a corresponding passage over each growth stage in order to equilibrate the other vital process, the development and finally to reach corresponding productions (Lazany, 2000, 2003).

Most of the reserches were centred on the influence of crop rotation on the yields, namely on the phytomass accumulation. The crop rotations with regard to wheat was very satisfactory in this order as forerunner plant: pea, beans, winter rape, bots, linseed, soja, red clover, potato, sugar beet, sunflower, corn etc. (Domuţa, Bandici, 2007).

After long tests demonstrated the importance of crop rotation on wheat yields on brown-red soils in Romanian Plain. On clay-illuvial podzols, the introduction of ameliorative plants such as red clover represented an element of outmost importance for increase of the wheat yield (Hera, 1986 a, b).

It is demonstrated that after 10 years monoculture, wheat yield decreases continously in comparative with rotations. It fluctuates as a consequence of changing climatic conditions. Under such circumstances, fertilization does not induce a significant yield increase. A particularly important problem is linked to wheat crop increment, which must fit the rising consumption needs of world population (Bandici, Guş, 2001; Muntean et al, 2011).

Advances in biomass accumulation dynamics in winter wheat in the pedo-climatic conditions of Western Plain of Romania were made by (Zăhan, 1989) during their studies on Transsylvanian wheat race.

The influence of each factor on dry biomass accumulation in wheat shows that crop rotation and fertilization determines essential differences in the accumulation of dry phytomass.

The influence of fertilization on biomass accumulation in winter wheat was studied. Frequent researches put in a direct relationship the pytomass accumulation with the fertilizers that was utilized (Zăhan, 1989).

The dynamics of the phenomena dealing with winter wheat growth made the object of feud researches (Domuţa, Bandici, 2008).

MATERIAL AND METHODS

The research was set at Researche and Development Station Oradea, between 2011 - 2012. This period was characterized by an alternation of favourable climatic conditions during 2011 (a normal climatic year) and dry climatic conditions during 2012, less favorable, consequently. The experimental design was polyfactorial in subdivides stands using as factors interaction: climatic conditions versus fertilization level. The influence of later factors was studied on the dynamics of winter wheat accumulation cultivated on brown luvic soils. As biological material, the Delia race of wheat was employed.

Experimental results (biomass accumulation) were analyzed by ANOVA (analysis of variance) and expressed as g of dry weight/10 plants (Bandici, 2007).

RESULTS AND DISCUSSIONS

The present paper presents the correlation between biomass accumulation and forerunner plant quality in winter wheat cultivation, function of climatic conditions current year.

Table 1 presents the biomass accumulation during the less favourable year 2011. The results show that the forerunner plant do not influence biomass accumulation increase as winter wheat advances in vegetation. The increase is dependent on the properties and quality of the forerunner plant, the best yields being obtained after the cultivation of pea. Thus, in wheat monoculture the biomass accumulation increases from 0.96 g. dry weight/10 plants (at beginning winter) to 45.40 g. dry weight/10 plants at complete ripening. If corn is used as forerunner plant, but specially after pea, the increases in yield are superior, varying between 0.87-60.43 g. dry weight/10 plants after corn and between 1.50-66.97 g. dry weight/10 plants after pea, respectively as winter wheats'forerunner plants.

The phenomenon keeps same pace but at values in 2012, a less favourable year (table 2). The biomass accumulation varies in wheat monoculture between 0.20-35.60 g. dry weight/10 plants and 0.23-42.83 g. dry weight/10 plants after corn and between 0.20-47.10 g. dry weight/10 plants after pea. Regardless to climatic conditions, at a different scale, a positive correlation was found between phenophase x fertilization level: as wheat advances to maturity, there is a progressive accumulation of total biomass in seeds (table 3 and 4).

Concerning 2011, a less favorable year, results show a very significant increase in biomass at the beginning of winter in unfertilized alternative (1.00 g dry weight/10 plants). At the complete ripening there is an increase to 49.92 g dry weight/10 plants, in unfertilized alternative (Zăhan, Zăhan, 1989).

In 2012, a less favorable year, biomass accumulation decreases as compared to a favorable year, taking values in a narrower, range between 0.22 g dry weight/10 plants at beginning of winter and 31.32 g dry weight/10 plants at compared ripening in unfertilized alternative. It is worth to mention that in 2011 (less favorable year) the quantity of accumulated biomass was directly proportional with fertilization on level as it was rising during study period (49.92 g dry weight/10 plants) in unfertilized alternative and 69.49 g dry weight/10 plants in fertilized alternative, organo-mineral complex was used in all experimental alternative as fertilizer.

In a less favorable year, 2011, biomass accumulation decreased depending on fertilization level (31.32 g dry weight/10 plants in unfertilized alternative and 51.80 g dry weight/10 plants in fertilized alternative using the same organo-mineral complex as fertilizer).

It is worth to mention that during the two research years, a negative correlation was found between percent participation of compound synthesized before fructification and seeds formation and fertilization level.

As fertilization level increases, the percent participation of compounds synthesized before fructification insides formation decreases. This phenomen is more accentuated in unfertilized alternatives as compared with fertilized with organo-mineral complex and is influenced unfavorable climatic conditions.

Thus, in 2011, a favorable year, increasing the fertilization had as result a decrease of participation percentage from 33.7 g dry weight/10 plants in unfertilized alternative to 15.3 g dry weight/10 plants in fertilized with organo-mineral complex alternatives.

In 2012, considered an unfavorable year, the decreases varied between 11.2 g dry weight/10 plants in unfertilized and 7.9 g dry weight/10 plants in fertilized alternatives using organo-mineral complex of fertilizers.

Table 1

The effect of the forerunner plant x phenophase on winter wheat biomass accumulation dynamics, on brown luvic soils Oradea 2011

Phenophase	**Total dry weight biomass, seeds and straw g./10 plants**											
	Forerunner plant											
	Wheat			**Corn**			**Pea III**			**Pea IV**		
	Totals d.W.	**Seeds**	**Straw**	**Totals d.W.**	**Seeds**	**Straw**	**Totals d.W.**	**Seeds**	**Straw**	**Totals d.W.**	**Seeds**	**Straw**
At winter beginning	0.96	-	0.96	0.87	-	0.87	0.87	-	0.87	1.50	-	1.50
At the end of winter	1.07	-	1.07	1.07	-	1.07	1.57	-	1.57	2.20	-	2.20
The beginning of vegetation	1.93	-	1.93	2.96	-	2.96	4.27	-	4.27	4.07	-	4,07
The formation of first interned	5.27	-	5.27	5.10	-	5.10	7.80	-	7.80	6.27	-	6,27
Straw elongation	13.47	-	13.47	19.17	-	19.17	17.17	-	17.17	14.00	-	14,00
The formation of spike	31.50	-	31.50	29.50	-	29.50	54.60	-	54.60	49.53	-	49,53
Beginning of seeds formation	34.63	-	34.63	42.83	-	42.83	57.90	-	57.90	54.63	-	54,63
Early ripening	39.67	10.00	29.67	52.90	13.33	39.57	59.93	14.33	45.60	56.80	11,00	45,80
Incomplete ripening	45.33	12.53	32.80	57.10	15.93	41.17	62.50	21.67	40.83	62.67	18,67	44,00
Complete ripening	45.40	15.67	29.73	60.43	24.33	36.10	63.60	27.00	36.60	66.97	30,67	36,30
DL 5% DL 1 % DL 0,1 %	For total plant biomass			0.071 g/10 plants d.w. 0.093 g/10 plants d.w. 0.119 g/10 plants d.w.			For seeds:			2.7 g/10 plants d.w. 3.6 g/10 plants d.w. 4.7 g/10 plants d.w.		

% participation of synthesised compounds prior to fructification and seeds' formation: Wheat = 14.1%; Pea III = 36.8%; Corn = 15.7%; Pea IV = 33.5%;

Statistical significations:

1. *For total plant biomass:* under 0.071 = insignificant; 0.071-0.093 = significant; 0.093-0.0.119 = distinct significant; over 0.119 = very significant;
2. *For seeds:* under 2.7 = insignificant; 2.7-3.6 = significant; 3.6-4.7 = distinct significant; over 4.7 = very significant;

Table 2

The effect of the forerunner plant x phenophase on winter wheat biomass accumulation dynamics, on brown luvic soils Oradea 2012

Phenophase	**Total dry weight biomass seeds and straw g./10 plants**											
	Forerunner plant											
	Wheat			**Corn**			**Pea III**			**Pea IV**		
	Totals d.W.	**Seeds**	**Straw**	**Totals d.W.**	**Seeds**	**Straw**	**Totals d.W.**	**Seeds**	**Straw**	**Totals d.W.**	**Seeds**	**Straw**
At winter beginning	0.20	-	0.20	0.23	-	0.23	0.30	-	0.30	0.20	-	0.20
At the end of winter	0.37	-	0.37	0.37	-	0.37	0.40	-	0.40	0.37	-	0.37
The beginning of vegetation	0.47	-	0.47	0.47	-	0.47	0.50	-	0.50	0.47	-	0.47
The formation of first interned	0.80	-	0.80	0.97	-	0.97	1.33	-	1.33	0.93	-	0.93
Straw elongation	3.73	-	3.73	3.43	-	3.43	4.37	-	4.37	4.33	-	4.33
The formation of spike	8.60	-	8.60	9.47	-	9.47	11.0	-	11.00	10.60	-	10.60
Beginning of seeds formation	24.83	-	24.83	25.50	-	25.50	34.03	-	34.03	33.13	-	33.13
Early ripening	33.87	9.83	24.04	36.00	8.50	27.50	35.73	11.33	24.40	41.33	10.83	30.50
Incomplete ripening	35.37	11.70	23.67	41.87	11.00	30.87	40.73	13.90	26.83	45.33	12.17	33.16
Complete ripening	35.60	13.37	22.23	42.83	12.80	30.03	43.43	17.50	25.93	47.10	15.97	31.13
DL 5% DL 1 % DL 0.1 %	For total plant biomass: 0.073 g/10 plants d..w. 0.096 g/10 plants d.w. 0.123 g/10 plants d.w.						For seeds: 2.7 g/10 plants d.w. 3.6 g/10 plants d.w. 4.7 g/10 plants d.w.					

% participation of synthesised compounds prior to fructification and seeds' formation:

Wheat = 10.5 %; Pea III = 28.3%;

Corn = 17.4%; Pea IV = 8.0 %.

Statistical significations:

1. *For total plant biomass:* under 0.073 = insignificant; 0,073-0.0096 = significant; 0.096-0.0.123 = distinct significant; over 0.123 = very significant;
2. *For seeds:* under 2.7= insignificant; 2.7-3.6 = significant; 3.6-4.7 = distinct significant; over 4.7 = very significant;

Table 3

The effect of fertilisation level x phenophase interaction on winter wheat dry weight biomass accumulation dynamics on brown luvic soils. Oradea 2011

Phenophase	**Total dry weight biomass. seeds and straw g./10 plants**								
	Fertilisation level								
	N_0P_0			**$N_{120}P_{80}$**			**$N_{100}P_{80}$ + 10t/ha manure**		
	Total s d.W.	**Seeds**	**Straw**	**Total s d.W.**	**Seeds**	**Straw**	**Total s d.W.**	**Seeds**	**Straw**
At winter beginning	1.00	-	1.00	1.17	-	1.17	0.97	-	0.97
At the end of winter	1.22	-	1.22	1.55	-	1.55	1.65	-	1.65
The beginning of vegetation	2.65	-	2.65	2.62	-	2.62	4.65	-	4.65
The formation of first interned	4.77	-	4.77	6.10	-	6.10	7.45	-	7.45
Straw elongation	11.62	-	11.62	16.85	-	16.85	19.37	-	19.37
The formation of spike	36.70	-	36.70	43.05	-	43.05	44.10	-	44.10
Beginning of seeds formation	43.62	-	43.62	49.55	-	49.55	49.31	-	49.31
Early ripening	47.62	9.50	38.12	52.90	13.75	39.15	56.45	13.25	43.20
Incomplete ripening	49.82	15.75	34.07	57.32	18.45	38.87	63.55	17.40	46.15
Complete ripening	49.92	21.00	28.92	57.95	24.50	33.45	69.49	27.75	41.74
DL 5% DL 1 % DL 0.1 %	For total green mass: 0.063 g/10 plants d.w. 0.083 g/10 plants d.w. 0.106 g/10 plants d.w.						For seeds: 2.3 g/10 plants d.w. 3.1 g/10 plants d.w. 4.0 g/10 plants d.w.		

% participation of synthesised compounds prior to fructification and seeds' formation:

N_0P_0 = 33.7 %;

$N_{120}P_{80}$ = 32.5 %;

$N_{100}P_{80}$ + 10t/ha manure = 15.3 %

Statistical significations:

1. *For total plant biomass*: under 0.063 = insignificant; 0,063-0.083 = significant; 0.083-0.106 = distinct significant; over 0.106 = very significant;
2. *For seeds*: under 2.3= insignificant; 2.3-3.1 = significant; 3.1-4.0 = distinct significant; over 4.0 = very significant;

Table 4

The effect of fertilisation level x phenophase interaction on winter wheat dry weight biomass accumulation dynamics on brown luvic soils. Oradea 2012

Phenophase	**Total dry weight biomass. seeds and straw g./10 plants**								
	Fertilisation level								
	N_0P_0			**$N_{120}P_{80}$**			**$N_{100}P_{80}$ + 10t/ha manure**		
	Total s d.W.	**Seeds**	**Straw**	**Total s d.W.**	**Seeds**	**Straw**	**Total s d.W.**	**Seeds**	**Straw**
At winter beginning	0.22	-	0.22	0.22	-	0.22	0.25	-	0.25
At the end of winter	0.35	-	0.35	0.37	-	0.37	0.40	-	0.40
The beginning of vegetation	0.45	-	0.45	0.47	-	0.47	0.50	-	0.50
The formation of first interned	0.90	-	0.90	0.95	-	0.95	1.17	-	1.17
Straw elongation	2.45	-	2.45	4.47	-	4.47	4.97	-	4.97
The formation of spike	5.82	-	5.82	11.30	-	11.30	12.62	-	12.62
Beginning of seeds formation	23.00	-	23.00	30.07	-	30.07	35.05	-	35.05
Early ripening	26.45	6.03	20.42	38.97	11.85	27.12	44.77	12.50	32.27
Incomplete ripening	30.22	7.35	22.87	43.05	14.07	28.98	49.20	15.15	34.05
Complete ripening	31.32	9.72	21.60	43.60	15.70	27.90	51.80	19.30	32.50
DL 5% DL 1 % DL 0.1 %	For total green mass: 0.063 g/10 plants d.w. 0.083 g/10 plants d.w. 0.106 g/10 plants d.w.						For seeds: 2.3 g/10 plants d.w. 3.1 g/10 plants d.w. 4.0 g/10 plants d.w.		

% participation of synthesised compounds prior to fructification and seeds' formation:

N_0P_0 = 11.2 %;

$N_{120}P_{80}$ = 9.8 %;

$N_{100}P_{80}$ + 10t/ha manure = 7.9 %

Statistical significations:

1. *For total plant biomass:* under 0.063= insignificant; 0,063-0.083 = significant; 0.083-0.106 = distinct significant; over 0.106 = very significant;
2. *For seeds:* under 2.3= insignificant; 2.3-3.1 = significant; 3.1-4.0 = distinct significant; over 4.0 = very significant;

CONCLUSIONS

The forerunner plants'quality has a positive effect on total biomass accumulation as compared with wheat monoculture, the obtained values being conditioned by a higher favourableness of climatic factors.

With regard to biomass accumulation in seeds, it was positively influenced by the quality of the forerunner plant, being higher in correlation with the forerunner plants'better qualities.

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