RESEARCHES REGARDING THE INFLUENCE OF CROP ROTATION AND FERTILIZATION LEVEL ON THE DYNAMICS OF TOTAL DRY PHYTOMASS ACCUMULATION IN WINTER WHEAT

Bandici Gheorghe-Emil, Ardelean Ileana, Stanciu Alina*

* University of Oradea, Faculty of Environmental Protection, 26 General Magheru St., 410048 Oradea, Romania, e-mail: gbandici@yahoo.com

Abstract

The knowledge of phytomass accumulation dynamics in winter wheat, correlated to concrete edaphic and climatic conditions, race and cultivation technologies, offers the possibility of guiding the process toward the realization of higher and stable production efficiency per surface unit. Research and production results were employed at the elaboration of the present work, mainly original researches developed by author referring to the biomass accumulation dynamics in winter wheat cultivated on brown-luvic soils in central area of the Western Plain of Romania. The present work is adding new information to an actual scientific area of interest and offers technical solutions for efficient technical interventions in correlation with biological capacity of the plant to put them into value. The growth of the winter wheat is characterized by an increase in the volume and weight of the whole plant: roots, stem, blades and spike.

Key words: forerunner plant, fertilization level, phytomass accumulation, phenophase, winter wheat.

INTRODUCTION

Researches conducted in our country and abroad expanded the utmost influence of such factors as: vegetation, soil and cultivation technologies on the biomass accumulation in winter wheat (Austin, R., B.,1978).

The synthesis of various conclussions formulated by different authors (risks included as in any synthetical approach) refers to the importance of knowledge on biomass accumulation influenced by crop rotation, fertilization, underlining influential factors (Bandici Gh., 1997) .

The importance of understanding the biomass accumulation dynamics in winter wheat was outlined by different authors. The underlying conclussions are presented next. (Lazany, J., 2000) .

Most of the reserches conducted in Romania were focussed on the influence of crop rotation on yields (Domuţa C., 2007,2008), namely on biomass accumulation, and produced an hierarchical ordination of crop rotations with regard to wheat from very beneficial to satisfactory in this order: pea, beans, winter rape, bots, linseed, soja, red clover, potato, sugar beet, sunflower, corn etc.

Bilteanu (1993), after long run 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 utmost importance for wheat yield increase (*Kramer Th., 1980*).

Dinca, D., (1982) made some references on the role of crop rotation on wheat yield, on the organic accumulation in whole plant and grains, respectively. It is demonstrated that after 10-year monoculture, wheat yield decreases continously as compared to crop rotations. It fluctuates as a consequence of changing climatic conditions. Under such circumstances, fertilization does not induce a significant yield increase.

Even in a simple crop rotation such as wheat-corn rotation, wheat capitalizes even moderate doses of fertilizers. The introduction of an ameliorative plant such as pea or soya significantly raises the economic efficiency of applied fertilizers (*Bingham J., 1980, Soltner D., 1990*). As several authors remark, a moderate fertilization in a crop rotation system influences positively not only the biomass accumulation in whole plant and grains, but also the biological quality of wheat yields *(Lazany J., 2003)* .

A particularly important problem is linked to wheat crop increment, which must meet the rising consumption needs of world population *(Sipos, Gh., 1979).*

The author presents a synthesis of researches developed in Romania, emphasizing the positive correlation between plant growth, biomass accumulation and climatic evolutions within cultivated areas of Romania (Şipoş G., 1979).

The complex influence of crop rotation is in relation with fertilization. *Ionescu N., (1985)* remarked that the effect of fertilizers on acid soils was greater in crop rotation as compared to monocultures characterized by a low biomass accumulation and consequently, a low yield.

Improvements in biomass accumulation dynamics in winter wheat during the pedo-climatic conditions of Western Plain of Romania were made by *Zăhan P. and* Zăhan R. (1989 a,b) during the studies on Transylvanian wheat race.

The influence of each studied factors on dry biomass accumulation in wheat shows that crop rotation and fertilization determines essential differences in what concerns the accumulation of dry biomass (Schmidt J., W., 1980, Salisbury F.B., C.W. Ross, 1995).

Concerning the influence of fertilization on biomass accumulation in winter wheat, frequent researches directly linked the biomass accumulation with the utilized fertilizers *(Bandici Gh., Guş P., 2001)*.

MATERIALS AND METHODS

The researches were set at the Agricultural Researches and Development Station (A.R.D.S.) Oradea, Romania, between 2008 and 2010, on soils characterized by temporary excess of humidity such as brown luvic soils (acid soils), the results showing the influence of (crop rotation) forerunner plant, fertilization level and phenophase on the total biomass. The experimental design was polyfactorial in subdivided stands using interaction factors: forerunner plant, fertilization level and phenophase. As biological material, the *Dropia* variety of wheat was used.

The total phytomass and, separately, each part of the plants were weighted in the laboratory. The results were analysed with ANOVA (analysis of variance). The phytomass was expressed as g of dry weight/10 plants.

RESULTS AND DISCUSSIONS

In the following paper we are presenting the results of the experiments concerning the influence of crop rotation and fertilization level on total dry biomass accumulation dynamics in winter wheat (table 1) and the influence of crop rotation, fertilization level and phenophase on total dry biomass accumulation dynamics in winter wheat (table 2).

There is a positive correlation between the quality of crop rotation and the evolution of values found in grain biomass accumulation. Thus, as compared to wheat monoculture with an average value of 12.55 g d.w./ 10 plants, corn and pea as wheat crop rotation determined distinct to very significant crop increments between 1.38 and 5.10 g d.w./10 plants (table 1).

Table 1

The influence of crop rotation plant and fertilization level on total dry biomass accumulation dynamics in winter wheat (Oradea, Romania, 2008-2010)

Investigated factor	Quantity of dry biomass (g. d.w./10 plants)							
	Total dry biomass, of which:			Grain			Straw g	% of part.
	g	Difference ±	Significance	g	Difference ±	Significance		
a. Crop rotation								
Wheat monocrop (Mt)	19.69	-	-	12.55	-	-	7.14	-
Corn (W-C)	21.07	+1.38	***	14.01	+1.46	**	7.06	-
Pea (P-W-C)	23.29	+3.60	***	17.18	+4.36	***	6.11	-
Pea (P-W-C-C)	24.79	+5.10	***	17.87	+5.32	***	6.92	-
LSD 5 % LSD 1 % LSD 0,1 %		0.139 0.115 0.292			2.27 3.28 4.80			
b. Fertilization level								
N_0P_0 (Mt)	18.07	-	-	11.54	-	-	6.53	-
$N_{120}P_{80}$	23.32	+5.15	***	16.62	+5.08	***	6.60	-
$N_{100}P_{80}$ + 10 t/ha manure	25.36	+7.29	***	18.54	+7.00	***	6.82	-
LSD 5 % LSD 1 % LSD 0,1 %		0.050 0.070 0.093			0.92 1.35 2.27			

Table 2

The influence of crop rotation plant, fertilization level and phenophase on total dry biomass accumulation dynamics in winter wheat (Oradea, Romania, 2008-2010)

Investigated factor	Quantity of dry biomass (g. d.w./10 plants)							
	Total dry biomass, of which:			Grain			Straw g	%
	g	Difference ±	Significance	g	Difference ±	Significance		
Phenophase								
At winter beginning	0.53	-	-	-	-	-	0.53	-
At the end of winter	0.95	+0.42	***	-	-	-	0.95	-
The beginning of vegetation	2.56	+2.03	***	-	-	-	2.56	-
The formation of first interned	5.04	+4.51	***	-	-	-	5.04	-
Straw elongation	12.04	+11.51	***	-	-	-	12.04	-
The formation of spike	28.04	+27.87	***	-	-	-	28.04	-
Beginning of seed formation	37.86	+37.33	***	-	-	-	37.86	26.4
Early ripening	42.28	+41.75	***	12.09	-	-	30.19	-
Incomplete ripening	45.44	+44.91	***	15.03	+2.94	***	30.41	-
Complete ripening	46.98	+46.45	***	19.11	+7.02	***	27.87	-
LSD 5 % LSD 1 % LSD 0,1 %		0.096 0.124 0.159			1.03 1.42 1.82			

Wheat cultivated after pea registered highest values in grain as well as in whole plant, surpassing significantly to distinctly significant the values obtained after corn (1.46-5.32 g d.w./ 10 plants).

Concerning the obtained fertilization level (see data in table 1), we observed a positive correlation between the total biomass accumulation in grains and the fertilization level. As compared to the unfertilized alternative, with respect to total plant biomass accumulation and grain biomass accumulation, mineral fertilization and mineral-organic fertilization determined very significant increments between 5.15 and 7.29 g d.w./ 10 plants and 5.08 and 7.00 g d.w./10 plants respectively, in grain.

Dynamics of biomass accumulation are expressed in table 2. Data analysis reveal an increase in plant biomass accumulation from beginning of winter to maturity (0.53-46.98 g d.w./10 plants).

Compared to the beginning of winter phenophase in wheat (0.53 g d. w./10 plants), the increment of biomass accumulation is very significant, varying between 0.42 and 46.45 g d.w./10 plants.

Next we are presenting the results of the experiments concerning the total dry phytomass of wheat cultivated after corn (W-C) on unfertilised brown luvic soils (N_0P_0) (Fig. 1), on brown luvic soils fertilised with organo-mineral complex ($N_{100}P_{80}$ + 10 t/ha manure) (Fig. 2), and total dry phytomass accumulation of wheat cultivated after pea (M-G-P-P) on unfertilised brown luvic soils (N_0P_0) (Fig. 3) and, finally, on brown luvic soils fertilised with organo-mineral complex ($N_{100}P_{80}$ + 10 t/ha manure) (Fig. 4).

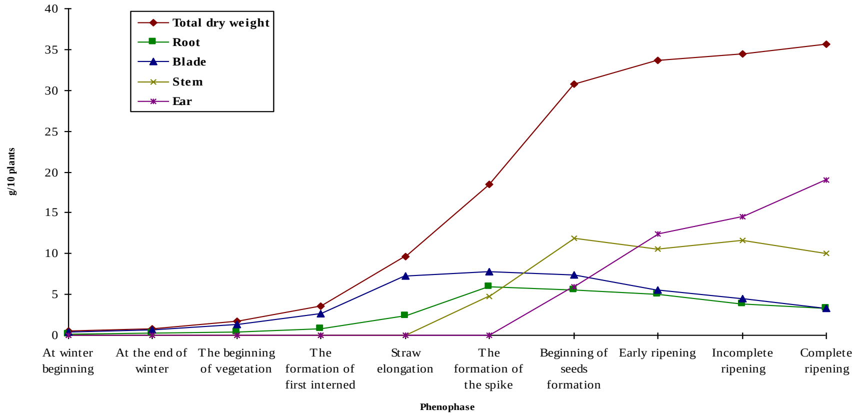

Fig. 1. The contribution of the weight of root, blade, stem and spike in the total dry phytomass of wheat cultivated after corn (W-C) on unfertilised brown luvic soils (N_0P_0) (Oradea, Romania, 2008 - 2010)

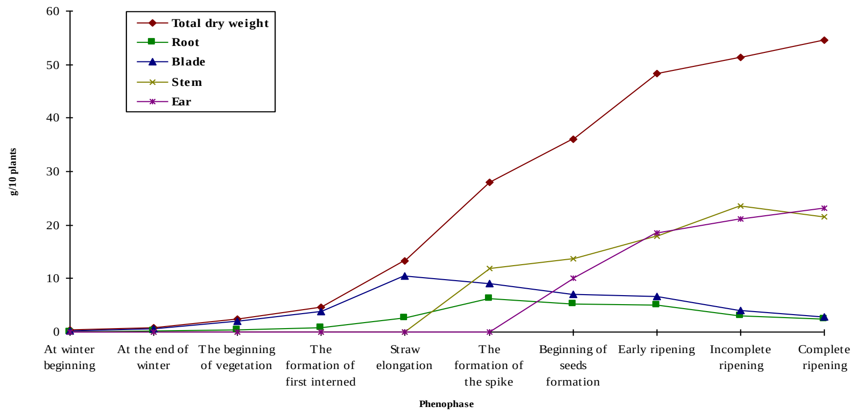

Fig. 2. The contribution of the weight of root, blade, stem and spike in the total dry phytomass of wheat cultivated after corn (W-C) on brown luvic soils fertilised with organic-mineral complex ($N_{100}P_{80}$ + 10 t/ha manure (Oradea, Romania, 2008 - 2010)

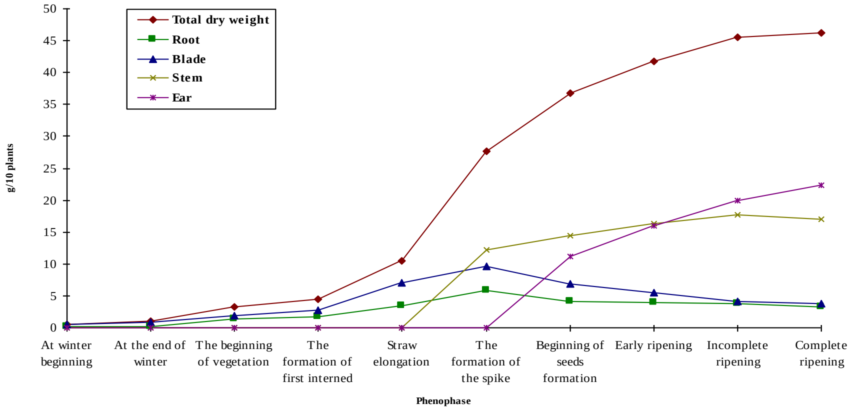

Fig.3. Contribution of the weight of root, blade, stem and spike in the total dry phytomass of wheat cultivated after pea (P-W-C-C) on unfertilised brown luvic soils (N_0P_0) (Oradea, Romania, 2008 - 2010)

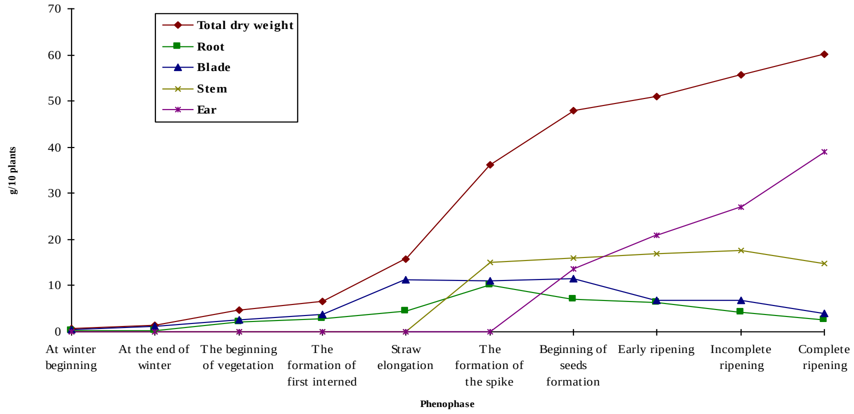

Fig.4. Contribution of the weight of root, blade, stem and spike in the total dry phytomass of wheat cultivated after pea (P-W-C-C) on brown luvic soils fertilised with organo-mineral complex ($N_{100}P_{80}$ + 10 t/ha manure) (Oradea, Romania, 2008- 2010)

As a result of the analysis that we made, the values registered and presented in Fig. 1-4, we can assert the following:

- there is a positive correlation between the phenophase and total plant phytomass accumulation regardless of the forerunner plant.
- the maximal values of total plant phytomass accumulation were found both in fertilised and unfertilised alternatives (mineral and organo-mineral fertilisers) corresponding to the formation of spike phase also depending on the quality of the forerunner plant (best alternative-pea).

Concerning the contribution of the plant components (roots, stem, blade, spike) at total plant phytomass, it is a function of each component. Thus, as regards the root, the forerunner plant influenced the weight of participation which reached the highest values in wheat monoculture (at the formation of the spike phase, 20-40%).

The rest of the forerunner plants utilised for wheat participation weight was identical with the monoculture, the participation percentage being superior and varying between 23 and 33%.

If the fertilisation level modified the values of the contribution of the weight of the root at the total plant phytomass (weight that was higher in the case of the monoculture), the corresponding phenophase was the formation of the spike, being identical with the monoculture.

The blade participated in a different way at the edification of the plant phytomass even from the beginning, the formation of first internode phase, to the phase of straw elongation. In the case of monoculture or with corn as a forerunner plant, the blade's participant weight was of 77% in the first internode phase. After pea, in the straw elongation phase the participant weight was of 67-87%.

As the fertilisation level increased from mineral to complex organo-mineral fertilisation, the stem weight was high regardless of the forerunner plant, but more accentuated in the case of wheat monoculture and after corn (39-42%). After pea, the registered values varied between 34-39%, in both cases taking into account the fertilization with mineral fertilizers.

CONCLUSIONS

We consider that the present short presentation of the data illustrates the participation of all plant components at the realisation of phytomass, the most of it belonging to stem and spike.

During the last phenophase, stem contributed substantially to total biomass accumulation being positively correlated to crop rotation plant and created agrofund.

Stem weight of total phytomass rose proportionally to agrofund increment due to mineral and organic-mineral fertilization, regardless of crop rotation plant, being more accentuated in the case of wheat monoculture and after corn as crop rotation plant respectiely after pea fertilized with mineral fertilizers.

Main contribution to phytomass accumulation had ear during last phenophase, regardless of crop rotation plant and agrofund, crop rotation plant and mixed fertilization, as compared to wheat monoculture.

REFERENCES

1. Austin R.B., 1978, „*ADAS, Qualerly Review*", 29, 76-87.
2. Bandici G.E., 1997, Contribuţii la stabilirea influenţei premergătoarei şi a fertilizării asupra dinamicii acumulării biomasei, la grâul de toamnă, cultivat pe soluri cu exces

temporar de umiditate, în centrul Câmpiei de Vest a României. Doctoral thesis. University of Agriculture Sciences and Veterinary Medicine Cluj-Napoca, Romania.

3. Bandici G.E., P. Guş, 2001, Dinamica acumulării de biomasă la grâul de toamnă. University of Oradea Press, Oradea, pp. 55-61.
4. Bingham J., 1980, „*Wheat breeding objectives and prospects”*, Midlsdeton Memorial Lecture”, 1-19.
5. Bîlteanu G., 1993, Fitotehnie, Ceres Printing House, Bucharest, pp. 457.
6. Dincă D., 1982, Asolamentele agriculturii moderne. Ceres Printing House, Bucharest, 257 pp.
7. Domuţa Cornel coord., 2007, Asolamentele în Câmpia Crişurilor, Editura Universităţii Oradea., 255 pp.
8. Domuţa Cornel coord, 2008, Asolamentele în sistemele de agricultură, Editura Universităţii Oradea, 297 pp.
9. Ionescu N., 1985, Eficienţa rotaţiei şi fertilizării la grâu şi la porumb pe solurile acide din sudul ţării. Probleme de agrofitotehnie teoretică şi aplicată, nr. 2, vol. VII: pp.107.
10. Kramer Th., 1980, „*Proc. 3 rd. Intern Wheat*” Conf. Madrid, 688-696.
11. Lazany J., 2000, Soil fertility management in Westik’s crop rotation experiment. Role of fertilizers in Sustainable Agriculture. CIEC Conference. pp.77-80.
12. Lazany J., 2003, Differences in soil carbon content in the treatments of Westik’s crop rotation experiment. Natural resources and sustainable development. International scientific session and reviewed papers. Oradea-Debrecen, pp. 119-120.
13. Salisbury F.B., C.W. Ross, - *Fisiologia vegetale*. Seconda edizione italiana condota sulla quarta edizione americana. Editura Zanichelli, 1995.
14. Schmidt J.W., 1980, “*Prod 3 rd. Intern Wheat*” Conf. Madrid, 30-37.
15. Soltner D., 1990, „*Phytotechnie speciale*”, Colection sciences et Techniques Agricoles, Angers.
16. Şipoş G., 1979, Tendinţe şi posibilităţi de creştere a producţiilor la principalele culturi agricole. Probleme de agrofitotehnie teoretică şi aplicată nr. 1, vol. I: 87-90, pp.107.
17. Zăhan P., R. Zăhan, 1989a, Cercetări privind influenţa plantei premergătoare şi a fertilizării asupra dinamicii de acumulare a masei vegetale la grâul cultivat pe soluri podzolice cu exces temporar de umiditate din Câmpia de Vest a ţării (I). Probleme de agrofitotehnie teoretică şi aplicată nr. 1, vol. XI: 97-102.
18. Zăhan, P., R. Zăhan, 1989b, Cercetări privind acumularea biomasei vegetale radiculare şi calitatea recoltei obţinute, sub influenţa plantei premergătoare şi a fertilizării la grâul cultivat pe soluri podzolice cu exces temporar de umiditate din Câmpia de Vest a ţării (II). Probleme de agrofitotehnie teoretică şi aplicată, nr. 1, vol. XI: 237-240.