RESEARCHES ON THE INFLUENCE OF CROP ROTATION AND OF THE NUTRITION REGIME ON THE GROWTH PROGRESS OF PHYTOMASS AND PRODUCTION IN WINTER WHEAT

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Abstract

The knowledge of phytomass accumulation 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. Data from scientific literature were also used in the present work.

The theoretical and practical importance as compared to other similar works is enhanced by a strict reference to a particular area in western 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.

Key words: winter wheat, crop rotation, fertilization level, phenophase, phytomass wheat components.

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 (Ionescu, 1985).

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 (Şipoş, 1979).

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).

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, 1982; Salisbury, Ross, 1995).

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, 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. (Domuța, 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 (Bîlteanu, 1993).

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).

Advances in biomass accumulation dynamics in winter wheat in the pedo-climatic conditions of Western Plain of Romania were made by (Zăhan, 1989a) 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 (Soltner, 1990).

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, 1989b).

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

MATERIAL AND METHODS

On a brown luvic soil, with a low fertility degree, with temporary excess of moisture due to the high content of clay (32,7%), at Agricultural Research and Development Station Oradea in the period 2011-2012, research was carried out regarding the influence of rotation, of the mineral and organic-mineral nutrition regime, on the growth of the phytomass and the production of autumn wheat, species Delia.

A multifactorial experiment (subdivided plats) was set up at ARDS Oradea, on soils characterised by temporary excess of humidity as brown luvic soils are having in view the realisation of total phytomass as function of phenophase, forerunner plant and fertilisation level.

Total phytomass and separately every plants parts were weighted in the laboratory. The results were analysed with ANOVA (analysis of variance), the phytomass being expressed as g. dry weight/10 plants.

RESULTS AND DISCUSSION

From the data in table 1, we notice the fact that until the beginning of the vegetation, the quantity of phytomass accumulated in the wheat plants on phenophases, is even larger as the precursory plant is better, that is 1.94 g. d.s./10 plants in the case of the crop rotation of 2 years (W-M), and of 2.72 g. d.s./10 plants in the crop rotation of 3 years (B-W-M), respectively of 3.88 g. d.s./10 plants in the case of the crop rotation of 4 years (M-G-P-P), compared to the monoculture of 1.70 g. d.s./10 plants.

Along with the advancement in vegetation of the wheat plants we observe a gradual growth of the quantity of accumulated dry substance, but the quality leap regarding the accumulation of phytomass is recorded between the phenophase of the elongation of the straw and the phenophase of the formation of spike of wheat, a case in which the quantity of accumulated dry substance is even larger as the precursory plant is better (peas), of 32.2 g. d.s./10 plants, compared to the monoculture of wheat (25.43 g. d.s./10 plants), and in the next phenophases the accumulation of dry substances will have a slowed rhythm, until the phenophase of full maturation.

Regarding the quantity of phytomass (g. d.s./10 plants) accumulated in the wheat plants under the influence of the mineral and organic-mineral nutrition (Table 2), we notice a growth of the dry substance even larger as the fertilization is better, complex organic-mineral (3.32 g. d.s./10 plants), compared to the unfertilized witness (2.03 g. d.s./10 planta). Also in this case, the quality leap of the growth of the phytomass was recorded between the phenophase of the elongation of the straw and the phenophase of the formation of spike of wheat, the accumulation being even larger as the fertilization level was better (complex, organic-mineral, - 31.64 g. d.s./10 plants), compared to the unfertilized witness (22.97 g. d.s./10 plants). In the following phenophases until full maturation we notice a slowing of the rhythm of accumulation of the phytomass.

The data in table 3 point out better the features of the formation of the phytomass of autumn wheat.

Unlike other species, autumn wheat is characterized in spring by a very high growth rhythm, as in a period of 90 days over 90 % of the total phytomass of the plant is realized. In the period previous to the intensive growth (October-March), the wheat plant accumulates only 5.5 % of the total quantity of phytomass.

Until the formation of spike, the wheat plant has accumulated 60.4 % of the total phytomass, and from this in the period 01. IV – 15.V, in only 45 days – 54.9 %. It results that in the 45 days before the formation of spike, autumn wheat has the most intense growth rhythm, the plants requesting in this time span a large quantity of water and nourishing elements.

Table 1

The influence of crop rotation plant on total dry phytomass (g.d.w./10 plants) in winter wheat (Oradea, 2011-2012)

Investigated factor	The beginning of the vegetation	The formation of the first interned	Straw elongation	The formation of spike	Beginning of seeds formation	Early ripening	Incomplete ripening	Complete ripening
Monoculture (Control)	1.70	4.19	10.70	**25.43**	33.42	38.21	40.70	40.93
(crop rotation 2 years) (W-M)	1.94	4.52	12.08	**26.16**	34.21	41.47	44.69	45.25
(crop rotation 3 years) (P-W-M)	2.72	5.64	12.37	**32.20**	41.51	43.12	46.28	48.01
(crop rotation 4 years) (P-W-M- M)	3.88	5.83	13.01	**31.84**	42.29	46.41	50.17	52.76
LSD 5% = 0.191 g/10 plants s.u. LSD 1% = 0.253 g/10 plants s.u. LSD 0.1 % = 0.324 g/10 plants s.u.								

Note: Non-significant=under 0.191; * Significant =0.191-0.253; ** = Significantly different =0.253 – 0.324; ***very significant = over 0.324

Table 2

The influence of fertilisation level on total dry phytomass (g.d.w./10 plants) in winter wheat (Oradea, 2011-2012)

Investigated factor	The beginning of the vegetation	The formation of the first interned	Straw elongation	The formation of spike	Beginning of seeds formation	Early ripening	Incomplete ripening	Complete ripening
N_0P_0 (Control)	2.03	4.06	9.09	**22.97**	31.80	34.59	36.91	42.95
$N_{120}P_{80}$	2.33	5.08	13.11	**30.65**	39.91	44.29	47.22	47.92
$N_{100}P_{80}$ + 10 t/ha #	3.32	6.01	13.95	**31.64**	41.82	48.04	52.22	53.13
LSD 5% = 0.165 g/10 plants s.u. LSD 1% = 0.219 g/10 plants s.u. LSD 0.1 % = 0.281 g/10 plants s.u.								

Note: Non-significant=under 0.165; * Significant =0.165-0.219; ** = Significantly different =0.219 – 0.281; ***very significant = over 0.281

Table 3

The influence of the phenophase on the progess of growth of the total phytomass of the winter wheat (g/10 plants d.s.) Oradea, 2011-2012

Phenophase/Date of taking of samples	Dry phytomass (g)	% of the total phytomass	Growth enhancement (g)	Growth enhancement (%)
At winter beginning	0.53	1.1	-	1.1
At the end of winter	0.95	2.0	0.42	0.9
Beginning of the vegetation	2.56	5.5	1.61	3.5 **(5.5)**
Formation of the first interned	5.04	10.7	2.48	5.2
Elongation of the straw	12.04	25.6	7.00	14.9
The formation of spike	28.40	60.4	16.36	34.8 **(54.9)**
Beginning of the formation of the grains	37.86	80.6	9.46	20.2
Maturation in milk	42.28	90.0	4.42	9.4
Maturation in ripening	45.44	96.7	3.16	6.7
Full maturation	46.98	100.0	1.54	3.3 **(39.6)**

If we analyse the structure of the biomass of autumn wheat, we notice that it shows significant variations, determined by the characteristics of the soil, crop rotation and the nutrition regime of the plants (Table 4). Thus, the grain production is currently under 50% of the total production of the plants.

Table 4

The compounds of the phytomass of autumn wheat (species Delia), depending on the crop rotation and the nutrition regime of the plants (Oradea 2011-2012)

Biological element	% of the total phytomass
Root mass	4-9
Strain mass	22-42
Foliar mass	5-10
Grain mass	35-43
Chaff mass	4-14

Analysing the data in table 5, we notice a growth of the wheat production over the monoculture (29.2 q/ha), depending on the rotation, the production being larger as the precursory plant is better, 35.3 q/ha in the case of the rotation W-M (crop rotation 2 years) and of 45.5-45.9 in the case of the crop rotations of 3 and 4 years.

The mineral nutrition regime influences the growth of wheat production, sop that over the unfertilized witness (26.1 q/ha), in the case of mineral and organic-mineral fertilization, a production of 43.9 q/ha and respectively of 46.9 q/ha was obtained.

Table 5

The influence of crop rotation, of the mineral and organic-mineral nutrition regime on the production of winter wheat on brown luvic soil (Oradea, 2011-2012)

Investigated factor	Grain production q/ha	% over monoculture	% over rotation W-M
a. Rotation			
Monoculture (Control)	29.2	100	83
Crop rot. 2 years (W-M)	35.3	121	100
Crop rot. 3 years (P-W-M)	45.5	156	129
Crop rot. 4 ani (P-W-M-M)	45.9	157	130
b. Fertilisation level			
N_0P_0	26.1	100	59,0
$N_{120}P_{80}$	43.9	169	100
$N_{100}P_{80}$+10 t/ha #	46.9	180	107

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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