

Assessment criteria of accumulation of dry matter by plants of winter crops in Forest-steppe Right-bank

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The purpose. To determine dependence of seeding rates and level of fertilizing on formation of dry matter by phytocenoses of triticale and Hungarian vetch. **Methods.** Field, laboratory, mathematic-statistical, comparative-calculation. Researches were carried out in the Institute of fodder crops and an agriculture of Podillia of NAAS. In experiments they seeded winter triticale of middle-early grade Polianske and middle-ripening grade Polovetske, Hungarian vetch of grades Orlan. Seeding rate of gramineous ingredient in one-way sowings was 5 million grains/hectare, of leguminous one — 3 million grains/hectare of viable seeds. In combined sowings the ratio was the following (%): 50:50, 75:75, 50:75 and 75:50. **Results.** It is determined that for winter triticale and Hungarian vetch the content and exit of dry matter in one-way and combined sowings were stipulated by seeding rates, level of mineral nutrition and weather environment. The greatest indexes were gained for mixture of winter triticale of grade Polianske with Hungarian vetch, which made 8,77 tons/hectare at importation of fertilizers in dose of $N_{45}P_{45}K_{45}$ and mixture ratio 75:50%. Main share in gross yield of dry matter in leguminous-gramineous phytocenose had gramineous ingredient — 5,87 tons/hectare, or 66,9%. Binary mixture with winter triticale Polovetske ensured exit of dry matter of 7,39 tons/hectare, that was on 15,3% below than in the previous mixture. **Conclusions.** Productivity of binary mixtures of winter triticale with Hungarian vetch is justified, that is regulated by optimum seeding rates and level of mineral nutrition. Dependence of accumulation of dry matter on weather environment is fixed by the framed models of phytocenoses which are regulated by results plural regression analysis.

Key words: *winter triticale, Hungarian vetch, fertilizers, seeding rates, dry matter.*

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In the dynamic changing of ecological situation under the action of stress factors of environment there is a necessity for the correct selection of species and varieties of forage crops for mixture growing, which are more adjusted to soil-climatic conditions of the region and provides stable yield. In the settle of this problem an important value has a growing of legume-cereal mixtures of winter crops, which are forming a yield, using the reserves of productive moisture of fall-winter period and provides high quality green forage starting from second half of May.

Efficiency of growing mixtures in created agrophytocoenosis is in crops, which differ in biological features, technological measures of growing and attitude toward environmental conditions, in comparison to the monoculture. The adaptation of mixed crops is predetermined, firstly, that at the components of mixture the critical phases of ontogenesis do not coincide with the maximal display of stress factors during the vegetative period. Secondly, crops itself influencing on the environmental factors – the strongest this correlation, the most resultative can influence on crops to achieve increasing its productivity [1,2,3].

It is found that in the mixture crops during a vegetation there is an intraspecific competition between components for the life factors, which is regulated by the separated elements of growing technology, due to that the indexes of the productivity changes [4,5,6]. For example, mineral fertilizers reducing fluctuation of dry matter content after years, leveling the unfavorable conditions during vegetation and provide stable yields [7,8].

Therefore the created models of agrophytocoenosis needs a deep study and estimation based on the complex finding outs their adaptive capacities for variable factors, namely extreme natural factors (lacks of moisture, temperature increasing in the vegetative period etc.) which can be regulated by the elements of growing technology.

The purpose of research consisted in determination of influence of sowing rates, mineral fertilizers doses and weather conditions on the dry matter indexes of Hungarian vetch and winter triticale different groups of ripeness for growing them in monoculture and binary mixtures.

Materials and methods. Researches were conducted in the Institute of feed research and agriculture of Podillya NAAN of Ukraine. Soil on an experimental field – typical for this area – grey forest middle loamy. Content of humus in an arable layer is 2,18 %, nitrogen (by Kornfeld) – 6,5 mg/100 gram of soil, mobile phosphorus (by Chirikov) – 14,9 mg/100g soil, exchange potassium (by Chirikov) – 9,0 mg/100 gram of soil. Hydrolytic acidity is 1,15 mg-ekv./100 gram of soil. After exchange acidity of pH_{sol} 5,8 this soil is low acidic. Dry matter content was determined by the thermostatically-weighted method (drying in a drying cabinet at a temperature of 105 ° C) according to DSTU ISO 6496: 2005.

In experiments sowed middle-early variety of winter triticale Polyanske and middle-ripening Polovecke, Hungarian vetch variety Orlan. Sowing rates of triticale in the monoculture are 5 million/seeds per hectare and Hungarian vetch – 3 million/seeds per hectare. Mineral fertilizers were applied in autumn in the pre-seed cultivation in the dose of $P_{30-45}K_{30-45}$ and in spring after vegetation retrieval where applied ammonium nitrate in a dose of 30–45 kg/hectare of a.s.

Weather conditions in the years of carrying out of research were different. In 2014 and 2015 an average monthly air temperature for April-May was 11,8–11,9°C and 13,0°C in 2016, which is for 1,2°C higher of norm. An amount and distributing of precipitations were uneven in a vegetative period. The most favorable weather conditions were observed in 2014.

Results of research. Observations are found, that at the age-related changes of plants in ontogenesis raises dry matter content in green forage of triticale and Hungarian vetch, the mechanism of accumulation of which were depended on the probed factors and specified weather conditions. So, in the monoculture of Hungarian vetch a competition for the life factors diminished in comparison to binary mixtures, especially on a mineral fertilizers background, where average dry matter content was 15,44–16,76 %, or was below by 1,27–2,59 % in comparison to control where grew up to 18,03 %. Dry matter accumulation in the triticale stipulated by variety – highest indexes are marked at the middle-early variety of Polyanske at control without fertilizers – 23,51 %, which has diminished due to different fertilization level from 22,25 to 20,24 %, at the same time, the middle-ripening variety Polovecke at the synchronous harvesting time for green forage they were 21,65; 20,94 and 19,44 % accordingly (table.1).

Table 1. Dry matter content in winter triticale and Hungarian vetch depending on a fertilizer and sowing rates, average for 2014–2016, %

Crop, variety	Sowing rates, %	Fertilizer doses		
		No fertilization	$N_{30}P_{30}K_{30}$,	$N_{45}P_{45}K_{45}$
Hungarian vetch, Orlan	100	18,03	16,76	15,44
	50 +50	18,35*/17,34**	17,58/16,74	17,34/15,85
	75+75	19,04/17,94	18,62/17,63	17,54/15,90
	50+75	18,81/19,01	17,74/17,24	16,88/15,89
	75+50	18,84/18,81	17,92/17,80	17,40/16,14
Winter triticale, Polianske	100	23,51	22,25	20,24
	50 +50	21,33	20,60	19,75
	75+75	21,31	20,87	19,54
	50+75	21,58	20,74	19,39
	75+50	21,83	21,30	20,00
Winter triticale, Polovecke	100	21,65	20,94	19,44
	50 +50	20,97	19,66	19,08
	75+75	20,50	19,72	18,95
	50+75	20,07	19,63	19,06
	75+50	21,19	19,93	19,65

Note (%):*1. Winter triticale,100; 2. Hungarian vetch,100; 3. Winter triticale,50+ Hungarian vetch,50; 4. Winter triticale,75+ Hungarian vetch,75; 5. Winter triticale,50+ Hungarian vetch,75; 6. Winter triticale,75+ Hungarian vetch,50.

**Dry matter with triticale var. Polianske

*** Dry matter with triticale var. Polovecke

When growing these crops in binary mixtures a declining tendency of dry matter content was kept on a mineral fertilizers background in comparison to the control and found out close correlation between the sowing rates and groups of ripeness of cereal component, which variously reacted on the nutrition elements and factors of environment. In particular, found out influence of sowing rates of a cereal component 75 % on dry matter content which provided highest indexes of triticale 20,26–21,04 and 17,58–18,05 % – of Hungarian vetch for interrelation of them in phytocoenosis 75:50 % regardless fertilizer level. When sowing 75 % of Hungarian vetch there are more density crops due to legume component added and tier placing of plants in phytocoenosis which prevents moisture evaporation and prolongs duration period between phases in plants. Such correlation between forage crops in the created model was accompanied with diminishing of dry matter content by 0,47–0,67 % in triticale and 0,20–0,24 % in a vetch which accordingly was 19,59–20,57 and 17,38–17,81 % at the different fertilizer background.

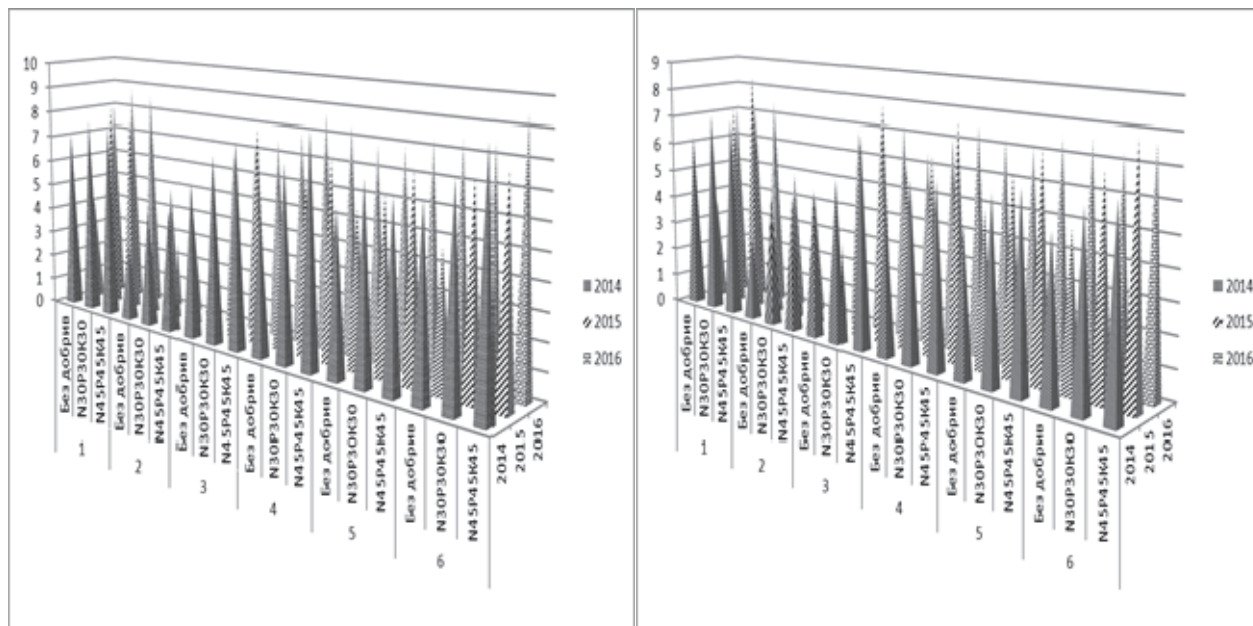
At the identical sowing rates of both components 50:50 or 75:75 % between plants there was no competition for the life factors in mixtures, and that is why indexes changing was insignificant in comparing to the sowing rate 50:75 %, where in triticale and Hungarian vetch accordingly was 19,72–20,57 and 17,20–17,78 %.

Mineral fertilizers also influenced on dry matter content in green forage of winter triticale, reducing its indexes by 1,50–1,84 %, when applying in the dose of $N_{45}P_{45}K_{45}$, and on a background of $N_{30}P_{30}K_{30}$ its diminished by 0,63–0,94 %, in Hungarian vetch it was accordingly by 1,66 and 1,10 % in comparison to the control. The highest indexes of dry matter content got on the unfertilized variants which made at the triticale variety of Polianske 21,51% and Polovecke 20,68 %, at the same time indexes of Hungarian vetch was depended on a mixture crop but were within the limits of 18,28–18,76 %.

Our supervisions shows that highest dry matter content where found at the droughty weather conditions in 2015 (GTK 0,98), which in Hungarian vetch was 18,49–18,69 and 22,93–23,49 % in triticale, while for enhanceable moisture (GTK 1,79 in 2014) and optimum temperature condition plants intensively formed vegetative mass, where dry matter content in Hungarian vetch declined by 1,37–2,77 and 5,09–5,18 % in winter triticale in comparison to an afore-mentioned year [9].

For determination of influence of weather conditions on dry matter content in agrophytocoenosis we have conducted the regressive analysis of the data we've got, where we found out a close correlation between dry matter content and weather factors. Thus, the coefficient of correlation between dry matter content and rainfall are $r=0,952-0,965$, and between dry matter content and average monthly air temperature are $r=0,926-0,983$ and determination are $R^2=0,938-0,967$ and $0,857-0,907$ accordingly. Thus, in a vegetative period dry matter accumulation at the plants of triticale and Hungarian vetch by 93,8–96,7 % where depended on a rainfall and by 85,7–90,7 % on the average monthly air temperature [10].

The highest dry matter output of 5,41–6,10 t/ha was formed in triticale at the optimum moisture conditions (83 mm) and average monthly air temperature of 13,0°C at GTK 1,05 and applying of mineral fertilizers in the dose of $N_{45}P_{45}K_{45}$, while at the limited rainfall (71 mm) and decline of air temperature by 1,1°C its diminished by 0,58–1,26 t/ha, or was 62,0–62,7 % from the total biomass yield. In Hungarian vetch output of dry matter raised to maximum in 2015 – 2,88–2,96 t/ha, which are more by 33,9–39,6 and 10,8–22,0 % in comparison to 2014 and 2016 accordingly. Findings testify of high efficiency of mineral fertilizers in binary mixtures, where the consumption of nutrition elements was determined by the moisture supplementation in a top-soil, by a temperature condition and rainfall during the vegetation (picture).



a) Triticale var. Polianske

b) Triticale var. Polovecke

Note (%): 1. Winter triticale, 100; 2. Hungarian vetch, 100; 3. Winter triticale, 50+ Hungarian vetch, 50; 4. Winter triticale, 75+ Hungarian vetch, 75; 5. Winter triticale, 50+ Hungarian vetch, 75; 6. Winter triticale, 75+ Hungarian vetch, 50.

Consequently, the output of dry matter in binary mixtures was stipulated by part of the cereal component in the green mass yield and by the dry matter content on a mineral fertilizers background. The highest indexes were provided by mixture of winter triticale var. Polyanske with Hungarian vetch, 8,77 t/ha when applying mineral fertilizers in the dose of $N_{45}P_{45}K_{45}$ and interrelation of components 75:50 %. Basic part of gross output of dry matter in legume-cereal mixtures were occupied by a cereal component which was 5,87 t/ha or 66,9 %. Binary mixture with including of middle-ripening variety of winter triticale Polovecke gives a dry matter output of 7,39 t/ha, which was by 15,3 % below previous mixture. However the highest indexes got from interrelation of components 50:50 % from a complete rate, that made 7,51 t/ha with content of winter triticale 72,0 %.

By a result of correlation regressive analysis of data the regressive model of dry matter output was built for legume-cereal mixtures of annual winter crops, rainfall and average monthly air temperature, between which it is set close cross-correlation, that is described the following equalization of multiple regression:

for mixture of Hungarian vetch and winter triticale var. Polovecke:

$$Y = 4,8164 + 0,0172x_1 + 0,0426x_2 \quad 1);$$

for mixture of Hungarian vetch and winter triticale var. Polyanske:

$$Y = 4,6753 + 0,0071x_1 + 0,2222x_2 \quad 2);$$

where, Y is an output of dry matter, t/ha;

x_1 is a rainfall, mm;

x_2 is an average monthly air temperature, °C.

The analysis of research results shows that with the increase of rainfall by 1 mm output of dry matter in legume-cereal mixtures rises by 0,0071–0,0172 t/ha, and with growth of average monthly air temperature on 1°C it is increased on 0,0426–0,2222 t/ha.

Conclusions.

Thus, accumulation of dry matter at the different groups of ripeness of winter triticale and Hungarian vetch at growing in binary mixtures regulated by the sowing rates and fertilization level and stipulated weather conditions. In the conditions of unsteady moisture and temperature application of new varieties of winter triticale and Hungarian vetch provides the production of high-quality and ecologically safe forage in a spring period.

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