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DYNAMICS OF INCREMENT OF POTATO FOLIAGE AND TUBERS DEPENDING ON DIFFERENT DOSES OF MINERAL FERTILIZERS

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In the article there are represented the results of researches and dynamics of growth of potato foliage and tubers of Galychanka and Oksamyt cultivars depending on using mineral fertilizers in the conditions of western forest and steppe region of Ukraine.

***Key words**: potato, cultivar, foliage, tuber, mineral fertilizers*

Harvest dimensions of potato tubers are closely dependent on the intensity of plants growth and development, increment of vegetative mass (foliage) and of tubers. These rates are closely interconnected. The most important role in the dynamics of potato growth of foliage and tubers is played by different doses of mineral fertilizers. Low rates of increment in the dynamics of growth of both potato foliage and tubers may be due to the fact that the increment of foliage in most cases does not reach optimum size because of insufficient nutrients in the soil [1, 2].

Analysis of recent researches and publications in which a solution of this problem has been started. Scientists M. Molotskyi [1], A. Zinchenko, V. Solotenko, M. Bilonozhko [2], elieve that to establish the causes that determine the final harvest, it is necessary to study its accumulation in dynamics. They confirm that the formation of the tuber harvest largely depends on the intensity of the growth of overground vegetative mass.

In their researches scientists V. Vytenko, V. Kutsenko [3], V. Kononuchenko, M. Molotskyi [4] suppose that with the increasing of overground mass there also increases the weight of tubers. Nevertheless, the increasing of foliage weight is productive only till a certain period. They also consider that the mass of foliage more than 48.5 tons/hectare has a negative impact on the tuber harvest. A negative influence has also humidity of soil, when it is scarce potato tubers accumulate mass better in comparison with foliage. The increase in foliage mass can be obtained from unilateral incensement of nitrogen supply, which leads to the tuber weight increasing. They suppose that in determining the final productivity of tubers a prominent role is played by the duration of tuber forming. Also it is important to note that under favorable conditions plants have enough time to accumulate big crop, comparing with a long period of growth and adverse weather and climate conditions [3,4].

Object of the research: to study the impact of different doses of mineral fertilizers on the dynamics of increment of potato foliage and tubers during the growing season.

Terms and methods of research. The researches were conducted during 2013 and 2014 in the experimental fields of Podilskyi State Agricultural and Technical University. Soil was humus vyluhuvanyy, deep, hard loamy in loesslike loams. Experimental plot had the following agrochemical indexes: humus content - 3.98%; lightly hydrolyzed nitrogen 122.8 mg/kg of soil, movable phosphorus - 85.9; exchangeable potassium - 166.8 mg/kg of soil; acidity pH - 6.5; (at a depth of one soil layer 0-30cm).

Mineral fertilizer experiments made in this ratio in eight versions: version without fertilizers and – control; II - $N_{90}P_{60}K_{60}$; III - $N_{60}P_{90}K_{90}$; IV – $N_{90}P_{120}K_{120}$; V - $N_{120}P_{150}K_{150}$; VI - $N_{180}P_{210}K_{210}$; VII - $N_{210}P_{240}K_{240}$;VIII - $N_{240}P_{270}K_{270}$. Repeated experiment three times.

Mineral fertilizers in the experiments were applied in the following ratio according to eight versions: I version without fertilizers – control; (At the first version any fertilizers were used before the control) II - $N_{90}P_{60}K_{60}$; III - $N_{60}P_{90}K_{90}$; IV – $N_{90}P_{120}K_{120}$; V - $N_{120}P_{150}K_{150}$; VI - $N_{180}P_{210}K_{210}$; VII - $N_{210}P_{240}K_{240}$;VIII -$N_{240}P_{270}K_{270}$. The experiment was repeated three times.

The subjects of the research were early-maturing varieties of potatoes of Galychanka and Oksamyt.

The main material of the research. According to many researchers, the application of fertilizers is favorable to the increment of the leaves (tubers) biomass before the flowering phase of plants. During the potato vegetation period accumulation of the leaves moist weight progresses unevenly. The growth of leaves and foliage was quite intensive during the first half of the growing season, what from a biological point of view can be explained by genetic properties of the plants, and then the accumulation of tuber mass took place more intensively.

According to the research results, the accumulation of foliage mass of Galychanka variety was increasing during the growing season especially before the phase of budding and the beginning of blossoming. An intensive development of the plants was recorded from the application of mineral fertilizers (table 1).

Experimental researches have established that in general the most developed vegetative mass was developed in plants in 2014, due to the large amount of precipitation during the growing season. Observation over the dynamics of vegetative mass growth also showed that from the beginning of the growing season leaves and foliage were growing intensively in the fertilized background.

1. Dynamics of accumulation of the foliage mass of Galychanka variety depending on doses of mineral fertilizers, gram per a plant.

(average meaning for 2012-2014)

Experiment version	Date of observation							
	21.V	1.VI	12.VI	21.VI	1.VII	10.VII	20.VII	31.VII
Without fertilizers (control)	56	163	215	201	178	146	99	53
$N_{30}P_{60}K_{60}$	96	179	209	340	341	264	203	188
$N_{60}P_{90}K_{90}$	105	221	279	401	400	379	333	271
$N_{90}P_{120}K_{120}$	110	228	315	496	439	401	349	234
$N_{120}P_{150}K_{150}$	130	274	381	550	524	486	424	329
$N_{180}P_{210}K_{210}$	152	326	468	678	636	608	544	429
$N_{210}P_{240}K_{240}$	143	290	441	601	553	508	449	342
$N_{240}P_{270}K_{270}$	142	284	440	606	542	499	450	340

During the years of the research on all versions of the experiment the maximum growth of the vegetative mass progressed from the phase of budding till the flowering one. Increasing doses of mineral fertilizers led to greater mass growth of foliage and leaves. The vegetative mass of Galychanka variety was increasing the most intensively in cases where there were higher doses of nitrogen fertilizers. The maximum vegetative mass was in plants of variant $N_{180}P_{210}K_{210}$, the minimum was received from the control variant (without fertilization).

It should also be noted that the indicators of potato vegetative mass slightly decreased after the blooming phase. It can be explained by the fact that since the end of the flowering phase of plants there begins the rapid accumulation of tuber mass. Plants partially start losing the leaves weight due to wilting, defoliation and desiccation of foliage.

Similar rates in the dynamics of foliage mass accumulation during the growing period were observed in Oksamyt variety (table 2).

2. Dynamics of the foliage mass accumulation of Oksamyt variety depending on the doses of mineral fertilizers, gram per a plant.

(average meaning for 2012-2014)

Experiment version	Date of observationДата спостереження							
	21.V	1.VI	12.VI	21.VI	1.VII	10.VII	20.VII	31.VII
Without fertilizers (control)	63	181	226	259	194	149	138	78
$N_{30}P_{60}K_{60}$	99	208	386	468	386	354	339	179
$N_{60}P_{90}K_{90}$	104	225	419	537	440	399	360	165
$N_{90}P_{120}K_{120}$	110	230	439	515	451	401	350	203
$N_{120}P_{150}K_{150}$	115	231	486	484	483	441	375	194
$N_{180}P_{210}K_{210}$	156	349	600	698	684	639	627	398
$N_{210}P_{240}K_{240}$	135	270	460	575	566	517	432	325
$N_{240}P_{270}K_{270}$	144	284	450	578	573	524	480	338

According to the research results the vegetative mass of Oksamyt variety plants was increasing the most intensively in variants with increased doses of nitrogen fertilizers. The maximum vegetative mass on the potato plants was noted in the variant with application of mineral fertilizers $N_{180}P_{210}K_{210.}$ The growth of the vegetative mass was progressing the most intensively from the phase of budding to the flowering one.

As it has already been discovered by our researches, the vegetative mass reaches approximately half of its final size, and since then the productivity of photosynthesis begins to work intensively on the accumulation of tubers mass. Accordingly, stimulation of the dynamics of assimilation surface growth is reflected both in the biochemical composition and in the intensity of photosynthesis and activity of potato tubers formation. By activating the dynamics of vegetative mass growth, and increasing the intensity of photosynthesis mineral fertilizers have a positive effect on biochemical processes and as a result on the growth and development of potato tubers.

The use of mineral fertilizers has a positive effect on the increment of tubers weight. According to experimental researches mineral fertilization significantly affected the mass of tubers. The beginning of tuber formation is observed in three weeks after germination.

The most intensive process of tuber formation happens from the phase of full flowering until the beginning of foliage parching. In the control variant this process ended much earlier in comparison with the variants with fertilizers. The highest increment of tubers was observed in the variants with double doses of all nutrients, and also with double doses of nitrogen and potassium and of phosphorus 120 kg per hectare (table 3)

3. Dynamics of the tubers mass accumulation of Galychanka variety depending on the doses of mineral fertilizers, gram per a plant (average meaning for 2012-2014)

Experiment variant	Date of observation						
	1.VI	12.VI	21.VI	1.VII	10.VII	20.VII	31.VII
Without fertilizers (control)	7,9	136	223	256	271	274	266
$N_{30}P_{60}K_{60}$	5,1	120	193	303	364	389	401
$N_{60}P_{90}K_{90}$	5,3	125	201	286	360	400	422
$N_{90}P_{120}K_{120}$	5,9	136	200	318	377	401	423
$N_{120}P_{150}K_{150}$	6,1	128	215	310	378	403	431
$N_{180}P_{210}K_{210}$	6,0	129	210	305	375	398	425
$N_{210}P_{240}K_{240}$	6,1	130	220	310	380	398	425
$N_{240}P_{270}K_{270}$	5,8	150	219	330	409	412	478

Increasing the dose of nitrogen to 180 kg/hectare led to the increase in the foliage mass compared with variants where higher doses of phosphorus and potassium were used. However, the weight of tubers of the variant was less. On the backgrounds of nutritious where simultaneously to nitrogen were used higher doses of potassium, as well as with double doses of NPK the increase in the foliage mass was accompanied by the increase in tuber mass for Oksamyt variety. (table 4)

Analyzing the rates of the tubers mass accumulation the highest level of plant productivity of Oksamyt variety was marked on the variants which were fertilized by the dose of $N_{180}P_{210}K_{210.}$ It significantly increased the analyzed rate compared to the control variant.

4. Dynamics of the tubers mass accumulation of Oksamyt variety depending on the doses of mineral fertilizers, gram per a plant (average meaning for 2012-2014)

Experiment variant	Date of observation						
	1.VI	12.VI	21.VI	1.VII	10.VII	20.VII	31.VII
Without fertilizers (control)	7,1	124	179	246	261	278	285
$N_{30}P_{60}K_{60}$	5,2	140	214	343	394	422	429
$N_{60}P_{90}K_{90}$	4,0	139	208	337	415	437	449
$N_{90}P_{120}K_{120}$	5,3	131	208	340	416	448	465
$N_{120}P_{150}K_{150}$	5,2	149	226	324	428	448	460
$N_{180}P_{210}K_{210}$	5,0	164	238	365	445	450	461
$N_{210}P_{240}K_{240}$	4,5	140	201	315	390	470	470
$N_{240}P_{270}K_{270}$	6,0	153	218	323	418	469	461

Conclusion: Based on the research results the maximum tuber mass exceeded the maximum foliage mass on the control variant (without fertilizers). On variants with the same doses of NPK the maximum tubers mass during the studied years was a little bit less. On the variants with double doses of mineral fertilizers and the ones with higher doses of nitrogen and potassium the maximum vegetative mass was considerably higher than the maximum tubers mass. Only in 2014, there were favorable weather and climate conditions which facilitated both increased accumulation of vegetative mass and the highest rates. By weight of tubers 2013 was the most favorable.

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ДИНАМІКА ПРИРОСТУ СТЕБЕЛ І БУЛЬБ КАРТОПЛІ ЗА РІЗНИХ ДОЗ МІНЕРАЛЬНИХ ДОБРИВ

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Встановлена динаміка зростання стебел і бульб картоплі в період вегетації рослин залежно від внесення доз мінеральних добрив.

Ключові слова: картопля, сорт, стебло, бульба, мінеральні добрива

ДИНАМИКА ПРИРОСТА СТЕБЛЕЙ И КЛУБНЕЙ КАРТОФЕЛЯ ПРИ РАЗЛИЧНЫХ ДОЗАХ МИНЕРАЛЬНЫХ УДОБРЕНИЙ

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Установлена динамика прироста стеблей и клубней картофеля в период вегетации растений в зависимости от внесения доз минеральных удобрений.

Ключевые слова: картофель, сорт, стебель, клубень, минеральные удобрения