BULLETIN of Armenian National Agrarian University

International Scientific Journal

ISSN 1829-0000
Reg. № 211.200.00169

Journal homepage: https://www.anau.am/en/teghekagir

UDC: 635.22:631.8 (479.25)

The Impact of Application Times and Various Dosages of Organomix and Bio-Liquid on the Potato Growth And Development

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ARTICLE INFO

Keywords:
organomix,
bio-liquid,
potato,
application times,
growth and development,
mineral fertilizers,
yield amount

ABSTRACT

The results of the field experiments concerning the impact of organomix organic fertilizer and bio-liquid growth stimulator on the growth, development, intensity of tuber accumulation, yield capacity and marketability of the potato cultivated in the irrigated brown semi-desert soils of the Masis province at Ararat region, RA, are introduced in the article.

Upon the two-year (2017-2018) investigations it has been disclosed that the fractional application (with sowing and through nutrition) of the same organomix dosage (10 t/ha) has had a more favorable effect on the yield amount (12.9%) of potato and its structural elements than the simultaneous (with sowing) application or through the combination of mineral fertilizers ($N_{90}P_{90}K_{90}+N_{60}$). Meanwhile, by applying the growth stimulating bio-liquid with the dosage of 14 l/ha (by means of moistening the planting material) before the potato planting the potato yield amount and the tubers' marketability have considerably increased (20.5 %) during the vegetation period in comparison to those in case of the top/foliar nutrition introduced with the same dosage.

Introduction

Coming forth as the second bread for humanity, potato has become widespread throughout Armenia; it is cultivated from the lowland areas up to 2025 m heights above the sea level. Great amount of research works are currently implemented aimed at the selection, seed-breeding and improvement of agro-techniques concerning that valuable crop.

The main pre-requisite for the increase of potato yield, its qualitative indicators, as well as the decrease of its cost price is the provision of maximum yield per unit area. To handle these issues together with numerous factors (introduction of new high-yielding sorts, application of efficient methods to combat pests and diseases, improvement of product sales methods) the application of scientifically justified mineral and organic fertilizers, as well as the use of the growth regulators have become particularly important, which provide high results with low costs in terms of both yield capacity increase and cost price reduction (Galstyan, 2007, Galstyan, et. al, 2009, Onayini, et. al, 2003).

At the same time in conditions of agricultural intensification the production of ecologically safe food has become an urgent issue which is intrinsically related to the provision of environment quality. Energetic materials, agro-chemicals and chemical methods of plant protection should be gradually denied, being substituted with organic fertilizers and composts, particularly when they are produced from the organic wastes appeared in the result of household and agricultural activities or with herbal tinctures and growth stimulators, which enhance the soil biological activity and promote the humification acceleration.

Considering the urgency of the above mentioned issues solution we have set up an objective to study and disclose the impacts of various dosages and application times of bio-liquid and organomix organic fertilizer produced from the household and agricultural wastes through bio-technological innovative methods by the Armenian-Norwegian joint venture "ORWACO" established in Abovyan town, on the growth, development, tuber accumulation and yield amount indicators of mid-early potato variety of "Ausonia" in conditions of Geghanist community of Masis province at Ararat region and to compare them with the results of the mineral fertilizers' impact applied in the region. The aim of such studies is to introduce a tangible recommendation to the agricultural industry on the gradual development of agriculture and on the production of ecologically safe food product.

Materials and methods

The studies were carried out in 2017-2018, in conditions of Geghanist community of Masis region (the land area belongs to the farmer Hrahat Hoveyan). The field experiments were implemented with three repetitions and in each repetition the size of the experimental bed made 20 m^2. The soils of the experimental plot are irrigated, brown meadow soils of semi-desert type where the humus content makes all in all 1.4 %; they have average environmental reaction (pH 6.9-7.1) close to the neutral one and are easily hydrolyzed. The nitrogen content is 2.49 mg in 100 gram soil, the mobile P_2O_5 is 7.8 mg, and the exchangeable potassium content makes 40.0 mg/100g soil (table 1). As we can see from the table data the soils of the experimental plot are poor in humus, weakly provided with the available nitrogen and well provided with mobile phosphorus and potassium (Arinuskina, 1970).

Table 1 Agro-chemical indicators of the experimental plot soils

Soil type and the year of experiment	Soil sample taking depth, cm	Humus, %	pH in the water extract	Absorbed cations, mg eq. in 100g soil			Content of mobile nutrients mg in 100 g soil,		
				CaI^{2+}	MgI^{2+}	The sum	N	P_2O_5	K_2O
Irrigated brown meadow 2017	0-25	1.4	6.9	23.3	5.2	28.5	2.49	7.8	41.0
Irrigated meadow 2018	0-25	1.4	7.1	24.2	5.0	29.2	2.59	7.4	39.0

The aim of the investigations is to study the impact of different dosages and simultaneous and fractional application times of organomix organic fertilizer and the bio-liquid growth stimulator on the growth, development, yield amount and commodity rate of the "Ausonia" potato variety.

The field experiments have been implemented for 8 variants:

1. Control(without fertilization)
2. Organomix 8 t/ha
3. Organomix 10 t/ha
4. Organomix 12 t/ha
5. Organomix 6 t/ha (with sowing) + Organomix 4t/ha(through nutrition)
6. Organomix 6 t/ha (with sowing)+ Organomix 4t/ha +bio-liquid 14l/ha (through nutrition)
7. Bio-liquid(wetting up the seeds) 14 l/ha+ organomix 6t/ha (with sowing) + organomix 4t/ha (through nutrition)
8. $N_{90}P_{90}K_{90} + N_{60}$.

In the 2nd, 3rd and 4th variants the organomix was introduced simultaneously together with sowing in spring and in the 5th, 6th and 7th variants it was done in fractions: 60% was introduced with sowing and 40 % through nutrition at the start of budding stage, besides, in one case the bio-liquid was introduced with the amount of 14 l/ha in the 6th and 7th variants (in the 6th variant) through spraying at the blossoming stage and in another case the potato tubes were moistened with the bio-liquid 3 days before planting and out of the mineral substances $N_{90}P_{90}K_{90}$ was introduced with sowing, while N_{60} at the budding stage through nutrition.

The data on yield capacity have been subjected to mathematical analyses upon the determination of the error (Ex,%) of the experiment and the least significant difference (LSD 0,95 g) through the method of dispersion analyses (Galstyan, 2015).

Results and discussions

In the result of the field experimental activities it has been found out that the different dosages and application times of organomix and bio-liquid have had a certain influence on the germination, growth and development process of potato. In comparison with both control variant (without fertilization) and that of fertilized with mineral fertilizers the germination of the potato planting material has averagely accelerated by 3-5 days throughout the studies in case of both simultaneous and fractional uses of organomix and bio-liquid. If the potato tubes (planting material) germinated 29-30 days after planting in the variant without fertilization or in the variant of $N_{90}P_{90}K_{90} + N_{60}$ after 31-32 days, then in the variants where organomix fertilizer and bio-liquid were introduced both simultaneously and fractionally the potato tubes germinated 25-27 days after planting.

The influence of organomix and bio-liquid was more clearly observed in the transitional phenological phases of potato. If the mentioned impact was less vivid in the initial phases, then in the last phases (blossoming, then the natural dieback of the tops) the impact of organomix and bio-liquid is more obvious in comparison with the variant of complete combination of mineral fertilizers and the duration of the plants' vegetation has been reduced by 5-6 days (table 2).

This circumstance is vital from the perspective that in the farm households there will be an opportunity to harvest the potato yield earlier, to better provide the population needs and which is of particular importance there will be an opportunity to accomplish the summer sowing (other crops) activities successfully in the region.

At the same time the investigations indicate that in comparison with the organomix and mineral fertilizers the bio-liquid has had a certain influence on the acceleration of the potato germination, as well as on the balanced growth and development of the plants surface and subsurface mass. In the 7th variant of the experiments, where the potato planting material has been treated with bio-liquid, it sprouted 6 days earlier than that of the variant without fertilization and 3 days earlier than that of fertilized only with organo-mix and 6 days earlier than that of the variants fertilized with mineral fertilizers. It is worth mentioning that in the variant where the planting material has been treated with bio-liquid the potato plants have grown up more opulently, the stalks and leaves are much more exuberant than in other variants and the surface mass of a plant has developed averagely, that is the stalk mass and the leaves have shown greater indices than those of the other variants by 20-38 g and 9-26 g respectively (Table 2).

Table 2 The impact of different dosages and application times of organomix, bio-liquid and mineral fertilizers on the phenological transition phases, surface mass and stolons of potato

Variants	average data for 2017-2018								The number of stolons, n
	germi-nation	From germination to the mentioned periods			Plants height, cm	The number of stalks, n	Weight, g/plant		
		budding	blossoming	maturation			stalks	leaves	
Without fertilization (control)	31.03	32	43	78	52.0	5.2	495.0	245.0	11.6
Organomix 8 t/ha with sowing	28.03	34	44	75	57.0	6.2	527.0	255.0	13,8
Organomix 10 t/ha -//-	27.03	34	44	75	59.0	6.5	530.0	256.0	15.6
Organomix 12 t/ha -//-	27.03	34	44	75	60.0	6.5	532.0	258.0	15,7
Organomix 6 t/ha with sowing+ 4t/ha nutrition	27.03	34	44	75	57.0	6.6	553.0	269.0	16.4
Organomix 6 t/ha with sowing + Organomix 4 t/ha nutrition + bio-liquid 14 l/ha nutrition	27.03	34	43	76	61.0	6.6	560.0	272.0	17,8
Bio-liquid 14 l/ha+ organomix 6 t/ha with sowing + organomix 4t/ha nutrition	25.03	32	43	74	62.0	7.2	565.0	281.0	17.8
$N_{90}P_{90}K_{90}$ with sowing + N_{60} nutrition	02.04	33	45	76	62.0	6.3	530.0	257.0	16.0

Upon the bio-liquid impact the number of the plants stalks has increased as well. If in the non-fertilized variant the number of stalks per plant made 5.2, in the variant of simultaneous and fractional application of organomix its number made 6.2 and 6.6 respectively, in the variant fertilized with mineral fertilizers it made 6.3, then in the variant fertilized with the same dosage of organomix, where the planting material was treated with bio-liquid the average stalk number per plant made 7.2 pieces.

The table data show that if in case of fractional application of bio-liquid+organomix 10t/ha the number of stolons per plant made 17.8 pieces, then in the variants where the same dosage of organo-mix was applied both simultaneously and fractionally the number of stolons made 15.6-16.4 pieces respectively, while in the non-fertilized variant the mentioned index made 11.6 and in NPK variant it amounted to 16.0 pieces.

The mentioned circumstance is accounted for the fact that in this case the bio-liquid comes forth as a growth stimulator, under the impact of which the apical (of the base) dominance of the planting material stays behind (Avagyan, 2004, Galstyan, 2007, Galstyan, 2013, Hayrapetyan& Shirinian, 2002, Galstyan, et al, 2015).

As it is known the apical dominance is related to the vast accumulation of physiologically active substances (auxins, vitamins, hiberelines) in the upper part of apical layer. Thus, the buds of the mid part of the tubes develop poorly/badly/ and those of the lower part don't develop at all. In case of influencing with the solution of stimulators (in the given case with bio-liquid) the active substances of the source /mother/ tube are re-distributed and the tube sprouts into great number of buds as a result of which both the surface and subsurface parts of the potato plant increase, which in their turn ensure the balanced growth and development of

the plants promoting the tubers accumulation, as well as the improvement of the yield quantitative and qualitative indices (Avagyan, 2004, Galstyan, 2007, Hayrapetyan, et.al, 2009).

The full ratio of simultaneous and fractional application of organomix and mineral fertilizers had a specific effect on the tuber accumulation of potato as well. If in the control variant during the vegetation period the daily average tuber accumulation rate made 8.05 g, then in the variants where organomix and mineral fertilizers were applied it made 10.9 g-13.9 g (table 3).

Besides, the highest intensity /13.9 g/ of the tuber accumulation was observed in the variant, where with the organomix of 10 t/ha dosage (fractional application) the bio-liquid had been introduced beforehand.

So, if in the variant where the 10 t/ha organomix was applied simultaneously and the same amount has been introduced fractionally the daily tuber accumulation made averagely 12.2 g and 13.0 g, then in the variant where the planting material treated with bio-liquid and organomix with 10 t/ha dosage have been used fractionally, it has amounted to 13.9 g or only upon the bio-liquid impact during the vegetation the tuber accumulation rate has increased by 1.7 g in a day.

Table 3 The impact of different dosages and application times of organo-mix, bio-liquid and mineral fertilizers on the tuber accumulation rate of potato according to its pheno-phases (the average data within the period of 2017-2018)

Variants	Tubers' weight according to the development phases , g			From budding to maturation	
	Budding	Blossoming	Maturation	Day	The daily average tuber accumulation, g
Without fertilization (control)	54.0	265.0	390.0	42	8.0
Organomix 8 t/ha with sowing	60.0	310.8	539.6	44	10.9
Organomix 10 t/ha -//-	62.4	341.0	623.6	46	12.2
Organomix 12 t/ha -//-	63.0	50.0	633.4	46	12.4
Organomix 6 t/ha with sowing+ 4t/ha nutrition	63.3	360.0	677.7	48	12.8
Organomix 6 t/ha with sowing +organomix 4 t/ha nutrition +bio-liquid 14 l/ha nutrition	63.9	351.0	726.9	51	13.0
Bio-liquid 14l/ha + organomix 6 t/ha with sowing+ organomix 4 t/ha nutrition	65.0	371.5	773.9	51	13.9
$N_{90}P_{90}K_{90}$ with sowing + N_{60} nutrition	62.0	342.0	684.2	51	12.2

The organic and mineral fertilizers have had a considerable impact on the increase of potato yield amount. The average data of three repetitive field experiments carried out within two years have shown that both the simultaneous and fractional application of organomix and organomix, bio-liquid and mineral fertilizers have increased the potato yield by 97.0 c/ha-198.0 c/ha or by 56.7%-115.8% against the variant without fertilization. It is noteworthy that the fractional application of organomix with the same dosage has had more efficient impact on the potato yield capacity, than the equivalent dosage (10 t/ha) of its simultaneous application. If in the variant of organomix 6 t/ha (with sowing) + organomix 4t/ha (through nutrition) the surplus of the potato yield has made 153.0 c/ha or 89.5 % against the control variant, then in the variant where the organomix has been applied simultaneously (with sowing) with the dosage of 10 t/ha the yield surplus has made 131.0 c/ha or 76.6% (table 4).

At the same time in case of fractional use of organo-mix, when the same bio-liquid dosage (14l/ha) was introduced before the planting of potato tubers (3 days before), a higher yield was provided than in the cases when the bio-liquid dosage was applied in the blossoming stage in the form of nutrition (through sprinkling). As a result in the variant where the potato tubers had been soaked with bio-liquid before planting the surplus of potato yield made 45,0 c/ha as compared to that of fractional use of organo-mix, while when the bio-liquid dosage had been given in the form of nutrition in the same fractional application, the yield surplus made 10,0 c/ha, which is almost within the range of LSD.

Upon the impact of simultaneous and fractional use of organo-mix, as well as upon that of bio-liquid and mineral fertilizers used in the potato sowings of the region the marketability of potato tubers and the average weight of commercial tubers have also grown up.

Thus, if in the control variant the marketability of potato tubers has made 65.6% in the yield fraction, the average weight of commercial tubers-68.0g, then in the variants of organomix 8-12 t/ha(simultaneous) the mentioned indices have fluctuated respectively within 74.4%-86.2% and 80.5g-85g, and in the variant where organomix with the dosage of 10t/ha has been used fractionally or in those where the bio-liquid dosage has been used at different timeframes the marketability of potato tubers has fluctuated within 86.0%-90%, the weight of commercial tubers-

Table 4 The impact of different dosages and application times of organomix, bio-liquid and mineral fertilizers on the potato yield amount and its structure (the average data within the period of 2017-2018)

Variants	The yield according to repetitions, c/ha			The average yield of tubers, c/ha	Yield surplus		The tubers according to fractions			The commodity of the tubers , %	The average weight of the trade tubers, g
	I	II	III		c/ha	%	100g	50-100g	Up to 50g		
Without fertilization (control)	165.0	173.0	175.0	171.0	-	-	33.6	32.0	34.4	65.6	68.0
Organomix 8 t/ha with sowing	270.0	267.0	267.0	268.0	97.0	56.7	43.0	31.4	25.6	74.4	80.5
Organomix 10t/ha with sowing	297.6	302.0	306.4	302.0	131.0	76.6	46.0	39.0	15.0	85.0	84.0
Organomix 12t/ha with sowing	310.0	303.6	310.4	308.0	137.0	80.1	45.6	40.6	13.8	86.2	85.0
Organomix 6t/ha with sowing+4t/ha nutrition	320.8	325.0	326.2	324.0	153.0	89.5	46.0	40.0	14.0	86.0	86.0
Organomix 6t/ha with sowing + organomix 4t/ha nutrition + bio-liquid 14l/ha nutrition	329.0	338.0	335.0	334.0	163.0	95.3	45.0	43.4	11.6	88.4	85.2
Bio-liquid 14l/ha+ organomix 6t/ha with sowing + organomix 4t/ha nutrition	371.0	366.0	370.0	369.0	198.0	115.8	46.5	43.5	10.0	90.0	88.0
$N_{90}P_{90}K_{90}$ with sowing + N_{60} nutrition	294.0	296.0	300.0	296.0	125.0	73.1	44.4	39.6	16.0	84.0	83.5
Ex, %	**1.8**										
LSD 0,95, c	**7.9**										

within 85.2g-88.0g, while in the variant of $N_{90}P_{90}K_{90}$ + N_{60} the marketability of potato tubers has made 84.0%, and the average weight of commercial tubers has made 83.5 g.

Conclusion

Based on the study results we have come to the following conclusions:

1. The increase of the dosages of organomix organic fertilizer produced by the "ORWAKO" Armenian-Norwegian joint venture has promoted the potato growth, development, tuber accumulation intensity, as well as the increase of the yield amount and its marketability.
2. In case of applying the the same dosage of organo-mix through the fractional method (with sowing and through nutrition) it has had a more efficient impact on the potato growth, development, yield amount and structural elements, than in case of applying it simultaneously (with sowing) or in the variant of combined mineral fertilizers $N_{90}P_{90}K_{90}$+N_{60}.
3. The bio-liquid, coming forth as a stimulant, has promoted the rapid germination of potato planting material, the disappearance of apical (base) dominance, the regular plants growth and development significantly increasing the yield amount and the tubers' marketability.
4. When implementing fertilization activities in mid-early and early potato sowings it is necessary to moisten the potato tubers with bio-liquid before planting, to fertilize them with 10 t/ha dosage of organomix, out of which 60% (6 t/ha) should be applied with sowing and 40% at the budding stage in nutritional form.

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