ISSN NO: 2770-0003
Date of Publication: 10-02-2022

The Significance of Mineral Nutrition on The Physical and Chemical Properties of Cellular Juice of Wormwood Leaves (Artemisia Leucodes Schrenk)

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Abstract. The research was carried out in order to study the importance of nitrogen and phosphorus fertilizers on the growth and development of plants, various forms of nitrogen fertilizers and the degree of phosphorus supply to the soil on the physicochemical properties of the cell sap of whitish wormwood leaves. It was revealed by authors that while cultivating whitish wormwood, the most effective form of nitrogen fertilization is urea, the main dose of which is applied to the soil in the phase of 3-4 true leaves. However, due to its slow action during this period, it is advisable to introduce 33% of the annual nitrogen norm in the form of ammonium nitrate. And changes in the values of pH, Eh and rH2 indicators during the growing season largely depend on the forms of nitrogen fertilizers used.

Key words: nitrogen, phosphorus, mineral nutrition, degree of soil supply, cell sap, urea, ammonium nitrate.

Introduction.

Years of research show that many metabolic processes depend on different redox reactions. Therefore, the magnitude of the redox potential (Eh) as indicator of the speed of electron movement plays important role in the growth , development of plants and their productivity [1].

Topicality of the work.

In turn, an indicator of the speed of electron movement - the occurrence of a redox potential in plant cells, depends on oxidative and reduction reactions. It should be emphasized that most redox reactions are accompanied by the participation of hydrogen ions, so this potential (Eh) largely depends on the acidity value (pH) and its temperature.

An analysis of the literature data showed that some researchers [3,4] recommend using the magnitude of the redox potential (Eh) as a general indicator of physicochemical processes in plant cells.

According to other researchers [1, 2, 3] who reckon that the magnitude of Eh does not give a complete picture of the course of redox processes. Based on these assumptions, some researchers recommended to use the indicator of the predominant processes, the level of the redox regime (rH2), when determining the degree of redox processes. The researches of the rH2 indicator make it possible to diversify the state of redox processes occurring in the cellular environment

Considering the importance of nitrogen and phosphorus fertilizers in the growth and development of plants, the purpose of this study was to investigate various forms of nitrogen fertilizers and the degree of soil phosphorus supply on the physicochemical properties of the cell sap of wormwood leaves.

Methods of research.

The researches were conducted in the conditions of field experiments. The experiments were carried out on the experimental plots of the Tashkent State Agrarian University (TashSAU). We studied the effect of various forms of nitrogen fertilizers on the physicochemical properties (pH, Eh and rH2) of the cell sap of the leaves of wormwood whitish under conditions of different soil phosphorus supply.

Plants were grown on the experimental site, small-plot experiments in four repetitions. The size of each plot is 480 m2 (24×20 m). Placement of plots on the site - four-tiered. Sowing seeds was implemented manually according to the scheme: 60x25x1 and 100 hole rows with a distance of 25 cm between holes and 60 cm between rows

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Plants were placed in each variant of the plot in the form of a 10-row strip, in which four middle rows were used for phenological observations, accounting for plant growth and development, one row on each side of the plant was left as protective lines, and on the plants of the remaining 4 rows carried out laboratory analyzes.

Agrotechnics on the experimental plot consisted of the following operations: plowing (in autumn) with the turnover of the layer, chiseling, double harrowing along and across the plot, as well as thinning. Sowing was carried out on a previously marked field. The scheme and rate of fertilizer application to the soil are shown in Table 1. Mineral fertilizers were used in the following forms: nitrogen in the form of ammonium nitrate, urea, potassium nitrate and ammonium chloride, phosphorus in the form of superphosphate ((CaH2PO4) 2 x H2O + 2CaSO4 x 2H2O) and potassium in the form of potassium chloride (KCl).

Irrigation was conducted in an old-irrigated typical gray soil, 4 times during the growing season : in the phase of 3-4 true leaves (1 watering), in the phase of the beginning of budding (1 watering), mass budding (3 watering) and flowering (1 watering).

Table 1

Scheme of field experiments

Forms of nitrogen fertilizers	Annual rate of mineral fertilizers, kg/ha			Period of application of fertilizers						
				In autumn	Before sowing	The period of budding			The period of flowering	
	N	P	K	P	N	N	P	K	N	K
NH_4NO_3	100	70	50	50	20	40	20	25	40	25
$CO(NH_2)_2$	100	70	50	50	20	40	20	25	40	25
NH_4NO_3	100	80	50	60	20	40	20	25	40	25
$CO(NH_2)_2$	100	80	50	60	20	40	20	25	40	25
NH_4Cl	100	80	50	60	20	40	20	25	40	25
KNO_3	100	80	50	60	20	40	20	25	40	25
NH_4NO_3	100	90	50	70	20	40	20	25	40	25
$CO(NH_2)_2$	100	90	50	70	20	40	20	25	40	25

The pH value and the redox potential (Eh) were determined using an LPM-60 m potentiometer with a glass electrode. The value of rH2, which reflects the level of the redox regime of cell protoplasm, was calculated using the Clark formula [5].

$$rH_2 = \frac{Eh}{30} + 2\,pH$$

Results and discussions.

It should be noted that the content of macro and microelements, including N, P, K, both in agricultural and medicinal plants, is very high and is of great practical importance for obtaining a high quality crop [6].

For instance, phosphorus is a part of many compounds, such as nucleic acids, ATP, ADP, NADP, ribulose diphosphate - an anhydride carbonate acceptor, etc., which are involved in the process of photosynthesis. Moreover, phosphorus is significant in the course of respiration processes and others. The lack of soil phosphorus supply leads to a slowdown in the biosynthesis of the above substances, the activity of processes such as oxidative and photosynthetic phosphorylation[7].

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The results of our studies on the pH value of the protoplasm of Artemisia leucodes Schrenk leaf cells show that the active acidity of the protoplasm is different in different variants. This may be quite natural due to the effect of varying degrees of soil phosphorus supply and the form of various forms of nitrogen fertilizers used in experiments (Table 2).

Table 2.

Influence of forms of nitrogen fertilizers at different doses of phosphorus on the acidity (pH) of protoplasm of leaves of Artemisia leucodes Schrenk

Forms of nitrogen fertilizers	Annual rate of mineral fertilizers, kg/ha			Provision of soil with phosphorus	Development phases				
	N	P	K		3-4 Real leaves	Budding	Flowering	Fruiting formation	Seed maturation
NH_4NO_3	100	70	50	weak	5,35±0,01	5,47±0,02	5,57±0,03	5,53±0,01	5,15±0,02
$CO(NH_2)_2$	100	70	50	weak	5,32±0,02	5,50±0,01	5,84±0,01	5,57±0,02	5,09±0,02
NH_4NO_3	100	80	50	Average	5,44±0,04	5,58±0,01	5,65±0,02	5,62±0,01	5,38±0,03
$CO(NH_2)_2$	100	80	50	Average	5,37±0,01	5,65±0,04	5,74±0,03	5,66±0,01	5,34±0,02
NH_4Cl	100	80	50	Average	5,32±0,01	5,54±0,02	5,61±0,01	5,58±0,01	5,23±0,01
KNO_3	100	80	50	Average	5,33±0,03	5,60±0,01	5,62±0,01	5,64±0,02	5,32±0,01
NH_4NO_3	100	90	50	High	5,52±0,04	5,62±0,01	5,70±0,02	5,67±0,01	5,24±0,01
$CO(NH_2)_2$	100	90	50	High	5,45±0,05	5,67±0,03	5,74±0,03	5,69±0,01	5,27±0,02

However, if we try to establish a relationship between the degree of soil phosphorus supply with the pH value of the protoplasm of leaf cells, then a fairly clear correlation is revealed between these properties.

The change in the pH value during the growing season in all variants of the experiments is also specific, i.e. starting from the development phase of 3-4 true leaves, the pH value gradually increases until the flowering period, some is found in fruit formation, and when the seeds ripen, a sharp decrease in the value of this indicator is found.

It worth noting that with an increase in the supply of soil with phosphorus, it is observed a shift in the acidity of the protoplasm of leaf cells to the alkaline. This pattern is found in all phases of the development of a given plant.

In all variation, i.e. regardless of the forms of nitrogen fertilizers and the availability of soil phosphorus, in the initial phases of development and at the end of the growing season, it is remarked a shift in the acidity of the protoplasm of leaf cells to the acid side, which indicates an increase in the concentration of hydrogen ions in these periods of development of Artemisia leucodes Schrenk.

Researches have confirmed that implementation of urea into the soil in all phases of development, a more noticeable shift in the acidity of the protoplasm to the neutral side is observed than when using ammonium nitrate and especially ammonium chloride and potassium nitrate. [8].

Similar data were obtained in the values of the redox potential (Eh) and the level of redox processes (rH2) (table 3).

The results of the study showed that in all forms, regardless of the availability of soil with phosphorus and forms of nitrogen fertilizers, from the initial phases of development to flowering, the value of the redox

ISSN NO: 2770-0003
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potential (Eh) increases. Then, during the period of fruit formation, there is some, and in the phase of seed maturation, there is a sharp decrease in the value of Eh is observed.

Table 3

Effect of forms of nitrogen fertilizers at different doses of phosphorus on the redox potential (Eh) of the protoplasm of Artemisia leucodes Schrenk leaf cells

Forms of nitrogen fertilizers	Annual rate of mineral fertilizers, kg/ha			Provision of soil with phosphorus	Development phases				
	N	P	K		3-4 Real leaves	Budding	Flowering	Fruiting formation	Seed maturation
NH_4NO_3	100	70	50	Weak	154±1,5	163±1,4	169±0,8	165±0,7	148±0,7
$CO(NH_2)_2$	100	70	50	Weak	149±1,3	167±1,7	171±0,8	169±0,8	146±1,1
NH_4NO_3	100	80	50	Average	159±1,2	171±1,3	174±1,2	171±0,5	150±0,7
$CO(NH_2)_2$	100	80	50	Average	156±1,3	173±0,8	177±1,9	174±0,8	148±0,6
NH_4Cl	100	80	50	Average	154±1,2	165±1,4	168±0,7	166±0,6	150±0,5
KNO_3	100	80	50	Average	155±1,0	170±1,7	173±0,6	171±0,5	153±0,6
NH_4NO_3	100	90	50	High	163±1,1	163±1,5	177±0,5	172±0,3	155±0,3
$CO(NH_2)_2$	100	90	50	High	159±1,2	178±1,2	181±0,9	174±0,6	152±0,9

The reason for the low values of Eh of the protoplasm of cells in the phases of development of 3-4 true leaves and seed maturation, i.e. at the beginning and at the end of the vegetation of plants, there is a weak activity of redox physiological processes in the above periods of ontogenesis (respiration, etc.).

Numerous researchers note that the value of the redox potential (Eh) does not give a complete picture of the direction of the redox regime (rH2)[4,9].

It is known that rH2 is an indicator of aerobicity and anaerobicity of the living system, i.e. cells. In this regard, we studied the effects of mineral nutrition on the redox regime (rH2) of protoplasm of Artemisia leucodes Schrenk cells, which was calculated using the Clark formula.[5].

It should be noted that the level of redox regime (rH2) of protoplasm of Artemisia leucodes Schrenk leaf cells also increases with increasing soil availability with phosphorus. [10].

However, the increase in rH2 as pH and Eh, depending on the availability of soil with phosphorus, within the range of "medium" and "high" is not significant.

In view of the above, and from the point of view of economic efficiency, it is desirable to grow this crop under conditions of medium availability of phosphorus soil. It should be noted that feeding plants in the development phase of 3-4 real leaves with ammonium nitrate, and in butonisation and flowering - urea give the best results.

Researchers [11] note that synthetic processes and outflow of substances from leaves to other organs of plant organism are associated with redox potential. For example, increased oxidative activity helps to accelerate the outflow of substances from leaves to other organs and vice versa, which leads to an increase in the intensity of synthetic processes. Therefore, with an increase in soil availability with phosphorus, an increase in the displacement of the redox potential of the protoplasm of Artemisia leucodes Schrenk leaf cells towards the predominance of reducing reactions over oxidative ones is observed.

Perhaps the direct correlation between sizes pH, Eh and rH2 on the one hand, and the content of the above-stated biologically active agents in raw materials has a talk with another which occur under the influence of mineral fertilizers. (N, P, K).

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Conclusion.

Thus, the results of our studies indicate that changes in the values of pH, Eh and rH2 during vegetation largely depend on the forms of nitrogen fertilizers used. For example, if at the beginning of vegetation, 33% of the required total amount of nitrogen fertilizers in the form of ammonium nitrate is added to the soil. And the remaining part of nitrogen fertilizers, starting from the period of butonisation, to be added in the form of urea, there is a significant increase in the value of the redox potential and the degree of the level of redox transformations, as a result of which synthetic processes in plant tissues are increased.

The feeding of Artemisia leucodes Schrenk, with an average soil availability of phosphorus, urea and especially ammonium sulfate, contributes to an increase in the reducing, i.e. synthetic capacity of tissues, which is reflected in the control of such integral indicators of the intensity and directivity of exchange processes as redox potential (Eh), pH value and indicator of prevailing processes (rH2).

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