2010 vol. 72, 83-92
DOI: 10.2478/v10032-010-0008-9

THE EFFECT OF FOLIAR NUTRITION WITH NITROGEN, MOLYBDENUM, SUCROSE AND BENZYLADENINE ON THE NITROGEN METABOLISM IN CARROT PLANTS

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Received: October 27, 2008; Accepted: January 20, 2010

Summary

The Kazan F_1 carrot was cultivated in years 2004-2005 in open-work containers sized 60×40×20 cm filled in with silt loam and located on the open field under shade providing fabric. The following combinations of experiments were arranged: (1) control - without foliar nutrition, and foliar nutrition with: (2) urea, (3) solution of urea+Mo, (4) urea+Mo+BA (benzyladenine - BA), (5) urea+Mo+BA+sucrose, (6) BA in the concentration of 5 mg·dm^{-3} and (7) BA in the concentration of 10 mg·dm^{-3}. In combinations 2-5 the following concentrations of components in solution were applied: urea and sucrose each in 20 g·dm^{-3}, molybdenum 1 mg·dm^{-3}, benzyladenine 5 mg·dm^{-3}. Foliar nutrition was applied three times. In leaves sprayed with urea and with solution of urea+Mo as well as urea+Mo+BA, an increased concentration of NO_3^- was observed when compared to other sites. Foliar nutrition did not result in any significant changes in content of N-total and dry weight in leaves. Foliar application of urea, as well as the solution of urea+Mo+BA, caused an increase in the activity of nitrate reductase (NR) in leaves when compared to the control. Whereas, after spraying the plants with BA only, a noticeable decline in NR activity was revealed in comparison with the control; interestingly, a higher concentration of BA (10 mg·dm^{-3}) was more effective. Foliar nutrition with urea+Mo+BA+sucrose and spraying with benzyladenine only (independently from the concentration) resulted in a significant decrease of the content of NO_3^- in storage roots when compared to other combinations. The highest level of nitrogen uptake by single storage root and leaves of one carrot plant was found after urea+Mo+BA+sucrose nutrition. In case of N uptake by yield of leaves and biological yield of whole carrot plants (roots+leaves) the highest values were observed in combination no. 6.

key words: benzyladenine, carrot, foliar nutrition, nitrate, nitrate reductase, nitrogen, molybdenum, sucrose

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INTRODUCTION

The biological value of vegetable yield is determined not only by a high content of elements beneficial for human health but it also depends on a low level of the harmful substances. Nitrate, among others, belongs to the controlled chemical compounds presenting a major threat to human health. Hence, a problem of searching for effective ways of nitrate content reduction in edible parts of vegetables, especially those consumed by children, is a subject of current interest. Maximum allowable concentration of these elements in food products for children in the EU is 200 mg $NO_3 \cdot kg^{-1}$ f.w. (Commission Regulation (EC) No 655/2004 of 7 April 2004; OJ L 104/48-49 of 08.04 2004). A detailed knowledge of nitrate metabolism in plants under the influence of factors modifying its content plays an important role in the discussion over this issue.

Some authors inform that foliar nutrition with urea or multicomponent fertilizer can reduce nitrate accumulation in yield (Rydz 2001, Stancheva *et al.* 2004, Wojciechowska *et al.* 2005). Other results indicate that cytokinins can indirectly affect the level of nitrate in plant tissue by increasing the activity of nitrate reductase (NR), an enzyme which reduces NO_3^- ions. The issue of synergist cooperation of cytokinins and nitrate in the stimulation of NR activity has been researched for years (Steer 1976). Banowetz (1992) examined the increase in NR induction in wheat seedlings under the influence of benzyladenine (BA). Yu *et al.* (1998) discovered that BA affected a rapid growth of transcription of *Nia*1 gene (coding nitrate reductase) in *Arabidopsis thaliana* seedlings and in consequence the significant increase in NR activity was observed. Induction of this enzyme occurred after the application of the cytokinin to the nutrient medium as well as directly on the leaves.

An equally interesting issue is the participation of sugars in plant nitrogen metabolism. High sugar supply improves and increases consumption of mineral nitrogen, which, in turn, enables the synthesis of organic nitrogen compounds crucial for plant growth. The efficiency of nitrogen assimilation is proportional to the productivity of photosynthesis measured by the sugar content (Masclaux-Daubresse *et al.* 2002). It was demonstrated that glucose affects the activity of nitrate reductase both at the stage of NR gene transcription as well as through post-translational regulation of the enzyme (Lillo *et al.* 2004). According to Morcuende *et al.* (1998) sucrose supplied exogenously causes an increase in nitrate reductase activity in tobacco seedlings.

The aim of work was to determine the effect of foliar nutrition with nitrogen, benzyladenine, sucrose and molybdenum on nitrogen metabolism in leaves and carrot storage roots, with emphasis on nitrate conversion in particular.

MATERIAL AND METHODS

In years 2004-2005 carrot Kazan F_1 was cultivated in 60×40×20 cm in open-work containers, placed in the open field under a shade providing fabric. The containers were filled in with medium silt loam (35% sand, 28% silt and 37% loam) with mean

content of organic substance 3.25% and the following contents of the available nutrient forms soluble in 0.03 M acetic acid: N ($N\text{-}NO_3$+$N\text{-}NH_4$) 28.0, P 4.3, K 28.8, Mg 137.4 and Ca 1424.7 $mg \cdot dm^{-3}$ of soil. The total sorption capacity of the soil used for the experiment was 11.2 $cmol^{+} \cdot kg^{-1}$ at 89.8% base saturation ratio. The soil reaction pH_{H2O} was 7.29 while total salt content (EC) was on the level of 0.45 $mS \cdot cm^{-1}$.

The sowing was performed on 20th April 2004 and 27th April 2005. The content of the available nutrient forms during vegetation period was maintained on the following levels: P 80, K 120, Mg 80, Ca 2000 $mg \cdot dm^{-3}$ of soil by means of fertilization (based on the results of the soil chemical analysis) conducted on 8th April and 5th July 2004 and on 25th April and 1st July 2005. Nutrients were supplied to the soil in KH_2PO_4, K_2SO_4, $CaCO_3$ and $MgSO_4 \cdot 7\ H_2O$ (with microelements content: 0.35% Mn, 0.3% Cu, 0.2% Zn, 0.05% B and 0.01% Mo).

The soil fertilization with nitrogen was applied three times during cultivation period (on 20th April, 5th July and 23rd August 2004 and on 25th April, 1st July and 22nd August 2005) to supplement the N-mineral content to the level of 100 mg $N \cdot dm^{-3}$ of soil basing on the results of chemical analysis of soil.

The following combinations of experiments were arranged: (1) control -without foliar nutrition, and foliar nutrition with: (2) urea, (3) solution of urea+Mo, (4) urea+Mo+BA (benzyladenine: BA), (5) urea+Mo+ BA+sucrose, (6) BA in the concentration of 5 $mg \cdot dm^{-3}$ and (7) BA in the concentration of 10 $mg \cdot dm^{-3}$. In combinations 2-5 there were following concentrations of components in solution: urea and sucrose each in 20 $mg \cdot dm^{-3}$, molybdenum 1 $mg \cdot dm^{-3}$, benzyladenine 5 $mg \cdot dm^{-3}$. In individual sites of the experiment plants were sprayed three times (30th June, 6th August and 24th August 2004 and 28th June, 1st August and 23rd August 2005). Each experimental treatment was randomized in three replications which consisted with thirty carrot plants per one container.

The carrot harvesting and yield evaluation were performed on 15th September, 2004 and 27th September 2005; soil samples for analysis were collected at the same time.

The analyses of plant material was performed immediately after harvesting in the fresh plant material. In carrot leaves the level of nitrate reductase activity (NR) was evaluated by *in vivo* method (Jaworski 1971) and the content of assimilation pigments was measured spectrometrically after the extraction with 80% aceton (Arnon 1949). In leaves and storage root samples the concentration of NO_3^- and NH_4^+ was assessed in extracts prepared using 0.02M $Al_2(SO_4)_2 \cdot 18H_2O$ with the use of ion-selective electrodes; the amount of N-total was determined by Kjeldahl method (Persson & Wennerholm 1999), the content of dry weight in 105°C. On the basis of crop quantity of top leaves and storage roots (the results of carrot yield are a subject of a separate publication - Smoleń & Sady 2009), as well as the determined content of total N, the average level of N uptake (taken with yield) by storage root and leaves of one carrot plant was calculated.

The soil pH_{H_2O} was assessed by potentiometer; total salt concentrations in soil (EC) was measured conductometrically and the content of N-NH_4, N-NO_3, P, K, Mg, Ca was determined after extraction with 0.03 M acetic acid (Nowosielski 1988). The nitrogen was assessed with the microdistillation method according to Bemner in Starck modification; K, Mg, Ca was determined by the AAS method, and P by the vanadium-molybdenum method (Ostrowska *et al.* 1991).

Obtained results were statistically verified by ANOVA module of Statistica 7.1 PL programme for significance level $P<0.05$. Changes of any significance were assessed with the use of multiple variance analysis (factors: combinations and years of study) using data from both years as repetitions (Trętowski & Wójcik 1991). The value of LSD (least significant difference) was calculated with Duncan test. The results presented in this paper (Table 1-5) are means from 2004 and 2005.

Detailed meteorological data during the experimental period have been presented previously (Smoleń & Sady 2008).

RESULTS

It has been revealed that foliar nutrition had a significant effect on the content of NO_3^-, NH_4^+ ions and the activity of nitrate reductase (NR) in carrot leaves (Table 1).

Table 1. The content of nitrate, ammonium ions, N-total, dry weight (% d.w.) and the activity of nitrate reductase (NR) in carrot leaves (means from 2004-2005)

Combinations	NO_3^-	NH_4^+	NR (nmol NO_2 $\cdot g^{-1}$ f.w.$\cdot h^{-1}$)	N-total in % d.w. (w/w)	% d.w. (w/w)
	(mg·100g^{-1} f.w.)				
1. Control	210.5 ab	232.3 c	494.2 d	2.74 a	22.9 a
2. Urea	341.4 d	199.3 b	546.1 e	2.97 a	28.0 a
3. Urea+Mo	365.6 d	206.7 b	501.1 d	3.12 a	20.5 a
4. Urea+Mo+BA	325.1 cd	163.8 a	557.9 e	2.95 a	23.2 a
5. Urea+Mo+BA+sucrose	268.9 bc	147.3 a	418.5 c	3.24 a	25.1 a
6. BA-5	206.8 ab	147.5 a	325.7 b	2.96 a	25.8 a
7. BA-10	183.2 a	148.7 a	269.5 a	3.09 a	24.1 a

Note: Means followed by the same letters are not significantly different for $P<0.05$

No comparable influence was observed in reference to dry weight and N-total. The lowest concentration of nitrate was found in carrot leaves treated with benzyladenine in concentration 10 mg·dm^{-3}, and next with 5 mg·dm^{-3} and control plants. The highest level of NO_3^- was assesed in leaves sprayed with urea+Mo, urea and urea+Mo+BA. In case of ammonium ions, the lowest concentration was revealed in leaves of plants collected from all combinations treated with benzyladenine (combinations no. 4-7), and the highest one was determined in the leaves of control plants. The lowest level of nitrate reductase activity in carrot leaves was found after application of the benzyladenine solution in the concentration 10 mg·dm^{-3}. Decreasing BA concentration till 5 mg·dm^{-3} resulted in the growth of

NR activity, yet it was significantly lower than in the combinations with urea (combinations no. 2-5) and the control. Treatment with the solution of urea+Mo+BA and urea alone resulted in the highest NR activity in carrot leaves.

Spraying of plants with all the solutions applied did not cause any significant changes in level of assimilation pigments in carrot leaves (Table 2). Foliar nutrition treatments influenced the concentrations of NO_3^-, NH_4^+, N-total and dry weight in carrot storage roots to a significant degree (Table 3). The lowest, comparable concentration of nitrate in carrot was determined in storage roots of plants sprayed with benzyladenine (in both concentrations) and the combination of urea+Mo+BA+sucrose. Roots of plants from other combination sites contained significantly greater amount of NO_3^-. In case of ammonium ions, the highest concentration was observed in carrot roots treated foliarly with urea+Mo, and the lowest - in leaves of control plants. Plants nourished with urea only were characterized by the highest content of N-total and the lowest one was found after spraying of plants with BA in the concentration 10 $mg \cdot dm^{-3}$. A significant increase in the level of dry weight, in comparison with other combinations, was observed in carrot storage roots after treatment with the mixture of urea+Mo+BA+sucrose as well as sole benzyladenine in the concentration 10 $mg \cdot dm^{-3}$.

Table 2. The content of assimilation pigments in carrot leaves (means from 2004-2005)

Combinations	($mg \cdot g^{-1}$ f.w.)			
	Chlorophyll a	Chlorophyll b	Chlorophyll a+b	Carotenoids
1. Control	1.00 a	0.43 a	1.43 a	0.52 a
2. Urea	1.12 a	0.48 a	1.60 a	0.61 a
3. Urea+Mo	1.04 a	0.41 a	1.45 a	0.56 a
4. Urea+Mo+BA	1.00 a	0.39 a	1.39 a	0.54 a
5. Urea+Mo+BA+sucrose	1.16 a	0.46 a	1.61 a	0.62 a
6. BA-5	1.05 a	0.43 a	1.48 a	0.57 a
7. BA-10	0.95 a	0.37 a	1.32 a	0.51 a

Note: see Table 1

Table 3. The content of nitrate, ammonium ions, N-total and dry weight (% d.w.) in carrot storage roots (means from 2004-2005)

Combinations	NO_3^-	NH_4^+	N-total in % d.w. (w/w)	% d.w. (w/w)
	($mg \cdot 100g^{-1}$ f.w.)			
1. Control	285.4 b	177.9 a	1.80 c	10.95 ab
2. Urea	270.5 b	180.9 a	2.00 d	10.91 a
3. Urea+Mo	314.5 b	212.2 c	1.82 c	11.35 ab
4. Urea+Mo+BA	311.4 b	197.9 abc	1.86 c	10.79 a
5. Urea+Mo+BA+sucrose	189.9 a	209.2 bc	1.66 b	12.47 c
6. BA-5	146.1 a	182.2 a	1.54 ab	11.75 bc
7. BA-10	150.4 a	190.7 ab	1.44 a	12.35 c

Note: see Table 1

Statistical calculations revealed a significant effect of foliar nutrition treatment on the average nitrogen uptake by storage root, by leaves of one carrot plant and by whole plant (in mg N·root^{-1}, mg N·leaves^{-1}, mg N·whole plant^{-1}). The same effect was observed in reference to average nitrogen uptake by yield of leaves and biological yield of carrot plants (roots+leaves) - in g N·m^{-2} (Table 4). Spraying plants with the solution of urea+Mo+BA+ sucrose led to the highest nitrogen uptake by a single root, by leaves and whole plant. In this case, as well as in combination no. 6 (BA-5) the greatest amount of nitrogen uptaken by yield of leaves and biological yield of carrot plants was noted. The lowest level of N uptake by a single root was revealed after foliar nutrition with urea exclusively. Reduction in nitrogen content in leaves together with the lowest N uptake by its yield were revealed in the control. In addition, the lowest level of nitrogen uptake by yield of carrot plants (roots+leaves) was noted in control and combination no. 2 (treatment with urea exclusively).

Table 4. The average nitrogen uptake by yield of carrot plants (means from 2004-2005)

Combinations	N uptake by the storage roots (mg N· root^{-1})	N uptake by leaves (mg N· plant leaves^{-1})	N uptake by a whole plant (mg N· plant^{-1})	N uptake by yield of storage roots (g N·m^{-2})	N uptake by yield of leaves (g N·m^{-2})	N uptake by biological yield of carrot plants /roots+leaves/ (g N·m^{-2})
1. Control	58.3 abc	66.7 a	125.0 a	8.1 a	9.3 a	17.4 a
2. Urea	48.4 a	71.4 a	119.8 a	7.4 a	11.0 b	18.4 a
3. Urea+Mo	60.7 abc	79.4 ab	140.1 ab	8.8 a	11.6 bc	20.4 b
4. Urea+Mo+BA	53.6 a	83.8 abc	137.4 a	7.9 a	12.2 bcd	20.1 b
5. Urea+Mo+BA +sucrose	71.6 c	101.5 c	173.1 c	9.2 a	13.2 cd	22.4 c
6. BA-5	67.8 bc	96.0 bc	163.8 bc	9.5 a	13.6 d	23.1 c
7. BA-10	56.4 ab	78.3 ab	134.7 a	8.6 a	12.0 bcd	20.6 b

Note: see Table 1

After carrot cultivation, the lowest concentration of N-NO_3 and N-NO_3+N-NH_4 in soil were noted when plants were sprayed only with benzyladenine in both concentrations and the highest values of those compounds were found in soil after cultivation of plants receiving foliarly only urea (Table 5). In case of N-NH_4 the lowest concentration in soil was noted in the combination in which plants were sprayed with urea+Mo+BA+ sucrose and the highest in soil after cultivation of plants receiving foliarly only urea.

Table 5. The content of N mineral in soil after carrot harvesting (means from 2004-2005)

Combinations	($mg \cdot dm^{-3}$ soil)		
	$N\text{-}NO_3$	$N\text{-}NH_4$	$N\text{-}NO_3+N\text{-}NH_4$
1. Control	55.1 bc	9.6 abc	64.7 cd
2. Urea	75.3 d	19.3 d	94.6 e
3. Urea+Mo	69.1 cd	13.1 c	82.2 de
4. Urea+Mo+BA	59.5 bcd	11.4 bc	70.9 cd
5. Urea+Mo+BA+sucrose	49.0 b	7.0 a	56.0 bc
6. BA-5	21.9 a	8.7 ab	30.6 a
7. BA-10	29.7 a	8.8 ab	38.5 ab

Note: see Table 1

DISCUSSION

The lowest content of nitrate was determined in carrot leaves and storage roots after foliar application of benzyladenine in both concentrations i.e. 5 and 10 $mg \cdot dm^{-3}$ (and in leaves in case of control). Spraying with the combination of urea+Mo+BA+sucrose resulted in very low level of nitrate in storage roots in comparison with other foliar nutrition treatments. Interestingly, foliar nutrition applied in these three solutions mentioned above led to the increase in the content of soluble sugars in roots. In case of urea+Mo+BA+sucrose mixture and BA applicated as a solution of 5 $mg \cdot dm^{-3}$, a higher content of carotenoids and greater mass of whole plant was obtained (the results of foliar nutrition on the yield and on the content of soluble sugars and carotenoids in carrot are a subject of a separate publication - Smoleń & Sady 2009). These results point to a stimulating effect of benzyladenine and sucrose in the applied combination on sugar level (and other cell components), which was reflected in a significant increase in the percentage content of dry weight and a decrease of N-total content in storage roots (Table 3). Increased level of non-nitrogen organic compounds (such as sugar) in plant tissue is often accompanied by lowered nitrate content (Behr & Wiebe 1992). Usually it results from a rise in photosynthesis productivity of plants. Yet, spraying carrot plants with the solutions applied in this experiment did not cause any significant changes in the content of assimilation pigments in leaves.

The experiments did not corroborate assumptions that a lowered content of NO_3^- in carrot leaves could have been a result of a higher activity of nitrate reductase. Mostly it was the use of BA that decreased NR activity. Observed correlation is difficult to explain. The level of examined parameters was assessed just after harvesting of the carrot crop in the final phase of plant growth i.e. in 22 and 35 days after third foliar nutrition treatment - for 2004 and 2005 respectively. Thus, NR activity reflected events which took place during the whole vegetation cycle. The lower activity of NR, when compared to other sites, in the leaves sprayed with BA only (in both concentrations) can be linked with the lower content of

NO_3^- (a substrate of this enzyme) in leaves and roots of those plants. Moreover, applied cytokinin could have resulted in the change in the twenty-four-hour cycle of nitrate reductase. There is some evidence that prove that such an influence is possible (Rożek & Wojciechowska 1990, Banowetz 1992). On the other hand, the use of BA in 5 $mg \cdot dm^{-3}$ concentration but in combination with urea (no. 4-5) did not have such an effect. Those observations can be explained by a stimulating influence of foliar nutrition with urea on the NR activity in both leaves and roots of carrot plants, what was already demonstrated in earlier works (Smoleń *et al.* 2006, Wojciechowska *et al.* 2006). In carrot leaves with urea applied foliarly and simultaneously fertilized with NH_4NO_3 3.7-time increase of NR activity was noted in the moment of harvesting in comparison to the period just before the last foliar application. Furthermore, urea applied foliarly (with no reference to nitrogen form applied into the soil) resulted in a significant increase in NR activity in leaves when compared to unfertilized plants (Wojciechowska *et al.* 2006). Similar correlations were observed in carrot roots (Smoleń *et al.* 2006).

Foliar nutrition with urea only did not result in increased level of ammonium ions in leaves in compareson to control plants (such correlation was noted only in roots after the application of urea and molybdenum mixture). Similar observation was made in experiments with lettuce (Wojciechowska 2004). These results can be the evidence of fast conversion of amide form into ammonium ions, which are then directly incorporated into plant organic compounds (Masclaux-Daubresse *et al.* 2002). Foliar nutrition with urea, fulfilling plant demand for nitrogen to a large degree, can contribute to the reduction in $N\text{-}NO_3$ uptake from soil, what was confirmed by the results presented in Table 5. However, effective lowering of the nitrate content in carrot roots occurred only after foliar application of urea + molybdenum + benzyladenine + sucrose mixture.

CONCLUSIONS

The presented results demonstrated a variable effect of foliar nutrition with urea, benzyladenine, sucrose and molybdenum on nitrogen metabolism in carrot plants. Application of benzyladenine only in concentrations 5 and 10 $mg \cdot dm^{-3}$ caused a significant decrease in nitrate content in carrot leaves and storage roots when compared to the use of solutions containing urea. A similar reduction in NO_3^- level was found in roots after application of urea+Mo+BA+sucrose solution. The lowest activity of nitrate reductase was observed in carrot leaves sprayed with benzyladenine in the concentration of 10 $mg \cdot dm^{-3}$, while the highest one - after application of urea+Mo+BA combination and urea only. Foliar nutrition with applied solutions had no significant effect on the content of assimilation pigments, N-total and dry weight in carrot leaves. Storage roots of plants nourished with urea only revealed the highest content of N-total, and the lowest N-total level after plant spray with BA in the concentration 10 $mg \cdot dm^{-3}$. The greatest nitrogen uptake by a single root was obtained after

spraying plants with the mixture of urea+Mo+BA+sucrose. In this case, as well as in combination BA-5, the highest N uptake by yield of leaves only and biological yield of whole carrot plants was noted.

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WPŁYW ODŻYWIANIA DOLISTNEGO AZOTEM, MOLIBDENEM, SACHAROZĄ I BENZYLOADENINĄ NA GOSPODARKĘ AZOTOWĄ MARCHWI

Streszczenie

Marchew Kazan F_1 uprawiano w latach 2004-2005 w pojemnikach ażurowych o wymiarach 60×40×20 cm wypełnionych glina średnią pylastą, umieszczonych na terenie otwartym pod cieniówką. Badano następujące kombinacje doświadczenia: (1) kontrola - bez dokarmiania dolistnego, oraz dokarmianie dolistne: (2) mocznikiem, (3) roztworem mocznik+Mo, (4) mocznik+Mo+BA (benzylodenina - skrót BA), (5) mocznik+Mo+ BA+sacharoza, (6) BA w stężeniu 5 $mg \cdot dm^{-3}$ i (7) BA w stężeniu 10 $mg \cdot dm^{-3}$. W roztworach z kombinacji 2-5 zastosowano następujące stężenia składników: mocznik i sacharoza po 20 $g \cdot dm^{-3}$, molibden 1 $mg \cdot dm^{-3}$, benzyloadenina 5 $mg \cdot dm^{-3}$. Odżywianie dolistne wykonywano trzykrotnie. W liściach roślin opryskiwanych mocznikiem oraz roztworem mocznika+Mo jak i mocznika+Mo+BA nastąpiło podwyższenie zawartości NO_3^- w porównaniu z pozostałymi obiektami. Dokarmianie dolistne nie powodowało istotnych zmian w zawartości N ogółem i suchej masy liści. Odżywianie dolistne mocznikiem jak i roztworem mocznika+Mo+BA wpłynęło na wzrost aktywności reduktazy azotanowej (NR) w liściach w porównaniu z kontrolą. Natomiast po opryskiwaniu roślin samą BA stwierdzono znaczne obniżenie poziomu aktywności NR w porównaniu z kontrolą, przy czym większe stężenie BA (10 $mg \cdot dm^{-3}$) było w tym zakresie bardziej efektywne. Odżywianie dolistne mocznikiem+Mo+BA+sacharozą oraz opryskiwanie samą benzyloadeniną (niezależnie od stężenia) powodowało istotne zmniejszenie zawartości NO_3^- w korzeniach spichrzowych w porównaniu z pozostałymi kombinacjami. Największą ilość azotu pobranego przez korzenie spichrzowe i liście stwierdzono w przypadku roślin odżywianych mocznikiem+ Mo+BA+sacharozą oraz w kombinacji nr 6 - w przypadku pobierania azotu wraz z plonem liści i biologicznym plonem roślin marchwi (korzenie+liście).