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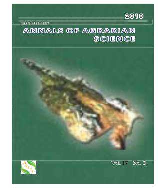

The influence of norms, forms and input rules of nitrogen fertilizers upon NO_3 consistency in orange and lemon crops

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A B S T R A C T

The paper overviews what is the influence of norms and forms of nitrogen-based fertilizers on the nitrate accumulation in the fruits of Washington Navel orange and Meyer lemon. Researches took place in Anaseuli on red and yellow soils of the experimental plots of subtropical crops and tea industry institutes of Georgian Agricurtural University. In order to determine the impact of nitrogen fertilizer norms on nitrate accumulation in Washington Navel orange, amonium sulfate and amonium nitrate have been used with the dozes-75, 150, 300, 450 g/per tree on the background of P,K,Ca,Mg in accordance with agricultural laws. As for the nitrate accumulation from the nitrogen fertilizer forms, we used amonium sulfate, amonium nitrate, ammonium sulfate, ammonium nitrate, carbamide, montanus nitrate and sodium nitrate on the background of P,K,Ca,Mg. In order to accumulate nitrates in Meyer lemon fruits in condition of yellow soil, single and twofold norms of carbamide and montanus nitrate of nitrogen fertilizers (150 and 300 g/per tree), various rules of input and organic fertilizers such as N:P:K have been applied in different ratios. It has been investigated that there is slight impact of nitrogen fertilizers on nitrate deposition in orange fruits and formed fruits are ecologically clean. The same relation has been identified in lemon fruits while using nitrogen fertilizers. Taking into account all above mentioned things we can figure out that the most efficient and pertinent nitrogen fertilizer norm to orange and lemon in case of having the red and yellow soil 150 g/per tree, for orange it is $P_2O_{5\ 300}K_2O_{200}$ and for lemon- $P_2O_{5\ 150}K_2O_{100.}$ As for nitrate accumulation in Meyer lemon prserving all nitrogen fertilizer application rules, growing tendecy of NO3 is obvious, but it does not exceed permissable limit (50 mg/kg).

Keywords: Soil, Fertilizers, Washington Navel orange, Meyer lemon, Fruits, Nitrates.

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Introduction

The role of organic and mineral fertilizers in oranges and lemons is especially important as it significantly increases their crop level and also strengthens plants to successfully cope with different diseases and extremely low temperature [1-5]. Undoubtedly, nitrogen fertilizer norms are very efficient guaranteeing very high level of productivity.

In order to get the high level of plant provision through the help of nutrition elements, plant diagnostics should be implemented. In addition, extreme attention is paid not to particular elements but to their merging antagonism and ion synergism abroad [6]. The nutrition optimization of all agricultural plants and particularly of orange and lemon should enhance the level of crop and provide ecologically clean crop respectively.

It can be concluded that we have studied the Washington Navel orange and Meyer lemon nitrate consistency, their norms, forms and input rules when applying nitrogen fertilizers in perennial field experiments.

Objects and Methods

Scientific researches regarding the influence of nitrogen fertilizer forms, norms and input rules upon red soil Washington Navel orange and yellow soil Meyer lemon fruits on NO3 consistency has been conducted in the west subtropical zone of Georgia. Soil agrochemical indicators prior to conducting the experiment are demonstrated in table#1.

Field experiment on orange has been laid out on the red soil. Replication of the experiment is possible six more time. There are six plants in each division, two of which are protective and four accounting units. All in all, in every variant there are 24 accounting plants. Plant feeding area covers 2.2x3.0 m. Fertilizers were delivered following the agricultural rules and calcareous fertilizers based on one exchange acidity. 20 kg manure per tree has been used on the background of $P_2O_{5\ 300}K_2O$ once in two years. The single norm of nitrogen fertilizers amounted 150 g/per tree.

Field experiment on yellow soil lemon on two-year seedlings. Plant spacing on 1.5x2.2 m, nutrition area 3.3 m2. Meyer lemon can be applied in the experiment for five times, there are six plants on each division, two of them protective and the rest accounting ones. Every variant amounts 20 accounting plants. Fertilizers have been delivered $N_{150}P_2O_{5\ 150}K_2O_{\ 100}$ g/per tree. Organic fertilizer-manure 15 kg/per tree. Calcareous fertilizer with one exchange acidity. In the process of experiment we have applied the peat on the whole area as well. Agricultural laws have been preserved when taking care of the plants [7]. Before conducting the experiment, total humus of sample soils has been determined through the Turin method by Nikitin modification [8], total N- by Kheldahl method, pH (H_2O, KC), total sum of absorbed roots has been determined by Capen and Glikovits method, P_2O_5 and K_2O by Oniani method, hydrolyzed N-by Turin and Kononova method [9,10]. Also, we have determined NO3 through the ion-selective method [11, 12].

Results and analysis

In the process of citrus cultivation and caring, significant attention is focused on relevance of above metioned indicators with standards, one of the most key regulatory roles of which is represented by mineral treatment [5, 13-15]. Thereafter, it must result in getting ecologically clean product, not containing excessive amount of harmful toxic substances (heavy metals, nitrates, fluorine, chlorine) [16].

Mineral fertilizers and particularly nitrogen fertilizers greatly influence upon the nitrogen consistency in separate parts of citrus plants, including their fruits too [17]. Therefore, we have been tasked to identify NO3 in pulp and skin of fruits, results are demonstrated in table#2.

According to researches conducted by O. Zardalishvili [18] we can conclude that fertilizer forms have a considerable impact on nitrate deposition in plants.

Table 1. *Soil agrochemical indicators before conducting the experiment*

Type of experiment	Soil Types	Soil Depth/ cm	Total Humus %	Total Nitrogen%	Acidity forms Mg. equivalent /100g		pH_{KCl}	Moving mixtures mg/100g soil		
					Exchange	Hydrolyzed		Hydrolyzed Nitrogen	P_2O_5	K_2O
Field experiment on orange	Red soil	0-15	4.69	0.20	2.10	7.56	4.92	10.6	74.0	56.0
		15-30	3.11	0.18	3.51	7.86	4.62	9.0	27.0	49.0
Field experiment on lemon	Yellow soil	0-15	2.58	0.18	1.12	8.54	5.31	12.8	33.0	16.50
		15-30	1.60	0.16	2.43	9.50	4.90	8.3	18.0	21.70

Table 2. *On NO_3 consistency in Washington Navel orange fruit*

Nitrogen fertilizer norms and forms on the background of PKCaMg (g/per tree)	Mg/100g	%	mg/1kg in fruit

Nitrogen fertilizer norms			
PKCaMg-background	0.71	0.0007	7.1
$(NH_4)_2SO_4$ 75	0.56	0.0005	5.6
$(NH_4)_2SO_4$ 150	0.44	0.0004	4.4
$(NH_4)_2SO_4$ 300	0.43	0.0004	4.3
$(NH_4)_2SO_4$ 450	0.55	0.0005	5.5
NH_4NO_3 75	0.91	0.0009	5.1
NH_4NO_3 150	0.60	0.0006	6.0
NH_4NO_3 300	0.42	0.0004	4.2
NH_4NO_3 450	0.38	0.0004	3.8
Nitrogen fertilizer forms			
Unfertilized	0.69	0.0007	6.9
PKCaMg-background	0.56	0.0005	5.6
$(NH_4)_2SO_4$	0.63	0.0006	6.3
$(NH_4)_2SO_4$ 60% NH_4NO_3 40%	0.40	0.0004	4.0
NH_4NO_3	0.69	0.0007	6.9
$(NH_2)_2CO$	0.65	0.0006	6.5
$NaNO_3$	0.63	0.0006	6.3

Nitrate consistency can be reduced by applying slow-release nitrogen fertilizers in the plants. Hence, the influence of nitrogen fertilizer norms and forms upon Washington Navel orange fruit on NO3 consistency is represented in Table#2, which clearly demonstrates there is no substantial difference among nitrogen fertilizer norms in this prism. Slightly exceeds NO3 consistency (0,1-0,35 mg 100g/juice) in fruits formed by the impact of Ammonium nitrate norms (75-150 g/per tree). In case of having higher norms, NO_3 consistency exceeds ammonium sulfate variant in comparison with ammonium nitrate variant. As for the influence of nitrogen fertilizer norms on orange fruit nitrate consistency, there was no considerable difference between them if not taking into account ammonium nitrate variant. Based on our result we can conclude that orange fruits belong to ecologically clean product, as 1 kg citrus should not consist more than 50 mg/kg NO_3 [11, 19].

The quality of Meyer lemon is determined by nitrate consistency as well, food element ratio and input timeframe violation in mineral fertilizers greatly impacts on it, resulting in nitrate accumulation in agricultural crop. Nitrates which are in reaction with secondary amines in acidic area, develop nitrosamines. These compounds are hazardous because they own carcinogenic and mutagenic defects [20].

In order to identify what is the Meyer lemon fruit (pulp, juice) consistency with nitrates, we have decided to examine what is the nitrate content in crop got from perennial field experiment in accordance with separate variants. Results are represented in Table# 3. According to Table# 3, we can figure out that the nitrogen fertilizers' usage does not cause the harmful nitrate consistency in lemon fruits and ranges within 18-26 mg/kg, which is by 24-32 mg/kg less than the standardized 50 mg/kg [19]. So, it is clear that the product obtained in conditions of our experiment is ecologically clean. If we compare separate variants with each other, we will see that the high nitrate level is vivid in the variant where phosphorous fertilizer has twofold agro technic norm ($N_1P_2K_1$) and in 100 g pulp and juice reaches 1.44-1.41 mg. Almost in every version NO3 consistency in pulp is by 0,01-0,05 mg more compared to juice. There is no vivid difference between nitrogen fertilizer forms, particularly in fractional input versions we can note the nitrate growing tendency in fruit pulp and juice in comparison with simultaneous input, which can be prescribed to input timeframes and N:P:K correlation. We can sum up that Meyer lemon fruit is ecologically clean and the most optimal norm for it is carbamide and ammonium saltpeter norm N.150g/per tree on the background of single agro technic norm ($P_2O_{5\ 150}K_2O_{100}$) of phosphorus and potassium.

Conclusion

Researches carried out on Washington Navel red and Meyer lemon yellow soil gardens in the west subtropical zone of Georgia concerning deviations caused by applying the nitrogen fertilizer norms, forms and input rules in citrus plants on nitrate consistency, we can make the following conclusions:

1. Norms and forms of nitrogen fertilizers do not have a strong influence upon NO3 accumulation in orange fruits, slight advantage is noted on ammonium nitrate version (150 kg/per tree). In case of slow-release nitrogen fertilizers, reduction of NO3 accumulation takes place;
2. Accumulation of NO3 in lemon fruits is not caused by nitrogen fertilizer norms, forms and input rules. The only clear thing is that the nitrate level increases on the twofold agro technic background of phosphorus fertilizers, but it does not exceed the acceptable norm (50 mg/kg);
3. Norms, forms and input rules of nitrogen fertilizers (150 g/ per tree) in condition of yellow/red soils of subtropical zone of Georgia does not cause the nitrate accumulation in lemon fruits and as a result, we get ecologically clean product.

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Table 3. *On NO3 consistency in Meyer lemon fruit*

Experiment Scheme	mg/100g		total
	Pulp	Juice	mg/kg in fruit
Unfertilized	1.25	1.22	24,7
P_1K_1	1.83	0.79	26,2
N_1P_1-$(NH_2)_2CO^x$	1.35	1.35	27,0
N_1K_1-$(NH_2)_2CO^x$	0.91	0.89	18,0
$N_1P_1K_1$-$(NH_2)_2CO^x$	1.00	1.00	20,0
$N_1P_1K_1$-$(NH_2)_2CO^{xx}$	1.12	1.07	21,9
$N_1P_1K_1$- $NH_4NO_3^x$	1.23	1.23	24,6
$N_1P_1K_1$- $NH_4NO_3^{xx}$	1.11	1.12	22,3
$N_1P_2K_1$-$(NH_2)_2CO^x$	1.44	1.41	26,5
$N_1P_1K_1$-$(NH_2)_2CO^x$+manure	1.02	1.02	20,2
$N_2P_2K_2$-$(NH_2)_2CO^x$+manure	1.20	1.20	24,0
$N_2P_1K_1$-$(NH_2)_2CO^x$	1.18	1.18	23,6
$N_2P_2K_2$-$(NH_2)_2CO^{xx}$	1.26	1.29	25,5

X- *simultaneous input*
XX- *fractional input*

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