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NITRATE ACCUMULATION IN OKRA AND CARROT AS INFLUENCED BY FERTILIZER APPLICATION

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Abstract

Excessive use of nitrogen fertilizers is a factor of nitrate accumulation in vegetables which causes health problems to the consumers. A study was conducted to assess the effect of NPK fertilizers on NO_3 accumulation in okra (*Abelmosclus esculentus*) and carrot (*Daucus carota*) at Ayub Agricultural Research Institute, Faisalabad. For okra five N (0, 100, 150, 175, 200 kg ha^{-1}) and two P_2O_5 rates (0, 75 kg ha^{-1}) were tested with 60 kg K_2O ha^{-1} as basal dose. To carrot four N (0,25,50,75 kg ha^{-1}), three P_2O_5 (0, 50, 75 kg ha^{-1}) and two K_2O rates (0, 25 kg ha^{-1}) were applied. Increasing fertilizer rates increased NO_3 concentration over control in okra and carrot. However, the application of N with P reduced NO_3 concentration in okra. Conversely, the NO_3 concentration in carrot increased significantly over control either N applied alone or with P. A balanced use of N and P (2:1) fertilizers reduced the NO_3 accumulation. Additionally, the doses of NPK fertilizers applied in this study did not pose health hazards to the consumers.

Introduction

Nitrate is often the dominant form of N taken up by the crops. Its relative ease of movement through soil facilitates its absorption by plants. The NO_3 accumulation in foodstuffs may create many health hazards. For example, high NO_3 concentration results in the oxidation of haemoglobin, ultimately restricting the ability of haemoglobin to carry oxygen and resulting in a bluish-tinged or oxygen starved baby (Kimmo, 1992). Similarly high NO_3 intake can reduce the body assimilation of iodine thus causing goitre. It has also been reported that NO_3 derivatives react under appropriate conditions with a variety of organic compounds to form nitrosamines and nitrosamides, which are carcinogenic. The lethal dose of NO_3 concentration for human is 17.6 mg kg^{-1} body weight (Deeb & Sloan, 1975).

Vegetables are generally considered NO_3 accumulators. Currently, the use of fertilizers in Pakistan is low as compared to other countries; however, many farmers apply heavy doses of N fertilizer with city effluents to vegetables in the vicinity of urban areas. This practice may cause NO_3 accumulation in vegetables. Sarfraz *et al.*, (1998) reported significant increase of NO_3 concentration in carrot, radish and tomato with the application of 50 to 200 kg N ha^{-1}. The balanced use of fertilizers is important for high crop yields of good quality. Mixed results were obtained on the effect of P and K levels on NO_3 accumulation. For example, Yimin *et al.*, (1992) and Hamdard *et al.*, (1985) found a reduction in NO_3 concentration in various plant species due to P and K applications. On the other hand, Barker & Maynard (1971) and Barker *et al.*, (1971) reported that P and K had little effect on NO_3 accumulation. Therefore, the objective of this study was to determine the effect of different levels of N, P and K fertilizers on NO_3 accumulation in carrot and okra.

Materials and Methods

Experiments on okra and carrot were conducted on research area of Soil Chemistry Section, Ayub Agricultural Research Institute, Faisalabad during 1996 and 1997. Composite soil samples were collected from 0 to 15 cm depth before sowing. Soil samples were air-dried, ground and passed through 2 mm sieve and preserved in plastic bottles for analyses. Soils were analyzed for pH, electrical conductivity of the saturated paste (EC_e), organic matter (OM), Olsen-P and ammonium acetate extractable-K by following the methods described by Page *et al.*, (1982). Total-N content was determined by method described by Tecator (1981). Soils having clay loam texture had pH 7.5, EC_e 0.66 dS m^{-1},OM 0.95%, total-N 0.055%, Olsen-P 7.5 mg kg^{-1} and ammonium acetate extractable-K 145 mg kg^{-1}.

Okra

Nine combinations of N and P rates (Table 1) were applied to okra in randomized complete block design with three replications. Basal dose of 60 kg ha^{-1} K_2O was applied to each plot. Full doses of P_2O_5, K_2O and half dose of N were applied at seedbed preparation. The remaining half dose of N was applied at flowering stage. Okra crop was sown on 11 April, 1996. The okra fruit samples were collected from each treatment and analysed for NO_3 concentration (Cataldo *et al.*, 1975).

Carrot

Seven combinations of N, P and K rates were applied to carrot (Table 2). Full doses of P_2O_5, K_2O and half N were applied at seedbed preparation, and the remaining half dose of N was applied with second irrigation. Carrot was sown on 26 September, 1996 and harvested on 27 January, 1997. Samples of carrot were taken from each treatment for NO_3 determination.

Results and Discussions

Effect of N on NO_3 concentration

The increasing rates of N increased NO_3 concentration (2 to 51%) in okra fruits (Table 1). The increase in NO_3 concentration was significantly higher with 200 kg N ha^{-1} than control treatment. In the case of carrot, 25 kg N ha^{-1} significantly enhanced NO_3 content over control treatment (Table 2). Similar results were reported by others (Sarfraz *et al.*, 1998; Ibrahim *et al.*, 1996; Yimin *et al.*, 1992; Barker *et al.*, 1971). Carrot showed a greater affinity for NO_3 than okra as 25 kg N raised NO_3 contents by 38% over control treatment. Accumulation of higher amounts of NO_3 in carrot has also been reported by Sarfraz *et al.*, (1998) supporting that N fertilization for carrot should be strictly controlled.

Effect of NPK on NO_3 concentration

Application of P with N decreased NO_3 concentration in okra fruits by 2 to 9 % compared with corresponding N rates alone (Table 1). This depressing effect of P on NO_3 accumulation was more pronounced up to 150 kg N ha^{-1}. The application of NPK reduced

Table 1. Effect of N and P rates on NO_3 concentration (fresh wt. basis) in okra fruits.

Nutrient rates (kg ha^{-1})		NO_3 concentration	NO_3 increase over control
N	P_2O_5	(mg kg^{-1})	(%)
0	0	414 d	-
100	0	421 d	2
150	0	488 cd	18
175	0	534 bcd	29
200	0	626 ab	51
100	75	413 d	-
150	75	448 d	8
175	75	583 abc	41
200	75	600 ab	45

*Means sharing the same letters are not significantly different at 5 per cent level of probability.

Table 2. Effect of NPK rates on NO_3 concentration (fresh wt. basis) in carrot.

Nutrients applied (kg ha^{-1})			NO_3 concentration	Increase over control
N	P_2O_5	K_2O	(mg kg^{-1})	(%)
0	0	0	478 b	-
25	0	0	657 a	38
25	50	0	592 a	24
50	50	0	608 a	27
50	50	25	561 ab	17
75	50	0	596 a	25
75	75	0	604 a	26

*Means sharing the same letters are not significantly different at 5 per cent level of probability.

Table 3. Daily intake of NO_3 by an adult (60 kg body wt.) from okra and carrot.

Vegetable	Max. NO_3 concentration on fresh wt. basis (mg kg^{-1})	NO_3 intake (mg)	Safe limit* (mg)
Okra	626	188	1056
Carrot	657	197	1056

*Total daily intake of <17.6 mg NO_3 kg^{-1} body weight is harmless (Deeb & Sloan, 1975).

the NO_3 contents of carrot by 8% against NP and by 15% against N alone (Table 2). The increase in NO_3 concentration over control was minimum (17%) with the application of NPK @ 50-50-25 kg ha^{-1} compared with other treatments. All the fertilizer treatments decreased, though not significantly, NO_3 concentration in carrot compared to 25 kg N ha^{-1} alone. Less NO_3 concentrations were obtained for higher rates of N (50 and 75 kg ha^{-1}) with P (50 and 75 kg ha^{-1}) than the lowest rate of N (25 kg ha^{-1}) alone. The depressing effect of K on NO_3 contents in the carrot might be due to that K decreased the soluble N contents in carrot through improving absorption, transportation and reduction of NO_3 (Yimin *et al.*, 1992; Hamdard *et al.*, 1985).

Nitrate toxicity

According to Deeb & Sloan (1975), the total daily intake of < 4 mg NO_3-N per kg body weight (equivalent to 17.6 mg kg^{-1} NO_3) is harmless. Assuming 300 g vegetable intake by a person having 60 kg body weight and maximum concentration of NO_3 in okra

(626 mg kg^{-1}) and carrot (657 mg kg^{-1}), it was found that these vegetable were not expected to pose any health hazard to consumers (Table 3).

The results showed that application of N alone enhanced the NO_3 accumulation in okra and carrot. A balanced use of N, P and K can help minimize NO_3 accumulation. Furthermore, the existing rates of fertilizers do not pose any health hazards to consumers.

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