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Effects of Nitrogen Rates on Nitrogen Accumulation, Ascorbic Acid and Essential Oil Contents in Parsley

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The effects of increased N rates (0, 100, 200 and 300 kg N ha^{-1}) on total-N, NO_3-N, NO_2-N accumulation, ascorbic acid, essential oil contents in parsley leaf and stalk during the seven harvesting times at two sowing times were investigated. Nitrogen rates had a significant effect on nitrogen, ascorbic acid and essential oil accumulation in leaf and stalk during the harvesting times in both sowing times. The highest values except essential oil were observed with 300 kg N ha^{-1} treatment. Nitrate content in leaf did not exceed the acceptable norm in parsley. Just only the 300 kg N ha^{-1} treatment in stalk was high when it was compared with literature. In addition, these criteria were changed during the harvesting time and still, only NO_3-N, NO_2-N, ascorbic acid, essential oil contents in leaf were affected by sowing times significantly.

Key Words: Nitrogen rate, Nitrogen accumulation, Ascorbic acid, Essential oil, Parsley.

INTRODUCTION

Parsley (*Petroselinum crispum* Nym.) is a popular herbal crop valued for it is aromatic and attractive leaves in cooking or in fresh consumption. It is utilized in human nutrition and drug industry in many Mediterranean countries.

Nitrogen has a pronounced influence on plant growth and development. All important and economic horticultural crops have recommended N rates for optimal yield. Applying N more than the plant requirements can increase the chances of N loss to the environment, therefore proper N fertility application is important for nutrient management[1].

Likewise, spinach and lettuce exceeding concentrations of nitrite (NO_2) and nitrate (NO_3) in parsley also threaten human health. The harmful effects of nitrate are not related to its toxicity significantly, which is low, but to the dangerous compounds that are synthesized in the organism. Indeed, the most serious danger comes from nitrite which is produced by nitrate reduction and which can lead to

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methaemoglobinemia or from nitrosamines and nitrosamides by reacting with amines and amides whose carcinogenic action is well known[2, 3]. It is reported that over-fertilization with nitrogen has a different result in NO_2 and NO_3 accumulation in some plants[4–8].

Parsley can be a source of ascorbic acid when it is consumed as part of human diet. Ascorbic acid content is related to nitrogen fertilization[9, 10].

The objective of this study was to evaluate the effects of nitrogen rates on nitrogen accumulation, ascobic acid and essential oil content in parsley leaf and stalk during 7 harvesting times at 2 sowing times.

EXPERIMENTAL

The study was conducted at the experimental field of Odemis Technical Training College. Italian variety of parsley was grown in randomized block design with three replications. The plot area was 2 m^2. The soil characteristics of field are given in Table-1. Fertilizer treatments included four N rates at 0, 100, 200, 300 kg ha^{-1} in two different sowing dates, 27 February 2004 and 27 March 2004.

TABLE-1
SOME PHYSICAL AND CHEMICAL PROPERTIES OF EXPERIMENTAL SOIL

Characteristics	Value	Characteristics	Value
pH	7.13	NH_4-N (mg kg^{-1})	11.20
Souble salt (%)	0.03	Available P (mg kg^{-1})	13.00
$CaCO_3$ (%)	0.33	Available K (mg kg^{-1})	90.00
Sand (%)	79.44	Available Ca (mg kg^{-1})	3246
Clay (%)	4.56	Available Mg (mg kg^{-1})	120.00
Loam (%)	16.00	Available Na (mg kg^{-1})	10.00
Texture	Loamy-sand	Available Fe (mg kg^{-1})	15.71
Organic matter (%)	1.23	Available Cu (mg kg^{-1})	1.80
Total N (%)	0.07	Available Zn (mg kg^{-1})	1.26
NO_3-N (mg kg^{-1})	9.50	Available Mn (mg kg^{-1})	10.20

Nitrogen fertilizer was applied in the form of ammonium nitrate, 1/3 at sowing and others at 20 d interval as a three division. Additionally, to all plots, 100 kg P_2O_5 ha^{-1} and 200 kg K_2O ha^{-1} were also applied in the form of triple superphosphate and potassium sulphate, respectively. The parsley plants were harvested seven times at each of two sowing dates. Harvest dates were in the first sowing on 20 May, 10 June, 7 and 21 July, 11 August, 10 September, 9 October 2004; and in the second sowing on 10 June, 7 and 21 July, 11 August, 10 September, 9 October, 19 November 2004. Common cultural practices were used during the growing season.

Parsley leaf and stalk were sampled from each harvest during the 7 harvest time and analyzed for their total N[11], NO_3—N[12], NO_2—N[13, 14], ascorbic acid[15] and essential oil[16]. Results were evaluated statistically by tarist programme[17].

RESULTS AND DISCUSION

Nitrogen accumulation (total-N, NO_3-N, NO_2-N) in leaves and stalks of parsley responted significantly to N treatment rates ($p < 0.01$). The highest leaf and stalk total-N, NO_3-N, NO_2-N accumulations were measured for 300 kg N ha^{-1} treatment at the two sowing times (Figs. 1–5). By this application, 90% increases of NO_3-N content, which is important for human health were observed in stalk compared to controls. The highest NO_3-N content in leaf average 469 mg kg^{-1} was found at

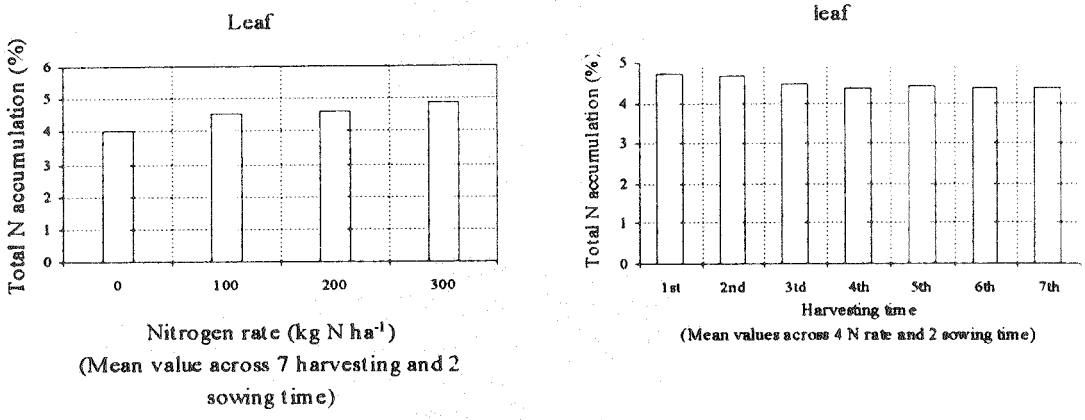

Fig. 1. Effects of nitrogen rates and harvesting times on total-N accumulation of parsley leaf

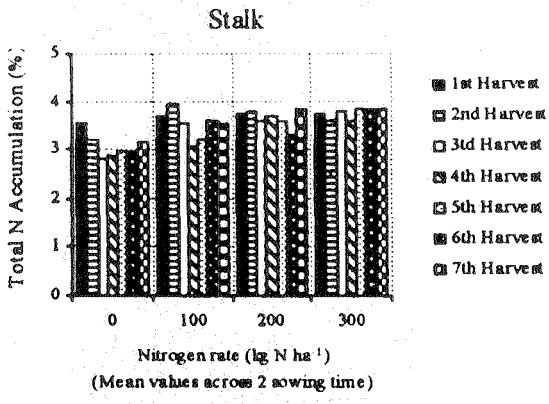

Fig. 2. Effects of nitrogen rates on total-N accumulation of parsley stalk during 7 harvesting time

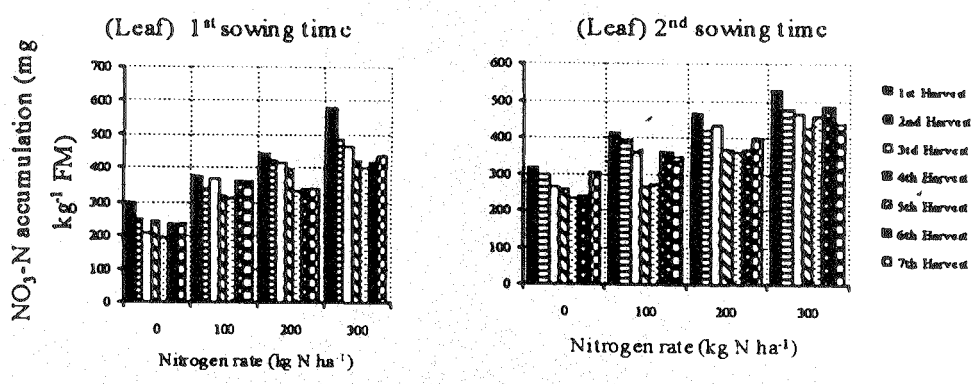

Fig. 3. Effects of nitrogen rates on NO_3-N accumulation of parsley leaf during 7 harvesting at 2 different sowing time

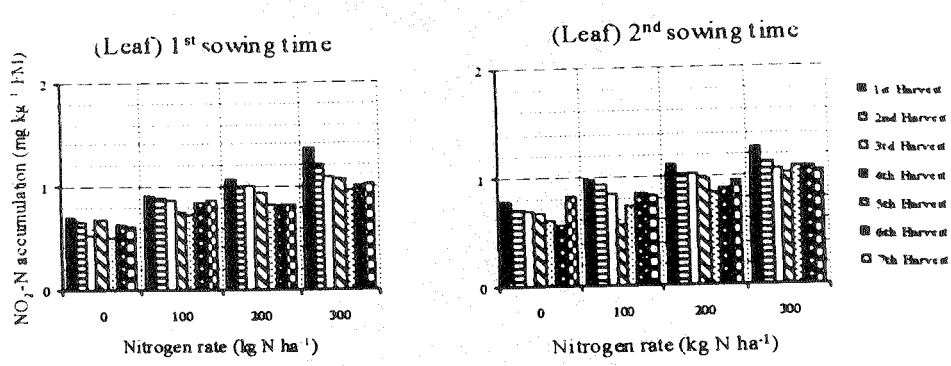

Fig. 4. Effects of nitrogen rates on NO_2-N accumulation of parsley leaf during 7 harvestings at

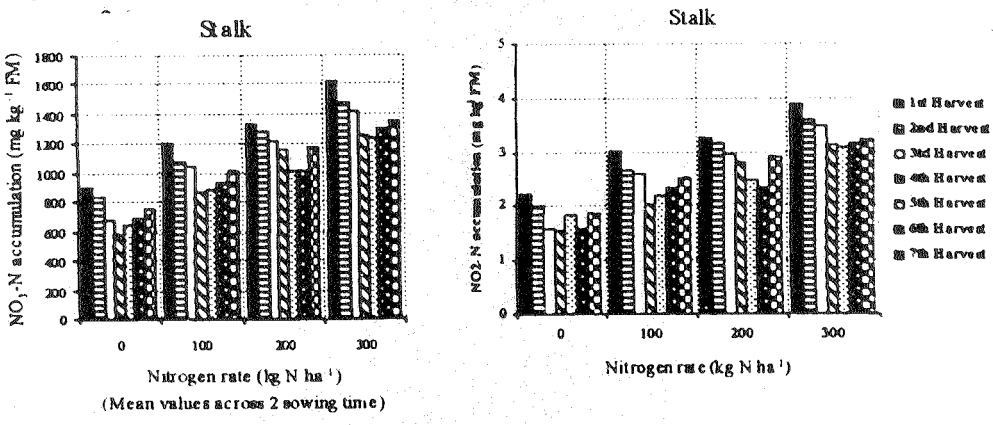

Fig. 5. Effects of nitrogen rates on NO_3-N and NO_2-N accumulation of parsley stalk during 7 harvesting times

second sowing time and average 1380 mg kg^{-1} in stalk was found at first sowing time with the highest N rate (Figs. 3, 5). Nitrate contents in leaf corresponded to the cited data: 866.03 ppm[18], 22.98–1952 mg kg^{-1}, 983 mg kg^{-1}, 195–580 mg kg^{-1} FM in leaves[4], 366–1851 mg kg^{-1} FM in vegetative parts[21] for parsley. However NO_3-N, NO_2-N accumulation in parsley stalk was higher than the measurements of some researchers[4, 18, 20]. Therefore, parsley stalks can be eliminated by consumers to reduce NO_3 intake.

FAO and WHO Food Commission (IEFCA) report the average daily NO_3 and NO_2 intake of a 60 kg person as 220–440 mg and 16–32 mg, respectively[2].

Ascorbic acid content in leaves and stalk which is the important quality criterion and essential oil amounts (leaf + stalk) were significantly increased by nitrogen rates ($p < 0.01$). The highest ascorbic acid values (93.6 mg 100 g^{-1} in leaf and 69.7 mg 100 g^{-1} in stalk as an average of 7 harvests) were determined for 300 kg N ha^{-1} treatment (Figs. 6, 7). Similar results have been reported by different researchers[9, 10] for parsley. Ascorbic acid content in leaves was found higher than stalks. Accumulation of ascorbic acid in response to increasing N rates may have dietary nutritional importance.

Maximum essential oil content of parsley was analyzed at 200 kg ha^{-1} N treatment (0.648% in the 1st sowing time and 0.623% in the 2nd sowing time as an average of 7 harvests) (Fig. 8). But it was not found between 100–200 kg N ha^{-1} treatments statistically. These values were higher than the measurements (0.17–

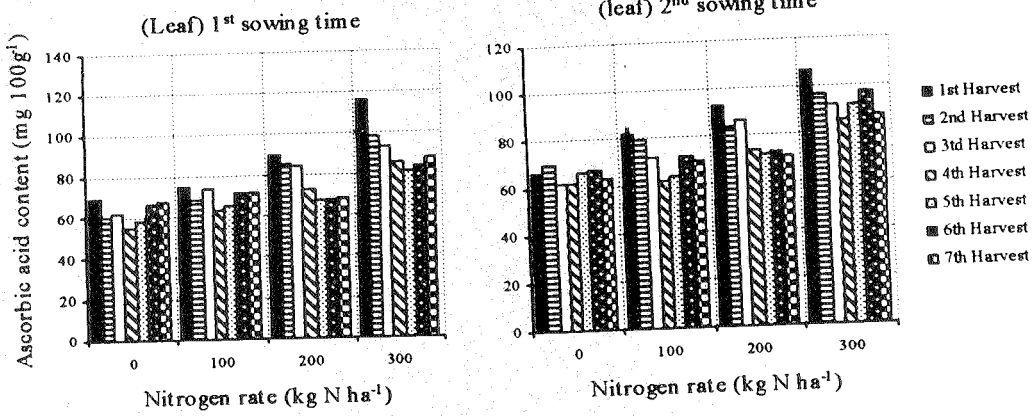

Fig. 6. Changes in ascorbic acid content of parsley leaf during 7 harvestings at 2 different sowing times

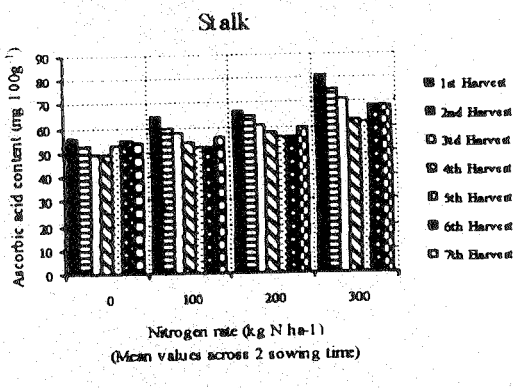

Fig. 7. Changes in ascorbic acid content of parsley stalk during 7 harvest.

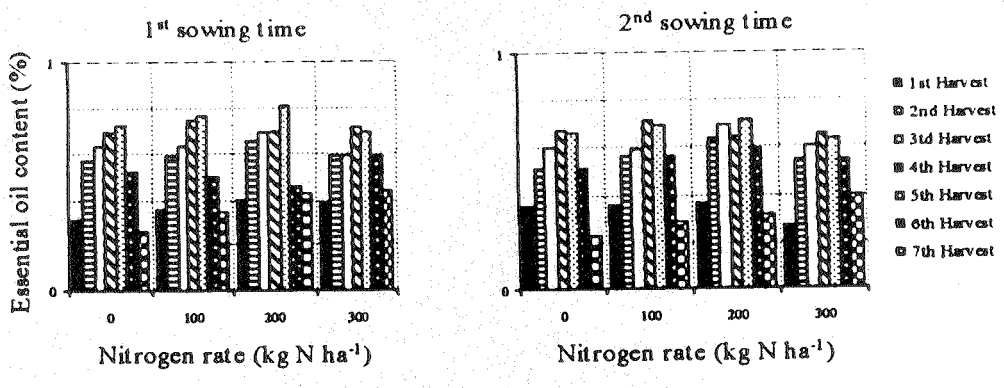

Fig. 8. Changes in essential oil content of parsley leaf + stalk during 7 harvestings at 2 different sowing times

0.58%) of Sancakoglu[22]. Essential oil content of parsley was changed according to sowing times, growth stage and ecological condions[23].

Nitrogen and ascorbic acid accumulation in parsley leaf, stalk and essential oil content were affected by harvesting times ($p < 0.01$). In both sowing times, the highest values have been obtained from first harvest. Similar results were reported by Gurgul *et al.*[9]

NO_3-N, NO_2-N, ascorbic acid accumulations in leaf and essential oil content were determined to be higher in the 2nd sowing time than in the first significantly ($p < 0.01$). But essential oil content was higher in 4th and 5th harvest times.

Consequently, in the study, no toxicity was determined NO_3-N content in leaf but on the other hand it was high in stalk at the maximum N rate (300 kg N ha^{-1}) only. Meanwhile, the highest essential oil content was obtained with 100 kg N ha^{-1} rate. Increasing the nitrogen, especially ascorbic acid concentration, in parsley would be expected to enhance the nutritional contribution of this culinary herbal crop.

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