MEASURING QUALITY IN VEGETABLES USING ELECTROCHEMICAL METHODS AND NUTRITIONAL VALUES.

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Abstract

The main aim of the following work was to assess the quality of the broccoli variety 'Belstar F1' and the radish variety 'Jarola F1' when grown by both organic and conventional methods. The chosen vegetables were planted at two different spacings, with three repetitions. The experiment was conducted in summer 2007. Quality was measured using electrochemical values (pH, redox potential and electrical conductivity) and the derived P-values, levels of vitamin C, mineral content, dry matter and roughage. Since it was organically grown, the P-value was low in broccoli, regardless of the planting space. In radish, there were significantly lower levels of vitamin C with a planting space of 0.3m x 0.35m. The levels of vitamin C were lower with the organic method but, on the other hand, the levels of Na in broccoli with a spacing of 0.6m x 0.5m were higher.

Keywords: organic, conventional, P-value, broccoli, radish, nutritional values

Zusammenfassung

Das Ziel dieser Arbeit war, die Qualität von dem Brokkoli 'Belstar F1' und dem Rettich 'Jarola F1' in ökologischer und konventioneller Anbau zu charakterisieren. Die gewählten Gemüsearten wurden in zwei verschiedenen Verbande und drei Wiederholungen gebaut. Der Versuch war im Sommer 2007 angelegt. Für die Charakteristik von Qualität wurden elektrochemische Werte gemessen, von denen der P-Werte, das Vitamin C, die mineralische Stoffe, die Trockenmasse, und der Faserstoff aufgezählt wurde. Durch die ökologische Anbau wurde bei Brokkoli ein niedrigerer P-Wert festgestellt – in beiden Verbande. Statistisch bedeutender Unterschied in dem Inhalt von Vitamin C ist bei dem Rettich bei 0,3x0,35 m vorgekommen, wo bei der ökologischen Anbau ein niedrigerer Wert von Vitamin C festgestellt wurde, als bei der konventionellen Anbau. Statistisch bedeutender Unterschied war auch in dem Inhalt von

Na bei Brokkoli in Verbande 0,6x0,5 m. Ökologische Anbau hat höheren Wert als konventionelle Anbau aufgewiesen.

Schlüsselwort: Ökologische, Konventionelle, P-Werte, Brokkoli, Rettich, Nährwert

Introduction

The production, distribution and sale of organic vegetables is increasing, and since they are often sold at a premium, consumers need to be provided with information about the quality of these various "bio-products" in comparison to the conventional products. It is generally recognized that they do not contain pesticide residues, but information about nutritional values, for example, is scarce. The results reported here are not what might have been expected for organic and conventionally grown vegetables, and further work is necessary to provide confirmation.

Materials and methodology

The broccoli variety 'Belstar F1' and the radish variety 'Jarola F1' were chosen for these experiments and were grown at two different planting spaces, with three repetitions, by both organic and conventional methods. The broccoli was spaced at 0.6m x 0.5m and 0.5m x 0.5m, and the radish at 0.2m x 0.35m and 0.3m x 0.35m. The broccoli seed was sown on 10.7.2007 and the radish on 15.8.2007 in both the organic plots and the conventional plots at the trial grounds of the Czech University of Life Sciences in Prague. The organic plots were in the second year of a transition to organic cultivation (law Nr.242/2000 digest).

The broccoli in the organic plots was protected against pests by a textile covering. The compound Ferramol Schneckenkorn was used against snails. The weeds were controlled by hoeing twice, on 30.8 and 19.9. The plots with conventional cultivation techniques were treated before sowing with the herbicide Stomp 400SC (40ml.100m^2) and fertilized with P (3.5kg.100m^2 Superphosphate Africa 17%), K (1,3kg.100m^2 Potash salt 60% K_2O) and Mg (2,6kg.100m^2 Magnesium salt 15% MgO). After planting, the broccoli was treated against pests with Sumithion Super (2ml.100m^2) and Karate (2.5 WG 4g.100m^2). The compound Mesurol Schneckenkorn was used against snails. The weeds were controlled by hoeing once, on 19.9.

The radish in the organic plots was protected against pests by a textile covering. The weeds were controlled by hoeing twice, on 27.8 and 20.9. The experimental plots

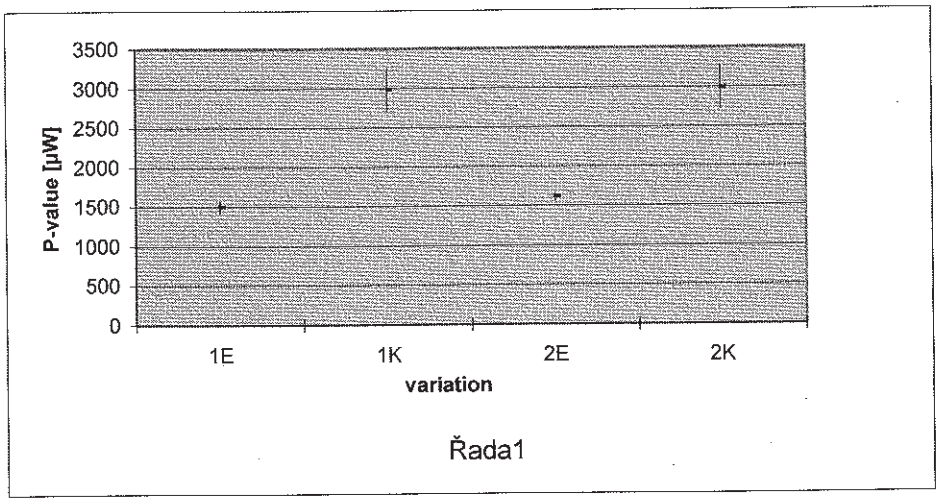
with conventional cultivation methods were treated before sowing with the herbicide Gramoxone (25ml.100m^2) and fertilized with P (3kg.100m^2 Superphosphate Africa 17%), K (1,3kg.100m^2 Potash salt 60% K_2O) and Mg (2,6kg.100m^2 Magnesium salt 15% MgO). Pirimor 50WG (5g.100m^2) was used against aphids on 29.8. The weeds were controlled by hoeing on 20.9.

The aim of the investigation was to compare the quality of broccoli and radish grown under organic and conventional systems using electrochemical methods and standard criteria for measuring nutritional value. The electrochemical values used for measuring quality were pH, redox potential and electrical conductivity, from which P – values were calculated (Hoffmann, 1997; El-Scherbiny, 1998). The nutritional value of the broccoli and radish was assessed by measuring the levels of vitamin C, dry matter, certain minerals (K, Na and Mg) and roughage. Vitamin C levels were determined using the RQ Flex method, and mineral levels were determined by mean capillary izotachforesis (Boček et al., 1986). Roughage was measured by means of oxidative hydrolysis, using the Hennenberg – Stohmann method (Lutonská, Pichl, 1983).

Results

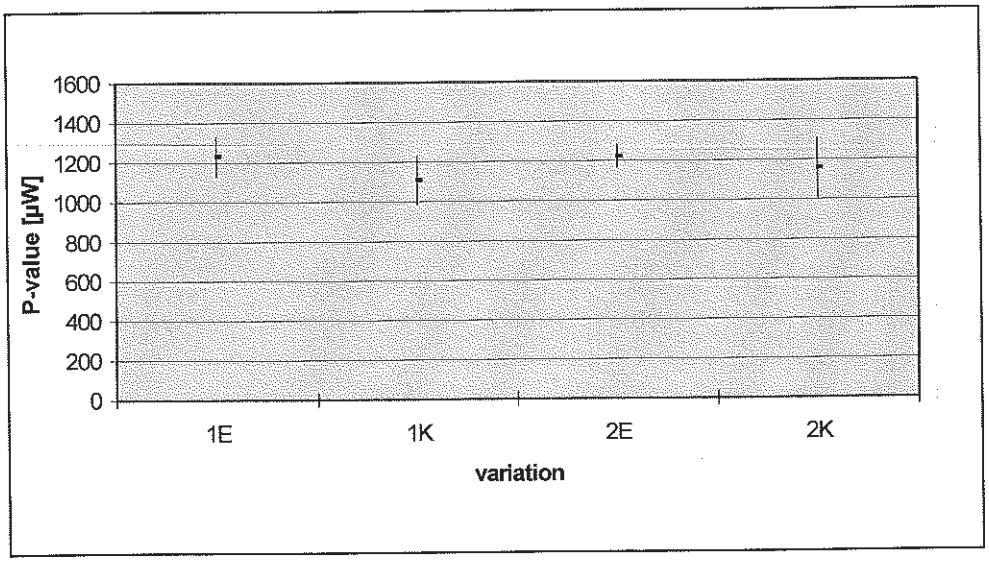
The electrochemical values measured in broccoli, after calculating the P- values (graph 1), were significantly lower in the organic plots compared to the conventional cultivation methods. P-values under organic cultivation were lower compared to the conventional method. There were no significant differences observed between the two spacings. The organic radish had higher P-values at both planting spaces, although the result was not statistically significant (graph 2).

Graph 1. P–value of broccoli in organic and conventional cultivation



E – organic production	1 – spacing 0.6x0,5m
K – conventional productional	2 – spacing 0,5x0,5m

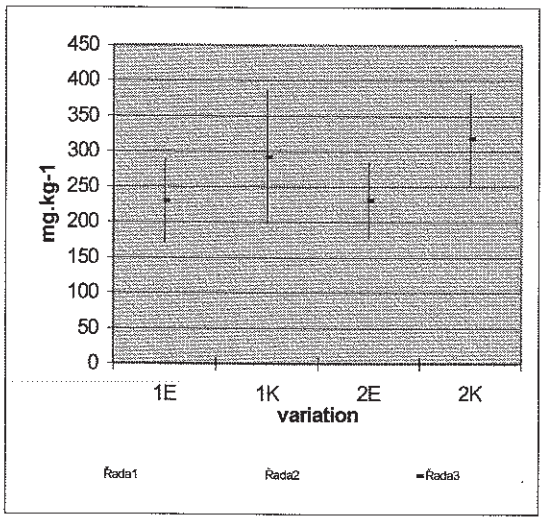
Graph 2. P–value of radish in organic and conventional cultivation



E – organic production	1 – spacing 0.20x0,35m
K – conventional productional	2 – spacing 0,30x0,35m

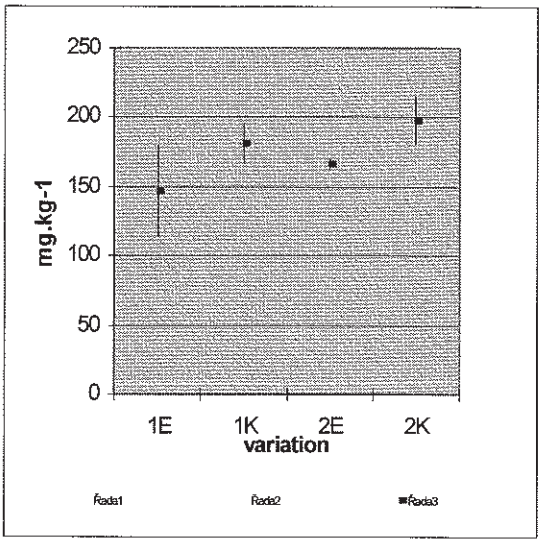
Vitamin C levels were higher in broccoli grown conventionally at both planting spaces (graph 3). Vitamin C levels in radish cultivated in the conventional system, at a planting space of 0,2m x 0,35m were higher than in the organic system, but not statistically significant. Higher levels of vitamin C were recorded under conventional cultivation compared to the organic system, at a planting space of 0,3m x 0,35m, and were statistically significant using 95% confidence intervals (graph 4).

Graph 3. Vitamin C in broccoli under organic and conventional cultivation



E – organic production
K – conventional productional
1 – spacing 0.6x0,5m
2 – spacing 0,5x0,5m

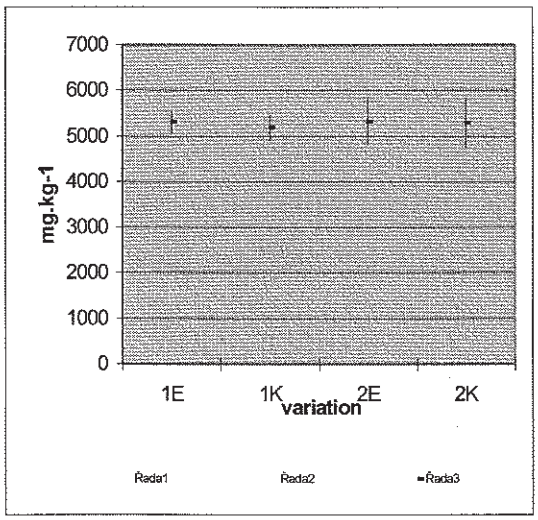
Graph 4. Vitamin C in radish under organic and conventional cultivation



E – organic production
K – conventional productional
1 – spacing .0,20x0,35m
2 – spacing 0,30x0,35m

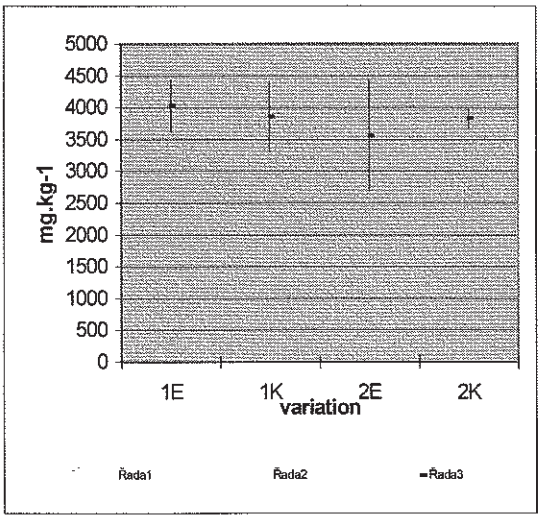
Mineral levels in broccoli were not significantly different regarding K and Mg (graphs 5 and 9). However, the levels of Na in the organic broccoli at a planting space of 0.6m x 0.5m were statistically significant (graph 7). In radish there were no significant differences observed in levels of K, Na and Mg (graphs 6, 8 and 10).

Graph 5. K in broccoli under organic and conventional cultivation



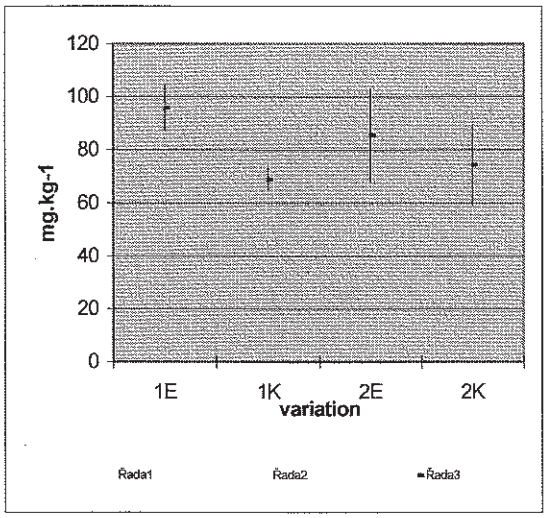
E – organic production 1 – spacing 0.6x0,5m
K – conventional productional 2 – spacing 0,5x0,5m

Graph 6. K in radish under organic and conventional cultivation



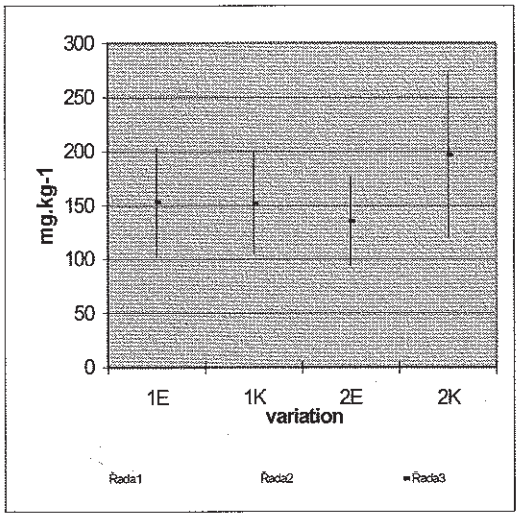
E – organic production 1 – spacing .0,20x0,35m
K – conventional productional 2 – spacing 0,30x0,35m

Graph 7. Na in broccoli under organic and conventional cultivation



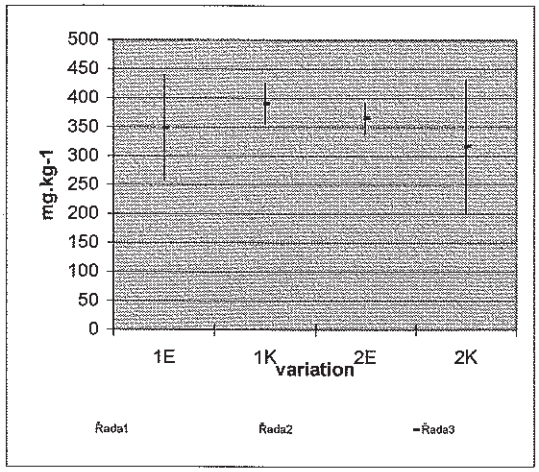
E – organic production 1 – spacing 0.6x0,5m
K – conventional productional 2 – spacing 0,5x0,5m

Graph 8. Na in radish under organic and conventional cultivation



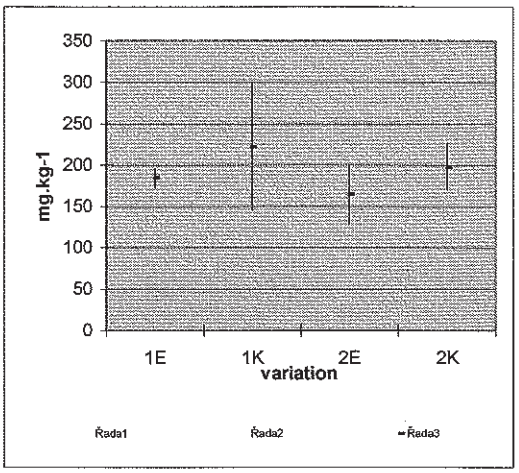
E – organic production 1 – spacing .0,20x0,35m
K – conventional productional 2 – spacing 0,30x0,35m

Graph 9. Mg in broccoli under organic and conventional cultivation



E – organic production 1 – spacing 0.6x0,5m
K – conventional productional 2 – spacing 0,5x0,5m

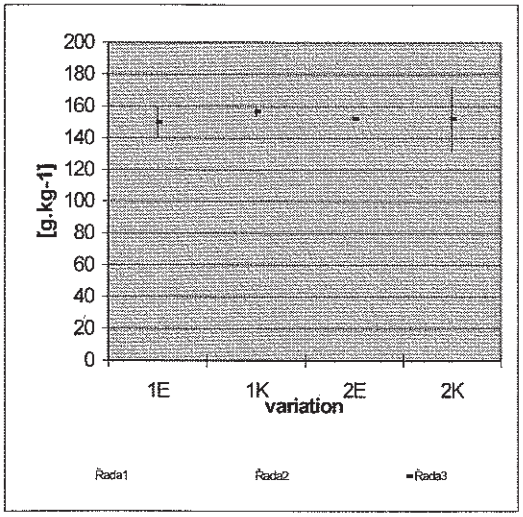
Graph 10. Mg in radish under organic and conventional cultivation



E – organic production 1 – spacing .0,20x0,35m
K – conventional productional 2 – spacing 0,30x0,35m

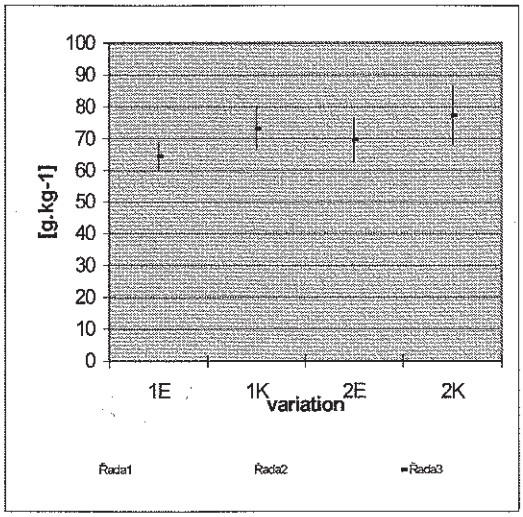
Measurements of dry matter showed higher amounts in both the vegetables grown by conventional methods, although they were not statistically significant (graphs 11 and 12).

Graph 11. Dry matter in broccoli under organic and conventional cultivation



E – organic production 1 – spacing 0.6x0,5m
K – conventional productional 2 – spacing 0,5x0,5m

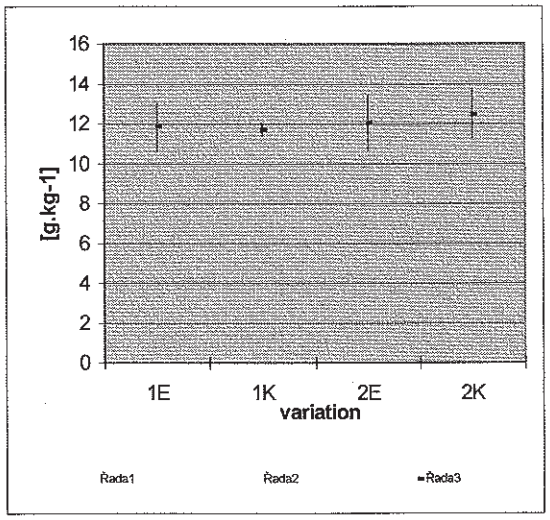
Graph 12. Dry matter in radish under organic and conventional cultivation



E – organic production 1 – spacing .0,20x0,35m
K – conventional productional 2 – spacing 0,30x0,35m

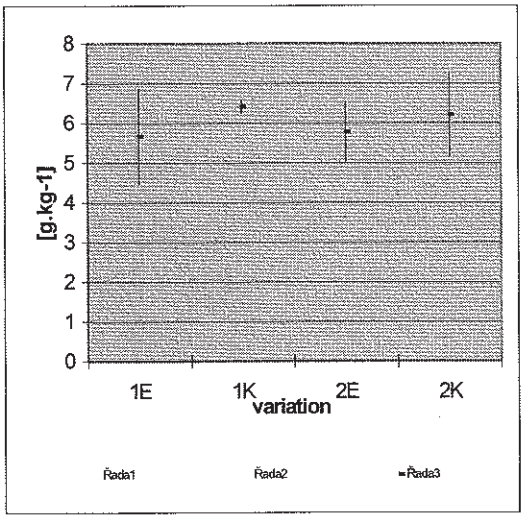
There were no significant differences in the amounts of roughage found in broccoli and radish grown organically and that grown by conventional methods (graphs 13 and 14).

Graph 13. Roughage in broccoli under organic and conventional cultivation



E – organic production 1 – spacing 0.6x0,5m
K – conventional productional 2 – spacing 0,5x0,5m

Graph 14. Roughage in radish under organic and conventional cultivation



E – organic production 1 – spacing .0,20x0,35m
K – conventional productional 2 – spacing 0,30x0,35m

Discussion

The results obtained from electrochemical measurements need to be treated with caution. Jezik (1999) and Hoffman (1997) have suggested that a low P- value in food is an indication of a high quality product. Organic food products usually have lower P-values than traditional products (Hoffman, 1997; Hailmann 2001). In our work this statement was confirmed only by the P- values observed in broccoli.

Some sources state that organic products have higher levels of nutrients and minerals. Worthington (1998), Heaton (2001), Afss (2003) and Tauscher et al. (2003) claim a slight increase in vitamin levels. Rembialkowska (2000) reported that the content of vitamin C in organic cabbage was 30% higher compared to conventionally grown cabbage. In tomatoes the content of vitamin C was higher by 27 % in an organic growing system, when compared to a conventional system (Worthington, 2001, in. Winter, Davis, 2006). In contrast, however, our results do not confirm this increase in vitamin C content in organically grown vegetables. Only the results for conventionally grown radishes show statistically significant, higher levels of vitamin C.

Regarding the content of mineral substances, there were, according to Woese et al. (1997) no differences. In contrast, Worthington (1998) and Heaton (2001) find a slight increase. Worthington (2001) (in. Winter, Davis, 2006) found a 29.3% increase in Mg in organic vegetables. Velimirov and Müller (2003), Afssa (2003) and Tauscher et al. (2003) observed that the content of mineral substances under organic production was higher. This was confirmed by measuring Na in conventionally cultivated broccoli at a planting space of 0,6 x 0,5m. The other aspects were not confirmed, and higher levels of minerals were not observed.

Kerpen (1988, in: Woese et al., 1995) states that organic carrots have higher dry matter, more than $2{,}7 g.100g^{-1}$ of the wet mass. Naredo (1993) determined higher levels of dry matter too, on average 4% in tomato, 16% in pepper and 65% in leek. In our investigation, no significant differences in dry matter were observed at all, and so the results speak rather in favour of conventional cultivation.

Other authors suggest that levels of roughage are slightly higher in organic tomatoes and carrots (Evers, 1989, Lagacé et al. 1989- cit. Woese et al. 1995 in: Prugar 2006). Our investigation suggests lower levels of roughage in organic vegetables.

Conclusion

A one year comparison of broccoli and radish grown organically and conventionally, in 2007, showed that P-values in organic broccoli and levels of vitamin C in radish (at a spacing of 0.3m x0.35m) were significantly lower than the same grown by conventional methods, pointing to the advantages of organic methods of production. Levels of Na were higher in organic broccoli, at a spacing of 0.6m x 0.5m. The other parameters showed no statistically significant differences. The investigation is still running and these parameters of quality will be monitored further to confirm these preliminary findings.

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