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THE POSSIBILITY OF USING DRIED ORGANIC AND ORGANOMINERAL FERTILIZERS AS AN ALTERNATIVE TO FARMYARD MANURE IN EARLY MATURING CAULIFLOWER

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Abstract

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Experiments were conducted in field plots to evaluate the effects of three alternative dried organic, or organomineral, fertilizers on yield and quality of the early maturing cauliflower variety, 'Gameta'. Plots were established in Žabčice (South Moravia, Czech Republic) in 2005–2007. We used the following fertilization treatments: Agormin T, Agro, Dvorecký agroferm, cattle farmyard manure and solo mineral fertilizers, compared to an unfertilized control. All plots, except the control, were fertilized to achieve the same level of nutrients, as determined by the soil analyses and the chosen target yield. We assessed the following traits at harvest: weight of above-ground mass, marketable yield, head weight and head diameter. Levels of ascorbic acid, nitrates, dry matter and mineral ions (potassium, sodium, calcium and magnesium) were measured in the heads. Agormin T significantly increased the weight of above-ground mass and total marketable yield. All organic fertilizers significantly increased head weight and head diameter in comparison to both the unfertilized control and mineral fertilizers. Ascorbic acid levels were not significantly affected by the fertilizers. The highest value of ascorbic acid was observed for farmyard manure, the lowest for Dvorecký agroferm. Dried fertilizers had no positive effect on ascorbic acid levels and total solids, as compared to farmyard manure. In contrast, Agormin T resulted in significantly lower levels of dry matter. Solo mineral fertilization resulted in the highest levels of nitrates in cauliflower heads. Fertilization with Agro and farmyard manure significantly increased the levels of nitrates in heads, as compared to the control, but all values were under the hygienic limit. The different fertilizer treatments did not have any significant effects on the levels of mineral cations. The dried granulated fertilizers Agormin T, Agro and Dvorecký agroferm were shown to be good alternatives to bulky farmyard manure for early ripening cauliflower. Only Agormin T decreased the dry matter content in heads.

organic fertilizers, cauliflower, yield, head weight, head diameter, ascorbic acid, dry matter, nitrates, mineral cations

Cauliflower is an important and frequently grown vegetable in the Czech Republic. Its cultivation requires intensive fertilizer applications, including the use of organic inputs (Rogolini et al., 2006). However the application of fertilizers involves the risk of nutrient losses to natural compartments of the environment. Misuse of N fertilizers, manures and crop residues is the main source of ground and surface water contamination by nitrogen (Beléc et al., 2003). One approach to reduce these losses is the development of nutrient efficient cultivars, which enable farmers to produce at lower soil fertility levels (Schenk, 2006). The second approach is to provide an appropriate management of fertilizer applications using slow release fertilizers or organic and organomineral fertilizers (Martinetti and Paganini, 2006). Manure management is of concern in areas with intensive animal production. Transportation

over long distances is not an option, because the water content of the raw manure often exceeds 90–95%. One of the effective solutions is transforming farmyard manure into dried granulated fertilizer (Zahradník and Petříková, 2006). In order to balance the nutrient content of the fertilizer, a certain amount of inorganic NPK may have to be added to the organic fertilizer. Work on broccoli (Beléc et al., 2003) has shown the positive effects of organic and organomineral fertilizers on biological activity in the soil and the yields of the subsequent wheat crop.

The objective of the presented paper was to study the effect of three alternative organic fertilizers on the yield and the nutritional value of cauliflower, and to assess the possibility of using these fertilizers as an alternative to farmyard manure.

MATERIAL AND METHODS

Experimental plots were established in training agriculture enterprise of Mendel University of Agriculture and Forestry Brno (MUAF) in Žabčice (average temperature 9 °C, average precipitation 490 mm, soil type Arenic Cambisol) in 2005–2007. We used the following fertilization treatments: Agormin T (an organomineral granulated fertilizer made from peat, with added basic nutrients), Agro (an organic granulated fertilizer made from poultry bedding and molasses), Dvorecký agroferm (an organic granulated fertilizer made from fermented and dried cow-dung, granulated), cattle farmyard manure and solo mineral fertilizers, compared with an un-fertilized control. A chemical analysis of the fertilizers is shown in Tab. Ia.

Ia: *Chemical analysis (% in dry matter) and recommended doses (t.ha^{-1}) of used fertilizers*

Fertilizer (producer)	N (%)	P (%)	K (%)	Dose (t.ha^{-1})
Agormin T (AGRO CS Inc., CZ)	1.14	0.21	3.55	2.5
Agro (MeM B.V., NL)	3.87	0.97	5.72	1.0
Dvorecký agroferm (AGRO Dvorce Ltd., CZ)	1.70	0.47	2.99	1.0
Cattle farmyard manure (MUAF Brno, Žabčice, CZ)	2.00	0.46	2.13	50

All plots, except the control one, were fertilized to the same level of nutrients (N and K), according to the soil analyses (Tab. Ib) and target yield – 25 t.ha^{-1} (i.e. 100 kg.ha^{-1} for N and 99.6 kg.ha^{-1} for K). There was no need to apply any phosphorus due to very high levels already in the soil (Tab. Ib). Nitrogen fertilization was done with correction to N_{min} content in the soil. We used calcium ammonium nitrate (27% N) and potassium sulphate (50% K_2O). Soil analyses were made 10 days before planting. Available nutrients (P, K, Ca and Mg) were extracted by Mehlich III. P content was analysed by colorimetry, K, Ca and Mg levels were determined by atomic absorption spectrophotometry.

Ib: *Soil analyses before fertilizing (mg.kg^{-1})*

Year	pH/$CaCl_2$	N_{min} (mg.kg^{-1})	P (mg.kg^{-1})	K (mg.kg^{-1})	Ca (mg.kg^{-1})	Mg (mg.kg^{-1})
2005	6.94	19.75	345.1	332.8	2514.7	232.0
2006	7.03	22.77	376.5	469.5	2712.0	269.5

The cattle farmyard manure came from the university experimental farm in Žabčice. It was applied at a rate of 50 t.ha^{-1} in the middle of October in 2004, 2005 and 2006, respectively. Other fertilizers were applied shortly before planting (Tab. II).

We used the cauliflower variety 'Gameta' (Moravoseed Ltd., CZ). It is an early ripening variety recommended for spring and autumn cultivation. The curd is of medium size, high domed, partially enclosed, medium nodulated and mild-grained. It is tolerant to become violet or yellow. Its growing season is 68–74 days.

The experimental design was a randomized block with 3 replications and plots of 16 m^2. Plots were kept free of weeds by manual hoeing, and water was applied by overhead sprinklers. An abbreviated management schedule is shown in Tab. II.

During harvest we assessed the weight of the aboveground mass (kg.m^{-2}), total marketable crop (kg.m^{-2}), individual head weight (g) and head diameter (mm). The marketable produce was assigned to class I or class II according to the current marketing standards of the European Union – Commission Regulation (EC) No. 963/98.

II: *Crop management schedule*

Operation	Year		
	2005	2006	2007
Sowing in greenhouse	17. 2.	12. 2.	12. 2.
Pricking out in multiplots 0.6 × 0.4 m (170 cells per plot)	23. 2.	20. 2.	19. 2.
Fertilizer applications	4. 4.	16. 4.	28. 3.
Plant spacing 0.5 × 0.5 m Covered with white bonded web fabric (17 g.m^{-2})	12. 4.	20. 4.	2. 4.
Removal of web fabric	10. 5.	15. 5.	25. 4.
First harvest	22. 6.	27. 6.	13. 6.
Second harvest	27. 6.	3. 7.	18. 6.

Curds were sampled by plot replications (a mix of 5 randomly taken curds per replicate during the first harvest) and submitted to analysis for nutritional values. Ascorbic acid levels (mg. kg^{-1} of fresh mass) and nitrate levels (mg.kg^{-1} of fresh mass) were measured using Reflectoquant® test strips with RQflex 2 apparatus (Merck KGaA, Germany) based on reflectometry (remission photometry). Dry matter (%) was determined by weight analysis after drying to a constant weight at 105 °C. Mineral cations (K, Ca, Na and Mg) were measured with an isotachophoretic analysator Ionosep 900.1 (Recman, Czech Republic). The data were statistically processed by analysis of variance and multiple range Tuckey HSD test ($P \leq 0.05$), using software Unistat 5.1.

RESULTS AND DISCUSSION

Fertilizers had a significant effect on the weight of above-ground mass and marketable yield. Both parameters varied significantly between years (Tab. III). The weight of above-ground mass in 2005 (average value 4.77 kg.m^{-2}) was significantly higher compared to 2006 and 2007. The average weight of above-ground mass was 3.45 kg.m^{-2} in 2006 and it was significantly higher as compared to 2007, when the average value was only 2.27 kg.m^{-2}. Average values of total marketable yield were 2.46 kg.m^{-2} in 2005, 2.22 kg.m^{-2} in 2006 and 1.12 kg.m^{-2} in 2007. In 2005 the total marketable yield was significantly higher as compared to 2007. The low values for the weight of above-ground mass and marketable yield in 2006 and 2007, respectively, were caused by unfavourable meteorological conditions in the spring. In 2006, long lasting snow cover delayed planting and high temperatures in June resulted in a shorter growing season. These aspects negatively influenced not only total yield but the external quality of the product as well. 2007 was very hot and dry in May and June.

III: *Analysis of variance for weight of above-ground mass and marketable yield in 2005–2007*

Source of variability	d.f.	MS	
		Weight of above-ground mass (kg.m^{-2})	Marketable yield (kg.m^{-2})
Fertilizer	5	4.309***	2.002***
Year	2	28.134***	9.028***
Fertilizer x Year	10	1.061*	0.416*
Residual	36	0.420	0.175

* $P \leq 0.05$, *** $P \leq 0.001$

During the three years of this study, the fertilizer Agormin T had the highest positive effect on above-ground mass, with an average value of 4.33 kg.m^{-2}. It was significantly higher compared to the control (2.35 kg.m^{-2}). None of the other fertilizers significantly differed from the control. None of the tested alternative fertilizers differed significantly from farmyard manure. Average values are presented in Tab. IV.

IV: *Effect of fertilizers on the above-ground mass (kg.m^{-2}) in 2005–2007*

Fertilizer	2005	2006	2007	2005–2007
Agormin T	6.07 b	4.63 b	2.23 ab	4.33 b
Agro	5.30 b	3.84 ab	2.59 b	3.91 ab
Dvorecký agroferm	5.26 b	3.93 ab	2.14 ab	3.78 ab
Farmyard manure	4.63 ab	3.41 ab	2.45 ab	3.49 ab
Mineral fertilizers	4.67 ab	2.34 a	2.37 ab	3.13 ab
Control	2.69 a	2.58 a	1.78 a	2.35 a

Different letters between rows indicate significant differences at P ≤ 0.05 (Tuckey HSD test)

Total marketable yield was influenced similarly (Tab. V). Agormin T supported the highest marketable yield – 2.58 kg.m^{-2}. It was more than twice as high as the control (1.19 kg.m^{-2}). Agro and Dvorecký agroferm also increased marketable yield compared to the control, but the differences were not significant. Bélec et al. (2003) reported for broccoli that organomineral fertilizer in combination with inorganic fertilizer gave yields as good as those obtained with conventional inorganic N fertilizer. Our results show that using the manufacturer's recommended dose of organomineral fertilizer (Agormin T), in combination with inorganic fertilizers, significantly increased the yield of cauliflower.

V: *Effect of fertilizers on marketable yield (kg.m^{-2}) in 2005–2007*

Fertilizer	2005	2006	2007	2005–2007
Agormin T	3.34 b	3.20 b	1.21 b	2.58 b
Agro	2.64 b	2.38 ab	1.45 b	2.16 ab
Dvorecký agroferm	2.69 b	2.55 ab	1.06 ab	2.10 ab
Farmyard manure	2.44 ab	2.19 ab	1.13 b	1.92 ab
Mineral fertilizers	2.39 ab	1.42 a	1.25 b	1.69 ab
Control	1.27 a	1.60 a	0.70 a	1.19 a

Different letters between rows indicate significant differences at P ≤ 0.05 (Tuckey HSD test)

There were significant differences between fertilizers for head weight and head diameter (Tab. VI). In 2005 the head weight and head diameter were significantly higher as compared to 2006 and 2007. Both traits were significantly higher in 2006 compared to 2007. The average head weight was 843.9 g in 2005, 796.2 g in 2006 and 516.3 g in 2007. The average head diameter was 276.5 mm in 2005, 254.2 mm in 2006 and 210.6 mm in 2007.

VI: *Analysis of variance for head weight and head diameter in 2005–2007*

Source of variability	d.f.	MS	
		Head weight (g)	Head diameter (mm)
Fertilizer	5	5407299.6***	160190.2***
Year	2	20944518.5***	771841.5***
Fertilizer x Year	10	1276297.5***	41674.9***
Residual	2258	116090.1	2490.5

*** P ≤ 0.001

All organic fertilizers significantly increased average head weight as compared to the unfertilized control (Tab. VII). Agormin T showed the best results, with an average head weight of 905.0 g. Agro, Dvorecký agroferm and farmyard manure had similar values, which did not significantly differ among themselves. Solo mineral fertilizer applications significantly increased average head weight compared

to the control, but this was significantly lower compared to all the organic fertilizers. Low head weights in the control plots and for mineral fertilizer treatments demonstrated the high demand for organic fertilizer in cauliflower.

VII: *Effect of fertilizers on head weight (g) in 2005–2007*

Fertilizer	2005	2006	2007	2005–2007
Agormin T	1008.3 c	1074.5 d	531.9 bc	905.0 d
Dvorecký agroferm	955.8 c	833.3 c	506.7 b	791.1 c
Farmyard manure	887.4 bc	795.2 bc	519.6 b	750.4 c
Agro	812.6 b	788.3 bc	600.3 c	745.1 c
Mineral fertilizers	785.4 b	548.3 a	523.0 b	630.7 b
Control	544.3 a	678.9 ab	384.2 a	547.9 a

Different letters between rows indicate significant differences at $P \leq 0.05$ (Tuckey HSD test)

Average values of head diameter are presented in Tab. VIII. The fertilizer influence on this trait was similar to head weight. Agormin T had the biggest heads, with an average diameter of 279.0 mm, followed by Dvorecký agroferm (259 mm), Agro (254.6 mm) and farmyard manure (251.4 mm). The control and mineral fertilizer treatments had significantly smaller head diameters compared to organic fertilizers.

VIII: *Effect of fertilizers on head diameter (mm) in 2005–2007*

Fertilizer	2005	2006	2007	2005–2007
Agormin T	300.3 d	304.3 d	214.6 b	279.0 d
Dvorecký agroferm	289.8 cd	264.5 c	211.7 b	259.6 c
Agro	274.4 b	254.8 bc	227.7 c	254.6 c
Farmyard manure	279.8 bc	250.2 bc	216.8 bc	251.4 c
Mineral fertilizers	270.5 b	203.0 a	211.3 b	231.1 b
Control	233.9 a	237.3 b	173.8 a	218.2 a

Different letters between rows indicate significant differences at $P \leq 0.05$ (Tuckey HSD test)

These results show the significant positive effects of all organic fertilizers on head weight and head diameter, in comparison to both mineral fertilizers and the unfertilized control. Except for Agormin T, which significantly increased both traits compared to all other treatments, none of the tested alternative fertilizers significantly differed from farmyard manure. From this point of view, dried organic fertilizers seem to be a full-value alternative to farmyard manure.

The ascorbic acid content in cauliflower heads was not influenced by fertilizer treatments, but it did vary significantly between years (Tab. IX). In 2005 the average ascorbic acid content was 969.5 $mg.kg^{-1}$, significantly higher compared to 2006 (895.8 $mg.kg^{-1}$) and 2007 (697.9 $mg.kg^{-1}$). The average ascorbic acid content was significantly higher in 2006 compared to 2007.

The dry matter content was significantly influenced by fertilizer treatments and varied between years. It was significantly higher in 2007 compared to 2006. The average value was 11.1% in 2007 and 9.8% in 2006. The average values were not significantly different in 2006 and 2005 (10.4%).

Over the 3-year period of assessment, the highest value of ascorbic acid was recorded for farmyard manure (906.8 $mg.kg^{-1}$), the lowest for Dvorecký agroferm (803.2 $mg.kg^{-1}$). It should be noted that the rank of the different treatments differed considerably from year to year, e.g. mineral fertilizers showed the highest ascorbic acid content in 2006 and yet had the lowest content in 2007 (Tab. X).

IX: *Analysis of variance for ascorbic acid and dry matter in heads in 2005–2007*

Source of variability	d.f.	MS	
		Ascorbic acid (mg.kg^{-1})	Dry matter (%)
Fertilizer	5	10873.8	4.426***
Year	2	354923.2***	7.630***
Fertilizer x Year	10	17525.3***	2.557*
Residual	36	5391.1	0.992

*** P ≤ 0.001, * P ≤ 0.05

X: *Effect of fertilizers on ascorbic acid (mg.kg^{-1}) in heads in 2005–2007*

Fertilizer	2005	2006	2007	2005–2007
Farmyard manure	983.7 a	936.7 b	800.0 c	906.8 a
Agro	954.6 a	879.3 b	775.0 bc	869.6 a
Mineral fertilizers	1005.9 a	1012.5 c	570.8 a	863.1 a
Control	997.1 a	922.7 b	620.8 ab	846.9 a
Agormin T	958.3 a	810.0 a	741.7 bc	836.7 a
Dvorecký agroferm	917.2 a	813.3 a	679.2 abc	803.2 a

Different letters between rows indicate significant differences at P ≤ 0.05 (Tuckey HSD test)

XI: *Effect of fertilizers on dry matter (%) in heads in 2005–2007*

Fertilizer	2005	2006	2007	2005–2007
Mineral fertilizers	11.2 a	12.1 d	10.6 a	11.3 b
Farmyard manure	11.0 a	11.2 cd	11.5 a	11.2 b
Agro	10.4 a	10.1 bc	11.5 a	10.7 ab
Dvorecký agroferm	9.9 a	8.9 ab	11.3 a	10.1 ab
Control	10.5 a	8.1 a	10.7 a	9.8 a
Agormin T	9.2 a	8.6 a	11.2 a	9.7 a

Different letters between rows indicate significant differences at P ≤ 0.05 (Tuckey HSD test)

The values are generally higher than those presented by Kopec (1998), who reported an average content of 383 mg.kg^{-1} of ascorbic acid in cauliflower. Our results are, up to a certain point, in accordance with those of Bímová and Pokluda (2006), who carried out an analogous experiment and found the highest ascorbic acid content in cabbage fertilized with farmyard manure to be 471.0 mg.kg^{-1}. Zahradník and Petříková (2006) assessed the effect of the same fertilizers on cucumber, and found the highest values of ascorbic acid followed the use of pure mineral fertilizers (113.0 mg.kg^{-1})

Dry matter content was significantly influenced by fertilizer in 2006 and over the 3-year period of assessment. The average values are shown in Tab. XI. The highest average values of total solids content were found following treatment with mineral fertilizer (11.3%) and farmyard manure (11.2%), which significantly differed from Agormin T with the lowest values (9.7%) and the control (9.8%). In comparison, Kopec (1998) observed a lower average value of total solids in cauliflower – 8.4%.

Fertilizers significantly influenced the levels of nitrates (Tab. XII). The nitrates levels varied significantly from year to year. In 2007 they were significantly higher compared to 2005 (28.0 mg.kg^{-1}) and 2006 (28.3 mg.kg^{-1}). The differences between the values in 2005 and 2006 were not significant (Tab. XII).

XII: *Analysis of variance for nitrates (mg.kg^{-1}) in cauliflower heads in 2005–2007*

Source of variability	d.f.	MS
Fertilizer	5	723.9***
Year	2	629.2*
Fertilizer x Year	10	440.2***
Residual	90	132.2

* P ≤ 0.05, *** P ≤ 0.001

The average values of nitrates levels in cauliflower heads are presented in Tab. XIII. The highest nitrate accumulations were found with the use of mineral fertilizers (36.1 mg.kg^{-1}), Agro (35.9 mg.kg^{-1}) and farmyard manure (31.6 mg.kg^{-1}), which significantly differed from the control (18.7 mg.kg^{-1}) which was lowest. Nevertheless, all values were well within the hygienic limit.

XIII: *Effect of fertilizers on nitrates levels (mg.kg^{-1}) in heads in 2005–2007*

Fertilizer	2005	2006	2007	2005–2007
Mineral fertilizers	36.2 d	39.7 c	32.5 ab	36.1 b
Agro	31.3 cd	33.5 b	42.8 ab	35.9 b
Farmyard manure	29.2 bc	28.7 b	37.0 ab	31.6 b
Agormin T	22.7 a	23.2 a	47.2 b	31.0 ab
Dvorecký agroferm	24.3 ab	22.0 a	43.3 ab	29.9 ab
Control	24.2 ab	22.7 a	9.3 a	18.7 a

We did not find any significant effects of fertilizers on potassium, sodium, calcium and magnesium levels in heads during the three years of this study, but there was significant variation between the years in the minerals levels (Tab. XIV). Sodium content was significantly higher in 2005 (3082.6 mg.kg^{-1}) as compared to 2006 (2994.4 mg.kg^{-1}) and 2007 (3034.2 mg.kg^{-1}). The highest calcium content was observed in 2007 (162.9 mg.kg^{-1}), significantly higher than in 2005 (130.6 mg) and 2006 (90.7 mg). In 2005 the calcium content was significantly higher than in 2006.

XIV: *Analysis of variance for minerals in cauliflower heads in 2005–2007*

Source of variability	d.f.	MS			
		K (mg.kg^{-1})	Na (mg.kg^{-1})	Ca (mg.kg^{-1})	Mg (mg.kg^{-1})
Fertilizer	5	129604.6	1797.6	2613.4	977.9
Year	2	35080.3	61015.1***	23519.0***	136874.5***
Fertilizer x Year	10	34108.8	1367.2	1472.7	894.6
Residual	36	72828.4	1090.8	1175.4	852.0

*** $P \leq 0.001$

Fertilizers did not significantly influence average values of potassium in heads in any year (Tab. XV). Zahradník and Petříková (2006) also found that different fertilizers had no significant effects on K content in cucumber. In our experiment the average values varied between 2917.7 mg.kg^{-1} (Agormin T) and 3242.4 mg.kg^{-1} (mineral fertilizers). These values are a little higher than those reported by Kopec (1998), who observed an average K content of 2450 mg.kg^{-1}.

XV: *Effect of fertilizers on K content (mg.kg^{-1})*

Fertilizer	2005	2006	2007	2005–2007
Mineral fertilizers	3300.7 a	3135.7 a	3290.8 a	3242.4 a
Control	3195.3 a	2934.0 a	3108.5 a	3079.3 a
Agro	2929.3 a	3043.8 a	3112.7 a	3042.9 a
Farmyard manure	2939.7 a	3008.8 a	3083.6 a	3018.9 a
Dvorecký agroferm	3101.7 a	2914.3 a	2814.9 a	2921.1 a
Agormin T	3028.7 a	2929.7 a	2794.9 a	2917.7 a

Different letters between rows indicate significant differences at $P \leq 0.05$ (Tuckey HSD test)

Sodium levels are presented in Tab. XVI. Regarding average values (2005–2007), the lowest Na levels were observed for the treatment with Agro (76.2 mg.kg^{-1}), the highest for farmyard manure (116.5 mg.kg^{-1}) but the differences were not significant. The fertilizer effect on Na levels was significant only in 2006, when Agormin T significantly increased Na content in comparison to Agro. Zahradník and Petříková (2006) also observed the highest Na levels in cucumbers fertilized with Agormin T. Cauliflower fertilized with alternative dried organic or organomineral fertilizers had lower Na levels compared to cauliflower fertilized with farmyard manure, which resulted in the highest Na concentration – average value 116.5 mg.kg^{-1}.

XVI: *Effect of fertilizers on Na content (mg.kg^{-1})*

Fertilizer	2005	2006	2007	2005–2007
Farmyard manure	214.3 a	61.4 ab	73.8 a	116.5 a
Agormin T	165.7 a	89.7 b	61.2 a	105.5 a
Dvorecký agroferm	162.3 a	56.7 ab	60.9 a	103.5 a
Control	189.3 a	60.1 ab	67.0 a	95.3 a
Mineral fertilizers	140.3 a	50.9 ab	74.6 a	88.6 a
Agro	116.0 a	41.2 a	71.3 a	76.2 a

Different letters between rows indicate significant differences at P ≤ 0.05 (Tuckey HSD test)

The highest average calcium content (in 2005–2007) was seen with Agro – 148.3 mg.kg^{-1}, the lowest with mineral fertilizers – 105.4 mg.kg^{-1}. Zahradník and Petříková (2006) also found significantly higher Ca levels in cucumbers fertilized with Agro. But the results of our experiment did not show significant effect of fertilizers. Agormin T did significantly increase Ca content in comparison to all other fertilizers in 2006 (Tab. XVII).

XVII: *Effect of fertilizers on Ca content (mg.kg^{-1})*

Fertilizer	2005	2006	2007	2005–2007
Agro	185.3 a	85.2 a	174.2 a	148.3 a
Agormin T	137.7 a	105.1 b	177.2 a	140.0 a
Dvorecký agroferm	118.3 a	92.4 ab	157.4 a	136.7 a
Control	163.3 a	89.3 ab	172.5 a	127.7 a
Farmyard manure	80.7 a	94.1 ab	156.4 a	110.4 a
Mineral fertilizers	98.0 a	78.3 a	139.7 a	105.4 a

Different letters between rows indicate significant differences at P ≤ 0.05 (Tuckey HSD test)

XVIII: *Effect of fertilizers on Mg content (mg.kg^{-1})*

Fertilizer	2005	2006	2007	2005–2007
Agro	154.0 a	55.3 a	278.3 a	162.5 a
Mineral fertilizers	173.7 a	63.3 ab	243.4 a	160.1 a
Control	131.0 a	62.5 ab	231.8 a	145.5 a
Dvorecký agroferm	142.7 a	61.9 ab	231.9 a	141.8 a
Agormin T	157.7 a	56.7 ab	207.3 a	140.5 a
Farmyard manure	126.0 a	68.6 b	221.8 a	138.8 a

Different letters between rows indicate significant differences at P ≤ 0.05 (Tuckey HSD test)

Similarly, with magnesium the fertilizer effect was significant only in 2006 (Tab. XVIII), when cauliflowers fertilized with farmyard manure had significantly higher Mg levels (68.6 mg.kg^{-1}) in curds than those fertilized with Agro (55.3 mg.kg^{-1}). Zahradník and Petříková (2006) also observed the highest Mg levels

in cucumbers fertilized with farmyard manure. Nevertheless, in our study the highest average values (in 2005–2007) were found with Agro (162.5 mg.kg^{-1}) and mineral fertilizers (160.1 mg.kg^{-1}), the lowest with farmyard manure (138.8 mg.kg^{-1}).

Minerals analyses during the period of this study, 2005–2007, revealed highly significant differences between years for sodium, calcium and magnesium content, while potassium content was more stable.

SOUHRN

Možnost použití sušených organických a organominerálních hnojiv jako náhrady za chlévský hnůj u raného květáku

V letech 2005–2007 byl sledován vliv alternativních sušených organických, respektive organominerálních hnojiv na výnos, kvalitu a nutriční hodnotu raného květáku odrůdy 'Gameta'. Polní pokusy byly prováděny v Žabčicích na jižní Moravě. Byly použity následující varianty hnojení: Agormin T, Agro, Dvorecký agroferm, hovězí chlévský hnůj, pouze minerální hnojiva a nehnojená kontrola. Pokus byl založen metodou znáhodněných bloků se třemi opakováními o výměře 16 m^2. Všechna organická hnojiva byla aplikována v doporučených dávkách výrobce a jednotlivé varianty byly dohnojeny minerálními hnojivy na stejnou úroveň hlavních živin dle půdního rozboru a očekávaného výnosu (25 t.ha^{-1}). Při sklizni byly hodnoceny hmotnost nadzemní biomasy, tržní výnos (I. a II. jakost), hmotnost růžice a příčný průměr růžice. V konzumní části – růžici byla stanovena celková sušina a dále obsah kyseliny askorbové, nitrátů a minerálních prvků – draslíku, sodíku, vápníku a hořčíku v čerstvé hmotě.

Výsledky prokázaly, že varianta s hnojivem Agormin T statisticky významně podpořila nárůst nadzemní biomasy a zvýšila trží výnos ve srovnání s nehnojenou kontrolou. Všechna organická hnojiva statisticky významně zvýšila průměrnou hmotnost růžice a příčný průměr růžice v porovnání s kontrolou a minerálním hnojením. Hnojení Agorminem T navíc statisticky průkazně zvýšilo hodnotu obou znaků oproti ostatním organickým hnojivům. Obsah kyseliny askorbové nebyl v tříletém hodnocení statisticky významně ovlivněn hnojením, nejvyšší obsah byl zjištěn při hnojení chlévským hnojem, nejnižší po aplikaci Dvoreckého agrofermu. Hnojení Agorminem T se projevilo statisticky průkazně nižším obsahem sušiny v růžicích oproti variantám hnojeným chlévským hnojem a pouze minerálními hnojivy. Nejvyšší obsah nitrátů byl zjištěn po hnojení pouze minerálními hnojivy, rovněž i hnojení Agrem a chlévským hnojem statisticky průkazně zvýšilo obsah nitrátů v růžicích. Obsah nitrátů byl ovšem celkově podlimitní. Hnojení nemělo vliv na obsah minerálních kationtů v růžicích květáku.

Lze shrnout, že kromě snížení obsahu celkové sušiny v růžicích po aplikaci Agorminu T působila sušená alternativní hnojiva přinejmenším stejně pozitivně na výnos a kvalitu raného květáku jako hovězí chlévský hnůj a mohou se stát jeho vhodnou náhradou.

organická hnojiva, květák, výnos, hmotnost růžice, příčný průměr růžice, kyselina askorbová, sušina, dusičnany, minerální kationty

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