

THE EFFECT OF QUICKLY FERMENTED PIG MANURE ON THE BROCCOLI YIELD PARAMETERS AND SELECTED SOIL PARAMETERS

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Abstract

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The effect of Difert (a pig manure fermented by caddices of domestic flies produced on sawdust litter) on broccoli yield parameters and selected soil parameters were investigated on gleic fluvisol in a small-plot field trial localized at area of Slovak University of Agriculture in Nitra (48°18' N, 18°05' E).

The results showed that Difert applied in doses of 250 kg N.ha⁻¹ and 350 kg N.ha⁻¹ acted positively on the yields of fresh primary broccoli roses. However, the results are not statistically significant. Also a positive effect on N, P, K, Ca, Mg contents in broccoli roses was recorded. Difert has a moderate alkalizing effect on soil and increases the content of C_{ox} in the soil. Moreover Difert insignificantly decreased the content of vitamin C and significantly increased the content of nitrates in broccoli roses, but the worst qualitative effect on broccoli parameters was detected by applying mineral N fertilizers, which significantly increased the content of nitrates in broccoli roses and insignificantly decreased the vitamin C content. However, it resulted in the highest broccoli yields. The application of mineral N fertilizers had a negative effect on the total content of carbon in the soil as well.

The effect of Difert on broccoli yield and soil parameters refers to the feasibility of reducing the maturing period of the manure from 6 months to 1 week, in order to decrease the manure storage capacities.

broccoli, yield, vitamin C, manure, fermentation, caddices, domestic fly

Animal breeding technology and the processing of its excrements greatly determine the quality of farm fertilizers. Consequently, they influence the mobility of macroelements and microelements in the soil better and the plant sorption ability as well. That results in higher and better quality yields of either field or garden plants (Eghball et al., 2004; Zaller and Köpke, 2004; Kouřimská et al., 2008).

The attention to the impact of manure storage (fermentation) techniques on its quality and soil parameters in Slovakia has been lesser in comparison with the neighbouring countries, which causes current average losses of nutrients at the levels of 30–40 % with nitrogen 10 % with phosphorus and 20 % with potassium, in manure production → application cycle (Kováčik, 2005). In efforts to solve the problem of

cutting down the process of manure fermentation, which lasts at least 6 months (sawdust used as litter), maintaining its existing positive effects on the soil and plants, Difert (a pig manure fermented by caddices of domestic flies for 7 days) has been tested on broccoli yield parameters and selected soil agrochemical parameters.

MATERIALS AND METHODS

Small allotment field trial with tested plant broccoli (Fiesta variety) was conducted in area of the Slovak Agriculture University in Nitra (48°18' N, 18°05' E) on gleic fluvisol, with its agrochemical parameters shown in Tab. I.

I: The basic agrochemical parameters of gleic fluvisol

pH _{KCL}	N-NH ₄ ⁺	N-NO ₃ ⁻	N _{an}	P	K	Ca	Mg	S	C _{ox}
	mg.kg ⁻¹								%
6.74	7.1	4.0	11.1	65.0	325	7 900	525	33.0	1.55

pH_{KCL} – (1,0 M KCl), N-NH₄⁺ – (colorimetrically, Nessler agent); N-NO₃⁻ – (colorimetrically, phenol acid – 2,4 disulphonic); N_{an} – counted as a sum N-NH₄⁺ + N-NO₃⁻; P – colorimetrically, Mehlich II; K – flame photometry, Mehlich II; Mg – (atomic absorption spectrophotometry, Mehlich II), S – nephelometry, octan ammonium)

The experiment was introduced with 4 nutritional treatments in four repetitions. No fertilizers were applied with treatment one – control treatment 0 (Tab. II). Only nitrogen, in the form of ammonium nitrate with dolomite, was added to soil with treatment 2 (treatment N). Phosphoric and potassium fertilizers had not been added, since their levels were sufficient with respect to the existing amounts of given nutrients in soil in accordance with the broccoli requirements (Tab. I). The dose of nitrogen was calcu-

lated as the difference between the nitrogen yield need and the amount of nitrogen in soil (200 – 50 = 150 kg.ha⁻¹). The amounts of Difert were chosen to supply 250 kg.ha⁻¹, 350 kg.ha⁻¹ respectively, of total nitrogen (e.g. the amounts allowed by nitrogen directive regarding the growing of vegetables demanded for nutrients in areas with a high degree of nitrates groundwater contamination danger (250 kg.ha⁻¹ N, treatment Difert₁) and low degree of contamination danger (350 kg.ha⁻¹ N, treatment Difert₂).

II: Treatments of experiment

Treatment			Dose		N	
No.	marking	description	manure	AND*	total	available
			t.ha ⁻¹	kg.ha ⁻¹	kg.ha ⁻¹	
1	0	Without fertilizers – control variant	-	-	-	-
2	N	Industrial N fertilizer (AND*)	-	545.5	150	150
3	Difert ₁	A pig manure fermented by caddices of domestic flies for 8 days	11.6	-	250	15.7
4	Difert ₂	A pig manure fermented by caddices of domestic flies for 8 days	16.3	-	350	22.0

* ammonium nitrate with dolomite

Despite the relatively high doses of Difert, with its agrochemical parameters shown in table III, only 15.7 kg.ha⁻¹ of available nitrogen was added to treatment 3 and only 22.0 kg.ha⁻¹ to the treatment 4, which is in comparison with treatment 2 (150 kg.ha⁻¹ of available nitrogen) approximately its 1/10th, 1/7th respectively (Tab. II). Difert resembles black tea with its colouring and the size of its particles. Difert is of brownish colour.

The broccoli was seeded on the 31st of May 2007 and planted out on the 6th of July 2007. For one section (2m x 2m) 9 plants were planted out. The size of one section was given by the amount of manure we could dispose. The harvest was performed continually in several terms (24th and 28th of September, 1st, 5th, 10th, 26th of October). Only the yield of primary broccoli roses was evaluated and the qualitative characteristics were researched (the amount of vitamin C, the amount of nitrates and the amount of macronutrients). The amount of nitrogen was specified after mineralisation with H₂SO₄ (Kjeldahl), the amount of ash matter after mineralisation with HClO₄ + HNO₃ (Kopová et al., 1955). The amount of vitamin C was specified by titration

with 2,6-dichlorinephenolindphenol. Ion-selection electrode type 07-35 and referential electrode type RCE 101 (Monocrystals Turnov) and been employed to specify the nitrates.

RESULTS AND DISCUSSION

Employing the analysis of variance confirmed the expected influence of treatments on yield parameters of broccoli primary roses. The effect on the yield was statistically significant and the effect on the vitamin C and nitrates content was highly significant (Tab. IV).

The highest yield expressed in fresh phytomass was achieved with treatment 2, e.g. with treatment with the highest amount of added available nitrogen. The growth in yield related to non-fertilized treatments was highly significant and growth in yield related to the tested fermented pig manure was significant (Tab. V). In accordance with Kansal et al. (1981) the growing doses of nitrogen, either from mineral fertilisers or from farm manure, the yield increases, whereas this relation has its concrete limit point,

III: Basic agrochemical and hygienic-toxicological parameters of Difert

Parameters	Pig manure fermented by caddices of domestic flies
pH (10 % water suspension)	7.85
The amount of dried content	87.8 %
The amount of burnable dried content	77.0 %
The amount of total nitrogen as a N total in dried content	2.45 %
The amount of total phosphorus as P ₂ O ₅ in dried content	3.96 %
The amount of total potassium as K ₂ O in dried content	2.11 %
The amount of calcium as Ca in dried content	1.91 %
The amount of magnesium as Mg in dried content	0.88 %
Elements under 20,0 mm	100.0 %
The amount of heavy metals in 100 % dry matter	
Cd	0.59–0.725 mg.kg ⁻¹
As	0.57–1.13 mg.kg ⁻¹
Hg	0.036–0.09 mg.kg ⁻¹
Cr	33.6–54.09 mg.kg ⁻¹
Ni	7.88–12.66 mg.kg ⁻¹
Pb	5.20–10.54 mg.kg ⁻¹

IV: The effect of variability on broccoli yield parameters

The source of variability	d.f.	F – values calculated			
		primary roses yield		vitamin C	NO ₃ ⁻
		fresh phytomass	dry matter	fresh phytomass	
Treatment	3	4.876 ⁺	4.374 ⁺	11.119 ⁺⁺	22.982 ⁺⁺
Repetition	3	0.323	2.138	0.669	0.636
Residual	9				
Total	15				

V: The effect of fermented manure (Difert) on yield parameters of broccoli

Treatment		Primary roses yield		The weight of one rose	The content of dry matter in a rose	Vitamin C	NO ₃ ⁻
No.	marking	fresh phytomass	dry matter	fresh phytomass	%	fresh phytomass	
		g per pot		g		(mg.kg ⁻¹)	
1	0	3,687.5 a	511.3 b	409.72	13.89	552.9 b	24.50 a
2	N	4,216.6 b	508.4 b	468.51	12.09	436.8 a	76.77 c
3	Difert ₁	3,738.3 a	458.6 a	415.37	12.28	530.2 b	52.83 b
4	Difert ₂	3,762.5 a	499.5 b	418.05	13.27	549.9 b	44.13 b
LSD* _{0.05}		355.920	37.385			52.810	14.463
LSD _{0.01}		511.294	53.705			75.864	20.777

* limit of significant difference at the level $\alpha = 0.05$

with the value dependent on the amount of nitrogen in the soil (Kováčik, 2002).

Difert had a minimum effect on fresh phytomass production employing both application doses.

The production of fresh phytomass was only slightly higher than in the not fertilized variant (Tab. V). Despite the obtained results we consider fermented manure to be positive, since it offers a solution for prob-

lematic of fast and ecological manure liquidation. The manure represents high volume, malodorous waste for animal breeders. The fact, that fermented manure had almost no effect on broccoli yields (despite its positive effect on sunflower and corn – Kováčik, 2007) it is considered positive, also because it is being retrieved from pig breeding process held on sawdust litter, whereas if such a manure ferments on standard basis shorter than half a year or a year, it results in lower yields (Kováčik, 2005). A noteworthy finding, that application of all fertilizers either mineral or organic, determined the broccoli yields by increasing the water levels in broccoli roses, has been observed. The production of dry matter remained the same (Tab. V).

The highest yield of dry matter had been obtained with treatment 1. Differences in dry matter yields among non-fertilized and fertilized treatments, where mineral nitrogen or Difert (16.3 t ha^{-1}) was applied, were statistically insignificant (Tab. V). This finding supports, that pig manure fermentation using caddices of domestic flies is feasible and express technique to solve the manure – waste processing.

The highest levels of vitamin C and the lowest levels of nitrates had been found in non-fertilized variant. This corresponds with world-wide knowledge regarding the negative effect of fertilizers containing nitrogen on vitamin C content (Pokluda, 2004; Mengel and Kirkby, 2001). It negatively correlates with the nitrates content (Marschner, 2005). The rate of

negative effects of different inorganic and organic forms of nitrogen, on radish in various vegetation periods seeded on vitamin C levels, is defined by Kováčik (2002). Achieved results are in line with his observations (Tab. V).

The differences in vitamin C content among fermented manure fertilized and non-fertilized treatments were statistically insignificant. Fermented manure acted more positively on the vitamin C content than the application of mineral nitrogen, e.g. it decreased the vitamin C and increased nitrates content in broccoli roses less markedly than mineral nitrogen (Tab. V). The worst quality parameters were achieved with treatment N (treatment 4).

The usage of fermented manure in both application doses increased the content of selected nutrients (N, P, K, Ca, Mg, S) in broccoli, which highlights the positive effect of Difert on qualitative parameters of grown plants (Tab. VI).

None of the treatments of the experiment determined the content of the soil in a significant manner. The well known aciditive effect of some mineral fertilizers had been confirmed (treatment 2). On the contrary, the application of both doses of Difert resulted in modest increase in pH values (Fig. 1). Fermented manure also positively influenced the content of carbon in soil. The content of C_{ox} rose along with the Difert doses increase. The reverse effect had been observed with mineral nitrogen, which corresponds with studies of Epstein and Bloom (2005).

VI: The effect of Difert on the nutritional content in broccoli roses

Treatment	N	Ranking	P	Ranking	K	Ranking	Ca	Ranking	Mg	Ranking	S	Ranking
No. marking	mg.kg ⁻¹ (100 % dry matter)											
1 0	33,518 a	4	6,528 ab	3	28,642 ab	3	7,407 a	4	1,729 a	4	7,469 a	4
2 N	37,826 ab	3	5,663 a	4	25,976 a	4	7,429 a	3	1,761 a	3	7,908 ab	3
3 Difert ₁	41,676 b	2	7,020 ab	2	30,091 b	1	8,703 b	1	1,872 a	1	8,763 bc	2
4 Difert ₂	42,504 b	1	7,220 b	1	29,715 b	2	8,148 ab	2	1,821 a	2	9,465 c	1
LSD* _{0.05}	6,393.50		1,809.36		2,907.69		1,058.13		147.545		1,225.79	
LSD _{0.01}	9,686.75		2,741.35		4,405.43		1,603.17		223.544		1,857.19	

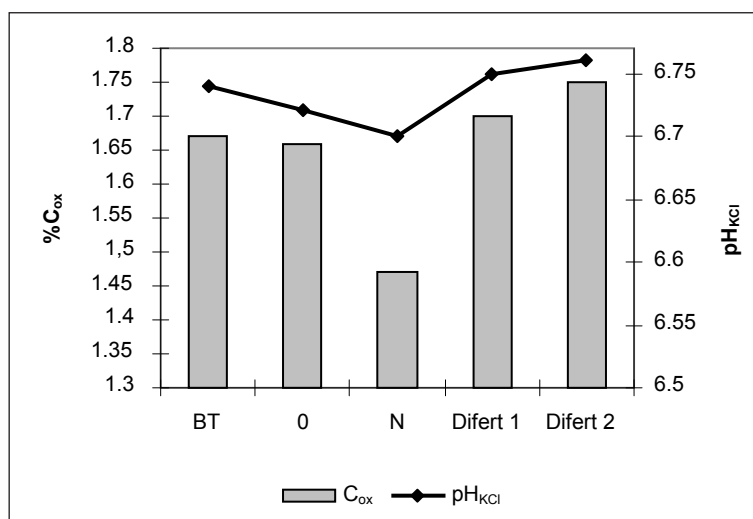
* limit of significant difference at the level $\alpha = 0.05$

CONCLUSION

The effect of fermented manure - Difert, applied in doses of 250 kg ha^{-1} and 350 kg ha^{-1} of nitrogen on the primary broccoli roses in fresh stage yield was positive, however statistically insignificant. Difert positively influenced the nutrients contents (N, P, K, Ca, Mg, S) in broccoli roses. Difert insignificantly decreased the vitamin C content and significantly increased nitrates content. Difert positively influenced soil pH and the C_{ox} content. In addition Difert had a moderate alkalizing effect and increased the content of oxidable carbon.

The worst effect on broccoli qualitative parameters and C_{ox} in soil had the application of the industrial nitrogenous fertilizer, which significantly increased the content of nitrates and decreased the content of vitamin C. However, it resulted in highest yields.

The effect of Difert (product of fast fermentation of pig manure made on sawdust litter) on broccoli yield parameters and soil shows the feasibility of the solution to shorten the process of manure maturing from 6 months to 1 week. This markedly solves the manure storage capacity issues and also helps to save resources.



1: Influence of fertilizers Difert on total carbon content (C_{ox}) and pH_{KCl} in soil BT – Before the trial

SOUHRN

Vliv rychle fermentovaného prasečího hnoje na výnosové parametry brokolice a vybrané půdní parametry

V polním maloparcelkovém experimentu, realizovaném v areálu Slovenské zemědělské univerzity v Nitře (48°18' N, 18°05' E) na glejové fluvizemi, byl posuzován efekt hnojiva Difert (prasečí hnůj vyrobený na pilinové podestýlce a týden fermentovaný larvami mouchy domácí) na výnosové parametry brokolice a vybrané půdní parametry.

Dosažené výsledky ukazují, že Difert aplikovaný v dávkách odpovídajících 250 a 350 kg N·ha⁻¹ působil pozitivně, i když statisticky neprůkazně, na výnos čerstvých primárních růžic brokolice. Taktéž byl zjištěn pozitivní efekt na obsah N, P, K, Ca, Mg v růžicích. Difert vykázal rovněž mírný alkalizující efekt na pH půdy a zvýšil obsah C_{ox} v půdě. Po jeho aplikaci byl neprůkazně snížen obsah vitamínu C a signifikantně narostl obsah dusičnanů v růžicích. Nejhorší kvalitativní parametry brokolice byly zjištěny při aplikaci minerálních dusíkatých hnojiv, které průkazně zvýšily obsah dusičnanů a neprůkazně redukovaly obsah vitamínu C. U variant s aplikací dusíkatých minerálních hnojiv bylo dosaženo nejvyššího výnosu brokolice a snížení celkového obsahu uhlíku v půdě.

Efekt hnojiva Difert na výnos brokolice a půdní parametry poukazuje na vhodnost řešení problematiky zkrácení doby fermentace hnoje ze 6 měsíců na 1 týden, čímž se významně řeší problematika skladovacích kapacit hnoje.

brokolice, výnos, vitamin C, hnůj, fermentace, larvy, moucha domácí

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