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EFFECT OF WET POULTRY MANURE ON WHEAT YIELD AND BIOLOGICAL STATUS OF SOIL

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ABSTRACT

Fowl manure application, as organic fertilizer, is the best way of poultry wastes utilization. Wet poultry manure is a concentrated and quick acting fertilizer. Application of WPM at optimal doses together with NK-fertilizing may provide balanced plant nutrition, significant increase of crop productivity and the improvement of production quality. Optimal applied dose of WPM was found to be 50 t ha^{-1} for podzoluvisols. WPM improves the soil properties and stimulates biological activity of arable horizon. Actual soil fertility status is noticeably affected by application of optimal doses of WPM.

INTRODUCTION

There are many specialized poultry farms in Belarus. Annual manure output is about 1.8 million tons. The share of fowl manure is about 90% from total volume. Utilization of fowl manure is actual problem for the farmers. Manure application, as organic fertilizer, is the best way of poultry wastes utilization. The main purpose of our investigation was to study the effect of wet poultry manure on spring wheat yield and influence on soil fertility properties, especially biological status.

MATERIALS AND METHODS

Fertilization effect of wet poultry manure (WPM) was studied in field experiment on sod-podzolic sandy loam soil. Arable horizon of soil was characterized by following agrochemical parameters: pH 5.2; humus content 2.0-2.2 %; total N content - 0.10 %; mobile phosphorus (P_2O_5) - 80-100 mg kg^{-1} (Kirsanov method); exchangeable potassium (K_2O) - 100-120 mg kg^{-1} (Maslova method). Spring wheat "Belaruskaya-80" was grown during three years. WPM was used without additives and in combination with NK-fertilizer. WPM studied doses - 25, 50 and 75 t ha^{-1}, N-fertilizer dose - 60 kg ha^{-1}, K-fertilizer - 60 kg ha^{-1}. WPM was applied 10-15 days before sowing. Wet poultry manure composition: water - 90.8 %; ash content - 2.04 %; total N - 0.58 %; NH_4^+ - 0.28 %; P_2O_5 - 0.42 %; K_2O - 0.22 %. Soil biological status was characterized by: CO_2 emission, potential N_2-fixing activity in soil and activity of hydrolytic (invertase, urease, cellulase) and redox (dehydrogenase, polyphenoloxidase, peroxydase) enzymes. Gaseous chromatography was used for the evaluation of CO_2 emission (Karjagina et al., 1987) and potential N_2-fixing activity in soil (Umarov, 1986). Soil enzyme activities were determined in accordance with methods described by Khaziev (1991).

RESULTS AND DISCUSSION

Optimal applied dose of wet poultry manure was found to be 50 t ha^{-1}. Application of 50 t ha^{-1} of WPM provided balanced nutrition of spring wheat on podzoluvisol soil and resulted in average grain yield (3.52 t ha^{-1}) and the average grain response - 1.68 t ha^{-1} for three-years experiment. At 75 t ha^{-1} applied dose of WPM a tendency to yield depression was observed (3.30 t ha^{-1}). Combination of WPM with NK-fertilizer resulted in further grain yield increase, however 50 t ha^{-1} dose remained optimal and provided 1.91 t ha^{-1} grain response as compared with 1.57 t ha^{-1} at dose 75 t ha^{-1} (Tab. 1).

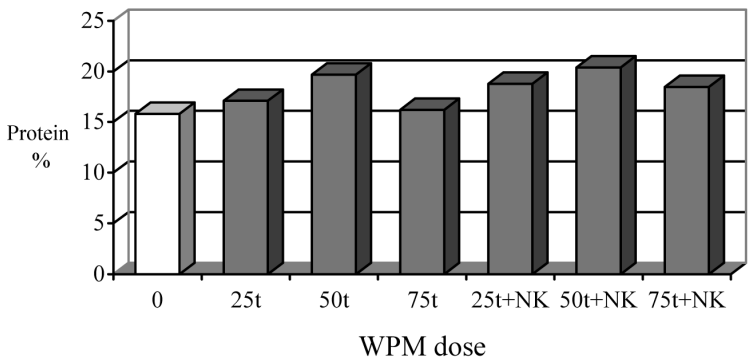
Table 1. The effect of wet poultry manure on yield of spring wheat "Belaruskaya-80".

Treatment (WPM, t.ha^{-1})	1st year		2nd year		3rd year		Average	
	yield	response	yield	response	yield	response	yield	response
control	1.91	-	1.94	-	1.67	-	1.84	-
NK*	2.59	0.68	2.43	0.49	2.39	0.71	2.47	0.63
25 t	2.40	0.49	3.69	1.75	3.01	1.33	3.03	1.19
50 t	2.87	0.96	3.98	2.04	3.72	2.04	3.52	1.68
75 t	2.82	0.91	3.51	1.57	3.57	1.89	3.30	1.46
25 t + NK	2.71	0.80	4.00	2.00	3.34	1.66	3.35	1.51
50 t + NK	2.71	0.80	4.54	2.5	4.18	2.5	3.81	1.97
75 t + NK	2.64	0.73	3.85	1.91	3.74	2.06	3.41	1.57
LSD_{05}		0.24		0.31		0.33		0.29

* N-dose - 60 kg.ha-1, K-dose - 60 kg.ha-1

The wheat grain quality was affected by wet poultry manure application. WPM applied with doses 25 and 50 t ha^{-1} resulted in the increase of protein content from 15.8 % to 17.1 and 19.7 % (Fig. 1). However a little reduction of irreplaceable amino acids (lysin, methionine, threonine, isoleucine) content in grain was observed at 50 t ha^{-1} treatment. Combination of WPM with NK-fertilizers provided the improvement of grain amino acid composition. Higher dose of WPM (75 t ha^{-1}) has lead to the reduction of grain protein content (Fig. 1).

Fig. 1. The effect of WPM on protein content in wheat grain.



Gluten content in wheat grain achieved 30.4% at optimal dose of WPM (50 $t.ha^{-1}$). Additional introduction of nitrogen and potassium fertilizers together with wet poultry manure resulted in the increase of gluten content in grain to 32.7%.

It was shown that the use of wet poultry manure stimulated the biological activity of soil. WPM optimal dose application was accompanied by significant increase of dehydrogenase activity (in 10 times), which is a reliable indicator of soil microflora status. The stimulation of soil hydrolytic enzymes (invertase, urease, and cellulase) activities was found at 25 and 50 t ha^{-1} WPM treatments (Table 2). High level of N_2-fixation in soil was observed during all the period of wheat vegetation (Tab. 3). It was found that the highest dose of WPM caused the depression of soil biological activity as compared with 50 t ha^{-1} WPM dose. There was a good correlation between biological activity depression and wheat yield decrease at 75 t ha^{-1} WPM dose.

Table 2. Influence of WPM on enzymatic activity of podzoluvisol soil.

Treatment (WPM, $t.ha^{-1}$)	Enzyme activity (mg of transformed substrate per 100 g of air-dried soil)				
	Dehydrogenase, mg TPF	Invertase, mg glucose	Urease, mg $N\text{-}NH^{+}_{4}$	Peroxidase, mg PG	Polyphenol-oxidase, mg PG
control	2.8	164.9	7.8	21.7	7.1
NK	3.3	180.3	15.2	25.1	8.2
25 t	22.8	199.3	18.8	28.8	9.3
50 t	60.7	224.8	31.5	30.9	10.8
75 t	53.5	218.3	20.7	27.7	8.9
25 t + NK	39.2	247.0	31.9	32.6	9.2
50 t + NK	58.0	260.1	35.0	37.7	11,9
75t + NK	52.6	240.1	29.7	29.3	8.6
LSD	7.3	16.1	2.2	1.5	0.8

Table 3. Influence of WPM on CO_2 emission, N_2-fixation activity in soil and decomposition of cellulose in soil.

Treatment (WPM, $t.ha^{-1}$)	CO_2 emission, mg/100 g/4 days	N_2-fixation, mg N_2/100g/24 hours	Decomposition of cellulose, %
control	35.6	1.4	22
NK	46.9	4.4	26
25 t	64.4	5.3	40
50 t	72.8	6.1	48
75 t	62.5	5.6	38
25 t + NK	57.4	5.1	54
50 t + NK	70.0	7.0	64
75 t + NK	61.8	6.4	54
LSD	10.2	0.5	12

Influence of WPM on soil fertility status resulted in optimization of pH value (from 5.2 to 5.6), hydrolytic acidity (from 2.6 to 1.9 mg-eqv/100g soil) and total base saturation (from 67.8 to 76.4 %). Application of wet poultry manure provided the increase of total and available nutrient contents. It is known that about 40% of total nitrogen and 60 - 65% of total phosphorus in WPM are in available forms for plant nutrition (Batchilo, 1990). Etanov, Sanginov (1983) also observed positive influence of WPM on soil agrochemical properties. There was no significant influence on humus and total N content in soil as a result of WPM application (Table 4). However there is an information about negative effect of WPM on some agrochemical properties (Karachentsov et al., 1983).

Table 4. Effect of WPM application on soil agrochemical parameters (WPM dose - 50 t ha^{-1}. Crop rotation: spring wheat, clover, clover, maize, barley, oat).

Parameter	Before experiment	After crop rotation
pH (KCl)	5.2	5.6
Hydrolytic acidity, mg-eqv/100g	2.6	1.9
Total base saturation, mg-eqv/100g	67.8	76.4
Humus, %	2.0 – 2.2	2.10 - 2.12
Total N, %	0.10	0.11
K_2O (Maslova method), mg/100g	10.0 – 12.0	14.0 – 15.0
P_2O_5 (Kirsanov method), mg/100g	8.0 – 10.0	7.0 – 11.0

CONCLUSION

Wet poultry manure is a concentrated and quick acting fertilizer. Application of optimal doses of wet poultry manure in combination with nitrogen and potassium fertilizers may provide balanced plant nutrition and significant increase of crop productivity and yield quality. Optimal applied dose of wet poultry manure for podzoluvisol soil was found to be 50 t ha^{-1}. Application of 50 t ha^{-1} of WPM resulted in average wheat grain yield - 3.52 t ha^{-1} and grain response - 1.68 t ha^{-1}. WPM doses 25 and 50 t ha^{-1} resulted in the increase of protein content in wheat grain from 15.8 % to 17.1 and 19.7 %. An optimal dose of WPM improves soil agrochemical and biological properties. There was the optimization of soil pH value, hydrolytic acidity and total base saturation. The stimulation of carbon dioxide emission, nitrogen fixation, hydrolytic and redox enzymes activities was found at 25 and 50 t ha^{-1} WPM treatments. Stimulation of biological activity in arable horizon of soil was observed, however highest dose (**75** t ha^{-1}) of fowl manure caused the depression of soil biological activity. Actual soil fertility status is noticeably improved by application of optimal doses of WPM.

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