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Article

Microgranular Fertilizers as an Option to Reduce Nutrient Surpluses when Growing Maize (*Zea mays*) in Regions with High Livestock Farming Intensity

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Abstract: The present contribution provides the first agro-economic and ecological account of the in-furrow application of a mineral and an organomineral micrograpular fertilizer in comparison to a wide spread mineral band fertilizer in temperate climate regions. The reduction of phosphorus inputs while maintaining the yield of maize plants (*Zea mays*) is the focus of the study. In a three-year field trial, the dry matter yields gained with the two phosphorus-reduced microgranular fertilizers and standard diammonium phosphate (DAP) fertilization were examined. The application of the organomineral microgranular fertilizer resulted in dry matter yields that were 15% higher (2.8 tons per hectare) than the DAP variant, while higher yields using the mineral microgranular fertilizer occurred only in a single year. The higher yield of the organomineral microgranular fertilizer and the lower phosphorus amounts applied with that product resulted in a moderate phosphorus excess of 2.7 kg P ha^{-1}, while DAP fertilization resulted in a surplus of 25.5 kg per hectare. A similar pattern of phosphorus balance was observed on the plots fertilized with the mineral microgranular fertilizer. We conclude that both tested microgranular fertilizers provide an adequate alternative to the wide-spread DAP fertilization in maize cultivation on fertile soils.

Keywords: microgranules; eutrophication; corn; phosphorus; DAP

1. Introduction

The intensification of agriculture has led to the eutrophication of ground and surface water systems through excessive phosphorus inputs across Europe [1,2]. It is undisputed that the phosphate rock resources for conventional fertilizer production are finite and must be used sustainably, although the extent of those resources is a subject of controversy in the literature [3,4]. Political restrictions to lower the amount of excess nitrogen and phosphorus in agricultural areas took on a new quality in Europe. In Germany, for instance, farmers are persuaded to invest in expensive, resource-consuming exports of their farm fertilizers, which are predominantly in liquid form, to areas with lower densities of livestock units [5,6]. To maintain the high yields necessary to compete on the globalized market, farm fertilizer is partly replaced with mineral fertilizer such as diammonium phosphate (DAP). The search for tools to face the above challenges drives a rapidly growing market of new seeding techniques and alternative fertilizer in microgranular form for precise nutrient and seed placement. Microgranular fertilizers are introduced to the soil along with the seeds, but at a distance of a few centimeters. This method is in contrast to DAP and other fertilizers that are applied as a band placed at a distance of 7–12 cm from the seed. The low distance between a microgranular fertilizer and the seed requires fewer amounts of both fertilizer and nutrients, especially phosphorus (P), to be used per plant, and calls for the components of the fertilizer itself to have a lower salt index [7]. The granules can be of mineral, organomineral or organic origin and are smaller than 2 mm in diameter; their dispersal prevents long-term osmotic gradients. Cheap by-products from food

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processing, such as oil cake and bone meal, are usually used as organic compounds for manufacturing microgranular fertilizer. These by-products are regionally available and thus avoid the additional import of finite resources such as rock phosphate for mineral fertilizer production. Furthermore, it is known that oil cake and bone meal act as biostimulants on soil bacteria [8,9], which may increase the positive effect of fertilizer application on the rhizosphere. Recently, progress has been made in evaluating the effect of microgranular fertilizer in potting and field experiments under different climatic conditions in Poland [10,11]. However, it is still unclear how microgranular mineral and organomineral fertilizers directly compare to conventional fertilizing systems, especially in the context of modern, highly efficient agricultural practices in regions with lower soil temperatures during the early development of corn. DAP and microgranular fertilizers are considered as starter fertilizers, which provide readily available nutrients during the sensitive early stages of plant development in maize. In comprehensive studies realized in the U.S. Corn Belt, the additional application of starter fertilizer placed in furrow, which is the same placement as for microgranular fertilizer, did not result in higher yields, irrespective of the soil P-contents, ranging from low to over-fertilized, or the management of the rye cover crop [12,13]. Only in no-till sites has a positive short-term effect of starter fertilizer been observed [12]. The latter might imply that significant effects of starter fertilizer are more likely to be achieved in colder soils, such as those found in central and northern Europe. An example of the latter is reported in a recent study from northern Italy. Therein, starter fertilization resulted in stronger crop performance, including the decisive factor of yield [14].

In general, only a few studies compare the typical placement for microgranular fertilizer, viz., in furrow, directly on or a few centimeters distant from the seed, with the fertilizer band placement [15–18]. Already at the beginning of the second half of the last century, band fertilizer application was identified as the most effective method for placing the nutrients for corn [19,20] especially in combination with broadcast P-fertilization, and has also been proven to be recommendable in a recent study [21].

The purpose of the present investigation was to study the effects of two different types of microgranular fertilizer, one of which has organic compounds while the other one is only mineral, in comparison to DAP band fertilization. Dry matter yields, corncob ratio, and nutrient balances reflect the economic and ecological potential of the tested fertilizing systems. A brief agroeconomic calculation of the standard fertilizer DAP and the most suitable microgranular fertilizer variant for the study site has been performed.

2. Materials and Methods

2.1. The Study area and experimental setup

Experiments were carried out as field trial with four fertilizer variants, each repeated four times, on plots measuring 13 meters in length and 3 meters in width near Wadersloh, western Germany (51.716995, 8.241482). The region is classified as having a European Atlantic climate (Cfb) as defined by Köppen and Geiger (1930) [22], characterized by mild winters and moderate summer temperatures. The average precipitation per year for Wadersloh is 673 mm, and the average annual temperature is 10.4 °C. Around 53% of the annual rainfall occurs during the maize vegetation period from April to September. Loamy sand with a humus content of 2.5% and an effective field capacity of 9% (volumetric) and pH of 5.7 is present on the study site. A calcium-acetate-lactate extraction (CAL-extract) [23] of the soil revealed moderate amounts of phosphorus (6.5 mg $100g^{-1}$), potassium (6.6 mg 100 g^{-1}) and magnesium (3 mg 100 g^{-1}).

The site has been used for maize cultivation for years and treated with the following plant protectants: Gardo Gold® (metolachlor and terbuthylazine) applied at the end of April in the form of two liters per hectare and at the beginning of June in the form of one liter combined with 0.3 liters of Buctril® (bromoxynil), 0.9 liters of MeisTer® (foramsulfuron, thiencarbazone, iodosulfuron, cyprosulfamide), one liter of manganese nitrate, and 0.2 liters of Zeavit (oat-derived phytochemicals). Regular tillage operations performed before sowing in early spring (March/April) involved plowing at a depth of 25 cm and, two times, grubbing to a depth of 6–10 cm, respectively. Following the representative long-term fertilization system of the study site, a pre-treatment and control with pig slurry (20 m^3 ha^{-1}) containing 8.6 kg of total N, 2 kg of P, 4.9 kg of K, 2.4 kg of S and 10.8 kg of Mg per m^3 has been realized.

The maize cultivar Farmpilot was sown with a density of 85000 seeds per hectare using the AMAZONE single corn seeder system (EDX 6000-2C precision air seeder). DAP fertilizer was applied in a band 12 cm below the soil surface, and the microgranular fertilizers Startec (*De Ceuster Meststoffen* NV (*DCM*), Bannerlaan 79, 2280 Grobbendonk, Belgium) and Wolf-nutraxP® (WolfNP) (MTD Products Inc., 5903 Grafton Road, Valley City Ohio 44280) were applied a few centimeters beneath the corn, respectively. 100 kg ha^{-1} of DAP was applied. The latter contains 18% total N, all in the form of NH_4-N, and 20% P. Startec can be classified as an organomineral fertilizer, of which 80% (weight of the original substance) is made up of the organic industrial by-products oil cake and deglued bonemeal and the mineral components ammonium phosphate, ammonium sulfate, EDTA-chelated Fe, Mn, Zn, Zinc sulfate and zinc oxide. The nutrient composition of Startec is 7.5% N, 9.6% P, 3.3% K, 4% S, 0,5% Fe and Mn respectively, plus 1.5% Zn. In the present study, Startec was applied at a rate of 25 kg ha^{-1}. WolfNP is classified as a mineral microgranular fertilizer and contains ammonium sulfate, kieserite (magnesium sulfate as a monohydrate) and Nu-TraxP. The latter is a fine-grained powder that can be dissolved in water as a coating for the product. WolfNP was applied using 100 kg of the product with the following mineral composition: 11% N, 0.2% P, 8.8% S, 7.5% Mg, 0,4% Mn and 0.1% Zn.

Application rates and nutrient inputs per hectare through the used fertilizer are summarized in Table 1. Differences in nutrient inputs reflect the application rates prescribed by the manufacturer of the respective fertilizer and their usage in agricultural practice.

Table 1. Application rates and nutrient inputs per hectare of used fertilizer.

		Nutrient type and input rate per hectare							
Fertilizer (type [1])	**Application rate per hectare in kg**	**N**	**P**	**K**	**S**	**Mg**	**Fe**	**Mn**	**Zn**
Diammonium Phosphate (mineral fertilizer)	100	18	20	-	-	-	-	-	-
Wolf-nutraxP® (mineral microgranular fertilizer)	100	11	0.2	-	8.8	7.5	-	0.4	0.1
Startec (organomineral microgranular fertilizer)	25	1.75	2.4	0.8	1	-	0.125 [2]	0.125 [2]	0.375 [2,3]
Pre-treatment of the whole study site with pig slurry (also used as control)	20000	172	39	98	48	21.6	-	-	-

[1] For seed band application. [2] EDTA-chelated. [3] EDTA-chelated and as oxide. - Absent or no data available.

2.2. Data Sampling and Statistical Analysis

Hand harvest was performed by removing 20 plants involuntarily per plot. Corn cob and the remaining plant were weighed and shredded separately using a garden shredder (AL-KO Master 32-40). Shredded material of corncob and remaining plant respectively for each of the four repetitions of a variant was used to determine the content of dry matter, crude protein, phosphorus and potassium. The latter data were used to calculate the year-specific removal of N, P and K by harvesting.

To ensure normal distribution of the data, yield and other parameters were transformed via an exponential function. Differences between fertilizer variants were tested using Student's t-test. All statistical analyses were performed in R software. For data selection, the package dplyr [24] was used. Visualization in R was conducted using the package ggplot2 [25] and via Microsoft Excel.

For the agroeconomic calculation, the silage yields of the two fertilizer variants, DAP and Startec, were compared with the costs. The costs include the purchase prices and the required quantity of liquid manure to be exported. The export prices for the liquid manure were determined on the basis of a separate survey from 2021 with 14 farms in northwestern Germany. The surplus of manure to be exported is based on the nutrient analyses of the pig manure used in the experiment and the legally defined limits for the nutrient load that may be introduced. The regulatory limits used in the sample

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calculation are based on the directly enforceable law of the German Fertilizer Directive (DüV, Article 97, Ordinance of 10 August 2021, BGB pp. 3436), a national implementation of the European Union Water Framework Directive (91/676/EEC, 2000/60/EC). To briefly note the relevant parts of the directives for the following calculation, an excess of 4.36 kg P per hectare and year (over a six-year average) in the fertilizing balance is permitted if the extractable soil phosphorus is ≤ 8.7 mg per 100 g of soil following the extraction procedure described by Schüller (1969) [23] using the calcium-acetate-lactate method (CAL-extract), or ≤ 10.9 mg per 100 g of soil after double lactate (DL) extraction [26] or ≤ 3.6 mg using the electro-ultrafiltration method [27]. No excess is permitted if more phosphorus can be extracted by following the above methods.

3. Results

Effect of Microgranular Fertilizer on Dry Matter Yield, Nutrient Balances and cost-benefit ratio Compared to DAP Fertilization

All results corresponding to the yields from different fertilizer plots are shown in Figure 1. No significant differences have been detected comparing the yields gained from control parcels and DAP fertilized plots. Significant differences in yield between the control and fertilizer variants only occurred in 2016 for WolfNP and Startec ($P < 0.001$). The average dry matter yield (whole plant) per hectare gained with the organomineral microgranular fertilizer Startec during the study was 2.9 Mg (15%) higher than the yield gained with DAP. This result was of statistical significance ($P = 0.028$). While the yield with Startec was only by tendency higher (10%) than from DAP plots in 2015, the difference in 2016 was 3.8 tons and thus highly significant ($P < 0.001$), and it was by tendency 3.2 Mg higher in 2017. The P balance of Startec-fertilized plots was significantly ($P < 0.001$) lower each year than that of DAP-plots (Figure 2). An agroeconomical comparison of the two fertilizer variants DAP and Startec resulted in a lower cost-benefit ratio for the latter fertilizer (Table 2).

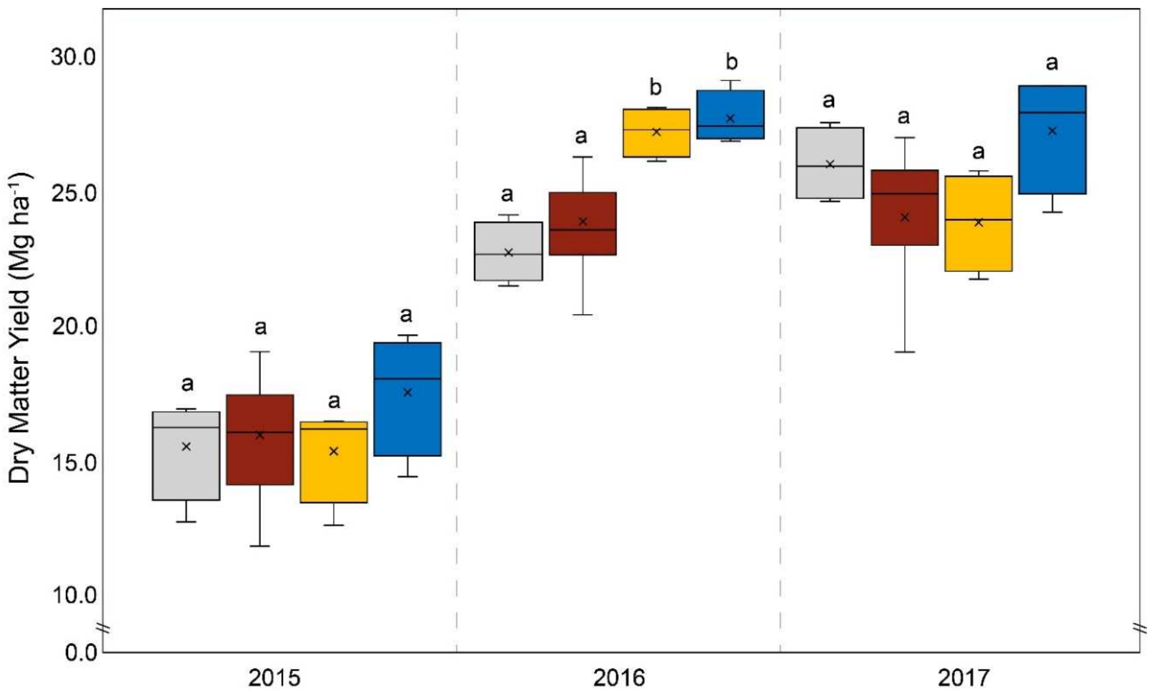

Figure 1. Dry matter yield in Mg gained per hectare from control plots (grey), diammonium phosphate fertilized plots (brown), plots treated with mineral microgranular fertilizer WolfNP (yellow) and organomineral microgranular fertilizer Startec (blue) from 2015-2017.

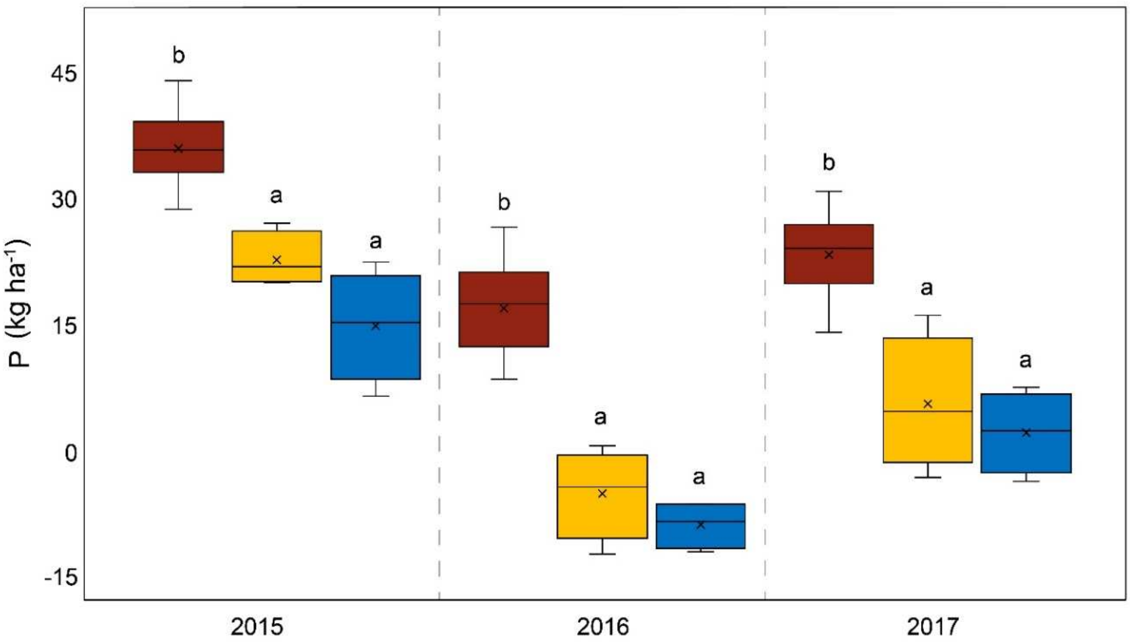

Figure 2. P balance in kg per hectare on diammonium phosphate fertilized plots (brown), plots treated with mineral microgranular fertilizer WolfNP (yellow) and organomineral microgranular fertilizer Startec (blue) from 2015-2017.

Table 2. Agroeconomic calculation per hectare of flexible fertilizer-specific factors.

Nr.	Keywords	Agroeconomic calculation of flexible fertilizer-specific factors per hectare			
		DAP		Startec	
1	Cost	40 €		60 €	
2	P balance (excess)	25.5 kg		2.7 kg	
3	Number of kg above permitted P excess *	21.2 kg		0.0 kg	
4	Necessary reduction of slurry	8.6 m³		0.0 m³	
5	Additional costs for slurry export **	41.11 €		0.0 €	
	Interim result for total costs	**82.11 €**		**60.00 €**	
6	Fresh matter yield	60.99 t		69.23 t	
7	Loss through ensilage	12 %		12 %	
8	Silage yield	53.67 t	1878.45 €	60.92 t	2132.20 €
9	Remaining benefit less expenses	1796.34 €		2072.20 €	
10	Surplus compared to DAP-fertilization	-		275.86 €	
	Cost-benefit ratio	**0.044**		**0.028**	

* Permitted P excess based on national German law applicable at the study site. ** Cost of slurry exports based on average data from 14 surveyed farms in northwestern Germany.

Over the average yields of the three-year study and in 2015 and 2017, there were no statistically relevant differences in yield between the mineral microgranular fertilizer WolfNP and DAP. In 2016, the application of WolfNP resulted in higher yields compared to DAP fertilization. The difference of 3.3 Mg reached a significant extent ($P < 0.001$). The same pattern in the P balance as described above for Startec is present in WolfNP plots compared to DAP plots in each year ($P < 0.0001$). However, the phosphorus excess with WolfNP was 7.7 kg P ha^{-1}. Statistically relevant differences in the N balance only occurred in 2016 in comparison to Startec ($P = 0.027$) and DAP ($P < 0.001$) (Figure 3). The average excess of nitrogen on plots treated with WolfNP was 5.7 kg N ha^{-1} over the three-year study. The proportion of the corncobs in the total mass of the plant varied over the three years from 57% in 2017 to 65% in 2016. Significant differences between the treatments only occurred in 2015, when the corncob ratio of WolfNP fertilized plants was higher than the control ($P = 0.023$).

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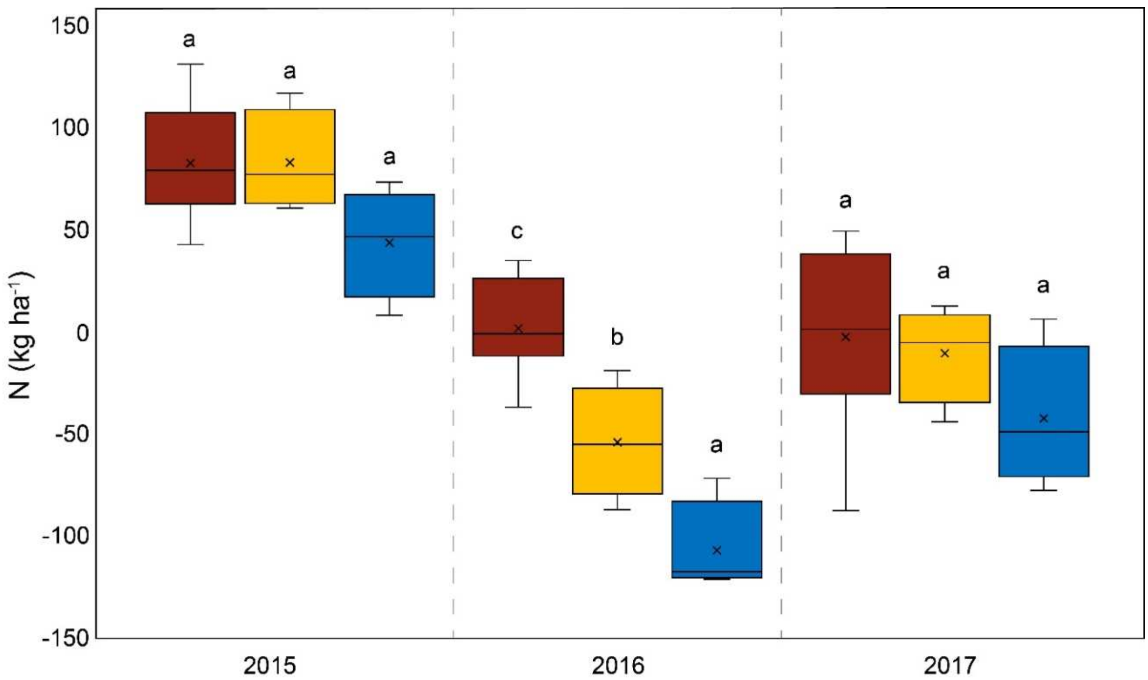

Figure 3. N-balance in kg per hectare on diammonium phosphate fertilized plots (brown), plots treated with mineral microgranular fertilizer WolfNP (yellow) and organomineral microgranular fertilizer Startec (blue) from 2015-2017.

4. Discussion

4.1. Comparing Yield and Nutrient Balances with DAP and Microgranule Fertilization

For the comparison of practical relevance of the four different fertilizing systems DAP, WolfNP, Startec and the control the amounts of phosphorus and nitrogen vary per unit of area (Table 1). The reduction of macroelements, especially phosphorus, is known to play a yield-limiting role in plant growth [28], which seems not to be the decisive factor on the fertile soil of our study site. The fertilizer treatment with the highest P input, viz. DAP, resulted in similar yields as in the case of the slurry treatment (control) without additional fertilizer, which was the variant with the lowest P influx (Table 1). In other studies, differences in P inputs and fertilizer types did not automatically result in differently plant available P forms within the soil P pool and thus did not affect yields depending on the crop [29,30]. Furthermore, the soil of the study site is moderately rich in P, which may lead to a smaller effect of the fertilizer. In a comprehensive review of several field studies, Quinn et al., (2020) [18] described a decreasing effect of band fertilization if the soil P is high, which does not necessarily mean that yield increases due to fertilizer application only occur in P-deficient conditions. Significant differences between WolfNP or Startec and the control only occurred in 2016, when both fertilizers led to higher yields than the slurry treatment. It must be pointed out that data that are statistically insignificant in scientific considerations cannot in each case be taken into account in the same theoretical way regarding their relevance in practice. With the organomineral fertilizer Startec 2.7 Mg more dry matter per year has been harvested compared to the control parcels, which were only pre-treated with pig slurry. This trend would be of high economic concern for agriculture, although it is statistically not of significance in the present study. A clear pattern of economic relevance can furthermore be found in the arithmetic mean yield gained with Startec, which was each year higher than all the other average yields from other variants. In the agricultural practice of temperate regions the applications of DAP is widespread whereas microgranular fertilizers are not that often used, although the market share of the latter has been growing during the last decade. The average yield gained with Startec was statistically higher, viz. 2,9 Mg ha^{-1}, than from DAP plots, which indicates that it is a more suitable fertilizer under the given conditions. In separate considerations of the single years, only in 2016, the yield from plots fertilized with Startec was in the significant range. Interestingly, in 2015 the difference between the yields of Startec and DAP variants was in the insignificant range of 10% (P =

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0.17) and the variation between the yields of the other fertilizer variants was also the lowest during the study time. In 2015, the early vegetation period of maize was comparatively dry, with 62 mm precipitation in total during May and June. That was approximately half the rainfall of the same period in 2016 and 2017 during the same period. Thus, water might be the key factor rather than the different nutrient influxes or other modes of action in terms of biostimulation through Startec's organic compounds, which are discussed at the end of that paragraph. Crucial changes of weather influences have been described as exceeding the impact of different fertilizing systems in other studies [17,31].

The proportion of corncobs in the total mass of the plant varied over the three years from 57% in 2017 to 65% in 2016. Between the fertilizer variants, significant differences only occurred in 2015, when the corncob ratio of WolfNP-fertilized plants was higher than the control. With one exception of WolfNP in 2016, each fertilizer variant resulted in average 2.6% higher corncob ratios compared to the control. Although that is a trend and not a statistically relevant result, an influence of additional fertilization to the slurry treatment on the corncob ratio must be assumed. In accordance with the differences in yield, the disparities in nutrient balances are higher due to the different compositions of the fertilizer used. The P balance of plots fertilized with Startec was +2.7 kg P ha^{-1}, while DAP fertilization resulted in an excess of 25.5 kg per hectare. The average P balances over the three years and those from the single years clearly differed in a significant manner. Thus, Startec is an adequate alternative to DAP fertilization in terms of yield and ecological impact for fertile fields with comparable conditions to those present on the study site. The only statistical differences in terms of the N balances of plots fertilized with Startec and DAP were present in 2016, although the N balances gained with Startec resulted in a negative amount of −35.8 kg N ha^{-1}, while the use of DAP resulted in an excess of 30.6 kg N ha^{-1}. Differences in this range are highly relevant in agronomical practice and for the environment. Similar results comparing the yield and nutrient balance of Startec and DAP were achieved in another study on a fertile loamy soil in northern Germany [32].

Over the three years, the dry matter yield with the mineral microgranular fertilizer variant WolfNP was nearly the same as with DAP (4% higher than DAP). In 2016, the conditions for WolfNP might have been optimal because the dry matter yield was 3.3 Mg ha^{-1} higher than that resulting from DAP plots. The same pattern in the P balance with highly significant differences as described above for Startec is present in WolfNP compared to DAP fertilized plots. The phosphorus excess with WolfNP was 7.7 kg P ha^{-1} and thus higher, albeit not statistically significant, than the P balance of Startec plots. This discrepancy can be explained by the higher dry matter yield from Startec plots. Differences between the three N balances of DAP, WolfNP and Startec plots are of statistical significance in 2016 and can be ascribed to the above differences in yield. The N-influx of the fertilizer variants themselves differs slightly due to the high N-influx by the slurry pre-treatment (Table 1). The average excess of nitrogen on plots treated with WolfNP was 5.7 kg N ha^{-1} over the three-year study, which is close to neutral and thus a goal for sustainable agriculture. However, the application of the organomineral microgranular fertilizer Startec resulted in higher yields and a lower nutrient surplus than the microgranules of mineral origin used in WolfNP. This may be because they have a more suitable nutrient composition for maize cultivation on loamy sand under the given climatic conditions. Furthermore, the organic compounds in Startec exert additional biostimulative effects. Startec's organic compounds, such as oil cake and bone meal, act to a certain extend on microbial activity. Oil cakes are used to rise microbial metabolism in bioremediation of soils [33] and further ranges of biotechnological application [9]. Also, bone meal is known to increase mineralization dynamics and thus extractable macronutrients in soils [8] and act as a biostimulant for bacteria [34]. Contrary to the well-described introduction of defined microbial inoculants in agricultural soils [35–40], the recovery of indigenous soil microbial biomass and diversity through replacing a part of the inorganic fertilizer by organic sources, gained new attention in recent studies [41–43]. Startec's organic compounds might support the indigenous microbiome in a similar yieldcincreasing way as biogas residues did in Zaho et al., 2023 [43] or dairy manure and rapeseed cake affected it in Wang et al., 2023 [42]. Differences in yields in our study due to the varying micronutrient inputs of the different fertilizers are negligible and overlapped by the nutrient inputs of the slurry pre-treatment.

4.2. Economic Consideration of DAP and Organomineral Microgranular Fertilizing Systems

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In agricultural practice, only profitable fertilizing systems will succeed. A brief comparative agroeconomic calculation for the two fertilizer variants DAP and Startec is summarized in Table 2. The regulatory limits used in the sample calculation are based on directly enforceable law of the German Fertilizer Directive (DüV, Article 97, Ordinance of 10 August 2021, BGB pp. 3436). To maintain high yields, farmers usually reduce organic fertilization but not mineral fertilization. Excess farm fertilizer is exported to farms with better nutrient balances, as present in areas with low densities of livestock units. The export of slurry, which usually has water contents of more than 90%, is resource consuming and socially not well accepted in general public.

Expected costs for exporting: € 4.87 per m^3 slurry based on the average of 14 farms in northwest Germany surveyed in 2021. Costs of € 10 per m^3 or more also arise in German agriculture. Fresh matter loss of 12% during ensilage is calculated high and the price for silage low to avoid any overestimation for the calculated example. The nutrients in slurry are also 25–40% higher in the case of N and 12–18% for P compared to average values for pig slurry [44]. Further, the cost of a specific technique (precision air seeder) that is not present on every farm but is generally widespread in practice is not included.

Purchasing costs for Startec are currently 50% above the price for DAP (Keyword 1). The application of the organomineral microgranular fertilizer avoids additional costs for slurry export (Keyword 5), which more than compensates for the fertilizer's higher price. As described above, the slurry included in the calculation is especially nutrient-rich, meaning that in practice, the required reduction in the quantity of slurry will tend to be higher, while the average costs per m^3 exported will not be significantly lower in the region in question. Further, the economic value of exported nitrogen, potassium and magnesium in the slurry is not included in this calculation as well. However, taking into account the higher crop yields gained with Startec (Keywords 6, 8–10), the cost-benefit ratio for using microgranular fertilizer (0.028) is lower and thus points to a more effective fertilizing system than that calculated for DAP (0.044) on our study site.

5. Conclusions

The organomineral microgranular fertilizer that was used performed better than diammonium phosphate (DAP) in terms of the dry matter yield of corn plants. The use of mineral microgranular fertilizer resulted in a similar yield to DAP. Compared with the DAP variant, phosphorus balances (nutrient input by fertilizer minus nutrient removal through harvest) were three times lower for the mineral microgranular fertilizer and nine times lower for the organomineral microgranular fertilizer. Both microgranular fertilizers can be considered an adequate alternative to DAP fertilization in maize cultivation on fertile loamy sand sites in central Europe.

Yields from control parcels, which have been amended with slurry, did not differ from those from DAP-fertilized plots. The usage of DAP on fertile soils must be critically questioned in its current form as standard fertilizer for maize growing in terms of ecology and sustainable management of finite rock phosphate resources.

Further studies have to be realized as parallel setup on different soil types, including extensive analyses of the soil phosphorus forms and the soil microbiome, to prove the effects of the microgranular fertilizer under different conditions in agricultural practice.

Author Contributions: Conceptualization, F.E.; methodology, F.E.; formal analysis, M.T. and J.A.; investigation, X.X.; data curation, M.T.; writing—original draft preparation, M.T.; writing—review and editing, F.E. and J.A. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

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