

Agronomic Efficiency of TerraNova Recycled P

Summary

- A recycled P product was obtained from TerraNova Energy GmbH.
- The product was analyzed in the laboratory for nutrient content and tested in the glasshouse for agronomic efficiency.
- The P content of recycled sources was 6.8%.
- The recycled P product showed good agronomic performance, but less than that of triple super phosphate (TSP).
 - Yield: 65% – 90% compared to TSP
 - P uptake: 70% – 80% compared to TSP
- High application rates are required due to the low P content of the product.

Source of recycled phosphorus and the recovery process

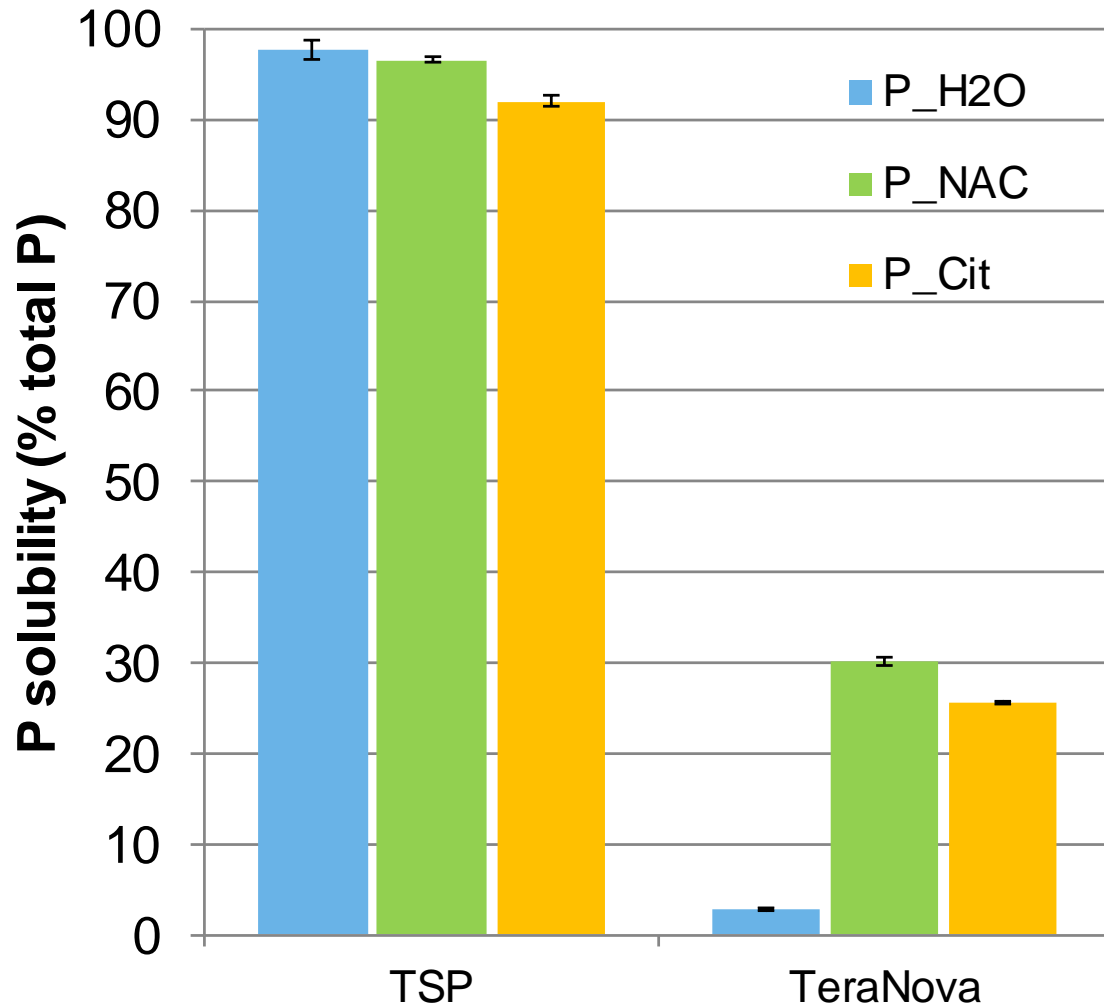
Recycled Product	Supplier	Source material	Process of P recovery
TerraNova	TerraNova Energy GmbH	Sewage sludge	<ul style="list-style-type: none">• Hydrothermal carbonization of dewatered sewage sludge,• Acidification of hydrochar slurry to solubilize Al- & Fe-phosphate,• Dewatering the hydrochar slurry by centrifugation/filtration and,• Crystallization of P in the filtrate by adding calcium silicate hydrate (P-RoC process). <p><i>Refer: TerraNova Process of P-recovery</i></p>

Nutrient content of recycled P (TerraNova)

Product	Macronutrients (%)						Micronutrients (mg/kg)					
	N	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu	Mo	B
TerraNova	1.48	6.76	0.10	8.08	0.13	7.34	9,378.0	73.8	390.9	5.9	5.8	19.1

- P content of the TerraNova recycled P product is about 6.8% (15.5% P_2O_5) which is lower than the average P content of common P fertilizers such as triple super phosphate (TSP, 45% P_2O_5) or diammonium phosphate (DAP, 46% P_2O_5).
- A higher field application rate is required for products with low P content.

Solubility of recycled P in water (H₂O), neutral ammonium citrate (NAC), or citric acid (Cit) solution



- Solubility of recycled P in water is very low compared to TSP.
- TSP is a water soluble P fertilizer.
- Solubility in neutral ammonium citrate (NAC) or in citric acid is commonly used to evaluate the plant-availability of fertilizer P.
- Solubility of recycled P in NAC is low. Only about 30% of its total P is soluble in NAC.
- This could indicate that plant availability of this product is limited.

Agronomic efficiency of recycled P (TerraNova)

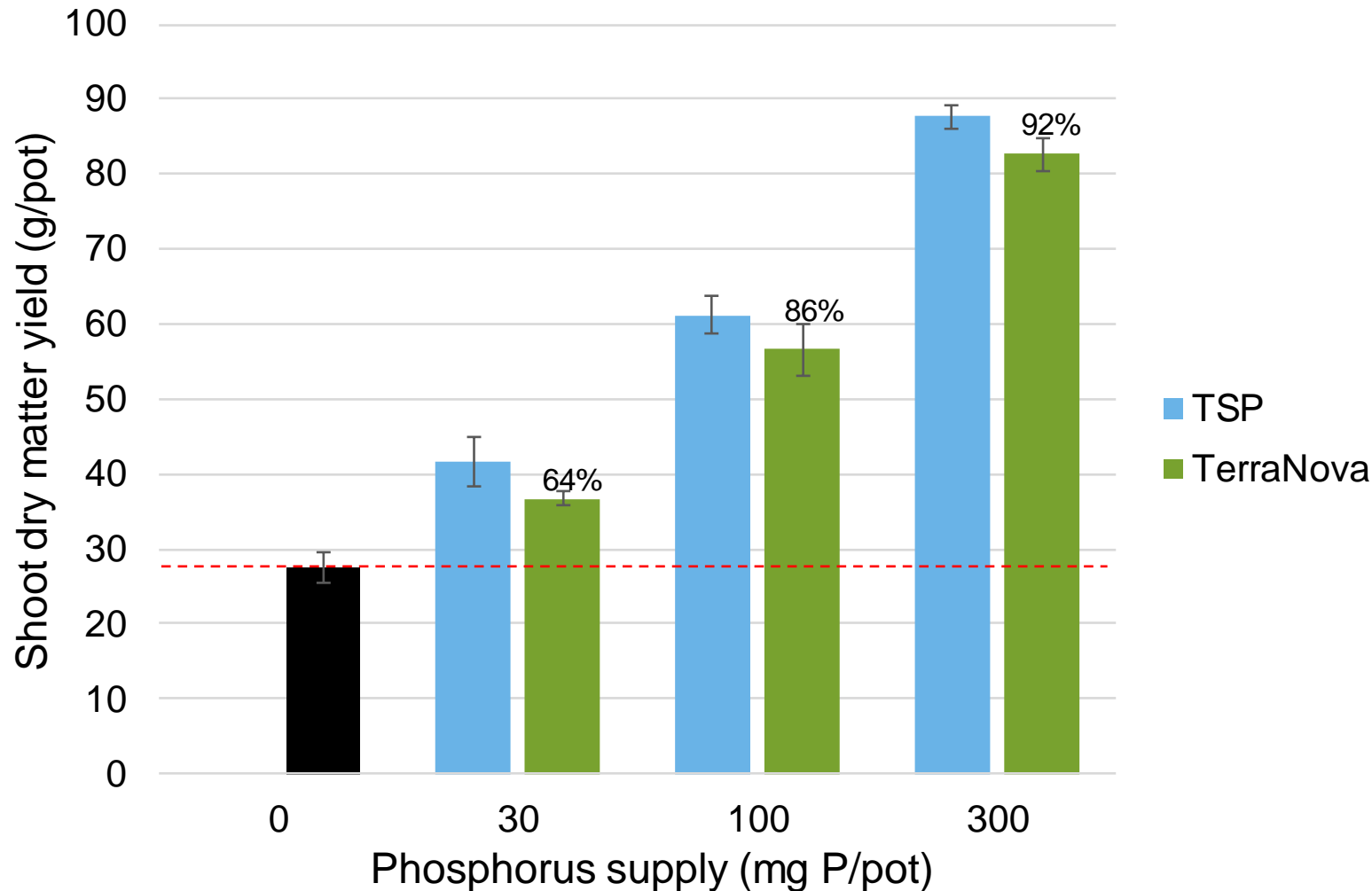
- Glasshouse trial using ryegrass

- Pot trial in a P-deficient soil (10 kg soil/pot)
- Trial duration: from May to September 2019
- P application rate: 0, 30, 100, 300 mg P/pot
- Harvesting (cuts): every 4 weeks



Agronomic efficiency of recycled P

Cumulative shoot DM yield of ryegrass - 5 consecutive harvests



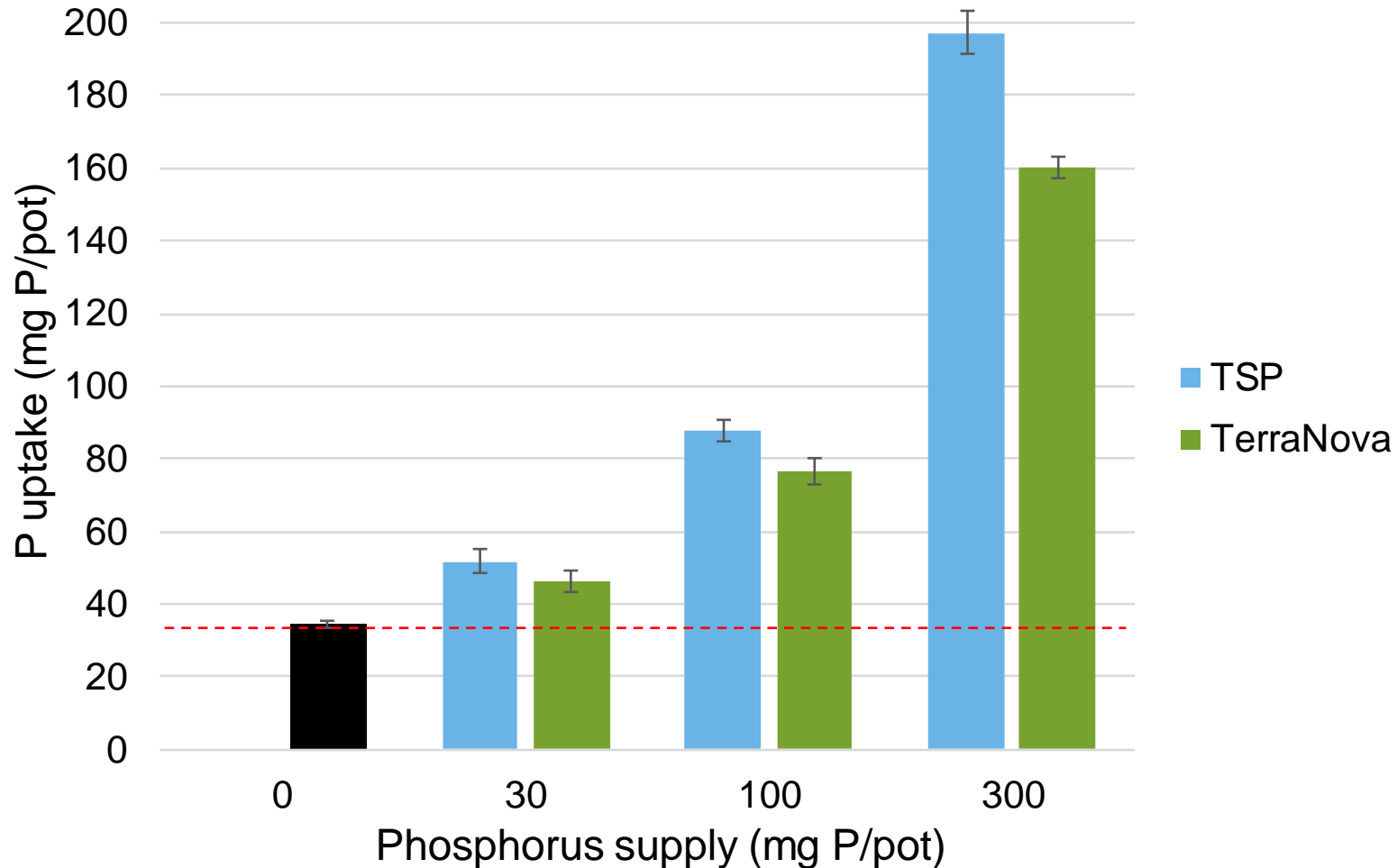
- P supply increased the yield.
- Recycled P source showed good performance, though lower than TSP.

$$Fert. Eq. (\%) = \frac{Yield(+P) - Yield(-P)}{Yield(+TSP) - Yield(-P)} \times 100$$

- Recycled P (TeraNova) application resulted in 64 – 92% of the yield achieved by conventional P-fertilizer (TSP).

P uptake of ryegrass fertilized with recycled P

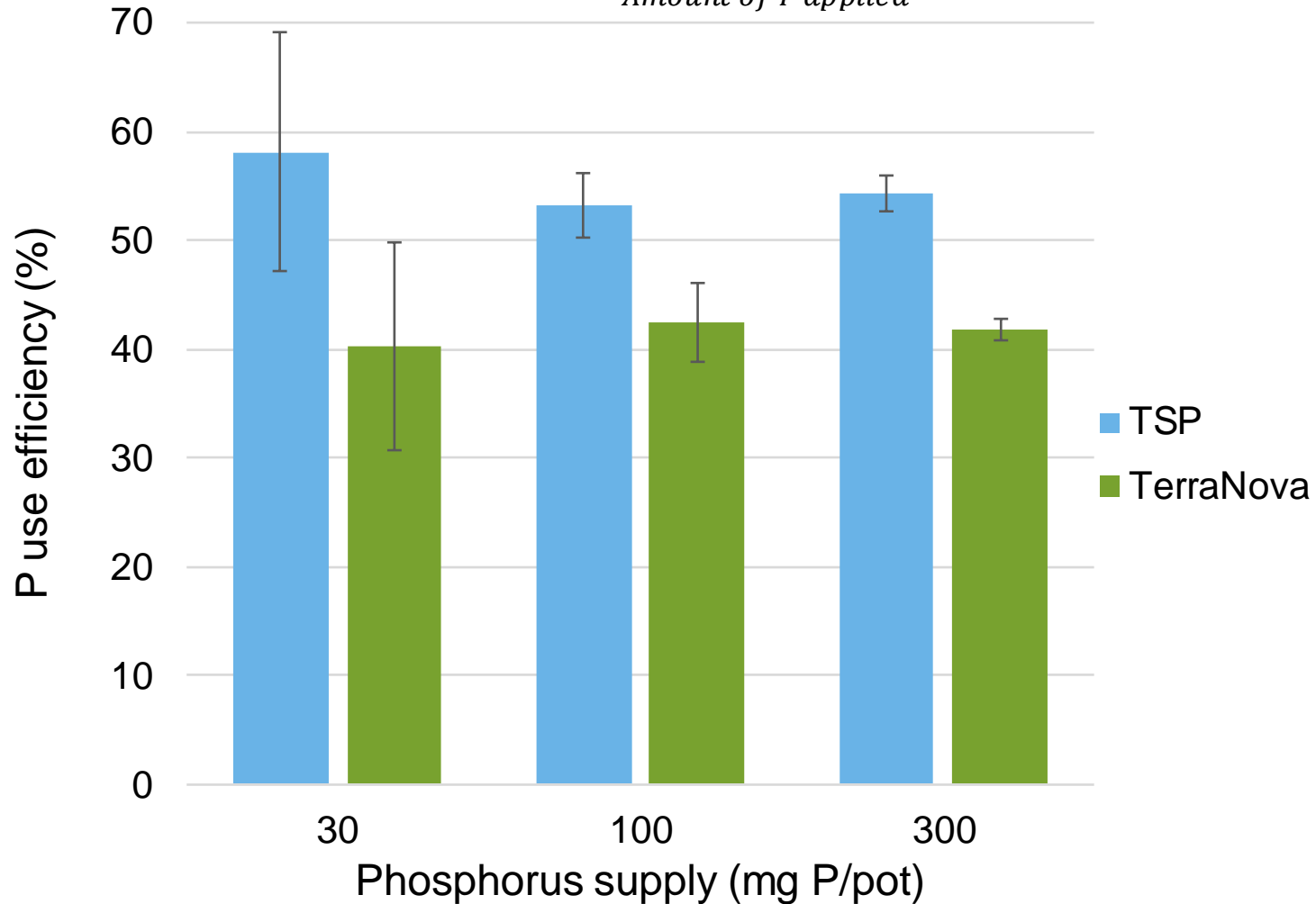
Cumulative P uptake of ryegrass - 5 consecutive harvests



- P uptake of ryegrass increased with increasing P supply.
- P uptake from recycled source was lower than TSP.

Fertilizer P use efficiency (PUE) of different P sources in ryegrass

$$PUE (\%) = \frac{P \text{ uptake of fertilied trt.} - P \text{ uptake of unfertilied trt.}}{\text{Amount of P applied}} \times 100$$



- Recycled product has a lower PUE than TSP.

Summary and conclusion

- The recycled P product tested in this study showed good agronomic performance.
 - 65% – 90% yield level compared to TSP
 - 70% – 80% P-availability compared to TSP
- Solubility of the recycled P product in NAC or in citric acid was low (25–30%). Solubility in NAC or in citric acid is usually considered as indication of plant availability. Surprisingly, the low solubility of the product in NAC or in citric acid did not correspond to low plant availability. Possibly, this can be attributed to the high P uptake efficiency of ryegrass.
- Due to its low P content, a high field application rate of recycled P product would be required. That means higher transport costs to the farmer's field and higher costs of field application.