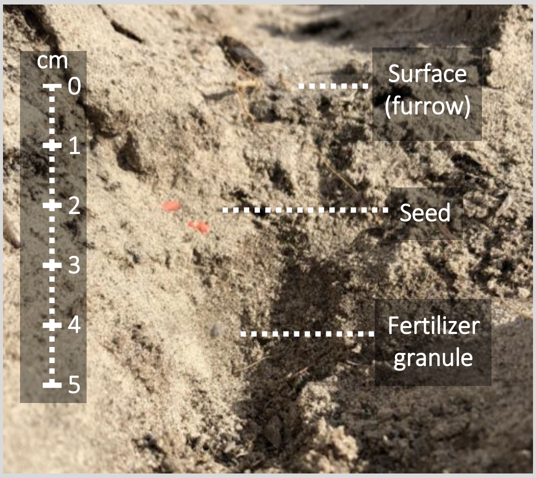
Spatial distribution of compound fertilizer granules at crop sowing

Compound nitrogen, phosphorus and sulphur (NPS) Fertilizers are made by combining a phosphate source such as ammonium phosphate (MAP, SMAP etc.) or phosphoric acid with other raw materials like ammonia, urea, ammonium and sulphur salts or sulphuric acid. Additional nutrients like potassium and trace elements may also be added. Different raw materials and differences in manufacturing processes result in granules that vary in size, density, nutrient composition analysis and handling properties.

Distribution

The nature of phosphorus (P) and its low soil mobility means the most effective applications are banded just below the seed in the drill row where soil moisture is higher than at the surface and where roots will intercept it. Different fertilizer products need to be applied for crops at different rates to achieve the same desired target P output. This, in turn, means that granule output from seeding machinery will differ and the space between granules, or granule distribution, will also vary with product.



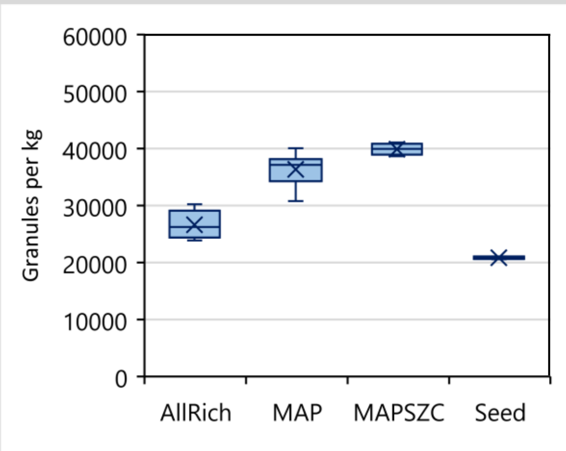
[1] Placement of phosphorus below the seed by a double-shoot air seeder boot.

Seeding

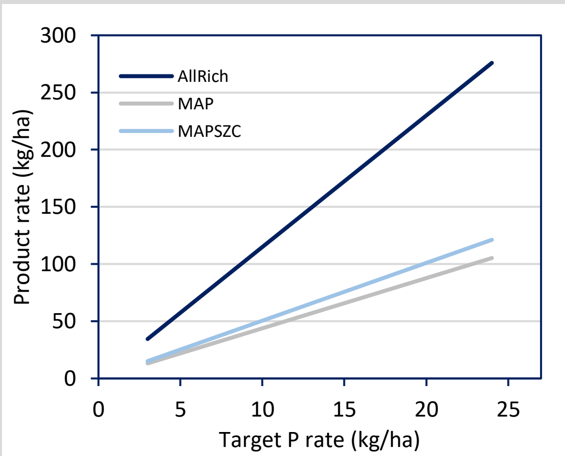
It follows that seeding with a low analysis product will require a higher output rate than a high analysis product, generally resulting in lower granule dispersion.

While this means more granules of a low analysis product per unit area, it also has logistical implications in higher loading, freight and storage requirements plus greater downtime from more frequent fills at seeding. Additionally, some low analysis compounds were not designed to flow through air seeders and may not have ideal handling characteristics for this purpose.

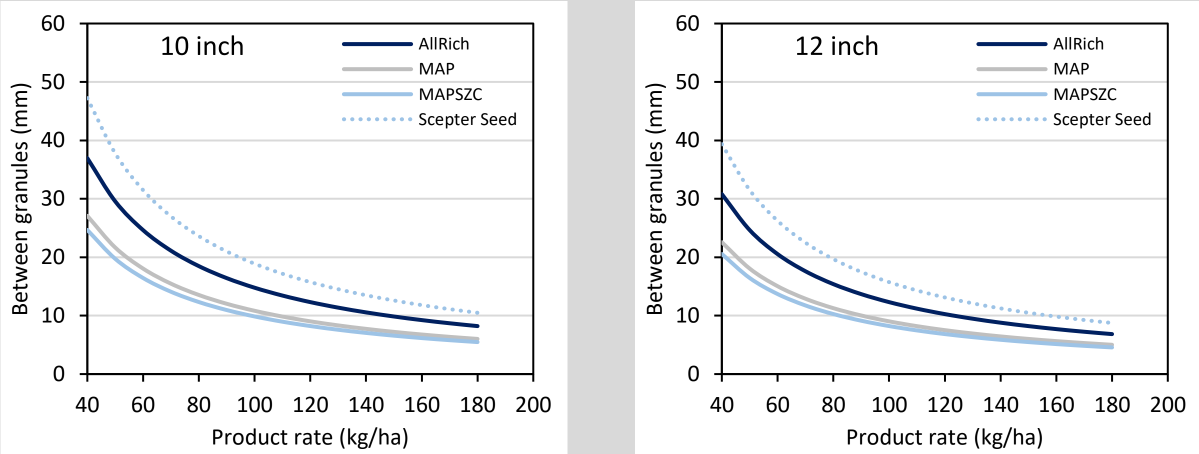
Detailed below is comprehensive data on some compounds that differ in NPS content. Counts were made multiple times to determine the precise number of granules in a unit mass of each product. This enables calculation of relative granule distribution within a representative seeding row under various scenarios.



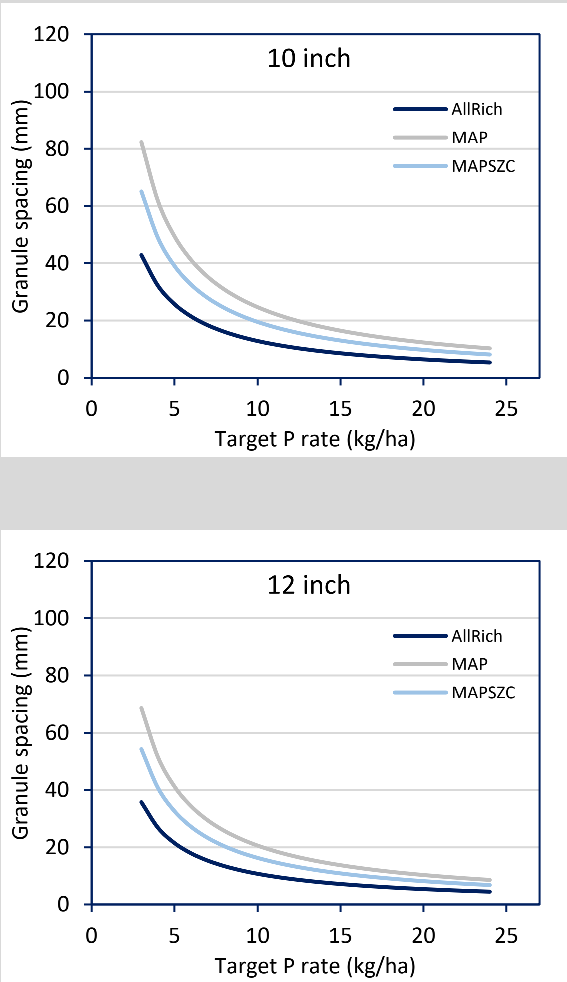
[2] Number of granules in a kilogram of various NPS compound products. X is mean of multiple counts.



[3] Product required to achieve target phosphorus application rate.



[4] Relative compound fertilizer granule and seed distribution along rows at 10-inch and 12-inch tine spacings.



[5] Granule distribution of compounds with different target phosphorus application rates at 10 and 12 inch tine spacings.

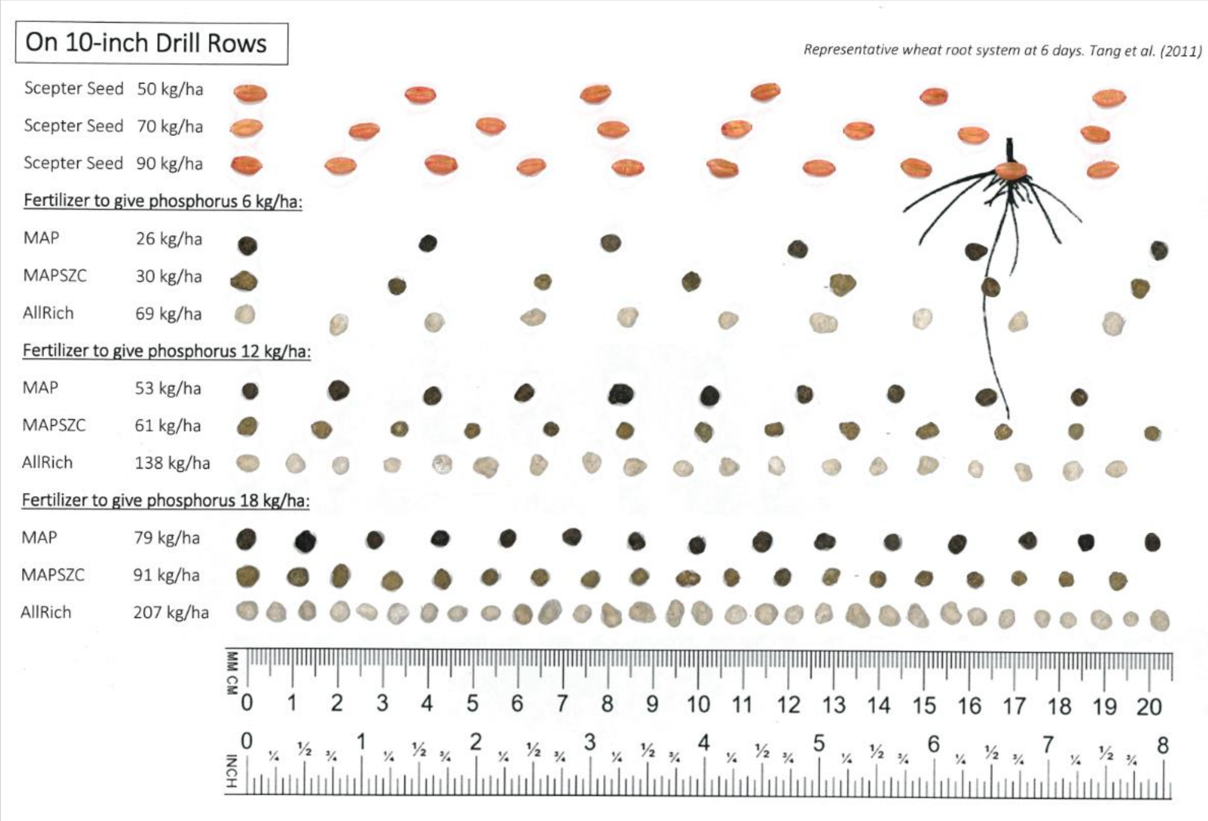
Analysis (%)

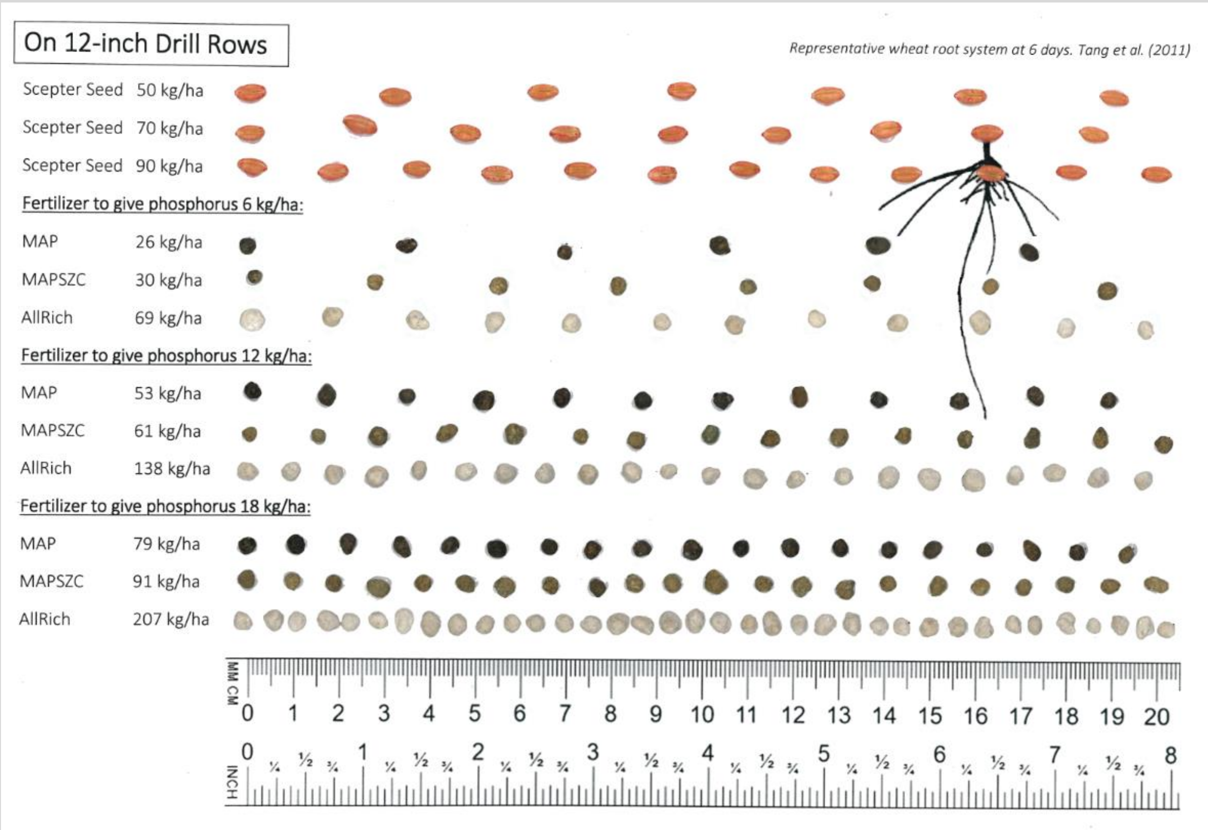
Product	N	P	S	BD t/m^3
AllRich	16.0	8.7	12.5	1.00
MAP	11.2	22.8	1.9	0.95
MAPSZC	11.6	19.8	8.0	1.03

Key Notes

- There are 36% more granules in a kilogram of MAP and 50% more in a kilogram of MAPSZC than in one kilogram of AllRich [2].
- Germinating seed spacing relative to fertilizer granules is important. Scepter wheat seed is much heavier than fertilizer granules [2] and there will always be more than one fertilizer granule per seed at equivalent rates.
- Significantly more volume of low P analysis product is required to produce an equivalent high analysis P rate. AllRich is more than double MAP and MAPSZC [3] at any given P rate. Nitrogen and sulphur will also differ significantly.
- At a moderate rate of low P analysis fertiliser application (AllRich 70 kg/ha = 6 kg P/ha), only increasing seed rate above 90 kg/ha would make seeds outnumber fertiliser granules within the row [4].
- Seeder tine spacing has a significant impact on within-row granule distribution [4], [5] and [6].
- Unless P application rates are very low or row spacing is very narrow, granule distribution from all compounds in the root zone should be readily accessible by young emerging roots.

[6] What does within-row seed and fertilizer granule distribution look like when applied at different rates and on different row spacings at seeding? A representative one-week-old root system is shown for comparison of root interception.





Tang L., Tan F., Jiang H., Lei X., Cao W., Zhu Y. (2011) Root Architecture Modeling and Visualization in Wheat. In: Li D., Liu Y., Chen Y. (eds) Computer and Computing Technologies in Agriculture IV. pp 479-490. CCTA 2010.