RLF TECHNICAL BULLETIN

Benefits of Starter and Pop-Up 'In Row' Liquid Fertilisers

Written and Authorised for release by:

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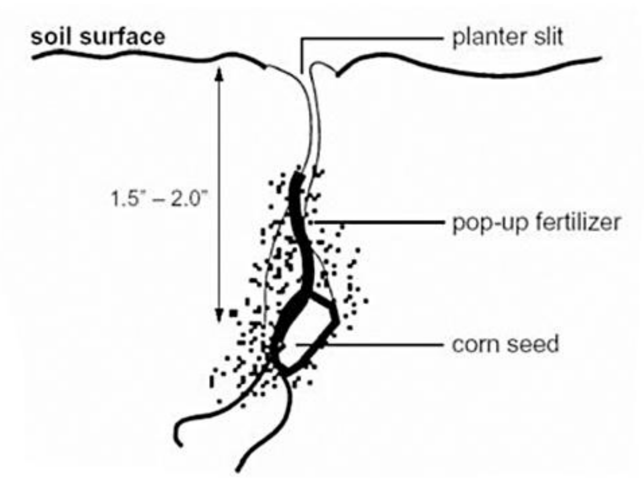
WHAT'S IN THIS BULLETIN

The difference between Pop-up and Starter fertilisers, their use and details relating to the advantages, impact of salt index and partial salt index and general case studies supporting the information presented.

INTEGRATING POP-UP AND STARTER FERTILISERS

Pop-up and starter fertilisers can be integrated in fertiliser program of the farm for effective use of fertiliser and improved yield. Starter fertiliser is placed near but not with the seed, while Pop-up fertilisers is placed in the planter furrow together with the seed. This ensures adequate nutrient availability from first day of germination; indeed, for seeds like cotton and fava bean that have impermeable seed coat not suitable for BSN priming, pop-up fertiliser offers BSN priming benefits albeit to a lesser degree.

The following diagram shows comparison of starter fertiliser and pop-up fertiliser placement in relation to root distribution and fertiliser uptake efficiency.



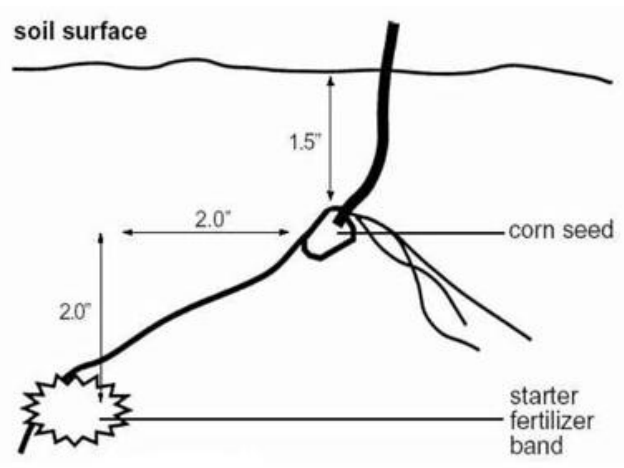


Illustration from Alley et al, Department of Crop & Soil Environmental Sciences, Virginia Tech.

Advantages of Pop-up and liquid fertiliser banding include:

- Fertiliser is placed close to the root system.
- Fertiliser is less available to weeds.
- Reduced fertiliser losses due to proper timing and placement of fertiliser.
- Minimising tie-up and fixation in soil, a phenomenon well proven when comparing liquid phosphate and granular phosphate applications.
- Increasing nutrient uptake by uniform and continuous banding of nutrient in rooting zones which minimises 'root depletion zone' impact.
- Fertiliser can bring about nutrient priming of seeds.
- Increasing yield potential by supplying essential elements to young seedlings from start of germination to early seedling growth during which the crop yield potential is set.
- Fungicides and insecticides can be placed close to the seed with pop-up fertilisers.

The main concern with use of Pop-up fertiliser is that high concentration of nitrogen and potassium sources with high Salt Index (SI) can cause salt injury by actually removing water from young seedlings. Fertiliser nitrogen sources that release ammonia (NH3) such as urea, UAN, or ammonium thiosulfate can also inhibit germination and damage seedlings. This is because ammonia can move easily across cell wall and when converted to ammonium ion (NH4+), it replaces calcium in cell membrane and membranes become leaky (non-functional).

Salt Index (SI) is defined as the ratio of osmotic pressure of a given weight of fertiliser material divided by the same weight of sodium nitrate times X100, sodium nitrate osmotic pressure is taken as 100 as the benchmark.

SI = Osmotic pressure of fertiliser material / Osmotic pressure of sodium nitrate X 100

Pop-up fertiliser rate should be used at lower rate than starter fertiliser and it should also be made from ingredients having low salt index to avoid crop damage. This can be achieved when fertiliser rate does not exceed 10kg of nutrients per hectare or total salt index is below 20. The following table shows the SI of different fertiliser groups arranged in increasing order of SI. It is clear that Pop-up fertilisers made with ammonium nitrate and potassium chloride are not suitable due to their high SI.

Table 1. Salt index and partial salt index of various fertilizer materials (arranged in increasing order of salt index within each category).

Material and analysis	*Salt index*	*Partial salt index*[a]
Nitrogen		
Anhydrous ammonia, 82% N	47.1	0.572
Urea, 46% N	74.4	1.618
Ammonium sulfate, 21% N, 24% S	88.3	3.252
Ammonium thiosulfate, 12% N, 26% S	90.4	7.533
Ammonium nitrate, 34% N	104	3.059
Phosphorus		
Superphosphate, 20% P_20_5	7.8	0.39
Triple superphosphate, 45% P_20_5	10.1	0.224
MAP, 10% N, 50% P_20_5	24.3	0.405
MAP, 11% N, 52% P_20_5	26.7	0.405
DAP, 18% N, 46% P_20_5	29.2	0.456
Phosphoric acid, 54% P_20_5		1.613[b]
Phosphoric acid, 72% P_20_5		1.754[b]
Potassium		
Monopotassium phosphate, 52.2% P_20_5, 34.6% K_20	8.4	0.097
Potassium sulfate, 50% K_20, 18% S	42.6	0.852
Potassium thiosulfate, 25% K_20, 17% S	68	2.72
Potassium nitrate, 13% N, 44% K_20	69.5	1.219
Potassium chloride, 60% K_20	116.2	1.936
Common liquid solutions		
2-20-20[c]	7.2	0.17
3-18-18[c]	8.5	0.22
6-24-6[c]	11.5	0.32
6-30-10[c]	13.8	0.3
9-18-9[c]	16.7	0.48
Ammonium polyphosphate, 10% N, 34% P_20_5[d]	20	0.455
4-10-10[e]	27.5	1.18
7-21-7[e]	27.8	0.79
28% N (39% ammonium nitrate, 31% urea)[e]	63	2.25
32% N (44% ammonium nitrate, 35% urea)[e]	71.1	2.221

[a]The salt index of a fertilizer containing more than one nutrient is the sum of the salt index of each component per unit (20 lb) of plant nutrient multiplied by the number of units in that formulation.

[b]Per 100 lbs of H_3PO_4.

[c]Formulated using potassium phosphate as the K source.

[d]Use with caution for seed-row placement.

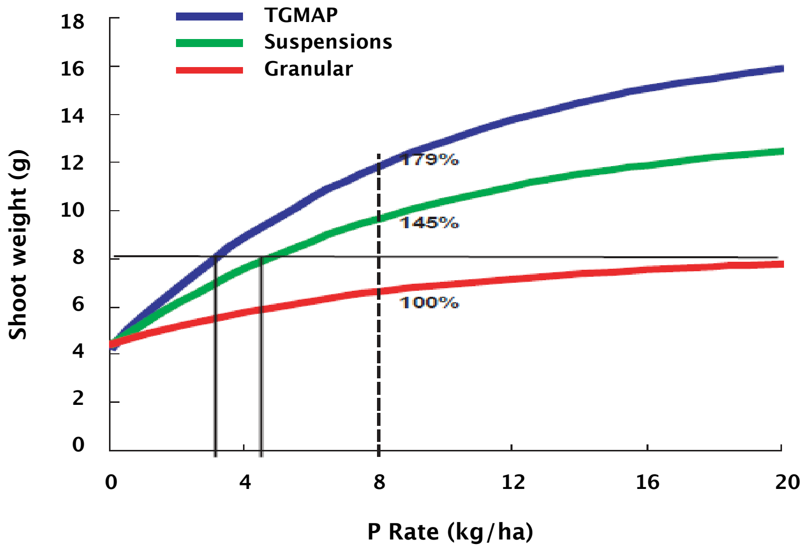
[e]Not recommended for seed-row placement.

CASE STUDIES OF FERTILISER TRIALS SHOWING BENEFIT OF LIQUID VERSUS GRANULAR FERTILISERS

Many published trials show that liquid fertilisers banded with the seed give higher yield per unit nutrient than granular fertilisers as shown in the following section.

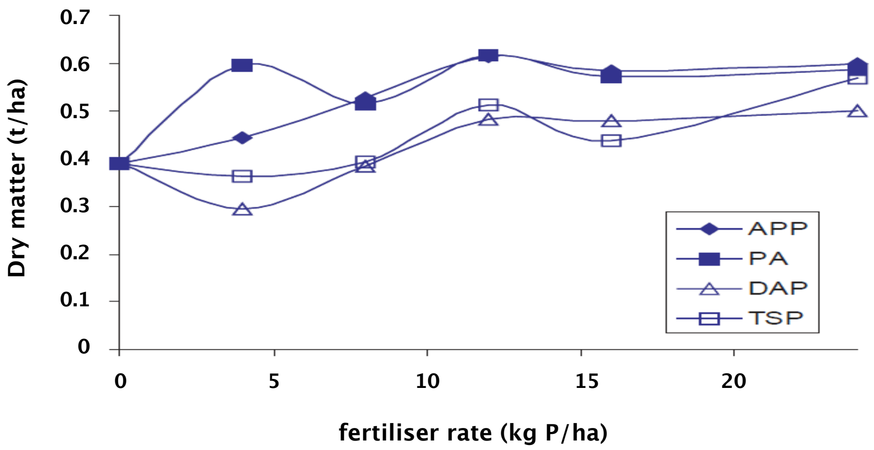
1. **Wheat shoot growth in Port Kenny SA**
   As the following graph shows, at equal rate of phosphorus per hectare, technical grade map used as liquid produced the highest yield followed by liquid suspension and granular fertiliser (source: Fluid Fertilisers).

PORT KENNY – P Rate Response

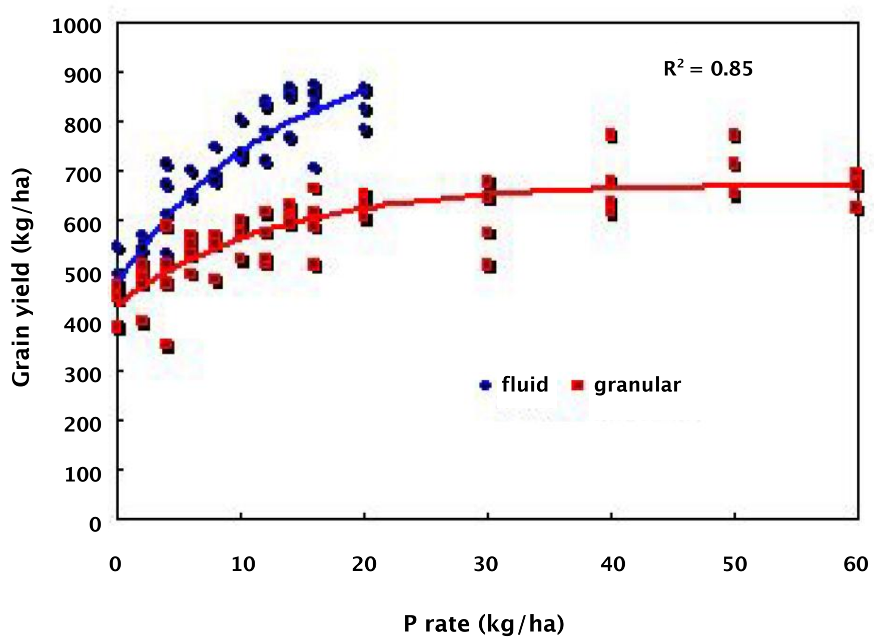


2. The following data from Birchip Cropping Group (BCG) shows that liquid fertiliser as ammonium polyphosphate (APP) or phosphoric acid (PA) was more efficient in mid-tiller dry matter production in wheat (source: Fluid Fertilisers).

(A). Effect of fertiliser type on mid till dm at BCG
lsd **(5%): P rate = 0.072; Fert. type = 0.0.068; P rate * type = n.s.**



3. Grain yield in wheat on Eyre Peninsula was higher with liquid than granular phosphate over a wide range of phosphorus fertiliser rates in trials by Bob Holloway and colleagues (source: The Potential of Fluid Fertilisers in Broadacre Agriculture – A GRDC Review 2003).



RLF PRODUCTS SUITABLE FOR POP-UP (IN-ROW PLACEMENT) OR SIDE BANDING

1. Power NP
2. Power NP+C (for low OM soils)
3. NPK injection
4. NPK + TE injection
5. Power PZ
6. Power N33+Mo
7. Power N26

About the Author of the Report

Dr. Hooshang Nassery | International Technical Director

EARLY YEARS

Hooshang Nassery was born in Tehran. He graduated from Tehran University with a B.Sc. in biology and a M.Sc. in Botany. His academic career started in Shiraz University as a demonstrator in Biology.

He was granted a British Council Scholarship to continue his studies towards Ph.D. in Plant Nutrition in the Botany Department of Sheffield University under the guidance of Professor J L Harley FRS, Professor H W Woolhouse and Professor I H Rorison. After his Ph.D., he returned to Shiraz University as Assistant Professor where he lectured and researched in the field of Plant Physiology and Plant Nutrition advancing to the posts of Associate and then full Professor in 1972.

MOVE TO AUSTRALIA

Dr Nassery moved to Australia in 1984 as a visiting professor in the School of Agriculture, University of Western Australia and researched in salt and flood tolerance at the university of Western Australia and WA Department of Agriculture for one year.

He moved to Adelaide and continued his career working with fertiliser companies in Australia. He was Director of Research and Development in Australian Mineral Fertilisers from 1986 to 1992. After working as a consultant for farmers and fertiliser industry for a couple of years, he joined Rural Liquid Fertilisers in 1995 to the present in the roles of National Technical Manager and currently as Global Technical Director. His role includes formulating and developing RLF products, the training of field staff, writing technical notes and insights and advising growers and corporate clients.

TODAY

Dr Hooshang Nassery lives in Adelaide and works as RLF Global Technical Director. In this role, he coordinates research and trials, develops products, writes technical bulletins, conducts training courses for RLF staff, agronomists and farmers and advises clients and corporations in Australia and overseas.

Areas of research and publications:

1. Phosphate response in plants from habitats of different phosphate status.
2. Root and root hair growth response to low phosphorus status.
3. Structural and physiological mechanism of salt tolerance.
4. Role of pH, calcium and other cations in membrane permeability and integrity.
5. Interaction of sodium and potassium uptake in plant roots.
6. Impact of salt and osmotic stress on root nutrient uptake.
7. Retention of sodium in stem as a mechanism of salt avoidance in plants.
8. Exclusion of sodium at the endodermal layer of root as a mechanism of salt avoidance.
9. Role of ATPase in nutrient uptake and radial transport in root.
10. Role of Pinocytosis in ion uptake and subcellular localization.
11. Mechanism of flood damage and flood tolerance in plants.

Co-authors and co-workers in research and publications:

1. Professor J L Harley FRS
2. Professor J F Sutcliffe
3. Professor I H Rorison
4. Professor Dennis A Baker
5. Professor Wolf Dieter Jeschke
6. Dr Hank Greenway
7. Dr Eugene Maas
8. Dr Richard Nieman
9. Dr M A Rezaian
10. Dr Gen Ogata
11. Dr F. Didehvar
12. Dr Ed Barret Leonard
13. Dr Tim Setter
14. Mr. A. Valamanesh
15. Mr. R L Jones
16. Mr. Clive Malcolm

Association with academic institutions:

Dr Nassery held research and teaching positions in the field of Botany, Plant Physiology and Plant Nutrition in the following universities and institutions, the results of his research work were 22 major refereed publications plus numerous abstracts, short communications and technical notes that are cited by researchers in 364 publications.

1. Tehran University, Iran.
2. Shiraz University, Iran.
3. Sheffield University, England.
4. Sussex University, England.
5. Wurzburg University, Germany.
6. University of California, Riverside.
7. University of Western Australia.
8. Flinders University of South Australia.
9. US Department of Agriculture Salinity Laboratory, Riverside, California.
10. Western Australian Department of Agriculture, Western Australia.