LIQUID FERTILIZER STUDIES

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Suspension Fertilizers: Simply stated, fertilizers may be either in a dry, liquid or gaseous form. The most common form of liquid fertilizers are the true solutions. Recently, a lot of progress has been made with suspension fertilizers. These, unlike the true solutions, have suspended solid particles in them. In 1970, with financial assistance from Phillips Petroleum and Stauffer Chemical Companies, we started a three year program to study the use of suspension fertilizers in Columbia Basin potato production.

Advantages of Suspensions: 1. Suspensions can be as concentrated in plant food as most dry products. The nutrient analysis for suspensions can be twice that of true solutions.

2. Product segregation is eliminated. Correctly prepared suspensions contain all nutrients in each drop.
3. Most trace elements, insecticides, herbicides and sulfur can be uniformly incorporated.
4. Suspensions can be pumped.
5. Initial cost of a suspension plant is relatively cheap.

Materials for Suspensions: 1. Ammonium polyphosphate solutions make suspension fertilizers possible.

2. Usually Uran solution is the source of nitrogen.
3. Very fine particle size muriate or sulfate of potash can be used.
4. Colloidal clay suspends the potash. It must be incorporated carefully and in correct amounts, or the suspension will fail.

Polyphosphates: Polyphosphates are a relatively new advance in fertilizer technology and have some properties that differ from the more common orthophosphates. In simple terms, polyphosphates are manufactured by restricting the amount of water available for reaction. Polyphosphates have more than one atom of phosphorus per molecule. The orthophosphates have only one. Thus, higher analysis phosphates are possible with the polyphosphates. Once in the soil, polyphosphates gradually convert by hydrolysis to orthophosphates. This conversion is necessary because plants normally take up only the ortho form. The time required for conversion varies with the soil conditions. In some cases, 50% of the polyphosphates hydrolize to orthophosphates within two weeks.

Polyphosphates have a large capacity for complexing metal ions such as zinc and iron into soluble complexes. This process, sequestration, prevents the formation of troublesome precipitates from impurities in liquid fertilizer and makes it possible to incorporate minor elements into suspension in amounts not possible in true solutions. Some workers have suggested that polyphosphates will make some normally unavailable minor elements in the soil available to plants. However, due to the rather rapid conversion of polyphosphates to orthophosphates in the soil, the sequestering of minor elements in the soil would seem to be of short duration and to have little practical importance.

Preparation and Application: The mixing of suspension fertilizers is best performed by informed commercial fertilizer dealers.

The application of suspensions is similar to that of clear liquid fertilizers, except that the nozzles should be bigger than 0.14 inches to prevent clogging. Some kind of agitation in the solution tank is necessary. Metering devices should be stainless steel and should be provided with positive pressure. Gravity flow systems used with clear liquids will not work. Daily flushing of the pumps, meters and lines with water is necessary to prevent sedimentation problems.

1970 Experiment with Suspension Fertilizers: The experiment was conducted on the WSU Othello Research Unit on a rill irrigated field, which was planted to potatoes in three of the last four years. The suspension fertilizer was a 12-12-12 and it was made by mixing ammonium - polyphosphate (9-30-0) and Uran (32-0-0) with fine crystal muriate of potash and 3% attapulgite clay at the Grange mixing plant at Connell.

Five nutrient rates were used (100, 200, 300, 400 and 500 lbs/acre of N, P_2O_5 and K_2O). Each fertilizer rate was applied five different ways: 1.) all broadcast before plowing, 2.) half broadcast before plowing and half banded at planting, 3.) all banded at planting, 4.) half banded at planting and half sidedressed two weeks later and 5.) all sidedressed two week after planting.

The fertilizer bands at planting time were about three inches on each side and slightly below the seed piece. The sidedressed bands were about 7 - 8 inches out from each side of the seed piece and somewhat deeper than the seed piece, but the location of the bands varied considerably. At the time of sidedressing about two inch long sprouts had developed, but almost no root growth had occurred.

For our broadcast applications we used a gasoline engine driven by a centrifugal pump with a cast iron impeller and a flooding type nozzle. For banding we used a PTO driven Nylon roller pump, however due to the abrasive action of the potash particles, Nylon roller pumps are not suitable for commercial handling of suspensions. For sidedressing we used a piston type metering pump driven by the tractor PTO through a 2:1 gearbox. All of these systems worked fairly well although calibration was difficult at the low fertilizer rates. In the future we plan to use ground wheels to drive either a centrifugal or a piston type metering pump.

A complete study of the fertilizer effects was included. The effect on total yield, percentage grade, specific gravity, blackspot, chip color, skin russetting and nutrient up-take were included but all the results are not ready for dissemination at this time. Some effects became obvious early in the growing season and these are presented.

Results: The potato seed was planted April 16 and 17. By mid-May it was obvious that consistent differences in time of plant emergence were present among the treatments. Both the method of applying the suspension and the amount used were causing differences in time of emergence (Table 1). Generally plant growth decreased as the amount of fertilizer applied increased. The greatest decreases occurred in those plots receiving the highest rates in which the fertilizer was all banded at planting.

Some of the differences in plant height were disappearing by mid-June, but the tallest plants occurred in those plots wherein the fertilizer was broadcast ahead of plowing (Table 2). Eventually the early suppression of growth disappeared as indicated by the dry weight of the vines shown in Table 3. The size of the vines increased as the amount of fertilizer applied increased, even in those plots wherein the fertilizer was banded at planting. Similar responses to high rates of dry fertilizer have been observed but recovery was more rapid and grade was not adversely affected.

Contrary to expectations, the percentage grade out of potatoes was greatly reduced by banding the suspensions at planting, especially at the higher rates (Table 4). The off-type tubers were predominately pointed-end, dumbbells and jelly-end rot. These abnormalities are normally associated with severe moisture stress early in the development of the tubers. It is possible that the readily soluble materials in suspension fertilizer caused a localized drought which was especially severe at the higher fertilizer rates when they were banded close to the seed piece.

These results may, with further experimentation, prove not to be typical. Factors such as placement of fertilizer bands, timing of early irrigations and differences in direction and rate of water movement into the soil may all influence the results obtained. With this in mind, experiments are planned for 1971 which will better define the proper placement and kind of irrigation necessary to avoid some of the adverse effects that occurred in 1970. For the present it seems that more caution is needed when using highly soluble fertilizer materials, than when pelletted dry mixes are used, if the salt effects are to be avoided.

Table 1. Height of plant above soil in inches May 26.[1]

	Pounds/Acre N, P_2O_5 and K_2O					
Placements	100	200	300	400	500	Mean[2]
Broadcast	3.0	2.9	3.2	2.9	2.8	3.0
1/2 Broadcast-1/2 Banded	3.0	2.7	1.9	1.9	1.9	2.3
Banded	2.5	2.0	1.4	1.3	1.3	1.7
1/2 Banded-1/2 Sidedressed	2.6	2.2	2.2	2.1	1.8	2.2
Sidedressed	2.8	2.5	2.8	2.3	2.9	2.7
Mean[2]	2.8	2.5	2.3	2.1	2.2	

[1] Each value is the mean of six replications.
[2] Each mean is the mean of 30 values.

Table 2. Height of plant above soil in inches June 9.[1]

	Pounds/Acre N, P_2O_5 and K_2O					
Placements	100	200	300	400	500	Mean[2]
Broadcast	10.2	10.3	9.8	9.6	9.0	9.8
1/2 Broadcast-1/2 Banded	7.9	8.3	7.1	5.8	6.0	7.0
Banded	7.9	8.2	5.6	4.9	3.8	6.1
1/2 Banded-1/2 Sidedressed	8.7	7.3	7.9	6.1	5.4	7.1
Sidedressed	9.4	8.2	8.6	7.8	7.3	8.3
Mean[2]	8.8	8.5	7.8	6.8	6.3	

[1] Each value is the mean of six replications.

[2] Each mean is the mean of 30 values.

Table 3. Air dry weight of the vines from 15 potato hills.[1]

Placements	Pounds/Acre N, P_2O_5 and K_2O 100	200	300	400	500	Mean[2]
Broadcast	1.6	1.7	2.0	2.6	2.7	2.1
1/2 Broadcast-1/2 Banded	2.7	2.3	3.3	3.8	3.7	3.2
Banded	2.7	3.0	3.3	3.7	4.3	3.4
1/2 Banded-1/2 Sidedressed	2.9	2.3	3.3	3.2	3.8	3.1
Sidedressed	2.7	2.2	2.4	3.2	3.3	2.8
Mean[2]	2.5	2.3	2.8	3.3	3.6	

[1] Each value is the mean of six replications.

[2] Each mean is the mean of 30 values.

Table 4. Percentage U.S. No. 1 Grade.

Placements	Pounds/Acre N, P_2O_5 and K_2O 100	200	300	400	500	Mean[2]
Broadcast	64	68	69	75	67	69
1/2 Broadcast-1/2 Banded	66	72	69	63	61	66
Banded	68	70	55	49	56	60
1/2 Banded-1/2 Sidedressed	68	72	67	62	51	64
Sidedressed	69	69	72	64	58	66
Mean[2]	67	70	66	63	58	

[1] Each value is the mean of six replications.

[2] Each mean is the mean of 30 values.