UNIVERSITY OF FLORIDA

Institute of Food and Agricultural Sciences
North Florida Research and Education Center – Suwannee Valley

Monopotassium Phosphate-Based Starter Fertilizers Enhance Snapbean Yield in Florida 96-08

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Abstract

A study was conducted in Gainesville, FL during the spring of 1996 to evaluate the effects of several monopotassium phosphate-based starter solutions on snapbean growth and yield. The effects of starter solution concentration and placement were also evaluated. Yield of snapbean was affected by starter solution formulation, concentration, and placement. Variations in yield response were due to soluble salt damage and differences in plant vigor related to soluble salt concentrations in the root zone. Yields were enhanced with ammoniated monopotassium phosphate compared to other starter solutions. Ammoniated monopotassium phosphate and standard monopotassium phosphate were the safest materials when placed directly on the seed. Solutions containing ammonium poly phosphate were the least safe as a seed directed application.

Materials and Methods

An experiment to evaluate the effects of monopotassium phosphate based starter fertilizers on snapbean was conducted in the spring season of 1996 at Gainesville, FL. The soil used was Arrendondo fine sand which tested high in phosphorus and medium in potassium (Mechlich-1 soil test extractant). The soil for the experimental area was plowed and disked and beds were formed on four-foot centers. Ammonium nitrate at 100 lbs/acre (33 lbs N/acre) was incorporated in the bed soil as the beds were rototilled and pressed. No other fertilizers were placed in the soil at this time. Drip irrigation tubing (Chapin Watermatics, Watertown, NY; 0.5 gal per min per 100 ft at 8 psi with 12-inch emitter spacing and 10 mil wall thickness) was placed in the center of the bed on the soil surface.

The starter fertilizer treatments (Table 1) were monopotassium phosphate (MKP, 0-10-7) ammoniated monopotassium phosphate (AMKP, 3-22-15), a mixture of AMKP and ammonium polyphosphate (APP, 10-34-0), APP alone, a mixture of MKP and monoammonium phosphate (MAP in a 1 MKP:2 MAP ratio, and a check where no starter fertilizer was applied. Starter fertilizers were applied at three concentrations, full-strength (straight), or at either a 10:1 or 20:1 water:fertilizer solution ratio. Fertilizers were formulated in solution and applied in appropriate volume to deliver 10

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lbs P_2O_5 per acre. Solutions were applied either to the seeds in the furrow before covering with soil or in bands in the soil two inches to side and two inches below the seed furrow. Fertilizer solutions were applied with a CO_2 pressurized back-pack sprayer. All starter solutions were formulated from liquid concentrates except treatment five, the mixture of MKP and MAP. This starter solution was formulated by first making a mixture of 1 part MKP and 2 parts MAP form solid fertilizer materials, finally formulating a solution of 2-14-3 (N-P_2O_5-K_2O) analysis. The 2-14-3 was then used to formulate the starter solutions.

The starter fertilizer solution delivery concentrations of 10:1 and 20:1 were selected from a laboratory experiment in which a range of starter concentrations were used to test snapbean seed germination in petri-dishes. Treatments were 1 part fertilizer stock to either 0, 1, 2, 3, 4, 5, 6, 7, 10, 15, 20, or 25 parts water. Filter paper in a petri-dish was wetted with the final solutions and five bean seeds were placed on the wetted paper. Covers were placed on the petri-dishes and the dishes placed in an incubator at approximately 30^{o}C. Near 100% germination and radical protrusion had occurred after six days for the 1:25 dilution for MKP, AMKP, and MKP plus MAP. Germination was 20% for APP and AMKP plus APP. Germination with all treatments was reduced to 60% with MKP, AMKP, and MKP plus MAP at the 10:1 dilution. Germination was prevented with all other solution concentrations. Based on this preliminary lab experiment, the dilutions of 10:1 and 20:1 were selected for the field experiment. They were selected to represent a projected difference in soluble salt effects with a seed-directed application of fertilizer and also because they represented reasonable dilution factors for a farmer to use in the field.

To prepare the bed for planting and fertilizer solution application, two "V"-shaped impressions were made in the soil with a metal wheel. The impressions were 1.5 inches deep and three inches wide at the top and were 12 inches apart on the 24-inch wide, six-inch tall bed. Into each impression was placed snapbean seeds to provide 80 seeds per row which was 20 feet in length. Therefore, 160 seeds were planted per plot. Each plot consisted of two rows on a bed and rows were 20 feet in length and beds were four feet on center.

For the "on-seed" starter fertilizer placement treatment, the fertilizer solution was sprayed on the seeds in the furrow and the seeds covered with soil. For the "side" placement treatment, a second narrow trench was made two inches to side of the seed furrows and the trench was one inch wide and 3.5 inches deep. Starter solutions were sprayed into the bottom of this trench and then soil was smoothed over the fertilizer and seed trenches. After planting, the experimental area was irrigated with overhead sprinklers to uniformly moisten the soil for germination. Planting, fertilization, and

irrigation were completed on 22 April 1996. 'Benchmark' snapbean variety (Rogers Seed Co.) was used for this experiment.

Metolachlor herbicide was used for weed control and overhead sprinklers were used briefly, to moisten the soil surface periodically until plants had emerged. Following emergence, drip irrigation was sued to provide water for snapbean growth. The drip irrigation system was operated daily in one or more 20 or 30 minute periods to maintain a tensiometer reading of -8 to -12 centibars at he six-inch soil depth.

On 5 May, nitrogen from ammonium nitrate was sidedressed at 30 lbs N per acre. The fertilizer was knifed into the center of the beds under the tube. On 13 May, a second sidedressing was made using 15-0-15 to apply 80 lbs N and K_2O per acre to the sides of the bed and covered over. The first sidedressing was done when the bean plants were at the first trifoliate leaf stage and the second application was made when plants had two trifoliate leaves.

On 16 May, when first open flowers were present, plants were evaluated for vigor and signs of soluble salt injury. Vigor ratings were made on a scale of 1 to 5 with 1 being predominantly dead or dying plants in the plot and 5 being vigorous plants. Soluble salt injury ratings were 1=none and 5 being severely necrotic and dying.

Snapbeans were harvested on 17 June by pulling plants from the ground in a 10-foot section of the plot across both rows. Marketable bean pods were removed from the plants and weighed. The number of plants from which beans were removed were counted. Data were analyzed by analysis of variance and means were compared using least significant difference values.

Results

Means for all treatments are presented in Table 2 for plant population at harvest, plant vigor, soluble salt injury, and for snapbean yield. Yield ranged from 15 30-lb cartons per acre for APP solution applied in concentrated formulation directly to the seed to 570 cartons for MKP applied in the 20:1 dilution directly to the seed.

Main effects are presented in Table 3 for information purposes. Mean comparison of main effects were not made since there were significant interactions between main treatments. Fertilizer material and placement interacted for all four characters measured (Table 4). Yield responses were related to soluble salt injury and subsequent loss of plant stand or plant vigor. With AMKP, MKP, or MKP plus MAP, placement, either on the seed or to the side did not differentially influence the yield. Solutions containing APP were injurious to bean plants when the solutions were placed on the seed. APP solutions placed to the side of the seed furrow resulted in yields similar to

those with AMKP, MKP, or MKP plus MAP. Yields of 400 cartons per acre are excellent bean yields for Florida when the average commercial yields are about 200 cartons per acre.

Placement of fertilizer and concentration interacted in their effects on all four characters (Table 5). Yields were increased proportionately as the fertilizer dilution increased when the solutions were placed on the seed. Solution concentration had no influence on yield when fertilizer was placed to the side of the row.

The three-way interaction for vigor and soluble salt injury was significant but not for yield or plant population. These results showed that solutions containing MKP can safely be used as a starter solution placed in close contact with the seed. Solutions containing APP were injurious when placed on the seed. All fertilizers performed satisfactory when placed to the side of the seed furrow. Most starter solutions, when safely placed, resulted in bean yields that were higher than with no starter solutions.

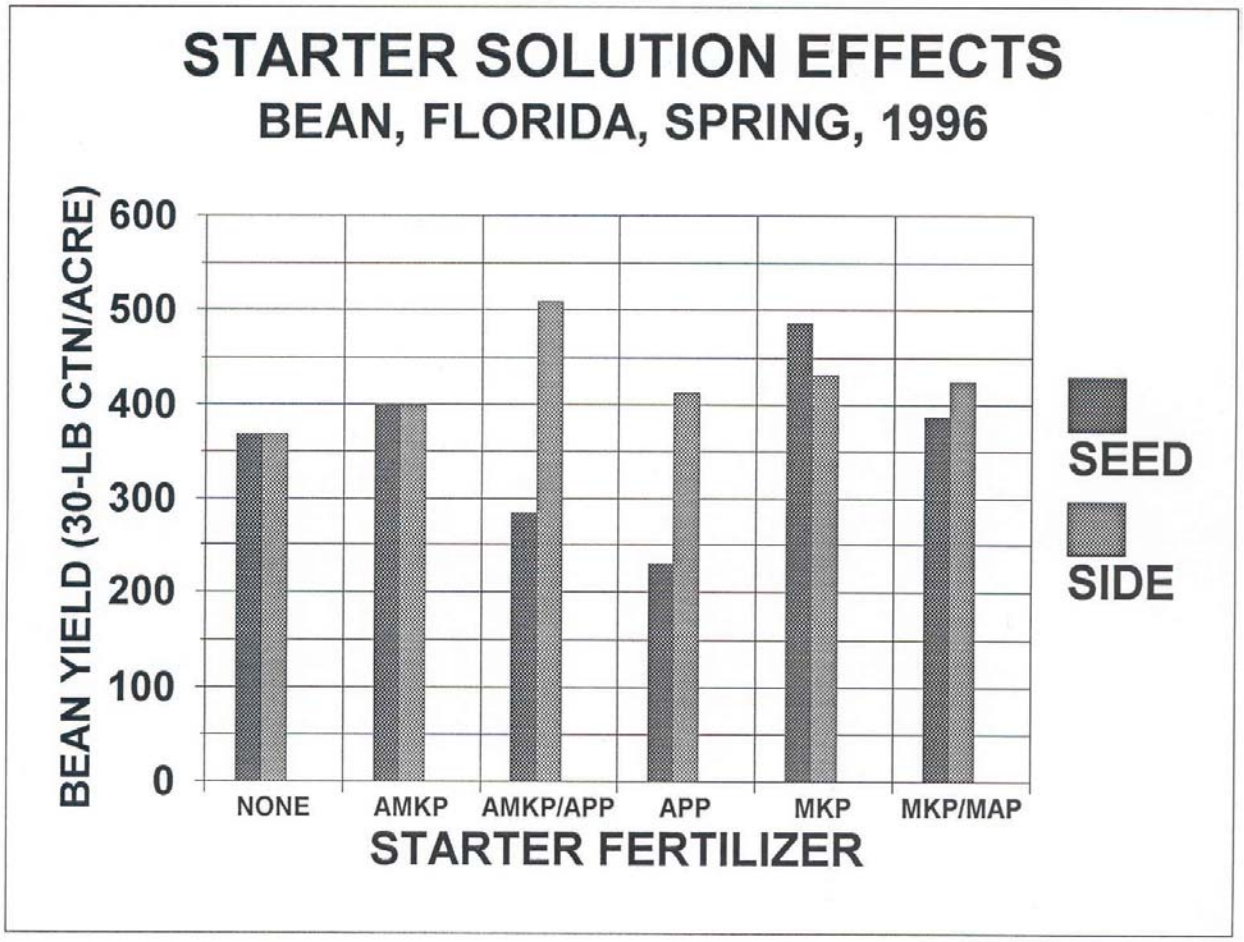

Table 1. Treatments used in experiment on starter fertilizers for snapbeans, Gainesville FL, Spring 1996.

Starter Ferilizer	Placement[y]	Concentration[z]
Ammoniated monopotassium phosphate (3-22-15) (AMKP)	On Seed	Straight
		10:1
		20:1
	To Side	Straight
		10:1
		20:1
Equal mixture of AMKP and Ammonium poly phosphate (AMKP + APP)	On Seed	Straight
		10:1
		20:1
	To Side	Straight
		10:1
		20:1
Ammonium poly phosphate (APP)	On Seed	Straight
		10:1
		20:1
	To Side	Straight
		10:1
		20:1
Monopotassium phosphate (0-10-7) (MKP)	On Seed	Straight
		10:1
		20:1
	To Side	Straight
		10:1
		20:1
Mixture of one part MKP and two parts monoammonium phosphate (MAP)	On Seed	Straight
		10:1
		20:1
	To Side	Straight
		10:1
		20:1

[z] Concentrations were straight (undiluted) fertilizer solution or either a 10:1 or 20:1 solution of water:fertilizer.

[y] Placement was either sprayed on top of seeds in furrow or banded to side of seed at two inches to side and two inches below seed.

Table 2. Effects of starter fertilizer, placement, and concentrations on snapbean yield and crop response, Gainesville FL, Spring 1996.

Starter Fertilizer	Fertilizer Placement[u]	Fertilizer Concentration[v]	Plant Population[w]	Plant Vigor[x]	Soluble Salt Damage[y]	Yield (carton/acre[z])
AMKP	On Seed	Straight	25050	1.0	4.3	255
		10:1	69350	3.2	2.7	445
		20:1	72250	3.0	3.0	500
	To Side	Straight	69350	5.0	1.0	460
		10:1	58800	3.3	2.0	340
		20:1	62050	3.2	2.5	400
AMKP/APP	On Seed	Straight	7600	1.0	4.7	35
		10:1	50100	3.3	2.0	360
		20:1	76600	4.0	1.7	455
	To Side	Straight	75900	4.0	1.3	530
		10:1	86800	2.8	2.7	480
		20:1	78800	3.3	2.0	515
APP	On Seed	Straight	1800	1.0	5.0	15
		10:1	50800	3.0	2.7	340
		20:1	64250	3.7	1.3	330
	To Side	Straight	65700	5.0	1.2	480
		10:1	66800	2.2	3.0	350
		20:1	6500	2.8	2.7	410
MKP	On Seed	Straight	67200	3.0	3.0	410
		10:1	65700	3.3	2.7	480
		20:1	79500	4.0	1.3	570
	To Side	Straight	78400	2.5	2.8	460
		10:1	50100	2.3	3.0	400
		20:1	66400	2.8	2.3	430
MKP/MAP	On Seed	Straight	50500	2.2	4.2	350
		10:1	58100	1.7	4.2	345
		20:1	73300	3.0	2.7	470
	To Side	Straight	61400	2.7	2.6	410
		10:1	70400	3.0	2.7	500
		20:1	51500	3.0	1.7	365
Check	No Starter	N/A	57700	4.0	1.0	360

[z] Yield in number of 30-lb cartons per acre.

[y] soluble salt damage rating of leaf and plant burn with 1=no damage to 5=severe damage, plants dead.

[x] Plant vigor rating of 1=poor vigor, stunted, and 5=vigorous, normal plants

[w] Plant population is number of plants at harvest

[v] Concentrations were straight (undiluted) fertilizer solution or either a 10:1 or 20:1 solution of water:fertilizer

[u] Placement was either sprayed on top of seeds in furrow or banded to side of seed at two inches to side and two inches below seed.

Table 3. Main effects of starter fertilizer programs on snapbean growth and yield, Gainesville FL, Spring 1996.

Starter Fertilizer	Fertilizer Placement[u]	Fertilizer Concentration[v]	Plant Population[w]	Plant Vigor[x]	Soluble Salt Damage[y]	Yield (carton/acre[z])
AMKP			59450	3.1	2.6	400
AMKP/APP			62600	3.1	2.4	400
APP			52400	2.9	2.6	320
MKP			67900	3.0	2.5	460
MKP/MAP			60850	2.6	3.0	610
	On seed		54100	2.7	3.0	360
	To side		67150	3.2	2.2	440
		Straight	50300	2.7	3.0	340
		10:1	62700	2.8	2.8	400
		20:1	69000	3.3	2.1	440

[z] Yield in number of 30-lb cartons per acre.
[y] soluble salt damage rating of leaf and plant burn with 1=no damage to 5=severe damage, plants dead.
[x] Plant vigor rating of 1=poor vigor, stunted, and 5=vigorous, normal plants
[w] Plant population is number of plants at harvest
[v] Concentrations were straight (undiluted) fertilizer solution or either a 10:1 or 20:1 solution of water:fertilizer
[u] Placement was either sprayed on top of seeds in furrow or banded to side of seed at two inches to side and two inches below seed.

Table 4. Interaction of starter fertilizer and placement on snapbean growth and yield, Gainesville FL, Spring 1996.

Starter Fertilizer	Fertilizer Placement[u]	Plant Population[w]	Plant Vigor[x]	Soluble Salt Damage[y]	Yield (carton/acre[z])
AMKP	On seed	55540	2.4	3.3	400
	To side	63400	3.8	1.8	400
AMKP/APP	On seed	44780	2.8	2.8	280
	To side	80470	3.4	2.0	510
APP	On seed	38960	2.6	3.0	230
	To side	65820	3.3	2.3	410
MKP	On seed	70790	3.4	2.3	490
	To side	64980	2.6	2.7	430
MKP/MAP	On seed	60620	2.3	3.7	390
	To side	61110	2.9	2.3	430
Prob.>F(interact)		0.0001	0.0001	0.0008	0.0023
LSD (0.05)		12000	0.65	0.63	110

[z] Yield in number of 30-lb cartons per acre.
[y] soluble salt damage rating of leaf and plant burn with 1=no damage to 5=severe damage, plants dead.
[x] Plant vigor rating of 1=poor vigor, stunted, and 5=vigorous, normal plants
[w] Plant population is number of plants at harvest
[v] Concentrations were straight (undiluted) fertilizer solution or either a 10:1 or 20:1 solution of water:fertilizer
[u] Placement was either sprayed on top of seeds in furrow or banded to side of seed at two inches to side and two inches below seed.

Table 5. Interaction of fertilizer concentration and placement on snapbean growth and yield, Gainesville FL, Spring 1996.

Fertilizer Placement[u]	Fertilizer Concentration[v]	Plant Population[w]	Plant Vigor[x]	Soluble Salt Damage[y]	Yield (carton/acre[z])
On seed	Straight	30420	1.6	4.2	215
	10:1	58810	2.9	2.8	390
	20:1	73180	3.5	2.0	470
To side	Straight	70130	3.8	1.8	470
	10:1	66575	2.7	2.7	415
	20:1	64760	3.0	2.2	425
Prob.>(interac)		0.0001	0.0001	0.0001	0.0001
LSD (0.05)		9000	0.51	0.49	86

[z] Yield in number of 30-lb cartons per acre.
[y] soluble salt damage rating of leaf and plant burn with 1=no damage to 5=severe damage, plants dead.
[x] Plant vigor rating of 1=poor vigor, stunted, and 5=vigorous, normal plants
[w] Plant population is number of plants at harvest
[v] Concentrations were straight (undiluted) fertilizer solution or either a 10:1 or 20:1 solution of water:fertilizer
[u] Placement was either sprayed on top of seeds in furrow or banded to side of seed at two inches to side and two inches below seed.